

CANADA
DEPARTMENT OF MINES AND RESOURCES
MINES, FORESTS, AND SCIENTIFIC SERVICES BRANCH
DOMINION FOREST SERVICE

Forest Fire Control Plan

for the

**Petawawa
Forest Experiment Station
CHALK RIVER, ONTARIO**



OTTAWA
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PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
CONTROLLER OF STATIONERY
1948

FOREWORD

This Fire Control Plan has been prepared for the information and guidance of all concerned.

Like other plans concerned with forest management, a fire control plan cannot be static and remain effective. Periodic revision and improvement become necessary as experience is gained and new techniques are developed. Suggestions for constructive change should be the aim of all personnel concerned with the operation of this Plan.

D. A. Macdonald,
Dominion Forester

MEMORANDUM

The following information was obtained from the records of the Department of the Interior, Bureau of Land Management, regarding the land owned by the United States in the State of California.

The land is situated in the County of San Diego, and is known as the "San Diego Land Grant". The grant was made by the United States Government to the State of California in the year 1850.

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PREFACE

Forest values at the Petawawa Forest Experiment Station, Chalk River, Ontario, are probably higher than in any other area of comparable size in Canada. This situation results not so much from the timber, recreational, and wild-life resources of the Station (which are by no means inconsiderable) as from the investment in long-term forest research which has accumulated during the past quarter of a century.

This area now contains more than 500 sample plots, most of which will require remeasurement over a period of several decades. Any forest fire on the Station constitutes a potential threat to these experiments, while a fire of major proportions would represent a most serious loss to Canadian research in silviculture, forest protection, and forest management. The intensity of forest-fire protection warranted under these circumstances is obviously much higher than commercial timber values alone would justify.

High as is the level of protection envisaged for the area, it must nevertheless be recognized as a plan of *protection*, and not of complete *exclusion* of fire. Even if such a plan were feasible—and the occurrence of lightning fires alone shows that such is not the case—it would not be practical either from the standpoint of due economy in administration of public funds, or from the standpoint of the public, for whose ultimate benefit the work of the station is conducted. Lightning fires are fortunately rare, but nevertheless do occur. The fact must, therefore, be recognized that some fires will start and that some damage from fire is inevitable. The problem then resolves itself into planning and executing fire-control operations in such a way that the possibility of significant impairment of research values by fire is extremely remote. At the same time, these high but intangible values must be balanced against actual protection costs. The solution is by no means easy, but in the light of past experience and probable future requirements the present Forest Fire Control Plan has been designed to achieve this end in the light of existing knowledge.

It has been said that most large fires are the result of either poor planning or poor execution of a good plan. A well-ordered fire control plan should specify the appropriate state of preparedness for each degree of forest-fire danger, so that, in any contingency, adequate and competent action may result. It should further commit to paper all pertinent information relating to the fire-protection service—including information which is frequently carried only in the minds of the more experienced personnel. Changes of staff may then be made with a minimum impairment of fire-control efficiency. So far as possible, the intention of the Petawawa Plan is to leave nothing of this nature to chance or memory.

The systematic planning of fire-control operations is by no means new to Canadian forestry practice. It is believed, however, that the Petawawa Plan incorporates a number of developments not hitherto adopted in this country. Such planning methods have been made necessary by the exceptional values requiring protection at this Station. But the intensification of forest management which is now evident in many parts of Canada will undoubtedly lead to a more general adoption of intensive forest protection measures; in fact, without adequate protection large investments in managed forests can hardly be justified. With this in view the Petawawa Forest Fire Control Plan is now issued in bulletin form, in the hope that—whatever defects it may develop in use—it may prove of interest and afford some guidance to others engaged in fire-control planning.

The text of the Plan as here published is that currently in use at the Petawawa Station. It is believed that the Plan is largely self-explanatory and that little additional comment need be made. A few of the specified objectives, particularly those pertaining to transport facilities and travel times, have not been fully realized at the time of writing, but work towards their attainment is in progress. Steps are also being taken to remedy the present lack of legislative authority for the regulation of public travel and use of fire in the area. All maps, schedules and details of organization relate to existing conditions and facilities.

In order to reproduce the maps on a scale suitable for binding in this bulletin some sacrifice of detail was necessary, especially in the fuel type maps. For purposes of illustration, however, these maps are as satisfactory as the two inch to the mile wall-maps actually used at the Station.

The Notes on Mapping Methods do not form a part of the Forest Fire Control Plan proper, but have been added in order to give a brief description of the methods used in preparing maps of fuel types, of areas visible from look-outs, and of travel-time zones. The Station was fortunate in having, as a basis for these, accurate maps of topography and cover types. Where such maps are not available very different procedures may have to be employed. In the latter connection the reader is referred to "Fire Control Planning in the Northern Rocky Mountain Region" by the late L. G. Hornby, United States Forest Service, 1936, which is still the principal reference work on this subject.

The Petawawa Forest Fire Control Plan was prepared by the Forest Protection Division of the Dominion Forest Service, in co-operation with the staff of the Forest Experiment Station at Petawawa. Material was freely borrowed from the source above mentioned, for which grateful acknowledgment is made. Valuable assistance was also received from the Divisions of Silvicultural Research, Surveys and Draughting, and Air Surveys Research of the Dominion Forest Service.

H. W. B.

April 5, 1948.

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PART II

FIRE ATLAS

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2. Fire-Risk Map (points of origin and causes of fires since 1930).
3. Fuel Types, Spring and Autumn.
4. Fuel Types, Summer.
5. Highview Tower, Visible Area.
6. Montgomery Tower, Visible Area.
7. Lookout Coverage and Communication.
8. Transport Routes and Travel Times.
9. Map of Fire-Fighting Facilities.

FOREST FIRE CONTROL PLAN

PETAWAWA FOREST EXPERIMENT STATION

PART I

FIRE CONTROL POLICY

1. Object of Protection

The Petawawa Forest Experiment Station, comprising an area of 92.6 square miles on the Petawawa Military Reserve, requires protection from fire in order that:

- (a) The results of forest research conducted on this area shall not be lost or impaired as a result of fire damage.
- (b) Destruction of commercial timber values and other property shall be kept within acceptably small limits.
- (c) Indirect values, including stream-flow and wild-life protection, aesthetic and recreational uses, and soil fertility shall not be adversely affected.
- (d) Fires originating on the Station area shall not spread to adjacent lands.

The importance of this Station from the standpoint of forest research necessitates the maintenance of exceptionally high fire-protection standards. In order to achieve the objects defined above:

- (a) The number of fires from avoidable causes must be kept to a minimum.
- (b) A thorough state of preparedness for the control of fires, commensurate with the prevailing degree of fire danger, must be maintained.
- (c) Fast and energetic action in the detection and suppression of fires is imperative.

2. Protection Standards

Acceptable Annual Burn

- (i) The total area burned over, when averaged by 10-year periods, should not exceed 10 acres per year, or approximately 0.02 per cent of the land area of the Station.
- (ii) On sample plots, experimental plantations, and other areas designated specifically for research projects, and on nurseries and transplant beds, the objective shall be to allow no burn of sufficient size to invalidate either the investigative work in progress, or other essential values.

As a guide to the attainment of these burned-area objectives, the following objectives relating to the fire-control organization are set forth:

(a) *Acceptable Discovery and Reporting Time*

Facilities for fire detection shall be such that all forest fires on the Station area may be discovered and reported to Headquarters by at least one observer within 5 minutes after the smoke has risen above vegetation surrounding the fire, and may be accurately located (normally by the intersection of lookout bearings) within a further 10 minutes after the first report is received.

(b) *Acceptable Attack Time*

- (i) Getaway time for the first attack crew shall not exceed 5 minutes after a fire is reported to Headquarters.

- (ii) The travel-time objective for fires on or threatening experimental areas as defined in Section 2 (ii) is a maximum of 1 hour.
- (iii) The travel-time objective for all other fires is a maximum of 2 hours.
- (c) *Acceptable Control Time*
 - (i) In the case of fires on or threatening experimental areas as defined in Section 2 (ii) above, the objective shall be to achieve control in not more than 20 minutes after arrival of the first-attack crew.
 - (ii) In the case of all other fires, the objective shall be to achieve control in not more than 1 hour after arrival of the first-attack crew.

It is to be noted that the elapsed-time objectives defined above are those which past experience indicates to be the maximum allowable, *under the most adverse conditions*, in order to keep the total burned area within the established objective. The vast majority of fires on the Station area have been discovered, reached, and controlled in a much shorter total time. This ratio of "average fire time" to "bad fire time" must also be maintained in order to keep within the acceptable burn limit.

3. Legislation and Agreements

Responsibility for forest-fire protection on the Station (i.e., the Forestry Area of the Petawawa Military Reserve) is defined in an Agreement between the Department of National Defence and the Department of the Interior dated August 27th, 1923. Pertinent sections of this Agreement are as follows:

"The Department of National Defence Agrees to:

"Section 8. Authorize the Forest Service to construct buildings, telephone lines, trails, or other improvements necessary for the administration of research or experimental work, or of fire protection on the Forestry Area:

"Section 10. Assist the Forest Service in fire protection on the Forestry Area to the extent of \$1,000 per annum either by means of the detail of the Department of National Defence employees qualified for fire protection work, by payment of accounts for service or supplies, or in such other way as may be mutually agreed upon by the parties to this agreement:

"Section 11. Assist the Forest Service in construction of permanent improvements required for fire protection only, on the Forestry Area, by payment of 50 per cent of the cost thereof, provided that all plans for such improvements shall have first been approved by the Department of National Defence:

"Section 12. Subject employees detailed to the Forest Service under the provision of Section 10 above to full control and instructions by the Forest Service for the time during which they are so detailed:

"Section 13. Report immediately to the Forest Service any fire on the Forestry Area observed by any officer or employee of the Department of National Defence:

"Section 14. On request of the Forest Service, call out National Defence personnel for fire fighting work on the Forestry Area:

"Section 15. Be responsible for pay, subsistence and transport of personnel called out under the provision of Section 14 above:

"Section 16. Place National Defence personnel called out under the provision of Section 14 above, under the instructions of the Forest Service while on fire fighting work in the Forestry Area:

"Section 17. Supply and maintain for use of the Forest Service for fire fighting purposes one portable gasoline pump and equipment therefor including hose and accessories:

"Section 18. In case a fire is discovered on Forestry Area by National Defence personnel, and no Forest Service personnel is available at the time, take all necessary steps to control and extinguish such fire; the Forest Officer to take over supervision of operations on arrival.

"*The Forest Service Agrees to:*

"Section 24. Provide for fire protection, to the extent of resources available, for the Forestry Area, including a lookout station, patrols, and ordinary fire fighting equipment:

"Section 25. Report immediately to the Department of National Defence any fire observed on the Training Area by any officer or employee of the Forest Service:

"Section 26. On request of the Department of National Defence, provide supervision of fire fighting operations on the Training Area, provided personnel is not at the time engaged on fire fighting work on the Forestry Area:

"Section 27. In case a fire is discovered on Training Area by Forest Service personnel, and no National Defence personnel is available at the time, take all necessary steps to control and extinguish such fire; National Defence authorities to take over operations on arrival, subject to the provisions of Section 26 above:

"Section 30. Co-operate with the Department of National Defence in every way possible for the efficient protection and management of the forest property at Petawawa Military Reserve."

Section 30 is now interpreted as meaning that "all fires starting in, adjacent to, or threatening the Forestry Area through military operations" are the responsibility of the Dominion Forest Service. (Reference: letter, Dominion Forester to Superintendent, Petawawa Forest Experiment Station, dated May 21, 1941. File 42490 For., Part VII.)

4. Co-operation

In the interests of forest conservation and for the mutual benefit of the parties concerned, the Station's fire-control organization is to co-operate with the Ontario Department of Lands and Forests and with any other governmental agency, municipality, corporation, or owner of private land whose property is near the Station, provided that:

- (a) Such co-operation shall not impair the efficiency of fire protection on the Station itself, and
- (b) Costs incurred in fighting fires outside the Military Reserve may be charged to the individuals or organizations concerned. (Reference: letter, Director of Forestry to Forester, Petawawa Forest Experiment Station, dated June 5, 1925. File 42490 For., Part III.)

The National Research Council, Chalk River, maintains facilities for the control of incipient forest fires on its property, but is also dependent on outside agencies for assistance in forest-fire protection. To the extent that it is possible in any fire emergency, this Station should render assistance to the National Research Council in the matter of fire suppression, as well as in prevention, detection, fire-danger warning, and training of personnel.

FIRE CONTROL ORGANIZATION

1. Personnel

The organization of fire-control personnel and channels of responsibility for forest-fire protection on the Station are shown in Appendix "A". Details of

the current strength and composition of the protection force are given in Appendix "B".

The duties of the various members of the fire-control organization are enumerated in Appendix "C".

2. State of Preparedness

The state of mobilization of the fire-control force should be adequate at all times to meet the prescribed protection standards. Wasted expenditure through excessive precautionary measures is, however, to be avoided. A state of preparedness which is commensurate with prevailing fire-danger conditions should therefore be maintained. A guide to daily administrative action in this connection is given in Appendix "D".

Analysis of past forest-fire records for the Station shows that the fire-control effort required increases rapidly as the Danger Index rises. This relationship, shown in Appendix "E", may also be used as a guide in planning the daily work of protection personnel.

The location of all fire crews should be shown each day on the office map provided for that purpose.

3. Fire Prevention

Ninety-six per cent of all forest fires fought by Station personnel from 1930 to 1947 were man-caused and therefore preventable.

Map No. 1 shows the location and extent of all recorded fires on the Station area. Map No. 2 shows the point of origin of all fires on the Petawawa Reserve since 1930, indicating areas of highest risk.

Fire prevention is a major part of the Protection Officer's responsibility. The cause of each new fire should be carefully analyzed, the circumstances investigated, and every effort made to prevent the recurrence of fires from a similar cause.

(a) *Education*

No opportunity should be lost to impress upon woods operators, tourists, soldiers, local residents, and school children the need for care with fire in the woods. Fire-prevention posters and road signs are to be displayed at conspicuous points. Care is to be taken that all fire-danger notice boards are correctly set each day.

(b) *Law Enforcement*

Laws and regulations pertaining to the use of fire in the forest are to be fully publicized and strictly enforced. Local regulations regarding such matters as smoking and lighting camp-fires, applicable to Forest Service employees on the Station, may be issued as necessary by the Superintendent.

(c) *Reduction of Hazard*

When controlled burning for any purpose, including military range-burning, is necessary during the fire season, adequate precautions must be taken to prevent the escape of fire. Particular attention is to be paid to weather conditions, inflammability, and the provision of sufficient men and equipment to ensure complete control of the fire.

Softwood plantations in high-risk areas should be protected by fire-guards, which are to be ploughed and burnt out periodically as required. Debris resulting from road-clearing or other improvements, and softwood logging slash are to be piled and burnt either in winter or during low-hazard periods. Hardwood slash is to be lopped and scattered.

4. Detection

(a) Lookouts

Lookout towers are to be manned as soon as fire danger develops in the spring, irrespective of the calendar date, and are not to be closed until fire danger ceases in the autumn. The Protection Officer should check the orientation of fire-finders at the beginning of each fire season.

The visible area coverage of the lookout towers is indicated on Maps 5, 6, and 7.

The equipment to be held at various points is shown in Appendix "F".

(b) Ground Patrols

Patrols may be ordered by the Protection Officer for surveillance of public travel, and to supplement lookout coverage under conditions of poor visibility, high fire danger, or abnormal risk, such as may occur on holidays or when military training is in progress. Patrol routes and frequency will be governed by the prevailing distribution of fire risk, taken in conjunction with fuel types (see Maps 3 and 4) and the area visible to lookouts.

Patrols will normally be made by car. Each patrolman should have a hand pump with full tank, fire shovel, axe, and bucket.

(c) Air Patrols

Under conditions of poor visibility combined with high fire danger, air patrols may be requested on authority of the Dominion Forester. If it is necessary for aircraft to land on the Reserve, prior confirmation must be obtained that the airfield at the Military Camp is serviceable for land-based craft, or that Corry Lake is free from obstacles to navigation (logs, dead-heads, etc.) for water-based craft, as the case may be.

(d) Co-operation

The co-operation of military authorities and the public in the matter of reporting promptly any fire discovered on or near the Reserve should be cultivated.

Any fire discovered outside the Reserve boundary is to be reported to the appropriate authority by the quickest possible means.

5. Communication

The location of permanent telephone routes is shown on Map No. 7. All communication equipment, including instruments, batteries, phone lines and field cable, is to be tested and inspected periodically, and maintained in good condition. Communication equipment is listed in Appendix "F".

6. Transport

Although the Chief Mechanic is responsible for the maintenance of M.T. vehicles and mechanical fire-fighting equipment, all personnel concerned with their operation are to exercise care and judgment in the interests of safety and economy.

Permissible road speeds are shown on Map No. 8, together with the estimated time required to reach any part of the area. Roads, bridges, and fire trails are to be maintained in a fully serviceable condition, indicated speeds should be safe for vehicles up to 5 tons gross weight.

Fire trucks Nos. 1 and 2 are to be kept loaded with fire-fighting equipment, as listed in Appendix "F", throughout the fire season.

During the fire season a boat suitable for use with an outboard motor and capable of carrying at least 6 men and equipment is to be held for fire-control duty at Corry Lake. Similar arrangements for water transport are to be made at Montgomery and Cartier Lakes.

Details of transport equipment available for fire control are shown in Appendix "F".

7. Suppression

(a) *Fire-call Procedure*

The action to be taken following report of a fire is outlined in Appendix "G".

(b) *Co-operation*

Before the start of each fire season, specific arrangements are to be made with local officers of the Department of National Defence, the Ontario Department of Lands and Forests, the National Research Council, the Canadian Pacific Railway, and the Municipality of Chalk River, regarding:

- (i) Action to be taken on fires on or near Reserve boundaries.
- (ii) Mutual assistance in the event of a major fire beyond the control of any one organization. While details of such arrangements must of necessity be made locally, no specific commitments which would involve expenditures outside the Station area are to be made without reference to the Dominion Forester.

(c) *Equipment*

All fire-fighting equipment is to be maintained at the highest possible level of efficiency. Equipment in storage is to be protected against theft and deterioration, and is to be stored in such a way as to be readily accessible when needed.

Power pumps should be tested for ease of starting and general serviceability at the beginning of each fire season, and should be given a thorough performance test, as detailed in Forest-Fire Research Note No. 13, towards the close of the season, so that major overhauls may be carried out during the winter. Not less than 25 per cent of the total stock of hand pumps and tanks should be tested each season, the entire stock being tested over a 4-year period. Fire hose is to be tested on the same percentage basis. Particular care is to be taken in the cleaning, drying, and storage of hose after use.

Fire-suppression equipment held at the Station is listed in Appendix "F". The location of fire-guards, water supplies and other fire-fighting facilities is shown on Map No. 9.

8. Training

Efficient fire protection depends not only upon a thorough understanding of his individual duties by each member of the force, but upon the ability of all members to work together as a co-ordinated unit.

At the start of the fire season a short "refresher" course should be given by the Protection Officer on individual fire-control duties. New personnel will require more careful training. The Fire Chief should supervise fire-fighting practice by crews.

A brief fire drill is to be held at least once a month during the fire season. If actual fires are infrequent, occasional mock fires should be staged to test the efficiency of the whole protection service from discovery to control.

Pending the preparation of a fire-control manual by this Service, the following references are recommended: Western Fire Fighter's Manual; Fireman's Guide, Region One, U.S. Forest Service; Forest Fire Fighter's Guide, Canadian Pulp and Paper Association.

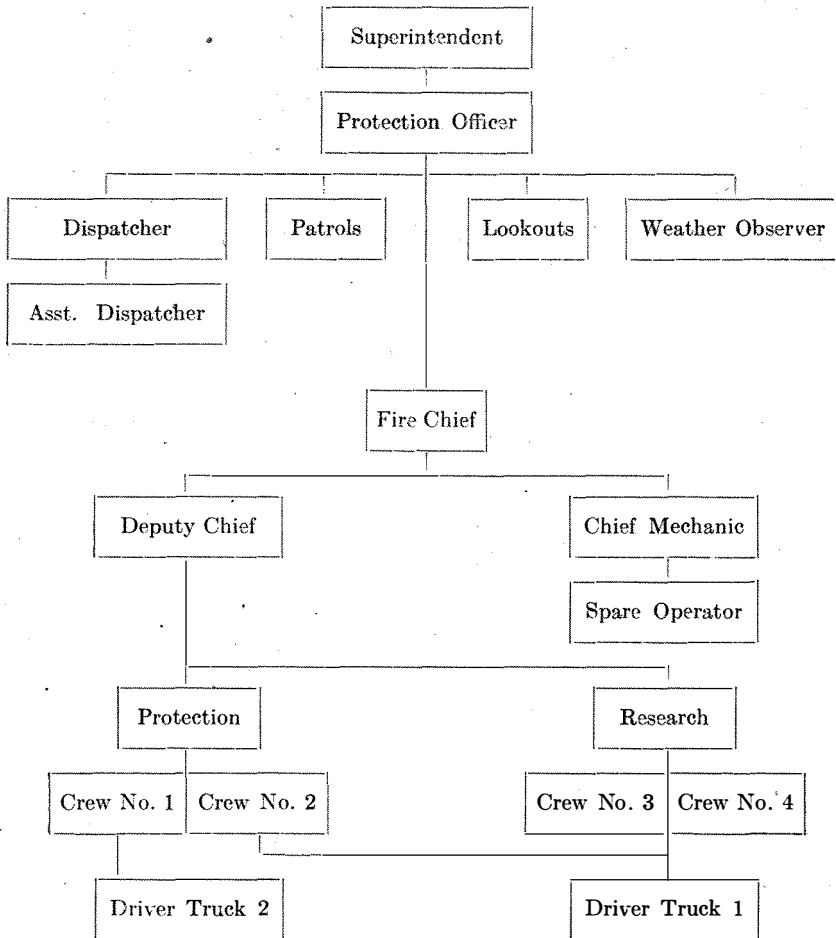
9. Reports

From a study of past fire records, much can be learned to assist in improving fire-control efficiency. Every forest fire occurring on the Station, or fought by Station personnel, is to be the subject of an accurate, individual report on Dominion Forest Service Form 135, accompanied by a map showing location, point of origin, and final area of the fire on Form 105A.

At the end of each fire season, the Superintendent is to submit to the Dominion Forester a report dealing with all phases of forest fire protection on the Station during the year. This report is to be accompanied by a summary of fire statistics on Forms 345 and 345A.

APPENDIX "A"

FIRE CONTROL ORGANIZATION



Crew No. 4 (Research; Truck No. 1; Pump "E")

APPENDIX "C"

FIRE CONTROL DUTIES

Superintendent

The Superintendent is responsible for the establishment of an efficient system of fire protection in the area under his supervision. The responsibility for the administration of fire protection is normally to be delegated to the Fire Protection Officer.

Fire Protection Officer

The Fire Protection Officer is directly responsible for all phases of forest fire protection, including weather station, communication system, and location of all protection equipment on the area; for the supervision of all prevention and detection measures, and for assistance to the Fire Chief in the organization of fire-fighting crews. Preparation of fire reports, fire-control plans, and estimates of expenditures are also his responsibility.

Lookouts (Towermen)

Towermen will report any fire starting on or near the Reserve immediately by phone to Headquarters. They will be on duty, except during wet weather, from 9.00 a.m. to 6.00 p.m. In periods of extreme or high danger they may be required to remain on duty for longer periods. When it becomes necessary for a towerman to leave his post, even for a few minutes, it will be his duty to notify Headquarters and the other lookouts when leaving and when returning to his post. When weather permits he will be given one day per month off duty at the discretion of the Superintendent. Permission to leave his post during hours of duty, even for investigation or control of a fire in the vicinity, must always be obtained.

Towers and cabins, also grounds around the latter, must be kept clean and neat. All instruments must be free from dust and in good working order. Exposed metal parts must be wiped regularly with an oily rag. Binoculars, compasses, and other property must be kept where they cannot be stolen. All fire equipment must be kept in good condition. Records of rainfall and any other information required are to be regularly and accurately kept.

Regular telephone reports to Headquarters will be as follows: on reporting for duty at 9.00 a.m., at 12.00 noon, and at 6.00 p.m. During periods of wet weather towermen will carry out improvements on the orders of their superior officer. These improvements may consist of trail cutting, brushing roads and trails, brushing phone lines, etc.

Towermen must at all times present a neat appearance to the public and should try to secure the hearty co-operation of all parties working or living in their district. They should cultivate a pleasant manner with the people with whom they come in contact and endeavour to interest them in the protection of the forests.

Towermen are responsible for obtaining their own food supplies.

Patrols

The Patrolman will make regular patrols by car or on foot, as instructed by the Protection Officer. On discovery of a fire, he will extinguish it if possible; if it is beyond control, he will notify Headquarters by the quickest means available.

He will ascertain the extent of public travel in the area, and warn visitors to observe adequate fire precautions. As in the case of towermen, tact and courtesy are always to be preserved in relations with the public.

Weather Observer

The Weather Observer will operate the meteorological station, and prepare weather reports and records as required by Head Office and by the Meteorological Division, Department of Transport. He will also be required to compute daily fire danger records and enter them on the fire danger chart, keep all fire danger notice boards up to date, bring to the attention of the Protection Officer daily weather forecasts, be responsible for the care of all meteorological instruments, and advise the National Research Council at Chalk River of daily fire danger conditions.

Dispatcher

The Dispatcher will mark on the fire-crew location map each morning the position of all protection crews working in the area. He will receive reports from lookouts, towermen, and patrols, determine location of fires on the fire plotting map and advise personnel concerned as quickly as possible. He will inform the Ontario Department of Lands and Forests, Pembroke, of fires reported on provincial land, and the National Research Council, Chalk River, of fires on or threatening their property.

Assistant Dispatcher

He will act for the Dispatcher during the latter's absence.

Fire Chief

The Fire Chief will take direct control of fire-fighting operations and supervise training and selection of personnel for fire-fighting crews. He will be responsible for such fire protection measures as posting of fire notices on roads, trails, camp-sites, etc., and removal of hazards, such as brush disposal on rights of way, phone lines, and in permit areas. He will be responsible for the upkeep of fire trucks and fire-fighting units other than pumps.

Deputy Fire Chief

He will assist the Fire Chief and will act as Chief during his absence.

Chief Mechanic

He will maintain all fire pumps in good condition, also fire trucks and all mechanical fire-fighting equipment. He assists the Fire Chief in the training of pump operators.

Spare Operator

He assists the Chief Mechanic in maintenance of equipment, and in operating any fire pump when necessary.

Fire Crews

During the fire season, 4 fire crews of 6 men each will be selected and trained from the most efficient available personnel on strength at the Station. Each crew is to be made up as follows: pump operator, siamese operator, nozzlemen 1 and 2, and hosemen 1 and 2.

Truck Drivers

Two truck drivers will be selected and trained to handle fire trucks Nos. 1 and 2. Both drivers must also be trained pump operators, and one must be available at all times at Headquarters.

APPENDIX "D"

STATE OF PREPAREDNESS ACCORDING TO FIRE DANGER

Nil Danger

Unless a thunderstorm has occurred in the past 48 hours, lookout men may get supplies, work on phone lines, clear and brush trails, etc.

Fire-crew personnel may be fully engaged on duties other than fire protection.

Low Danger

At least one lookout is to be manned.

Field work in which members of protection crews are employed may be carried out in the less accessible parts of the area, but key personnel and at least one crew are to be available on call from Headquarters.

Moderate Danger

Both lookouts are to be manned.

Key personnel are to remain close to or in touch with Headquarters.

One complete fire-fighting crew is to be ready for immediate action. A stand-by crew should be on close call.

High Danger

Both lookouts are to be manned.

If visibility is poor all regular patrols must be covered, with extra patrols on much-travelled routes.

All members of protection crews are to be in close touch with Headquarters. Road construction crews (other than No. 1) are to be concentrated at Headquarters and will respond with Crew No. 2 to first-alarm fire calls. All fire transport, fire-fighting equipment, and regular pump operators should be ready for immediate action.

Key personnel and at least one stand-by crew are to remain on duty during Sundays and holidays.

Extreme Danger

All steps under High Danger remain in force.

Additional patrols will be placed as required according to visibility conditions.

An adequate reserve force is to be held on stand-by duty on Sundays and holidays.

APPENDIX "E"

FIRE OCCURRENCE AND BEHAVIOUR IN RELATION TO THE DANGER INDEX
(Based on fires occurring on Petawawa Military Reserve, 1930 to 1946)

Degree of Fire Danger (Eastern Danger Index)	Number of Days of Danger in Ave. Fire Season	Average Frequency of Fires	Average Rate of Perimeter Increase	Relative Fire-Control Effort Required
			Chains per hour	Per cent
Extreme.....	3	1 fire per 10 days	74	100
High.....	28	1 fire per 16 days	63	53
Moderate.....	59	1 fire per 63 days	50	11
Low.....	54	1 fire per 102 days	51	7
Nil.....	26	No fires.....	No fires	0

(Fire-Control Effort is expressed as a percentage by multiplying Average Frequency of Fires by Average Rate of Perimeter Increase.)

APPENDIX "F"

EQUIPMENT SCHEDULES

1. Equipment to be Held at Lookout Stations

Item	Quantity
Fire-finder and map.....	1
Binoculars, coated lens, pr.....	1
Telephone set.....	1
Compass, forestry.....	1
Hand pumps with tanks.....	2
Shovels, fire.....	2
Axes, fire.....	2
Rain gauge.....	1

2. Equipment to be Kept on Fire Trucks

Item	Quantity	
	Truck No. 1	Truck No. 2
Power Pumps.....	3 (B,C and E)	1 (D)
Hose, linen, 1½ in., (in bags) feet.....	7,500	2,500
Hose, intake, 2 in., with strainer.....	3	1
Hose, intake, 1 in., with strainer.....		1
Tool boxes, pump, with siamese, nozzles and tips, tools, etc.....	3 (B,C and E)	1 (D)
Nozzles, fog, sets.....	1	1
Tripod, gas tank (for pump "B").....	1	
Gas tank, portable (for pump "B").....	1	
Carrying rack (for pumps "C" and "E").....	1	
Pump, fan-belt drive.....		1
Hose, rubber, ¾ in., feet.....		300
Reel, hose, live.....		1
Tank, water, 180-gal.....		1
Cans, gas, pack (for pumps).....	3	1
Cans, gas, naphtha (for torches).....	1	
Cans, coal oil (for torches).....	1	
Torches or guns, brush-burning, complete.....	2	1
Hand pumps with tanks.....	6	2
Buckets, canvas.....	6	2
Shovels, fire.....	12	6
Tools, fire-fighting, Stevenson.....	6	
Axes, fire.....	11	4
Saws, crosscut.....	1	
Telephone, portable, with case.....	1	
Belt, lineman's.....	1	
Climbers, telephone, pr.....	1	
Cable, field telephone, miles.....	2	
Rations, 1-meal packs.....	24	

3. Current Holdings of Fire-fighting Equipment

(At Headquarters Stores except as noted in Items 1 and 2 above)

Item	Total Quantity
Axes, D.B.....	37
Buckets, canvas.....	20
Cans, gas, square, G.I., 2½ gal.....	8
Cans, gas, round, G.I., 5 gal.....	1
Cans, gas, kidney pack, G.I., 6 to 7 gal.....	3
Helmet, smoke, in case.....	1
Hose, linen, 1½ in., feet.....	27,500
Hose, rubber, ¾ in., feet.....	300
Bags, hose, Wright pattern.....	30
Folders, hose.....	1
Vulcanizer, hose.....	1
Nozzles, 1½ in., straight stream, with tips.....	20
Nozzles, fog or straight stream, with tips.....	1
Nozzles, fog, with applicator and tips.....	1

3. *Current Holdings of Fire-fighting Equipment (Contd)*

Item	Total Quantity
Pumps, hand, with hose and clamps.....	60
Pumps, power, 1-stage centrifugal, with tools and accessories.....	3
Pumps, power, 4-stage centrifugal, with tools and accessories.....	1
Pumps, power, 6-stage centrifugal, with tools and accessories.....	2
Pumps, power, positive displacement, with tools and accessories.....	1
Pumps, fan-belt drive, positive displacement, with tools and accessories	1
Reel, hose, live, $\frac{3}{4}$ -in. hose.....	1
Siamese, $1\frac{1}{2}$ in.....	15
Shovels, fire-fighting, bulldog.....	110
Tanks, back-pack, 5 gal., for hand pumps.....	40
Tanks, water, 180 gal.....	1
Tools, fire-fighting, Stevenson.....	17
Torches & guns, brush-burning, complete.....	5
Wetting agents, gal.....	5

Transport and Miscellaneous Equipment Available for Fire Control

Item	Quantity
Trucks, stake body, $2\frac{1}{2}$ ton.....	3 (includes Fire Truck No. 1)
Trucks, stake body, $1\frac{1}{2}$ ton.....	1
Trucks, 4 x 4, $\frac{3}{4}$ ton, 4-wheel drive.....	1 (Fire Truck No. 2)
Trucks, $\frac{1}{2}$ ton.....	2
Trucks, 8 cwt.....	1
Trucks, dump.....	2
Jeep, 4-wheel drive.....	1 (assigned to Fire Chief)
Coaches, 5-passenger.....	2 (1 assigned to Protection Officer)
Tractor, D7, with blade.....	1
Tractor, D4, with blade.....	1
Horses.....	2
Wagon.....	1
Plough.....	1
Canoe, canvas, 17 feet, square stern.....	1
Canoe, canvas, 15 feet.....	1
Rowboats.....	4 (3 assigned to fire control)
Outboard motors, for above.....	3
Camp equipment, complete.....	30-man unit
Radio pack-sets, complete.....	2
Batteries, radio, spare.....	2
Chargers, battery radio.....	2

APPENDIX "G"

FIRE-CALL PROCEDURE

1. All fires are to be reported immediately to the Dispatcher at Headquarters.
2. The Dispatcher is responsible for notifying all other personnel concerned. The siren will normally be used as the alarm for persons in the vicinity of Headquarters.
3. The Fire Chief will decide what crews, equipment and transport are to be employed, and the route and method of attack to be followed, and will direct actual fire-fighting operations. To aid in making these decisions he may consult:
 - (a) The fire danger chart, weather forecast, and fuel-type map (No. 3 or 4), to determine the fire's probable rate of spread and resistance to control.
 - (b) The travel-time map (No. 8) to find the best route and probable elapsed time till arrival of the crew.
 - (c) The map of fire-fighting facilities (No. 9) to locate pump set-ups, fire-breaks, etc., as well as plantations or experimental areas which may be threatened.
4. Crew No. 2 is composed of Headquarters personnel and will be the first to respond for fire-fighting duty. At the sound of the alarm its members will assemble at the door of the 5-car garage and await instructions.
5. Crews 3 and 4 will normally be called out only on second alarm, but in periods of high or extreme danger they may be instructed to respond on first alarm.
6. Crew No. 1, which will be employed near the centre of the Station area for the greater part of the fire season, will take initial action on all fires which can be reached more quickly by it than by Headquarters crews. In other cases it will be called only for reinforcement action. No. 1 is equipped to act as an independent fire-fighting unit. It must have transport within easy reach of work, and maintain communication with Headquarters, the frequency of contact depending on fire-danger conditions.
7. Normal sequence of fire calls:
 - 1st Alarm—Crews 1 and 2, initial action depending on location.
 - 2nd Alarm—Crews 3 and 4.
 - 3rd Alarm—All remaining available men employed at the Station.
 - 4th Alarm—Petawawa Military Camp.
 - 5th Alarm—(a) National Research Council (for fires near research establishment)
 - (b) Canadian Pacific Railway (for fires near Chalk River village)
 - (c) Ontario Department of Lands and Forests (for fires near provincial lands).

Fig. 1. SUMMARY of FIRES PETAWAWA — FIVE-YEAR AVERAGE 1930-1934
(Including Military Area)

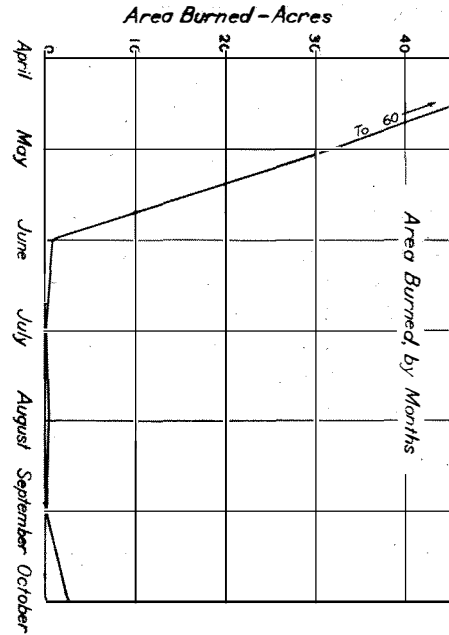
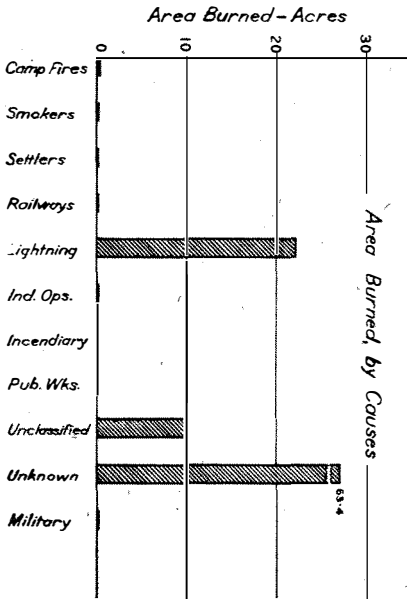
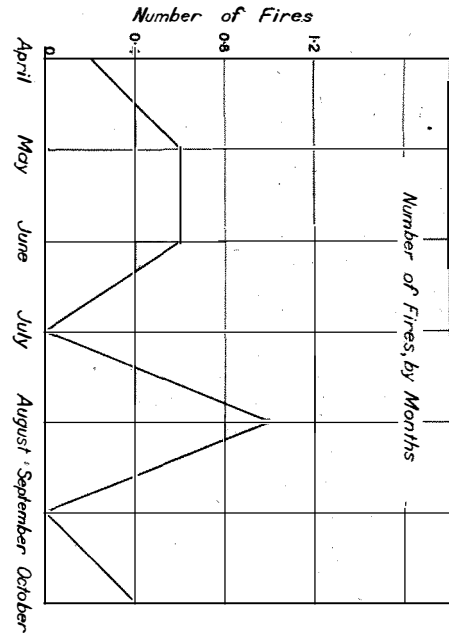
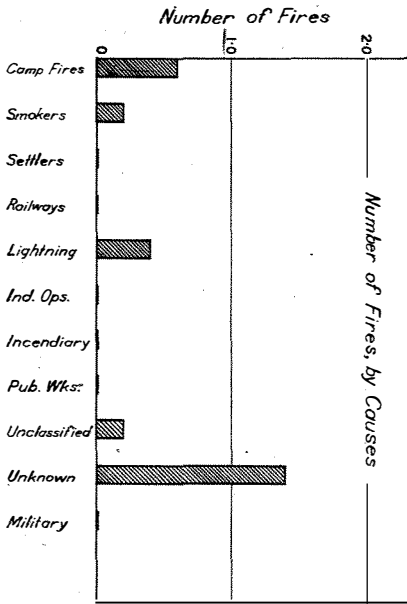


Fig. 2. SUMMARY of FIRES PETAWAWA — FIVE-YEAR AVERAGE 1935-1939
(Including Military Area)

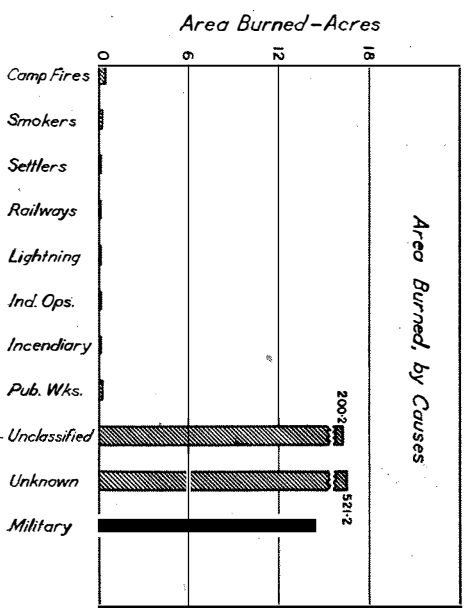
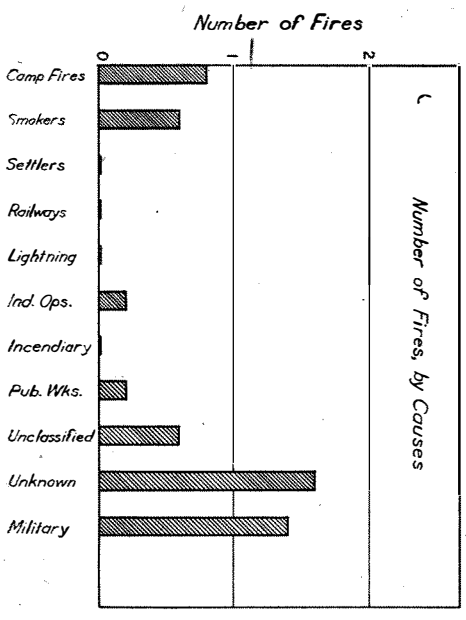
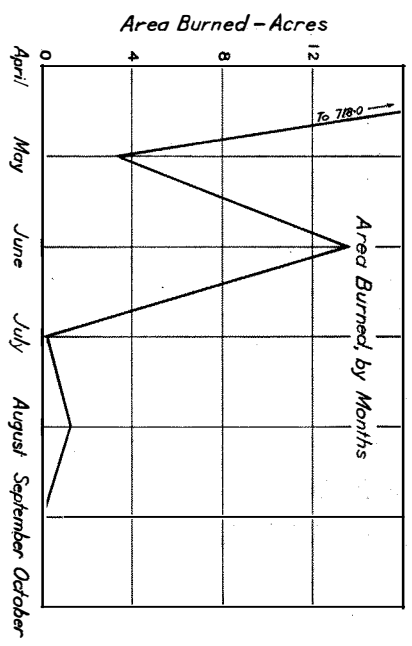
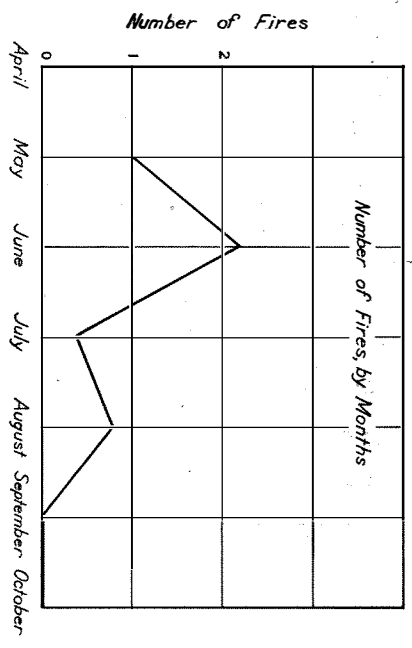


Fig. 3. SUMMARY of FIRES PETAWAWA — FIVE-YEAR AVERAGE 1940-1944
(Including Military Area)

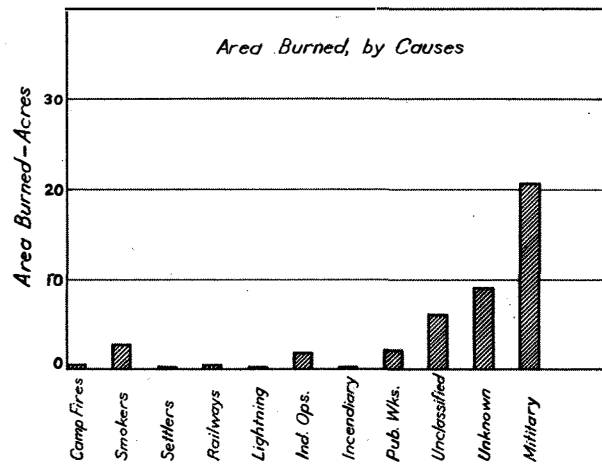
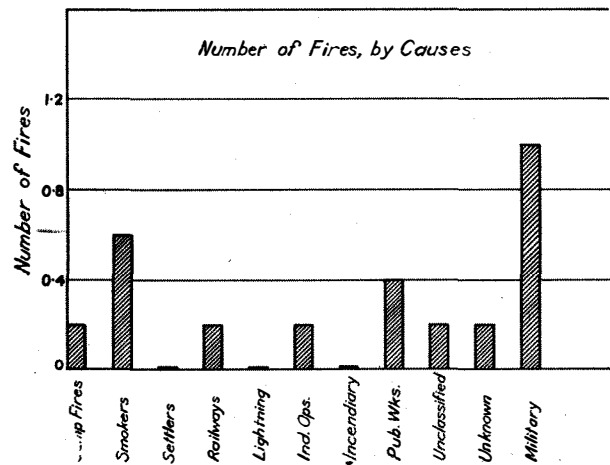
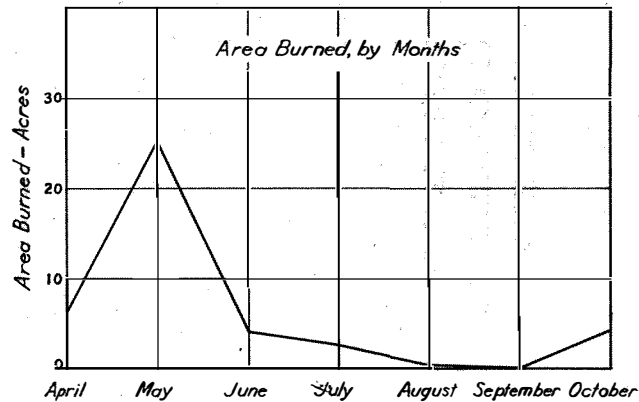
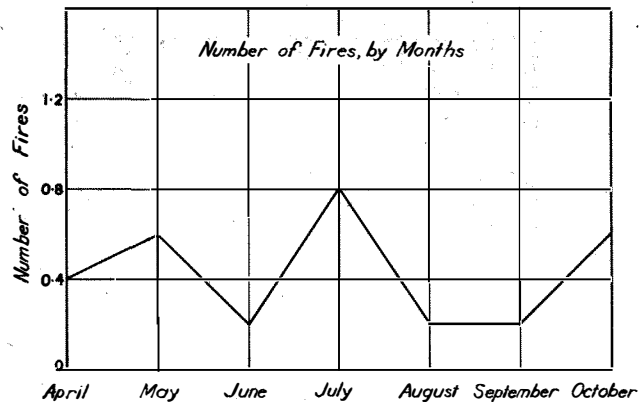


Fig 4. SUMMARY of FIRES PETAWAWA
(Including Military Area)

Number of Fires and Area Burned - by Years.

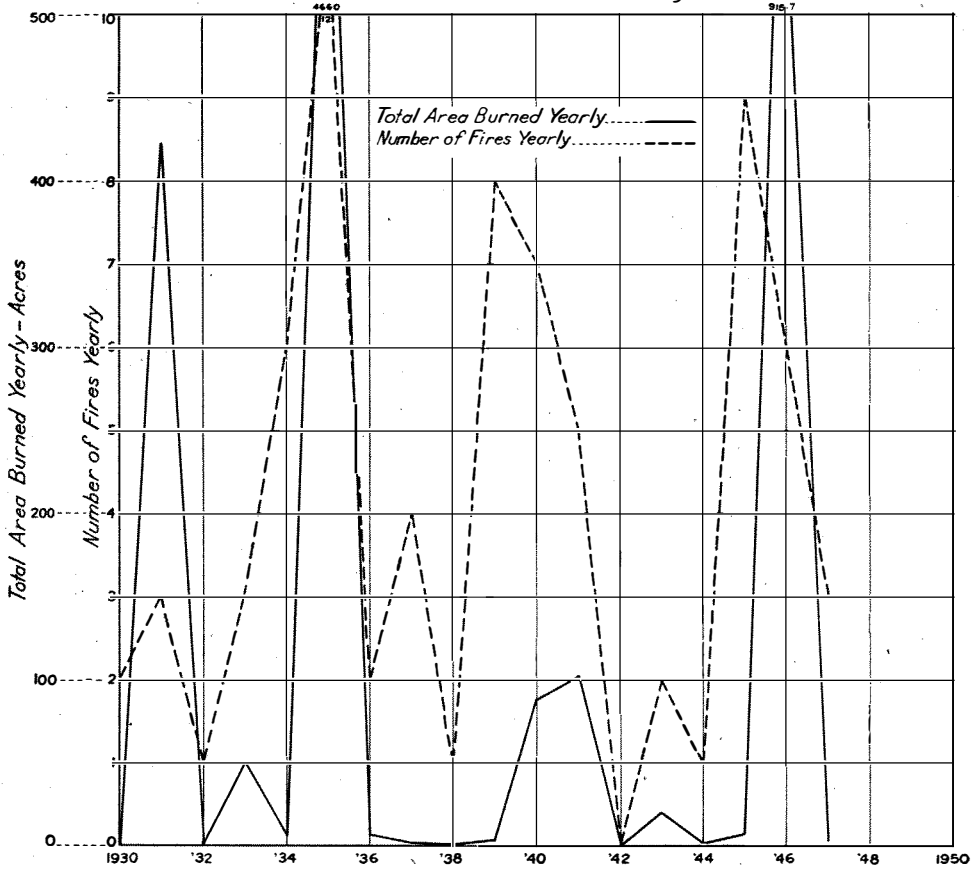


Fig.5. SUMMARY of FIRES PETAWAWA
(Including Military Area)

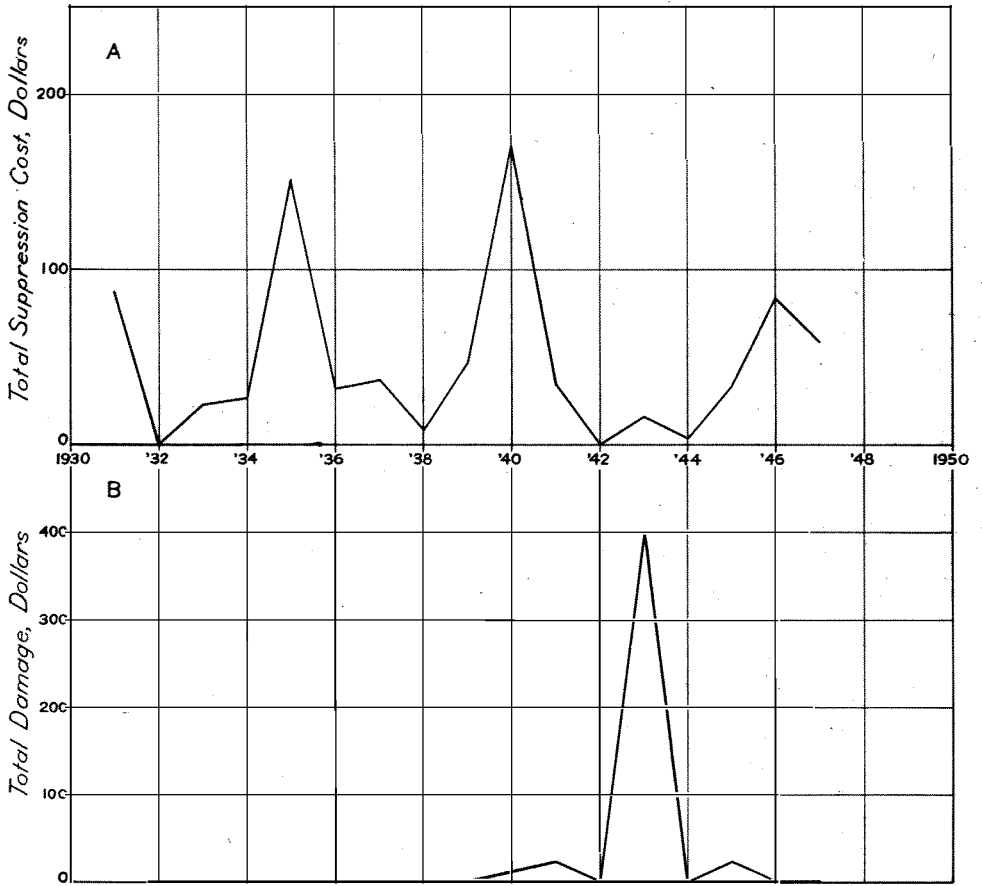


Fig.6. SUMMARY of FIRES PETAWAWA
(Including Military Area)

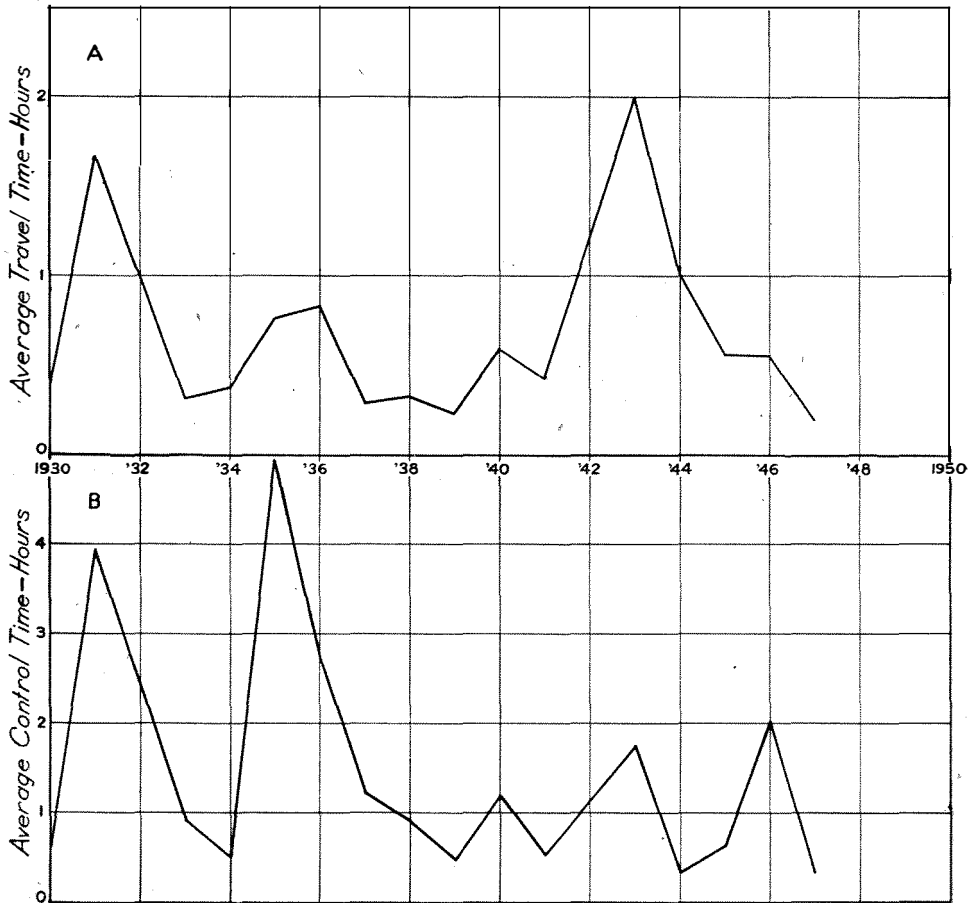


Fig. 7. PETAWAWA FOREST EXPERIMENT STATION
 Fire Danger Index.
 (From Eastern Fire Danger Table, Forest-Fire Research Note No. 12)

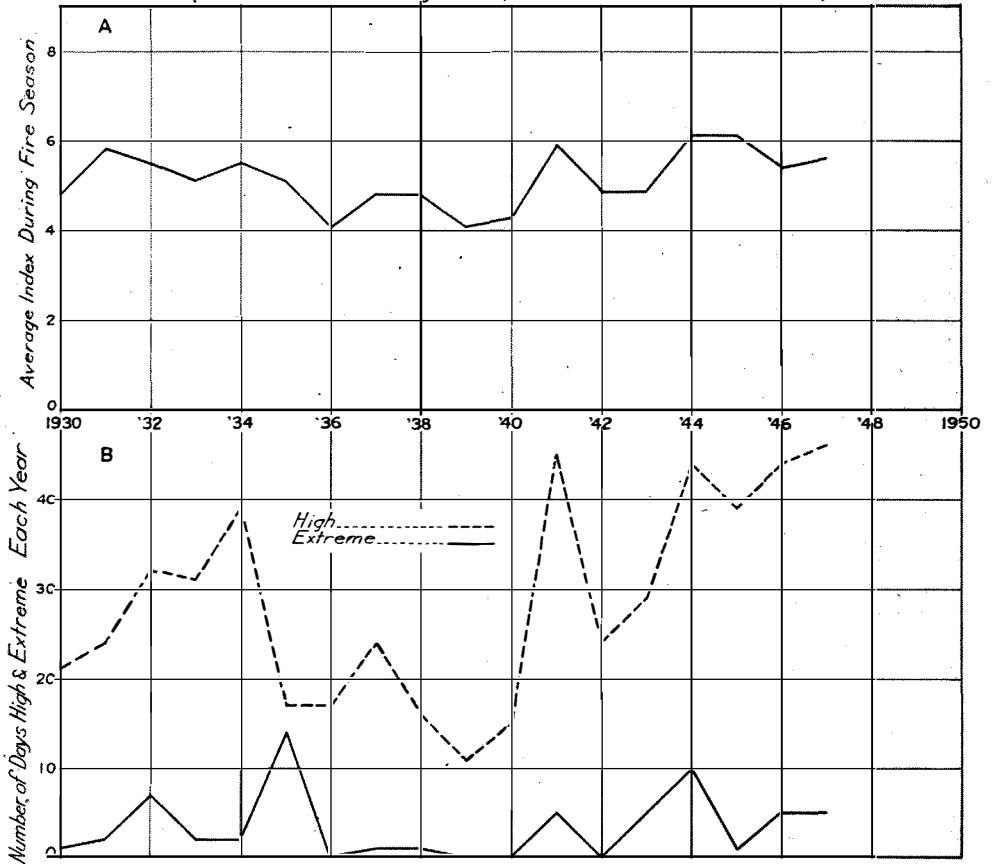
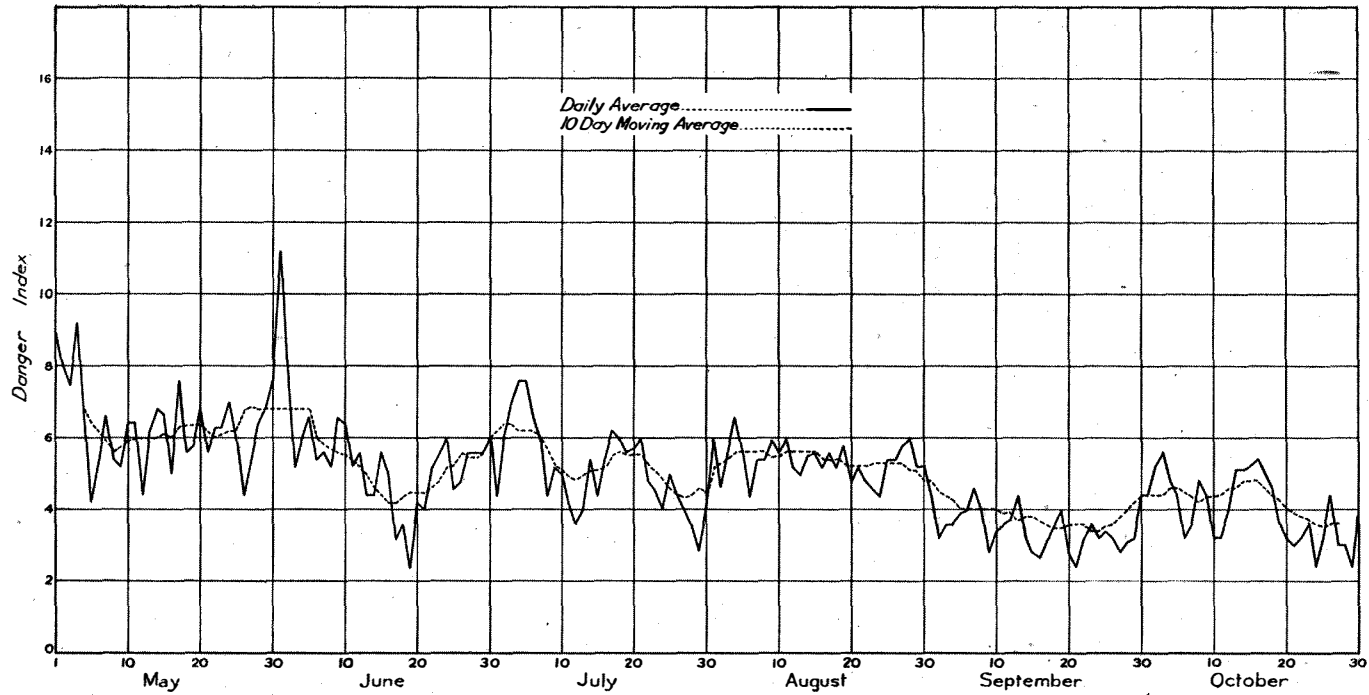


Fig. 8. PETAWAWA FOREST EXPERIMENT STATION
Average Fire Danger, Eastern Danger Index 1930-45.



NOTES ON MAPPING METHODS

I. FUEL TYPES

The fuel-type classification employed in Maps 3 and 4 is based on that developed by Hornby (see Preface). Two fundamental characteristics of fire behaviour are recognized—rate of spread and resistance to control. In certain fuel types, such as grass and “flash” fuels generally, the rate of spread of fire may be very high, although the effort required to control a given perimeter is relatively small. In some other fuel types, such as muskegs, the reverse is generally true.

Four rate-of-spread classes have been adopted—Low (L), Moderate (M), High (H), and Extreme (E). These are shown by different colours on the maps. The same nomenclature has been used in differentiating four classes of control difficulty, which are indicated by the type of hatching or by solid colour. For example, a fuel type with low rate of spread and high resistance to control is shown cross-hatched in green. The indicated fuel characteristics are based on fuel moisture and weather conditions corresponding to “high” fire danger (Index 9 to 12 on the Wright Scale).

Owing to the small area of the Station, the existence of detailed cover-type maps, and knowledge gained from previous fire-hazard research in many of the fuels concerned, a different mapping procedure from that employed by Hornby was adopted. Each cover type was assigned a rating as to fire-control difficulty and rate of spread, according to the judgment of fire-control officers with long experience at the Station, together with data from several hundred test fires set for fire-hazard studies. The classification adopted is shown in Table 1.

TABLE I—COVER TYPES AND FUEL-TYPE RATINGS

Cover type	Spring and Autumn		Summer	
	Rate of Spread	Control Difficulty	Rate of Spread	Control Difficulty
Softwood:—				
Mature:				
White Pine.....	M	M	M	M
Red Pine.....	H	H	H	H
Jack Pine, open.....	H	M	H	M
Jack Pine, dense.....	M	H	M	H
R. & W. Pine.....	H	H	H	H
R., W. & J. Pine.....	H	M	H	M
Spruce-Balsam.....	L	E	L	E
Pine-Sp.-Bals.....	M	H	M	H
Black Spruce.....	L	H	L	H
B. Sp.-Cedar-Larch.....	L	H	L	H
Young Growth:				
Natural.....	H	H	H	H
Plantations.....	E	E	E	E
Mixedwood.....	H	M	M	M
Tolerant Hardwood.....	E	M	L	M
Intolerant Hardwood:				
Open.....	E	M	M	M
Dense.....	E	M	L	M
Oak Ridge:				
Open.....	E	H	H	H
Dense.....	E	M	M	M
Plain, heath.....	H	M	H	M
Plain, grass.....	E	L	M	L
Alder-Willow or Mixedwood Swamp.....	M	M	L	M
Muskeg.....	L	H	L	H
Recent Burn (within 5 years).....	E	H	H	H
Cut-Over (within 5 years):				
Softwood, with slash.....	E	H	E	H
Softwood, slash burned.....	H	M	H	M
Mixedwood and Hardwood, slash lopped and scattered.....	E	H	M	H

The above ratings for control difficulty were increased by one class in areas where fuels were exceptionally dense. Mature stands with merchantable volumes of less than 500 cubic feet to the acre were classified as "open".

The ratings obtained from Table I were modified according to slope and aspect as indicated in Table II. The addition of these topographic influences would perhaps justify the use of some other expression than "fuel-type" rating when applied to the final values; however, as fuels remain the primary element in the classification this convenient term has been retained.

TABLE II—EFFECT OF SLOPE AND ASPECT ON FUEL-TYPE RATING

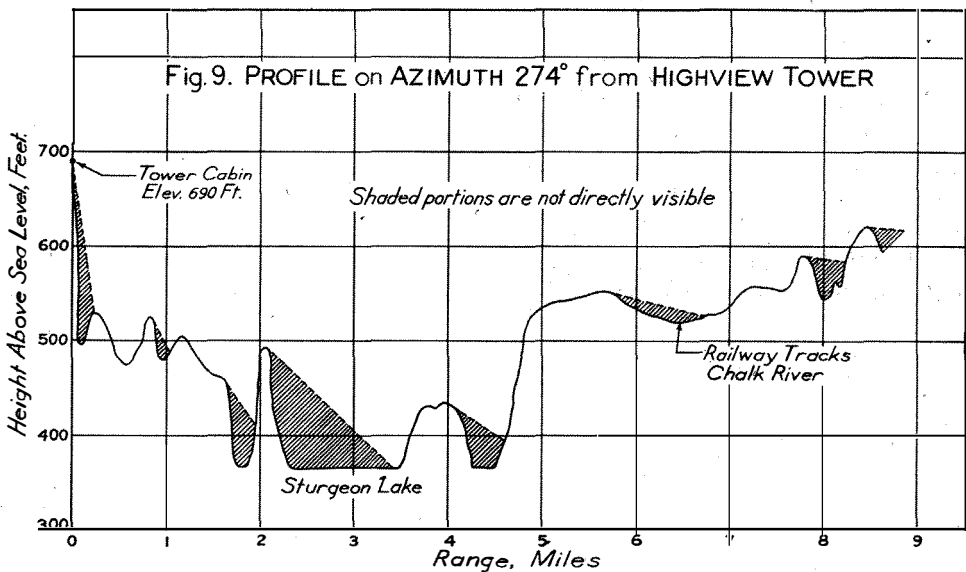
Slope	Aspect	Change in Rating from Table I	
		Rate of Spread	Control Difficulty
Less than 12%.....	All	No change	No change
12 % to 20%.....	N & NE	Reduce 1 class	No change
12 % to 20%.....	E, SE and NW	No change	No change
12% to 20%.....	S, SW and W	Increase 1 class	No change
More than 20%.....	N and NE	No change	Increase 1 class
More than 20%.....	E, SE and NW	Increase 1 class	Increase 1 class
More than 20%.....	S, SW and W	Increase 2 classes	Increase 1 class

The final types were marked on Maps 3 and 4 according to existing cover-type boundaries, modified where necessary by considerations of slope and aspect.

II. AREAS VISIBLE FROM LOOKOUTS

Reliable contour maps are necessary for visible-area mapping by the method here described. Unless the contours are shown with a high degree of accuracy, quite erroneous results may be obtained. If such maps are not available, it is preferable to work with photographs or sketches made from the lookout point.

The procedure used in preparing Maps 5 and 6 was briefly as follows. On the contour map, radial lines were drawn from the lookout tower at intervals of about 15 degrees of azimuth, covering the Station and some adjoining areas. A profile was then plotted for each such line, in the form shown in Figure 9, allowance being made for the height of forest cover. Any convenient scale may be used for plotting purposes, but the vertical scale should be greatly exaggerated in relation to the horizontal. By laying a straight-edge from the lookout tower cabin to each summit on the profile, areas not directly visible were readily determined, and were shaded as shown in Figure 9.



The boundaries of these shaded areas were then marked on the corresponding azimuth line on the contour map. After several adjacent lines had been so marked, boundaries of non-visible areas were filled in between the lines either by inspection or by use of intermediate profiles. Non-visible areas were shaded on the contour map.

On completion of this stage, the map was taken to the lookout tower and the work verified by direct observation. Some experience is necessary to interpret the oblique view, as seen from the lookout, in terms of its appearance in plan on the map. This checking is best performed on a day of slight haze, which enhances the aerial perspective and gives a better separation of topographic features at successive distances.

Finally, areas of exceptionally heavy screening were marked on the map. No arbitrary rule was adopted for this purpose, both the depth of the shaded area in the profile and the steepness of the contour being taken into account. It may be remarked that even the heaviest screening encountered at this Station would scarcely be judged severe by standards applicable in mountainous regions.

Tests with smoke generators have shown, however, that there is usually a delay of some minutes in discovering smoke in areas designated as heavily screened, and errors in reported bearings may be considerable.

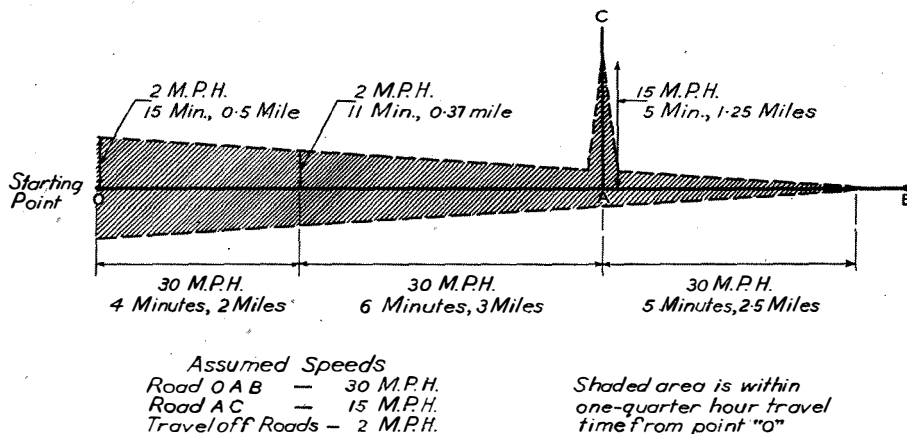
Map No. 7, showing the combined coverage of the two lookout towers, was obtained by superimposing Maps 5 and 6 on a tracing table. Areas directly visible to at least one lookout, and those heavily screened from both, were differentiated from other classes of coverage.

III. TRANSPORT ROUTES AND TRAVEL TIMES

For the mapping of transport routes and travel-time zones, a base map giving the location of roads, fire trails and footpaths is required. Information should also be available as to maximum weights and speeds of vehicles that can be used on each road, streams navigable by canoe or motor-boat in areas not accessible by road, the general nature of the topography, vegetation, and other factors affecting travel on foot, and facilities for air transport if the latter is used.

In preparing Map No. 8, the average permissible motor-vehicle speed for each road was first entered. For foot travel away from roads, an average speed of 2 miles per hour was assumed for the first hour's walking, and 1 mile per hour thereafter. These figures were modified to some extent according to local topography and location of paths. Travel by outboard motor-boat was assumed to be at an average rate of 2 miles per hour; this conservative estimate makes allowance for delays caused by additional handling of equipment when water craft are used.

Fig. 10. METHOD of PLOTTING TRAVEL-TIME ZONE BOUNDARIES



Travel-time zones were based on distances from the Station Headquarters at Corry Lake. In determining the boundary of the one-quarter hour time zone, the distance along each main road that could be covered in 15 minutes at the indicated speed was first scaled off on the map. For instance, on a 30-m.p.h. road a point $7\frac{1}{2}$ miles from Headquarters could be reached (see Figure 10). Next, the farthest point from Headquarters that could be reached in 15 minutes was

marked on each side road branching from the main road. Where the branch-road speed was less than the main-road speed, the time required to reach the branch-road junction was first found; then the additional distance that could be travelled in the remaining time at the new speed was determined.

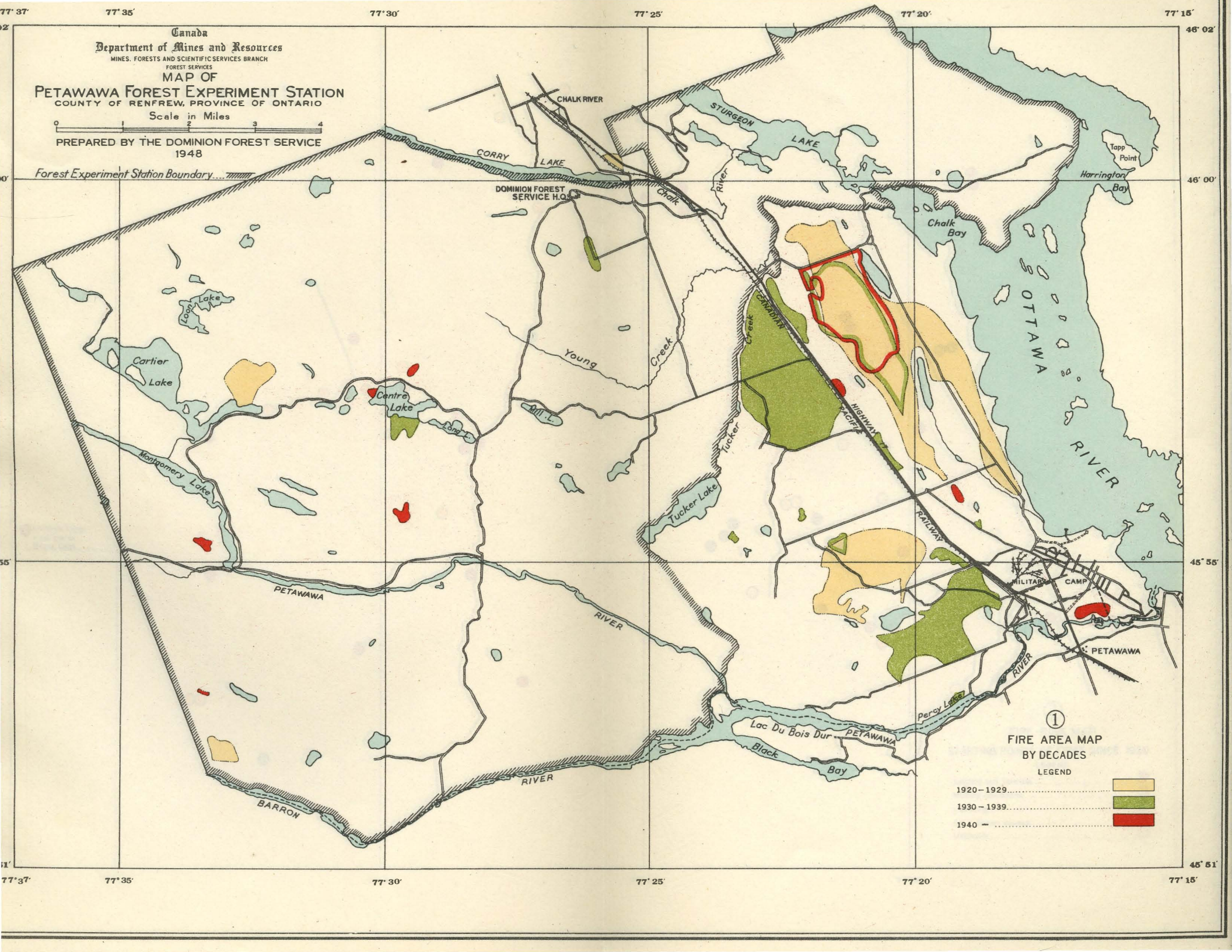
The quarter-hour travel-time distance on each road having been marked, the farthest point that could be reached by combined car and foot travel, within the same time limit, was scaled off on either side of the road at intervals of about one mile. A continuous line was drawn through all these points to form the quarter-hour zone boundary. Sections of the zone are typically tongue-shaped, being widest at the start and narrowing to a point at the extremity, as shown in the idealized example of Figure 10. On the Petawawa plains, however, where motor travel is not confined to the roads but is possible almost everywhere, the zone covers a broad, irregular area.

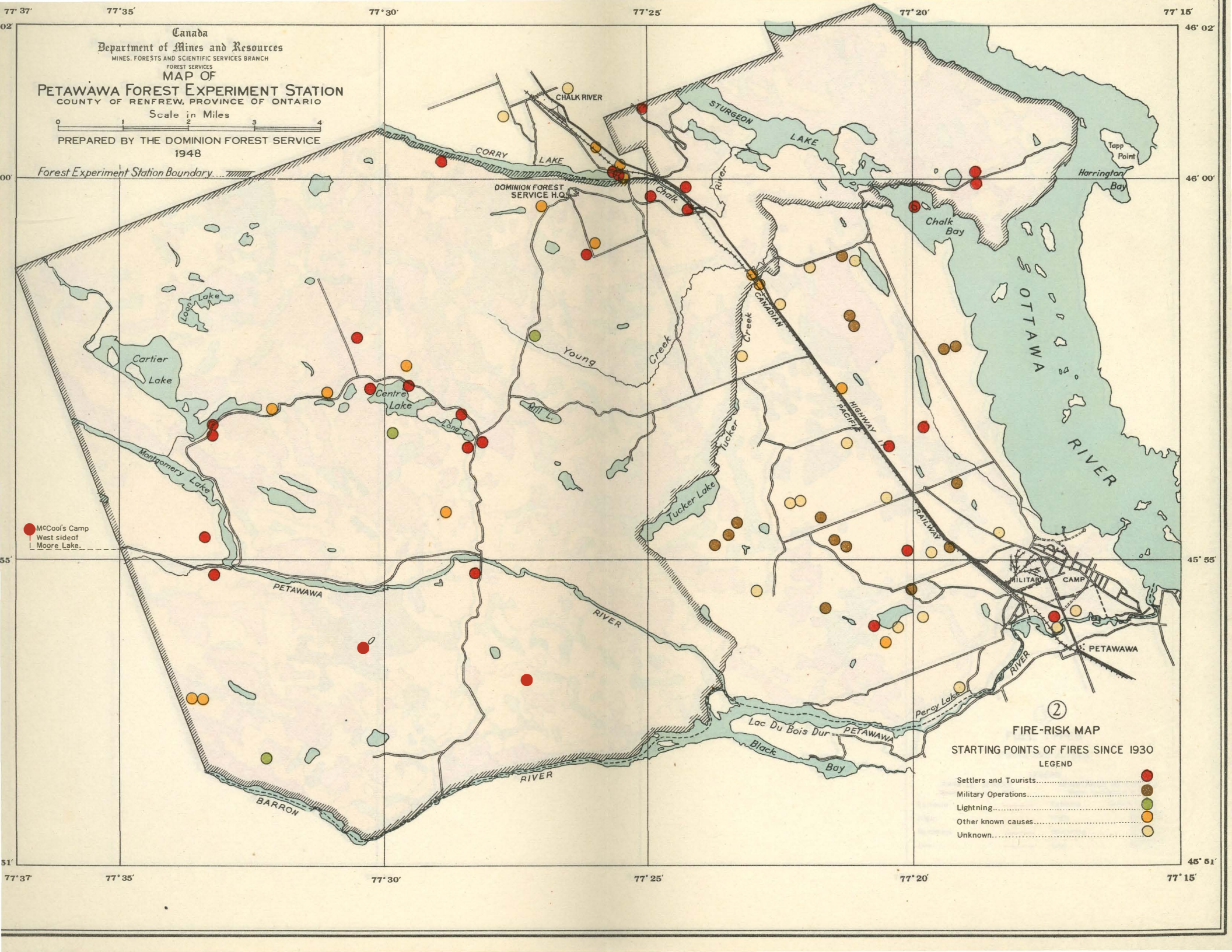
Limits of travel at one-half hour, one-hour, and two-hour intervals were determined in similar fashion, each additional distance being scaled off from the previous zone boundary. No part of the Reserve was as much as three hours' travel-time distance from Headquarters. For larger areas, where fire-crews would be available at more than one centre, the zones would normally indicate travel-time limits pertaining to the nearest centre, but the mapping procedure would be similar to that here illustrated. A modification of this method might be employed to define air-transport coverage.

Certain parts of the area were found to be equally accessible by means of two or more different travel routes. For example, there is a point between Sturgeon Lake and the north boundary of the Reserve which could be reached equally well from the road running northwest of Highview Tower, or a road north of the Reserve (not shown on Map No. 8) which joins the latter, or by boat across Sturgeon Lake. In cases of this nature where serious ambiguity might exist, the boundaries between main travel routes were marked on the map. These boundaries do not necessarily represent equal travel times by the different routes; walking distance (and therefore fatigue on arrival at a fire) was also taken into account.

In the preparation of this and most of the other fire-plan maps, certain assumptions and generalizations were inevitable. These maps must therefore be regarded as approximations rather than as exact representations of fact. So far as possible, however, the conditions shown were checked by field examination of sample portions, and by practical trial.

PART II
FIRE ATLAS





Canada
Department of Mines and Resources
MINES, FORESTS AND SCIENTIFIC SERVICES BRANCH
FOREST SERVICES
MAP OF
PETAWAWA FOREST EXPERIMENT STATION
COUNTY OF RENFREW, PROVINCE OF ONTARIO
Scale in Miles
PREPARED BY THE DOMINION FOREST SERVICE
1948

Forest Experiment Station Boundary

McCool's Camp
West side of
Moore Lake

②
FIRE-RISK MAP
STARTING POINTS OF FIRES SINCE 1930
LEGEND
Settlers and Tourists.....
Military Operations.....
Lightning.....
Other known causes.....
Unknown.....

MAP OF

PETAWAWA FOREST EXPERIMENT STATION
COUNTY OF RENFREW, PROVINCE OF ONTARIO

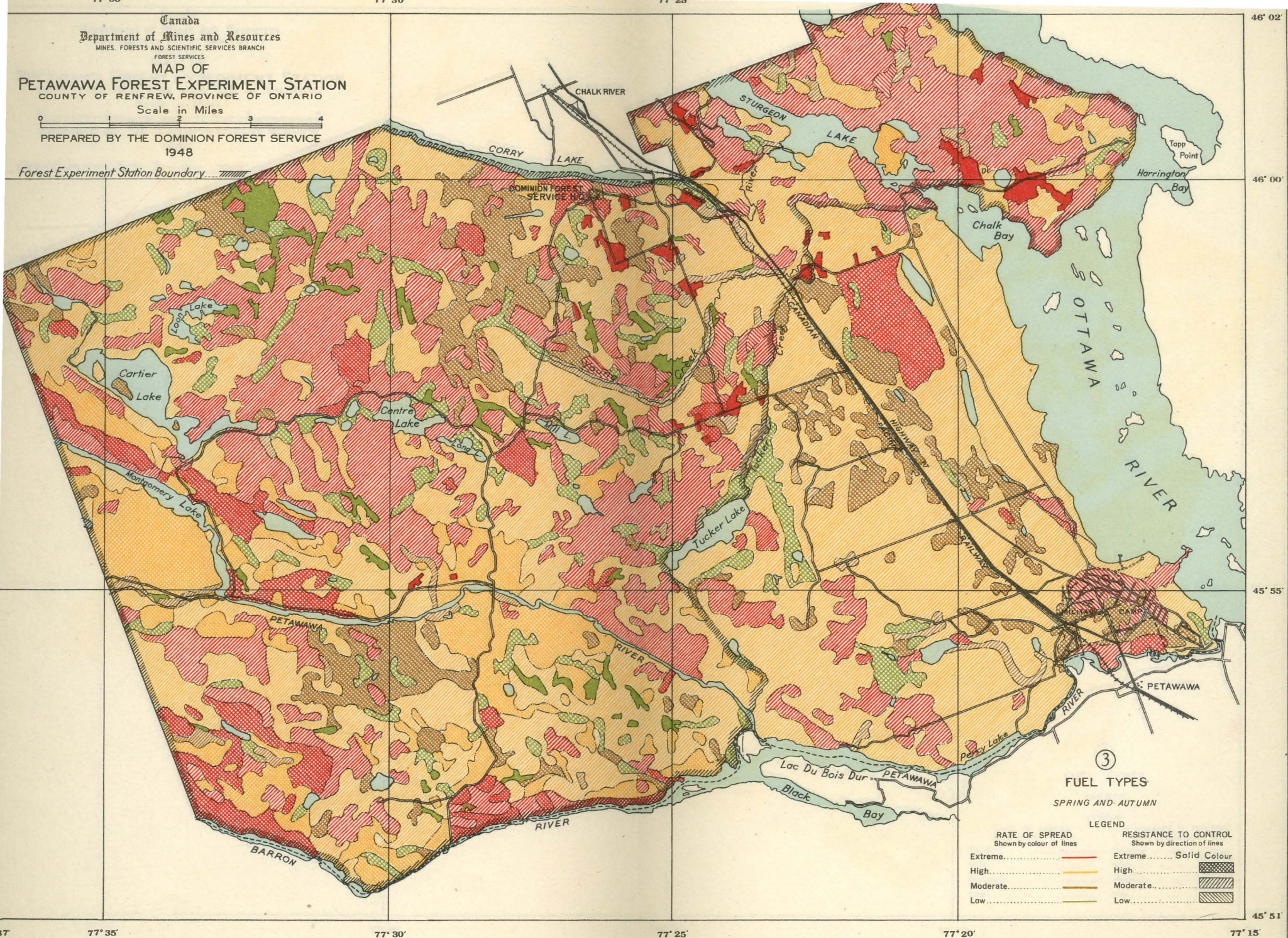
Scale in Miles

0 1 2 3 4

PREPARED BY THE DOMINION FOREST SERVICE

1948

Forest Experiment Station Boundary.....

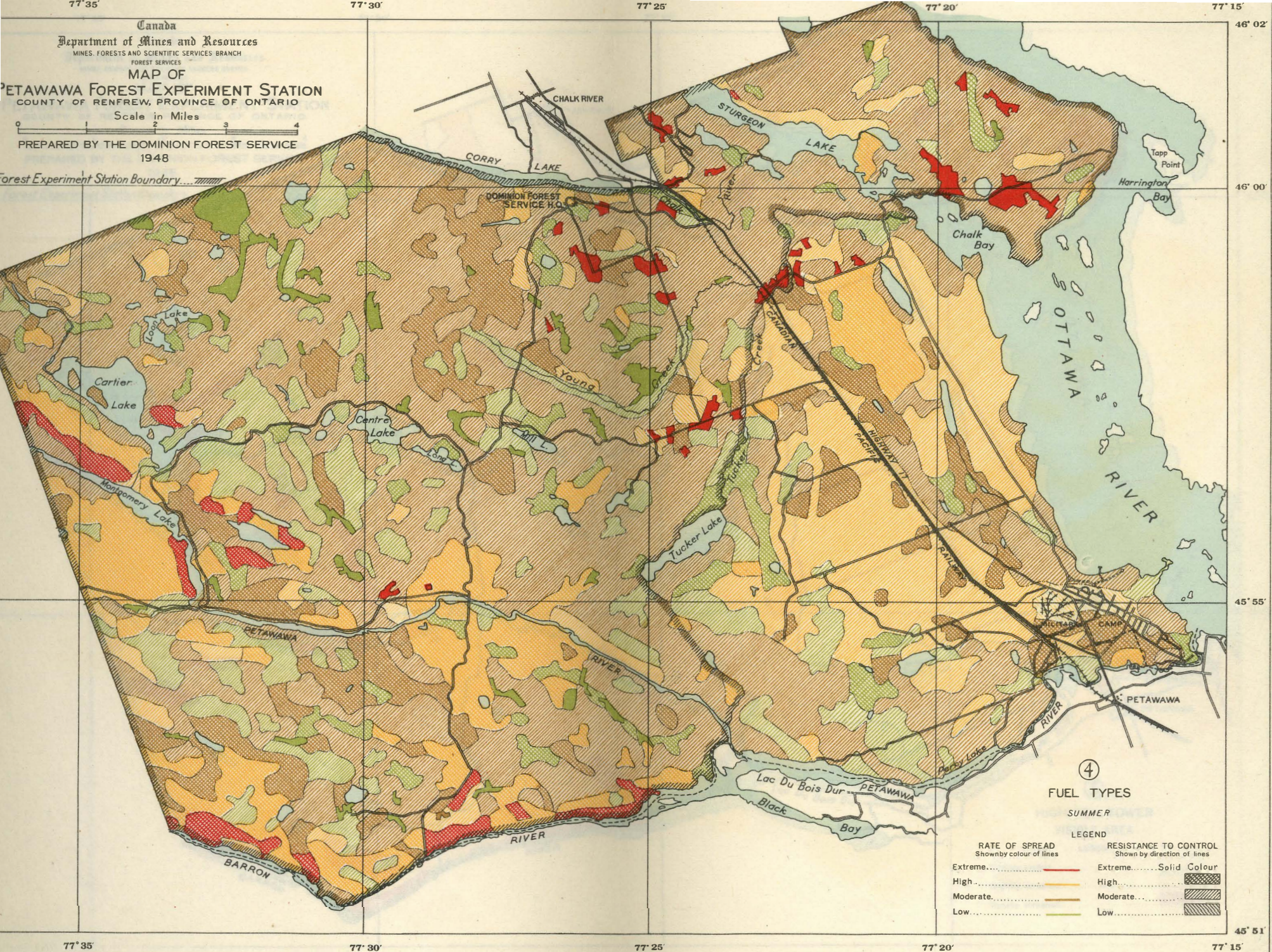


③

FUEL TYPES

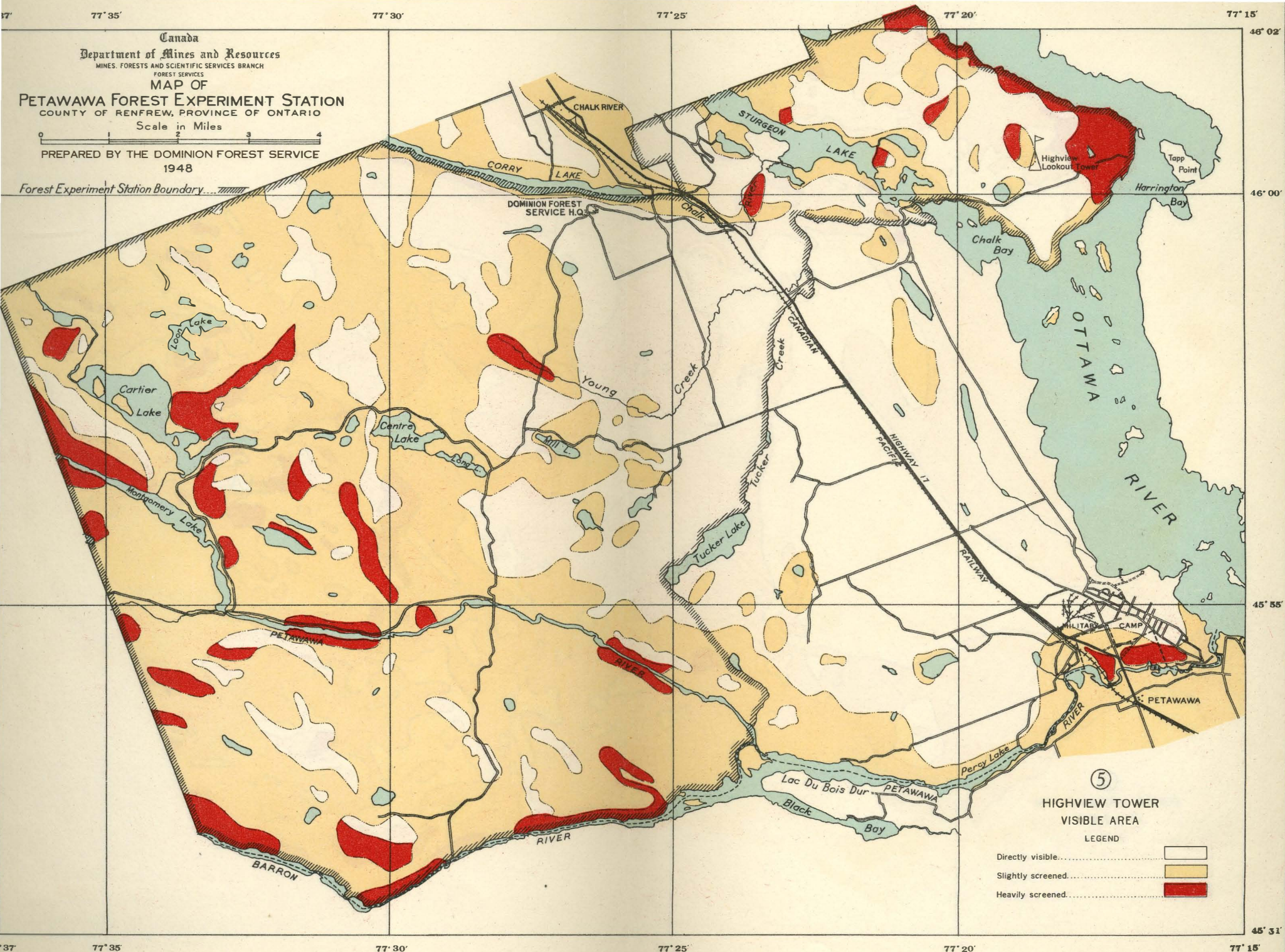
SPRING AND AUTUMN

LEGEND	
RATE OF SPREAD Shown by colour of lines	RESISTANCE TO CONTROL Shown by direction of lines
Extreme.....	Extreme..... Solid Colour
High.....	High.....
Moderate.....	Moderate.....
Low.....	Low.....



Canada
Department of Mines and Resources
MINES, FORESTS AND SCIENTIFIC SERVICES BRANCH
FOREST SERVICES
MAP OF
PETAWAWA FOREST EXPERIMENT STATION
COUNTY OF RENFREW, PROVINCE OF ONTARIO
Scale in Miles
PREPARED BY THE DOMINION FOREST SERVICE
1948

④
FUEL TYPES
SUMMER
LEGEND
RATE OF SPREAD
Shown by colour of lines
Extreme.....
High.....
Moderate.....
Low.....
RESISTANCE TO CONTROL
Shown by direction of lines
Extreme.....Solid Colour
High.....
Moderate.....
Low.....

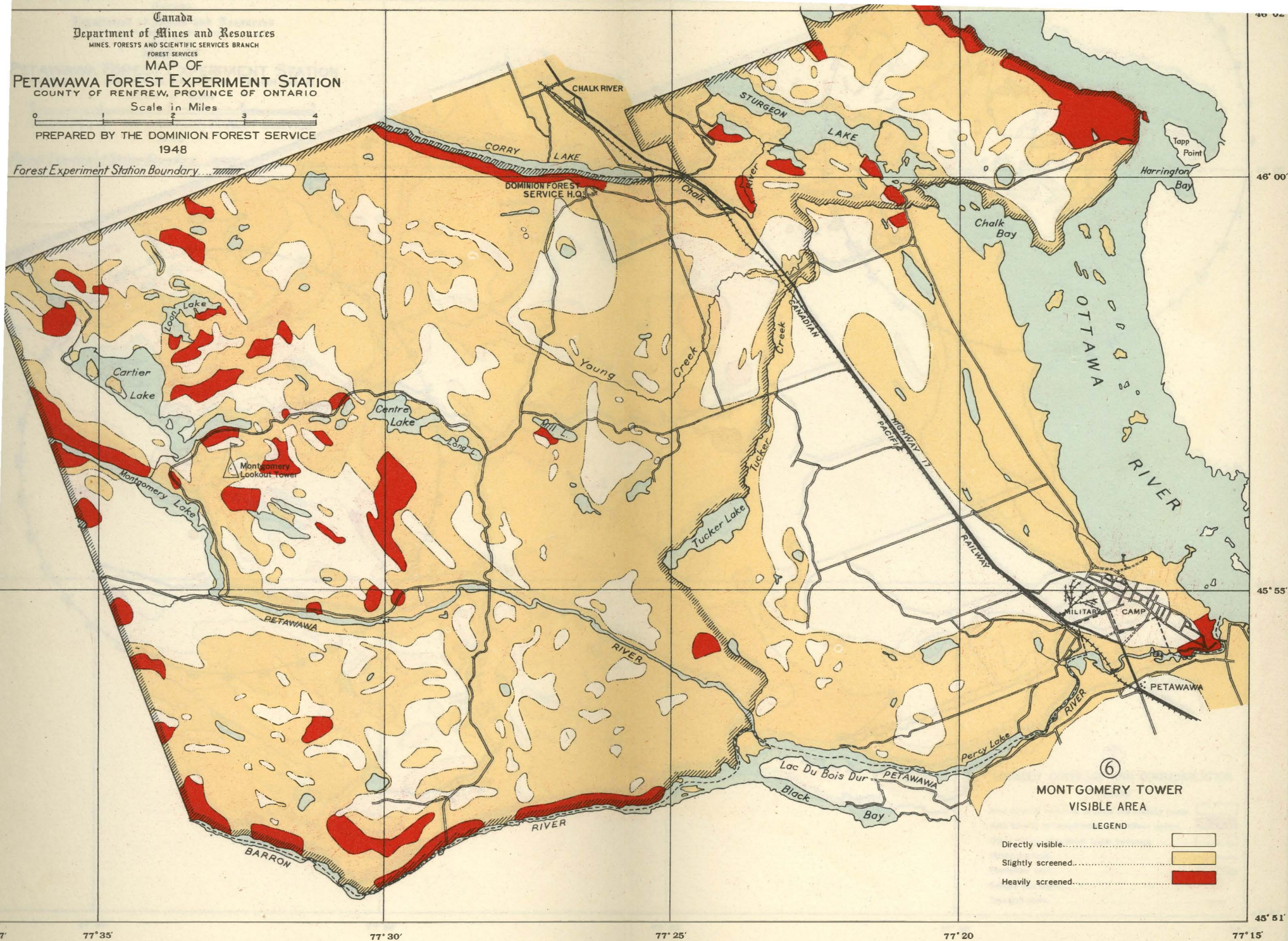


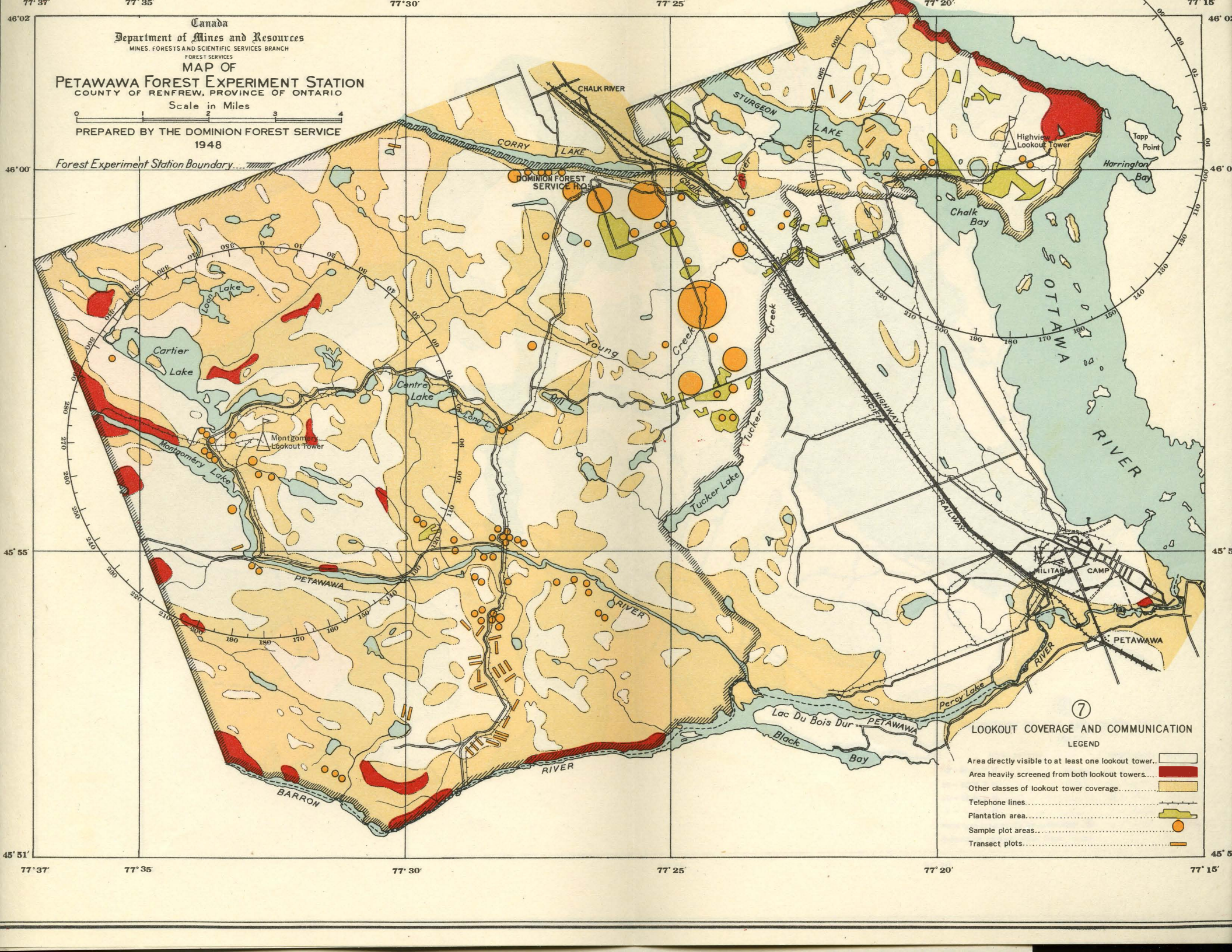
PETAWAWA FOREST EXPERIMENT STATION
COUNTY OF RENFREW, PROVINCE OF ONTARIO

Scale in Miles

PREPARED BY THE DOMINION FOREST SERVICE
1948

Forest Experiment Station Boundary



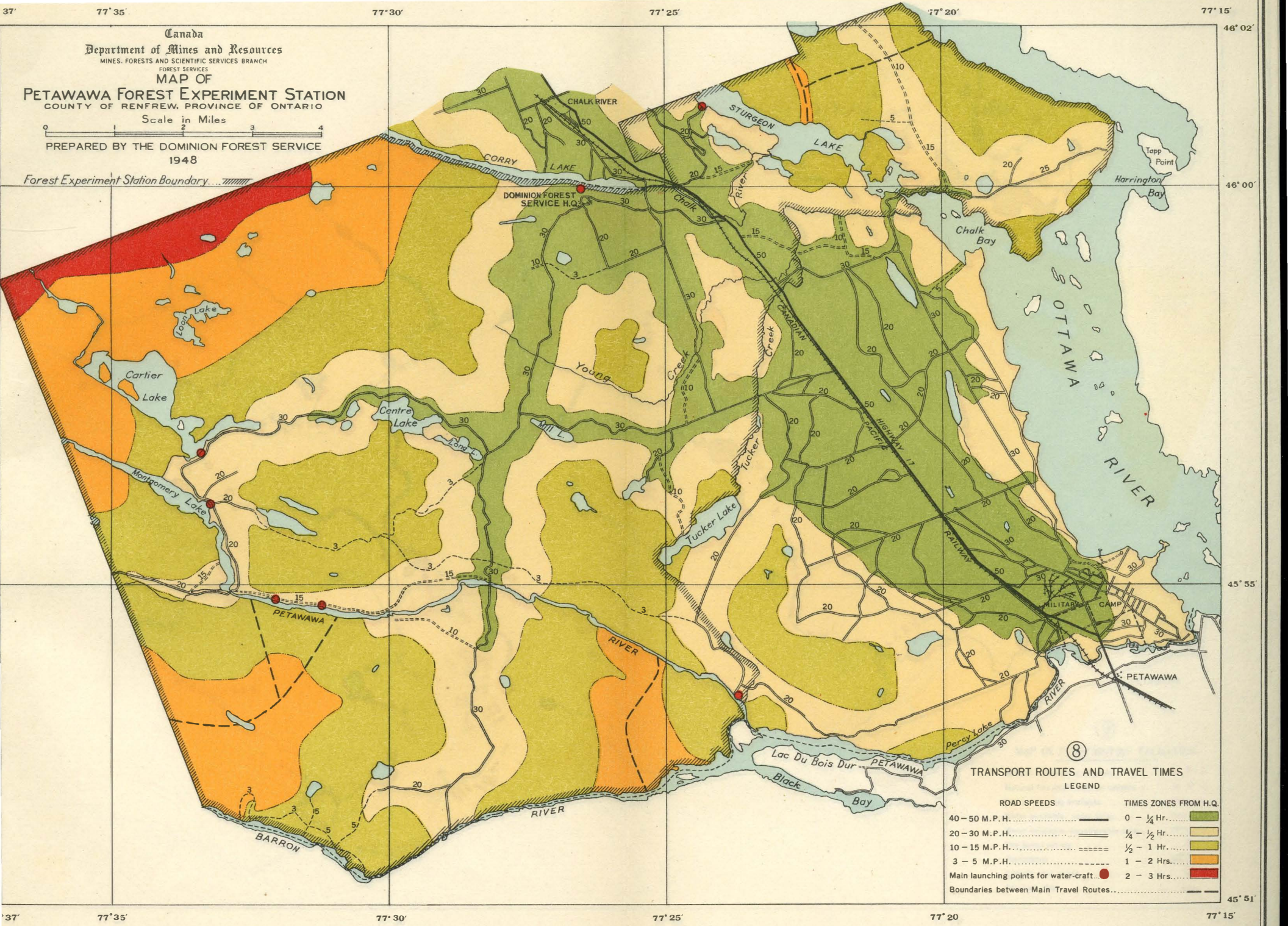


Canada
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FOREST SERVICES
MAP OF
PETAWAWA FOREST EXPERIMENT STATION
COUNTY OF RENFREW, PROVINCE OF ONTARIO
Scale in Miles
PREPARED BY THE DOMINION FOREST SERVICE
1948

Forest Experiment Station Boundary

⑦
LOOKOUT COVERAGE AND COMMUNICATION
LEGEND

- Area directly visible to at least one lookout tower.
- Area heavily screened from both lookout towers.
- Other classes of lookout tower coverage.
- Telephone lines.
- Plantation area.
- Sample plot areas.
- Transect plots.



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MAP OF
PETAWAWA FOREST EXPERIMENT STATION
COUNTY OF RENFREW, PROVINCE OF ONTARIO
Scale in Miles
PREPARED BY THE DOMINION FOREST SERVICE
1948

Forest Experiment Station Boundary.....

⑧
TRANSPORT ROUTES AND TRAVEL TIMES
LEGEND

ROAD SPEEDS		TIMES ZONES FROM H.Q.	
40 - 50 M.P.H.	————	0 - ¼ Hr.	Light Green
20 - 30 M.P.H.	———	¼ - ½ Hr.	Yellow
10 - 15 M.P.H.	=====	½ - 1 Hr.	Orange
3 - 5 M.P.H.	1 - 2 Hrs.	Dark Orange
Main launching points for water-craft. ●		2 - 3 Hrs.	Red
Boundaries between Main Travel Routes. ———			

