

PROGRESS

In Developing Natural Resources

STATE OF MINNESOTA

LEGISLATIVE REFERENCE LIBRARY
STATE CAPITOL
ST. PAUL, MINNESOTA 55155



HC
107
.M6
A342
1954/56

**Biennial Report on the Work of the Office of
Range Resources and Rehabilitation**

1954 - 1956

PROGRESS

*In Developing
Natural Resources*

STATE OF MINNESOTA



Published by the
**OFFICE OF IRON RANGE RESOURCES AND
REHABILITATION**

624 State Office Building
St. Paul 1, Minnesota

November, 1956

LEGISLATIVE REFERENCE LIBRARY
STATE OF MINNESOTA

State of Minnesota
Office of Iron Range Resources and Rehabilitation
624 State Office Building
St. Paul, Minn.

To Governor Orville L. Freeman and the Legislature of the State of Minnesota:

I am herewith submitting to you the biennial report of the Iron Range Resources and Rehabilitation Commission.

This is the report for the twenty-fifth biennium, covering the period beginning July 1, 1954, and ending June 30, 1956.

Respectfully submitted,

Kaarlo J. Otava,
Commissioner

**IRON RANGE RESOURCES AND REHABILITATION
COMMISSION**

BIENNIAL REPORT

July 1, 1954 to June 30, 1956

CONTENTS

	Page
Members of the Commission	5
Dedicated Task (introduction)	7
Progress in Industrial Development (summary).....	11
Industrial Development	12
Resources Development	17
Peat Progress	19
Iron Ore Survey	27
Potential in Marl	30
Iron Range Mapping	32
Duluth Port Survey.....	35
Water Resources	43
Forest Development	53
Caterpillar Attacks on Aspen	59
Soil Texture in Aspen Sites	64
White Pine Blister Rust Control	66
Brush Invasion on Pine Sites	67
Forest Plantation Management	69
Youth Camp	69
Farm Program	71
Legume Research	75
Receipts and Outlays	79

STATE OF MINNESOTA

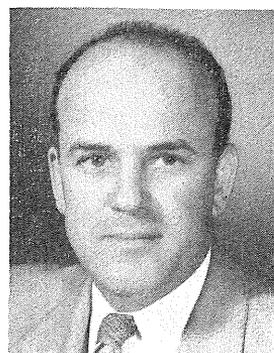
Iron Range Resources and Rehabilitation Commission

St. Paul, Minnesota

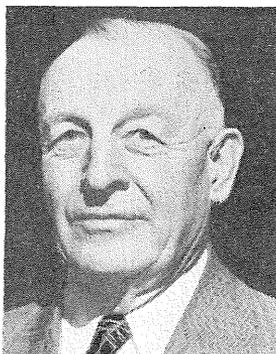
1956



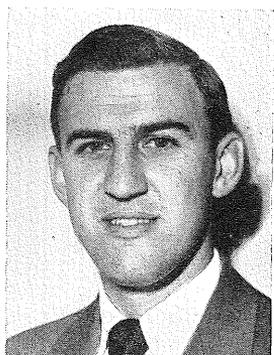
**SENATOR
ELMER PETERSON,**
Chairman, Hibbing



REP. PETER X. FUGINA,
Secretary, Virginia



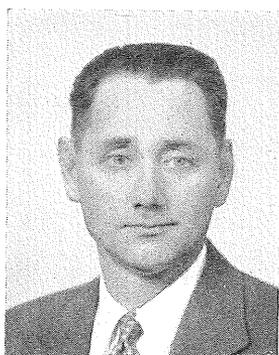
DR. GEORGE A. SELKE,
Commissioner Department
of Conservation
State Office Building
St. Paul



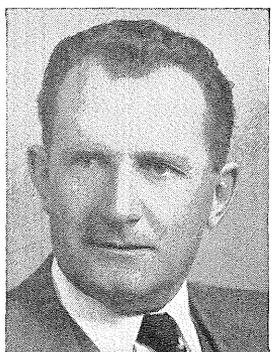
REP. KARL F. GRITTNER,
Vice Chairman, St. Paul



SENATOR GEORGE O'BRIEN
Grand Rapids



KAAKRO J. OTAVA,
Commissioner, Office of Iron
Range Resources and
Rehabilitation
State Office Building
St. Paul



REP. CHARLES L. HALSTED
Brainerd



**SENATOR
HERBERT ROGERS**
Duluth

Dedicated Task

Encouraging signs of progress and new developments are noted in the records of the Office of the Iron Range Resources and Rehabilitation during the past two years, ending June 30, 1956. This report covers activities and projects initiated within that biennial period, along with those which were started in past years.

Your present commissioner took office in May, 1955, under appointment by Governor Orville L. Freeman, and in the period since then several programs were launched, including:

A Duluth port survey in view of the St. Lawrence Seaway and Great Lakes developments.

A survey of marl (lime) deposits as another potentially important Minnesota resource.

Promotion of a farm management program in an effort to gain new insight on operating problems and best agricultural potentials in northern Minnesota.

A mineral survey to determine the extent of remaining iron ore reserves in the Eveleth area—and to prospect for new deposits—in an effort to bolster a depressing economy in the community.

Assisting in establishment of Youth Conservation Camp in Itasca county, considering its value in forest development.

Governor's Conference

Also noteworthy among the activities in the past year was the Governor's State-Wide Resources Conference, held at Hibbing under sponsorship of the Office of Iron Range Resources and Rehabilitation. Significant facts and suggestions were presented by experts and leaders in nearly the whole scope of the Minnesota resource picture. The Conference, as the Governor had predicted, proved to "be of real value in reaching an understanding of the future potential of our state, and in the development of a long-term program for the maximum utilization of our human and natural resources." And the published report of the Conference now serves as an important source and summary of information on Minnesota resources.

Numerous project proposals were presented to the Commissioner and the IRRRC advisory body and their worthiness and potentials were carefully considered. Some were rejected as impractical, some were regarded as questionable in view of legal restrictions or because they failed to come within the intent of the Legislative act which established the Office of Iron Range Resources and Rehabilitation in 1941.

IRRRC Operation

The law pertaining to the Commissioner provides that when he determines that distress or unemployment exists, or may exist in the future, in any county by reason of the removal of natural resources, or a possible limited use thereof, he may use IRRRC funds considered necessary for the development of the remaining resources, and for the vocational training and rehabilitation of the residents.

~~Reference:~~ Operating funds are derived from a portion (5%) of state occupation taxes on iron ore. The total received varies yearly, depending on the amount of ore tonnage shipments from the mines.

Proposed projects are submitted to the Iron Range Resources and Rehabilitation Commission, which recommends approval or disapproval. The Commission, created in 1943 by the Legislature, consists of seven members: three state senators, three state representatives, and the state Commissioner of Conservation. The method, manner and time of payment of funds proposed to be disbursed also are presented for approval or disapproval of the Commission.

Funds Diverted

Of the funds available to the IRRRC, certain amounts have been made available to other state agencies—such as the University of Minnesota and the Department of Conservation—by appropriation transfers authorized by the Legislature. Substantial sums were thus directly diverted by transfer in the last biennial period and in previous years.

Fund transfers totaled \$719,564 in 1954-1955 and \$587,770 in the year ending June 30, 1956.

The transfers cut deeply into IRRRC operating funds and therefore practically ruled out consideration of any large-scale new projects.

Money expended for some earlier projects is being currently recovered under contracts or leases. Among them are: Seed warehouse at Cook; rutabaga canning at Grand Rapids; wood processing plant at Deer River; hardboard project at Duluth; Chun King refrigerated warehouse and plant at Duluth; veneer dryer at Grand Rapids.

Project Aims

Forest development and forest product utilization to help re-establish a once important industry in the cut-over region of northern Minnesota continue to be major projects. These are stimulating new industry, creating more jobs and building timber revenue. Even greater benefits lie ahead in the future.

Projects, such as topographic mapping and investigation of water supplies, are conducted on a cooperative basis with the federal government. Data assembled is proving an important aid for industrial development.

IRRRC peat research is on a sound basis under scientists of the University of Minnesota and its Duluth Branch. Their discovery that peat serves as an excellent binder in the processing of taconite ore in laboratory tests points out the promising potentials in the development of this abundant Minnesota resource.

Benefits Noted

The IRRRC can point to tangible results in the industrial development and rehabilitation programs in the distressed areas. New industries, established with IRRRC fund aid and on the basis of IRRRC experience and research, have created a great number of new jobs with significant annual payroll contributions to the economy of the communities directly affected. Additional benefits are derived by those who supply the raw materials and services for the new industries. And, it should be noted, these industries are drawing on natural resources previously dormant or little used.

Problems have been encountered in the experiments and progress in some cases is slow, but every effort has been made

to develop the projects on a sound basis. Even projects which were discontinued in the past—such as the iron powder plant—may be considered to have contributed to a long-range program of research in the use of Minnesota's natural resources. Indeed, the large scale iron powder experiment may have succeeded but for the death of Charles V. Firth shortly after the Aurora site was selected. The Firth process was successful in laboratory tests and he died before the furnace he was especially designing was completely blueprinted. Others had to visualize the Firth plans.

Research is Key

Assembled knowledge and past experience, too, led to an accelerated search for chemical derivatives from peat.

Significant agricultural information has been collected to help develop the best use of available farm lands in northern Minnesota.

A natural resource such as iron ore cannot be replaced by man. Forest resources are renewable when properly managed and developed. Other resources such as peat, titanium, manganese, nickel-copper and marl await development.

Therefore future planning in the work of the Office of Iron Range Resources and Rehabilitation demands courage and foresight to meet the day of depletion and to offset depressing economical factors now and in the years ahead. To that task this office is dedicated—for the benefit of the Iron Range area and of the great state of Minnesota as a whole. And with the continued splendid cooperation of its staff and those it must work with in government and private industry, steady progress is assured.

KAARLO J. OTAVA, Commissioner
Office of Iron Range Resources
and Rehabilitation

PROGRESS IN INDUSTRIAL DEVELOPMENT

**SUMMARY OF IRON RANGE RESOURCES AND REHABILITATION PROJECTS
CURRENTLY IN OPERATION**

PROJECT	Total IRRRC Funds Expended	Average No. of Employees	Annual Payroll	Annual Purchases (Raw Materials)
Cedar Products, Inc., Deer River (wood processing plant)	\$ 273,394	25	\$ 102,000	Uses Mostly Western Timber
Chun King Sales, Inc., Duluth (Oriental American Foods packer)	199,983	500	1,200,000	\$3,000,000
McLeod, Inc., Grand Rapids (molded veneer products)	15,000	53	140,000	37,000
Superwood, Inc., Duluth (hardboard from aspen)	367,500	155	900,000	400,000
Nu-Ply, Inc., Bemidji (hardboard-veneer plant)	358,983	45	180,000	72,000
Arrowhead Seed Growers, Cook (legume, grain seed processor)	27,654	4	10,000	38,000
GRAND TOTALS	\$1,242,514*	782	\$2,532,000	\$3,547,000

Chun King employs an additional 500 in its related firms, including Frozen Foods Corp., Northland Foods, Wilderness Valley Farms, Orient Express and CK Foods, Inc.

*Recoveries by royalties or rentals to June 30, 1956, total \$362,788.05 and will continue until full amount expended for each project is recovered.

BENEFITS ALSO EXTEND TO MINNESOTA SUPPLIERS OF RAW MATERIALS, EQUIPMENT AND SERVICES FOR THE NEW INDUSTRIES

Industrial Development

Now in operation at Bemidji is an experimental wood products plant built with the assistance of the Iron Range Resources and Rehabilitation Commission. The plant is the result of a community-wide project in which residents of Bemidji participated.

The IRRRC provided \$350,000 for construction and equipment and the plant was leased to the newly formed Nu-Ply Corporation of Bemidji, a private investor group which put up about \$150,000 for the project. Residents of Bemidji backed the project by investing an additional \$180,000 for operating capital.

The project was approved by the IRRRC in June, 1954, and construction began that summer. In February, 1956, the plant was formally dedicated. Under terms of the lease agreement, Nu-Ply is paying a rental or royalty of not less than \$35,000 a year for use of the state-owned pilot plant.

Plant Design

The plant was designed to produce a type of plywood which uses a core made from low grade Minnesota wood, such as aspen, with surfaces made of native hardwood. Northern Minnesota has abundant stands of aspen (poplar) for which increased utilization is being sought. It has been estimated that Minnesota has an annual surplus of about 600,000 cords of aspen, and 300,000 cords of other hardwoods.

First tests in the new process were begun in March, 1956, and a type of pressed hardboard produced entirely from aspen is among the initial results. From these experiments, it is hoped a type of plywood can be developed which can be economically produced and profitably marketed, using the so-called lower grade timber resources in the cut-over area.

Approximately 45 men are employed at the plant and eventually it may give employment to as many as 70 persons. If successful, the plant will help stimulate the start of a producing industry in Bemidji and establish a more stabilized economy in the area.

Hardboard is Core

The hardboard produced at the plant is essentially the core for the new plywood product. The hardboard, meanwhile, is being marketed through Superwood Corporation, Duluth, a similar state plant which also produces a type of hardboard from aspen pulpwood.

The Bemidji plant is being expanded to provide storage space and a humidifier building. Equipment is being designed for laying veneer by machine rather than by hand methods. Also, plans are being readied for marketing the new plywood.

Duluth Plant

Superwood Corporation, formerly Superior Wood Products, is the result of a hardboard-from-aspen project started in 1947. Long past the experimental stage, the plant now operates at full capacity the year around with an average of 155 employes. Production tripled after the first three years of operation. The corporation currently is planning a new addition that will enable it to double present production at the plant. Regular payments to the state are being made monthly under terms of the lease.

Grand Rapids Plant

At Grand Rapids the Wolmac Company, now called McLeod, Inc., under a change in corporate ownership, is employing 53 people in the production of molded veneer products (again using aspen). The IRRRC part in the McLeod project dates back to 1950 when it allotted \$15,000 for the installation of a veneer dryer for producing veneer at the plant. The veneer board is molded into odd sizes and shapes and sold to manufacturers, such as office equipment builders. The company is paying monthly rental for use of the kiln.

The McLeod operation has resulted in the establishment of another separate small industry in Grand Rapids which manufactures and markets water skis and related items made from the molded plywood. Its purchases from the McLeod company are averaging \$2,000 a month.

Deer River Plant

The wood processing project at Deer River has a history dating back to 1947 when the IRRRC authorized an expenditure of \$250,000 for plant construction and equipment, including a dry kiln and planing mill. Since June, 1955, the plant has been operated by Cedar Products, Inc., which took over the lease held by Karl Rasmussen. Cedar Products, a subsidiary of the Weyerhaeuser interests, ships in green lumber and processes it into roof decking and other similar construction materials. Approximately 25 men are employed at the plant.

Chun King Grows

Chun King Sales, Inc., Duluth, which received IRRRC assistance in 1950, has developed to the point where it now ranks as the largest packer of American Oriental foods in the world. During the past two years it has repaired buildings, improved facilities and added equipment for processing frozen foods.

Complete recovery of the funds expended by the IRRRC for plant expansion appears certain before the end of another year. Payments in the form of rental and royalties are being made each month.

Chun King, using enormous quantities of vegetable products, has been a strong stimulant for revived and expanded truck farming in the Duluth area. Employing 500 persons on a year around basis, it has established a substantial payroll in the Duluth area economy. The business has helped to return to production land that had lain idle for years in northeastern Minnesota.

Chun King and its related firms employ upwards to 1,000 persons a good share of the year, with a total payroll in excess of \$2,000,000. It is the only unionized American-Oriental packer in the food industry.

The Chun King interests have acquired some 5,000 acres of land near the Iron Range and plans eventually to put a good share of this into cultivation growing celery, head lettuce, onions, blueberries, potatoes and tomatoes.

Their purchases of services, equipment and materials, which originate in Minnesota, such as cans, shipping cases, labels, onions, celery, poultry, fresh eggs and flour, range between \$3,000,000 to \$4,000,000 a year.

Grand Rapids Plant

Operations are continuing, though not on a full scale, in a rutabaga canning project at Grand Rapids. The plant is operated by the Arrowhead Canning Company. The IRRRC first entered the project in July, 1945. Efforts are being made to step up production to meet a great number of unfilled orders. The project was initiated because of the great possibilities of expanding the use of lands well suited for the growing of high quality rutabagas.

Floodwood Plant

Negotiations were conducted in the past two years with United States, Canadian and European private peat processors on the sale of the state-owned Floodwood peat plant but none of the proposals was considered adequate. The plant, designed to process peat for horticultural purposes and for livestock and poultry litter, has been idle since 1950. Current expenses on the plant are confined to maintenance and a watchman.

The plant is being kept intact for the time being with the hope that some of the experiments in the University of Minnesota peat research program will result in a product that could be made at Floodwood with far less expense to the state than if a new plant had to be built.

Frozen Foods

Under consideration is a proposal for IRRRC assistance in establishing a frozen food processing plant in Itasca county. The plan was submitted to the Commission in October, 1955, by an Itasca county group which pointed to a need for a stable economic cash crop, other than dairy products, for farmers in northern Minnesota, especially in the Iron Range area.

A quick-freeze plant is proposed for research in developing new processes for the freezing of strawberries, raspberries and other products produced in the area. Asparagus, wild blue berries, poultry products, potato products and specialty items are suggested as other potentials.

The proposal was held for further study of marketing aspects of the plan and investigation of crop potentials in the area. In addition, the sponsoring group is attempting to raise private financial support considered necessary to start such a project.

Cook Warehouse

The Cook warehouse project dates back to 1947 when a building was constructed and sold to the Arrowhead Seed Growers Cooperative for the full cost. Monthly payments are being made for recovery of the investment. The plant cleans and processes grain and legume seeds, and serves as a marketing outlet for wool growers in the area. It also provides custom seed cleaning service for its membership.

Warehouses Sold

Two idle potato warehouses, built during previous administrations, were sold in the past year, as authorized by the Legislature. Bids were called for and the building at Embarrass was sold for \$1,600; and the one at Lakeland for \$1,050.

Resources Conference

One of the largest and most complete conferences ever held on Minnesota resources was held in Hibbing in November, 1955, under sponsorship of the Iron Range Resources and Rehabilitation Commission. The State-Wide Resources Conference was called by Governor Orville L. Freeman for a thorough examination and evaluation of Minnesota resources for present use and future development.

Cooperating in the arrangements for the Conference were Minnesota's state department of business development, the department of conservation and the University of Minnesota's school of technology.

The Conference drew more than 500 persons, including 385 registered participants, despite difficult travel conditions because of a snow storm on the eve of its opening.

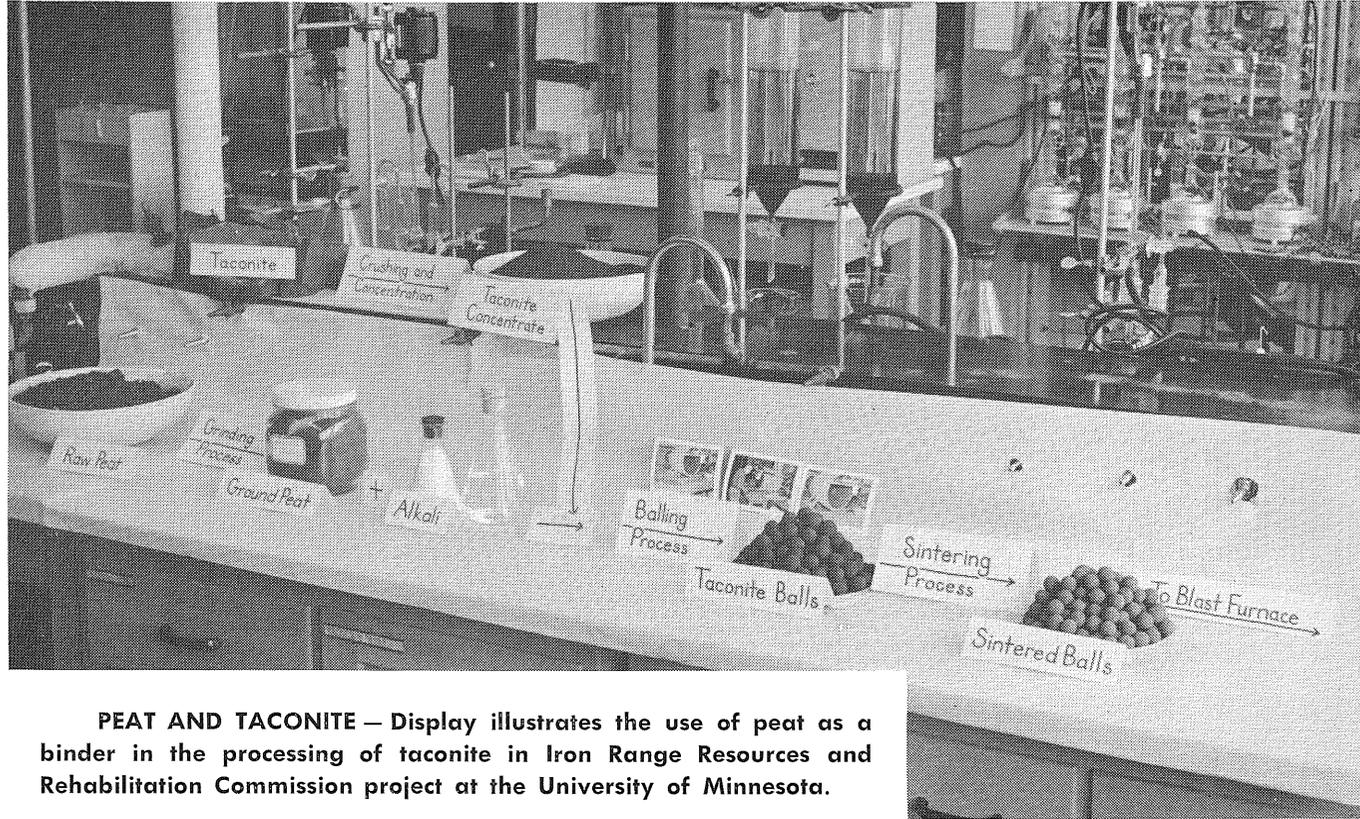
Personal invitations to participate were extended by Governor Freeman to government, industry and private organizations interested in Minnesota's natural and human resources.

Distinguished speakers, experts in their field, appeared on the three-day program which covered a broad range of topics, including: (1) forestry resources; (2) mineral resources; (3) water resources; (4) industrial, recreational and tourist facilities; (5) agriculture and soils; (6) human resources; (7) power and energy.

The Conference proved to be an outstanding outlet for suggestions, opinions, interpretations and significant facts about Minnesota resources from leaders and experts in the various fields, as well as from a great number of laymen.

A complete record of the Conference was published in book form by the IRRRC and it now serves as a valuable source for knowledge and creative thinking for all persons interested in Minnesota's industrial and recreational development, and in the conservation and development of its human and natural resources.

The book, entitled "Outlook on Minnesota's Resources," has been distributed to Conference participants, libraries and other general public information outlets, and is available to other interested persons upon request to the office of the Iron Range Resources and Rehabilitation Commission.



PEAT AND TACONITE – Display illustrates the use of peat as a binder in the processing of taconite in Iron Range Resources and Rehabilitation Commission project at the University of Minnesota.

Peat Progress

Minnesota ranks as the fifth country in peat-bog acreage in the world. It is estimated that there are seven billion tons of machine peat on an air dried basis in Minnesota and that this constitutes roughly one-half of the United States reserves. Much of the peat lies in northern Minnesota.

With these vast reserves, and in the light of what other countries are doing in the utilization of peat, it is only natural that Minnesota should be tremendously interested in developing this potential resource.

State interest in peat dates back to the 1870s. Professor E. K. Soper's report on a comprehensive survey of Minnesota peat bogs was published in 1919. Since that time there have been periodic studies in the use of Minnesota peat and the Iron Range Resources and Rehabilitation Commission has taken an important part in the research for the last 15 years.

Project Aims

The need for a planned and continuing program of study and research, aimed toward the economical recovery of the potential values known to be present in Minnesota peat, has long been recognized. Such a program was urged in a report by O. A. Sundness, Duluth, a Snyder Mining Company official, after he and Representative Fred W. Schwanke, Deerwood, returned from an International Peat Symposium in Ireland in the summer of 1954.

As a step in the direction of a long-range program, a research project was set up at the University of Minnesota and its Duluth Branch under sponsorship of the IRRRC. This project is aimed at the development of basic knowledge on peat and its constituents, from the viewpoint of eventually developing chemical products from peat. This newest research is three-pronged, utilizing and requiring the assistance and cooperation of three University of Minnesota groups: the Duluth Branch chemistry department, the chemical engineering department on the Minneapolis campus and the soils department on the agricultural campus.

New Discovery

As a result of this new research important advancements are noted, among them a significant discovery which promises to make close partners of peat and taconite—two of Minnesota's most abundant resources.

University researchers found that ground-up peat reinforced with an alkali solution is an excellent binder for the balling or pelletizing of powdered taconite concentrate.

Taconite, as it is mined, contains only about 25 per cent iron. Because this iron content is too low for direct feed of the rock to the blast furnaces, the ore must be concentrated. This is accomplished by grinding taconite into tiny particles and then separating the magnetic iron from the mother rock in magnetic separators.

Ore Into Pellets

The resulting purified ore contains about 62 per cent iron but is much too fine for the blast furnace. To obtain a suitably loose packing which will allow the furnace blast to pass through the ore during the smelting operation, it is necessary to form the powdered ore into one-half to three-quarter-inch balls or pellets in a balling drum. The pellets then are baked or sintered in a furnace to strengthen them so they will withstand handling, shipping and feeding into the blast furnace.

Function of a binder is to give the pellets sufficient strength to withstand handling between the balling drum and the sintering furnace and to hold their form while being baked.

Binders Used

Binders currently in use in taconite processing in northern Minnesota are bentonite, a clay shipped in from outside the state, and gelatinized starch. Approximately 10 pounds of bentonite or four pounds of starch are used per ton of taconite concentrate.

In the new peat process about seven and one-half pounds of peat and alkali per ton are required.

Cost of the bentonite ranges from 13 to 15 cents while the starch cost runs between 15 and 24 cents per ton of taconite processed.

Preliminary estimates indicate the cost of the peat and alkali binder probably will be below that of bentonite.

It is stressed that indications of peat's qualities as a taconite binder are based on laboratory studies alone and that much additional laboratory and pilot plant work remains to be done before its use in the commercial processing of taconite will be undertaken.

Rice Lake Peat

Peat used in the taconite binder study came from the extensive Rice lake bogs near Duluth. Further studies will be made of the suitability of peat from other Minnesota areas.

Consultative assistance of highly specialized personnel in other divisions of the University also has been enlisted, including the mines experiment station and the horticulture and geology departments.

It was E. W. Davis of Silver Bay, former director of the mines experiment station and founder of the present-day taconite industry in Minnesota, who invited the investigation of methods of using peat as a binder for taconite concentrate.

To make information on an international scope readily available to Minnesota researchers a comprehensive library of the world's literature on peat is being established in the form of a modern punched card system.

Peat Library

Work on the punched card system is about two-thirds complete and the code that was originally set up on a tentative basis has now been revised to a permanent status.

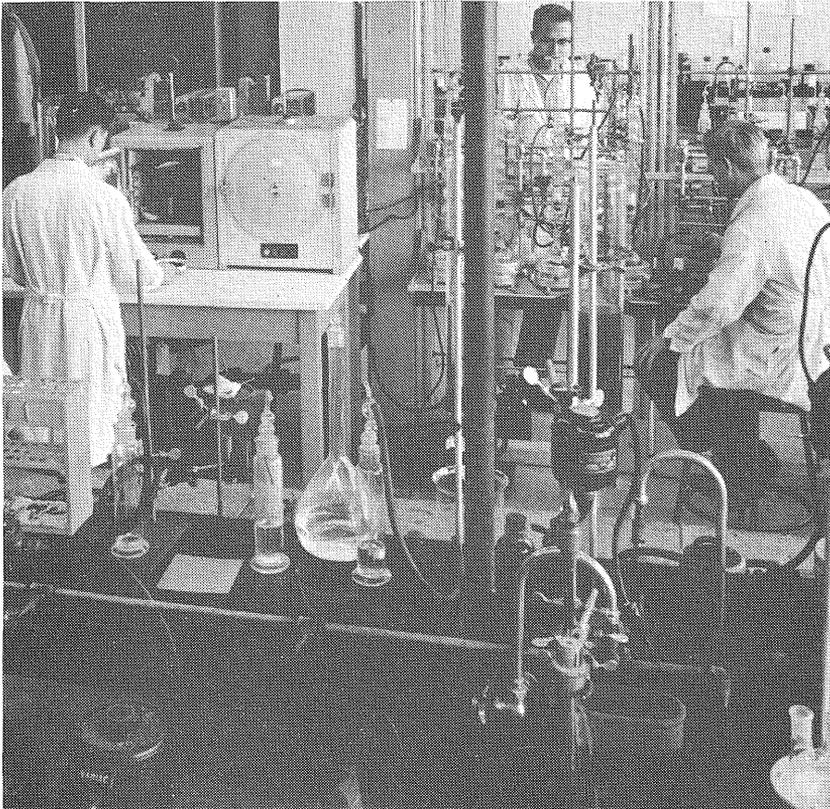
In connection with the punched card library, a new process has been developed for directly photocopying material onto the punched cards. The process is fast; the cards do not require photosensitive surfaces; the possibility of errors is eliminated, as well as the necessity for proofreading; material such as graphs and illustrations, which could not be copied by typing, can be reproduced by this process. And most significant of all for a library of many thousands of cards—the total cost per card is a small fraction—about 10 to 20 per cent—of the cost of typing.

The chemical engineering group, in consultation with the soils department, prepared a series of nitrogen—containing peat-based products for potential agricultural use.

Soil Conditioning

A method has been developed for the preparation from peat of ammonium humate on a larger-than-laboratory scale. This method was used successfully for the preparation of one and two-pound samples. These samples have been submitted to the soils group for evaluations in agriculture and horticulture tests.

Our researchers extended the larger-than-laboratory ammonium humate process to the preparation of ammoniated peat via the direct reaction of anhydrous ammonia with air-dried peat. Thus far, products containing up to 4.7 per cent total nitrogen have been produced. Nitrogen levels of 10 per cent and higher are considered desirable in horticulture applications.



SCIENTISTS AT WORK in extensive chemical engineering laboratory, established exclusively for research on peat by the Office of Iron Range Resources and Rehabilitation.

Peat Sampling

A systematic sampling of peat bogs was undertaken by the Duluth Branch team. About 700 samples were taken from 12 bogs—10 in St. Louis county, one in Carlton county and one in Itasca county. A particular effort was made to select as many different representative types of bogs as possible, with the ultimate aim of classifying peat bogs into a few basic groups from the chemical point of view.

It is very unlikely that this can be accomplished from the data on these 12 bogs alone. Therefore, future sampling is planned which will cover bogs in other parts of the state. Once such a classification is completed, however, the task of surveying the hundreds of bogs in this state should be greatly simplified.

In every bog the sampling procedure is as follows: At each of certain selected points, which together form a systematic geometric pattern on the surface, cylindrical one-foot-long samples are taken for every foot from the surface to the bottom of the bog.

Steps Streamlined

Before the various composite samples could be analyzed, simpler and more rapid procedures had to be developed that would accurately give the needed analytical information on large numbers of samples in a reasonable time. To date about three-fourths of the steps in the peat analysis have been streamlined to the point where they are practical and efficient, yet every bit as accurate as the far longer procedures used previously. Work is now in progress on the remaining steps.

Analysis of all the bog composites and of one set of layer composites is now essentially complete, while that of the remaining layer composites is partially complete.

Peat Classified

In view of the fact that several markedly different types of peat deposits have been recognized in Minnesota, a preliminary classification scheme has been prepared, based on the nature of the plant remains in the various strata, morphology, origin, environmental factors, and the nature of the adjacent geological material. The practical utilization of the various Minnesota peats

for agricultural, industrial and other purposes is largely dependent on proper recognition and identification of these deposits. This work is being correlated with chemical analysis data.

Soil conditioner experiments using peat-derived humic acids in comparison with synthetic polymer conditioners showed the peat products to be largely ineffectual the second year, in contrast with synthetics.

Earlier Studies

By way of background, it should be noted that in the past Minnesota has sought commercial uses of peat as a fuel and for horticultural purposes and poultry and stable litter, but they proved economically unsound because of price competition. Therefore, most recent studies have been directed in chemical research.

The world's annual production of peat for commercial use, mostly as fuel, in recent years has been about 50 million tons (air-dry basis). Russia, with 30 to 35 million tons, accounts for about two-thirds of this. Ireland produces 4.0 million tons, Denmark and Germany 1.5 million tons each, Holland, 0.8 million tons, followed by numerous other smaller producers.

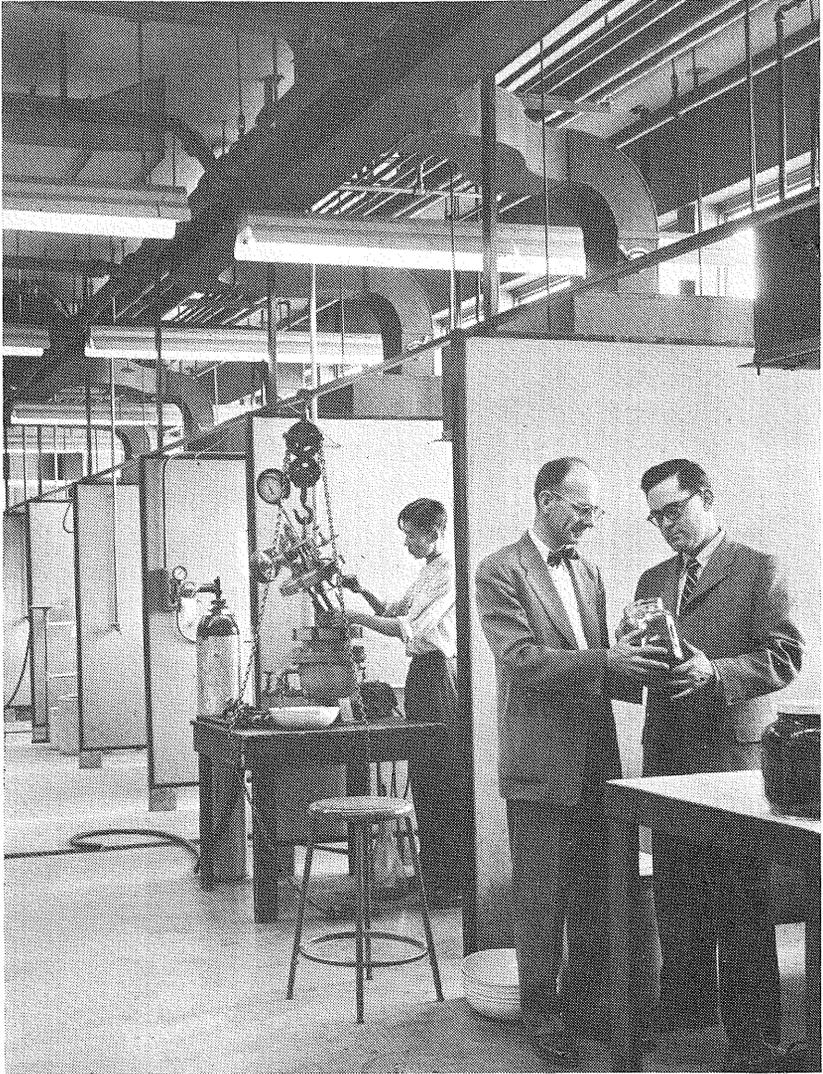
The United States, with an annual production of some 120,000 tons, is far down near the bottom of the list. Actually, with an annual consumption of about 250,000 tons, the U. S. imports more than it produces!

Peat Potential

Largest producers in the U. S. are New Jersey, Florida and Ohio, with about 25,000 tons each, then Michigan with about 13,000 tons. Smaller quantities are produced in about 20 other states. In 1950, Minnesota, with a production total of 400 tons, was at the bottom of this list. Today Minnesota is no longer tabulated among the peat-producing states—even though it has about one-half (some three and one-half million acres) of the total peat deposits in the United States!

So it is no wonder that Minnesota looks hopefully toward the day of profitable use of its vast peat reserves for the benefit of the state and all its people.

University scientists, working under sponsorship of the Iron Range Resources and Rehabilitation Commission, are driving toward a common objective: Marketable products from Minnesota peat. New progress has been made in this effort. Indeed, the successful laboratory tests of the use of peat in processing taconite alone raises staggering possibilities.



SEARCH FOR POTENTIALLY valuable products from peat goes on daily in huge University of Minnesota laboratory.

In summary, it can be said that significant progress is being made on Minnesota peat research under sponsorship of the Iron Range Resources and Rehabilitation Commission, including:

LABORATORY—Establishment of a chemical engineering laboratory, devoted exclusively to research on peat, has been completed and essential equipment has been provided.

PERSONNEL—New, well-qualified scientific and engineering personnel have been recruited and they are gaining the specialized knowledge and experience required for effective work on peat.

SPECIAL HELP—Consultative assistance of highly specialized personnel in other departments of the University of Minnesota has been enlisted such as the mines experiment station and the departments of horticulture and geology.

AGRICULTURAL PRODUCTS—A series of nitrogen-containing peat-based products has been prepared for potential agricultural use. Evaluations will be made in agriculture and horticulture tests.

TACONITE BINDER—The discovery was made that certain derivatives of peat possess excellent and unexpected properties as binders for the pelletizing of taconite ore.

PEAT ANALYSIS—Research on the comprehensive group analysis of peat has been extended and refined. A method has been worked out for determining the pentoses and pentosans present in peat. A rapid method of determining ammoniacal nitrogen in ammoniated peat products has been developed.

PEAT SAMPLING—About 700 samples were taken from 12 bogs in St. Louis, Carlton and Itasca counties by the Duluth Branch, University of Minnesota. The ultimate aim is to classify peat bogs into a few basic groups from the chemical point of view.

PEAT LIBRARY—Work is about two-thirds complete on establishment of a comprehensive library of the world's literature on peat. The library is in the form of a punched card system which makes readily accessible important information on peat.

Iron Ore Survey

An intensive mineral investigation was started in the fall of 1955 in the Eveleth area in St. Louis county as a new project of the Iron Range Resources and Rehabilitation Commission. A sum of \$150,000 was allocated for the start of the project.

The project was initiated at the request of Eveleth city and school officials who declared the community faced the threat of eventually becoming a "ghost town" unless additional iron ore reserves are found in the area.

Earlier, the Eveleth city council and the board of education had conducted a study to support their request for an exploration of remaining iron ore reserves in the area. A report on the study was presented to Governor Freeman and the IRRRC.

Decline Noted

The city of Eveleth, approximately five square miles in size, lies entirely within the 55 square miles which comprise Independent School District No. 39. City population is 6,187 and total population for the school district is 7,718.

According to the Eveleth study, in 1940 total mineral (iron ore) tonnage within the area of the school district was 42,178,258 (excluding Leonidas). By 1954 the tonnage had decreased to a total of 14,694,860 (including Leonidas).

The report said the decrease has been caused primarily by the shipment of iron ore and noted that if shipping continues at this rate, and if no further ore is discovered, it will have the following effects:

- a. A loss of the residents moving to other nearby communities. This shift in residence would cause the nearby governments many hardships and expenses because they would have to expand their overcrowded facilities. The cost of the new facilities and the subsequent cost of maintaining them would far exceed the cost of maintaining the efficient and adequate facilities now available in Eveleth.
- b. A drastic reduction in the high standard of education now offered to the residents.

- c. A resulting multiple reaction that eventually would make Eveleth a "ghost town."

Minnesota mineral records and iron ore tax rolls were examined in the study.

Their findings led them to believe a thorough investigation will lead eventually to the discovery of large quantities of iron ores. "Such discoveries," they said, "may result in an increase in the mineral tonnages and industrial use thereof. This effect would also have a very favorable reaction toward obtaining new and necessary industries."

Among the findings noted in the Eveleth report were:

1. In several cases tonnage actually mined from certain mines or pits far exceeded that which was supposedly available in prior years. Estimated tonnages as listed on the state's records were understated and it is therefore reasonable to assume that the present estimated tonnages are understated also.
2. The State of Minnesota does not directly establish or verify the tonnages or quality of all of the ore bodies. Since the production of iron ore is the state's greatest industry, it seems unreasonable that the state does not have the equipment to drill or explore the quantity and quality of this resource.
3. Many of the estimated tonnage figures are based upon engineers' reports which are more than 25 years old. New and more accurate methods of mining and engineering have taken place since that time but tonnage figures and state records have not been altered to reflect this progress.
4. Ore in abandoned underground mines needs careful consideration. Many known bodies of ore now considered unminable would be minable with a change of mining methods. Mines listed as "exhausted" on the tax rolls should be carefully explored.
5. There are, the Eveleth officials believe, high grade ore bodies within the city and school district boundaries which have not been discovered.

First work in the mineral survey was conducted by Dr. Frank F. Grout, professor emeritus of geology and minerology at the University of Minnesota, and an authority on iron ore resources. He completed the geophysical part of the survey, checking records of the University School of Mines, the state tax department, the division of lands and minerals and Oliver Iron Mining Division. On the basis of that study, backed by his expert knowledge of the area, he mapped locations considered best for further exploration.

Then the IRRRC began an electrical resistivity survey of the areas selected in the Grout study. This will be followed by a magnetometer survey. Results will be plotted on charts to show where test drilling is advisable.

Potential in Marl

In February of 1956 the Iron Range Resources and Rehabilitation Commission approved an initial appropriation of \$3,800 to enable the University of Minnesota to start an investigation of marl deposits known to exist in the lakes and bogs of Minnesota.

Marl, or bog lime, is a term commonly used for deposits in lakes and bogs which consist mainly of calcium carbonate. It is described as a soft, earthy material found as a fresh water deposit in lake basins and bogs in marshes or low areas that once were covered with water. Earlier analyses (Thiel, 1933) show that Minnesota marls range in carbonate content from 30 to 94.5 per cent.

Marl is used in the United States for the manufacture of portland cement and for liming soils. It has been suggested that it could be used for introducing lime into live stock and poultry food. The potential in the development of marl as another important Minnesota resource is therefore apparent.

Samples Taken

Funds for the investigation were released to the University in March and a two-man party began sampling of typical lakes, working on open water areas first while the ice was still safe. Several hundred samples were obtained at depths running down to 30 feet. These samples are being processed for preliminary and detailed chemical analysis.

Surveys indicate marl deposits are most abundant in Crow Wing county and is known to exist in plentiful quantities in the north central area of the state. But these marls are little utilized because of the lack of proper processing methods.

The potential use of marl for agricultural purposes is emphasized by soil surveys which show that over 6 million acres of Minnesota cropland need lime. Only about 25 per cent of that number are now receiving lime. It would require over 17 million tons of lime to bring the soils up to the desired lime content and about 2 million tons would be required annually thereafter.

Marl for Liming

Utilization of marl as agricultural lime is difficult because the material becomes lumpy on removal from the bed where it is normally saturated with water. The mines experiment station of the University of Minnesota is conducting filtering and drying experiments to see if a practical method of handling the marl could be developed which would be better than the present crude methods of excavating and spreading. Any method developed must be able to compete with the ground limestone now produced in southeastern Minnesota and trucked into other parts of the state.

If a proper method is developed of excavating and preparing marl for use as agricultural lime it should be possible to cut the cost of liming soils in the northern half of Minnesota to one-half of the present cost, according to our researchers.

Marl for Stock

In order to appraise the possibility of using marl in the manufacture of stock food the University's agricultural experiment station was asked to prepare a summary of the amounts used, requirements as to calcium carbonate content, objectionable impurities and price of ground limestone now produced. This summary will be included in a final report on completion of the marl investigation project.

Possibility of using Minnesota marl for portland cement has been under investigation for over 10 years by the Lehigh Portland Cement Company which has spent large sums of money in exploration, testing and acquiring lands. The Lehigh company has cooperated by furnishing information and giving permission to excavate marl on its land for test purposes.

A good start has been made in marl investigation. Further sampling on land areas and a large amount of chemical work will be carried on in the coming months.

Iron Range Mapping

Great new strides have been accomplished in the Iron Range Resources and Rehabilitation topographic mapping program in northern Minnesota in the past two years. Maps published during the fiscal years 1955 and 1956 covered areas totaling 1,007 square miles.

In addition, topographic mapping is well under way or nearing completion on other areas totaling 2,539 square miles. The IRRRC concentrates mapping on the Iron Range and adjacent areas because of its tremendous importance in iron ore and taconite development and in prospecting for other mineral resources.

The topographic mapping work is done by the U. S. Geological Survey on a cooperative basis with the IRRRC. The cost is shared equally by the IRRRC and the federal government. Actually, state funds cover only about 40 per cent of the total cost of the final maps because the cost of engraving and printing them is borne entirely by the federal government.

Use of Maps Noted

Along with their importance in mining and prospecting, topographic maps provide essential knowledge in planning industrial and recreational developments, soil erosion control, flood control, water use and conservation, highway routing, subdivision planning, sewage disposal, drainage, and radar and television location and construction.

Topographic maps accurately depict physical features of a locality or region, as well as man-made improvements such as buildings, roads, bridges and dams.

The Iron Range Resources and Rehabilitation mapping program, in cooperation with the federal government, was started in 1949 and has continued each year since then.

First step after the IRRRC commissioner approves mapping of a given area is aerial photography. Then follows:

Establishment of basic control by engineers in the field; stereo-compilation, which involves drawing the map from the photographs on which the critical control has been drafted; field com-

pletion, which involves checking in the field the many details that cannot be definitely determined from the aerial photos; drafting; final review for errors and style; engraving and printing.

Maps Published

Topographic maps published under the IRRRC program in the fiscal years 1955 and 1956 include:

LOCATION	Area (Sq. Miles)
Cohasset East (Cohasset SE)	51
Cohasset West (Cohasset SW)	51
Grand Rapids (Pokegama Lake NE)	51
Greenwood Lake (Greenwood River)	202
Silver Bay (East End)	199
Siseebakwat Lake (Pokegama Lake NW)	51
Stephen (Argyle)	199
Whyte (Kane)	203

Areas for which topographic mapping is under way and progressing in the various steps toward completion include:

LOCATION	Area (Sq. Miles)
Basswood Lake	59
Brimson Lake	203
Crooked Lake	202
Cross Lake	154
Ensign Lake	43
Fall Lake	171
Grand Marais NE	1
Grand Marais NW	8
Isabella River	202
Lake Markham	203
Little Marais NE	25
Little Marias NW	49
Little Marais SW	14
Lutsen NE	24
Lutsen NW	40
Pine River	190
Snowbank Lake	171
Soudan NE	41
Soudan NW	45

Soudan SE	44
Soudan SW	43
Split Rock NE	7
Split Rock NW	38
Tofte SE	15
Tofte	160
Tofte SW	42
Tower NE	31
Tower NW	38
Tower SE	31
Tower SW	45
Warren	200

The state appropriation through the Iron Range Resources and Rehabilitation Commission for topographic mapping in 1955 was \$54,000; in 1956, \$50,000. Each of the sums was matched by federal allotments in the two fiscal years.

Duluth Port Survey

The Iron Range Resources and Rehabilitation Commission is sharing in the financing of surveys to obtain information necessary in the planning of intensive port development at Duluth as a result of the opening of the Great Lakes-St. Lawrence Seaway projects.

The Lake Superior port of Duluth, with the finest natural harbor on the Great Lakes, is regarded as a natural state resource which merits development to the fullest extent to promote economic expansion and increase employment opportunities.

Therefore, the IRRRC, acting in the best interests of the State, agreed to appropriate annually the sum of \$15,000 for a period of two years, the funds to be used for the purpose of making an economic and physical survey of the port facilities and economic potentialities of the port of Duluth. The two-year period commenced July 1, 1955 and expires June 30, 1957.

In the agreement it was noted that:

Distress and unemployment exist in St. Louis county and in the port of Duluth.

A **portion** of this unemployment is due to the fact that at one time 1,500 men were employed as stevedores in the Duluth port.

Employment has dwindled at the present time to approximately 100 part-time stevedores.

Facilities for handling package freight have been abandoned or put to other purposes.

The St. Lawrence-Great Lakes Seaway will make it possible for the port of Duluth to revive the package freight industry.

The funds will be administered by the Port Authority of Duluth, a body created by state legislative action.

A **survey** is necessary for the intelligent expansion and development of the natural resources, consisting of the Port of Duluth.

Fund Status

The appropriations by the IRRRC represent only part of the financing held necessary for development of the Duluth port for conduct of foreign and domestic commerce to the fullest extent. At present, under state law, appropriations are permitted by the City of Duluth and the County of St. Louis for a two-year period, the calendar years of 1956 and 1957.

The annual appropriation from the city is approximately \$8,000 provided by tax of 15/100 mills, and from the county about \$110,000 provided by tax of ½ mill. The Port Authority expects to have a surplus of perhaps \$150,000 for the two-year period, which is to be devoted for purchase of land and property for terminal development.

An initial study, entitled "Lake Traffic at the Port of Duluth-Superior," was made by Dr. Richard O. Sielaff, director of research and development for the Port Authority, and professor and chairman, division of social studies, University of Minnesota, Duluth Branch. The study was made with the aid of basic data from official records of the U. S. Army Corps of Engineers.

Port Study

Dr. Sielaff's report notes two major problems. First, development of Duluth port physical facilities or capital equipment; second, promotion of foreign and domestic trade through the port.

Objectives of the study, he said, were to provide port commissioners with information regarding:

1. The relative importance to be given the development of receipts and shipments in stabilizing the Duluth, St. Louis county and Minnesota economy.
2. The kinds of products which have been successfully directed through the port in past years and which may profitably be given further study and development in the future.

Among the points noted in the Sielaff report are these:

● In total traffic tonnage the Duluth-Superior harbor is undoubtedly one of the dominant ports of the Great Lakes and perhaps the world. Total traffic in the Duluth-Superior port fluctuated between approximately 50 and 77 million tons during the years 1940 through 1954.

● There has been a steady but irregular growth in total traffic since the first year of record, 1871, when only 92,820 tons were shipped in or out of the harbor, some in sailing vessels.

● Over the years shipments (largely iron ore) have far exceeded receipts.

● Since early years Duluth-Superior has gone on to build such an enormous traffic in bulk commodities like iron ore, grain and coal, that harbor promotion has largely under-emphasized the development of the type of traffic on which other Great Lakes ports have survived for half a century or more.

● Major consideration and emphasis must continue on largest shipments, iron ore, but at the same time it will be beneficial to give attention to increasing receipts as well as shipments of products other than iron ore.

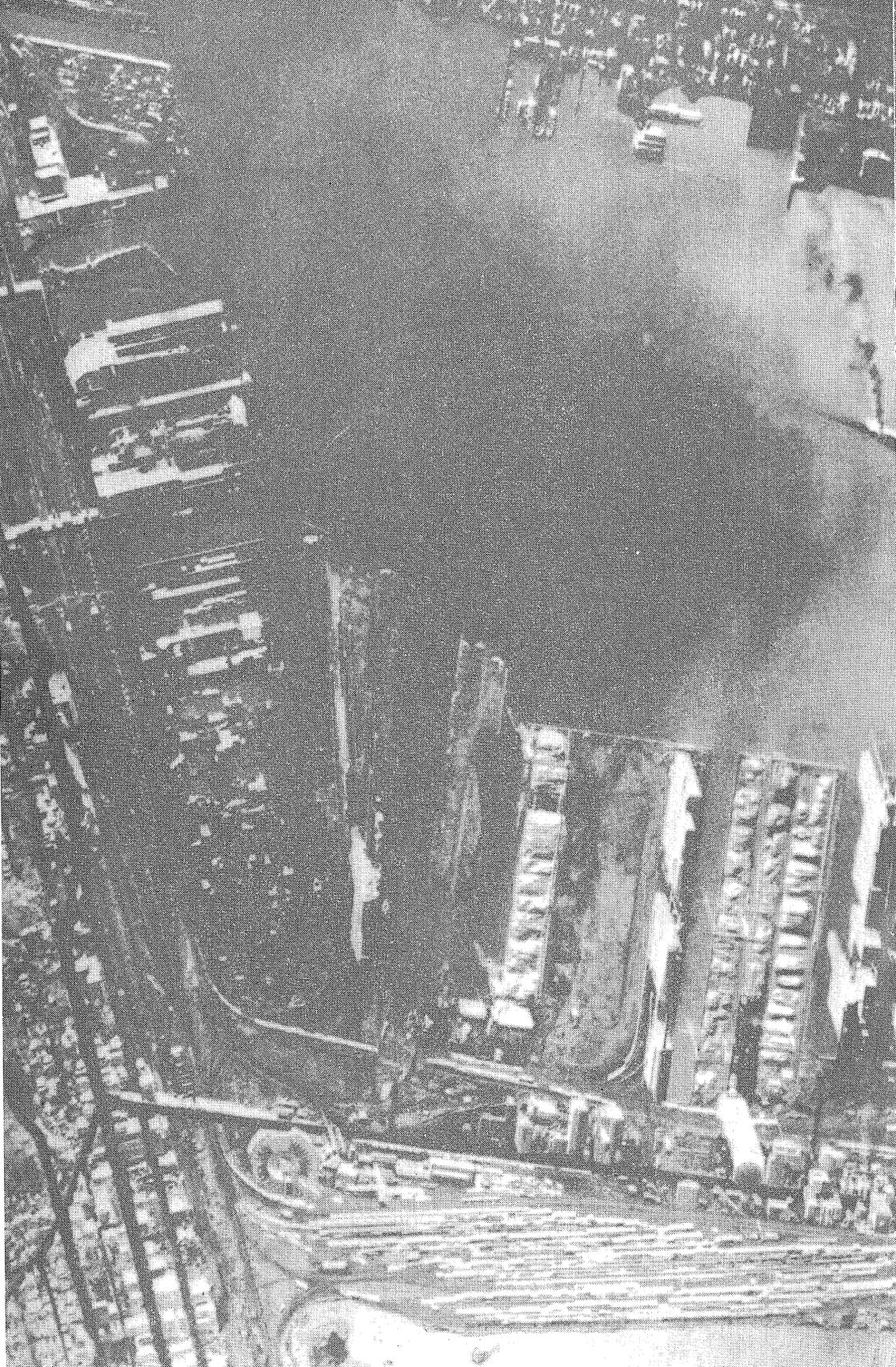
● Economic status, summarized: Port traffic is increasing and is much greater than that of other Great Lakes ports, but for more than a half century it has been increasingly weighted on the side of shipments. While receipts have not necessarily decreased over the long run, they have not increased as have shipments.

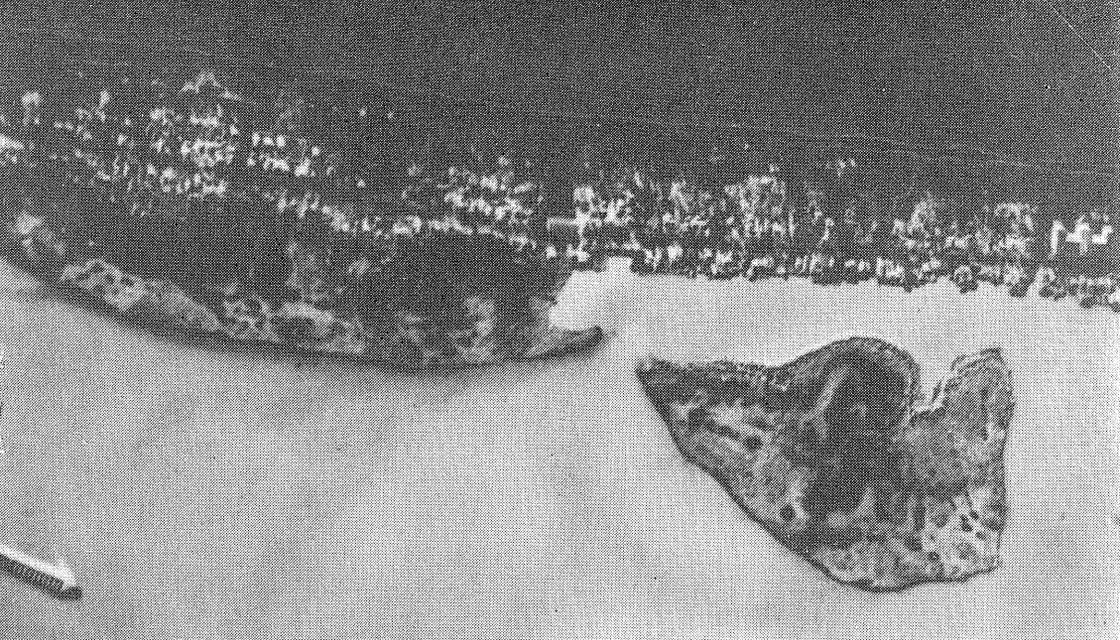
● Presently there is little stability in shipments and receipts. Careful selection of products will lend a greater degree of stability to port traffic. As a practical matter it may be difficult to do more than encourage all types of traffic, but long range planning for the Duluth and Minnesota economy should not neglect opportunities for stabilizing trade.

● Of considerable significance is the disappearance of package freight traffic. While the traffic in these products seems small in the total picture, it did provide employment locally to many people.

● Bituminous coal is the largest receipt at the Duluth-Superior port. Limestone is second largest.

● Bulk commodities have been the principal strength of the Duluth-Superior port for many years. In the study and development of the port, consideration might well be given to aid in developing trade in these areas even more as well as in the smaller manufactured products.





PORT DEVELOPMENT — Aerial view of Duluth outer harbor showing site (outlined below) of proposed public terminals for anticipated Seaway traffic.



● Grain storage and shipping facilities in the whole Twin Ports area is expected to increase by 100 per cent with the completion of the St. Lawrence Seaway projects. Existing facilities can accommodate 55 million bushels. If plans of the grain trade materialize Duluth-Superior will become the largest grain handling ports in the world.

● As to resumption of package freight service, it is found that present day terminal costs and ship costs make that service unattractive to steamship companies. However, it is believed that a new type of service, "roll on—roll off," will serve the needs of industry requiring package freight service in a more efficient and economical manner.

● Existing private facilities within the harbor are inadequate for general cargo and sea trade.

● The Port of Duluth, during its development stage and after, will be the greatest single factor in creating employment, not only in the Duluth area, but in the state, as a whole, and the hinterland that it will serve.

● Formation of a bi-state authority is being considered to offset the threat of a type of competition that would seriously affect the progress of each of the Duluth and Superior, Wis., ports.

Regarding financing of the Duluth port development, the Port Authority commissioners are quoted as feeling "that inasmuch as the Port Authority of Duluth is actually a state public corporation and that the benefits derived from the port will be had by the state at large, financial assistance should be given by the state as well as the county and city."

Water Resources

Knowledge of available water supplies in Minnesota is becoming more and more important because of the ever increasing use of water in modern civilization. This use is increasing at a much faster rate than our population because per capita use also is increasing.

There are many indications that industrial development in Minnesota will greatly increase in the next few years, with a corresponding need for additional water supplies.

Processing of taconite ore, the refining of petroleum, and rapidly developing chemical and plastic industries which use large quantities of water represent some of the newest activities which depend upon adequate supplies of water.

And with the trend of industry toward less congested areas the need for complete water data becomes increasingly important. Construction of the St. Lawrence Seaway, with the prospect of lowered transportation costs to world markets, will make Minnesota more attractive for industrial sites.

Demand Grows

As a result of economic expansion, demand for data on water resources is increasing at a phenomenal rate. On the Mesabi Range this has been brought about largely by the current and potential expansion connected with the mining of taconite and other low-grade ores.

Not only does the beneficiation process require larger volumes of water but the additional personnel required to process the ore has added considerably to the population.

This situation undoubtedly will continue, probably at an accelerated rate, and requires a considerable amount of long-range planning to obtain the basic water data necessary to conserve this most precious resource—water.

Surface Water

Investigation of surface water supplies on the Mesabi Iron Range area was begun in 1942, as a cooperative project, with the Iron Range Resource and Rehabilitation Commission and the U. S. Geological Survey participating on an equal basis.

The purpose of this investigation is to obtain and provide data relative to the water resources of the area, as a necessary basis for sound economic development of the other resources, principally taconite.

Water is a resource which varies from time to time and cannot be satisfactorily inventoried by taking stock at intervals. It is a renewable resource, being more or less continuously replenished by rainfall. Because it is only more or less replenished, continuous records over long periods of time are necessary to provide satisfactory data as a basis for wise use.

Gaging Stations

The cooperative investigation has been continued and expanded by addition of gaging stations as the probable future needs became evident, and at the beginning of this biennium 17 gaging stations were being operated under this cooperative program:

- Bear Island River near Ely
- Dark River near Chisholm
- Dunka River near Babbitt
- Embarrass River near Embarrass
- Embarrass River at outlet of Eshquagama Lake nr. McKinley
- Isabella River near Isabella
- South Kawishiwi River near Ely
- Partridge River near Aurora
- Pike River near Embarrass
- Poplar River at Lutsen
- St. Louis River near Aurora
- Stoney River near Babbitt
- Sturgeon River near Chisholm
- East Swan River near Toivola
- Swan River near Toivola
- Snake River near Warba
- West Two River near Iron Junction

It was necessary to construct gaging cableways at three of these stations to provide measuring facilities formerly available at bridges, together with a concrete weir on Dark River near Chisholm to improve the records at this station. Costs of operating these gaging stations during the fiscal year 1955 was \$17,404, of which the IRRRC paid \$8,925 and the U. S. Geological

Survey \$8,479. Federal funds were insufficient to meet all cooperative offerings by the States, and the difference was distributed among the cooperating parties on a pro rata basis as provided by the cooperative agreement.

Costs Shared

The cost of operating these gaging stations during the fiscal year 1956 was \$14,450, and these costs were shared equally by the IRRRC and the U. S. Geological Survey.

A cooperative investigation of the water resources in parts of Kittson, Marshall, and Roseau counties was begun in 1953 and under this program nine gaging stations were installed. These are:

- Middle River near Strandquist
- Snake River at Alvarado
- Snake River at Warren
- Tamarac River near Stephen
- Tamarac River near Strandquist
- No. Branch Two Rivers at Lancaster
- So. Branch Two Rivers at Lake Bronson
- So. Branch Two Rivers near Pelan
- Thief River near Gatzke

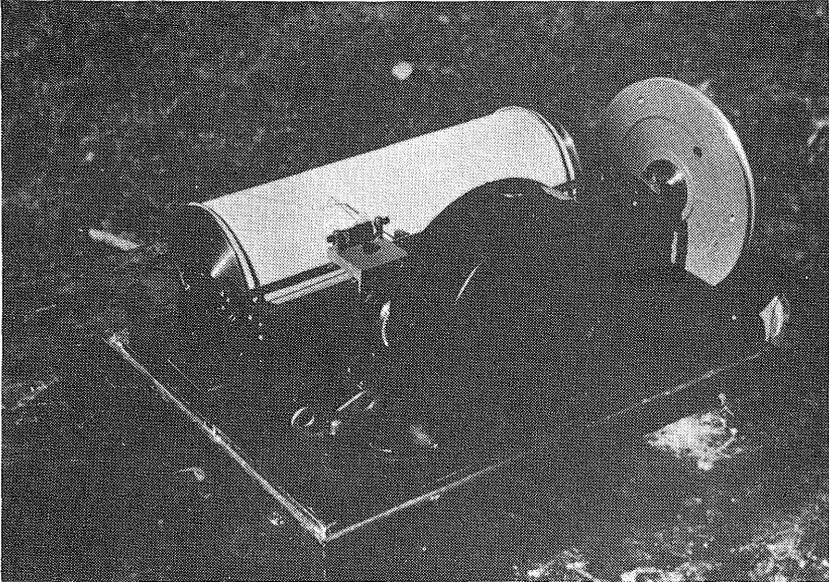
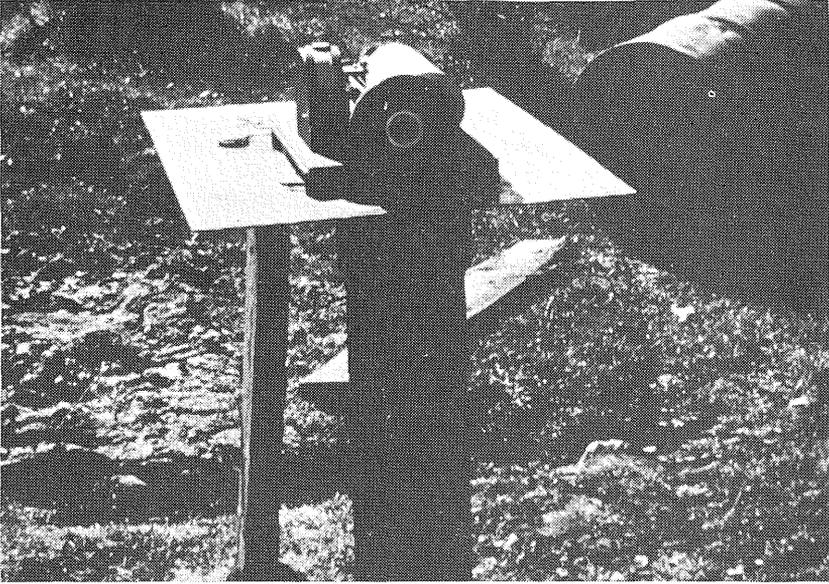
Supplemental discharge measurements of streamflow were also made at other points as needed to aid the investigation.

The gaging station on Tamarac River near Stephen was discontinued September 30, 1955, because further records at this point were considered unnecessary. The remainder of the stations were discontinued on June 30, 1956, except for South Branch of Two Rivers at Lake Bronson.

Records collected are available for evaluating the water resources of the Kittson, Marshall and Roseau areas.

Operation of the Lake Bronson station was continued by the U. S. in cooperation with the Minnesota Department of Conservation, Division of Waters. The Lake Bronson area appears to be the most promising for development of additional water supplies, and continuing records are necessary to evaluate this possibility.

The cost of this surface water investigation for the fiscal year 1955 was \$11,783.62 of which the IRRRC paid \$6,044.31 and



MEASURING WATER — Temporary installation of recording gage for pumping test in the Mountain Iron-Virginia area.

the U. S. Geological Survey \$5,739.31. Costs of continuing the investigation during the fiscal year 1956 was \$8,814.82, with costs shared equally by the IRRRC, and the U. S. Geological Survey.

Additional records of streamflow may be desirable in the Mesabi Range area as the use of taconite increases, and these should be established as soon as probable developments can be foreseen.

Ground Water

Investigation of ground water in the Mesabi Range area, which started in 1952, was continued by the U. S. Geological Survey in cooperation with the IRRRC. As a result of the mining and beneficiation of taconite, the economy in the Mesabi Range area is generally expanding and larger amounts of ground water are needed to meet present and future demands.

Major geologic factors control occurrence of ground water. All of Minnesota is underlain by a complex system of Precambrian crystalline and metamorphic rocks. Mantling practically all the older rocks are glacial deposits which, in places, are more than 500 feet thick.

In northern Minnesota the glacial drift is underlain almost entirely by crystalline and metamorphic rocks, except for the western edge where there are Cretaceous shales and sandstone. Also, in the extreme northwest is an area of limestone, shale and sandstone of Paleozoic age.

Potential Source

In the eastern and northeastern parts there are large areas where the drift is thin or absent. Generally, in areas of thin drift only small supplies of ground water can be obtained above bedrock.

However, in the Range area there are several areas where the glacial deposits exceed 100 feet in thickness and where there is a trough or depression in the bedrock. One of the largest of these is between Virginia and Mountain Iron, and a detailed investigation of this valley was continued with the objective of mapping the geology and evaluating the ground water resources.

Field work indicated that the glacial deposits filling the Virginia-Mountain Iron valley include several aquifers which are potentially capable of yielding large supplies of ground water.

Maps Prepared

A series of maps showing the configuration of the bedrock surface was prepared for the eastern half of the Range where the taconite development is most intensive. Iron mining companies cooperated by furnishing drill hole data.

This information on the bedrock topography was compiled as transparent overlay maps on the same scale as the standard topographic maps. A similar compilation for the western half of the Range has been started.

These maps can be used to delineate ground water basins, show the direction of movement of underground water, and locate glacial or pre-glacial drainageways that might contain water-bearing deposits of sand or gravel.

Similar glacial drifts are found in: 1) Area south of Hibbing; 2) Vicinity of Kelly Lake; 3) Vicinity of Embarrass Lake; 4) Area south of Chisholm.

Municipal Water

The available data on the existing municipal ground water supplies has been collected. This includes data on depth and occurrence of ground water and information on water levels, pumpage, well yields and quality.

Several of the municipalities on the Range obtain all or part of their water supply from the mines. As a result of mining activities, Aurora, Chisholm, Hibbing and Mountain Iron have been faced with curtailment or elimination of this source of water. Each of these municipalities has conducted exploratory programs to locate ground water supplies and all this information was collected in the field as the work progressed.

Water-Level Observation

Observation wells provide data which are useful in evaluating the adequacy of the ground-water reservoirs and for planning additional developments in the future. The following wells in St. Louis county are presently equipped with recording gages to provide continuous records of water-level fluctuations:

SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 5, T. 57 N., R. 20 W., Hibbing
SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 12, T. 58 N., R. 18 W., Virginia

NE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 13, T. 58 N., R. 18 W., Virginia
SW $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 16, T. 58 N., R. 20 W., Chisholm

Detailed geologic and hydrologic field work is continuing in an area south of the Range in the Virginia, Eveleth, and Kirk quadrangles, the southern limit being State Highway 216. Records of existing wells are being collected, including information such as depth, occurrence of water, types of material drilled through, water levels, yield and quality.

Pumping Tests

Several pumping tests have been conducted to determine the hydraulic characteristics of the water-bearing formations and a test-drilling contract was let on May 17, 1956 to map the subsurface geology and study the distribution, thickness, and extent of the water-bearing formations.

It is also planned to drill some test holes through the glacial deposits in the bedrock valleys at Hibbing, Kelly Lake, Embarrass Lake, and Chisholm to determine the occurrence of ground water.

Kittson-Marshall-Roseau

Investigation in parts of Kittson, Marshall, and Roseau counties was terminated as of June 30, 1956. A progress report on the geology and water resources was prepared in June 1955. Later, a supplementary report was prepared entitled, "Memorandum on exploratory test drilling for ground-water supplies in Kittson, Marshall, and Roseau counties, Minn., June-November 1955."

Water supplies have always been meager in this area and the quality is poor in many places. Additional industrial and municipal water supplies, particularly for the refining of sugar beets, would bolster the economy of the area considerably.

Exploratory test drilling in the Lake Bronson-Halma area, Kittson county, revealed the presence of thick, relatively extensive water-bearing deposits which probably are capable of yielding large ground-water supplies. Northeast of the village of Warren, Marshall county, in the vicinity of sec. 11, T. 155 N., R. 47 W., test drilling and data on farm wells indicate that additional moderate supplies of ground water can probably be developed.

Fiscal Data

The cost of cooperative ground-water investigations for the period July 1, 1954 to June 30, 1955 was \$99,905.40, of which the IRRRC contributed \$51,224.43 and the U. S. Geological Survey \$48,680.97. About 30% of this amount was spent on the Mesabi Range area and the balance for the Kittson, Marshall, and Roseau counties project. As stated elsewhere in this report, Federal funds were insufficient to meet all cooperative offerings of the several States, and the difference was distributed proportionately among the cooperating agencies as provided by the cooperative agreement.

During the period July 1, 1955 to June 30, 1956 \$95,280.00 was encumbered for the investigation. This amount is shared equally by the IRRRC and the U. S. Survey. A portion of this sum is, as yet, unspent because test drilling had to be suspended on the Range until the spring of 1957. If the full amount of the test-drilling contract is not spent, this amount will be reduced. About 80% of the total encumbrance was for the Mesabi Range; the balance was for the supervision of test drilling in Kittson, Marshall, and Roseau counties which had been contracted for prior to July 1, 1955.

It is planned to continue the systematic inventory of the ground-water resources in the Mesabi Range area as outlined above. If the test-drilling program determines the existence of additional ground-water supplies in the glacial drift filling the bedrock valleys at Hibbing, Kelly Lake, Embarrass Lake, or Chisholm, these areas should be investigated in detail. Additional observation wells should be installed where necessary or existing wells should be used for this purpose. The nature of recharge to the water-bearing formations should be investigated in detail by drilling auger holes. Geophysical techniques, such as seismicographic surveying to map the bedrock, should be investigated.

Quality of Water

During the biennium, quality-of-water investigations were conducted in parts of Kittson, Marshall, and Roseau counties and in the Mesabi Iron Range area.

The investigation in Kittson, Marshall, and Roseau counties, which began in 1953, was a part of a comprehensive water-resources inventory and consisted of studies to determine the chem-

ical quality of water in streams, lakes and wells, and to determine the sources of dissolved salts in water. Such studies provide basic information for the evaluation of the suitability of available water supplies for industrial, municipal, domestic, and agricultural uses and for the overall development of water resources.

In addition to studies of the quality of ground water from representative wells and test holes, the investigation included quality studies of streams draining the area. Chemical-quality data were obtained at the following stations:

- Thief River near Gatzke
- Red River of the North at Oslo
- Snake River above Warren
- Snake River near Alvarado
- Middle River near Strandquist
- Middle River at Argyle
- Tamarac River near Strandquist
- Tamarac River near Stephen
- Red River of the North at Drayton (N. Dak.)
- South Branch Two Rivers at Pelan
- South Branch Two Rivers at Lake Bronson
- Two Rivers below Hallock
- North Branch Two Rivers near Lancaster
- State Ditch 85 near Lancaster
- North Branch Two Rivers at Lancaster
- Red River of the North at Emerson (Manitoba)
- Roseau River at International Boundary near Caribou

Detailed field studies were also made for the Middle River in the beach-ridge area.

The investigation in the Mesabi Iron Range area began in 1955 and consists of studies similar to those for Kittson, Marshall, and Roseau counties. Studies were started in April 1956 for streams in the upper St. Louis River basin, and chemical-quality data is being obtained at the following stations:

- Partridge River near Aurora
- Second Creek near Aurora
- St. Louis River near Aurora
- Embarrass River at Embarrass
- Embarrass River near McKinley
- West Two River near Iron Junction

Total cost for the cooperative quality-of-water investigation for the period July 1, 1954, to June 30, 1955, was \$6,331.54, of which the IRRRC contributed \$3,246.96 and the U. S. Geological Survey \$3,084.58. Federal funds were insufficient to meet all cooperative offerings of the several States, and the difference was distributed proportionately among the cooperating agencies as provided by the cooperative agreement. During the period July 1, 1955, to June 30, 1956, \$6,188.66 was spent for the investigation. This amount was shared equally by the IRRRC and the U. S. Survey.

Of the total amount spent in the biennium for quality of water investigation about one-third was for the investigation in the Mesabi Iron Range area, and the remainder was for the investigation in Kittson, Marshall, and Roseau counties. The progress report "Geology and Water Resources of parts of Kittson, Marshall, and Roseau counties, Minnesota" which was released to the Commission in June 1955, includes a summary of the results of the quality-of-water investigation.

The present investigation of the quality of the water in a part of the Iron Range area will provide basic data on the chemical quality of present and potential water supplies. The information is pertinent to the use and diversion of water for present and future industrial and municipal developments. As developments continue, it is anticipated that additional studies will be needed for most of the Iron Range area.

Forest Development

Timber and timber lands once exploited in the development of Minnesota now support the second largest industry in the state.

This renewable resource properly developed can support an expanded timber economy and provide more jobs for Minnesota residents.

Facts concerning the 18.1 million acres of commercial forest land in Minnesota have been determined by a forest survey project carried out by Iron Range Resources and Rehabilitation foresters.

Operating on a project basis, the office of Iron Range Resources and Rehabilitation employs 30 trained foresters (when available) to carry out programs to develop the timber resources on county held tax forfeited lands of the state. These projects have the following points as their goal:

1. Stabilize our forest industries at as high a level as possible.
2. Create more jobs.
3. Promote more complete use of Minnesota forest products.
4. Increase production on forest lands.
5. Develop new uses for wood and wood products.

Achievement of these goals mean more jobs and a better standard of living for the residents of timber producing areas.

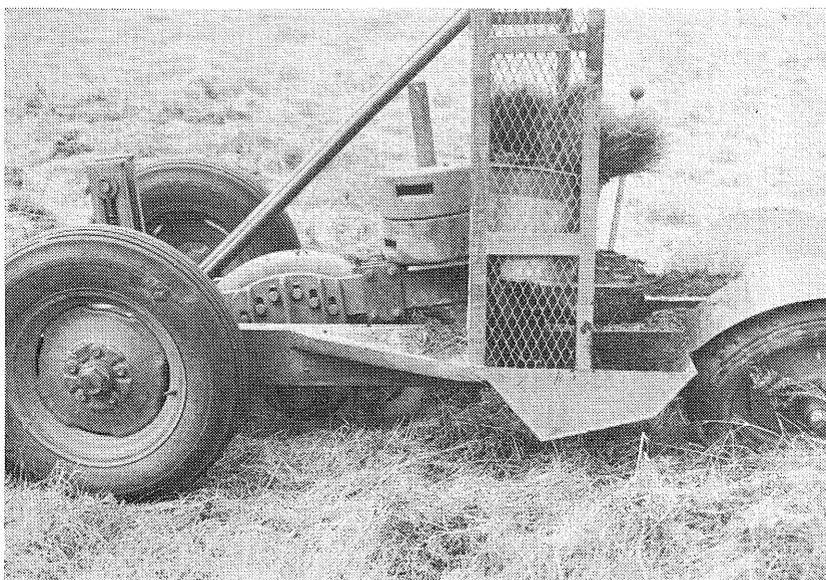
Iron Range Resources and Rehabilitation has fostered numerous projects to achieve such goals. These projects may be summarized under one of the following four types of activities.

1. Obtain forest resources information
 - a. What is the extent of our timber resource?
 - b. Who owns it?
 - c. How fast is the timber growing?
 - d. How fast is the timber being cut?
2. Promote better management and care for forest lands
 - a. Tree planting
 - b. Aids to natural regeneration

- c. Timber stand improvement
- d. Timber management planning
- 3. Promote efficient land management
 - a. Zoning
 - b. Land Classification
 - c. Relocate lost section corners
- 4. Utilize timber resources
 - a. Products research
 - b. Consultant services to wood products users
 - c. Motivate research findings through pilot plant production

Before any project is initiated, it must meet two tests. One—it must benefit Minnesota and fall within the goals of the Office of Iron Range Resources and Rehabilitation. Two—it must not be a duplication of working being carried out by some other group.

Encouragement and guidance through the IRRRC has accelerated progress in the management of tax-forfeited lands. Tech-



PLANTER — Close-up of tree-planting machine.

nical assistance in the preparation of long-term management plans, land classification and land improvement have helped prevent many mistakes and have enabled the community to share in the benefits of stable income from good tax-forfeited land management at an early date.

Land Restocked

In 1955, twelve of the forested counties with over 3,794,000 acres of tax-forfeited lands reported \$394,776 income after deducting expenses for management and administration. This money is divided in lieu of taxes among the taxing districts (state 10%, county 30%, school district 40% and township 20%).

The future will bring even greater incomes if the large areas of immature timber are wisely administered.

With the advice of Iron Range Resources foresters and the loan of heavy equipment from IRRRC, many acres of non-produc-



TRACTOR AND DISK in operation in brushy area. Areas such as those have been brought into production by disking to knock back brush and then either planted or allowed to seed naturally so that trees may once again occupy the sites.

tive land have been restocked with trees by planting and by disking to give nature a better chance of regenerating the forests.

Over 4,000 acres of tax-forfeited lands were put back in production in the past two years.

Corners Marked

More than 850 miles of section line have been re-established by surveyors who re-established nearly 3,900 section corners. These corners were re-established with iron pipes which should last much longer than the wooden stakes set by surveyors in the 1890's.

Development programs such as those fostered by IRRRC draw heavily on new knowledge. And the IRRRC forestry program produces a portion of the new knowledge used in the development of Minnesota's timber resource.

During the past biennium, the University of Minnesota, St. John's University, Wilderness Research Center, Mark Hurd Mapping Company and the facilities of the Federal Forest Service research units at the Lake States Forest Experiment Station, and the Madison Forest Products Laboratory have been utilized through contract to produce portions of the new knowledge used in our program.

Activities Noted

Activities in the past two years have added knowledge in charcoal production, modification of aspen lumber through the use of overlays, coniferous grafting, plantation management, aspen site analysis, jack pine brush relationships, aspen defoliation damages, aerial photo film and scales, and forest survey techniques.

These activities combined with other research being carried out throughout the country have been drawn upon to motivate the development of Minnesota's timber resources.

Minnesota's many small wood-using industries have an IRRRC friend through a utilization consultant project inaugurated during the biennium. Through this program Minnesota woods and Minnesota industry can be brought closer together. These industries can also benefit from wood-working knowledge available through this program.

Charcoal Testing

The Iron Range Resources and Rehabilitation Commission takes an active part in efforts to discover new uses for Minnesota's forest resources, including low grade woods.

Experiments in charcoal production as a means of utilizing low value forest types were conducted in an IRRRC project at St. John's University, Collegeville, Minn.

St. John's was chosen as the site for the experiment because of the abundance of various tree types there and the need for a stable institution which would keep long-term records of the project. A wood burning kiln was built there for the experiments.



KILN ERECTED for tests in charcoal production.

Varying degrees of success are reported in the burning tests, but most of them produced excellent charcoal. All species of hardwoods present in the St. Cloud area have been used to some extent and all produced charcoal with a satisfactory relationship between the fixed carbons and volatile materials.

Many of the volatile materials remaining in the charcoal are in the nature of tars. No attempt has been made at this time to recover any gaseous products, or products of distillation.

These experiments also are checking the structural materials used in the construction of a small charcoal kiln and the subsequent operation of a kiln of this type.

The Commissioner and the IRRRC forest project supervisor visited huge wood distilling plants at Marquette and Iron Mountain, Michigan, in an effort to interest those private industries in considering the establishment of similar operations in Minnesota. Charcoal is a by-product of the distilling plants.

A major problem in commercial charcoal production is the enormous cost of a briquetting plant which is considered necessary to market charcoal on a competitive basis with the by-product of the distilling plants.

Lumber Overlays

Continued efforts to find new and improved uses for Minnesota's abundant aspen stands is illustrated in an Iron Range Resources project to test overlay methods for giving aspen lumber a finer, stronger and superior outer surface. The work is being done by the U. S. Forest Products Laboratory.

In the overlay process the lumber is given a plastic-like outer coating. A quantity of aspen overlaid lumber was prepared and tests made for strength, bond, durability and workability. These tests have not as yet been completed but the work done thus far does look encouraging.

Coniferous Grafting

A great deal of research is being conducted in northern Minnesota and throughout the United States in the field of tree genetics for improving strains and varieties. As information becomes available for this research, it is disseminated to field per-

sonnel and normally this information is only of a scholastic interest to the forest managers and only becomes of interest to them when further research in field application has been conducted.

In this regard, IRRRC work with coniferous grafting at the Quetico Wilderness Research Center is an attempt to find ways to put genetic information to work in the forest. Several thousand grafts have been made in the past three years. The take or immediate success ratio in these grafts is very encouraging; however, their growth rates and future mortality are as yet unknown.

EFFECTS OF CATERPILLAR ATTACKS ON ASPEN

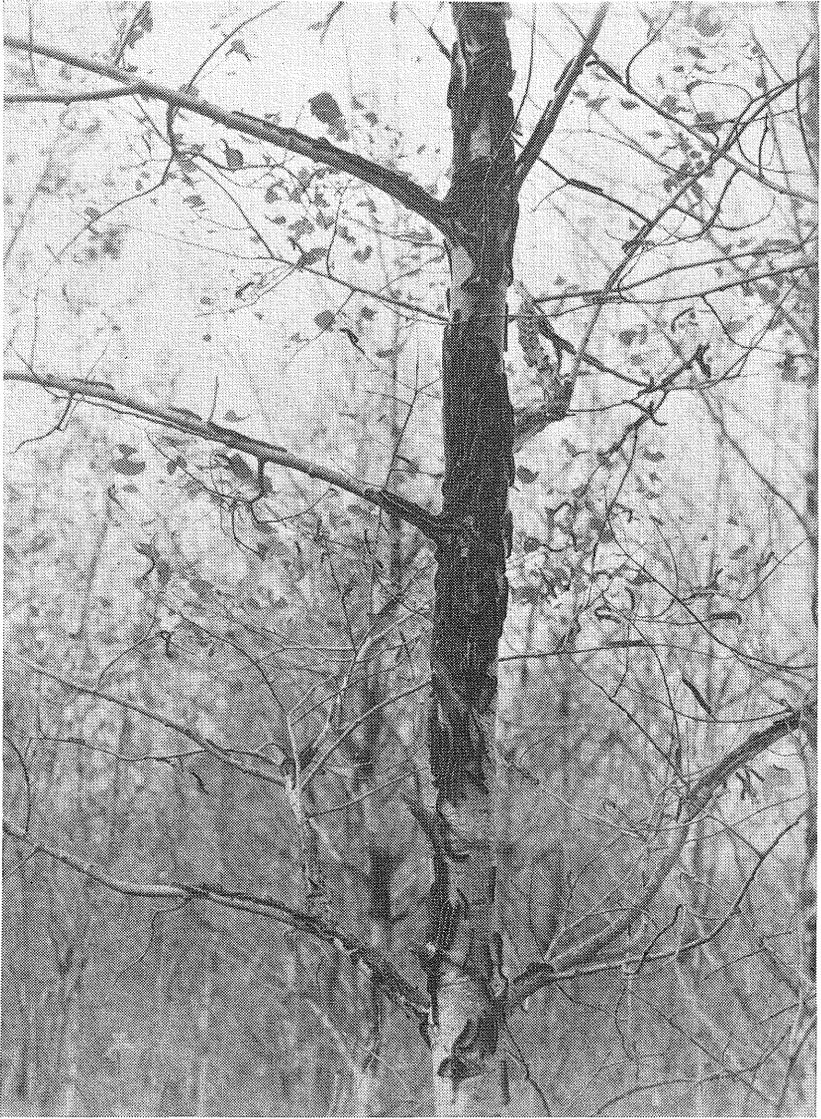
The relentless march of the armies of tent caterpillars through sections of northern Minnesota's aspen (poplar) forests during the summer months is not a new development. Periodic caterpillar epidemics have been observed since the earliest records of the late 1870's.

In 1950 state and federal officials were flooded with demands for the spraying of forest areas of northern Minnesota where large stands of aspen were stripped of foliage by the caterpillar attacks. Knowledge of the effects of the attacks and on the control of the caterpillars was meager.

So in spite of very insistent demands, control operations recommended were limited to private property, particularly resorts and summer home sites along lakes, and to state and federal recreational areas. General spraying did not seem justifiable for economic reasons.

Study Approved

In 1953, because of the growing importance of aspen in timber development and as part of Minnesota's tourist attraction, the Iron Range Resources and Rehabilitation Commission approved a study of the caterpillar attacks and their effects on aspen.



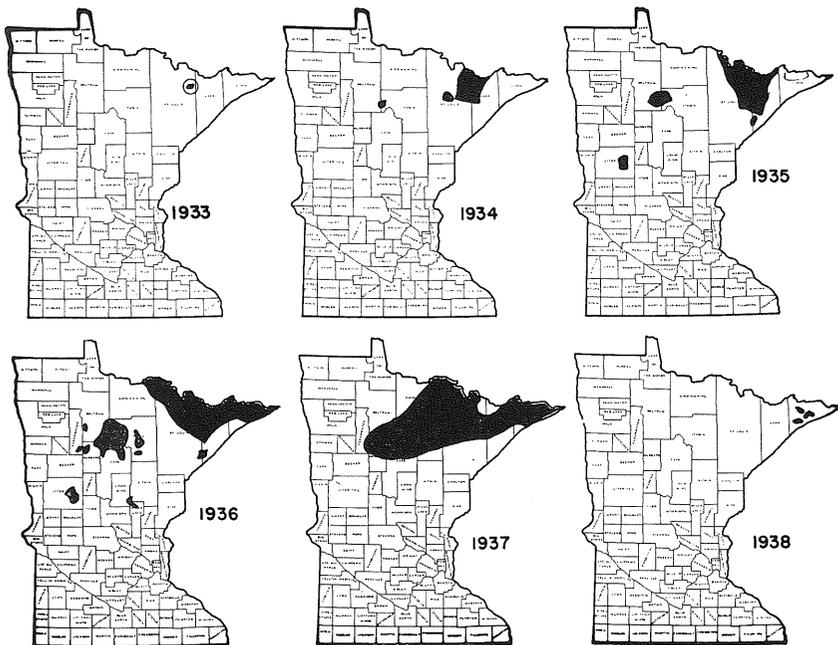
NOT A PRETTY SIGHT! Dark splotches on trunk of aspen are swarms of tent caterpillars, moving from branch to branch as they devour every leaf in their path.

The study was made by the school of forestry and the department of entomology and economic zoology of the University of Minnesota.

A summary of their report follows:

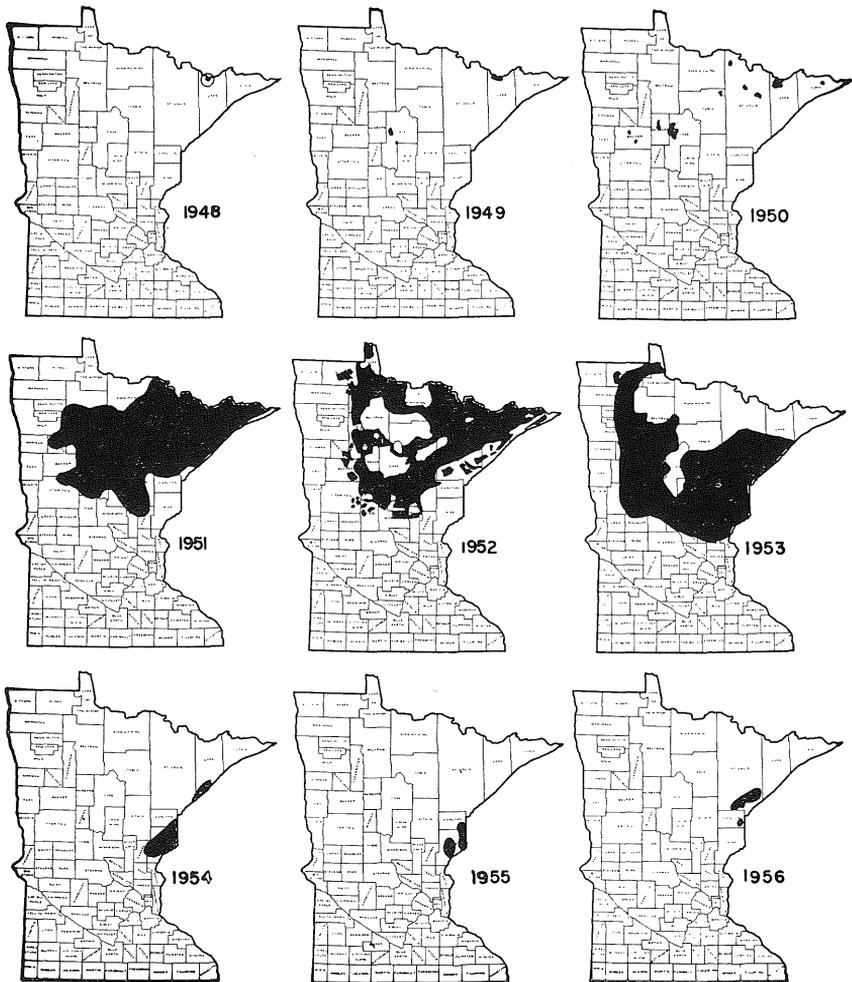
The periodic epidemic appearances of the forest tent caterpillar, which in the past have occurred at about 10-year intervals in Minnesota forests, have been of increasing intensity and duration. It is reasonable to expect that the aspen forests of Minnesota, covering about 6 million acres, will be seriously defoliated by this insect in the future.

Serious defoliations in the most recent outbreaks, which began in 1948, have not caused aspen mortality nor is there evidence that aspen losses to *Saperda* borers or to *Hypoxyylon* cankers have increased materially following attack. Hazel, the caterpillar's preferred food among understory shrubs, has not been seriously affected. Forest managers regard hazel as the most detrimental brush species in Minnesota.



PAST OUTBREAK — Shaded areas on maps show distribution of tent caterpillar outbreak in Minnesota, 1933-1938.

Most important of all of the effects of defoliation was reduction in the annual basal area growth of aspen. This was very small in the first year of light defoliation, but increased to about 70 per cent of normal in the first year of heavy defoliation and to about 90 per cent in the second and third years of heavy defoliation. Even in the year after cessation of defoliation, basal area growth losses were between 15 and 20 per cent in areas where previous defoliation had been heavy.



RECENT OUTBREAK — Shaded areas on maps show distribution of tent caterpillar outbreak in Minnesota, 1948-1956.

Volume Losses Weighed

Balsam fir in the understory has shown an increased radial growth during periods of defoliation. However, since less than 20 per cent of the aspen forests carry an important coniferous understory, of which a high proportion is balsam fir, the coniferous volume and growth has been far below that of the associated aspen. The increased radial growth in balsam was less than one-third of the decrease in aspen. It is apparent that aspen volume losses have far outweighed gains by conifers.

In those few aspen stands where pine seedlings are found defoliation may help to establish regeneration. However, since neither aspen nor brush mortality has followed defoliation, and since the stand again closes in following reduced populations of the caterpillar, the favorable effects on pine regeneration are probably short-lived.

In its overall effect upon timber values the forest tent caterpillar is most significant in reducing the growth of aspen.

Control by Spraying

In evaluating the possibilities of control by aerial spraying in future outbreaks where commercial aspen is threatened with severe defoliations, consideration should be given to periodic annual growth of the stands. This, with predicted growth losses and assessment of local stumpage values, would permit the forest manager to determine whether he can afford to spray to control the insect strictly on the basis of timber production.

Present stumpage values for aspen do not permit control by spraying. But if such values should continue to rise during the next 10 years, it may be that the forest manager of selected aspen stands may find spraying feasible during future epidemics of the forest tent caterpillar.

At the present time the caterpillar population has been reduced to a low level by various natural control agents over most of the area infested during the past few years, but some heavy defoliation can be expected at least through 1957. Thus the current outbreak will have lasted at least four years longer than the one that persisted from 1933-1938.

● We cannot predict aspen site on the basis of soil properties as a result of the study, but their importance to aspen site has been clarified and emphasized.

Forty-five of the 80 permanent aspen study plots established in northern Minnesota for the forest tent caterpillar investigations were selected for the study. Plots varied from flat swamplands to excessively drained ridge tops. Precipitation and other climatic factors vary considerably between plots.

Data Collected

Research work in aspen sites, first started in the fall of 1953 by U. S. foresters with the cooperation of the IRRRC, included a reconnaissance soil survey of good and poor sites and a literature review.

In general, analysis of data collected on the reconnaissance soil survey showed that a number of single soil characteristics show some relationship to site quality, but none appear to be related strongly enough to permit forecasting sites on that single characteristic alone.

The literature review, completed during 1955, showed that a great deal of information was available on the relationship of individual factors such as soils, water tables, fire history and natural vegetation to aspen site quality. Many studies had little or no data from Minnesota.

Test Begins

Also, the literature review indicated that the present major research need was to correlate previous work and test the site knowledge under Minnesota conditions.

The site information on aspen was published by the Lake States Experiment Station.

Now under way is a project designed to test under Minnesota conditions the site knowledge now available and to provide the practicing forester with a useable aspen site classification system. Field work was started in May, 1955, and approximately 100 plots have been completed in Wadena, Becker, Hubbard, Mahanomen, Clearwater, Beltrami, Cass, Itasca, Aitkin, Crow Wing and St. Louis counties.

WHITE PINE BLISTER RUST CONTROL PROGRAM

The 1953 and 1955 state legislatures provided \$5,000 per year for white pine blister rust control, the amounts to be transferred from Iron Range Resources and Rehabilitation funds to the Minnesota department of agriculture.

In Minnesota's virgin forests white pine occurred in mixtures with red and jack pine on pine lands, and with spruce, balsam and hardwoods. Pure white pine stands were rare. White pine was the tree that gave character and distinction to the entire northern forest.

White pine is now growing in varying numbers on approximately one million acres in Minnesota. The white pine on 233,260 acres is deemed in need of protection from blister rust. Of this acreage 68,683 is in federal ownership.

Disease Widespread

The presence of white pine blister rust, a European disease of white pine and currants and gooseberries, in the state has been known since 1916. The disease is now present throughout Minnesota's white pine growing areas.

Blister rust infection and the damage done by the disease can be held to low levels in selected white pine stands by suppressing and keeping suppressed the currant and gooseberry growth in and near those stands. Control work has been under way in the state since 1917 and large acreages were covered with relief labor in the 1930's. Since then the program has lagged on non-federal lands.

In the fiscal years 1955 and 1956 essentially all of the state blister rust control appropriation was spent in Itasca State Park. White pine is the most valuable aesthetic tree in the park. The white pine plantations at the Badoura State Nursery were protected in the fiscal year 1955. In the spring of 1956 control work was done in Interstate and O'Brien state parks.

Acres of pine protected totaled 1,908 in Itasca State Park; 47 at Badoura; 28 at O'Brien and 5 at Interstate.

STUDY OF BRUSH INVASION ON JACK PINE SITES

The idea of sustained yield is a basic principle in the practice of forestry. However, in order to obtain sustained yield it is essential that once a forest is harvested it is regenerated without a deterioration in forest type.

A major obstacle to the successful regeneration of forest stands is the competition from ground vegetation, including brush. "Brush" includes all woody ground vegetation which will reach two feet in height but which will not attain tree size.

Because of the importance of jack pine as a Minnesota resource the Iron Range Resources and Rehabilitation Commission initiated an investigation of brush invasion on pine sites. The study was undertaken by the University of Minnesota school of forestry, with emphasis on jack pine sites.

Areas Studied

Areas were investigated in the following counties: Beltrami, Clearwater, Hubbard, Koochiching, Lake of the Woods and Wadena. There are 986,000 acres of jack pine type in the state.

Data was collected in the field so that stand basal area, stand age, site index, brush density, brush age, soil factors and average diameter of the stand could be determined.

An analysis of the data indicates brush density increases with the following: Stand age, stand basal area, site index, average diameter of the stand, silt plus clay content of the soil, and brush age.

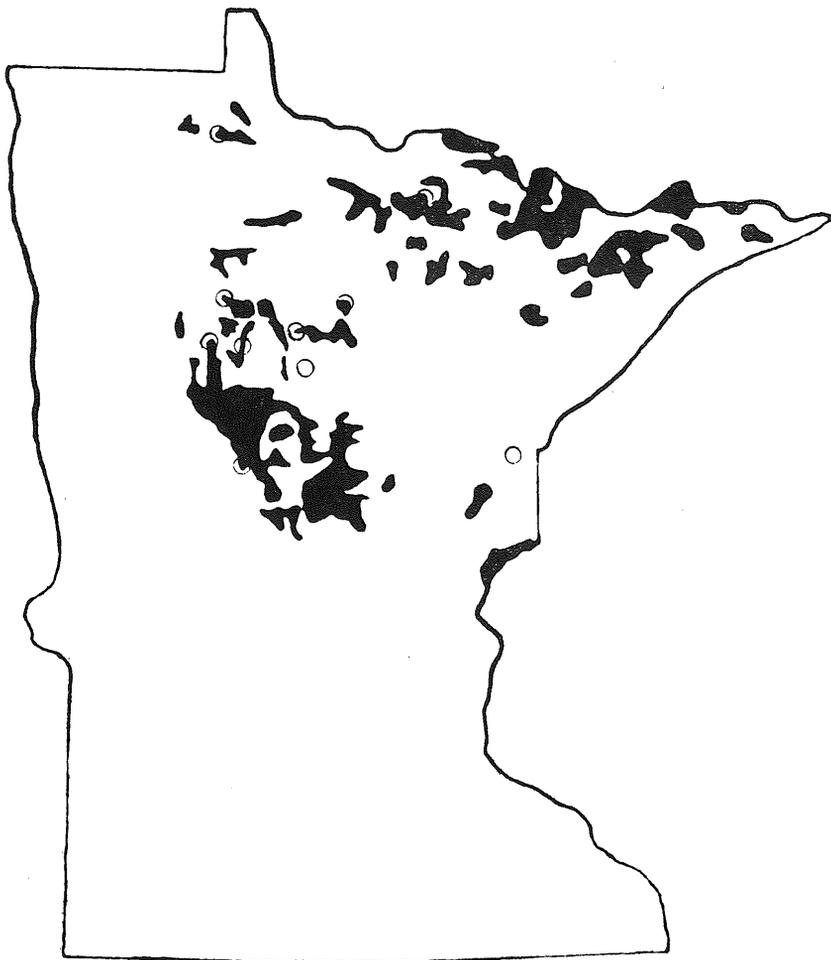
Trends Indicated

As a result of these trends it might be concluded that brush density has a basic relation to site. In a broad sense the better sites have larger average stand diameters, stand basal areas, and silt plus clay contents of the soil than are found on the poorer sites. Stands on the better sites have greater densities of brush at a younger age than stands on the poorer sites.

Initial invasion of a pine stand by brush species is a much slower process than had been thought previously. However, once

invasion starts brush expansion or increase in density is very rapid under the right conditions.

The relationship between brush density and various characteristics of the forest stand, and especially the slow rate at which brush populations invade, strongly suggest that brush control by proper forest care techniques is possible. However, additional data is needed before specific silvicultural recommendations can be made.



BRUSH INVASION — Generalized map of the major pine areas in Minnesota indicating the approximate location of areas investigated (Lake States For. Ex. Sta. Data).

RESEARCH IN MANAGING FOREST PLANTATIONS

Research in forest plantation management was conducted by the U. S. Forest Service under a cooperative agreement with the Iron Range Resources and Rehabilitation Commission.

Work was concentrated on studies involving aerial application of herbicides for planting area preparation and plantation release.

Studies re-examined consisted of tests of the effectiveness of aerial spraying in killing back brush just prior to planting on both lowland and upland sites. Judging from the early survival of black spruce and tamarack on three widely separated plantations put in on brushing lowland following herbicide treatment, this approach to the reforestation of non-stocked swamp lands of good site quality offers a lot of promise.

Aerial Spraying

Aerial spraying also shows much promise of doing an effective job of pre-planting release on upland sites. A 20-acre plot of hazel, willow and other brush was sprayed near Babbitt in July, 1954, and planted the following spring to red pine and white spruce. After the two growing seasons, the brush has not made sufficient comeback to require further treatment.

Research in use of herbicides in grass release in lowland areas was expanded with the installation of two four-acre plots (aerial application) west of Rabey in Aitkin county. Results will be checked in 1957. If a herbicide can be successfully used to control grass on lowland areas it will be a great aid in reforesting large areas of swamp which have gone out of timber production. A summary report of exploratory work in grass control has been published.

YOUTH CAMP

In 1955 the Iron Range Resources and Rehabilitation Commission was called upon to assist in the establishment of a second state Youth Conservation Commission Work camp at Thistle-dew lake in northern Minnesota.

The Legislature, in view of over-crowded conditions at the State Training School for Boys at Red Wing, had appropriated

\$30,000 to equip and repair a forestry camp and \$175,000 for its operation during 1955-1957.

Purpose of the appropriations was to develop a rehabilitation program for the older boys from the Training School and to establish a work program to assist in the development and preservation of the state's natural resources.

Value of Camp

Value of the proposed camp was considered by the IRRRC not only from the rehabilitation viewpoint but also from the standpoint of development of natural resources, particularly forests.

The IRRRC contributed \$20,000 for construction of the camp. This appropriation, coupled with the active support of Governor Freeman in which he made \$5,000 available to the building of the camp, and some construction assistance from the Conservation Department, made the building of the camp possible.

The camp site at Thistledew lake in Itasca county was selected because of the excellent potential of the George Washington Forest for further development as well as a work resource for the boys.

Huts Purchased

Thirteen metal-covered huts that made up the low-cost veteran's housing unit in Hibbing were purchased and moved to the camp site. Much of the preparatory work, such as setting up water, sanitation and power facilities, was accomplished by the boys and staff assigned to the camp.

Heating installation, well drilling and erection of three and one-half miles of power lines were accomplished through contract service.

Much of the activities were necessarily concentrated in establishing the camp. However, in the time since the first small group arrived at the camp in September, 1955, the boys and staff planted approximately 20,000 trees; worked on timber stand improvement on a Norway pine plantation; cleared brush on Mirror lake road to make the lake accessible for summer home sites; worked on blister rust control; graveled two and one-half miles of road to Moose lake for public access to the lake; and cleaned Thistledew camp grounds for public use.

Farm Program

During the first year of this biennial period studies were carried on in the use of chemicals in brush control and also in the use of fertilizers on potato varieties.

Brush and weed control studies were conducted in Lake, St. Louis, Pine and Kanabec counties. Control was practiced on farms, principally in pastures, and along roadsides because of its importance from the recreational or tourist viewpoint. Lake county was principally interested in the latter phase of weed control.

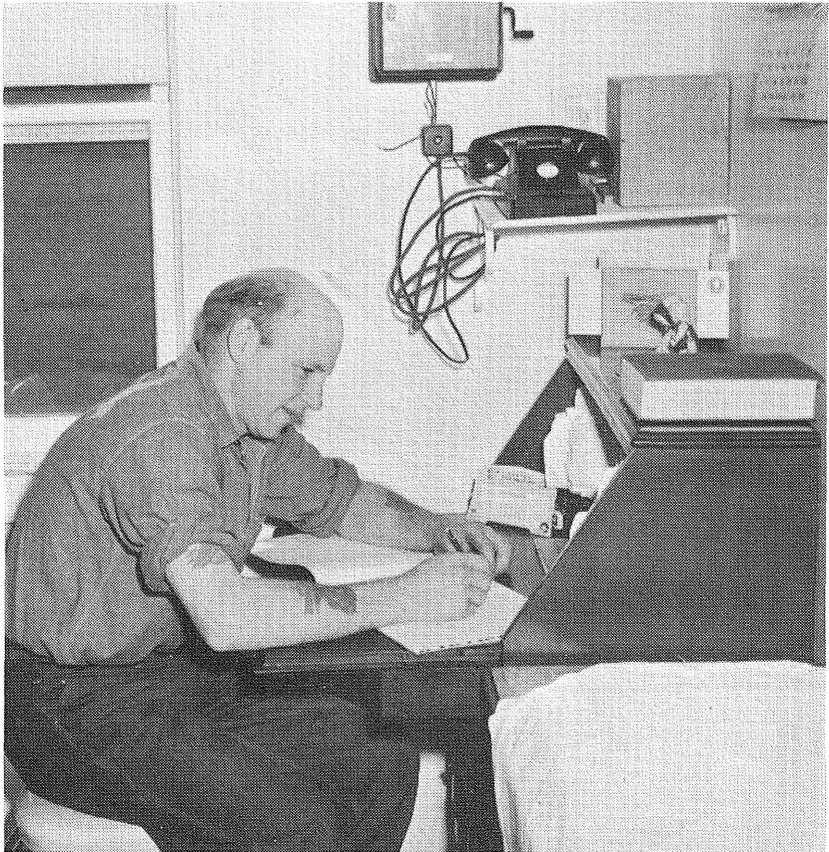


POTATO DIGGER in operation on north St. Louis county farm.

The work was carried on in the form of demonstrations to give farmers and the public an opportunity to become acquainted with the type of equipment and chemicals used, and method and rate of application.

Potato Experiments

For several years the Iron Range Resources and Rehabilitation Commission has been concentrating a potato study in St. Louis county, checking varieties—especially new ones—and fertilizer applications.



KEEPING FARM RECORDS sounds ominous but David Swedberg finds it easy because he does a little every day. On many other farms the accounting work is done by the farmer's wife.

In the last two growing periods 102 varieties of potatoes were tested in trial plots under expert guidance. The IRRRC supplied the fertilizer.

Most of the varieties were discarded but a few consistently demonstrated ability to produce good yields and of high quality. Through this work two varieties have become popular in St. Louis county and elsewhere in the state. These are the Kennebec and Cherokee potatoes.

The Kennebec is a late potato and is now the principal late variety grown in St. Louis county. The Cherokee is a medium early potato and is of lesser importance. Both are of good quality and the yield is good.

Typical yields in the trial plots in 1955: Kennebec, 412 bushels per acre; Cherokee, 382; and Green Mountain, 293.

There are other qualities that determine the popularity of a potato, such as resistance to scab and blight, and set of tubers and eating quality. The Kennebec appeared to be good in all respects in the trials.

Farm Management

A total of 118 northern Minnesota farmers is enrolled in a farm management study which was begun in 1956 as a new IRRRC project. The study is spread over 10 northeastern counties, including St. Louis, Koochiching, Clearwater, Carlton, Itasca, Cass, Crow Wing, Aitkin, Beltrami and Hubbard.

The IRRRC has provided account books and a field man to assist farmers in the cut-over region in setting up adequate book-keeping procedures. This study, first ever made in the area, was set up in response to numerous requests from county leaders and from farmers themselves.

Objectives in the program are to encourage the keeping of adequate records and thereby gain an insight on farm problems peculiar to the northeast section.

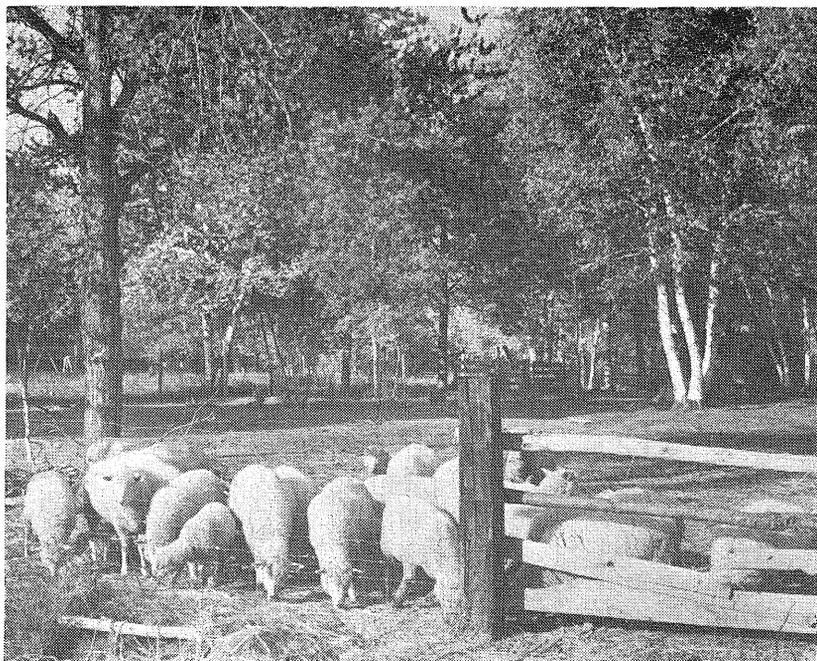
Dairying, principal source of income in the region under study, will receive the closest scrutiny. However, there are other

phases of agriculture that will be analyzed, such as sheep and beef cattle production, poultry raising, potato production and hog raising.

Interest in the study is keen among agricultural men in the field as well as among the farmers themselves. County extension agents, agricultural instructors in the schools and veterans' classes are cooperating.

Once properly under way with IRRRC help, the farm management program is expected to carry on under its own leaders.

The IRRRC agricultural field representative has been assigned to the farm management program. His work in farm improvement has been discontinued to avoid duplication of similar activities by the county agricultural agents. The small fruit program also has been terminated.



SHEEP RAISING as part-time farming.

LEGUME RESEARCH

In the past two-year period the Iron Range Resources and Rehabilitation Commission continued its research program on legume seed production. Principal objectives are to determine the various factors which affect seed yields and to find ways of increasing seed yields and improving seed quality of alfalfa, alsike clover, red clover and sweet clover. The work is being done by University of Minnesota scientists.

Reason for the project is concern over declining legume seed production in Minnesota. For a number of years prior to 1940 Minnesota was the leading producer of seed of alfalfa, alsike clover and sweet clover, and ranked high in production of red clover seed.

Summarized, it can be said that tangible progress has been made in increasing yields of seed of all four legume seed crops—Alsike clover, alfalfa, sweet clover and red clover.



SWEET CLOVER that was placed under cages (center of photo) to exclude insect pollinators yielded an average of only 13 pounds of seed per acre compared to an average of 1,287 pounds per acre when flowers were pollinated by the bees.

Progress Made

The researchers obtained relatively high yields of those seed crops. The yields obtained often were many times the average for the state.

Yields in some cases were moderate or low and usually it was possible to determine why. Sometimes other factors, such as adverse weather during the growth of the crop or during flowering, were responsible.

Among the observations that can be made are these:

ALSIKE CLOVER—With alsike clover we have come nearer to being sure there will be high yields, if the procedures we have learned are carried out, than with any other crop. If adequate fertilizer of the right kind is applied, if injurious insects are controlled and if adequate numbers of bee colonies are provided, and if the weather is satisfactory, it is possible to obtain high yields. Yields have been as high as 800 pounds per acre. Also, experience gained on alsike clover has proved valuable with other crops.



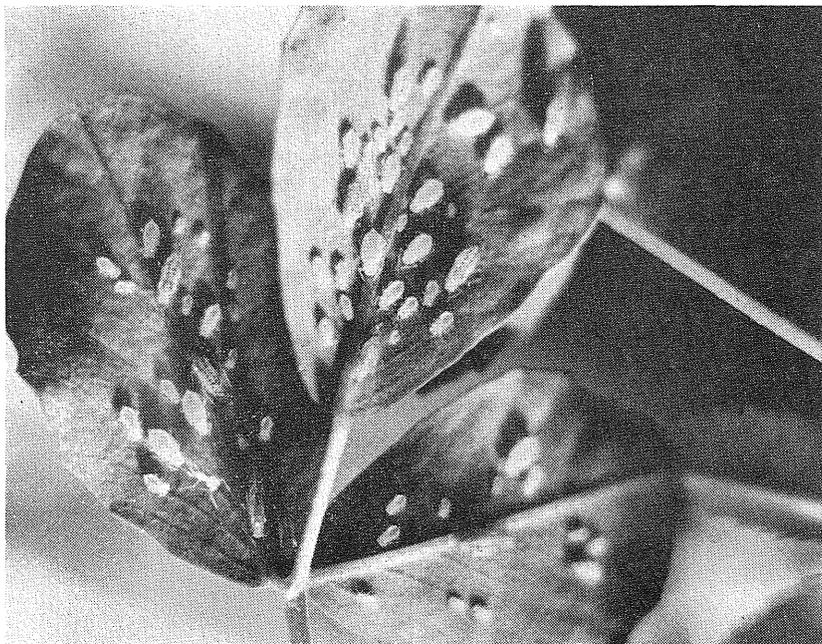
ALSIKE CLOVER field in bloom with honey bee colonies along the border of the field on farm in Roseau county.

ALFALFA—This legume has more problems affecting it than any of the other seed crops. However, much progress has been made toward increasing alfalfa seed production. On occasions 700 pounds per acre were obtained; in some plots even more.

SWEET CLOVER—This is a most important soil improver and the most important honey crop known. Marked progress has been made in protecting stands by control of sweet clover weevil.

RED CLOVER—Potentially, red clover is a very important seed crop for Minnesota. It is a seed crop that western states are not likely to grow in quantity. Minnesota can grow it profitably. Work on red clover has been largely exploratory but results are extremely encouraging. Yields of 500 to 700 pounds per acre have been obtained. The future for red clover is bright.

BREEDING for resistance to diseases and injurious insects, and breeding for attractiveness to bees are sound and promising lines of work.



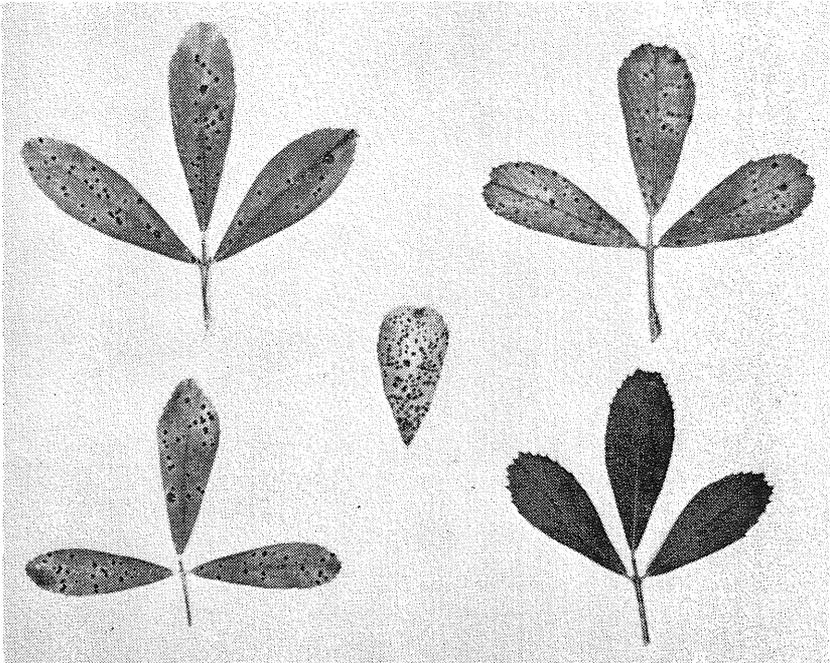
TWO NEW INSECT problems were noted in the legume research. They are the sweet clover aphid and the spotted alfalfa aphid. Camera close-up shows aphid at work, causing severe injury to sweet clover seedling.

WEED CONTROL—Development of cultural procedures to obtain better quality, cleaner seed is necessary.

SEED HARVEST—Much of the seed produced in a field is lost before or at the time of harvest. Harvest methods need to be improved.

The legume research during the past two years was a continuation of a project begun in 1951 when \$35,000 was provided for expanded studies by the University of Minnesota. A similar sum was provided for the fiscal year 1952-1953. Sums of \$40,000 were appropriated for each of the succeeding two years, and \$30,000 for the year ending June 30, 1957, after which the program will be terminated.

In view of the fact that the IRRRC has already allotted a total of \$180,000 for University of Minnesota legume research, the Commissioner and the Commission believe any further work in this program should be a Legislative matter.



PROGRESS has been made in search for disease resistant strains of alfalfa. Pictured are leaves from alfalfa plant susceptible to common leaf spot and leaf (lower right) from a resistant plant.

RECEIPTS AND OUTLAYS

RECEIPTS

	1954-1955	1955-1956
Taxes:		
5% of Occupational Tax on Iron Ore....	\$750,611.40	\$1,233,214.65
Transfers In:		
Recovery of unobligated balances of transfers out in prior years;		
Dept. of Agriculture .....	.85	2.37
Dept. of Conservation:		
Division of Forestry	10,151.84	16,130.99
Division of Lands & Minerals..	9,939.57	12,057.60
Division of Waters	12.85	.....
Legislative Interim Commission on Forestry	384.11	.....
TOTAL RECEIPTS	\$771,100.62	\$1,261,405.61

Receipts from IRRRC Projects Credited to General Revenue Fund

Restitutions .....	.....	47.20
Property rentals	11.50	1.00
Stores for Resale:		
Arrowhead Canning Co., Grand Rapids, Minn.	1,375.00	1,625.00
Arrowhead Seed Growers Coop., Cook, Minn.	999.95	1,000.00
Cedar Products, Inc., Deer River, Minn.	2,000.00	3,100.00
Chun King Sales, Inc., Duluth, Minn.....	9,999.96	73,860.15
McLeod, Inc., Grand Rapids, Minn.....	1,800.00	1,800.00
Milkhouses, Iron Range Area	59.25	.....
Nu-Ply Corporation, Bemidji, Minn.....	.....	8,750.01
Superwood Corp., Duluth, Minn.	36,750.00	36,750.00
Sales of Buildings:		
Potato warehouse, Embarrass, Minn.....	.....	1,600.00
Potato warehouse, Lakeland, Minn.....	.....	1,050.00
TOTALS	\$52,995.66	\$129,583.36

EXPENDITURES AND TRANSFERS

PROJECT	1954-1955	1955-1956
Administration	\$ 34,743.41	\$ 29,326.13
Agriculture:		
Farm Development	4,848.67	4,499.38
Small Fruit	4,542.57	1,541.58
Legume Seed Investigations	39,712.97	40,000.00
Forestry Development	149,930.57	152,768.21
Forestry Rehabilitation Camp, Thistledew Lake		17,398.43
Governor's Statewide Resources Conference.....		4,718.93
Marl Survey		3,800.00
Mineral Survey		5,340.95
Nu-Ply Corporation (plywood pilot plant)....	354,657.91	4,326.00
Peat Processing Plant, Floodwood, Minn.....	2,739.57	3,590.35
Peat Research (chemical products from peat)	45,280.05	45,715.00
Port Authority of Duluth		15,000.00
Topographic Mapping (U. S. Geological Survey).....	54,000.00	50,000.00
Water Investigations (U. S. Geological Survey).....	69,440.70	62,500.00
TOTAL EXPENDITURES	\$759,896.42	\$440,524.96

TRANSFERS OUT

University of Minnesota (beneficiation of manganiferous and low-grade ores).....	83,050.00	87,500.00
Department of Agriculture	5,000.00	5,000.00
Department of Conservation:		
Division of Forestry	551,403.00	349,842.00
Division of Lands & Minerals.....	80,111.00	115,428.00
Board of Health		15,000.00
Forestry Study Commission		15,000.00
TOTAL TRANSFERS OUT	\$719,564.00	\$587,770.00
TOTAL EXPENDITURES AND TRANSFERS	\$1,479,460.42	\$1,028,294.96