ERRATA SHEET

Part Two - Chapter XXV - Subregion "C"

Pg. II-11, Para. 20, Line 7; change six to 6.5.

Pg. IV-5, Table 10, Condition III; change Slight to Moderate.

Pg. IV-18, Para. d, Line 4; change 2,895 to 2,210.

Pg. V-6, Para. 9, Line 7; change 12 to 15.

Pg. V-9, Para. 15, Line 8; change 12 to 15.

Table following page V-10; change Table 4 to Table 16, and delete -8-.

Pg. VII-2, Para. 3, Line 2; change 256,000 to 262,000 and para. 4, next to last line; change 6,300,000,000 to 6,500,000,000.

Following Pg. VII-4, Table 31, sheet 6, under column "Average annual generation (1000 kwh); insert 2,700 once to apply to "Village of Enosburg" plants.

Pg. VII-5, Para. 10, Last line; change the Lamoille River to Otter Creek.

Pg. IX-23, Para. 41, Line 9; change These and other to Cranberry Lake and many other.

Pg. X-3, Para. 8, Lines 7 and 9; change the estimated visitation figure of approximately 4,500,000 to read the estimated figure of approximately 6,300,000 visitor days; and visitation amounts to 7.7 to visitor days amount to 12.1.

Pg. X-31, 4th line from bottom of page; change Vermont to New York.

Pg. X-37, Para. 55, Line 5; change acquired by gift at Atwater Kent and financed to read a gift of Mr. Atwater Kent financed.

Pg. XIV-9, Para. 10, next to last line; change seven to twelve.

Pg. XIV-15, Para. 16, sixth line; change XXXV to XXIX.

NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE
150 CAUSEWAY STREET
BOSTON 14, MASSACHUSETTS

Final revisions
Subregion "C"
Chapter XXV, Part Two
March 14, 1955

1. Attached are revised pages ix, III-1, III-2, VI-1, VI-2, VI-4, VI-5, VI-6, VI-7, VI-8, VI-11, VI-12, VI-13, VI-14, VI-15, VI-16, VI-17, VI-18, VII-3, VII-4, VIII-1, X-13, X-14, X-27, X-38, X-39, X-40, X-41, X-45, X-51, X-52, XI-13, XI-15, XI-16, XI-17, XI-18, XI-19, XI-20, XIV-1, XIV-5, XIV-14, XIV-17, XIV-17a, XIV-20, XIV-24, XIV-25, XIV-26, and XIV-27, comprising the final revision for Part Two, Chapter XXV of the Report of the New England-New York Inter-Agency Committee entitled The Resources of the New England-New York Region. Note that each revised page is identified by the revision symbol in the lower corner. It is requested that you open the binding of your copy, remove the superseded pages, insert the revised pages and destroy the replaced pages.

2. Also attached is an errata sheet showing minor corrections for which no revised pages are furnished. It is requested that you make all the changes indicated on the errata sheet.

3. Upon completion of the above, the copy of this chapter of the Report which you have will be in final form.

G. B. Troland

G. B. TROLAND
Coordinator

FOREWORD

This book contains one chapter of Part Two of the Report of the New England-New York Inter-Agency Committee, organized by direction of the President of the United States for the purpose of making a comprehensive survey of the land, water and related resources of the New England-New York Region.

The complete report comprises three parts:

Part One - The General Report.

Part Two - The Technical Report, with detailed studies of the river basins and special subjects.

Part Three - Reference Data.

THE RESOURCES

OF THE

NEW ENGLAND-NEW YORK REGION

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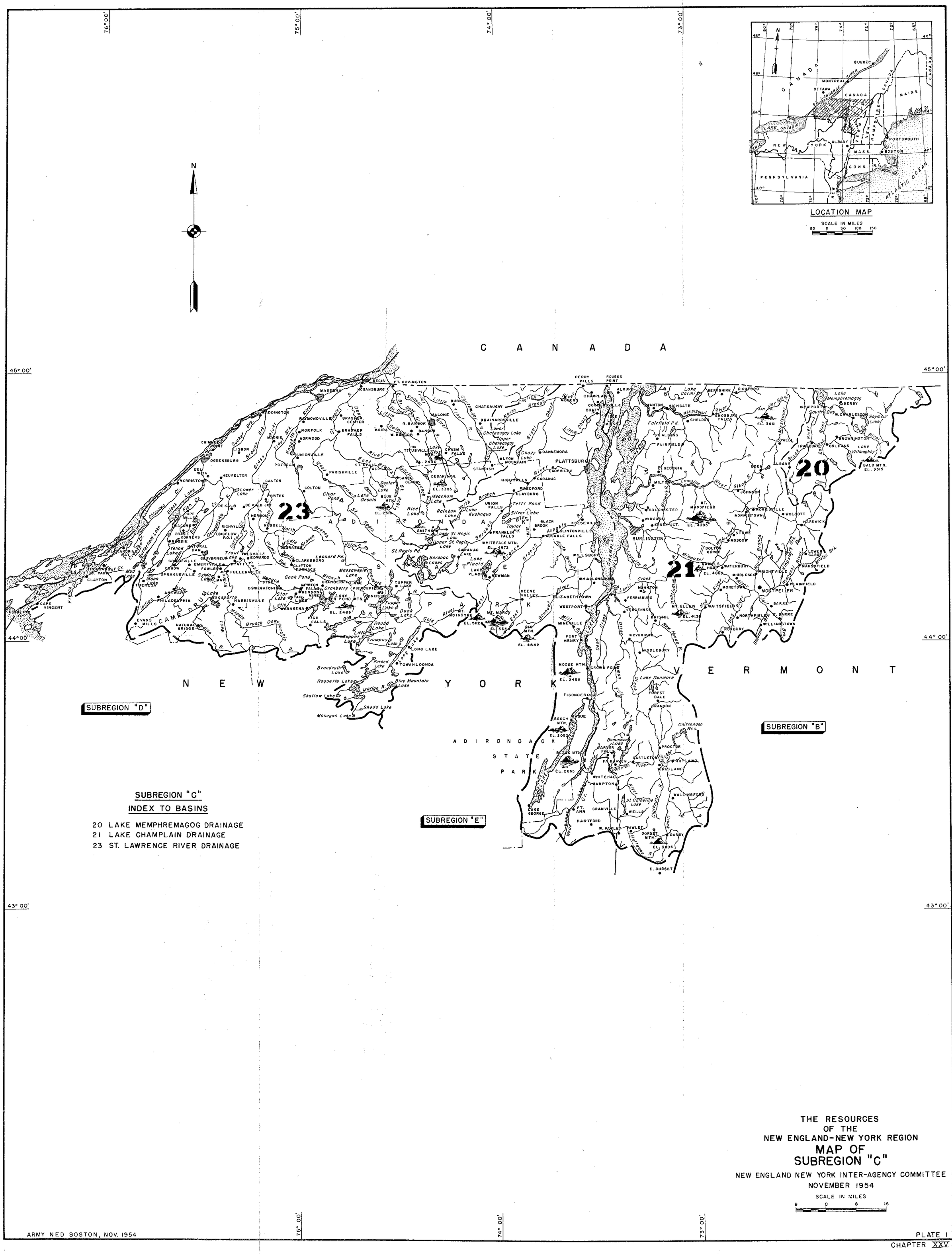

THE RESOURCES
OF THE
NEW ENGLAND-NEW YORK REGION

MAP OF SUBREGION "C"

NEW ENGLAND NEW YORK INTER-AGENCY COMMITTEE
NOVEMBER 1954

SCALE IN MILES
8 0 8 16

ARMY NED BOSTON, NOV. 1954

PLATE I
CHAPTER XXV

THE RESOURCES

OF THE

NEW ENGLAND-NEW YORK REGION

PART TWO

CHAPTER XXV

SUBREGION "C"

VERMONT - NEW YORK

NEW ENGLAND NEW YORK INTER-AGENCY COMMITTEE

SUBREGION "C"

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SUBREGION "C"

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1. For convenience in making the survey of land and water resources the designation Subregion "C" was adopted by the Committee for that portion of the New England-New York Region which includes the drainage basins of the rivers in the states of New York and Vermont draining into the St. Lawrence River. Thus it embraces the basins of Lake Memphremagog and Lake Champlain and of the St. Lawrence River in the United States. It borders on Canada and lies west of the valley of the Connecticut River. The total area of the subregion is 13,833 square miles, of which 5,209 square miles are in northern and western Vermont and 8,624 square miles are in northeastern New York.

2. In extent, Subregion "C" is more than 200 miles long from east to west measured along the international boundary between the United States and Canada and as much as 125 miles wide extending south of the international boundary. The surface of the subregion varies from river and lake lowlands at elevations of less than 100 feet, mean sea level, to hills and mountains rising higher than 4,600 feet. Two large lakes, and many smaller lakes and rivers occupy the lower elevations. Approximately 60 percent of the land surface is forested. The remainder is largely in pasture land used in dairy agriculture. Aside from dairying the predominant economic activities are the raising of orchard crops, recreation activities and a variety of local industries. Most of the population of 516,400 people

in the subregion is scattered in rural areas with only a few major cities of more than 10,000 population.

SURFACE WATER

3. Major lake and river systems. - Three lake and river systems comprise Subregion "C". The Lake Memphremagog Drainage Basin includes 591 square miles of area in northern Vermont; five-sixths tributary to Lake Memphremagog itself and one-sixth drained by three streams flowing into the St. Francis River in Quebec. The Lake Champlain Drainage Basin has an area of 7,705 square miles in northwestern Vermont and northeastern New York. Within this basin ten of the rivers draining into Lake Champlain have drainage areas of more than 250 square miles. Both Lake Memphremagog and Lake Champlain extend across the United States-Canadian boundary and are drained by rivers flowing into the St. Lawrence River in the Canadian Province of Quebec. In northeastern New York the St. Lawrence Drainage Basin has an area of 5,539 square miles. This is the area in the United States drained by the St. Lawrence River between the Lake Ontario and the Lake Champlain Drainage Basins and comprises only a small part of the entire St. Lawrence River system. All of the principal rivers in Subregion "C" flow generally northward, draining directly or through larger streams and lakes into the St. Lawrence River.

Navigation on St. Lawrence River in Thousand Islands section. Subregion "C".

4. Lakes. - The largest of many lakes formed by bedrock glacial deposition or artificial damming within Subregion "C" is Lake Champlain with a surface area of 435 square miles. Together with Lake George (44 square miles) and connecting waterways, Lake Champlain occupies a long narrow trough extending north and south across the center of the subregion. Lake Memphremagog (37 square miles, of which 10 are in the United States) is the largest lake in the northeastern part of the subregion. Scattered small lakes, ponds and artificial reservoirs, including Lake Placid and the Saranac Lakes, occupy headwater areas in the west-central part of the subregion.

TOPOGRAPHY AND GENERAL GEOLOGY

5. Topography. - The terrain of Subregion "C" is a composite of rolling lake and river lowlands and subdued mountainous areas. The small lowland area around Lake Memphremagog lies between eastern uplands known as the Caledonia Mountains and the Green Mountains to the west. The north-south trending Green and Taconic Mountains rising to elevations above 4,000 feet west of Lake Memphremagog separate its lowland area from the Lake Champlain Lowland farther to the west. The Lake Champlain Lowland descends to an elevation of 95 feet at the Canadian border. It widens to the north and merges with the flat plain of the St. Lawrence Valley, which encircles the northern flank of the Adirondack Mountains. The Adirondack Mountains are heavily wooded with an irregular arrangement of rounded peaks rising to elevations

of more than 5,000 feet. Many lakes, ponds and marshy areas lie in upland sections of the Adirondacks which separate the Lake Champlain Lowland on the east from the St. Lawrence Valley on the northwest. Within Subregion "C", the St. Lawrence Valley is a comparatively narrow flat plain extending for 115 miles along the reach where the river forms the United States-Canadian international boundary.

6. A generally north and south trend is characteristic of each of the lake and river lowlands within Subregion "C". The Lake Memphremagog lowland has an elevation of about 700 feet. The Lake Champlain Lowland and the St. Lawrence Valley lie at lesser elevations of about 100 and 300 feet. In contrast, the mountain elevations within Subregion "C" are lowest on the east in the White Mountains and highest towards the west within the Adirondack Mountains, where Mount Marcy rises to an elevation of 5,344 feet. The Green and Taconic Mountains immediately east of the Lake Champlain lowlands rise to intermediate elevations of between 1,500 and 4,400 feet.

7. Bedrock. - The under-lying bedrock formations of Subregion "C" are of geologic ages ranging from the early Pre-Cambrian to the Ordovician period. The oldest bedrocks found in the subregion are within the Adirondack Mountains where gneisses, granitic igneous rocks and marble and sedimentary rocks of Cambrian ages crop out. In the St. Lawrence Valley sandstones and limestones of Cambrian and Ordovician systems

occur. Formations underlying the Lake Champlain lowlands are composed largely of limestones and slates of geological ages similar to those of the Adirondacks. Schists, gneisses, and some granitic rocks predominate in the Green, Taconic and White Mountains, and similar bedrock types underlie the lowlands around Lake Memphremagog.

8. Surficial geology. - Most of the land surface of Subregion "C" is covered by glacial drift, which includes both glacial till and outwash. In the lowlands thick glacial deposits have partly buried most of the pre-glacial river valleys. In addition, marine clays are found particularly in the St. Lawrence Valley. Glaciation left most of the mountain peaks and ridges of the subregion smooth and rounded. Glaciation also left many lakes, ponds, and swamps upon the glacial drift of the partly filled valleys in all parts of the subregion. The upland lakes in the Adirondacks and in the headwaters of the St. Lawrence and Lake Champlain Drainage Basins are examples.

9. Forests. - Approximately sixty percent of the subregion is forested. The lake and river plains, used largely for dairying, are the principal areas of open land free of forests. The hardwood combination of sugar maple, beech and yellow birch is the principal forest type. Softwood types, chiefly spruce-fir and soft pine, predominate west of the Lake Champlain

lowland and south of the St. Lawrence Valley in the Adirondack Mountains. Much of this heavily forested area is within the New York State Forest Preserve land set apart from commercial use. The forest is second-growth as a result of commercial cutting, previous land clearing or forest fires.

10. Soils. - Glacial till, outwash and lacustrine deposits have been the parent materials for most of the soils in Subregion "C". Hilly and mountainous areas, characteristically have shallow, stony soils interspersed with many rock outcrops and are unsuitable for crop agriculture. Throughout the subregion many swamp and marsh lands are unusable for agriculture as a result of poor drainage. A few areas of well-drained limestone, outwash and alluvial soils in the St. Lawrence Valley and around Lake Champlain and Lake Memphremagog have the best soils for the crop, orchard and dairy farming in the subregion.

MAPS

11. The physical and cultural characteristics of Subregion "C" are shown on maps and charts of State, Federal and Canadian agencies. The entire subregion is covered by topographic sheets of the U.S. Geological Survey at a scale of 1:62,500 (approximately 1 inch to 1 mile). Geological survey general maps (scale 1:500,000) are available for the entire subregion. The Army Map Service used a scale of 1:250,000 in sheets covering the whole subregion.

The Army Map Service also has maps at scales of 1:500,000 and 1:25,000 for parts of the subregion. The shores and channels of the St. Lawrence River and Lake Champlain are shown on U.S. Lake Survey charts having scales of 1:10,000, 1:30,000 and 1:40,000. Maps of the U.S. Bureau of Public Roads, Vermont State Highway Department and New York State Department of Public Works give patterns of transportation.

12. Neighboring areas in Canada are shown on maps of the Canadian Department of National Defence at scales of 1:63,360 (1 inch to 1 mile) and 1:253,440 (1 inch to 4 miles).

CLIMATE

13. Subregion "C" has a humid, continental climate which is characterized by long, cold winters, short mild summers and 30 to 40 inches of precipitation each year. The principal influences on climate within the subregion are differences in elevation ranging from about 95 feet to 5,000 feet affecting temperature, the orographic effect of the mountains on precipitation and moderating effects of large bodies of water such as Lake Champlain, St. Lawrence River and Lake Ontario on temperature. The areas with the mildest climates are at low elevations near the largest lakes in the subregion.

14. Temperature. - Within the subregion average annual temperatures are between 40°F. and 45°F. Average monthly temperatures fall as low as 15°F. in mountain locations during

winter months and rise as high as 70°F. in the summer near the St. Lawrence River, Lake Champlain and Lake Memphremagog. There are temperature extremes in the subregion ranging from below -44°F. to above 104°F. Depending upon elevation and location in relation to mountain or lake areas, the growing season varies between 100 to 160 days. (See Table 1).

15. Precipitation*. - The subregion receives an annual precipitation of 30 to 40 inches but locally average annual precipitation is as low as 19 inches and as high as 60 inches. Mountainous areas, such as the Adirondacks, receive the greatest amounts of average annual precipitation; lake and river lowlands the smallest amounts. Characteristically, throughout the subregion there is a late summer maximum in average monthly precipitation. During the winter most of the precipitation is in the form of snow, with the total amount of snowfall ranging from 62 inches to 137 inches. (See Table 2).

HYDROLOGY

16. Surface water. - The annual runoff from the river basins in Subregion "C" has been measured at 70 stream-gaging stations of which 52 are presently being operated. A substantial start was made on this work about 1903 and was expanded gradually as

* Precipitation is the quantity of water deposited on the earth in the form of hail, mist, rain, sleet or snow. The U.S. Weather Bureau's definition of "precipitation" does not include dew, fog and frost.

Table 1 - Temperature data, Subregion "C"

Station	Newport, Vermont	Burlington, Vermont	Lake Placid, New York	Ogdensburg, New York	Tupper Lake, New York
Years of record	9	64	46	61	40
Elevation (feet, m.s.l.)	766	331	1,864	258	1,700
Month			Degrees Fahrenheit		
January	18.1	18.8	14.4	17.9	16.6
July	67.5	70.3	63.8	70.2	64.8
Annual	42.0	45.1	39.6	44.6	40.6

Table 2 - Precipitation data, Subregion "C"

Station	Newport, Vermont	Burlington, Vermont	Lake Placid, New York	Ogdensburg, New York	Tupper Lake, New York
Years of record	16	112	45	62	42
Elevation (feet, mean sea level)	366	331	1,864	258	1,700
Precipitation (annual)			(inches)		
Average	37.12	32.36	38.25	30.99	37.13
Maximum	44.97	49.44	49.11	-	-
Minimum	26.73	22.62	29.24	-	-

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need for information on streamflow increased. By 1950 a total of about 1,300 station years of record had been collected.

17. Average annual runoff varies from 10 inches in the upper Lake Champlain Lowland to 35 inches in the Green Mountains of Vermont and the Adirondack Mountains of New York. The watershed having the highest measured average yield was that of the Waterbury River near Waterbury, Vermont, with a measured yield of 28.24 inches.

18. Average annual evapo-transpiration ranges from 17 inches in a small area in the Green Mountains of Vermont to 22 inches over the Lake Champlain Lowland with an average over the subregion of about 20 inches. Evapo-transpiration is defined as the total of all water losses and is equal to precipitation less runoff. The average annual evaporation from water surfaces is about 23 inches with little apparent variation over the subregion.

19. Because of the wide variation in the yield of drainage basins from year to year and from basin to basin, the work of determining the average annual flow of the rivers in the subregion is continuous. Information is seriously deficient on the yield of small streams on which data are needed especially for the study of water supplies for small communities, farm ponds, irrigation, and the design of culverts and bridges.

20. In order to balance properly the surface-water studies in Subregion "C" the work should be expanded in the following three principal phases (Table 3): a. Permanent type stream-gaging stations should be established on 4 rivers and on 5 small areas of less than 5 square miles. Gages should be installed on the large lakes of the area. These should generally be recording gages to be of maximum value. b. A number of short-term temporary stations should be established on ungaged streams of potential value and operated for a sufficient length of time to establish the relation of their discharge with the discharge at nearby base stations, after which time they would be moved to other locations. The yearly cost of this phase of the program would be about $10,000 and should continue for five years. c. The great accumulation of basic data that has been collected over the past half century should be analyzed to yield the greatest benefit from the available information. A comprehensive analytical program would cost $10,000 per year for a period of five years.

21. Ground water. - The supply of ground water in Subregion "C" is widely available but generally limited in quantity. It originates as precipitation over the area that percolates below the surface to ground water reservoirs. As a general rule these reservoirs are relatively shallow and fill to the surface of the ground nearly every spring. They discharge to springs,

Table 3 - Estimated costs of needed additions to surface water investigations, Subregion "C"

Project	Unit Cost		Total Cost	
	Installation	Yearly operation	Installation	Yearly operation
1. 4 permanent stations	$3,500	$850	$14,000	$3,400
5 small-area stations	1,500	750	7,500	3,750
4 recording lake stations	3,000	400	12,000	1,600
6 non-recording lake stations	50	300	300	1,800
2. Temporary stations		10,000	50,000	
3. Comprehensive analysis of data		10,000	50,000	
Totals			$133,800	$10,550

streams, lakes or to the sea. The base flow of the rivers of the area is maintained by the discharge from ground water reservoirs.

22. Surveys of ground water reservoirs determine the direction of movement of the water, the specific yield, transmissibility, rate of discharge and recharge, and the size and storage capacity of the reservoir. Records of fluctuations of the water table and the draft from the reservoir are kept in important areas. These surveys and records are being made in the subregion in the State of New York

and should be continued until all of the subregion is surveyed. Such surveys have not yet been started in the State of Vermont. Results of the surveys are being published in U.S. Geological Survey Water Supply Papers and special reports and are available to the public.

23. Quality of water. - The natural surface waters of Subregion "C" are soft, relatively low in suspended material and mineral content, and generally excellent for domestic, agricultural, and industrial uses. Many of the rivers of the subregion have been polluted by the discharge of large volumes of untreated sewage and industrial wastes and process water with resulting damage to recreation, fishing, and municipal, agricultural, and industrial water supplies.

24. The quality of ground water in the subregion is generally harder and more highly mineralized than the surface waters but is generally suitable for domestic, industrial, and agricultural uses. The temperature of the ground water remains low and fairly constant throughout the year.

25. The sanitary quality of the surface and ground water has been determined by the various State departments of health and the data are generally available and adequate. For those industries requiring water having certain exacting physical or chemical qualities, sufficient information is not now available to determine the areas in the subregion where such water can

be found. All streams carry quantities of sediment during periods of high flow.

27. Lake levels. - Both Lake Champlain and Lake Memphremagog are regulated under conditions pursuant to the Boundary Water Treaty of 1909 between United States and the United Kingdom acting in behalf of Canada. Although the level of Lake Memphremagog has varied between 679 feet and 686 feet, normally it is regulated by the Dominion Textile Company at a level between 679.28 feet and 683.00 feet, U. S. Coast and Geodetic Survey Datum, 1929 General Adjustment. The level of Lake Champlain is regulated by an order of 1937 of the International Joint Commission between a maximum of 95.5 feet and a minimum of 92.5 feet.

SECTION II - ECONOMIC DEVELOPMENT

INTRODUCTION

1. Subregion "C" is rather sparsely settled as shown in Table 4, with a total population just over one-half million persons, although the Vermont portion of the subregion contains nearly two-thirds of the total population of that State. Economic activity in the subregion is carried out generally on a smaller scale than in the other subregions of the New England-New York area, excepting only the more northerly portions of Subregions "A" and "B".

2. Barriers and passageways. - Economic development within Subregion "C" has been strongly influenced by certain of its physical characteristics. The heavily forested mountain ranges of the subregion have retarded economic development, except for wood-using industries and recreational uses, and have served as barriers to the development of transportation and trade. In contrast, the valley of the St. Lawrence River and the lowland bordering Lake Champlain have, throughout the period of European

Table 4 - Areas and populations by basins and States, Subregion "C"

Basin	Area (square miles)	Population
Lake Memphremagog	591	19,500
Lake Champlain	7,703	338,900
St. Lawrence	5,539	158,000
Totals	13,833	516,400
State		
New York	8,624	272,000
Vermont	5,209	244,400
Totals	13,833	516,400

penetration into eastern North America, served as agricultural areas and as primary routes for transportation, military conquest, and trade. The St. Lawrence Valley provides an easy passageway in northeast and southwest directions on the western margin of the subregion. A major north-south route between Montreal to the north and the Hudson River and New York City to the south is provided by the Lake Champlain lowland across the center of Subregion "C". Another north-south route of lesser importance crosses the Lake Memphremagog lowland in the eastern part of the subregion passing onto the Connecticut River Basin.

3. Economic data. - Analysis of economic activity in the subregion is somewhat impeded by the fact that, while economic data are generally available on a State or county basis, Subregion "C" cuts across portions of two States and portions of several counties in each State. Thus the New York portion of

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the subregion includes all of Clinton, Franklin, and St. Lawrence Counties, a substantial portion of Essex County, and small portions of Jefferson, Lewis, Herkimer, Hamilton, Warren and Washington counties. Since the New York State Department of Commerce publishes economic data on a regional and county basis figures may be used for their "Northern Area", including the six counties of Essex, Clinton, Franklin, St. Lawrence, Jefferson and Lewis. When data for Jefferson and Lewis counties are eliminated from the Northern Area totals the remainder is a fairly good approximation of data for the New York portion of the subregion.

4. The Vermont side of Subregion "C" includes Grand Isle, Franklin, Chittendon and Lamoille Counties, nearly all of Washington, Addison, Orleans, and Rutland Counties, and small parts of Orange, Caledonia and Bennington counties. Most of the excluded portions of Vermont lie to the east of Subregion "C" and are part of the Connecticut River Basin. In some instances Vermont data are available on a county basis, while in others only approximations may be obtained through the use of State-wide data.

5. Owing both to the nature of the data and to fundamental physical factors the economic analysis of many aspects of Subregion "C" may be most realistically carried out by separate consideration of the New York and Vermont segments of the subregion. Lake Champlain has in the past (and to a considerable degree even today) acted as a powerful physical barrier dividing the subregion nearly into two halves and has impeded the development of

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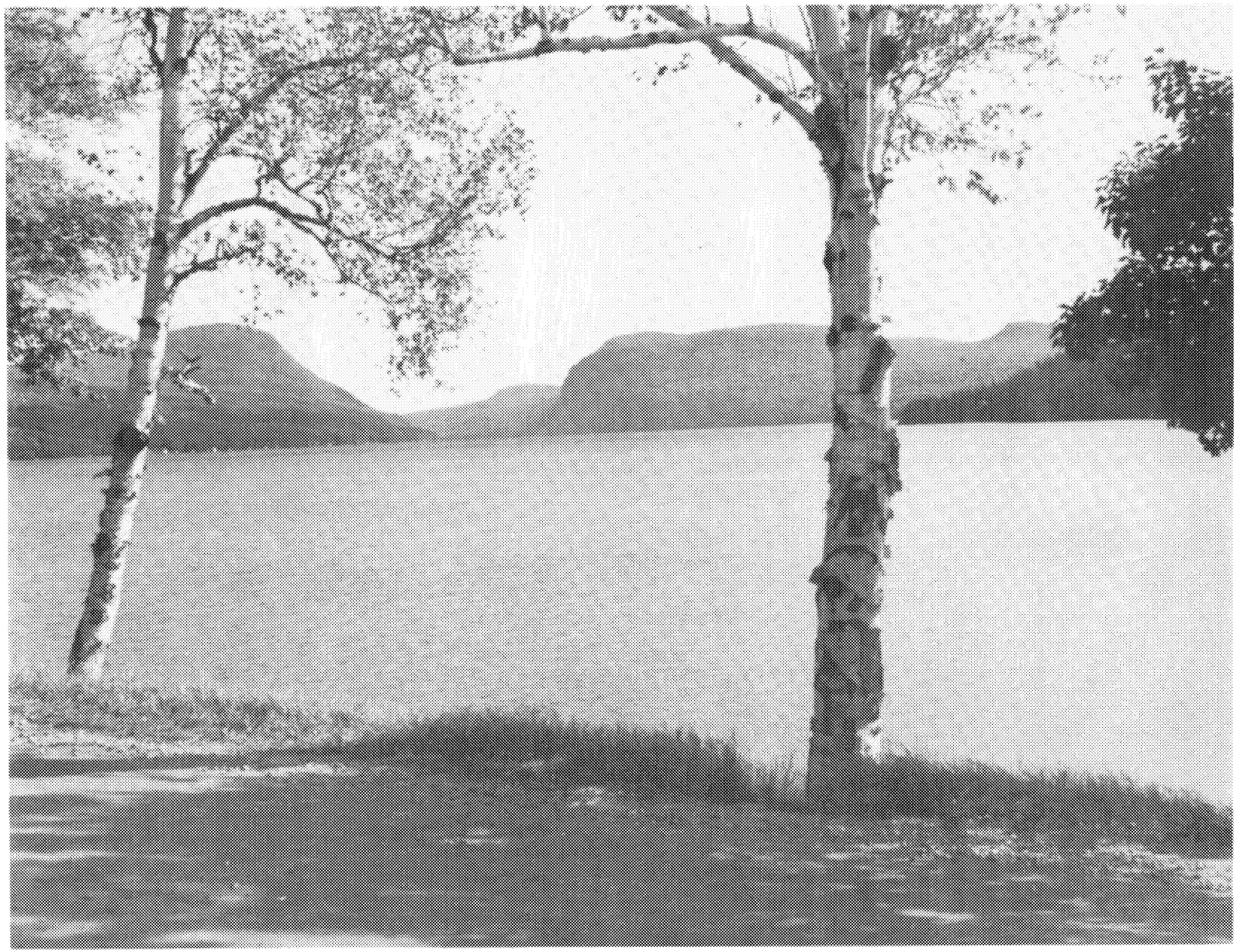
important east-west economic intercourse. Railway and highway bridges, air travel, and radio and television communication have recently somewhat reduced the importance of this barrier, but the natural land transport routes still form a north-south pattern. As a result, the New York segment of the area is heavily oriented toward the south and New York City, and to a much smaller degree toward the north and Montreal. The Vermont segment of the subregion is primarily a part of the well-defined New England regional economy, oriented toward Boston as the principal metropolitan center, although it does have some economic connections with lower New York State.

NEW YORK SEGMENT OF THE SUBREGION

6. Table 5 shows the population data for the four counties accounting for most of the Northern Area of New York State. An outstanding characteristic of the area population has been its slow growth. Even from 1940 to 1950, when population was growing rapidly in most of the rest of the country, the population grew by only about 4 percent in the area. Most of the 1940-1950 gain occurred in St. Lawrence County. This county is the home of several institutions of higher learning, so that a portion of its gain reflects a new classification of college students in the 1950 Census. As is indicated below, however, several new economic developments are taking place in the area that will doubtless stimulate additional population growth in the area.



Scenic Willoughby Lake in northern Vermont. Lake Memphremagog Drainage Basin. Subregion "C".

7. The Adirondack Mountains which occupy a large portion of the area, are a physical factor that has been a retarding influence in the development of commerce and industry as well as the related element of population growth. In general the area is sparsely settled and includes only three communities having more than ten thousand persons. Only 41 percent of the population in 1950 was classified as being in an urban area. The vacation attractions of the mountains, however, together with those of Lake Champlain to the east and the Thousand Islands section of the St. Lawrence River to the north, make it a leading resort area of the State and bring substantial seasonal population increases.

Table 5 - Population - Clinton, Essex, Franklin and St. Lawrence Counties, New York, Subregion "C"

Year	Total population
1940	223,568
1950	232,435
1953 (est.)	239,574

Source: U. S. Bureau of Census. 1953 estimate by New York State Department of Health, Bureau of Vital Statistics. Reproduced on Page 2, N.Y. State Business Facts, Northern Area, 1954 Supplement, N.Y. State Department of Commerce.

8. Sources of employment. - In 1950, 112,472 persons were employed in the Northern Area of New York, with 74,383 of these in Clinton, Essex, Franklin, and St. Lawrence Counties. Despite the fact that it is one of the least industrialized portions of New

York State, the area's principal field of employment is manufacturing, which employs 22 percent of the workers. Agriculture, an important activity in the area, ranks second with 18.8 percent of employment in 1950, while wholesale and retail trade employed 16.5 percent in 1950. 1/ Professional employment, such as medical and educational, was higher than the New York average, with 11.5 percent. Personal services accounted for 7.2 percent of employment, while transportation, communication, and utilities accounted for 6.6 percent, less than the New York State average. Construction occupied 5.5 percent of total employment. Finance, insurance and real estate; business repair services; and public administration employed small numbers, all well below the New York State average. On the other hand, mining employed 2.4 percent, well above the New York State average.

9. Manufacturing. - Over one-quarter of the factory employees in the area work in the primary metals industry, principally in the aluminum plant at Massena. The site is favored with the plentiful electric power essential to the refining of aluminum.

10. Another important employer in the area is the pulp and paper industry, employing nearly one-fourth of the area's manufacturing workers. The early growth of this industry reflected the availability of pulpwood from the vast forests of the area. At present second and later growth forests still supply a

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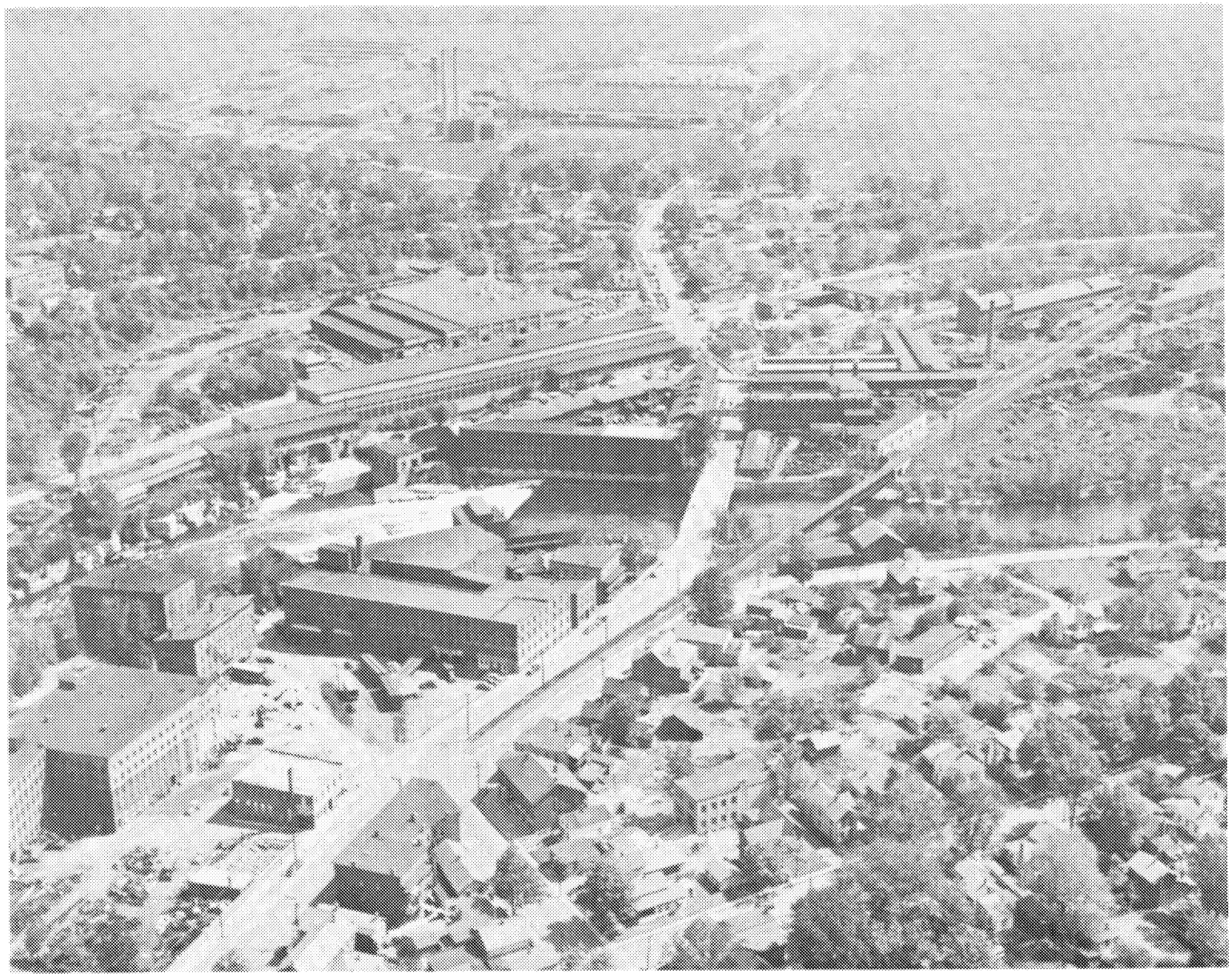
1/ These percentages and the ones below are for six counties of the "Northern Area".



Industrial development, Watertown, New York. St. Lawrence Drainage Basin. Subregion "C".

considerable portion of the raw materials of the industry, but large amounts of pulp wood and wood pulp are now imported. The forested area of the basin lying in the Adirondack Forest Preserve has been legally closed to harvesting of timber since 1894 by an amendment to the New York State constitution. Forested areas lying outside the preserve are now largely owned in extensive blocks and are subject to careful forest management. Greater use of the forest resources of the area would be possible with selective cutting practices.

11. A variety of machinery plants give employment to the third largest group of factory workers. These plants include producers of air brakes, paper-making machinery and presses. Also lumber and wood-products firms account for a sizable segment of factory employment.

12. Agriculture. - The greatest proportion of the area's agricultural employment and output is in the dairy products industry, with St. Lawrence being one of the two leading dairy counties in the State and about fifth among all counties in the United States in this respect. Most of the milk is shipped into the New York City market, although some is processed locally into cheese, ice cream and other dairy products. Other agricultural crops important in the area are McIntosh apples grown in the Lake Champlain valley, seed potatoes in several areas, and maple syrup and sugar in St. Lawrence County.

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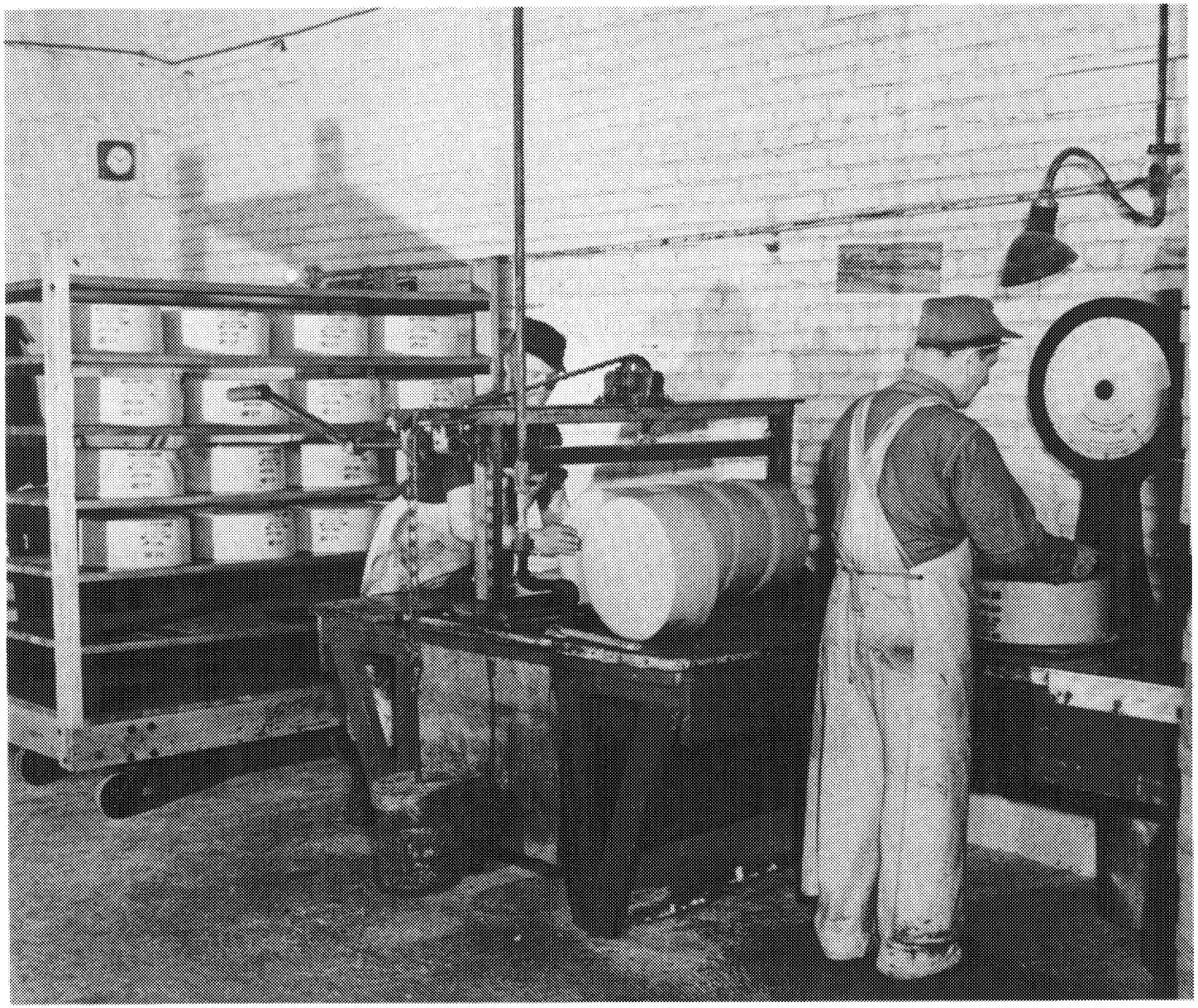
13. Mining. - Mining is of great relative importance in the area. Iron mining, once an important activity in the area, has declined in importance only to recover somewhat during World War II. Talc, zinc and lead are also extracted in the area. At Willsboro, Essex County, a good quality of abrasive garnet is obtained as a byproduct of wollastonite mining. Titanium is produced by the National Lead Company at Tahawus, Essex County. Graphite was formerly mined at several places in Essex and Warren Counties.

14. Anorthosite is one of the major rocks of the Adirondack Mountains, with extensive deposits in Essex and Franklin counties. In the past it has been used chiefly as a monumental and building stone similar to granite in strength and durability, and as a construction material for roads. Most of the dimension stone came from quarries near Keeseville, New York. At present extensive experiments are being carried on to find commercially feasible ways of using anorthosite as a raw material in aluminum production. In view of the extensive nature of the deposits discovery of economic production methods would be of considerable significance to the area.

15. Transportation facilities. - The area is served by railroads running north from Albany, Utica and Syracuse as well as an east-west (Ogdensburg to Rouses Point) line across the northern reaches. Daily air service is provided to the main communities.



Processing of dairy products. Cheese factory. Subregion "C".

Main highways reach north both in the eastern and western sections of the area. While other highways extend east and west across the northernmost sections, highway communication east and west is more difficult in the mountainous sections further south. Two new thruways, recently proposed, would extend into this area. One expressway would extend north from Albany to Montreal, serving the eastern portion of this area, while the other would run north from the vicinity of Binghampton serving the western part of Subregion "C". Actual plans for these highways have not yet been formulated, however.

16. The region also possesses water transportation facilities. Ogdensburg, New York is the most important harbor of the region on the St. Lawrence River. The harbor possesses several wharves and two grain elevators, with the channel dredged to a controlling depth of eighteen feet. In 1951 imports from Canada amounted to nearly 300,000 tons, with pulpwood amounting to slightly over 200,000 tons of this. Exports to Canada amounted to about 240,000 tons, with bituminous coal accounting for 193,000 tons. Lakewise receipts at Ogdensburg included sizeable quantities of bituminous coal and petroleum products. Ogdensburg is the most easterly United States port for deep draft Great Lakes navigation. Petroleum products also travel via the New York State Barge Canal to Oswego and thence to Ogdensburg.

17. The other port of economic importance in the area is Waddington, located on the St. Lawrence River below Ogdensburg. This port has a ten foot channel and in 1951 received 109,000 tons of pulpwood from Canada.

18. The St. Lawrence Seaway and Power Project. - The effect of the St. Lawrence Seaway, to be completed in about five years, should be considered. Most of the new traffic on the Seaway will be through traffic and will likely bypass the ports of Subregion "C". However, if one or more ports are deepened and if the power facilities to be constructed attract new industry, these ports may benefit from new traffic, depending upon the type of industry developed. Expansion of aluminum production, for example, might call for importation of bauxite via the Seaway.

19. The St. Lawrence Power project is expected to contribute to the economic expansion of the Northern Area. The generation of up to 6.5 billion additional kilowatt hours of power annually for the United States from the waters of the river at Massena will provide the base for a local expansion of industry and population, the exact extent of which cannot now be foreseen. The huge powerhouse, dams, canal locks, and other installations associated with the St. Lawrence project, together with the great new lake to be created, are expected to become major tourist attractions in the years ahead. This would bring considerable new business to stores, motels, restaurants and gasoline stations in the area and encourage their expansion. During the period of construction the immediate area will feel a

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sizeable stimulus from the construction payrolls and other expenditures. The influx of workers and their families will create further demands for schools, housing and public facilities.

20. New York State Barge Canal. - Another water transport facility available to the area is the channel running from Sorel, Canada, on the St. Lawrence River through the Richelieu River and Chambly Canal to Lake Champlain and thence to the New York State Barge Canal System, connecting with the Hudson River. The controlling depth of this passageway is twelve feet up to the Chumbly Canal in Canada which has a depth of but ~~six~~ 6.5 feet. The chief cargoes at present are small amounts of newsprint, pulpwood and petroleum products. The petroleum products are largely northbound and are mostly discharged at various ports on Lake Champlain.

21. Air base at Plattsburgh, New York. - The easternmost county of the area, Clinton, will benefit from the building of an air base at Plattsburgh, New York. The project is expected to create demands for housing and public utilities, and will bring increased business to local stores and service establishments.

22. Income Levels. - In view of the predominance of agriculture, the comparative lack of manufacturing, the relative paucity of certain natural resources development in the region, and the consequent lack of a dense population, income levels in the region are not high. For example, in 1949 median family incomes ranged from $2,493 in Essex

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County to $2,829 in Clinton County, with the N. Y. State median family income figure at $3,487. A further measure is per capita income estimated in 1952 at $1,183 for the entire Northern Area, in contrast of $1,661 for New York State outside of the New York Metropolitan Area.

VERMONT SEGMENT OF THE SUBREGION

23. In 1950, the population of the entire state of Vermont was 377,747, of which the portion of Vermont lying in Subregion "C" accounted for 244,400. The area covered by the Vermont segment of the subregion comprises 54.5 percent of the total land area of Vermont. Consequently, data for the entire State of Vermont have sometimes been used as representative of the portion in Subregion "C". Since the Vermont side of the subregion comprises over half the State, both in population and area, its economic activities materially affect such factors as state and local revenues, services, grants in aid, etc. This is in contrast to the New York segment of the subregion which comprises only a small portion of that State.

24. Vermont is in general sparsely populated, although slightly more populated than the New York side of the subregion. Urban population in the Vermont segment accounts for 42.4 percent of total population. There are several small cities within the area of which Burling-

ton and Rutland are the largest. An outstanding feature of the entire State's population has been its slow rate of growth, with 314,000 persons enumerated in 1850 and 378,000 a century later in 1950. Slight losses of population were recorded in the 1910-1920 and 1930-1940 decades, while the highest rate of growth, 5.2 percent, was shown in the decade 1940-1950, a figure that is well below the national average for this decade.

25. Table 6 shows the distribution of employment by a broad industrial classification for the Vermont segment of the subregion, in 1950.

Table 6 - Distribution of employment, 1950
Vermont segment of Subregion "C"

Type of Employment	Numbers Employed	Percent of Total
Total Employed	84,553	100.0
Agriculture	15,909	18.8
Mining	1,572	1.9
Construction	4,149	4.9
Manufacturing	17,844	21.1
Transportation, communication, and other public utilities	6,339	7.5
Wholesale and retail trade	14,022	16.6
Finance, insurance, and real estate	2,540	3.0
Business and personal services, excluding private household	4,993	5.9

Source: U.S. Bureau of Census

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26. Agriculture. - As late as 1870, the majority of workers in Vermont were engaged in agriculture at a time when manufacturing industry was growing rapidly in many other sections of the national economy. Since that time agriculture has suffered a relative decline in Vermont. With improved national transportation, production of staple crops shifted westward leaving many abandoned farms in Vermont. In numerous cases these farms have returned to woodland. Of the farms that remain the more successful have concentrated, typically, in dairy farming. In some counties in the Champlain basin a large proportion of the total area is devoted to dairying, the products generally being sent to the Boston market. As the importance of dairying would indicate, the principal crop of the area is hay.

27. Poultry raising is another important farm activity in the area, while a few farms have been successful in specializing in apples and horse-raising. The production of maple syrup and sugar provides an important sideline to many farmers.

28. The following data indicate the dominance of dairy farming in the area. In 1949 in the eight counties comprising nearly the total area of the Vermont side of the subregion the total value of farm produce was $58,625,583, with that of dairy products accounting for $48,930,865. The value of poultry products came to $2,814,978 and that of fruit and nuts to $629,745.

29. To some extent, Vermont agriculture has suffered from inadequate management practices, insufficient capital, and in some places undermaintenance of soil fertility. Marketing arrangements

for supplying local needs could be better coordinated. It is probable that a greater supply of local capital would give greater independence to producers and permit better coordination with local markets. Sideline possiblities that have been suggested to diversify farming include beef cattle, sheep, young stock for sale to dairymen near metropolitan areas, and poultry. An experiment has recently been undertaken to determine whether musk ox, whose undercoating of hair resembles cashmere wool, could provide a new industry for abandoned farms.

30. Mining. - The principal minerals produced in Vermont are stone, slate, asbestos, and copper. Granite is the most important stone. The Barre district is the largest producer of rough monumental granite in the country, producing in 1950 a product with a total value of $3,887,000, about half the total value of the rough monumental granite produced in the United States. In that same year the industry gave employment to about 1,750 granite cutters. Marble was at one time a product of considerable importance, but in recent years operations have ceased in several areas. Figures of Vermont marble production are not published, but Proctor and West Rutland are now the principal marble centers.

31. Some roofing slate is produced in Vermont, although the product has lost some of its former popularity. Mill stock slate is also produced for door steps and similar uses. The slate belt in the state extends southwest from Lake Bomoseen into New York State. Data regarding production are not published.

32. One mine in Vermont produces most of the domestic asbestos output. This amounts to about 6 percent of the domestic consumption with the remainder being imported. Small quantities of copper are produced by one company in Orange County, with a little gold and silver being recovered in the refining operation of that company. Fairly sizeable amounts of talc are produced in Vermont, although New York State is the principal source of supply of this product.

33. Manufacturing. - The following table indicates the distribution by industries of manufacturing workers in Vermont in 1947, the last year for which reliable data are available, and the values added by manufacture.

Table 7 - Vermont manufacturing, 1947, Subregion "C"

Industry group	Number of production workers (annual av.)	Value added by manufacture (dollars)
All industries	30,239	$149,685,000
Textile mill products	4,580	17,490,000
Apparel and related products	1,425	4,035,000
Paper and allied products	2,386	19,744,000
Stone, clay, and glass products	2,279	12,583,000
Machinery (except electrical)	5,622	30,686,000
Food and kindred products	1,670	14,692,000

34. These data are for the entire State of Vermont and in some industries convey an inaccurate impression of the manufacturing activities of the Lake Champlain drainage basin. For example much of the production of machinery occurs at Springfield, Vermont in the Connecticut River basin. Also much of the paper production occurs at East Ryegate and Bellows Falls, both in the Connecticut River basin. On the other hand certain important forest products, not shown in the table, notably lumber and timber products and furniture and fixtures, taken together account for about one-fifth of manufacturing employment in the whole State in 1947. A small amount of employment is also provided by printing and publishing and leather and leather products.

35. Several of the industries of the area are based upon the resources of the area, including paper and allied products, stone, clay, and glass products, food and kindred products, and the lumber and furniture industries. On the other hand textile products, apparel, and machinery depend largely upon the importation of raw materials into the area.

36. Most of the manufacturing establishments in the area are small. On the Vermont side there are some 650 manufacturing businesses of which only 48 employ over 50 workers. Burlington, Barre, and Rutland account for 368 of the total of manufacturing firms in the area. The small size of these firms and the accompanying lack of capital has undoubtedly been a factor in the small amount of industrial research carried on in the area.

16.

37. Transportation. - In the past the region has been well provided with railroad service. Indeed, in the nineteenth century Vermont was the scene of competitive railway building by companies anxious to open the first route from Boston to Montreal. In more recent years Vermont's railroads have suffered severely from highway competition, especially in milk transport, as well as from the decline of the marble business. As a result the principal line on the west side of the State, the Rutland Railroad, has been in severe financial difficulties for well over two decades and has markedly curtailed operations. The highway system was well built up during the 1930's and today is more nearly adequate than that of many other areas. Scheduled airlines provide daily service to and from Boston and New York.

38. Recreation. - In recent years, Vermont has become an increasingly important tourist and recreational center. Skiing at Mount Mansfield, Pico, Manchester and other centers has proven very popular and has considerably enhanced the economic level of the area. Vermont has also become an objective of many city folk desirous of buying an abandoned farm to rehabitate as a summer or year-round home. The annual recreation income of the entire State is estimated to be in the vicinity of $100,000,000.

39. Income Levels. - As is the case with the New York Segment of the subregion income levels in the Vermont segment are comparatively low. Median family incomes in 1949 ranged, within the area, from a low of $1,926 in Grand Isle County to a high of $2,905 in

Washington County, with the median family income for the whole state at $2,573. Per capita income for the entire state was estimated at $1,336 in 1952. Again, as with the New York segment, the reasons are the relative importance of agriculture, the relative unimportance of manufacturing, the lack of many kinds of natural resources, and the comparative sparcity of the population. In these respects the two segments of the region bear a considerable similarity to each other.

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SECTION III - STORAGE AND STREAM FLOW REGULATION

1. Existing major water storage in Subregion "C" amounts to about 562,000 acre-feet. Most of the storage is used to regulate stream flow for power purposes but some of it is maintained for public water supply, recreation and other uses. An additional 498,000 acre-feet of useful storage could be developed in conjunction with additional hydroelectric power development.

2. Existing storage. - The existing storage in the drainage basins of the subregion ranges in amount from about 5,000 acre-feet in the Lake Memphremagog Drainage Basin to about 323,000 acre-feet in the Lake Champlain Drainage Basin. The Lake Champlain Drainage Basin contains nearly three-fifths of the total existing storage in the subregion. The existing storage, by drainage basins, is shown in Table 8.

3. Potential storage. - The principal areas of potential storage are in the Raquette and Grass River watersheds in the St. Lawrence Drainage Basin. The only other area of potential storage, amounting to approximately one-fifth of the potential storage, is in the Saranac River watershed of the Lake Champlain Drainage Basin. The potential storage, by drainage basins, is shown in Table 8.

Table 8 - Existing and potential useful storage, Subregion "C"

Drainage basin	Usable storage capacity Existing (acre-feet)	Usable storage capacity Potential (acre-feet)
LAKE MEMPHREMAGOG		
Subtotals	5,000 (approx.)	0
LAKE CHAMPLAIN		
Great Chazy River	14,000	0
Saranac River	26,575	90,800
Ausable River	25,510	0
Lake George	85,000	0
Mettawee River	4,130	0
Poultney River	13,475	0
Otter Creek	25,364	0
Winooski River	98,540	0
Lamoille River	28,980	0
Missisquoi River	1,147	0
Subtotals	322,721	90,800
ST. LAWRENCE		
Oswegatchie River	60,100	0
Grass River	0	79,300
Raquette River	152,000	328,000
St. Regis River	0	0
Salmon River	2,620	0
Chateaugay	20,000	0
Subtotals	234,720	407,300
TOTALS	562,441	498,100

SECTION IV - WATER SUPPLY

1. This section presents a summary of the surface and ground water resources of Subregion "C". The discussion covers the quantity, quality and present uses of the water for water supply; the estimated future water supply needs; the availability of water to supply future needs; the control of public water supply reservoirs and the effects on water supply of an increase in supplemental irrigation.

SURFACE WATER AVAILABLE

2. Safe yields. - The minimum monthly flow for the period October 1929 to September 1949 was determined for each stream where gaging records of the U.S. Geological Survey were available, and this flow was used as the safe yield. For ungaged areas, the safe yield was estimated by comparison with gaged areas. Subregion "C" has about 3,060 miles of streams with safe yields in excess of one million gallons per day as summarized below:

Safe yield in million gallons per day	Approximate miles of streams in Subregion "C"
Over 100	330
10 - 100	760
1 - 10	1,970
Total over 1	3,060

3. Many miles of streams have yields less than one million gallons per day. Some of these could provide sufficient water for

public water supply for a number of the smaller communities. Larger water supplies could be taken from the 3,060 miles of streams having safe yields greater than one million gallons per day and from the numerous lakes in the subregion.

4. Natural quality. - The hardness of the surface waters ranges from 10 to 152 parts per million with a median of 36. The pH varies from 6.6 to 9.2. In a few locations the color, iron and manganese content may require control. If these characteristics are controlled as required by the needs of the users, the untreated surface waters are suitable for domestic, agricultural and most industrial uses. Table 9 gives the median, minimum, and maximum values for selected physical and chemical characteristics at 88 locations of untreated surface waters in this subregion and also gives the values for one analysis each of the Ogdensburg and Ticonderoga, New York, and Irasburg, Vermont, public water supplies.

5. In 1952 the maximum and minimum weekly average water temperatures of Lake Champlain at Plattsburgh, New York, were 73° F. and 35° F. respectively. For 25 weeks of this one-year period the weekly average lake water temperature was less than the ground water temperature (48° F.).

6. The data available on the bacteriological, chemical, (including biochemical and mineral) and physical qualities of the surface waters of Subregion "C" are adequate to define the general utility of the water. These data may be obtained from the Bureau

Table 9 - Chemical and physical characteristics of untreated surface waters - February 1954, Subregion "C"
(in parts per million)

	For 88 locations			Ogdensburg, New York water supply 1/	Ticonderoga, New York water supply 1/	Irasburg, Vermont water supply 1/
	Median	Minimum	Maximum			
Color	12	0	75	0	15	5
pH 2/	7.2	6.6	9.2	7.9	7.3	7.2
Turbidity	Trace	0	15	Trace	Trace	0
Iron (Fe) & Manganese (Mn)	0.10	0.00	1.50	0.06	0.35	-
Chloride (Cl)	1.8	0.0	22.0	17.0	2.2	0
Fluoride (F)	0.10	0.05	0.40	0.05	-	-
Free Ammonia Nitrogen	-	-	-	-	0.02	-
Nitrate Nitrogen	0.15	0.00	4.90	0.20	-	0.28
Oxygen consumed 3/	2.9	1.7	10.2	-	2.2	-
Hardness as $CaCO_3$	36	10	152	98	20	68
Alkalinity as CaCO	29	5	128	88	14	-

1/ Single analysis.
2/ Not in parts per million. Measure of hydrogen ion concentration.
3/ Of 29 sources.

of Environmental Sanitation of the Vermont and New York State Departments of Health and the Vermont State Water Conservation Board. These departments have continuing programs to supplement information now available on the sanitary quality of surface waters. Supplemental analyses are made to meet requests for information needed by prospective water users at specific locations. In conjunction with this study, the U.S. Geological Survey collected a limited number of surface water samples during high and low-stream flows for mineral analysis.

7. Sanitary quality. - The sanitary quality of the surface waters and their suitability for water supply uses are summarized in Table 10. The estimated 2,210 miles of Conditions I and II water are widely distributed throughout the subregion and are mostly located in mountainous areas. There are about 685 miles of water in Condition III which are distributed in the principal streams. There are about 135 miles of water in Condition IV which are located downstream of industrial plants and centers of population in both New York and Vermont and about 30 miles of water in Condition V distributed at 15 different locations.

8. Approximately 5 percent (165 miles of 3,060 miles) of the streams that have a safe yield in excess of 1.0 million gallons per day have been so impaired for water supply uses by the discharge of municipal and industrial wastes that they are in Conditions IV or V. In a recent survey about 80 farms reported restrictions on the use of surface water due to pollution.

Table 10 - Summary of approximate present effects of industrial and municipal pollution on water quality - February 1954, Subregion "C"

Condition	Suitability for water supply uses	Degree of pollution	Approximate miles of streams in basin 1/
I	Suitable for all water supply uses. Use as domestic water supply may require disinfection.	None	2,210
II	Suitable for public water supply after filtration and disinfection, for practically all industrial uses 2/ without treatment, for agricultural uses and for irrigation of crops.	Not appreciable	
III	Suitable for most industrial uses 2/ without treatment and for irrigation of crops consumed after cooking.	~~Slight~~ Moderate	685
IV	Suitable for some industrial uses 2/ without treatment.	Severe	135
V	Suitable for no water supply uses.	Gross	30

1/ Having yields greater than 1.0 million gallons per day. Since Section V of this chapter considers only those streams affected by pollution regardless of flow, figures in the two sections may not agree.

2/ Quality requirements for industrial water vary widely. Condition I water may require treatment for some industrial uses. Condition IV water is used without treatment for some industries not requiring a high quality water. As water conditions decrease from I to IV, it becomes suitable for fewer industrial uses or becomes more difficult to make suitable by treatment.

9. Ground water information. - Investigations of the occurrence, general availability, quantity, and quality of ground water are being made jointly by the U.S. Geological Survey and the State of New York. These investigations consist of: (a) studies of existing geological literature; (b) geological mapping where needed to define roughly the areal extent of the water-bearing bodies; (c) collection and interpretation of existing subsurface information from test borings, domestic, industrial, and public supply wells and springs and other sources of ground water data; (d) an inventory of existing chemical analyses and collection of a limited number of samples for chemical analyses. Where information for this report was not available, additional data were collected and areas of large and moderate yields were delineated. The areas and yields are shown on the individual yield maps in Chapters XXVI, XXVII, and XXVIII. These will be defined more precisely by the current and contemplated cooperative studies.

10. Ground water adequate to meet the needs of individual rural homes and farmsteads for domestic water and stock watering is available from bedrock or unconsolidated deposits at most places throughout the subregion. Some supplies prove inadequate during dry seasons.

11. Yield from unconsolidated deposits. - The aquifers in unconsolidated deposits range from a thin veneer of glacial till of

low permeability to thick beds of glacial outwash, some of which are highly permeable. Till, present in most areas, is widely used as a source of rural water supplies, but during periods of low precipitation it may yield insufficient quantities of water even for small domestic and farm use. Permeable unconsolidated deposits that are thin or unfavorably situated and unconsolidated deposits consisting largely of fine-grained materials that have relatively low permeability generally yield less than 35 gallons per minute (50,000 gallons per day) to individual wells. Extensive deposits of sand and gravel, potentially the most productive of all the aquifers in Subregion "C", can be expected to yield more than 50,000 gallons per day per well under favorable conditions and could probably yield in excess of 1,000,000 gallons per day in places where properly constructed wells induce river infiltration. In general, large-capacity wells in gravel deposits have not yet been attempted in Subregion "C".

12. Yield from bedrock. - The highest yields from the bedrock are reported from quartzite and limestone. Average yields from these rocks, according to available records, may be about 50,000 gallons per day. Groundwater occurs in the bedrock of the area largely in secondary openings which commonly are minute and have incomplete interconnections; thus, typical yields from most bedrock formations are low.

13. Ground water quality. - The ground water hardness in Subregion "C" varies from 14 to 390 parts per million, with a median of 90 ppm. Water from wells drilled in calcareous rock formations is very hard and

highly mineralized. Water derived from sandstone beds is somewhat softer. In general, the quality of water from unconsolidated aquifers is more satisfactory since it contains less hardness and fewer other objectionable constituents. Provided the hardness and other undesirable characteristics are controlled in the areas where they occur, the ground water is satisfactory for most water supply uses. The spring water in this subregion is relatively soft and is suitable for domestic, agricultural and most industrial uses.

14. Table 11 gives the median, minimum, and maximum values of selected physical and chemical characteristics of the untreated water from 107 ground water sources used as public water supplies. Also included in Table 11 are the physical and chemical characteristics of the Norwood, New York, and Winooski and Albany, Vermont, public ground water supplies.

15. The sanitary quality of ground water taken from properly constructed wells which are located a safe distance from sources of pollution is satisfactory. Special precautions must be taken in the areas of limestone rock formations where large solution channels may permit pollution to travel long distances.

WATER USE

16. Water uses considered here are domestic, industrial, and agricultural. Domestic water includes that used for household purposes and by commercial establishments such as stores, hotels, restaurants, and markets. Industrial water includes that used for process, cooling,

Table 11 - Chemical and physical characteristics of untreated ground waters - February 1954, Subregion "C"
(in parts per million)

	For 107 locations			Norwood, New York water supply 1/	Winooski, Vermont water supply 1/	Albany, Vermont water supply 1/
	Median	Minimum	Maximum			
Color	1	0	50	5	15	0
pH 2/	7.4	5.9	9.0	7.7	7.4	7.4
Turbidity	0	0	15	Trace	0	0
Iron (Fe) & Manganese (Mn)	0.04	0.00	0.60	0.15	-	0.00
Chloride (Cl)	2.2	0.0	195.	23.8	23.9	1.1
Fluoride (F)	0.15	0.05	0.45	0.25	0.0	-
Nitrate Nitrogen	0.59	0.02	3.00	0.10	0.44	0.79
Hardness as $CaCO_3$	90	14	390	250	97	81
Alkalinity as $CaCO_3$	65	9	292	173	55	68

1/ Single analysis.
2/ Not in parts per million. A measure of hydrogen ion concentration.

boiler feed and miscellaneous uses. Agricultural water includes that used for stock watering, spraying, and irrigation.

17. Rural and agricultural water use. - Rural domestic and agricultural water supplies have little effect on the water resources in the subregion except when large amounts of water are used for irrigation. Approximately 14.0 million gallons per day are used for domestic and agricultural purposes (excluding irrigation) by about 23,800 farm water systems and 22,500 rural non-farm water systems (giving a total of 46,300). These serve about 185,000 persons. It is estimated that 80 to 90 percent of the water is obtained from ground sources.

18. On the basis of a recent survey, it is estimated that approximately 27 percent of the farm systems (6,450) and 14 percent of the rural non-farm systems (3,150) are inadequate to meet the present water supply needs. The inability of many of these 9,600 systems (total) to supply adequate water may be due to faulty development rather than to a lack of ground water.

19. Irrigation water supply. - Supplemental irrigation is water sprayed onto the land once or twice a week in amounts such that rainfall plus the added water totals one to two inches per week. Nearly all of this water is used by crops or evaporates. In 1950, approximately 280 acre-feet (90 million gallons) of water were used to irrigate about 800 acres of crops. This was supplied as follows: constructed ponds, 10 percent; and natural lakes, ponds and streams,

90 percent. In 1950, this water use was not important, averaging 0.71 million gallons per day over the estimated 130-day frost free period in the subregion.

20. Municipal and industrial use. - Of the 163.27 million gallons per day (mgd) of total water used, industry utilizes 122.63 mgd. One hundred and ninety-seven public water systems supply 49.02 mgd of which 40.64 mgd are used for domestic purposes by 331,200 people and 8.38 mgd are used for industrial purposes. Industries supply an additional 114.25 mgd for their use. More detailed data are given in Table 12. Significant amounts of water are used in about 200 towns and cities.

21. Industrial water use. - Total industrial water use in this subregion is divided by type of use as follows:

a. Process water, 90.88 mgd (74 percent, not including 6.15 mgd reuse).

b. Cooling water, 19.90 mgd (16 percent, not including 6.86 mgd reuse as cooling water).

c. Boiler feed, 5.71 mgd (5 percent)

d. Miscellaneous, 6.14 mgd (5 percent)

Total (obtained from sources) 122.63 million gallons per day.

Total reuse 13.01 million gallons per day.

Industrial water use may also be divided by type of industry as follows:

a. Wood and wood products, 31.25 mgd (26 percent)

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Table 12 - Summary of municipal and industrial water use and sources - February 1954, Subregion "C"

	WATER USE							SOURCE OF WATER 1/							
	Public water system							Surface				Ground			
Basin	Total MGD	No.	Total output MGD	Water for domestic use MGD	Population served	Water for industrial use MGD	Private industrial systems Total MGD	Total MGD	No.	Municipal systems Total MGD	Private industrial systems Total MGD	Total MGD	No.	Municipal systems Total MGD	Private industrial systems MGD
St. Lawrence	77.10	48	14.70	13.30	87,900	1.40	62.40	71.40	27	13.50	57.90	5.70	21	1.20	4.50
Lake Champlain	76.97	136	32.74	26.29	232,100	6.45	44.23	69.68	58	26.65	43.03	6.01	69	4.81	1.20
Lake Memphremagog	9.20	13	1.58	1.05	11,200	0.53	7.62	0.84	4	0.55	0.29	7.56	7	0.23	7.33
Totals for Subregion "C"	163.27	197	49.02	40.64	331,200	8.38	114.25	141.92	89	40.70	101.22	19.27	97	6.24	13.03

1/ Eleven public water systems have combined sources of water (surface and ground) and supply 2.08 million gallons per day.

b. Pulp and paper mills, 29.80 mgd (24 percent)

c. Mining, quarrying and metal products, 29.56 mgd (24 percent)

d. Milk and milk products, 18.43 mgd (15 percent)

e. Miscellaneous, 13.59 mgd (11 percent)

Total - 122.63 million gallons per day.

22. Municipal and industrial surface water use. - Of the 163.27 million gallons per day (mgd) of total water used, 141.92 mgd come from surface sources. Eighty-nine public systems obtain water from surface sources and supply a total of 40.70 mgd. The remaining 101.22 mgd are supplied by industry.

23. Municipal and industrial ground water use. - There are 19.27 million gallons per day of ground water used in this subregion. Ninety-seven public water systems supply 6.24 mgd and industry supplies 13.03 mgd.

24. Municipal and industrial surface and ground water use. - Eleven public water systems supply 2.08 million gallons per day from a combination of surface and ground sources.

25. Reuse. - After use and discharge, industrial and domestic water becomes available to other water users, provided the quality is satisfactory. In this subregion some waters are deteriorated by the discharge of sewage and industrial wastes. The waters are in Conditions IV or V downstream of 41 out of about 200 communities from which used domestic and/or industrial waters are discharged.

Conditions IV or V waters are "severly" or "grossly" polluted, respectively, and are unsuitable for domestic and most agricultural and industrial water uses.

WATER SUPPLY NEEDS

26. The water use and population trends for each river basin and a number of localities in Subregion "C" are presented graphically in the several river basin chapters. From a study of these trends, it is concluded that in the year 2000 water use for domestic purposes may rangefrom 1.1 to 3.3 times the present amount, depending on the locality within the subregion. Prudent planning for the future should provide for the development of adequate resources to meet this anticipated demand. Although future uses of water in industry and agriculture cannot be predicted with assurance, it is assumed that the increase in water use for these will be the same as that for domestic purposes. This estimate does not consider the anticipated effects of the St. Lawrence Seaway and Power Project; however, considering the surplus of water throughout the subregion, ample water resources are available to meet the needs resulting from the project. The St. Lawrence Seaway and Power Project is discussed in Chapter XXIX, Special Subjects Subregion "C".

27. Future availability for industrial and public water supplies. - There will be a large surplus of water available at least to the year 2000. This surplus varies from less than one million gallons per day on the upper reaches of the tributaries to more than 100 million

gallons per day adjacent to the St. Lawrence River or to Lake Champlain. This large surplus of water could support new wet industries if additional transportation, public utilities, labor and other essentials could be provided. Even with the increased demand which may result from the development of the St. Lawrence Seaway and Power Project a surplus of water will probably exist at least to the year 2000. The existing and proposed studies would outline areas favorable for the development of both large and small water supplies. The information thus obtained would serve as an aid in determining the best method for the development of dependable municipal and industrial ground water supplies.

28. Rural and agricultural water supplies. - Rural-domestic, and agricultural water supplies are not considered above. In general, except for irrigation water, they have little effect on the available water supply in this subregion, and are not affected by other water supply requirements. Approximately 9,600 rural water supplies (of a total of 46,300), excluding irrigation, are inadequate. Rural water supply needs will probably increase due to the greater demands of modern plumbing systems and improved agricultural practices. The existing and cooperative ground water studies may be helpful to these water users in developing dependable ground water supplies.

29. Future development of irrigation water supply. - Future needs for irrigation are not known. If improved practices make irrigation profitable on more farms or if the agricultural pattern changes, the demand for irrigation water could increase markedly and could significantly reduce the water available in small tributaries. This

reduction could affect municipal and industrial supplies as well as other irrigation water supplies and would force consideration of the legal basis for the use of water for irrigation purposes.

30. Future quality. - The quality of the water in the future will depend on the action taken to maintain or improve the present water conditions by control of municipal and industrial pollution, and to a small degree by improved land-use practices to control erosion.

CONTROL OF PUBLIC WATER SUPPLY RESERVOIRS

31. Although there is multiple purpose use of water in Subregion "C" the highest priority use is for domestic supply.

32. State of Vermont. - The watersheds of two public water supplies, Montpelier and Brandon, Vermont, are covered by State orders which essentially prohibit all recreational uses. In addition, all public water supplies in Vermont are protected by general laws which prohibit pollution of surface waters used for public water supplies.

33. State of New York. - There are no lakes, ponds, or reservoirs controlled for public water supply in the section of New York which is included in Subregion "C".

BENEFITS TO WATER SUPPLY FROM STREAM FLOW REGULATION

34. The safe yield downstream of a storage reservoir could generally be increased by flow regulation. The increase would depend on the method of reservoir operation, as indicated in the inventory

power plans. Since a general surplus of water is available downstream of all of these reservoirs, the increase in flow and the small improvement in water quality which could be achieved by reservoir operation would not result in a monetary benefit to water supply.

CONCLUSIONS

35. It is concluded that:

a. A large surplus of surface water is available for domestic and industrial water supply purposes for at least the next 50 years on the basis of foreseeable needs. This valuable natural resource could be attractive to new industries having water demands of more than 100 million gallons per day. However, water use competition and pollution adversely affecting water use may result in water shortages in limited areas.

b. Run-off patterns, developed through the operation of proposed gaging stations on small tributaries for short durations, would be helpful in establishing the safe yield for water supply purposes.

c. The hardness of the surface waters ranges from 10 to 152 parts per million with a median of 36. Slightly alkaline waters generally occur with a median pH of 7.2. Provided excessive color, iron and manganese content are controlled in the localized areas where they occur, the waters are suitable for domestic, agricultural and most industrial uses.

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d. The present quality of 165 miles of streams with safe yields in excess of one million gallons per day have been impaired for water supply uses by discharges of sewage and industrial wastes. Approximately ~~2,895~~ 2,210 miles of streams are essentially unaffected. The quality of the surface waters will not deteriorate further if waste treatment is provided to control waste discharges.

e. Although there is multiple purpose use of water, the highest priority use is for domestic supply.

f. Data available on the quality of the surface waters are adequate to define the general usefulness of the untreated water for industrial uses.

g. Ground water is available in most places throughout the subregion in small quantities which can be developed to meet the needs of individual rural homes and farms, except for irrigation. Moderate quantities can be developed along the main stems of the principal streams and adjacent to the major lakes in the subregion, and in several localized areas yields of about a million gallons per day can be developed.

h. The ground water hardness ranges from 14 to 390 parts per million with a median of 90. The ground waters are generally harder and have a higher mineral content than the surface waters. Provided the excessive hardness, iron and manganese are controlled in the localized areas where they occur, the ground waters are suitable for most water uses.

i. A large increase in agricultural water use for supplemental irrigation could significantly reduce the water available in small watersheds, especially during dry hot weather, and would raise a question as to the legal basis for use of water for irrigation purposes.

j. The domestic water supply requirements of the 185,000 rural inhabitants have little effect on the available water supply in the subregion and, in general, are not affected by other water supply requirements.

k. The water developed by these rural families is inadequate in about 21 percent (9,600) of the systems to meet the demands for domestic and agricultural water with no allowance for irrigation.

l. New reservoirs could result in increased low flows and slightly improved water quality. Since a general surplus of water is available at downstream points, there would be no monetary benefits to water supply.

WATER SUPPLY PLAN

36. The water supply plan is as follows:

a. Improvement of water quality. - The water supply interests should closely coordinate their needs with water pollution control agencies in formulating a comprehensive water pollution control plan.

b. Ground water investigations. - Investigations of the occurrence, general availability, quantity, and quality of ground

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waters are being made jointly by the U.S. Geological Survey and the State of New York and should be continued until they are completed. To determine the ground water potential of the Vermont portion of this subregion the following studies on the ground water should be made.

Location	Approximate area in square miles	Type of study
Lake Memphremagog Drainage Basin	591	Reconnaissance
Rural areas, Lake Champlain Drainage Basin	3,620	Reconnaissance
Urban areas, Lake Champlain Drainage Basin	998	Intermediate

(1) A reconnaissance study would entail the collection of a limited amount of data on springs, wells, and major water supplies. It would also include the collection of a limited number of samples for chemical analyses and a very general geologic mapping program.

(2) An intermediate study would involve a fairly thorough inventory of data on springs and wells, their chemical characteristics and collection of samples for chemical analyses. In addition, it would include sufficient geologic investigations and mapping to define the principal water bearing units, their areal extent, thickness and water bearing characteristics.

(3) Excluding publication costs the ground water studies in the Vermont portion of this subregion would cost an estimated $65,000 including salaries; field, office and travel expenses; equipment; and preparation of the report, maps and illustrations.

The ground water studies would outline source areas favorable for the development of both large and small water supplies and would aid in determining the best methods for the development of dependable ground water supplies.

c. Investigation of supplemental irrigation. - A study of supplemental irrigation should be made to determine when water used for irrigation purposes has increased so as to affect other water uses. The study would include the annual collection of data on the acreage irrigated, the amount of water used, the sources of water and the types of crops irrigated. Assuming collection of data by existing agricultural field staffs and organizations, it is estimated that the services of one man, part-time, would be required to analyze data and coordinate field activities in each State. The estimated annual cost of the investigations is approximately $3,500.

SECTION V - POLLUTION CONTROL

1. This section presents an inventory of the causes and sources of pollution of the water resources, the effects of pollution on present water conditions, pollution prevention measures in effect, and stream classifications legally adopted for best use of the water resources in Subregion "C". In the absence of legal classifications of streams transporting pollution as required by State laws which would define the pollution control measures needed to permit the best use of the water resources, three provisional plans are presented. Each provisional plan is evaluated as to its effect on water quality improvement for higher uses and the costs and benefits to pollution control under the treatment measures shown, including an evaluation of monetary benefits or losses as a result of constructing water conservation and development projects.

2. In the economic development of Subregion "C", population and industry have become well-distributed throughout the area although most concentrated along the larger rivers and near Lake Champlain. It is along these principal watercourses that the largest use of the water resources for the transportation of sewage and industrial wastes has been made. While the use of the water resources as the final place of disposal for waterborne wastes is indispensable, the discharge of untreated sewage and industrial process wastes has resulted in serious deterioration in the quality of receiving waters. It is this use that is most in conflict with other legitimate and desirable water uses, especially recreational,

industrial water supply and, in some instances, public water supply and agricultural water supply.

PRESENT STATUS OF POLLUTION AND POLLUTION CONTROL

3. Pollution contributed to water resources. - In recording the sources of pollution in this subregion, the following procedures were established in order that a reasonable and equitable tabulation of data would result:

a. A municipality having multiple public sewers discharging to the same watercourse was counted as one source of pollution.

b. Where a municipality has multiple public sewers discharging to and affecting more than one watercourse, each watercourse was counted as receiving one source of pollution.

c. In compacted areas, multiple private domestic outlets discharging to a single watercourse were counted as one source of pollution.

d. Any industry having multiple waste outlets has been counted as a single source of pollution.

e. Any industry discharging both organic and inorganic wastes has been recorded as only one source of pollution in whichever category is most significant to the problem.

f. Industrial plants discharging employee sewage only were counted as sources of sewage pollution.

g. Industrial plants discharging both process wastes and sanitary wastes have been counted as sources of industrial

wastes.

h. Sources of sewage pollution contributed to by less than 40 persons have been excluded as not significant to over-all water resource development.

4. On the above bases there has been recorded a total of 194 separate significant sources of pollution in Subregion "C". Sewage and organic industrial wastes have been computed to contribute a total population equivalent of approximately 1,307,000 persons to the pollution loads transported by the principal river systems and lakes. Inorganic wastes, including those discharged in combination with predominantly organic wastes, contribute significant amounts of chemicals, metals, suspended matters and similar materials.

5. Sources of sewage pollution. - Of the total of 194 separate significant sources of pollution, 120 are caused by discharges of sewage from municipalities, other population centers, institutions, schools, and industrial plants. Included are effluents from sewage treatment facilities, adequate or inadequate, of which there are 24. These 120 sources of sewage pollution are reported to have a total contributory population of 261,980 persons and the population equivalent has been computed to be approximately 255,700 persons. Sewage discharges account for approximately 20 percent of the total pollution load discharged to the water resources of Subregion "C".

6. One of the sources of sewage pollution has a contributory population of 20,000 persons; five from 10,000 to 20,000; 10 from 5,000 to 10,000; 36 from 1,000 to 5,000; 13 from 500 to 1,000; and

55 are contributed to by less than 500 persons.

7. Sources of industrial waste pollution. - The 74 sources of industrial waste pollution are caused by the discharge of process wastes from 48 food and food products plants, 6 textile mills, 12 paper and allied products mills, five primary metal plants and the remaining 3 from a miscellany of manufacturers. Many of these plants also discharge sanitary wastes from employees. Sixty-six of the separate discharges of industrial wastes are predominantly organic in nature while eight are primarily inorganic. When plants are operating at or near capacities, the population equivalent of organic industrial wastes is computed to be about 1,051,000 persons, approximately 80 percent of the total pollution load to watercourses. Of this total, the pulp and paper industry accounts for a population equivalent of about 903,000 persons; the textile industry, 42,000 persons; and the food and food products industries account for the remaining population equivalent of 106,000 persons.

8. Table 13 summarizes the data on sources of sewage pollution and Table 14 summarizes the data on sources of industrial waste pollution. For detailed information on individual sources of sewage and industrial waste pollution in Subregion "C", reference is made to Section V in each of Chapters XXVI through XXVIII.

Table 13 - Sources of pollution--municipal
Subregion "C"

Drainage Area	Sources of Pollution (In Number of Municipalities*)	Population Served by Sewerage System	Amount of Pollution Discharged to Watercourse (In Terms of Equivalent Number of People**)
Lake Memphremagog	10	8,835	9,910
Lake Champlain	71	176,240	153,000
St. Lawrence River	39	76,905	92,785
Totals	120 1/	261,980	255,695

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.

**Includes industrial wastes discharged into municipal sewerage systems.

1/ Total includes four institutions, two factories discharging sanitary wastes only, one school, and one State park.

Table 14 - Sources of pollution--industrial
Subregion "C"

Drainage Area	No. of Sources 1/		Population Equivalent (In Terms of Number of People) 2/	% of Total Subregion C
	Organic	Inorganic 2/		
Lake Memphremagog	3	0	630	0.1
Lake Champlain	40	5	193,500	18.4
St. Lawrence River	23	3	856,765	81.5
Totals	66	8	1,050,895	100.0

1/ Industries having separate outlets discharging wastes directly to watercourse.

2/ Population equivalent does not apply to inorganic wastes.

EFFECTS OF POLLUTION ON PRESENT CONDITION OF WATER RESOURCES

9. Water resources transporting pollution. - Over some segments of their flows, pollution is transported by 22 principal rivers and 35 of their tributaries; by nine lesser tributaries to Lake Champlain; one barge canal; and by two major lakes, Champlain and Memphremagog. The main stems of streams and tributaries transporting pollution have a total length of flow of approximately 1,979 miles as shown in Table ~~12~~ 15.

10. Miles of watercourse seriously affected by pollution. - One hundred and seventy-seven miles of watercourse in Subregion "C" are seriously affected by pollution transported. Thirty-three miles are in nuisance condition during critical periods of flow and temperature, and the water qualities over these stretches are generally unsuitable for any normal use. The other 144 miles of seriously polluted stretches of streams are not in nuisance condition during critical periods but are of a low quality equivalent to that generally acceptable for such uses as power development, navigation, other limited industrial purposes and for transportation of the present pollution load without nuisance. The aesthetic quality of these waters is poor.

11. Miles of watercourse significantly affected by pollution. - There are about 687 miles of stretches of main stems where pollution transported has resulted in a significant effect on water qualities. Over these stretches of streams, which vary in length from about one mile to many miles in some cases, the water condition is

approximately equivalent to a quality generally suitable for such uses as recreational boating, irrigation of crops consumed after cooking, habitat for wildlife and common food and game fishes indigenous to the region and for some industrial processes without treatment and others with treatment. Some of these waters are of a reasonably good quality, suitable for public water supply with adequate filtration and disinfection if shown by technical study, while others may not always be of a suitable aesthetic quality.

12. Lakes and ponds affected by pollution. - Of the lakes and ponds of Subregion "C", only the two major lakes are significantly affected by pollution. Lake Memphremagog, including South Bay, is affected by pollution transported by the Black, Clyde, and Barton Rivers and by pollution from Newport, Vermont. Lake Champlain is affected by pollution transported by nine of its principal tributaries and direct discharges from five lakeside municipalities. In most instances, the effect is confined to the immediate vicinity of the outfall sewer, while in some others the effects are spread over a radius of several hundred yards or more. In these two lakes, the pollution is less serious and the affected water areas are suitable for such uses as recreational boating, habitat for wildlife, and common food and game fishes indigenous to the region and for irrigation of crops consumed after cooking. Most of the waters in these lakes are not affected by pollution and the unaffected waters are of a high quality, suitable for any water use except public water supply without filtration and disinfection.

13. Water resources unaffected by pollution. - In addition to the 864 miles of streams seriously or significantly affected by pollution, there are 1,115 miles in these same streams that receive no pollution or are relatively unaffected by it. About one-fifth of these waters is of a very high quality, suitable for any water use. The other four-fifths are also of high quality but not suitable for public water supply unless filtered and chlorinated. In addition, in the relatively undeveloped upper portions of the river basins and in the smaller tributaries, there are hundreds of miles of streams and many lakes and ponds, receiving only natural pollution from run-off, that are of a high quality, many being suitable for any water use. Being more remote from population and industry, these waters are most important to fish and wildlife, agricultural, recreational and possible power development interests at the present time.

14. Soil erosion and agricultural practices. - Although erosion of row cropland and stream bank erosion have been sufficiently severe in many places to warrant corrective measures by soil conservation interests, such erosion has not been reported by the New York and Vermont State water pollution control authorities as a significant pollution factor in relation to present water uses. Neither has the use of agricultural fertilizers or insecticides been reported as a significant pollution factor. However, the U. S. Department of Agriculture, Soil Conservation Service, reported that in 1952 there were 85 farms not using streams because of pollution

and there may be others that have not reported.

15. Table 15 summarizes by principal drainage basin areas the effects of pollution on receiving water conditions. The approximate present condition of these waters is indicated by their suitability for use based on the tentative water quality standards of the New England Interstate Water Pollution Control Commission. Conditions I through V are approximately equivalent to Classes A through E of the interstate standards. All of the water uses shown in Table 15 may not be made or contemplated to be made at the present time. Suitability for use is intended solely as an effective means of describing present water conditions. Table 16 is a reproduction of the interstate water quality standards.

Table 15 - Approximate* effects of pollution on quality of water resources

Subregion "C"

Key to Symbols

Condition	Description
I	Suitable for any water use. Character uniformly excellent.
II	Suitable for bathing and recreation; irrigation and agricultural uses; good fish habitat; good aesthetic value. Acceptable for public water supply with filtration and disinfection.
III	Suitable for recreational boating, irrigation of crops not used for consumption without cooking, habitat for wildlife and common food and game fish indigenous to the region. Suitable for public water supply if shown by technical studies.
IV	Suitable for transportation of sewage and industrial wastes without nuisance and for power, navigation and other industrial uses for which it is acceptable.
V	Waters falling below the above descriptions--considered unsatisfactory for any normal use.
*	Not a precise evaluation--tentative pending completion of all detailed classification studies.

Drainage Area	Number of Sources of Pollution		Approximate Present Conditions in Miles				
	Sewage	Industrial	I	II	III	IV	V
Lake Memphremagog (tributary streams)	10	3	0	40	49	4	0
Lake Champlain (tributary streams)	71	45	41	296	471	124	30
St. Lawrence River (tributary streams)	39	26	233	505	167	16	3
Lake Memphremagog (lake proper)	Condition III in South Bay and in vicinity of Newport; otherwise Condition II prevails						
Lake Champlain (lake proper)	Condition III in vicinity of confluence with Missisquoi, Camoille, Winooski, LaPlatte, Great Chazy, Ausable, Bouquet Rivers; Otter Creek; and Mill Brook; in vicinity of direct discharges of pollution from Burlington, Rouses Point, Westport, Plattsburg, and Port Henry; otherwise Condition II prevails.						
Totals	120	74	274	841	687	144	33

POLLUTION CONTROL MEASURES IN EFFECT

16. Sewage treatment facilities. - Only 24 of the 120 separate sources of sewage pollution in Subregion "C" have been provided with treatment facilities. Twenty-two of these facilities provide septic tank or primary treatment and two provide secondary treatment. Primary sewage treatment facilities have a total contributory population of 79,240 persons and the two secondary sewage treatment plants are small and have a total connected population of only 1,540 persons. There are 96 sources of sewage pollution having a total contributory population of 181,200 persons, nearly 70 percent of the total sewage pollution load, that are discharged directly to watercourses without treatment.

NEW ENGLAND INTERSTATE WATER POLLUTION CONTROL COMMISSION
TENTATIVE PLAN FOR CLASSIFICATION OF WATERS
(As Revised and Accepted December 8, 1950)

	CLASS A	CLASS B	CLASS C	CLASS D
		SUITABILITY FOR USE		
	Suitable for any water use. Character uniformly excellent.	Suitable for bathing and recreation, irrigation and agricultural uses; good fish habitat; good aesthetic value. Acceptable for public water supply with filtration & disinfection.	Suitable for recreational boating, irrigation of crops not used for consumption without cooking; habitat for wildlife and common food and game fishes indigenous to the region.	Suitable for transportation of sewage and industrial wastes without nuisance, and for power, navigation and other industrial uses.
		STANDARDS OF QUALITY		
Dissolved oxygen	Not less than 75% sat.	Not less than 75% sat.	Not less than 5 p.p.m.	Present at all times.
Oil and grease	None	No appreciable amount	Not objectionable	Not objectionable
Odor, scum, floating solids, or debris	None	None	None	Not objectionable
Sludge deposits	None	None	None	Not objectionable
Color and turbidity	None	Not objectionable	Not objectionable	Not objectionable
Phenols or other taste producing substances	None	None	None	
Substances potentially toxic	None	None	Not in toxic concentrations or combinations	Not in toxic concentrations or combinations
Free acids or alkalies	None	None	None	Not in objectionable amounts
Coliform bacteria	*Within limits approved by State Department of Health for uses involved	Bacterial content of bathing waters shall meet limits approved by State Department of Health and acceptability will depend on sanitary survey.		

* Sea waters used for the taking of market shellfish shall not have a median coliform content in excess of 70 per 100 ml.

NOTE: Waters falling below these descriptions are considered as unsatisfactory and as Class E.
These standards do not apply to conditions brought about by natural causes.
For purpose of distinction as to use, waters used or proposed for public water supply shall be so designated.

Table 16

Lake George Village has a secondary sewage treatment plant, the effluent from which is negligible and has not been counted as a source of pollution.

17. Industrial waste treatment facilities. - Of the 74 separate significant sources of industrial waste pollution in Subregion "C", only eight have been provided with any degree of treatment. For the most part, treatment is by sedimentation or lagooning. Three facilities treat organic wastes and the effluents have a combined population equivalent of 30,640 persons. The other five treatment facilities treat inorganic wastes. The 66 sources of untreated industrial wastes have a combined population equivalent of nearly 1,021,000 persons.

18. Adequacy of sewage treatment facilities in operation. - Twenty-three of the existing sewage treatment facilities including the one at Lake George Village are adequate in capacity and design, while two are not. Twenty primary plants provide satisfactory treatment for a total connected population of 64,000 persons as do three secondary plants serving populations totalling 2,145 persons. The two sewage treatment plants that are inadequate in capacity have a total contributory population of approximately 15,240 persons, about 20 percent of the population served by treatment facilities. Twenty-four of the sewage treatment facilities are reported to be satisfactorily operated, while one is not operated satisfactorily.

19. Adequacy of industrial waste treatment facilities in operation. - Only three of the eight existing industrial waste treatment

facilities are adequate in capacity. The other five industrial waste treatment facilities discharge unsatisfactory effluents. Operation of six of the treatment facilities is satisfactory and is unsatisfactory at the remaining two.

20. Tables 17 through 20 summarize the data on sewage and industrial waste treatment facilities in operation in Subregion "C".

Table 17 - Existing treatment facilities--municipal

Subregion "C"

Degree of Treatment Provided	Number of Municipalities* Served	Number Treatment Plants	Population Served
Primary	22	22	79,240
Secondary 1/	3	3	2,145
No treatment	96	0	181,200

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers; sanitary sewage wastes discharged by industry directly to watercourse and industrial wastes discharged into municipal sewerage systems.

1/ Includes a small plant serving 605 persons at Lake George village having a negligible effluent and not counted as a source of pollution.

Table 18 - Existing treatment facilities--industrial*

Subregion "C"

Type Industry	Number of Industrial Plants	Number of Industrial Plants Having: Treatment Facilities	No Treatment Facilities	Undetermined Facilities
Food and food products	48	2	46	0
Textile mill products	6	1	5	0
Paper and allied products	12	0	12	0
Primary metal	5	3	2	0
Miscellaneous	3	2	1	0
Totals	74	8	66	0

* Industries having separate outlets discharging wastes directly to watercourse.

Table 19 - Adequacy of existing treatment facilities--municipal

Subregion "C"

Drainage Area	Number of Municipal* Treatment Facilities	Adequacy with Relation to: Capacity: Satisfactory	Capacity: Unsatisfactory	Operation: Satisfactory	Operation: Unsatisfactory
Lake Memphremagog	0	-	-	-	-
Lake Champlain	18 1/	16 1/	2	17	1
St. Lawrence River	7	7	0	7	0
Totals	25 1/	23	2	24	1

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.

1/ Includes a small plant serving 605 persons at Lake George village having a negligible effluent and not counted as a source of pollution.

Table 20 - Adequacy of existing treatment facilities--industrial

Subregion "C"

Drainage Area	Number of Industrial* Treatment Facilities	Adequacy with Relation to: Capacity		Operation	
		Satis-factory	Unsatis-factory	Satis-factory	Unsatis-factory
Lake Memphremagog	0	-	-	-	-
Lake Champlain	4	1	3	3	1
St. Lawrence River	4	2	2	3	1
Totals	8	3	5	6	2

* Industries having separate outlets discharging wastes directly to watercourse.

POLLUTION CONTROL LEGISLATION IN EFFECT

21. New York State pollution control legislation. - The New York State Comprehensive Water Pollution Control Law (Article 6, Public Health Law) was enacted in 1949 and became effective on April 20 of that year. This law requires the official classification of and assignment of quality standards to the receiving waters as a basic preliminary step which must be taken before the Water Pollution Control Board is in a position to develop and enforce comprehensive programs of pollution abatement with respect to any particularly designated waters. However, after classifications are accomplished, the Board must then proceed as rapidly as its facilities will permit with the development and execution of an abatement program for such waters. In the execution of an abatement program, the policy is established by law to encourage voluntary correction of pollution so far as possible. However, the Board is given authority

to issue and enforce orders requiring abatement of pollution when the circumstances are reasonable and such action becomes necessary.

22. The New York law treats new sources of pollution and existing sources of pollution differently. In the case of the former, the mechanism for pollution control is the requirement that approval of plans and a written permit must be obtained from the Water Pollution Control Board for all new outlets which are intended to discharge polluting substances into waters of the State. This same requirement applies also to modified sewage or waste disposal systems when they are altered or changed to such an extent as to materially change the effects of the waste discharge on the receiving waters. These requirements apply irrespective of whether waters have been classified or not.

23. For the abatement of pollution which was in existence at the time the Law became effective, the Board is required to follow certain specified procedures under a program consistent with the declaration of policy as stated in the act. In brief, with respect to development and execution of an abatement program for any particular waters, the following steps must be taken:

a. Survey of waters within the specified drainage basin to obtain data essential to proper classification of such waters. Classification must be based on the principle of best usage of waters in the public interest and with regard to their hydrologic features, bordering land usage, present and foreseeable future water usages and the extent of their present defilement.

b. Preparation and publication of a report on such surveys to be used as a basis for public hearing.

c. Public hearing relative to the proposed classifications.

d. Adoption of classifications by the Water Pollution Control Board, taking into consideration the suggestions and comments received at the time of public hearing.

e. Development of a general comprehensive plan for abatement of pollution within the specified drainage basin. Such a plan sets forth the problems related to each source of pollution, outlines the steps which should be taken for correction and outlines the procedures to be followed by the Board in achieving the desired objectives.

f. Promotion and execution of the comprehensive pollution abatement plan. In this connection, the Board will rely so far as possible on cooperation to get the pollution problems solved. However, when cooperative methods fail to achieve the desired results, the Board has authority to issue and enforce orders requiring the abatement of the pollution.

24. Vermont State pollution control legislation. - Chapter 276 of the Vermont Laws, Acts of 1947, as amended by the Acts of 1949 and 1951, created the Vermont State Water Conservation Board and various sections thereof define the policy, membership, tenure of office, records, commissioner, assistants and duties of the Board. The enforcement of the provisions of Chapter 277, Acts of 1943, as amended by the Acts of 1947, 1949, and 1951, for the control of pollution of waters is vested in the Water Conservation Board except that the

Board's authority shall not infringe upon the powers and duties of the State Board of Health, of local officials in respect to matters of public health, nor of the Public Service Commission respecting water used for the development of hydro-electric power. The Board may issue an order directing the reduction, control or elimination of pollution and may cause its enforcement by suit in equity brought before the chancery court in the county wherein such pollution shall have been found to originate. The suit shall be brought by the Attorney General in the name of the State and shall enjoin a person for continuing such pollution. Section 4 adopts classes of waters for the purposes of classification of the waters of the State and Section 5 declares:

> "I. That the waters of all reservoirs, natural or artificial wholly within the State, used for public water supply and all waters flowing into such reservoirs are to be Class A waters of Vermont; and
>
> "II. That the waters of each natural lake and pond, wholly within this State, and having an area of twenty or more acres, and the waters flowing into such natural lakes and ponds are to be Class B waters of Vermont except such lakes and ponds as are used for public water supply; provided, however, that on petition to the Vermont State water conservation board by ten persons who own property on or near a lake, or pond so classified, alleging they suffer injustice or inequity as a result of this classification, the board shall hold a public hearing convenient to such lake or pond. The board may place the waters of such lake or pond, or the waters flowing into it, in a different class. Such waters shall remain in the class fixed by the board until changed by act of the legislature; and
>
> "III. The Vermont State water conservation board is directed, under procedure following to determine what degrees of purity of the remaining waters of the State should be obtained and maintained in the future to provide the people of Vermont with the maximum of beneficial use and enjoyment of such waters. The board shall make such tests of any such water as it deems necessary for determining its present classification."

Other sections of Chapter 277 provide for hearing, notices, appeals, petitions for change, penalties and other such provisions necessary to the administration of the act.

25. Interstate pollution control legislation. - Both New York and Vermont are signatory to the New England Interstate Water Pollution Control Compact which created the New England Interstate Water Pollution Control Commission. As members, each State pledges to provide for the abatement of existing pollution and for the control of future pollution of interstate inland and tidal waters and to put and maintain the waters thereof in a satisfactory condition consistent with the highest classified use of each body of water as assigned by the Commission. The Commission has jurisdiction in the Lake Champlain Drainage Basin in Subregion "C".

26. International Joint Commission. - The International Joint Commission has authority over pollution of boundary waters which stems directly from the Treaty of January 11, 1909, entered into by the United States and Great Britain. The Treaty created the International Joint Commission and assigned to it specified authority to investigate, regulate and control the use of boundary waters. Articles II and IV of the Treaty refer to pollution and Article VIII to uses for domestic and sanitary purposes.

STREAM CLASSIFICATIONS ADOPTED FOR BEST USE OF WATER RESOURCES

27. Stream classifications adopted in Vermont. - In addition to the public water supply reservoirs and their tributaries and the natural lakes and ponds of twenty acres or more and tributaries

thereto that were classified on passage of the State water pollution control law in 1949, the Vermont Water Conservation Board classified the waters of the St. Albans Bay area and the La Platte River in 1954. The 28 miles of tributary streams which enter St. Albans Bay were classified as B water with the exception of about five miles of Class C below the St. Albans municipal sewage treatment plant. The La Platte River classification provides for B quality water with the exception of four small sections of the river and certain tributaries which will be Class C.

28. Considerable progress towards classification of other waters in the basin has been made. Field investigations and surveys have been completed or are in progress in the Otter Creek, Lamoille River, Castleton River, Poultney River, Metawee River and Upper Winoski River drainage areas. In addition, public hearings leading to classification of these streams in the best public interest have been held or are scheduled.

29. In Vermont, Class B waters shall be suitable for bathing and recreation, irrigation and agricultural uses; a good fish habitat; of good aesthetic value; and acceptable for public water supply with filtration and disinfection. Class C waters shall be suitable for recreational boating, irrigation of crops not used for consumption without cooking and for common food and game fishes indigenous to the region.

30. Stream classifications adopted in New York. - As yet none of the waters in the New York portion of the subregion has been classified as required by law, but progress leading to classification has been made. During 1953 the New York Water Pollution Control Board completed its field investigations and surveys in the southern half of the Lake Champlain Drainage Basin in New York and the preparation of its technical report is underway. It is expected that public hearings will be scheduled for early in 1955.

31. Classifications adopted by interstate commission. - Occupied elsewhere in the compact area, the New England Interstate Water Pollution Control Commission has not yet taken steps towards classifying any of the interstate waters of the Lake Champlain Drainage Basin. Field investigations and studies completed or underway by State pollution control agencies will undoubtedly serve as bases for interstate classifications at a later date.

32. International Joint Commission. - The International Joint Commission has not yet been directed by the Governments of the United States and Canada to investigate conditions of pollution of boundary waters in Subregion "C".

PROVISIONAL POLLUTION CONTROL, COSTS, AND BENEFITS

33. Provisional pollution control plan. - In each Section V of Chapters XXVI through XXVIII, three provisional pollution control plans are presented. These provisional plans are defined as follows:

Provisional Plan A would provide primary treatment for most sources of sewage pollution and an equivalent or similar degree of treatment for sources of industrial waste pollution.

Provisional Plan B would provide secondary treatment for each source of sewage pollution and an equivalent or substantial degree of treatment for each source of industrial waste pollution.

Provisional Plan C would provide secondary or a similar degree of treatment for all sources of pollution except where providing primary or a similar degree of treatment would result in approximately the same improved water conditions as secondary or similar treatment. All plans would provide for chlorination of sewage effluents.

34. Exceptions to the above plans were made in certain instances where only one method of treatment was shown under all three plans. These exceptions were made when the treatment shown was obviously the only reasonable and equitable method for a source of pollution, such as subsurface disposal for small sources of sewage pollution, land application of small amounts of milk wastes or connection of wastes to an available municipal sewerage system.

35. The science of sewage and industrial waste treatment is too complex to lend itself readily to definitions but for the purposes of this section primary treatment of wastes is interpreted as the process by which, in a series of devices and structures, approximately 30 to 50 percent of the significant polluting materials is removed. Secondary

treatment is interpreted as primary treatment plus such additional treatment as would result in an overall reduction of significant polluting materials of 60 percent or more.

36. Provisional Plan C. - For the planning of water resources development in the drainage areas of Subregion "C", Provisional Plan C as outlined in each Section V of Chapters XXVI through XXVIII has been taken as a guide to pollution control, costs and benefits. These plans are consolidated below to serve as a guide in coordinating pollution control in the plans for water resources development for Subregion "C".

37. Cost estimate criteria. - All cost estimates for provisional pollution control projects have been adjusted to the 1949 Engineering News-Record construction cost index. In computing annual charges for provisional pollution control projects, an interest rate of 2.5 percent and an amortization period of 30 years have been taken for all public construction. For private construction, an interest rate of 4 percent and an amortization period of ten years have been used in computing annual charges for provisional projects.

38. The cost estimates for municipal sewage treatment works construction include costs for intercepting sewers but do not include costs for sewerage systems or extensions thereto since such costs are not generally considered a part of sewage treatment costs. Where sewerage construction is required however, the costs are substantial. For industrial waste treatment or disposal construction, no costs have been included for in-plant or yard changes that may be required

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in connection with treatment. Such costs could only be determined after detailed in-plant investigations at each manufacturing plant. In some instances the cost of in-plant or yard changes would be minor and in some others these costs may approach that of the treatment facility to be constructed. No corrections in the estimated construction costs for industrial waste treatment facilities have been made for savings that may be realized through greater utilization of raw materials or recovery of valuable by-products as a result of pollution control measures taken.

39. The annual charges for sewage treatment will vary with each municipality, generally being highest per capita in small communities and decreasing with increasing populations to be served. Further, final costs will be greatly influenced by industrial wastes intercepted, method of financing, design and construction materials and equipment specified. Annual charges for industrial waste treatment will also vary with individual plants and will largely be determined by volume and character of wastes to be treated, choice of plant design, construction materials and equipment specified and in-plant or yard changes required.

40. Water quality criteria. - Subsequent discussion of water qualities in this section is based on (a) the "Tentative Plan for Classification of Waters" of the New England Interstate Water Pollution Control Commission (as revised and accepted December 8,1950) and (b) stream flows exceeded 95 percent of the time. Where quantitative data on stream velocities, temperatures, reaeration coefficients

and other self-purification factors below individual sources of pollution were not available, water conditions have been estimated from other pollution data. Water conditions I through V are approximately equivalent to water classes A through E of the interstate standards.

41. The provisional plan presented in this section is not conceived to be the most feasible or desirable plan for controlling pollution in Subregion "C". Such a plan can be determined only after best water uses have been determined and classifications adopted by the State authorities and after appropriate surveys and investigations of pollution of boundary waters by the International Joint Commission. Neither are the methods of treatment or disposal shown necessarily the only methods available to produce a similar reduction in pollution. The provisional plan presents data sufficient on which to judge the benefits and costs of pollution control in the subregion and to serve as a guide in planning and coordinating water resources development. In serving this purpose, no attempt is made to classify any of the waters in Subregion "C" or to usurp in any way the primary rights and responsibilities of the States of New York and Vermont to control the pollution of their waters or of the International Joint Commission to control pollution of boundary waters.

PROVISIONAL POLLUTION CONTROL PLAN

42. Treatment and disposal facilities. - The provisional plan for pollution control for Subregion "C" would provide a total of 186

treatment facilities, 115 for sources of sewage pollution and 71 for sources of industrial waste pollution. Sewage treatment projects would serve wastes having a total population equivalent of about 251,775 persons and industrial waste treatment projects would serve wastes having a total population equivalent of approximately 1,050,895 persons. Table 21 summarizes the data on the provisional pollution control plan ans shows the number and kind of facilities that would be provided and the type and population equivalent of wastes to be treated. For details on treatment facilities for individual sources of pollution, reference is made to Provisional Plan C, Section V in each of Chapters XXVI through XXVIII.

Table 21 - Summary of treatment facilities, provisional pollution control plan

Subregion "C"

No. of Facilities	Type of Waste	Estimated Population* Equivalent	Type of Treatment or Disposal
48	Sewage	127,585	Secondary treatment, chlorination
26	Sewage	73,925	Primary treatment, chlorination
1	Sewage	7,000	Connect to municipal system having secondary facilities
12	Sewage	34,650	Add secondary treatment to existing facilities
1	Sewage	4,200	Enlarge existing primary plant, add chlorination
4	Sewage	675	Add chlorination only
23	Sewage	3,740	Subsurface disposal
5	Sewage	3,920	Nothing required

42-B

Table 21 (Continued)

No. of Facil-ities	Type of Waste	Estimated Population* Equivalent	Type of Treatment or Disposal
9	Industrial	8,225	Connect to municipal system having secondary facilities
4	Industrial	15,150	Connect to municipal system having primary facilities
7	Industrial	57,200	Chemical coagulation; sedimentation or flotation
12	Industrial	57,675	Biological oxidation
3	Industrial	10,250	Coagulation, sedimentation, biological oxidation
1	Industrial	22,000	Coagulation, sedimentation or flotation for paper and ground wood wastes, evaporation for waste sulfite liquors
3	Industrial	362,000	Sedimentation or flotation for paper and ground wood wastes, lagoons for sulfite liquors
1	Industrial	457,000	Flotation or sedimentation for paper mill and ground wood wastes; nothing for waste sulfite liquors.
2	Industrial	6,300	Sedimentation or flotation
1	Industrial	30,000	Coagulation; sedimentation or flotation; renovate lagoons
18	Industrial	24,175	Land application
2	Industrial	DNA 1/	Lagoons
3	Industrial	DNA 1/	Enlarge or renovate lagoons
2	Industrial	290	Subsurface disposal
3	Industrial	630	Dilution (regulated discharge)
1	Industrial	Negligible	Nothing required
2	Industrial	DNA 1/	Nothing required

* Population equivalent in number of persons based on biochemical oxygen demand.

1/ DNA - population equivalent based on biochemical oxygen demand does not apply

43. Reduction in pollution load. - Under the provisional pollution control plan for Subregion "C", treatment and disposal facilities would result in a reduction of approximately 37 percent of the present pollution load or a population equivalent of about 488,000 persons. Sewage treatment facilities would remove a population equivalent of some 176,000 persons, nearly 70 percent of the present sewage pollution load. Industrial waste treatment facilities would remove a population equivalent of about 312,000 persons, nearly 30 percent of the present industrial waste pollution load. In addition to reduction in pollution load by treatment, the regulated discharge of milk plant wastes and the discharge of waste sulfite liquors from lagoons during favorable periods of stream flows and temperatures would result in marked improvement in receiving streams although there would be little reduction in the total pollution load eventually discharged. The adequate lagooning of inorganic wastes would also markedly improve receiving streams.

44. Approximate water quality improvement. - With the treatment shown under the provisional pollution control plan for Subregion "C", it is estimated that approximately 703 miles of watercourse would be improved for higher uses than are possible under present conditions of pollution. These miles of improved watercourse represent about 80 percent of the present significantly polluted stretches of streams in Subregion "C". About three miles of watercourse would be improved to a very high quality and these waters would become suitable for any water use; 573 miles would be of a

high quality acceptable for any water use except public water supply unless filtered and disinfected; and 127 miles would be of a good quality suitable for such uses as recreational boating, habitat for wildlife and common food and game fishes indigenous to the region; irrigation of crops consumed after cooking and a number of industrial purposes without treatment. No waters in the subregion would be less suitable for use. Under the provisional plan, all of the 33 miles of stretches of watercourses in nuisance condition during critical periods under present pollution loads would be improved, all to a degree suitable for many legitimate purposes.

45. In addition to the streams that would be improved by the provisional plan, the affected areas in the two major lakes would be improved. Without exception, all fresh water impoundments would become suitable for any water use, although most would require filtration and disinfection before use as public water supplies.

46. Table 22 summarizes the approximate effects of the provisional pollution control plan on water conditions in Subregion "C" with respect to suitability of the waters for use. Data are presented by drainage areas and show the miles of main stems of streams transporting pollution.

ESTIMATED COSTS FOR POLLUTION CONTROL PROJECTS

47. Estimated construction costs for provisional pollution control. - Based on the sewage and industrial waste treatment projects summarized in Table 21, the total construction cost for the provisional

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Table 22 - Approximate effects of provisional pollution control plan on water conditions

Subregion "C"

Drainage Area	Approximate Present Water Condition in Miles					Approximate Water Condition Under Provisional Plan in Miles					Net Water Quality Improvement in Miles			
	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV
Lake Memphremagog	0	40	49	4	0	0	91	2	0	0	-	51	2	-
Lake Champlain	41	296	471	124	30	41	696	225	0	0	-	400	106	-
St. Lawrence River	233	505	167	16	3	236	625	63	0	0	3	122	19	-
Lake Memphremagog (lake proper)	Condition III in South Bay and in vicinity of Newport; otherwise Condition II prevails.					Condition II prevails in South Bay and throughout the lake.								
Lake Champlain (lake proper)	Condition III in vicinity of confluence with principal tributaries and direct discharges from lakeside municipalities.					Condition II prevails throughout the lake.								
TOTALS	274	841	687	144	33	277	1412	290	0	0	3	573	127	-

pollution control plan for Subregion "C" has been estimated to total approximately $14,322,000. Of this total the construction cost of public sewage treatment projects, which includes those for public schools and institutions, accounts for an estimated $10,787,000; private sewage treatment and disposal projects to serve individuals, factories and private institutions would cost approximately $433,000; and industrial waste treatment and disposal facilities would cost an estimated $3,102,000.

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48. Public sewage treatment projects are considered as those which would be financed by public funds and private sewage and industrial waste treatment projects as those to be financed by private capital. Table 23 summarizes the estimated construction costs and annual charges for the provisional pollution control plan for Subregion "C".

BENEFITS RESULTING FROM WATER QUALITY IMPROVEMENT

49. Benefits resulting from pollution control may be both tangible and intangible. A tangible benefit would be represented by a direct savings in costs for water treatment for public or industrial water supply as a result of pollution control. Another example of a tangible benefit would be recovery of valuable by-products in the process of reducing pollution. Intangible benefits are those which do not readily lend themselves to computation in monetary terms. Protection of the public health, abatement of nuisance conditions and enhanced aesthetic values through pollution control are examples of intangible benefits. For the most part, benefits assigned to pollution control are intangible, largely through the absence of suitable criteria for monetary evaluations. There are occasions, however, where suitable data are available

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Table 23 - Summary of estimated construction costs* and annual charges for provisional treatment and disposal facilities

Subregion "C"

Pollution to be Served	Estimated Construction Cost	Estimated Annual Capital Charge 1/	Estimated Annual Operation and Maintenance Charge	Total Estimated Annual Charge 1/
	Lake Memphremagog Drainage Basin			
Municipal sewage	$1,045,000	$50,000	$22,000	$72,000
Private sewage	--	--	--	--
Industrial wastes	15,000	1,800	1,200	3,000
Totals	$1,060,000	$51,800	$23,200	$75,000 2/
	Lake Champlain Drainage Basin			
Municipal sewage	$6,985,000	$334,000	$300,000	$634,000
Private sewage	125,000	15,400	3,600	19,000
Industrial wastes	2,090,000	258,000	59,000	317,000
Totals	$9,200,000	$607,400	$362,600	$970,000 2/
	St. Lawrence River Basin			
Municipal sewage	$2,757,000	$132,000	$171,000	$303,000
Private sewage	308,000	38,000	8,000	46,000
Industrial wastes	997,000	123,000	50,000	173,000
Totals	$4,062,000	$293,000	$229,000	$522,000
	Grand totals			
Municipal sewage	$10,787,000	$516,000	$493,000	$1,009,000
Private sewage	433,000	53,400	11,600	65,000
Industrial wastes	3,102,000	382,800	110,200	493,000

* Based on 1949 Engineering News-Record construction cost index.

1/ Based on amortization periods of 30 and 10 years at $2\frac{1}{2}$ and 4 percent interest respectively for public and private construction.

2/ Total applies only during 10-year amortization of industrial waste and private sewage treatment costs.

when tangible benefits from pollution control can be computed on a monetary basis, although such data are not available for Subregion "C".

50. Benefits that may accrue from water quality improvement through pollution control depend upon the uses the improved water resource will serve. There are also potential benefits through the conservation of water resources for future use. In Subregion "C", the water resources serve as public water supplies, industrial water supplies, agricultural water supplies, for all types of recreation, as a habitat for fish and wildlife, for power development, for navigation and for transportation of sewage and industrial wastes. Save the last three which do not require a good water quality, these water uses are the ones potentially to be benefited by pollution control.

51. There is an appreciable number of benefits that could accrue from pollution control as a result of improving the waters of the subregion for their highest best use. From a consideration of the present economy and the stream improvements that could be effected through pollution control, the following benefits could result if the water resources are developed for the purposes for which they are best suited. In the absence of suitable criteria, no monetary evaluations are made

and although presented as intangible, these benefits have been proven through the years as most desirable and worthy of attainment. For the most part, they have been the basis for investment of many millions of dollars in existing sewage and industrial waste treatment facilities in this and other areas that have been constructed to serve the best interests of the public.

a. There could be a significant benefit to the public health by reducing the chances for waterborne diseases by the treatment of, or elimination of municipal, institutional and industrial sewage pollution. Sewage polluted waters are always a potential health menace.

b. Large volumes of readily accessible water at desirable industrial sites could be made suitable for and attractive to new industrial development that could result in increased income and economic stability in the subregion.

c. The construction of the needed municipal sewage treatment works could make the communities served more attractive to new industries requiring this municipal utility which could be of real significance to local economies.

d. A number of industries now discharging industrial wastes may realize significant savings through recovery of valuable by-products and greater utilization of raw materials.

e. Industrial, residential, and recreational real estate now located on or dependent on waters presently receiving pollution

could be made more desirable and, thereby, appreciably increased in value when pollution is abated.

f. Pollution abatement may make large areas of land and water resources suitable for greater development by the recreation industry and could, thereby, add to the income and economic stability of the subregion by an increased tourist and vacation trade.

g. Control of pollution could protect and enhance the extensive lake frontage recreation development and could contribute substantially towards insuring the continued income from this economically important industry.

h. Farms not using streams because of pollution could have these water resources available for most or all agricultural purposes.

i. Industries contributing to damages to water resources could experience a worthwhile benefit from improved public relations through abatement of pollution for which they are responsible.

j. Aesthetic nuisances and unsatisfactory water conditions created during periods of low flows and high temperatures could be eliminated.

k. The general welfare of the people could be enhanced by the conservation of a vital natural resource for its best uses and by a greater opportunity to benefit therefrom. Further, clean streams could enhance the general reputation of the subregion in the eyes of visitors and vacationists.

52. Resource development and benefits. - There is, of course, a direct inter-relation between water resource development and benefits

from pollution control. The more extensive and varied water use becomes the more benefits can be obtained from pollution control to maintain the necessary water qualities for the purposes served. Should further development of Subregion C be undertaken with an integrated plan, it could result in a significant increase in industrial and recreational development which would be accompanied by an increase in population. These developments would appreciably enhance the value of the water resources for public water supply, industrial water supply and recreation. Land abutting on or served by water resources suitable for industrial, residential and recreational use would also be increased in value. Pollution control measures to maintain acceptable water qualities under these circumstances would produce benefits in proportion to the magnitude of the economic development.

MONETARY BENEFITS OR LOSSES TO POLLUTION CONTROL FROM CONSERVATION AND DEVELOPMENT PROJECTS

53. Power development, power storage and flood control projects. - Evaluations of power development, power storage, and flood control projects studied in Subregion "C" indicate that no monetary benefits or losses would accrue to pollution control from their construction and operation under the provisional pollution control plan.

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SECTION VI - FLOOD CONTROL AND DRAINAGE

GENERAL PROBLEMS

1. High flows occur nearly every spring in Subregion "C" from a combination of melting snow and rainfall. Stages of spring overbank flooding are frequently increased by ice jams. These conditions cause relatively little damage in Lake Memphremagog and St. Lawrence Drainage Basins, but are a major problem in Lake Champlain Drainage Basin, where the flood losses in the Winooski River sub-basin average $317,000 annually at 1949 price levels. Local flash floods, resulting from short summer storms between May and November, are responsible for a large portion of the average annual damage.

2. Erosion problems are generally confined to open farmland although substantial erosion occurs on heavily grazed forest land, and on old abandoned logging roads and skid trails. Sheet erosion is in evidence throughout the agricultural portion of the watershed and erosive action is steadily destroying fertile soils. Streambank erosion is serious in some of the tributary streams.

HISTORY AND ANALYSIS OF FLOODS

3. Flood history. - The great flood-producing storms in Subregion "C" have been generally either of the transcontinental or cyclonic type in the late winter and spring, or of the hurricane type in the fall. In addition, flash floods have resulted from local thunderstorms and cloudbursts.

4. Records of flood damages in the St. Lawrence Drainage Basin are sparse. Recent records indicate that reported damages have generally occurred at the time of the spring run-off, but not always at the time of the peak run-off, because many overflows are due to ice jams.

5. The only major flood in the last 50 years affecting the Lake Memphremagog Drainage Basin occurred in November 1927 when two lives were lost along the Black River and one along the Clyde River. This flood, the greatest recorded in northern Vermont, resulted from a Caribbean tropical storm which traveled over this area. The intense precipitation, falling on a saturated earth after a wet October, caused the great flood.

6. In the Lake Champlain Drainage Basin the great storms and floods of record cover only parts of the basin and when a storm occurs over the entire area, it often has a significant variation of intensity over different sections. The major flood-producing storms in the last century include the storm of October 1869 in Vermont; that of March 1913 in the Adirondacks and the southern part of the watershed; that of October 1924 in the Adirondacks; the November 1927 storm in Vermont, which caused the greatest flood discharges and the most extensive damages recorded in northern Vermont history; the storm of March 1936 affecting the entire watershed; and, finally, the storm of September 1938 which also occurred over the entire watershed but was most severe over the New York portion.

7. Land management. - In many areas land management practices of the past have contributed to the rapid run-off of flood waters. Some of the agricultural land has been overcropped, pastures have been overgrazed and farm forests have been inadequately managed and damaged by grazing. Forests have been clearcut and the cutover areas have been burned and reburned. Logging roads and skid trails have been constructed without due regard to the resulting run-off and erosion. These practices have adversely affected the hydrologic characteristics of the subregion.

8. Data on flood flows. - Flood data are available from published records at 34 stream-gaging stations, some of which have been in operation for various periods of time since 1903 on the main rivers and tributaries in Subregion "C". Additional information on stream flow is contained in Section I of Chapters XXV through XXVIII.

9. Analysis of floods. - In the Lake Champlain Drainage Basin the greatest flood damages occur on the Winooski River. The principal damage areas today are: the reach on the main stream of the Winooski from above Waterbury to Bolton Gorge, and East Creek, a tributary of Otter Creek, at Rutland. A detailed study of the flood situation on the Winooski River has been conducted, taking into account flood frequencies, annual damages, tributary contributions and all other pertinent data. Detailed damage studies have been previously made on East Creek at Rutland in connection with an investigation for flood control at this locality. No such detailed studies have been made for the other tributaries in the Lake Champlain Drainage Basin as damages on the other tributaries are relatively small. The

Mettawee watershed has extensive agricultural flooding and bank erosion problems, while all other problem areas in Lake Champlain Drainage Basin are limited to isolated locations.

10. In the Lake Memphremagog Drainage Basin, the flood of November 1927 was caused by heavy rains falling on a saturated earth after a wet October. Floods are infrequent and relatively minor. The large amount of natural storage provided by the numerous lakes and ponds in this basin tend to minimize any potential floods.

11. In the St. Lawrence Drainage Basin, flood problems exist on the Oswegatchie and Salmon Rivers. Floods are usually due to ice jams rather than to high discharges. Relatively little damage is caused by the high flows in the spring of the year on the other streams in this basin.

DAMAGES

12. Flood damages. - Storms which produce major floods in Subregion "C" cause damages in areas larger than a single river basin. The storms of November 1927, March 1936 and September 1938 were of this character. The simultaneous occurrence of floods in several river basins disrupts transportation. Access between localities separated by flood areas involves extensive detours which are often two or three times as long as the customary route. The storm of November 1927 was the greatest recorded in the Vermont area of the subregion. These major floods also caused shutdowns of damaged industrial plants and delays of incoming shipments of raw materials into the area. At the same time, outgoing shipments of dairy products, aluminum, paper, lumber,

wood products, and machinery were delayed until repair of flood damages was effected.

13. Headwater damages. - Headwater flood damages were estimated for agricultural crops, for other agricultural resources and for urban, residential and industrial facilities. Average annual damages were estimated for sample tributaries and projected to each area on a per square mile basis. Estimates were made of the losses that would occur at flood stages above and below a flood of record. In determining agricultural crop losses by stage, the flooded area for each crop was first related to flood stages. Per acre crop values, modified to reflect monthly variations in crop values and the percent chance of flood occurrence by months, were then applied to the area of each crop inundated at various stages to develop stage-crop loss relationships. Stage-damage relationships for all types of damageable values were converted to damage frequency curves in accordance with the methods outlined in Part Three of the report. The total average annual loss for the headwater areas in Subregion "C" was found to be $202,000 at 1949 price levels. Figures for headwater damages also include areas along the main streams which have only minor damages.

14. Main stream and tributary damages. - A detailed study was made of the flood situation on the Winooski River in Lake Champlain Drainage Basin. No detailed flood damage surveys were made in other areas of Subregion "C" since damages were relatively smaller by comparison. In the Winooski River Basin all major items of prob-

able damage were investigated, including industrial properties, commercial establishments, highways, bridges, railroads, and utilities, with a view of determining the present extent of development and use and the extent of damage that would be sustained in the event of future floods. The main rivers and tributaries were divided into damage zones and the estimated losses at various stages of flooding, for each item of damage, were summarized to arrive at a stage-damage curve for each zone. The curves of stage-damage were correlated with stage-discharge and discharge-frequency relationships to develop curves of damage-frequency. The area under these latter curves gave the estimated annual loss for each zone. The total estimated annual loss for all the main stream and tributary damage zones in Subregion "C" was found to be about $530,000 at 1949 price levels. The figure for the St. Lawrence Drainage Basin is not included in this estimate.

15. Erosion damages. - Erosion damages on cropland were determined by estimating the rate of soil loss and the average annual reduction in yield due to erosion. Application of the yield reduction data and the effective soil loss rate indicates that the average annual equivalent value of the loss in Subregion "C" over a 30-year period at 4 percent discount rate is $117,600 at 1949 price levels. A full description of the calculation is given in Part Three of the report.

16. Sedimentation damages. - Each year some land, especially on steep slopes, or recently plowed land, suffers erosion in times

of severe storm, and the eroded material may reach highways, drainage ditches and streams. The sediment produced by erosion may cause an amount of damage reflected in additional costs necessary to clean highway culverts, protect bridges and maintain navigation channels. These maintenance costs are such a small percentage of the total that accounts do not show them separately. Monetary evaluation of sedimentation damages has not been included in damage totals.

17. Sedimentation of water supplies is not a serious problem in Subregion "C" although some costs are incurred to reduce sediment in domestic water supplies. There is insufficient data available to permit preparing an accurate estimate of the cost of sediment removal.

18. Total damages. - Total average annual flood and erosion damages are shown in Table 24.

NEEDS

19. Subregion requirements. - The average annual damages in the subregion, which total $851,100, indicate a need to consider flood protection and erosion control measures to reduce losses. At the hearings of the Committee at Montpelier, Vermont and Syracuse, New York, no specific requests were made for flood protection or erosion control measures in the basins comprising Subregion "C", except in Lake Champlain Drainage Basin. In this basin three problems were mentioned: the one concerned bank erosion and channel

Table 24 - Average annual flood and erosion damages, Subregion "C"

Drainage Basin	Headwater areas	Main stream and tributary damage zones	Cropland 1/ erosion	Total annual damages in subregion
Lake Memphremagog	$ 1,300	$ 2,500	$ 3,500	$ 7,300
Lake Champlain	130,700	529,000	73,300	733,000
St. Lawrence	70,000	-	40,800	110,800
Totals	$202,000	$531,500	$117,600	$851,100

Based on 1949 price levels.

1/ These figures represent only the net loss of income from yield decline due to sheet erosion.

silting along the New Haven and Middlebury Rivers, tributaries of Otter Creek, near Bristol; the other concerned silt deposition and drainage problems along Otter Creek and the Lemon Fair River; and the third concerned the frequent flooding of agricultural lands between urban centers on the Mettawee River.

20. A fairly intensive land treatment program is needed in Subregion "C" to improve soil and water relationships. The program is needed to reverse the present trend towards deterioration of soil and water resources and to make maximum use of the capacity of the soil profile to regulate stream flow. Erosion problems are becoming increasingly important in this subregion and cause more damage than they should because of poor land use and treatment in the past. Overbank flooding causes more damage than erosion under present conditions and may be expected to become progressively more serious as hydrologic conditions deteriorate. Improvements in land management practices and desirable conversions in land use are needed to build up the soil and water resources of the subregion and make it a more effective regulator of stream flow.

PLANS OF IMPROVEMENT

21. Authorized flood control improvements. - There are eight authorized Federal flood control projects in Subregion "C". These are all located in the Lake Champlain Drainage Basin and are listed in Table 25. The plan for flood control consists of: modification of the three reservoirs at East Barre, Wrightsville, and Waterbury; local protection works at Waterbury; and flood protection works at Rutland. All these projects have been authorized and considered warranted for construction. The local protection project for Waterbury is dependent upon the attitude of local interests towards the conditions of local cooperation.

22. In addition to the completed Federal projects, a number of projects in Subregion "C" have been completed by local interests, but these measures are of a limited nature.

Table 25 - Authorized flood control projects, Subregion "C"

Location				
Waterbury	Vermont	Reservoir modification	Winooski River	Raise dam and increase spillway capacity.
Wrightsville	Vermont	Reservoir modification	Winooski River	Raise dam and increase spillway capacity.
East Barre	Vermont	Reservoir modification	Winooski River	Raise dam and increase spillway capacity.
Middlesex to Montpelier	Vermont	Channel improvement and reconstruction of Montpelier Dam	Winooski River	Completed in 1938.
Waterbury	Vermont	Levees; floodwalls; channel clearing; removal of dam	Winooski River	Awaiting definite statement of local cooperation.
Proctor	Vermont	Channel widening; extension of Proctor Dam	Otter Creek	85% completed by local interests; no interest shown to complete work.
Rutland	Vermont	Channel clearing; levee; flood wall; two pumping stations	Otter Creek	Not initiated.
Hardwick	Vermont	Bank revetments; reconstruction of Hardwick Dam	Lamoille River	Bank revetments completed. Hardwick Dam reconstruction not wanted locally.

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23. Consideration of additional flood control improvements. - Studies were made in Subregion "C" of a number of sites for additional detention reservoirs in the Lake Champlain Drainage Basin but were found to be economically unjustifiable at the present time. Additional local protection projects have likewise been found unfeasible at this time.

24. The Weather Bureau Office at Burlington, Vermont issues general warnings (of degree of flood rather than specific stage) for the Winooski River in the Lake Champlain Drainage Basin. In addition, using procedures and alerts provided by the Weather Bureau and a headwater reporting network established in cooperation with the Weather Bureau, a local flood warning representative disseminates flood warnings for Otter Creek in the Rutland area.

25. Effect of power projects on flood control. - There are a total of 9 projects in the inventory power plans for the basins in Subregion "C" including 3 storage projects, 4 power projects, and 2 combined power and storage projects. In addition there are 4 power projects under construction. Information on the power projects is shown in Table 30 in Section VII. Any benefits to flood control from operation of the projects would be incidental to their primary purpose of producing hydroelectric power. No evaluation of these incidental monetary

26. Water flow retardation measures. - The land treatment measures planned for the primary purpose of securing an optimum level of agricultural production in the subregion would, upon installation, exercise a beneficial effect on the hydrologic char-

acteristics of the subregion. They include adjusting land use with land capability, adoption of improved cropland and forest land management practices, and installation of the necessary minor structures needed to make the land conversions and improved management measures fully effective.

27. In twelve areas in the subregion, all in the Lake Champlain Drainage Basin, damages or physical conditions have been sufficient to justify further investigations of the possibility of waterflow retardation measures. The investigations are necessary to determine the cost and effectiveness of small retarding structures. The surveys could be made in approximately 8 months at an estimated cost of $24,000. If these preliminary surveys indicate that water retarding structures are justified, then additional funds would be needed for design and construction.

28. Effect of land treatment program on floods. -The beneficial effect of the proposed land treatment program in reducing flood, erosion and sedimentation damages in Subregion "C" is dependent upon three principal variables:

a. Frequency and type of flood producing storms.

b. Acceptance of the program by landowners and the progress which they make to put the various elements of the program into operation throughout the subregion.

c. Continuation of the practices throughout the years after they have once been put into operation.

29. The full benefits of the program in reducing flood flows

Stream bank erosion, Wells Brook, Wells, Vermont. Subregion "C".

would not be felt immediately upon adoption of the program. Instead the benefits would increase with time. From some of the work contemplated in the program, such as small structures, flood flow reduction would begin to accrue as soon as they were constructed; other operations would produce their full benefits within two or three years; from some the full benefit would not be felt for four or five decades. The program would have its maximum effectiveness on floods of the one-year or two-year frequency. It would probably have only a very small effect on major spring floods.

BENEFITS

30. The authorized flood control projects at Rutland, Vermont and Waterbury, Vermont, which are considered warranted for construction, would provide protection to local areas of damage in the Winooski River and Otter Creek Basins. The total average annual benefits from reduction of flood damages which would be derived from these flood control projects in Subregion "C" amount to $268,200. Construction of the flood protection works at Rutland, Vermont in Otter Creek Basin would cost $4,280,000. Annual charges are estimated at $174,800 and benefits at $190,000 giving a benefit-cost ratio of 1.09 to 1. Construction of the local protection works at Waterbury, Vermont on the Winooski River would cost an estimated $2,810,000. Annual charges are estimated at $116,000 and benefits at $78,200 giving

a benefit-cost ratio of 0.67 to 1. Although this construction is not economically justified it is considered warranted in view of the hazard to human life and the intangible benefits to be derived from safeguarding the State Hospital at Waterbury, Vermont.

31. Consideration was given to the construction of other reservoirs and local protection works, but the benefits were not sufficient to justify the costs at this time. There are flood control benefits incidental to the land treatment measures and to the reduction of flood damages by a combination of alert forecasting and local planning for mobilization of flood fighting forces. Benefits from land treatment measures would amount to $33,200 by reduction of flood damages in the headwaters and main rivers. Land treatment measures would reduce erosion loss by $117,600 annually at 1949 price levels. Table 26 gives a summary, by drainage basins, of all benefits in Subregion "C".

SUMMARY AND CONCLUSIONS

32. Serious flooding has been experienced on the rivers of Subregion "C". Major flood damages are limited to the Winooski River and Otter Creek, both in the Lake Champlain Drainage Basin, with the greatest losses being experienced along the Winooski River. The estimated flood damages that would be occasioned by

Table 26 - Summary of ultimate flood reduction and erosion control benefits incidental to land treatment
Subregion "C"

Drainage Basin	Flood control projects	Flood reduction	Erosion 1/ control	Total annual benefits
Lake Memphremagog	-	$ 100	$ 3,500	$ 3,600
Lake Champlain	$268,200	29,600	73,300	371,100
St. Lawrence	-	3,500	40,800	44,300
Total benefits, Subregion "C"	$268,200	$33,200	$117,600	$419,000

Based on 1949 price levels.

1/ These figures represent only the net income benefit from elimination of yield decline due to sheet erosion.

a recurrence of the major flood of November 1927 in the Winooski River Basin would amount to $16,109,000 at 1949 price levels. Damages along the main streams and tributaries in the subregion have been largely urban, but appreciable damage to farm lands and to highways and railroads in rural areas has occurred in some localities.

33. Eight flood control projects have been authorized in Subregion "C" on the Winooski, Otter and Lamoille Rivers. The flood control reservoirs constructed in the Winooski River Basin have reduced damages substantially. Projects providing for channel widening and bank revetment on Otter Creek and the Lamoille River are substantially complete and have greatly reduced flood damages.

34. The plan for flood control in Subregion "C" consists of the authorized projects considered warranted for construction in the Winooski River and Otter Creek Basins, and comprises: (1) Modification of three existing dams in the Winooski River Basin at East Barre, estimated cost $3,171,300; at Wrightsville, estimated cost $2,020,000; and at Waterbury, estimated cost $620,000; and construction of local protection works at Waterbury, estimated cost $2,810,000; (2) Construction of flood protection works in Otter Creek Basin at Rutland, Vermont, estimated cost $4,280,000, all at 1949 price levels. The three dam-modification

projects are designed for safety only, no additional flood benefits would accrue therefrom. The flood reduction benefits from the local protection works at Waterbury, on the Winooski River and at Rutland, in Otter Creek Basin, would amount to $268,200. New projects for flood control have been considered, but none have been justified.

35. The inventory power plan for the rivers of the subregion would provide some incidental flood control benefits because of improved stream flow regulation. These benefits have not been estimated.

36. Water flow retardation studies proposed for Lake Champlain Drainage Basin might provide further benefits if investigation shows their construction to be justified.

37. In urban and industrial areas particularly, an economical reduction of flood damages may be obtained by providing a flood forecasting and warning service, coupled with local plans for evacuation and other protective measures. In areas where there is a very short time interval between the onset of rainfall and ensuing flood, it is possible to train a local representative in procedures for issuing warnings based on a special river and rainfall network reporting to him.

38. Sheet erosion is extensive in parts of the subregion. Eroded soil moves into streams, reducing channel capacity and increasing water-treatment costs. Overbank flooding causes more damage than erosion under present conditions and may be expected to become more serious as hydrologic conditions deteriorate. A great portion of the annual erosion damages would be eliminated by installation of the land treatment measures described in Section XI.

DRAINAGE

39. There are two major problem areas in Subregion "C", both in Otter Creek Basin. One involves about 8,000 acres along Otter Creek between Proctor and Middlebury; the other involves 3,000 acres of cropland on Lemon Fair River near Weybridge. These areas should be studied to determine whether or not provisions for drainage are justified. There are also three local problem areas in the Lake Champlain Drainage Basin, which, investigations and studies indicate, are susceptible of improvement through group farm drainage, or, where conditions would be alleviated by any flood control improvements that are provided in the vicinity. There are also three sites in Lake Memphremagog Drainage Basin where drainage relief was found to be not feasible, so that their best use is as wildlife marshes.

SECTION VII - POWER DEVELOPMENT

EXISTING AND UNDEVELOPED WATER POWER

1. General. - The aggregate capacity of the existing water power plants in Subregion "C" was about 316,500 kilowatts as of December 31, 1953. The undeveloped hydroelectric power resources of the subregion, including the St. Lawrence power project, are estimated to amount to about 1,332,485 kilowatts. This estimate of undeveloped potential is based on practical economic and engineering criteria and is comprised of considered projects having a benefit-cost ratio under private financing of 0.60 to 1 or more plus projects under construction. It therefore appears that the total water power resources of Subregion "C" amount to nearly 1,649,000 kilowatts of which about 19 percent is at present (1953) developed.

2. Existing hydroelectric development. - Of the 316,500 kilowatts already developed approximately 285,500 kilowatts or 90 percent are utility installations. The 88 plants in this classification produce on the average about 1,564 million kilowatt-hours annually reflecting a capacity factor of about 63 percent. The remainder of the existing water power plants comprises about 31,000 kilowatts of capacity in 29 stations operated by non-utility establishments. These facilities generate on the average about 142 million kilowatt-hours annually representing a capacity factor of 52 percent. In addition to the foregoing existing developments there are four projects under construction in the Raquette River

Basin by the Niagara Mohawk Power Corporation with a combined installed capacity of 82,000 kilowatts capable of an average annual output of 182 million kilowatt-hours.

3. Existing regulatory storage capacity. - Existing regulatory storage totals about 476,000 acre-feet of which about ~~256,000~~ 262,000 acre-feet is located in the Lake Champlain and Lake Memphremagog Drainage Basins. The Carry Falls Reservoir on the Raquette River, New York (110,000 acre-feet) and Lake George, (85,000 acre-feet) are the subregion's two largest storage reservoirs.

4. Undeveloped hydroelectric power. - Detailed discussions of the subregion's undeveloped hydroelectric power potential appear in Part Two, Chapters XXVI to XXVIII, inclusive. The inventory power plans presented therein include 9 new developments, one redevelopment and additional installed capacity at nine existing plants. These plants, including four projects under construction, would provide additional installed capacity of 392,485 kilowatts, average annual output of 793 million kilowatt-hours, including 32.8 million kilowatt-hours at existing plants without additional installation, and storage capacity of 498,100 acre-feet. All of the projects, except for the 4,800-kilowatt Burlington, Vermont development on the Winooski River, are located in New York State. In addition, the St. Lawrence Power Project would provide, upon completion, 940,000 kilowatts of installed capacity and average annual generation of about ~~6,300,000,000~~ 6,510,000,000 kilowatt-hours (See Chapter XXIX).

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The St. Lawrence Seaway and Power Project as it will appear when completed. Subregion "C".

5. The distribution of the existing and undeveloped hydroelectric capacity among the various river basins is shown in Table 27. Projects now under construction are classified as "Undeveloped" and the capacity loss through inundation of existing plants by new projects has been deducted.

Table 27 - Existing and undeveloped hydroelectric capacity, Subregion "C"

River basin	Installed capacity (kilowatts) Existing	Undeveloped
Lake Memphremagog Drainage Basin	5,950	0
Lake Champlain Drainage Basin		
Great Chazy	3,600	0
Saranac	28,395	74,235
Ausable	4,852	0
Otter Creek	24,405	0
Winooski	23,120	4,800
Lamoille	21,290	0
Poultney	1,886	0
Missisquoi	5,247	0
Bouquet	1,321	0
Lake George Basin	5,920	0
Rivers of St. Lawrence Drainage Basin		
Oswegatchie	38,548	0
Grass	1,200	46,870
Raquette	82,430	266,580
St. Regis	7,745	0
Salmon	4,710	0
Chateaugay	720	0
Totals	261,339	392,485
St. Lawrence Power Project	55,150	940,000
Grand totals	316,489	1,332,485

6. Undeveloped regulatory storage capacity. - The inventory power plans for Subregion "C" would make available additional regulatory storage capacity of 498,100 acre-feet, the three largest reservoirs being Oxbow in the Raquette River Basin (328,000 acre-feet), Clare in the Grass River Basin (79,000 acre-feet) and Union Falls in the Saranac River Basin (51,000 acre-feet). Distribution of existing and undeveloped storage is shown in Table 28.

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Table 28 - Existing and undeveloped storage capacity, Subregion "C"

River basin	Usable storage capacity (acre-feet) Existing	Undeveloped
Lake Memphremagog Drainage Basin	5,500	0
Lake Champlain Drainage Basin		
Great Chazy	14,000	0
Saranac	26,575	90,300
Ausable	25,450	0
Otter Creek	25,364	0
Winooski	35,750	0
Lamoille	28,980	0
Poultney	13,445	0
Missisquoi	1,147	0
Lake George Basin	85,000	0
St. Lawrence Drainage Basin		
Oswegatchie	60,100	0
Grass	0	79,300
Raquette	152,000	328,000
St. Regis	0	0
Salmon	2,620	0
Chateaugay	0	0
Totals	475,931	498,100

7. Detail data on existing and undeveloped water power of Subregion "C" are presented in Tables 29, 30 and 31. Brief summaries of the existing hydroelectric power and storage projects and the inventory power plans for each basin are given below.

8. Lake Memphremagog Drainage Basin. - There are four existing utility hydroelectric plants in the Lake Memphremagog Drainage Basin with a combined capacity of 5,950 kilowatts. Existing usable storage totals 5,500 acre-feet.

Table 29 - Summary of existing and undeveloped hydroelectric power by river basins, Subregion "C"

	Existing projects					Undeveloped projects				
	Utility plants		Industrial plants 1/		Total	New plants 2/		Additions to existing plants		Total
River basin	No.	Installed capacity-kw	No.	Installed capacity-kw	Existing capacity-kw	No.	Installed capacity-kw	No.	Added capacity-kw	undeveloped capacity-kw
Lake Memphremagog Drainage Basin	3	5,950	0	0	5,950	0	0	0	0	0
Lake Champlain Drainage Basin	50	98,130	20	21,906	120,036	5	37,135	4	41,900	79,035
St. Lawrence River Drainage Basin	34	126,273	9	9,080	135,353	9	157,770	5	155,680	313,450
Totals	87	230,353	29	30,986	261,339	14	194,905	9	197,580	392,485
St. Lawrence Power Project		55,150 (Massena Project)			55,150	1	940,000			940,000

1/ Existing mechanical water power installations are not included.

2/ Includes 3 storage and pondage-only projects and 4 projects under construction.

Table 30 - Pertinent data-Undeveloped hydroelectric power projects- Subregion "C"

River basin and project	River	State	Drainage area sq. miles	Gross static head-feet	Maximum drawdown feet	Usable power storage acre-feet	Installed capacity KW	Energy - 1000 Kwh Average Year	Energy - 1000 Kwh Adverse year - 1941	Estimated first costs
Lake Champlain Drainage Basin										
Saranac River Basin										
New projects										
Lower Saranac Lake	Saranac	N.Y.	146	-	-	38,000	0	-		$ 5,616,000
Union Falls 1/	Saranac	N.Y.	329	112	-	51,000	6,335 2/	11,000 2/		9,448,000
Tefft Pond	Saranac	N.Y.	347	238	-	-	26,000	58,100		14,803,000
Redford 3/	Saranac	N.Y.	486	-	-	1,800	0	0		2,972,000
Sub-total						90,800	32,335	69,100		$ 32,839,000
Additional Capacity at Existing Plants										
High Falls	Saranac	N.Y.	496	272	-	-	20,000	37,900		3,618,000
Cadyville	Saranac	N.Y.	575	77	-	-	5,200	11,500		1,448,000
Mill "C"	Saranac	N.Y.	577	66	-	-	4,700	10,200		1,181,000
Kent Falls	Saranac	N.Y.	577	162	-	-	12,000	22,300		2,190,000
Sub-total							41,900	81,900		$ 8,437,000
Additional energy at four other existing plants					-	-	-	2,300		$ 0
Total - Saranac River Basin						90,800	74,235	153,300	95,460	$ 41,276,000
Winooski River Basin										
Burlington	Winooski	Vt.	1,060	54	-	-	4,800	26,500	20,700	$ 2,751,000
Sub-total, Lake Champlain River Basin						90,800	79,035	179,800	116,160	$ 44,027,000

Table 30 (Continued)

River basin and project	River	State	Drainage area sq. miles	Gross static head-feet	Maximum drawdown feet	Usable power storage acre-feet	Installed capacity KW	Energy - 1000 Kwh Average year	Energy - 1000 Kwh Adverse year - 1941	Estimated first costs
St. Lawrence Drainage Basin										
Grass River Basin										
New plants										
Clare	Grass	N.Y.	268	260	50	79,300	25,660	67,434		$ 16,500,000
Jacksons Falls	Grass	N.Y.	329	70	0	Pondage	7,860	24,099		4,300,000
Sub-total						79,300	33,520	91,533		$ 20,800,000
Redevelopments										
Pyrites 4/	Grass	N.Y.	335	130	0	Pondage	14,550	44,610		$ 4,100,000
Less replaced capacity and energy							- 1,200	- 7,500		
Total - Grass River Basin						79,300	46,870	128,643		$ 24,900,000
Raquette River Basin										
New plants										
Oxbow	Raquette	N.Y.	498	-	0	328,000	-	-		$ 10,800,000
Moosehead Rapids	Raquette	N.Y.	784	85	0	Pondage	29,000	66,062		14,500,000
Stark 5/	Raquette	N.Y.	877	105	0	Pondage	22,500	51,000		6/
Blake Falls 5/	Raquette	N.Y.	918	69	0	Pondage	14,400	33,000		6/
Rainbow Falls 5/	Raquette	N.Y.	929	104	0	Pondage	22,500	51,000		6/
Five Falls 5/	Raquette	N.Y.	932	104	0	Pondage	22,500	51,000		6/
Sub-total						328,000	110,900	252,062		$ 25,300,000 8/

Table 30 (Continued)

River basin and project	River	State	Drainage area sq. miles	Gross static head-feet	Maximum drawdown feet	Usable power storage acre-feet	Installed capacity Kw	Energy - 1000 Kwh: Average year	Energy - 1000 Kwh: Adverse year - 1941	Estimated first costs
St. Lawrence Drainage Basin										
Raquette River Basin (Continued)										
Additional capacity at existing plants 7/										
Piercefield	Raquette	N.Y.	722	35	0	Pondage	10,200	19,470		$ 4,600,000
Higley Falls	Raquette	N.Y.	974	42	0	Pondage	12,080	12,500		4,100,000
Colton	Raquette	N.Y.	979	283	0	Pondage	87,400	108,400		29,800,000
Hannawa	Raquette	N.Y.	991	79	0	Pondage	25,200	30,000		4,600,000
Sugar Island	Raquette	N.Y.	995	63	0	Pondage	20,800	29,400		9,900,000
Sub-total						0	155,680	199,770	———	$ 53,000,000
Additional energy at 12 existing plants								32,800		
Total - Raquette River Basin						328,000	266,580	484,632	374,410	$ 78,300,000 8/
Total- St. Lawrence Drainage Basin						407,300	313,450	613,275	472,691	$103,200,000 8/
Total - Lake Champlain Drainage Basin						80,800	79,035	179,800	116,160	44,027,000
Total, rivers of Subregion "C"						498,100	392,485	793,075	588,851	$147,227,000 8/
St. Lawrence Power Project, at International Rapids						———	940,000	6,280,000	———	———

1/ Replaces two existing plants having a total capacity of 4,665 Kw and average annual energy of 15 million Kwh.
2/ Incremental only.
3/ Pondage
4/ Existing plant - 1,200 Kw; 7,500,000 Kwh.
5/ Under construction.
6/ Not available.
7/ Existing capacity and energy equals 47,200 Kw and 295,000,000 Kwh respectively.
8/ Does not include costs of projects under construction.

Table 31 - Physical data-Existing utility and non-utility storage and power projects, Subregion "C"

River basin and project	River	Drainage area (sq.miles)	Gross static head (feet)	Maximum drawdown (feet)	Usable storage (acre-feet)	Installed capacity (kw)	Average annual generation (1000 kwh)	Owner or operator
Lake Memphremagog Drainage Basin								
Utility								
Newport	Clyde	140	140	-	Pondage	3,600	12,000	Citizen Utilities Co.
Charleston	Clyde	107	62	-	Pondage	800	3,000	Citizen Utilities Co.
West Charleston	Clyde	105	78	-	Pondage	1,400	4,500	Barton Village
Norton	Coaticook			-	-	150	-	New Hampshire Electric Coop.
Sub-total - utility plants					-	5,950	19,500	
Non-utility (none)								
Other usable storage					5,500			
Basin Total					5,500	5,950	19,500	
Lake Champlain Drainage Basin								
Great Chazy River Basin								
Utility (none)								
Non-utility								
Lasell	Great Chazy	80	200	-	Pondage	2,400	8,000	The William H. Minor Foundation
McGregor	Great Chazy	79	124	-	Pondage	1,200	4,000	The William H. Minor Foundation
Sub-total - non-utility plants					-	3,600	12,000	
Other usable storage					14,000			
Basin Total					14,000	3,600	12,000	

Table 31 - (Continued)

River basin and project	River	Drainage area (sq.miles)	Gross static head (feet)	Maximum drawdown (feet)	Usable storage (acre-feet)	Installed capacity (kw)	Average annual generation (1000 kwh)	Owner or operator
Lake Champlain Drainage Basin-(Cont'd.)								
Saranac River Basin								
Utility								
Indian Rapids	Saranac	607	14	-	10,000	480	3,000	New York State Electric and Gas Co.
Kent Falls	Saranac	577	162	-	Pondage	6,400	25,000	New York State Electric and Gas Co.
Mill "C"	Saranac	566	66	-	Pondage	2,250	11,500	New York State Electric and Gas Co.
Cadyville	Saranac	560	77	-	Pondage	2,400	14,500	New York State Electric and Gas Co.
High Falls	Saranac	495	272	-	Pondage	8,000	44,000	New York State Electric and Gas Co.
Union Falls	Saranac	329	60	-	11,000	2,400	8,600	Paul Smiths Elec. Lt. and Pwr. & R.R. Co.
Franklin Falls	Saranac	291	52	-	3,440	2,265	6,200	Paul Smiths Elec. Lt. and Pwr. & R.R. Co.
Sub-total - utility plants					24,440	24,195	112,800	
Non-utility								
Plattsburgh								
Plant No. 2	Saranac	608	20	-	Pondage	600	1,600	Imperial Paper and Color Corp.
Plant No. 1	Saranac	606	42	-	Pondage	1,200	7,000	Diamond Match Co.
	Saranac	605	29	-	Pondage	2,400	10,000	Diamond Match Co.
Sub-total - non-utility plants					-	4,200	18,600	
Other usable storage					2,135			
Basin Total					26,575	28,395	131,400	
Ausable River Basin								
Utility								
Lake Placid								
Lake Placid	Chubb	39	36	-	Pondage	332	900	Village of Lake Placid, N. Y.
Rainbow Falls	Chubb	38	16	-	Pondage	300	400	Paul Smiths Elec. Lt. and Pwr. & R.R. Co.
	Ausable	478	92	3	13,650	2,640	15,000	New York State Electric and Gas Co.
Sub-total - utility plants					13,650	3,272	16,300	
Non-utility								
Paper Mill								
Plant No. 1	West Branch	237	90	-	Pondage	1,400	5,500	J. J. Rogers Co.
	Ausable	477	22	-	Pondage	180	500	R. Prescott & Son
Sub-total - non-utility plants					0	1,580	6,000	
Other Usable Storage					11,800			
Basin Total					25,450	4,852	22,300	

Table 31 - (Continued)

River basin and project	River	Drainage area (sq. miles)	Gross static head (feet)	Maximum drawdown (feet)	Usable storage (acre-feet)	Installed capacity (kw)	Average annual generation (1000 kwh)	Owner or operator
Lake Champlain Drainage Basin-(Cont'd.)								
Bouquet River Basin								
Utility								
Meigsville	Black	19	550	-	Pondage	700	3,000	Wadhams & Westport Pwr. & Lt. Co.
Plant No. 2	Bouquet	134	51	-	Pondage	621	700	Wadhams & Westport Pwr. & Lt. Co.
Sub-total - utility plants					-	1,321	3,700	
Non-utility (none)								
Other usable storage					-			
Basin Total					-	1,321	3,700	
Lake George Basin								
Utility								
Port Henry	Mill Brook	28	380	-	Pondage	1,800	5,000	Niagara Mohawk Power Corp.
Ashley	Halfway Cr.	80	66	-	Pondage	680	2,500	Niagara Mohawk Power Corp.
Sub-total - utility plants					-	2,480	7,500	
Non-utility								
Lower Mill	Lake George Outlet	234	30	-	Pondage	430)		International Paper Co.
Island Mill	Lake George Outlet	234	62	-	Pondage	1,310)		International Paper Co.
"C" Mill	Lake George Outlet	234	22	-	Pondage	300)	13,000	International Paper Co.
"B" Mill	Lake George Outlet	234	70	-	Pondage	1,050)		International Paper Co.
"A" Mill	Lake George Outlet	234	32	-	Pondage	350)		International Paper Co.
Sub-total - non-utility plants					-	3,440	13,000	
Other usable storage					85,000			
Basin Total					85,000	5,920	20,500	

Table 31 - (Continued)

River basin and project	River	Drainage area (sq. miles)	Gross static head (feet)	Maximum drawdown (feet)	Usable storage (acre-feet)	Installed capacity (kw)	Average annual generation (1000 kwh)	Owner or operator
Lake Champlain Drainage Basin-(Cont'd.)								
Poultney River Basin								
Utility								
Hydeville	Castleton	40	40	-	10,300	270	400	Central Vermont Public Service Corp.
Carvers Falls	Poultney	184	115	-	Pondage	1,560	8,000	Central Vermont Public Service Corp.
Sub-total - utility plants					10,300	1,830	8,400	
Non-utility								
Fair Haven	Castleton	98	16	-	Pondage	56	-	Fair Haven Slate Co.
Other usable storage					3,145			
Basin Total					13,445	1,886	8,400	
Otter Creek Basin								
Utility								
Bristol	New Haven	47	115	-	Pondage	150	800	Central Vermont Public Service Corp.
Salisbury	Leicester	31	160	-	Pondage	1,300	3,700	Central Vermont Public Service Corp.
Silver Lake	Sucker Brook	9	676	-	1,378	2,200	4,500	Central Vermont Public Service Corp.
Patch	East Creek	51	30	-	Pondage	400	1,000	Central Vermont Public Service Corp.
Glen	East Creek	42	173	-	Pondage	2,000	5,000	Central Vermont Public Service Corp.
Pittsford	East Creek	17	481	37	17,218	3,600	5,000	Central Vermont Public Service Corp.
Vergennes No. 9	Otter Creek	872	40	-	Pondage	1,400)		Green Mountain Power Corp.
Vergennes No. 9A	Otter Creek	872	16	-	Pondage	160)	11,000	Green Mountain Power Corp.
Vergennes No. 9B	Otter Creek	872	35	-	Pondage	1,000)		Green Mountain Power Corp.
Weybridge	Otter Creek	750	33	-	Pondage	3,000	17,000	Central Vermont Public Service Corp.
Middlebury Lower	Otter Creek	629	31	-	Pondage	2,250	7,500	Central Vermont Public Service Corp.
Middlebury Upper	Otter Creek	628	24	-	Pondage	180	900	Central Vermont Public Service Corp.
Middlebury Upper East	Otter Creek	628	20	-	Pondage	160	1,500	Central Vermont Public Service Corp.
Sub-total - Utility plants					18,596	17,800	57,900	

Table 31 - (Continued)

River basin and project	River	Drainage area (sq. miles)	Gross static head (feet)	Maximum drawdown (feet)	Usable storage (acre-feet)	Installed capacity (kw)	Average annual generation (1000 kwh)	Owner or operator
Lake Champlain Drainage Basin-(Cont'd.)								
Otter Creek Basin - (Cont'd.)								
Non-utility								
Huntington Falls	Otter Creek	749	40	-	Pondage	1,200	9,800	Vermont Marble Co.
Beldens	Otter Creek	632	40	-	Pondage	1,200	9,100	Vermont Marble Co.
Proctor	Otter Creek	363	114	-	Pondage	3,930	22,000	Vermont Marble Co.
Center Rutland	Otter Creek	307	27	-	Pondage	275	1,600	Vermont Marble Co.
Sub-total - Non-utility plants					-	6,605	42,500	
Other usable storage					6,768			
Basin Total					25,364	24,405	100,400	
Winooski River Basin								
Utility								
Waterbury	Waterbury	109	148	-	23,000	5,520	15,000	Green Mountain Power Corp.
Moretown No. 8	Mad	143	48	-	Pondage	500	2,000	Green Mountain Power Corp.
Gorge No. 18	Winooski	1,058	34	-	Pondage	3,000	15,000	Green Mountain Power Corp.
Essex No. 19	Winooski	1,043	65	-	1,650	4,800	29,000	Green Mountain Power Corp.
Middlesex No. 2	Winooski	531	52	-	Pondage	3,200	15,000	Green Mountain Power Corp.
Montpelier No. 4	Winooski	195	60	-	Pondage	600	3,000	Green Mountain Power Corp.
Marshfield No. 6	Winooski	23	378	-	Pondage	5,000	8,000	Green Mountain Power Corp.
Sub-total - Utility plants					24,650	22,620	87,000	
Non-utility								
Champlain	Winooski	1,080	38	-	Pondage	500	1,100	American Woolen Co.
Other usable storage					11,100			
Basin Total					35,750	23,120	88,100	

Table 31 - (Continued)

River basin and project	River	Drainage area (sq. miles)	Gross static head (feet)	Maximum drawdown (feet)	Usable storage (acre-feet)	Installed capacity (kw)	Average annual generation (1000 kwh)	Owner or operator
Lake Champlain Drainage Basin-(Cont'd.)								
Lamoille River Basin								
Utility								
Hyde Park	Gilion	56	25	-	Pondage	150	300	Village of Hyde Park
Plant No. 2 (Hardwick)	Nichols Brook	11	116	-	Pondage	460	500	Village of Hardwick
Woods Falls	Lamoille	709	52	-	Pondage	5,000	20,000	Central Vermont Public Service Corp.
Milton	Lamoille	701	100	-	Pondage	6,000	30,000	Central Vermont Public Service Corp.
Clarks Falls	Lamoille	700	42	-	Pondage	3,000	13,000	Central Vermont Public Service Corp.
Fairfax Falls	Lamoille	540	86	-	Pondage	2,880	19,000	Central Vermont Public Service Corp.
Cady's Falls	Lamoille	268	42	-	Pondage	1,300	5,000	Village of Morrisville
Morrisville	Lamoille	240	52	-	Pondage	1,800	7,000	Village of Morrisville
Plant No. 1 (Wolcott)	Lamoille	130	50	-	Pondage	700	2,000	Village of Hardwick
Sub-total - Utility plants					-	21,290	96,800	
Non-utility (none)								
Other usable storage					28,980			
Basin Total					28,980	21,290	96,800	
Missisquoi River Basin								
Utility								
Highgate Falls	Missisquoi	827	59	-	1,147	1,780	10,500	Swanton Village
Plant No. 2	Missisquoi	590	16	-	Pondage	150	2,700	Village of Enosburg
Plant No. 1	Missisquoi	590	21	-	Pondage	600		Village of Enosburg
Parker	Missisquoi	136	10	-	Pondage	192	200	Citizens Utilities Co.
Baker	Missisquoi	102	56	-	Pondage	600	2,000	Citizens Utilities Co.
Sub-total - Utility plants					1,147	3,322	15,400	
Non-utility								
Swanton	Missisquoi	863	10	-	Pondage	175	500	E. W. Bailey
Sheldon Springs	Missisquoi	814	75	-	Pondage	1,750	6,000	Missisquoi Corp.
Sub-total - Non-utility plants					-	1,925	6,500	
Basin Total					1,147	5,247	21,900	
Total - Lake Champlain Drainage Basin					255,711	120,036	505,500	

Table 31 - (Continued)

River basin and project	River	Drainage area (sq. miles)	Gross static head (feet)	Maximum drawdown (feet)	Usable storage (acre-feet)	Installed capacity (kw)	Average annual generation (1000 kwh)	Owner or operator
St. Lawrence Drainage Basin								
Oswegatchie River Basin								
Utility								
Eel Weir	Oswegatchie	1,572	12	-	Pondage	2,700	11,600	Niagara Mohawk Power Corp.
Theresa	Indian	323	68	-	Pondage	1,615	7,400	Niagara Mohawk Power Corp.
Theresa	Indian	323	15	-	Pondage	130	500	Village of Theresa
Philadelphia	Indian	229	20	-	Pondage	128	600	Village of Philadelphia
Philadelphia	Indian	229	55	-	Pondage	500	3,100	Niagara Mohawk Power Corp.
Heuvelton	Oswegatchie	973	14	-	Pondage	1,040	5,200	Niagara Mohawk Power Corp.
Gouverneur	Oswegatchie	745	7	-	Pondage	160	900	Village of Gouverneur
Hailesboro	Oswegatchie	660	30	-	Pondage	1,320	7,200	Niagara Mohawk Power Corp.
Fowler	Oswegatchie	660	15	-	Pondage	900	5,000	Niagara Mohawk Power Corp.
Oswegatchie	East Branch	284	34	-	Pondage	800	6,000	Niagara Mohawk Power Corp.
South Edwards	East Branch	283	82	-	Pondage	2,680	19,600	Niagara Mohawk Power Corp.
Flat Rock	East Branch	263	57	-	Pondage	6,000	17,700	Niagara Mohawk Power Corp.
Browns Falls	East Branch	178	267	-	Pondage	15,000	53,000	Niagara Mohawk Power Corp.
Sub-total - Utility plants					-	32,973	137,800	
Non-utility								
Natural Dam	Oswegatchie	748	20	-	Pondage	1,020	3,500	Rushmore Paper Co.
Emeryville	Oswegatchie	650	32	-	Pondage	1,655	8,000	Rushmore Paper Co.
Harrisville	West Branch	200	34	-	Pondage	520	1,700	Harrisville Paper Corp.
Talcville	East Branch	341	16	-	Pondage	160	240	International Talc Co.
Newton Falls Lower	East Branch	171	21	-	Pondage	680)	12,100	Newton Falls Paper Co.
Newton Falls Upper	East Branch	171	32	-	Pondage	1,540)		Newton Falls Paper Co.
Sub-total - Non-utility plants					-	5,575	25,540	
Other usable storage					60,100			
Basin Total					60,100	38,548	163,340	
Grass River Basin								
Utility								
Pyrites	Grass	335	75	-	Pondage	1,200	-	Niagara Mohawk Power Corp.
Non-utility (none)								
Basin Total					-	1,200	-	

Table 31 - (Continued)

River basin and project	River	Drainage area (sq. miles)	Gross static head (feet)	Maximum drawdown (feet)	Usable storage (acre-feet)	Installed capacity (kw)	Average annual generation (1000 kwh)	Owner or operator
St. Lawrence Drainage Basin-(Cont'd.)								
Raquette River Basin								
Utility								
Raymondville	Raquette	1,131	17	-	Pondage	2,000	12,900	Niagara Mohawk Power Corp.
Norfolk	Raquette	1,066	41	-	Pondage	4,500	25,900	Niagara Mohawk Power Corp.
East Norfolk	Raquette	1,063	31	-	Pondage	3,000	19,400	Niagara Mohawk Power Corp.
Yaleville	Raquette	1,046	14	-	Pondage	725	3,800	Niagara Mohawk Power Corp.
Norwood	Raquette	1,045	21	-	Pondage	2,000	13,100	Niagara Mohawk Power Corp.
Potsdam	Raquette	1,031	9	-	Pondage	150	1,200	Village of Potsdam
Sugar Island	Raquette	995	63	-	Pondage	4,800	30,000	Niagara Mohawk Power Corp.
Hannawa	Raquette	991	79	-	Pondage	7,200	44,800	Niagara Mohawk Power Corp.
Colton	Raquette	979	283	-	Pondage	29,520	159,700	Niagara Mohawk Power Corp.
Higley Falls	Raquette	974	43	-	Pondage	4,480	27,500	Niagara Mohawk Power Corp.
South Colton	Raquette	942	85	-	Pondage	19,350	44,000	Niagara Mohawk Power Corp.
Carrys Falls	Raquette	877	-	35	110,000	-	-	Niagara Mohawk Power Corp.
Piercefield	Raquette	722	35	-	Pondage	1,200	6,500	Paul Smiths El. Lt. & Pwr.& R.R. Co.
Sub-total - Utility plants					110,000	78,925	388,800	
Non-utility								
Yaleville	Raquette	1,046	14	-	Pondage	510	-	Martin Paper Co.
Unionville	Raquette	1,037	17	-	Pondage	1,480	8,900	Raquette River Paper Co.
Hewittville	Raquette	1,036	13	-	Pondage	1,515	8,400	Raquette River Paper Co.
Sub-total - Non-utility plants					-	3,505	17,300	
Other usable storage					42,000			
Basin Total					152,000	82,430	406,100	
St. Regis River Basin								
Utility								
Hogansburg	St. Regis	842	11	-	Pondage	700	3,100	Niagara Mohawk Power Corp.
Allens Falls	West Branch	200	218	-	Pondage	4,400	27,000	Niagara Mohawk Power Corp.
Parishville	West Branch	177	130	-	Pondage	2,400	14,500	Niagara Mohawk Power Corp.
Keese Mills	East Branch	21	18	-	Pondage	245	200	Paul Smiths El. Lt. and Pwr. and R.R. Co.
Sub-total - Utility plants					-	7,745	44,800	
Non-utility (none)								
Basin Total					-	7,745	44,800	

Table 31 - (Continued)

River basin and project	River	Drainage area (sq. miles)	Gross static head (feet)	Maximum drawdown (feet)	Usable storage (acre-feet)	Installed capacity (kw)	Average annual generation (1000 kwh)	Owner or operator
St. Lawrence Drainage Basin-(Cont'd.)								
Salmon River Basin								
Utility								
Macomb	Salmon	183	54	-	Pondage	1,000	6,800	Niagara Mohawk Power Corp.
Whittlesey	Salmon	181	23	-	Pondage	360	2,400	Niagara Mohawk Power Corp.
Chasm Falls	Salmon	126	266	-	Pondage	3,350	24,200	Niagara Mohawk Power Corp.
Sub-total - Utility plants					-	4,710	33,400	
Non-utility (none)								
Other usable storage					2,620			
Basin Total					2,620	4,710	33,400	
Chateaugay River Basin								
Utility								
Chateaugay	Chateaugay	120	88	-	Pondage	720	5,200	New York State Elec. & Gas Corp.
Non-utility (none)								
Basin Total					-	720	5,200	
St. Lawrence River (Main Stem)								
Utility								
Massena	St. Lawrence River	303,000	42	-	Pondage	55,150	529,000	St. Lawrence River Power Co.
Non-utility (none)								
River Total					-	55,150	529,000	
Basin Total					214,720	190,503	1,181,840	
Total Utility Plants in Subregion "C"						285,503	1,564,300	
Total Non-utility Plants in Subregion "C"						30,986	142,540	
Grand Total - Subregion "C"					475,931	316,489	1,706,840	

9. The Coordinated Plan for Lake Memphremagog basin does not include any new storage and power projects. None of the sites investigated in detail met the economic criteria adopted for inclusion in an inventory power plan.

10. Lake Champlain Drainage Basin. - There are 50 existing utility hydroelectric plants in the Lake Champlain basin with a combined installed capacity of 98,130 kilowatts, and 20 non-utility stations of 21,906 kilowatts capacity. The three largest utility plants are High Falls (8,000 kilowatts) and Kent Falls (6,400 kilowatts) on the Saranac River and Milton (6,000 kilowatts) on the Lamoille River. The largest industrial plant is the Vermont Marble Company's plant on the ~~Lamoille River~~ Otter Creek (3,930 kilowatts).

11. Existing usable storage for power and stream flow regulation totals about 256,000 acre-feet of which about 85,000 acre-feet are available in Lake George. Over 60 percent of the total is impounded in Vermont and the remainder in New York.

12. The Coordinated Plan for the Lake Champlain Drainage Basin includes one power project on the Winooski River, Vermont, with installed capacity of 4,800 kilowatts, and five new developments and additional installed capacity at four existing plants on the Saranac River, New York. The plan would increase the available storage for stream flow regulation in the basin by 90,800 acre-feet and provide 79,035 kilowatts of additional installed capacity capable of producing additional average annual generation of

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179,800,000 kilowatt-hours, including additional energy output at existing downstream plants.

13. St. Lawrence Drainage Basin. - There are 35 existing utility hydroelectric plants in the St. Lawrence Basin with an aggregate installed capacity of 181,423 kilowatts and nine non-utility stations with 9,080 kilowatts installed. The St. Lawrence River Power Company, a subsidiary of the Aluminum Company of America, diverts water from the St. Lawrence River through a canal to a 55,150-kilowatt power plant located near the mouth of the Grass River. Other utility plants are Colton (29,520 kilowatts) in the Raquette River watershed and Browns Falls (15,000 kilowatts) in the Oswegatchie River watershed.

14. Existing usable storage in the basin totals about 215,000 acre-feet of which about 110,000 acre-feet is available at Carry Falls reservoir in the Raquette River watershed.

15. The Coordinated Plan for the St. Lawrence Drainage Basin includes (a) one storage and power project, one power-only project and one redevelopment, all in the Grass River watershed; (b) one storage-only project, one power-only project and additional capacity at five existing plants, all in the Raquette River watershed.

16. These projects would increase the basin's available storage by about 407,000 acre-feet, provide 231,550 kilowatts of additional capacity capable of generating about 427,000,000 kilowatt-hours of average annual energy. Four projects under construction in the

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Raquette River watershed by the Niagara Mohawk Power Corporation would add 81,900 kilowatts and about 186,000,000 kilowatt-hours to the above mentioned undeveloped potential. The largest projects in the plan are Colton (116,920 kilowatts) and Hannawa (32,400 kilowatts) on the Raquette River.

17. Existing power supply. - The demand for electric power in the subregion is met by hydroelectric and fuel-electric plants of the utilities serving the area, namely, the Central Vermont Public Service Corporation, Green Mountain Power Corporation and Citizens Utilities Company in Vermont and the Niagara Mohawk Power Corporation, the New York State Electric and Gas Company, and Paul Smiths Electric Light and Power and Railroad Company in New York State. An additional supply of power is available to the subregion by virtue of interconnections maintained with the New England Electric System and the Public Service Company of New Hampshire.

18. Estimated future needs for additional generating capacity. - These needs are discussed in detail in Chapter XXXVIII, Special Subjects, Subregion "E".

19. Possible utilization of the subregion's undeveloped water power. - The possibilities of developing presently unused hydroelectric sites are presented in Chapter XXXVIII, Special Subjects, Subregion "E".

20. Power values. - Power values assigned to the capacity and energy made available by the inventory power plans and other considered

projects have been determined on the basis of the costs of generating equivalent power by privately financed steam plants, these being considered the most likely alternative sources of power in the absence of the hydroelectric projects. The at-site values are equal to the cost of steam-electric generation, plus the cost of transmission from the steam plants to the market, less the cost of transmission from the hydroelectric project to the market, with allowance for losses and other adjustments.

21. Alternative steam generating units have been selected with average size and thermal efficiency appropriate to the market area. Capital costs range from $180. to $220. per kilowatt, depending on size, location and other pertinent factors. Cost of fuel has been estimated at levels varying from 36 to 42 cents per million B.T.U. Assumptions with respect to annual fixed charges for alternative steam plants based on private financing, vary between 10.9 and 11.9 percent of the capital costs.

22. All costs are based on 1949 price levels. For the purpose of this discussion the market for the subregion's undeveloped water power comprises load centers in northern and central Vermont and northeastern New York State now served by the interconnected transmission networks of the Central Vermont Public Service Company and the Green Mountain Power Corporation in Vermont, and the Niagara Mohawk Power Corporation and the New York State Electric and Gas Corporation in New York State. Power values have been computed by

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drainage basins and represent average values weighted in accordance with the capacity and energy allocated to each market area. These values are summarized in Table 32. For a detail discussion of power values and power markets, see Chapter XXXVIII, Special Subjects, Subregion "E".

Table 32 - Composite at-site power values, Subregion "C"

River basin	Power values	
	Capacity (kilowatt-year) (Dollars)	Energy (kilowatt-hour) (Mills)
Lake Memphremagog Drainage Basin	31.75	4.3
Lake Champlain Drainage Basin		
Saranac	30.75	4.0
Ausable	30.50	4.0
Otter Creek	29.75	3.7
Winooski	30.25	3.9
Lamoille	31.00	4.1
Missisquoi	31.70	4.3
St. Lawrence Drainage Basin		
Oswegatchie	29.25	3.2
Grass	29.50	3.3
Raquette	29.50	3.3
St. Regis	29.50	3.3
Salmon	30.00	3.6
Chateaugay	29.25	3.1

23. Basis of cost estimates and annual fixed charges. - The project cost estimates are based on 1949 price levels. They include the cost of dam and power facilities, acquisition of land, reservoir clearing, relocation of existing highways and utilities and construction of access roads with adequate allowance for engineering, overhead and contingencies. The estimates of annual charges are based on private financing. They include (1) a return

of 5.5 percent on the capital investment; (2) depreciation based on a sinking fund accumulating at 5.5 percent over a service life of 50 years; (3) allowance for insurance, and the replacement of major items of property estimated to have a useful life of less than 50 years; (4) Federal, State and local taxes. Federal income taxes are based on the existing 52 percent tax rate, a 5.5 percent allowable rate of return and the projects financed through 50 percent mortgage bonds, and 50 percent equity capital. Annual fixed charges on investment employed in the economic analysis of the subregion's undeveloped water power projects are itemized in Table 33.

Table 33 - Estimated annual fixed charges - Hydroelectric projects, Subregion "C"

Item	Percent of investment
Rate of return	5.5
Depreciation	0.4
Insurance	0.1
Replacements	0.2
Taxes	
Federal (income)	2.2
Federal (miscellaneous)	0.1
State and local, approximately	1.7
Total	10.2

24. Estimated annual operation and maintenance costs. - Annual charges for maintenance and operation vary with the size of the installation. Such charges, including a 25 percent allowance for administration and general overhead, have been estimated to range from $13.75 per kilowatt for plants of 2,500 kilowatt capacity to less than $2.00 per kilowatt for plants exceeding 120,000 kilowatts.

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With respect to storage-only projects annual operation and maintenance costs have been assumed as $20,000 for projects involving up to 50,000 acre-feet capacity with $1,000 added for each additional 25,000 acre-feet of capacity.

25. Comparison of benefits and costs. - The estimated first costs, annual costs and benefit-cost ratios for the inventory power plans of Subregion "C" are shown in Table 34. The estimated power benefits, also shown in Table 34, were derived by applying the composite river-basin unit values, shown in Table 32, directly to the aggregate of the capacities and average year outputs of the inventory plan projects including the additional energy output at existing plants.

Table 34 - Estimated power benefits, costs and benefit-cost ratios - Inventory power plans, Subregion "C"

Drainage basin	Lake Champlain	St. Lawrence	Total
Installed capacity	79,035kw	231,550kw	310,585kw
Average annual energy	179,800,000kwh	427,275,000kwh	607,075,000kwh
Total first cost	$ 44,027,000	$103,200,000	$147,227,000
Annual cost	$ 5,196,800	$ 12,858,000	$ 18,054,000
Annual benefits	$ 3,146,700	$ 8,241,000	$ 11,387,900
Benefit-cost ratio	0.62 to 1	0.64 to 1	0.62 to 1

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26. Summary. - Subregion "C" possesses a water power potential aggregating about 708,974 kilowatts, exclusive of the St. Lawrence River, of which some 316,489 kilowatts have been developed, leaving about 392,485 kilowatts as the undeveloped hydroelectric potential. Benefit-cost ratios for all power inventory plan projects are in a range less than unity, the combined ratio being 0.62 to 1 for all inventory power plan projects. However, the effects of changes i n cost levels for both hydroelectric and alternative steam plants, coupled with other factors which must be considered in supplying future power needs of the region may lead to the ultimate utilization of the subregion's undeveloped water power.

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SECTION VIII - NAVIGATION AND BEACH EROSION

1. This section summarizes navigation and beach erosion problems of the United States portion of the main stem of the St. Lawrence River; the streams tributary to the St. Lawrence in this reach; Lake Champlain and the streams tributary to the lake; and Lake Memphremagog and the streams tributary to it. Detailed treatment of these subjects is contained in Chapter XXIX, Special Subjects, Subregion "C".

ST. LAWRENCE RIVER

2. Navigation. - In the 115-mile reach of the St. Lawrence River here considered, existing facilities are, in general, adequate for the present needs of commercial and pleasure craft. Great Lakes vessels of deep draft go down the river to Ogdensburg, New York. Existing channels and harbor facilities are adequate to accommodate them. There is considerable traffic beyond Ogdensburg moving in vessels small enough to pass through the locks of the canals. Existing natural and improved channels in the river are adequate to accommodate these vessels. The navigation features of the St. Lawrence Seaway and Power Project when completed will provide a channel of 27-foot depth for seagoing vessels. The cost for the navigation features of the project is estimated at $79,218,000. Commerce includes the transportation of coal, petroleum products, pulp wood, grain, timber products, sand, gravel and stone. Lake vessels engaged in traffic to the St. Lawrence River ports are usually adequately served by depths of about 20 feet. Harbor facilities required

consist principally of docks, with adequate depths between channel and dock face and cargo handling equipment. The deepest draft vessels that can pass through the canal locks require depths of about 14 feet. The principal cities along the United States shore of the St. Lawrence River are Cape Vincent, Clayton, Alexandria Bay, Morristown and Ogdensburg, all of which have harbors from which commercial vessels and regularly scheduled ferries operate.

3. The St. Lawrence River forms the boundary between New York State and the Canadian Province of Ontario from Lake Ontario as far as a point near the mouth of the St. Regis River. Below this point the St. Lawrence River is entirely in Canada. In general, navigation in the St. Lawrence River between Ogdensburg and the mouth of the St. Regis River is difficult because of narrow places in the channel and swift currents. With the completion of the St. Lawrence Seaway and Power Project, conditions on this portion of the river will be changed radically. The changes resulting from the construction of the project will undoubtedly stimulate recreational boating, but it is difficult to predict at present what new navigation facilities will be required.

4. Beach erosion. - There are, in general, no serious shore erosion problems along the mainland shores or islands of the St. Lawrence River between Lake Ontario and Ogdensburg, New York.

Levels of the Great Lakes fluctuate irregularly from year to year and from month to month, depending upon the volume of water present and other factors. The range of fluctuation between the lowest and the highest mean monthly level has been 6.61 feet. Under normal lake and river stages little erosion of the shore is experienced since most of the shore at normal level is protected by bedrock or narrow beaches. At higher stages wind-generated waves do attack and erode the bluffs of glacial till above the beach or bedrock. River currents are not a major factor in shore erosion in this vicinity. Ice damage occurs when river levels rise while ice is firmly attached to structures such as pilings or stone-filled cribs. No requests for additional protection of publicly-owned properties have been made by local interests. Beaches presently in use at State parks are considered to be adequate for present requirements of the area. No plan has been prepared for additional beach protection improvements.

LAKE CHAMPLAIN

5. Almost two-thirds of Lake Champlain lies within the State of Vermont, about one-third in the State of New York and about 17 square miles in Canada. The lake has many tributary streams, the principal ones being the Great Chazy, the Saranac, the Ausable and the Mettawee in New York; the Missisquoi, Lamoille, Winooski, and Poultney Rivers, and Otter Creek in

Vermont. The lake forms a part of a series of inland navigable waterways which interconnect the St. Lawrence River, the Hudson River and the Great Lakes. The controlling depth of the waterways leading to the Hudson River and the Great Lakes is 12 feet and to the St. Lawrence River, 6.5 feet.

6. Substantially all of the navigation improvements in Lake Champlain have been provided by the United States, with the exception of dredging of approaches and areas adjacent to wharves which have been constructed by State, municipal and private interests. During the last 20 years, studies for navigation improvements were authorized by Congress at four localities: at Rouses Point, New York; Burlington, Vermont; Otter Creek, Vermont and the channel in the vicinity of Milton and South Hero, Vermont. Reports on the studies were submitted between 1936 and 1942, and all were unfavorable. Existing navigation improvements are generally adequate for the needs of the present and immediately prospective commercial and pleasure traffic.

7. Beach erosion. - The shoreline of Lake Champlain is over 300 miles long. Beaches are generally narrow, and many are completely submerged during high lake level. The shore material consists largely of sandy clay and boulder deposits of glacial origin. The lake shore frontage is largely developed for recreation and is occupied by numerous seasonal dwellings. Protective measures taken against shore erosion including revetments, walls and rip-rap have been generally effective.

8. Navigation. - Navigation on Lake Memphremagog consists entirely of pleasure boating. The principal tributaries, all draining into the southern end of the lake, are the Clyde River, the Barton River and the Black River. These streams are not navigable. Navigation on the lake is generally restricted by ice conditions to the seven months of the year from April to October. There is no existing Federal navigation project for the lake, and none is considered necessary.

9. Beach erosion. - Shore erosion due to ice and wave action constitutes a problem along the lake shore. All of the properties affected are privately owned. Shore erosion control by revetment now carried out by individual owners is the most feasible method of combating further erosion.

SECTION IX - FISH AND WILDLIFE

WILDLIFE

1. Forest wildlife. - The most important game animals of the subregion are the forest-game species. These include the white-tailed deer, black bear, varying hare, ruffed grouse, gray squirrel, and woodcock. Foxes are numerous in some areas and the racoon population has been increasing steadily over the entire subregion. Bobcat hunting is popular among men equipped for such sport.

2. The most valuable member of this group is the white-tailed deer. It is found in all but the more intensely agriculturalized sections of the subregion. Highest concentrations are found throughout the central Adirondacks and the upland of Vermont. Deer are eagerly sought throughout their range, and the number of hunters is increasing steadily. The number of deer hunters in New York State increased from 75,040 in 1930 to 285,782 in 1946, an increase of 381 percent. In spite of the many hunters, under-utilization is common throughout much of the mountain country. In 1950 approximately 5,400 deer were taken throughout the subregion. The greater portion of the subregion is classed as bear range, much of which is particularly well suited to the species, and the annual harvest is estimated to be in the vicinity of 100 animals.

3. The forest and woodland habitat is the most widespread type in the subregion which accounts for the high values attributed to the forest-game species. Of the forest small-game group, the

ruffed grouse and varying hare receive most attention from sportsmen. It is estimated that between 35,000 to 45,000 grouse are harvested within the subregion annually. Hares are eagerly hunted in some segments of the subregion. The estimated kill in Washington County, Vermont, in 1944, was 10,004 hares which illustrates the popularity of the species. It is estimated that about 30,000 hares are harvested annually over the subregion. Gray squirrels are most popular east of Lake Champlain. One of the least utilized of the small-game species is the woodcock. Although harvest potentials are high over much of the subregion, the 1944 kill was estimated to be approximately 4,000 birds. Raccoons and foxes are potentially valuable game animals whose utilization has fallen far short of the supply. Bobcats are not harvested in great numbers, but they do provide much sport for individuals possessing good dogs. In 1944, about 20 bobcats were reported taken west of Lake Champlain, whereas east of the lake, in 1948 and 1949, 64 and 71 bounties were paid, respectively.

3. Agricultural wildlife. - Farm-game species are respresented by the pheasant, Hungarian partridge, and cottontail rabbits. The pheasant is a marginal game bird, shootable numbers of which are maintained only through a stocking program. Cottontail rabbits absorb a significant amount of hunter pressure, and in ,1944 it was estimated that about 20,000 animals were harvested. At present, the St. Lawrence plains area supports the only known significant population of Hungarian partridges in the entire New England-New York area.

About 300 birds were taken during the first open season held recently.

5. Furbearing animals. - Fur animals represent a significant portion of the wildlife values within the subregion. Beaver, muskrats, and mink contribute most of the values. In 1951, about 3,500 beaver were harvested in the subregion. St. Lawrence and Franklin Counties, New York produced about two-thirds of this total. Muskrat concentrations exist along the eastern shoreline of Lake Champlain, St. Lawrence lowland, and South Bay of Lake Memphremagog. The following figures summarize the muskrat take in Vermont over a three-year period: 1950-22,017; 1951 - 44,000: 1952 - 47,680. The combined Lake Champlain-Memphremagog production accounted for the greatest percentage of these. It was estimated that about 12,000 animals were harvested over the New York portion of the subregion in 1944. Following are mink harvest figures for Vermont covering a three-year period: 1950 - 2,182; 1951 - 2,400; 1952 - 1,623. Roughly half of these came from Subregion "C". In 1944, New York yielded an estimated 500 mink in the subregion area. Otters, skunks, and weasels range much of the subregion, but harvest figures are small. Fisher and marten also range the more remote Adirondack Mountains.

6. Aquatic wildlife. - Three outstanding waterfowl areas exist within the subregion. Lake Champlain, possesses a large amount of good habitat, both in New York and Vermont. The St. Lawrence River is important and that segment between Tibbets Point and Chippewa Bay is outstanding for gunning opportunities as well as production of waterfowl. In the aggregate, some of the lakes, marshes, potholes

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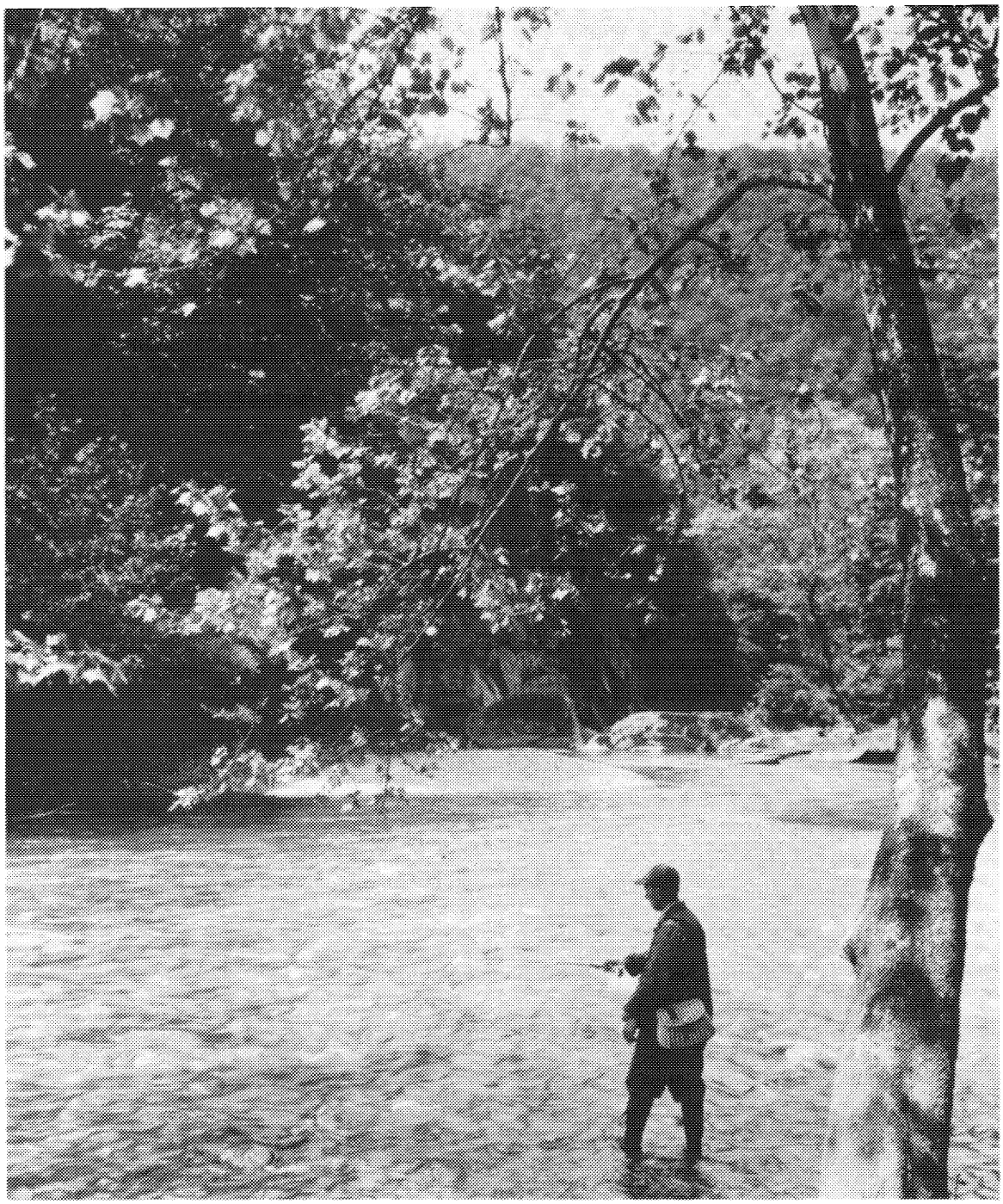
and streams on the St. Lawrence lowland significantly augment the waterfowl values. Although somewhat smaller in size, the Lake Memphremagog Drainage Basin waterfowl values are of considerable importance. In the absence of subregion harvest numbers, State check figures on bag success are presented. Vermont Statewide sample checks made in 1950 revealed that 648 ducks were harvested by 654 hunters and 1,463 ducks were taken by 1,098 hunters in 1951. One sample bag check made in the St. Lawrence River area in 1945 showed that 934 ducks were taken at the expenditure of 288 hunter days. The upland and mountain country holds insignificant waterfowl values.

7. Fishery resources. - Subregion "C" has a large amount of fishable waters. Lake Champlain is prominent for its utilization of fishermen while the St. Lawrence River, the extensive lake system in the central Adirondacks, Lake George and Lake Memphremagog provide an enormous amount of fishing. The subregion is also dissected by many river and streams that are particularly significant from a fisheries standpoint.

8. The subregion presents a wide variety of fish species and fishing opportunities. There is an abundance of both cold-water and warm-water fish habitat. Of the many species represented, brook trout ranks high in preference among many fishermen. Headwaters and feeder streams of practically all the drainage systems offer trout fishing. Generally, trout fishing deteriorates downstream, and as a rule portions of rivers flowing through intense agricultural belts, such as the St. Lawrence and Champlain lowlands, provide poor-



Sport fishing. Stream in mountainous terrain. Subregion "C".

quality brook trout habitat. High caliber habitat is usually found in the higher elevations of the Adirondacks and mountains in Vermont. In addition to brook trout, rainbow and brown trout are widely distributed over the basin and form an important part of the stream fishery.

9. Trout fishing is by no means limited to streams, since a significant number of lakes and ponds also offer good trout and salmon fishing. However, this number does not compare with the multitude of lakes that formerly offered trout fishing. Lakes of the cold-water type were changed through infiltration by warm-water species.

10. The greatest fishery values throughout the entire subregion are centered in fish of the warm-water type. The smallmouth bass, northern pike, pickerel, yellow perch, and walleyed pike are the most important species taken. By far the greatest percentage of lakes and ponds throughout the subregion provide this type of fishing, as do lower segments of most major rivers. Although warm-water fishing does not generally receive the high esteem associated with trout and salmon, fishery of this type has the broadest appeal and receives high utilization. The demand for and pressure on these species is increased considerably by the great number of vacationists that are attracted to this subregion.

ECONOMIC ASPECTS

11. Fish and wildlife resources form an important part of the economic structure of this subregion. They attract a host of resident

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and non resident recreation seekers and stimulate many business activities. Although the fish and wildlife resource has far-reaching beneficial aspects, it is difficult to state its full value in terms of dollars. Perhaps the greatest values, yet the ones most difficult to determine because of their intangible nature, are recreational and aesthetic. Hunter expenditure data are available in some instances which may indicate with some degree of reliability the relative importance of the resources but they do not portray the entire value.

12. Included below is a summary of some sportsmen expenditures available at this time. In most instances, the data are on a Statewide basis and not sufficiently detailed for application to Subregion "C" alone. However, a comprehensive picture of the importance of the resource can be gained from these expenditure figures. It is also recognized that prices have increased markedly since the 1944 Vermont survey, but no attempt has been made to bring the figures in line with present prices.

a. The 1950-51 New York fishing-license sales totaled 723,225 for which the State collected $2,068,019 in fees. For the 1951-52 season, the State collected $1,783,149, for the sale of 794,436 licenses, and in 1952-53 collected $1,789,335 for 798,291 licenses sold.

b. New York hunting license sales in 1951-52 totaled 866,876 for a total of $1,884,427 collected in fees. In the 1952-53 season, $2,081,524 in fees were collected through the sale of 921,987 licenses. During these years, New York ranked among the

Waterfowl habitat with duck blinds for hunters. Lake Champlain. Subregion "C".

first ten of the 48 States in the sale of hunting and fishing licenses.

c. During the 1950-51 season, Vermont collected $408,986 from the sale of hunting and fishing licenses. Of this, 56 percent came from residents and 44 percent from nonresidents, and the 1951-52 total was $445,525, 53 percent of which was attributed to residents and 47 percent to nonresidents.

d. License sales in Vermont for the 1950-51 season in counties coming within the subregion totaled $195,323 and for the 1951-52 season totaled $209,451.

e. Vermont Statewide license receipts have increased from $147,941 in 1937-38 to $445,525 in 1951-52, an increase of more than three times over the 15-year period.

f. The 1944 Vermont game crop was harvested at an expenditure of over $1,300,000. Each deer killed by a resident in that year meant the expenditure of $73 and each killed by a nonresident the expenditure of $227.

g. Expenditures by resident and nonresident fishermen and hunters in Vermont in 1944 approached $5,000,000. Approximately 96 percent of the total expenditure was spent for goods and services from private individuals. The hotelman, restaurant operator, sporting-goods dealer, and service station attendant primarily benefit from the increased volume of business.

13. A portion of the fur value for the basin can be determined quite reliably. Because of the close check kept on beaver harvested over the subregion, a reliable annual value can be determined. In recent years, this beaver value has been about $64,000 annually. No

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computations have been made to include other fur animals, but it is felt that these values would substantially increase the beaver figure particularly since Lake Champlain, Lake Memphremagog, and the St. Lawrence lowland produce many muskrats.

NEEDS AND DEVELOPMENT OF THE FISH AND WILDLIFE RESOURCES

14. Management of the fish and wildlife resources indigenous to Subregion "C" and enforcement of regulatory laws are functions of the Fish and Game Service of Vermont and the Division of Fish and Game of New York State. Detailed research, generally extending over a prolonged period, usually precedes the formulation of management regulations. Many problems have developed in conjunction with expanding industry and growing population. Water systems, lakes and rivers have suffered through pollution and dam construction. Land-use practices in the fields of forestry and agriculture have been, in many instances, damaging to the resource. Drainage projects have accounted for the loss of much valuable habitat as has wetland filling. Undesirable fish populations and species have often resulted from the introduction of non-indigenous species.

15. Wildlife resources. - Subregion "C" is noted principally for its forest-game production, with game production throughout the agricultural regions being of lesser importance. Management and development of most of the wildlife resources in the subregion is closely related to pulpwood and saw timber production. To date, the major portion of forest habitat improvement has come about with no

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particular emphasis on its improvement; rather, it has been incidental to timber cutting. Game managers have long been aware of the beneficial aspects following timber harvesting, and it is possible that additional benefits could be derived through the use of modified forestry methods that could be practiced in the field of commercial forestry. If the improvement of forest wildlife habitat is to succeed on a wide scale, the importance of such a program should be emphasized.

16. Deer.-- New York and Vermont have made significant progress in managing and developing the fish and wildlife resources of the subregion. Of the wildlife group, deer have received most attention. The harvest is closely regulated by season length, legal limit, and sex of the species to be harvested. Widespread surveys of winter range conditions have been made over large segments of the subregion. It has long been recognized that much of the range, particularly winter range, is taxed beyond its deer-carrying capacity. It was found that winter mortality, due to starvation, has varied from year to year with the severity of the weather. Critical conditions appear to develop with snow depth of 20 inches or more. In the Adirondacks it was observed that the breeding potential of deer is below that of deer in the southern New York range, and it has been suggested that the quality of available food on the Adirondack range may be a contributing factor in this breeding disparity. The situation is further aggravated by the present law in both States that allows only the bucks to be taken within the area of the subregion.

17. The needs of deer in these critical areas can best be met by management of both deer and habitat. Under present conditions, deer management is primarily a problem of population management. State officials have long recognized the necessity for open seasons on antlerless deer from time to time, particularly in areas where a surplus occurs, such as in the mountain country, and New York has opened the season on antlerless deer in certain parts of the Adirondacks in 1954. In the low foothill country on the fringe of the Adirondacks the control of year-round hunting may be a problem. Habitat capable of supporting a significant deer population exists over much of this area which, at present, is all but devoid of deer. Out-of-season hunting probably contributes to this situation. Overcoming the general disregard that the hunter has for the law and the apathy the remaining population has towards law enforcement is a difficult task, but one necessary for the proper management of the deer herd.

18. A study should be made of the deer herd on the Adirondack fringe or foothill country. There is a need for data in order that proper consideration may be given to the problem from which specific management techniques may be forthcoming.

19. Types and effects of land ownership. - One of the principal problems in the Adirondacks confronting game officials in determining proper management techniques for thedeer herd is the extensive blocks

of private lands and parks throughout the entire mountain region. Many large areas are at the present time held in private ownership open to hunting by club members, or, as in some cases, closed entirely to hunting. It is unfortunate that hunting is limited to such a degree for the insufficient annual kill of deer results in a perpetuation of poor range conditions and heavy losses of deer during severe winters. Other game species as well as fish are also underutilized.

20. The areas being held in a wilderness condition by New York also present a problem in proper utilization of the fish and wildlife resource. Large blocks of land are being held in a more or less inaccessible state, with little or no road development taking place to improve accessibility. Timber cutting is accomplished only in special situations such as blowdowns, with the result that little forest game habitat is improved. The status of these wilderness areas should be reviewed with a view towards further utilization of the resources.

21. In general, the interests of the timberland owner and operator are not compatible with the State's public hunting interests. In most cases, the wood products are the only consideration, and game species, a by-product of the forest, are given only passing consideration, mostly to the extent of leasing holdings to private clubs which in turn exclude the average hunter.

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Resolving existing difficulties would greatly benefit the public as regards the availability of hunting and fishing areas.

22. Forest small-game. - The principal problem concerning the forest small-game species appears to be one of insufficient harvest and not one of maintaining suitable numbers. In the Adirondacks, the restrictions imposed by private holdings and the inaccessibility of some public lands increases the difficulty by leaving much woodland unhunted. However, there are many accessible State-owned lands and open hunting areas in this mountainous region that are also underhunted. Grouse hunting has a large following but in the Adirondacks this is done mostly outside the extensively forested mountainous regions. East of Lake Champlain, grouse are more heavily utilized. The same also holds true for the varying hare, which receives limited attention west of the lake, while to the east of the lake interest and utilization run high. Populations of both species apparently are maintained adequately over most of the subregion. A factor in maintaining this population comes about as a result of general forestry practices, for these small-game species do not readily lend themselves to intensive management, principally because of the vastness of such an undertaking. However, it has been shown that indirect methods, such as forestry practices that benefit deer also benefit small-game species such as grouse, varying hares, and, in some instances, woodcocks. Some additional benefits would probably accrue from modifications of standard forestry practices designed

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expressly to benefit forest game species but, in general, present handling of forest lands throughout most of the subregion appears to favor these various species.

23. Pheasant. - In trying to maintain suitable pheasant populations over areas within the subregion, the States have been faced with the problem of inadequate and insufficient habitat. As a result, where the species does exist, its position is marginal and dependent upon constant stocking. Some time ago, Vermont recognized the difficulty and expense in maintaining an adequate population in the agricultural belt along Lake Champlain and abandoned its system of stocking artificially raised birds. New York has a continuing program of pheasant stocking even though land use practices are not compatible with the production of a suitable game crop either along Lake Champlain or on the St. Lawrence lowland. Considering the expense involved in raising pheasants, and the overall marginal situation, some thought should be given to discontinuing this program in the subregion.

24. Waterfowl. - There exists an intense interest in waterfowl throughout certain segments of the subregion. These are the St. Lawrence and Thousand Islands area, Lake Champlain, and Lake Memphremagog. These and contiguous areas have been rather extensively surveyed to determine waterfowl utilization or potentials for development. The New York-Ontario-St. Lawrence Waterfowl Investigation, completed in 1948, and the New York-Lake Champlain Waterfowl Investigation, completed in 1949, are fine examples of detailed

surveys of this type. In 1951 and 1952, Vermont made an island nesting study of black ducks on Lake Champlain, and also expanded their wood-duck nesting box program to 100 boxes from the original 30. Result of the surveys indicated that marsh improvement measures would be worthwhile. Improvement of habitat would include impoundments to raise or stabilize water levels or to create new marshes. Impoundments and ditching, including pot-hole formation, seem to be the management methods holding greatest promise on the St. Lawrence lowland.

25. One of the principal problems associated with waterfowl in Lake Champlain and the areas directly associated with the lake and dependent upon it for its water is that of water levels. Substantial habitat acreages become of extremely limited value to waterfowl as the level of the lake begins to drop. Usually this coincides with the critical waterfowl periods when demand for habitat is high. Stabilization of water levels within the marsh areas would render large benefits to waterfowl along Lake Champlain. Private shooting areas as well as open shooting grounds exist along the eastern shoreline of Lake Champlain that have not been improved although they possess oustanding potentials. The acquisition of additional public marshland for the purpose of establishing a chain of refuges along the lake and the maintenance of controlled public shooting areas would be a desirable feature in the overall waterfowl development program in the Lake Champlain valley.

26. The need for State-owned waterfowl areas open to public hunting is becoming ever more critical in the waterfowling areas in the subregion. The turnover of property ownership is bringing on more posting, and owners of areas utilized by waterfowl are leasing hunting rights to clubs or selling them outright. Waterfowl hunting opportunities are becoming fewer for the average licensed hunter. Vermont and New York have acquired waterfowl areas near Lake Champlain that possess important development potentials. The Vermont developments are the Little Otter Creek Waterfowl Management Area, Dead Creek Waterfowl Management Area, and Richville Waterfowl Management Area, and those in New York are Lake Alice, Ausable Marsh, and Wickham Marsh, the latter being leased by the State. These areas are to be developed with a view towards increasing waterfowl utilization and providing additional public shooting grounds.

27. The Missisquoi National Wildlife Refuge and the Sandbar Waterfowl Refuge on Lake Champlain are two outstanding waterfowl areas in the subregion on which improvement work is being carried on. The principal development on Sandbar has been aimed at water-level stabilization through a system of diking. Results thus far have been very successful since the controlled water levels have made usable much habitat that would ordinarily not be available. Also, the stabilization of water levels has caused the establishment of desirable vegetative forms preferred by waterfowl and muskrats, while replacing the less desirable species. At the present time, a considerable amount of timber cutting is taking place on the Missisquoi Refuge for the purpose of providing more cleared area.

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28. The State of New York has proposed a refuge system for the St. Lawrence lowland in which the establishment of two large refuges was recommended in addition to several small refuges scattered through the region. Of the several management possibilities on this lowland, an enlarged system of refuges appears to be of primary importance. Second in priority is the improvement of habitat conditions. Ten small marsh areas, averaging seven to ten acres in size have been completed. Plans include the development of 60 pot-holes in an attempt to increase numbers of waterfowl species, such as pintails, redheads, and gadwalls.

29. As a result of concern about the loss of wildlife habitat through the increased rate of wetland drainage, fill, and pollution, the U. S. Fish and Wildlife Service has undertaken a program of integrated land-use planning, wherein the wildlife use of wetlands fits into a plan including all other economic uses of these lands. As an early phase in the development of that program, a Nationwide inventory of wetlands resources was initiated by the Service, in cooperation with the various States and the Soil Conservation Service of the Department of Agriculture. Because of time factors, a complete survey could not be made, and it was agreed that 90 percent of each State's wetland areas considered most important to waterfowl would be inventoried. Recently completed was the survey of the sub-region. To date, the program has not progressed beyond the inventory status. However, plans are now being developed for a more complete study of the wetlands of this and other areas.

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30. Development of fur-animal habitat, principally for muskrats, is usually coincidental with development of waterfowl areas. Both thrive in much the same type habitat. However, there are many small wetland areas in the subregion that could be improved and made productive of muskrats at very little cost.

31. Public relations have proved difficult on some segments of the sub-region particularly in the matter of a policy or program beneficial to fish and wildlife. Enforcement of the game laws has been difficult in some areas. Perhaps the most difficult problem concerns opening up large areas that are presently in private holdings in the Adirondacks where opportunities exist for habitat development and resource management. Conservation officials are reluctant to expend public funds for developing better hunting and fishing on areas where free public use is discouraged. On the other hand, private clubs and organizations seldom have the personnel or facilities to establish improvement programs for these resources.

32. Fishery resources. - There is an intense demand for trout throughout the greater portion of the subregion in remote areas as well as within the more accessible areas around the large population centers. Greatest fishing pressure exists in the latter situation. Since the subregion embraces some of the most attractive recreational country in the northeast, a host of non-residents swell the fisherman ranks. The attempt to satisfy the demands of these anglers presents one of the major fishery problems over the subregion. The maintenance of trout fishing throughout much of the subregion is dependent upon

a broad stocking program and already a large portion of the money expended in conservation departments in both New York and Vermont goes for propagation of fish. Much of the success of the program can be attributed to the cooperation of many fish and gun clubs for their assistance in making plantings.

33. Biologists of the Branch of Game-Fish and Hatcheries of the U. S. Fish and Wildlife Service surveyed a number of trout streams and ponds in the Green Mountain National Forest, Vermont. The waters surveyed are in a drainage adjacent to Subregion "G" with comparable stream habitat in many areas. Information gathered on mountainous headwater streams may also be applicable to streams of the same type in the Adirondacks.

34. The survey showed that the trout themselves created the worst problem because of overcrowding populations of small-sized fish. It was found that trout in these streams were reaching maturity and breeding at a small size. Almost one-third of the three-inch class were mature; over 80 percent of the four-inch class and about 94 percent of the five-inch class were in breeding condition. Beginning with the four-inch size group, the major portion of all fish taken were mature and able to sustain the population. Where a large number of fish mature at a very small size before reaching legal size, there is a pyramiding population with few trout being removed by fishermen.

35. Because of the inability of many of the mountain streams to produce legal-size fish in a significant quantity, they have become known as "Small Trout" streams. Natural conditions place several

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barriers in the way of good trout production. The gradient, for instance, may be steep and cause severe and damaging scouring during periods of high runoff during which time food organisms are destroyed, as are other desirable habitat features. Some streams may also be deficient in basic nutrients, particularly those that flow through areas of granite formations. However, many of the feeder streams in the subregion flow through limestone areas and are generally rather rich in nutrients. The water itself may often be too cold for good growth. Fishery regulation and management on these streams poses a challenge for remedies are not easily applied. Perhaps New York may be taking a step in the right direction with the enactment of recent legislation pertaining to legal-size limits in problem streams. This legislation will soon make it possible to lower the legal size limit in problem streams in certain areas of the Adirondacks. This regulation should increase utilization.

36. The once important lake trout and brook trout fishery over much of the subregion, particularly in the Adirondacks, declined to a position of mediocrity in many bodies of water while in other situations the value of the fishery is completely gone. This condition prevails in hundreds of lakes and ponds throughout much of the Adirondacks. The introduction of competitive species caused the downward trend in trout sand salmon fishery at about the turn of the century and ultimately resulted in the loss of the fishery in many trout

and salmon lakes and ponds. Much of the damage was accomplished by fishermen while dumping the contents of their live bait pails into various bodies of water, after which a phenomenal spread and invasion of connecting waters took place. Spite stocking may also have occurred. The problem of the bait pail has been outstanding since the period of contamination began. Trout waters are still being invaded and lost. Yellow perch are the most troublesome fish at the present time in the Adirondacks, but bass and walleyes are also widespread. Hordes of stunted introduced species that are generally poorly adapted to the type of ponds prevailing in the Adirondack area and which, in many cases, fail to provide a tolerable substitute for the angler for the trout that have been displaced. In the larger lakes of the central Adirondacks, the bass fishery has become extremely important and is in particular demand among the summer residents. Since a large share of the annual income of the area is dependent upon these vacationists and transients, efforts in fishery management are directed towards satisfying these demands for bass and other warm-water fish. This amounts to the problem of managing cold-water lakes and ponds for the production of warm-water species.

37. The restoration of trout fishing in the Adirondacks is meeting with success through the pond reclamation program. In order to protect reclaimed ponds and other remaining brook trout waters, recent legislation has made it unlawful to fish with bait fish alive or dead, in the vicinity of these ponds.

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38. Significant advancement in the management of the fishery resources of the subregion have been made. Biological surveys have been made of many lakes, ponds and streams for the purpose of formulating sound fishery management programs. These data formed the basis for classifying waters as to the species best suited to them. However, the fishery picture has changed considerably since the early 1930's when the initial survey was made in New York, and through investigational work management programs have been altered considerably since that time. In order to augment the early surveys and to keep abreast of changing conditions, plans have now been made for a new survey in New York to fill gaps and provide more adequate coverage of problem areas. To insure the continuance of public fishing, New York has acquired perpetual fishing rights to many miles of the best fishing streams in the subregion. Important mileage for fishing has been acquired on the Grass, Little Salmon, St. Regis, Oswegatchie, Deer, Chateaugay and Big Salmon Rivers.

39. There is need for further fishery research over much of the subregion, particularly on the big lakes in the Adirondacks, before a sound fishery management and development program can be formulated. Since it appears that warm-water species are to stay in many of the cold water lakes, methods of management must be developed. Research on Lake Champlain, such as is presently being carried on by Vermont, should be continued and expanded.

40. Dams on the watershed can be either beneficial or detrimental. On many of the streams, they are particularly beneficial in acting as

barriers to undesirable species. The case of dams situated near the mouths of rivers short distances from Lake Champlain may illustrate beneficial effects, since such dams prevent the ascent of undesirable species into trout waters. On the other hand, dams may be detrimental in that they may limit the movement of spawning fish. Dams at Swanton on the Missisquoi and at Ogdensburg on the Oswegatchie illustrate the barrier effect of dams by restricting the movement of walleyes. The function of the dam at Ogdensburg is twofold, for it also restricts the upstream movement of the undesirable carp. Perhaps the earliest and most extensive damage took place when anadromous species were first denied the use of the large St. Lawrence River tributaries by the construction of downstream dams. Great Atlantic salmon runs once occurred over much of the subregion. Impoundments behind dams have in some instances caused the loss of segments of trout streams while creating habitat unsuitable for trout in the pool and restricting the movement of fish in the vicinity of the reservoir.

41. Early dams supplying power for the many small streamside mills did little to regulate the flow of water in a stream, since the power was used at its source and no attempt was made to store water over any extended period. In most cases, these dams and ponds were small and were drawn down daily so that the effects of these structures were primarily those of barriers. Present-day power installations demand large storage reservoirs capable of impounding waters over extended periods. During the hours when power demand is

negligible, waters may be cut off completely, resulting in the drying of stream beds and destruction of fish habitat. To illustrate, the dam at Newton Falls on the East Branch Oswegatchie River is operated so as to cause wide fluctuations in downstream water levels and at times the stream bed is dry for some distance below the dam. There is little or no fish production in this reach. The same conditions exist at Cranberry Lake, where, in recent years, many trout have been lost in the outlet during periods when the water flow was shut off. Cranberry Lake ~~These~~ and many other storage dams in New York are controlled by commissions or boards whose members are appointed by the State, but the State Conservation Department has no control over their operation and no provision is made for minimum flows below these storage reservoirs for the purpose of preserving fish habitat. Another method which dried up a river bed is the use of a penstock or canal bypassing a segment of stream and leading water to a point where the power head could be increased. The old plant at Brown's Falls on the Oswegatchie River illustrates this method. These diversions leave a reach of the original riverbed dry and unproductive.

42. There are opportunities for improvement work on some streams in the subregion. Over much of this area the major stream improvement problems generally are holding the water temperatures down and counteracting the effects of erosion insofar as possible. Standard stream improvement techniques could be employed to advantage. Other standard stream improvement techniques such as bank stabilization, building deflections and the provision of cover could be employed

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to advantage throughout much of the subregion.

43. Effects of pollution. - Pollution within the subregion does not seriously affect the fish and wildlife resources. Pollution of a domestic and industrial nature exists on a rather wide scale, but most of the water is of a quality suitable to provide habitat for fish and wildlife. Severe conditions are more of a local nature but low flows and high temperatues may at times create problem areas along significant reaches of streams. The problem does not warrant primary consideration from the standpoint of fish and wildlife, but the institution of abatement processes would be a benefit to the fish and wildlife resources.

COORDINATION WITH OTHER LAND AND WATER DEVELOPMENT PROGRAMS

44. Power. - Development of the water resources for power generally involves impounding large bodies of water, particularly in the case of storage reservoirs, which have a great influence on fish and wildlife resources. In the case of the large storage and stream flow regulation reservoirs extensive land areas and much stream mileage is usually inundated. Wildlife losses are usually high; greatest harm generally being done to deer, since wintering habitat is usually most suitable in low basins and bottomland areas along rivers. In some areas, the central Adirondacks, for example, the loss of an important yard can deal a critical blow to a great number of deer during a severe winter. Also very important is the permanent loss of high quality trout water following construction

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of upstream reservoirs and the barrier effect on the free movement of fish posed by dams. In addition to long stream segments lost through inundation reservoirs may develop populations of warm-water fish that could disperse into trout streams above, as well as below, the reservoir. Fluctuations within the reservoirs may have a detrimental influence on fish productivity within the pool, and by shutting off flows below dams, destroy stream habitat for fish and aquatic fur-bearers alike. The use of penstocks or conduits can cause extensive damage to the fishery resource, particularly when used in series such as are found in the power development plans for the Adirondacks. The "in unison" method of operating these series of projects, which are either connected by or have long penstocks, would presumably by-pass and de-water long segments of stream bed. Within these reaches fishery values would be completely lost.

45. There are few if any prospects of mitigating wildlife losses at power projects. The method of operation precludes the development of terrestrial habitat within the flow line and only infrequently may an opportunity present itself for the development of a marsh area or a small stable-level sub-impoundment for waterfowl. Such developments involve the construction of low water control structures within or adjacent to the reservoir area. Mitigating fishery losses may also be difficult because of the priority claim on water by power. The provision of minimum flows at all times below dams and in segments of streams by-passed by penstocks would do much to preserve stream fishery values. Also, minimizing

fluctuations within reservoirs would benefit the fishery resource. Overall, power development in the subregion would cause considerable damage to the fish and wildlife resource.

46. Flood control. - Projects designed expressly for the purpose of controling flood flows may not always be harmful to the fish and wildlife resource. Principle objections may often be to the barrier effect of the dam and loss of short stream segments if a minimum pool is held. However, quite often these dry bed reservoirs present opportunities for development and intensive management of the wildlife resource which may increase values above those of the pre-project period.

47. Plate 2 shows the effects that power and flood control projects would have on the fish and wildlife resources. The map contains a brief legend but included below is a more complete legend to be used in interpreting the effects of power and flood control developments on the fish and wildlife resource.

Reservoir areas shown in red. Severe losses to fish and wildlife resources generally, or severe losses to areas of special importance to either fish or wildlife resources.

Reservoir areas shown in brown. Significant losses generally, or severe damages to fish and wildlife resources on small areas and areas of less than first-rate importance.

Reservoir areas shown in green. Only moderate losses to fish and wildlife generally or damages to only one element of fish and

wildlife resources of average quality. Also included are projects wherein losses are identified with a reduction in potential.

Reservoir areas shown in dark blue. Slight effect insofar as fish and wildlife resources are concerned, or wherein benefits and losses, although considerable, would counterbalance.

Reservoir areas shown in orange. Effects generally of a beneficial aspect with a wide range of degree, or presenting development potentials that could significantly increase the fish and wildlife resource values on the areas immediately affected by the project. Generally, flood control projects offer most possibilities.

48. The map depicting the effects of power and flood control developments on fish and wildlife cannot be regarded as affording a precise evaluation. The degree of losses indicated represent judgment decisions as to the total effects on fish and wildlife resources after considering all factors, including whatever benefits may accrue to fish and wildlife in the post-development period.

49. Land management. - Land use and fish and wildlife interests are closely associated in natural resources development in the subregion since the improvement of land use generally benefits the fish and wildlife resources. Practices such as stream bank erosion control, allowing marginal lands to revert to woodland, the improvement of grassland pasture, contour strip cropping and the maintenance of a protective grass cover benefit the fish and wildlife resources.

Of major importance is the treatment of the forests in the subregion since the wildlife wealth of the area is centered in the forest game group. Forest habitat is improved by timber stand improvement, proper cutting practices, tree planing and disease and insect control. Livestock grazing in woodland is usually very damaging to forestry interests as well as forest wildlife habitat, and fencing woodland pasture areas so as to limit grazing would be very beneficial. The farm pond building program also provides distinct benefits to fish and wildlife as do other provisions in land management programs such as the construction of shallow water impoundments and improvement of habitat for terrestrial wildlife species.

50. Insect control. - Certain types of insect control measures, such as spraying and ditching, can have deleterious effects on fish and wildlife either directly or indirectly, by damaging the plant and animal life on which fish and wildlife depend. In the case of spraying, the dosage per acre and location of spraying are the important factors, and they should be under the supervision of a competent entomologist. Competent biologists should also be consulted. In the case of ditching and drainage practical experimentation in other areas has shown the possibilities of fish and wildlife-insect control coordination. Research and consultation should develop techniques that will effect a reasonable degree of insect control without undue adverse effects upon fish and wildlife.

51. Drainage. - There are but few possible drainage projects within the subregion. However, since none of these would drain marshes or other wetland areas having actual wildlife values or possessing habitat development potentials, the effects on the resource would be negligible. Drainage projects would be minor engineering undertakings, associated for the most part with small agricultural units.

52. Navigation. - Navigation improvements would have little effect on the fish and wildlife resource.

FISH AND WILDLIFE PLAN

53. In the chapters on individual basins in Subregion "C", the broad outlines of comprehensive fish and wildlife plans are discussed. Some of the items in these plans are already well-established procedures in the programs of the State fish and wildlife agencies, as well as the programs of other agencies concerned with fish and wildlife. Others are in an experimental stage, but have a potential for more widespread application when techniques have been refined. A third class includes items that are purely future possibilities at this time. There is an inherent variability in the details of the fish and wildlife plans for the various basins of this subregion. Adequate summation on a subregional basis is difficult. In general terms the features of the fish and wildlife plan embrace:

a. Provision of increased public access to productive fish and wildlife habitat areas.

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b. Continuation or institution of public information programs on conservation, particularly with regard to sportsman-landowner relations.

c. Continuation of research, both basic and applied, into the many pressing fish and wildlife problems.

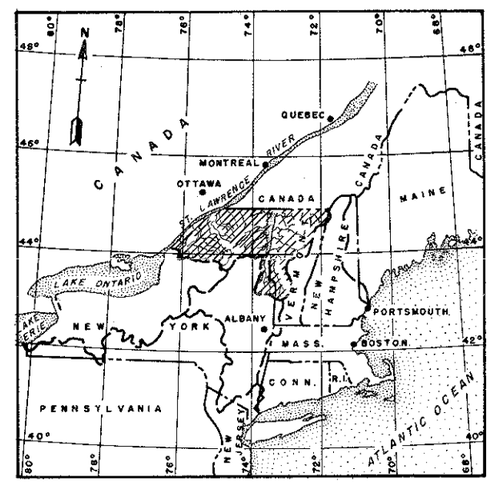
d. Improvement of fish and wildlife habitat including abatement of pollution.

e. Improvement of wetlands for waterfowl and other wildlife.

f. Expansion of lake and pond fisheries management.

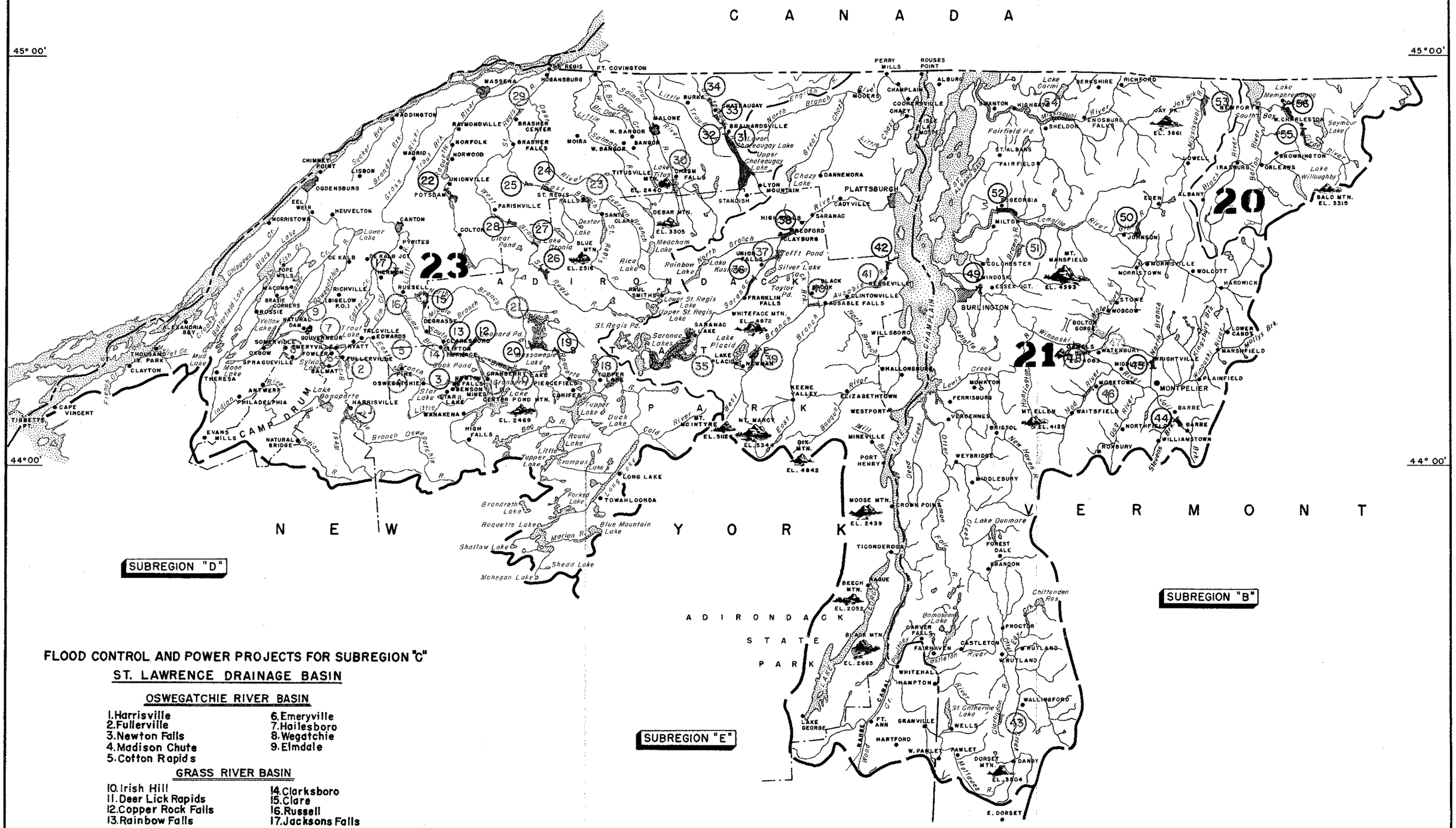
g. Revision of regulations where they are not adapted to the requirements of the present day fish and wildlife conditions.

h. Improvement of stocking practices for both fish and wildlife, according to the most up-to-date management principles.



LOCATION MAP

SCALE IN MILES



FLOOD CONTROL AND POWER PROJECTS FOR SUBREGION "C"

ST. LAWRENCE DRAINAGE BASIN

OSWEGATCHIE RIVER BASIN

1. Harrisville
2. Fullerville
3. Newton Falls
4. Madison Chute
5. Cotton Rapids
6. Emeryville
7. Hailesboro
8. Wegatchie
9. Elmdale

GRASS RIVER BASIN

10. Irish Hill
11. Deer Lick Rapids
12. Copper Rock Falls
13. Rainbow Falls
14. Clarksboro
15. Clare
16. Russell
17. Jacksons Falls

RAQUETTE RIVER BASIN

18. Oxbow
19. Burnt Island
20. Moosehead Rapids
21. Jordan
22. Hewittville

SAINT REGIS RIVER BASIN

23. Saint Regis Falls
24. Nicholville (Upper)
25. Fort Jackson
26. Five Mile
27. Sylvan Falls
28. Parishville (Upper)
29. Brasher Center (Lower)

SALMON RIVER BASIN

30. Titusville

CHATEAUGAY RIVER BASIN

31. Brainardsville
32. South Chateaugay
33. Chateaugay Mill
34. Chateaugay Chasm

LAKE CHAMPLAIN DRAINAGE BASIN

SARANAC RIVER BASIN

35. Lower Saranac
36. Union Falls
37. Tefft Pond
38. Redford

AUSABLE RIVER BASIN

39. Cherry Patch Pond
40. Rome
41. Keeseville
42. Alice Falls

OTTER CREEK RIVER BASIN

43. Tinmouth

WINOOSKI RIVER BASIN

44. East Barre
45. Wrightsville
46. Moretown
47. Waterbury
48. Bolton Gorge
49. Burlington

LAMOILLE RIVER BASIN

50. Gihon
51. Browns River
52. East Georgia

MISSISQUOI RIVER BASIN

53. Jay Branch
54. North Sheldon

LAKE MEMPHREMAGOG DRAINAGE BASIN

55. Pensioner Pond
56. Salem Pond

SUBREGION "C"
INDEX TO BASINS

20 LAKE MEMPHREMAGOG DRAINAGE
21 LAKE CHAMPLAIN DRAINAGE
23 ST. LAWRENCE RIVER DRAINAGE

LEGEND

SEVERE LOSSES
SIGNIFICANT LOSSES
MODERATE LOSSES
NEUTRAL
BENEFICIAL

EFFECT ON FISH AND WILDLIFE OF HYDROELECTRIC AND FLOOD CONTROL DEVELOPMENTS FOR SUBREGION "C"

NEW ENGLAND NEW YORK INTER-AGENCY COMMITTEE

NOVEMBER 1954

SCALE IN MILES

D. OF I., F. & W. SERV., NOV. 1954

PLATE 2

CHAPTER XXV

SECTION X - RECREATION

LAND AND WATER RESOURCES OF RECREATIONAL VALUE

1. Subregion "C" has many natural features of superior or exceptional recreational value, including major portions of the Green and Adirondack Mountains, beautiful lakes in mountainous settings, dramatic river gorges and waterfalls, and the majestic St. Lawrence River with its intricate clusters of wooded islands.

2. The islands of the St. Lawrence have long been a famous resort area known as the "Thousand Islands." In Lakes George, Champlain and Memphremagog there are also attractive groups of islands enhancing the beauty of these large bodies of water.

3. The highlands of the Adirondacks have many smaller lakes and ponds. There are a number of lakes also on the northern slopes of the Green Mountains. Nearly all of these offer excellent recreational environment.

4. Lake Champlain, with its broad expanse of stable water, and Lake George, in its narrow valley, continue to influence travel and recreation as they did early exploration, conquest and settlement. Recreational facilities are sheltered along their shores, in the numerous coves and inlets, much as were the camps of Indian war parties and Colonial forces. Many of the strategic sites that figured in the Colonial and Revolutionary wars now provide ideal situations for recreational development. Cumberland Bay, Crown

Point, Lake George Beach and Battleground, Fort Ticonderoga and Rogers Rock are among the scenes of conflict along this historic water route that are today the scenes of important developments for public recreation. Lake George, although considerably smaller than Lake Champlain, has a steeper, more mountainous shoreline with heavy forest cover on all sides. Its intense beauty is widely famed.

5. To the west of Lake Champlain, the tumbled Adirondacks, with elevations occasionally reaching 5,000 feet, at a number of points press closely upon the shore. On the eastern shoreline the land is fairly low and rolling, rising only gradually for several miles before the more regular peaks and ridges of the Green Mountains extend to heights well above 3,000 feet.

6. In northern Vermont these peaks and ridges are more widely spaced then in the central and southern parts of the State. The valleys between them are broader and afford a more open character to the landscape than is found elsewhere in the mountainous parts of the subregion.

7. Climatic conditions are highly favorable to varied recreational activities. The cool mountains are ideal for the more strenuous types of summer recreation and their heavy snowfall makes them adaptable to winter sports through a long season. The lower lands about Lake Champlain and along the St. Lawrence are within easy access of the mountains, and their slightly higher temperatures afford a somewhat longer summer recreational season. The normally

Recreation area, Thousand Islands section, St. Lawrence River. Subregion "C".

clear and crisp fall weather throughout the sub-region results in a season of foliage coloration of great beauty, which is an increasingly important visitor attraction.

FACTORS INFLUENCING RECREATIONAL USE

8. While the resident population of Subregion "C" is small in total and widely scattered, it lies close to large population centers to the north, south and west. The greater part of the population, which numbered 516,400 in 1950, is concentrated along the major water routes of the St. Lawrence River and Lake Champlain and the lowlands adjoining them. By comparing the resident population figure with the estimated figure of approximately 6,300,000 visitor days ~~visitation figure of approximately 4,500,000~~, the recreational importance of the subregion becomes apparent. The seasonal visitor days ~~visitation~~ amount to 12.1 ~~7.7~~ times the resident population. The greater part of this visitation can be accounted for by the fact that almost 3,000,000 people live in the major Canadian and American cities and towns that are within easy weekend travel distance of most of the unusual attractions of the subregion.

9. Major routes of travel within the subregion have only in recent times deviated from locations along the principal water arteries of early exploration, conquest and settlement. Today a modern highway system not only follows the shores of Lake George, Lake Champlain and the St. Lawrence River, but it also penetrates the Green Mountains and the terrain of the Adirondacks, long avoided by travelers because of its rugged character. Desirable for their scenic and recreation qualities, these mountain areas are now

accessible by a network of paved and all-weather motor roads.

10. Population and resort centers of the subregion are served by many forms of commercial passenger transportation. The New York Central and the Delaware and Hudson Railroads, the Greyhound and Trailways Bus Lines, the Colonial Airline, private air taxis, and car and boat renting establishments fulfill many of the transportation needs of the subregion. The more scenic mountain areas and water courses are traversed by extensive networks of popular and well marked foot trails and canoe routes. The growth and diversity of transportation media are major factors which have influenced the recreational use and development of the subregion's resources.

11. Many towns and villages within the subregion receive a major part of their income in the performance of needed services for the visiting recreationalists. Ticonderoga, Lake Placid, Tupper Lake, Saranac Lake, Lake George, Alexandria Bay, Clayton, Cranberry Lake, Long Lake, Ausable Forms, Keeseville, and Keene are among the prominent tourist villages in the New York portion. Plattsburgh, an important population center, is also a leading service center for vacationists' needs. In 1952 this city provided food service and various types of lodging, including camping at the nearby Cumberland Bay Campsite, for more than ten times its own population.

12. In many of the villages and towns in the Vermont portion of the subregion, recreation plays a comparably important role in

the economy of the resident population. Hubbardton, Salisbury, Vergennes, Basin Harbor, Shelburne, Waterbury, Stowe, St. Albans, Newport, and the villages on Grand Isle are a few of these. Because of their tourist accommodations Rutland, Burlington, Montpelier and Barre are important travel stops and derive considerable revenue and employment from serving the vacationist.

13. Available estimates of population trends indicate that the local population of the subregion will increase more slowly than that of neighboring sections. Considering the yearly influx and increase of visitors, the percentage of the local population engaged in one aspect or another of the recreation industry should increase as that industry becomes an even more important element in the subregion's economy.

14. Recreation as an economic factor and commodity has a long background throughout much of the subregion. However, it was not entirely a matter of economics but perhaps more largely the anticipated human benefits to the minds and bodies of its citizens which prompted New York State in 1883 and 1885 to pass legislation which established a precedent not only in the evolution of the State's economy but also in the whole field of conservation under public authority. Lands in the major wilderness areas were withdrawn from sale and set aside as a forest preserve. Public recreational use of natural resources in a wilderness condition became a reality in 1892 when the forest preserve concept was broadened and the Adirondack Park was created. State ownership of land within the

area set up for the Adirondack Forest Preserve gradually increased until in 1950 the State owned 2,177,476 acres of the total prescribed 5,602,418 acres.

15. By 1937 more than $16,000,000 had been spent on land purchases. In 1952 alone the public spent approximately three times that amount for the privilege of using the natural resources within the boundary of the Adirondack Forest Preserve. Needless to say, the area could not have excited such spending today had it not been for the comprehensive efforts which have been exerted over a period of more than 70 years. Efforts in preserving the natural setting and providing facilities for its enjoyment are of incalculable value to this and future generations. The State's long-term investment in conservation and recreation is paying off in the form of direct and indirect economic benefits to the people of the region. In a broader sense, it has long paid off in the intangible benefits of health, inspiration and enjoyment.

16. Federal and State investments in conservation and recreation elsewhere in the subregion, though of more recent origin, are also paying off in both tangible and intangible forms. The Green Mountain National Forest and the State forest parks in Vermont, as well as the State parks outside the Adirondacks in New York, have steadily grown in popularity. They add materially to the economy of the subregion and have been amply justified.

PRESENT USE OF THE RESOURCES FOR RECREATION

17. Recreational use of the resources of Subregion "C", which had an early beginning, has experienced a continuous expansion. Public and private interests have provided a wide range of facilities and accommodations for the vacationer, the tourist and the sportsman. The variety of these, including hotels, lodges, motels, camps for boys and girls, club camps, public parks, forest preserves, public camp grounds, hiking trails, motor roads, boat liveries, bathing beaches, winter sports developments and historic sites, attracts many visitors to the subregion annually.

18. Public non-urban recreation developments. - Practically every type of recreational development suitable to the environment can be found within the subregion. There are 42 areas containing 32,328 acres that have been set aside for public recreation by State and Federal governments. These areas had a total of 1,546,842 visitors in 1952. Twelve of these areas are in Vermont and 30 in New York State.

19. This group is listed, with information on development and use, in Table 35. It represents a broad development of varied facilities. There are, however, gaps in facilities for certain activities, caused primarily by physiographic limitations. For example, with the exception of the immediate Lake Champlain shoreline and the Lake Memphremagog Drainage Basin, the Vermont portion of the subregion has few water areas adaptable to recreation use and development.

Table 35 - Public recreation developments, Subregion "O"

Name of public development	Size in acres	Facility development*						Attendance record-1952	Attendance trend 1940-1950 inclusive (percent)	1950-1952 inclusive (percent)
		Camping	Picnicking	Boating	Swimming	Winter sports	History			
LAKE CHAMPLAIN DRAINAGE BASIN										
NEW YORK										
1. Crown Point Res. campsite	103	x	x				x	35,962	+ 37.4	+ 15.
2. Cumberland Bay campsite	50	x		x	x			196,450	+ 51.8	+108.3
3. Fish Creek Ponds campsite	200	x	x	x	x			58,637	- 57.1	+ 23.2
4. Hearthstone Point campsite	85	x		x				74,911	- 51.8	+ 70.4
5. Lake George Battleground campsite	40	x	x				x	13,652)		
6. Lake George Battleground Park	35		x	x	x			92,025)	+ 33.3	+ 50
7. Lake George Beach State Park	33		x	x	x			298,660)		
8. Lake George Islands (57 islands)		x	x	x	x			11,782	- 62.1	- 12.6
9. Meadowbrook campsite	10	x	x					11,171	- 24.3	+ 27.3
10. Mt. Van Hoevenberg Bobsled Run	1mile					x		9,441		+ 3.6
11. Poke-O-Moonshine campsite	10	x	x					16,129	+ 14.0	+ 12.0
12. Roger's Rock campsite	500	x			x			36,622		+ 40.8
13. Rollins Pond campsite	**	x		x	x			6,306		+125
14. Wilmington Notch campsite	20	x						24,410	+ 63.6	- 1.2
State Totals	1,086							886,158	+ 2.7	+ 51

Table 35 - (Continued)

Name of public development	Size in acres	Facility development*						Attendance record-1952	Attendance trend 1940-1950 inclusive (percent)	1950-1952 inclusi (percen
		Camping	Picnicking	Boating	Swimming	Winter sports	History			
LAKE CHAMPLAIN DRAINAGE BASIN										
VERMONT										
15. Branbury State Forest Park	23		x		x			63,390		+ 29.1
16. Camel's Hump State Forest ***	7,748									
17. D.A.R. State Forest Park **	120	x	x		x					
18. Elmore State Forest Park	140		x	x	x			17,810	+ 68.5	+ 22.9
19. Hazen's Notch State Forest Park ***										
20. Monroe State Forest Park ***	200									
21. Mt. Mansfield State Forest and Mansfield Underhill	20,944	x	x			x		113,161	+500	+ 41.8
22. Mt. Philo State Forest Park	160	x	x					14,075	+ 8.4	+ 3.2
23. St. Albans Bay State Forest Park	45		x	x	x			27,607	+ 83.3	+178.5
24. Sand Bar State Forest Park	10	x	x	x	x			50,240	+179.2	+ 34.2
25. White Rocks Green Mt. National Forest area	5		x					8,000		+700
State totals	29,395							294,283	+277.7	+ 45.4
Grand totals	30,481							1,180,441	+ 26.8	+ 50

* Fishing ~~and hunting~~ are available at most areas without need for developed facilities.

** Acquired or opened in 1952.

*** No developed facilities available.

Table 35 - (Continued)

Name of public development	Size in acres	Facility development*						Attendance record-1952	Attendance trend 1940-1950 inclusive (percent)	1950-1952 inclusive (percent)
		Camping	Picnicking	Boating	Swimming	Winter sports	History			
ST. LAWRENCE DRAINAGE BASIN										
NEW YORK										
1. Burnham Point State Park	12	x	x	x	x			17,525	- 11	+ 14
2. Canoe Picnic Point State Park	70	x	x	x				8,925	+ 16.2	+ 91.7
3. Cedar Island State Park	10	x	x	x				4,225	+ 16.6	+ 20.8
4. Cedar Point State Park	48	x	x		x			64,975	+ 36.6	+ 78.7
5. Cranberry Lake campsite	25	x	x		x			17,491	+ 11	+ 39.6
6. DeWolf Point State Park	13	x	x	x	x			22,375	+ 59.1	+ 65.5
7. Eel Weir campsite	15	x	x					31,003	- 17.8	+ 60.9
8. Forked Lake campsite	**	x						5,192		- 8.4
9. Golden Beach campsite	75	x						31,585	- 31.9	+ 2.3
10. Grass Point State Park	27	x	x	x	x			48,150	+ 53.7	+ 57.1
11. Kring Point State Park	39	x	x		x			42,550	+ 88.5	+ 74
12. Lake Eaton campsite	80	x			x			23,868	- 58.4	+ 30.3
13. Mary Island	13	x	x	x				4,025	+ 8.3	+ 4.0
14. Meachem Lake campsite	100	x						44,337	+ 14.4	+ 31.0
15. Watterson Point State Park	6		x	x				4,225	+ 16.6	+ 20.8
16. Wellesley Island State Park	1300**									
State Totals	1833							366,401	+ 2.0	+ 52
LAKE MEMPHREMAGOG DRAINAGE BASIN										
VERMONT										
Crystal Lake State Forest Park	14.5				x			13,000	------	+300
Subregional totals	32,328	29	27	17	19	2	2	1,546,842	+ 20	+ 50

* Fishing and hunting are available at most areas without need for developed facilities.

** Acquired or opened in 1951.

This situation exists to a lesser degree along the western and northern slopes of the Adirondacks outside the limits of the Adirondack Park. While important recreational lakes are within easy weekend travel distances of the population of the subregion, many of the residents are not within a distance of such facilities convenient for day outings.

20. In Vermont, the utilization of resources for public recreation is being accomplished by a variety of agencies. While most of these agencies have other major interests, they all participate in recreational development.

a. The Vermont State Forest Service, administering the State Forests and State Forest Parks, in addition to its conservation functions, has long recognized its responsibility for providing facilities for public use and has developed areas offering a variety of recreation activities. Eleven of the State's 20 forest recreation developments lie within the subregion.

b. The United States Forest Service, among its other responsibilities in administering the Green Mountain National Forest, has provided a number of recreation facilities on these public lands. One of the four recreational areas within the Green Mountain National Forest lies within the subregion.

c. The Green Mountain Club, a citizen group, has exerted considerable effort in making the scenic grandeur of the Green Mountains available to anyone who is willing to walk for it. Along

a 260-mile foot trail, running the length of the State, are provided 50 overnight camps and shelters for the long-distance or local hiker. Much of the trail and a number of the camps are within the boundaries of the Green Mountain National Forest. From Sherburne Pass, about 10 miles east of Rutland, to the Massachusetts line the Long Trail and the Appalachian Train occupy the same location.

d. The Vermont Historic Sites Commission, discussed below, has a number of specialized educational and recreational areas under its judrisdiction.

21. In New York State the Division of Lands and Forests in the Department of Conservation has developed a number of recreational areas in that portion of the Adirondack Park within the subregion. Among them, these areas offer the visitor varied activities, including boating, swimming, hunting, fishing, picnicking, historic sites appreciation, and others. Winter sports facilities have been developed by this agency at White Face Mountain and Mount Van Hoevenburg. Nineteen of the public areas shown in Table 35 are under the administration of the Division of Land and Forests, as are hundreds of miles of foot trails and a number of scenic canoe routes. Along these are found overnight shelters and other trailside facilities.

22. The Division of Parks in the State Department of Conservation, New York administers 12 parks for general recreation

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within the subregion. These are located at Lake George and along the St. Lawrence River in the vicinity of the Thousand Islands.

23. The Adirondack Mountain Club, since its organization in 1922, has constructed, marked and maintained a system of trails through the mountainous wilderness of the Adirondacks. It has also built numerous trailside shelters and lodges to accommodate the hiker and the student of nature.

24. Private recreation developments. - Private and commercial uses of the resources of the subregion for recreation were of early origin and private agencies continue to furnish important public services. Private estates, sporting lodges and camps were among the first recreational facilities to appear, particularly in the Adirondack Mountains. Some of these remain intact and in private use, while others have become "dude" ranches, resorts, or organized camps open to the public. There are now approximately 104 camps in the subregion under organizational or commercial sponsorship. Hotels and lodges now number more than 265 establishments, visited chiefly in connection with recreation. Motels and roadside cabins accommodate an increasing number of visitors. Facilities of this type are developing rapidly and have a patronage often estimated 1,000,000 visitor days a year. The tourist home, an old supplement to the family income, is still quite common in the subregion. In many cases this form of commercial accommodation has developed into full-time businesses.

25. Many of these commercial enterprises offer their guests recreational facilities in connection with lodging. Court games, golf, swimming, boating and horseback riding, are often offered in a summer package vacation plan by hotels, lodges, dude ranches and camps. In winter many of these same establishments offer similar package vacations including transportation to and from ski areas, evening activities, sugaring-off parties, and other cold-weather sports.

26. A large proportion of the 517,400 residents of the subregion are profitably employed either directly or indirectly in supplying the recreational needs of tourists and vacationists who number around 6,300,000 annually. The total annual expenditures in connection with recreation are estimated to be more than $261,500,000.

RECREATION NEEDS AND POTENTIALITIES

27. Visitor use of facilities. - An appraisal of existing public developments within the subregion permits the formulation of certain conclusions based upon size of areas, attendance records and activity facilities offered. Some of the conclusions which follow are in contrast to conventional planning rules, illustrating the individuality and specific values of the recreation resources in the subregion:

a. Area popularity and proportionate growth of attendance are restricted by acreage only where facility development can no longer be expanded within the current bounds of the area.

Recreational fishing and boating. Thousand Islands section.
St. Lawrence River. Subregion "C".

Golden Beach and Wilmington Notch Campsites are perhaps the outstanding examples of visitation stabilized by limitation of area. Under normal conditions future visitation of these areas will probably fluctuate only slightly unless additional land is made available and further developments added.

b. From the over-all attendance increase for the subregion, it is evident that should additional attractions or accommodations be offered at stabilized areas they would be absorbed with little effect upon the attendance to other existing recreational developments.

c. It is apparent that visitation and area popularity are controlled largely by the number, kind and quality of facilities offered, rather than by the numbers and distribution of the resident population.

d. Recreation areas with water features are likely to experience greater visitation than areas without water features. Water features must, however, be developed to serve their full potential. Crown Point and Fish Creek Ponds Campsites and Lake George Islands are examples of areas with inadequately developed water features.

e. Camping developments usually attract a large attendance. Single purpose camping areas, however, fail to have continuing growth of attendance in proportion to the subregion as a whole. Although facilities for picnicking constitute a necessary development, picnicking does not have sufficient attraction by itself to support any major area development. A number of camping areas in the subregion

which lack supporting facilities show far less than the average attendance increase. These include Forked Lake Campsite, Golden Beach Campsite, Mary Island, Crown Point Reservation Campsite, Lake George Islands, Pole-o-Moonshine Campsite, Wilmington Notch Campsite, Gifford Woods State Forest Park, and Mount Philo State Forest Park.

f. A combination swimming and camping development offers the greatest summertime recreational attractions within the subregion. Although each use facility is a sound investment in its own right, its potential for public use is increased considerably when the two attractions are combined. Cumberland Bay Campsite is an outstanding example of this.

g. Areas developed specifically for swimming or swimming and boating seem to need no other activities to encourage attendance growth, even beyond capacity limits, when they are located near population centers which provide the other necessary guest accommodations. St. Albans Bay, Branbury and Lake George Beach State Parks are good examples of this.

h. As in the case of swimming areas, facilities provided for skiing and other winter activities need no supporting development for subtained popularity. Developed winter activity areas need not be located near population centers, since visitors have accepted the controling factors of climate and terrain. Although winter sports developments are justifiable as single purpose projects, visitation increase is more pronounced when they are supplemented by summer

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use facilities. This is illustrated by the case of the Mount Mansfield area in Vermont which has summer facilities in contrast Mount Van Hoevenberg Bobsled Run which does not have such facilities.

28. Based on the available data there appears to be need within the subregion for additional development of public recreational facilities. Desirable additions to the present systems of public areas include:

a. Supporting recreation facilities at many of the existing public use areas.

b. Increased acreages for a number of existing areas to provide for further development and expansion.

c. The establishment of additional general recreation areas, to include a variety of activity facilities.

d. More areas for aquatic recreation and day use facilities in the Vermont section and the northern and western slopes of the Adirondack Mountains.

e. A system of highway wayside areas to accommodate the vacation motorist as well as the daily traveler, to make available in a safe manner scenic vistas and provide convenient facilities for picnicking and relaxation.

f. Interpretation through signs and markers of scenic and natural features within established areas, along the roadside and trails, and in new or expanded areas.

29. The needs for non-urban recreation are gorwing steadily and considerable effort is being exerted, throughout the subregion,

to meet them. Many of the resources of recreation importance are currently being used for one recreational purpose or another. Many are being used for conflicting purposes. There are also many superior resources which have not been utilized for recreational development. Table 36 lists these resources and features. It also presents a listing of activities which appear to be harmonious with the existing resources and which would permit, if developed, greater recreational use of the features in the subregion.

EFFECTS OF OTHER RESOURCE USES ON RECREATION

30. Pollution. - Although progress has been made toward the control of water pollution throughout much of the subregion, the need is increasing for more and varied sources of high quality water for recreation use. Continued abatement of and increased safeguards against the pollution of current and potential recreation waters is needed.

31. Stream regulation and power development. - Flood control and hydroelectric power developments often create impoundments of high recreational value. On the other hand, dam construction often eliminates or appreciably alters natural features of exceptional quality. Waterfalls and cascades, fishing and canoeing streams, geological formations of special interest, and natural areas of distinction are often lost as a result of stream control measures.

32. The small amount of fluctuation in the lakes high in the Adirondacks, such as Tupper, Cranberry, Saranac, and Placid, makes

Table 36 - Natural resources important to recreation, Subregion "C"

Names and locations of natural resources important to recreation	Qualities of natural elements important to recreation for use and development	Development possibilities										
		Swimming	Boating	Camping	Picnicking	Hiking	Nature study	Scenic enjoyment	Wildlife sports	Winter sports	Wilderness	History study
LAKE CHAMPLAIN DRAINAGE BASIN												
NEW YORK												
LAKE GEORGE AREA												
Pilot Knob Buck Erebus and Black Mountains along the eastern shore line of Lake George	Dramatic mountain scenery fronting on Lake George with wildlife, geologic and forest features of exceptional recreation values	x	x	x	x	x	x	x	x	x	x	
SARANAC LAKES												
Upper, middle and lower	Valuable resources throughout: water, forest, mountain scenery, wildlife of high quality. Heavily used but with desirable expansion.	x	x	x	x	x	x	x	x			
SARANAC RIVER												
Tributary streams and small ponds	Highly scenic river with cascades, falls, ponds, wildlife, forests and scenic geologic features	x	x	x	x	x	x	x	x			
Mountain range containing Mt. Marcy (highest in State), Street, MacIntyre, Colden, Haystack, Skylight, Dix, Nipple Top and McComb Mountains	Most outstanding mountain formations in the Adirondacks, having recreationally important forest, geologic and wildlife features			x	x	x	x	x	x	x	x	

Table 36 (continued)

Names and locations of natural resources important to recreation	Qualities of natural elements important to recreation for use and development	Development possibilities										
		Swimming	Boating	Camping	Picnicking	Hiking	Nature study	Scenic enjoyment	Wildlife sports	Winter sports	Wilderness	History study
NEW YORK (continued)												
AUSABLE RIVER Tributary streams, small peaks, and Wilmington Notch area and Whiteface Mountain	Most dramatic river and streams in the basin. Superb mountain setting for waterfalls, cascades, natural pools and deep gorges. Good forest, wildlife and geological features create exceptional scenic and recreational values	x		x	x	x	x	x	x			x
LAKE PLACID and MT. WHITNEY	Scenic companions with Whiteface Mountain in background. Good water element with supporting forest and wildlife features	x	x	x	x	x	x	x	x	x		
BOUQUET RIVER Tributary streams in headwater area	Accessible scenic mountain views with attractive streams, forest cover and wildlife features			x	x	x	x	x	x			
LAKE CHAMPLAIN shoreline--its water and islands	Accessible, adaptable, versatile resources offering locations for individual and group facilities to utilize outstanding land, water, wildlife and historic features	x	x	x	x		x	x	x	x		x

Table 36 (continued)

Names and locations of natural resources important to recreation	Qualities of natural elements important to recreation for use and development	Development possibilities										
		Swimming	Boating	Camping	Picnicking	Hiking	Nature study	Scenic enjoyment	Wildlife sports	Winter sports	Wilderness	History study
VERMONT												
Northern Green Mountains including Jay Peaks, Sugarloaf Mountains, Jay Branch and upper Missisquoi River Hazens Notch	Exceptionally rugged terrain with interesting forest cover and wildlife, geological formations and mountain streams of scenic beauty. Prevailing semi-wilderness environment	x		x	x	x	x	x	x	x	x	x
Bolton Gorge area including Camels Hump Mountain, Bolton Gorge and Waterbury Reservoir area with Bolton Mountain	Land and water features create a scenic environment possessing good forest cover, wildlife and elements valuable for sight-seeing and vacation purposes	x	x	x	x	x	x	x	x	x	x	
Lincoln Gap and Mt. Abraham area	Good mountain scenery supported by forest, wildlife and geological features			x	x	x	x	x	x	x	x	
Chittenden Reservoir and Blue Ridge Mt. area	Scenic water and mountain area near Rutland where water features are needed for recreation purposes. Forest and wildlife elements of good quality and variety	x	x	x	x	x	x	x	x	x		

Table 36 (continued)

Names and locations of natural resources important to recreation	Qualities of natural elements important to recreation for use and development	Development possibilities										
		Swimming	Boating	Camping	Picnicking	Hiking	Nature study	Scenic enjoyment	Wildlife sports	Winter sports	Wilderness	History study
VERMONT (continued)												
Lake Champlain shore line, water and islands, including Button Bay, Otter Creek to Vergennes, Chimney Point, Mt. Independence, Isle La Motte, Grand Isle	Accessible, adaptable and versatile resources offering sites for individual and group facilities to utilize the outstanding land, water, wildlife, forest and historic features of scenic, recreation and cultural importance	x	x	x	x	x	x	x	x			x
Rivers												
Mettawee (headwaters Dorset Mt. area)	A good balance of scenic mountain and stream features				x	x	x	x	x	x	x	
Lamoille River-Cambridge to Hyde Park	Scenic valley floor flanked by good mountains					x	x		x	x	x	
Winooski River (see Bolton Gorge area)												
Mad River to Moretown	Good rural and mountain scenery along a highly interesting mountain stream cut through rock ledge in many places				x	x	x	x	x	x	x	
Missisquoi River (see Northern Green Mountains)												

Table 36 (continued)

Names and locations of natural resources important to recreation	Qualities of natural elements important to recreation for use and development	Development possibilities										
		Swimming	Boating	Camping	Picnicking	Hiking	Nature study	Scenic enjoyment	Wildlife sports	Winter sports	Wilderness	History study
ST. LAWRENCE DRAINAGE BASIN												
NEW YORK												
RAQUETTE RIVER												
Tupper Lake district including Tupper and Little Tupper Lakes, Raquette Lake, Forked Lake, Long Lake and Raquette River - source to outlet of Tupper Lake	Outstanding mountain and lake scenery of high recreational quality. Good forest cover predominates. Lakes provide high quality of water with stable levels and interesting shorelines. The area is well populated with wildlife. The Raquette River here provides a major portion of the excellent OLD FORGE to LOON LAKE canoe route. Within this small area is an exceptionally complete variety of recreational resources; mountains, rivers, forests, lakes, marshes and wildlife.	x	x	x	x	x	x	x	x	x	x	
Raquette River below Tupper Lake outlet, to Colton, N.Y. with the Catamount Mt. area and Salisbury Marsh area	Highly scenic mountain river with intermittent cascades and quiet pools. Valuable wildlife areas and scenic swamplands. Semi-wilderness area important for maintaining balance of wildlife and related activities		x	x	x	x	x	x	x		x	

Table 36 (continued)

Names and locations of natural resources important to recreation	Qualities of natural elements important to recreation for use and development	Development possibilities										
		Swimming	Boating	Camping	Picnicking	Hiking	Nature study	Scenic enjoyment	Wildlife sports	Winter sports	Wilderness	History study
NEW YORK (continued)												
GRASS RIVER												
Cranberry Lake and Grass River to Russell	Good recreational body of water situated in a mountain environment. Good forest cover and wildlife. Marsh areas, cascades, and quiet pools provide valuable wildlife environment.		x	x	x	x	x	x	x		x	
OSWEGATCHIE RIVER												
Headwaters and Indian River (Lakes Black and Bonaparte)	Good water features, recreationally adaptable terrain, forest and wildlife. Waterfalls and rapids in upstream areas.	x	x	x	x	x	x	x	x			
ST. REGIS RIVER												
Sources to Parishville and Nicholsville, with tributary ponds and streams.	Semi-wilderness conditions in mountainous terrain. Good water features and forest cover provide a good balance in the variety of recreational resources.	x	x	x	x	x	x	x	x	x	x	

Table 36 (continued)

Names and locations of natural resources important to recreation	Qualities of natural elements important to recreation for use and development	Development possibilities										
		Swimming	Boating	Camping	Picnicking	Hiking	Nature study	Scenic enjoyment	Wildlife sports	Winter sports	Wilderness	History study
NEW YORK												
SALMON RIVER Headwaters to Malone, N.Y. including Titusville Mountain, Huckleberry Marsh, Chasm Falls area	Dramatic variety of natural features, including precipitous mountain slopes, stream gorges, wide valley floor, marsh area scenic rock formations, better than average forest cover and good good wildlife.	x		x	x	x	x	x	x	x	x	
CHATEAUGAY LAKES	Good quality of water with recreationally adaptable shoreline.	x	x	x	x	x	x	x	x			
ST. LAWRENCE RIVER Including the Thousand Islands and International Rapids areas	The river itself an outstanding scenic feature possesses elements of recreation importance; broad water area of stable elevation, outstanding island formations and with variable shorelines, rock formations, flora and faura; low rolling valley floor provides easy travel and is now a major tourist route.	x	x	x	x	x	x	x	x			x

Table 36 (continued)

Names and locations of natural resources important to recreation	Qualities of natural elements important to recreation for use and development	Development possibilities										
		Swimming	Boating	Camping	Picnicking	Hiking	Nature study	Scenic enjoyment	Wildlife sports	Winter sports	Wilderness	History study
LAKE MEMPHREMAGOG DRAINAGE BASIN												
VERMONT												
LAKE MEMPHREMAGOG	Sizeable scenic water feature with good shoreline and island formations.	x	x	x	x	x	x	x				
LAKE WILLOUGHBY	Highly scenic, mountain, forest and geologic features.	x	x	x	x	x	x	x	x	x		

them prime recreational water areas. On the other hand, water level fluctuations in the Waterbury Reservoir, Vermont and other impoundments have discouraged recreational development and use of otherwise attractive areas.

33. Should features similar to those of the Ausable River waterfalls, cascades and cliffs, or the falls and rapids of the Saranac River, be inundated or otherwise altered by water control projects, their loss could not be replaced.

34. In some parts of the subregion where recreational water areas are scarce, the substitution of one recreational resource for another might be desirable. A reservoir at the Titusville site on the Salmon River would offer greater recreational opportunities than are now available in this general vicinity. However, to achieve the best recreational use of this and other reservoir sites, more stable pool levels would be necessary.

35. Discussions of the recreational values of the individual water control projects within the subregion are found in Sections X of Chapters XXVI and XXVIII on the Lake Champlain and St. Lawrence Drainage Basins.

HISTORICAL AND ARCHEOLOGICAL RESOURCES

36. Historic and prehistoric sites are generally recognized as major elements in National, State and local recreational programs. They are in themselves irreplaceable sources of knowledge of the past. Their proper presentation to the public is a means of inspiration in the difficult present and for the uncertain future. By visual illustration of the life and problems of earlier generations they help to place present-day American institutions, achievements, and problems in perspective and to foster the highest type of patriotism. They are, when well interpreted, endlessly fascinating to the traveler, and visits to them in many parts of the Nation now account for an important part of total tourist travel. Developed historic sites are economic assets to the communities and states in which they exist.

37. For purposes of this presentation, historical and archeological resources are defined as including those sites and structures which, by reason of historical or prehistoric associations, are believed worthy of preservation or commemorative marking, and those which, by their interest and accessibility, can be made available to the public for recreational and educational purposes.

38. Although Subregion "C" includes only the areas draining into the St. Lawrence River, the

them prime recreational water areas. On the other hand, water level fluctuations in the Waterbury Reservoir, Vermont and other impoundments have discouraged recreational development and use of otherwise attractive areas.

33. Should features similar to those of the Ausable River waterfalls, cascades and cliffs, or the falls and rapids of the Saranac River, be inundated or otherwise altered by water control projects, their loss could not be replaced.

34. In some parts of the subregion where recreational water areas are scarce, the substitution of one recreational resource for another might be desirable. A reservoir at the Titusville site on the Salmon River would offer greater recreational opportunities than are now available in this general vicinity. However, to achieve the best recreational use of this and other reservoir sites, more stable pool levels would be necessary.

35. Discussions of the recreational values of the individual water control projects within the subregion are found in Sections X of Chapters XXVI and XXVIII on the Lake Champlain and St. Lawrence Drainage Basins.

HISTORICAL AND ARCHEOLOGICAL RESOURCES

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38. Although Subregion "C" includes only the areas draining into the St. Lawrence River, either directly or through Lakes Champlain and Memphremagog, in northern New York State and northern and western Vermont. In order to present a coherent historical treatment, this region is here treated as including the

whole western slope of the Green Mountains south of Bennington, which is actually in the Hudson River Basin is included in this discussion in order to present a coherent historical treatment. The Subregion includes the great northern war trail between the St. Lawrence and Hudson Valleys by Lake Champlain, which was followed by war parties from time immemorial and was the route of contending armies through the Colonial wars, the Revolution, and the War of 1812. The St. Lawrence itself was the chief pathway of the French in their exploitation of the fur trade of the continent, and a war trail second only to that by Lake Champlain.

39. In this country Rogers' Rangers and the Green Mountain Boys won their fame. Within it relations with Canada have always been of prime importance, and it has been the haunt of smugglers from the days of Jefferson's Embargo to those of the experiment in National prohibition.

40. Here and nearby, the expanding New England Yankee stock built and maintained for fourteen years the independent Republic of Vermont, later pushing on around the Adirondacks to settle the St. Lawrence Valley. In the Adirondack Mountains, the great concept of outdoor recreation was developed, and here the ruthless exploitation of natural resources was first challenged, under State auspices, by the related concept of conservation.

41. Historic and prehistoric sites. - The following list of historic sites in Subregion "C" is not intended to be inclusive. It consists of sites that are now open to the public, can be presented effectively to the public in their present state, or can be made effectively presentable through restoration or museum development. The scenes of historic events that are of such nature, or have been so changed by modern intrusion, that neither structures nor the possibility of effective restoration or other presentation exists, are not included. Houses of early periods and architectural merit still in use as private dwellings are omitted, except where they have important historical associations. The classification used is that of the categories established by the Advisory Board on National Parks, Historic Sites, Buildings and Monuments in connection with the National Historic Sites Survey. The sites are as follows:

a. Historic Sites and Structures.

I. Spanish and Portuguese Exploration and Settlement: None.

II. French Exploration and Settlement:

*Fort Ste. Anne, Isle LaMotte, Vermont.

*Fort St. Frederic, Crown Point, New York.

Chimney Point, Vermont.

*Fort Ticonderoga, Ticonderoga, New York.

III. Dutch and Swedish Colonial Settlements: None

* See note at the end of the list.

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IV. English Colonization to 1700: None.

V. The Development of the English Colonies, 1700-1775:

*Fort William Henry, Lake George, New York.

*Lake George Battleground, Lake George, New York.

*Fort Crown Point, Crown Point, New York.

Crown Point Military Road, Springfield-Chimney Point, Vermont.

*Walloomsac Inn, Old Bennington, Vermont.

Jedediah Dewey House, Old Bennington, Vermont.

VI. War for American Independence:

*Hubbardton Battlefield, East Hubbardton, Vermont.

*Bennington Battle Monument, Old Bennington, Vermont.

*Gunboat Philadelphia, Essex, New York.

Fort Haldimand, Carleton Island, New York.

*Hazen's Notch, Lowell, Vermont.

VII. Political and Military Affairs, 1783-1830:

Isaac Tichenor Mansion, Old Bennington, Vermont.

*General John Strong House, West Addison, Vermont.

Macdonough Shipyard, Vergennes, Vermont.

Fort Cassin, Ferrisburg, Vermont.

*Kent-Delord House, Plattsburg, New York.

*Smuggler's Notch, Mt. Mansfield, Vermont.

VIII. Advance of the Frontier to 1830:

*Hyde Log Cabin, Grand Isle, Vermont.

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* See note at the end of the list.

IX. Political and Military Affairs, 1830-1861:

*John Brown Farm, North Elba, New York

*Stephen A. Douglas Birthplace, Brandon, Vermont

X. War Between the States:

None.

XI. Westward Expansion and Extension of National Boundaries, 1830-1890:

None.

XII. Commerce, Industry and Agriculture to 1890:

None.

XIII. Means of Travel and Communication:

*S. S. Ticonderoga, Shelburne, Vermont.

XIV. Exploitation of Natural Resources to 1890:

None.

XV. The Arts and Sciences to 1890:

*Eagle Tavern, East Poultney, Vermont

*Kent Tavern, North Calais, Vermont

*Remington Art Memorial, Ogdensburg, New York

*Rokeby (Rowland Robinson House), Ferrisburg, Vermont

*Little Red Cottage, Trudeau Sanatorium, Trudeau, Vermont

*Stevenson Memorial Cottage, Saranac Lake, New York

*Old Stone House, Brownington, Vermont

*Shelburne Museum, Shelburne, ~~Vermont~~ New York

(Note: * signifies that the site has been recognized as possessing historical interest and is kept open to the public by one agency or another, or is under development for this purpose).

CCB

42. In this list no archeological sites or structures are shown. Survey work now under way in the Lake Champlain Lowland may reveal sites that are susceptible of development for educational purposes. Famous military sites, such as those at Ticonderoga and Crown Point, are listed under the first appropriate heading, without repetition.

43. There do not appear to be any structures now standing that have important associations with the activities of the Green Mountain Boys or any in Western Vermont intimately associated with the development of the temporary Vermont Republic and State. The sites of a number of important structures of these periods have, however, been marked by the Vermont Historic Sites Commission or local patriotic groups.

44. The gunboat Philadelphia and the lake steamer Ticonderoga are interesting and important surviving objects definitely of historical-educational value. Several fine historical museum collections have been omitted as not being housed in structures of special interest, or as being parts of general museums. The Shelburne Museum, on the other hand, has been included because it consists of structures brought together in effective synthesis to illustrate a broad period. Similarly, the Remington Art Memorial at Ogdensburg,

New York, and the Old Stone House at Brownington, Vermont, have been included because of both the interest of the structures and the historical nature of the museum material housed in them.

45. Doubtless a number of houses in both western Vermont and northern New York that would well repay the attention of local historical groups have been omitted. There are probably also old mills and other structures capable of illustrating early industrial development.

46. The preservation and use of historic sites: New York. - The organization and policies of the State of New York for the care of historic sites are described in Chapter XXXVII - Subregion "E" - Hudson River Basin. In Subregion "C", New York has, however, a number of important areas under its jurisdiction. These include the Lake George Battleground, Crown Point Reservation, and the John Brown Farm. It also extends technical assistance to private agencies engaged in historic sites work.

47. The Lake George Battleground Park is contiguous to the Lake George Battleground Campsite, and separated only by a roadway from the Lake George Beach State Park. This group of areas is administered by the New York Division of Land and Forests, Conservation Department. The Crown Point Reservation is administered by the same agency. These sites combine historical and general recreational features. The John Brown Farm was transferred in 1953 from the Conservation Department to the Department of Education as being primarily historical in character. This farm was the home of

John Brown, the famous abolitionist, for a few years. He is buried there with a number of his followers in the Harper's Ferry raid.

48. Vermont. - The State of Vermont in 1937 acquired a portion of the Hubbardton Battlefield and became more active in historic sites preservation with the establishment of the Historic Sites Commission by legislation enacted in 1947. The Vermont Historic Sites Commission Act may be briefly summarized as follows:

Sec. 1. Established a historic sites commission composed of the director of the Vermont Historical Society, the director of the Vermont Development Commission, and a third member appointed by the governor biennially. The State Forester is ex-officio executive secretary; the chairman is designated by the Governor. The Commissioner of Highways and the State Forester are directed to cooperate with the Commission.

Sec. 2. The Commission assumes the property and functions of the former Hubbardton Battlefield Commission, which is terminated by the Act.

Sec. 3. The Commission may designate and mark historic sites, receive contributions, acquire for the state historical property by contract, purchase, gift, or lease, and manage, preserve and develop the same for public use. Special attention is to be given to the development of President Coolidge's birthplace and grave in Plymouth, and to the birthplace of President Arthur in Fairfield.

Sec. 4. The Commission may employ all necessary and proper assistance and make rules and regulations for the use of property under its control. It is directed to cooperate with State and local organizations with similar objects.

Sec. 5. Members of the Commission serve without pay but are reimbursed for expenses.

Sec. 6. Appropriates $10,000.00 for the use of the Commission for each of the two succeeding fiscal years.

Sec. 7. Repeals 1937 legislation.

Sec. 8. The Act to take effect on passage.

49. The Vermont Historical Society was active in promoting this legislation and furnished the professional historical membership of, and the research facilities for, the Commission. The 1947 Act integrates the leading historical organization of Vermont with the State government for purposes of historic sites work, while the Society itself retains its identity and independence as a private association carrying on other scholarly activities. The Society, with its library and museum, has its headquarters in the Supreme Court Building next to the Capitol in Montpelier. It carries on a variety of programs designed to make the people of Vermont conscious of their historical heritage.

50. In the few years since its establishment, the Historic Sites Commission has planned and erected a system of historic sites markers throughout the State. The aluminum markers, painted in colors of green and gold, are attractive, the texts are well written

and the sites appear to be carefully chosen. There are approximately 75 markers now in position along the highways of Vermont, and more are in preparation. They cover not only military and political sites but also the scenes of literary achievement and of industrial, scientific, and agricultural experiment and development.

51. In line with present policy, sites already marked by patriotic societies are not usually included in the Historic Sites Commission marker system. This policy leaves a number of interesting and important sites without modern interpretive marking readily observable from the highway. There are, moreover, no turnouts ordinarily provided, the markers being set directly at the edge of the road and consituting, in some cases, traffic hazards. On the whole, however, this is a splended system of markers. It is described in detail in an excellent illustrated booklet, Historic Vermont: A Guide to Some Historic Sites and Roadside Markers, prepared by the Historic Sites Commission.

52. The Commission as yet has few historic sites under its administrative jurisdiction. A few acres of the Hubbardton Battlefield were already the property of the State when it was set up. It is hoped to expand and develop this area into a major historical park, but no funds seem so far to have been made available for this purpose. There is also a 22-acre area including the birthplace of President Chester A. Arthur, near Fairfield, under its administration. This site is now under development with a parking lot, picnic ground, and a reconstruction of the house being built. The Hyde log cabin,

on Grand Isle in Lake Champlain, dating from 1783 and one of the last remaining log cabins in the State, is in process of development as a pioneer museum.

53. The Commission is planning the eventual development of a limited but well-rounded system of State-owned historic sites. More broadly, the Historic Sites Commission is actively stimulating local interest in sites work.

54. General protection and development of historic sites. - There is comparatively little historic sites work being done in Subregion "C" by public authority other than that of the States. There are no Federally-owned sites, and no sites operated under cooperative agreement with the National Park Service under the Historic Sites Act of 1935. A few towns have acquired and maintain historic structures, notably the Remington Art Memorial, a three-story brick mansion built in 1809 by David Parish, a landowner, now having a unique collection of the work of the artist, Frederic Remington, and owned by the city of Ogdensburg, New York.

55. Vermont. - Much fine work has been done by historical, patriotic, and special puspose commemorative organizations. The Vermont Historical Society, aside from its work with the Historic Sites Commission, is developing its own property, the Kent Tavern, at North Calais, acquired by gift ~~at~~ of Mr. Atwater Kent ~~and~~ financed with funds from his estate. This handsome brick inn, dating from 1837, is being made into an excellent exhibit of "Vermont country" materials of the early 19th century.

56. Historic sites work in Vermont has been largely under private auspices, though the Federal government and several States provided funds for the first notable development in the field, the building of the Bennington Battle Monument in 1887-91, on the site of the American supply depot that formed the British objective in August, 1777. The monument, formerly maintained by the Bennington Battle Monument and Historical Association, has recently been transferred to the Historic Sites Commission.

57. The Daughters of the American Revolution have been active in sites work in Vermont and the General John Strong House in West Addison, a fine brick structure built in 1782, is the State headquarters of the organization and is maintained as a house museum. The local DAR chapter owns and displays the cottage birthplace of Stephen A. Douglas in Brandon. A number of sites markers have also been placed by chapters of the DAR throughout the State.

58. A few sites in Vermont are owned and maintained by county historical societies. In the subregion, the Orleans County Historical Society owns the Old Stone House, a three-story granite structure built as a classical academy in the 1830's and now housing the Society's collections of local historical material.

59. Individuals as well as organizations are caring for or developing a number of important sites. The notable Shelburne Museum, at Shelburne, Vermont, is largely the work of Mrs. J. Watson Webb. This pastoral village of early Vermont buildings,

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assembled from various points in the State and furnished with period material, was begun in 1946 and is still under development. The Vermont Historical Society has furnished valuable technical assistance. The Museum owns and until recently operated the sidewheel steamer Ticonderoga, last of the Old Lake Champlain passenger ships.

60. The family of Rowland E. Robinson, noted Vermont author of the late 19th century, still owns Rokeby, his home in Ferrisburg. The house, dating from 1784 and with antique furnishing, is open to the public. At East Poultney, the Eagle Tavern, where Horace Greeley boarded while learning the printer's trade has been reopened with careful attention to its period and personal associations. In Bennington the Walloomsac Inn, which is reported never to have closed its doors since it was opened in 1764, is operated with due regard to its 18th century origin. Many fine old homes, in Bennington, Castleton, and elsewhere, are cherished by their owners for their period associations and maintained with period furnishings, while currently in use as dwellings.

61. New York. - Private development of historic sites is dramatically exemplified on the New York side of Lake Champlain at Fort Ticonderoga. Here the Pell family, who have owned the site for over a century, have in the last generation restored the famous old fort in large part to its original appearance and present in it priceless collections of military and other period items. The site is now administered by the Fort Ticonderoga Association,

a non-profit corporation. Fort Ticonderoga receives annually more than 125,000 visitors and constitutes probably the most popular and memorable feature of a tour of the Champlain Lowland. Associated historical features in the vicinity, including Fort Mount Hope and Mount Defiance, are now being developed by private agencies.

62. At Lake George the complete restoration of Fort William Henry has been undertaken. This is an expensive commercial undertaking but is being done with careful attention to documentary and archeological evidence. Technical assistance is furnished by the State Historian and State Archeologist, of the Education Department in Albany. During the 1953 season archeological excavation was begun and rapidly advanced, and a temporary museum was built to house the historical material that was being found in profusion. Visitors, under careful guidance, were admitted to the area to watch the excavation. The complete restoration is expected to take several years.

63. Near Essex, New York on the west shore of Lake Champlain, on display in a temporary shed there are the well preserved hull and equipment of the gunboat Philadelphia. This was one of Benedict Arnold's gallant little fleet, sunk in the battle at Valcour Island in 1776 and raised intact in 1935 by Mr. L. F. Hagglund, its present owner. Mr. Hagglund has also recovered fragments of some of Arnold's other ships from the bottom of the lake. The Philadelphia

is the only complete American war vessel remaining from the Revolution. As such it is a priceless relic.

64. At Plattsburg, New York, the Kent-DeLord House built in 1797 by Chancellor James Kent, the famous jurist, and occupied by the British during the battle of September, 1814, is maintained as a house museum by a private group. At Saranac Lake the Stevenson Memorial Cottage, where Robert Louis Stevenson came for his health in 1887 and where he did some of his most distinguished writing, is maintained as a shrine by the Stevenson Society of America. At nearby Trudeau, the Trudeau Sanatorium preserves as a memorial the Little Red Cottage where Dr. Edward L. Trudeau began his great work in the cure of tuberculosis.

65. Sites of historic significance in the subregion are probably better known and cared for than is the case in most parts of the country. Both New York and Vermont have official State agencies conducting continuous surveys and cooperating with private groups and individuals in preservation and public presentation of important areas. Awareness of the cultural and economic value of the local historical heritage is widespread. There are few sites or structures of importance presently known that have not been accorded at least minimum protection. No water control projects are known to threaten significant sites.

66. Among the sites not at present accorded recognition or care perhaps the most significant is Mount Independence. This area was an integral part of the defenses of the Lake Champlain gateway

in 1776 and at one time had a larger garrison than Fort Ticonderoga, just across the lake and connected with it by a floating bridge. There are important remains of extensive fortifications here on a naturally dramatic site, completely neglected though not in serious condition. Mount Independence is at present away from major routes of travel and is largely devoted to woods and pasture.

67. Fort Cassin at the mouth of Otter Creek, which protected Macdonough's shipyard at Vergennes, is another neglected site. No immediate threat to the remains of this structure is known. The Macdonough shipyard site itself is at present used to some extent as a yacht basin and probably not in danger of serious impairment of the natural setting, though it might be considered a desirable industrial site.

68. Chimney Point, the scene of a considerable French settlement in the 18 century, opposite Crown Point and at the end of the connecting Lake Champlain highway bridge, has received no attention other than a marker. Archeological remains here would be destroyed by any extensive building at this attractive point.

69. Needs and potentialities of historical resources. - While a great deal has been done in developing and interpreting historic sites within the Lake Champlain-Lake George valley, considerable additional presentation would be possible in this region, rich in the remains of two centuries of imperial and national expansion and conflict. Fort Ste. Anne on Isle LaMotte, the scene of the first white settlement (1666) in the valley and in Vermont, is still traceable in outline. It is well cared for by the adjoining Shrine of Ste. Anne, which owns the fort site, and has been marked by the Historic Sites Commission, but there has been no physical development. Possibilities of exploiting this significant site are eminently worth investigation.

70. At Chimney Point, where French settlers lived for nearly 30 years under the protection of Fort St. Frederic just across the lake, the possibilities of effective development seem never to have been investigated by systematic archeological survey. It is important to recognize that French occupancy of the Champlain country was not strictly military. There was a serious attempt here to absorb the valley into Canada politically through settlement, and it deserves commemoration. Development here would properly follow archeological investigation and be conditioned by its results.

71. On the New York side of the lake, Fort St. Frederic and Fort Crown Point, illustrating the rise and fall of French power, are well preserved, as ruins, by the State in its Crown Point

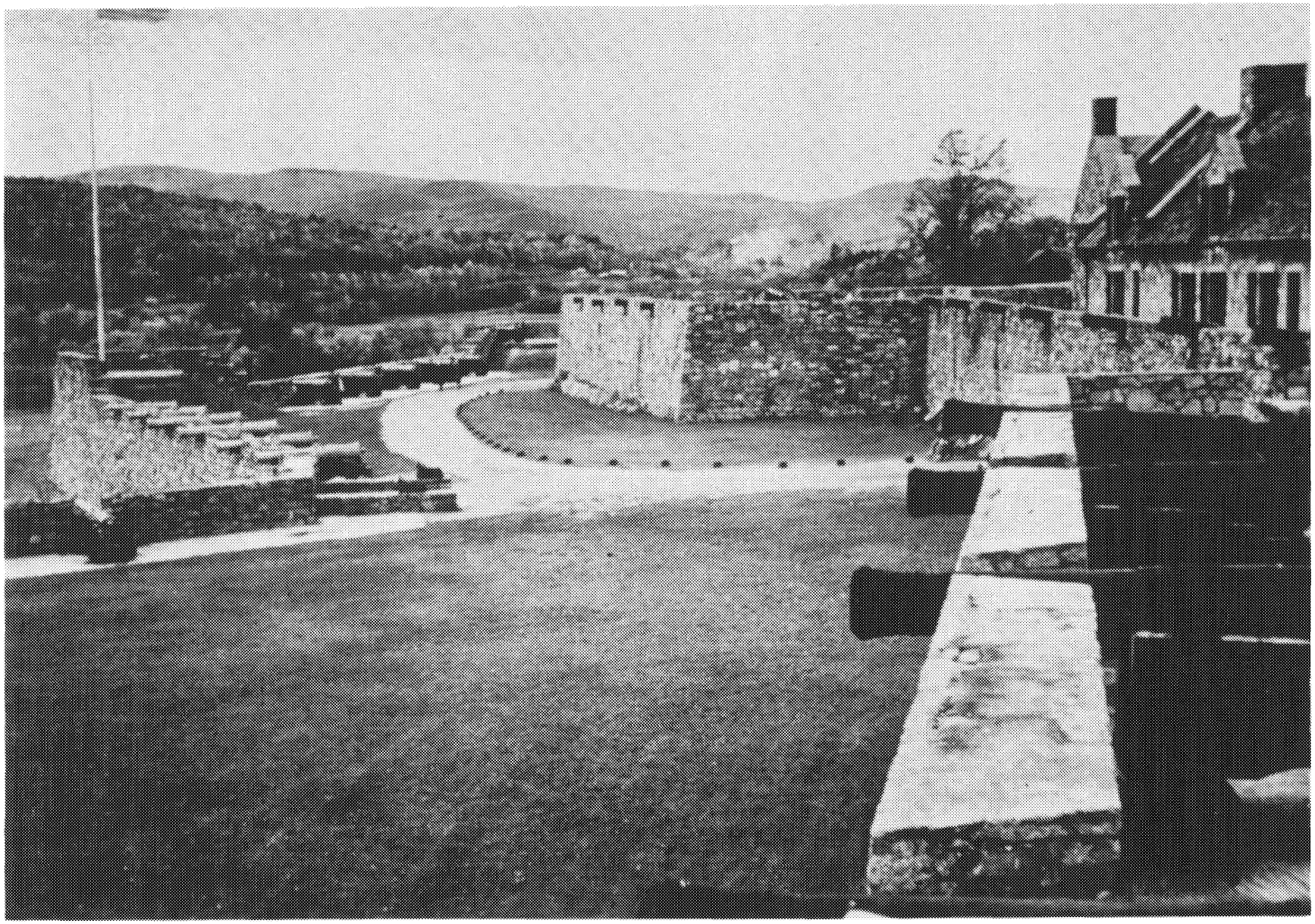
Reservation. Interpretation, however, is at a minimum and much more could be done, through marking, museum development, and literature, to make this imposing group of structures intelligible to the public. The restoration of Fort St. Frederic to its original appearance, as proposed for study by the Joint Committee to Study Historic Sites in 1950, would be entirely feasible from a physical standpoint. Complete plans are available. It would result in a truly spectacular development within sight of the heavily traveled Lake Champlain Bridge, and would be quite comparable to Fort Ticonderoga as a tourist attraction. There is no question, however, that it would be an expensive operation.

72. At Fort Ticonderoga much remains to be done if the structure is to be fully restored. Outside the fort, but within the Fort Ticonderoga Association's holdings, little has been done toward interpreting auxiliary structures. In particular, the French Lines, a group of earthworks about half a mile west of the Fort, where Abercrombie's frontal attack of 1758 was beaten off with heavy loss, are almost completely overgrown and inadequately marked. There appears to be distortion in interpretation here, for Ticonderoga's reputation as a stronghold was based largely on this battle which never reached the Fort itself.

73. Recent commercial development of sites in the general vicinity of Fort Ticonderoga illustrates the great popular appeal of the area, both historically and scenically. Mount Hope, an

outlying post about a mile and a half west of the Fort and occupied by American forces in 1777, has been developed as Fort Mount Hope. This is a small site with fragmentary remains and no major historical significance, but has many visitors. Mount Defiance, the dominating height south of Fort Ticonderoga, from which Burgoyne's artillery threat drove the Americans out of the whole position on the lake, is also under development. An area of 500 acres including the top of the mountain, reached by private toll road, provides a splendid view of the lake and the mountain ranges flanking it. Historical interpretation consists chiefly in a narrative account given at intervals over a loudspeaker. Plans appear to include considerable recreational development along the attractive wooded slopes of the mountain. Coordination of interpretation at the varied historical and semi-historical enterprises in the Ticonderoga area would be helpful in assisting the tourist to understand what took place here.

74. At Lake George the current reconstruction of Fort William Henry will presumably go far toward making the historical significance of this position apparent to the traveler, and will illustrate for him some of the most colorful episodes of the Anglo-French struggle for power in North America. While the nearby Lake George Battleground is State property and has some rather imposing monuments, it is dominated, almost overwhelmed, by the adjoining recreational area



Historic site. Restored Fort Ticonderoga, Lake George, New York. Subregion "C".

and little interpretational work has been done. The need for general recreational facilities at this point seems obvious and there is little likelihood that much can be done to explain the events that took place here between 1755 and 1777. It should not be forgotten, however, that Sir William Johnson's victory here was an important event and that the whole hill east of the Battlefield now covered with picnic tables and campsites was an important fortified position during more than one campaign. Archeological investigation here would undoubtedly be fruitful. If it ever becomes feasible to move the general recreational facilities, the Lake George Battleground can be made into a highly attractive and instructive historical area.

75. There are two sites on the Vermont side capable of illustrating important phases of the Revolutionary campaign of 1777 and inherently attractive enough to be of park caliber. Mount Independence is a plateau about a mile long and a half mile wide, rising abruptly from Lake Champlain to a height of 150 to 200 feet. It is ringed with the remains of earthworks enclosing the ruins of an eight-bastioned fort. It is largely wooded at present and has considerable potential for general recreation, including water sports. Waterfront recreational areas are badly needed in Vermont's park system. There is room enough to keep these activities separate from historical features. Mount Independence faces the restored Fort Ticonderoga and the dramatic height of Mount Defiance. This fortified hilltop,

which formed with Fort Ticonderoga an integral part of the American defensive position on Lake Champlain in 1776-77, was the starting point of the American retreat which led to Hubbardton and, eventually, to Saratoga and victory. Improvement of a few miles of local road would make it readily accessible from Route 22A.

76. Hubbardton Battlefield has been an area of interest to the State of Vermont for a number of years, but the State's holdings are still relatively insignificant and include no development beyond a small monument and a Historic Sites Commission marker. The scene of the action of Hubbardton is a wooded ravine with flanking hilltops. A stream flows through the bottom of the ravine. It was here that Colonel Seth Warner's men were surprised at breakfast. Flanking attacks and counter-attacks swept up and over the adjoining hills. The area necessary to include the scene of the action would be from 200 to 500 acres. It is scenically attractive and could be developed into an excellent historical park, with limited picnic facilities, with a minimum of effort and expenditure. Hubbardton was the only battle of the Revolution fought on Vermont soil and was an important episode in the Burgoyne campaign. Both Mount Independence and Hubbardton Battlefield deserve recognition and development.

77. There are few physical remains along Lake Champlain illustrating the events of the War of 1812. The imposing earthworks built at Plattsburgh were long ago leveled. The Kent-Delord House in the town has associations with the battle, and there is a fine

monument overlooking the bay where Macdonough won his victory in 1814. Probably the most significant physical remains are those associated with the building of the victorious American fleet - the basin at Vergennes where the shipyard was, and the remains of Fort Cassin, at the mouth of Otter Creek, the fort that stood off the British until Macdonough was ready. Otter Creek is still navigable and the National Park Service has popularized a boat trip on the Chesapeake and Ohio Canal of the type which might be used here. Macdonough's fleet and the British ships that he captured lie sunk in the mud at Whitehall. Perhaps the hull of his famous flagship, the Saratoga, could be identified and returned to Vergennes where it was built, as the central feature of a museum development.

78. The Bennington area is lacking in the most effective presentation of the expedition that foreshadowed Burgoyne's downfall in 1777. On the New York side, near the little town of Walloomsac, is the Bennington Battlefield. At the top of the hill that dominates Old Bennington in Vermont is the Bennington Battle Monument. Six or seven miles of winding Revolutionary road, little traveled now, lie between the two. Along this road are stone markers indicating the sites of the Breakenridge Farm, Seth Warner's home, and the camp of General Stark before the battle. There is little or nothing in the interpretation at Bennington Battlefield to attract the traveler to follow the historic road to Old Bennington. This seems a situation

in which a simple cooperative arrangement could be worked out to mutual advantage by installing maps and other devices to direct tourists both ways on "Stark's Route," or some name similarly appropriate.

RECREATION PLAN FOR DEVELOPMENT AND ESTIMATE OF FUTURE USE

79. The recreation plan is offered as a guide for the preservation, development and use of the resources for recreation of the subregion. It is based on current needs and potentialities and is designed to provide for the protection of significant scenic, scientific and historic features. It also provides for the expansion, and, in some instances, redevelopment of existing non-urban public parks, recreational areas and historic sites and the establishment of additional recreational areas utilizing outstanding land and water features.

80. Since the plan deals principally with initial phases of planning, it is not intended to present detailed estimates or to confine developments to specific locations. These would logically follow the adoption of general development plans and would be undertaken by the agencies sponsoring the projects.

81. The principal features of the recreation plan are summarized below:

a. Further development of established public recreational areas, with particular consideration being given to providing additional facilities for picnicking, camping, water recreation, winter sports, hiking trails and natural history interpretation.

b. Establishment of 11 major recreation areas utilizing outstanding lake, river and mountain features.

c. Establishment of 20 major camping areas at strategic locations in the Adirondack and Green Mountains.

d. Improvement of facilities at existing highway wayside areas and the establishment of additional areas at appropriate locations along the principal traveled routes.

e. Establishment of additional sites along major canoe routes and hiking trails for overnight stops, rest stops and for cooking meals.

f. Preservation of wilderness conditions where they exist in the Adirondack and Green Mountains.

g. Establishment of a system of back country scenic routes and tourways to provide access to the scenic and cultural features of the countryside.

h. Full development of the historic features for educational purposes and as tourist attractions.

i. Continued cooperation between public agencies and private groups toward adequately marking, preserving and presenting historic sites.

82. Estimate of future use. - The plans, if carried out, would permit greater opportunities for public use of the lakes, mountains, forests, streams and historic features in connection with recreation. It is conservatively estimated that through further development of the

resources of the subregion for non-urban recreational use, visitor attendance would approach 9,050,000 annually, an increase of 2,750,000 over present use.

83. Cost of the plan. - The estimated development costs, as well as operation and maintenance costs, are for development of public areas only. As set forth in Table 37, the total development costs are $8,625,000, which includes the cost of physical improvement only in the Lake Champlain and St. Lawrence Drainage Basins, and the cost of land and physical improvements in the Lake Memphremagog Drainage Basin. Total annual operation and maintenance costs amount to $313,500 and the total annual costs are estimated at $782,000.

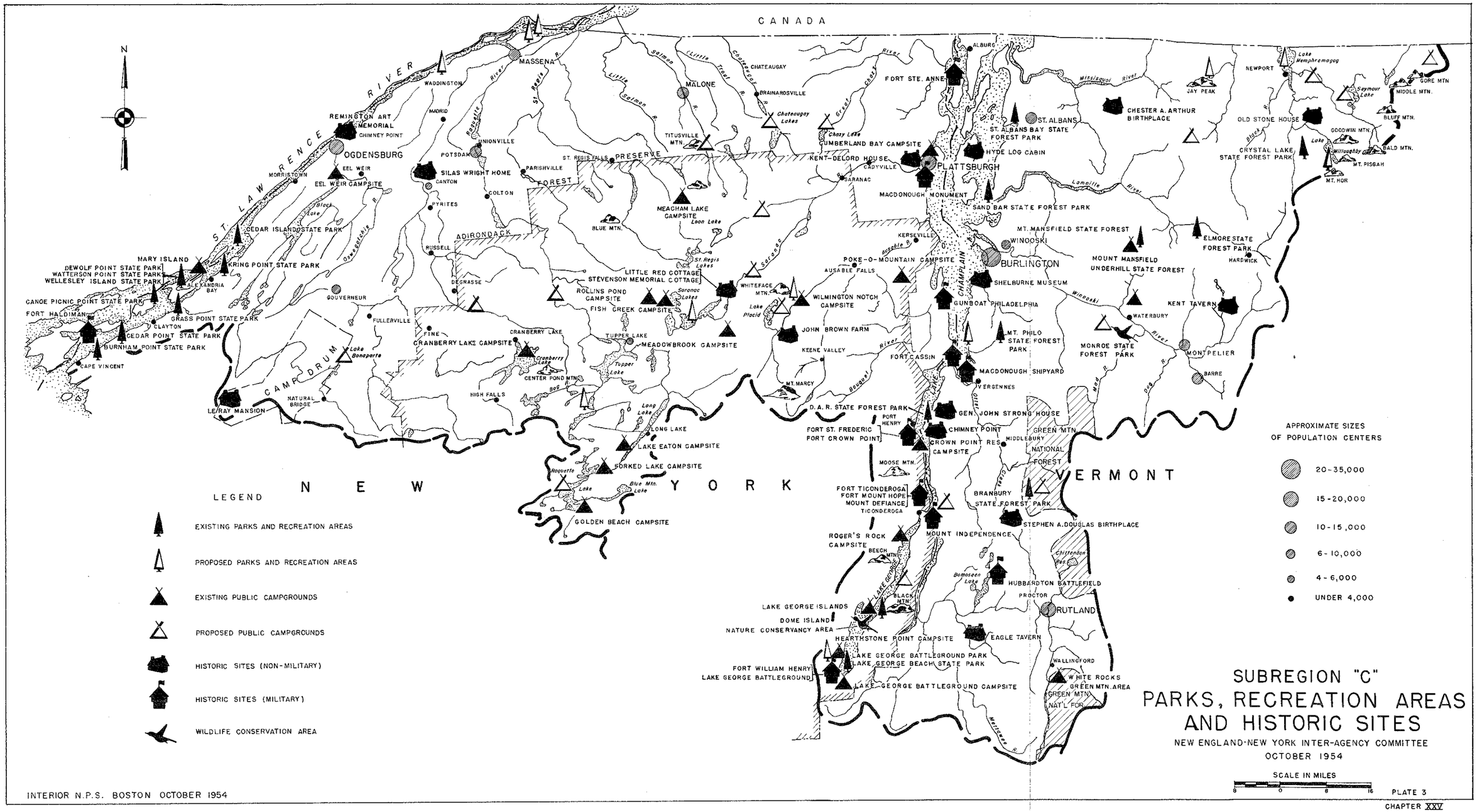
84. Benefits of the plan. - Both tangible and intangible benefits would result from further development of the resources along the lines set forth in the recreation plan. These benefits cannot be fully expressed in monetary terms. However, one indication of the tangible benefits may be found in the economic effects on business and trade of the money spent by visitors using the recreation resources, areas and facilities of the subregion. Such expenditures are estimated to be about $261,500,000 annually. With the development of the subregion in accordance with the proposed recreation plan it is expected that expenditures in connection with non-urban types of recreation would rise to about $302,750,000 annually, an increase of $41,250,000 over present expenditures.

85. Intangible benefits, although they are not measurable in monetary terms, are highly significant and constitute the basic ofjectives of recreational development. They include, among others, contributions to the physical and spiritual health and welfare of individuals as a result of participation in outdoor recreation.

Table 37 - Estimated costs of recreation development, Subregion "C"

Drainage basin	Total cost of development	Total operation and maintenance cost	Total annual cost
Lake Memphremagog	$ 1,320,000	$ 41,000	$ 112,600
Lake Champlain	4,910,000 *	169,000	435,600
St. Lawrence	2,395,000 *	$103,500	233,800
Totals	$ 8,625,000	$ 313,500	$ 782,000

* Does not include cost of land.



SUBREGION "C"
PARKS, RECREATION AREAS AND HISTORIC SITES

NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE
OCTOBER 1954

INTERIOR N.P.S. BOSTON OCTOBER 1954

PLATE 3

CHAPTER XXV

SECTION XI - LAND MANAGEMENT

GENERAL

1. Subregion "C" comprises an area of mountains in Vermont and New York, and the adjacent foothills and nearly level plains to the north and west. It makes up 12 percent of the New England-New York Region, and shows a wide range of topography, vegetation and soil conditions.

2. The most suitable lands in Subregion "C" have been used for the production of agricultural crops for the past 150 to 200 years. The remainder of the land surface has been maintained in forest cover and most of it has been cut over for forest products several times.

3. Despite many decades of experience in managing the farm and forest resources of the area, many questions relating to resource use remain unsettled. Questions of particular importance at the present time relate to: (a) the abandonment of agricultural lands, (b) the generally high cost of agricultural production which stems from relatively infertile soils and long, rather severe winters, (c) problems related to the prevalence of poor quality forest stands, and (d) relative distance from milk consuming centers.

4. Physical characteristics. - Physiographic features are dominated by: (a) the lake plain, which is referred to as the St. Lawrence-Northern Adirondacks Border Area, (b) the Adirondack Mountain and Border Area which forms the headwaters of the St.

Lawrence Drainage Basin; (c) the Champlain Lowland; (d) the Northern New England Upland and Plateau Area; (e) the Slate and Limestone Area; and (f) the Green Mountains.

5. The topography ranges from practically level areas in the lake plain to rugged mountainous areas with many peaks above 3,000 feet. However, much of the agricultural area is a transition zone from lowland to mountains and may be thought of as a broad valley.

6. The subregion has a cool humid climate with some tempering effect of the lakes, and a frost free growing season of from 120 to 170 days. Precipitation is moderate to heavy and is rather well distributed throughout the year.

7. Soils. - The soils on most of the lake plain and the Champlain Lowland were formed from sediments laid down under water. The majority of them are heavy silts and clays, but there are also extensive areas of sandy alluvial soils and some shallow soils developed on limestone. Most of the soils except the sandy outwash areas show the influence of limestone which is the principal bedrock in many areas. Many of the soils are imperfectly to poorly drained. The mountainous and foothill areas are characterized by stony soils of glacial till origin, mostly from crystalline bedrocks. Soil textures are satisfactory for production of most crops in the Vermont portion, while in New York the sandy soils are near marginal or marginal.

8. This wide range of soil conditions presents many management and utilization problems. The soils are reasonably productive, and respond well to treatment. High quality forage production is a notable asset of the subregion.

LAND USE

9. In terms of acreage the most important use of land in the subregion is for the production of timber and other forest products. In the aggregate, the farm and non-farm forests of the area occupy approximately 58 percent of the total land area (Table 38). About 48 percent of the total land area is included in farms and about one-third of this is wooded. Except for woodland more acres are used for pasture production than for any other purpose. About 1.7 million acres are used for this purpose and nearly a million acres are used for forage crops, principally hay. More than 5 percent of the land area is used for roads, railroads, residential, commercial and other non-agricultural purposes. Some changes in these uses are expected to result from the St. Lawrence Seaway and Power Project.

10. Cropland. - About one-fourth of the land classified as cropland by the 1950 Census was used only for pasture or was idle. Of the 1,274,410 acres harvested, more than 82 percent was used for hay crops, 8 percent for row crops, and slightly less than 9 percent for small grains. Fruit, nuts and grapes make up only 0.7 percent of the principal crops (Table 39). The important row crop is corn

Table 38 - Use of land, Subregion "C"

Type of use	Area 1/	Portion of total
	Acres	Percent
Farm land		
Cropland 2/	1,710,810	19.2
Pasture land (open)	999,157	11.2
Woodland	1,439,009	16.1
Other farm land	147,316	1.7
Subtotals	4,296,292	48.2
Non-farm land		
Forest land	3,705,891	41.6
Water area	463,040	5.2
Roads, railroads, cities, towns, etc.	445,689	5.0
Subtotals	4,614,620	51.8
Total area	8,910,912	100.0

1/ Developed from the 1950 Census of Agriculture.
2/ Includes 769,000 acres used only for pasture.

for silage, with potatoes, vegetables and beans contributing only a small part of the row crop percentage. The most important small grain is the oat crop, a large acreage of which is harvested as hay. Most of the area's production is from dairying with other crops being secondary.

11. Forest land. - A wide range of forest types and species are found on the approximately 5,100,000 acres of land in forest use.

Table 39 - Acreage of principal crops, Subregion "C"

Crop	Acres 1/	Percent of total
Corn	93,320	7.3
Potatoes	8,310	0.7
Vegetables	2,240	0.2
Dry field and seed beans	740	0.1
Other row crops	460	2/
Mixed grains	16,750	1.3
Oats	88,920	7.0
Grain hay	42,230	3.3
Other close seeded crops	6,800	0.5
Alfalfa hay	43,070	3.4
Clover-timothy	729,290	57.2
Other hay	221,410	17.4
Grass silage	11,980	0.9
Fruit, nuts and grapes	8,890	0.7
Total cropland harvested	1,274,410	100.0

1/ Developed from the 1950 Census of Agriculture.
2/ Less than 0.1 percent.

The major types are (a) spruce-fir, common to mountainous sections; (b) northern hardwoods, generally distributed throughout the subregion; and (c) white pine, best adapted to light sandy soils but widely distributed throughout the subregion and of major importance in the forest economy.

12. Principal softwood species are spruce, fir, white pine, and hemlock with smaller amounts of larch, pitch pine, red pine and northern white cedar. Hardwoods are principally beech, white and

yellow birch, maple, basswood, ash, aspen, white oak, and red oak with relatively smaller amounts of hickory, elm, gray birch, and black cherry.

13. Subregion "C" contains practically all of the major forest types of the northeast except the oak-hickory type. Present types are highly susceptible to encroachment of undesirable species and temporary types since so much of the area is in a transitional zone between types. A large percentage of the present forest area supports stands composed primarily of low grade hardwoods.

FARMLAND

14. Value of farm production. - Farm product sales, the major source of income for farm people, amounted to about 200 million dollars in 1949. About 88 million dollars or nearly 80 percent of the total was derived from the sale of dairy and poultry products (Table 40). The second largest income came from the sale of other livestock products and made up slightly more than 12 percent of the total. The other 8 percent is distributed among field crops, vegetable, fruits, horticultural specialties and forestry products.

15. Farm characteristics. - In addition to physical features, land use and production data, other characteristics of the subregion's agriculture should be noted. Virtually all business decisions concerning the use of farm land resources are made by individual farm operators on about 24,000 farms. These 24,000 farms represent almost every conceivable situation with respect

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Table 40 - Value of farm product sales in 1949, Subregion "C"

Products	Value 1/	Portion of total
	Thousand dollars	Percent
Crops		
Field crops	3,230	2.9
Vegetables	481	.4
Fruits	1,583	1.5
Horticultural specialties	540	.5
Subtotal	5,834	5.3
Livestock products		
Dairy products	81,855	74.5
Poultry products	5,625	5.1
Other	13,549	12.4
Subtotal	101,029	92.0
Forest products 2/	2,989	2.7
Totals	109,852	100.0

1/ Developed from 1950 Census of Agriculture.
2/ Based largely on stumpage value of forest products sold from farms.

to size, adequacy of capital resources and adequacy of equipment.

16. One of the striking features concerning Subregion "C" is the number of large and relatively large farms. Over 16,000 farms, or 69 percent of the farms, are larger than 100 acres. In addition 15 percent fall into the 50- to 99-acre group, leaving only 16 percent in the less than 50-acre group (Table 41).

Additional data from the 1950 Census of Agricultural classification show that three-fourths of the total farms in the subregion are commercial and one-fourth are non-commercial. Almost one-half of the commercial farms have an annual gross income of from $5,000 to $25,000 or more with three-fifths of this number in the $5,000 to $9,999 income group. Only one-fifth are below the gross annual income figure of $2,499. About 6.8 percent of the total number of farmers either have their major interest (in terms of income) elsewhere, are of an age where a larger unit is of no interest or are severely limited in capital resources.

Table 41 - Approximate distribution of farms by size groups, 1/ Subregion "C"

Size class	Number of farms	Percent of total
Less than 10 acres	1,215	5.1
10 to 49 acres	2,580	10.8
50 to 99 acres	3,564	15.0
100 to 219 acres	9,714	40.9
More than 220 acres	6,751	28.2
Totals	23,824	100.0

1/ Source: 1950 Census of Agriculture.

17. The material previously presented is intended to a large measure to describe the general character of agriculture and types of farming in Subregion "C". Some other pertinent features of the

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farms are listed below:

a. The great bulk of the farmers, amounting to about 95 percent of the total, own all or part of the land which they operate.

b. Most of the farms are served by electric power lines and a majority have telephone service. Roads between farms and markets are generally adequate.

c. There are a number of commercial farms that are not adequately equipped with modern machinery and equipment. About 20 percent of all farms selling whole milk, for example, did not have milking machines in 1950.

FOREST LAND

18. Forest conditions. - Approximately 80 percent of the forest land is in private ownership. The balance is owned by States and other local political units. No accurate count is available of the number of private owners controlling the approximately 4,000,000 acres of private land. An estimated 24,000 farmers own approximately 1,400,000 acres or slightly less than 60 acres per owner. An additional 500,000 acres are in ownerships of over 5,000 acres and controlled by about 50 owners. The remaining 2,000,000 are in small ownerships averaging about 300 acres per owner and held by about 7,000 owners.

19. Timber harvesting operations have been carried on over a period of some 200 years in this area. These harvesting operations have not been aimed at improving the residual stand but have been of a "high grading" nature. Consequently, the quality of most of the stands, as reflected in species distribution and in size of tree and quality of product, has consistently declined. At the present time a large percentage of the forest area supports a poor stand of culls and undesirable trees. On such stands much of the current growth is unusable either because it occurs on cull trees of good species or because it occurs on weed species.

20. Farm forest land. - Slightly over one-half of the forest land in farm ownership or about 770,000 acres, is currently grazed by livestock. This practice prevents effective reproduction, affects stand densities, causes soil compaction, and reduces growth.

21. A substantial portion of the taxes in Subregion "C" is now secured on its forest land. A major problem exists in the development of a fair and reasonable method of taxing forest land. Several methods of taxing forest lands are in current use, with corresponding lack of uniformity in methods. Under some taxing procedures it is apparent that taxing policy prevents the initiation of good forest management.

22. Practically all of the small farm owners have marketing problems. The absentee owner is usually unfamiliar with his timber tract and with the prospective purchaser. He has little or no

Forestry practices. Selection and designation of trees to be harvested. Subregion "C".

knowledge of the products that should be produced from his stumpage such as veneer logs, handle stock, dimension, pulpwood or fuelwood and is at the mercy of the local operator when a sale is made. Under such conditions a landowner may develop a somewhat deflated idea of the value of his forest products.

PROBLEMS IN THE CONSERVATION OF LAND RESOURCES

23. Land use adjustment. - An important management problem on many farms is the limited amount of first class agricultural land. The predominant agricultural soils are lacustrine and glacial till, with considerable lime influence. Most of these soils are heavy and are imperfectly to poorly drained. The more sandy soils occur in the Adirondack Mountain area. Many of these soils are stony and low in both water holding capacity and natural fertility. It is of interest to note that 56 percent of the St. Lawrence Drainage Basin and 71 percent of the combined Lake Champlain - Lake Memphremagog Drainage Basins occur in the mountains and foothill or border areas. Potential crop or pasture production may be so low in the foothill and border areas, especially on fields that are steep or located at great distances from farmsteads, that the lands involved cannot be economically operated. This situation prevails on many dairy or livestock farms, and is partly reflected in the acreages of cropland not harvested and not pastured.

24. Existing though rather limited land use capability data indicate that in the subregion about 1.0 percent of the land

presently used for crops should be forested, and an additional 4.0 percent should be devoted only to pasture or permanent grass cover. Another 2.4 percent of the present cropland should be used only for long-term grass. Almost 7.0 percent of the land presently designated as pasture should be retired to trees in accordance with safe land use principles. Table 42 ,indicating anticipated land use adjustments on land in farms, shows changes planned for the purpose of improving operational methods on individual farms, as well as the changes required by land capabilities.

25. Wetlands. - A National inventory of wetlands is currently being conducted by the U. S. Fish and Wildlife Service in cooperation with the U. S. Soil Conservation Service and the State fish and wildlife agencies. One of the anticipated results of this inventory will be the delineation of wetlands possessing a high value for waterfowl use in their present condition and those of low value on which drainage would be unobjectionable from the waterfowl standpoint.

26. Improvement measures on open land. - The more intensive use of the valley lands and of lands on the lower hill slopes located conveniently near to farm buildings may increase erosion hazards and the need for drainage improvement. For this reason attention must be given to proper conservation and drainage measures on lands remaining in cultivation or pasture. Since erosion losses are greatest on land in clean tillage, and of little consequence on land protected by permanent, close-growing vegetation,

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Table 42 - Anticipated land use adjustments on farmland, Subregion "C"

Present land use 1/		Anticipated use, 1975						
Type of use	Land area	Rotation cropland	Other hay	Permanent pasture	Orchard	Woodland	Other land	Urban industry
	acres	acres	acres	acres	acres	acres	acres	acres
Rotation cropland	1,480,600 2/	1,313,840	35,240	60,880	-	8,460	57,280 3/	4,900
Other hay	221,400	-	199,560	10,320	-	5,740	5,000 3/	780
Permanent pasture	999,100	36,350	8,200	865,050	-	62,000	24,300	3,200
Orchard	8,800	-	-	-	8,770	-	-	30
Woodland	1,439,100	1,800	100	26,100	-	1,406,010	-	5,090
Other land	147,300	-	-	-	-	2,000	144,830	470
Totals	4,296,300	1,351,990	243,100	962,350	8,770	1,484,210	231,410	14,470

1/ From 1950 Census of Agriculture.
2/ Includes row crops, small grain, rotation hay and hay pasture, and 118,900 acres of cropland not pastured and not harvested.
3/ Land which will not be needed by 1975 according to anticipated food requirements, but is available if needed, and for which there is no change in use recommended.

a conservation program for open lands should consist of (a) devoting as much cropland to grass as is possible consistent with individual farm requirements, (b) applying proper conservation and drainage measures to cropland and pasture and (c) managing the land to attain optimum conservation and production.

27. On rotation cropland, erosion control normally can be obtained through improved rotation and by contour or graded strip cropping and sod waterways. Excess surface run-off, as expected on long slopes or heavy soils of low permeability for water, may necessitate the use of diversions or terraces. The diversions or terraces may also improve drainage. Some rearrangement of fields to facilitate strip cropping and construction of diversions or terraces is needed, and this often involves removal of stone walls or hedgerows. The practices of seeding and management of permanent pastures, including fencing to control grazing, are aimed at establishing and maintaining adequate grass cover. Clearing some pasture areas of stone or brush is recognized as both feasible and practical. Drainage improvements on nearly level land would permit more intensive productive use of such land, and tend to compensate for the retirement of steep crop and pasture lands. Improvement measures suggested are in addition to those applied under existing programs. The tendency of dairy farmers to grow more grass and less corn reduces the erosion hazards and may increase the total livestock carrying capacity of individual farms.

28. Tables 43 and 44 indicate the suggested capital improvements on open farm lands, and the acreages of periodic (annual) practices needed to supplement the practices now in use. Wide variation in measures needed and applied on individual farms is to be expected.

Table 43 - Capital improvements needed on open farm lands, Subregion "C"

Type of improvement	Unit	Quantity
Erosion control		
Strip cropping	acre	180,000
Diversions	mile	1,785
Other 1/	acre	8,450
Seeding permanent pasture	acre	39,000
Land clearing	acre	67,300
Fencing to distribute grazing	mile	4,550
Drainage	acre	245,652
Farm ponds	each	7,650

1/ Mostly sod waterways.

Table 44 - Acreages of annual or periodic practices to supplement existing openland practices, Subregion "C"

Practice	Acres
Fertilizing rotation hay and pasture	791,200
Fertilizing permanent pastures	77,200
Fertilizing cultivated crops	264,820
Liming crops and pastures	942,640
Other practices	
Cultivated crops	78,600
Hay and pasture lands	178,860

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29 Improvement measures on forest land. - The major problem is the development of a satisfactory growing stock of desirable species. There are several steps to be carried out to accomplish this. First and most important is the development of new industries based on the utilization of low quality forest products. Next, and nearly as important, is the application of the taxing prerogative on forest lands. A yield tax or a combination yield and annual land tax appears to provide the most logical solution to the taxation problem. Cooperative marketing, integrated logging and utilization, improved forest credit, and additional technical assistance to land owners are other means which would aid in solving the forest land problem.

30. Actual physical measures proposed for the forest land of the subregion include but are not limited to: (a) disease and insect control; (b) planting trees on about 354,000 acres; (c) timber stand improvement on about 734,000 acres of forest land; (d) erosion control on 700 miles of access and logging roads; (e) 3,100 miles of fencing to protect woodland from livestock; (f) construction of about 300 miles of access roads and trails in forest areas; and (g) construction of about 20 miles of telephone lines.

31. The development of an integrated logging operation is needed to convert standing timber into its proper product. Under present conditions an operation is usually carried on to produce either sawlogs or pulp or occasionally both. No attempt is made

Tree planting project on land of marginal agricultural value. Subregion "C".

to sort out veneer logs, handle stock, or other high quality material and great quantities of high quality stumpage goes into low quality products. The removal of unmarketable trees by other means than logging appears feasible.

ECONOMIC JUSTIFICATION OF LAND MANAGEMENT MEASURES

32. The ultimate justification of the measures previously described is of two sorts. First, the measures provide some assurance that the increasing food and fiber needs of the subregion and Nation are met; and second, the measures, when installed in appropriate combinations on individual farms according to soundly conceived time schedules, would add to the material welfare of the farm families involved. The program for the subregion was formulated with the above considerations in mind. Each measure was included in the program with the thought in mind that it would return benefits in excess of costs.

33. As partial justification for the program, all possible costs and returns of a tangible nature have been summarized and compared. In some instances, other values of more intangible and subjective character have been identified and described.

34. Tables 45 and 46 summarize the cost and benefit calculations. Table 45 shows an aggregate installation cost for the program of slightly less than 66 million dollars with an annual amortization charge of about 3 million dollars, and an annual maintenance cost of about 13.3 million dollars, or a total annual cost of about

16 million dollars. This compares with an average annual benefit of more than 18 million dollars. Based upon these figures, the benefit-cost ratio for the program would be 1.1 to 1.

Table 45 - Estimated cost of improvement measures, Subregion "C"

Measures	Installation cost (dollars)	Annual charge 1/ (dollars)	Annual O&M 2/ (dollars)	Total annual cost (dollars)
Openland measures:				
A. Capital improvements				
Erosion control	3,301,400	153,680	145,750	299,430
Drainage improvement	8,801,530	409,712	374,300	784,012
Land clearing	2,624,700	122,180	-	122,180
Farm ponds	3,060,000	142,443	153,000	295,443
Other	1,872,500	87,164	111,200	198,364
Subtotals	19,660,130	915,179	784,250	1,699,429
B. Periodic practices				
Fertilizer and lime	-	-	10,663,160	10,663,160
Other	-	-	1,564,990	1,564,990
Subtotals	-	-	12,228,150	12,228,150
C. Facilitating measures	14,891,000	693,176	-	693,176
Subtotals	34,551,130	1,608,355	13,012,400	14,620,755
Forestry measures:				
Tree planting	7,221,000	319,168	-	319,168
Timber stand improvement	16,233,000	717,499	-	717,499
Other measures	7,607,500	336,252	302,200	638,452
Subtotals	31,061,500	1,372,919	302,200	1,675,119
Grand totals	65,712,630	2,981,274	13,314,600	16,295,874

1/ Installation costs for openland measures amortized over a 50-year period; and for forestry measures a 60-year period was used.

2/ Operation and maintenance.

Table 46 - Annual benefits anticipated from land treatment and management measures, Subregion "C"

Type of benefit	Annual value
	(dollars)
Increased crop and pasture production on openland 1/	
Forage crops	14,173,000
Other crops	1,304,000
Increased timber production 2/	2,714,000
Reduction of soil erosion damage	104,000
Reduction of flood water damage 3/	30,000
Total	18,325,000

Based on long range projected prices.

1/ Gross value of production less estimated costs of harvesting, storing, marketing, etc.

2/ Converted to annual equivalent values by using a 4 percent interest rate.

3/ Floodwater damage is that in the headwaters, above the main stem and tributary damage zones.

Table 45 - Estimated cost of improvement measures, Subregion "C"

Measures	Installation cost (dollars)	Annual charge 1/ (dollars)	Annual O&M 2/ (dollars)	Total annual cost (dollars)
Openland measures:				
A. Capital improvements				
Erosion control	3,392,400	157,916	155,750	313,666
Drainage improvement	5,776,190	273,537	218,200	491,737
Land clearing	2,624,700	122,180	-	122,180
Farm ponds	3,060,000	142,443	153,000	295,443
Other	1,439,600	67,013	111,200	178,213
Subtotals	16,292,890	763,089	638,150	1,401,239
B. Periodic practices				
Fertilizer and lime	-	-	9,799,860	9,799,860
Other	-	-	1,488,840	1,488,840
Subtotals	-	-	11,288,700	11,288,700
C. Facilitating measures	14,891,000	693,176	-	693,176
Subtotals	31,183,890	1,456,265	11,926,850	13,383,115
Forestry measures:				
Tree planting	7,221,000	319,168	-	319,168
Timber stand improvement	16,233,000	717,499	-	717,499
Other measures	7,607,500	336,252	302,200	638,452
Subtotals	31,061,500	1,372,919	302,200	1,675,119
Grand totals	62,245,390	2,829,184	12,229,050	15,058,234

1/ Installation costs for openland measures amortized over 50-year period; and for forestry measures a 60-year period was used.
2/ Operation and maintenance.

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Table 46 - Annual benefits anticipated from land treatment and management measures, Subregion "C"

Type of benefit	Annual value
	(dollars)
Increased crop and pasture production on openland 1/	
Forage crops	14,387,000
Other crops	1,008,000
Increased timber production 2/	2,714,000
Reduction of soil erosion damage	104,000
Reduction of floodwater and sediment damage 3/	228,000
	18,441,000

1/ Gross value of production less estimated costs of harvesting, storing, marketing, etc.

2/ Converted to annual equivalent values by using a 4 percent interest rate.

3/ Floodwater damage is that in the headwaters, above the main stem and tributary damage zones.

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SECTION XII - MINERALS

MINERAL INDUSTRY

1. In Subregion "C" the variety of mineral raw materials is probably as great as in any other equal area in the United States (Table 47). The mineral industry based on these raw materials is of great importance, not only to the economy of the parts of New York and Vermont in the subregion, but as a source of essential materials for the manufacturing and construction industries of other parts of the United States.

2. Minerals and rock materials used in the active mineral industries are: asbestos, clay, granite, iron ore, limestone and dolomite, marble, sand and gravel, sandstone, slate, slate granules and flour, talc, wollastonite (with byproduct garnet), zinc and lead with silver and byproduct pyrite concentrate. In the past copper, feldspar, graphite, kaolin, ocher, phlogopite and muscovite mica, manganese, quartz, and whetstones were produced.

3. Asbestos has been known in Lamoille and Orleans Counties of Vermont since the early eighties and production has been almost continuous since about 1929. The major production since 1943 has come principally from the east slope of Belvidere Mountain. In 1953 about 90 percent of the United States production came from this area.

Table 47 - Mineral production, Subregion "C"

Product	State	1947	1948	1949	1950	Value 1950
Iron ore, usable, long tons	New York	2,514,000*	2,932,000*	2,345,000*	2,917,000*	$27,915,000*
Lead, recoverable content of ore, short tons	New York	1,496	1,231	1,317	1,484	401,000
Lime, short tons	Vermont	Concealed	22,743	28,914	32,843	416,000
Silver, recoverable content of ore, troy oz.	New York	22,000	19,000	18,000	33,000	30,000
	Vermont	21,000	25,000	27,000	28,000	25,000
Slate, short tons	New York	141,780	125,520	122,180	151,160	2,055,000
	Vermont	Concealed	192,940	184,040	238,740	4,472,000
Stone**, short tons	Vermont	392,000	395,000	442,000	447,000	8,039,000
Talc, short tons	New York	Concealed	119,716	115,636	163,974	4,040,000
	Vermont	77,327	70,922	64,508	72,135	906,000
Wollastonite, short tons	New York	80	75	500	800	16,000
Zinc, recoverable content of ore, short tons	New York	34,116	34,256	37,973	38,321	10,883,000
Asbestos, clays and other undistributed	Vermont	$5,480,000	$2,407,000	$3,582,000	$4,038,000	4,038,000
					Total	$63,236,000

*Includes production from McIntyre mines, Lake Sanford, New York (in Subregion "E").

**Granite and marble only.

4. Clay is used at one plant to supply the local brick needs in the vicinity of Burlington, Vermont.

5. The Barre district, Washington and Orange Counties, Vermont, is the major producing area in the United States of monumental granite and formerly had a considerable output of dimension stone. Granite was also quarried in St. Lawrence County, New York, and in the vicinity of Derby, Orleans County, Vermont, near Lake Memphremagog. Most of the former producers of monumental and dimension stone are now quarrying small quantities of rough building stone, road metal, and aggregate, mainly for local uses.

6. The largest part of the iron production of the subregion and, in fact, of the entire State of New York, has come from magnetite deposits which occur in a wide belt from central St. Lawrence County, northwest of the Adirondacks, to Clinton and Essex Counties near Lake Champlain. Magnetite was originally discovered in 1824 in the Mineville district, Essex County. This deposit later developed into the New Bed-Harmony mine which has been in almost continuous production since that time. The Chateaugay Mine, Lyon Mountain district, Clinton County, was first opened in 1867 and about 1941 it became the second most important iron mine in the Adirondack region. The ore is exceptionally low in phosphorus and other impurities. Deposits in St. Lawrence County, near Benson Mines and Clifton Furnace were discovered in 1858. The Benson mine, in continuous operation since 1941, has an annual production of

about 4 million tons of crude ore. The high purity of the iron concentrate produced here is of great importance in special steel alloys and the concentrate commands premium prices.

7. In the past considerable amounts of limestone and dolomite were used for dimension stone, but now most of it is used for burned lime, crushed stone, agricultural stone, and flux. Limestone and dolomite occur in most parts of the subregion from Cape Vincent, Jefferson County, New York, in the St. Lawrence River Basin, eastward to the Lake Memphremagog Basin.

8. The marble deposits in the Otter Creek Valley between Brandon and Danby, Vermont, are some of the most important in the world. Quarries are active at Proctor and Rutland.

9. Sand and gravel are widespread and large quantities have been used. Requirements of these materials for road metal and other construction materials are mainly met from local deposits in all parts of the subregion.

10. The only known commercial grade colored slates in the United States occur in the Vermont-New York slate district, which ranks second to Pennsylvania in the production of slate. The principal deposits occur along or near the New York-Vermont border from Rutland County, Vermont into Washington County, New York. Most of the slate produced in the subregion is used for roofing or as granules and flour in asphaltic shingles and special surface mixtures. In 1951, the output of 42 operations was valued at about $6,000,000.

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11. The Gouverneur district in New York has been the leading domestic source of industrial talc since 1880. In 1952, New York ranked first among the industrial talc producing states, its sales of about 153,000 tons with a value of about $4,000,000 having exceeded the combined value of the output of the next three states. Vermont is a large producer of talc -- most of it coming from Lamoille and Washington Counties.

12. Eight hundred tons of wollastonite was produced at Willsboro, Essex County, New York in 1950 valued at $16,000. Later production figures are not available. The wollastonite has been used mostly in the manufacture of ceramic materials and as a chemical raw material in welding rod coatings. Garnet is recovered as a byproduct and is stockpiled for future abrasive use.

13. In 1950, the Balmat and Edwards zinc mines in St. Lawrence County, New York, ranked third and eleventh among individual zinc mines in the United States. The combined production, 38,321 tons, places St. Lawrence County fifth among the zinc producing counties in the United States. Sphalerite, the principal ore of zinc, was discovered in St. Lawrence County in 1835 in the area where the Balmat mine was developed and began operations in 1930. Since 1949, it has been one of the top ranking domestic zinc mines. The Edwards mine was discovered in 1903 and commenced large scale operations in 1915.

GEOLOGIC MAPPING AND INVESTIGATIONS

14. About 60 percent of the bedrock of the subregion has been mapped geologically on a scale of 1 inch to 1 mile or larger. About 56 percent of that part of the subregion in New York and a small part in Addison and Rutland Counties, Vermont have been surveyed by airborne magnetometer.

15. Special geologic maps have been made of many small areas, usually in the vicinity of known mineral deposits. The U. S. Bureau of Mines diamond drilled iron, lead, and zinc prospects in the New York section of the subregion and the U. S. Geological Survey has explored talc deposits in the Vermont section by diamond drilling.

16. Several mineral resource and bedrock investigations are in progress or have been completed recently. Detailed geologic mapping of the Grenville series of the Gouverneur quadrangle has been completed by the U. S. Geological Survey and reports on the geology and the talc deposits of the Gouverneur quadrangle are to be published by the Geological Survey.

17. Reports on a deposit of high-grade crystalline dolomite near Gouverneur and on the pyrite deposits of Jefferson and St. Lawrence Counties were published recently by the New York State Science Service. A report on the magnetite deposits and magnetic anomalies in St. Lawrence County, New York is in preparation by the U. S. Geological Survey.

18. The geology of the northwestern Adirondacks, and the relationship of the metallic oxide minerals and magnetic anomalies

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are being investigated by the U. S. Geological Survey and mapping of the bedrock geology in the northeastern Adirondacks is being continued.

19. The sand, gravel, and clay deposits of the St. Lawrence lowland were investigated in 1953 as materials for possible economic use.

20. The New York State Science Service is remapping on a large scale the bedrock geology of the Port Henry-Elizabethtown area, and investigating its mineral resources. The U. S. Geological Survey is mapping the bedrock geology of the quadrangles which cover the asbestos and talc-bearing serpentines in central and northern Vermont, and has completed field work on bedrock geology of the Barre, Montpelier, and Hyde Park quadrangles. The State Geological Survey is mapping the bedrock geology of the Irasburg and Jay Peak quadrangles, Vermont. General geologic mapping in the Champlain Lowland area in Vermont has been sponsored chiefly by colleges and universities.

GENERAL GEOLOGY

21. The subregion is underlain by a variety of rocks which contain many kinds of mineral deposits. The bedrock determines the major topographic features and the surficial deposits form the minor features. The Adirondack, Green and Taconic Mountains are underlain in large part by metamorphic rocks, and large igneous intrusive masses form the mountain peaks in the eastern Adirondacks. The

bedrock of St. Lawrence and Lake Champlain lowlands consists of limestone, dolomite, shale, and sandstone. In Vermont, the valley of Otter Creek, partly separated from the Champlain Lowland by the Taconic Mountains, is carved in marble and quartzite.

22. Surficial geology. - The surficial materials in Subregion "C" include residual deposits which are accumulations of weathered material overlying the bedrock; deposits left by a continental glacier that covered the New England-New York area in the recent geologic past; deposits resulting from a marine invasion as the glacier retreated, and recent deposits such as river alluvium and accumulations in swamps, bogs, and lakes.

23. The residual deposits, consisting of clay containing small deposits of manganese and iron, are discontinuous, and are restricted to the area along the western foothills of the Green Mountains.

24. Materials deposited by glacial processes are extensive and widespread. Till, a mixture of clay, silt, sand, gravel, cobbles, and boulders deposited directly by the ice, covers most of the valley walls and upland areas, and caps some of the lower mountains. Materials deposited by glacial processes and reworked by meltwater and collectively called outwash occur mainly in the lower parts of valleys and in the lowlands of the subregion. The outwash deposits consist chiefly of stratified sand and gravel and form topographic features known as outwash plains, terraces, kames, and some eskers. The outwash plains and terraces are most prominent

in broad, open valleys. In places near the mouths of some of the streams tributary to Lake Champlain the outwash deposits overlie till as well as bedrock and merge with deltas. Clay and silt (varved clay) deposits formed on the bottoms of glacial lakes occur in some of the major stream valleys. Marine clays deposited along the shore of Lake Champlain during the retreat of the glacier in general overlie the till and outwash deposits.

25. Bedrock geology. - The regional bedrock geology can be summarized most effectively by describing each of the major physical divisions of the subregion.

26. In the western and northern foothills of the Adirondack Mountains, in northern Jefferson and western St. Lawrence Counties, New York, the bedrock is chiefly metamorphosed sedimentary rock intruded by bodies of igneous rock that range in composition from gabbro to granite. The metamorphic rocks consist mainly of gneiss, marble, and schist. These rocks are pre-Cambrian in age.

27. In the St. Lawrence Valley and western part of the Lake Champlain Lowland sandstone, limestone, shale and dolomite overlap and dip gently north and east away from the Adirondack uplift, here composed, for the most part, of older intrusions of anorthosite, granite, syenite, and gabbro. In the eastern foothills of the Adirondacks, limestone, shale, and sandstone overlie older metamorphic and igneous rocks. The sedimentary rocks dip gently eastward, underlie most of the Lake Champlain Lowland, and form the western foothills of the Taconic Mountains. The valley of Otter

Creek between the Taconic and Green Mountains in Vermont, is formed chiefly in folded beds of marble.

28. The Taconic and Green Mountains are made up of folded slate, phyllite, and schist; slate and phyllite are most common in the Taconic Mountains and overlie the marble and limestone, at least locally.

29. Most of the metamorphosed intrusives (serpentine), which contain asbestos and talc deposits, occur on the east flank of the Green Mountains and extend southward from the Canadian border to, and beyond, the southeastern edge of the subregion. These serpentinitic rocks are commonly associated with metamorphosed volcanic rocks such as greenstone and amphibolite.

30. The principal geologic structures of the subregion are: (1) the Adirondack dome, or uplift, composed chiefly of metamorphic and igneous rocks, (2) the belt of downfaulted blocks of gently dipping sedimentary rocks along the eastern edge of the Adirondack dome, (3) the zone of thrust faults in western Vermont that separates the gently dipping sedimentary rocks from folded rocks to the east, and (4) the Green Mountain anticline (upfold) formed chiefly of schist and gneiss.

MINERAL COMMODITIES

31. Abrasives. - In Vermont, phyllite was formerly quarried for whetstones about one mile north of Lake Willoughby in the town of Brownington and in the vicinity of Northfield. Large reserves

of phyllite are available but it is unlikely that these quarries will be reopened under current market conditions. Table 48 gives data on sources of abrasive and other mineral commodities.

32. Garnet is recovered as a byproduct from the wollastonite operation near Willsboro, Essex County, New York and stockpiled for possible future use as an abrasive material.

33. Asbestos. - Asbestos deposits in Lamoille and Orleans Counties, Vermont are associated with peridotite rocks intruded into schist, gneiss, and metamorphosed volcanic rocks (greenstone and amphibolite). These peridotites occur in a belt of peridotitic rocks that extends from Newfoundland to Alabama and include the famous asbestos deposits of southeastern Quebec.

34. The Belvidere Mountain deposit in Lowell and Eden townships, the chief present source of domestic asbestos, contains principally slip-fiber asbestos in an irregular network of fracture and shear zones in serpentine. Published data are lacking on the size, grade, and reserves of this deposit, but they are believed to be substantial.

35. Other asbestos deposits occur in north-central Vermont. Recently some of the most promising deposits have been diamond core drilled. Although discovery of additional deposits of commercial grade asbestos appears to be likely in north-central Vermont, the future possibilities cannot be appraised accurately until information on recent exploration and geologic mapping, now

Table 48 - Distribution of mineral commodities in river drainage basins, Subregion "C"

Mineral commodity	River drainage basins in Subregion "C"		
	St. Lawrence	Lake Champlin	Lake Memphremagog
Abrasives		X	X
Asbestos		X	
Clay	X	X	
Copper		X	X
Diatomite	X		
Fluorite		X	
Garnet		X	
Granite	X	X	X
Graphite	X	X	
Iron ore and ocher	X	X	
Limestone and dolomite	X	X	X
Manganese		X	
Molybdenite		X	
Peat	X	X	
Pegmatite minerals	X	X	
Pyrites	X	X	X
Sand and gravel	X	X	X
Sandstone, quartzite	X	X	
Slate		X	
Talc and serpentine	X	X	
Wollastonite		X	
Zinc, lead and silver		X	

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in progress, is published.

36. Carbonate rocks. - The carbonate rocks, limestone, dolomite, and marble, which are among the subregion's most important mineral resources, outcrop in the Champlain Lowland and Otter Creek Valley in Vermont, and in the Champlain Lowland and St. Lawrence Valley in New York.

37. Nearly all the commercial marble of the New England-New York region is quarried near Proctor and West Rutland in the Otter Creek Valley of Vermont. The quarries are located chiefly in places where overturning of the strata and rock flowage have caused abnormal thickening of the marble layers.

38. Small amounts of dimension limestone are quarried intermittently at Swanton, Vermont and at Isle La Motte, Vermont, in Lake Champlain. Limestone has been quarried at many places in the past for local use as a building stone and for crushed stone for concrete aggregate. In 1952-53 twelve plants produced lime from carbonate rocks for use in agricultural, constructional, metallurgical, and chemical products.

39. Although reserves of carbonate rocks are large, geologic investigations are needed. Information concerning supplies of stone suitable for special chemical and industrial purposes is inadequate. However, the New York State Science Service, in cooperation with the New York State College of Ceramics at Alfred University, has mapped, diamond drilled, and sampled the White

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Crystal dolomite deposit near Rock Island Bridge, north of Gouverneur, New York. At least 68,000,000 tons of high-grade dolomitic marble were estimated on the basis of this work.

40. Clay. - Three types of clay deposits are present in the subregion; glacio-lacustrine (varved clays), glacio-marine, and residual. The glacial clays, both fresh water and marine, occur locally along the St. Lawrence River Valley, in areas adjacent to Lake Champlain, and upstream in some of the major stream valleys. Residual clays are irregularly distributed in a belt along the western foothills of the Green Mountains between Bristol, Vermont and the southeastern edge of the subregion.

41. In the past bricks were made from the glacial clays principally along the St. Lawrence River Valley and in the Champlain Lowland. The only brick plant now active (1954) is at Essex Junction, about 6 miles east of Burlington, Vermont, where both sand and water-struck brick are produced. The quantity and quality of the glacial clays are not well known. However, the outlook for future expansion of the brick industry in the subregion is poor.

42. A number of mixed kaolin, ocher, sand, and low-grade manganiferous iron deposits occur along the western foothills of the Green Mountains from the vicinity of Bristol, Vermont as far south as the Vermont-Massachusetts State line beyond the area of Subregion "C". They were derived from the decomposition of the

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underlying feldspathic gneiss, schists, and quartzites. In general, these residual deposits can be outlined by physiographic and structural features, but the exact position, size, and quality can only be determined by closely spaced drill holes. The deposits were worked for iron in the early part of the 19th Century.

43. Kaolinitic clays occur in a belt of separate residual deposits between Monkton, Addison County and East Dorset, Bennington County, Vermont. The belt has a maximum width of 2 miles. The deposits are very irregular in shape and size and reserves are difficult to estimate. Before the mine at Forestdale was closed in 1922, due to a cave-in, more than 80,000 tons of kaolin were mined and used as a paper filler. Although some of the kaolin is of high quality, most of it requires beneficiation and no mines are being worked (1954).

44. Copper. - Sulfide minerals, chiefly pyrite, have been found at many places in the metamorphosed sedimentary and volcanic rocks of the Green Mountains. Some of the deposits have been prospected, but records of mining and examination are available for only two, the Udall mine near Walcott, Lamoille County, Vermont, and the Berkshire mine, at Berkshire, Franklin County, Vermont. Neither deposit appears to be promising, although an unknown amount of ore was mined from the Udall mine in the 19th Century. Extensions of trends of the mineralized belts in southeastern Quebec in Canada, where base metals are now produced, might be discovered by airborne magnetometer surveys.

45. Diatomite. - The most important deposits of diatomite in Subregion "C" occur at Clear Lake, Riley Pond, and Crooked Lake, New York. Estimated reserves of raw diatomite in these deposits are large, but little is known about the quality of the material, and it is doubtful whether it could compete, commercially with enormous deposits in other parts of the country. Many of the deposits are on State land where mining is prohibited.

46. Fluorite. - Several occurrences of fluorite are associated with non-titaniferous magnetite at the Palmer Hill mines near Ausable Forks and in the Barton Hill section of the Mineville district, New York. If the Palmer Hill mines are reopened, there is a possibility that byproduct fluorite might be recovered in the production of magnetite concentrate. Small quantities of fluorite have been obtained from veins in schists and gneisses near Oxbow, Jefferson County, and Macomb, St. Lawrence County, New York.

47. Granite. - In 1950, the Barre district of Vermont ranked first in the United States in production and value of monumental granite. Dimension granite is quarried in small amounts on Wellesley Island at Alexandria Bay at the northern end of Picton Island, New York, and at Derby, Vermont. Granite tailings and waste rock from concentrators and iron mines at Lyon Mountain and Mineville, New York, are used for concrete aggregate and road construction.

48. The extent of granitic intrusions below the surface greatly exceeds the possibility of economic quarrying. Although

dimension stone production has been declining, the use of granite as a monumental stone appears unlikely to follow this downward trend. The Barre district will probably continue to maintain its production. The small, intermittent production of rough architectural stone from other quarries in the subregion will fluctuate according to the local demand. The principal products obtained from granitic rocks, except for monumental stone, probably will continue to be riprap and crushed stone, the latter chiefly mine waste rock and mill tailing.

49. The Adirondack anorthosite might become a potential source of alumina, if the beneficiation process, now being investigated by the U. S. Bureau of Mines, is found to be economical.

50. Graphite. - Graphite occurs in two districts; one in the eastern and the other in the western Adirondack Mountains. Graphite deposits of the eastern Adirondacks occur in strongly folded and faulted metamorphosed sedimentary rocks in Essex, Warren, and Washington Counties, New York. Most of the graphite produced in these counties prior to 1921 came from about 9 mines. Between 1850 and 1921, these mines, now inactive, produced a large part of New York's flake graphite output. Graphite is disseminated in discontinuous beds which range in thickness from 3 to 30 feet, and in grade from 4 to 8 percent. Small contact metamorphic graphite deposits in Essex County range in grade up to a maximum of about 14 percent graphite. The deposits near Hague, Warren County,

New York are a source of Madagascar-type flake graphite. The ore requires extensive crushing to separate the graphite from the hard unweathered rock. The result is a product too fine to compete with standard Madagascar flake.

51. The graphite deposits in the western Adirondacks occur in a belt of meta-sedimentary rocks that extends from the Jefferson-St. Lawrence County line near Rossie northeastward to Canton, New York. Very fine-grained flake graphite was produced for paint purposes, foundry facings, and battery manufacture at two localities, one near Pope Mills and the other 3 miles south of Rossie. The graphite ore near Pope Mills was reported to be mined out in 1942 and only a very small quantity of ore was produced at the Rossie deposit.

52. Processes for beneficiating low-grade graphite ores have been improved in recent years, and further research on the improved methods of treating graphite-bearing rocks is desirable. For this reason reexamination of some of the New York State graphite deposits appears to be warranted.

53. Iron ore and ocher. - More than 75 percent of the magnetite mined in the Adirondacks area and all of the magnetite of low titanium content (non-titaniferous) produced come from Subregion "C". Most of the ore comes from the Benson open pit mine near Star Lake, the New Bed-Harmony mine at Mineville, and the Chateaugay mine at Lyon Mountain. Magnetite is mined also at the "81" mine southwest of Lyon Mountain, and the Fisher Hill mine north of Mineville.

Inactive mines in the Benson district are at Clifton Furnace Ruins, Jayville, and a mine southwest of Russell. Magnetite has been mined in the past at Crown Point and Port Henry in Essex County, and Ausable Forks, Clintonville, Clayburg, and Dannemora in Clinton County. Mining has exhausted most of the known magnetite deposits of southeastern Essex County and Whitehall, Washington County, and no new deposits have been indicated by airborne magnetometer surveys.

54. At the Benson mine, magnetite, with subsidiary hematite (martite), occurs in a very large, low-grade ore body, on the east limb of an overturned anticline. At Mineville, the Old Bed and Harmony ore bodies are in two separate folds in a local anticline of granite gneiss and gabbro on the north-west limb of a large syncline. The ore bodies at Lyon Mountain are large, cigar-shaped masses which occur in folded granite gneiss.

55. The reserves of nontitaniferous magnetite ores are known to be very large, and ample to support the present rate of production for many years. Some of the larger deposits, revealed by magnetic anomalies and by subsequent drilling, are low grade and are not now considered commercial (1954), as they occur at depths too great to be mined by open pit methods.

56. Hematite deposits occur in the Grenville marble and schist in belts that strike northeastward between Antwerp and Theresa, Jefferson County on the south, and Canton, St. Lawrence

County on the north. The ore bodies, some of which are high in phosphorous and silica, are scattered, irregular in form, and variable in grade. The iron content of the highest grade deposits ranges from 40 to 55 percent.

57. The most promising ocher deposits (residual limonite) occur at South Wallingford and Brandon, Vermont. The irregular distribution and pockety occurrence, as well as the variable quality of the product, are factors which led to the closing of these mines in the early part of the 19th Century.

58. Manganese. - The Kinney-Cobble mine at East Wallingford, Vermont probably contained the most extensive and highest grade manganese deposit developed in the residual manganiferous iron ore belt. The mine was worked as early as 1820, but principally in 1888. The ore mined contained both manganese and iron minerals associated with yellow, gray, and white clay. Both the ore, and beds that contain the ore, are extremely irregular and discontinuous. Future production of manganese from this and other residual deposits is unlikely.

59. Molybdenite. - Molybdenite occurs in a mineralized zone more than 3,000 feet long and as much as 125 feet wide on the west side of Granite Hill, on the Wallingford-Shrewsbury town line, Rutland County, Vermont. It was prospected in 1934 to 1936 and optioned by the Molybdenum Corporation of America. No data on the reserves have been published.

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60. Peat. - Many swamps and lakes in the subregion contain large reserves of peat. In 1922, the U. S. Geological Survey published the most recent detailed survey of deposits in this subregion. Insofar as known, no peat deposits have been worked commercially. Possibilities of future development are only fair because the deposits are isolated and it is doubtful if the quality and quantity of peat would justify a large scale commercial operation. Most of the deposits are too far from markets to warrant draining for farming.

61. Pegmatite minerals (including phlogopite mica). - In 1954, all of the pegmatite mines were closed. In the past pegmatite minerals, principally feldspar, were produced in the northwestern and eastern foothills of the Adirondack Mountains; near De Kalb and Oswegatchie, St. Lawrence County; near Crown Point and Ticonderoga, Essex County; and near Fort Ann, Washington County, New York. Most of the pegmatites in which commercial deposits have been found are on the border of large granite intrusions or lie within the older gneiss and schists. Minable deposits of feldspar, quartz, and mica are commonly found in the extremely coarse-grained parts of a pegmatite.

62. The outlook, based on current information, for redevelopment of the known feldspar deposits is not promising and the possibility of minable quantities of strategic mica and beryl being found appears less likely. However, no attempt has been made to

investigate and evaluate these and other pegmatites in the subregion by mapping techniques recently developed and used effectively in the principal pegmatite districts of the United States. The Crawford phlogopite mica deposit near Degrasse, St. Lawrence County, New York was prospected in 1940 and 1941. The mica occurs in veins, in "books" one to six inches across and as much as six inches thick, enclosed in a lens of impure marble (now a diopside-hornblende gneiss). Further work on this deposit and other occurrences in St. Lawrence County is not anticipated in the immediate future.

63. Pyrites. - In 1953, pyrite was being recovered as a by-product at the Balmat zinc mine, New York where it is stockpiled. Prior to 1921, about 600,000 tons of pyrite concentrate, averaging about 40 percent sulfur, was produced from the Cole and Stella mines. These mines and other promising prospects occur in a belt of gneiss between Antwerp, Jefferson County, and Canton, St. Lawrence County, New York. The ore bodies are lenticular sheets or vein-like bodies and range from a few feet to 50 feet in width; their length is not known. The sulfides are irregularly disseminated in the gangue, or in pockets, veinlets, and layers. In some deposits pyrrhotite is more abundant than pyrite. Overall reserves of pyrite and pyrrhotite in this mineralized belt have not been estimated.

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64. Sand and gravel. - Most of the sand and gravel produced in the subregion is obtained from glacial deposits including glacio-fluvial, glacio-lacustrine and glacio-marine deposits. Large deposits of materials suitable for building sand and aggregate (including asphaltic road mixes) occur in all parts of the subregion. In the uplands, deposits occur in glacial lake deltas, kames, outwash moraines and eskers; in the lowlands of the St. Lawrence River and Champlain Valleys, deposits are chiefly in glacio-marine sediments. Deposits of sand and gravel occur in non-glacial sediments in the major stream valleys, but these deposits are usually smaller and less sorted than the deposits in glacial materials.

65. Most of the large sand and gravel deposits that have been worked commercially are in the Champlain Valley; other large deposits of good quality for general use occur in the Adirondacks. The glacio-marine sand and gravel deposits in the St. Lawrence lowlands are not of good quality because the proportions of weak-rock pebbles and clay in sand are high.

66. Small amounts of industrial sand (molding) are produced at Swanton, Vermont. At Ticonderoga, New York, a local sand was used as foundry core sand. Deposits of molding sand occur near Willsboro and Whalonsburg, Essex County, New York, but have not been worked on a commercial scale.

67. Sandstone and quartzite. - Two quarries (1953) at Malone, New York are producing dimension stone from the Potsdam sandstone.

In the past the Potsdam sandstone was quarried at places between Clayton, Jefferson County and Burke, Franklin County; and between Keeseville, Essex County, and Fort Ann, Washington County. The Potsdam sandstone generally contains too much iron for use as a high-grade silica material. However, at Moira and Bangor, Franklin County, New York, the white Potsdam sandstone contains beds that analyze 98 to 99 percent or more silica and were once quarried for glass sand. Thick beds of high silica sandstone that might be suitable for use in the manufacture of ferrosilicon occur in the Potsdam formation, but no detailed surveys have been made to locate them.

68. Deposits of clean, white quartzite that may be suitable for the manufacture of glass and ferrosilicon occur in the Cheshire quartzite which occurs along the western part of the Green Mountains and forms low, broken ridges in the foothills west of the Green Mountains as far north as Monkton, Vermont.

69. Slate (including slate granules and flour). - The slate deposits in Subregion "C" are in the Taconic Mountains in northeastern Washington County, New York, and west-central Rutland County, Vermont, and in the Northfield-Montpelier area in east-central Washington County, Vermont. Most of the deposits are in Washington County, New York. In 1952, 26 small slate deposits were being worked; in Whitehall, Hampton, Fort Ann, Hartford, and Granville Townships, Washington County, New York. The more important deposits in Rutland County are near Castleton, Fair Haven, Poultney,

Wells, Pawlet, and West Pawlet. In the past slate, in small amounts, was quarried in the Northfield-Montpelier area of Vermont.

70. The only known commercial grade natural colored slates in the United States occur in the Vermont-New York slate district. The commercial slates occur in the Mettawee and Normanskill formations. The Mettawee includes green, purple, and variegated slates; the Normanskill, red, bright green, and black slates. Red slate, which is most in demand, occurs in lenses and is prospected with difficulty.

71. Most of the slate quarried in Vermont is for roofing; that in New York is ground for granules and flour; and small amounts from both states are used for mill stock and flagging. In 1951 the value of slate products sold by 42 producers in the district was about $6,000,000.

72. The production of roofing granules is one of the major non-metallic mineral industries in the subregion. The natural color slate granules produced at Castleton, Vermont, and Granville and Hampton, New York, are used by roofing paper manufacturers throughout the United States. The industry first used waste material, but to meet the demand and specifications of the manufacturers, quarries were developed to produce the proper quality of granules. Roofing slate production has declined markedly, but slate granules for surfacing roofing material has steadily increased. In recent years the principal slate granule producers have been able to develop markets for their slate fines for use as fillers.

73. Studies on the utilization of slate have been made at the Mineral Industries Experiment Station, Pennsylvania State College. Some of the experimental work was done on the use of slate in acoustical tile, lightweight aggregate, mineral wool, slate-lime brick, and pressed slate.

74. Talc and serpentine. - Two principal types of talc and serpentine deposits occur in the subregion; (a) deposits related to igneous rocks, chiefly serpentine, in Vermont, and (b) deposits related to metamorphic rocks, chiefly crystalline limestone and schist, in New York. Both kinds of deposits have been mined for many years. Active talc mines are at Gouverneur, Talcville, and Balmat, New York, and at Johnson and Waterbury, Vermont.

75. Talc, associated with metamorphosed Grenville limestone, occurs in the Gouverneur district in two related belts; one near Balmat, the other near Talcville, St. Lawrence County; and also near Natural Bridge, Lewis County, New York. In the Gouverneur district, from which comes the fibrous commercial talc, the deposits in the belts are highly folded, elongate zones of variable thickness interlayered with non-commercial zones of talc-bearing limestone. The talc belts have a composite strike length of more than 6 miles, a probable depth down dip of more than 2,000 feet, and average thicknesses ranging possibly from 125 to 135 feet in the mines. The talc belt near Balmat contains one or more zones of commercial talc, 6 to 25 feet thick, and rarely as much as 75

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feet. Near Taloville commercial talc constitutes the major part of the belt. Most of the rock mined is a tremolite-anthophyllite schist partially altered to serpentine and talc, of which talc makes up about 10 to 25 percent of the mined and ground rock. The deposit near Natural Bridge is in an irregular, brecciated mass of limestone containing complex aggregates of serpentine, talc, carbonates, and diopside. Massive serpentine is often much more abundant than other minerals.

76. Talc is currently produced (1953) at 4 localities near Balmat and Fowler, at 2 localities near Taloville, and 1 locality near Natural Bridge. The principal production has come from the fibrous talc mines in the Gouverneur district which produces a very low iron product; granular, massive talc is produced near Natural Bridge. Other domestic talc producers have been unable to equal the high quality of the fibrous talc produced in the Gouverneur district.

77. The talc and serpentine deposits in Vermont are in the same belt of serpentine rocks described above under the heading "Asbestos". The individual serpentine bodies range from less than 100 feet to at least 3.5 miles in length and from a few feet to about a mile in width.

78. The talc at Johnson and Waterbury, Vermont is mined by underground methods and timbering is necessary in many places. The grinding mills commonly are located near the mine. The talc

is higher in iron than that of New York and has a more limited range of uses. It is believed that the reserves of talc in New York and Vermont are adequate to meet normal and emergency demands for a long time.

79. "Vermont verde antique" (serpentine) has been quarried in the past at Roxbury, Vermont, for green marble. Small quantities also have been quarried at Moretown, Vermont.

80. Wollastonite. - The Willsboro deposit, about 2.5 miles southwest of Willsboro, Essex County, New York, is the only wollastonite deposit developed in Subregion "C". The deposit comprises two parallel, lens-shaped bodies of wollastonite-rich skarn that are presumably separated by a fault zone. The larger body which has a strike length of about 2,000 feet and an average thickness of 43 feet, has been diamond drilled to a depth of 200 feet. The ore bodies consist chiefly of wollastonite with relatively thin layers of garnet (andradite) and pyroxene. The crude ore contains about 75 percent waste. The garnet is recovered and stockpiled for possible future use as a low-priced abrasive material for stone grinding and polishing and in the optical lens grinding industry. Between 1938 and 1948, small quantities of wollastonite were produced chiefly for experimental purposes. Since 1948, the wollastonite has been used mostly in the manufacture of ceramic materials and as a chemical raw material in welding rod coatings. In February 1953, the reserves of probable ore to a depth of 200 feet were

estimated at more than 3,720,000 tons.

81. Zinc and lead (with byproduct silver). - The major zinc deposits occur in the Gouverneur district of New York in a belt of Grenville limestone that extends from Sylvia Lake northeastward to Edwards. The principal mines in this belt are the Edwards, and the Balmat, half a mile east of Sylvia Lake. The Hyatt mine, near Talcville, was closed in 1950. The deposits are of two types; zinc-pyrite (Edwards and Hyatt) and zinc-lead-pyrite with small quantities of silver (Balmat). In 1951, the Balmat and Edwards mines produced about 40,000 ounces of recoverable silver, and an unreported amount of pyrite.

82. At the Edwards mine the ore zone has been explored to a depth of 3,300 feet (1953). The ore bodies at both the Edwards and Balmat mines are a result of replacement of impure limestone apparently along bedding lines. At Balmat pyrite and sphalerite are the principal sulfides and comprise about 25 to 50 percent of the ore.

83. In the past, several deposits have been prospected or worked to a small extent in the vicinity of Balmat, Talcville, and Edwards. The most important of these are the Webb deposit, 1.75 miles southwest of Edwards, and the Parker deposit, along the south shore of Sylvia Lake. The Webb and Parker deposits are in Grenville limestone. The Parker deposit, in part under Sylvia Lake, was explored to some extent prior to 1943, but no attempt has been

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made to develop the ore.

84. In the vicinity of Rossie, Bigelow, and Macomb, St. Lawrence County, 14 deposits were worked for their lead content during the past century. The principal production came from the Coal Hill vein and Victoria deposits, about 1.5 miles south of Rossie. The Coal Hill mine produced about 4,000 tons of lead between 1837 and 1852; the Victoria deposits probably had a total production of 2,000 tons; the Macomb district, 1,000 tons; and the Bigelow district, 500 tons of lead.

85. The lead-zinc deposits in the vicinity of Rossie, Macomb, and Bigelow, about 2 miles south of Pope Mills, are fissure veins that range up to 1,000 feet in length and from 2 to 6 feet in width. The veins, in Grenville limestone and Potsdam sandstone, contain galena with subordinate amounts of chalcopyrite, sphalerite, and pyrite.

86. The average zinc content of the ores of the Gouverneur district is high compared to that of other domestic zinc deposits. The Edwards and Balmat mines will probably be able to maintain production at the current rate for many years.

87. Galena was mined on a small scale on Lyon Hill, Brandon, Vermont in the early 1880's. During the summer of 1941 the deposit was diamond drilled by an important lead company. Following recent geochemical prospecting another large mining company has taken an option on large acreages in the vicinity of the mine.

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FUTURE POSSIBILITIES

88. The mineral industry in Subregion "C" will probably continue in the future about as it has in the recent past, though considerable increases are to be expected in the use of sand and gravel and crushed stone in highway construction. The demand for these materials will also be greater due to increase in building construction as formerly rural areas become urban and industrial with the northward spread of manufacturing enterprises from centers in southern New England and New York.

89. Asbestos production could be greatly increased if a method were developed to remove chemically combined iron so that the fiber mined in northern Vermont would meet the specifications of strategic grade asbestos. Such an increase in production seems a possibility inasmuch as the asbestos industry has already found ways experimentally of removing the iron and commercial methods should presumably follow.

90. Unlike most engineering projects for which costs can be rather closely estimated, research and development of mineral resources cannot be forecast very far in advance. Any program must be adjusted to findings during the course of the work, and costs cannot be determined until the final objective is attained. In routine geologic quadrangle mapping there is always the hope that something meriting detailed exploration will be found. Exploration on one deposit revealed by geologic mapping of a quadrangle may

easily cost several times as much as the whole geologic map, but a major discovery would return many times the combined cost of the survey and the exploration. Changing market conditions, technical advances and international political changes will affect all programs. The recommendations below should be considered as only the beginning of a program that will develop as it progresses.

MINERALS PLAN

91. Subregion "C" should be mapped geologically by quadrangles on scales of one and two inches to the mile, giving priority to specific quadrangles in which economic minerals are known to occur. Such a program would require several hundred man years of professional work for completion despite the appreciable geologic work already finished.

92. A priority should also be given to areas to be flooded, and detailed geologic investigations should precede construction of dams, particularly within areas now covered only by reconnaissance geologic mapping.

93. A program of topographic mapping at a scale of 2 inches to a mile should be carried out in urban and industrial areas and along transportation routes not yet covered by such maps, particularly in the Champlain Lowland of Vermont and New York and in the vicinity of mining operations. This program would assist in the location of nearby minable sand and gravel deposits. Such maps should be supplemented by maps at a similar scale of the unconsolidated

surficial deposits to show areas actually underlain by sand and gravel, as well as other types of surficial deposits and the geology of the bedrock in known mineralized areas.

94. The serpentine belt in and east of the Green Mountains in Vermont should be surveyed by flights with airborne magnetometers to find previously unknown masses of serpentine with which asbestos and talc may occur. Since copper is mined in adjacent Quebec these flights should be extended to cover the projection of the Quebec copper belt in Vermont, in search for anomalies possibly indicating the occurrence of copper. Similar flights should cover the Adirondack area in search for new iron deposits.

95. Pegmatite investigations similar to those made by government agencies in 1942-1945 should be continued in a search for strategic minerals, such as mica, beryl, columbite-tantalite, and for feldspar.

96. Investigation and design of improved beneficiation methods for the graphite ores of the eastern Adirondack area is recommended. If successful, thorough geologic exploration and development of the known deposits should follow, and a search be made to find other deposits from which graphite might be recovered by the improved methods.

97. The white Cheshire quartzite which outcrops along the western front of the Green Mountains in Vermont should be tested as a possible source of silica for a glass manufacturing industry and the production of ferrosilicon.

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98. When the demand for sulfur justifies it, a further exploration of the pyrite deposits in Jefferson and St. Lawrence Counties, New York should be carried out to determine the extent of their reserves.

99. The costs of the minerals plan have not been estimated.

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SECTION XIII - INSECT CONTROL

1. This section provides information on the present status of insect-borne diseases, insect disease vectors, and pest insects in Subregion "C"; data to determine the need for and approximate cost of control programs; and benefits that may accrue from such control programs. Insects adverse to public health are considered in two categories: (a) those that are capable of carrying and transmitting disease micro-organisms (vectors) and (b) those that reduce the efficiency and comfort of man and affect his economic status.

PRESENT STATUS OF INSECTS ADVERSE TO PUBLIC HEALTH AND THEIR CONTROL

2. Disease and vector problems. - The principal mosquito vector implicated in the transmission of malaria in the eastern part of the United States is *Anopheles quadrimaculatus*. Data indicate that this vector is present and that the disease was once endemic in the subregion. In recent years there have been no locally acquired cases. However, during and following World War II the disease was brought into the subregion by war veterans who returned from malaria infested areas. Despite the sporadic appearance of the disease and the presence of the vector, malaria is not considered to be a public health problem in this subregion.

3. Although eastern equine encephalitis, a mosquito-borne disease, has not been reported from this subregion, an epidemic occurred in the New England-New York area in 1938. This outbreak was

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centered in Massachusetts where 34 human cases were definitely identified. Several species of mosquitoes which have been implicated in the transmission of this disease are found in the subregion. Those include Aedes atropalpus, A. triseriatus, A. vexans, Culiseta melanura, and Mansonia perturbans. One or more of these species is common in a wide variety of habitats during the spring, summer, and fall.

4. Twenty cases of tularemia have been reported from five counties in New York including Jefferson and Lawrence Counties, which comprise a portion of the subregion. The disease is primarily found in wildlife, the reservoir host, and is rare in man. Transmission of the disease from wildlife to man may occur either through contact with a diseased animal or as a result of insect bites. In other parts of the United States deer flies and certain other biting insects have been implicated in the transmission of this disease. However, the deer flies species common to this subregion have not been implicated as vectors of tularemia.

5. Pest insect problem. - Many pestiferous insects are known to occur in sufficient numbers within the subregion to create a public health problem by reducing the physical efficiency and comfort of the people. In addition to annoyance, some cases of illness and incapacitation have occurred as the result of insect bites.

6. Aside from the purely public health aspect, insects affect the income of the subregion by reducing the recreational and resort

season and the use of recreational facilities. An increase in recreational income would generally result from carefully planned insect control measures. The actual insect control cost is estimated to be 5 percent of the additional recreational income resulting from insect control. These estimates are based upon figures obtained in other parts of the United States where insect problems were somewhat similar and where evaluations of benefits have been determined.

7. All of the insects considered in this section develop in water or very wet soil. The abundance of any species depends upon the presence of suitable breeding areas and the climatic conditions during its time of development. The principal species of insects found in the subregion are described below. Further information helpful in determining control measures may be found in standard references on entomology under the scientific name of the insect.

8. Mosquitoes. - There are approximately 34 species of mosquitoes known to occur in the subregion. Ordinarily 19 are troublesome as pests. A number of species of *Aedes* mosquitoes may be differentiated from the other members of the group by their ability to produce only one brood in the spring. These mosquitoes develop in temporary pools in forest and grassland areas and result in insect infestations of relatively short duration in woodland recreational and suburban areas. The principal species in this group are: *Aedes aurifer*, *A. excrucians*, *A. fitchii*, *A. implacabilis*, *A. intrudens*

A. stimulans, and A. triseriatus. Breeding areas favorable for development of these species exist over a considerable portion of the subregion. Ditching and filling are the most permanent control measures which can be instituted but are often impractical because of the large areas involved and because it is impossible to drain many low-lying areas. Larviciding the edges of certain highly productive pools in and adjacent to urban and recreational areas is often practical and effective. A few other species of Aedes mosquitoes develop either intermittently or continuously throughout the spring and summer. Aedes canadensis and A. cinereus are important pests in this category. Two additional species, Aedes sticticus and Aedes vexans develop in large numbers in isolated pools after floods. Aedes vexans is the major pest of all these species, not only because it is capable of migrating three miles or more from its place of development, but also because it develops in enormous numbers and has an unusually wide range of breeding places.

9. The northern house mosquito, Culex pipiens, biting during the evening and at night, is an urban pest throughout the summer months. It develops in water found in barrels, cans, fish pools, street drains and in slow-flowing streams and ponds polluted with garbage, sewage and other filth. A single breeding place may produce enough mosquitoes to seriously annoy an entire village. Control of this species is highly desirable in many urban areas and can only

be effectively accomplished by a coordinated and carefully managed community effort.

10. Another mosquito, Mansonia perturbans, is sometimes a bad pest locally during the summer and control is often highly desirable. Because the larvae do not come to the surface of the water for air during their development, special, carefully timed and supervised control measures are required.

11. Black flies. - Prosimulium hirtipes and Simulium venustum are the most troublesome species of black flies in the subregion because of the painful bites they inflict on man. There are about 20 species of black flies known to be in this subregion. However, with the exception of the two species mentioned above, they do not constitute a pest problem. Black flies develop principally in fast-flowing streams and the adults emerge in numbers in May and early June. Bites from these insects, for most people, produce an itching and swelling which disappears in a few days. With other people, several bites or repeated bites often cause serious illness. In addition, the presence of hundreds of swarming flies, whether of a biting or a non-biting species, is annoying.

12. The successful and practical aerial larviciding of streams with DDT for black fly control has been accomplished in this subregion. In an adjacent subregion, ground application of insecticide to streams at quarter-mile intervals has also been successful in certain black fly areas. While the actual cost of insecticides is

very low, the difficulty of applying a larvicide to an inaccessible stream is often great. Determination of the best practical method of control must be based upon specific surveys and field studies.

13. Deer flies and horseflies. - Many species of deer flies and horseflies occur in the subregion. Several species of the genus Chrysops (deer flies) are pests during June, July, and August and attack during the daytime, inflicting painful bites. These insects are solitary in habits and ordinarily not many attack at one time. They do not constitute a public health problem equal to that produced by mosquitoes or black flies. The larvae of these insects develop sparingly in a wide variety of habitats and effective larval control is not practiced in the subregion. Adults are shade-loving, therefore, clearing of land is of some value in reducing their attacks. A complete compilation of various species of Tabanus (horseflies) found in New York, with their distribution and seasonal occurrence is presently being prepared by L. L. Pechuman.

14. Punkies. - Punkies, (sand flies, "no-see-ums", midges) principally Culicoides obsoletus, bite predominantly in the late afternoon and are bad pests during late spring and early summer. In heavily-infested areas they appear by the hundreds and in these densities create a public health problem. Little is known about the habitat in which they develop or measures which can be employed to secure control of the insect in the larval or adult stages.

15. Pest insect season. - The active insect season in this

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subregion generally coincides with the frost-free period. Black flies appear in late April or early May and attack fiercely in the vicinity of fast-flowing streams. Sometime during June, the black fly season subsides and the early spring Aedes mosquitoes replace them as the principal pest. When the early spring Aedes populations commence to subside in June and early July, the multiple generation summer species of mosquitoes become numerous. Punkies often reach pestiferous proportions in late May and June.

BENEFITS AND COSTS OF INSECT CONTROL

16. The annoyance and discomfort produced by biting insects in this subregion vary from season to season and from year to year. These factors complicate any effort to evaluate the relief secured through insect control on a monetary basis. In addition, it is highly improbable that accurate data could be obtained on medical expenses and man-hours of work lost as a result of insect attacks. It would be difficult to assign monetary values to benefits derived from the mere freedom from insect attacks by the inhabitants and workers when no actual medical expense or work loss is involved, although these benefits are probably the most important. For these reasons, public health insect control benefits are generally classified as intangible.

17. A partial evaluation of tangible benefits can be made by a measurement of the effects of insect annoyance upon the income from recreational business. Insect attacks affect recreational

income by reducing the length of the tourist season and the use of the recreational facilities within the subregion. Replies received from resort operators, State park superintendents, and residents to inquiries made by entomologists and studies made in other localities, indicate that an increase in tourist patronage may be expected after some measure of insect control has been achieved and information about the improved conditions has been publicized. The average annual cost in this subregion for temporary control of pest insects in those communities where projects are in operation and where organized projects may be initiated is approximately $51,000. In some rural camps and resorts, adulticiding and limited larviciding and ditching are often practical. The average annual cost for this type of control depends on conditions in and around each area to be protected, the size of the breeding area to be controlled and its proximity to the camp or resort.

18. The magnitude of a public health insect problem and the feasibility of its control is not determined solely by the number of insects present in a given area, but it is also related to the number of people affected and to the type and extent of the control measures involved. In this subregion, the expenditure of funds for insect control appears to be justifiable on an economic basis. This is especially true in the resort and recreational areas where the tourist season is reduced as much as six weeks as a result of the annoyance produced by biting insects.

EFFECTS OF WATER RESOURCE DEVELOPMENTS ON INSECTS

19. Nearly every insect species of public health importance in the subregion develops in water. Studies in various parts of the United States have shown that additional insect problems frequently arise because of habitat alterations resulting from development of these resources and that, in a large measure, they can be minimized or even prevented if specific consideration is given to them during the planning and construction phases of the projects. In Subregion "C", however, extensive watered areas are already present so that total increases in insect populations in the area, as a whole, resulting from the creation of additional watered areas, are of little significance. The major factor to be considered is the effect of reservoir impoundments on insect densities and their proximity to concentrations of human populations and to existing or proposed recreational areas. In general, the impoundments studied in this subregion would not result in a large increase in insect densities. Instead, there would be a favorable reduction in insect breeding areas as a result of inundation.

20. To discourage the development of new breeding areas, certain precautionary measures should be taken during the planning and construction of the reservoirs. These measures include marginal drainage of ponds, sloughs and depressions and clearing five- to ten-foot strips around the perimeter of watered areas. During the period of impoundment, provision should be made to maintain shore-

lines and ditches by removing drift, and marginal and aquatic growth.

21. Impoundments for wildlife habitat. - Wildlife areas of a type favorable for insect production, such as marshlands and shallow fresh water impoundments, should be located preferably more than three miles from recreational areas, and urban and suburban developments, as the flight range of practically all insects of public health importance in the subregion is about 3 miles. If the above areas are planned closer than the recommended distances and a potential insect problemis found inherent in the development of the project, the developing agency and the appropriate public agency engaged in insect control should insure the carrying out of required insect control measures. Provision should be made in the plans for the evaluation, prevention, and control of insect problems associated with each individual project. It has been found that in some areas the construction of impoundments for wildlife habitat has resulted in increased mosquito breeding. In these areas, trees, brush and debris inundated by the impoundment were not removed and their accumulation along the shore resulted in ideal conditions for mosquito breeding by creating an insect shelter similar to that found in a swamp during the spring.

22. Farm ponds. - It has been found that insect production is at a mimimum if appropriate measures are included in the planning of farm ponds. Measures which have proved successful are fish stocking, elimination of shallow portions, the removal of woody vegetation,

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fertilization of the pond to increase plankton and occasional drainage.

EFFECTS OF INSECTS ON RECREATIONAL DEVELOPMENTS

23. A reduction in the use of recreational facilities frequently occurs as a result of the nuisance produced by biting insects. Because pest insects are prevalent within Subregion "C", all areas selected for recreational development will be subject to their attacks. Therefore, in the planning for the improvement and expansion of existing recreational facilities, and the acquisition in the future of new areas, it is necessary to consider the magnitude of the insect pest problem, and to include in the recreational plans an adequate insect control program. When new areas have been selected for recreational development, an entomologist should survey each area and outline an adequate control program.

24. Existing legislation. - In the State of New York, local boards of health and county health commissioners may take steps to control mosquitoes, black flies, punkies, ticks and other insects detrimental to health when community action is required. Costs of drainage for mosquito control may be borne wholly by the owner or may be borne in part by the municipality by assessment upon property owners who are benefited. Several communities have appropriated money specifically for mosquito and black fly control by consent and approval of the taxpayers. The State Entomologist's Office, State Science Service, is officially authorized to advise other agencies on such matters as mosquito control, but it has no administrative unit or organization for actual control work.

25. Vermont legislation provides for the establishment of a Mosquito Control Advisory Committee which considers and studies mosquito control problems, coordinates plans for mosquito control work and provides advice to the Commissioner of Agriculture with respect to carrying out the provisions of the law. The commissioner or his duly-authorized agent after consultation with the Mosquito Advisory Committee may survey mosquito breeding areas and conduct biological studies to determine methods best adapted for abatement of mosquito annoyance.

CONCLUSIONS

26. It is concluded that:

a. Vector-borne diseases do not constitute a public health problem at this time although vectors of several human diseases are present.

b. Of the many pest insect groups in the subregion, the black flies and mosquitoes constitute the principal pest problem. Other pest insects are generally of borderline public health significance but occasionally reach densities which constitute a serious pest problem.

c. The average annual cost of controlling pest insects where organized community projects are in operation or may be desirable is estimated to be about $51,000 for the entire subregion. The average annual cost for control in camps and resorts depends upon conditions in and around each area to be protected, the size of the

breeding area to be controlled, and its proximity to the camp or resort.

d. The benefits to be derived from pest insect control are primarily intangible. However, it is estimated that an increase in recreational income could be expected as the result of pest insect control at resorts and camps.

e. Entomological surveys should be conducted at proposed flood control, power and recreational sites when definite plans are formulated. Where insect control measures are necessary, they should be included as an integral part of the development and operation of the facility. At waterfowl developments, insect control programs should be instituted where necessary to provide adequate control with minimum adverse effect upon the wildlife resources.

INSECT CONTROL PLAN

27. The plan for Subregion "C" for the control of insects adverse to public health utilizes three basic approaches: research, dissemination of information, and direct assistance. The features of the plan are:

a. Continuance of insect studies and investigations, especially of horseflies, deer flies, and punkies.

b. Provision of technical guidance by insect control experts for control programs.

c. Provision during the planning, construction and operation of reservoir and wildlife developments for protective and control measures against vector and pest insects when such developments would

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be within three miles of existing or anticipated centers of population or recreational areas. Where potential insect problems arise as a result of the development of a project, those concerned should determine appropriate measures for the solution of these problems and carry out the required measures as an integral part of the development.

d. Assistance in the selection and planning of adequate insect control measures to permit maximum utilization of existing and proposed recreational developments. This would include coordinating the insect control program with wildlife programs in order that control could be effectively instituted with a minimum adverse effect upon wildlife.

e. Periodic surveillance by entomologists of recreational and wildlife developments to determine the effects of their operation on insect densities and to determine when additional insect control may be necessary.

f. Institution or continuation of existing insect control projects in major urban areas. Estimated average annual cost $51,000.

g. Institution of insect control programs in camps and resorts. Estimated costs variable but approximately $200 to $500 per unit.

SECTION XIV - COORDINATED BASIN PLAN

GENERAL DISCUSSION

1. Subregion "C" includes the drainage basins of the rivers in the States of New York and Vermont draining into the St. Lawrence River. It embraces the basins of Lake Memphremagog and Lake Champlain and of the St. Lawrence River in the United States. It borders on Canada and lies west of the valley of the Connecticut River. The total area of the subregion is 13,833 square miles of which 5,209 are in Vermont and 8,624 are in New York. The dominant features of the terrain are the two large lakes, Lake Memphremagog and Lake Champlain (including Lake George and connecting waterways), the St. Lawrence River from the Thousand Islands section to the Canadian border and the mountainous areas of the Adirondacks in New York and the Green Mountains in Vermont. Approximately 60 percent of the area is forested, and much of the forest area lies within the New York State Forest Preserve. The best soils for agricultural use are in the St. Lawrence Valley and the lowlands adjacent to Lake Champlain and Lake Memphremagog. The predominant economic activities are the raising of orchard crops, dairying, and the provision of services for recreationists.

2. Storage and stream flow regulation. - The existing usable water storage, exclusive of flood control storage, amounts to 562,441 acre-feet used mainly to regulate stream flow for power

purposes. In connection with further hydro-electric power developments an additional 498,100 acre-feet of storage could be developed. The St. Lawrence River draws upon the storage of the Great Lakes system, which is steady and practically inexhaustible. This is the storage that will be drawn upon by the St. Lawrence Seaway and Power Project.

3. Water supply. - A large surplus of surface water is available in the subregion for domestic and industrial water supply purposes for at least the next 50 years on the basis of foreseeable needs. Ground water is available in most places throughout the subregion in small quantities which can be developed to meet the needs of individual rural homes and farms, except for irrigation. The natural surface waters are soft, relatively low in suspended material and mineral content, and generally excellent for domestic, agricultural, and industrial uses. Pollution has affected adversely more than 800 miles of the streams with resulting impairment for many forms of water use. The ground water is generally suitable for domestic, industrial, and agricultural uses. A large increase in the use of water for supplemental irrigation could so reduce the water available in some of the small watersheds as to raise a question as to the legal basis for such use. There is a need for additional investigations of the yield of small streams, data on which would be useful for the study of water supplies for small communities, farm ponds, and irrigation, and for the design of

culverts and bridges. There is also a need for additional information concerning the ground water resource.

4. Pollution control. - Over some segments of their flows, pollution is transported by 22 of the principal rivers of the subregion and by 35 of their tributaries. The main stems of streams and tributaries transporting pollution have a total length of flow of approximately 1,979 miles, of which 177 miles are seriously affected. Lake Memphremagog is affected by pollution brought in by the Black, Clyde, and Barton Rivers and by pollution from the municipality of Newport, Vermont. Lake Champlain is affected by pollution brought in by nine of its principal tributaries and by pollution discharged directly into the lake from five municipalities. In Lake Champlain the effect of pollution, in most instances, is confined to the immediate vicinity of the sewer outfalls while in other instances the effects are spread over a radius of several hundred yards. Most of the waters of these lakes are not polluted. Erosion of soil from cropland and stream banks has not been reported as a serious pollution of the streams in the subregion. There are 96 sources of sewage pollution, having a total contributory population of over 180,000 persons, that are discharged directly to watercourses without treatment. Of the 74 separate significant sources of industrial waste pollution, only eight have been provided with any degree of treatment. The sources of untreated industrial wastes have a population equivalent

of approximately one million persons. The laws of the States of Vermont and New York provide for agencies to classify streams and to enforce orders requiring abatement of pollution. Some progress has been made in Vermont in the classification of streams. None of the waters in the New York portion of the subregion has yet been classified, although progress leading to classification has been made. The subject of pollution in the international waters of the St. Lawrence River lies within the jurisdiction of the International Joint Commission, but the Commission has not been directed by the governments of the United States and Canada to investigate conditions of pollution of boundary waters in Subregion "C". Both New York and Vermont are member states of the New England Interstate Water Pollution Control Compact. The Commission created by that Compact has not classified the streams of the Lake Champlain Drainage Basin to which its jurisdiction extends. It would appear therefore, in summary, that the situation as regards pollution in Subregion "C" is one of concern, particularly in the Lake Champlain Drainage Basin. Steps directed toward correction of existing pollution and preservation of the water resources against pollution from new sources in the future need to be taken. Such action is now in progress by the Vermont and New York State pollution control agencies.

5. Flood control and drainage. - Serious flooding has been experienced on the rivers of Subregion "C". Major flood damages have been incurred on the Winooski River and Otter Creek, both in the Lake Champlain Drainage Basin; the greatest losses being experienced along the Winooski River, where it is estimated that a

recurrence of the major flood of November, 1927 would cause estimated damages of over 16 million dollars. Eight Federal flood control projects have been authorized in Subregion "C" on the Winooski and Lamoille Rivers and Otter Creek. Studies of a number of sites for additional detention reservoirs in the Lake Champlain Drainage Basin were made, but all were found to be economically unjustified because the costs would exceed the benefits. Some reduction in flood damage could be accomplished by improving the flood warning service. The hydroelectric power projects in the inventory power plans for the river basins of this subregion would produce only such flood control benefits as might be incidental to their primary purpose of producing hydroelectric power. The land treatment measures planned for the primary purpose of securing an optimum level of agricultural production in the subregion would, upon installation, exercise a beneficial effect on the hydrologic characteristics of the subregion, but they would probably have only a small effect on major spring floods. In 12 areas, all in the Lake Champlain Drainage Basin, there is a need for investigations to determine the feasibility of water flow retardation measures. Sheet erosion of top soil is extensive in parts of the subregion, and overbank flooding causes considerable damage. Much of the erosion damages could be alleviated by installation of land treatment measures. There are two major drainage problems in the subregion, both in the Otter

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Creek Basin in Vermont which need to be studied for the purpose of determining whether or not drainage projects would be justified.

6. Power development. - The water power potential of Subregion "C", not including the main stem of the St. Lawrence River, aggregates about 708,974 kilowatts, of which some 316,489 kilowatts have been developed, leaving 392,485 kilowatts as the undeveloped hydroelectric potential. The St. Lawrence River power project will have a total installed capacity of 1,880,000 kilowatts of which 940,000 kilowatts will be in the United States section. The other ten projects included in the inventory power plans would aggregate about 311,000 kilowatts for the rivers of the subregion and increase annual generation by about 607,000,000 kilowatt-hours.

7. Navigation. - In the 115-mile reach of the St. Lawrence River lying within Subregion "C", existing navigation facilities are, in general, adequate for present needs. The navigation features of the St. Lawrence Seaway and Power Project, when completed, will without doubt cause radical changes in the navigation picture. Whereas at the present time deep-draft vessels are confined to the St. Lawrence River and the Great Lakes above Ogdensburg, New York and the St. Lawrence River below Montreal, Canada, the construction of the Seaway will permit deep-draft navigation from the Atlantic Ocean throughout the St. Lawrence River in its entirety. The new navigation facilities that will

certainly be required with the growth of waterborne commerce using the Seaway cannot be precisely predicted. Lake Champlain forms a part of a series of inland navigable waterways which interconnect the St. Lawrence River, the Hudson River, and the Great Lakes. Existing navigation improvements in Lake Champlain are generally adequate for the needs of present and immediate prospective commercial and pleasure traffic. Navigation on Lake Memphremagog consists entirely of pleasure boating. There is no Federal navigation project for Lake Memphremagog, and none is considered necessary. In summary, the principal needs of navigation for Subregion "C" are for completion of the St. Lawrence Seaway and the construction of auxiliary navigation facilities, the precise nature of which will depend upon future eventualities.

8. Beach erosion. - There are, in general, no serious shore erosion problems along the mainland shores or islands of the St. Lawrence River in the reach here considered. At high lake stages there is some erosion by wind-generated waves, and during freezing weather some damage occurs due to fluctuations of river levels while ice is attached to structures. No requests for additional protection of publicly owned properties against erosion have been made. In Lake Champlain there is some shore erosion, all on private holdings; and protective measures have been generally effective. In Lake Memphremagog shore erosion due to ice and wave action has been a problem for private owners of lake-shore properties.

9. Fish and wildlife. - The forest and woodland type of habitat is the most widespread in the subregion. Of the forest small-game group ruffed grouse and varying hare are the most hunted species. Farm-game species are represented by the pheasant, Hungarian partridge and cottontail rabbits. The St. Lawrence plains area supports the only known significant population of Hungarian partridges in the entire New England-New York region. Fur-bearing animals including beaver, muskrat and mink are harvested in the subregion. There are three outstanding waterfowl areas: Lake Champlain, the St. Lawrence River and the Lake Memphremagog Drainage Basin. There is a large amount of fishable waters, including the St. Lawrence River, the extensive lake system in the central Adirondacks, Lake George and Lake Memphremagog, and numerous streams. There is an abundance of both cold-water and warm-water fish habitat. The brook trout ranks high in preference among fishermen. Fish and wildlife resources form an important part of the economic structure of the subregion. There is a need for close coordination between game managers and foresters. Much good could come from management of the deer herd since much of the range is taxed beyond its deer carrying capacity. For some unaccountable reason the deer herd on the Adirondack foothill country is smaller than might be expected from the apparently suitable character of the habitat. A study is needed to discover the reasons for this shortage. There is great interest in waterfowl throughout certain

segments of the subregion, notably the St. Lawrence and Thousand Islands areas, Lake Champlain and Lake Memphremagog. Marsh improvement measures, such as creation of small impoundments and provision of wooden duck nesting boxes, have proven valuable in increasing productivity. There is a need for more waterfowl areas open to public hunting. Much of formerly good trout fishing waters have been deteriorated through the introduction of less desirable species, largely the result of carelessness on the part of fishermen in dumping the contents of live bait pails overboard. There is a need to restore trout fishing through the initiation of a pond reclamation program. There is a need for further fishery research, particularly on the big lakes in the Adirondacks, to furnish a basis for a sound fishery management development program.

10. Recreation. - The subregion has many natural features of outstanding recreational value including major portions of the Adirondack Mountains, the Green Mountains, and the St. Lawrence River with its well-known resort area, the Thousand Islands. Lake George, Lake Champlain, and Lake Memphremagog are large and beautiful bodies of water in mountainous settings, extremely satisfying to the seeker of rest, recreation and nature study. The climatic conditions are favorable to year-round recreational activities. The resident population is small but the seasonal visitation by seekers of recreation amounts to more than ~~seven~~ twelve times the resident population. Many towns and villages within the subregion receive

the major portion of their income from the performance of services and the furnishing of supplies to visiting recreationists. Forty-two areas that have been set aside for public recreation had a total of more than one and one-half million visitors in 1952. The total annual expenditures in connection with recreation are estimated to be more than $261,000,000. Needed additions to the present systems of public recreation areas include increased facilities; increased areas at existing public-use areas; additional general recreation areas; additional aquatic recreation and day-use facilities in the Vermont section and the northern and western slopes of the Adirondack Mountains; increase in the number of highway wayside areas for the accommodation of motorists and improved interpretation, through signs and markers, of scenic and natural features. The region is rich in historic and prehistoric sites of the kind generally recognized as major elements in recreational programs. There is a need for expansion, and, in some instances, redevelopment of existing non-urban public parks, recreational areas and historic sites and the establishment of additional recreational areas utilizing outstanding land and water features.

11. Land management. - Soils are satisfactory for production of most crops in the Vermont portion of the subregion while in New York the sandy soils are of near marginal or marginal suitability. The wide range of soil conditions presents many problems of management and utilization. The soils are reasonably productive. High

quality forest production is a notable asset of the subregion. In terms of acreage, the most important use of land in the subregion is for the production of timber and other forest products. In the aggregate the forests occupy approximately 58 percent of the total land area. The major types of forest growths are spruce, fir, common to mountainous sections; northern hardwoods, generally distributed throughout the subregion; and white pine. Much of the present forest area supports stands composed primarily of low-grade hardwoods, a large percentage of which consists of culled and undesirable trees. On such stands much of the current growth is unusable.

12. One of the striking features of Agriculture in Subregion "C" is the great number of large and relatively large farms, 69 percent of which are over 100 acres. Most of the farms are served by power lines and telephone service; and farm-to-market roads are generally adequate.

13. There is a need for some changes in land use for the purpose of improving operational methods and to better fit land capabilities. Attention needs to be given to conservation and drainage measures on some of the land in cultivation to forestall erosion. The major problem in the improvement of forest land is the development of a satisfactory growing stock of desirable species. There is a need for the development of new industries based on the utilization of low grade forest products. There is also a need for measures to accomplish disease and insect control, tree planting,

timber stand improvement, erosion control, fencing, and the construction of access roads.

14. Minerals. - The minerals industry of Subregion "C" is of great importance, both to the subregion and to the manufacturing and construction industries of the nation. Included in the mineral resources of the subregion are asbestos, clay, granite, iron ore, limestone and dolomite, marble, sand and gravel, sandstone, slate, talc, wollastonite, zinc, lead, silver, copper, feldspar, graphite, kaolin, ocher, mica, manganese, quartz, and whetstone. The Barre district of Vermont is the major producing area in the United States of monumental granite. A large part of the iron production of the State of New York has come from magnetite deposits within the subregion. The marble deposits in the Otter Creek Valley, Vermont, are some of the most important in the world. The only known commercial grade colored slates in the United States occur in the Vermont-New York slate district. The minerals industry will probably continue in the future about as it has in the recent past though considerable increases are expected in the use of sand and gravel and crushed stone for construction. Asbestos production could be greatly increased if a method were developed to purify it by removing combined iron. There is a need for further exploration of the mineral resources of the subregion involving a program of geological mapping together with geophysical reconnaissance. There is also a need for investigation of improved beneficia-

tion methods for the graphite ores of the eastern Adirondack area and testing of the white Cheshire quartzite of the Green Mountains in Vermont as a possible source of raw material for the manufacture of glass.

14. Insect control. - Many pestiferous insects occur within the subregion in sufficient numbers to create a public health problem by reducing the physical efficiency and comfort of the people and, in some cases causing illness. The principal pests are mosquitoes, black flies, deer flies, horseflies, and punkies. A decrease in the use of recreational facilities frequently occurs as a result of the annoyance caused by biting insects. As available information concerning the biology and habits of the pest insects is incomplete, there is a need for research, especially on horseflies, deer flies, and punkies. Inasmuch as pest problems can frequently be avoided by taking early measures for control, there is a need for the concurrent collaboration of entomologists with engineers and other planners during the planning of water resource projects such as dams, reservoirs, wildlife habitat improvements and recreational areas to insure that definite arrangements are made to solve problems of insect propagation incident to the projects and to assist in the execution of control measures as an integral part of development. There is a need for insect control projects in major urban areas and in camps and resorts.

VIEWS OF LOCAL INTEREST

15. Public hearings held by the Committee at Syracuse, New York on October 16, 1951 and at Montpelier, Vermont on March 19, 1952 afforded local interests an opportunity to express their views with reference to the subjects to be covered in the regional survey. A group spoke in favor of continuing the present program of soil conservation, such as ditching, terracing and fertilizing but it was stated that the practices would not be continued by the farmers if the Federal Government should withdraw its financial support.

15a. When the survey was nearing completion and tentative findings of the Committee had been drafted, additional public hearings were held on this chapter and other chapters on the river basins of Subregion "C" at Montpelier, Vermont on January 12, 1955; Concord, New Hampshire, on January 13, 1955; Albany, New York on February 8, 1955; Syracuse, New York on February 9, 1955; and Buffalo, New York on February 10, 1955.

15b. A need for low-cost power was expressed at the Montpelier hearing. Representatives of conservation and wildlife interests expressed general approval of the report but were opposed to the construction of any dam unless there is an urgent need for power, and unless wildlife values damaged by such construction would be replaced. Persons interested in conservation education spoke in favor of wide dissemination of the report. Spokesmen for associations interested in conservation favored continued protection of the New York State Forest Preserve; other interested persons noted constitutional barriers to the use of areas in the New York Forest Preserve for power purposes.

15c. The views expressed by those who appeared and the views expressed in written statements have been considered by the Committee in the preparation of the report.

FEATURES OF THE COORDINATED PLAN

16. Upon the basis of the inventory of the land, water, and related resources of Subregion "C" and the measures required for their conservation, development, and utilization a Coordinated Plan is presented below. The several measures are summarized in Sections I and III through XIII, inclusive, of this Chapter, and are set forth in detail in Chapters XXVI to XXIX, inclusive. The principal features of the Coordinated Plan are as follows:

a. Storage and stream flow regulation.

In connection with further hydroelectric power developments an additional 498,100 acre-feet of storage would be developed as a part of the power development features of the Coordinated Plan as described in subparagraph e, below.

b. Water supply.

(1) Expansion of investigations of surface water resources to include permanent and temporary stream gaging stations. Estimated annual cost $10,000 for 5 years.

(2) Analysis of basic surface water data. Estimated annual cost $10,000 for 5 years.

(3) Continuation of the investigations of the occurrence, general availability, quantity, and quality of ground waters being carried out jointly by the U. S. Geological Survey and the State of New York.

(4) Initiation of studies similar to those in (3), above, to determine the ground water potential of the Vermont

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portion of the subregion. Estimated cost, $65,000.

(5) Initiation of a continuing study of the trends in the use of water for supplemental irrigation. Estimated annual cost, $3,500.

c. Pollution. - Installation of facilities for treatment or disposal of municipal and industrial and private wastes. In the absence of stream classifications required by law the Provisional Pollution Control Plan described in Section V of this Chapter is offered as one of several plans to serve as a guide or frame of reference in planning water resource development. Estimated cost, $14,322,000. The Provisional Plan is summarized below.

(1) Public sewage treatment projects, including those for public schools and institutions. Estimated cost, $10,787,000.

(2) Private sewage treatment and disposal projects to serve individuals, factories, and private institutions. Estimated cost, $433,000.

(3) Industrial waste treatment and disposal facilities. Estimated cost, $3,102,000.

d. Flood control and drainage.

(1) Construction of flood protection works on Otter Creek at Rutland, Vermont. Estimated cost $4,280,000.

(2) Modification of three dams on the Winooski River to provide increased spillway capacity to safeguard the structures, and the construction of local protection works at Waterbury, Vermont. Estimated costs as follows:

Sites	Estimated cost
East Barre Dam	$3,171,300
Wrightsville Dam	2,020,000
Waterbury Dam	620,000
Waterbury local protection	2,810,000
Total Winooski River flood control cost	$8,621,300

(3) Initiation of waterflow retardation studies at 12 areas in the subregion within the Lake Champlain Drainage Basin to determine the cost and effectiveness of small retarding structures. Estimated cost $24,000.

(4) Improvement of the warning service to give timely notice of flood threats. No estimate of cost of this improvement has been made.

(5) Initiation of drainage studies at five areas in the basin to determine whether provision of drainage is justified. No estimate of cost of this feature has been made.

Some reduction in peak run-off could be expected from the land treatment features of the Coordinated Plan.

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e. Power development.

(1) Hydroelectric power projects as summarized in Table 49:

Table 49 - Summary of power and storage projects, Subregion "C"

River basin	Additional usable storage (acre-feet)	Additional installed capacity (kilowatts)	Additional annual generation (1,000 kilowatt hours)	First cost (dollars)
Lake Memphremagog Drainage Basin	0	0	0	0
Lake Champlain Drainage Basin				
Saranac	90,800	74,235	153,300*	41,276,000
Winooski		4,800	26,500*	2,751,000
St. Lawrence Drainage Basin				
Grass	79,300	46,870	128,643	24,900,000
Raquette	328,000	184,680	298,632	78,300,000
Totals	498,100	310,585	607,075	147,227,000

*Including additional energy output at existing downstream plants.

(2) Completion of the power features of the St. Lawrence Seaway and Power Project. Installed capacity 940,000 kilowatts (in United States); average annual generation 6,500,000,000 kilowatt-hours.

f. Navigation and beach erosion.

(1) Completion of features solely for navigation of the St. Lawrence Seaway and Power Project. Estimated cost, $79,218,000.

g. Fish and wildlife.

(1) Provision of increased public access to productive fish and wildlife habitat areas.

(2) Continuation or institution of public information programs on conservation, particularly with regard to sportsmen-landowner relations.

(3) Continuation of research, both basic and applied, into the many pressing fish and wildlife problems.

(4) Improvement of fish and wildlife habitat, including abatement of pollution.

(5) Improvement of wetlands for waterfowl and other wildlife.

(6) Expansion of lake and pond fisheries management.

(7) Revision of regulations where they are not adapted to the requirements of the present-day fish and wildlife conditions.

(8) Improvement of stocking practices for both fish and wildlife according to the most up-to-date management principles.

h. Recreation.

(1) Further development of established public recreational areas.

(2) Establishment of 11 major recreation areas utilizing outstanding lake, river and mountain features.

(3) Establishment of 20 major camping areas at strategic locations in the Adirondack Mountains and in the Green Mountains.

(4) Improvement of facilities at existing highway wayside areas and establishment of additional areas at appropriate locations along the principally travelled routes.

(5) Establishment of additional sites along major canoe routes and hiking trails for over-night stops, rest stops, and the cooking of meals.

(6) Preservation of wilderness conditions where they exist in the Adirondack Mountains and Green Mountains.

(7) Establishment of a system of back-country scenic routes and tourways to provide access to the scenic and cultural features of the countryside.

(8) Full development of the historic features for educational purposes and as tourist attractions.

(9) Continued cooperation between public agencies and private groups toward adequately marking, preserving, and presenting historic sites. The estimated cost of the recreation features of the

Coordinated Plan is $8,625,000.

i. Land management.

(1) Land use adjustments; changing land from present uses to other and more productive uses. Costs not estimated.

(2) Capital improvements to crop and pasture land, including erosion control, land clearing, fencing, seeding to pasture, drainage, and farm ponds. Estimated cost, $19,660,130.

(3) Periodic practices for crop and pasture land; including application of fertilizers and liming and other measures. Total annual cost, $12,228,150.

(4) Forestry measures, including tree planting, timber stand improvement, and other measures. Total installation cost, $31,061,500.

(5) Facilitating measures for crop and pasture land, including educational assistance, technical services and similar measures. Estimated cost, $14,891,000.

j. Minerals.

(1) Completion of topographic mapping at a scale of two inches to the mile, particularly in the Lake Champlain lowland of Vermont and New York and in the vicinity of mining operations.

(2) Geographical survey of the serpentine belt in and east of the Green Mountains in Vermont.

(3) Investigation of pegmatite in search of feldspar and strategic minerals such as mica, beryl, and columbite-tantalite.

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(4) Investigation and design of improved beneficiation methods for the graphite ores of the eastern Adirondack area.

(5) Testing of white Cheshire quartzite outcropping along the western front of the Green Mountains in Vermont as a possible source of silica.

(6) Exploration of pyrite deposits in Jefferson and St. Lawrence counties in New York.

k. Insect control.

(1) Continuation of biological studies and investigations and control programs, especially of black flies, deer flies, and punkies.

(2) Maintenance of limited entomological surveillance periodically at water resource developments to determine the effects of the projects on insect population.

(3) Provision during planning, construction, and operation of reservoirs, wildlife impoundments and farm ponds for protection and control measures against vector and pest insects when such developments would be within three miles of existing or anticipated centers of population or recreation areas.

(4) Assistance in the selection and planning of recreational areas to insure inclusion of adequate measures for the control of insects.

(5) Insect control measures in urban areas.

(6) Insect control measures in rural camps and resorts.

Estimated cost of the insect control features of the Coordinated Plan, $51,000. No estimate of the cost of the suggested investigations and other features has been made.

APPRAISAL OF THE COORDINATED PLAN

17. The appraisal of the Coordinated Plan is influenced by the fact that the plan is offered as an inventory of possibilities rather than as a definite program for implementation in accordance with a specified time schedule. Monetary values have been assigned to benefits which can be identified and measured. Intangible benefits are described.

18. Cost estimates are based on 1949 prices and annual charges include amortization, interest, maintenance, and operation. The amortization period is taken as the anticipated useful life of structures or the average tenure of landowners. In general, the interest rate is taken at 2-1/2 percent for public works and 4 percent for private works. The annual costs of features of the plan which are of a private nature are based on private financing, while the costs of features that would normally be provided by municipal, State or Federal agencies are based on public financing. The estimate of annual charges for the power features of the plan are based on the use of private capital with an average rate of return of 5-1/2 percent of the first cost of the project plus

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estimated interest charges which would accrue during the construction period.

19. Storage and stream flow regulation. - New conservation storage of approximately 498,100 acre-feet which is incidental to the hydroelectric power features of the plan, would provide improved stream flow regulation and increased industrial and hydroelectric power and other conservation benefits. Costs and benefits are discussed below under power development.

20. Water supply. - The benefits from the water supply investigations included in the Coordinated Plan are intangible. The study of supplemental irrigation would give warning when this use threatens to infringe upon other water uses. The ground water investigations would outline source areas favorable for the development of both large and small water supplies. The information thus obtained would also serve as an aid in determining the best methods for the development of dependable ground water supplies. Additional stream gaging stations would supply information on the yield of small streams needed especially for the study of water supplies for small communities and for irrigation. The information is also needed in the designing of highway culverts and bridges. The estimated cost of the gaging stations and the analysis of surface water data is $20,000 for a period of 5 years. The estimated total cost of the ground water investigations in the State of Vermont is $65,000. The investigation of the trend in supplemental irrigation would cost $3,500 annually.

21. Pollution control. - The pollution control features of the Coordinated Plan would improve the water quality of the polluted reaches of the streams and lake areas. Pollution control would improve almost all water uses of the rivers, lakes and streams, particularly for fishing and recreation, and would reduce the chance of waterborne diseases. The benefits of pollution control have not been assigned a monetary value. The estimated first cost of pollution control measures are $14,322,000, and the estimated annual charges are $1,567,000.

22. Flood control and drainage. - The only plans for flood control in Subregion "C" are those for Otter Creek and the Winooski River both in Vermont. Construction of the flood protection works at Rutland, Vermont in Otter Creek Basin would cost $4,280,000. Annual charges are estimated at $174,800 and benefits at $190,000 giving a benefit-cost ration of 1.09 to 1. Construction of the local protection works at Waterbury, Vermont on the Winooski River would cost an estimated $2,810,000. Annual charges are estimated at $116,000 and benefits at $78,200 giving a benefit-cost ratio of 0.67 to 1. Although the latter construction is not economically justified it is considered warranted in view of the hazard to human life and the intangible benefits to be derived from safeguarding the State Hospital at Waterbury. Modification of the dams at East Barre, Wrightsville and Waterbury would cost $5,811,300 but because these modifications are designed only to protect the existing dams from washing out there would be no additional flood control benefits.

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23. Waterflow retardation investigations would provide information as to the economic justification of small water retarding structures in 12 areas of the basin. Reductions in flood damages may be obtained by an improvement in flood warning services. The reduction in flood and erosion damages incidental to the land management features of the Coordinated Basin Plan would ultimately amount to an estimated $150,800 annually. The inventory power plan would provide some incidental flood control benefits which have not been estimated.

24. Power development. - The power developments in the Coordinated Plan, not including the St. Lawrence Seaway and Power Project would provide an increase in hydroelectric power capacity of 310,585 kilowatts, with average annual energy output of 607,075,000 kilowatt-hours, including the increase of energy at existing plants resulting from regulated flow. The estimated annual value of the power from the new projects would be $11,387,000. This value is based on the cost of generating equivalent power by means of privately financed steam plants in the subregion as the most likely alternative source in the absence of the hydroelectric projects. The total cost of new developments is estimated at $147,227,000. Annual charges are estimated as $18,054,000 based on private financing. The benefit-cost ratio is 0.63 to 1.0. Although this benefit-cost ratio is less than unity, the effects of changes in cost levels of both hydroelectric and alternative steam plants coupled with other factors which must be considered in supplying future power needs may lead to the ultimate utilization of the subregion's undeveloped water power.

25. Navigation. - The principal navigation feature of the Coordinated Plan is the construction of the St. Lawrence Seaway. The completion of this project will enable ocean-going vessels to enter the Great Lakes from the Atlantic Ocean and will confer upon lakeports, a new status as seaports. One of the principal justifications for the project is its essentiality to the national defense. The estimated first cost of the works solely for navigation is $79,218,000. The benefits have not been assigned a monetary value.

26. Fish and wildlife. - The fish and wildlife features of the Coordinated Plan would provide for correction of existing abuses and deficiencies of the fish and wildlife resources of the subregion. Improved relations between sportsmen and the holders of large tracts of land and forests would attract increased numbers of hunters and fishermen to the subregion, with consequent economic advantages to the residents catering to the needs of sportsmen. The investigations into the causes of deer scarcity in the peripheral areas of the Adirondacks could result in a great increase in the availability of good deer hunting. Likewise, the measures for improvement of habitat for waterfowl and the improvement of fish habitat could go far to preserve these assets from depletion. No estimate of the costs of the fish and wildlife features of the Coordinated Plan has been made and the benefits have not been assigned in monetary values.

26. Recreation. - The recreational features of the Coordinated Plan would permit greater opportunities for public use of the lakes,

mountains, forests, streams and historic features in connection with recreation. It is estimated that the further development of the resources of the subregion along the lines suggested would increase visitor attendance by 2,750,000 persons per year. The estimated first costs of the features of the plan are $8,625,000 and the estimated annual charges are $782,000. Both tangible and intangible benefits would result from the recreational developments. As a measure of the tangible benefits the increase in the expenditures of visitors could be expected to amount to $41,250,000. Taking 10 percent of this increase as a measure of the tangible benefit of the recreational improvements gives a benefit-cost ratio of 5.3 to 1.0. The intangible benefits, although not measurable in monetary terms, constitute the basic objectives of recreational development that include, among others, contributions to the physical and spiritual health and welfare of individuals as a result of participation in outdoor recreation.

28. Land management. - The Coordinated Plan would provide measures to meet the expanding needs for food and fiber and provide for the conservation and improvement of soil and forest resources and for the conservation of water and the reduction of peak runoff. The major benefits from conserving and improving crop and pasture land and from tree planting and other forestry measures are susceptible of monetary evaluation. The aggregate installation cost of these measures is slightly less than $66,000,000 and the annual charges about $16,000,000. The benefits are estimated at about $18,000,000. Based on these figures the benefit-cost ratio would be 1.1 to 1.

29. Minerals. - The minerals features of the Coordinated Plan would complete quadrangle topographic, and geologic mapping and might indicate the location of mineral deposits of commercial value. The costs have not been estimated. The benefits are not capable of monetary evaluation but the results would be of assistance to engineers, contractors, miners and prospectors and might result in the establishment of profitable new industries.

30. Insect control. - The insect control features of the Coordinated Plan would make it possible for camps, resorts and communities to control insect pests and disease vectors. While the benefits are not capable of monetary evaluation the measures would make life more comfortable for residents and visitors. The recreation industry would probably be benefited by an increase in the number of vacationists. The provision of insect control measures during construction and operation of future water resource development projects would minimize insect breeding and enhance the recreational value of the area.

RECOMMENDATION

31. The Committee recommends that the Coordinated Plan, as heretofore described, serve as a guide for the development, conservation and use of the land, water and related resources of Subregion "C".