

HOUSING FOR AN EXPANDING SUB-ARCTIC  
COMMUNITY            URANIUM CITY, SASK.

Submitted in partial fulfillment of  
the requirements for the degree of  
Master in Architecture, August 1956

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## ABSTRACT OF THESIS

HOUSING FOR AN EXPANDING SUB-ARCTIC COMMUNITY, a thesis presented by Alan H. Hanna, and submitted in partial fulfillment for the degree of Master in Architecture to the Department of Architecture on August 28, 1956.

As Canadians push further and further beyond the railheads into their trackless, wealthy northland, they must find more effective ways of furnishing shelter for themselves. The established methods are uneconomical of time and labor, and would be a burden to the seasonal and already over-taxed transportation facilities.

It is the purpose of this thesis to show a way of building which is more economical of time, labor, and transportation; and to propose a residential setting designed to minimize the physical and sociological drawbacks of this high latitude outpost.

Arch Jan. 2. 1957

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July 26, 1956

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Dear Dean Belluschi:

In partial fulfillment of the requirements for the degree Master in Architecture, I herewith respectfully submit a thesis entitled "Housing for an Expanding Sub-Arctic Community."

Sincerely yours,

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## ACKNOWLEDGEMENTS

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CHAPTER I      BACKGROUND

location, geology

history and early mining activity

climate of Uranium City

## CHAPTER I BACKGROUND

## 1. Location, Geology

Uranium City is located near Martin Lake, north of Lake Athabasca, at a latitude of  $59^{\circ}34'$  N and longitude  $108^{\circ}37'$  W, about 159 miles from the Saskatchewan-Northwest Territories boundary. The town is roughly 440 miles northwest of Prince Albert, Saskatchewan, and about 450 miles northwest of Edmonton, Alberta. (See Figs. 1 and 2)

The Beaverlodge area is typical shield country, marked by rock ridges trending in a northeast-southwest direction, interspersed with muskegs, small lakes and streams. The pattern is complicated by extensive faulting. The vegetative cover is confined almost exclusively to jackpine with a few poplar. The town itself is situated on lake beaches, representing a former level of Martin Lake. The soil material is a mixture of sand and gravel, of varying degrees of coarseness, sometimes extending to a depth of 20 feet. Occasional rock outcrops appear throughout the area, including two lofty rock ridges. The site is limited to the east by the deeply incised valley of the Fredette River. The area is not in the permafrost zone, although outliers of permafrost do occur in the muskegs. The site of the town as now developed is relatively level, except for a well-developed beach ridge, which runs through the main part of the town. The rugged hills surrounding the large Martin and Beaverlodge Lakes form a particularly attractive setting in the immediate vicinity of the townsite.



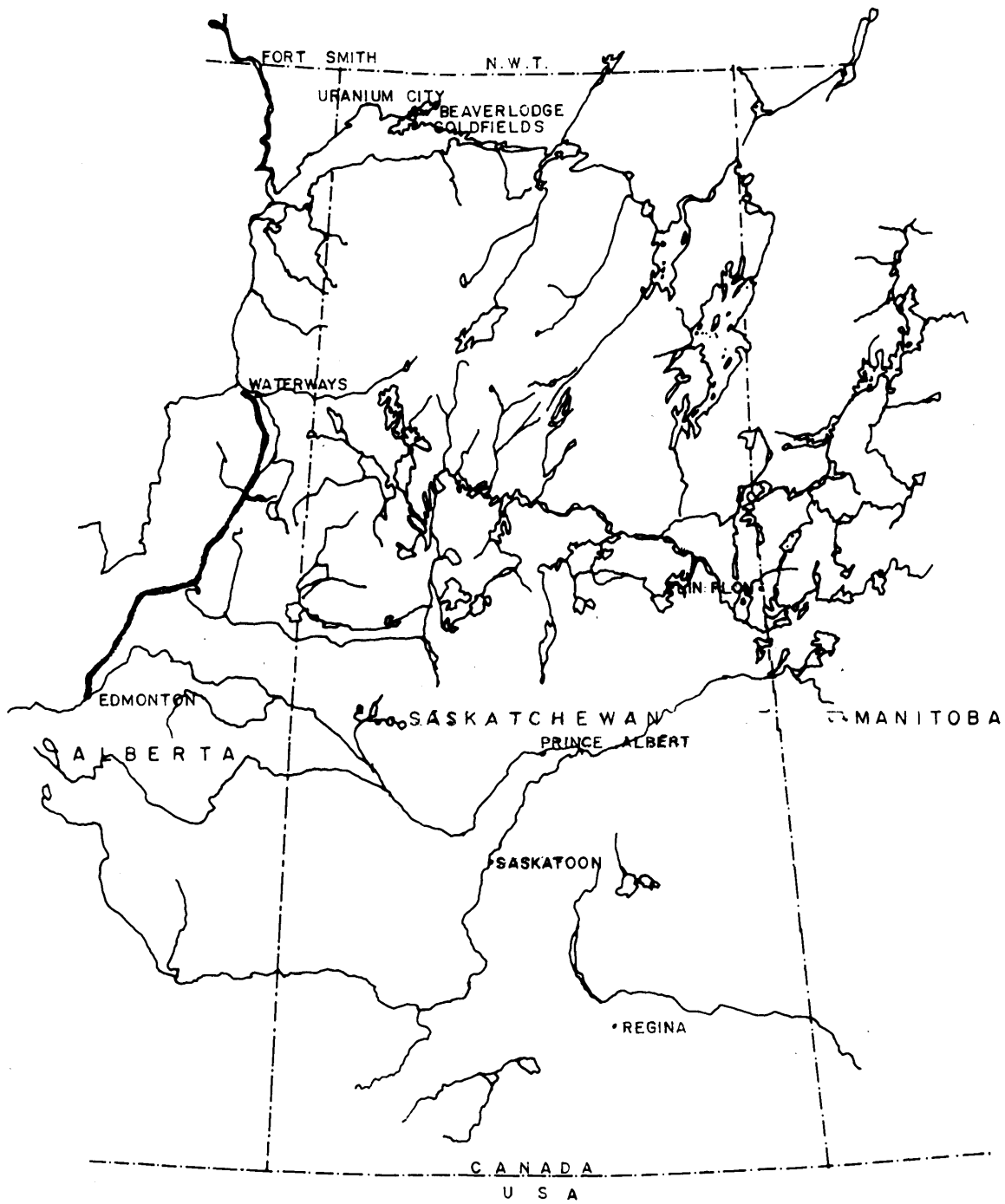


FIG.1 GENERAL LOCATION MAP

M  
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## 2. History and Early Mining Activity

In 1952 the town of Uranium City was established in Northern Saskatchewan. Much has been written about the town in popular magazines, but this material deals mainly with the fabulous uranium strikes that have been made in the area, with the fortunes that have been won and lost and with the eccentric characters one meets in such pioneer areas. These articles, while interesting, contain little factual information about the town itself, its establishment, or administration.

The purpose of establishing a town here was to provide an organizational and service centre for the Beaverlodge uranium area. The mining companies expressed a desire to avoid the expenditure and administrative headaches attendant upon the establishment of a company town; so it was decided that a town be established under government auspices. If no such action had been taken and if several mines had developed in the area, each mine would have to have had a small town clustered around the mine shaft and the problems of educational services, hospital and health services, retail merchandising and banking, etc., would have been multiplied. In addition, the town serves as a base for further exploration of the area.

Prior to the discovery of radio-active minerals, gold mining was the principal mining activity. In the 1930's, several gold strikes were made in the area, and in 1938, the Consolidated Mining and Smelting Company established a 1,000-ton a day mill on their Box Mine property. At the same time, the town of Goldfields came into being on Lodge Bay. This mine operated during World War II, but closed down shortly after because of the low grade of ore. Population declined and in 1948 the town was disincorporated, the land reverting to the crown.

Meanwhile, in 1946, the federal government crown corporation, Eldorado Mining and Refining Company, initiated exploration projects for radioactive minerals around Lake Athabasca, and by 1948 a small community called Beaverlodge developed as a base for operations. By 1950, a large enough ore body was established to warrant sinking of mine shafts. The need for improved communications was met by a construction road build in 1951, financed by the federal and provincial governments, Eldorado and several smaller mining companies. This 14-mile stretch of road between Bushell and Ace Lake was completed in 1952 and has since been improved and widened to its present state as Uranium Road. In this same period, the Eldorado Company completed the present Beaverlodge airstrip.

In 1952, many large uranium concessions in the Beaverlodge area and elsewhere, already worked over by large companies and syndicates, were opened for public staking, bringing about a rush of prospecting which attracted world attention. Although the site of Uranium City had been chosen previously and the indicated street pattern north of Uranium Road surveyed, it was not until 1952 that the town first became inhabited. Evidently, some building construction occurred in the December of 1952, particularly in the present commercial area. However, the town was essentially made up of tents and tent frames. During the winter of 1952, most of the buildings at Goldfields capable of being moved were hauled across the ice on Beaverlodge Lake to the townsite. By the end of 1953 the population of Uranium City was reported to be in excess of 700, with another 1,000 or more people in the remainder of the area. By the end of 1954, the Uranium City population was estimated at 1,000 people, with 1,500 in the surrounding area. Of these 1,500 people, about 700 were located at Eldorado's mine settlement. In

September, 1955, a visiting consultant estimated that the population in Uranium City might be as high as 1,500 people.

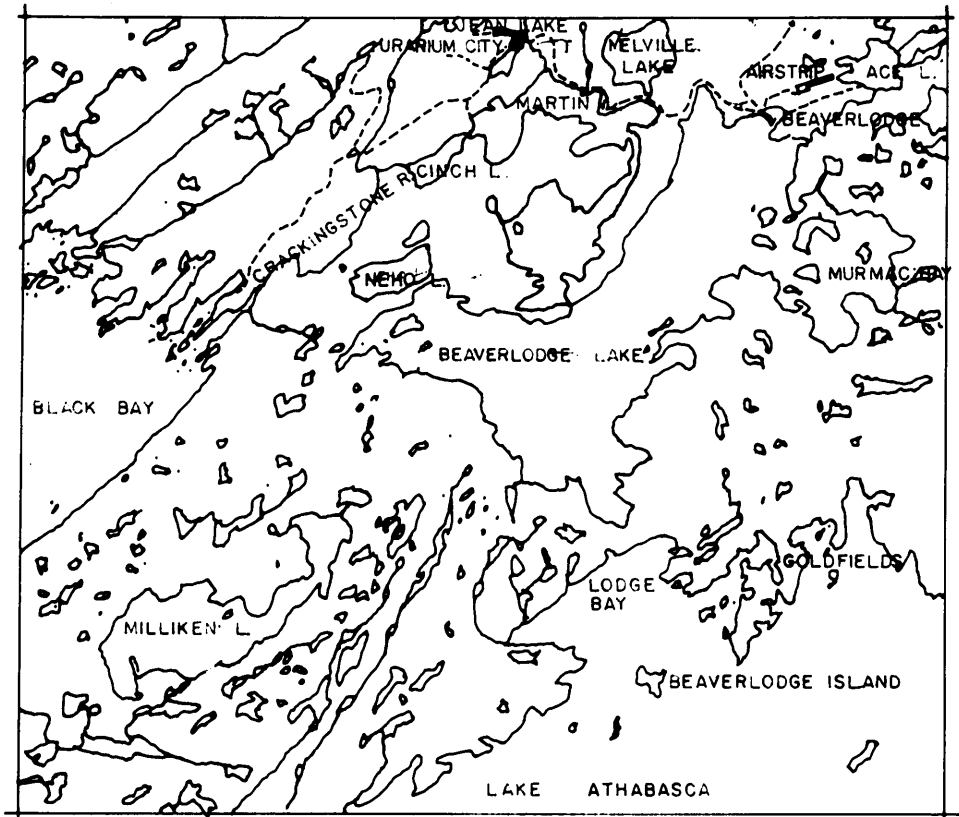


FIG. 2 BEAVER LODGE URANIUM AREA  
 scale one inch = one mile  
 roads -----

*Handwritten signature or initials*

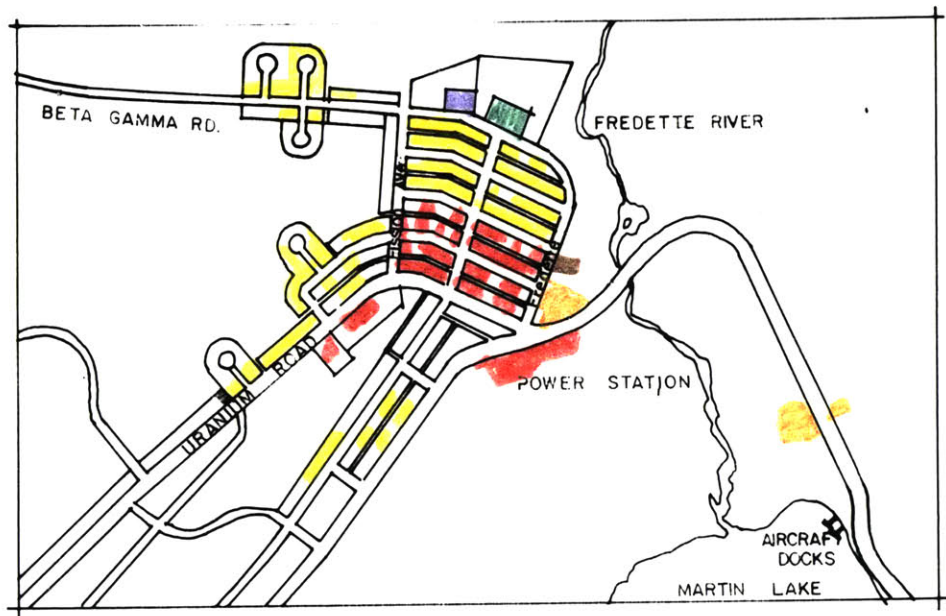


FIG. 3 TOWN PLAN OF URANIUM CITY 1954

LEGEND

- commercial
- residential
- administration
- hospital
- school
- church

### 3. Climate of Uranium City and a Comparison with Regina, Saskatchewan, and Boston, Massachusetts

The Beaverlodge area has not had a regular Weather Station; however, weather records have been kept at Fond-du-Lac, some 50 miles east, at at Fort Smith, N.W.T., to the northwest. Comparisons show these sets of records to be very similar in almost all respects, so it is very reasonable to assume that Uranium City, located between these two, would also be the same.

Based on available records, it can reasonably be stated that the local climate is comparatively dry, the summer seasons short and the winter long and cold. Yet it is of interest to note that during the past few years, Uranium City's weather has been quite pleasant with more frequent and prolonged clear weather in comparison with that of Southern Saskatchewan.

The following data are taken from the "Climatological Atlas of Canada" and the "Climatic Atlas of the United States."

TABLE I.1 TEMPERATURE DATA

	<u>Uranium City</u>	<u>Regina</u>	<u>Boston</u>
Mean January Daily Temperature	-18	0	30
Mean January Daily Minimum Temperature (sunrise)	-25	-10	20
Mean January Daily Maximum Temperature (early afternoon)	- 8	10	35
Mean April Daily Temperature	25	40	45
Mean July Daily Temperature	60	65	70
Mean July Daily Minimum Temperature (sunrise)	50	52	60
Mean July Daily Maximum Temperature (mid afternoon)	70	80	80
Mean October Daily Temperature	32	40	50
Mean Annual Temperature	25	35	45
Mean Annual Minimum Temperature (mean of lowest temperature each year over a period of years)	-50	-40	-10
Mean Annual Maximum Temperature	90	100	95
Extreme Lowest Recorded Temperature (1921-1950)	-65	-50	-15
Extreme Highest Recorded Temperature	100	110	100
Winter Design Temperature			
1%	-50	-40	10
2 1/2%	-46	-35	
5%	-40	-30	
10%	-35	-25	
Summer Design Temperature 10%	75	80	87
Mean Annual Total Degree Day 65° Base (Mean of 60° for one day would be 5 degree days)	15,000	11,000	6,000



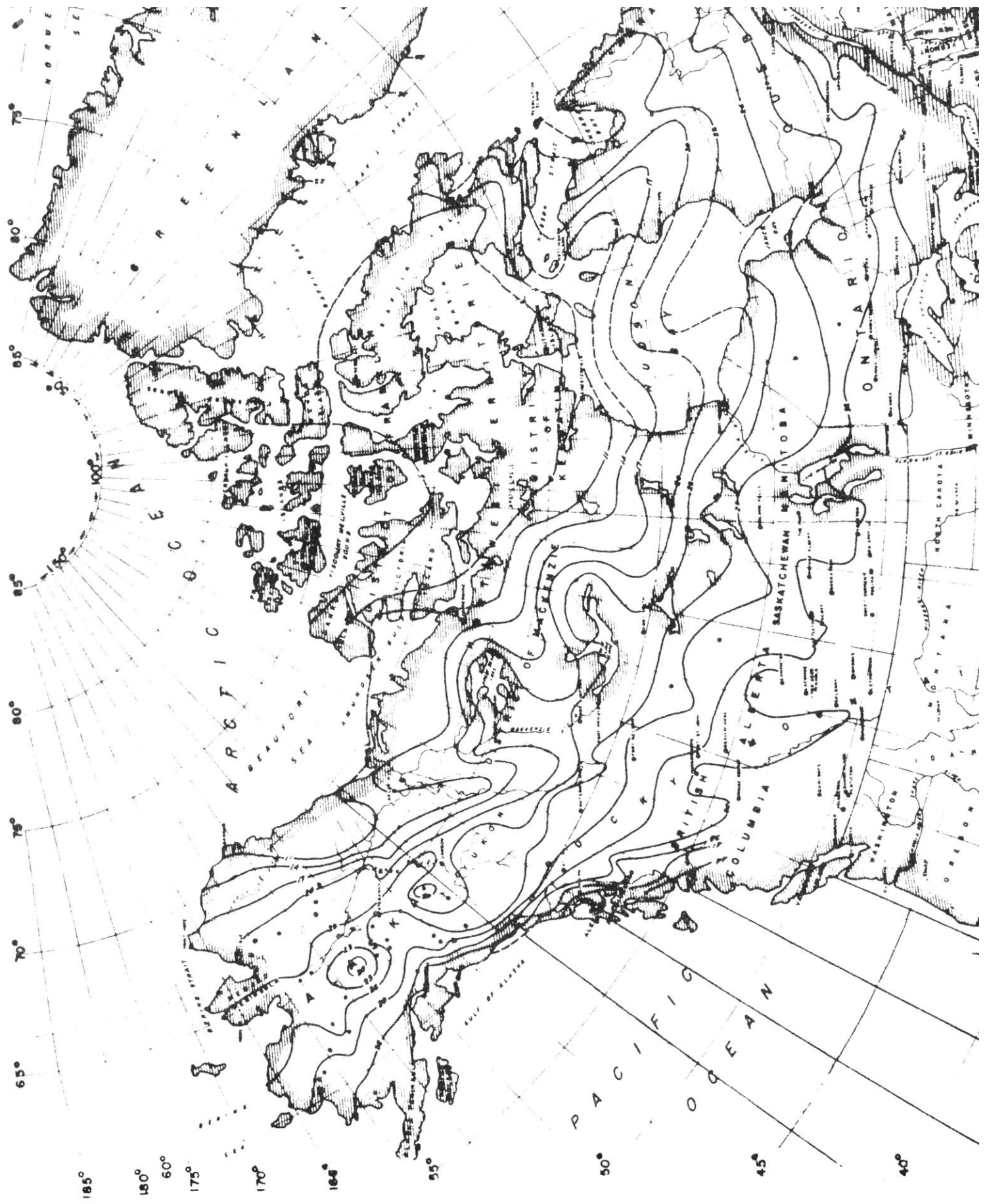


FIG 4 MEAN ANNUAL TEMPERATURE

TABLE I.2 HUMIDITY

	<u>Uranium City</u>	<u>Regina</u>	<u>Boston</u>
Mean January Vapor Pressure Inches of Mercury	almost nil	.050	.15
April	.100	.150	
July	.375	.425	..6
October	.150	.200	

TABLE I.3 PRECIPITATION

	<u>Uranium City</u>	<u>Regina</u>	<u>Boston</u>
Mean Annual Total Precipitation (inches)	12	15	45
Mean Annual Rainfall	10	12	40
Mean Winter Season Rainfall	0	0	10
Mean Spring Season Rainfall	2	2.5	10
Mean Summer Season Rainfall	6	7.5	10
Mean Autumn Season Rainfall	2	2	10
Maximum Precipitation in 24 Hours (1921-1950)	3	6	10
15-Minute Rainfall once in 10 Years	.75	.85	1.25
Maximum Recorded Depth of Snow on Ground (1941-1950)	30	30	
Computed Maximum Snow Load	30 psf.	30 psf.	
Mean Annual Snowfall	35	40	50
Mean October Snowfall	5		
Mean November Snowfall	8	5	
Mean December Snowfall	7	8	
Mean January Snowfall	5	8	
Mean February Snowfall	4	7	

	<u>Uranium City</u>	<u>Regina</u>	<u>Boston</u>
Mean March Snowfall	4	7	
Mean April Snowfall	2	5	

TABLE I.4 SUN ALTITUDES IN URANIUM CITY

<u>Month</u> <u>(21st day)</u>	<u>Altitude</u> <u>at Noon</u>
January	10
February	20
March	30
April	42
May	50
June	54
July	50
August	42
September	30
October	20
November	10
December	6

November, December, January 9:00 A.M. - 3:00 P.M.  
Approximately 6 hours possible sun per day

May, June, July 2:00 A.M. - 8:00 P.M.  
Approximately 18 hours possible sun per day

Comparison with Boston:

Approximately 3 more hours daylight in June  
Approximately 3 less hours daylight in December

TABLE I.5 HOURS OF SUNSHINE

	<u>Uranium City</u>	<u>Regina</u>	<u>Boston</u>
Mean Annual Total Hours of Bright Sun	1,900	2,200	2,200
Mean January Total Hours of Bright Sun	60	100	
Mean April Total Hours of Bright Sun	200	200	
Mean July Total Hours of Bright Sun	300	325	
Mean October Total Hours of Bright Sun	100	150	
Mean November Total Hours of Bright Sun	50	100	

WIND<sup>1</sup>

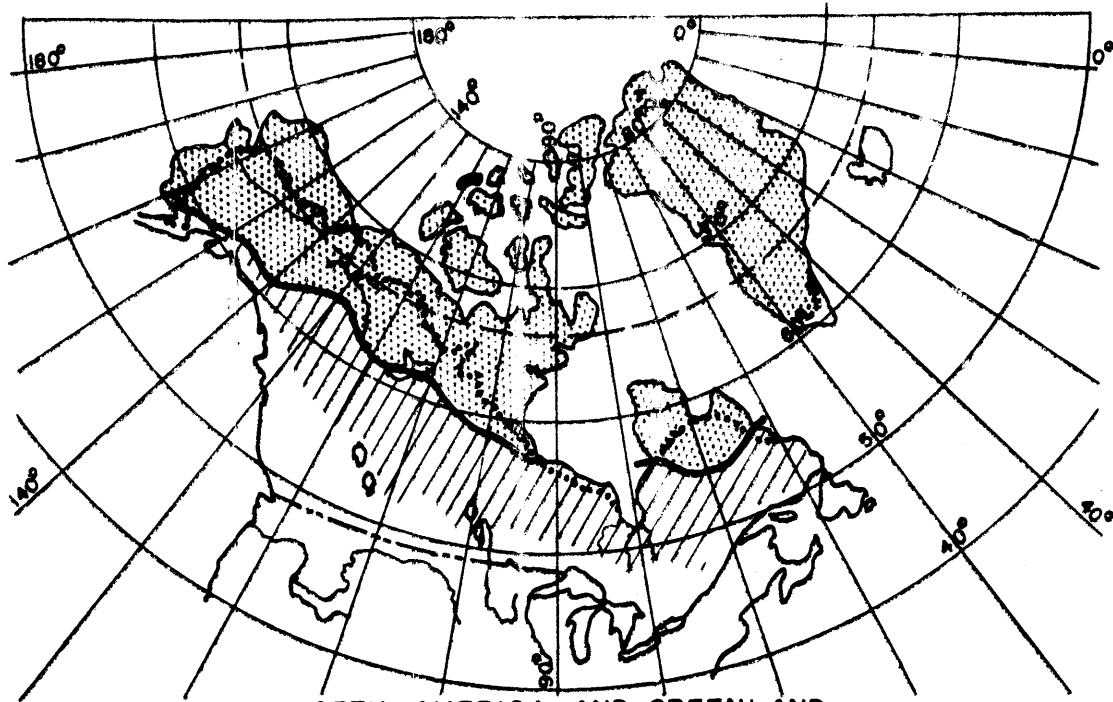
For most stations in Canada, there is no data available on the lowest temperatures occurring in different wind speed ranges. However, some information has been compiled on five stations in northwestern Canada, one of these being MacMurray, Alberta. The Building Research Climatologist with the Meteorological Division in Ottawa felt that the conditions in Uranium City would not be greatly different from MacMurray.

In general, the lowest temperatures occur with light winds, this being most noticeable at MacMurray.

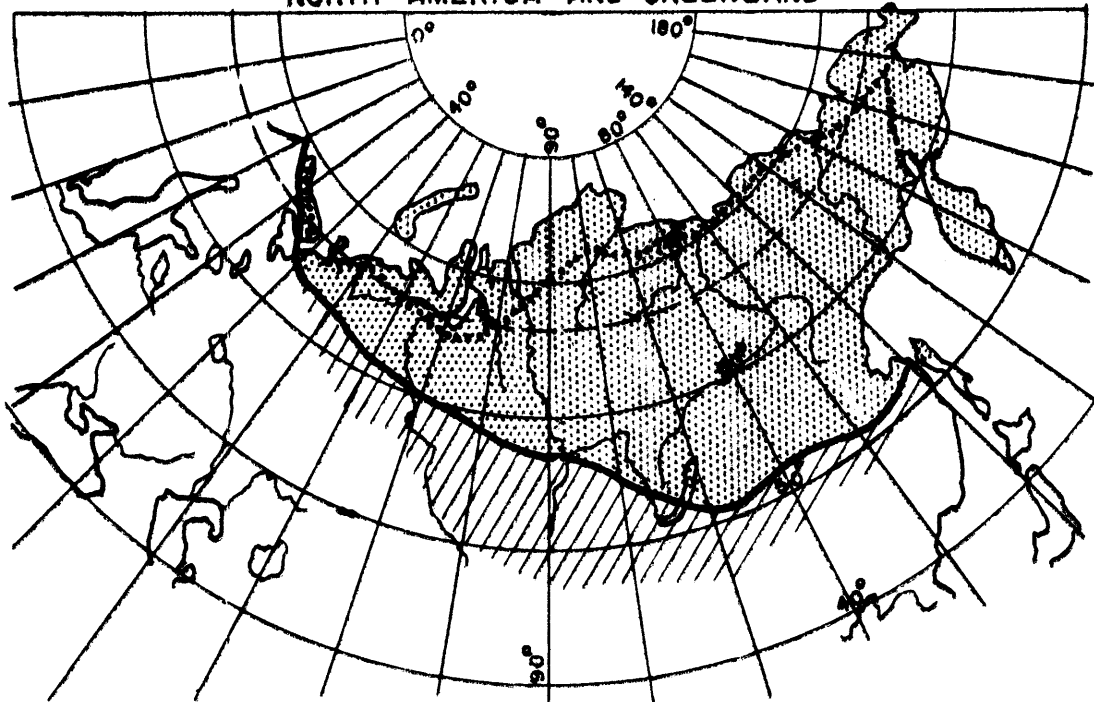
MINIMUM TEMPERATURES IN DEGREES F. FOR VARIOUS WIND SPEEDS

	<u>0-9</u>	<u>10-19</u>	<u>20-29</u>	<u>30-39</u>	<u>40 up</u>
MacMurray, Alberta	-57	-35	-12	34	---

<sup>1</sup> D. W. Boyd, Building Research Climatologist. From a letter dated June 12, 1956.






**NORTH AMERICA AND GREENLAND**



**NORTHERN EURASIA**

500 0 500 1000 MILES

-  Approximate southerly limit of continuous permafrost
-  Area of discontinuous permafrost
-  Approximate limit of trees

**DISTRIBUTION OF PERMAFROST**

*Figure 8.*

CHAPTER II

population and production

housing

general development plan

## CHAPTER II

## 1. Population and Future Production Estimates

A report submitted June 15, 1955, to the government by the Beaverlodge Local Development Area Advisory Committee concluded that employment potential generated by actual production of uranium ore is the only index of population growth. The stable employment opportunities created by the investment of large sums of capital in plants and refining facilities constitute the logical basis upon which project needs for a development northern community of a permanent nature. Exploration and drilling activities would not by themselves be conducive to the formation of permanent settlements, although with the establishment of refineries there is every reason for sustained activity in this line.

The committee's projected estimates of mine production and populations are summarized below:

TABLE II.1 SUMMARY OF BASIC PROJECTIONS

Source: Beaverlodge Local Development Area Report

	<u>1955</u>	<u>1956</u>	<u>1957</u>	<u>1958</u>	<u>1959</u>
1. Mine production (tons per day)	1,600	2,400	3,000	3,500	4,000
2. Total Number of Mine Employees	1,600	1,900	2,400	2,400	2,400
3. Total Population of the Area	3,500	5,000	7,200	7,700	8,000
4. Population Distribution					
at mines	1,800	2,000	2,100	2,100	2,100
at Uranium City	1,700	3,000	5,100	5,600	5,900
5. School Enrollment	250	400	720	850	950



By 1957, however, the expansion of milling facilities will give a minimum milling potential of 3,250 tons per day, with the further likelihood of additional mill construction being undertaken by other companies to bring the rated capacity up to 4,000 tons per day. The indications are then that production estimates based on milling potential will in fact occur two years sooner than predicted.<sup>1</sup>

In a "Guide for Development of Uranium City and District," prepared by K. Izumi and G. R. Arnott, Planning Consultants, population estimates for Beaverlodge were based on the following considerations:

1.	Total Population . . . . .	7,580
2.	Employed Persons	
	Industrial . . . . .	2,400
	All Others . . . . .	960
		<u>3,360</u>
3.	Families by Size	
	1 person . . . . .	1,680
	2 persons . . . . .	504
	3 persons . . . . .	396
	4 persons . . . . .	353
	5 persons and up . . . . .	427
		<u>3,360</u>
4.	Average size of Families of two or more persons . . . . .	3.5
5.	Proportion of Total Population Employed . . . . .	42 %

<sup>1</sup> "Guide for Development of Uranium City and District," p. 6.

## 2. Housing

The following discussion of existing housing and future needs is adapted from the "Uranium City and District Guide for Development."

The objective observer must conclude that the great majority of buildings falls below minimum standard. This is in terms of floor area, general arrangement, construction and exterior appearance. Many of the more temporary buildings serving as dwellings are not worth enough to justify the cost of installing kitchen and bathroom facilities. As one index of housing conditions, it is significant that the consulting engineers for the sewer and water system made a reconnaissance survey in December, 1955, and noted that there were 43 dwellings out of a total of 272 that would be neither practical nor suitable for the installation of plumbing facilities.

The initial problem facing the town authorities will be their policy toward existing owners of sub-standard dwellings. Experience has shown the extreme difficulty, for both humane and political reasons, of removing temporary buildings used for shelter unless the occupants have suitable alternative places to live. To prevent recurrence of the condition, minimum building standards must be adopted and enforced for all new areas and a program worked out for outright removal of the worst buildings, upgrading of existing suitable buildings by means of occupancy permits with time limit provisions and relocating certain dwellings on other sites.

This program will have to be tackled in a vigorous manner if the original intentions behind the establishment of a central townsite are to be realized to the fullest extent, namely that Uranium City would serve as the principal

location for private business and the residences of mine employees with families, with "key" personnel and single workers only being housed at the mines.

Several of the mines have begun to support this policy. For example, Rix Athabasca has five houses in the town-site; Eldorado Mining and Refining Company has build 23 houses for resale to employees under generous terms and has assisted owner-building through sale of lumber, etc. To encourage this trend, other companies in the area need to be satisfied that location in Uranium City will be the best long-term solution for their housing program.

Adoption of planning measures which provide for future growth and at the same time which improve the existing conditions should reinforce this trend. The housing needs of the various companies should be determined, so that programs can be incorporated in the planning of new subdivisions in advance.

#### Housing Requirements

In accordance with the population estimates, housing to accomodate the ultimate size of families will be desirable in accordance with the following table.

TABLE II.3      Distribution of 1,680 Families by Size for Beaverlodge Area

<u>Family Type</u>	<u>Persons in Family</u>	<u>Total Number</u>
Married, childless	2	504
Married, one child	3	400
Married, 2 children	4	365
Married, 3 children	5	223
Married, 4 children	6	118
Married, 5 or more	7 plus	70
		1,680 families

To determine the number of families for which housing could ultimately be required at Uranium City, it is necessary to approximate the family accommodations that will be available at the various mine sites.

TABLE II.4      Assumed Family Accommodations at Mines

<u>Location</u>	<u>Family Dwellings</u>
Gunnar Mines	200
Eldorado Mining and Refining	50
Other Mines	25-30
Total	275-280
Balance of families to be housed at Uranium City	1,400 Families

Existing Accommodation at Uranium City

As of December, 1955, accommodation in Uranium City was roughly as follows:

272 buildings on single lots in the residential zone

30 apartments in the commercial district (estimate only)

34 dwellings in the commercial district (estimate only)

### Additional Accomodation Required at Uranium City

Ultimate number of families to be housed	1,400
Existing available accomodation	<u>336</u>
Required accomodation	1,064

Up to now, subdivision has been based exclusively on the single family dwelling situated on its own lot. This policy does not recognize the varying site needs of other dwelling types such as apartments, terraces or row houses, or even duplexes.

### General Development Plan

Taken from "Guide for Development - Uranium City and District."

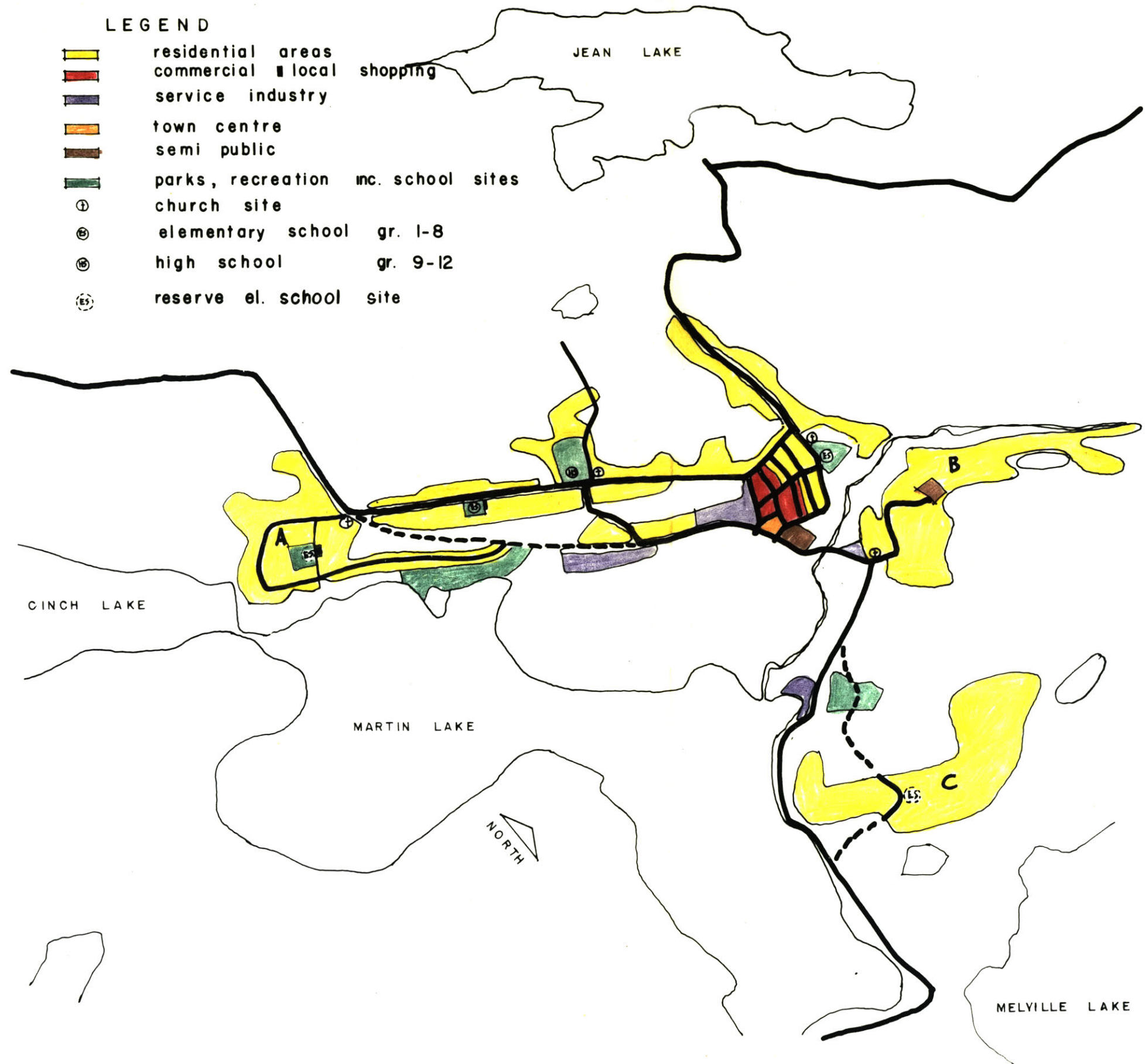
Figure 6 shows in outline form the major directions in which Uranium City can grow in order to accomodate a population of around 6,000 people. It is intended to serve as a guide for development and as such still requires translation into detailed designs before actual construction can proceed in the new areas. This particularly applies to the proposed residential area.

### Residential Land

There are three major tracts of land that air photo analysis indicates as being potentially suitable for residential expansion. These segments, noted A, B, and C on the plan, comprise some 90, 50, and 95 acres respectively, a total of some 235 acres. In view of the fact that all of this land may well be required to take care of expansion of the town, the "Guide for Development" recommended that surveys and other field investigation be undertaken this year in order that their feasibility can be established and so that plans can be

proposed in advance.

Detailed site information is not available at this time, but this is not of prime importance, since the purpose of this thesis is not to show detailed located buildings, but rather to indicate a way of building that the author feels would be technologically and sociologically suitable for this area generally.



**LEGEND**

- residential areas
- commercial  local shopping
- service industry
- town centre
- semi public
- parks, recreation inc. school sites
- ⊕ church site
- ⊞ elementary school gr. 1-8
- ⊞ high school gr. 9-12
- ⊞ reserve el. school site

FIG. 6. URANIUM CITY GENERAL DEVELOPMENT PLAN scale 1" = 1600'

CHAPTER III HOUSING DESIGN CRITERIA

demands of climate

demands of size and remoteness

dwelling planning standards



## CHAPTER III

## 1. Special Site and Space Demands of the Climate

As was previously stated, the climate of Uranium City is characterized by long, cold winters and short but pleasant summers. Three months of the year (December, January, and February) have mean daily temperatures below -10 degrees, with January's being -25 degrees. Admittedly, people become amazingly well acclimatized to such weather, yet will still be forced to spend more of their time indoors during these months, especially their leisure time. These same months have short hours of daylight, the sun shining from about 9 A.M. to 3 P.M. at a low angle (0 degrees - 10 degrees). Surprising as it may seem, temperatures in the neighborhood of 15-20 degrees below zero can be very pleasant if there is little wind and the sun is shining. Well bundled-up children can play outdoors for hours. But for almost four months there are long, dark, and cold evenings when even running an automobile becomes a major operation. A family in which is usually considered minimum accomodation during this period is bond<sup>u</sup> to feel the lack of space very strongly. To lead normal lives, people here will require more space in their homes than is usually considered necessary to pursue individual hobbies and family activities. More closet space will also be required for the storage of bulky off-season clothing. For comfort in spaces close to the entrance, and to control heat loss, a vestibule is a must for any door opening to the outside.

Orientation of buildings must be carefully considered to capture the maximum amount of sunshine in the winter - one of the principal design factors being the low angle of incidence (6 degrees at noon on December 21st).

In contrast with the winter months, when the sun shines only about 6 hours a day, the summer sun shines for almost 18 hours. Obviously, then, it is advantageous to be able to shut out the light when desired for sleeping. This is a simple matter for normal windows, but should also be considered in the design of skylights, where used.

Although the snowfall is relatively light (approximately 30 inches a year) almost all of it remains for the whole winter period. The siting and design of the buildings should take into account drifting that will occur, especially near entrances, etc. However, snow drifting is very difficult to predict, even when the prevailing directions and speeds are known, since the microclimatic variations are almost unpredictable and can only really be checked by actual site observation. Then it will change again, when the buildings are put up, so there is really no positive way of knowing. Certain general precautions can be taken, though, such as windbreaks, fencing to force snow-drifting where it is wanted, etc.

## 2. Special Demands of Remoteness, Size and Physical Nature of the Community

The general accepted standard for open space adequacy in existing cities on this continent is ten acres of all types of recreation space per one thousand persons. On this rather arbitrary basis, Uranium City should theoretically plan for about sixty acres.<sup>1</sup> However, because of the many unbuildable steep slopes and rocky ground that penetrate and surround the entire townsite, the resulting finger-like plan will, in fact, have far more than the suggested 60 acres of open space.

---

<sup>1</sup> American Public Health Association, "Planning the Neighborhood." Public Administration Service. P. 47.

It is, therefore, a proposal of this thesis that the residential areas be planned for higher net densities than are generally found in Western Canadian cities. The standard methods of subdivision for residential areas, along with the high cost of building, have resulted in cramped living quarters in areas of visually monotonous low densities. In Uranium City, because of extremely high building costs due to difficult transportation facilities and labor shortage, the result would probably be even worse. The purpose of this thesis then is to attempt to solve both these problems - the first by proposing a more economic way of building in this area and the second by proposing local groupings of homes in a method that will give maximum sunlight necessary, privacy, yet achieve higher net densities.

Along with the psychological and visual reasons for proposing higher densities, there are also several sound functional reasons. The first and most obvious one, of course, is the shortage of suitable land for housing development. By "suitable" is meant land that is reasonably close to the centre of town, well drained, accessible, preferably sloped to the south and with enough soil cover to permit installation of sewer and water facilities below frost level. It is desirable to reduce undue spreading out of the townsite from both the point of view of transportation, which is difficult and expensive in the winter, and utilities which are also very expensive.

Many of the people who come to Uranium City as workers will be from larger centres and will tend to dislike the fact that it is a small town. It is desirable, then, to alleviate this feeling as much as possible and one way of doing it is to place people in closer proximity to their neighbors - heightening the feeling of belonging to the community. Rather forbidding weather can occur in the winter and it would be comforting to feel as little isolated

as possible. This feeling of isolation, or of being "cut off" from the rest of the world (which is in fact partially true), can be best combatted in the local and small-scale grouping of the dwellings, whether they are detached houses, duplexes, or apartments.

### 3. Dwelling Planning Standards

The checklist of minimum dwelling planning standards used in this project are those put forth by the American Public Health Association in their publication "Planning the Home for Occupancy." They are based on standards designed to contribute to the physical and mental health of the family. Each dwelling should have well organized, effective space for:

1. Sleeping and dressing
2. Personal cleanliness and sanitation
3. Food preparation and preservation
4. Serving food and dining
5. Recreation and self-improvement
6. Extra-familial association
7. Housekeeping
8. Care of infants or of the ill and infirm
9. Circulation between various areas of the dwelling
10. Operation of utilities.

In the eyes of the author, the following standards based on the above ten activities represent minimum requirements for satisfactory housing. The trend of today seems to be to plan smaller, more "efficiently" crowded dwellings to offset the increasing cost of building. This thesis will attempt to show that a more effective and more human approach to this problem of economy lies in a

search for more efficient methods of enclosing space to form dwellings - not in reductions of the space itself. For these reasons, the following standards will be used. The following space allotments do not necessarily represent a "room," but indicate only the actual space necessary to perform the functions. All figures in the following table are in square feet.

Minimum Floor Space Requirements for Basic Household Activities

	<u>Number of Persons</u>					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
Sleeping and dressing	74	148	222	296	310	444
Personal cleanliness and sanitation	35	35	35	35	70	70
Food preparation and preservation	8	76	97	97	118	118
Food service and dining	53	70	91	105	119	146
Recreation and self-improvement	125	164	221	286	357	383
Extra familial associations	17	17	34	34	51	51
Housekeeping	48	91	110	127	146	149
Care of infant or the sick	-	124	124	124	124	124
Circulation	20	20	35	35	45	45
Operation of utilities	<u>-</u>	<u>20</u>	<u>20</u>	<u>20</u>	<u>20</u>	<u>20</u>
Square feet of floor space (rounded off to the nearest 50 feet)	400	750	1,000	1,150	1,400	1,550

These represent essential space requirements of a dwelling which, without extravagance, will make physical and emotional health possible.

CHAPTER IV BUILDING IN URANIUM CITY

climate demands on building

transportation

labor

## CHAPTER IV

## 1. Demands of Climate and Terrain on Building

When building in the sub-arctic within the three-zone and not in an area of permafrost (such as Uranium City), the building problems are very similar to Southern Saskatchewan. The main difference is the lower winter design temperatures, -46 degrees Fahrenheit, and the attendant insulation problem. Keeping heating equipment, size, and operating costs at as low a level as possible is desirable because of the high cost of fuel, so walls and roof, and exposed floors with U factors in the vicinity of 0.05 are desirable. With such cold temperatures, vapor barriers are very important, the best solution being a moisture resistant insulation material.

Because of the low annual rainfall and its central position on the continent, it is an area of relatively low humidity and low vapor pressure. Thus the problem of material deterioration through excess moisture is not nearly as great as Boston.

The long cold winters cause ground freezing to a depth of approximately 10 feet. From an economic viewpoint, then, this seriously challenges the feasibility of attempting to put spread footings down this deeply, or of building basements at all. Another factor, that of the rough terrain with large exposed rocks, also points to some other foundation solution, such as the use of cast-in-place piers.

The snow fall is not heavy, the maximum recorded depth on the ground being only 30 inches. This, along with the fact that the snow is very dry and blows around easily, gives quite light snow loading on roofs. The National

Building Code of Canada suggests 30 pounds per square foot, this probably being well on the safe side. However, the snow that does fall stays practically all winter and because of its dryness tends to drift easily. So snow drifting next to buildings is a factor which should be considered.

## 2. Transportation

The author feels that the high cost and difficulties of transporting building materials to Uranium City is the greatest limiting factor to building in this area. The basic transportation services to Uranium City and District are limited to year-round air service to Prince Albert and Edmonton (some 400 miles) and to summer season water-borne barge service from railhead at Waterways, Alberta (some 150 miles)(see Fig. 7). The extremely high cost of air freight makes this method of transporting building materials practically impossible. The only other connection to the "outside" in the foreseeable future is a winter road and a possible future summer road to either Bitumont, Alberta (150 miles) or to La Ronge, Saskatchewan (400 miles) or to Meadow Lake, Saskatchewan (500 Miles). The great difficulty of building roads in this inaccessible country means that it is likely to be several years before anything is done and a large number of housing units must be erected in the meantime if Uranium City is to grow as planned.

## 3. Labor

In an outpost area such as Uranium City where there is not a very large or reliable supply of labor close at hand, the designer must think in terms of attracting the skilled laborers from other centres. This would be very difficult to do even at high wages, if all there is to offer is seasonal employment. Since it is next to impossible to work outdoors for about 6 months of



# Trucking route will help north

The Meadow Lake-Uranium City trucking road is going to mean big things for the north, resources department officials said Tuesday.

"The group of 10 going to build the winter road from La Loche to the south shore of Lake Athabasca deserve a lot of credit for their pioneering spirit," said Resources Minister J. H. Brockelbank.

Martin Semchuck of Meadow Lake is president of the firm and Arthur Porter, head of a trucking firm, is secretary-treasurer.

At present the government is working on a road in the Ile a la Crosse area that will eventually link Meadow Lake with Buffalo Narrows. This will be a summer road that the group of businessmen can use for truck hauls in winter months.

Between Buffalo Narrows and La Loche are trails that can be adapted for a winter road. The firm plans to run their road north east from La Loche to Wasekan Lake. From there it will be largely by an overland route 190 miles north to Lake Athabasca.

An official estimated the group would be able to operate trucks on their winter road for five and a half months each year, roughly from Dec. 1 to May 15.

The big volume of business is likely to be into Uranium City rather than out, he said. In the summer months Uranium City gets much of its supplies by the cheap water route along the Athabasca river from Edmonton. This has the drawback that the barges cannot be operated in winter months.

"A pound of butter that is flown in is an expensive pound of butter," said the department official. "I don't know how much cheaper the truck rates will be, but it should mean a substantial saving."

He said that for this firm to build an all-year road would be out of the question. The cost would be staggering and when it was completed they would have to compete in summer months with goods hauled in from Alberta by water.

Freight out of Uranium City probably would not amount to much, at least for the present, he said. The product of the north's uranium refineries goes out by plane to eastern Canada.

To make the return trip pay, the northern businessmen plan to haul fish and fur to Meadow Lake presumably from Buffalo Narrows and lakes in that area.

"But this is more than a simple road to Uranium City," said the official. "It is a long step toward development of the vast potential of the northern half of our province."

To date the north of the province has largely been developed from Alberta on the west and Manitoba on the east. The Lynn lake railway in Manitoba has been the route out for mining and power development in eastern Saskatchewan.

On the west the Athabasca lake area has been served and serviced from goods sent up Athabasca river.

The only link northern Saskatchewan has with the rest of the province is by air.

The official said the provincial government has an agreement with the enterprisers that it can use the private road if it wishes.

He added that if a mining strike was made along the road route an all-weather road could be considerably hastened.

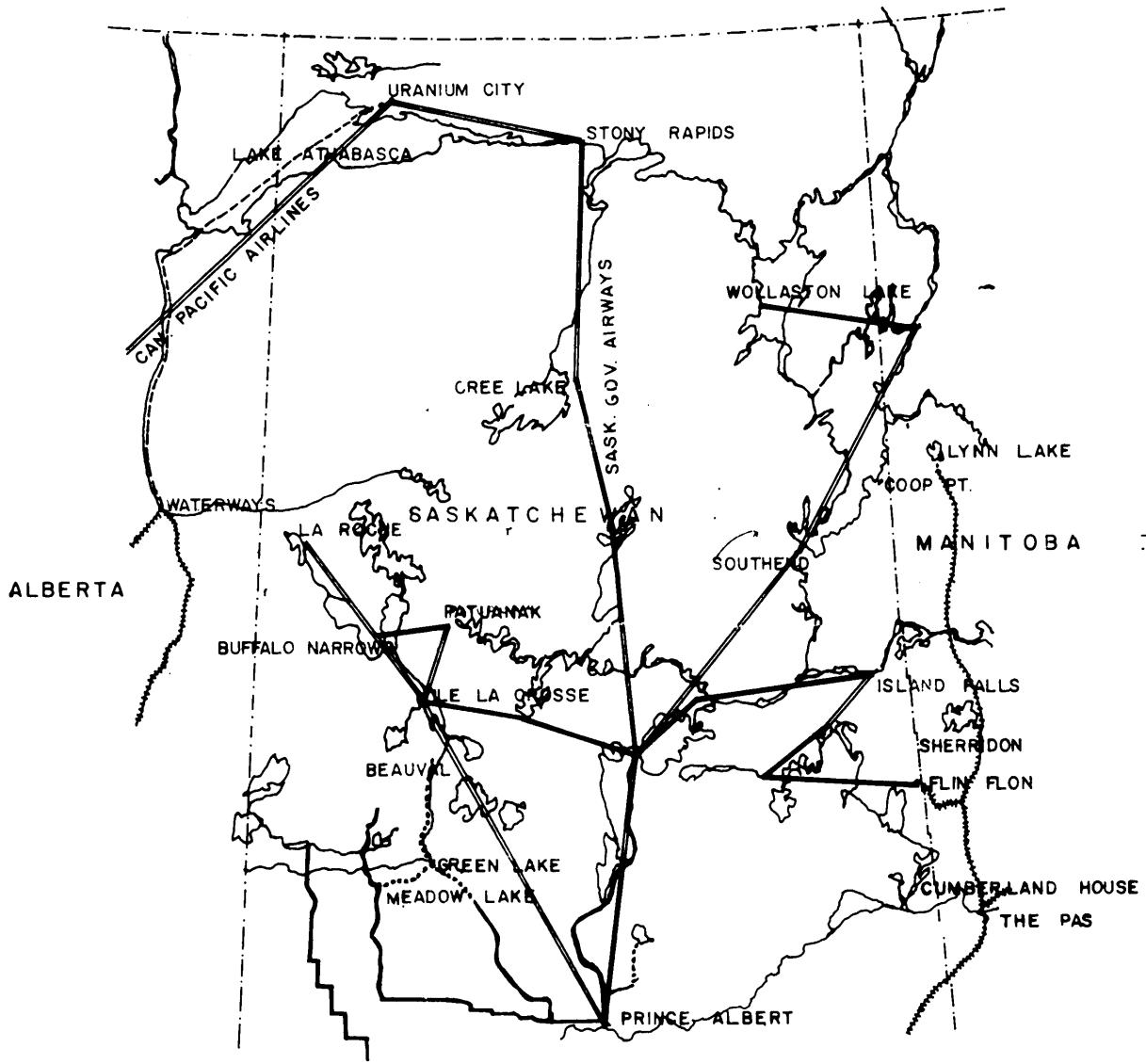


FIG. 7 SETTLEMENT & COMMUNICATIONS  
IN NORTHERN SASKATCHEWAN

scale 1" = 75 miles

LEGEND

- air route
- barge route
- prov. highways
- other roads
- railway

4  
6  
6  
6  
6

the year in this climate, a way of building should be devised which offers year-round employment for all workers.

CHAPTER V OUTLINE OF PROPOSAL

basic considerations

selection of materials

the building process

future possibilities

## CHAPTER V

## 1. Basic Considerations:

In the first four chapters, the significant background information was discussed briefly, and proposals were made in the various sections as they occurred in relation to this information. Perhaps this is a good point, then, to reiterate briefly so there will be no doubt in the reader's mind as to the basic aims of this study.

In the near future there is planned considerable expansion of this relatively inaccessible northern community. The people are going to need places to live at a price they can afford to pay. High transportation costs tend to raise the price of everything, including building materials, yet it is thought that for many reasons, the homes built here should be larger than we normally consider adequate in temperate climates. It is felt that the direction of thought which will eventually lead to a solution to this problem lies in the choice of building materials and the technology of using these in a system of building which will minimize all the limitations of climate and locality, and maximize the size and flexibility of enclosure which can be economically provided.

Because of the lack of reliable information on costs and the presence of so many unpredictable factors in estimating costs, the proposal will be based on logical reasoning and that if it is truly sound it is assumed it would be economically sound also. The point is it would be foolish to try to prove economic advantage with fictitious cost figures. The result should be judged only on its reasonableness.

The following are the criteria used in the choice of materials and the building system.

#### MATERIALS

minimum shipping weight  
 minimum shipping bulk  
 reasonable in cost  
 high insulation qualities  
 structural qualities with minimum weight

#### BUILDING SYSTEM

maximum flexibility  
 fast erection  
 year-round employment  
 a system that allows a completed house to be sold or an enclosed, weather-tight shell for those who wish to do the interior finishing themselves  
 finished product has low maintenance and operating costs (especially with regard to heating)

The following are the considerations upon which the site planning suggestions are based.

maximum amount of sun in every dwelling unit (especially in winter)  
 lot shapes and sizes which will provide flexibility in the placement of single family detached houses  
 street and lot arrangement which will provide short utility runs

street and lot arrangement which will provide as much visual interest without sacrificing privacy or public open space

## 2. Selection of Materials

The first materials to be considered for building in Uranium City were the local ones. These are rock and very small trees. Uranium City is quite close to the northern limit of trees and although they make nice scenery, the native Jackpine and Poplar from this far north have little to offer structurally, as we generally consider timber. A future possibility, though, if production warranted, could be to use these trees to manufacture a composition board for facings and finishing, and fibre board for insulation. Studies would have to be made to determine the amount of available timber for this purpose, and the rate of growth. If re-growth proved to be very slow, as it probably is in the far north, stripping the land through extensive lumbering operations could have serious results through wind and water erosion, turning the surrounding landscape into a barren, arctic-like tundra.

The extensive use of rock for building would be extremely slow and require a very large seasonal labor force. However, stone can and should be used for foundations in some cases, and can also be used to form snow fencing, wind breaks and to model the landscape in the immediate building surrounds.

When considering materials to be brought in (by barge now and truck in the future) the prime consideration from a transportation viewpoint is weight and bulk. Also, since good thermal insulation must be provided, it seems most reasonable that the principal materials should have good insulation qualities as well. Then, if your material has adequate structural qualities, too, it

would seem that it would be a most appropriate materials to be using here. When looking over our standard building materials, wood, steel, concrete, brick, all the desirable qualities are not present at one time. One must then look at our new materials.

After considerable research, some forms of foamed plastic kept reappearing again and again as having great potential. Here is a material that can be transported in its dense, low bulk form. It can then be expanded into its low density, yet surprisingly strong form almost on the site. The insulation qualities are excellent, some forms are impervious to moisture and many forms are very easily worked with standard woodworking tools. Yet, there is a form of this material on the market now, called Dylite, produced by the Koppers Chemical Company, which when transportation costs are considered, is almost competitive just as an insulation material. It is expanded to almost 30 times its shipping density by the application of heat. In this form it is relatively stiff, because of its cell construction, requires no vapor barrier, yet 4 inches of this material gives a K factor of approximately 0.05 (standard stud construction sheathed and plastered with 4 inches of rockwool insulation gives a K factor of approximately 0.07). Although the material has only been on the market a short time, it has already proved itself well enough that at least two other large chemical companies are bringing out competitive products in the near future, which, in time, should lower the price. The Dow Chemical Company markets a similar material but only in the expanded form, under the trade name of Styrofoam. It has been used successfully as insulation and as a core of material with wood, metal and sprayed-on concrete facing.



There are several ways that the foamed plastic can be used structurally: as a core material in a stressed skin panel with plywood, metal or plastic faces; certain types of plastics can be mixed with a foaming agent and literally poured like concrete, in such a case it could be reinforced with a plastic or metal mesh and designed like a thin shell concrete structure. However, the types of plastics which can be used in the latter method are very expensive at the present time, and will be out of the question from a cost standpoint for some time to come. So taking all things into consideration, it was decided that the most effective way of using this material at the present time or near future is as a core for a stressed-skin panel.

The use of a panel system of building was decided upon for other reasons also - the foremost among these being that this type of construction lends itself very easily to local pre-fabrication which is a step forward in utilizing industrial processes in this field of building.

"More and more the tendency will develop to pre-fabricate the component parts of buildings rather than whole houses. Here is where the emphasis belongs, for man will always rebel against over-mechanizations which is contrary to life. Pre-fabrication, as a logical progressive process, arrived at raising the standards of building will finally lead to the combination of both, which means higher quality for lower prices. There are many analogous cases of industry successfully offering improved commodities at lesser prices to serve as evidence for such a statement. Thus pre-fabrication at last becomes a vital instrument to solve the housing problem economically."<sup>1</sup>

Plywood was chosen as a facing material for the panels because of the fact that it is a local material (produced in British Columbia), it is strong, weather resistant, workable, and is available in fairly convenient sizes.

The panel sizes were chosen from the available size of the facing material (4' widths) and for a size and weight that two men could handle. The lengths

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<sup>1</sup> Gropius, "Rebuilding our Communities," p. 33

of all panels are multiples of its width so that the panels may be used together vertically, horizontally, and laterally. In this way, a small number of similar panels can be assembled into a large variety of individual buildings of different size and appearance (see drawings).

### 3. The Building Process

The first step would be the establishment of a small plant<sup>1</sup> at Uranium City where the panels could be fabricated all year round. The size of the plant suggested would be capable of producing component parts enough for 200 dwellings a year and would have enough unheated space to store 6 months' production. The figure of 200 dwellings a year was arrived at from the "Guide for Development" which predicts the need for at least 800 more dwellings being required by 1960 or thereabouts.

The raw materials, expandable plastic, plywood, wood for millwork and splines, glue, etc., are brought in by barge in the summer months. In the future, they will also be able to truck them in during the winter, which will alleviate the necessity for stockpiling the raw materials for the winter production.

If a material similar to Dylite (expandable Polystyrene beads) is used as a core for the panels the assembly of panels would be approximately as follows.<sup>2</sup>

1. The expandable polystyrene is pre-expanded to the desired density (approximate 2 lbs/cu ft) in a pre-expander (see Fig. 9).

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<sup>1</sup> See Appendix for approximate size and for machinery required. See drawings for suggested layout.

<sup>2</sup> From an interview with engineers of the Koppers Chemical Company.

2. One panel face is placed on the lower bed of the press and the panel thickness spacer and edge retainer is clamped into place as shown in Fig. 8. The plywood is coated with a glue which will adhere the plywood faces tightly to the foam. The plastic which has now been pre-expanded to the desired density is poured up to the top of the edge retainer.
3. The upper face is then coated with the same glue as the lower face and is placed on top. The press is then clamped down.
4. The steam is turned on and the probes are slowly pulled out. This causes the plastic to foam. The press is necessary to prevent the foaming action from bowing out the faces of the panel. The foaming action stops when the temperature cools down to approximately 140°.

It is estimated that one station such as this is capable of about 8 cycles per hour or in other words, the production of 8 panels per hour.<sup>1</sup> This means that enough panels for an average-sized house can be produced each day. Hence the figure of approximately 200 dwellings per year is arrived at. Therefore, a one station set-up as outlined above would satisfy the basic housing requirements. It is assumed that the climate would allow outside work for approximately 6 months of the year. This means that the full year's production of house shells must be erected in these six months - or at the rate of about two every working day.

A crew of men would erect the shell of the house and would be followed by glazers and roofers so that the dwelling can be completely closed in. During the six months in the winter, the same men can finish the houses as they will then be working in a completely closed-in space and can use portable oil

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<sup>1</sup> From interviews with engineers of Koppers Chemical Company.

heaters for warmth. At this time the plumbing, electrical, and heating will be installed and the interior partitions, closets, cabinets, etc., built. This will enable every man involved to work all year round.

A suggested scheme for rental purchase of housing by future owners is brought forward by the Planning Consultants in the "Guide for Development."

"A variation that limits the company's part to the construction of house shells only may prove practical for companies in the Beaverlodge Area. Under this scheme, the employee would buy a partially completed house, consisting of the foundation, structural fram, roof, and, possibly, the exterior finish and do most of the interior finish himself. In this way the employee's contribution would be in the form of labor of "sweat" equity. With the use of good workable plans and sound materials, the community can be assured that a presentable home will result, all be it not without a great deal of work on the part of the owner."

Under the proposed system, it would be at this stage that the owners who wished could invest their "sweat" equity. Interior partitions, cabinet work, closets, flooring, painting, are all things that the average owner could do if he so desired.

Since the installation of heating, electrical, and plumbing must be done by trained workers, I feel that although the owners did do some of the finishing work themselves, the construction workers would still have work all winter.

#### 4. Future Possibilities

Since the system is not based on the pre-fabrication of a single house, but on the manufacture of component building parts which can be used in many ways, the plant should not have to curtail operations after the initial housing need is satisfied. With a little imagination, there is no reason

pre-expanded plastic foamed in core of panel with steam by inserting steam probes, turning on steam and withdrawing probes.

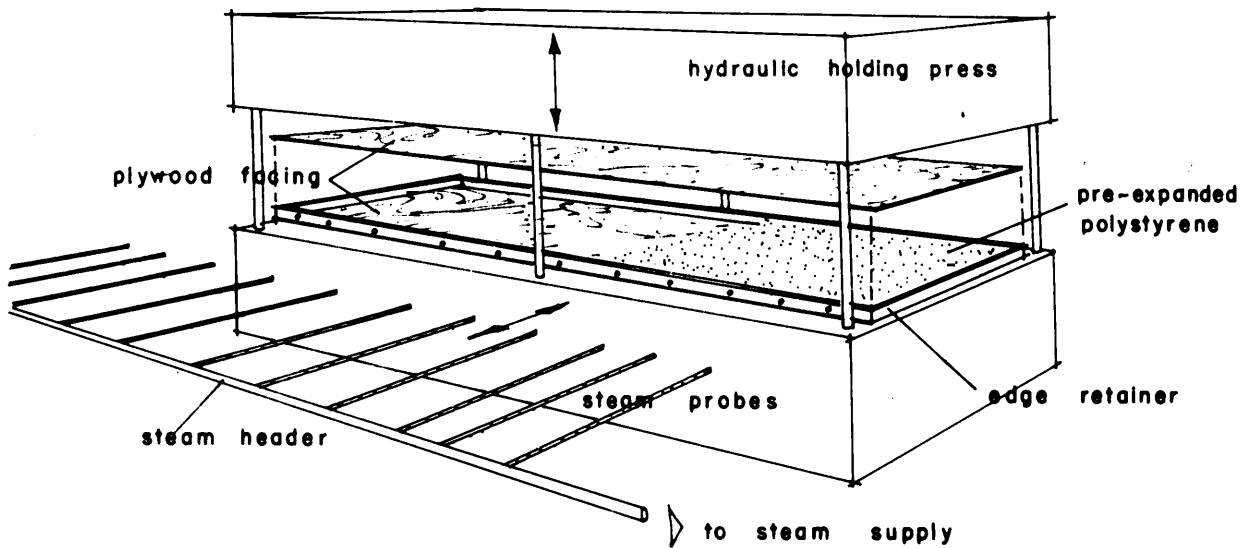


FIG. 8 DIAGRAM OF PANEL ASSEMBLY STATION

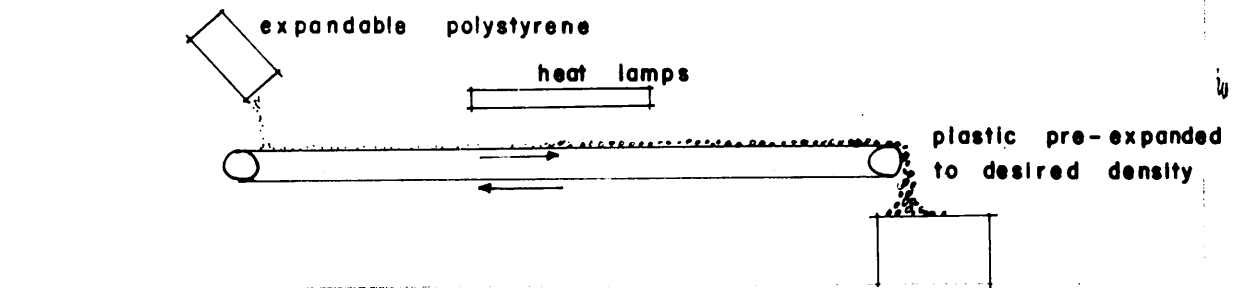


FIG 9 DIAGRAM OF SIMPLE PRE-EXPANDER

why this could not be adapted to schools, nurseries, community buildings, mining service buildings, or almost any size of one or two story buildings that might be required anywhere in the surrounding area. It is even possible that Uranium City could be a central distribution point for pre-fabricated building parts of many types, and would give the city another permanent industry, employing a non-seasonal labor force.

It is also conceivable that the plant itself could use its facilities and branch out into other related fields, like manufacture of plywood or fibre-glas boats, reinforced plastic bathroom fixtures, etc. The plant, though small, could be an economic and social asset to the community.

APPENDIX

proposed space requirements  
for panel fabrication plant

## Proposed Space Requirements for Panel Fabrication Plant

<u>HEATED SPACE</u>	<u>AREA IN SQUARE FEET</u>
1. Assembly Room - plastic pre-expansion, gluing, and panel assembly station	1,500
2. Milling, cutting, and woodworking	1,000
3. Boiler Room	200
4. Small office, staff washrooms, etc.	<u>200</u>
	2,900

UNHEATED SPACE

1. Storage of basic materials for winter production	
10,000 sheets plywood	2,000
600 drums expandable polystyrene	1,000
glue, misc.	500
2. Storage for lumber and winter production of panels	
6,000 panels (piled 20 panels high)	<u>12,000</u>
	15,500

MAJOR EQUIPMENT REQUIRED

milling and woodworking equipment  
 holding press (capacity 80 tons)  
 plastic pre-expander  
 boiler (for steam foaming of plastic and heating)  
 steam probes and extracting equipment  
 glue mixing, etc.



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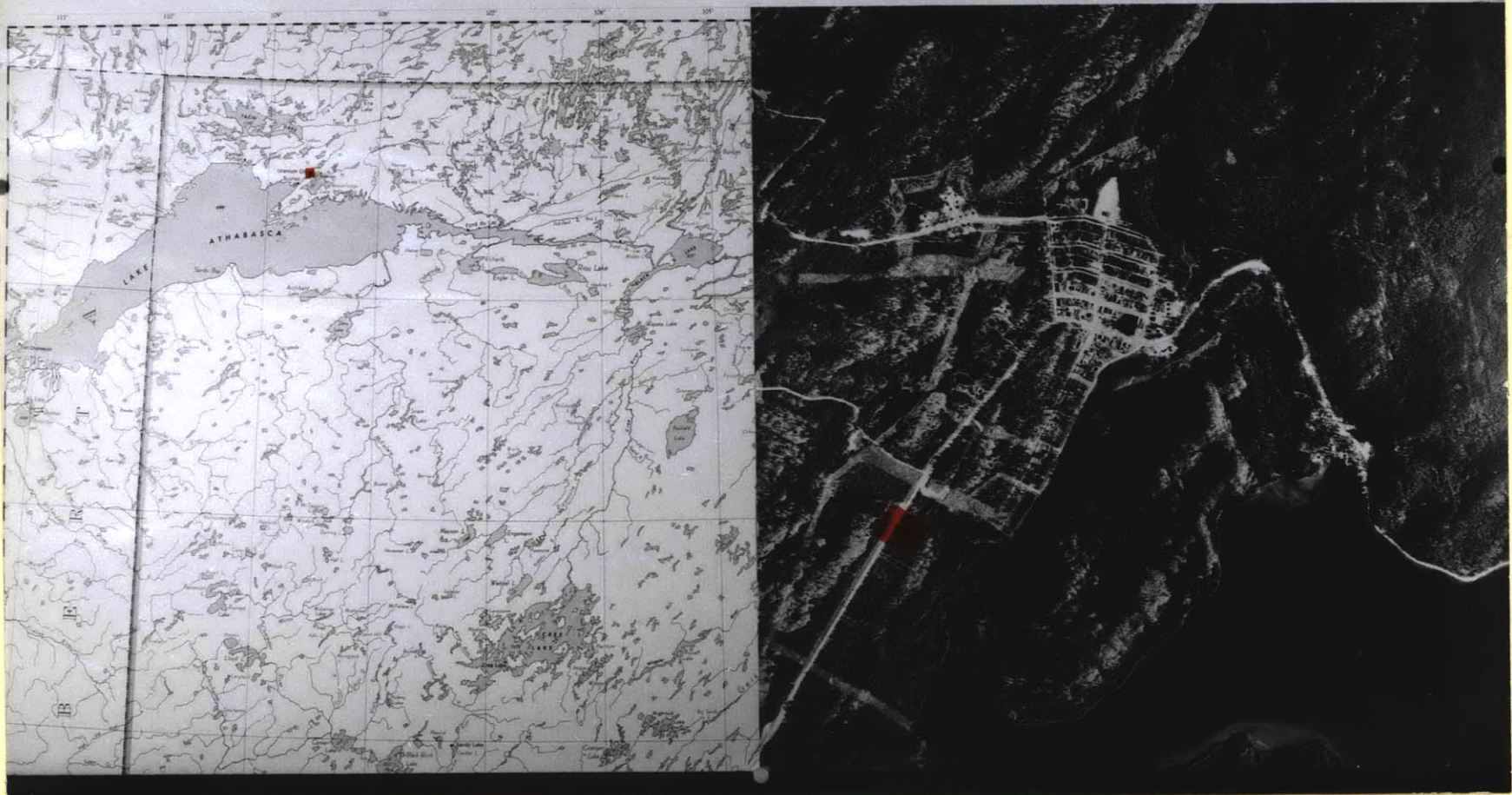
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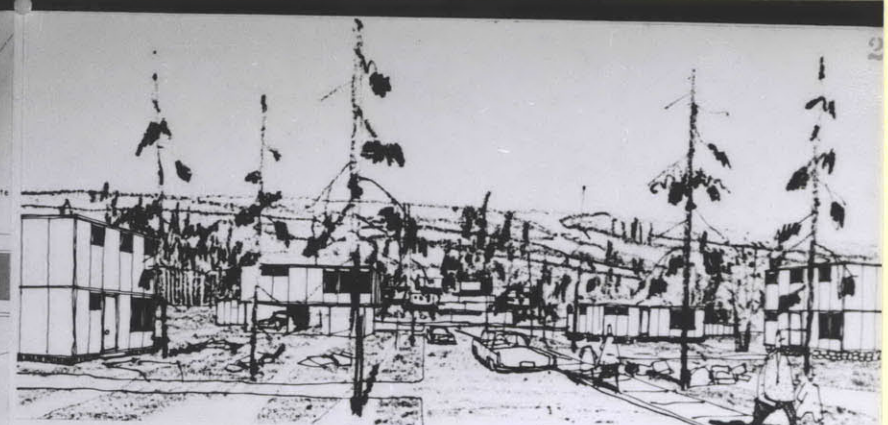
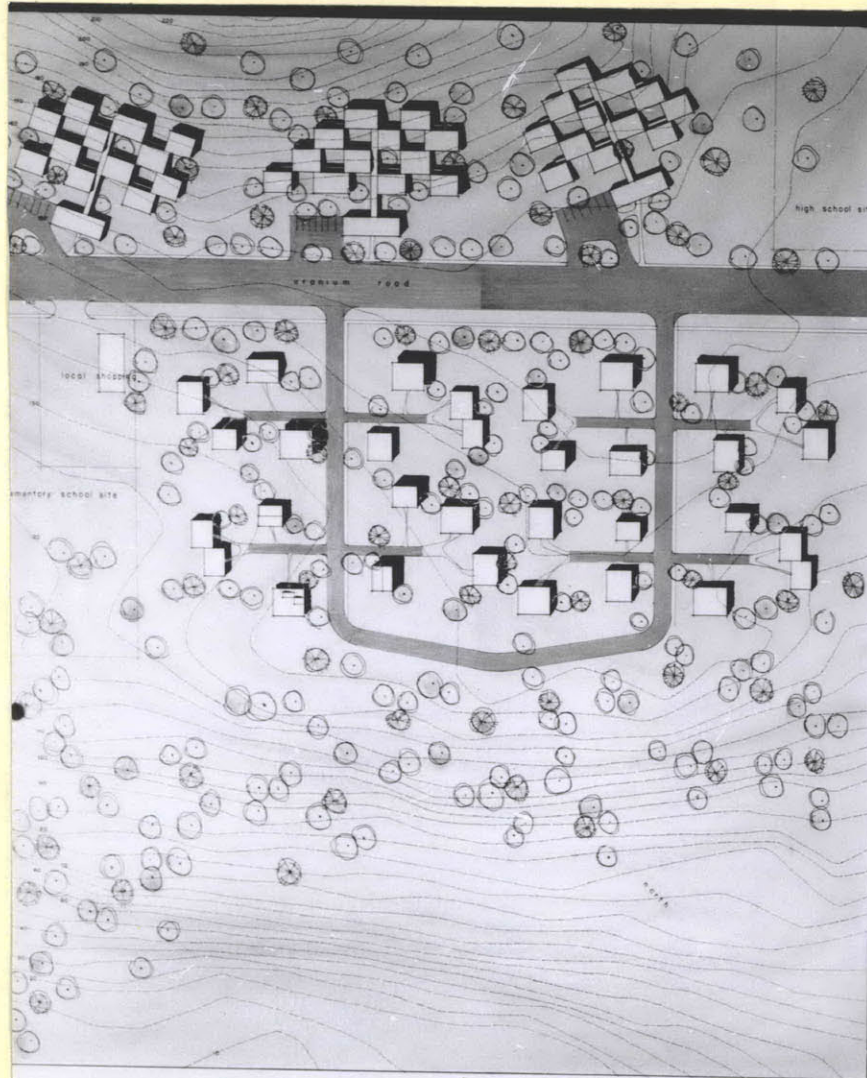
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# HOUSING FOR AN EXPANDING SUBARCTIC COMMUNITY

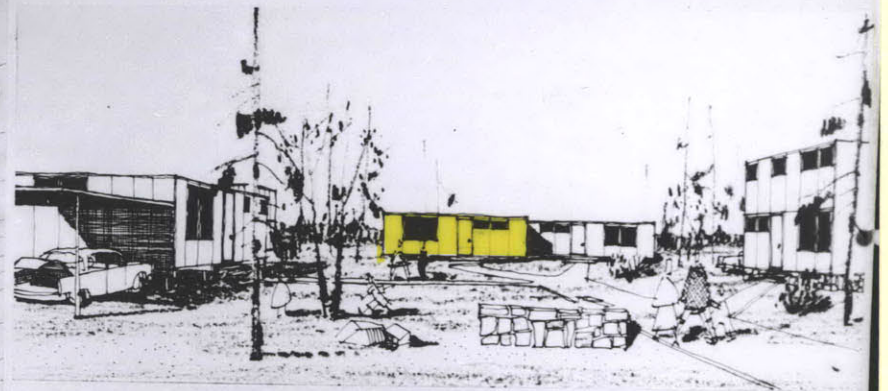
URANIUM CITY SASKATCHEWAN

MASTERS IN ARCHITECTURE THESIS  
ALAN H. HANNA AUGUST 1956  
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

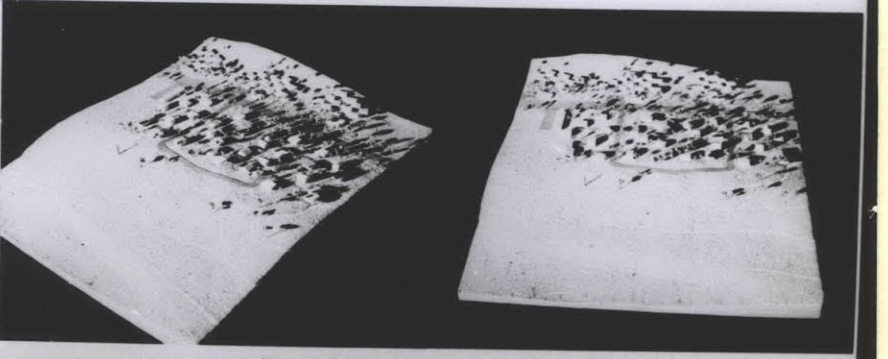
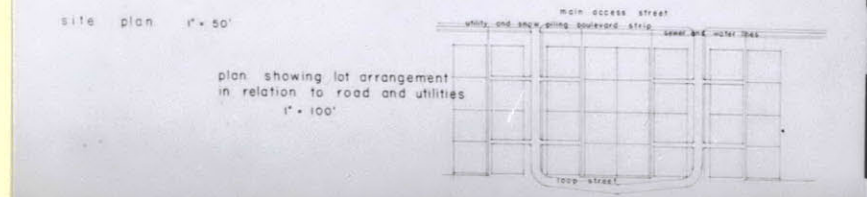




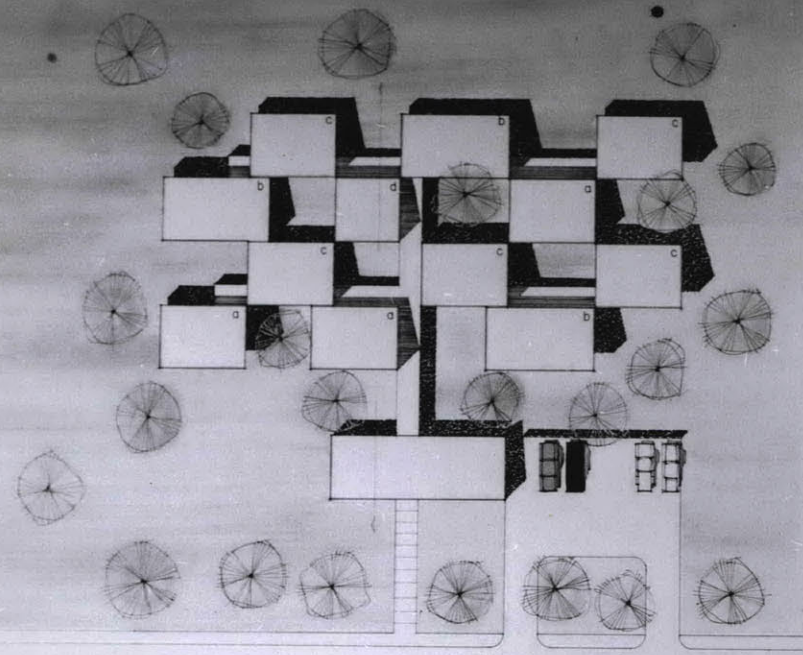
looking down loop street toward uranium road



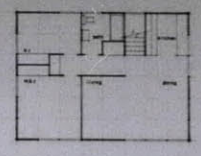
looking into typical housing group from loop street



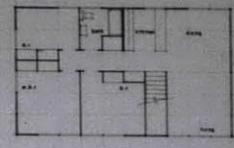
site model



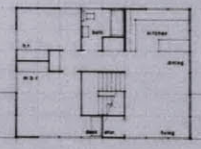
site plan typical apartment scale 1" = 16'



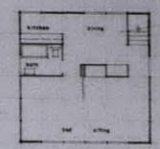
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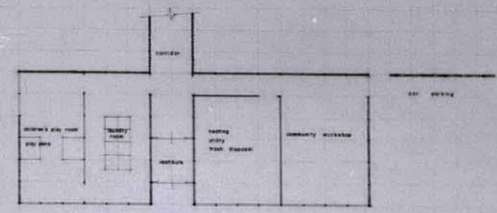
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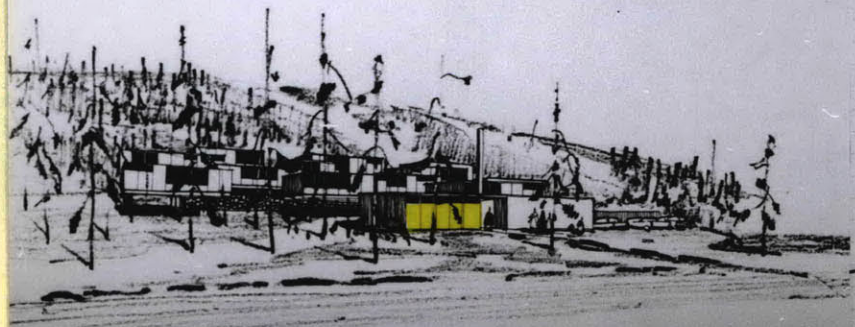


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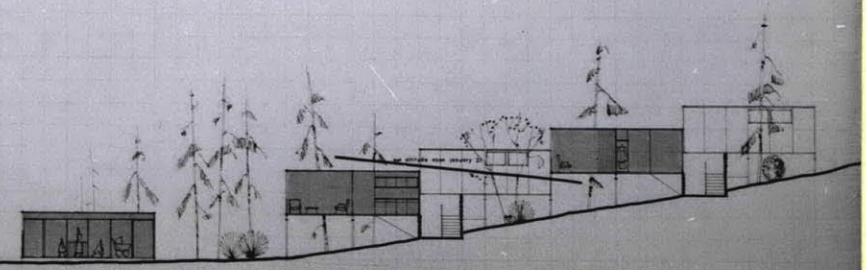


community service building

scale 1" = 8'

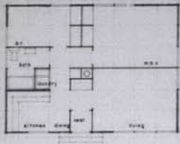


typical apartment as seen from uranium road

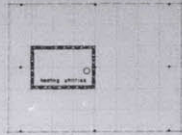


section thru apartments

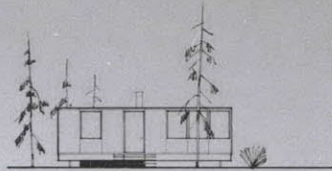
detached single family dwellings  
scale 1"=8'



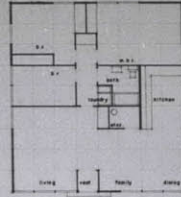
floor plan



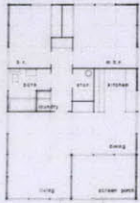
foundation plan



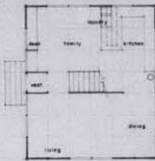
front elevation



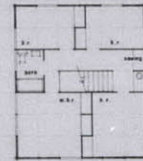
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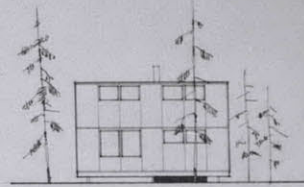
floor plan



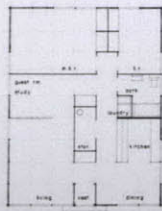
first floor



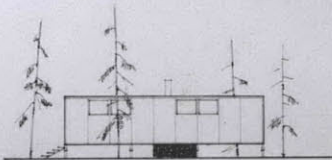
second floor



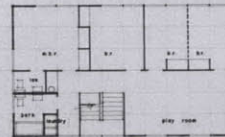
rear elevation



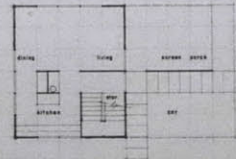
floor plan



side elevation



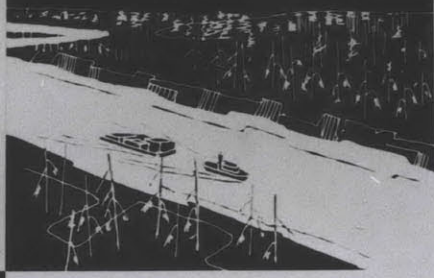
second floor



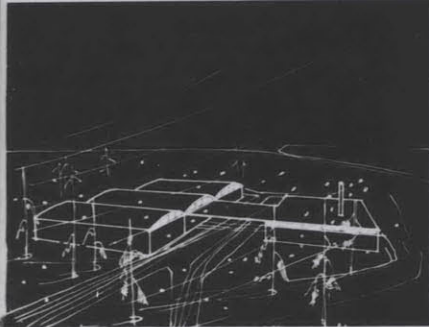
first floor



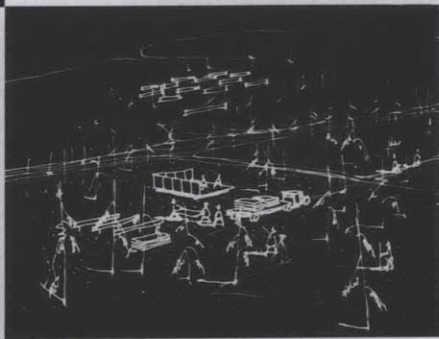
materials for years production brought in by barge during summer shipping season (June - September)



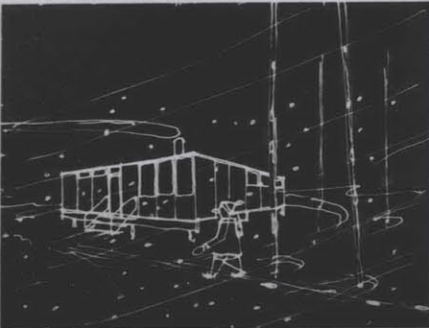
small factory produces the component parts of panelized house year-around, winter production stored for erection in summer



years production (200 dwellings) erected and closed in during summer

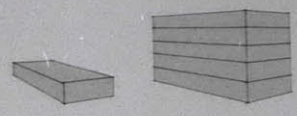


men who erect dwellings in summer work inside the closed-in house shells, completing them during the winter months.

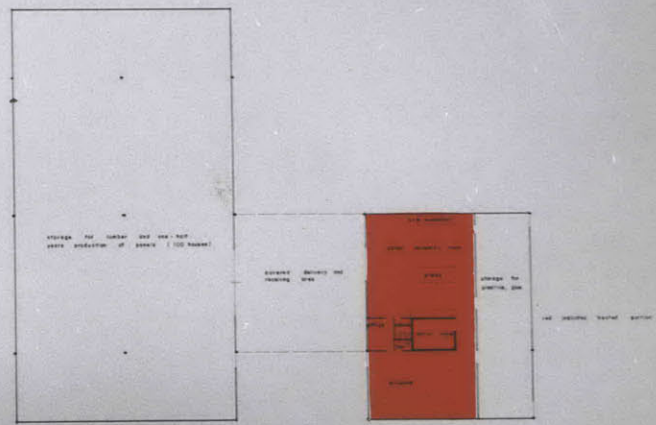


the building system

under the proposed system the materials used to build a small house shell have a weight of approx. 3 1/2 tons and a shipping bulk of about 350 cubic feet.



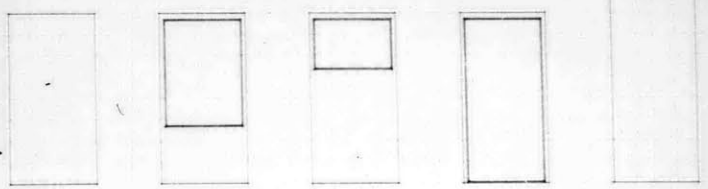
with normal stud wall and joist construction and equivalent insulation, a similarly-sized house shell has a weight of approx. 17 tons and its component parts require approx. 1600 cubic feet to transport.



diagrammatic plan of small factory capable of producing 200 dwellings a year

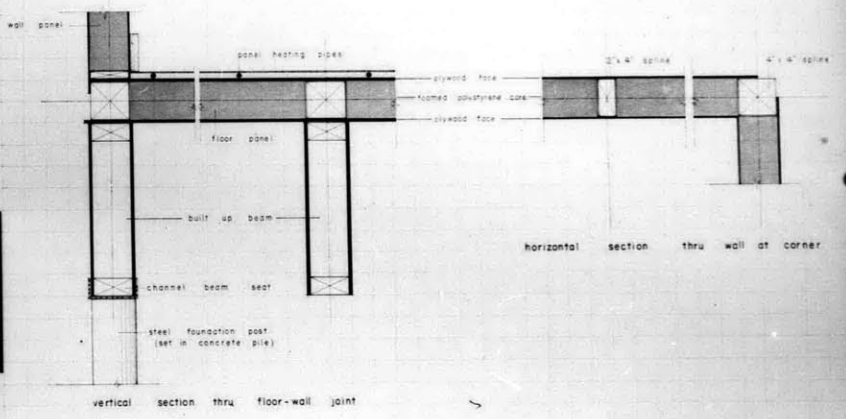
scale 1" = 16'

structural system details  
scale 3" = 1'



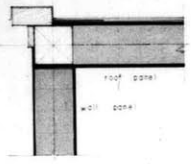
wall panels  
scale 1" = 2'

roof and floor panels

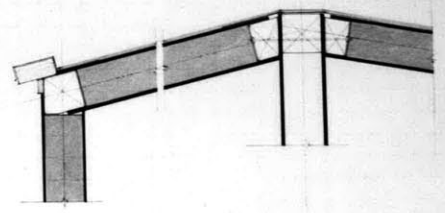


horizontal section thru wall at corner

vertical section thru floor-wall joint



flat roof



pitched roof

