Fairbanks: A Study of Environmental Quality

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ABSTRACT. Fairbanks, Alaska is used as a case study for assessing problems of environmental quality that may intensify or develop in rapidly expanding northern settlements. Constraints imposed by site and situation are severe, although they have been partially overcome by high-cost technological measures. Additionally, flood damage, inadequate community action, and high costs have led to poor housing conditions and a housing shortage. Disposal of solid, liquid and gaseous wastes, inadequately controlled in the past, has now become a serious problem. Enforcement of new health standards and the development of community-wide planning represent recent measures to improve environmental quality.

RÉSUMÉ. *À Fairbanks, une étude sur la qualité du milieu.* Fairbanks, Alaska, sert aux auteurs comme étude de cas, pour évaluer les problèmes de qualité de l'environnement qui devraient s'intensifier ou se développer dans les communautés urbaines nordiques en expansion rapide. Les contraintes qu'imposent le site et la situation sont sévères, bien que des mesures technologiques très coûteuses les aient partiellement surmontées. De plus, les inondations, l'action inadéquate des communautés et les coûts élevés ont mené à une pauvreté et une rareté du logement. Mal contrôlée par le passé, l'évacuation des déchets solides, liquides et gazeux est maintenant devenue un problème sérieux. La mise en force de nouveaux standards de santé et le développement d'une planification à l'échelle de la communauté sont des mesures récentes pour améliorer la qualité du milieu.

РЕЗЮМЕ. *Изучение состояния окружающей среды г. Фэрбенкса.* Город Фэрбенкс на Аляске был избран объектом показательного исследования, целью которого является выявление и оценка серьезности проблем, возникающих и разрастающихся в связи с загрязнением окружающей среды при быстром росте и развитии населенных центров на Севере. Состояние среды, обусловленное расположением города и ситуацией в нем, серьезно, хотя частично и было улучшено дорогостоящими технологическими мерами. Разрушительное наводнение, недостаточность принятых по борьбе с ним мер и дороговизна привели, в дополнение, к плохим жилищным условиям и к общей нехватке жилья. Имевший место в прошлом недостаточный контроль за ликвидацией твердых, жидких и газообразных отходов в настоящее время привел к серьезным проблемам. Проведение в жизнь новых строгих санитарно-гигиенических мер, наряду с разработкой общегородской системы планирования, направлены на улучшение состояния окружающей среды.

INTRODUCTION

The establishment and maintenance of high standards of environmental quality remain major problems for settlements throughout northern North America (Alter 1972a; Grainge and Shaw 1971; Parran 1954). Most of them lack an adequate system of water supply and satisfactory means of disposal of sewage and solid waste. Housing conditions remain largely substandard despite the existence of numerous projects for the building of new structures and the improve-

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ment of existing ones. Betterment has been limited by at least four major factors: severe climatic stress — especially the extreme seasonal changes in temperature; poor siting of many settlements; remoteness, and hence the high cost of obtaining essential materials; and inadequate community action. Nevertheless, as long as settlements remain small, problems of environmental quality can be contained, or even solved, at reasonable cost. Once the settlements begin to grow rapidly, however, these problems, if not dealt with in good time, tend to become more numerous, more complex, and more costly to resolve (Alter 1972b; Hoch 1972).

In 1950, Fairbanks was a small town of just under 6000 inhabitants, with virtually no community services. There was no public water system, no sewage treatment plant, and existing sewers were often frozen up in winter. Housing conditions were also poor. According to the results of one survey, its residential areas were characterized by a shortage of dwelling space and rampant multiple occupation, while a great number of shack towns existed on the periphery of the city where few, if any, standards of health or decency were enforced (Beck 1953).

By 1970, the city's population had jumped to over 17,000, while the geographic area it occupied had increased more than fivefold through annexations. A significant question facing those responsible for administering the city and the surrounding urban area was, in brief: to what extent had housing and community services developed and been improved to meet the demands of the current and projected increases in population?

The purpose of the present study is to provide a general assessment of the city's environmental quality immediately before the economic expansion and growth of population to be expected with the construction of the Trans-Alaska Pipeline. The authors' endeavour has been to identify current problems of environmental quality so that improvements may be made where possible and changes of every kind monitored during the anticipated period of expansion.

METHOD OF STUDY

During the period July 1972 to June 1973, the authors studied four matters of much concern for the people of Fairbanks: the general urban setting, housing quality, water supply and waste control. Information on the general urban setting, control of air pollution, and on the disposal of waste water and solid wastes, was collected from field analyses, interviews and secondary sources. Data on housing generally and on the condition of dwellings were obtained mainly from a survey of the U.S. Public Health Service known as NEEDS ("Neighborhood Environmental Evaluation and Decision System"), which the authors directed, with the aid of six field workers, in the summer of 1972. The study area included the city of Fairbanks and most of the surrounding developed area, comprising a total of 560 blocks with a population of approximately 19,350, according to the 1970 census. In the course of the survey, every fourth dwelling was evaluated in terms of external and internal condition. Variations in block size and in the number of dwellings per block made it desirable to consolidate the resulting data into "neighbourhoods", i.e. groups of blocks approximately one-quarter mile (400 m) in length and in width. These neighbourhoods were designed to correspond to census tracts,

so that a comparison could be made with 1970 census data. While the population sizes of the neighbourhoods made them too small for quantitative analysis, they were adequate for the purposes of portraying the wide variation in conditions existing throughout Fairbanks. This portrayal should assist community leaders to better pinpoint the problem areas.

THE SETTING

As happened in the case of so many northern settlements, the site of Fairbanks was selected by chance. Gold was discovered in 1902 in an area immediately north of the present city. With the news of the gold strike, a trader who was in the area at the time stayed on, and the place along the Chena River where he anchored his boat later became downtown Fairbanks.

The main area of settlement is located in the Tanana Valley floodplain and is surrounded by hills to the west, north and east. The Tanana River flows south of the city, while a tributary, the Chena River, flows through the middle of Fairbanks (Fig. 1). Recurrent flooding has been a major problem. Overflowing of the Chena caused serious damage in the years 1905, 1911, 1930, 1948 and 1967. The particularly devastating flood of August 1967 resulted in seven drownings and damage estimated at $98 million (George 1973). In 1973, plans were approved for the construction of a flood control structure on the Little Chena River, a tributary of the Chena. The purpose of providing the facility is to impound excess water temporarily during spring runoff and periods of storm (George 1973). This structure, along with the already-existing diversion dike, which prevents water from the Tanana River from flowing into the Chena upstream from Fairbanks, should protect the area from extensive flood damage in the future.

Because of its northern and interior location, Fairbanks experiences great seasonal variations in temperature. Mean monthly readings vary from −24.4°C in January to 15.9°C in July, with a yearly average of −3.5°C. The frost-free period in the valley area lasts for an average of 106 days (Rieger *et al.* 1963). Temperature

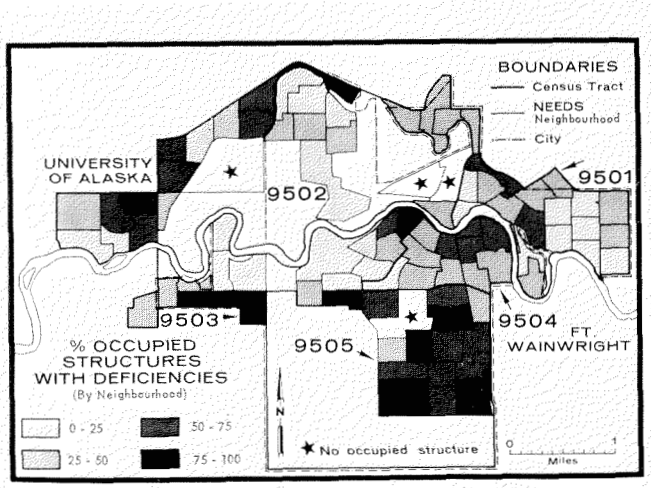

FIG. 1. Percentages of occupied structures with deficiencies, by neighbourhood, in the Fairbanks area, 1972.

inversions often develop when cold stable air settles in low-lying areas in winter when air pollution problems are at their most pronounced (Benson 1969; Holty 1973). Furthermore, significant problems in sanitary engineering arise, since chemical reactions are slow at low temperatures, and so decomposition and dilution rates of organic and inorganic waste products are reduced. The difficulty of limiting excessive heat loss, preventing freeze-thaw damage, and combating disease organisms causes costs of developing and maintaining adequate systems of sewage disposal to increase (Alter 1972a).

Permafrost occurs both in the form of ice lenses and as "cement" in large portions of the Tanana floodplain. Most of the city of Fairbanks area, though, is situated on the Salchaket soil series, which is well-drained, sandy, and underlain by coarse sand and gravel. Thus permafrost is usually absent here, or does not occur at depths of less than 15 feet (4.6 m) (Rieger *et al.* 1963). Congeliturbation is also limited in this soil series. Yet tilted garages and sunken houses provide occasional evidence of permafrost and indicate that careful checks must be made of soil conditions at all building sites.

HOUSING

The NEEDS survey used in the study was designed primarily for a rapid assessment of the exterior characteristics of buildings. Since such potentially serious internal problems as fire hazards, and damaged stairs, flooring, etc., were neglected in the survey, its results provide a less critical assessment of housing quality than those of a comprehensive investigation would have done. Within the limitations of their resources, the authors were, nevertheless, able to provide a basis for later, more detailed examination of housing conditions in selected areas of the city and its surroundings.

Of the 1,217 dwellings surveyed in detail (and termed for present purposes "occupied structures") 40.4 per cent had some deficiency (Table 1). According to the classification of NEEDS, a structure may have any combination of minor, moderate, or major deficiencies or no deficiencies (Indiana 1972). Therefore, in Table 1, the sum of minor, moderate, and major deficiencies does not equal the category "any deficiencies". Thirty per cent of the occupied structures had minor

TABLE 1. Fairbanks area: quality of housing

Region	Total numbers of structures	Minor deficiencies		Moderate deficiencies		Major deficiencies		Any deficiencies	
		No.	%	No.	%	No.	%	No.	%
9501	373	92	24.6	52	13.9	10	2.6	112	30.0
9502	267	68	25.5	64	23.9	18	6.7	109	40.8
9503	210	53	25.2	36	17.1	13	6.2	72	34.3
9504	174	62	35.6	43	24.7	17	9.7	78	44.8
9505	194	95	49.2	75	38.8	32	16.5	121	62.6
Total	1217	370	30.4	270	22.1	90	7.3	492	40.4

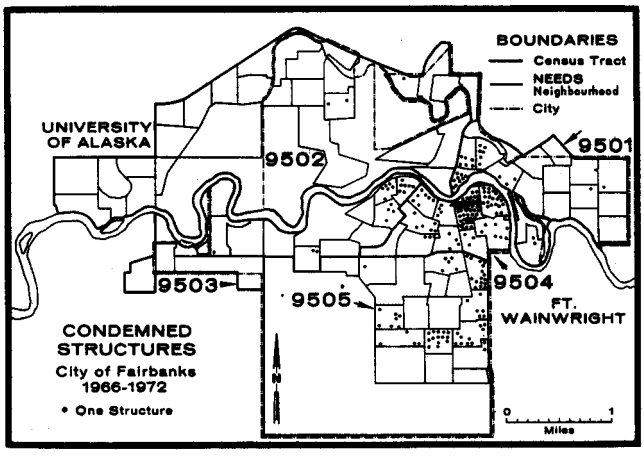

FIG. 2. Structures condemned in the city of Fairbanks, 1966-72.

deficiencies, e.g., loose material on outside walls, neglected paint, or damaged windows and screens. Twenty-two per cent of the structures had moderate deficiencies, e.g. a roof with loose or missing material; or a foundation or outside wall displaying open cracks or lacking material. Seven per cent of the structures had major deficiencies, *e.g.* a sagging roof, a leaning wall or foundation, or had been condemned by the city authorities. The areas having dwellings with the greatest proportion of structural deficiencies were region 9505 or "south" Fairbanks, region 9504 or "downtown", and region 9502 (Fig. 1).

The large number of housing deficiencies in Fairbanks can be attributed to several causes. First, the 1967 flood severely damaged approximately 600 structures and caused minor damage to thousands of others (A.S.H.A. 1971). Nearly 3,000 disaster home loans were made by the Small Business Administration after the flood (A.S.H.A. 1971). Most of the structures condemned in the city since 1966, particularly in regions 9504 and 9505, were casualties of the 1967 flood (Fig. 2). Secondly, many of the city's older structures have not survived the harsh environment or the modern city building and fire codes. Thus, in the commercial area of region 9504, four hotels have been condemned and one other has burned down since 1971. Thirdly, the city's strict building standards do not apply to neighbourhoods outside the city limits. The Fairbanks North Star Borough, which has jurisdiction over them, does not have building code regulations except those regarding flood-proofing, fire prevention, and waste disposal. Further, no borough regulations exist for condemnation procedures (Fig. 2). Indicative of the impact of the environment, particularly the flood, and the lack of adequate housing codes, region 9502 had eight neighbourhoods in which at least half of the occupied structures had some deficiency (Fig. 1). All but one of these neighbourhoods lie outside the city limits.

Today a housing shortage exists in Fairbanks because of the flood damage to homes, the loss of downtown hotels, and the recent rise in population. Further, since as many as 25 per cent of the family units in the Fairbanks area are below the poverty level in terms of income, many are unable to afford adequate housing

(Sessions 1967; Wilbur Smith 1971; A.S.H.A. 1971). Housing is expensive in the area because of the inflated costs of labour, materials, transport and maintenance. In 1970, the median value of owner-occupied housing units in the city was $30,000, while rented units cost an average of $199 per month, and since then prices have increased. In 1974, a typical new three-bedroom house sold for over $45,000. Rents charged for privately-owned apartments have risen comparably. In short, little new low-cost private housing is now being built. Existing low-cost housing in Fairbanks generally means low quality housing — poorly constructed and badly maintained — with the exception of public housing. Of this, however, there is very little — in fact, an apartment complex built in 1952, consisting of 75 units, provides the only public housing available in Fairbanks. There is an urgent need for more low-cost housing, whether private or public.

WATER SUPPLY

A potable water supply system did not come into being in Fairbanks until 50 years after the founding of the city. Prior to December 1953, water was supplied from wells and by haulage, and in warm weather the Northern Commercial Company arranged for the watering of yards and operated a system of fire protection. Between 1954 and 1973, the number of customers of the Municipal Utilities water distribution system increased tenfold to a total of 3,139. The water, as pumped from wells near the Chena River, has an iron concentration of 2-4 mg/litre. It is chlorinated and heated at the power plant, and then activated silica, more chlorine, polyelectrolyte, ferric sulphate, and lime are added to it. The processes of coagulation, sedimentation, filtration, fluoridation, and if needed, post-chlorination then follow before the water is stored and pumped into the distribution system. The product is an excellent-quality water which is better in every respect than that required under the standards for drinking water of the U.S. Public Health Service (U.S.G.S. 1974). During the cold periods of the year, water is continuously circulated through the single-main distribution system (Wallace and Westfall 1954).

Water supply is restricted by the city council to areas within the city limits. The areas outside rely on haulage and wells for their water supply. It has been shown that the quality of groundwater is poor in many portions of the Fairbanks area (Smith and Casper 1974; Cederstrom 1963).

The following problems of quality and quantity were identified by Smith and Casper (1974):

1) Iron and manganese content frequently exceeds recommended standards;
2) High nitrate concentrations present localized problems;
3) Quantity of groundwater is a problem at random locations in hills to the north and west of Fairbanks;
4) In general, the water is classified as hard (average of 258 mg/litre of calcium and magnesium hardness).

Quality and quantity of water over most of the study area not served by the municipal system was found to be poor. Some areas which had very serious water quality problems, such as Lemeta and Aurora, were recently annexed to the city (1970), and are now having municipal services installed.

WASTE CONTROL

In Fairbanks, proper disposal of waste products has not kept pace with their increased quantity. Thus, today the settlement faces serious air pollution and difficult problems in the disposal of sewage and solid waste.

Air pollution

During winter periods of extreme cold and temperature inversion, the moisture in the air freezes so that ice fog encloses the settled area. In the early nineteen fifties, ice fog was a problem only when daily average temperatures dropped to approximately −40°C. In recent years, the sources of moisture — power plants, houses, vehicles, etc. — have all increased in number. Automobiles, in releasing into the atmosphere carbon monoxide and fine droplets of moisture, which form ice particulates instantly, appear to be the most pernicious source of pollution (Weller, 1969). The U.S. standard for carbon monoxide (9 parts per million average for eight hours) was exceeded on 73 per cent of the days from December 1972 through February 1973 (Gilmore and Hanna 1973). Ice fog now occurs at average temperatures as high as −31.7°C, and so its incidence is greatly increased. For example, during the winter of 1971-72, on only three days were average temperatures below −40°C, but on 30 days they were below −31.7°C (A.H.R.C. 1973).

Another air pollution problem arises in spring and early winter, when particulate levels exceed U.S. primary standards. In spring, runoff causes glacial silt and loess materials to flow on to road surfaces; the particulates are then thrown into the air by passing vehicles (Holty 1971). In early winter, the roads are sanded when ice conditions occur; again, vehicles propel particulates into the atmosphere.

Attempts to solve the air pollution problem in Fairbanks have so far failed. In the past, proposals for the creation of mass transit systems have been rejected by the community, and one existing regulation (concerning vehicle idling) has never been enforced. A number of measures, such as a city transit system, improved traffic flow, mandatory vehicle inspections, strict enforcement of the regulation concerning vehicle idling, protective garages, and installation of electric plug-ins in the downtown area, may provide partial solutions. However, with an anticipated increase in the number of vehicles, any attempted solution will be increasingly costly.

Sewage disposal

Sewage treatment has received considerable attention within the community over the past few years (Philleo 1972). In all, there are five separate sewage systems. One serves the city of Fairbanks; two are located at Fort Wainwright, the U.S. Army base; one serves the University of Alaska campus and nearby areas; and one is located at the Fairbanks International Airport. Only the system serving the university area, completed in 1971, and the airport plant, are designed for secondary treatment. The other three systems provide primary treatment only. Thus, the Chena River, which receives the outfall, has become polluted by sewage.

Above Fairbanks, the water of the Chena River is relatively clear. In the course of research by the Alaska Water Laboratory, coliform counts have been recorded

of approximately 50 per 100 millilitres upstream from Fairbanks, but over 500,000/100 ml downstream of it. (Frey *et al.* 1970). Moreover, streamflow varies greatly, from an average of 270 cubic feet (76 cu. m) per second in winter to 2,280 cubic feet (65 cu. m) per second in summer.

Since State regulations demand that the flow of sewage into the Chena be stopped, local plans have been introduced to integrate the sewage systems, to provide secondary treatment, and to release the waste water into the larger Tanana River. At present, a pure oxygen sewage treatment plant is in the initial stage of construction.

Solid waste

Study was focused on two aspects of solid waste control: the presence of waste products on premises, and the system of collection and disposal of refuse. Data collected during field observations indicated a generally unsightly state of premises (Table 2 and Fig. 3). Accumulations of rubbish in the form of non-decomposable solid wastes such as plastics and metal containers were found on 20 per cent of the premises. Uncollectable discards such as large non-disposable items like refrigerators and metal oil drums, were found on 19 per cent of the premises. Ten

TABLE 2. Fairbanks area: conditions of premises

Region	Total numbers of premises	Accumulations of rubbish		Neglected landscape		Uncollectable discards		Abandoned vehicles	
		No.	%	No.	%	No.	%	No.	%
9501	420	59	14.0	62	14.7	69	16.4	32	7.6
9502	331	87	26.2	74	22.3	74	22.3	48	14.5
9503	243	42	17.3	41	16.5	31	12.	14	5.6
9504	248	30	12.0	43	17.3	32	12.9	16	6.4
9505	246	76	30.9	71	28.9	78	31.7	42	17.1
Total	1488	294	19.8	291	19.5	284	18.9	152	10.2

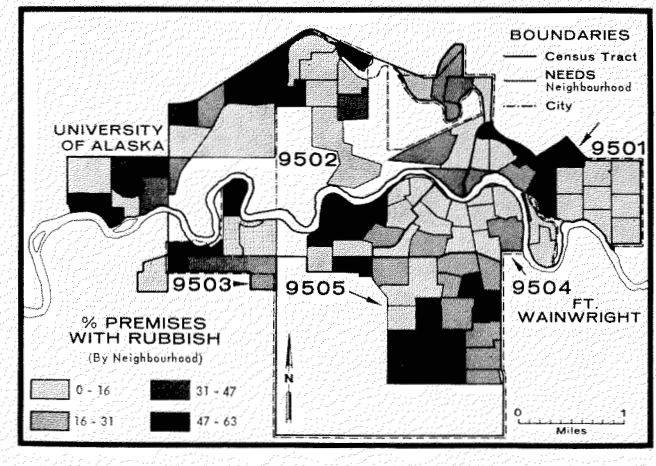

FIG. 3. Percentages of premises with rubbish accumulation, by neighbourhood, in the Fairbanks area, 1972.

per cent of the premises held abandoned vehicles. These figures are significantly high, and represent safety hazards. Surprisingly, of the 152 dwellings with abandoned vehicles, 121 were within the city, despite the existence of city codes banning such vehicles. On the other hand, putrescible material was found on only two per cent of the surveyed premises. A city ordinance requiring households to use plastic bags, rather than metal cans, for storage of refuse appears to be effective.

Overall, there are five separate solid-waste collection systems operating in the Fairbanks area: the city (residential only), the University of Alaska, Fort Wainwright, and two privately-owned concerns that serve commercial establishments within the city and both commercial and residential places outside the city. All bring their solid wastes to the city landfill, except Fort Wainwright which has its own disposal site. In September 1972, the State authorities threatened to close the city dump permanently because it failed to meet required standards. It is located south of the city near the Tanana River. In that area the ground water table is near the surface, so that solid waste compaction cells frequently fill with water and, therefore, the local groundwater may be polluted. At present, ground water contamination at the site is being studied more intensively. Further, little ash or other material has been available to cover the waste products; therefore the dump is virtually open. The Fairbanks North Star Borough was given control of solid waste disposal in 1973, and is currently operating the site as a modified sanitary landfill. It is also trying to develop a more comprehensive and integrated area-wide system for the collection of solid waste.

CONCLUSIONS

Because of its northern interior location in a floodplain surrounded by hills, Fairbanks faces severe environmental constraints. It is technologically possible to overcome some of these constraints. For example, specially designed systems of water supply and means of disposal of waste can prevent damage from extreme cold and from freeze-thaw activity (Wallace and Westfall 1954; Heinke and Dean 1973). Also, diversion dikes and retention structures can reduce the hazard of flooding. However, such technological solutions are very costly.

In addition to environmental constraints, the combination of inadequate, and sometimes unenforced, regulations, together with population growth, has given rise to serious problems in housing and the control of waste. Since the population of the city and surrounding area will increase significantly with the coming of the Trans-Alaska Pipeline and the stepping up of oil activities on North Slope, housing shortages and problems of air pollution will undoubtedly be further aggravated. For the present, the problems of disposal of sewage and solid waste are being alleviated through the coordinated efforts of the city and borough governments, albeit under pressure from the State.

If Fairbanks is to develop, but at the same time maintain a healthy urban environment, more will be necessary than joint city-borough master plans, new regulations concerning the environment, and the spending of additional money on housing and engineering projects, necessary as all of these are. There will have to be a consensus in the community behind the development and implementation

of all required measures. Unfortunately, a recent sample poll of citizens in the Fairbanks area by Swanson *et al.* (1973) indicated that such a consensus does not now exist. For example, less than half of the city residents interviewed said they favoured the extension of the city's water supply and sewage systems, despite problems of water quality in unserviced areas. Further, only 28 per cent of the city residents interviewed said they favoured the development of a city transit system, despite its potential importance in a local plan for the control of air pollution. In general, a significant proportion of Fairbanks residents cling to a concept which might be called "frontier Alaska", the essence of which is that Alaskans are, and should be, less bound by rules and regulations common to urban dwellers in the rest of the United States. Yet, as is brought out in this study, from the viewpoint of environmental quality, "frontier Alaska" is an anachronism.

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