ESTABLISHMENT OF INGERSOLL CREEK WESTERN WHITE PINE DEMONSTRATION AREA

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.

R. White, editor
R. White Woods inc.

EXECUTIVE SUMMARY

An area containing one known blister rust resistant (bark reaction) western white pine was intensively surveyed using survey strips at 20m intervals. The stand consisted of young (23-year-old) mixed species where western white pine made up 20% of the component. A total of 683 white pine were subsequently examined for blister rust incidence and possible resistance. Of these trees, 31% were infected, 9% were dead and 60% were healthy. Six additional bark reaction trees were located and recorded within the stand immediately surrounding the previously identified blister rust resistant tree.

These individuals were considered to possibly be the offspring of a single parent (veteran) tree in the vicinity. The basal cankers of bark reaction trees varied in activity and all had inactive looking patches of sunken bark along the canker margins. The typical diamond-shaped yellow-orange margins seen in aggressive, girdling attacks were absent. Western white pine individuals which can outgrow stem cankers have an important resistance mechanism since the rust can still complete its life cycle, thus reducing selection pressures for new and more virulent races.

The following recommendations were made for intensive management of this area as a result of this project. Establishment of the area as a western white pine breeding source should be given high priority, along with continual monitoring. All other species should be removed to leave a stand of pure white pine in order to help identify other possible blister rust resistant candidates to produce highly resistant seed orchard stock for very high risk areas. These individuals should also be pot-grafted and planted in order to start a clone bank for blister rust resistant material to be used in future breeding work.

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1 INTRODUCTION

Western white pine (*Pinus monticola*) has several defense mechanisms to ward off attack by blister rust (*Cronartium ribicola*). Several appear to be inherited as single genes and result in the elimination of the rust. Others are more complex in their action, conferring a more tolerant type of reaction involving multiple genes. One such mechanism is a bark reaction. After the fungus reaches the stem, a series of reactions can occur that, depending on individual and family, result in the death or substantial curtailment of the fungus. The effectiveness of the resistance depends on two separate reactions:

1. the ability of a seedling to initiate a necrotic response in the cortex after invasion by the rust;

2. the ability of a seedling to rapidly produce a strong wound-periderm.

On July 4, 1986 a white pine parent tree (No. 9094) was selected by Rod Martin Tree Improvement for Westar Timber Ltd. adjacent to a proposed demonstration area that exhibited both a necrotic and wound-periderm response to blister rust. A subsequent field examination by Dr. Richard Hunt (Forestry Canada, Victoria) and the Nelson Region protection section, confirmed the find.

The purpose of this study is twofold. First, to carry out field reconnaissance in the stand surrounding parent tree No. 9094 for location of additional white pine trees exhibiting bark reactions. Second, upon finding additional rust resistant genotypes, to conduct on-site blister rust incidence and pre-stand tending surveys for development of a management plan to maintain and preserve valuable white pine genotypes.

2 CONCLUSIONS

The stand surrounding parent Tree No. 9094 is a 23-year-old naturally regenerated, mixed stand in the biogeoclimatic zone ICHa1, ecotype 4C. Extending south from tree No. 9094, six additional trees with varying degrees of necrotic bark reaction were located in two distinct areas (Figure 1). Of the six trees age 23 years, all had basal cankers within 25cm of ground level with 25-50% of the circumference of the tree taken up by the canker. The basal cankers varied in activity as denoted by pitchiness and all exhibited inactive-looking patches of sunken bark along the canker. The basal cankers varied in activity, as denoted by pitchiness, and all exhibited inactive-looking patches of sunken bark along the canker margins. The necrotic patches revealed dead tissue beside living tissue, with a sharp boundary between. In all cases fungus inactivity was detectable with only minute spotty yellow-orange colouration. None of the trees displayed the typical diamond shaped yellow-orange margin.

A total of 683 white pine trees were examined for the blister rust incidence survey. Healthy, infected and dead trees are shown in Table 1. Table 2 shows extent of damage by the most damaging canker on the 215 trees. There were 258 cankers on 215 trees giving an infection rate of 1.2 cankers/tree.

There were 124 stems on 26 plots yielding 9 540 stems/ha (Table 3). The white pine component was 21% or 2 000 stems/ha. Sixty percent or 1 200 stems/ha of the white are canker-free, with the remaining 40% infected or dead. Fifty percent of the white pine component is at or near cone-bearing age.

3 RECOMMENDATIONS

Based on stand parameters and the identification of six bark reaction trees, I recommend approximately 1.5ha to be set aside and managed as a white pine training and demonstration area. Data from the pre-stand tending survey indicated this area contained the greatest white pine component and encompassed five of the six bark reaction trees plus the canker-free white pine veteran. Stand boundaries have been painted blue and all bark reaction trees have been monumented in the field and catalogued in Table 4.

Initial activities should be to space the stand removing all species other than white pine. Slash material should be manually cut, piled and burned in the nearest available opening. This treatment would leave roughly 2 000 stems/ha and would help identify other bark reaction candidates, promote flower production and cross pollination of more desirable genotypes. The stand is at or near cone bearing age necessitating treatment within the next several field seasons to maximize benefits. Opening of the stand may increase selection pressure by greater air turbulence facilitating the long range spread of rust sporidia. This would be advantageous by infecting more trees and increasing the chances of exposing more bark reactions. The planting of additional *Ribes* species in openings created by spacing would also expedite the selection pressure.

For the six bark reaction trees and Tree No. 9094 cultural treatments should be conducted yearly to promote vigour and cone production as the basis of establishing an advanced generation breeding program which could be incorporated into the Forestry Canada program. Cultural treatments would involve the clearing of all competing vegetation two metres beyond the drip line and fertilization of each candidate tree.

Once candidates are into flower production, a mating design of controlled breeding could occur, combining the genes of similar and different resistance types (e.g., by crossing the six bark reaction candidates with one another). These bark reaction individuals would also be crossed with individuals with fungicidal short shoot resistance or needle shed resistance from pollen obtained from the United States Forest Service (USFS). Rod Martin Tree Improvement has previously obtained pollen from the USFS and performed similar work for Westar Timber in 1983-84. The purpose of these controlled crosses is to generate highly resistant seed orchard stock for the production of seed for extremely high risk areas.

Presently Tree No. 9094 has been producing cones, and would be receptive to control pollination in spring of 1987. The other bark reaction trees (1-6) have not produced any cones to date and need cultural treatments.
Since western white pine can be grafted with relative ease, it is recommended that the six bark reaction candidates be pot grafted and planted at the Ministry of Forests

Kalamalka Research Station in Vernon and used as the start of a clone bank for rust resistant material for future breeding work. Rod Martin Tree Improvement has performed white pine grafting for the USFS in Idaho in past years and will have three-year-old root stock available in the spring of 1988.

Canker studies should be initiated in 1987 to monitor canker growth or inactivity (vertical and horizontal) on the six bark reaction candidates and any other abnormal cankers within the stand. Yearly photographs of canker development would visually put the numerical measurements into perspective.

Other small research projects to be considered for inclusion in the demonstration area would be a canker excising trial, a pruning trial amongst planted *Ribes* and fill-in planting of resistant genotypes from Westar's tree improvement program.

From an operational standpoint the area could be used as a small natural seed production area complementing the Harris Road natural seed production area at the north end of the ICHa2 biogeoclimatic zone. This site is well suited and observed bark reaction mechanisms substantiates that varying resistance exists in the stand. The stand is near cone bearing age and trees could be collected by climbing. The site is flat on moderately productive well drained soils (ICHa1,4C) and access can be obtained three-quarters of the way around the block with minimal brushing of the existing road. The site is within one hour driving time from a cone storage facility at Nakusp. Seed from the healthy or slow canker growth trees would be advantageous to reforestation until such time that better resistant stock can be produced.

4 MATERIALS AND METHODS

An inspection of the stand surrounding Tree No. 9094 determined that the white pine component increased as one progressed south toward the junction of Branch 7 and Whatshan Road. There were few western white pine stems to the north of Tree No. 9094. Therefore, starting at Tree No. 9094 a detailed inspection of all cankered white pine in an expanding spiral to the south was conducted for possible bark reactions.

The blister rust incidence survey was comprised of 12 parallel survey strips at 20m intervals running due west through the stand using Whatshan Road and Branch 7 as the predetermined baselines for the area to be surveyed (Figure 3). Using the "nearest neighbour" technique, all white pine trees along the cardinal direction for each strip were examined for the presence of blister rust infection and possible bark reactions. Rust-free trees were tallied as healthy. For diseased trees, the type of canker and the extent of the damage were recorded according to the following categories:

Type of Canker	**Extent of Canker**
Branch canker	within 35cm of bole (Lethal)
Branch canker	beyond 35cm of bole (Non-lethal)
Bole canker	less than 1/4 around the bole
Bole canker	1/4 to 1/2 around the bole
Bole canker	1/2 to 3/4 around the bole
Bole canker	more than 3/4 around the bole

Dead white pine, both standing and fallen were tallied to determine the total mortality since stand establishment.

Pre-stand tending survey data was summarized from 26 plots (1.26m radius) taken on the 12 parallel survey strips with plot intervals every 20m.

5 DISCUSSION

The most significant finding in this survey was the discovery of six additional bark reaction trees within the immediate stand surrounding Tree No. 9094. The close proximity of bark reaction tree No. 6 to No. 9094 leads one to speculate that these two trees may have originated from the same parent. Conversely, bark reaction trees No. 1-5 are 200m from No. 9094, and are probably of a different origin. One can speculate that the canker-free white pine veteran may be the parent of the five progeny exhibiting the bark reactions (Figure 1). A follow-up rust inoculation of progeny from seed collected from the white pine veteran would help to verify this assumption. Multiple genotypes exhibiting bark reactions spread throughout the stand would allow broader flexibility in management options for a demonstration area and complement the C.F.S. white pine breeding program.

White pine trees that are able to remain alive even though cankered exhibit an important resistance mechanism which permits the fungus to continue its life cycle, thus decreasing selection pressures for new races (Hoff 1982). This trait should be one of the priority mechanisms selected for and incorporated into the Forestry Canada breeding program. These horizontal resistance mechanisms (necrotic response to fungus) could be control-bred with one another and other vertical resistant immunities (obtained from the USFS) and the progeny incorporated into the Forestry Canada program.

The naturally regenerated white pine stand within the demonstration area has a blister rust infection rate of 40% since establishment (Tables 1 and 2). Presently, 31% of the living white pine is infected with blister rust, occurring primarily on the limbs (62%). Fewer cankers were detected on the bole of the tree (38%). This implies that continued selection pressure is occurring and that "expected" mortality of white pine will increase over an extended period of time, though offset to some extend, by the genotypes exhibiting bark reactions. Assuming all present lethal cankered trees would die (488/ha), the stocking of healthy white pine would exceed 1 800 stems/ha. If all other species were removed from the stand, a sufficient number of healthy white pine would be left to maintain stand stocking. Further monitoring of the stand may discover more trees exhibiting bark reactions.

6 REFERENCES

Hoff, R.J. 1982. Horizontal resistance. In Proceedings of servicewide genetics workshop on breeding insect and disease resistant forest trees. U.S. Department of Agriculture, Forest Service. Washington, DC, U.S.A. pp. 292-299.

TABLE 1 TREE STATUS

Tree Status	Number	Percent	
Healthy	410	60%	Healthy
Infected	215	31%	Infected
Dead	58	9%	Dead

TABLE 2 EXTENT OF DAMAGE

	Number	Percent
Branch Canker only - beyond 35 cm	83	39%
Branch Canker only - within 35 cm	50	23%
Bole Canker less than 1/4 around	18	8%
Bole Canker 1/4 to 1/2 around	21	10%
Bole Canker 1/2 to 3/4 around	37	17%
Bole Canker greater than 3/4 around	6	3%

TABLE 3 STAND TENDING SURVEY SUMMARY

SPECIES	DIAMETER CLASSES (CM)									
	0	2	4	6	8	10	12	14	16	Σ
Pw	2	8	4	4	1	2	2	1	2	26
Hw	18	26	2	2	1	1	-	-	1	51
Cw	2	12	2	2	2	-	1	-	-	21
Fdi	2	8	2	2	-	1	1	-	-	16
S	-	1	1	-	-	1	-	-	1	4
Pl	-	-	-	-	-	1	-	-	-	1
Act	1	1	-	-	-	-	-	-	-	2
Ex	-	1	2	-	-	-	-	-	-	3
Σ	25	57	13	10	4	6	4	1	4	124

124 stems in 26 plots = 4.77 stems/plot or 9540 stems/ha

(A) **STAND COMPOSITION**

Pw	21%	2 003	stems/ha
Hw	13%	1 240	stems/ha
Cw	41%	3 911	stems/ha
Fdi	17%	1 621	stems/ha
S	3%	286	stems/ha
Pl	1%	95	stems/ha
Act	2%	191	stems/ha
Ex	2%	191	stems/ha

(B) 50% of white pine component is at or near cone bearing age

Average Age	= 23 years
Average Mtn	= 6.5cm
Mean Diameter	= 7.0cm
Average % Live Crown	= 80%

TABLE 4 ACCESS TO BARK REACTION TREES

Key Starting Point:	White Pine Veteran: From junction of Branch 7 and Whatshan Road, go South on Branch 7 - 80m to Tie Point (11cm birch), East side of road. White pine veteran is due West 45m. Tree specs: Age - 115 years, Height - 25m, Diameter - 33.9cm.
Bark Reaction Tree No. 1:	From white pine veteran candidate tree is 17m, 172°. Tree specs: 23 years, 8.5m height, 8.8cm diameter. Canker activity: 1/4 to 1/2 basal canker, vertical canker growth curtailed, spotty marginal rust activity, light pitching, three inactive limb cankers.
Bark Reaction Tree No. 2:	From white pine veteran candidate tree is 32m, 228°. Tree specs: 23 years, 6.8m height, 5.5cm diameter. Canker activity: 1/4 bole canker at 25cm, spotty marginal rust activity, no other cankers, little pitching.
Bark Reaction Tree No. 3:	From white pine veteran candidate tree is 31m, 240°. Tree specs: 23 years, 9.1m height, 10cm diameter. Canker activity: 1/2 bole canker at base, vertical rust activity curtailed, spotty marginal rust activity, no other cankers, moderate pitching.
Bark Reaction Tree No. 4:	From white pine veteran candidate tree is 20m, 306°. Tree specs: 23 years, 7.7m height, 8cm diameter. Canker activity: at base 1/4 bole canker, vertical rust activity curtailed. Spotty marginal activity, light pitching.
Bark Reaction Tree No. 5:	From white pine veteran candidate tree is 10m, 344°. Tree specs: 21 years, 6.3m height, 7.5cm diameter. Canker activity: at base 1/4 to 1/2 bole canker, vertical activity curtailed, spotty marginal activity, moderate pitching.
Bark Reaction Tree No. 6:	From junction of Branch 7 and Whatshan Road go North on Whatshan Road - 140m to Tie Point (5cm birch), West side of road. Candidate tree is 30m, S88W.
Bark Reaction Tree No. 9094:	From junction of Branch 7 and Whatshan Road go North on Whatshan Road - 140m to Tie Point (5cm birch), West side of road. Candidate tree is 20m, S78W.

FIGURE 1 BARK REACTION TREE LOCATIONS

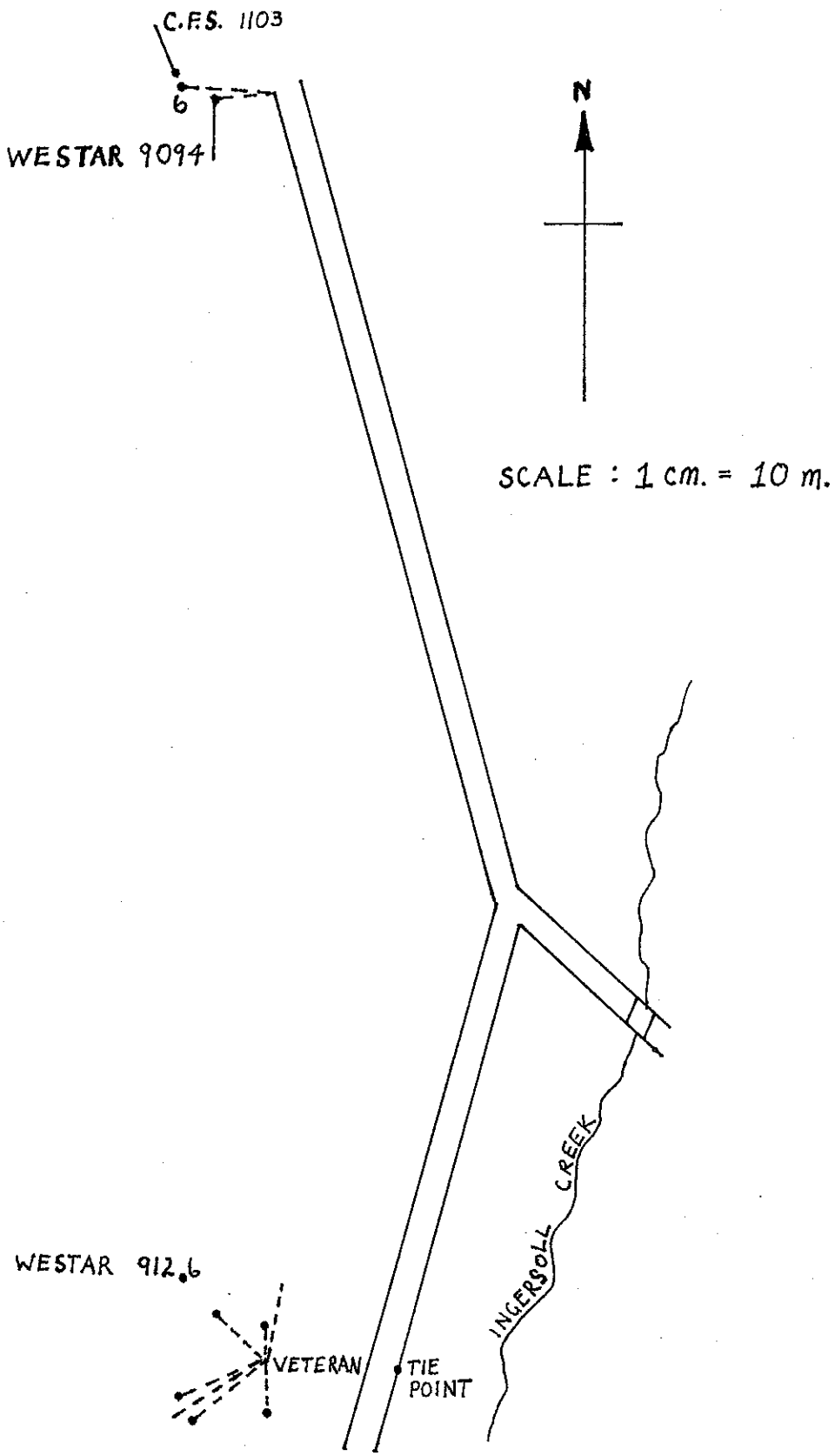

FIGURE 2 ACCESS TO DEMONSTRATION AREA

INGERSOLL CREEK WHITE PINE DEMONSTRATION AREA
(LAT. 118°05.2'N LONG. 50°01'W)

From the West side of Arrow Park Ferry (12km South of Nakusp on Hwy. 6) go 7.7km on Lower Mosquito Road; then left on Stevens Road for 11.5km; then left on Whatshan Road for 9km to junction of Branch 7 and Whatshan Road. This is the NW corner of proposed demonstration area.
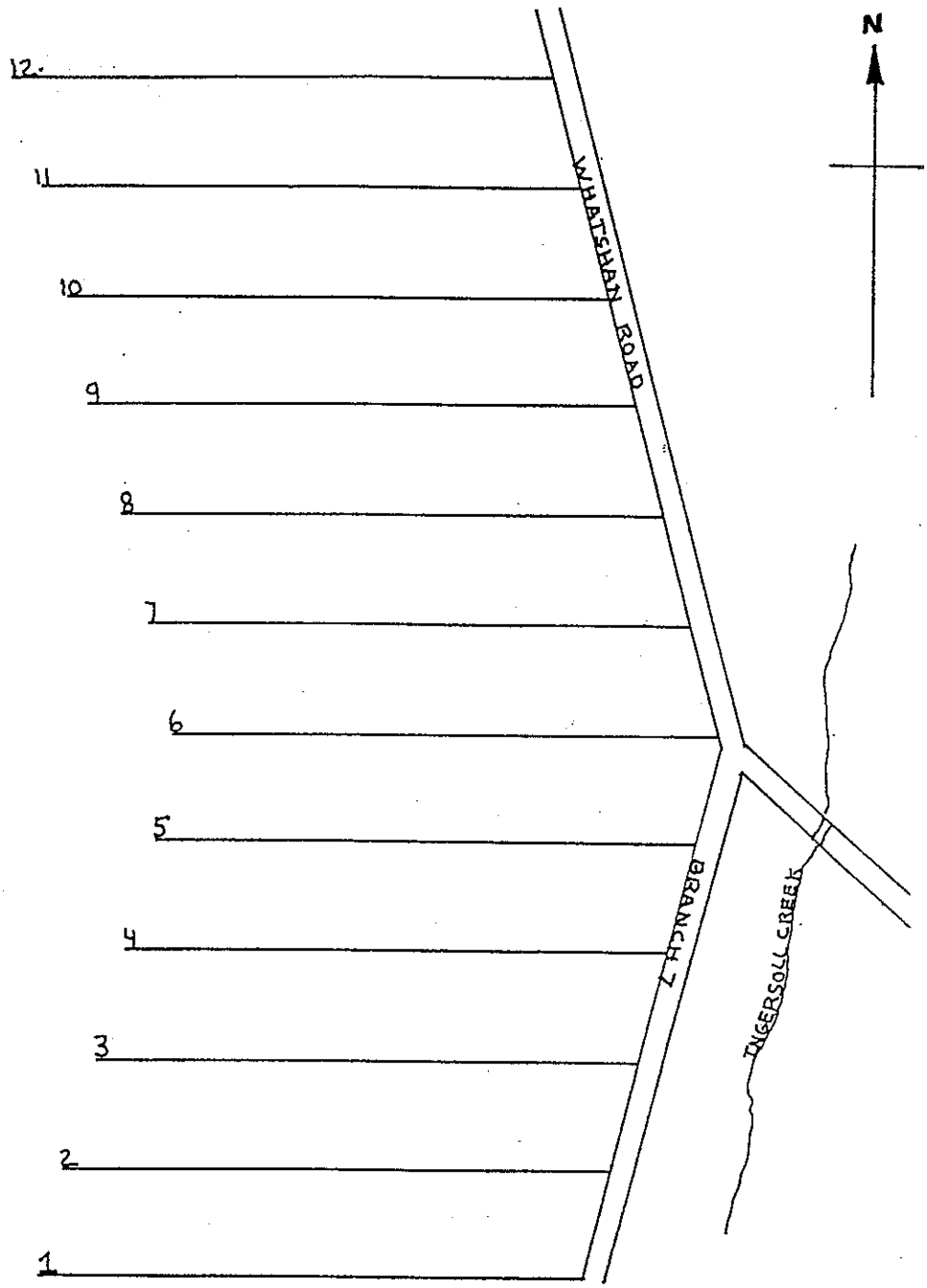
FIGURE 3 STAND TENDING SURVEY MAP