CONFIDENTIAL

THE ARSENIC PROBLEM AT YELLOWKNIFE

REPORT OF ENVIRONMENTAL AND MEDICAL INVESTIGATIONS

OCCUPATIONAL HEALTH DIVISION
DEPARTMENT OF NATIONAL HEALTH AND WELFARE
OTTAWA

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This report covers a continuing survey of the arsenic problem at Yellowknife for the period 1950-1955.

Environmental Investigation

This describes the development of collection and disposal methods for control of the hazard. In this section of the report an assessment of environmental contamination is provided. The survey was carried out by Kingsley Kay, J.P. Windish and J.L. Monkman, of the Laboratory Services, Occupational Health Division with the assistance of Consolidated Mining and Smelting Company; Giant Yellowknife Gold Mine; Analytical Laboratory, Mines Branch, Mines and Technical Surveys Department; Lands Division, Northern Administration and Lands Branch, Northern Affairs and National Resources Department; and Food and Drugs Divisions.

Clinical Investigation

This covers the medical aspects of the examination of population sample and urinary analyses.

An analysis of hospital admission from 1948 to 1953 is included.

This section was completed by Dr. D.L. Henderson with the assistance of the Research Division.

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THE ARSENIC PROBLEM AT YELLOWKNIFE
ENVIRONMENTAL REPORT FOR THE YEARS 1950-55

Since 1950, a continuing environmental survey of the arsenic problem in the Yellowknife area has been carried out by Kingsley Kay, J.P. Windish and J.L. Monkman, of the Laboratory Services, Occupational Health Division. Assistance has been received from the following: Consolidated Mining and Smelting Company; Giant Yellowknife Gold Mine; Analytical Laboratory, Mines Branch, Mines and Technical Surveys Department; Lands Division, Northern Administration and Lands Branch, Northern Affairs and National Resources Department; and Food and Drugs Divisions.

1. There are two main producing mines in Yellowknife - Con, situated about one mile south of the Townsite and Giant Yellowknife which is about three miles north of the town. The Townsite and Con Mine lie south of the Giant Mine as will be seen in Figure 1. The area is around 40 percent lakes, some of which constitute drainage sub-groups. In general, the land is flat and rocky. Precipitation is very low. The wind is from NW to NE quarter roughly half the time throughout the year. In the spring south winds occur.

2. The ores treated at both mines are of the arseno-pyrite variety, requiring roasting at some stage in their processing for full recovery of the gold. The fumes so produced contain arsenic trioxide and sulfur oxides. Con roasted its first ore in 1941, shut down after a few months, then resumed roasting in July, 1948. Two to three tons of arsenic trioxide per day were discharged in the roaster fumes from a 100 foot stack. The Giant roaster, four miles north of Con, first went into operation on January 29, 1949. Giant was emitting to the atmosphere, through a 150 foot stack around 8 tons of arsenic trioxide per day. By mid-February, 1949, two men working at Akaitcho, one and one-half miles north of Giant, had been hospitalized with a definite diagnosis of arsenic poisoning caused by drinking contaminated snow-water. In May, arsenic poisoning resulted in the death of six cows pastured one mile west of Con. Many dogs in the town and surrounding district showed symptoms of poisoning and there was some loss of wild-life, generally attributed to arsenic.

3. In August 1949, Con put into operation on an experimental basis a collection device which had been developed and used previously for another purpose at the Consolidated Mining and Smelting Company's plant at Trail, B.C. This method of collection, which came to be known as the "impinger" method, involved trapping the arsenic fume in water. This, however, resulted in the formation of about 16 tons of arsenic-bearing sludge per day. This sludge was discharged to a nearby lake.

4. Giant Yellowknife Mine was meanwhile exploring the possibility of installing a Cottrell precipitator.

5. Officers of the Department of National Health and Welfare and the Department of Mines and Resources began conferring on the public health danger in May, 1949. The area had been visited in that month by a representative of the Public Health Engineering Division. In the Fall of the year the Occupational Health Division in company with Mines and Resources officials held consultations with representatives of the Companies in Yellowknife.

6. The method of collection at Con Mine had been subject to failures due to corrosion of parts. Giant had not made

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progress on a collection installation. The Department of National Health and Welfare then recommended that roasting be stopped until adequate collection procedures had been installed.

7. The recommendation of the Department was not found acceptable by North West Territories Council to which it was submitted. However, a series of meetings in Ottawa were arranged early in 1950, and both companies entered into agreements to speed installation of effective collection systems. The Occupational Health Division was made responsible for continuing study of the hazard in order to maintain close watch on the situation until the hazard had been brought under control.

PART I

(a) COLLECTION OF ARSENIC FROM ROASTER FUME

8. During 1950, Con Mine continued experiments with its impinger method in which waste roaster gases are cooled with diluting air, then drawn down a vertical duct whose outlet is immersed in water. A cone is seated in the water, with its pointed end projecting well into the duct. This results in a continuously decreasing orifice through which the gases must pass at continuously increasing speeds. The condensed arsenic trioxide particles impinge on the water surface, lose their momentum, are wetted and retained in the water to form a slurry. The cleaned air escapes around a baffle and is discharged to a stack. Difficulties with corrosion of cones were first met with but were reduced late in 1950 and stack collection efficiencies around 95% followed. Our stack tests in July, 1954, showed that high collection efficiencies were being maintained (See Table 1). Further tests in July 1955, have confirmed the situation.

9. On January 20, 1950, Giant Mine ordered a cold Cottrell precipitation unit for arsenic collection. Delivery was scheduled for August 1950, but was not completed until spring of 1951. The Cottrell plant went into operation on October 29th, 1951, and yielded anticipated collection efficiencies around 95%.

10. The Cottrell equipment was designed to handle the fume from around 3,000 tons dry concentrate roasted per month. This represented double the production from the two horizontal roasters in operation at inception of the Cottrell collection. Roaster capacity was therefore added, in the form of a roaster of vertical type which had been brought into the area by another mine. This was purchased and put into operation during 1952. Roaster tonnages were then gradually increased to an average maximum of around 2900 tons per month by the end of 1953, as will be seen in Figure 2.

11. As production reached maximum, the Mine began encountering difficulties with collection. These were investigated for several months by the Mine and the Precipitation Company, supplier of the equipment. Early in 1954, it was decided that the introduction of the vertical roaster had produced an exceptional dust load which accounted for the loss of roughly half the collection efficiency. These figures were confirmed from our tests run in July 1954. (See Table 2).

12. It was recommended by the Precipitation Company that a spray tower for humidification of fume be constructed. This

presented the problem of disposal of arsenic-bearing water. The Mine did not consider that safe disposal could be effected and therefore placed an order for an additional Cottrell unit. Construction of the unit was immediately commenced and in the interim, metallurgical investigations were continued to alter the composition of the roaster fume.

13. The additional Cottrell unit began operating February 28, 1955, and under various conditions of trial, the system has collected at an average efficiency of around 70 percent with roaster tonnage of dry concentrate at the 3,000 ton per month level. This situation has been confirmed from our stack tests run in July, 1955. (See Table 3). A striking reduction in the arsenic settling on the area has followed, as demonstrated in Figure 3 covering fall pan estimations by Giant.

14. In order to further improve collection, it is now proposed to return to horizontal type roasters and to scrap the vertical unit. This will involve reconstruction over a period of approximately two years during which time the Mine would aim to collect at a stack efficiency of around 75 percent.

PART I

(b) DISPOSAL OF COLLECTED ARSENIC

15. In Con Mine, operation of the impinger resulted in production of a slurry, thickened to a sludge before being pumped to the disposal area. As previously stated the quantity of sludge approximated 16 tons per day. It contained around 20% solids, 50-60% being arsenic trioxide. The liquid phase of the sludge carried in solution 1-3 percent arsenic trioxide and some sulfur oxides. In 1949, this sludge was discharged at the rear of the roaster house from where it ran along the edge of a tailings pile for 1,000 feet and then entered Pud Lake. This body of water became heavily loaded with arsenic (See Figure 4). Following the cases of arsenic poisoning, the Company undertook to store the sludge for it was known that Pud Lake drained through a marsh into Kam Lake which was the largest body of water adjacent to the Townsite. Figure 4 indicates that movement of arsenic from Pud Lake to Kam Lake occurred. The concentration of arsenic in Kam Lake gradually rose as the level in Pud Lake fell.

16. Early in 1950, Con pumped the sludge into trenches dug in its tailings pile. The permanent frost line was about four feet below the surface so that there was not expected to be seepage in that direction. Seepage ditches were dug alongside the trenches to carry any overflow water back to the impinger. Capacity limitations and overflow problems during freezing weather made this method unsatisfactory. A natural depression in the pillow-lava, close to the roaster building, was therefore dammed by a cement wall to form a collection and settling basin. Geological examination of the area had shown no faults, but a few small shears were jointed to eliminate any possibility of seepage. Since the fall of 1950, the arsenic slurry has been pumped to the basin, allowed to settle and the supernatant pumped back to the impinger for reuse. During the winter there are possibly five months during which the slurry freezes and no solution can be returned to the impinger. As more than twice as much water is used in the impinger as is freed from the slurry, no difficulty has been encountered in using the basin in this way during the summer months. The storage basin is still in use and so far there

has been no direct indication of seepage. More recently there has been some indication that arsenic from the tailings pile may be finding its way into Pud Lake for the summer levels of this lake have risen (See Figure 4).

17. Giant Mine gave consideration to a number of methods for disposal or storage of the dry arsenic trioxide collected by the Cottrell plant. Underground storage in stopes prepared especially for the purpose was the method finally adopted as being the safest. The stopes are dug in a permafrost area about 500 feet from the nearest mine workings; they are completely frozen so that no migration of water will take place. Connecting raises are driven to the surface for ventilation and dumping of arsenic into the stopes. After the stopes are excavated, their entrances are sealed off with concrete bulkheads. Each morning a screw conveyor discharges the previous day's catch of arsenic down a raise to the stope. Cold air is continuously blown into the stope during winter to keep it permanently frozen. After a stope is filled with arsenic it is sealed off with concrete, the operation being carried out from the surface. This method appears to work satisfactorily.

Summary on Collection and Disposal

18. In the case of Con Mine, production has been carried on without significant change since 1949. The same roasting technique has been in use since the impinger collectors were installed. High efficiency appears to have been maintained by the collectors (Table 1).

19. The problem of disposal of the arsenic-bearing sludge at Con Mine is under immediate control but it is evident that the surface storage of large quantities of arsenic may ultimately present a menace to health particularly in view of the effect of weathering over years on the foundations of the basins. Yellowknife Townsite is one mile from the basin. This suggests that if the Townsite were to develop in size, the direction of the development should probably be directed away from the storage site.

20. The Cottrell precipitator installed by Giant Mine provided the advantage of dry collected material which could be safely stored in frozen dry underground areas. In the operation of this mine the disposal problem appears to be solved for future years.

21. The Cottrell precipitator installed by Giant Mine has been widely employed in ore roasting. It has appeared to be the case that Giant Yellowknife Mine deviated from the conditions of roasting for which its collection system was designed, in providing additional roaster capacity by the purchase of a different type of roaster locally. As a result the roaster tonnage capacity for which the unit was designed, yielded a particulate load in fume which exceeded the design characteristics of the collector.

22. The additional Cottrell unit installed this year has increased collection efficiency to an average of around 70 percent (Table 3). This has been reflected in a substantial drop in arsenic settling on the area (Figure 3). The action being taken to return to the original conditions of roasting by redesign of the plant equipment may be expected to restore the proper fume conditions for high efficiency collection.

PART II. ARSENIC CONTAMINATION IN THE AREA

23. Continuing assessment of the hazard at Yellowknife was undertaken in 1950, and an Occupational Health field officer

has visited the area twice yearly since that time. Environmental samples have been collected from various sources since 1951. The two mines have cooperated in the effort to assess the extent of contamination of the area and have provided data and carried out analyses for arsenic in samples from their areas.

24. Composite analysis of all data secured on the environmental situation has been carried out by the Laboratory Services of the Occupational Health Division. The data has included estimations on drinking water, general water bodies in the area, grass in winter and summer, and arsenic settling from the air. Each year samples of milk and locally grown vegetables have been analyzed. The efficiency of the collection systems installed at the two stacks has been confirmed by our stack sampling tests in the past two years.

The Condition of the Drinking Water

25. The two Mines and the Townsite use Yellowknife Bay as source of drinking water. A comprehensive record of the changes in the arsenic level of the water of Yellowknife Bay is given in Figure 5. This covers data obtained on Townsite tap water since February 1950. Chemical analysis was done by Con Mine. The increase in concentration each spring breakup is noteworthy but the duration is limited. Attention is drawn to an increase in the duration of the higher levels at breakup of ice, in 1955. This may reflect that the arsenic contamination of the area was augmented in the past Fall by the situation at Giant. The great reduction in arsenic released after February 28th (Figure 3) apparently did not offset the amount laid down previously in the winter.

26. Table 4 shows levels of arsenic in the three supplies as determined in July and December since 1952. The United States Public Health Service standard calls for not more than 0.05 parts arsenic per million for continuous use but it is suggested (Public Health Reports Vol. 58, page 1763, 1943) that in emergencies arsenic in concentrations up to 1 to 2 p.p.m. might be permitted for several days. It is, therefore, evident from Table 4 that the arsenic in the area has not contaminated the drinking water to a significant extent in July and December except that the level of 0.13 p.p.m. for Giant this past July was beyond the USPHS limit. This level was not reached in the Townsite supply as will be seen from Figure 5 and is reminiscent of the fleeting rise which occurred on July 30, 1954, also shown in Figure 5. Furthermore a tap water sample at Giant Mine showed only 0.015 p.p.m. on 25th June and 0.009 p.p.m. on July 12th. It is therefore supposed that the July sample from Giant represented a fleeting rise in concentration.

Arsenic in Locally-Produced Food

27. The possibility that arsenic might become incorporated into locally-grown vegetables and in milk produced in the area was recognized when the problem at Yellowknife first came under investigation. This was strongly indicated in 1950 from tests on celery and cabbage. Outer portion celery as drawn from a local storehouse was contaminated to the extent of 2590 p.p.m. - inner portion 185 p.p.m. Cabbage showed 674 p.p.m. for outer portion and 66 p.p.m. inner portion. Appropriate warning was issued by the Medical Officer of Health concerning careful washing of vegetables.

28. In 1951, a great improvement was noted. Cabbage showed only 2.5 p.p.m. for outer portion and 0.2 p.p.m. inner portion.

In succeeding years a further reduction took place. Outer portion fell to 0.4 p.p.m. by 1954 and inner portion to 0.03 p.p.m. Potatoes were tested in 1951, and 1952, and showed 0.3 p.p.m. and 0.05 p.p.m. respectively. Milk production has been on a continuing basis since 1951. In that year milk was found to contain 0.1 p.p.m., the same amount in 1952, 0.05 p.p.m. in 1953, 0.05 p.p.m. in 1954 and 0.05 p.p.m. in 1955.

29. As a food tolerance of 1 p.p.m. arsenic is allowed, the conclusion was reached that locally-grown vegetables, if properly washed, were not a significant source of arsenic after 1950.

Broad Assessment of General Contamination

30. It was recognized that even after stack collection of arsenic from roaster fume had been effected it would take time for the general contamination to be carried away through the drainage system in the area. Therefore a series of environmental checks was instituted with a view to following the level of general contamination.

31. Con and Giant lie on a NNE - SSW axis. The Townsite, an elongated area lies across this axis between the two mines. It was known that the wind blew from N, NE and NW around 50 percent of the time throughout fall, winter and spring months with some reduction in this proportion during the early summer. Con mine had reduced its effluent to small proportions by the time the sampling program was started in December 1951, hence the extent of contamination would in fact largely represent a measure of the contamination by Giant.

32. Water bodies form a substantial proportion of the region, running as high as 40 percent in some areas. Therefore selected samples of water were taken from each area to establish the year to year changes in the general level of water contamination. The results of these tests carried out in July and October from 1952 to 1955 are shown in Table 5. It is to be emphasized that these water samples were not solely drinking water but included a selection of lakes some of which had been used, as in the Con area, for disposal of collected arsenic. In fact the average level of arsenic in water bodies in the Con area was on the average higher than elsewhere because Con had polluted neighboring waters with arsenic sludge.

33. Table 5 establishes first that winter levels are below summer levels which is consistent with the yearly drainage of large amounts of arsenic into the water system at spring thaw. This arsenic load raises summer values. Winter levels rose for both Con and Giant areas in 1953 and fell in 1954 but an explanation for this rise is not evident. Considering all values, for summer and winter in each year, it is evident that a reduction in average level of arsenic in the overall water system of the area has not taken place. This must be attributed to the delay in bringing about fully efficient stack collection.

34. The assessment of general contamination of the Yellowknife land mass was approached by a grass sampling program. The results of this program of sampling are summarized in Table 6. As would be expected winter grass showed a considerably higher level of contamination than grass collected in the summer, the latter being exposed for a much shorter period. Winter grass contamination in the Giant area has shown some reduction between December 1951 and December 1954, possibly reflecting its high contamination level in 1951. However,

Con area has shown little change. This is consistent with the fall pan estimations of settled arsenic shown in Figure 6 and to be discussed later. In fact, as matters transpired, the reduction in effluent at Giant Mine was short-lived after the Cottrell began operation in October 1951. By the Fall of 1952 efficiency was falling and the effluent load was on the increase toward levels existing before Cottrell collection. In approximate terms, Giant's low efficiency collection and doubled roaster tonnage created as much pollution as its half scale roasting without collection of arsenic from the fume. The seemingly low arsenic concentration of Townsite winter vegetation in 1951 suggests that meteorological conditions may have reduced the transport in that year. Finally, average winter grass contamination for all points in the area shows little change over the period. This is in general agreement with water bodies contamination previously discussed and with fall pan data in Figure 6 for winter periods.

35. The summer grass values represent arsenic laid down over a shorter period and hence should reflect short term changes in the pollution events. The 1952 values were low. This is consistent as Giant was collecting at high efficiency during the spring and furthermore is confirmed by the fall pan data in Figure 6. In 1953, a rise occurred in arsenic on summer grass and this rise corresponded to the reduced collection efficiency at Giant. The reduction in contamination from summer 1953 to 1954 at Giant and Townsite is most likely a meteorological effect for no major reduction in Giant effluent was effected at this time. Con grass values showed a rise over 1953, not a fall, but the significance of the rise did not affect the overall average reduction for the whole area. Summer grass values for 1955 show a reduction from 1954. This is consistent with the greatly reduced arsenic discharge from Giant this year (Figure 3).

36. Assessment of the load of arsenic settling on the Yellowknife land mass was estimated by determining the arsenic falling into exposed pans over periods of several weeks during the year. A series of fall pans had been employed in the Con area from 1949. These were continued after the Con stack collection reached full operation in 1950. The findings from these pans are plotted in Figure 6 as average settled arsenic in pounds per acre per year. Because of the almost negligible effluent from Con after February 1951, the results from these pans give an indication of the contamination from Giant.

37. The findings conform generally to the grass and water data already discussed. Settled arsenic for the winter grass contamination period, June - December, in each year from 1951 - 1954 was very similar. Settled arsenic for the summer periods also followed changes in grass contamination. Figure 6 indicates that fall pan arsenic responded to the various changes which occurred in collection at the two mines. A major decrease followed inauguration of collection at Con Mine and Giant Mine in 1951. The increased arsenic discharge following the increase in roaster tonnage at Giant in 1952 was reflected in the findings.

38. The 1955 settled arsenic load is revealed first in Figure 3 which shows the striking reduction in settled arsenic in the Giant area as a result of the commencement of operation of a second Cottrell on February 28, 1955. This reduction in effluent was reflected in February to May fall pan values for the Con Area (Figure 6) and in summer vegetation levels for 1955. A reduction in summer water bodies levels (Table 5) was not recorded, no doubt because of the heavy load of arsenic laid down before the second Cottrell was put into operation.

39. Giant roasted 1500 tons of concentrate without collection prior to December 1951. Present operations cover roasting of 3,000 tons at 70 percent collection efficiency. It is aimed to maintain efficiency at 75 percent during a period of reconstruction lasting up to two years. In this event, around one-half as much arsenic will be discharged as in 1951. This should lead to substantial reduction in general contamination.

Summary on Arsenic Contamination in the Area

40. Prior to 1951, maximum levels of settled arsenic (Figure 6) were occurring. A significant reduction was brought about by the control at Con Mine.

41. The estimations carried out between 1951 and 1954 on water bodies, grass and settled arsenic, indicate that significant reduction of arsenic in the Yellowknife area in this period was prevented by the low collection at Giant.

42. The commencement of the operation of an additional Cottrell at Giant on February 28, 1955, was reflected in fall pan values at Giant (Figure 3) and Con (Figure 6). It was also indicated by a fall in 1955 summer grass. Thus, a new period in the arsenic situation at Yellowknife has been entered. If Giant continues to collect at present efficiency, around one half the arsenic evolved in 1951 prior to collection, will be discharged. This should lead to substantial reduction in general contamination.

Conclusions from the Environmental Findings

1. Collection - If Giant Mine continues to collect arsenic at present efficiency, the general level in the area should fall. Every effort should be made to speed reconstruction at this Mine so as to derive higher efficiencies from present Cottrell equipment.

2. Disposal - There is suggestive evidence that arsenic may be finding its way into Pud Lake from material laid down in Con tailings pile or from the storage basin. This aspect warrants close observation.

3. Continuing Assessment - In view of the reconstruction planned at Giant Mine to increase collection efficiency continuing assessment of arsenic distribution in the area for a further extended period is indicated. Substantial advantages would be obtained if the collection and analysis of samples were centred in Yellowknife. This would provide more direct contact with the Mines and the Local Medical Officer of Health. A review of the assessment program with officers of the Northern Affairs Department and the Department of Mines and Technical Surveys is recommended.

THE ARSENIC PROBLEM AT YELLOWKNIFE
MEDICAL REPORT FOR THE YEARS 1951 - 53

In 1951 it was decided to add a medical survey to the continuing environmental survey. After discussion with the Research Division regarding methods best suited to the project the following were chosen.

1. Medical Examination

The purpose was to examine a selected cross section of the population for evidence of ill effects which could be attributed to exposure to arsenic. It was decided that the school population, some 230 pupils forming approximately 10% of the total population, would be suitable since this embraced ages to 17 years, social status, racial difference, wage distribution, sex distribution, and was representative of the community.

The examinations were carried out with the co-operation of the Principal of the local school and took place at six monthly intervals. The examinations were of general nature such as would be carried out for insurance purposes or for entrance to the Armed Services but particular attention was paid to those parts which might indicate overexposure to arsenic. History was somewhat difficult to obtain because of the nomadic nature of those engaged in mining and because of the ages of the children.

The attendance register was inspected and throughout showed a high level of attendance.

It was noted that the children, in winter, were freely exposed to contact with snow.

Results of Examination

No evidence of ill effects which could be charged to overexposure to arsenic were found and the state of health was of a high order throughout the period of study.

2. Urinary Examination

Certain children were selected to supply urinary samples for analysis for arsenic content. The problem was complicated because of difficulties in obtaining a full supply at any one time and because of the changing population which made follow through impossible in some cases. Because of the above the number of samples dropped from 54 to 40 during the investigation.

The results of this analysis appear in the Tables which follow.

3. Hospital Statistics

The hospital admissions for the period from the opening of the Hospital in January 1948 to December 1952 were surveyed. From these data was collected and submitted to the Research Division for statistical treatment. The results appear in the tables together with a review of the analysis by the statistician.

Certain factors peculiar to Yellowknife should, however, be remembered in interpreting the tables. These are:

a. Private accommodation is limited and many single men live in bunkhouses at the mines.

b. Treatment is difficult in bunkhouses and there is a hospital available at no extra cost.

c. Because of a. and b. above many patients are admitted to hospital for minor conditions which would elsewhere be treated at home.

d. The effects of alcoholic indulgence are included under the heading of "poisons". This is by no means a rare cause for hospital admission.

e. There are few old persons in Yellowknife.

f. Tuberculosis cases are not admitted but passed straight through to Edmonton.

Conclusions

1. There is at present no evidence of ill effects which could be charged to overexposure to arsenic.

2. If present control is maintained, our opinion is that no undue hazard from atmospheric pollution by arsenic should occur.

3. That environmental investigation should continue since this will reveal any failure in control and provide opportunity to institute preventive measures to ensure the health of the community.

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REVIEW OF YELLOWKNIFE HOSPITAL STATISTICS

Comparative data was located for three other large hospital populations and, although it was not possible to make very precise analysis, the comparisons brought out some interesting relationships. The three hospital populations with which comparison was made are: (1) certain hospitals in England and Wales, 1949, (2) hospitals under the Saskatchewan Hospital Services Plan, 1950, and (3) the public general hospitals in Ontario, 1936-37.

Table I, attached, shows the numerical distribution of Yellowknife hospital admissions for each of the years 1948 to 1952, with the 1948-52 total shown also for each sex, according to disease group. The per cent distribution of the 1948-52 total for Yellowknife according to disease group is compared with that for the other three groups in Table II. Table III compares the per cent distribution by disease group for each sex for the Yellowknife and England and Wales surveys. The proportion of each sex concerned in each of the groups is given in Table IV, and the per cent distribution by age group for each sex is given for each group in Table V. Table VI gives per cent distribution over the disease groups for males and females by single years 1948 to 1952 for Yellowknife.

From Table II, it is noted that diseases of the respiratory system, skin and cellular tissue, and bones and organs of movement are relatively more frequent in the Yellowknife statistics (respiratory diseases appear high also in Saskatchewan but this is said to be due to the extent of hospitalization for removal of tonsils and adenoids). Accidents, poisonings, and violence are also more frequent in Yellowknife relative to total admissions. Neoplasms and diseases of the genito-urinary system are considerably less frequent in relation to total in Yellowknife than in the other three groups. Special admissions are more frequent than in England and Wales or Saskatchewan but not quite as high as in Ontario.

When the data of Table III is also considered, the following pattern becomes apparent:

Disease Group	Relative Yellowknife Incidence (both sexes) (Table II)	Relative Sex Differences (Table III)
Neoplasms	very low	males slightly lower than females in both surveys
Diseases of the genito-urinary system	low	males lower than females to same extent in both surveys
Diseases of the respiratory	high	males higher than females in both surveys but not to as great an extent in Yellowknife
Diseases of the skin and cellular tissues	very high	males higher than females in both surveys, but more so in Yellowknife
Diseases of the bones and organs of movement	high	males higher than females in both surveys, but males very high in Yellowknife and females lower in Yellowknife than in England and Wales
Effects of poisons	high (Effects of poisons; Accidents and violence)	practically no difference between sexes in England and Wales; in Yellowknife males are over twice as high relatively as females
Accidents and violence		males higher than females in both surveys, but females same in both surveys while males much higher in Yellowknife than in England and Wales
Special admissions	high (steady growth)	sexes almost the same in England and Wales, but in Yellowknife females almost twice as high as males

Based on the age distribution of those admitted to hospital, it is presumed that in the general population of Yellowknife there is a considerable excess of males over females, particularly at the working ages, and that for both sexes there is only a small proportion of elderly persons, (See Tables IV and V.)

The remarkably low incidence of neoplasma and the low incidence of diseases of the genito-urinary system, particularly for females, is probably attributable almost entirely to an aspect of the age distribution indicated for the population of Yellowknife, i.e. the low proportions at the older ages.

In at least one study(1) it has been found that the incidence of diseases of the bones and organs of movement is high for males who are occupied in mining. Whether or not the very high incidence for males in Yellowknife is solely attributable to the fact of mining rather than partly due to an aspect on the mining process, such as the specific air pollution being considered, cannot be deduced from the data at hand. It may be noted, however, that while the incidence for males is very high in Yellowknife compared with the data for England and Wales (Table III) that for Yellowknife females is comparatively low.

In the same report,(2) it is indicated that the incidence of accidents in Yellowknife tends to be high for males engaged in mining. That the high incidence for accidents is probably very directly related to mining is indicated by the fact that the incidence is very high for males while for females it is not any higher than in England and Wales.

Diseases of the respiratory system have a somewhat higher relative incidence in Yellowknife than in the other populations represented in Table II (as remarked on page 11, the high incidence in Saskatchewan is said to be related to hospitalization for the removal of tonsils and adenoids). Table III indicates that the increased impact in Yellowknife has been relatively greater for females than for males. If there is any connection between this incidence and the specific air pollution being considered, it might be related to a degree of "protection" which the males might be afforded through the occupation of mining and which most of the females therefore would not receive.

Diseases of the skin and cellular tissues and the effects of poisons, on the other hand, appear to have relative incidence in Yellowknife which are out of proportion for both males and females. While no conclusions about the cause of these incidences may be drawn from the data at hand, it might be considered significant that outstanding differences in incidence at Yellowknife as compared with other populations studied exist with regard to effects which might be most expected.

No comparative statistics were located in which the effects of antimony and arsenic were separated out from the total group of poisonings. However, in considering the higher relative incidence of the effects of poisons in the Yellowknife data, it must be kept in mind that effects of antimony and arsenic do form the bulk of the group.

(1) Nuffield Provincial Hospitals Trust, "Hospital and Community, II. Hospital-Treated Sickness Amongst the People of Ayrshire", p.74.
(2) Ibid., p.84.

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Table VI shows the per cent distribution of Yellowknife hospital admissions over the disease groups for males and females separately for each year, 1948 to 1952. Per cent distributions are also shown in this table for total admissions for these years and for the combined group of years. The marked deviations from other data, referred to above and shown in Tables II and III, are well sustained through the individual years of the period, within ranges of variation which may be expected from year to year in a small population which is concentrated geographically. However, there is very little, if any, evidence of trends which might be related to the specific air pollution being considered in the study.(1) The incidence of diseases of the skin and cellular tissue, which is high for Yellowknife throughout the period, is very high for both sexes for the year 1948. It might be considered reasonable to suppose that during the early years of the pollution the population was more susceptible to this type of disease than later when the pollution was still in effect but a resistance had been built up to it or better precautions against it had been worked out. A slight downward trend in the incidence of diseases of the bones and organs of movement is noted after 1949 for males; in 1950 the incidence in this disease group was high for females, but otherwise there does not appear to be any particular trend for females with regard to this group. A sizeable growth took place in the relative importance of "special admissions" over the period, particularly for females. More precise information concerning the reasons for the admissions might be of interest. Total numbers concerned in the rates for poisonings are much too small to allow for any decision regarding the variation in this incidence between years.

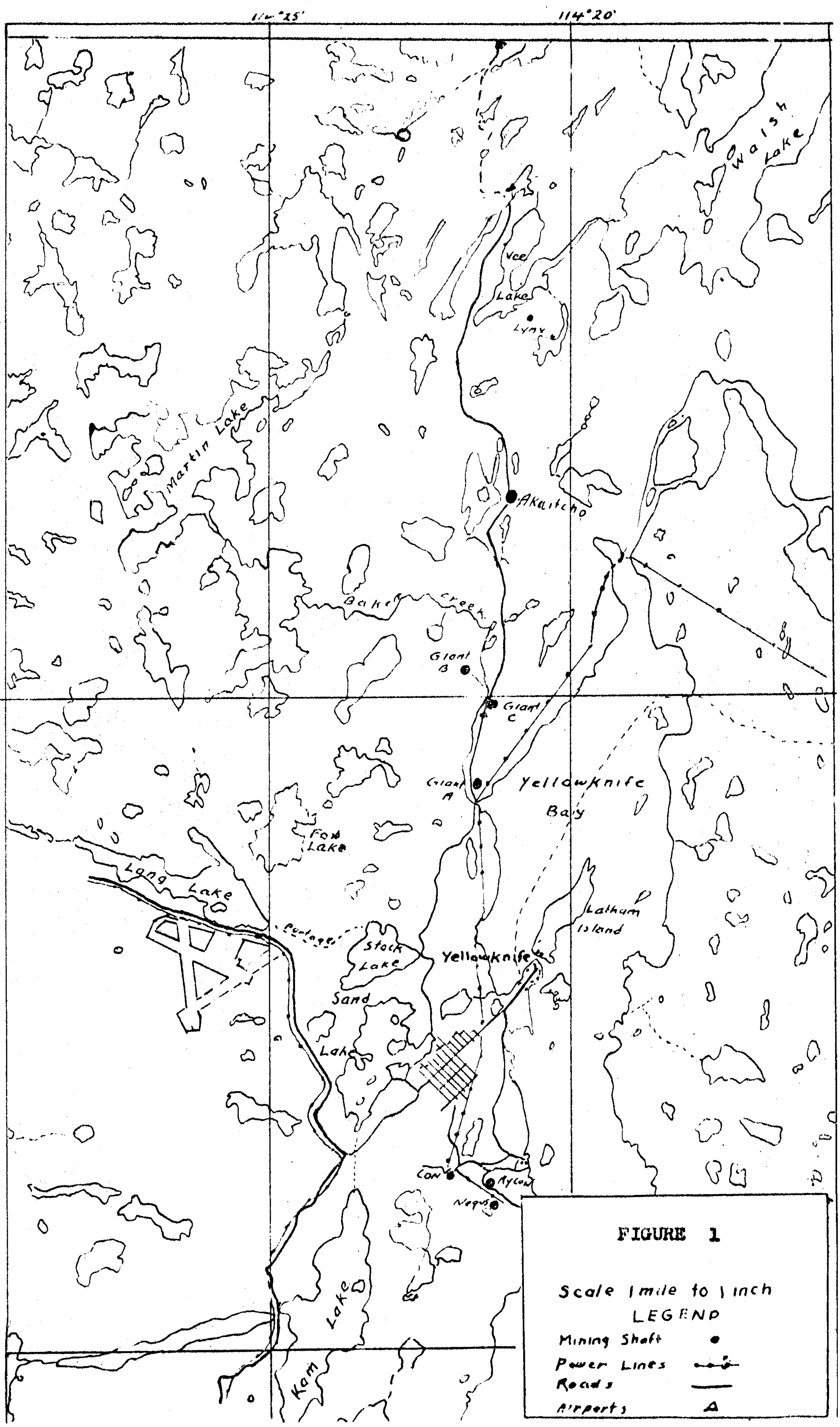
Summary

The data on Yellowknife hospital admissions show very particular deviations from that for studies related to (1) certain hospitals in England and Wales, 1949, (2) hospitals under the Saskatchewan Hospital Services Plan, 1950, and (3) the public general hospitals in Ontario, 1936-37. It is felt that these comparative studies concern populations which could not possibly be considered to have been subjected, as a whole, to the same type and extent of air pollution as that being considered in Yellowknife. However, within the period studied, changes occurred in the extent of pollution and there does not seem to be evidence in the data at hand that these changes were reflected in the incidence of disease as measured by hospital admissions. There is, then, no particular reason for assuming that the particular deviations which do exist in the incidence of disease in Yellowknife are connected with the specific air pollution being considered than with any other set of circumstances obtaining throughout the period, such as location, chief occupation (regardless of related air pollution), etc. In order to attempt to assign the deviations more precisely, it would be necessary to have more extensive information, such as data on hospital admissions for a period of years preceding 1946, for the years 1946 and 1947, and for a succession of years following 1951, the year in which pollution is understood to have ceased. The extent to which this data might be collected following 1951 would depend on the trends indicated as each year's information was assessed.

(1) It is understood that pollution by one large mine began in 1946 and that this was augmented in 1949 by pollution from another large mine. Apparatus for the elimination of most of this pollution (for one mine, 98 per cent elimination) was installed and put into operation during 1951.

Note: Pollution did not in fact remain under control. In 1952 pollution again rose. D.L.H.

Research Division,
February, 1954.


114°25'
114°20'
Walsh Lake
Vee Lake
Lynx
Martin Lake
Akaitcho
Baker Creek
Giant B
Giant C
Giant A
Yellowknife Bay
Fox Lake
Long Lake
Portage
Stock Lake
Yellowknife
Latham Island
Sand Lake
Con
Rycon
Negus
Kam Lake
FIGURE 1
Scale 1 mile to 1 inch
LEGEND
Mining Shaft
Power Lines
Roads
Airports

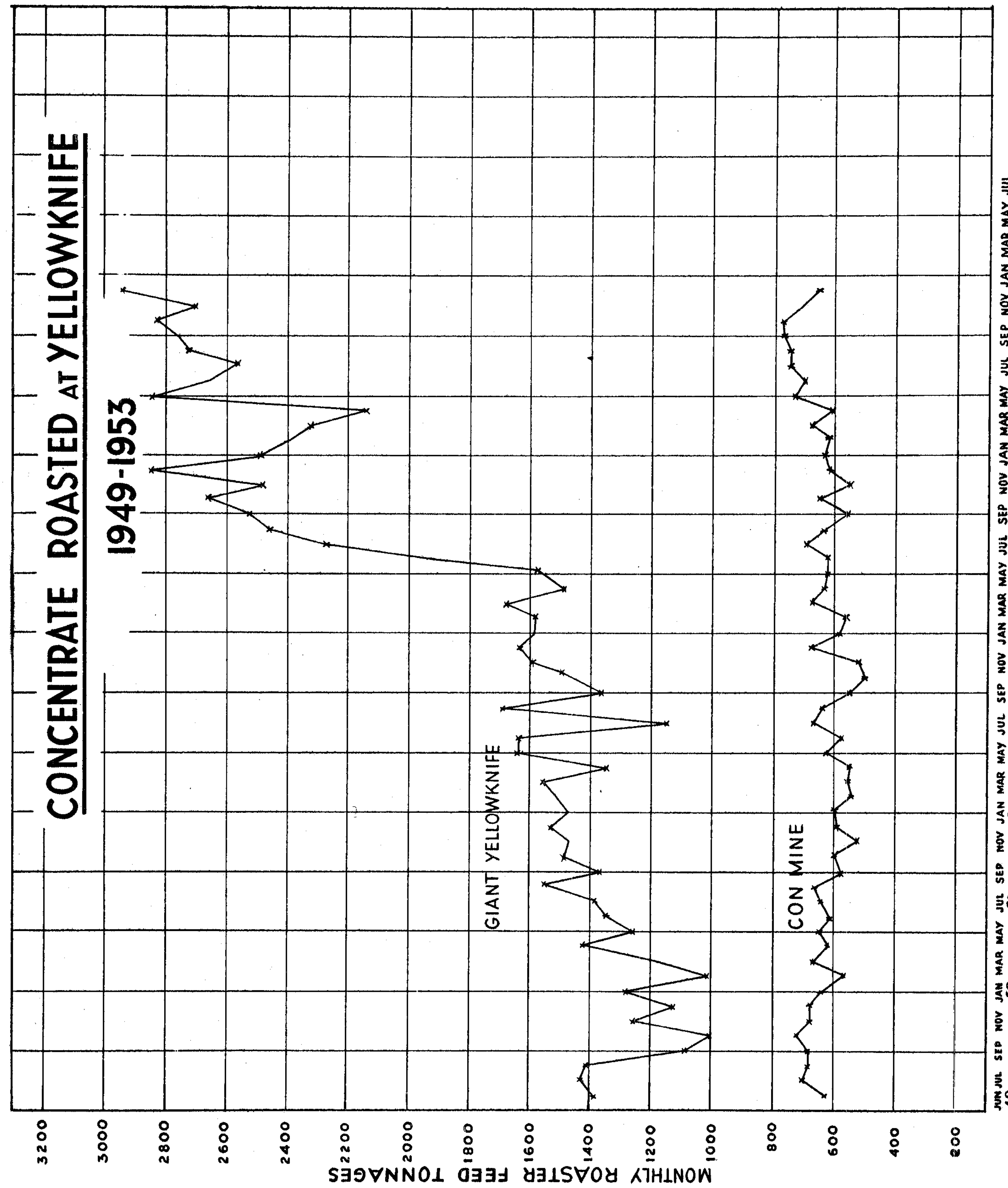

CONCENTRATE ROASTED AT YELLOWKNIFE
1949-1953
GIANT YELLOWKNIFE
CON MINE
MONTHLY ROASTER FEED TONNAGES
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
JUN JUL 49
SEP
NOV
JAN 50
MAR
MAY
JUL 50
SEP
NOV
JAN 51
MAR
MAY
JUL 51
SEP
NOV
JAN 52
MAR
MAY
JUL 52
SEP
NOV
JAN 53
MAR
MAY
JUL 53
SEP
NOV
JAN 54
MAR
MAY
JUL 54

FIGURE 2

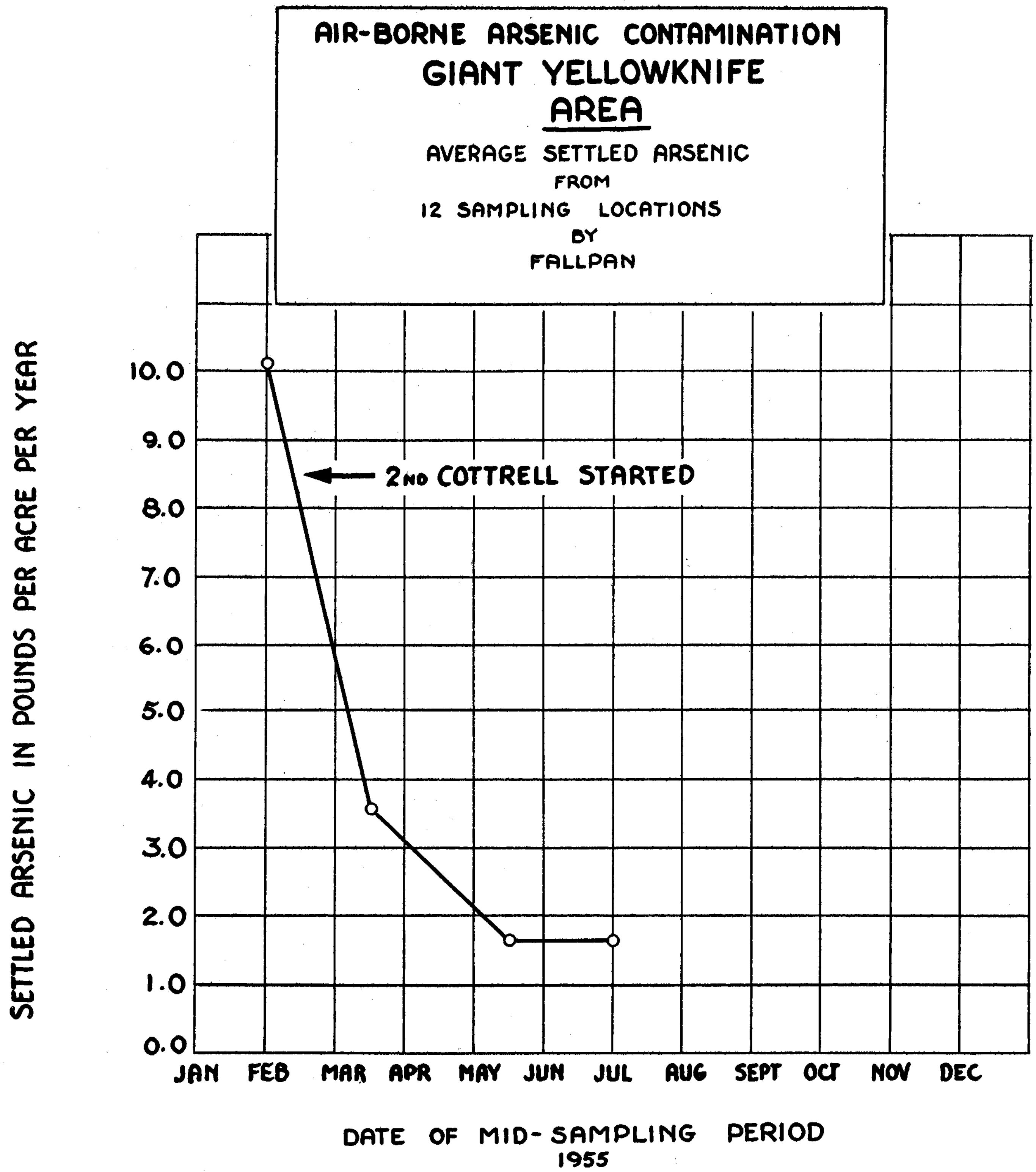

AIR-BORNE ARSENIC CONTAMINATION
GIANT YELLOWKNIFE
AREA
AVERAGE SETTLED ARSENIC
FROM
12 SAMPLING LOCATIONS
BY
FALLPAN
SETTLED ARSENIC IN POUNDS PER ACRE PER YEAR
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
2ND COTTRELL STARTED
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEPT
OCT
NOV
DEC
DATE OF MID-SAMPLING PERIOD
1955

FIGURE 3

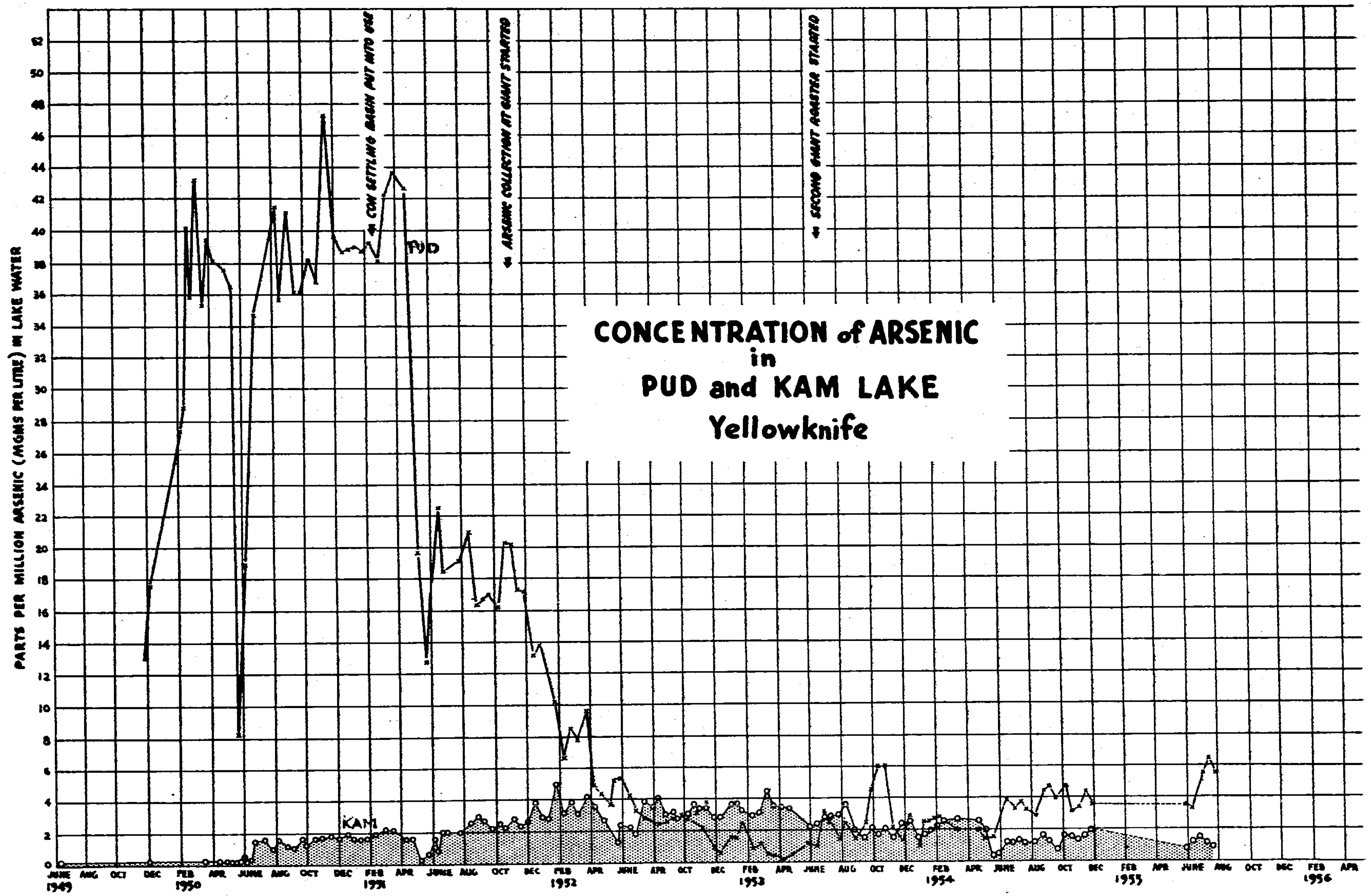

CONCENTRATION of ARSENIC in PUD and KAM LAKE Yellowknife
PARTS PER MILLION ARSENIC (MGMS PER LITRE) IN LAKE WATER
CON SETTLING BASIN PUT INTO USE
ARSENIC COLLECTION AT GIANT STARTED
SECOND GIANT ROASTER STARTED
PUD
KAM
1949
1950
1951
1952
1953
1954
1955
1956

FIGURE 4

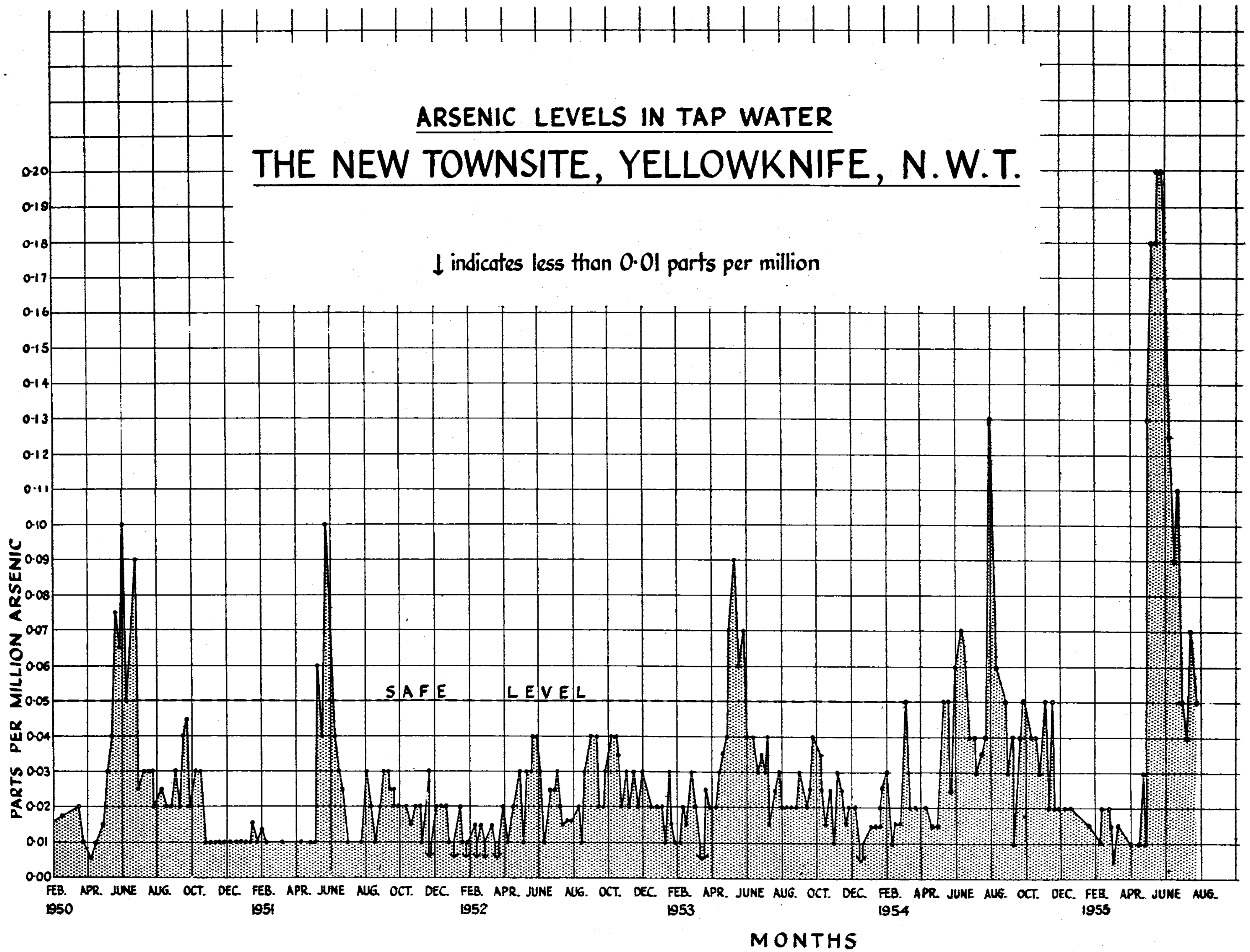

ARSENIC LEVELS IN TAP WATER
THE NEW TOWNSITE, YELLOWKNIFE, N.W.T.
↓ indicates less than 0·01 parts per million
SAFE LEVEL
PARTS PER MILLION ARSENIC
0·00
0·01
0·02
0·03
0·04
0·05
0·06
0·07
0·08
0·09
0·10
0·11
0·12
0·13
0·14
0·15
0·16
0·17
0·18
0·19
0·20
FEB. APR. JUNE AUG. OCT. DEC.
1950
FEB. APR. JUNE AUG. OCT. DEC.
1951
FEB. APR. JUNE AUG. OCT. DEC.
1952
FEB. APR. JUNE AUG. OCT. DEC.
1953
FEB. APR. JUNE AUG. OCT. DEC.
1954
FEB. APR. JUNE AUG.
1955
MONTHS

FIGURE 5

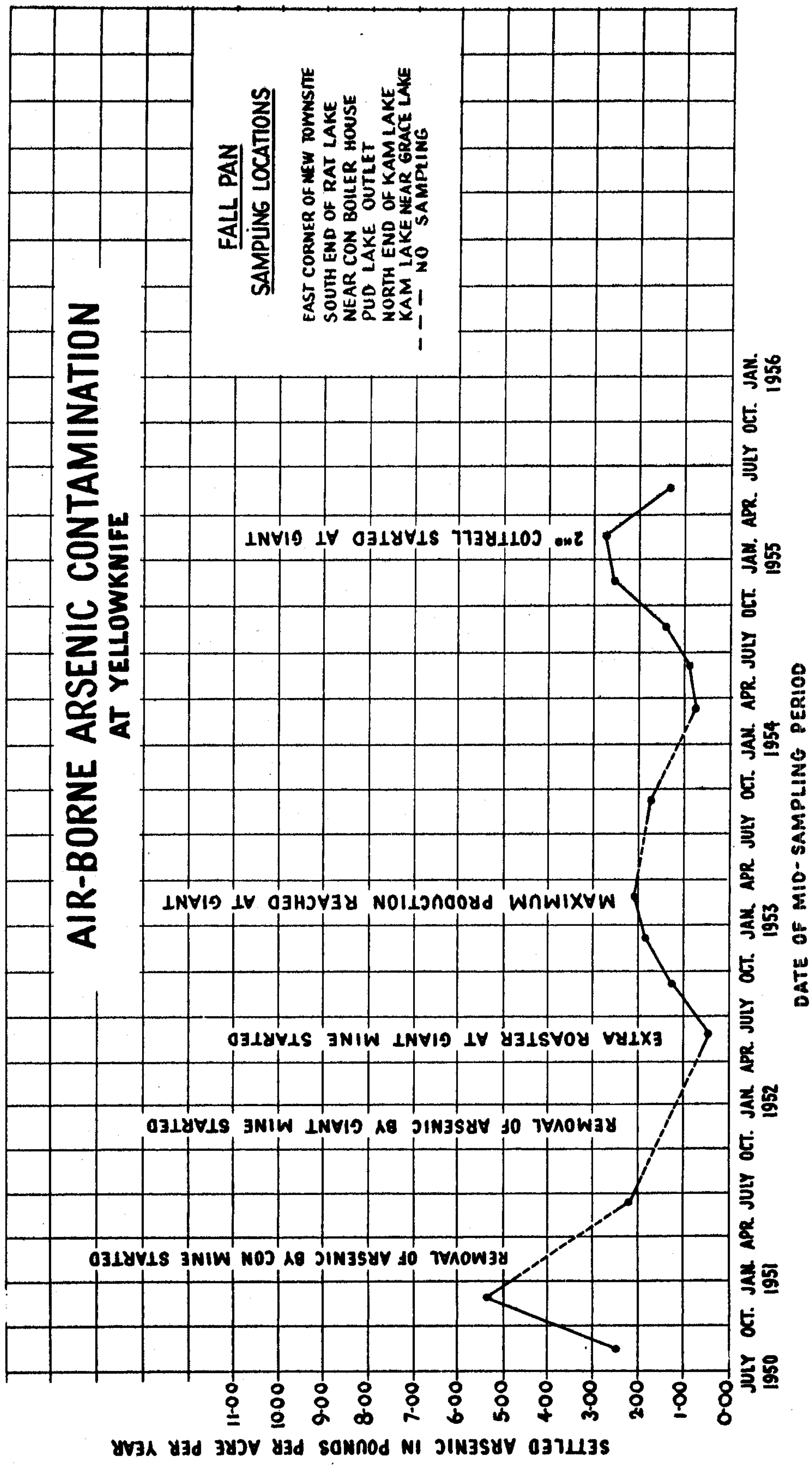

AIR-BORNE ARSENIC CONTAMINATION
AT YELLOWKNIFE
FALL PAN
SAMPLING LOCATIONS
EAST CORNER OF NEW TOWNSITE
SOUTH END OF RAT LAKE
NEAR CON BOILER HOUSE
PUD LAKE OUTLET
NORTH END OF KAM LAKE
KAM LAKE NEAR GRACE LAKE
— — — NO SAMPLING
REMOVAL OF ARSENIC BY CON MINE STARTED
REMOVAL OF ARSENIC BY GIANT MINE STARTED
EXTRA ROASTER AT GIANT MINE STARTED
MAXIMUM PRODUCTION REACHED AT GIANT
2ND COTTRELL STARTED AT GIANT
SETTLED ARSENIC IN POUNDS PER ACRE PER YEAR
0·00
1·00
2·00
3·00
4·00
5·00
6·00
7·00
8·00
9·00
10·00
11·00
JULY 1950
OCT.
JAN. 1951
APR.
JULY
OCT.
JAN. 1952
APR.
JULY
OCT.
JAN. 1953
APR.
JULY
OCT.
JAN. 1954
APR.
JULY
OCT.
JAN. 1955
APR.
JULY
OCT.
JAN. 1956
DATE OF MID-SAMPLING PERIOD

FIGURE 6

TABLE 1

ARSENIC COLLECTION EFFICIENCIES AT CON MINE BY STACK SAMPLING TESTS JULY 1954

Date	Sampling Period (24 Hour Clock)	Sampling Time (Minutes)	Collection Efficiency (Percent)	Tons Arsenic Discharged Per Day
21st		40	98.3	0.058
22nd	1140-1420	160	97.6	0.082
23rd	1110-1320	130	98.0	0.068
26th	0950-1230	160	98.4	0.053
26th	1500-1643	103	98.6	0.048
28th	1720-1801 1900-1952	93	99.1	0.028
28th	2115-2355	160	99.3	0.024
29th	1210-1358	108	99.1	0.030
29th	1820-1940	80	96.2	0.129
29th	1950-2110	80	96.2	0.129
30th	1930-2300	210	95.3	0.160

Average Efficiency 97.8 Percent

Average Discharge Per Day 0.074 Tons

I85
9.55

TABLE 2

ARSENIC COLLECTION EFFICIENCIES AT GIANT MINE

BY STACK SAMPLING TESTS

JULY 1954

Date	Sampling Period (24 Hour Clock)	Sampling Time (Minutes)	Collection Efficiency (Percent)	Tons Arsenic Discharged Per Day
9th	1650-1800	70	24.3	7.79
12th	1430-1640	120	50.2	5.13
13th	1035-1435	240	42.6	5.91
15th	0757-1157	240	48.0	5.35
15th	1416-1816	240	45.5	5.61
17th	0758-1158	240	45.4	5.62
17th	1406-1806	240	47.3	5.42
19th	1130-1230	60	39.3	6.25
19th	1408-1508	60	33.8	6.82

Average Efficiency 41.8 Percent

Average Discharge Per Day 5.99 Tons

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TABLE 3

ARSENIC COLLECTION EFFICIENCIES AT GIANT MINE

BY STACK SAMPLING TESTS

JULY 1955

Date	Sampling Period (24 Hour Clock)	Sampling Time (Minutes)	Collection Efficiency (Percent)	Tons Arsenic Discharged Per Day
12th	1024-1154	90	58.4	4.75
12th	1610-1810	120	75.5	2.79
13th	1536-1736	120	69.1	3.61
13th	1536-1736	120	71.6	3.31
13th	2151-2351	120	66.5	3.93
13th	2151-2351	120	63.8	4.22
14th	1209-1409	120	38.3	6.24
14th	1209-1409	120	53.7	4.68
15th	1041-1241	120	69.0	4.13
15th	1041-1241	120	73.9	3.48
15th	1653-1853	120	73.1	3.59
15th	1653-1853	120	83.5	2.20
16th	1050-1250	120	74.5	2.45
16th	1050-1250	120	64.6	3.39
16th	1800-2000	120	72.8	2.60
16th	1800-2000	120	69.5	3.02

Average Efficiency 67.4 Percent

Average Discharge Per Day 3.65 Tons

185
9.55

TABLE 4

ARSENIC IN TAP WATER

YELLOWKNIFE N.W.T.

AREA	NO. OF SAMPLING POINTS	PPM[1] ARSENIC BY WEIGHT					
		DEC 1952	JULY 1953	DEC 1953	JULY 1954	DEC 1954	JULY 1955
GIANT	1	0.008	0.05	0.005	0.000	0.000	0.13
TOWNSITE	1	0.008	0.03	0.005	0.000	0.000	0.01
CON	1	0.008	0.03	0.005	0.002	0.000	0.01
AVERAGE		0.008	0.04	0.005	0.001	0.000	0.05

(1) PARTS PER MILLION BY WEIGHT

TABLE 5

ARSENIC IN WATER BODIES

YELLOWKNIFE N.W.T.

AREA	NO. OF SAMPLING POINTS	PPM(1) ARSENIC BY WEIGHT					
		DEC. 1952	JULY 1953	DEC 1953	JULY 1954	DEC 1954	JULY 1955
GIANT	7	0.46	1.2	0.86	0.94	0.55	1.11
TOWNSITE	7	0.11	0.14	0.11	0.16	0.12	0.15
CON	7	1.16	1.32	1.50	1.58	1.20	1.86
AVERAGE		0.58	0.89	0.82	0.89	0.62	1.04

(1) PARTS PER MILLION BY WEIGHT

These figures do not reflect drinking water levels which are shown in Fig. 4 and Table 4. Water bodies form a substantial proportion of the region of Yellowknife. Therefore selected samples of water were taken from each area to establish the general level of contamination. Because Con Mine had polluted neighboring waters with arsenic sludge, the waters in its area are, on the average, higher in arsenic content than elsewhere. The Townsite water supply is drawn from Yellowknife Bay, not from small lakes.

TABLE 6

ARSENIC DEPOSIT ON GRASS AT YELLOWKNIFE

AS SAMPLED IN JULY AND DECEMBER

Area	No. of Sampling Points	Parts Per Million Arsenic by Weight							
		Dec 1951	July 1952	Dec 1952	July 1953	Dec 1953	July 1954	Dec 1954	July 1955
Giant	11	2600	200	2000	700	1600	330	1700	156
Townsite	7	250	50	750	120	1150	71	1230	72
Con	8	250	13	300	35	400	58(1)	395	45
Average		1250	102	1140	340	1110	181	1170	99

(1) Average 7 points

185
9.55

ARSENIC IN URINE OF YELLOWKNIFE SCHOOL CHILDREN

GROUPS	NUMBER OF CHILDREN	AVERAGE ARSENIC LEVEL(3)	STANDARD DEVIATION	SIGNIFICANCE OF DIFFERENCE
A. CONTROL(1)	47	0.0058	0.011	A vs. B $P < 0.01$
B. EXPOSED GROUP DECEMBER 1951(2)	40	0.063	0.041	B vs. C $P < 0.01$
C. SAME GROUP APRIL 1952(2)	40	0.027	0.0063	C vs. A $P < 0.01$

(1) Ottawa school children age and sex - matched.
(2) Excludes children for whom urinalysis was not available for both December 1951 and April 1952.
(3) Micrograms of arsenic per 1 ml. urine.

Reported Arsenic in Mgm. As per Liter Urine (γ As per 1 ml.)

Author	No. of Subjects	Mean	Standard Deviation	Remarks
Bang	31	0.100	0.140	
Webster	43	0.015	0.015	
Griffon & Buisson	12	0.021	0.026	
Griffon & Buisson	31	0.031	0.035	Some exposure to As.
Kingsley & Schaffert	25	0.116	0.051	
Cox	16	0.025	0.021	
Cox	20	0.067	0.108	Includes above groups and 4 who had eaten fish previously.
Myers & Cornwall	14	0.037	0.046	
Swales & Pate	10	0.097	0.100	
Watrous & McCaughey	13	0.129	0.057	
Watrous & McCaughey	10	0.110	0.063	Exposure to arsenic.
Monkman	47	0.0058	0.011	Ottawa school children.

I - HOSPITAL ADMISSIONS, YELLOWKNIFE, 1948-52, BY DISEASE GROUP

Disease Group(2)	Int. List Group No.	Number of Admissions							
		Year					Total, 1948-52		
		1948	1949	1950	1951	1952	T	M	F
Infective and parasitic diseases	(I)	18	16	20	5	26	85	51	34
Neoplasms	(II)	3	6	1	8	2	20	11	9
Allergic, endoc. system, metabolic, and nutr. diseases	(III)	11	9	15	4	12	51	22	29
Diseases of the blood and blood-forming organs	(IV)	1	-	1	5	1	8	5	3
Mental, psychoneurotic and personality disorders	(V)	1	11	10	4	7	33	11	22
Diseases of the nervous system and sense organs	(VI)	25	25	29	27	33	139	98	41
Diseases of the circulatory system	(VII)	21	17	31	22	22	113	90	23
Diseases of the respiratory system	(VIII)	106	145	163	230	129	773	512	261
Diseases of the digestive system	(IX)	93	95	98	153	103	542	358	184
Diseases of the genito-urinary system	(X)	24	20	23	19	23	109	45	64
Deliveries and complications of pregnancy, childbirth, and the puerperium	(XI)	120	117	123	138	128	626	0	626
Diseases of the skin and cellular tissue	(XII)	106	47	70	57	51	331	252	79
Diseases of the bones and organs of movement	(XIII)	56	84	70	54	37	301	272	29
Congenital malformations	(XIV)	3	6	10	11	12	42	39	3
Certain diseases of infancy	(XV)								
Symptoms, senility and ill-defined conditions	(XVI)	24	17	21	24	16	102	53	49
Accidents, poisonings, and violence(1)	(XVII)	124	96	141	134	174	669	603	66
Special admissions		3	6	14	38	34	95	45	50
TOTAL		739	717	840	933	810	4,039	2,467	1,572

(1) Over 1948-52, there were 66 males and 18 female admissions for effects of poisons and 537 male and 48 female admissions because of accidents and violence.

(2) Sixth Revision of the International List of Diseases and Causes of Death, adopted 1948.

Source: As compiled by Dr. D. L. Henderson, Occupational Health Division, Department of National Health and Welfare.

Research Division, February, 1954.

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9.55

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II. PER CENT DISTRIBUTION OF YELLOWKNIFE HOSPITAL ADMISSIONS, 1948-52, BY DISEASE GROUP COMPARED WITH SIMILAR DISTRIBUTIONS FOR ENGLAND AND WALES, 1949, ONTARIO, 1936, 37, AND SASKATCHEWAN, 1950

	Disease Group(1)	Yellowknife 1948-52	England & Wales 1949	Sask. 1950	Disease Group(2)	Ontario 1936-37
I.	Infective and parasitic diseases	2.1	4.1	2.0	Infectious and parasitic diseases	2.6
II.	Neoplasms	0.5	10.2	4.0	Cancer and other tumours	5.4
III.	Allergic, endoc. system metabolic and nutr. diseases	1.3	3.0	3.1	Rheumatic and general diseases	3.3
IV.	Diseases of the blood and blood-forming organs	0.2	0.7	0.4	Diseases of the blood and blood-forming organs	0.5
V.	Mental, psychoneurotic and personality disorders	0.8	1.2	0.2		
VI.	Diseases of the nervous system and sense organs	3.4	7.3	3.5	Diseases of nervous system	4.6
VII.	Diseases of the circulatory system	2.8	5.5	5.2	Diseases of circulatory system	3.3
VIII.	Diseases of the respiratory system	19.1	12.2	22.2	Diseases of respiratory system	5.2
IX.	Diseases of the digestive system	13.4	14.4	15.0	Diseases of digestive system	30.2
X.	Diseases of the genito-urinary syst.	2.7	9.2	4.5	Diseases of genito-urinary system	7.8
XI.	Deliveries and complications of pregnancy, childbirth, and the puerperium	15.5	15.0	17.0	Pregnancy and the puerperal state	18.9
XII.	Diseases of the skin and cellular tissue	8.2	2.0	2.5	Diseases of the skin	2.0
XIII.	Diseases of the bones and organs of movement	7.5	3.2	3.4	Diseases of bones and organs of movement	1.4
XIV.	Congenital malformations)	1.0	(1.7	0.7	(Congenital malformations	0.4
XV.	Certain diseases of early infancy)		(0.4		(Diseases of early infancy	0.5
XVI.	Symptoms, senility and ill-defined conditions	2.5	3.5	7.4 (3)	Senility and ill-defined causes	1.1
XVII.	Accidents, poisonings and violence	16.6	5.9	8.2	Chronic poisoning and intoxication, and injuries and accidents	10.0
	Special admissions	2.4	0.7	-	Miscellaneous	3.0
	T O T A L	100.0	100.0	100.0	T O T A L	100.0
	Number of cases(4)	4,039	131,912	155,951	Number of cases(4)	46,378

For footnotes see next page.

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FOOTNOTES - TABLE II

(1) Sixth Revision of the International List of Diseases and Causes of Death adopted 1948.
(2) International List of Causes of Disease, Injury and Death (1929 Revision).
(3) Other specified and ill-defined causes (broader scope than group XVI).
(4) Admissions in the case of Yellowknife; discharges in the case of England and Wales; live discharges in the case of Saskatchewan and Ontario.

Source: Yellowknife - as compiled by Dr. D. L. Henderson, Occupational Health Division, Department of National Health and Welfare.
England and Wales - Hospital Morbidity Statistics, General Register Office, London.
Saskatchewan - Annual Report of the Saskatchewan Hospital Services Plan, 1950.
Ontario - A Survey of Public General Hospitals in Ontario, Part IV. Special Morbidity Studies Division of Medical Statistics, Ontario Department of Health.

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III - PER CENT DISTRIBUTION OF YELLOWKNIFE HOSPITAL ADMISSIONS, 1948-52, BY DISEASE GROUP COMPARED WITH DISTRIBUTION FOR ENGLAND AND WALES, 1949, FOR SEX

Disease Group(2)	Per Cent of Total			
	Yellowknife, 1948-52		England and Wales, 1949	
	M	F	M	F
Infective and parasitic diseases	2.1	2.2	5.0	3.5
Neoplasms	0.4	0.6	9.6	10.6
Allergic, endoc. system metabolic and nutr. dis.	0.9	1.8	2.2	3.4
Diseases of the blood and blood-forming organs	0.2	0.2	0.7	0.7
Mental, psychoneurotic and personality disorders	0.4	1.4	1.0	1.3
Diseases of the nervous system and sense organs	4.0	2.6	8.8	6.3
Diseases of the circulatory system	3.7	1.5	7.1	4.3
Diseases of the respiratory system	20.8	16.6	15.6	9.5
Diseases of the digestive system	14.5	11.7	20.5	10.2
Diseases of the genito-urinary system	1.8	4.1	5.4	11.9
Del. & complic. of preg., childbirth, and the puerp.	-	39.8	-	25.5
Diseases of the skin and cellular tissue	10.2	5.0	2.6	1.6
Diseases of the bones and organs of movement	11.0	1.8	4.2	2.5
Congenital malformations	1.6	0.2	2.3	1.3
Certain diseases of early infancy)			0.6	0.3
Symptoms, senility and ill-defined conditions)	2.1	3.1	4.0	3.2
Effects of poisons	2.7	1.1	0.2	0.2
Accidents and violence	21.8	3.1	9.5	3.1
Special admissions	1.8	3.2	0.8	0.7
TOTAL(1)	100.0	100.0	100.0	100.0

(1) Admissions in the case of Yellowknife; discharges in the case of England and Wales.
(2) Sixth Revision of the International List of Diseases and Causes of Death, adopted 1948.

For Sources: see Table II.

Research Division,
February 1954.

IV - DISTRIBUTION OF HOSPITAL ADMISSIONS BY SEX, YELLOWKNIFE, ENGLAND AND WALES, SASKATCHEWAN, AND ONTARIO HOSPITAL DATA(1)

Survey	Number			Per Cent		
	M	F	T	M	F	T
Yellowknife 1948-52(2)	2,465	1,575	4,040	61.0	39.0	100.0
England and Wales, 1949	53,786	77,152	130,938	41.1	58.9	100.0
Saskatchewan, 1950	63,203	92,748	155,951	40.5	59.5	100.0
Ontario, 1936-37	18,858	29,882	48,740	38.7	61.3	100.0

(1) For sources, see Table II.
(2) Totals as obtained from distribution supplied by ages; distribution supplied by diagnosis gives 2,467 males and 1,572 females, a total of 4,040.

V - PER CENT DISTRIBUTION OF HOSPITAL ADMISSIONS BY AGE GROUP FOR EACH SEX, YELLOWKNIFE, ENGLAND AND WALES, SASKATCHEWAN, AND ONTARIO HOSPITAL DATA(1)

Age Group	Yellowknife 1948-51		England & Wales 1949		Saskatchewan 1950		Age Group	Ontario 1936-37	
	M	F	M	F	M	F		M	F
Under 1	5.6	6.9	3.5	1.6	5.1	2.4	Under 1	3.6	1.8
1-4	7.9	9.6	7.9	4.2	10.5	5.4	1-9	16.6	8.6
5-14	4.4	7.4	15.2	9.0	16.3	10.5	10-19	13.6	11.8
15-24	22.4	20.9	9.1	16.4	11.9	19.5	20-29	15.6	29.6
25-44	38.7	46.9	23.8	39.1	18.0	37.2	30-49	24.7	30.8
45-64	18.3	6.3	28.1	20.8	20.2	15.7	50-69	18.1	12.8
65 & over	2.4	1.2	12.0	8.4	17.9	9.2	70 & over	7.0	3.7
N.S.	0.3	0.8	0.5	0.6	-	-	N.S.	0.7	0.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	Total	100.0	100.0

(1) For sources, see Table II.

Research Division,
February, 1954.

CONFIDENTIAL

VI - PER CENT DISTRIBUTION OF YELLOWKNIFE HOSPITAL ADMISSIONS, BY DISEASE GROUP, FOR MALES, FEMALES, and TOTAL ADMISSIONS, SINGLE YEARS 1948 TO 1952 AND GROUPED 1948-52

Disease group[1]	Yellowknife Hospital Admissions																	
	Males						Females						Total					
	1948	1949	1950	1951	1952	1948-52	1948	1949	1950	1951	1952	1948-52	1948	1949	1950	1951	1952	1948-52
I. Infective and parasitic dis.	2.4	2.1	2.5	0.5	3.0	2.1	2.5	2.4	2.2	0.5	3.5	2.1	2.4	2.2	2.4	0.5	3.2	2.1
II. Neoplasms	0.4	0.5	0.2	0.9	0.2	0.4	0.4	1.4	-	0.8	0.3	0.6	0.4	0.8	0.1	0.9	0.2	0.5
III. Allergic, endocrine system, metabolic & nutritive diseases	1.3	0.5	1.3	0.2	1.2	0.9	1.8	2.4	2.5	0.8	1.9	1.8	1.5	1.3	1.8	0.4	1.5	1.3
IV. Diseases of the blood and blood-forming organs	-	-	0.2	0.7	-	0.2	0.4	-	-	0.3	0.3	0.2	0.1	-	0.1	0.5	0.1	0.2
V. Mental, psychoneurotic and personality disorders	-	1.2	0.4	0.2	0.6	0.4	0.4	2.1	2.5	0.8	1.3	1.4	0.1	1.5	1.2	0.4	0.9	0.8
VI. Diseases of the nervous system and sense organs	3.5	3.9	4.0	3.5	4.9	4.0	3.2	2.8	2.5	1.9	2.8	2.6	3.4	3.5	3.5	2.9	4.1	3.4
VII. Diseases of the circulatory system	3.1	3.5	5.2	2.8	3.7	3.6	2.5	0.7	1.3	1.6	1.3	1.5	2.8	2.4	3.7	2.4	2.7	2.8
VIII. Diseases of the respiratory system	16.1	20.9	19.5	28.6	17.2	20.8	11.6	19.2	19.2	18.6	13.9	16.6	14.3	20.2	19.4	24.7	15.9	19.1
IX. Diseases of the digestive sys.	13.2	14.4	14.0	15.7	15.0	14.5	11.6	11.5	7.9	17.5	9.1	11.7	12.6	13.2	11.7	16.4	12.7	13.4
X. Diseases of the genito-urinary system	3.1	2.1	1.9	1.4	0.8	1.8	3.5	3.8	4.1	3.0	6.0	4.1	3.2	2.8	2.7	2.0	2.8	2.7
XI. Deliveries and complications of pregnancy, childbirth, and the puerperium	-	-	-	-	-	-	42.1	40.9	38.7	37.7	40.4	39.8	16.2	16.3	14.6	14.8	15.8	15.5
XII. Diseases of the skin and cellular tissue	17.0	8.4	10.9	7.6	7.9	10.2	10.2	3.8	4.1	3.8	3.8	5.0	14.3	6.6	8.3	6.1	6.3	8.2
XIII. Diseases of the bones and organs of movement	11.2	18.6	10.9	9.0	6.7	11.0	1.8	1.4	4.1	0.8	1.3	1.8	7.6	11.7	8.3	5.8	4.6	7.5
XIV. Congenital malformations)	0.7	0.9	1.9	1.8	2.4	1.6	-	0.7	-	0.3	-	0.2	0.4	0.8	1.2	1.2	1.5	1.0
XV. Certain diseases of early infancy																		
XVI. Symptoms, senility and ill-defined conditions	2.6	2.8	1.5	2.6	1.2	2.1	4.2	1.7	4.1	2.5	3.2	3.1	3.2	2.4	2.5	2.6	2.0	2.5
XVII. (Poisonings	1.3	1.9	3.6	1.8	4.7	2.7	0.7	1.4	1.3	1.4	0.9	1.1	1.1	1.7	2.7	1.6	3.2	2.1
(Accidents and violence	23.6	17.6	20.9	19.4	27.4	21.8	3.2	2.8	2.8	2.5	4.1	3.1	15.7	11.7	14.0	12.8	18.3	14.5
Special admissions	0.4	0.9	1.0	3.4	3.0	1.8	0.4	0.7	2.8	5.2	6.0	3.2	0.4	0.8	1.7	4.1	4.2	2.4
TOTAL	99.9	100.2	99.9	100.1	99.9	99.9	100.5	99.7	100.1	100.1	100.1	99.9	99.7	99.9	99.9	100.1	100.0	100.0

(1) Sixth Revision of the International List of Diseases and Causes of Death, adopted 1948.

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