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EXTENDED AERATION SEWAGE TREATMENT PERFORMANCE EVALUATION CARMACKS, YUKON TERRITORY

REGIONAL PROGRAM REPORT NO. 95-01

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EXECUTIVE SUMMARY

Carmacks is currently the only community in the Yukon or NWT with a mechanical plant providing secondary sewage treatment. The village is anticipating the need to upgrade and expand the plant. This extended aeration plant has been in operation since 1974, however there had never been a detailed performance assessment completed.

Most Yukon communities treat their sewage in large lagoons, however the Carmacks plant only occupies a 3 meter by 9 meter space. The plant currently serves about 200 people. Mechanical treatment systems such as this are being considered for some other northern communities which have no suitable sites for lagoons.

In Carmacks, staff of the Yukon office of Environmental Protection (Environment Canada) completed a characterization of treatment plant operating conditions and performance during one 24 hour period in October 1993 and another 24 hour period during January 1994. Monthly water quality and flow monitoring data collected by the Village of Carmacks is also summarized.

The plant consists of an aeration tank and two clarifiers. Sewage is held an average of 24 hours in the aeration tank. There it is continuously mixed with the activated sludge (microbes) and air is blown into the mixture. The mixture then flows into two clarifiers in which the sludge settles to the bottom and is pumped back into the aeration tank. Treated water is decanted off the top of the clarifiers and discharged to the Yukon River.

The study showed that the plant is capable of producing a non-toxic discharge, with nutrient and bacterial levels typical of a well operated secondary sewage treatment plant (BOD_5 18-24 mg/l and faecal coliforms less than 60,000 counts/100 ml). The plant also demonstrated very high levels of nitrification. Ammonia influent levels were 30 to 40 mg/l while effluent levels of .1 to .3 mg/l were achieved. However, there are often problems with high levels of sludge carry-over in the discharge of treated water to the river. At these times the discharge has high levels of biological oxygen demand and faecal coliform bacteria. Recommendations to help solve this problem are made and include, for example, better control of air and solids pumping in the plant and more frequent disposal of excess sludge from the clarifier.

RÉSUMÉ EXÉCUTIF

Carmacks est présentement la seule communauté au Yukon avec une usine mécanique procurant un traitement secondaire des égouts. Le village anticipe d'agrandir et améliorer l'usine. Cette usine à aération prolongée est en opération depuis 1974, par contre il n'y a jamais eu d'évaluation détaillée de ses performances.

La plus part des communautés du Yukon traitent leurs égouts dans de larges lagunes. L'usine de Carmacks n'occupe seulement que 3 mètres par 9 mètres. Cette usine présentement ne sert que 200 personnes. Les systèmes mécaniques de traitements, tel que celui-ci, sont envisagés pour adoption, par d'autre communautés ayant un problème d'espace.

Le personnel du bureau de Protection de l'Environnement (Environnement Canada), a complété une caractérisation des conditions d'opération et performances du système de Carmacks durant une période de 24 heures en octobre 1993 et durant une autre période de 24 heures en janvier 1994. Un sommaire de la qualité de l'eau et des débits échantillonnés par le village de Carmacks, y est inclus.

L'usine consisté en deux clarificateurs et une cuve d'aération. Les égouts sont retenus pour 24 heures dans la cuve d'aération. Il y a un mélange continu avec les boues activées, et de l'air est injectée dans le mélange. Le mélange coule vers les deux clarificateurs, où les boues se déposent et sont repompées dans la cuve d'aération. L'eau traitée est décantée des clarificateurs et rejetée au fleuve Yukon.

L'étude démontre que l'usine est capable de produire un effluent non-toxique, avec des taux d'élément nutritifs et de bactéries typique d'une usine de traitement secondaire bien opérée (DBO_5 18-24 mg/l, coliformes fécaux moins de 60,000/100ml). L'usine démontre un haut niveau de nitrification. Les niveaux d'ammoniac de l'influent étaient de 30 à 40 mg/l tandis que les niveaux de l'effluent se retrouvent vers 0.1 à 0.3 mg/l. Par contre, il y a souvent des problèmes dû aux larges quantités de boues déchargées au fleuve. Durant ces épisodes, les taux de DBO_5 et de bactéries coliformes fécales étaient élevés. Des recommandations pour solutionner ce problème sont inclus dans le rapport, tel par exemple, de mieux contrôler l'air et les pompage des boues de l'usine, et un enlèvement, plus fréquent, de l'excès des boues du clarificateur.

ACKNOWLEDGEMENT

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GLOSSARY

ACTIVATED SLUDGE: Sludge particles produced from raw sewage by the growth of organisms *in aeration tanks in the presence of dissolved oxygen. The term 'activated' comes from the fact* that the particles are teeming with bacteria, fungi and protozoa. These living organisms feed on the nutrients contained in the sewage.

AERATION TANK: The tank where raw sewage is mixed with the activated sludge. Air is used to mix the tank contents and ensure oxygen levels are high enough to support the living organisms in the activated sludge.

AIR-LIFT: A special type of pump consisting of a vertical pipe submerged in the sludge to be pumped from the bottom of a clarifier into the aeration tank. Compressed air is injected into the pipe near the pipe bottom. Fine air bubbles mix with the sludge to form a lighter mixture which rises in the pipe and discharges into an overhead horizontal line which directs the sludge to the aeration tank.

BOD_5 (Biochemical Oxygen Demand): A laboratory test which measures the dissolved oxygen consumed by microbial life while it feeds on the nutrients in the sample. It is a measure of how well a wastewater has been treated. Wastewater discharges containing high levels of BOD will *similarly use up the dissolved oxygen in the lakes or rivers to which they are* discharged. Fish and fish food organisms may be harmed if dissolved oxygen levels get low enough.

CLARIFIER: In an extended aeration plant wastewater flows from the aeration tank into the clarifiers. A clarifier is a small hopper shaped tank which is designed to settle out the activated sludge particles. The clear final discharge is decanted from the surface of the water in the clarifier. The settled sludge in the bottom of the clarifier is pumped back into the aeration tank.

COMPOSITE SAMPLE: Individual samples collected at regular time or flow intervals are mixed together to produce a single 'composited' sample (eg. one sample is collected every 30 minutes over a three hour period and the six resulting samples are mixed together to make one composited sample). Composited samples better represent the average quality of a wastewater stream.

DIFFUSER: A device (such as a submerged tube with small holes) into which compressed air is blown to create very small bubbles which are effective at putting dissolved oxygen into water.

DISSOLVED OXYGEN: Molecules of atmospheric oxygen which exist in water as part of the solution (i.e. not as small bubbles). This is the form of oxygen used by fish and other aquatic organisms to 'breathe'.

FAECAL COLIFORM BACTERIA: These bacteria are found only in the feces of warm blooded animals. Their presence in water is used as an indicator of the possibility that disease bearing bacteria may also be present.

MLSS (Mixed liquor suspended solids): The suspended solids found in the aeration tank and which largely consist of activated sludge and some raw sewage solids.

MLVSS (Mixed liquor suspended solids): The volatile portion of the MLSS. The MLVSS is used as an indication of the portion of the MLSS which is made up of living organisms.

NITRIFICATION: In the presence of dissolved oxygen, bacteria can convert the ammonia and organic nitrogen found in sewage into nitrate - a more stable and less toxic compound.

RESIDENCE TIME: Where there is a flow passing continuously into and out of a tank or clarifier, the residence time is calculated as the flowrate divided by the volume of the tank. It is used as a measure of how long (theoretically) the wastewater spends in the tank before it is discharged.

Extended Aeration Sewage Treatment Performance Evaluation Carmacks, Yukon Territory

1.0 BACKGROUND

Carmacks is currently the only community in the Yukon or NWT with a mechanical plant providing secondary sewage treatment. The village is anticipating the need to upgrade and expand the plant. Environment Canada recognized that Carmacks, as well as other northern communities, would benefit from having a better understanding of how well the existing plant is performing. There had never been a detailed assessment of the plant performance completed.

Staff of the Yukon office of Environmental Protection (Environment Canada) completed a characterization of treatment plant operating conditions and performance during one 24 hour period in October 1993 and another 24 hour period during January 1994. Monthly water quality and flow monitoring data collected by the Village of Carmacks is also summarized.

Carmacks is located at 62° 6′N 136° 18′ W (about 170 km northwest of Whitehorse). Permafrost occurrence in this region is discontinuous and does not affect the operation of the village sewer system. The extreme minimum temperature recorded at Carmacks to date is -57.8° C. The annual average temperature is - 3.8° C.

2.0 SEWAGE TREATMENT FACILITY DESCRIPTION

The plant has been in operation since 1974. Yukon communities have generally relied on long term storage lagoons for sewage treatment. Carmacks, apparently, does not have a suitable site close enough to the Village to warrant this approach. It is not known whether any formal assessment of treatment alternatives has ever been carried out.

2.1 Community Water Supply

Carmacks is somewhat unusual in the Yukon in that the municipality has sewer infrastructure but does not have drinking water infrastructure. Residents and businesses have individual water wells. This approach means the community does not have to take special measures to prevent freezing of water supply lines in the winter - i.e. there are no bleeders. Nonetheless, it is possible that some individuals do run their water taps in order to protect their well water lines from freezing in the winter. There is no chlorination of water supplies.

2.2 Sewer System Loads

The Village of Carmacks has reported that the following sources are connected to the sewage treatment plant:

a) 53 residences (152 residents)
b) Carmacks hotel (40 units plus a beverage lounge and restaurant)
c) A kindergarten through grade 12 school (104 students)
d) a 20 unit motel
e) a restaurant
f) community hall, church, convenience store
g) 5 gov't buildings (approx. 4 to 6 people each)

The current population for the entire community is 489 residents but the sewer system only serves the core area of the community.

2.3 PLANT DESCRIPTION

A copy of the original specifications for the plant may be found in Appendix A. The conceptual flow diagram is presented in Figure 1. Figure 2 illustrates the overall plant layout.

2.3.1 Wet Well

Sewage enters a one metre diameter wet well through a 20 cm diameter sewer pipe located about .7m above the bottom of the wet well. There are two pumps in the wet well although only one is normally used at any given time. Pump #2 was in use on the days that this study was carried out. Each pump has three sets of sensors which detect the wastewater level in the wet well - the bottom one turns the pump off, the middle one turns the pump on and the top one turns the pump on in case the middle sensor has a failure or turns the back-up pump on should there be a problem with the primary pump. In this way the primary pump cycles on and off as it periodically pumps out the wastewater which has accumulated in the wet well. There are hour totalizers logging the run-hours for each of the two pumps.

2.3.2 Aeration Tank

Sewage is pumped from the wet well into the 80,000 litre aeration tank which is 3.3m deep x 3.6m wide x 6.8m long. There is no comminutor for the influent. There is only a coarse bar screen on the wet well discharge. The aeration tank has five diffusers which discharge air into the sewage. They are located along one wall of the aeration tank .3m from the bottom of the tank. Several tests were carried out using a dissolved oxygen (D.O.) meter and a conductivity probe to evaluate the completeness of mixing in the aeration tank. There was less than a 10% variation in the D.O. and conductivity

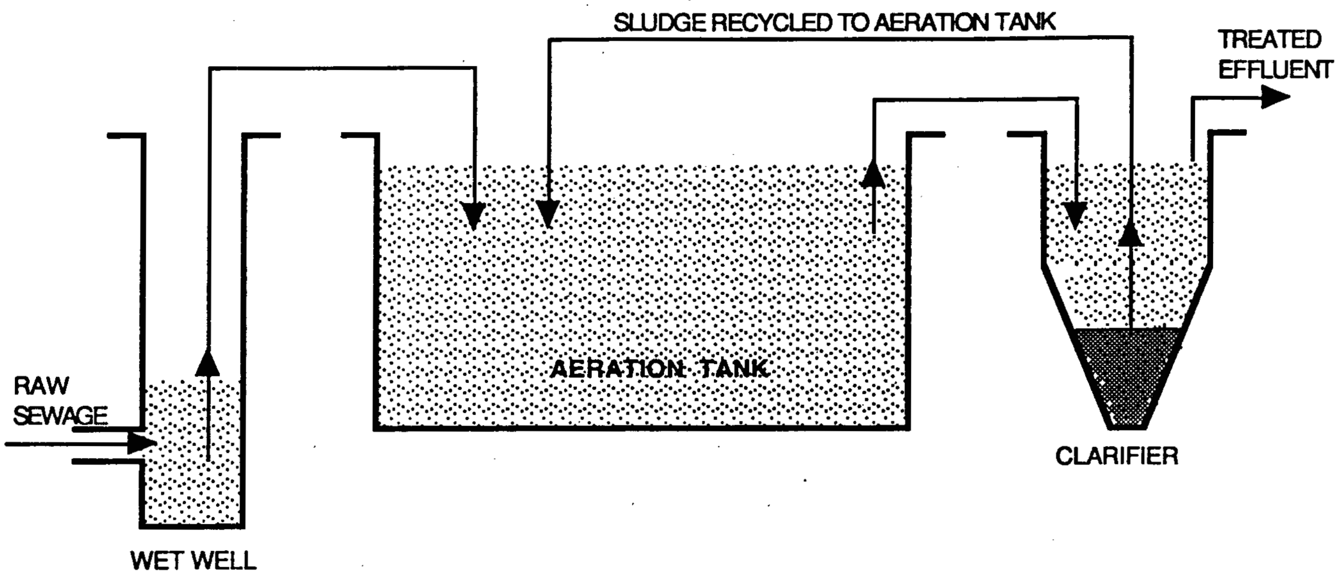
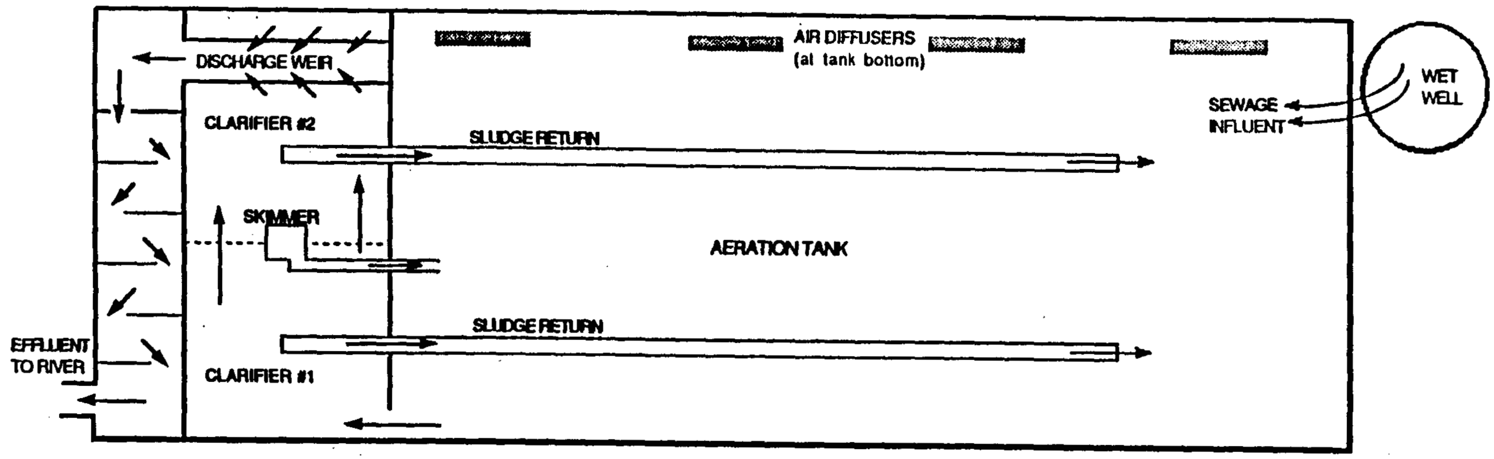
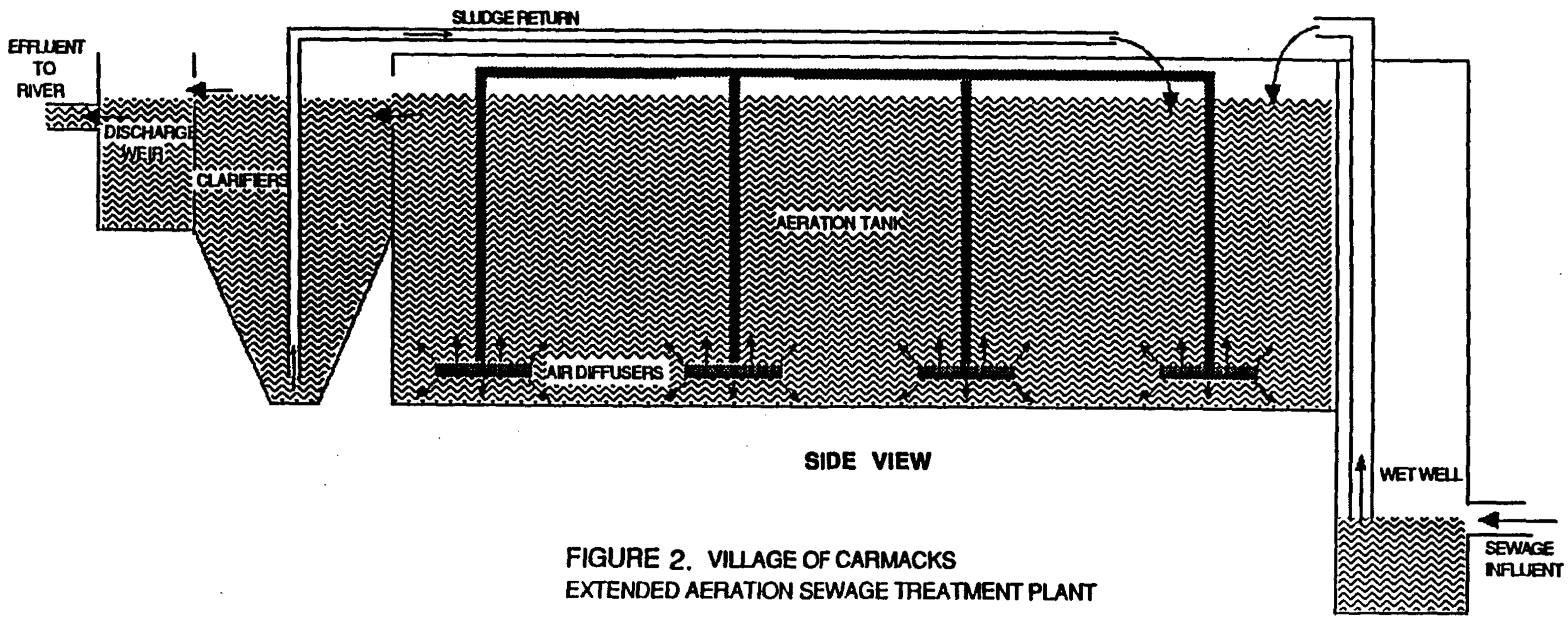


FIGURE 1.
CONCEPTUAL FLOW DIAGRAM
CARMACKS EXTENDED AERATION PLANT

NOTE: DRAWING IS NOT TO SCALE



TOP VIEW



SIDE VIEW

FIGURE 2. VILLAGE OF CARMACKS
EXTENDED AERATION SEWAGE TREATMENT PLANT

throughout the tank. This indicates that the tank is well mixed and so surface grab samples were considered representative of the wastewater quality in the aeration tank. The aeration system runs continuously. The original design called for delivery of a minium of 131 m3 of air per kg of applied BOD_5. This is in addition to the air required to operate the sludge return air lift pumps and the skimmer in the clarifiers.

2.3.3 Clarifiers

The discharge from the aeration tank flows by gravity into the first of two clarifiers through a slot about .2 m wide and 1m deep. Each clarifier is about 3.3 m square and 3m deep . Two sides of the clarifier taper to form a hopper shape in the bottom half. Each clarifier has one sludge return air lift pump. A skimmer is located at the mid-point between the two clarifiers and discharges floating solids back to the aeration tank. The second clarifier discharges into a rectangular overflow weir which routes the final effluent from the treatment plant.

2.3.4 Effluent Discharge to the Yukon River

The effluent discharges from the plant to the Yukon River through a 15 cm pipe. During the low flow period of a typical summer the end of the discharge pipe is almost exposed at the water's edge. There is no diffuser on the end of the pipe. Under these conditions the effluent does not mix well with the river.

Dye tests have been conducted by the federal Dept. of Indian Affairs and Northern Development (DIAND) to evaluate the effluent dispersion pattern in the river. The results of this test program have been reported by DIAND (Ref. 1). The dye tested completed during the summer of 1994 indicated that mixing was very poor for about one kilometer downstream of the discharge.

2.3.5 Routine Monitoring and Maintenance

The Village's municipal works staff person is the operator for the treatment plant. The plant operator attended a one week training course sponsored by the BC Wastewater Assoc. in October of 1993. This training significantly increased the operator's ability to improve plant performance.

There is an inspection of the sewage treatment plant completed daily. A simple mixed liquor sludge settling test and aeration tank DO test is completed once a week. The sludge settling test is carried out by collecting a 1 litre MLSS grab sample in a 1 litre graduated cylinder from the surface at the centre of the aeration tank. The sample is left undisturbed for 30 minutes and the level the sludge blanket has settled to in the cylinder is noted at that time.

Periodically, the plant is shut down and the aeration tank and the clarifiers are pumped out to remove accumulated sludge. The sewage flow is diverted directly into the Yukon River while the plant is shut down for sludge removal. The material pumped out is disposed of in the municipal septage pit. It appears that this has happened about once every six months. Roughly the bottom 1/3 of the aeration tank contents is left so that there is biomass present for re-starting the plant. The entire treatment plant is heated with a conventional furnace during the cold weather periods.

2.4 Regulatory Requirements - Effluent Quality

2.4.1 Existing Requirements

There are two federal statutes which apply to the discharge from this treatment plant, the Yukon Waters Act (YWA) and the Fisheries Act (FA). Effluent standards under the YWA are established by site specific water licences established by the Yukon Territorial Water Board (YTWB) and enforced by the Yukon Northern Affairs Program within DIAND. Environment Canada administers section 36(3) of the Fisheries Act which prohibits the discharge of deleterious substances into fish-bearing waters. Compliance with section 36(3) is often assessed using a fish toxicity test known as the static LC_{50} fish bioassay (Ref. 2).

The existing YTWB water licence prescribes the following effluent standards for the Carmacks sewage treatment plant discharge:

Parameter	Maximum Concentration for Any Grab Sample
BOD_5	150mg/l
Suspended Solids	150mg/l
Oil and Grease	5 mg/l
pH	6 - 9 pH units
Phosphorous	5 mg/l
Faecal Coliforms	5.2×10^7 counts per 100ml

Effluent is sampled quarterly for these parameters. Prior to this study, routine samples have been grabs. There has been no routine sampling of influent.

2.4.2 Future Regulatory Requirements

The water licence for the Carmacks sewage treatment plant will expire on June 4, 1996. The Village of Carmacks will need to apply to the YTWB for a licence renewal well before this time to ensure a new licence is in place before the old one expires. It is not possible at this time to state what the new effluent standards will be. The YTWB looks at each licence on a case by case basis. It can be said that the existing Carmacks requirements are not very stringent relative to many Yukon municipal water licences.

Before the Village makes major changes to improve the existing sewage treatment facility they will want to know what effluent standards will apply. Typically licensees will develop plans for up-grading treatment facilities based on assumed effluent discharge standards. They will then bring these plans to the Water Board as the basis for a new licence and seek approval for the plans and the proposed discharge standards. The licensee takes the findings of the Board into account and revises the plans accordingly.

3.0 STUDY DESIGN

Overall Study Design

At the outset of the program it was known that the plant had problems with sludge carry-over into the effluent flowing out of the final clarifier. The effluent would normally be quite clear during the first three or four minutes of a wet well pump cycle. Subsequently there would be high levels of suspended solids in the effluent as the sludge blanket rose in the clarifier and sludge was discharged with the effluent.

The October study was designed to answer the question - if the sludge carry-over problem was solved, what quality of effluent could be produced? When the effluent samples from the ISCO bottles were composited, the sample was decanted, if necessary, to intentionally exclude the settleable solids so that relatively clear effluent would be analyzed.

The January study was designed, in part, to determine whether any reduction in the amount of sludge carry-over could be achieved by running the wet well pump continuously rather than in on/off slug flow cycles.

3.1 Water Quality - Influent and Effluent

During the October 93 and January 94 EP sampling programs, the influent and effluent were measured at 30 minute intervals over a 24 hour period using ISCO automatic samplers. The influent sample was withdrawn from the wet well and the effluent sample was withdrawn just after the clarifier over-flow. The sampler intake used for the influent sample collection prohibited the collection of solids over 1cm in size. Each ISCO had 24 one litre sample bottles. Samples from the 24 bottles were mixed to create composites for a high flowrate period, a low flowrate period, a mid-flowrate period, and a 24 hour composite. These four sets of samples were analyzed for faecal coliforms, BOD_5, suspended solids, oil & grease, COD, ammonia, nutrients and metals. BOD_5, MLVSS and coliform tests were completed in the EP Whitehorse lab. All other analyses were performed at the EP laboratory in Vancouver. The ISCO samplers did not have refrigerated storage. In the October program samples were composited and cooled as soon as each composite period was completed. This was not possible during the January period and those composite samples were held up to 24 hours at 9 degrees celsius.

Following the October 93 and January 94 sampling programs by EP, the Village embarked on a more intensive monthly monitoring program. This program included 24 hour composites for influent and effluent characterization, flow monitoring and some LC_{50} bioassay toxicity testing. Samples were collected by the plant operator. Sample analysis was carried out by a private laboratory in Vancouver, B.C. This data is also presented and discussed in this report.

Although the results have not been reported as part of this study, DIAND Water Resources has also undertaken analyses periodically for *Giardia* cysts in the treatment plant influent and effluent as well as other water quality parameters (Ref. 1).

The ISCO samplers used both by the Village and by EP for sample collection collected a fixed volume of sample at regular time intervals. Ideally, the volume of sample collected each hour should be proportional to the amount of flow through the plant during that hour. Otherwise, the composited samples will be somewhat more influenced by water quality during the low flow periods than they really should be. This factor is not very important for the effluent since the 24 hour retention time means that water quality changes occur slowly in any case. The effect will be more pronounced for the influent, the quality of which can change more quickly. For this reason, composites were also collected over shorter time intervals during the peak flow and the low flow periods.

3.2 Bioassay

Effluent samples from each of the four composited samples described in section 3.1 were also analyzed using the Microtox toxicity test. One grab sample from the effluent was also tested for toxicity to fish using the static 96 hour LC_{50} test.

3.3 Water Quality - Aeration Tank

Periodic grab samples were taken from the aeration tank to check the sludge settling characteristics using the sludge settling test described in section 2.3.5 above.

3.4 Influent/Effluent Flowrates

In October, the influent flowrate to the wet well was measured continuously using an ISCO Model 3220 submerged probe level sensor in the wet well. The flowrate was calculated based on the rate at which the wet well filled between pump cycles. In January, a 60 degree V-notch weir was installed complete with a Stevens A-71 level recorder to measure the effluent flowrate.

4.0 RESULTS

4.1 October 19-20 Program

In reviewing the October data the reader must keep in mind that the effluent samples taken were of the effluent with settleable solids removed - each aliquot was decanted to remove settleable solids which were normally present in large quantities for the last half of each wet well pump cycle. There is no question that coliform, BOD_5 and suspended solids levels would have consistently been extremely high if these samples had been included (for example see January 24-25, 1994 results in Table 2).

A total of eight sample sets were collected as follows:

Sample Set ID	Description
A	Effluent Composite 17:30 to 20:30
B	Influent Composite 18:00 to 21:00
C	Effluent Composite 03:30 to 06:30
D	Influent Composite 03:00 to 06:00
E	Effluent Composite 22:30 to 01:30
F	Influent Composite 22:00 to 01:00
G	Effluent Composite 24 hour composite
H	Influent Composite 24 hour composite

In addition, a 10 gal sample for 96 hour LC_{50} fish bioassay was collected as a grab from the effluent at 04:30.

The influent and effluent water quality results are summarized in Table 1. The complete data sets can be found in Appendix B. Some of the BOD_5 and faecal data could not be used because the analysis did not meet standard confidence criteria as set out in Appendix B.

The quality of the effluent (with suspended solids removed) is consistent with a very well performing secondary treatment plant (BOD_5 18-24 mg/l, faecal coliforms less than 60,000 counts per 100 ml). The plant achieved virtually complete conversion of the toxic ammonia in the influent to nitrate (a process known as nitrification) and passed the 96hr LC_{50} fish bioassay test with no mortalities.

This test program provided an indication that if the clarifier performance could be substantially improved, the plant could treat existing sewage flows very well.

TABLE 1.

OCT 19-20/93 WATER QUALITY SUMMARY

	INFLUENT - B	INFLUENT - D	INFLUENT - F	INFLUENT - H	EFFLUENT-A**	EFFLUENT-C**	EFFLUENT-E**	EFFLUENT-G**	EFFLUENT**
	18:00-21:00	03:00-06:00	22:00-01:00	24 HOURS	17:30-20:30	03:30-06:30	22:30-01:30	24 hour	4:30 AM
	COMPOSITE	COMPOSITE	COMPOSITE	COMPOSITE	COMPOSITE	COMPOSITE	COMPOSITE	COMPOSITE	GRAB
PARAMETER ANALYZED									
Average Flow - l/min	75	28	48	60	75	28	48	60	
Suspended Solids (NFR-mg/l)	100	<10	49	50	<10	<10	<9	<10	
pH	7.4	7.7	7.3	7.5	7.2	7.2	7.2	7.3	
Alkalinity (mg/l)	356	325	334	345	149	148	150	147	
Chloride (mg/l)	47	27	45	37	44	43	44	43	
Ammonia NH3-N (mg/l)	31.1	38.1	29.7	37.1	0.3	0.1	0.3	0.2	
Nitrite (mg/l)	<.002	<.002	<.002	<.002	0.17	0.06	0.13	0.11	
Nitrate (mg/l)	0.02	0.02	0.01	0.02	25.6	26.5	26.7	26.5	
Phosphate PO4-P (mg/l)	8.5	5.3	5.8	6.3	4.7	5.1	5.0	4.8	
BOD5 (mg/l)	183	73	167	223	21	--	--	18	
Chemical Oxygen Demand (COD)	479	173	424	337	98	61	52	56	
Faecal Coliform (counts/100ml)	1.69E+07	8.44E+05	3.30E+06	1.10E+07	4.11E+04	4.00E+04	2.56E+04	5.11E+04	
LC50 bioassay									>100%
BOD Loading (kg BOD/m3-day)				0.24					
Clarifier Overflow (m3/m2-day)					16	6	10	13	

OTHER SAMPLES : 96hr LC50 effluent grab sample 04:30 20 Oct = 100% (no mortalities)
MLSS aeration tank grab sample - 2065 mg/l and MLVSS same sample = 1483 mg/l.

** *NOTE - all October Effluent Samples were decanted to remove settleable solids*

A number of measures were taken prior to the October program to try and improve clarifier performance. The control level in the wet well was lowered so that the pump would not stay on as long during each pump cycle. During the test the pump cycle duration varied from 5 to 7 minutes and during each cycle approximately 2300 litres of sewage was pumped through the plant. The time between pump cycles ranged from 30 minutes during the high flow period to 90 minutes during the middle of the night. Since the sludge return rate directly affects the retention time in the clarifier, the sludge return out of both clarifiers was throttled back as much as possible to try and reduce the total flow through the clarifiers. The sludge return could not be reduced much below 1 litre/sec each. Below this flowrate the flow stopped completely. During the test the bottom and sides of the clarifier were clear of encrusted sludge. Encrusted sludge effectively reduces the capacity of the clarifier, reducing the retention time available for settling the suspended solids.

The following observations were taken in the plant:

- aeration tank dissolved oxygen (D.O) was 2.2 to 2.4 mg/l during the high flow periods and 5 to 5.5 mg/l during the low flow period (2 am to 6 am);

- the flow pattern on the surface of the tank indicated uniform aeration and mixing; the solids in samples of the aeration tank MLSS settled to 90% of the sample volume after 30 minutes in tests carried out over the 24 hour program;

- there was no foaming and the mixed liquor suspended solids (MLSS) were chocolate brown;

- only a typical 'musty' odour in the plant, and;

- the aeration tank water temperature was steady at 11 degrees C.

During the high flow periods the sludge blanket in the clarifier would settle to 1.5 to 2 ft below the water surface between pump cycles. The sludge blanket rose during the pump cycle and overflowed into the weir after 3.5 minutes. Even at the low flow (04:30 hours) the sludge blanket reached the surface by the end of each pump cycle. There was no floating sludge in the clarifiers at any time.

About 50 to 66% of the sludge in the aeration tank and the clarifiers was pumped out by a vacuum truck in early September. No sludge had been 'wasted' since that time other than what is routinely lost with the effluent.

4.2 RESULTS JANUARY 24-25 PROGRAM

General Comments:

The January program was designed in part to see if running the wet well pump continuously might improve clarifier performance by eliminating the surge flows which occur when the wet well pumps are cycled on and off. Although these pumps had been operated in this 'continuous ' mode occasionally in the past, this may not be the recommended operating condition for this pump. Because of this, the pump was left in this mode for as little time as possible. It was run continuously starting January 23 so that there would be one day for the plant to stabilize prior to commencing the test.

The plant had not been de-sludged since the October test period. The outdoor temperature during this test was between -15 to -25 degree C. EP staff did not observe the plant's performance in as much detail as the October program since they were only able to be at the plant for the first hour and the last hour of the 24 hour test period.

Solids were not intentionally excluded from these test results as they had been in the October program. The reported results reflect actual effluent conditions.

The aeration tank temperature was 9 degrees C. At 13:00 and 17:00 on the 24th the D.O. was 5.5 and 1.5 mg/l, respectively. At 08:00 on the 25th it was 2.0 mg/l. The solids in a sample of the aeration tank MLSS (mixed liquor suspended solids) settled to 30 to 50% of the sample volume after 30 minutes in four tests carried out over the 24 hour program.

The following samples were collected:

Sample Set ID	Description
1	Effluent Composite 11:30 to 14:00 25 Jan.
2	Effluent Composite 02:30 to 04:30 25 Jan.
3	Effluent Composite 24 hour composite starting 14:30 24 Jan.
4	Influent Composite 02:30 to 05:30 25 Jan.
5	Influent Composite 11:30 to 13:30 25 Jan.
6	Influent Composite 24 hour composite

No samples were collected for toxicity testing.

The influent and effluent water quality results are summarized in Table 2. The complete data sets can be found in Appendix B. The effluent BOD_5 data could not be used because the analysis did not meet standard confidence criteria as set out in Appendix B.

The results indicate that the clarifier is not able to handle existing loads even when the sewage is pumped continuously through the plant rather than intermittently. Inspection of the individual effluent composite samples (24 bottles, one per hour) showed that there were very high levels of sludge carried into the plant effluent most of the time.

TABLE 2.

JAN. 24-25/94 WATER QUALITY SUMMARY

	INFLUENT - 4	INFLUENT - 5	INFLUENT - 6	EFFLUENT-3	EFFLUENT-1	EFFLUENT-2
	02:30-05:30	11:30-13:30	24 hour	24 hour	11:30-14:00	02:30-04:30
	COMPOSITE	COMPOSITE	COMPOSITE	COMPOSITE	COMPOSITE	COMPOSITE
PARAMETER ANALYZED						
Average Flow - l/min	25	65	44	44	65	25
Suspended Solids (NFR-mg/l)	30	370	100	3600	1160	6200
pH	7.6	7.2	7.4	6.3	6.8	6.4
Alkalinity (mg/l)	382	350	332	233	314	674
Chloride (mg/l)	50	63	53	50	50	51
Ammonia NH3-N (mg/l)	44.1	33.2	40.7	106	18.1	193
Nitrite (mg/l)	<.002	0.002	<.002	0.008	<.002	0.012
Nitrate (mg/l)	0.006	0.02	<.002	0.05	0.02	0.12
Phosphate PO4-P (mg/l)	4.9	9.4	6.7	23.0	22.0	113.0
BOD5 (mg/l)	252	147	207	SEE NOTE	SEE NOTE	SEE NOTE
Chemical Oxygen Demand (COD)	270	790	450	5260	1780	9290
Faecal Coliform (counts/100ml)	2.20E+07	1.40E+07	5.40E+07	4.50E+06	5.60E+06	5.50E+06
LC50 bioassay						
BOD Loading (kg BOD/m3-day)			0.16			
Clarifier Overflow (m3/m2-day)				10	14	5

NOTE: Although all of the effluent BOD analyses failed the data confidence test, the data does indicate that the BOD's were in excess of 1000 mg/l.

4.3 RESULTS OF THE VILLAGE OF CARMACKS MONITORING PROGRAM - FEB 94 TO AUG 94

The data collected under this program is presented in Table 3. In addition, periodic assessment of the daily flows were carried out. This flow data is presented in Table 4.

Problems with sludge carry-over in the effluent from the clarifier continued. This makes it difficult to interpret the effluent data and the overall plant performance apart from this problem. However, it is clear that the plant continued to achieve good levels of nitrification and produced a non-toxic discharge except for one sample (4-Aug/94). The sample appeared to have failed because of elevated ammonia (no nitrification occurring). There is not enough information to establish why this occurred. It may have been related to a sludge clean-out which had occurred a few days earlier.

It should be noted that although there was a continuous flow recorder on the effluent weir, the flows could only be accurately interpreted on the few days when the pumps were taken off of their normal on/off cycle and run continuously instead.

4.4 DISCUSSION OF RESULTS

4.4.1 Aeration tank performance

The plant was originally designed for a flowrate of 80,000 litres per day and a loading of 15.5 kg BOD_5/day or .2 kg BOD_5 /$M^3 \cdot$day of aeration tank capacity. These design parameters were within the .16 to .40 kg BOD_5 per $M^3 \cdot$day range of values often reported in the literature as design criteria for extended aeration plants such as this (Ref. 3,4,5,6). In October and January the plant flow was 108% and 79% of the design flow, respectively. The plant BOD_5 loading was 120% and 108% of design respectively (see BOD loading rate on Tables 1 and 2). The aeration tank seems to be able to handle the wide variation in influent BOD_5 levels quite well. The highest recorded 24 hour average influent BOD_5 to date has been 236 mg/l (4 Aug.) The highest recorded flow to date has been 95,000 litres/day. If we assume these two could coincide, the BOD_5 loadings would be 140% of the design levels.

Despite the aeration tank being operated close to or above the original design parameters there is no obvious sign that it is over-loaded. Reasonable dissolved oxygen levels are maintained in the tank. Treatment levels are good, apart from the clarifier problems. The problem with the loss of solids from the clarifier is no doubt affected by the poor sludge settling characteristics found in samples of the aeration tank mixed liquor from time to time. According to the literature (Ref. 3,6, 7), this could be due to :

a) proliferation of poor settling filamentous microorganisms due to periods of very low aeration tank dissolved oxygen (<0.5 mg/l) and/or very high food to micro-organism (F/M ratio) ratios.
b) over-aeration
c) denitrification

TABLE 3.

CARMACKS VILLAGE
SEWAGE TREATMENT PLANT MONTHLY WATER QUALITY SUMMARY
FEBRUARY 1994 TO AUGUST 1994

	2-FEB-94		7-APR-94		28-APR-94		26-MAY-94		30-JUN-94		4-AUG-94	
	INFLUENT	EFFLUENT	INFLUENT	EFFLUENT	INFLUENT	EFFLUENT	INFLUENT	EFFLUENT	INFLUENT	EFFLUENT	INFLUENT	EFFLUENT
	24 HR COMP.	24 HR COMP.	24 HR COMP.	24 HR COMP.	24 HR COMP.	24 HR COMP.	24 HR COMP.	24 HR COMP.	24 HR COMP.	24 HR COMP.	24 HR COMP.	24 HR COMP.
Parameter Analyzed												
Suspended Solids (mg/l)	63	—	55	—	112	<5	138	269	51	56	236	37
pH	—	—	—	—	7.3	7.4	7.3	7.4	7.2	7.3	7	7.4
Ammonia NH3-N (mg/l)	29	2	13	2	21	2	15	0.21	6.8	9.2	15	15
Phosphate PO4-P (mg/l)	—	3.87	4.6	3.87	6.11	3.87	5.6	8.6	1.6	3.1	3.6	1.7
BOD5 (mg/l)	190	70	74	70	144	70	207	50	48	85	120	36
Oil & Grease (mg/l)	29	<5	7	<5	31	<5	36	<5	<5	10	23	5
Total Coliform (counts/100ml)	>2.40E+06	>2.40E+06	4.60E+06	4.60E+06	2.40E+07	1.10E+05	2.40E+07	2.40E+05	1.10E+08	2.30E+07	2.40E+05	2.40E+05
Faecal Coliform (counts/100ml)	1.10E+06	4.60E+05	9.30E+05	4.60E+06	1.10E+07	4.60E+04	1.10E+07	1.50E+04	4.60E+05	4.30E+04	2.40E+05	4.30E+04
LC50 bioassay		>100%				>100%						75% (FAILS)

TABLE 4. PLANT FLOW SUMMARY - DAILY RECORD

	TOTAL FLOW	Average Flow	Lowest Flow	Highest Flow
DATE	litres/day	litres/min	litres/min	litres/min
19-20 Oct	86970	60	27	120
24-25 Jan	63238	44	17	196
3-May	41710	29	10	279
25-May	36830	26	11	47
5-Jul	84318	59	45	120
19-Jul	94749	66	43	129

There is no evidence to support the occurrence of denitrification (item c.). There has not been any investigation of the presence of poor settling filamentous mircroorganisms (item a.).

Situation b) has not been assessed because it is difficult to control the amount of air. This is because the blowers operate at a fixed speed and all the air flows either to the aeration tank or to the sludge return air lifts. Also, there are no timers. Most extended aeration plants do not aerate continuously but rather cycle the blowers on and off. The cycle intervals vary widely but generally a cycle of 5 minutes on and 5 minutes off is felt to be reasonable. To evaluate condition b) the Village could change the sheaves on the blowers and/or install a timer. It would also be beneficial to install air pressure gauges on the air lines so that air flow can be monitored. It should be pointed out that the aeration rate is constant and the sludge settling problem is not. Its affect on sludge settling may be dependent on the F/M ratio.

Regarding c), there is no evidence of denitrification occurring in this plant under normal operating conditions.

It is clear that even when the aeration tank solids settle well, problems in the clarifier still occur.

4.4.2 Clarifier performance

In a typical pump cycle the effluent starts out clear at the beginning of the cycle. As the cycle progresses the level of the settled sludge (i.e. sludge blanket) in the clarifier starts to rise. At some point in the 5 to 7 minutes that the wet well pumps are on the blanket will reach the surface of the clarifier and sludge will flow out with the effluent. The effluent quality at this point in time is extremely poor. When the wet well pump shuts off, the sludge blanket will start to sink again until the next pump cycle. During the peak flow periods the time between pump cycles is often not adequate to allow the clarifier to clear up much at all.

This problem has persisted year round and every hour of the day. There are a number of factors which are undoubtedly influencing clarifier performance. These are:

a) sludge return rate
b) lack of flow equalization
c) sludge settling characteristics
d) lack of a sound basis for de-sludging the plant

a) Sludge return rate
It appears that the sludge return rate is probably considerably higher than it needs to be. The rate is roughly twice the typical sewage flowrate. This significantly reduces the retention time (the time available for the solids to settle out of the wastewater) in the clarifier. The air lifts which control the sludge return rate cannot be throttled back

beyond a certain minimum flow or they will cease functioning entirely. Mechanical pumps have been used in some plants and these allow more control over the sludge return rate.

b) Lack of flow equalization

Clarifiers perform best when flow changes through them are as slow as possible. With the on/off cycle which is currently used the clarifiers go from no flow to full flow in a matter of seconds. The high velocities and the currents created in the clarifier when the wet well pump cycles 'on', have an adverse affect on clarifier performance. One wet well pump delivers approximately 440 l/min.

Clarifiers of this type are often designed based on an overflow rate measured as m^3 of effluent per day per m^2 of clarifier cross-sectional area. The range of values used for clarifier design is 8 to 17 $m^3/m^2 \cdot day$ (Ref. 3, 7). These guidelines do not appear to take the sludge return rate into account although it is felt that they should. The recommended sludge return rate is typically in the range of 75% to 200% of the plant flow rate. The Carmacks sludge return rate is typically close to the upper end of this range.

For the purposes of this analysis the affect of the sludge return rate on the calculation of the overflow rate will be ignored. The cross-sectional area of the two Carmacks clarifiers together is 6.6 m^2. The clarifier over-flow rates experienced during the October 93 and January 94 tests are reported on Table 1 and 2 and range from a low of 6 $m^3/m^2 \cdot day$ to a high of 16 $m^3/m^2 \cdot day$. At the highest recorded sewage inflow rate of 279 l/min. the corresponding clarifier overflow rate is 61 $m^3/m^2 \cdot day$. The clarifier would be seriously over-loaded at this rate.

The maximum pumping rate of one wet well pump is roughly 440 l/min. So when the pump is running on an on/off cycle, the corresponding clarifier overflow rate during the 'on' cycle is 98 $m^3/m^2 \cdot day$ - a value which exceeds the recommended range by a factor of ten.

We are left to question why the January 94 test results were so poor given that the wet well pump was running continuously so that the flow rate through the plant was much more equalized. There are at least three possible answers to this.

First, the effluent quality was at its worst during the low flow 02:30-04:30 period. Under low flow conditions the clarifier should have been performing very well. At very long retention times, however, denitrification can cause sludge to float in the clarifier rather than settle. If this were the cause then it is not a result of the wet well pumps running continuously. The plant operator has never reported problems with this kind of 'floating sludge' previously. However, it is possible that it occurs from time to time during the night and by the time the operator is at the plant (08:00) the higher morning flows have flushed the floating sludge out. This should be investigated further.

Second, the poor effluent quality could be explained by a clogged sludge return air lift although the sludge return was operative when the plant was inspected in the morning. This does happen from time to time although they do not usually unclog themselves.

Without sludge return the clarifiers simply fill up with sludge.

Thirdly, apart from the problems in the low flow period there were also high solids in the effluent during the high flow period. It was apparent during the January test that the clarifier was not handling the peak flows. In the continuous wet well pumping mode, once the clarifier is upset, it takes many hours for it to recover.

c) Sludge settling characteristics
As discussed under section 4.4.1 on aeration tank performance, the sludge does exhibit poor settling characteristics from time to time. During these occasions, this contributes to poor clarifier performance.

d) Lack of a sound basis for de-sludging the plant
The frequency on which the plant needs to be de-sludged should be based on measurable criteria. The plant has been, in effect, continuously disposing of sludge by discharging it with the effluent. In addition, most of the sludge is cleaned out of the aeration tank and the clarifier roughly every six months. It is important that sludge not be disposed of on an ad hoc basis. This can result in low solids levels in the plant and it is these solids which the plant depends on for treatment of the sewage. Conversely, too much solids is a problem as well. Both of these conditions can adversely affect overall treatment performance in general and clarifier performance in particular.

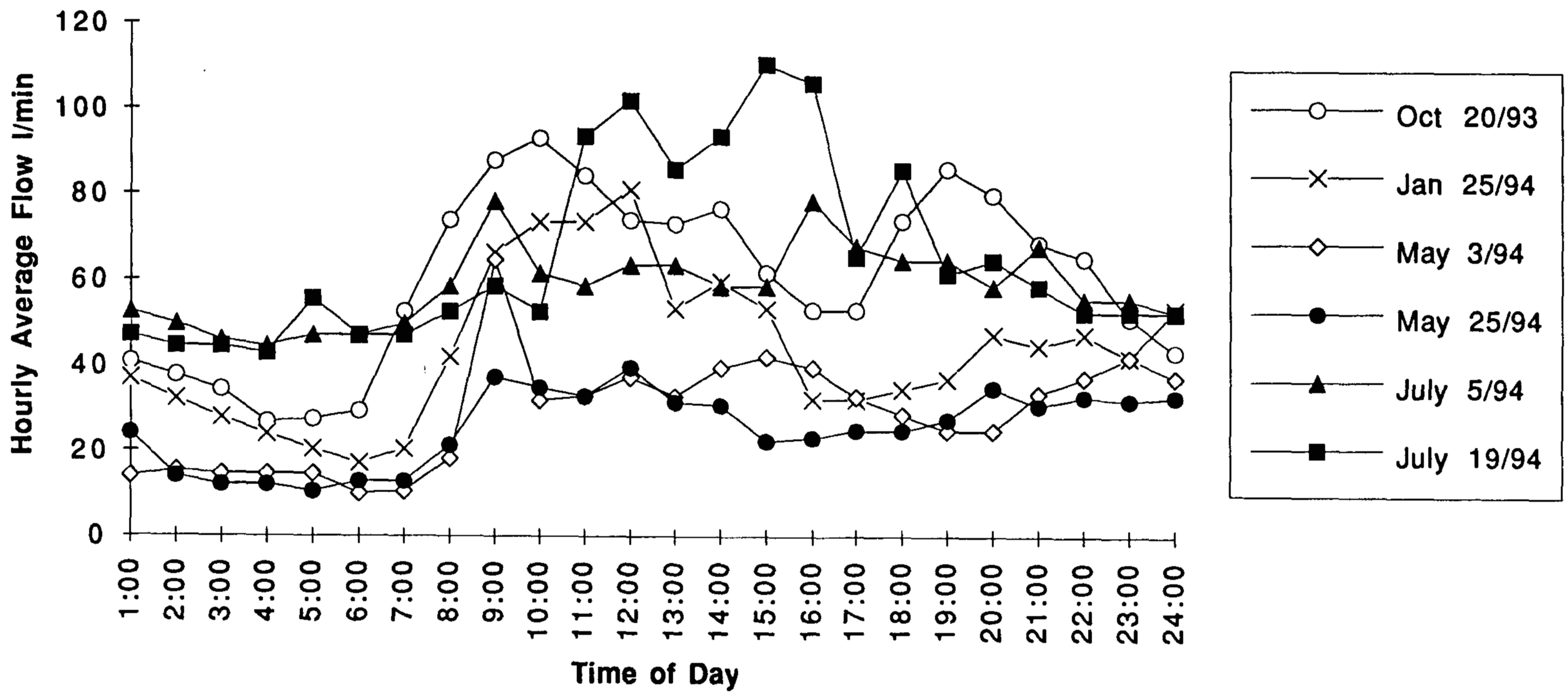
When extended aeration plants were originally developed some designers felt they could be operated without having to periodically remove sludge. Experience has demonstrated that this is not true. Undoubtedly, this type of plant will operate best if sludge were continuously removed (called 'sludge wasting') at rates based on daily measurements of the sludge concentrations in the aeration tank, sludge return rates and the volume of sludge in the clarifiers. The effect of a daily sludge wasting program on the effectiveness of the plant could be evaluated during the summer months with some minor modifications to allow a portion of the sludge return flow to be diverted to an aerated holding tank outside the plant. This type of program should be run for several weeks.

Improvements should be made to the tools used to scrape down the clarifier walls. The existing tool cannot effectively reach all the walls. This permits sludge to eventually cake up on the walls and effectively reduces the performance of the clarifier. In this case the effect appears to be minor since the existing tools are somewhat effective. However, a change will make it possible to complete the task more quicker and more effectively.

4.4.3 Sewage Flows

The daily flow records shown in Figure 3 demonstrate that the flows through the plant are often highly variable during the daytime. This is to be expected on a plant serving fewer than 200 residents and with some relatively significant loads from the service sector. Undoubtedly the loads from the hotel and the motel increase substantially during the busy

Figure 3.
Sewage Flowrate Summary



summer tourist season. Tour buses which stop in Carmacks will also result in high loads of short duration.

One persistent characteristic of the daily flow pattern is the steadiness during the low flow period between 02:00 and 06:00. This 'base flowrate' ranges from 25 % to 70% of the average flow in the six days of flow record presented in Table 4 (reported as low-flow). Inspection of the weir flow records show a consistent flat line during the overnight period almost every day. The only variation occurred in mid-June when this flow increased and stayed higher each night at least through to the end of August 94, which is the most recent record available.

The source of this over-night flow should be verified. If the source should be shown to be bleeders or groundwater infiltration into the sewer system then there may be potential to significantly reduce the hydraulic loading on the plant.

5.0 CONCLUSIONS

5.1 The clarifier is inadequate for existing flows as presently operated. During the frequent clarifier upsets the effluent quality is extremely poor and fails to meet the requirements of either the existing water licence or the Fisheries Act. In the short term there is potential to implement measures which could improve clarifier performance.

5.2 The aeration tank is capable of treating existing loads to a secondary level. This means that, provided adequate separation of suspended solids from the treated effluent occurs, the effluent can achieve the most stringent requirements used to date by the Yukon Territorial Water Board for municipal wastewater, including non-toxicity of the discharge.

6.0 RECOMMENDATIONS

6.1 SHORT TERM

The following measures are recommended:

a) investigate source of the over-night base flows (see section 4.4.3)

b) implement procedure for determining when sludge should be removed from the plant (see section 4.4.2(d)).

c) improvements should be made to the tools used to scrape down the clarifier walls. (section 4.4.2 (d)).

d) the test with the pumps running continuously should be repeated with closer monitoring of the impact on the clarifier. This will help in the assessment of the benefits of flow equalization.

e) investigate the microbial characteristics of the sludge. This will aid in the assessment of why the sludge does not settle well in the clarifier at times.

Also, assuming that it would be at least a couple of years before any major changes are made to the entire treatment system, there are a number of measures which should be investigated.

f) as per the discussion in sections 4.4.1 and 4.4.2(a) and (d), modifications should be made which will permit better control of the sludge return and air supply systems. Consideration should be given to conducting a test program with continuous sludge wasting.

g) there is a possibility of relatively low cost plant modifications which would expand clarification capacity. These should be investigated.

6.2 LONG TERM

The community needs to establish estimates of the future sewage loads over 5 year, 10 year and 20 year horizons. It is recognized that this is not an easy task for a small community. Even one new mine in the area can have major impacts. The best scenario would be to expand capacity in five year increments. Although this is not a practical option for some treatment technologies, it may be possible with Rotating Biological Contactors (RBCs), for example.

Once the estimates for future loads are completed, it will be possible to determine the extent, if any, to which the existing plant will form a component of the next system expansion.

7.0 REFERENCES

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APPENDIX 'A'

SPECIFICATIONS

SEWAGE TREATMENT PLANT

General

Furnish and install complete a factory built sewage treatment plant utilizing the extended aeration process with all necessary equipment for efficient plant operation. The plant shall be a welded steel rectangular tank structure. All compartments shall be protected inside and out with a bitumastic coating for corrosive protection. The principal items of equipment shall include: bar screen, air diffusers, effluent trough, return sludge air lifts, air skimming device, rotary blowers complete with necessary motors and controls, ~~water spray foam control system~~, overflow weir, instructions on operation and maintenance, all necessary internal piping and all other required items as hereinafter called for in the specifications or shown on the drawings.

Operating Conditions

The treatment plant shall be capable of treating a total daily flow of 20,000 US gallons per day of domestic sewage with an organic loading of 34 pounds of five (5) day B.O.D. The total daily flow shall be treated in (one) XXXX treatment plant units. Treatment plant(xx) shall be Model(xx) AD200 as manufactured by xxxx Western Pump XXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX Pollution Systems Co., New Westminster, B. C.

Construction

The treatment plant shall consist of all necessary compartments, baffles, piping, and valves as shown on the drawings and as required by these specifications. The sidewalls, bottoms, and partitions shall be constructed of not less than 1/4" structural grade low carbon steel. The structure shall be so reinforced to withstand normal pressures inside and out, for below ground (above ground optional). All piping shall be Schedule 40 with steel fittings. All control valves shall be placed on the outer perimeter of the tank walls for easy access and maintenance.

Protection Against Corrosion

All surfaces shall be coated with two (2) separate coats of material equivalent to Koppers 50 Bitumastic. The Bitumastic material shall be applied evenly by airless spray equipment at constant elevated temperature in strict accordance with coating manufacturer's recommendation for this service. The initial coat shall be allowed to dry before applying the final covering coat. The coated surface shall be inspected thoroughly to insure no voids have occurred in the coating process. The contractor shall thoroughly inspect the structure after it has been placed in position at the job site and repair any abrasions or damage to the structure with a "touch up kit" furnished by the manufacturer.

Aeration Tank

The aeration compartment shall have sufficient capacity to provide at least 24 hour detention of the average daily flow. The aeration tank shall have adequate returns at aeration wall bottom to insure complete circular movement to prevent dead spots where solids may collect.

Final Settling Tank

The final tank shall provide 4 hour detention based on a run-off period of 24 hours. The bottom of the tank shall be hopper shaped, formed by sloping the sidewalls at least 60 degrees to insure effective removal of solids. The tank shall be properly baffled, including scum baffles and adjustable steel vee notch overflow trough. An adjustable air lift type skimming device shall be provided where indicated on the plans.

Sludge Return

Settled sludge shall be returned from the final settling tank to the inlet end of the aeration tank by air lift assembly(s). The air lift(s) shall have a minimum capacity equal to 150 per cent of the average daily flow. The air supply for air lift(s) shall be provided from the blowers and be controlled by a regulating valve. Valves shall be provided for regulating return sludge flow and utilized for blowing down the air lift(s) to prevent clogging.

Blowers

There shall be furnished 2 blowers of the positive displacement type, each with a capacity of not less than 93 C.F.M. free air at 5 P.S.I. Each blower shall be equipped with an air relief valve and a filter silencer, all mounted on a structural steel base and driven by an electric motor of not less than 5 H.P. through V-belt and pulley drive. Electric motors shall be dripproof construction and shall not be overloaded beyond the nameplate rating. The motors shall be wound for 208 volts, 3 phase, 60 cycle current. The blowers and motors shall be mounted in ventilated weather-proof enclosure or mounted on a structural base for remote installation as shown on the drawings.

Froth Control

A froth control spray system, including sufficient non-clog nozzles and pumps shall be mounted in the settling chamber on shelf provided. The pump shall have adequate capacity to deliver sufficient effluent water to the spray nozzles. Pump shall be Model SP33A as manufactured by Hydromatic Pump Co. . And be 115 volt, 1 phase, 60 cycle.

Air Diffusion Header--Air Piping

An air distribution header on which the individual air diffuser assemblies are mounted shall be capable of carrying a minimum of 2,100 CF per pound of applied B.O.D. plus air for the air lift and skimming device. Diffuser elements shall be so positioned in aeration tank as to insure sufficient velocities to prevent solids from settling out. Each diffuser drop shall be individually valved and unioned to facilitate easy removal.

Field Service

At the time the sewage treatment plant is filled with water or sewage, power connections are completed and all equipment is approved for service, the equipment manufacturer shall provide the services of a qualified representative to instruct Owner's representative in the proper maintenance and operation of sewage plant. The manufacturer's representative shall turn over to the Owner's representative at this time a "Service Manual" depicting in detail all operating instructions and procedures. This service shall be available for one eight (8) hour working days and shall be provided at no additional cost to the Owner.

Electrical Controls

There shall be provided for each blower an across-the-line manual starter including overload and low voltage protection, plus fused disconnect switch. Outlets and starters for the frother control pumps plus any accessory items provided.

CHLORINATION EQUIPMENT (HYPO) WITH ENCLOSURE (NOT REQUIRED)

General

The chlorination equipment shall consist of chemical feed pump, polyethylene solution tank, suction and discharge base and fittings, pre-wired electrical switch and outlet, and heated, weather-proof enclosure. The chlorination equipment shall be completely factory assembled and shipped as a unit.

Construction

The chlorine equipment enclosure shall be constructed of 10 gauge mild steel, and shall be coated inside and out with a protective paint to resist weathering. The housing shall have a hinged lid for access to the equipment. This lid shall be supplied with a hasp and lock to prohibit entrance of unauthorized personnel.

Feed Pump & Accessories

The feed pump shall be as manufactured by ______________ Model No. ________ or equal, and shall have a capacity of ________ GPD maximum at a maximum pressure of _____ PSI. The positive displacement pump shall be driven by an electric motor operating on 115 volt single phase sixty cycle current. The solution tank shall be manufactured of polyethylene and shall have a capacity of __________ gallons. The tank shall be furnished with a matching lid on which the chlorine solution pump shall be mounted. The solution suction line shall be fitted with a strainer, foot valve, and weight. The solution discharge line shall be of sufficient length to reach the bottom of the contact chamber and shall be fitted with check valve and injection diffuser.

Mounting

The equipment enclosure shall be fitted with anchoring clips. Anchor bolts shall be furnished for anchoring the enclosure to the chlorine contact tank on which the enclosure shall be attached with machine bolts.

CHLORINATION EQUIPMENT (HYPO) WITH ENCLOSURE (Cont'd.) (NOT REQUIRED)

Mounting

The equipment enclosure shall be fitted with anchoring clips. Anchor bolts shall be furnished for anchoring the enclosure to the chlorine contact tank on which the enclosure shall be attached with machine bolts.

Electric Heater

The electric strip heater shall be mounted on the rear wall of the enclosure. The capacity of the heater shall be ______ watts while operating on ______ volt 60 cycle current. The heater shall be pre-wired and thermostatically controlled. It shall be equipped with a properly sized and fused disconnect switch.

Chlorine Contact Tank

The chlorine contact tank shall be constructed of steel plate and shall be installed ______ remote from the plant ______ attached to the sewage treatment plant. It shall have proper baffling within and shall have inlet and discharge connections. The total liquid capacity shall be ______ gallons to provide ______ minute detention of the average daily flow.

Comminutor

The incoming sewage shall be continuously and automatically screened, and reduced to solids of a size which will pass through a 1/4" slot. This shall be accomplished by the installation of a $LCL size Worthington comminutor. The comminutor shall have a capacity of .05 MGD and shall have hardened stainless steel cutters rotating at 56 RPM. The comminutor gear motor shall be 1/4 h.p. operating on 208 volt 3 phase 60 cycle current. It shall be totally enclosed for outdoor operation. An instruction manual and complete set of spare cutters shall be furnished with the comminutor. A disconnect switch and starter shall be provided for the comminutor in the control panel located in the main blower enclosure. Electrical service from the blower enclosure to the comminutor shall be by others.

Comminutor and By-Pass (Attached)

The comminutor shall be mounted in the aeration tank on a structural steel frame. To the exterior of the aeration tank wall shall be attached a diversion box with slide gates for diverting the flow to the removable bar screen or to the comminutor. The bar screen chamber shall be shipped attached to the plant. The comminutor shall be shipped unattached, but on the same shipping vehicle.

Comminutor and By-Pass (Remote) (NOT REQUIRED)

The comminutor shall be mounted in a pre-fabricated steel chamber. The chamber shall be fitted with diversion slide gates, inclined bar screen, anchor bolts, and mounting for comminutor. The comminutor and by-pass chamber shall be completely factory assembled, tested, and shipped as one unit. It shall be constructed similar to that of the sewage plant and shall be as detailed on the drawings. The bar screen shall be constructed on 1/4" by 1-1/4" steel bars and shall be spaced with one (1) inch openings between bars. The chamber shall be furnished with ______ outlets. The chamber shall be mounted on a concrete pad as detailed on the drawings. Such pad to be by others.

Sludge Storage Tank (NOT REQUIRED)

A sludge storage tank shall be provided as specified or shown on the plans. It shall be designed to hold a minimum of _____ cubic feet. The tank shall be constructed of 1/4" steel plate and coated as specified for the sewage treatment plant. It shall be provided with necessary inlet and outlet piping and baffles.

______ The tank shall be installed remote from the tank.

______ The tank shall be installed as an integral part of the plant.

______ The tank shall be provided with a diffuser and regulator valve.

______ The tank shall be equipped with a flame trap and enclosed top.

APPENDIX 'B'

APPENDIX 'B'

CARMACKS SEWAGE TREATMENT PLANT
OCTOBER SAMPLING

BOD5 ANALYSIS

SAMPLE ID #	SMPL VOL (ml)	"P-VALUE" (dec.%)	DO.1 (mg/L)	DO.2 (mg/L)	BOD5 (mg/L)	VALID?	DELTA DO (ppm)
A - Eff.	18	0.06	8.30	7.20	18.3		1.10
A - Eff.	36	0.12	8.05	5.50	21.3	t	2.55
B - Inf.	3	0.01	8.30	6.90	140.0		1.40
B - Inf.	9	0.03	8.00	2.50	183.3	t	5.50
C - Eff.	18	0.06	9.00	7.10	31.7	fail	1.90
C - Eff	36	0.12	7.90	6.00	15.8	fail	1.90
D - Inf.	3	0.01	8.30	7.70	60.0		0.60
D - Inf.	9	0.03	8.10	5.90	73.3	t	2.20
E - Eff.	18	0.06	8.20	7.30	15.0	fail	0.90
E - Eff.	36	0.12	7.60	6.40	10.0	fail	1.20
F - Inf	3	0.01	8.10	6.80	130.0		1.30
F - Inf.	9	0.03	7.90	2.90	166.7	t	5.00
G - Eff	18	0.06	8.20	8.00	3.3		0.20
G - Eff.	36	0.12	7.90	5.70	18.3	t	2.20
H - Inf.	3	0.01	8.10	7.30	80.0		0.80
H - Inf.	9	0.03	8.05	1.10	231.7	t	6.95
H - Inf.	9	0.03	7.95	1.50	215.0	t	6.45
Diln H2O	300	1.00	8.20	8.00	0.2	w	0.20

NOTE: "t" - Dilution strength meets criteria for residual DO at least 1 mg/L and DO uptake at least 2mg/L
"w" - Dilution Water meets criteria for DO uptake of no more than 0.2 mg/L

CARMACKS SUMMARY

SAMPLE ID #	BOD5 (mg/L)
A - Eff.	21.3
B - Inf.	183.3
D - Inf.	73.3
F - Inf.	166.7
G - Eff.	18.3
H - Inf.	223.4

TOTAL SOLIDS	2065	(mg/L)
VOLATILE SOLIDS	1483	(mg/L)

CARMACKS BAC-T SAMPLE RESULTS
SAMPLE DATE:
ANALYSIS DATE: 93/10/21

SAMPLE	TYPE	CONC.	VOLUME FILTERED(ml)	VOLUME CORRECTION	COUNT	COUNT/100ml
A	EFFL	-3	0.1	0.9	37	41111
A	EFFL	-4	0.01	0.9	5	55556
A	EFFL	-5	0.001	0.9	2	222222
C	EFFL	-3	0.1	0.9	36	40000
C	EFFL	-4	0.01	0.9	2	22222
C	EFFL	-5	0.001	0.9	2	222222
E	EFFL	-3	0.1	0.9	23	25556
E	EFFL	-4	0.01	0.9	1	11111
E	EFFL	-5	0.001	0.9	0	0
G	EFFL	-3	0.1	0.9	46	51111
G	EFFL	-4	0.01	0.9	3	33333
G	EFFL	-5	0.001	0.9	1	111111
B	INFL	-4	0.01	0.9	358	3977778
B	INFL	-5	0.001	0.9	152	16888889
B	INFL	-6	0.0001	1	115	115000000
D	INFL	-4	0.01	0.9	76	844444
D	INFL	-5	0.001	0.9	7	777778
D	INFL	-6	0.0001	1	0	0
F	INFL	-4	0.01	0.9	297	3300000
F	INFL	-5	0.001	0.9	66	7333333
F	INFL	-6	0.0001	1	26	26000000
H	INFL	-4	0.01	0.9	348	3866667
H	INFL	-5	0.001	0.9	99	11000000
H	INFL	-6	0.0001	1	23	23000000

CARMACKS SEWAGE TREATMENT PLANT
JANUARY SAMPLING

TOTAL SOLIDS, VOLATILE SOLIDS, & FAECAL COLIFORMS ANALYSIS

SAMPLE ID #	BOD5 (mg/L)	VALID? (BOD5)	TSS (mg/L)	TVSS (mg/L)	F. COLIF. (count/100ml)
A - Inf.	251.7	pass	374	279	2.2E+07
B - Inf.	146.7	pass	28	33	1.4E+07
C - Inf.	206.7	pass	101	74	5.4E+07
A - Eff.		fail-r	1509	789	5.6E+06
B - Eff.		fail-r	6240	3225	5.5E+06
C - Eff.		fail-r	4590	2605	4.5E+06
control		pass			0.0E+00

NOTE: "fail-r" - residual DO for each run too low to pass test

CARMACKS SEWAGE TREATMENT PLANT
JANUARY SAMPLING

BOD5 ANALYSIS

SAMPLE ID #	SMPL VOL (ml)	"P-VALUE" (dec.%)	DO.1 (mg/L)	DO.2 (mg/L)	BOD5 (mg/L)	VALID?	DELTA DO (ppm)
A - Inf.	3	0.01	7.80	4.80	300.0	t	3.00
A - Inf.	9	0.03	7.60	1.50	203.3	t	6.10
B - Inf.	3	0.01	7.70	6.10	160.0	fail-u	1.60
B - Inf.	9	0.03	8.40	4.00	146.7	t	4.40
C - Inf.	3	0.01	9.10	7.00	210.0	t	2.10
C - Inf.	9	0.03	9.10	3.00	203.3	t	6.10
A - Eff.	2	0.01	8.00	0.80	1080.0	fail-r	7.20
A - Eff.	3	0.01	7.90	0.00	790.0	fail-r	7.90
A - Eff.	9	0.03	7.00	0.00	233.3	fail-r	7.00
A - Eff.	20	0.07	6.00	0.00	90.0	fail-r	6.00
B - Eff.	2	0.01	7.40	0.20	1080.0	fail-r	7.20
B - Eff.	3	0.01	7.40	0.00	740.0	fail-r	7.40
B - Eff.	9	0.03	5.90	0.00	196.7	fail-r	5.90
B - Eff.	20	0.07	4.20	0.00	63.0	fail-r	4.20
C - Eff.	2	0.01	7.40	0.40	1050.0	fail-r	7.00
C - Eff.	3	0.01	7.50	0.00	750.0	fail-r	7.50
C - Eff.	9	0.03	6.20	0.00	206.7	fail-r	6.20
C - Eff.	20	0.07	4.80	0.00	72.0	fail-r	4.80
Diln H2O	300	1.00	8.20	8.10	0.1	w	0.10

NOTE: "t" - Dilution strength meets criteria for residual DO at least 1 mg/L and DO uptake at least 2 mg/L
"fail-r" - Test failed due to too low a residual DO \ "fail-u" - Test failed due to insufficient DO uptake
"w" - Dilution Water meets criteria for DO uptake of no more than 0.2 mg/L

CARMACKS SUMMARY
BOD5, TSS, TVSS, & FAECAL COLIFORMS ANALYSES

SAMPLE ID #	BOD5 (mg/L)	VALID? (BOD5)	TSS (mg/L)	TVSS (mg/L)	F. COLIF. (c./100ml)
A - Inf.	251.7	pass	374	279	2.2E+07
B - Inf.	146.7	pass	28	33	1.4E+07
C - Inf.	206.7	pass	101	74	5.4E+07
A - Eff.		fail-r	1509	789	5.6E+06
B - Eff.		fail-r	6240	3225	5.5E+06
C - Eff.		fail-r	4590	2605	4.5E+06
control		pass			0.0E+00

SAMPLE IDENTIFICATION

Carmacks Sewage Influent/Effluent Samples   Oct. 19-20/93
Samples Collected by : Vic Enns (403)667-3403   EP Yukon

SAMPLE I.D.

TOT. METALS	C.O.D.	NUTS		
A1	A2	A3	A	Effluent Composite 17:30 to 20:30
B1	B2	B3	B	Influent Composite 18:00 to 21:00
C1	C2	C3	C	Effluent Composite 03:30 to 06:30
D1	D2	D3	D	Influent Composite 03:00 to 06:00
E1	E2	E3	E	Effluent Composite 22:30 to 01:30
F1	F2	F3	F	Influent Composite 22:00 to 01:00
G1	G2	G3	G	Effluent Composite 24 hour composite
H1	H2	H3	H	Influent Composite 24 hour composite

RESULTS FOR CARMACKS SEWAGE TREATMENT SAMPLES

Parameter Analyzed		Units	A1 932175-001	B1 932175-002	C1 932175-003	D1 932175-004	E1 932175-005
ALKALINITY		mg/l	-	-	-	-	-
CHLORIDE		mg/l	-	-	-	-	-
CONDUCTIVITY		uS/cm	-	-	-	-	-
METALS/TOTAL (WATER-ICP)	AG	mg/l	<.01	<.01	<.01	<.01	<.01
	AL	mg/l	.07	1.41	.07	<.06	<.06
	AS	mg/l	<.06	<.06	<.06	<.06	<.06
	B	mg/l	.1	.19	.1	.03	.1
	BA	mg/l	.056	.1	.053	.1	.053
	BE	mg/l	.002	.002	.002	<.001	<.001
	CA	mg/l	56.7	58.6	55.4	60.2	55
	CD	mg/l	<.006	<.006	<.006	<.006	<.006
	CO	mg/l	<.006	<.006	<.006	<.006	<.006
	CR	mg/l	<.006	.008	<.006	<.006	.01
	CU	mg/l	.021	.147	.02	.053	.018
	FE	mg/l	.136	.658	.165	.319	.072
	K	mg/l	9.5	13.2	9.6	8	9.5
	MG	mg/l	11.5	12.1	11.5	12.7	11
	MN	mg/l	.157	.16	.135	.254	.164
	MO	mg/l	<.01	<.01	<.01	<.01	<.01
	NA	mg/l	47.9	53.6	47.1	22.2	46.9
	NI	mg/l	<.02	<.02	<.02	<.02	<.02
	P	mg/l	4.2	8	4.3	4.9	4.2
	PB	mg/l	<.06	<.06	<.06	<.06	<.06
	SB	mg/l	<.06	<.06	<.06	<.06	<.06
	SE	mg/l	<.06	<.06	<.06	<.06	<.06
	SI	mg/l	8.31	12	8.36	7.06	8.2
	SN	mg/l	<.06	<.06	<.06	<.06	<.06
	SR	mg/l	.358	.392	.354	.401	.348
	TI	mg/l	<.002	.017	<.002	.002	<.002
	V	mg/l	<.01	<.01	<.01	<.01	<.01
	ZN	mg/l	.191	.194	.11	.06	.11
NITROGEN/AMMONIA		mg/l	-	-	-	-	-
/NITRITE		mg/l	-	-	-	-	-
/NITRITE+NITRATE		mg/l	-	-	-	-	-
OXYGEN DEMAND/CHEMICAL		mg/l	-	-	-	-	-
PH		Rel.U.	-	-	-	-	-
PHOSPHORUS/TOTAL		mg/l	-	-	-	-	-
RESIDUE/FILTERABLE		mg/l	-	-	-	-	-
/NON-FILTERABLE		mg/l	-	-	-	-	-
TURBIDITY		FTU	-	-	-	-	-

RESULTS FOR CARMACKS SEWAGE TREATMENT SAMPLES

Parameter Analyzed		Units	F1 932175-006	G1 932175-007	H1 932175-008	A2 932175-009	B2 932175-010
ALKALINITY		mg/l	-	-	-	-	-
CHLORIDE		mg/l	-	-	-	-	-
CONDUCTIVITY		uS/cm	-	-	-	-	-
METALS/TOTAL (WATER-ICP)	AG	mg/l	<.01	<.01	<.01	-	-
	AL	mg/l	.72	.69	.06	-	-
	AS	mg/l	<.06	<.06	<.06	-	-
	B	mg/l	.17	.09	.1	-	-
	BA	mg/l	.088	.097	.054	-	-
	BE	mg/l	<.001	.003	.001	-	-
	CA	mg/l	57.8	59.1	56.3	-	-
	CD	mg/l	<.006	<.006	<.006	-	-
	CO	mg/l	<.006	<.006	<.006	-	-
	CR	mg/l	<.006	<.006	<.006	-	-
	CU	mg/l	.073	.087	.017	-	-
	FE	mg/l	.421	.51	.093	-	-
	K	mg/l	10	10	9.3	-	-
	MG	mg/l	12	12.3	11	-	-
	MN	mg/l	.185	.212	.127	-	-
	MO	mg/l	<.01	<.01	<.01	-	-
	NA	mg/l	49	42.2	45.2	-	-
	NI	mg/l	<.02	<.02	<.02	-	-
	P	mg/l	5.7	6.3	4.2	-	-
	PB	mg/l	<.06	<.06	<.06	-	-
	SB	mg/l	<.06	<.06	<.06	-	-
	SE	mg/l	<.06	<.06	<.06	-	-
	SI	mg/l	10	9.79	8.19	-	-
	SN	mg/l	<.06	<.06	<.06	-	-
	SR	mg/l	.381	.389	.352	-	-
	TI	mg/l	.014	.008	<.002	-	-
	V	mg/l	<.01	<.01	<.01	-	-
	ZN	mg/l	.21	.158	.132	-	-
NITROGEN/AMMONIA		mg/l	-	-	-	-	-
/NITRITE		mg/l	-	-	-	-	-
/NITRITE+NITRATE		mg/l	-	-	-	-	-
OXYGEN DEMAND/CHEMICAL		mg/l	-	-	-	98	479
PH		Rel.U.	-	-	-	-	-
PHOSPHORUS/TOTAL		mg/l	-	-	-	-	-
RESIDUE/FILTERABLE		mg/l	-	-	-	-	-
/NON-FILTERABLE		mg/l	-	-	-	-	-
TURBIDITY		FTU	-	-	-	-	-

RESULTS FOR CARMACKS SEWAGE TREATMENT SAMPLES

Parameter Analyzed		Units	C2 932175-011	D2 932175-012	E2 932175-013	F2 932175-014	G2 932175-015
ALKALINITY		mg/l	-	-	-	-	-
CHLORIDE		mg/l	-	-	-	-	-
CONDUCTIVITY		uS/cm	-	-	-	-	-
METALS/TOTAL (WATER-ICP)	AG	mg/l	-	-	-	-	-
	AL	mg/l	-	-	-	-	-
	AS	mg/l	-	-	-	-	-
	B	mg/l	-	-	-	-	-
	BA	mg/l	-	-	-	-	-
	BE	mg/l	-	-	-	-	-
	CA	mg/l	-	-	-	-	-
	CD	mg/l	-	-	-	-	-
	CO	mg/l	-	-	-	-	-
	CR	mg/l	-	-	-	-	-
	CU	mg/l	-	-	-	-	-
	FE	mg/l	-	-	-	-	-
	K	mg/l	-	-	-	-	-
	MG	mg/l	-	-	-	-	-
	MN	mg/l	-	-	-	-	-
	MO	mg/l	-	-	-	-	-
	NA	mg/l	-	-	-	-	-
	NI	mg/l	-	-	-	-	-
	P	mg/l	-	-	-	-	-
	PB	mg/l	-	-	-	-	-
	SB	mg/l	-	-	-	-	-
	SE	mg/l	-	-	-	-	-
	SI	mg/l	-	-	-	-	-
	SN	mg/l	-	-	-	-	-
	SR	mg/l	-	-	-	-	-
	TI	mg/l	-	-	-	-	-
	V	mg/l	-	-	-	-	-
	ZN	mg/l	-	-	-	-	-
NITROGEN/AMMONIA		mg/l	-	-	-	-	-
/NITRITE		mg/l	-	-	-	-	-
/NITRITE+NITRATE		mg/l	-	-	-	-	-
OXYGEN DEMAND/CHEMICAL		mg/l	61	173	52	424	56
PH		Rel.U.	-	-	-	-	-
PHOSPHORUS/TOTAL		mg/l	-	-	-	-	-
RESIDUE/FILTERABLE		mg/l	-	-	-	-	-
/NON-FILTERABLE		mg/l	-	-	-	-	-
TURBIDITY		FTU	-	-	-	-	-

RESULTS FOR CARMACKS SEWAGE TREATMENT SAMPLES

Parameter Analyzed		Units	H2 932175-016	A3 932175-017	B3 932175-018	C3 932175-019	D3 932175-020
ALKALINITY		mg/l	-	149	356	148	325
CHLORIDE		mg/l	-	44.2	46.9	43.1	27
CONDUCTIVITY		uS/cm	-	743	934	731	778
METALS/TOTAL (WATER-ICP)	AG	mg/l	-	-	-	-	-
	AL	mg/l	-	-	-	-	-
	AS	mg/l	-	-	-	-	-
	B	mg/l	-	-	-	-	-
	BA	mg/l	-	-	-	-	-
	BE	mg/l	-	-	-	-	-
	CA	mg/l	-	-	-	-	-
	CD	mg/l	-	-	-	-	-
	CO	mg/l	-	-	-	-	-
	CR	mg/l	-	-	-	-	-
	CU	mg/l	-	-	-	-	-
	FE	mg/l	-	-	-	-	-
	K	mg/l	-	-	-	-	-
	MG	mg/l	-	-	-	-	-
	MN	mg/l	-	-	-	-	-
	MO	mg/l	-	-	-	-	-
	NA	mg/l	-	-	-	-	-
	NI	mg/l	-	-	-	-	-
	P	mg/l	-	-	-	-	-
	PB	mg/l	-	-	-	-	-
	SB	mg/l	-	-	-	-	-
	SE	mg/l	-	-	-	-	-
	SI	mg/l	-	-	-	-	-
	SN	mg/l	-	-	-	-	-
	SR	mg/l	-	-	-	-	-
	TI	mg/l	-	-	-	-	-
	V	mg/l	-	-	-	-	-
	ZN	mg/l	-	-	-	-	-
NITROGEN/AMMONIA		mg/l	-	.302	31.1	.135	38.1
/NITRITE		mg/l	-	.165	<.002	.056	<.002
/NITRITE+NITRATE		mg/l	-	25.8	.016	26.6	.022
OXYGEN DEMAND/CHEMICAL		mg/l	337	-	-	-	-
PH		Rel.U.	-	7.17	7.38	7.24	7.66
PHOSPHORUS/TOTAL		mg/l	-	4.71	8.49	5.11	5.31
RESIDUE/FILTERABLE		mg/l	-	500	490	490	350
/NON-FILTERABLE		mg/l	-	<10	100	<10	<10
TURBIDITY		FTU	-	3.2	54	3.4	12

RESULTS FOR CARMACKS SEWAGE TREATMENT SAMPLES

Parameter Analyzed		Units	E3 932175-021	F3 932175-022	G3 932175-023	H3 932175-024
ALKALINITY		mg/l	150	334	147	345
CHLORIDE		mg/l	44.1	45	42.5	37
CONDUCTIVITY		uS/cm	738	883	727	869
METALS/TOTAL (WATER-ICP)	AG	mg/l	-	-	-	-
	AL	mg/l	-	-	-	-
	AS	mg/l	-	-	-	-
	B	mg/l	-	-	-	-
	BA	mg/l	-	-	-	-
	BE	mg/l	-	-	-	-
	CA	mg/l	-	-	-	-
	CD	mg/l	-	-	-	-
	CO	mg/l	-	-	-	-
	CR	mg/l	-	-	-	-
	CU	mg/l	-	-	-	-
	FE	mg/l	-	-	-	-
	K	mg/l	-	-	-	-
	MG	mg/l	-	-	-	-
	MN	mg/l	-	-	-	-
	MO	mg/l	-	-	-	-
	NA	mg/l	-	-	-	-
	NI	mg/l	-	-	-	-
	P	mg/l	-	-	-	-
	PB	mg/l	-	-	-	-
	SB	mg/l	-	-	-	-
	SE	mg/l	-	-	-	-
	SI	mg/l	-	-	-	-
	SN	mg/l	-	-	-	-
	SR	mg/l	-	-	-	-
	TI	mg/l	-	-	-	-
	V	mg/l	-	-	-	-
	ZN	mg/l	-	-	-	-
NITROGEN/AMMONIA		mg/l	.285	29.7	.211	37.1
/NITRITE		mg/l	.132	<.002	.11	<.002
/NITRITE+NITRATE		mg/l	26.8	.014	26.6	.019
OXYGEN DEMAND/CHEMICAL		mg/l	-	-	-	-
PH		Rel.U.	7.23	7.32	7.34	7.53
PHOSPHORUS/TOTAL		mg/l	5.01	5.78	4.82	6.3
RESIDUE/FILTERABLE		mg/l	490	500	490	450
/NON-FILTERABLE		mg/l	<9	49	<10	50
TURBIDITY		FTU	3.3	36	2.1	36

CARMACKS S.T.P. - MONITORING

WATER SAMPLE INVENTORY

STATION	DATE / TIME		NUTS	COD
CARMACKS S.T.P. EFFLUENT 11:30 - 14:30 25/1/94	25/1/94		1	7
CARMACKS S.T.P. EFFLUENT 2:30 - 4:30 25/1/94	25/1/94		2	8
CARMACKS S.T.P. EFFLUENT 24 HR. COMP.	25/1/94		3	9
CARMACKS S.T.P. INFLUENT 2:30 - 5:30 25/1/94	25/1/94		4	10
CARMACKS S.T.P. INFLUENT 11:30 - 13:30 25/1/94	25/1/94		5	11
CARMACKS S.T.P. INFLUENT 24 HR. COMP.	25/1/94		6	12

Notes: "COD" means Chemical Oxidation Demand

"NUTS" means Nutrients for analysis.

eas\smplinv.crl

RESULTS FOR CARMACKS STP SAMPLES

SAMPLE #

Parameter Analyzed	Units	940160-001 (1)	940160-002 (2)	940160-003 (3)	940160-004 (4)	940160-005 (5)
ALKALINITY	mg/l	314	674	233	382	350
CHLORIDE	mg/l	50	51	50	50	63
NITROGEN/AMMONIA	mg/l	18.1	193	106	44.1	33.2
/NITRITE	mg/l	<.002	.012	.008	<.002	.002
/NITRITE+NITRATE	mg/l	.02	.128	.058	.006	.022
OXYGEN DEMAND/CHEMICAL	mg/l	1780	9290	5260	270	790
PH	Rel.U.	6.79	6.37	6.34	7.61	7.22
PHOSPHORUS/TOTAL	mg/l	22	113	23	4.9	9.43
RESIDUE/FILTERABLE	mg/l	410	1200	420	480	475
/NON-FILTERABLE	mg/l	1160	6200	3600	30	370
TURBIDITY	FTU	135	26	55	22	150

Parameter Analyzed	Units	940160-006 (6)
ALKALINITY	mg/l	332
CHLORIDE	mg/l	53
NITROGEN/AMMONIA	mg/l	40.7
/NITRITE	mg/l	<.002
/NITRITE+NITRATE	mg/l	.017
OXYGEN DEMAND/CHEMICAL	mg/l	450
PH	Rel.U.	7.41
PHOSPHORUS/TOTAL	mg/l	6.7
RESIDUE/FILTERABLE	mg/l	490
/NON-FILTERABLE	mg/l	100
TURBIDITY	FTU	51