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ROBSON BIGHT ECOLOGICAL RESERVE #111

EVALUATION OF POTENTIAL IMPACTS

- SOUTHWESTERN BOUNDARY -

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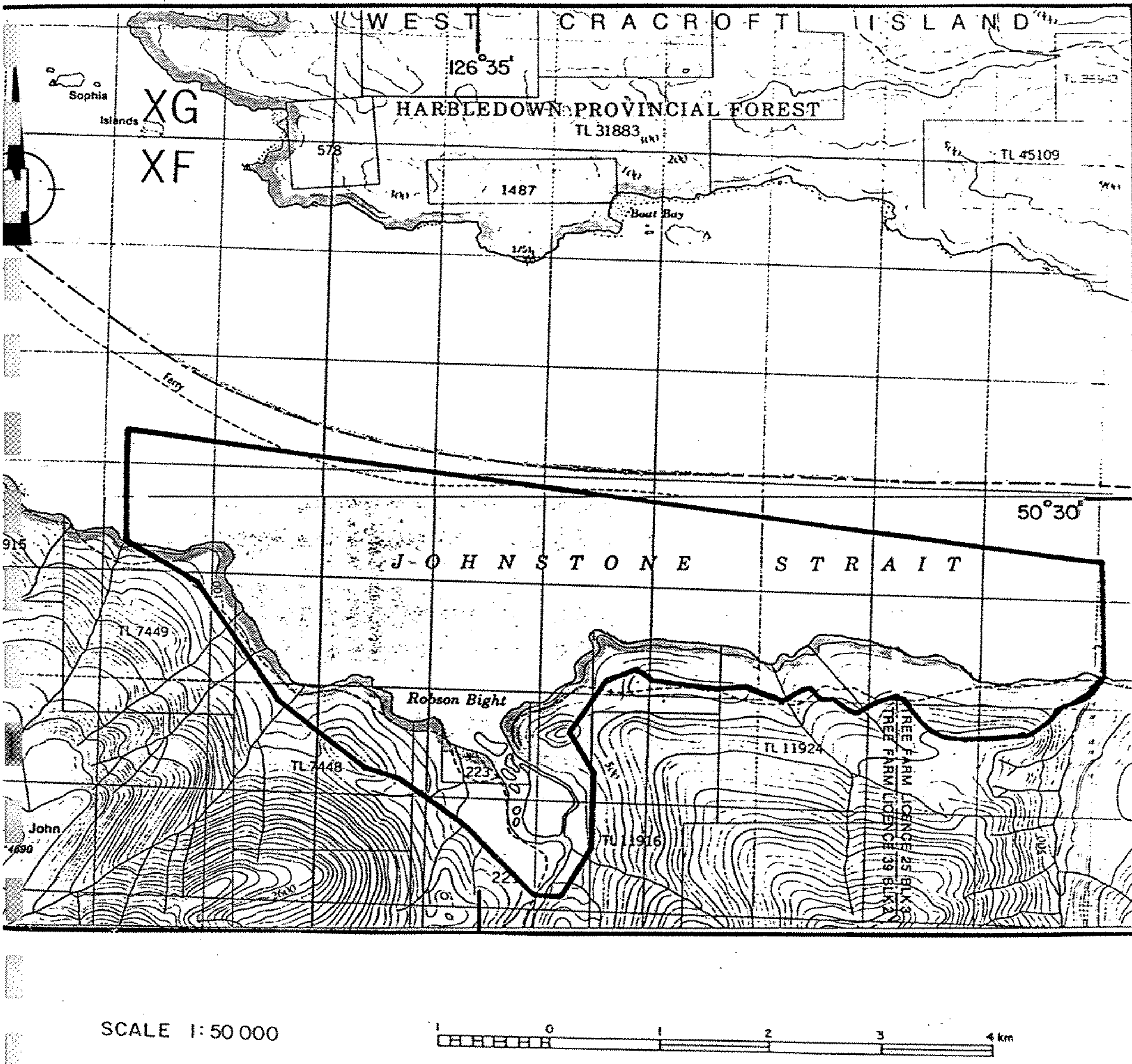

SCALE 1:50 000

N.T.S. No. 92 L/7,10E

ECOLOGICAL RESERVE No. III
ROBSON BIGHT

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EVALUATION OF POTENTIAL IMPACTS

- SOUTHWESTERN BOUNDARY -

1.0 INTRODUCTION

Concern has been expressed regarding the long-term viability of the upland portion of the Robson Bight Ecological Reserve #111, which is perceived primarily as a buffer between inland forest management activities and the marine portion of the Reserve and its killer whale habitats. Consequently, the objective of this evaluation is an, "assessment of the long-term potential for detrimental impacts of exposing the southern edge of the reserve to clearcuts". The main focus is, "on the potential for blowdown, but obvious potential for other damaging impacts such as erosion, mass movement, and sedimentation should be pointed out."

2.0 METHODS

The assessment is based on a review of pertinent existing information and 3.5 days of fieldwork.

Existing information reviewed and considered includes:

1. **Climate/weather** data (wind direction and intensity)
   - **long-term** from Port Hardy Atmospheric Environment Service weather station
   - **short-term** from a wave study within Robson Bight that included a temporary weather station (Associated Engineering Services Ltd., 1980)

2. **Terrain/Soils**
   - 1:50,000 terrain/soils maps for the North Vancouver Island Study Area (Mapsheets 92L/1,2,7,8) from B.C. Ministry of Environment.
   - 1:5000 topography (10 m contours) - MacMillan Bloedel Ltd.

3. **Tree species, age and condition**
   - forest cover mapping - 1:5000 - MacMillan Bloedel Ltd.
   - detailed cruise data - Reid Collins (re. land/timber trade areas)

4. **Ecosystems**
   - 1:40 chain map of habitat types, included in Tsitika Folio.

5. **Projected Roads and Cutblocks**
   - on 1:5000 map from MacMillan Bloedel Ltd.

6. **Review of recent literature**
   - dealing with windfall in Coastal B.C. (Rollerson, two undated reports), and review of windfall patterns in the Tsitika watershed (Holmes, 1984)

7. **Air photography**
   - 1:20 000 1979 and 1987 color (MacMillan Bloedel Ltd.)
   - 1:20 000 1981 black and white (Province of B.C.)
   - 1: 5 000 color (Province of B.C.)

Of the 3.5 days of fieldwork, two days were spent traversing the entire length of the upland ecological reserve boundary area from the Tsitika River westwards; and 1.5 days were spent determining windfall history flanking Johnstone Straight, in the Naka Creek and Eve River areas and on the lowlands from Port MacNeill to Rupert Inlet. This allowed development of both local and regional windfall perspectives, for terrain exerting varying degrees of topographic influence on wind behaviour.

Field observations included:

1. Measurement of the orientation of historic windfall within the forest (196 windfall orientations measured):
   a) in the vicinity of the reserve boundary and proposed road alignment, and
   b) in nearby areas

2. Observation of the frequency and orientation of windfall along cutline boundaries, including both right-of-way and clearcut boundaries, in the Naka Creek Block of Tree-Farm Licence 25.

3. Distribution of windfall-originated stands, including those arising from the 1908 hurricane.

4. Terrain/soils observations
   a) to allow refinement of existing mapping, and production of an interpretive soil map along the boundary and road alignment, stressing soil depth and drainage (1:10 000), and

b) to evaluate erosion hazard (both mass wasting and surface erosion), with special attention directed to gullies and streams.

5. Vegetation observations
   a) to allow refinement of existing ecosystem (habitat type) mapping along the boundary and road alignment (1:10 000), and,
   b) to verify and refine stand data from the existing forest inventory, particularly regarding stand condition.

In addition, discussions of wind behaviour and windfall were held with knowledgeable local personnel, including:

- J. Slater, Division Engineer, Menzies Bay (formerly Eve River, MacMillan Bloedel)
- M. Watkinson, K. McGourlick, Resident Foresters, Northern Vancouver Island (Western Forest Products)
- R. Gunnell, Logging Manager, Naka Creek Operation (Frank Beban Logging Ltd.)

3.0 EVALUATION OF THE STUDY AREA

3.1 CLIMATE - WINDSPEEDS AND ORIENTATION

Monitoring of wind and waves was undertaken in the vicinity of Robson Bight from June 1979 to February, 1980 when booming and barge loading of logs was under consideration. The wind monitoring station was located on an exposed, shore bluff on the projecting point of land situated approximately three kilometers west of the mouth of the Tsitika River (see Figure 4). Comparison of this short-term data with longer-term wind data from the Port Hardy Airport station, which is located in an area of extensive subdued topography, revealed similarities sufficiently strong to conclude that the Port Hardy records, "can be used for long-term wave prediction purposes" (Associated Engineering Services Ltd., 1980).

Consequently, in the absence of conflicting local information derived from local observations and recent windfall history (see next section), it is suggested that the long-term Port Hardy data can be used to provide a general picture of 'normal' wind behaviour in the vicinity of the Ecological Reserve. However, it is insufficient to provide details of windspeeds and local wind orientation, and it may well not encompass a long enough time period to provide information on extreme windstorm events.

For the 1955 to 1980 period of record for the Port Hardy station (see Appendix I), maximum hourly and peak gust speeds were usually associated with ESE winds, suggesting that the orientation of southeast gales commonly associated with low pressure systems crossing the Coast is modified somewhat by the more easterly orientation of Johnstone Straight and its flanking mountain ranges. Maximum hourly speeds were generated by ESE winds for six months of the year; varied from E to S for ten months of the year; and were from the W or WNW in only the remaining two months.

Peak wind gusts at Port Hardy Airport were from the ESE for nine months of the year, from the E for two months and from the S for the remaining month. Peak gusts attained speeds in excess of 100 kph in seven months, from October to April inclusively. In comparison, AESL's (1980) short-term observations included two 'major southeast storms' with peak gusts in excess of 90 kph. During this winter period of highest windspeeds, the wind was almost invariably from the ESE.

Although the prevailing winds are easterly to southeasterly, the record indicates the occurrence, at times, of potentially damaging winds from the west and northwest. These winds are likely associated with the passage of a strong Pacific cold front moving in an eastward direction. "Winds at Port Hardy generally blow from the northwest in such a synoptic situation, turning more westerly in Johnstone Straight. A brief surge of strong southerly, 'down-valley' winds through the Tsitika valley, and perhaps along some creeks on the southwestern boundary, could also be expected immediately behind such a cold front" (Taylor, pers. comm.).

3.2 WINDFALL HISTORY

Measurement of windfall orientations during this evaluation are most instructive when subdivided into five populations, as follows:

a) Scattered windfall within the forest and windfall along cutlines in recent decades (since approx. 1910)
   i) on slopes flanking Johnstone Straight, and
   ii) in north-south oriented valleys including the Tsitika, Naka and Teissum valleys.

b) Windfall-originated stands from the 1908 windstorm
   i) on slopes flanking Johnstone Straight,
   ii) in north-south oriented valleys, and
   iii) on the subdued Nahwhitti Lowland of northern Vancouver Island.

3.2.1 Windfall of Recent Decades

'Windfall of recent decades' encompasses windfall since approximately 1910, including windfall during the Port Hardy period of climatic normals since 1955.

On slopes flanking Johnstone Straight, recent windfall orientation is largely in agreement with the Port Hardy wind data. Recent windfall along rights-of-way and clearcut block edges in the Naka Creek Block of T.F.L. 25 is most instructive. Here cutlines essentially oriented east-west to northwest-southeast have experienced little or no windfall, as shown in photographs a to c of Figure 1. Notable exceptions are small projections of non-commercial timber on rocky sites that were left standing. These projections have consistently been subject to windfall, although it appears that the small size of timber (height, diameter, crown size) has restricted the extent of windfall. Refer to photographs a to c of Figure 2.

In the vicinity of the Ecological Reserve boundary and proposed Tsitika Main road west of the Tsitika River, there has been little windfall in recent decades. The easterly winds appear to have been largely incapable of causing windfall particularly in the rather open, climax redcedar-hemlock stands that predominate. These stands are characterized by small crowns (often spike-topped) in the main redcedar canopy, a shorter sub-canopy of western hemlock, and a dense tall shrub canopy of salal in response to the relatively high light intensity under the canopy. The large diameter but small-crowned redcedar are only infrequently overturned by wind. The much shorter-lived hemlock have a high incidence of dwarf mistletoe. This hemlock tends to be broken by wind rather than overturned as mistletoe and decay fungi progressively weaken the tops and boles. The openings so created engender regeneration of more hemlock (and lesser redcedar), thereby maintaining the uneven-aged nature of these near-climax stands.

In north-south oriented valleys, historic windfall strongly points to down-valley winds. A helicopter reconnaissance of the Tsitika watershed, involving 12 windfall areas initially located on air photography, indicated that windthrown trees consistently fell along the contours of the valley, that the damaging winds were from the south to southeast, and that the valley is important in directing winds (Holmes, 1984). Within the Naka and Teissum Creek valleys, southerly down-valley winds are continually producing windfall on the southern edge of east-west oriented standing timber firebreaks (Gunnel, pers. comm.; Holmes, 1984; Watkinson, pers. comm.); this was verified on the ground by the author. The potential for down-valley winds to be damaging essentially as far as the mouth of the Tsitika is demonstrated by a group of eight recently (1987-88?) windfallen trees with an average orientation of 0° (range from 320° to 50°), near where the Ecological Reserve boundary crosses the Tsitika River.

FIGURE 1. Lack of windfall along openings oriented parallel to sub-parallel to Johnstone Straight, in the Naka Creek Block of Tree-farm Licence 25.

TOP: Cutblock clearcut in 1979; boundary is oriented NW-SE.

MIDDLE: Minimal windfall (one hemlock on corner) along Peel Main (constructed 1986) approximately 1 km east of Peel Creek.

BOTTOM: Lack of windfall on Peel Main 1.5 km east of Peel Creek.

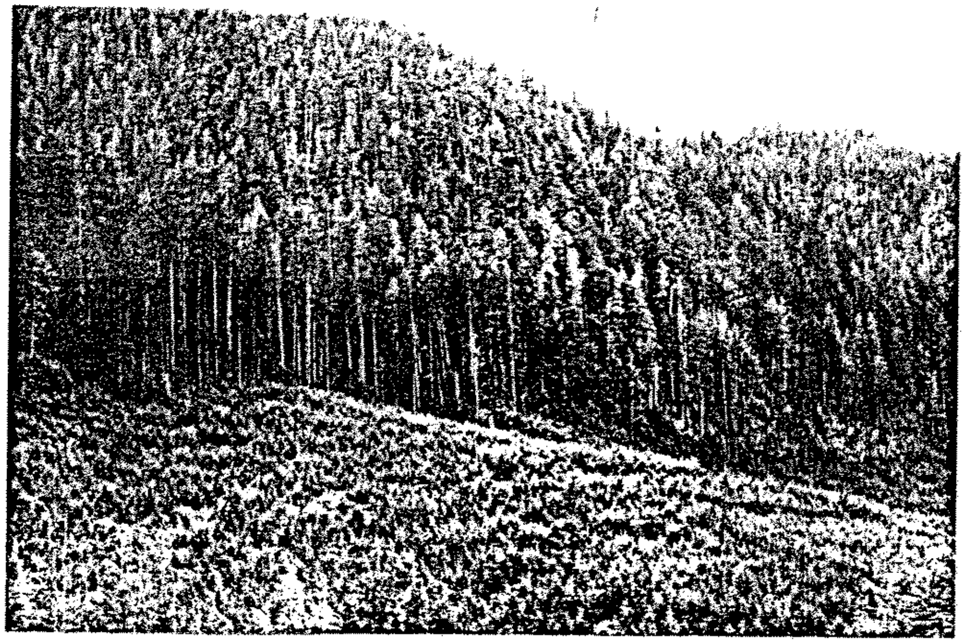


FIGURE 2. Small windfall patches of timber on rocky sites projecting into clearcuts or on exposed road corners, in the Naka Creek Block of Tree-farm Licence 25.

3.2.2 1908 Windfall-Originated Stands

A major windstorm involving hurricane-force winds was experienced on northern Vancouver Island in the early 1900's, resulting in the complete or nearly complete windfall of entire forest stands. Release of advanced regeneration and natural seeding-in has produced essentially even-aged stands of western hemlock with variable but lesser components of amabilis fir and/or Sitka spruce (see Figure 3). The total extent of these now immature stands suggests that this was an unusual meteorologic event, likely having a return period of at least a century, perhaps of several centuries. Within Tree-Farm Licence 6 and Block 4 of T.F.L. 25, 1908 windfall-originated stands cover approximately 14,500 hectares of the 171,000 hectares of productive land; this is in excess of eight percent of the productive forest (J. Barker, pers. comm.).

Measured windfall orientations conclusively indicate that this major windstorm did not conform to the Port Hardy station normals. On the Nahwhitti Lowland of northern Vancouver Island, where there is little topographic control of winds, windfall orientation indicates that the storm winds were from the southwest (based on 58 measurements).

Along Johnstone Straight, these winds were apparently redirected by topography. Windfall orientations indicate that, at least at low elevations, these storm winds turned approximately 45° to come directly from the west, essentially parallel to the coast (based on 33 measured orientations), leading to windfall only on topographically susceptible slope positions. Similar orientations were found in the lower Adam-Eve valley (i.e. within 5 km of the coast - 21 measurements).

Within the lower Tsitika valley, here oriented north to south, a 1908 windfall stand of pure western hemlock is situated on a fluvial terrace downstream of the point where the E.R. 111 boundary crosses the river. Old windfall orientations here show that the 1908 storm winds blew down-valley (average windfall orientation of 330°, based on 7 measurements). Windfall in the lower Naka and lower Teissum valleys was similarly blown down by southerly winds.

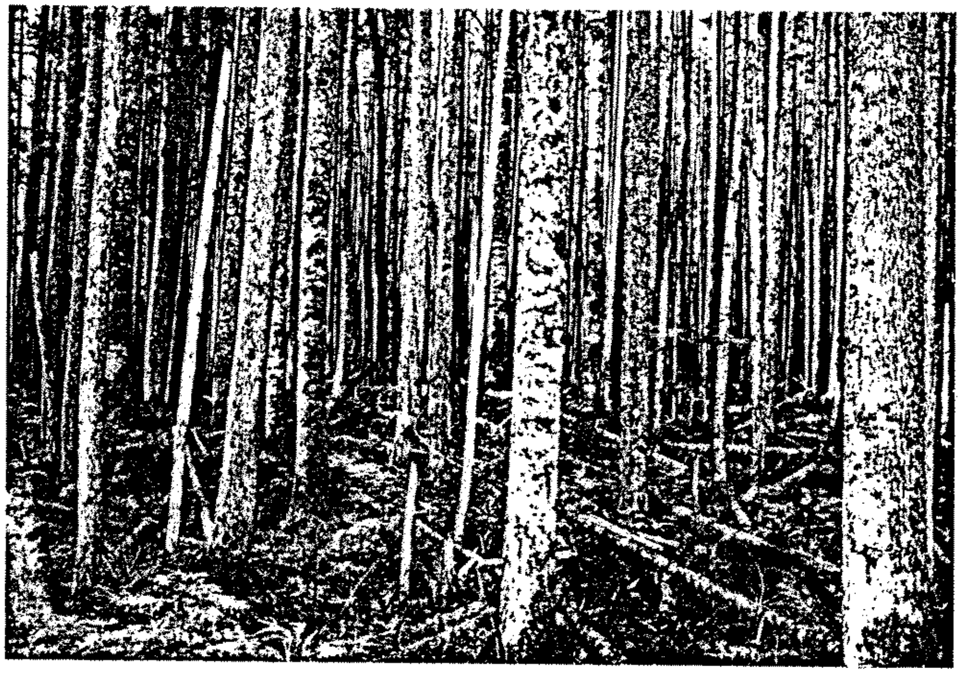
It is clear from both 1908 windfall and windfall in recent decades that storm winds initially oriented from either the southeast (typical winter gales) or from the southwest (1908 hurricane) will be modified by topography to produce local down-valley winds essentially from the south. Within the Tsitika, such winds do reach the mouth of the river.

Figure 4 is a 1:250 000 scale map that summarizes the above described predominant wind directions based on both recent and 1908 windfall orientations.

FIGURE 3. Relatively even-aged stands of western hemlock, amabilis fir and Sitka spruce that have developed since windfall of the previous stands by the hurricane of the early 1900's.

TOP: Adjacent to Rupert Main, 15.5 km; Nawhitti Lowland.

BOTTOM: Near Highway 19 - Rupert-400 Junction. Note windfallen tree with upturned roots, typical of windfalls used to determine wind orientation.



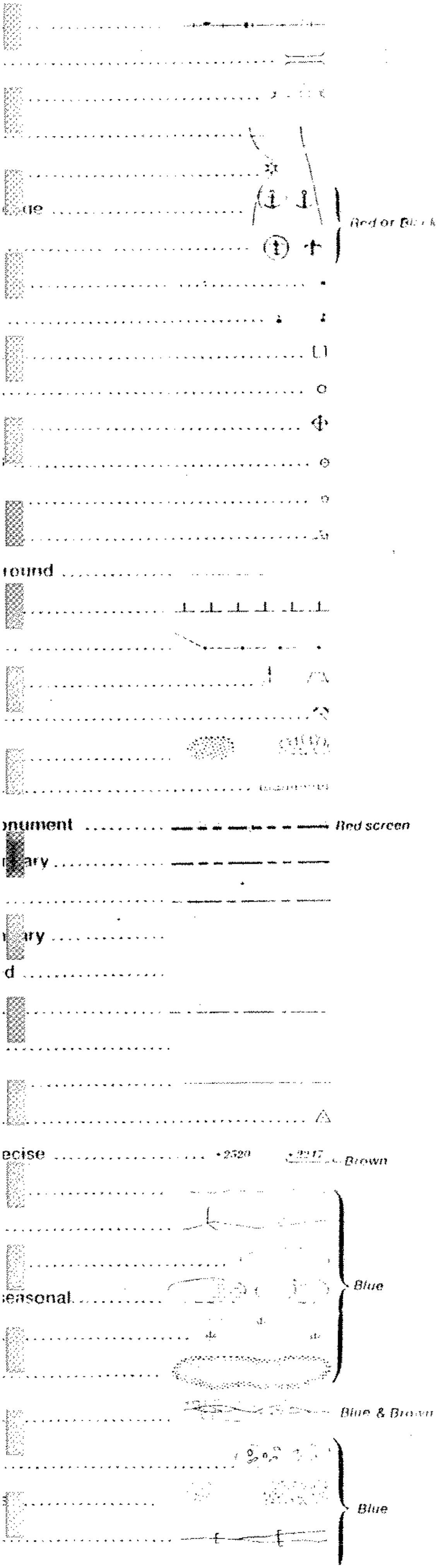


FIGURE 4. Predominant wind directions that have historically caused windfall

LEGEND:

 in recent decades

 early 1900's windstorm

3.3 TERRAIN AND SOIL CONDITIONS

To the west of the Tsitika River, Ecological Reserve #111 consists of two main terrain types. Flanking the river mouth are a number of river terraces of various ages; to the west is an upland area comprised largely of morainal materials (mainly till veneers) and shallow organic accumulations over hummocky and ridged bedrock. A narrow band of sandy, gravelly glaciofluvial is located from the toe of the slope adjacent to the back of the river terraces up to approximately 50 metres elevation (Chatterton et al, [1980]; Rollerson, pers. comm.). In addition is a small fluvial fan at the mouth of a creek situated 1.2 km west of the Tsitika mouth, which was impacted by a debris torrent several decades ago. This torrent was initiated by a debris slide on the valley side one kilometer upstream of the mouth of this creek.

The fluvial terraces are underlain by cobbly, sandy alluvium. This coarse, permeable material is at the surface on the youngest surfaces; but is overlain by a capping of silty materials that becomes progressively thicker on older fluvial surfaces. Soils and plant communities vary with terrace age, as follows:

<25 years	- rapidly drained Regosol - Pseudotsuga menziesii-Alnus rubra-Rhacomitrium canescens
25-125 years	- well drained Dystric Brunisol - Pseudotsuga menziesii-Hylocomium splendens
125-750 years	- moderately well drained Dystric Brunisol - Pseudotsuga menziesii-Tsuga heterophylla-Polystichum munitum
>750 years	- moderately well drained Podzol(?) - Abies amabilis-Tsuga heterophylla-Polystichum munitum-Tiarella spp.
> ?	- moderately well drained Humo-ferric Podzol - Tsuga heterophylla-Vaccinium parvifolium-Hylocomium splendens

The above ages and plant community names are first approximations. Refer to Figure 5 for photographs of these seral stages. In the first three stages, which are located on fluvial islands behind the estuary, rooting is well into the mineral soil and the forest, the Douglas-fir in particular, is relatively windfirm. In later stages, as western hemlock and amabilis fir enter the sere, rooting becomes progressively shallower and windfirmness decreases.

FIGURE 4 (On the following two facing pages). Successional stages of vegetation of the fluvial terraces and islands near the mouth of the Tsitika River, within Ecological Reserve #111.

LEFT PAGE:

TOP: Red alder - Douglas-fir - Rhacomitrium canescens pioneer community on well drained cobbly sandy fluvial materials - Circa. 10 years since deposition of fresh fluvial material.

MIDDLE: Douglas-fir - Hylocomium splendens community on similar materials - at 65 years.

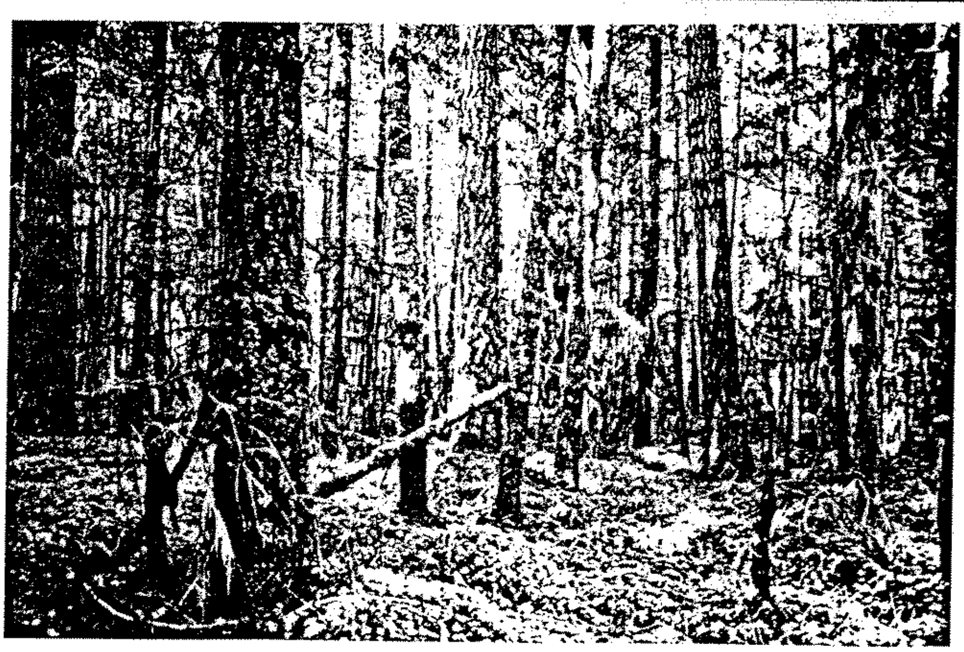
BOTTOM: Douglas-fir - Hylocomium, as above, but approximately 90 years since deposition.

RIGHT PAGE:

TOP: Stand of Douglas-fir with sub-canopy of western hemlock and minor Sitka spruce, a swordfern community some 200 years since deposition. Note that windfall is negligible to this time in the succession.

MIDDLE: Successionally advanced stage - a western hemlock, amabilis fir, minor Sitka spruce stand on an older fluvial terrace; soil now moister and with a silty capping. Windfall history is now significant; if this stand is felled by wind, it will likely be replaced by a western hemlock dominated stand as the abundant advanced regeneration is released.

BOTTOM: 1908 windfall-originated, pure western hemlock stand on fluvial terrace.



The morainal upland to the west occupies lower slopes and toeslopes that are only gently to moderately sloping. The soils are generally deep (i.e. circa. one metre to compact till or bedrock), and moderately well to imperfectly drained. Seepage is common in the lower part of these soils during the rainy season (October to March). The most subdued toeslopes have poorly drained mineral and shallow organic muck soils, supporting redcedar-salal-skunk cabbage communities with inclusions of poorly drained bog soils that are characterized by sphagnum mosses and small trees of yellow cedar and mountain hemlock. Rollerson (pers. comm.) has noted that the top of the small glaciofluvial terrace has developed a cemented soil horizon, thereby negating the coarser, originally more permeable nature of the soil parent materials. This, "iron pan has resulted in impeded drainage and shallow rooting (30-50 cm), while the soils on the scarp slope (downslope) are well drained and deeply rooted.

Bedrock projections and bedrock slopes mantled with shallow, well drained Folisol soils predominate just inland of the coast and on low ridges, including one prominant ridge that forms part of the Reserve boundary.

Map #1 , at a scale of 1:10 000, indicates groupings of soils based on soil materials, soil drainage and soil depth. It is widely accepted that, **other factors being equal,** soils having restricted rooting depth, that is shallow and/or poorly drained soils, are more susceptible to windfall than deep, freely drained soils. However, in reality, soil depth and restricted drainage greatly limit the size and density of trees, and may alter species composition. Consequently, the greater intrinsic suceptibility to windfall of shallow or wet soils may well be mitigated to varying degrees by the smaller tree size of these more adverse sites.

3.4 VEGETATION

Map #1 also shows the distribution of ecosystems within and adjacent to the terrestrial portion of Ecological Reserve #111. This information is superimposed on the forest cover mapping provided by MacMillan Bloedel Ltd.

From the windthrow susceptibility point-of-view, the structure of the various forest stands is most critical - that is, species composition, height and stand density. In this regard, two main stand types are highlighted on Map #2:

a) near climax, redcedar-western hemlock stands with lower density and rather open canopy. Such stands are referred to as the **CH phase**, and

b) seral stands resulting from past disturbance (windthrow of previous stand, fluvial erosion and deposition), that are more densely stocked and have a closed canopy. Species composition includes various mixes of western hemlock, amabilis fir, Sitka spruce and Douglas-fir. These stands are collectively referred to as **HA phase** stands.

These two stand types (successional phases) are illustrated in Figure 6. Regardless of other site factors, stand structure alone renders HA phase stands far more susceptible to windfall than CH phase stands. A clearcut boundary through an HA phase stand results in a virtual wall of trees upon which wind forces can act. In strong contrast, a clearcut boundary through a CH phase stand presents a permeable, open, somewhat feathered edge to the wind. On the Nahwhitti Lowland (Block 4 of T.F.L. 25 and T.F.L. 6) and in the upper Tsitika, boundaries through HA phase stands have usually been subject to excessive windthrow damage, whereas boundaries through CH phase stands have been windfirm or subject to only minor windthrow of particularly susceptible trees (trees with defect, high germination point etc.) (McGourlick, Slater, Watkinson; pers. comm.).

The extent of decay and mistletoe infection (hemlock only) influences bole strength and hence the likelihood of stem breakage by wind. Based on field observations, experience with similar stands elsewhere and mensuration plots (Reid Collins, 1985), the following defect classes are inferred and mapped (see Map #2):

a) Fluvial sites:
   i) Immature Douglas-fir stands - negligible defect
   ii) Mature Douglas-fir dominated stands - low defect
   iii) Overmature hemlock-amabilis fir stands - low to moderate
   iv) 1908 hemlock stand - negligible defect
   v) Red alder stands - negligible defect.

b) Morainal/rocky sites:
   i) Near climax redcedar-hemlock stands (CH phase) - moderate defect in the redcedar; moderate defect (high incidence of mistletoe; few other defects) in the western hemlock.
   ii) Mature to overmature hemlock-amabilis fir stands (HA phase) - low to moderate defect
   iii) 1908 stands (H, HB, HS, HFS) - negligible defect.

The above tabulation indicates that defect is low or low to moderate in most stands and is unlikely to seriously predispose stands to windfall. Where the incidence of defect is moderate, in the CH phase stands, the canopy structure favors windfirmness. Appropriately oriented falling lines will likely be subject to minor windfall and wind breakage of individual trees with particular defects.

FIGURE 6. The two contrasting successional phases of forests found in and adjacent to the Robson Bight Ecological Reserve.

TOP: The HA phase, indicative of a disturbance history. This stand which resulted from the 1908 hurricane, is located 300 metres southwest of the westerly corner of the terrestrial portion of E.R. #111.

BOTTOM: The CH phase, the near climax, open stand condition that results from centuries of stand evolution in the absence of major disturbance (fire, windfall etc.)

4.0 RESERVE BOUNDARY VIABILITY

Two aspects of the long-term viability of the southwestern Reserve boundary are considered - potential windfall impacts and potential erosion impacts.

4.1 POTENTIAL FOR WINDFALL IMPACT

Analysis of historic wind and windfall patterns indicates that the boundary will be subject to winds parallel to Johnstone Straight from both the east and west, and to down-valley winds from the south. The following evaluation considers two scenarios:

a) clearcutting to the boundary (an unlikely, worst-case scenario considering past practices of MacMillan Bloedel Ltd. and policy of the Ministry of Forests), and

b) patch clearcut layout with due consideration to windfall, slope stability and aesthetic/visual values. This includes consideration of preliminary layouts of two cutblocks tentatively scheduled for logging in 1992.

4.1.1 Clearcutting to the Reserve Boundary

The general configuration of the boundary is northwest to southeast. Without regard to local topographic effects, such an orientation is generally favorable considering the easterly or westerly winds of Johnstone Straight and the southerly down-valley winds of the Tsitika. In general, clearcutting to this boundary would be expected to cause minor windfall and breakage of particularly susceptible trees as the winds roll along the forest edge, especially in the CH phase stands (64% of the southwestern boundary). The mistletoe infected hemlock component of the CH phase stands would be particularly susceptible to breakage.

The general boundary configuration needs to be further evaluated with respect to local topographic effects on wind behaviour. This evaluation indicates that exposure of the boundary to down-valley winds is a particular concern for the +/-250 m of boundary west of the Tsitika River because of boundary orientation (SE-NW) in relation to down-valley winds, shallow soils (low outcrops) and windfall history. Past this point, the boundary is afforded topographic shelter from down-valley winds by a northeasterly-facing slope; furthermore, moderation of down-valley wind is anticipated as the flow opens onto Robson Bight. To protect the vulnerable 250 metres of boundary, it is recommended that a leave strip of forest be considered downstream of the creek that flows into the Tsitika just south of Block 103 (see green shaded area on Map #4).

For the next +/-1000 metres to the northwest, the boundary is situated on the back of a large fluvial terrace that supports an overmature western hemlock-amabilis fir stand, 50 to 60 metres in height. Cutting right up to the boundary here would result in a narrow elongated notch confined by a steep sideslope and tall timber. Such a notch would be vulnerable to windfall if a down-valley wind gained access. Consequently, it is recommended that all timber on the flat terrace be left standing (i.e. all of map unit D as shown on Map #1). Consideration should also be given to leaving timber on the adjacent sideslope up to 40-50 metre elevation (see green shaded area on map #4). Because of ground configuration, this would reduce the 'notch effect' even further, and allow yarding with good deflection from Tsitika Main. A topographic break at 40-50 metres elevation (largely coincident with the break from well drained glaciofluvial scarp slope to the imperfectly drained glaciofluvial terrace described by Rollerson [pers. comm.]) limits deflection past this point. Consequently, yarding disturbance could well be excessive, unless short spur roads were constructed to this slope break.

To the west, the boundary is located through predominantly CH phase stands not susceptible to windfall; on deep, moderately well drained soils, and on favorable topography (smooth, concave lower slopes and toeslopes) apart from minor exceptions, as follows:

a) a +/-600 m section on the crest of a rocky ridge. Although topographically exposed, this ridge is parallel to ESE Johnstone Straight winds and supports only short, open CH phase stands, apart from a small patch of 1908 windfall stand on deeper soils in a small saddle lying between rock ridges. Within CH phase stands, clearcutting right to the boundary on this ridge could well result in minor windfall similar to that illustrated in Figure 2. Clearly, a falling boundary along the base of the south side of the ridge, coincident with deeper, well drained colluvial and morainal soils would be more windfirm because of deeper rooting and less exposed topographic position.

b) a +/-500 m section of poorly drained soils and shallow soils over rock, which starts about 200 m southeast of the northernmost corner of the terrestrial portion of the Reserve. These soils are susceptible to windfall, although small tree size and a boundary orientation sub-parallel to and in the lee of ESE winds mitigates the risk. A similarly oriented falling line coincident with the break to deeper, better drained soils would be advantageous.

4.1.2 Cutblock Layout Considerations

The recently revised development plan for Tree-farm Licence 39 includes the extension of Tsitika Main adjacent to the Ecological Reserve and two 1992 clearcut blocks (#102 and #103) as shown conceptually on Map #3. Layout of these blocks has incorporated considerations of windfall risk and mitigation of aesthetic impacts of clearcutting. Comments on the present 'paper' layouts may be subject to refinement after final layout and location of roads and falling lines on the ground. The Ministry of Parks should have an opportunity for detailed evaluation and comment as part of the normal referral process.

Block 103 is well separated (more than 2 km) from the Reserve boundary. Its most wind prone edge is the northern boundary of the block, which may be susceptible to down-valley winds. Windfall in this vicinity would have no impact on the Ecological Reserve providing it did not result in excessive disturbance adjacent to the nearby creek, which could marginally increase sediment input to this creek. This risk could be managed if the falling line is either set back from the small creek or located some distance across the creek (with appropriate care during yarding), depending on ground/streamside conditions.

The layout of Block 102 no longer abuts the Reserve boundary along part of its northerly edge. Its elongated shape and orientation is excellent with respect to both the commonly experienced ESE storm winds and the early 1900's windstorm (W to NW winds here) of Johnstone Straight. Only the short western boundary has an unfavorable orientation because of exposure to ESE winds. If the boundary is located at the slope break into the gully, the remaining stand will receive some topographic protection both on the gully sides and by way of slight shelter from the low ridge to the east. Block 102 also avoids the exposed crest and upper slopes of the ridge that forms the Reserve boundary to the north since it will extend only to the base of rock outcrops below the ridge. This will avoid windfall on the ridge crest along the Reserve boundary.

Future cutblocks to the northwest of #102 could be located up to the Reserve boundary with minimal windfall impact because of favorable boundary orientation and continuous stands of CH phase forest communities. However, the marginal merchantability of stands along much of the boundary will likely result in leave areas adjacent to the boundary, notably in areas of shallow soils to bedrock and poorly drained soils (map units B and C of Map #1). Future cutblock boundaries will need to be appropriately located to handle the easterly and westerly winds along Johnstone Straight.

4.2 POTENTIAL EROSION IMPACTS

An overview of terrain on slopes flanking the ecological reserve boundary reveals conditions generally favorable to road construction and logging. Gentle to moderate toeslopes and lower slopes predominate. Where steep slopes occur, they tend to be short and frequently broken by bedrock controlled benches. The steepest slopes (to 35 degrees) occur adjacent to the large fluvial terrace from 250 to 1250 metres northwest of the Tsitika River. An evaluation of slope stability should be undertaken if this is to be logged. These slopes are underlain by well drained glaciofluvial materials that, "are typically quite stable following logging ... but may experience one or two very minor debris slides/sloughs following logging" (Rollerson, pers. comm.). However, even this low risk would be avoided if timber is left below the 40-50 metre elevation break as discussed earlier (see 4.1.1 and Map #4).

As indicated on the 1:5000 map of proposed cutblock #102, the easterly and westerly falling lines should be located so as to exclude the steep gully sides that flank two small streams that flow to and across the Ecological Reserve. Debris slides on these oversteepened gully sides would be a risk following logging as root systems deteriorate. Such slides would not likely directly impact the Reserve, but indirectly could lead to increase transport of sediment, bedload and woody debris into the Reserve.

Consequently, standard road construction along Tsitika Main and associated secondary haulroads, and logging practices applied in both the proposed and future cutblocks are not anticipated to lead to excessive erosion problems, and transport of sediment and debris into the reserve should be minimal. This assumes that normal practice includes adequate ditching and culverting, regular maintenance of roads and drainage structures, minimal cuts on backspar trails, cross-ditching of backspar trails as necessary, and prompt retirement of branch and spur roads on completion of logging. Consideration should be given to erosion control seeding of cut, fill and sidecast slopes along Tsitika Main.

The creek 1.2 kilometers west of the Tsitika mouth has been scoured by debris torrents some 50 or so years ago, resulting in deposition of debris on its alluvial fan almost to the beach. A similar natural event could well re-occur because of the marginal stability of slopes in the upper part of this small watershed.

5.0 SUMMARY

Review of both climatic data and historic windfall orientations indicates that damaging winds in the vicinity of the Robson Bight Ecological Reserve are strongly influenced by topography, blowing parallel to Johnstone Straight and down the valley of the Tsitika as far as the mouth of the river. Strong Johnstone Straight winds regularly blow from the ESE during the passage of winter storms, but occasionally blow from the WNW. The down-valley winds may originate as either SE or SW winds. The major windstorm of the early 1900's produced winds sufficiently strong to blow down entire stands of trees. These initially SW winds were redirected by topography so as to blow both down Johnstone Straight from the west and down the Tsitika from the south.

Evaluation and mapping of soils suggests some soils are inherently more susceptible to windfall because of restricted rooting depth. This arises from either poor soil drainage or shallowness to bedrock. However, since these adverse soil conditions significantly reduce both tree size and stand density, the greater intrinsic susceptibility to windfall is mitigated to some extent.

Two broad forest types can be distinguished:

a) near climax, redcedar-western hemlock stands with lower density and rather open canopy: the **CH phase**, and

b) seral stands resulting from past disturbance that are more densely stocked and have a closed canopy. Species composition includes various mixes of western hemlock, amabilis fir, Sitka spruce and Douglas-fir: the **HA phase**.

Regardless of other site factors, stand structure alone renders HA phase stands far more susceptible to windfall than CH phase stands. Evaluation of weakening stem defects caused by decay fungi and mistletoe indicates that defect is low or low to moderate in most stands and is unlikely to seriously predispose stands to windfall. Where the incidence of defect is moderate, in the CH phase stands, the canopy structure favors windfirmness. Consequently, appropriately oriented falling lines will likely be subject to minor windfall and wind breakage of particularly defective trees.

Potential windfall impact on the southwestern boundary of Ecological Reserve #111 was evaluated from two scenarios - clearcutting to the boundary, and patch clearcuts; recognizing that the latter scenario is far more realistic.

The general configuration of the Reserve boundary is favorable. For the most part, clearcutting to this boundary would be expected to cause minor windfall and breakage of particularly susceptible trees as the winds roll along the forest edge, especially in the CH phase stands. Further evaluation of boundary configuration in relation to local topography reveals that exposure of the boundary to down-valley winds is a particular concern for the +/-250 m of boundary west of the Tsitika River. Past this point, the boundary is afforded topographic shelter and moderation of down-valley wind is anticipated as the flow opens onto Robson Bight. To protect the vulnerable 250 metres of boundary, it is recommended that a leave strip of forest be considered. For the next +/-1000 metres to the northwest, the boundary is situated on the back of a large fluvial terrace that supports an overmature western hemlock-amabilis fir stand, 50 to 60 metres in height. Cutting right up to the boundary here would result in a narrow elongated notch vulnerable to windfall if a down-valley wind gained access. Consequently, it is recommended that all timber on the flat terrace be left standing with consideration given to leaving timber on the adjacent sideslope up to 40-50 metre elevation. To the west, the boundary is located through relatively windfirm CH phase stands on favorable topography and soils apart from two 500-600 m sections of adverse soils with shallow rooting. Clearcutting right to the Reserve boundary in these sections could well result in minor windfall.

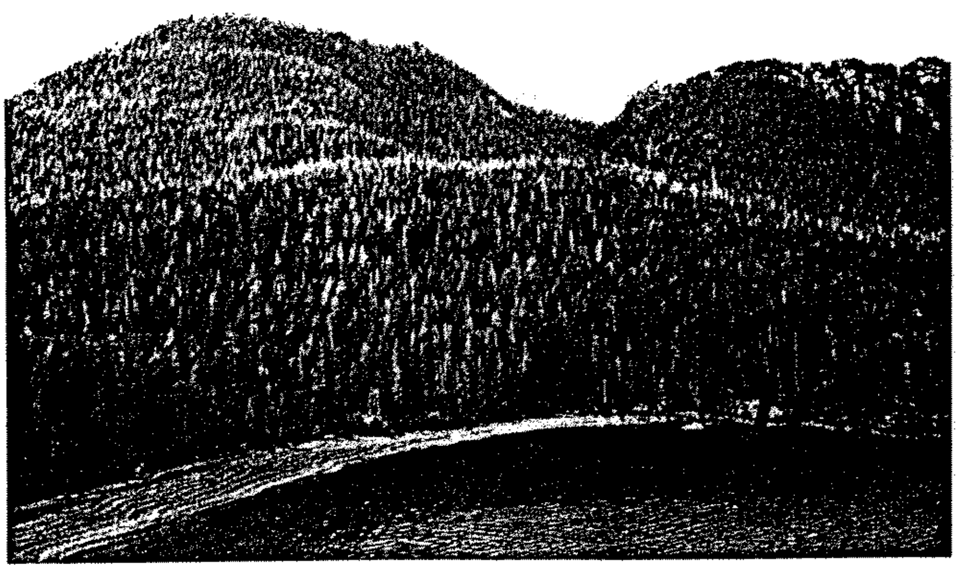
The current development plan includes the extension of Tsitika Main adjacent to the Ecological Reserve and two 1992 clearcut blocks. Revised layout of these blocks has incorporated considerations of windfall and aesthetics. Block 103 is well separated from the Reserve boundary and windfall on its most susceptible north edge is not anticipated to adversely affect the Ecological Reserve. Block 102, which no longer abuts any part of the Reserve boundary, has favorable shape and orientation with respect to both the commonly experienced ESE storm winds and the early 1900's windstorm along Johnstone Straight. Furthermore, the limited merchantability of the timber on the crest and upper slopes of the ridge that here forms the Reserve boundary has restricted the cutblock to the base of rock outcrops below the ridge, thereby avoiding windfall on the ridge crest.

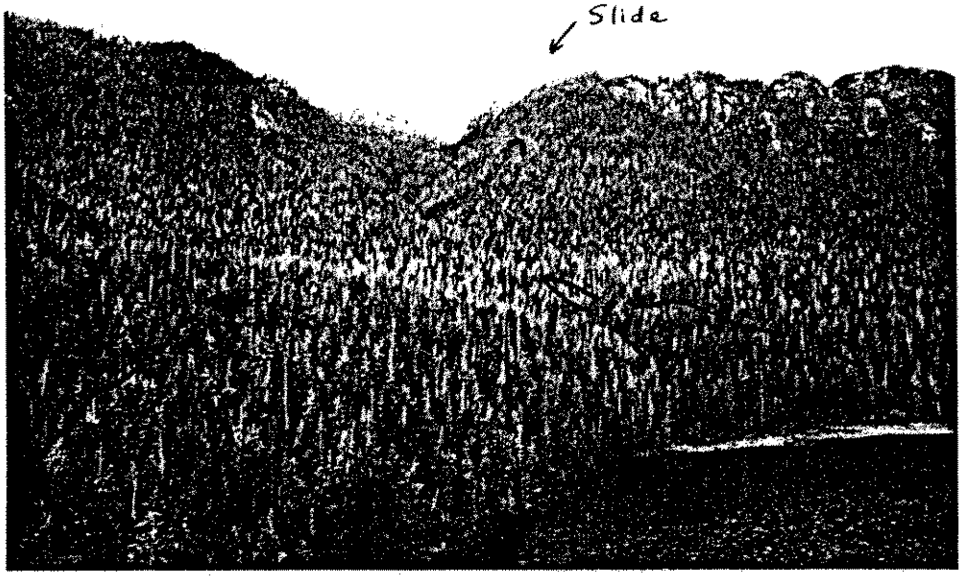
Future cutblocks to the northwest of #102 could be located up to the Reserve boundary with minimal windfall impact because of favorable boundary orientation and continuous stands of CH phase forest communities. However, the marginal merchantability of stands along much of the boundary will likely result in leave areas adjacent to the boundary, notably in areas of shallow soils to bedrock and poorly drained soils. Future cutblock boundaries will need to be appropriately located to handle the easterly and westerly winds along Johnstone Straight.

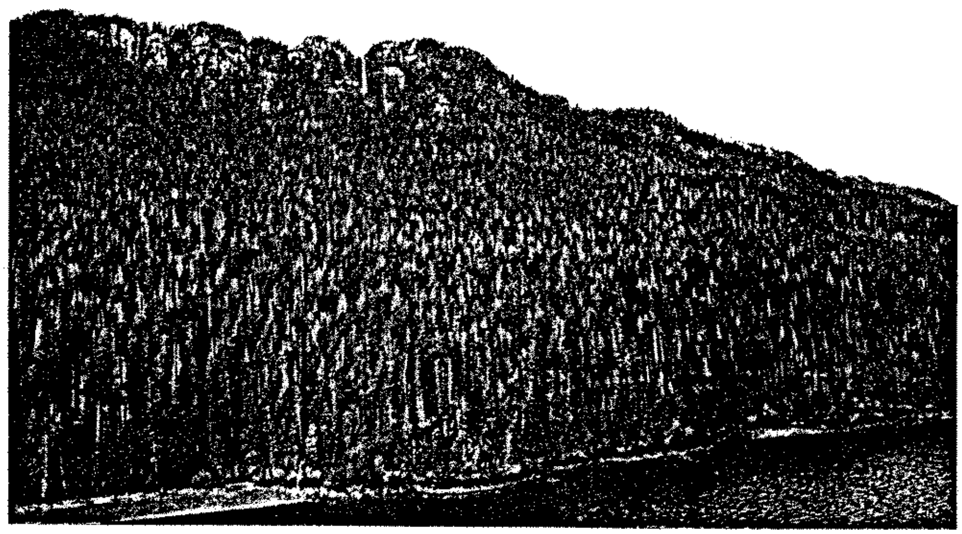
An overview of terrain on slopes flanking the ecological reserve boundary reveals conditions generally favorable to road construction and logging. Consequently, standard road construction and logging practices are not anticipated to lead to excessive erosion problems, and transport of sediment and debris into the reserve should be minimal. This assumes that normal practice includes adequate ditching and culverting, regular maintenance of roads and drainage structures, minimal cuts on backspar trails, rehabilitation of backspar trails as necessary, and prompt retirement of branch and spur roads on completion of logging. Consideration should be given to erosion control seeding of cut, fill and sidecast slopes along Tsitika Main.

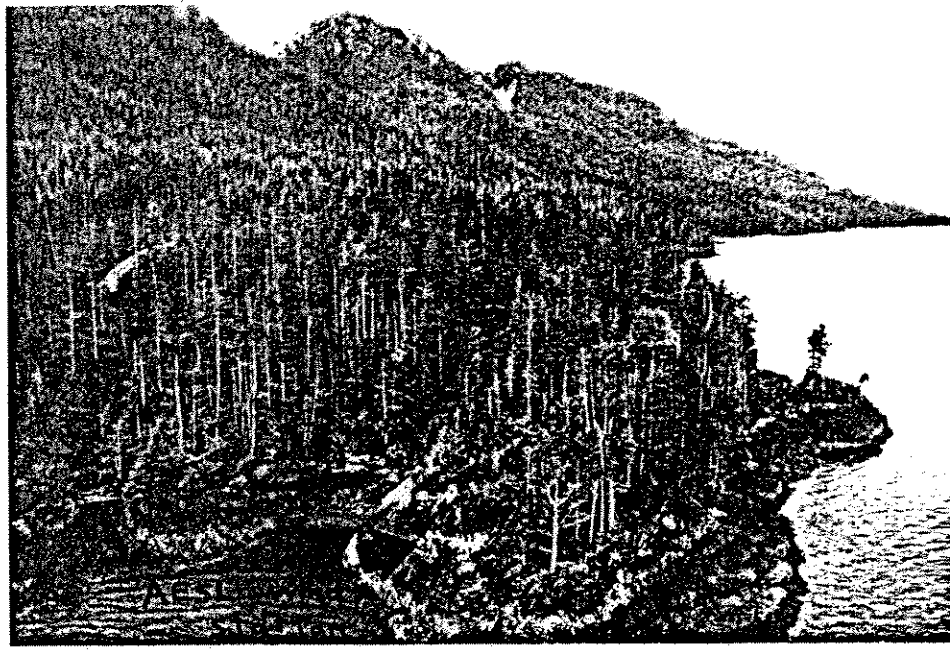
The creek 1.2 kilometers west of the Tsitika mouth, which was debris torrented some 50 or so years ago, could experience a similar natural event because of the marginal stability of slopes in the upper part of this small watershed.

FIGURE 7. (Following three pages) A series of photographs covering the full length of the southwestern terrestrial portion of Ecological Reserve #111.

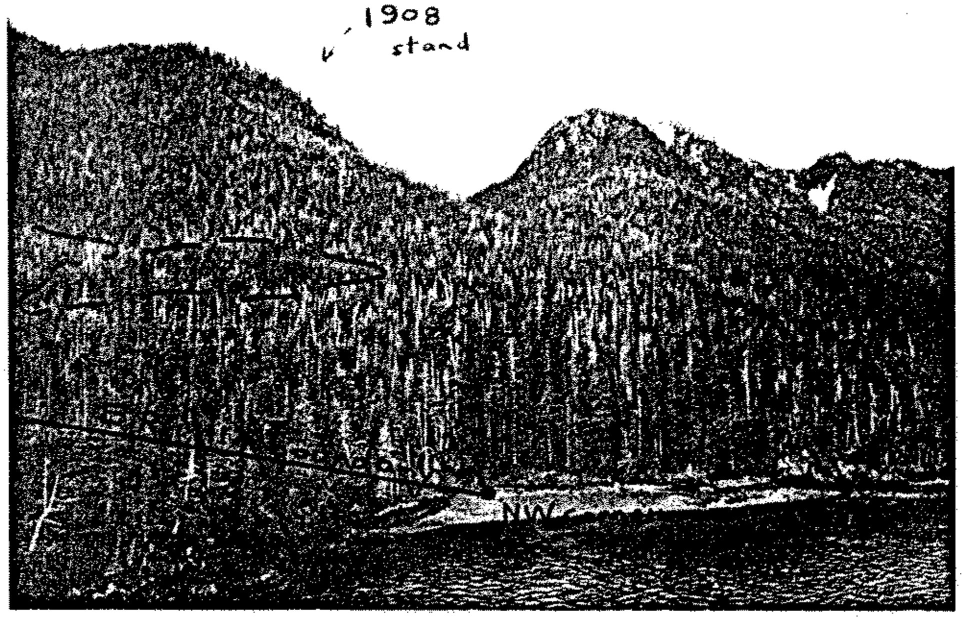


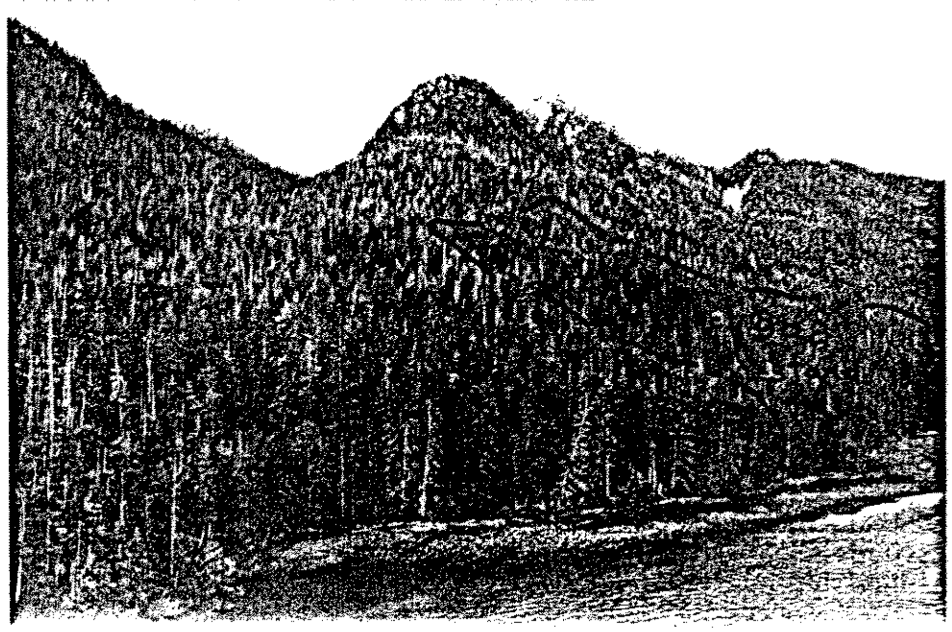

Slide





1908
stand





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7.0 APPENDIX I:

Port Hardy Airport

Wind data

PORT HARDY A B.C. PERIOD 1955-80 PERIODE

Lat. 5 °41'N Long. 127°22'W Elevation 22 m Altitude

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	
PERCENTAGE FREQUENCY														**FRÉQUENCE EN %**
N	0.3	0.6	1.5	3.2	6.0	7.9	8.3	6.7	3.4	1 2	0.4	0.2	3 3	N
NNE	0.2	0.5	1.0	2.0	3.3	3.5	4.1	3.4	2.3	0.9	0.3	0.1	1.8	NNE
NE	0.4	1.3	1.8	3.4	5.1	5.4	6.5	6.9	5.6	2.0	0.7	0.2	3.3	NE
ENE	0.4	0.9	1.6	2.3	2.7	2.7	3.3	3.4	3.0	1.4	0.6	0.3	1.9	ENE
E	9.8	7.1	8.1	6.1	5.4	5.7	5.3	7.0	7.9	7 1	7 6	6.8	7.0	E
ESE	24.3	24.7	17.6	10.8	5.3	4.3	3.3	4.3	8.1	18.2	24.7	26 8	14.4	ESE
SE	13.2	12.6	8.8	6.6	3.5	3.1	2.4	3 6	6.9	12 1	13 6	13.4	8.3	SE
SSE	5.6	4.9	4.3	3.7	2.1	1.5	1.3	1.6	2 3	4 2	5 4	6.1	3.6	SSE
S	9.4	8.9	8.6	8.9	6.4	4.9	4.0	4.7	6.2	8 6	9 9	10.0	7.5	S
SSW	3.5	3.8	5.2	5.3	4.6	2.8	2.3	2.3	2.9	3 6	4 1	4.3	3.7	SSW
SW	6.3	7.5	8.8	8.5	7.3	5.6	4.4	5.4	5.3	6.5	6.6	7.0	6.6	SW
WSW	4.3	4.3	5.8	5.5	5.1	4.0	3.6	3.5	3.5	3.6	4.2	4.5	4.3	WSW
W	6.9	6.4	8.1	7.5	8.1	7.8	7.1	6.4	6.3	5.8	5.9	6.2	6.9	W
WNW	1.9	2.1	3.2	3.6	4.2	4.3	3.9	3.1	2.9	1.8	1.7	1.7	2.9	WNW
NW	1.5	1.9	3.6	6.0	8.6	10.8	10.7	7.3	4.7	2.4	1 4	1.2	5.0	NW
NNW	0.3	0.8	1.7	3.5	7.6	9.7	11.0	6.7	3.0	1 3	0.5	0 5	3.9	NNW
Calm	11.7	11.7	10.3	13.3	14.7	16.0	18.5	23.7	25.7	19.3	12 2	10.7	15.6	Calme

MEAN WIND SPEED IN KILOMETRES PER HOUR
VITESSE MOYENNE DES VENTS EN KILOMÈTRES PAR HEURE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	
N	10.1	10.0	11.7	12.4	14.0	14.4	13.9	11.9	8.7	8.1	7 1	9 5	11.0	N
NNE	13.2	9.6	9.0	9.7	10.1	10.1	10.3	8.9	7.2	6.3	7.4	12.7	9.5	NNE
NE	9.1	8.2	8.0	8.0	8.3	8.1	7.8	7.2	6.3	6.3	6.3	11.7	7.9	NE
ENE	15.0	12.5	10.4	9.7	9.2	8.4	8.1	7.6	6.8	7.6	8.8	18.8	10.2	ENE
E	29.4	22.2	22.2	16.8	13.5	11.7	9.7	8.8	10.9	15.7	25.8	28 5	17.9	E
ESE	30.7	29.4	28.2	25.2	21.3	19.6	16.3	14.9	18.8	25.2	29.5	31.2	24.2	ESE
SE	16.3	16.7	16.0	15.5	12.4	10.6	10.0	9.7	12.4	15.6	16.5	16.7	14.0	SE
SSE	10.5	10.1	11.1	11.2	9.5	8.3	7.6	8.0	9.0	10.0	10.1	10.4	9.7	SSE
S	7.9	8.4	9.1	10.2	8.8	8.6	6.9	6.9	7.4	8.1	8.2	8.5	8.3	S
SSW	9.6	9.7	10.6	11.6	12.2	11.2	8.9	8.1	8.4	9.9	10.1	10.1	10.0	SSW
SW	9.6	9.3	9.6	9.8	9.1	9.0	6.9	7.2	8.4	9.3	9.5	10.3	9.0	SW
WSW	9.9	9.7	10.0	10.2	9.4	9.2	7.6	7.9	8.7	9.1	9.5	10.8	9.3	WSW
W	10.4	10.4	10.8	10.4	9.9	9.6	8.7	8.4	9.2	9.6	10.1	10.8	9.9	W
WNW	13.8	16.1	15.5	15.7	13.6	13.5	12.5	11.8	13.4	12 8	14.0	14.4	13.9	WNW
NW	14.3	15.4	17.1	17.4	16 6	15.8	15.3	14.6	14.2	13.3	16.3	15.9	15.5	NW
NNW	14.5	15.5	16.3	17.7	18.1	17.7	17.6	15.8	14.4	13.4	14.5	17.0	16.0	NNW
All Directions	16.6	15.4	14.2	12.2	10.8	10.5	9.5	7.8	8.0	11.7	15.6	17.0	12.4	Toutes directions
Maximum Hourly Speed	106 W	80 ESE	76 ESE	83 E	68 WNW	48 SVL	53 S	46 ESE	56 ESE	71 ESE	76 ESE	74 SVL	106 W	Vitesse horaire maximale
Maximum Gust Speed	113 ESE	119 ESE	111 ESE	103 E	84 E	77 ESE	72 S	83 ESE	78 ESE	101 ESE	111 ESE	108 ESE	119 ESE	Vitesse maximale des rafales

Height of anemometer 10.1 m hauteur de l'anémomètre

TE OF RUN / DATE DU PASSAGE : 26 SEP / SEPT /88
E OF RUN / HEURE DU PASSAGE: 1713
PROGRAM / PROGRAMME : GRP105

W I N D S P E E D V S D I R E C T I O N
VITESSE DU VENT EN FONCTION DE LA DIRECTION

WIND SPEED LIMIT
LIMITE LA VITESSE: 64

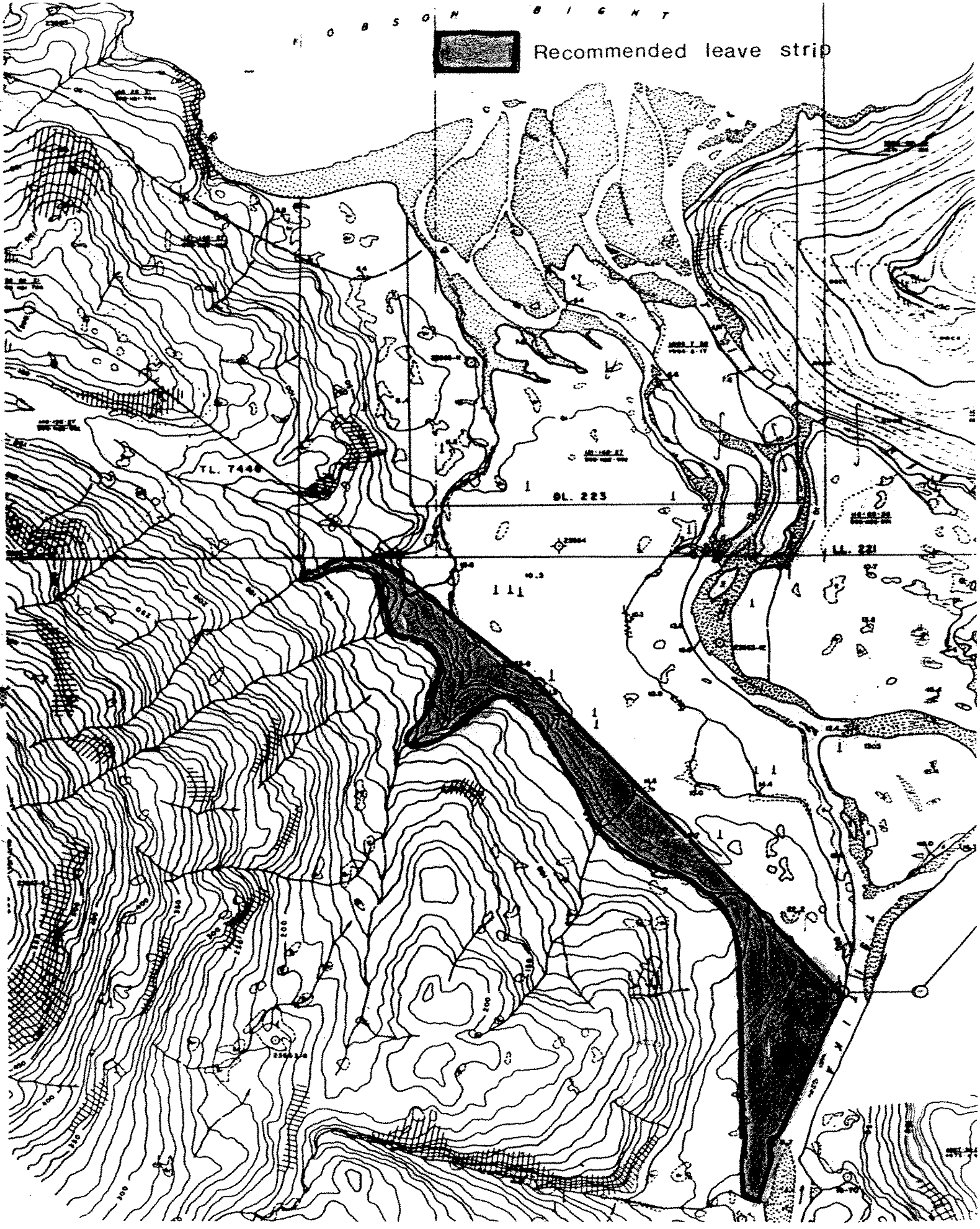
OJECT NUMBER
MERO DU PROJET: 12345

STATION: PORT HARDY A
B.C. / C.B.
1026270

FOR / POUR: YRS/ANNEES
1953-1987

WIND SPEED CLASSES / CLASSES DES VITESSES DE VENT (KM/H)

ND DIRECTION RECTION DU VENT		1- 9	10- 19	20- 30	31- 42	43- 55	56- 69	70- 84	85-100	101-117	118-999	MEAN MOYENNE	PERCENTAGE OF OCCURRENCES BY DIRECTION / PERCENTAGE DES OCCURRENCES SELON LA DIRECTION	% OF SPEEDS) LIMIT / % DES VITESSES) LIMITE
NE	15,957	3.75	1.38	.05	.02	.01						7.8	5.2	0.2
	66,069	3.85	5.36	5.35	4.95	1.63	.37	.03				23.9	21.6	0.1
	36,197	4.95	4.57	1.75	.47	.06	.01					13.1	11.8	0.2
S	35,479	7.71	3.32	.49	.05							8.7	11.6	0.2
	33,816	6.71	3.88	.41	.03							9.0	11.0	0.0
	29,437	4.76	4.09	.67	.08							10.7	9.6	0.0
NW	27,154	2.06	4.19	2.32	.28	.01						15.9	8.9	0.2
N	15,598	2.27	2.36	.44	.02							11.2	5.1	0.0
LM/ ALME	46,875												15.3	
TAL	306,582	36.05	29.15	11.48	5.90	1.71	.37	.02				12.10	*100.0%	* 0.3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Recommended leave strip
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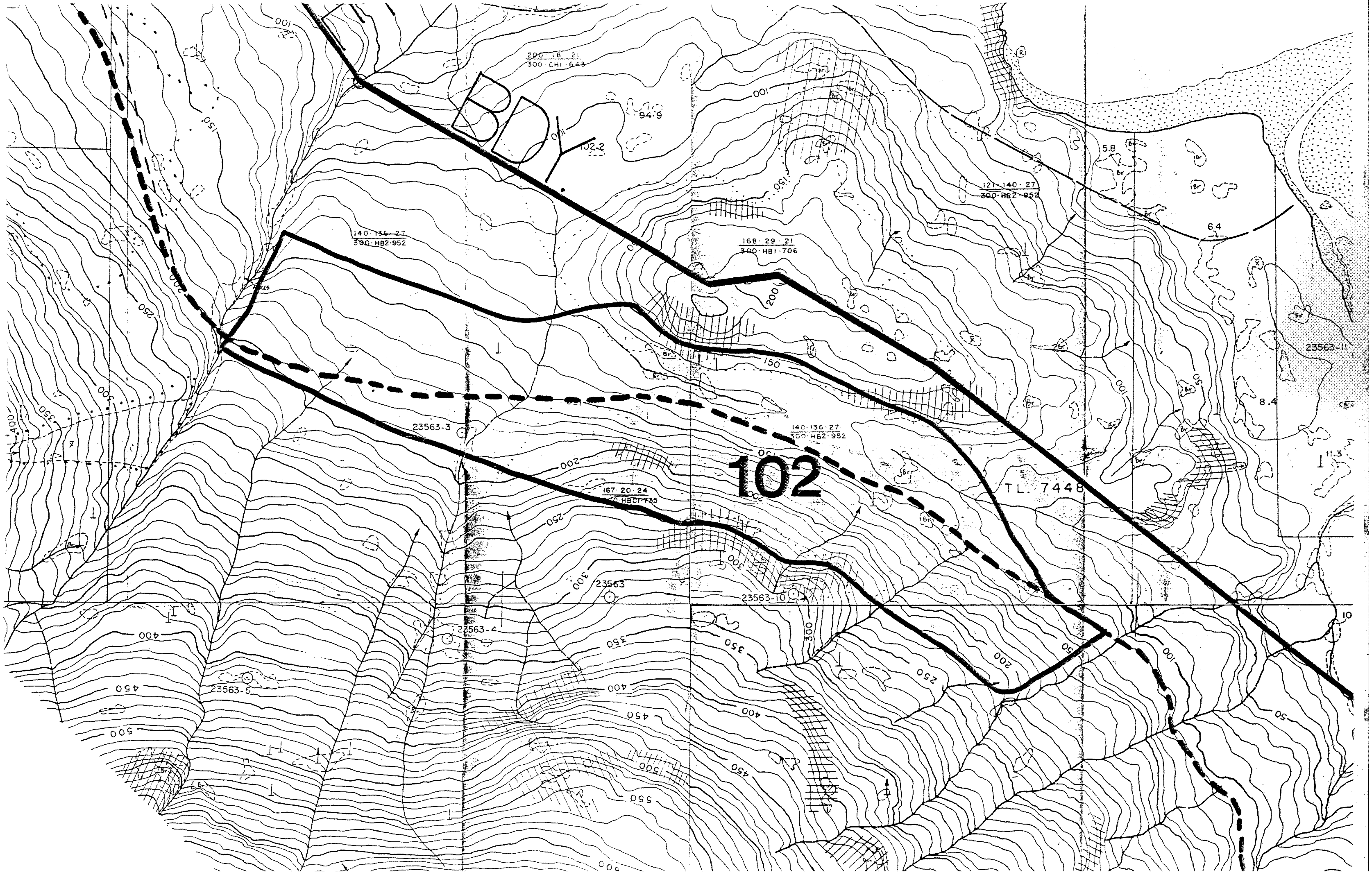
BL. 223
LL. 221


BDY.
102
TL. 7448
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121·140·27
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167·20·24
23563-3
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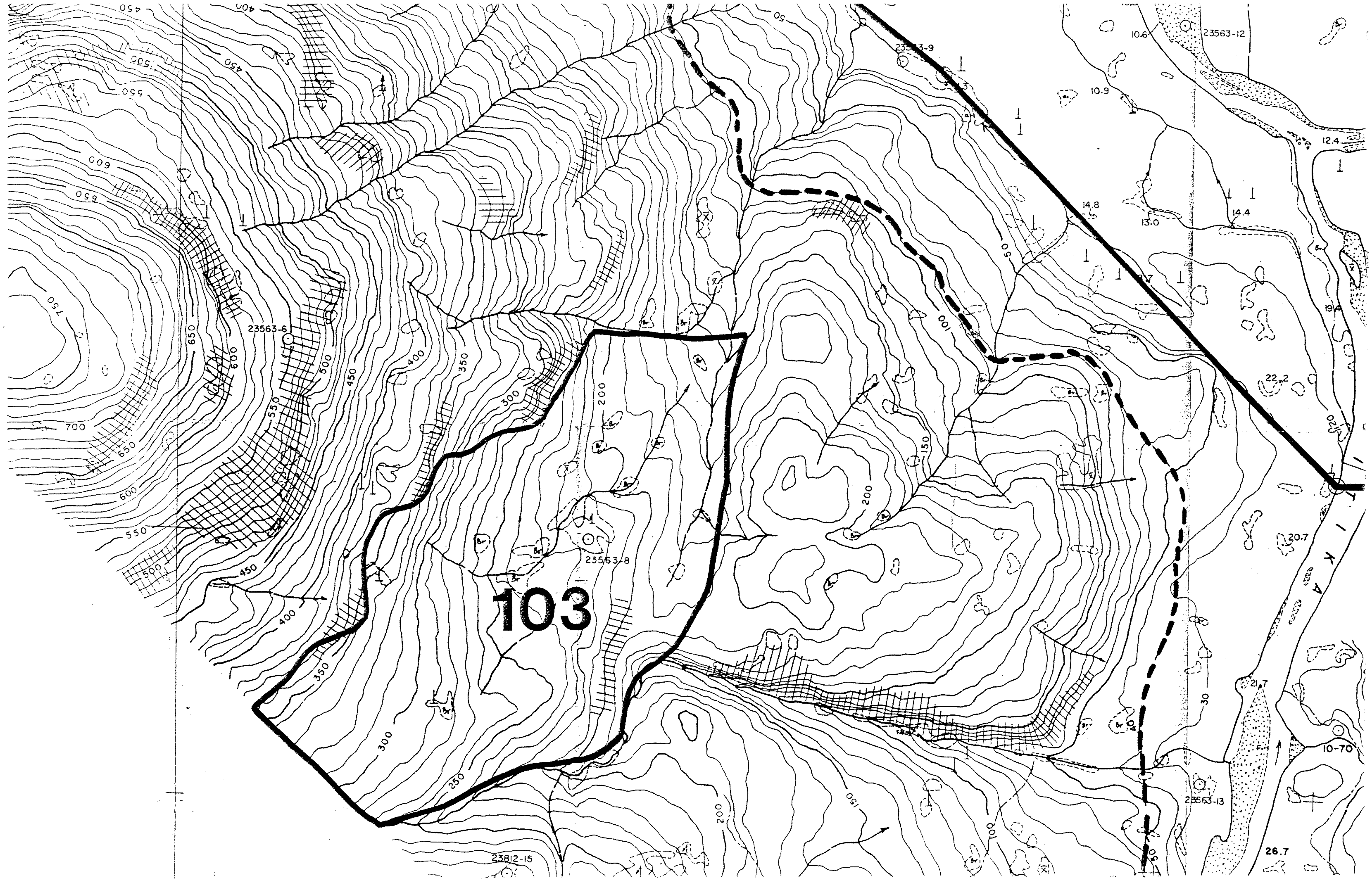
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14.4
19.4
22.2
20.7
21.7
26.7
10-70