

**ESTABLISHMENT OF THE SPACING TRIAL
IN ARMILLARIA ROOT DISEASE-INFECTED STANDS
IN THE MERRITT FOREST DISTRICT**

by

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FOREWORD

This report is one of a series of internal reports distributed by Forest Protection Branch, B.C. Ministry of Forests, to record accomplishments and interim or provisional results for the information of staff, colleagues, and others.

In the Canada-British Columbia Forest Resources Development Agreement (FRDA) 1985 to 1990, over 100 pest control projects were directly funded by the province and administered by protection staff. To facilitate application of the results, and development of improved forest health management strategies, the contractors reports have been edited and distributed as internal reports. Accordingly, any opinions and recommendations expressed are those of the contractor, and not necessarily those of the ministry or the FRDA management committee.

For details or more information about the report or project, please contact forest health staff at Protection Branch or at the forest region offices.

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The guidelines for internal reports outlined in the Protection Manual were adhered to as closely as possible. All manuscripts were altered to comply with a common format, but entire reports were not rewritten to conform to a standardized outline.

Most Executive Summaries were the work of Graham Hawkins of MoF Inventory Branch (formerly with Pacific Coast Forest Biology). All word processing was accomplished by Catriona Kaufman of Top Kat Services. Will Gordon of R. White Woods inc. prepared all maps and figures.

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ABSTRACT

Two *Armillaria ostoyae*-infected stands in the Merritt Forest District were selected for a spacing trial. In each of the stands, three treatment areas were delineated. The treatments were: (1) control - no spacing; (2) space as normal; and (3) space removing *Armillaria*-infected trees and any trees within one metre of these. Ten 5.64m radius (100m²) permanent sample plots were established in each treatment area. Both stands had clearings scattered throughout. The mean density in the first site was approximately 1 763 stems/ha, and for the second site, 3 500 stems/ha. As the trees were generally present in thickets, the permanent sample plots were established in thickets. The density of stems in the plots ranged from 59 (5 900 stems/ha) to 278 (27 800 stems/ha). Site 1 had 14.6 percent of the trees infected with *Armillaria* and Site 2 had seven percent of the trees infected with *Armillaria*. The plots will be monitored over time to determine the spread of *Armillaria* in spaced and unspaced areas.

EXECUTIVE SUMMARY

The objective of the project was to establish a trial and demonstration area to show the effects of spacing to different densities in young stands of Douglas-fir infected with root disease.

Two stands in the Merritt Forest District were selected which had a high root disease incidence and were suitable for juvenile spacing or thinning operations. The sites were sufficiently far apart (3.7km) and were large enough for delineation of three treatment blocks. Treatment units were laid out and ten 5.64m radius (100m) permanent sample plots (PSP's) were established per treatment type on each site, for a total of 60 PSP's. Of these PSP's, two types were established: five plots per treatment unit with no root disease and five per treatment unit containing at least one infected tree. Data on tree growth, stocking, and infection status was obtained within these plots and stem maps were produced. Concurrently, a root disease survey was conducted in each area to determine pre-treatment disease levels and location for each site. General information was also obtained for the site and stand.

The initial survey determined that overall stocking was 1 760 stems/ha in the first site and 3 500 stems/ha in the second site, with density ranging from 5 900 to 27 800 stems/ha. *Armillaria* root disease levels were measured as 14.6% at Site 1 and 7% at Site 2. Other pathogens were not present to any significant extent. *Armillaria* was diffuse in distribution at Site 1, with infection occurring mainly as single trees, and was aggregated into distinct infection centres at Site 2. The following treatments were subsequently conducted in the winter of 1987-88: control (no spacing), spacing to normal standards, and spacing to normal standards plus removal of *Armillaria*-infected trees and any trees within a one-metre radius of infection sources. Trees greater than 15cm dbh or less than two metres in height were not removed unless infected. Douglas-fir was favoured over the other stand components.

The following recommendations were made for follow-up work on these sites:

- resurvey sample plots to map stems removed versus stems remaining after treatment;
- maintain each area and re-examine all plots regularly in order to assess post-treatment spread. This should be performed every one or two years.

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1 INTRODUCTION

1.1 Armillaria ostoyae

Armillaria ostoyae poses a serious problem in stands in the southern interior of British Columbia. This root disease fungus attacks and kills most conifers and some hardwood species. Trees of all ages are attacked. Losses to this pathogen can be severe. It is common in infected, disturbed stands to find *Armillaria* infection centres spreading from cut stumps (Roth *et al.* 1977). Cut stumps provide low vigour tissue on which *A. ostoyae* can gain a foot hold. Colonization of the stump continues over the next several years and a strong inoculum potential is built up. This strong potential allows the fungus to spread to and kill vigorous trees in the immediate area.

This phenomenon has been implicated in stands which have high *A. ostoyae* incidence and which have been selectively harvested (Roth *et al.* 1977). However, it is clear that not all stands which have been selectively harvested in the past are afflicted with severe *A. ostoyae* infection. It would appear that stands must be at risk to the disease at the time of harvest in order for the disease to intensify on cut stumps. In such stands the fungus may or may not be evident (in terms of expression of symptoms in crop trees). The fungus may, in fact, be restricted to distal portions of roots of healthy trees in the absence of nutrient sources such as stumps.

While this phenomenon has been well documented for stumps created by selected harvest procedures, it is not clear whether this will hold true for smaller stumps which are created by spacing procedures. Spacing in obviously infected stands is a highly questionable procedure. Further losses to the stand can be expected after spacing. Such future losses are very difficult to quantify. It is likely, however, that understocked portions of the stand will result. In some cases plantation failures have occurred in stands spaced without consideration of the root disease present. In such cases, in addition to the monetary loss associated with an understocked stand, there is the waste of funds expended in the spacing procedure. Even where plantation failure does not eventually occur, losses to root disease in spaced stands decrease the benefits which can be expected from the spacing procedure and make these stands poor candidates for spacing.

If these spacing stumps provide nutrient sources which allow a build-up of *A. ostoyae* inoculum potential, spacing may have dire consequences for stands in which the fungus is present. In fact, if spacing procedures cause a significant increase in root disease impact, they may have a net negative impact on the productivity of the stand. Creation of food source stumps may even result in the creation of *Armillaria* problems where they had not previously existed.

It has been suggested that in some cases removal of infected trees and those immediately surrounding them may in fact reduce the impact of *A. ostoyae* in the stand (Roth *et al.* 1977; Roth and Rolph 1978). Such "strategic spacing" relies on stumps being colonized by other fungi, thus preventing spread of *A. ostoyae* from the

infected tree stumps to adjacent ones. However, there is some question as to whether other fungi will colonize such stumps to the exclusion of *A. ostoyae*. Spacing stumps do not die immediately after spacing. Thus, there is a delay period during which saprophytes will not be able to colonize the stumps. As well, if *A. ostoyae* is present at low levels on the distal portions of roots, it will have a head start on the colonization of the stump. At any rate, *A. ostoyae* appears in many stands in the interior to be a strong saprophytic competitor. Thus, removal of infected trees and surrounding healthy trees may not reduce *A. ostoyae* levels significantly.

1.2 Objectives

In 1987, this project was initiated to clarify the effect of spacing procedures on *A. ostoyae* incidence in southern British Columbia. More specifically, three questions were addressed.

1. Does spacing exacerbate the spread of *Armillaria ostoyae* where the fungus is present and causing symptom expression?
2. Does spacing cause *A. ostoyae* losses in crop trees where the fungus was previously not in evidence?
3. Can strategic spacing to remove *A. ostoyae*-infected trees be used to reduce future losses to root disease in spaced stands?

The answers to these questions were deemed necessary to evaluate the advisability of spacing procedures on *A. ostoyae*-infected stands or in stands in infected areas. This study consisted of the establishment of permanent sample plots in two *A. ostoyae*-infected stands to study the effect of spacing on *A. ostoyae* establishment and spread.

2 METHODS

Two stands were selected in the Merritt Forest District in the Kamloops Forest Region. Both stands were near Nicola Lake, in the IDFj biogeoclimatic subzone (Figures 1 and 2). The kilometre values given on the maps are distances from the Monck Park turn-off. The stands were selected because they had *A. ostoyae* infection, Douglas-fir as the leading species, and were of appropriate age and density of spacing. Each stand was divided into three treatment areas of approximately equal size (Figures 3 and 4). The treatments for each site are presented in Table 1.

Within each treatment area ten 5.64m radius permanent sample plots were positioned. They were positioned in a subjective manner to ensure that they had sufficient stocking density to justify spacing and to determine their infection status. Two types of plots were selected:

1. no root disease symptoms present (five plots per treatment area); and
2. at least one *A. ostoyae*-infected tree (five plots per treatment area).

Within each plot, all trees were stem mapped. The species, height class and infection status of each tree were recorded. Size classes were defined in this study as: one to two metres; two to five metres; and greater than five metres. These classes were chosen to represent different risks and inoculum potentials of the trees for *A. ostoyae*. Infection status consisted of symptomatic, live infected and dead infected. Symptomatic trees showed chlorosis and shortened leaders. Live infected trees typically had resinosis, and upon examination had *A. ostoyae* fans beneath the bark at or near the root collar. Dead infected were dead trees which had mycelial fans in and under the bark at the root collar. In treatment two plots, all infected trees and all trees within one metre of infected trees were marked with spray paint at the ground and at breast height for removal at spacing.

The treatment areas were otherwise spaced normally. Spacing occurred in the winter of 1987-88. Douglas-fir was favoured. Trees less than two metres were not removed (except if they were infected in treatment two). Trees greater than 15cm diameter at breast height were similarly not removed unless infected in treatment two. The lodge-pole pine in Site 1 were commonly infected with dwarf mistletoe and *Atropellis* canker, hence the codominant pines were removed at spacing.

3 RESULTS

In Site 1, the pre-stand tending survey showed 1 760 stems/ha. Of these, 1 667 were Douglas-fir and 56 were yellow pine. The majority of these were less than 10cm in diameter. Site 2 was estimated at 3 500 stems/ha. Of these, 3 000 were Douglas-fir and 500 lodgepole pine. The majority of these were greater than one metre tall and less than five centimetres in diameter. The two sites had lots of clearings and thickets, hence the relative low overall stems per hectare.

The root disease survey completed on the two sites found that in Site 1 most of the infections occurred as single tree infection, and in Site 2 most infections occurred as centres. Site 1 had 14.6% of the trees infected, while Site 2 had seven percent of the treed area in infection centres.

A stem map was drawn for each permanent sample plot. (A complete set of maps is with the original report, MoF Forest Health Section, Protection Branch, Victoria.) The individual plots varied in tree density from 59 trees (5 900 stems/ ha) to 278 trees (27 800 stems/ha). Half of the plots were located to include visible and active *A. ostoyae* infection. The remaining half had no visible *A. ostoyae* infection.

4 RECOMMENDATIONS

The sample plots in treatment areas 1 and 2 should be resurveyed and mapped in the summer or fall of 1988 to ensure an accurate representation of the trees removed from the plot during spacing. As well, it is necessary that the plots be maintained and tidied up after the spacing procedure to ensure that they are not lost over the next few years.

Re-examination of all plots in all treatment areas will be necessary to assess the infection status of trees present and map the spread of *Armillaria* within them. This should be done every year or at least every two years.

5 REFERENCES

- Roth, L.F., C.G. Shaw and L. Rolph. 1977. Marking ponderosa pine to combine commercial thinning and control of *Armillaria* root rot. J. For. Oct. 1977: 644-647.
- Roth, L.F., and L. Rolph. 1978. Marking guides to reduce *Armillaria* root rot in ponderosa pine are effective. For. Sci. 24(4): 451-454.

TABLE 1 THE TREATMENTS PERFORMED AT EACH SITE

	Site 1	Site 2
Control	- no spacing	- no spacing
Treatment 1	<ul style="list-style-type: none"> - space normally - except remove codominant pines (infected with dwarf mistletoe) 	- space normally
Treatment 2	<ul style="list-style-type: none"> - space as for Treatment 1; as well - remove all yellow (chlorotic) red and dead trees, including those > 15cm dbh and < 2m - space as for Treatment 1; as well - remove all trees within 1m of all infected trees 	<ul style="list-style-type: none"> - space as for Treatment 1, and - remove infected trees as for Site 1, Treatment 2

FIGURE 1 **LOCATION OF SITE 1**

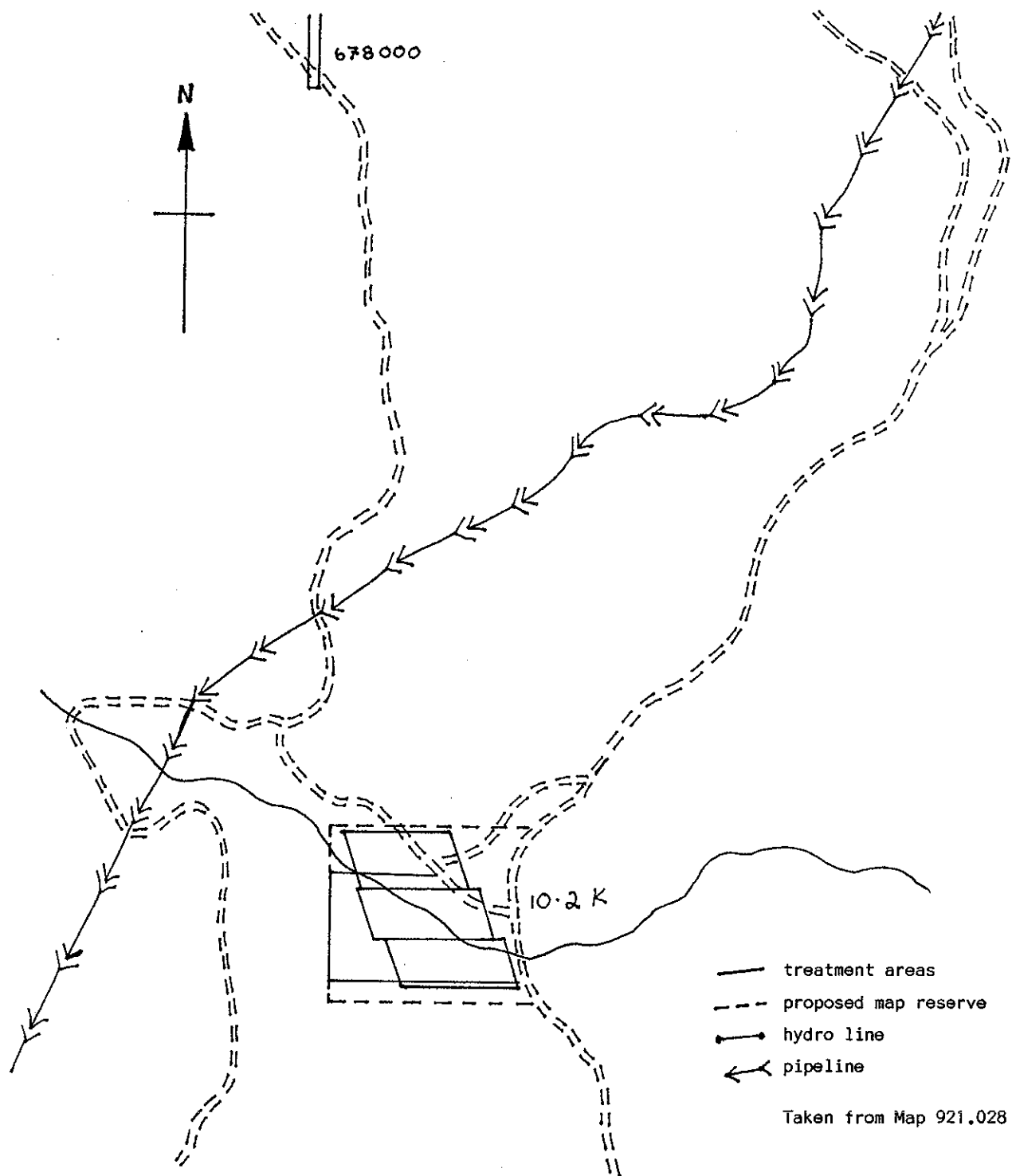


FIGURE 2 **LOCATION OF SITE 2**

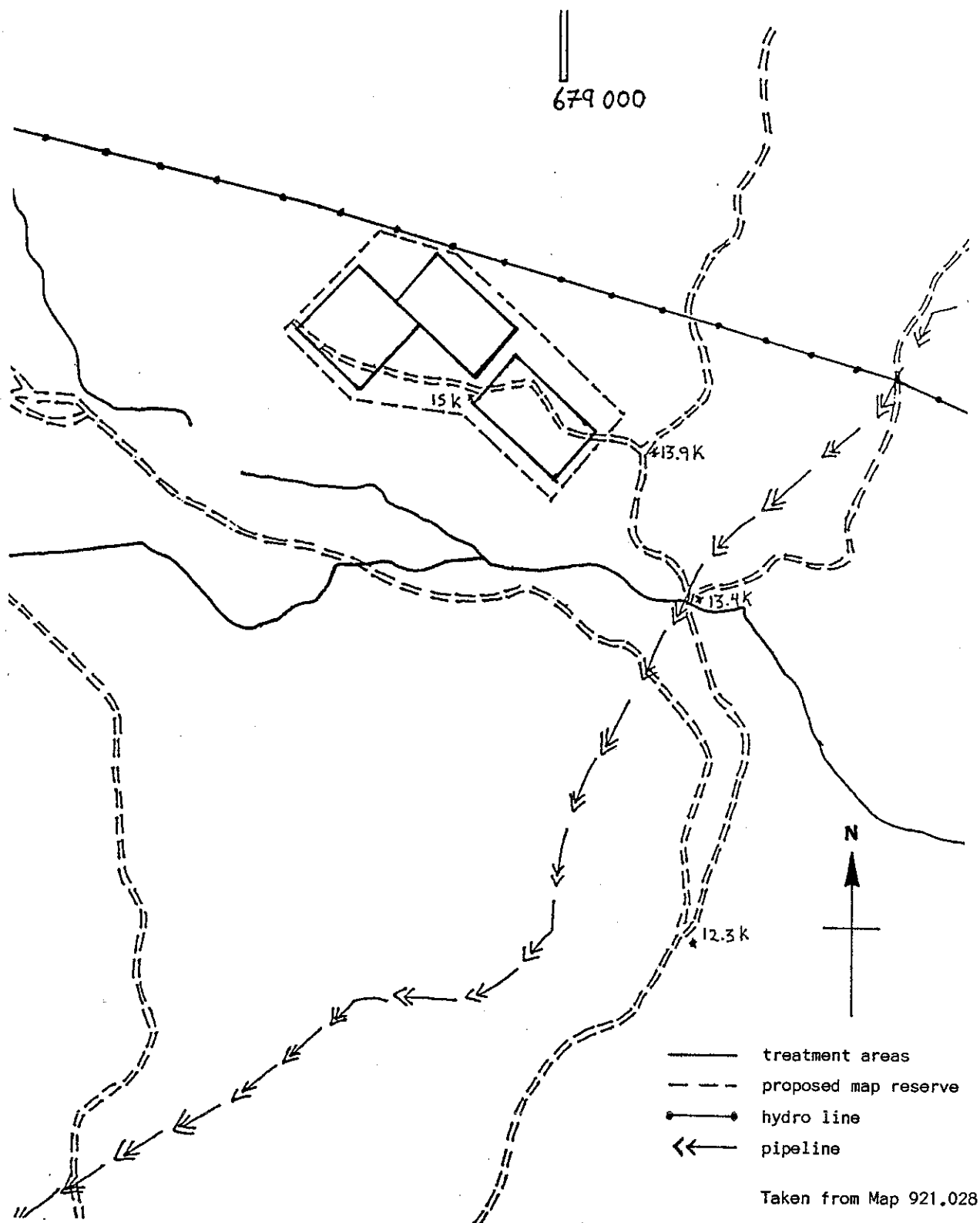


FIGURE 3 LOCATION OF TREATMENTS IN SITE 1

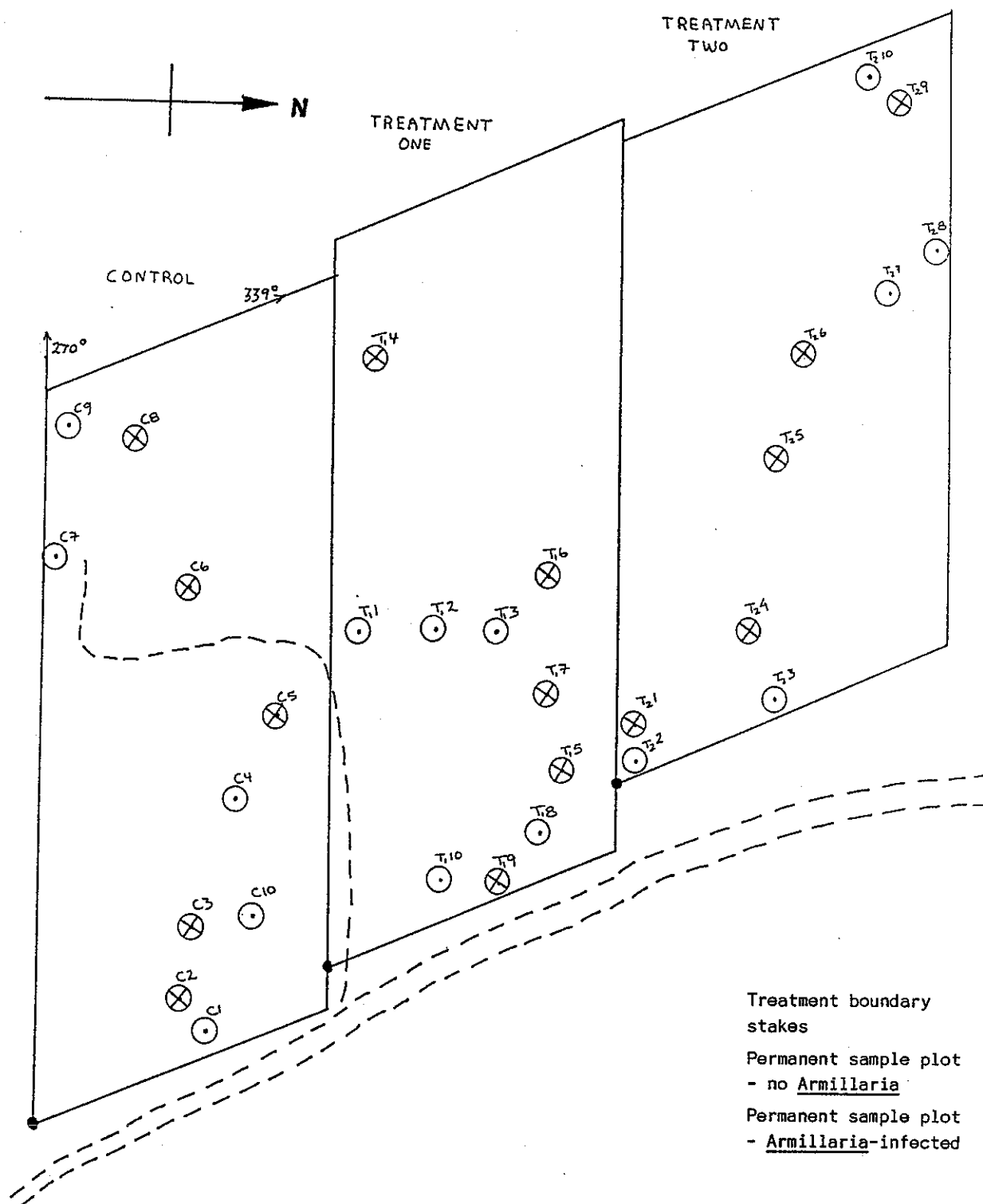


FIGURE 4 LOCATION OF TREATMENTS IN SITE 2

