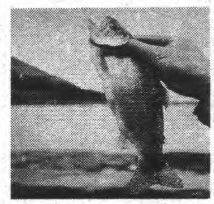
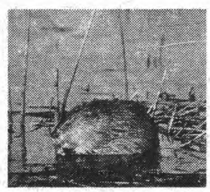
Canada Alberta Northwest Territories

Northern River Basins Study









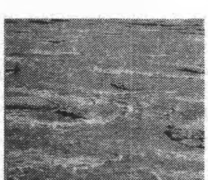


NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 34

A PRELIMINARY RADIO TELEMETRY NOISE SCAN

PEACE AND ATHABASCA RIVER DRAINAGES

MARCH, 1993





Prepared for the
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PREFACE:

The Northern River Basins Study was initiated through the "Canada-Alberta-Northwest Territories Agreement Respecting the Peace-Athabasca-Slave River Basin Study, Phase II - Technical Studies" which was signed September 27, 1991. The purpose of the Study is to understand and characterize the cumulative effects of development on the water and aquatic environment of the Study Area by coordinating with existing programs and undertaking appropriate new technical studies.

This publication reports the method and findings of particular work conducted as part of the Northern River Basins Study. As such, the work was governed by a specific terms of reference and is expected to contribute information about the Study Area within the context of the overall study as described by the Study Final Report. This report has been reviewed by the Study Science Advisory Committee in regards to scientific content and has been approved by the Study Board of Directors for public release.

It is explicit in the objectives of the Study to report the results of technical work regularly to the public. This objective is served by distributing project reports to an extensive network of libraries, agencies, organizations and interested individuals and by granting universal permission to reproduce the material.

NORTHERN RIVER BASINS STUDY
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Whereas the above publication is the result of work conducted under the Northern River Basins Study and the terms of reference for that project are deemed to be fulfilled,
IT IS THEREFORE REQUESTED BY THE STUDY OFFICE THAT;
this publication be subjected to proper and responsible review and be considered for release to the public.

(Dr. F.J. Wrona, Ph.D., Science Director) 28 JAN 94 (Date)

Whereas it is an explicit term of reference of the Science Advisory Committee "to review, for scientific content, material for publication by the Board",
IT IS HERE ADVISED BY THE SCIENCE ADVISORY COMMITTEE THAT;
this publication has been reviewed for scientific content and that the scientific practices represented in the report are acceptable given the specific purposes of the project and subject to the field conditions encountered.
SUPPLEMENTAL COMMENTARY HAS BEEN ADDED TO THIS PUBLICATION: [ ] Yes [✓] No

(Dr. P. A. Larkin, Ph.D., Chair) 14 Feb 94 (Date)

Whereas the Study Board is satisfied that this publication has been reviewed for scientific content and for immediate health implications,
IT IS HERE APPROVED BY THE BOARD OF DIRECTORS THAT;
this publication be released to the public, and that this publication be designated for: **[ ] STANDARD AVAILABILITY [ ] EXPANDED AVAILABILITY**

(Bev Burns, Co-chair) April 7/94 (Date)

(Lucille Partington, Co-chair) April 7/94 (Date)

A PRELIMINARY RADIO TELEMETRY NOISE SCAN
PEACE AND ATHABASCA RIVER DRAINAGES, MARCH, 1993

STUDY PERSPECTIVE

Knowledge of the timing and extent of fish movements is fundamental to the Study objective of understanding when and where fish are most likely to be affected by changes in water quality and quantity. Radio transmitters implanted into released fish enable researchers to continuously monitor fish movement with negligible influence on their behaviour. Such monitoring capability allows researchers to gather data on fish dispersal, and behaviour relative to other environmental parameters e.g., effluent outfalls, obstructions. It offers the capability to monitor large areas for mobile fish species known to exhibit extensive movement as well as enabling the tracking of multiple species/specimens at the same time with minimal interference from environmental conditions e.g., ice cover, water temperature. Earlier Study work involving radio transmitters confirmed the usefulness of the technique. However, background noise is commonly encountered in radio signal reception. Many factors can come into play to generate the noise which can occur over a range of frequencies. The earlier telemetry project identified the need to consider prior identification of "noisy" frequencies to aid in the selection of equipment i.e., radio transmitters. This project involved the examination of noise levels at 11 sites on the Peace, Athabasca rivers where there was a high probability of noise problems if radio telemetry work was to be undertaken. Investigations revealed a range of problems at each site. This information will now assist researchers in designing a radio telemetry program unique to each site.

Related Study Questions

6) *What is the distribution and movement of fish species in the watersheds of the Peace, Athabasca and Slave river? Where and when are they most likely to be exposed to changes in water quality and where are their important habitats?*

14) *What long term monitoring programs and predictive models are required to provide an ongoing assessment of the sate of the aquatic ecosystems. These programs must ensure that all stakeholders have the opportunity for input.*

REPORT SUMMARY

Prior to consideration of large-scale radio telemetry studies on fish populations in the Athabasca and Peace river drainages, the Northern River Basins Study requested information on radio noise that could interfere with signal reception. The general objective of the project was to determine which frequencies in the 140-180 MHz band were suited for use on individual stretches of the river likely to be used in future fish telemetry studies. The particular sites of interest were the location of pulp and paper mill operations, and at remote downstream sites exhibiting complete effluent mixing from these operations.

Eleven sites were investigated and six separate noise scans were conducted at each site. A large number of frequencies at the 0.1 MHz order of magnitude within each reach were noise-free during the period of testing; the report also identifies frequencies on which noise interference occurred.

A description of the physical suitability of each site for installation of a radio telemetry ground station is provided. Seven of the eleven sites investigated were rated as having moderate, good, or excellent potential for the installation of a fixed telemetry station. Of the four sites rated as having poor potential, the major limiting factor was excessive river width.

Overall, the study identified several noise spectra within the 140-180 MHz range associated with the industrial/municipal developments on the Athabasca and Peace River systems which could potentially interfere with signal reception from fish radio transmitters. However, the study also identified many suitable frequencies for use on individual river reaches and the drainage.

ACKNOWLEDGEMENTS

Mr. D. Marko of the Northern River Basins Study is thanked for his assistance in obtaining access to the mill sites for the study team. Mill personnel who provided information and assistance were: Mark Spatford at Alberta Pacific, Wayne Crouse and Tom Tarpey at Daishowa, Mark Frith at Slave Lake Pulp, Wendy Lyka and Ian Holland at Millar Western, Brian Steinback at Alberta Newsprint, and Laudy Lickacz at Weldwood.

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1.0 INTRODUCTION

Knowledge of fish movements throughout the Northern River Basins Study (NRBS) area is essential to understanding contaminant burdens in fish and identifying critical fish habitats. Radio telemetry is often employed to gather data on fish dispersal, migration, and behaviour relative to environmental parameters. Telemetry provides the opportunity to search large areas to find mobile species, and to track multiple species and many individuals, and it is rarely affected by seasonal conditions (e.g., ice cover).

The value of radio telemetry in the NRBS area was confirmed in the fish radio telemetry studies conducted in summer and fall of 1992 and winter 1993 (R.L. & L. Environmental Services Ltd. 1993a and 1993b). Data were collected on movements of six species in the upper Athabasca River, using both a ground station and aerial reconnaissance.

During aerial data collection for the 1992 radio telemetry demonstration study, it was observed that reception of signals on some frequencies was hampered by noise events. The source of these noise events was unknown, although many occurred in urban, industrialized locations (e.g., Hinton). It should be noted that the noise rarely prevented identification or reception of the signal; however, it reduced the range of reception and thus increased the possibility of the signal being missed.

Background noise is commonly encountered in radio signal reception. This interference can be caused by many factors, both natural (e.g., sunspot activity) and man-made (e.g., engine ignition noise, mobile radio transmissions, electrical generators and powerlines). Noise can occur over a wide range of frequencies, and can vary from hour to hour, and thus it can never be completely avoided. Researchers can attempt to avoid those frequencies exhibiting high noise levels or, if unavoidable, employ equipment that is reliable in the presence of noise (i.e., noise filters, signal coding, high-powered transmitters, high-gain directional antennae).

Within the Northern River Basins Study Area (Athabasca/Peace rivers), significant noise problems for fisheries radio telemetry studies are likely to be encountered only within a limited number of municipal/industrial areas. The remainder of the drainage area, being relatively undeveloped, will not experience high levels of anthropogenetic noise. In March 1993, the NRBS commissioned R.L. & L. Environmental Services Ltd. to conduct noise scans at Northern Alberta pulp mill sites to identify problem frequencies. If practical, these frequencies can be avoided during future telemetry study planning, and thus optimize data collection.

1.1 OBJECTIVES

In spring 1993, the Northern River Basins Study (NRBS) was considering implementing a large-scale fisheries radio telemetry study that could incorporate ground (fixed) stations in the vicinity of northern Alberta pulp and paper manufacturing facilities. The NRBS recognized that orders for radio transmitters would have to be placed prior to the study initiation, and in the absence of noise-level data for probable study sites, the potential existed that a large number of transmitters could be affected by background noise. A frequency scan was thus essential to identify radio noise levels in these areas.

An intensive noise study would entail monitoring each potential ground station site for a minimum of 24 to 48 h to ensure both constant noise events (e.g., pumphouse electrical equipment) and random noise events were recorded. Since insufficient time and funding was available to undertake the full study before the end of March 1993, the next option was to determine which frequencies would be most problematic. While random noise events occurring throughout a 24 h period potentially could be a greater problem, the time constraints dictated that only noise from machinery constantly or frequently in use could be captured. It was understood at the time of study planning that it was impractical to distinguish between noise sources, and that any frequencies with noise regardless of source should be flagged. Therefore, the primary objective of the study was to capture noise events from constant sources and occasional noise events from random sources.

A second objective was to observe and record physical conditions at potential ground station sites. These observations were to be made within the context of successful ground station setup and reception. The study was designed so that only subjective evaluations would be made; physical measurements of water depths, bank height etc. were beyond the scope of the investigation. The intent was to capture order-of-magnitude observations. For example, in practical terms it is unnecessary to obtain precise measurements on bank height (e.g., whether the river bank is 3.0, 3.5, or 4.0 metres high). It is important, however, to know whether the river bank is 3 m or 30 m high, since bank height (and thus antenna height) can influence reception.

In summary, this study was designed to provide information that:

1) would allow radio transmitters to be ordered prior to commencing a fish telemetry study at selected sites on the Athabasca and Peace river systems;

2) would identify radio frequencies exhibiting the least interference for reception of signals from transmitters;

3) would identify frequencies with continuous radio noise influences;

4) would allow subjective evaluation of the physical suitability of the site for a ground station.

The Terms of Reference are presented in Appendix A.

1.2 STUDY AREA

The study focussed on the immediate area of four pulp and paper developments on the Athabasca River system, and one development on the Peace River. Remote sites, located downstream of these areas and in the vicinity of where complete effluent mixing during low flow periods is likely to occur, also were investigated.

The location of sites examined (Table 1.1) were as follows:

- Hinton (Weldwood of Canada Ltd. mill) - Site located above but near combined pulp/sewage point discharge, remote site located at Obed Mountain Coal Bridge crossing (20 km downstream);

- Whitecourt mills - Site located above but near the Alberta Newsprint Company Ltd. outfall, Town of Whitecourt near the confluence of the McLeod and Athabasca rivers, but above the Millar Western Pulp Ltd. point discharge; remote site located near Blue Ridge (23 km downstream of Millar Western);

- Lesser Slave River mill - Site located above but near the Slave Lake Pulp Corporation Ltd. point discharge, remote site located at Smith near the confluence of the Lesser Slave and Athabasca rivers (47 km downstream);

- Alberta Pacific mill - Site located above but near the Alberta Pacific Forest Industries Inc. point discharge, remote site at Poacher's Landing (6 km downstream);

- Peace River mill - Site located above but near the Daishowa mill point discharge, remote site located at Notikewin Provincial Park (163 km downstream).

Individual study site maps are presented in Appendix B.

Table 1.1 Area and sites investigated for radio signal noise, March 1993.

AREA	LOCATION OF SITE	UTM COORDINATE
Hinton Mill	Weldwood Water Intake	11U 5917900 N 460995 E
Hinton Remote	Obed Mtn. Coal Bridge	11U 5930650 N 476250 E
Whitecourt Mill	Millar Western Lagoon	11U 6001500 N 585600 E
Whitecourt Mill	Alberta Newsprint Intake	11U 6003400 N 577880 E
Whitecourt Remote	Blue Ridge Bridge	11U 6002150 N 605350 E
Lesser Slave River Mill	Slave Lake Pulp Intake	11U 6129100 N 660800 E
Smith Remote	Smith Bridge	11U 6117550 N 688400 E
Athabasca Mill	Alberta Pacific Intake	12U 6092580 N 377800 E
Athabasca Remote	Poacher's Landing	12U 6091850 N 383150 E
Peace River Mill	Daishowa Intake	11V 6246200 N 488600 E
Peace River Remote	Notikewin Provincial Park	11V 6349250 N 490975 E

2.0 METHODS

2.1 SCHEDULE

With the assistance of NRBS staff, contacts were established with mill management personnel and access to industrial sites obtained during the period 17-19 March 1993. On site evaluations were carried out between 22 and 28 March 1993. Initially, the Weldwood Mill at Hinton was investigated. The research team then returned to base to refine the equipment and procedures, after which the remainder of the sites were scanned.

2.2 SYSTEM DESIGN

The Northern Alberta Institute of Technology (NAIT), Telecommunications Engineering Technology Department, was subcontracted to provide technical and analytical assistance during the survey. Mr. J. Want, Program Head, Telecom Section, was on-site at all locations to conduct the noise scans. A report on the analysis is included as Appendix C.

An IFR Model A8000 portable spectrum analyzer was utilized to conduct the noise scan. Power for operation was provided by a 12 volt adaptor allowing generation on-site from a vehicle. A single omni-directional antenna was utilized. Although some signal loss is experienced with this type of antennae, use of a broad band high gain antennae (i.e., a log periodic antennae) would have required adding a directional component to the study (impractical within the time frame) and would have been of no advantage as the exact location of the receiver sites was unknown. Specifications for the spectrum analyzer and antenna are provided in Appendix C.

The frequencies examined for radio noise were those in the 140-180 MHz bandwidth. These frequencies are located in high-use ranges, and are also frequently selected by biological researchers and suppliers of telemetry equipment. Most (91%) of the frequency scans were conducted between 0800h and 1600h, as this work period would be most likely to encounter use of radio communications, electrical motors at industrial sites, etc., and when industrial activity was likely to be greatest. Time constraints, however, meant that observations had to be recorded on a weekend day at Alberta Pacific and Slave Lake. Scanning on a weekend day at the Alberta Pacific site likely did not bias the results, since this plant was not yet in production, and pumphouse electrical equipment was in operation at both the Alberta Pacific and Slave Lake Pulp sites during the period of the scan.

2.3 SITE SELECTION

Data were collected from all of the locations specified in the Terms of Reference. At some locations, however, the specific site where the data were collected differed. Timing constraints meant that vehicular access had to be gained at all sites. Moreover, the amount of equipment needed to perform the analysis (e.g., spectrum analyzer, battery, camcorder, cameras) meant that carrying the equipment overland was impractical.

Generally, test sites were selected along the shoreline of the river (Athabasca, Peace, Lesser Slave rivers) near each mill site (intake or effluent discharge point), or near a river access point at the downstream remote locations. Alternate locations for conducting the noise scans were needed at the Alberta Pacific and Slave Lake Pulp sites. At both of these intake sites, electrical equipment was in operation and the strong fields around the electrical transformers necessitated moving the site. In the case of Slave Lake Pulp, the site was moved to the discharge point, while at Alberta Pacific, the site selected was approximately 300 m from the river and intake facilities.

Each site also was subjectively evaluated and photographed for potential use as a fixed station radio telemetry site. Topographical features and physical parameters such as bank height, line of sight (antennae positioning), river width,, access, security, and conveniences (e.g., power) are described.

2.4 SIGNAL ACQUISITION

A brief description of some of the terms used in the following section is provided to aid in understanding the subsequent discussion. Frequency span (sweep range) refers to the interval between radio frequencies, whereas resolution can be viewed as the degree of precision, or capability to distinguish between component parts. Assuming a constant sweep time, the sweep range and resolution have an inverse relationship, such that as the sweep range decreases, the ability to distinguish between frequencies increases. An analogy can be drawn to a microscope, in that as the magnification is increased, less of the total object can be seen, but more detail is present. The noise floor represents a lower limit where noise spectra can not be distinguished from static; the noise floor decreases as resolution increases.

Initially a wide-band low resolution scan, incorporating all frequencies in the 140-180 MHz range was conducted. Due to the low resolution (300 KHz) available when scanning a wide range such as 140-180 MHz, the frequencies with noise could only be identified to the nearest 1 MHz. At this resolution, the number of frequencies with noise within a 1 MHz frequency span could not be determined (i.e., there may be one or several frequencies with noise, but the analyzer would only display a single spectral component). The next step was to narrow the sweep range (increase the resolution to 30 KHz), which resulted in a 10 MHz bandwidth being scanned (e.g., 140-150 MHz). Increasing the resolution also quadrupled the total scan time, since instead of a 40 MHz frequency span being scanned at one time, the 40 MHz bandwidth was scanned in four 10 MHz intervals.

Narrowing the bandwidth had two effects in addition to increasing the time needed to perform the scans. Firstly, the spectrum analyzer now displayed noise spectra at the 0.1 MHz order of magnitude, and thus the noise spectra were separated into components (e.g., noise on 148.1 MHz, 148.6 MHz, etc.). Secondly, this lowered the noise floor (e.g., 26 dBμV to 13 dBμV), which allowed frequencies with noise that had gone undetected at the higher noise floor to now be detected. The sweep range was then further narrowed to display only the 148-152 MHz bandwidth (3 KHz resolution), since these frequencies were previously used for radio telemetry on the Athabasca River (R.L. & L. Environmental Services Ltd. 1993a).

The spectrum analyzer was monitored both in the "live" and "peakhold" (storage) modes. The peakhold mode allowed the spectrum analyzer to run unattended for a period of time, however, when this mode was employed, the observer could not distinguish between randomly-occurring noise (e.g., mobile telephone) and industrial noise (e.g., pump). Noise generated by automotive ignition systems was detected by the spectrum analyzer, and scans had to be repeated in several cases after interested mill personnel arrived at the site to observe the procedures.

The noise data were recorded in three ways. Firstly, the spectrum analyzer display was videotaped with a Sony CCD-TR4 video camera recorder (HandiCam), and the tape was returned to NAIT for analysis. Secondly, the display was photographed with an Olympus OM-2 camera equipped with a macro lens. Thirdly, observations were recorded on a form or in a field notebook. Photographs of site layout were taken at each location investigated (Appendix D).

It was anticipated that additional data could have been collected by employing the reference transmitter used in the fisheries telemetry projects (R.L. & L. Environmental Services Ltd. 1993a and 1993b); however, the battery in the reference transmitter expired the day the field component commenced.

3.0 RESULTS

3.1 NOISE DETECTION

Table 3.1 summarizes the frequencies on which radio noise was detected; the specific noise levels for each frequency, measured in dBμV, are presented in graphical and tabular form in Appendix B. In order to relate the results in terms applicable to radio telemetry, the SRX_400 radio telemetry receiver (Lotek Engineering Inc.) described in the Athabasca River fish radio telemetry demonstration project (R.L. & L. Environmental Services Ltd. 1993a) is used for discussion purposes. The minimum noise signal at the narrowest resolution (3 KHz) varied between 0 and -3 dBμV, which is a noise floor 13 to 17 dB above the minimum signal detectable by an SRX_400 receiver.

The implication of this is that noise identified on the frequencies listed in Table 3.1 can be detected by the SRX_400 receiver, and thus potential noise interference exists on all of those frequencies. If the frequencies with the highest associated noise levels are avoided (i.e., frequencies listed in Table 3.1), then the chance of noise interference is reduced. The question of whether noise from mill or industrial sources would interfere with signal reception from a radio transmitter can best be answered by range testing at the fixed station site. Signals emitted by a transmitter may be of sufficient strength that they can be decoded by a data logger even in the presence of background noise.

Table 3.2 identifies frequencies in the 140-180 MHz range for which noise was not detected. It cannot be assumed that these frequencies are totally free of noise, but only that these frequencies were clear during the period when that particular bandwidth was being scanned. For example, at the Slave Lake Pulp discharge there was a spectral event measuring 14 dB on the 148.6 MHz frequency during the 30 KHz resolution scan, which did not show on the 3 KHz resolution scan completed approximately 60 minutes later (Appendix B).

The criteria for including the frequencies listed in Table 3.2 was that a minimum 1.0 MHz noise-free frequency span be available (i.e., 143.0 - 144.0 MHz); this was for presentation purposes only. Table 3.1 presents data on those frequencies on which noise was detected, so that individual frequencies not listed in the Table 3.1 were noise-free during the testing period. This distinction is important when the type of transmitter (i.e., coded or pulsed) to be used is considered.

There are two general categories of transmitters that are currently used in radio telemetry; these are standard pulse controlled and coded. Normal pulse controlled transmitters usually operate on the basis that one transmitter occupies one frequency; however, pulse repetition (i.e., beats per minute) can be varied allowing use of several transmitters on the frequency. Typically, pulsed transmitters operate on a 10 KHz frequency separation so that in theory 100 or more transmitters could be placed in a 1.0 MHz bandwidth. Coded transmitters are a variant of pulsed transmitters. In the coded transmitters offered by Lotek Engineering Inc., a 16 bit digital identification code is inserted into every eighth pulse. Digital encoding provides a unique numerical identification system and permits a large number of transmitters (e.g., up to 100) on a single frequency. Reducing the number of frequencies to be searched reduces the scan cycle time, which in turn reduces the possibility that a transmitter will go undetected.

Table 3.1 Bandwidths with noise spectra measured at specific locations along the Athabasca and Peace rivers, March 1992. All spectra identified potentially could interfere with radio transmitter reception; noise levels (dB) on individual frequencies are indicated in Appendix C.

AREA	LOCATION	10 MHz BAND-WIDTH	1 MHz BANDWIDTHS									
			0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
Hinton Mill	Weldwood Water Intake	140-150				.1-.8						.6-.9
		150-160			.6-.8		.9	.8				.6-.8
		160-170		.1-.8			.7	.3		.2-.4	.7	
		170-180	.6	.4								
Hinton Remote	Obed Mtn. Coal Bridge	140-150				.6			.7		.5	.6-.9
		150-160			.5-.9							
		160-170					.7					
		170-180										
Whitecourt Mill	Millar Western Lagoon	140-150			.6						.1-.7	.2-.8
		150-160	.3-.9	.2-.9	.5-.9		.5					.9
		160-170	.2		.2	.1-.4	.4-.8		.5		.5	.0-.5
		170-180			.1	.4		.0		.0-.2		.9
Whitecourt Mill	Alberta Newsprint Intake	140-150	.2	.0-.5		.0-.9	.0		.8		.1-.7	.8
		150-160	.9	.6-.9	.7	.2-.3	.5	.0-.7		.1-.7	.1-.7	
		160-170	.2-.6		.2-.5	.4	.2-.4	.5	.5-.6			.0
		170-180		.4		.6		.0				.2-.9
Whitecourt Remote	Blue Ridge Bridge	140-150		.4	.8			.0-.5			.7	.7-.9
		150-160	.5	.0	.3-.8	.2	.5-.6	.0		.6		
		160-170	.9		.5	.5						.8
		170-180		.4		.0		.0		.5	.2	.8-.9
Lesser Slave River Mill	Slave Lake Pulp Intake	140-150	.4		.3	.7	.8	.0			.7	.3-.5
		150-160	.0		.1-.8		.6	.0		.7		
		160-170				.4		.3				
		170-180						.0				
Lesser Slave River Mill	Slave Lake Pulp Outlet	140-150									.6	
		150-160			.1-.8		.6	.0	.5	.8		
		160-170		.7	.5			.0-.9				
		170-180						.0				
Smith Remote	Smith Bridge	140-150	.4	.1-.4			.5	.4		.0	.0, .7-.9	
		150-160			.6-.8							.6
		160-170			.2			.2			.0	
		170-180										
Athabasca Mill	Alberta-Pacific Intake	140-150			.8						.7	
		150-160										
		160-170										
		170-180						.0				.0
Athabasca Remote	Poacher's Landing	140-150			.8			.0			.7	.9
		150-160	.0									
		160-170			.4							
		170-180										
Peace River Mill	Daishowa Intake	140-150			.6	.9	.9	.0, .5	.3		.7	.8
		150-160	.0		.4-.8	.6		.0-.3				
		160-170			.5	.7	.4	.0			.3, .8	
		170-180						.0-.3				
Peace River Remote	Notikewin Provincial Park	140-150		.2	.8	.2					.4, .7	
		150-160	.0					.0				
		160-170	.6		.5		.4					.0
		170-180						.0				.0

Table 3.2 Clear radio frequencies in general reaches of the Athabasca and Peace rivers when measured in late March 1993. Criteria for inclusion in the table were that a minimum of 1 MHz bandwidth be noise-free.

GENERAL REACH INCLUDING REMOTE SITES				
HINTON	WHITECOURT	LESSER SLAVE RIVER	ATHABASCA	PEACE RIVER
140.0-143.0	146.9-148.0	145.5-146.9	140.0-142.7	140.0-141.1
143.9-146.6	155.8-157.0	147.1-148.5	142.9-144.9	146.4-148.3
146.8-148.4	161.0-162.1	150.1-152.0	145.1-148.6	153.4-160.5
150.0-152.4	166.7-168.4	152.9-154.5	150.1-162.3	165.1-168.2
153.0-154.8	169.9-171.3	157.9-159.5	162.5-174.9	169.1-174.9
155.9-159.5	173.7-174.9	159.7-161.6	175.1-178.9	175.4-178.9
161.9-164.6	175.1-176.9	163.5-164.9		
165.4-167.1		166.0-167.9		
168.8-170.5		168.1-174.9		
171.5-180.0		175.1-180.0		

Table 3.3 identifies the noise-free bandwidths grouped for the Athabasca River drainage; Peace River noise-free frequencies are presented in Table 3.2. The rationale for grouping the data is that, depending on the species selected for telemetry studies, movements between general areas may occur (e.g., Hinton area to Whitecourt area).

Another option for analyzing the noise spectra can be to consider only the readings from the remote stations. Since the remote locations are free of noise spectra associated with pulp mills (e.g., pumphouse electrical equipment) and are removed from any industrial activities, the data collected there provide a baseline of frequencies on which noise spectra were found (Figure 3.1). The majority of the clear frequencies were located above 155 MHz, although noise-free frequencies were identified throughout the 140 to 180 MHz bandwidths.

Table 3.3 Clear radio frequency slots for sites along the Athabasca River from Hinton to Poacher's Landing when measured in late March 1993.

ALL ATHABASCA DRAINAGE
147.1-148.0
173.7-174.9
175.1-176.9

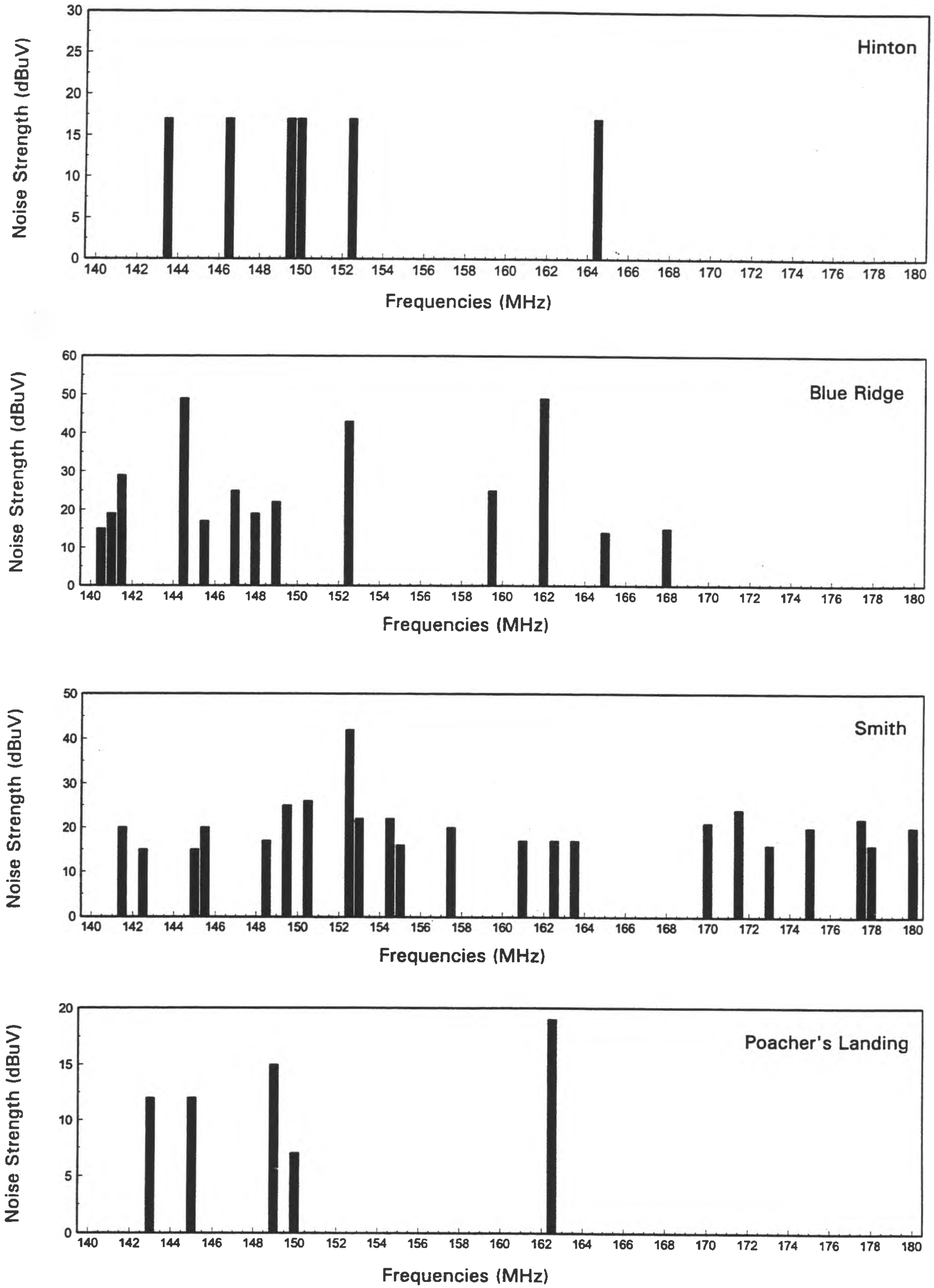


Figure 3.1. Frequencies with noise spectra from Athabasca River remote sites, March 1993.

3.2 SITE DESCRIPTIONS

At each site a description of the topographical features and physical suitability of the site for installation of a ground station was recorded. Data on the availability of potential ground station locations was considered an adjunct to the noise spectra collections, and as such, there was no attempt to investigate all potential site locations in the vicinity of a mill or remote site. This type of survey would, ideally, require several days. Potentially limiting factors (e.g., river width) were identified in the Radio Telemetry Demonstration Study (R.L. & L. Environmental Services Ltd. 1993a) as having the potential to reduce or eliminate signal reception. All pumphouse sites had visible power sources (i.e., power lines entering the building), and most had visible telemetry antennae or were fed by telephone lines. Information on nearby boat launches also was included, since boat ignition systems can block radio signal reception. Rating of the sites was on an ordinal scale, with divisions of excellent, good, moderate, and poor. The following section describes preliminary site characteristics observed at each location.

Hinton Area

Observations were made at both the Weldwood-Hinton water intake pumphouse and at the discharge location; both sites were located along the south shore of the Athabasca River. Both sites had good potential for installation of ground stations. The major limiting factor at both sites was low streambank height, which was approximately 4 m above river level in late March. Both sites had a sufficient line of sight for directional antennae. River width was estimated to be 200 metres. The presence of mid-channel gravel/cobble bars suggested that the river was relatively shallow (e.g., less than 5 m) in the general vicinity and thus water depth would not reduce signal transmission from a radio-tagged fish.

The remote site investigated in the Hinton area was the Obed Mountain Coal Bridge. This site had moderate potential for operation of a ground station. The major limiting factor at this site was the presence of the coal conveyor belt and high voltage electrical transmission lines; the conveyor belt was part of the bridge structure and the power lines were in close proximity to the bridge. The north shore streambank above the bridge was estimated to be 25 m in height, whereas the only suitable location along the south shore was along the boulder berm built in conjunction with the bridge crossing. The bridge itself may obstruct the line of sight in a downstream direction. The river width at the bridge was approximately 100 m. As indicated in the noise spectra results section, the conveyor belt was not in operation during the time the site was visited, and it is unlikely that the transmission lines were carrying power at peak load; thus it is difficult to estimate the degree of interference at this site. Should a ground station be required over 300 m in distance from the bridge, there will not be direct access to the site and trees will likely obstruct the line of site, and an alternate site should thus be selected.

Whitecourt Area

Access to the confluence of the Athabasca and McLeod rivers was gained through the Millar Western Pulp Ltd. property. This site offered moderate potential for a ground station. The major limiting factor was river morphology; there were two river channels separated by mid-channel islands in the immediate area, and it was not feasible to check whether the north channel was suitable for fish passage. Another limiting factor was bank height, which was approximately 3 m above river level in late March. Proximity to Whitecourt may cause problems, in that residents hike along the river bank in the immediate area, and therefore the potential for vandalism exists. A boat launch is located in the park immediately upstream of the Athabasca and McLeod rivers' confluence; boat traffic would cause interference. Positive factors include good lines of sight for the antennae. The river was estimated to be 200 m wide at this location, and river depth was estimated generally to be less than 5 m.

The Alberta Newsprint Company (ANC) site was located at the ANC pumphouse. Similar to the Millar Western site, the major limiting factor was river morphology. The Athabasca River split into two channels near the ANC pumphouse, which suggested that the optimum ground station site be located at the pumphouse or immediately upstream. The line of site was excellent in the pumphouse area, and river depths were estimated to be less than 3 m. The river width was estimated to be 200 m. Overall, the ANC pumphouse had good potential for a ground station.

The Whitecourt remote location was at the Blue Ridge Bridge (Highway 658), and this site was rated as having good potential for a ground station. Access to the area was excellent, the lines of sight were good, and there was sufficient room for two antennae. The river width was estimated to be 300 m, and the south shore bank upstream of the bridge was some 20 m above river level. The river was a singular channel at the bridge and without any mid-channel bars or islands, which suggested moderate or greater river depth. Minor limiting factors included river width and the possibility that, depending on the final antennae site chosen, the bridge could interfere with the downstream line of sight.

Lesser Slave River Area

Two sites were investigated near the Slave Lake Pulp Ltd. mill; these were the mill pumphouse and the discharge pipe. The preferred location was at the discharge pipe, due to its distance from the electrical transformers and high voltage power lines. The river width was estimated at 40 m and the river bank was approximately 3 m high. Both sites had sufficient lines of sight for antennae. Access was excellent at both sites. The Slave Lake Pulp location was rated as having excellent potential for a ground station.

The remote location in the Lesser Slave River area was at the north end of the Highway 2A bridge at Smith. The river bank was approximately 10 m above river level, and the river width was estimated to be 250 m. The bank face was in repose, and generally shrub covered. Both banks were heavily treed, and thus lines of sight were poor. The close proximity to Smith increases the possibility of vandalism. Overall, the Smith location was rated as having poor potential for a ground station. Due to difficulty of access, it was not possible to conduct a reconnaissance of the Lesser Slave - Athabasca confluence.

Athabasca Area

The Alberta Pacific Forest Industries Ltd. (ALPAC) site investigated was at the pumphouse, which was under construction at the time of the survey. The river was estimated to be 400 m wide, and river depth could not be estimated. The left upstream bank height was less than 3 m, and the banks were in repose. The pumphouse site was in a clearing cut in heavily forested land, so that the only available area for the antennae would be in relatively close proximity to the pumphouse (and thus close to a noise source). The major limiting factors of this site were wide channel width, low river banks, poor line of sight, and proximity to a noise source. The overall potential of this site was poor.

The Athabasca area remote station was located at Poacher's Landing, which is in the Pine Sands Recreation Area. As such, it receives a moderate to high amount of recreational use, which in turn increases the possibility of vandalism. The recreation area includes a gun club, and stray bullets potentially can cause substantial damage to a data logger, even when housed in a steel security cabinet. The river was estimated to be 400 m wide at Poacher's Landing. The river appeared to be relatively shallow in the area, based on the number of gravel bars visible and shown on topographic maps. The left upstream bank was approximately 3 m in height. The line of sight was rated as moderate, depending on how close the antennae were placed to the river's edge. The overall rating for the Poacher's Landing site was poor, based on bank height, river width, and security concerns.

Peace River Area

Access to the Peace River was gained through the Daishowa (Peace River Pulp Ltd.) plant site. The river was estimated to be 600 m wide at the pumphouse, and the bank was approximately 20 m above river level. The lines of site were excellent and there was sufficient room for two antennae. There were no mid-channel islands in the area, which suggested that the Peace River was relatively deep at this location. The major limiting factors at this site were river width and depth. Prior to installation of a ground station additional testing will have to be completed to determine if a transmitter located along the left upstream bank can be detected by a station on the opposite bank. If the transmitter cannot be detected, consideration should be given to installing a ground station on both banks. The Highway 686 bridge provides access to the east bank. Overall, the Daishowa site has moderate potential for a ground station.

The Peace River area remote location was at the Notikewin Provincial Park boat launch. The river was singular channel and approximately 500 m wide at this site. As with the Daishowa site, river depth could not be estimated, although the lack of mid-channel gravel bars suggested it was relatively deep. The streambanks were low in the area, and sites with elevation greater than 5 m above river level were a substantial distance from the river's edge. With the exception of the immediate area of the boat launch, the river bank was densely covered with trees and shrubs, thus restricting the lines of sight. The major limiting factors at the Notikewin location are river width, depth, bank height, potential for vandalism, and excess noise. Ignition noise from outboard engines and vehicles would cause interference with radio signal reception. Unlike the Daishowa site, however, there is no close access to the opposite bank. Overall, the Notikewin Provincial Park has poor potential as a ground station site.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Noise scans in the 140-180 MHz band were conducted in late March 1993. The sites selected were in close proximity to pulp and paper mills along the Athabasca and Peace rivers. There are a number of frequencies in the 140-180 MHz range that are suitable for radio telemetry transmitters; however, generally the higher frequencies contained the clearest slots. No completely clear wide band (i.e., 4 MHz) was available to provide a fish telemetry channel at any site and channels will have to be chosen between the spectral components found at each site. Researchers should avoid ordering transmitters tuned to frequencies known to have noise (Table 3.1).

Of the 11 sites investigated, only the Slave Lake Pulp outfall was rated as having excellent physical potential for a radio telemetry ground station. There were six sites having good or moderate potential for a ground station. Sites with poor potential for installation of a ground station generally had several limiting factors. The major factor of concern was river width, which increased the probability of not detecting a radio transmitter along the far shore. In addition, depths were a concern, with signals from a transmitter implanted in a demersal species (e.g., burbot) swimming in a mid channel location, being potentially undetectable. These physical characteristics may influence the technical requirements of future telemetry studies (i.e., power output of the transmitters, sensitivity of receivers and antennae, etc.) which also determines the maximum distance at which a transmitter can be received.

At selected ground station sites it is recommended that a continuous 48 h noise scan be performed prior to permanent (i.e., duration of a long-term radio telemetry project) installation of the station and implantation of radio transmitters. The final position of the telemetry station could be optimized based on this scan.

In addition, an on-site evaluation of signal reception, specifically at sites exhibiting extreme channel widths or low antennae elevations (low banks), should be determined prior to fixed station installation. This is particularly applicable at mill and remote sites associated with the ALPAC and Daishowa mills, where separate recording stations on either bank could be required.

5.0 LITERATURE CITED

R.L. & L. Environmental Services Ltd. 1993a. Fish radio telemetry demonstration project Athabasca River. Prepared for Northern River Basins Study, Subproject 3121. R.L. & L. Rep. No. 335F: 42 p + 6 app.

R.L. & L. Environmental Services Ltd. 1993b. Seasonal movements of radio tagged fish in the upper Athabasca River - Summer 1992 to Late Winter 1993. Prepared for Northern River Basins Study, Subproject 3121-B2. R.L. & L. Rep. No. 335E-F: 48 p + 3 app.

APPENDIX A

TERMS OF REFERENCE

NORTHERN RIVER BASINS STUDY
TERMS OF REFERENCE

PROJECT 3121-B3 RADIO TELEMETRY - NOISE SCAN

DRAFT

A. PURPOSE

1. Determine the background radio "noise" that would likely interfere with the reception of radio signals from fish equipped with radio transmitters.

2. Recommend a radio frequencies most suited for use on individual stretches of the rivers likely to be used in future fish movement studies using radio tags.

3. Describe preferred sites for location of ground stations.

B. NEEDS

1. On-site, daytime, determinations of radio noise at sites located within 5 river reaches on the Peace and Athabasca rivers.

2. Locations vary but typically one ground site is to be located in the immediate vicinity of a major industrial outfall and the other is located in the vicinity of where "complete mixing of effluent with the water column during recorded low flow periods" is likely to occur.

3. A report is to be prepared outlining recorded radio noise, recommended radio frequency at each site and river reach, and a description of preferred ground station site location characteristics.

C. SPECIFIC REQUIREMENTS

1. Scanning of radio noise in approximately the 140 - 180 MHz band e.g. Spectrum analysis. Initial scanning to be done in the 148-152 MHz range.

2. Collection of daytime information with a minimum of 3-4 analytical hours spent at sites likely to have considerable background noise. Remote sites are to be scanned a minimum of 2 hours.

3. Reaches and sites to be scanned are:

    a) Hinton (Weldwood Mill) - ground site above but near combined pulp/sewage outfall, zone of influence site near Obed Mountain road crossing.

b) Whitecourt - ground site above but near the Alberta Newsprint Company outfall, Town of Whitecourt near the confluence of the McLeod and Athabasca Rivers but above the Miller Western outfall, remote site near Blue Ridge.
c) Slave Lake - ground site above but near the Slave Lake Pulp Corporation outfall, remote site near the confluence of the Lesser Slave and Athabasca rivers.
d) Alberta Pacific - ground site above but near the Alberta Pacific Forest Industries Inc. effluent point, remote site near Poacher's Landing.
e) Daishowa - ground station above but near the Daishowa mill effluent point, remote site near the Notikewin River.

D. REPORTING REQUIREMENTS

1. Ten copies of the DRAFT report are to be submitted to the Project Liaison Officer (Ken Crutchfield, Office of the Science Director, Northern River Basins Study Office, by March 31st., 1993.

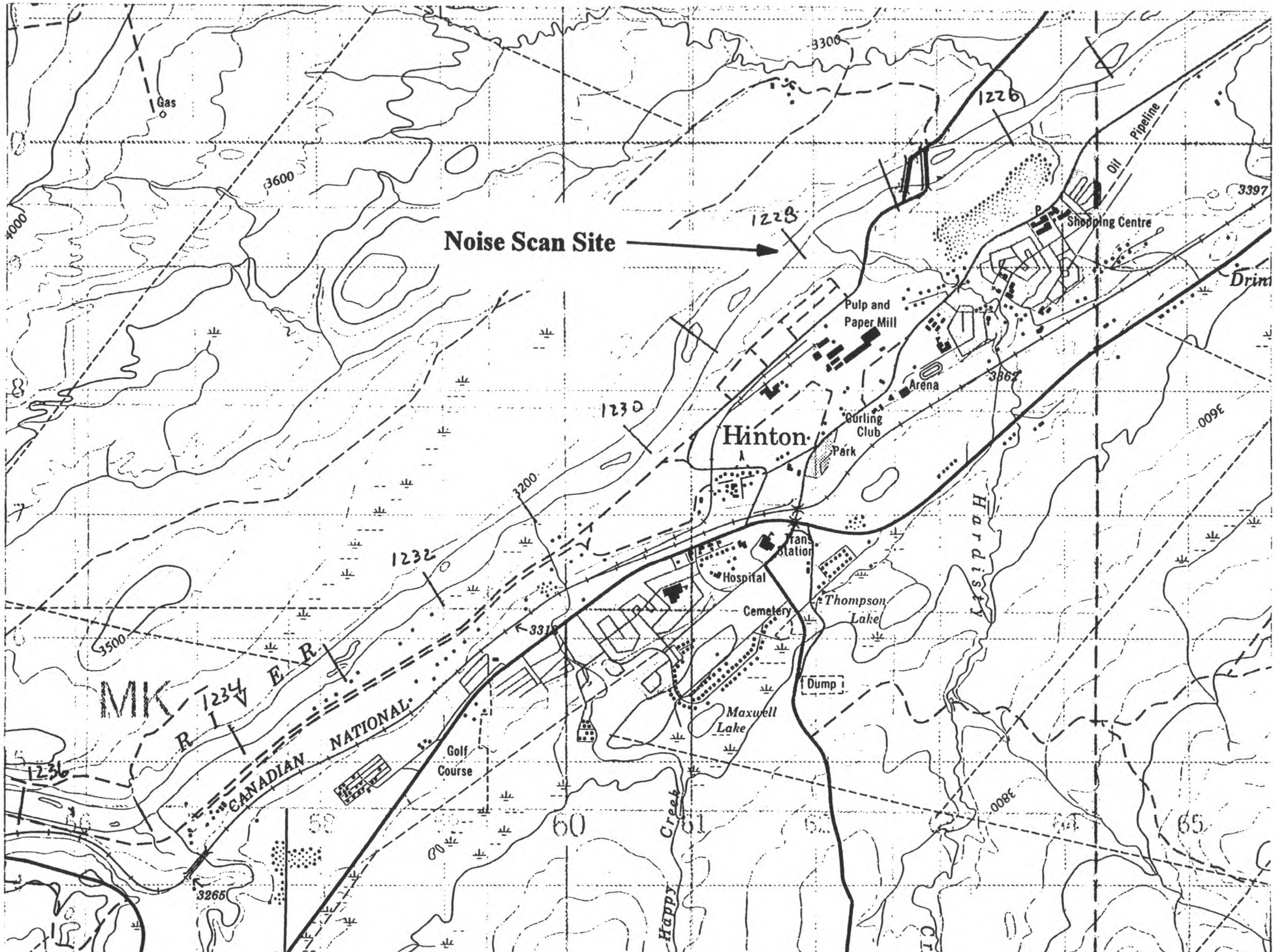
2. Review comments on the draft report are to be incorporated into the final report. The contractor is to submit ten cerlox bound copies and two unbound, camera-ready originals of the final report to the Project Liaison Officer. An electronic copy of the report, in Word Perfect 5.1 format is to be submitted with the final report. The final report is to contain a table of contents, executive summary, list of figures & tables, acknowledgements and an appendix with the Terms of Reference for this contract.

3. Sites to be noted on 1:50 000 NTS scale maps. UTM coordinates are to be provided for each site in tabular format within the report.

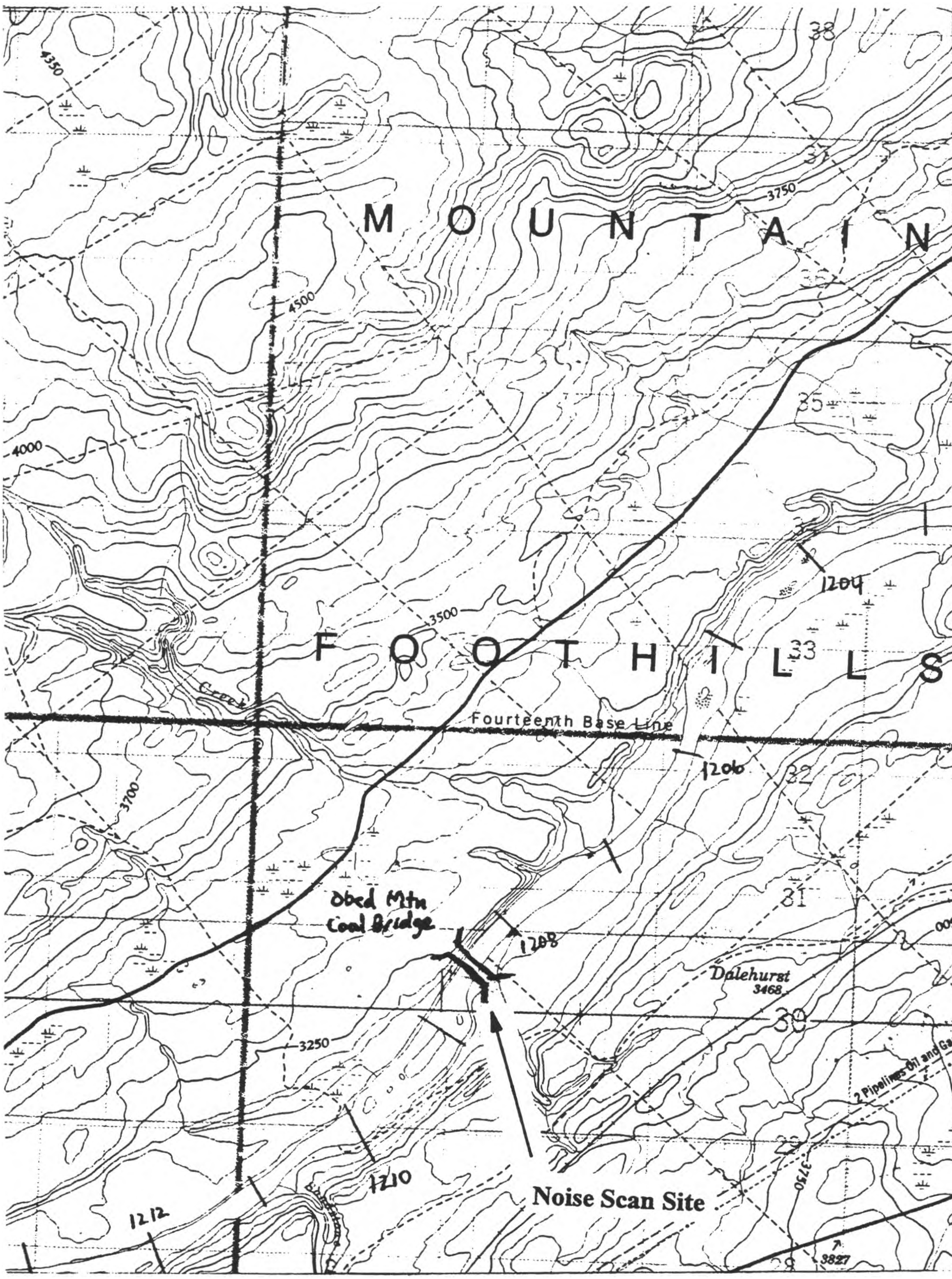
4. Black and white photographs of equipment and sites are to be incorporated into the report.

APPENDIX B

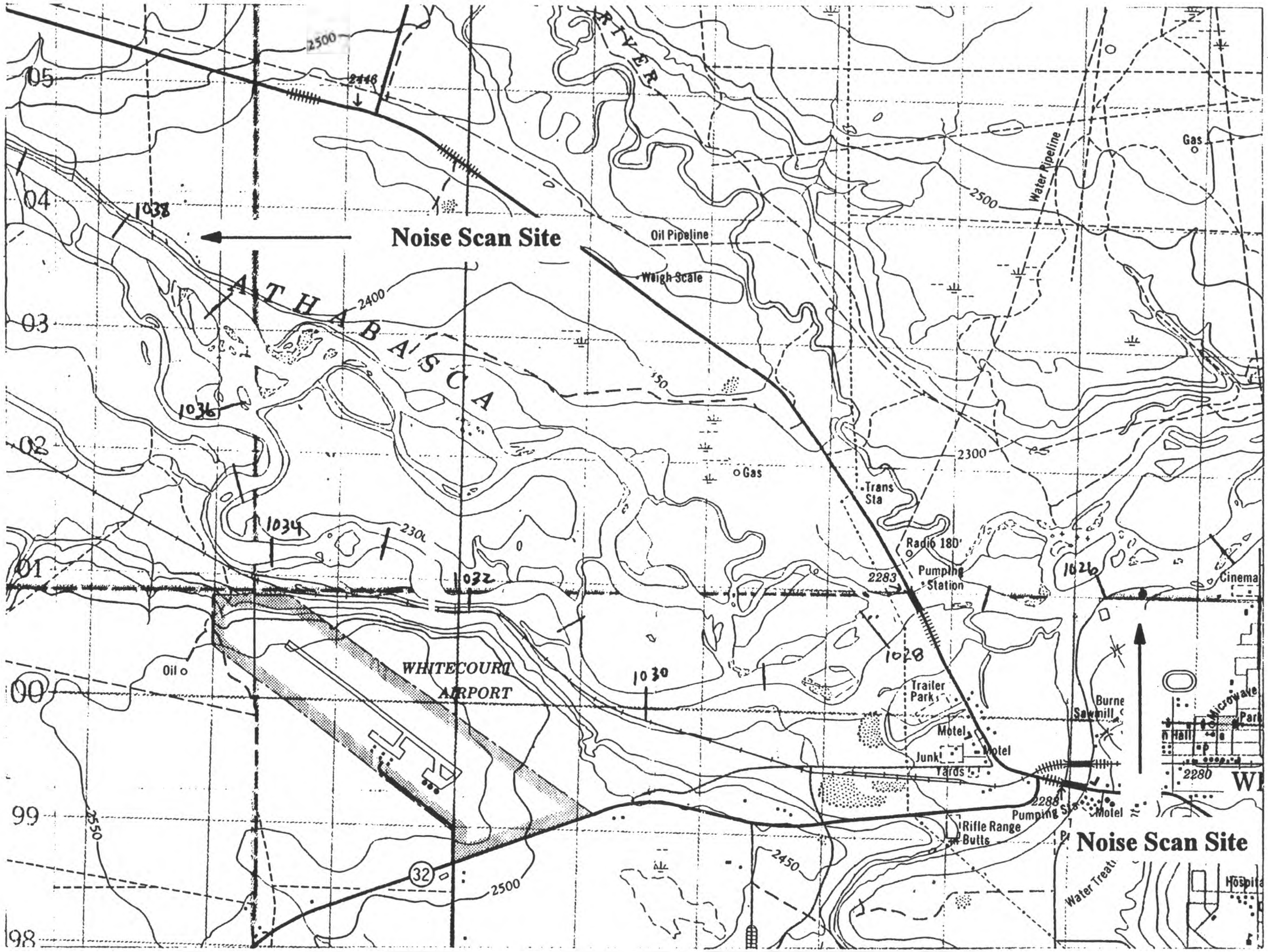
NOISE SCAN LOCATIONS



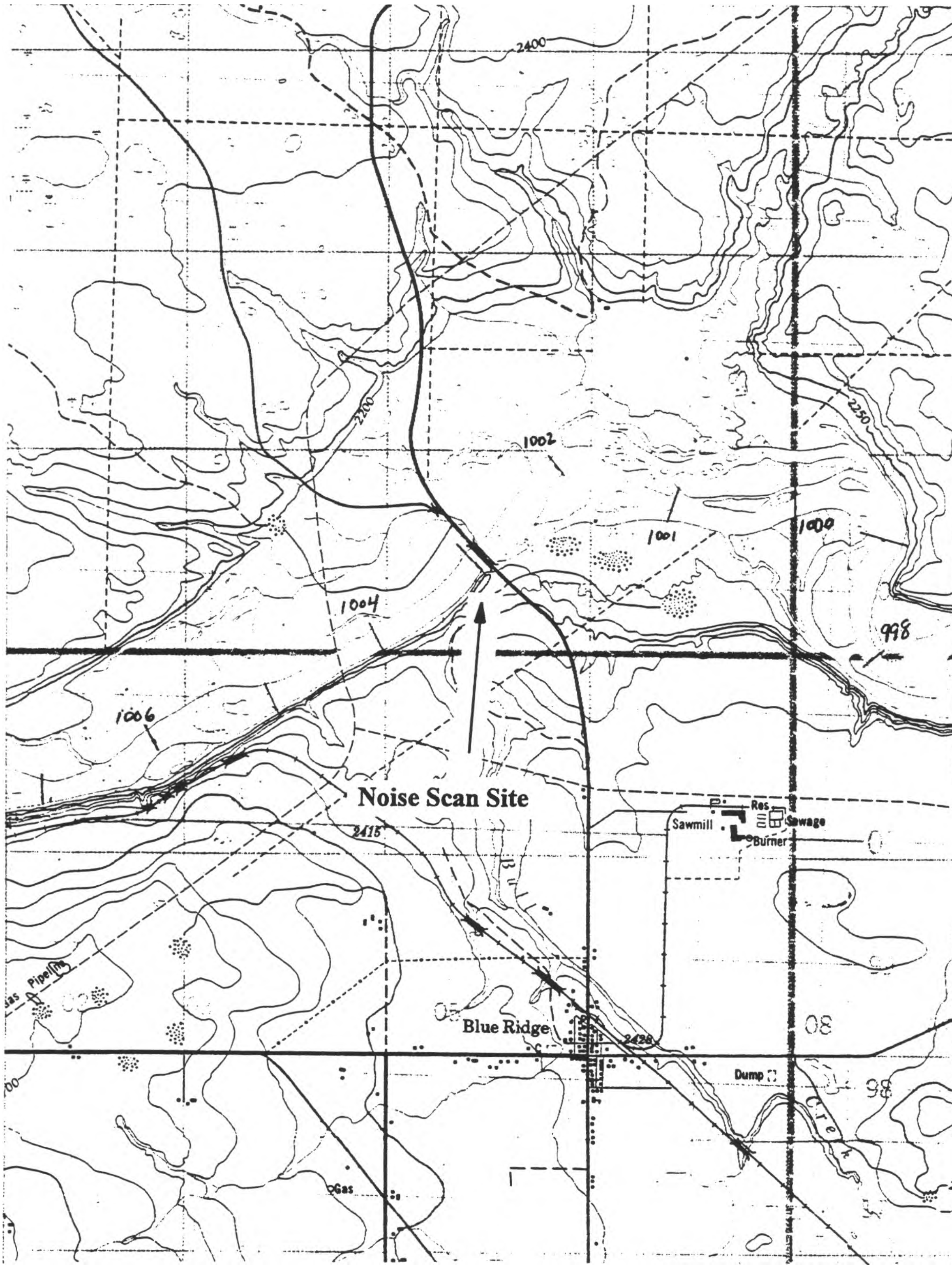
Appendix B, Figure B1. Location of noise scan conducted along the mainstem Athabasca River near the Weldwood Mill at Hinton, March 1993. From NTS map 83 F/5.



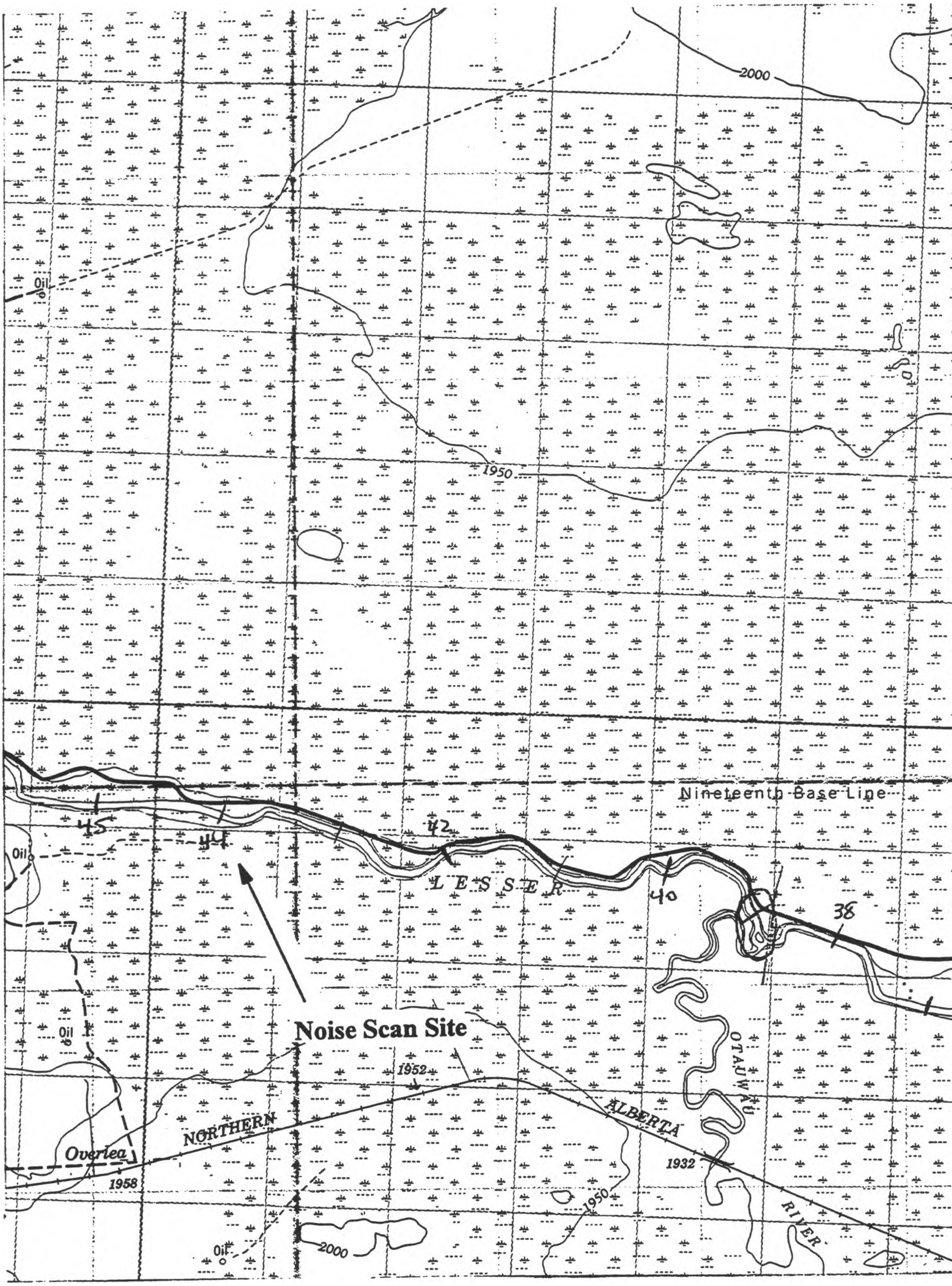
Appendix B, Figure B2. Location of noise scan conducted along the mainstem Athabasca River at Obed Mountain Coal Bridge (Hinton remote), March 1993. From NTS map 83 F/6.



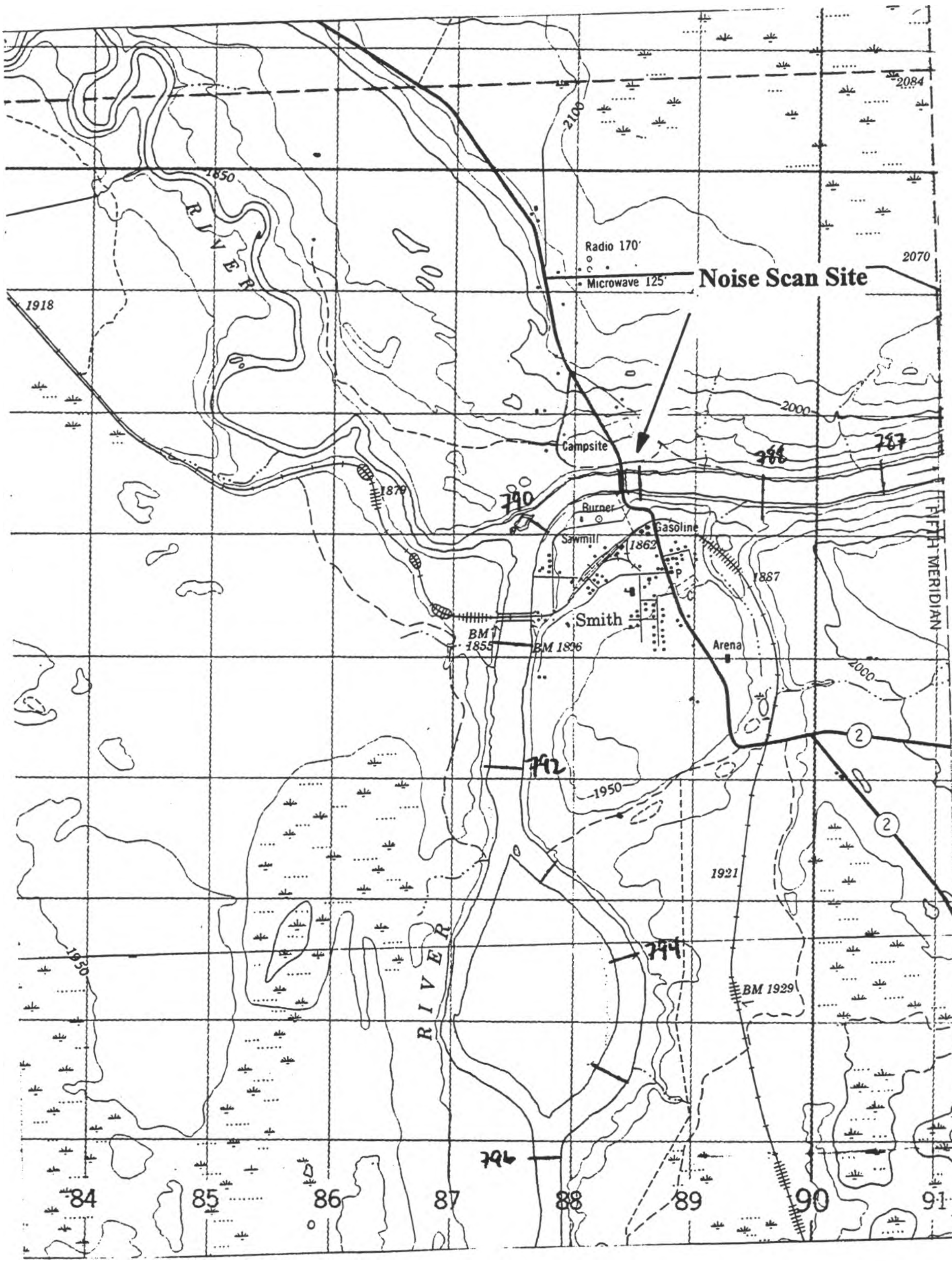
Appendix B, Figure B3. Locations of noise scans conducted along the mainstem Athabasca River near ANC and Millar Western mills, March 1993. From NTS map 83 J/4.



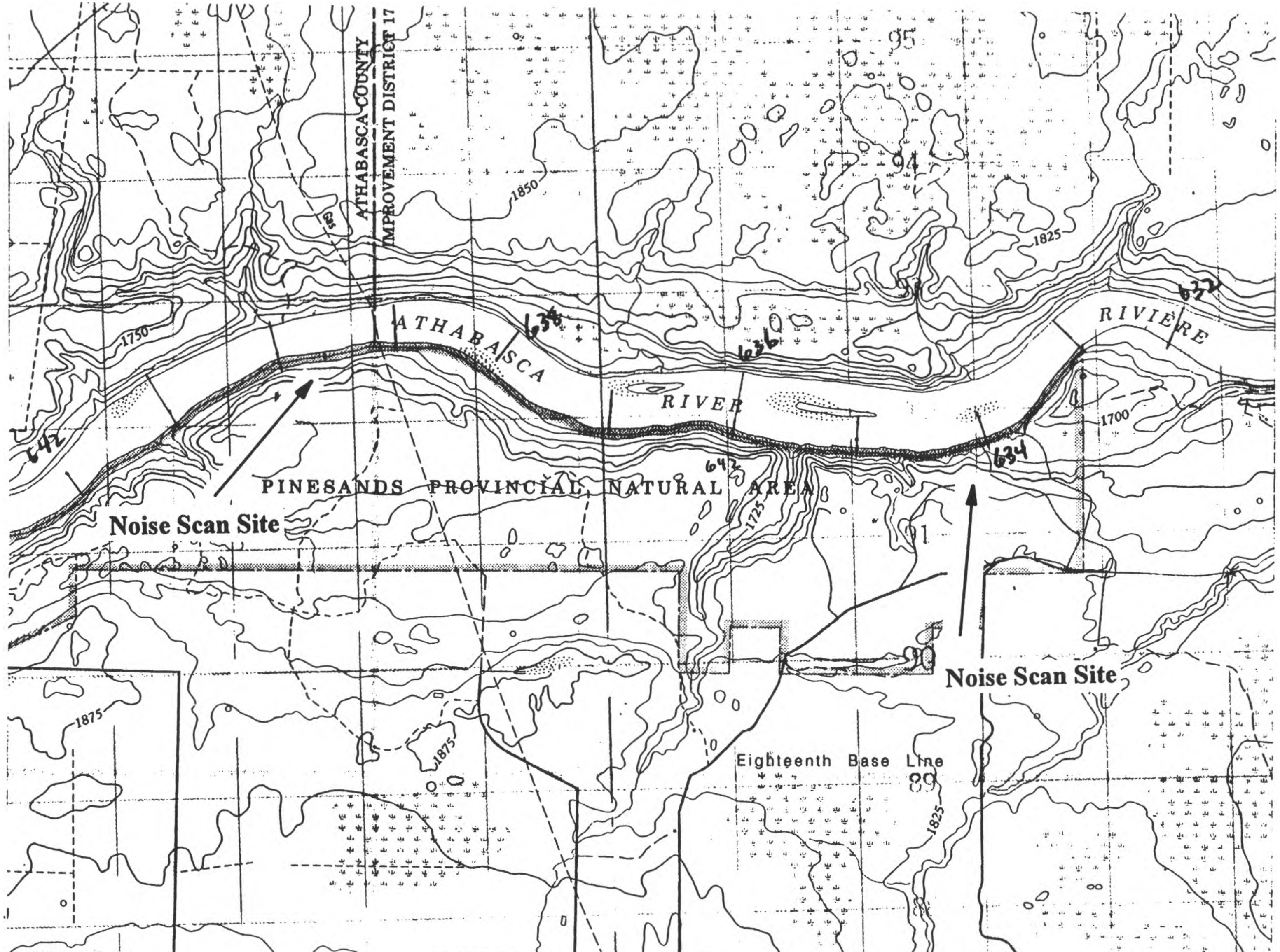
Appendix B, Figure B4. Location of noise scan conducted along the mainstem Athabasca River near Blue Ridge (Whitecourt remote), March 1993. From NTS map 83 J/3.



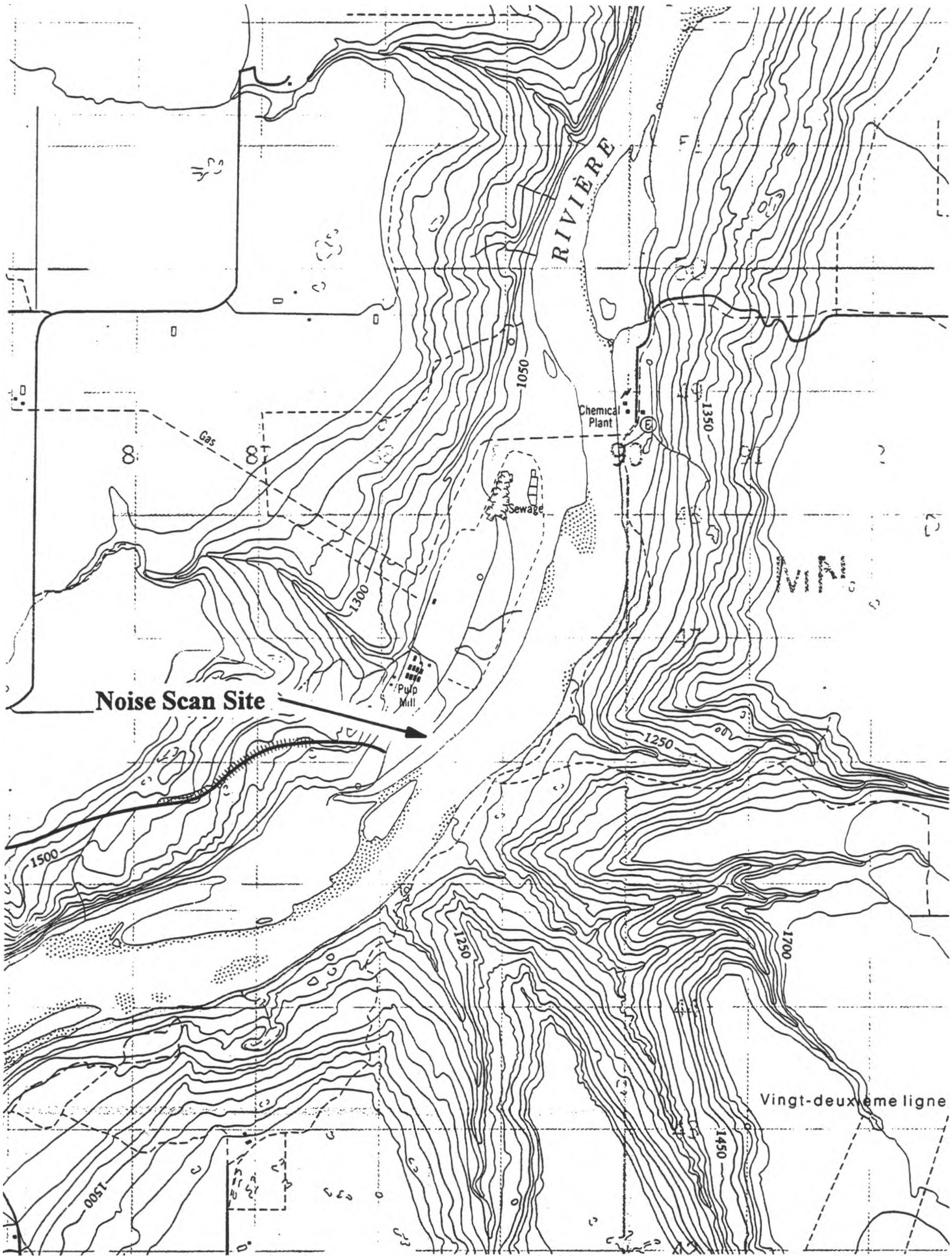
Appendix B, Figure B5. Location of noise scan conducted along the Lesser Slave River near the Slave Lake Pulp Mill near Slave Lake, March 1993. From NTS map 83 O/8.



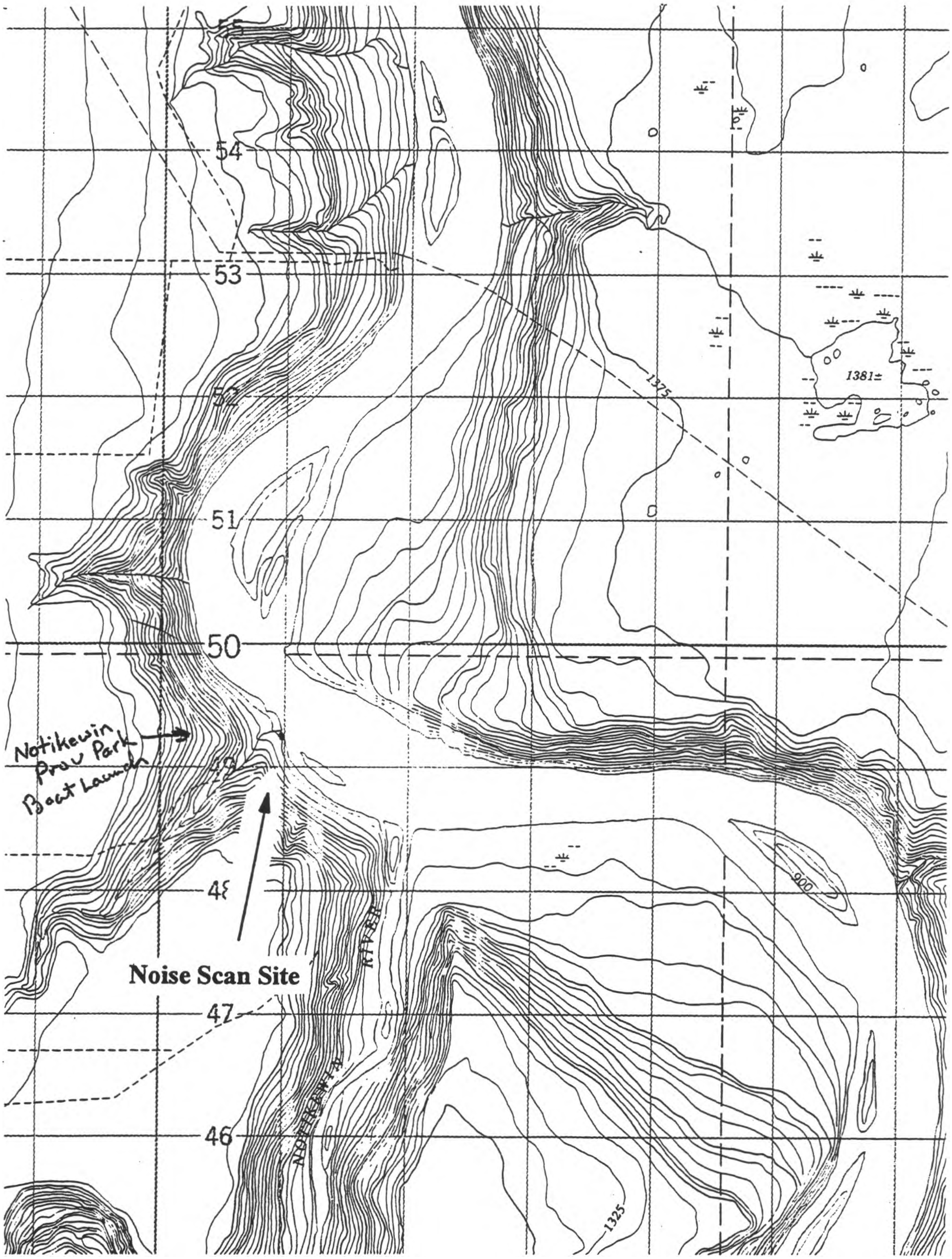
Appendix B. Figure B6. Location of noise scan conducted along the mainstem Athabasca River at Smith (Slave Lake Pulp remote), March 1993. From NTS map 83 O/1.



Appendix B, Figure B7. Locations of noise scans conducted along the mainstem Athabasca River near ALPAC and at Poacher's Landing (ALPAC remote), March 1993. From NTS map 83 I/15.



Appendix B, Figure B8. Location of noise scan conducted along the mainstem Peace River at Daishowa (Peace River Pulp) Mill, March 1993. From NTS map 84 C/6.



Appendix B, Figure B9. Location of noise scan conducted along the mainstem Peace River at Notikewin Provincial Park (Daishowa remote), March 1993. From NTS map 84 F/6.

APPENDIX C

NOISE SCAN TECHNICAL REPORT

Prepared by
NORTHERN ALBERTA INSTITUTE OF TECHNOLOGY

Report on

Radio Telemetry Noise

for

R. L. & L. Environmental Services Ltd.

Prepared by

Northern Alberta Institute of Technology

Office of Applied Research and Product Development

and

Telecommunications Engineering Technology

CONTENTS:

APPENDICES:

RADIO TELEMETRY NOISE SCAN:

1. Introduction and Objective

This noise scan was requested by R.L. and L. Environmental Services and prepared by the Northern Alberta Institute of Technology, Telecommunications Section. The objective of the frequency scan was to assist R.L. and L. Environmental Services in choosing quiet channels for their telemetry equipment. Tests were made at the following sites on the dates indicated:

1.1 Hinton Area, Monday, March 22, 1993
- 1) Weldwood Pulp Mill Water Inlet
- 2) Weldwood Pulp Mill Water Outlet
- 3) Obed Mountain Road (Athabasca Bridge) Test Site

1.2 Whitecourt Area, Thursday, March 25, 1993
- 1) Miller Western Pulp Mill Water Outlet
- 2) Alberta Newsprint Pulp Mill Water Outlet
- 3) Blue Ridge Control Site

1.3 Peace River Area, Friday, March 26, 1993
- 1) Diashawa Pulp Mill Water Inlet
- 2) Notikewin Provincial Park Test Site

1.4 Slave Lake Area, Saturday, March 27, 1993
- 1) Slave Lake Pulp Mill Water Inlet
- 2) Slave Lake Pulp Mill Water Outlet
- 3) Lesser Slave Lake Bridge Test Site Near Smith

1.5 Athabasca Area, Sunday, March 28, 1993
- 1) ALPAC Pulp Mill Water Inlet
- 2) Poacher's Landing Test Site

2. Procedure

The procedure used was to set up the spectrum analyzer and conduct three scans at each site, where each scan would narrow the frequency resolution and lower receiver noise level. Each scan was run on a real time basis for half of the duration of the test and on a storage basis for the balance. Both were recorded on video so that an estimate of the transient noise could be obtained. It was expected that a scan would be completed at both the Water Inlet and the Water Outlet at each pulp mill. This proved to be impossible because of a lack of vehicle access to some of the water inlet or outlet sites.

2.1.1 Scan 1, 135 mHz to 185 mHz.
The resolution was set at 300 khz and the full range of frequencies was swept every 2 seconds.

2.1.2 Scan 2, the bandwidth from 140 mHz to 180 mHz was broken into five 10-mHz bands. Each band was swept with a resolution of 30 khz every 2 seconds.

2.1.3 Scan 3, 147 mHz to 152.5 mHz.
The resolution was set at 3 khz. This scan was made with high resolution as it covered the bandwidth of existing equipment used by R.L. & L. This band was also swept every 2 seconds.

2.2 Procedure Deviations

2.2.1 Monday, March 22, 1993 at the Weldwood Plant and at the Obed site.
We were in the process of setting up the above procedures at these first sites. The third scan was made, but not recorded, at the Weldwood site. The video camera batteries failed at the Obed site, thus the frequencies were recorded manually, but very few of the levels were recorded.

2.2.2 Sunday, March 28, 1993 at the ALPAC and Poacher's Landing sites.
The parameter storage features of the IFR A8000 Spectrum Analyzer maintained the sweep timing of 200 msec per division from Thursday through Saturday. On Sunday, it reset all parameters to automatic optimization. This deficiency was not noted until the last scan at Poacher's Landing. The resulting changes to the Noise levels are shown on the frequency plots.

3. Equipment

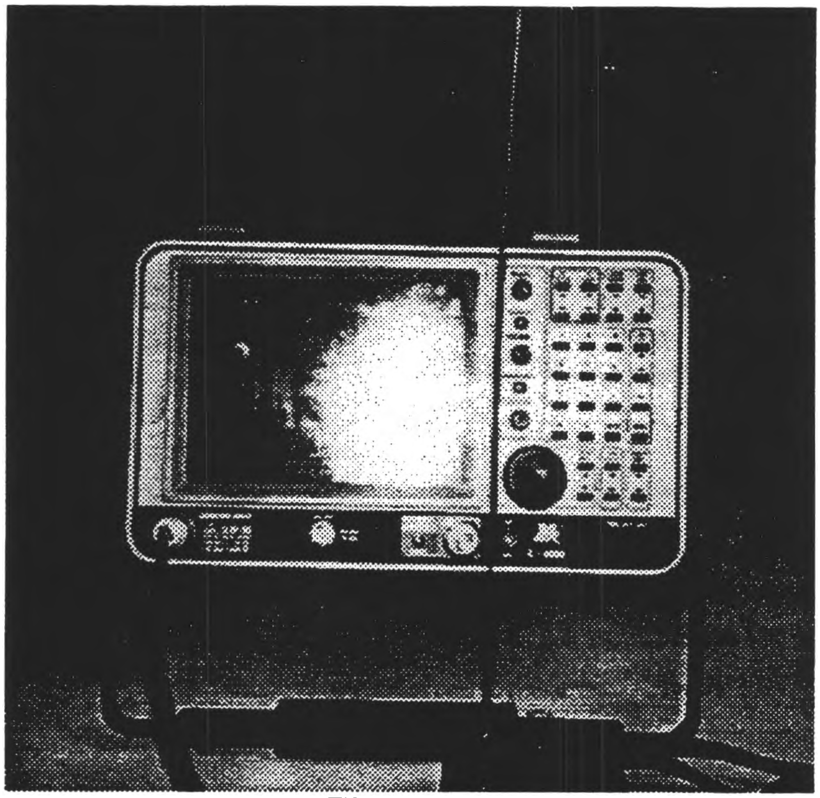


Figure 3.1

IFR 8000 Spectrum Analyzer and Antenna

The equipment set up consisted of a spectrum analyzer equipped to operate from a vehicle cigarette lighter adapter, a magnetic car top antenna and a Sony camcorder. The equipment was set up as shown in Figure 3.2. The specific equipment and pertinent specifications are listed below.

3.1 IFR A8000 Spectrum Analyzer as shown in Figure 3.1 and 3.2.
Set for 50 input impedance and parameters as shown on the Radio Noise Scan Data Sheets.

3.1.1 IFR A8000 Spectrum Analyzer Technical Specifications.
(See Appendix 3).

3.2 Larsen LM-MM Magnetic Cartop Antenna
This antenna was cut for ¼ wavelength at 150 mHz (0.5 meter) and is equipped with 11 feet 10 inches or 361 cm. of RG 58 coaxial cable coupling the antenna to the Spectrum Analyzer. This antenna length provided .23 wavelength at 140 mHz and .31 wavelength at 180 mHz.

3.3 Sony CCD - TR4 Video Camera Recorder

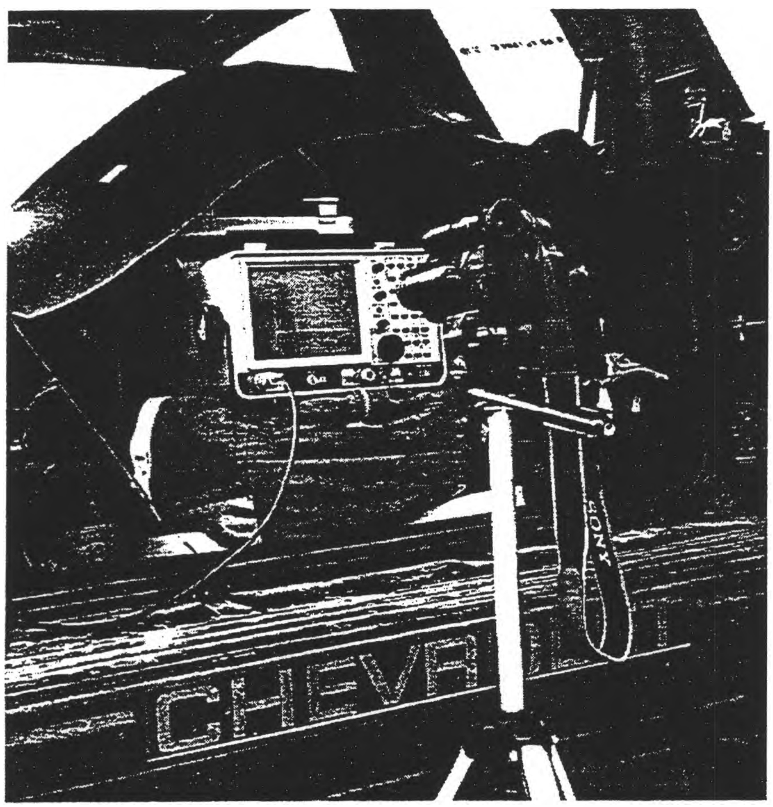


Figure 3.2

Equipment Setup

4. Results

4.0.1 Minimum Measurement Accuracy from Performance Specifications Appendix 3.

Scan 1. - 50 mHz Bandwidth
Frequency Accuracy ± 1.5 MHz
Level Accuracy ± 2 dB

Scan 2. - 10 mHz Bandwidth
Frequency Accuracy ± 0.3 MHz
Level Accuracy ± 2 dB @ 10 dB / division
Level Accuracy ± 0.5 dB @ 2 dB / division

Scan 3. - 5 mHz Bandwidth
Frequency Accuracy ± 0.15 MHz
Level Accuracy ± 2 dB @ 10 dB / division
Level Accuracy ± 0.5 dB @ 2 dB / division

The noise level on all readings was taken as the center of the noise floor and varied by ± 2 dB on all readings. No signals less than 3 dB above the noise level where distinguishable.

Every time the resolution bandwidth is reduced by a factor of 10, the thermal noise level should drop by 10 dB. The results show changes of from 5 dB to 12 dB depending on the location.

4.1 Radio Scan Data

The data was taken from the video recording and tabulated.

See Appendix 1, pages 16 to 27.

4.1.1 Weldwood Plant

The results at the water outlet were found to be consistent with those found at the water inlet and were not separately recorded. These sites are in close proximity.

4.1.2 Obed Mountain Site

The measurements at this site were made on the basis of significant frequencies found during the scan. This scan was taken after business hours when the plant was not operating. The site is very close to large overhead power lines and the main conveyor belt moving the coal to the rail spur. It is expected that if the coal mine was in full operation, both of these devices would produce noise in the bandwidth scanned. Therefore, these results must be taken as highly unreliable.

4.1.3 ALPAC and Poacher's Landing Sites

Due to an error in the sweep time on the Spectrum Analyzer, the resolution and the noise level are not consistent. This has the effect of making the noise level 10 dB too high in many of the readings. This is indicated on the graphical results.

4.2 Radio Scan Graphical Data

The data obtained for the three scans are plotted for all sites tested with the exception of the Obed Mountain test site.

See Appendix 2, pages 28 to 38.

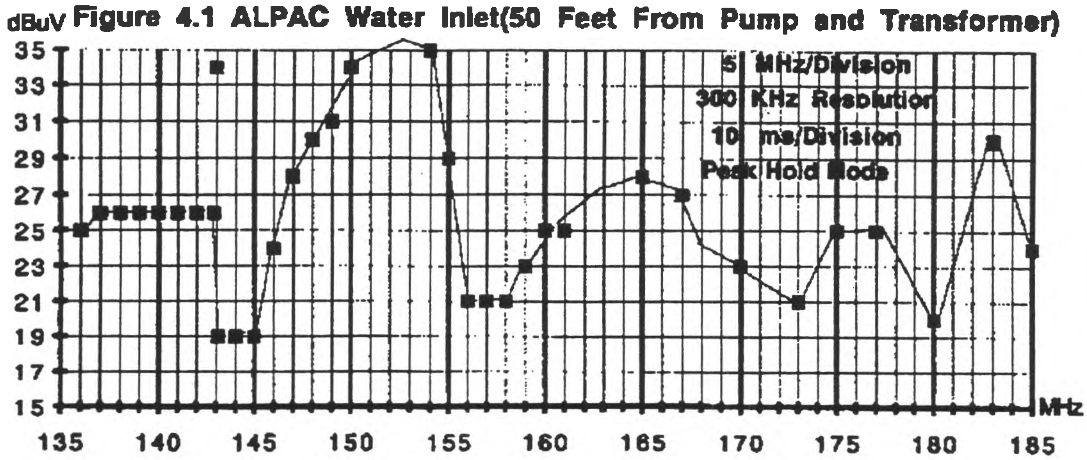


Figure 4.1

Noise Level Due to Pumping Equipment at the ALPAC Water Inlet Site

4.3 Short Duration Transmission

There were a large number of spectral components observed at many sites that occurred for a duration of less than 2 seconds with a repetition rate of once every 2 seconds or more. These transmissions would appear every second or third sweep and then often disappear for some time. Some examples are given below:

Millar Western Site	150.9 mHz 149.7 mHz
Alberta Newsprint Site	150.9 mHz 149.8 mHz
Blue Ridge Site	149.7 mHz
Weldwood Site	149.75 mHz 159.6 mHz 167.2 mHz

Slave Lake Water Inlet Site	142.3 mHz 157.7 mHz 165.3 mHz
Diashowa Water Inlet Site	145.0 mHz 153.6 mHz 163.7 mHz

Due to the bursty nature of these signals it is possible many other examples were not recorded. When the spectrum analyzer was in storage mode (peak hold) we would observe a large number of random spectral components as well as these repeated short duration signals.

4.4 Noise due to Electrical Machinery and Vehicle Traffic

The water inlet sites required large sources of electrical power to operate the pumping equipment. These sites produced random bursts of spectra right across the band of frequencies scanned. In some cases, this noise was at very high levels as shown in Figure 4.1

At the ALPAC water inlet site it was necessary to move to the access road about 1000 feet from the pumping equipment to reduce the noise level which was exceptionally high as shown in Figure 4.1

This can also be observed at the Slave Lake Pulp Mill where moving about 1000 feet from the water inlet to the water outlet substantially reduced the noise.

The effect of vehicle traffic with spark type ignition systems is illustrated in Figure 4.2. This observation was made at the ALPAC site on the access road to the water inlet.

The only valid signal shown in Figure 4.2 occurs at 148.7 mHz and is well below many of the components caused by a truck passing nearby.

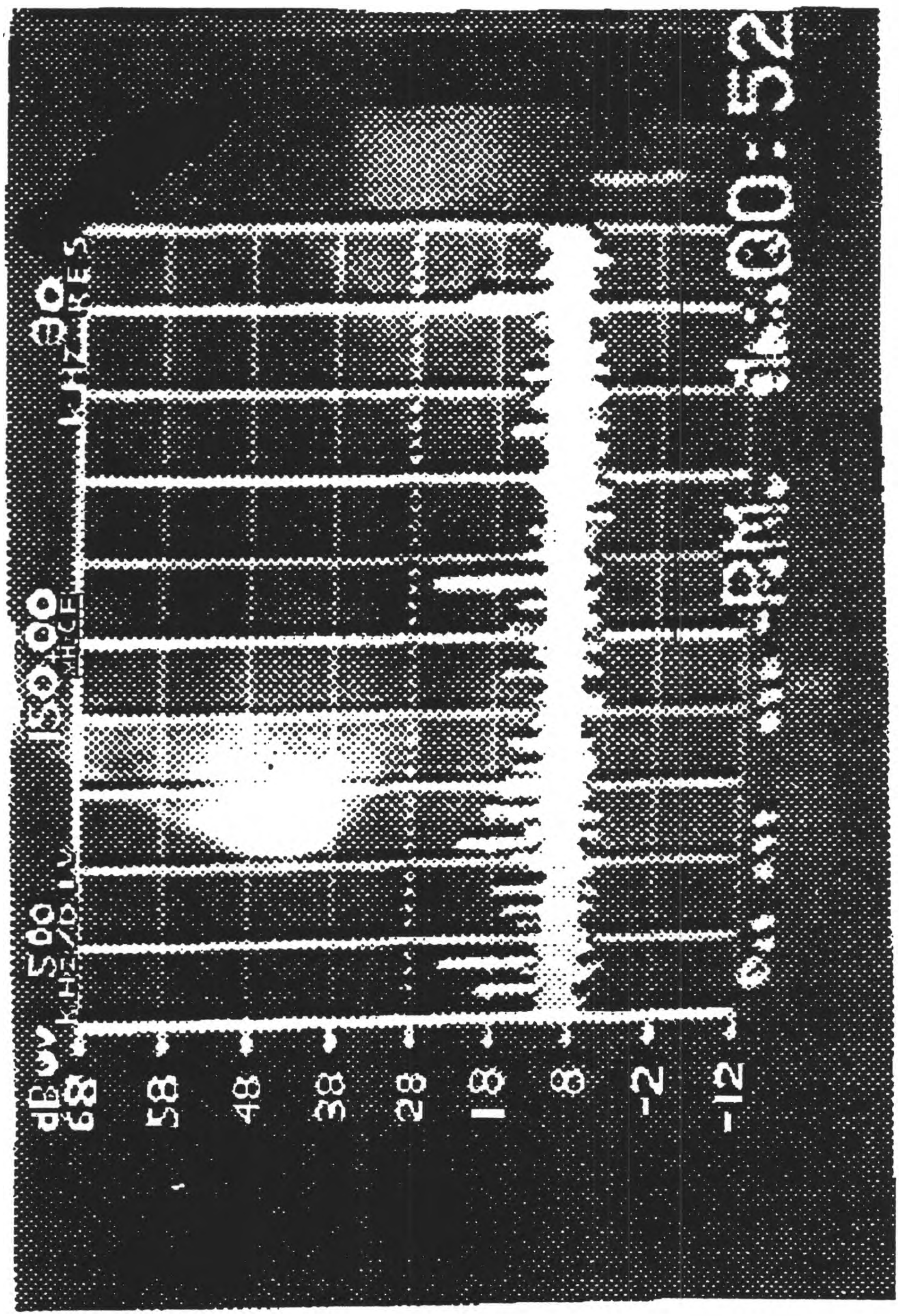


Figure 4.2

ALPAC Water Inlet Access Road Vehicle Ignition Interference

5. Conclusions

5.1 Correlation of Results

The reason for completing a wide band wide resolution scan followed by narrower band, narrower resolution scans was to maintain a check on results. It was expected that a spectral component on the wide band scan would break down into several spectral components in narrower band scans due to narrower resolution. We found this procedure worked well but many frequencies were intermittent and showed up only during a particular scan. We also expected that as the resolution bandwidth was reduced by a factor of 10 the ambient noise power level would also fall by a factor of 10 exposing additional signals that were below the noise level in the previous scan. We often found less than 10 dB drop in noise level when the resolution was reduced from 300 kHz to 30 kHz and greater than 10 dB when the resolution dropped from 30 kHz to 3 kHz.

In general, this procedure worked. The minimum noise signal level at the narrowest resolution varied between 0 and -3 dBµV which is a noise floor 17 dB to 13 dB above the minimum signal detectable by the SRX 400 telemetry receiver used by R.L. & L. In all cases, it was impossible to distinguish signals that were less than 3 dB above the center of the ambient noise level.

5.2 Noise from Electrical Machinery and Vehicle Traffic

The scans were run both in real time and storage mode at each site. This was done to detect signals that were repeated from those that occurred due to electrical equipment or vehicle traffic. In storage mode, both random occurring spectra and actual radio signals are indistinguishable. Most of the noise from equipment was found to be very local. At locations where we could gain access to sites that were more than 1000 feet from the source of disturbance this type of noise could be reduced 10 to 20 dB. It will be a challenge to find telemetry sites that are far enough away from sources of equipment noise. Where this is impossible antennas with sufficient gain and directivity will be required.

5.3 Validity of Noise Scan Data

All signal levels determined during the scans at all sites are of high enough level to be received by the telemetry receiver. The major difficulty in producing results that are conclusive comes from the uncertainty that all radio systems in the area of a given site were in use at the time the scan was made. One measure of both the frequency accuracy and validity of the test is the General Mobile Telephone system operated by Alberta Government Telephones between 152.6 mHz and 152.9 mHz. This band of frequencies is conspicuous by its absence at the ALPAC and Poacher's Landing sites. These sites were tested on a Sunday and although the site construction crews were active it is possible that many of the other sources of radio signals were not. This would make these sites abnormally quiet.

At the Obed road site very little radio noise was found. This scan was made when the mine was not in operation and outside of normal business hours. It is expected that this site would produce much more noise when the plant is in operation due to nearby overhead power lines, vehicle traffic to the mine and the very long conveyer system used at the mine.

To have confidence in the results these sites would have to be scanned during business hours when the plant is in full operation.

5.4 Improvement of Results

Additional reliability of the results could be obtained by extending the 3 kHz resolution scan to the whole bandwidth. This would require double the time at each site to complete the scan. It would reduce the noise level to about -3 dBµV and allow measurements to be made that more closely resemble the channel bandwidth of the SRX 400 telemetry receiver. The spectrum analyzer used is capable of a resolution of 300 Hz. At this resolution the noise level would be about -13 dBµV. This would produce results that would detect noise in the individual telemetry channels and very close to the minimum receive level of the receiver. This would require making forty 1 mHz scans to cover the bandwidth from 140 mHz to 180 mHz. This would require spending at least two days at each site.

5.5 Useable Radio Spectrum

There is no completely clear 4 mHz slot to provide telemetry channels at most sites. The channels will have to be chosen in between the spectral components found at each site. The range of frequencies used in the narrow scan from 148 to 152 mHz can be used at all sites with careful selection of the channels used. If the receiving antennas can be placed far enough away from disturbing influences or have enough directive gain most of the disturbing influences can be eliminated.

Location Weldwood Plant Water Inlet-Hinton (Mon. 22/03/93)

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV	Comment
160	5	300	10	10	12	

Frequency Scan Width MHz 135 to 165

Frequency MHz	144	150	153	162	172	174	182
Level dBuV	40	52	49	25	23	40	45

Frequency Scan Width MHz 140 to 150

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
145	1	30	50	10	7

Frequency MHz	143.1	143.6	143.8	149.6	149.8	149.9
Level dBuV	14	42	23	14	54	42

Frequency Scan Width MHz 150 to 160

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
155	1	30	50	10	7

Frequency MHz	152.6	152.7	152.8	154.9	155.8	159.6	159.8
Level dBuV	32	31	32	42	52	36	62

Frequency Scan Width MHz 160 to 170

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
165	1	30	50	10	7

Frequency MHz	161.1	161.2	161.4	161.6	164.7	165.3	167.2	167.4	168.7
Level dBuV	42	22	22	28	27	42	32	42	40

Frequency Scan Width MHz 170 to 180

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
175	1	30	1000	10	7

Frequency MHz	170.6	171.4
Level dBuV	38	22

Location Obed Bridge-Hinton (Mon. 22/03/93 After Business Hours)

A8000 Parameters	Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV	Comment
	160	5	300	10	10	12	

Frequency Scan Width MHz: 135 to 185

High power trasmission line normally expect corona noise This site was very quiet. The scan at this site was completed after business hours.

Frequency MHz		
Level dBuV		

Frequency Scan Width MHz: 140 to 150

A8000 Parameters	Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
	145	1	30	50	10	7

Levels Not recorded

Frequency MHz	143.6	146.7	149.6	149.8	149.9
Level dBuV					

Frequency Scan Width MHz: 150 to 160

A8000 Parameters	Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
	155	1	30	50	10	7

Frequency MHz	152.5	152.6	152.7	152.8	152.9
Level dBuV	17	17	17	17	17

Frequency Scan Width MHz: 160 to 170

A8000 Parameters	Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
	165	1	30	50	10	7

Frequency MHz	164.7
Level dBuV	

Frequency Scan Width MHz: 170 to 180

A8000 Parameters	Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
	175	1	30	1000	10	7

Very Quiet

Frequency MHz	
Level dBuV	

Frequency Scan Width MHz: 147.5 to 152.5

A8000 Parameters	Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
	150	0.5	3	200	10	-3

Frequency MHz	148.5	149.7
Level dBuV	9	

Location **Miller Western Plant Water Outlet- Whitecourt (Thurs. 25/03/93)**

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV	Comments
160	5	300	200	10	16	

Frequency Scan Width MHz 135 to 185

Frequency MHz	138	150	153	154	155	158	161	165	169	170	176
Level dBuV	36	44	31	39	39	38	31	43	30	31	21

We are on the rim of the Fermentation Pool. There are several pumps nearby

Frequency Scan Width MHz 140 to 150

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
145	1	30	200	10	7

Frequency MHz	142.6	149.7
Level dBuV	14	44

Switching Hash 140to141.5 and 142 to 143 MHz at up to 21dBuV Should get at least 1000 feet from any pumping eqpt

Frequency Scan Width MHz 150 to 160

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
155	1	30	200	10	7

Frequency MHz	150.9	151	152.5	152.6	152.7	152.8	152.9	154.5	159.9
Level dBuV	45	42	20	18	18	16	18	39	34

Frequency Scan Width MHz 160 to 170

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
165	1	30	200	10	7

Frequency MHz	160.2	162.2	163.1	163.4	164.4	164.8	166.5	168.5	169	169.5
Level dBuV	41	41	37	37	32	27	16	16	32	40

All Components except164.4, 166.5, 168.5 and 169.0 may be hash

Frequency Scan Width MHz 170 to 180

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
175	1	30	200	10	7

Frequency MHz	172.1	175	179.9	173.4	177	177.2
Level dBuV	14	16	16	17	16	19

173.4, 177.0, 177.2 could be hash

Frequency Scan Width MHz 147.5 to 152.5

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
150	0.5	3	200	10	-3

Frequency MHz	148.1	148.5	148.6	148.7	149.2	149.4	149.75	150	150.3	150.6	150.8	150.9	151.2	151.4	151.9
Level dBuV	11	11	31	7	8	42	41	6	6	6	7	34	7	7	7

Appendix 1 — Radio Noise Scan Data

Location Alberta Newsprint Plant Water Outlet- Whitecourt (Thurs. 25/03/93)

A8000 Parameters

Center Freq. MHz		Scan width MHz/cm		Resolution KHz		Sweep Rate mSec/cm		Gain dB/cm		RX Noise Lev dBuV		
	160		5		300		200		10		16	Comments

Frequency Scan Width MHz 135 to 185

Frequency MHz	138	143	150	154	155	157	166	170
Level dBuV	25	46	46	45	49	48	31	30

Frequency Scan Width MHz 140 to 150

A8000 Parameters

Center Freq. MHz		Scan width MHz/cm		Resolution KHz		Sweep Rate mSec/cm		Gain dB/cm		RX Noise Lev dBuV	
	145		1		30		200		10		7

Frequency MHz	140.2	141	141.5	143	143.2	143.9	144	146.8	148.4	149.8
Level dBuV	17	18	18	26	44	49	26	31	21	46

Frequency Scan Width MHz 150 to 160

A8000 Parameters

Center Freq. MHz		Scan width MHz/cm		Resolution KHz		Sweep Rate mSec/cm		Gain dB/cm		RX Noise Lev dBuV	
	155		1		30		200		10		7

Frequency MHz	151	151.9	152.7	153.2	153.3	154.5	155	155.7	157.1	157.5	157.7	158.1	158.7
Level dBuV	16	26	21	45	16	49	16	35	48	23	16	23	43

Frequency Scan Width MHz 160 to 170

A8000 Parameters

Center Freq. MHz		Scan width MHz/cm		Resolutio KHz		Sweep Rate mSec/cm		Gain dB/cm		RX Noise Lev dBuV	
	165		1		30		200		10		7

Frequency MHz	160.2	160.6	162.2	162.5	163.4	164.2	164.4	165.5	166.5	166.6	169
Level dBuV	46	11	18	11	42	22	42	16	11	26	29

Frequency Scan Width MHz 170 to 180

A8000 Parameters

Center Freq. MHz		Scan width MHz/cm		Resolution KHz		Sweep Rate mSec/cm		Gain dB/cm		RX Noise Lev dBuV	
	175		1		30		200		10		7

Frequency MHz	171.4	173.6	175	179.2	179.9
Level dBuV	11	16	15	23	11

All values except 175 &179.2 could be noise

Frequency Scan Width MHz 147.5 to 152.5

A8000 Parameters

Center Freq. MHz		Scan width MHz/cm		Resolution KHz		Sweep Rate mSec/cm		Gain dB/cm		RX Noise Lev dBuV	
	150		0.5		3		200		10		- 4

Frequency MHz	148.1	148.5	148.7	149.75	150	150.9	151.6
Level dBuV	5	16	7	45	6	15	26

Location Blue Ridge Control Site- Whitecourt (Thurs. 25/03/93)

A8000 Parameters	Center Freq. MHz	160	Scan width MHz/cm	5	Resolution KHz	300	Sweep Rate mSec/cm	200	Gain dB/cm	10	RX Noise Lev dBuV	14	Comments

Frequency Scan Width MHz 135 to 185

Frequency MHz	136	143	150	153	154	155	165	171	172	176	179	181
Level dBuV	17	17	25	41	18	22	25	22	21	22	22	25

Frequency Scan Width MHz 140 to 150

A8000 Parameters	Center Freq. MHz	145	Scan width MHz/cm	1	Resolution KHz	30	Sweep Rate mSec/cm	200	Gain dB/cm	10	RX Noise Lev dBuV	7

Frequency MHz	141.4	142.8	145	145.5	148.7	149.7
Level dBuV	20	15	15	20	17	25

Frequency Scan Width MHz 150 to 160

A8000 Parameters	Center Freq. MHz	155	Scan width MHz/cm	1	Resolution KHz	30	Sweep Rate mSec/cm	200	Gain dB/cm	10	RX Noise Lev dBuV	7

Frequency MHz	150.5	152.3	152.4	152.5	152.6	152.7	152.8	153.2	154.5	154.6	155	157.6
Level dBuV	26	18	42	42	42	42	42	22	22	15	16	20

Frequency Scan Width MHz 160 to 170

A8000 Parameters	Center Freq. MHz	165	Scan width MHz/cm	1	Resolution KHz	30	Sweep Rate mSec/cm	200	Gain dB/cm	10	RX Noise Lev dBuV	7

Frequency MHz	160.9	162.5	163.5	169.6
Level dBuV	17	17	17	21

Frequency Scan Width MHz 170 to 180

A8000 Parameters	Center Freq. MHz	175	Scan width MHz/cm	1	Resolution KHz	30	Sweep Rate mSec/cm	200	Gain dB/cm	10	RX Noise Lev dBuV	7

After 5:00 PM

Frequency MHz	171.4	173	175	177.5	178.2	179.8	179.9
Level dBuV	24	16	20	22	16	23	20

Frequency Scan Width MHz 147.5 to 152.5

A8000 Parameters	Center Freq. MHz	150	Scan width MHz/cm	0.5	Resolution KHz	3	Sweep Rate mSec/cm	200	Gain dB/cm	10	RX Noise Lev dBuV	-3

Frequency MHz	148.7	149.75	149.9	150	150.95
Level dBuV	14	22	6	10	8

Appendix 1 Radio Noise Scan Data

Location Diashowa Plant Water Inlet-Peace River (Fri. 26/03/93)

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV	Comments
160	5	30	200	10	8	

Frequency Scan Width MHz: 135 to 165

Frequency MHz	137	144	145	150	153	154	156	164	163	171	176	182	Levels Uncalibrated (Resolution too narrow)
Level dBuV	17	21	21	21	31	25	17	70	16	17	25	17	

Frequency Scan Width MHz: 140 to 150

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
145	1	30	200	10	9

Frequency MHz	142.6	143.9	144.9	145	145.5	146.3	148.7	149.8
Level dBuV	25	22	21	21	17	24	16	18

Frequency Scan Width MHz: 150 to 160

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
155	1	30	200	10	9

Frequency MHz	152.4	152.5	152.6	152.7	152.8	153.6	155	155.3
Level dBuV	30	30	30	30	30	26	17	17

Frequency Scan Width MHz: 160 to 170

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
165	1	30	200	10	9

Frequency MHz	162.5	163.7	164.4	165	168.3	168.8	163.7 MHz Offscale >70dBuV
Level dBuV	16	70	22	16	35	15	

Frequency Scan Width MHz: 170 to 180

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
175	1	30	200	10	9

Frequency MHz	175	175.3
Level dBuV	18	24

Frequency Scan Width MHz: 147.5 to 152.5

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
150	0.5	3	200	10	-3

Frequency MHz	148.7	149.8	150
Level dBuV	12	16	12

Location Notikewin Provincial Park (Fri. 26/03/93)

A8000 Parameters	Center Freq. MHz	160.5	Scan width MHz/cm	5	Resolution KHz	300	Sweep Rate mSec/cm	200	Gain dB/cm	2	RX Noise Lev dBuV	17	Comments

Frequency Scan Width MHz 135 to 185

Frequency MHz	146	148	150	155	160	163	175	180
Level dBuV	20	20	20	21	19	21	22	21

Frequency Scan Width MHz 140 to 150

A8000 Parameters	Center Freq. MHz	145	Scan width MHz/cm	1	Resolution KHz	30	Sweep Rate mSec/cm	200	Gain dB/cm	2	RX Noise Lev dBuV	12

Frequency MHz	141.2	142.8	143.2	146.7	150
Level dBuV	17	17	17	18	17

Frequency Scan Width MHz 150 to 160

A8000 Parameters	Center Freq. MHz	155	Scan width MHz/cm	1	Resolution KHz	30	Sweep Rate mSec/cm	200	Gain dB/cm	2	RX Noise Lev dBuV	12

Frequency MHz	155
Level dBuV	19

Frequency Scan Width MHz 160 to 170

A8000 Parameters	Center Freq. MHz	165	Scan width MHz/cm	1	Resolution KHz	30	Sweep Rate mSec/cm	200	Gain dB/cm	2	RX Noise Lev dBuV	12

Frequency MHz	160.8	162.5	164.4	169	164.4MHz offscale
Level dBuV	16	19	21	17	

Frequency Scan Width MHz 170 to 180

A8000 Parameters	Center Freq. MHz	175	Scan width MHz/cm	1	Resolution KHz	30	Sweep Rate mSec/cm	200	Gain dB/cm	2	RX Noise Lev dBuV	12

Frequency MHz	175	180
Level dBuV	21	20

Frequency Scan Width MHz 147.5 to 152.5

A8000 Parameters	Center Freq. MHz	150	Scan width MHz/cm	0.5	Resolution KHz	3	Sweep Rate mSec/cm	200	Gain dB/cm	2	RX Noise Lev dBuV	0

Frequency MHz	148.4	148.7	150	Very Quiet Site
Level dBuV	6	13	8	

Location Slave Lake Pulp Plant Water Inlet (Sat. 27/03/93)

A8000 Parameters	Center Freq. MHz	160.5	Scan width MHz/cm	5	Resolution KHz	300	Sweep Rate mSec/cm	200	Gain dB/cm	10	RX Noise Lev dBuV	17	Comments

Frequency Scan Width MHz 135 to 185

Frequency MHz	138	153	154	163	166	176
Level dBuV	24	39	39	24	30	23

This site was within 100 feet from the power line and the pump house We observed large corona and switching transient noise

Frequency Scan Width MHz 140 to 150

A8000 Parameters	Center Freq. MHz	145	Scan width MHz/cm	1	Resolution KHz	30	Sweep Rate mSec/cm	200	Gain dB/cm	10	RX Noise Lev dBuV	12

Frequency MHz	140.4	142.3	143.7	144.8	145	149.3	149.5
Level dBuV	20	30	22	18	15	24	18

Offscale>24

Frequency Scan Width MHz 150 to 160

A8000 Parameters	Center Freq. MHz	155	Scan width MHz/cm	1	Resolution KHz	30	Sweep Rate mSec/cm	200	Gain dB/cm	10	RX Noise Lev dBuV	10

Frequency MHz	152.1	152.5	152.6	152.7	152.8	154.6	155	157.7
Level dBuV	25	30	30	30	30	21	15	30

Frequency Scan Width MHz 160 to 170

A8000 Parameters	Center Freq. MHz	165	Scan width MHz/cm	1	Resolution KHz	30	Sweep Rate mSec/cm	200	Gain dB/cm	10	RX Noise Lev dBuV	10

Frequency MHz	163.4	165.3
Level dBuV	18	30

Frequency Scan Width MHz 170 to 180

A8000 Parameters	Center Freq. MHz	175	Scan width MHz/cm	1	Resolution KHz	30	Sweep Rate mSec/cm	200	Gain dB/cm	10	RX Noise Lev dBuV	10

Frequency MHz	175
Level dBuV	18

Frequency Scan Width MHz 147.5 to 152.5

A8000 Parameters	Center Freq. MHz	150	Scan width MHz/cm	0.5	Resolution KHz	3	Sweep Rate mSec/cm	200	Gain dB/cm	2	RX Noise Lev dBuV	0

Frequency MHz	148.7	150
Level dBuV	11	8

Location **Slave Lake Pulp Plant Water Outlet(1000Feet From Pump) (Sat. 27/03/93)**

Frequency Scan Width MHz 140 to 150

A8000 Parameters

Center Freq. MHz	145	Scan width MHz/cm	1	Resolution KHz	30	Sweep Rate mSec/cm	200	Gain dB/cm	10	RX Noise Lev dBuV	12

Frequency MHz	148.6
Level dBuV	14

Frequency Scan Width MHz 150 to 160

A8000 Parameters

Center Freq. MHz	155	Scan width MHz/cm	1	Resolution KHz	30	Sweep Rate mSec/cm	200	Gain dB/cm	10	RX Noise Lev dBuV	10

Frequency MHz	152.1	152.5	152.6	152.7	152.8	154.6	155	156.5	157.8
Level dBuV	25	22	22	22	22	14	15	22	24

Frequency Scan Width MHz 160 to 170

A8000 Parameters

Center Freq. MHz	165	Scan width MHz/cm	1	Resolution KHz	30	Sweep Rate mSec/cm	200	Gain dB/cm	10	RX Noise Lev dBuV	10

Frequency MHz	161.7	162.5	165	165.3	165.9
Level dBuV	36	19	13	23	23

Frequency Scan Width MHz 170 to 180

A8000 Parameters

Center Freq. MHz	175	Scan width MHz/cm	1	Resolution KHz	30	Sweep Rate mSec/cm	200	Gain dB/cm	10	RX Noise Lev dBuV	10

Frequency MHz	175
Level dBuV	20

Frequency Scan Width MHz 147.5 to 152.5

A8000 Parameters

Center Freq. MHz	150	Scan width MHz/cm	0.5	Resolution KHz	3	Sweep Rate mSec/cm	200	Gain dB/cm	2	RX Noise Lev dBuV	-3

Frequency MHz
Level dBuV

No signals above the noise floor

Appendix 1 Radio Noise Scan Data

Location Lesser Slave River Bridge Test Site Near Smith(Sat 27/03/93)

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV	Comments
160	5	300	200	10	14	

Frequency Scan Width MHz 135 to 185

Frequency MHz	152	153	154
Level dBuV	34	46	46

Frequency Scan Width MHz 140 to 150

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
145	1	30	200	10	9

Frequency MHz	140.4	141.1	141.4	144.5	145.4	147	148	148.9
Level dBuV	15	19	29	49	17	25	19	22

Comments: We are about 200 feet from the road and it is difficult to determine the effect of vehicle ignition noise.

Frequency Scan Width MHz 150 to 160

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
155	1	30	200	10	9

Frequency MHz	152.6	152.7	152.8	159.6
Level dBuV	43	43	43	25

Frequency Scan Width MHz 160 to 170

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
165	1	30	200	10	9

Frequency MHz	162.2	165.2	168
Level dBuV	49	14	15

Comments: Moving coat for sun shield?

Frequency Scan Width MHz 170 to 180

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
175	1	30	200	10	9

Frequency MHz
Level dBuV

Comments: No valid signals

Frequency Scan Width MHz 147.5 to 152.5

A8000 Parameters

Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
150	0.5	3	200	2	- 2

Frequency MHz	148	148.7
Level dBuV	4	10

Location ALPAC Water Inlet (About 1000 feet from pump house on road) (Sun 26/03/93)

A8000 Parameters

Center Freq. MHz		Scan width MHz/cm		Resolution KHz		Sweep Rate mSec/cm		Gain dB/cm		RX Noise Lev dBuV		Comments
	160		5		300		10		10		15	

Frequency Scan Width MHz: 135 to 185

Frequency MHz	136	153	176	182	183
Level dBuV	20	29	20	35	35

Frequency Scan Width MHz: 140 to 150

A8000 Parameters

Center Freq. MHz		Scan width MHz/cm		Resolution KHz		Sweep Rate mSec/cm		Gain dB/cm		RX Noise Lev dBuV	
	145		1		30		50		10		8

Frequency MHz	142.8	148.7
Level dBuV	17	17

No valid signals at any frequency150 to 180 MHz except 175mHz

Frequency Scan Width MHz: 150 to 160

A8000 Parameters

Center Freq. MHz		Scan width MHz/cm		Resolution KHz		Sweep Rate mSec/cm		Gain dB/cm		RX Noise Lev dBuV	
	155		1		300		5		10		12

Frequency MHz
Level dBuV

No valid signals
The Spect Analalyser parameters changed to 300KHz res.

Frequency Scan Width MHz: 160 to 170

A8000 Parameters

Center Freq. MHz		Scan width MHz/cm		Resolution KHz		Sweep Rate mSec/cm		Gain dB/cm		RX Noise Lev dBuV	
	165		1		300		5		10		12

Frequency MHz
Level dBuV

No valid signals
The Spect Analalyser parameters changed to 300KHz res.

Frequency Scan Width MHz: 170 to 180

A8000 Parameters

Center Freq. MHz		Scan width MHz/cm		Resolution KHz		Sweep Rate mSec/cm		Gain dB/cm		RX Noise Lev dBuV	
	175		1		300		5		10		12

Frequency MHz	175	179
Level dBuV	22	23

No valid signals
The Spect Analalyser parameters changed to 300KHz res.

Frequency Scan Width MHz: 147.5 to 152.5

A8000 Parameters

Center Freq. MHz		Scan width MHz/cm		Resolution KHz		Sweep Rate mSec/cm		Gain dB/cm		RX Noise Lev dBuV	
	150		0.5		30		50		10		8

Frequency MHz	148.7
Level dBuV	11

No valid signals
The Spect Analalyser parameters changed to 30KHz res.

Location Poachers Landing Test Site (Sun 26/03/93)

A8000 Parameters	Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV	Comments
	160	5	300	10	10	15	

Frequency Scan Width MHz 135 to 185

Frequency MHz	137	163	182
Level dBuV	19	20	25

Frequency Scan Width MHz 140 to 150

A8000 Parameters	Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
	145	1	30	50	10	8

Frequency MHz	142.8	145	148.7
Level dBuV	12	12	15

Frequency Scan Width MHz 150 to 160

A8000 Parameters	Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
	155	1	30	50	10	8

Frequency MHz
Level dBuV

No valid signals

Frequency Scan Width MHz 160 to 170

A8000 Parameters	Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
	165	1	300	5	10	13

Frequency MHz	162.4
Level dBuV	19

Frequency Scan Width MHz 170 to 180

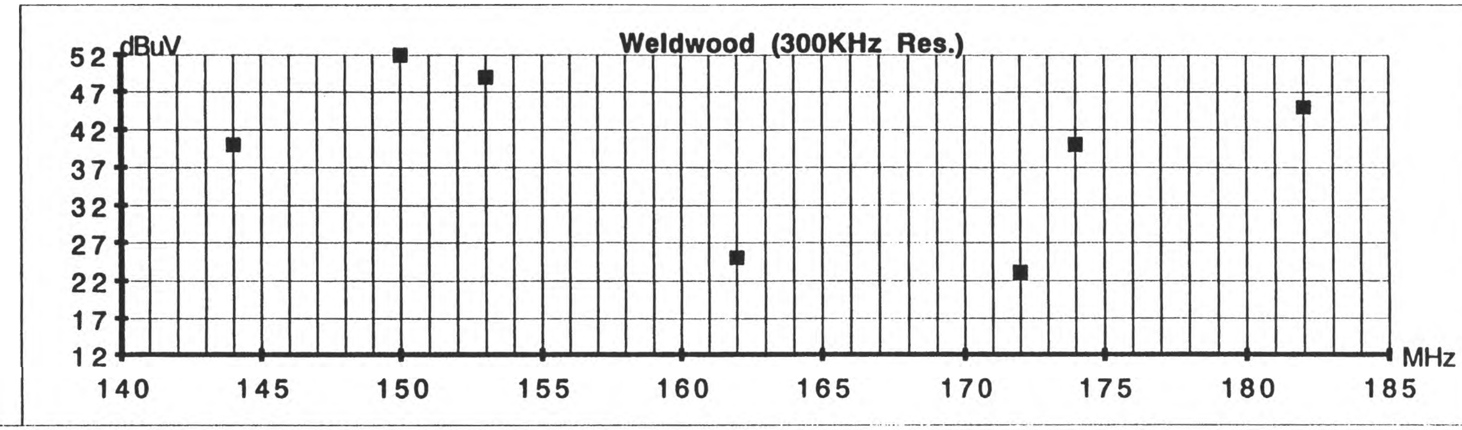
A8000 Parameters	Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
	175	1	300	5	10	12

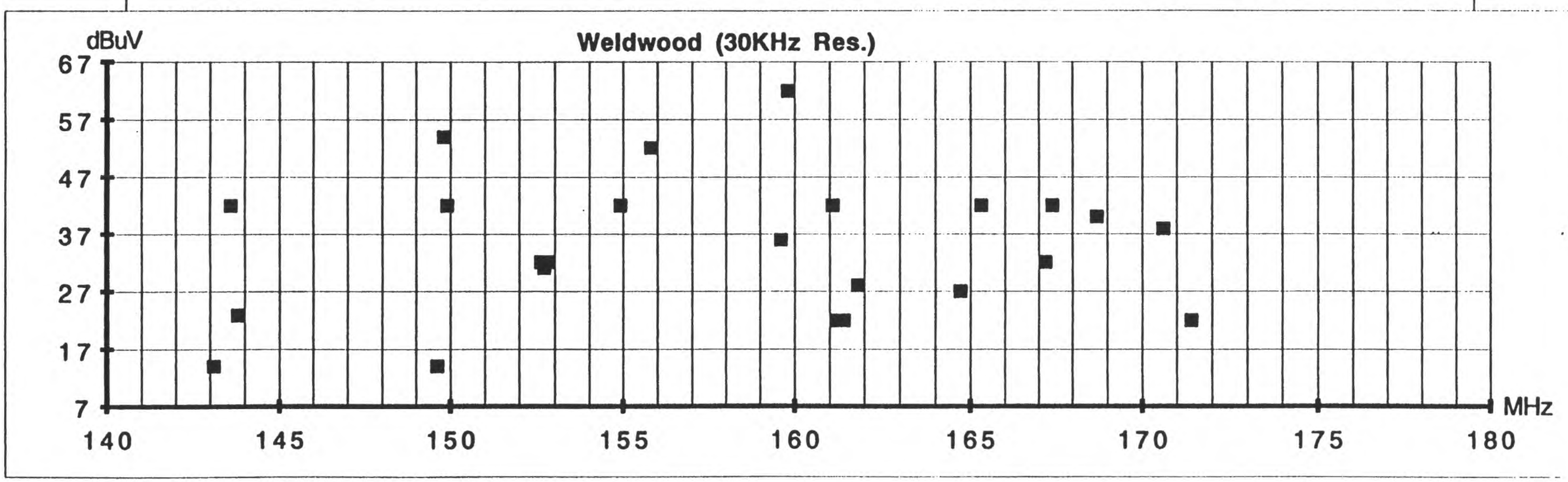
Frequency MHz
Level dBuV

Frequency Scan Width MHz 147.5 to 152.5

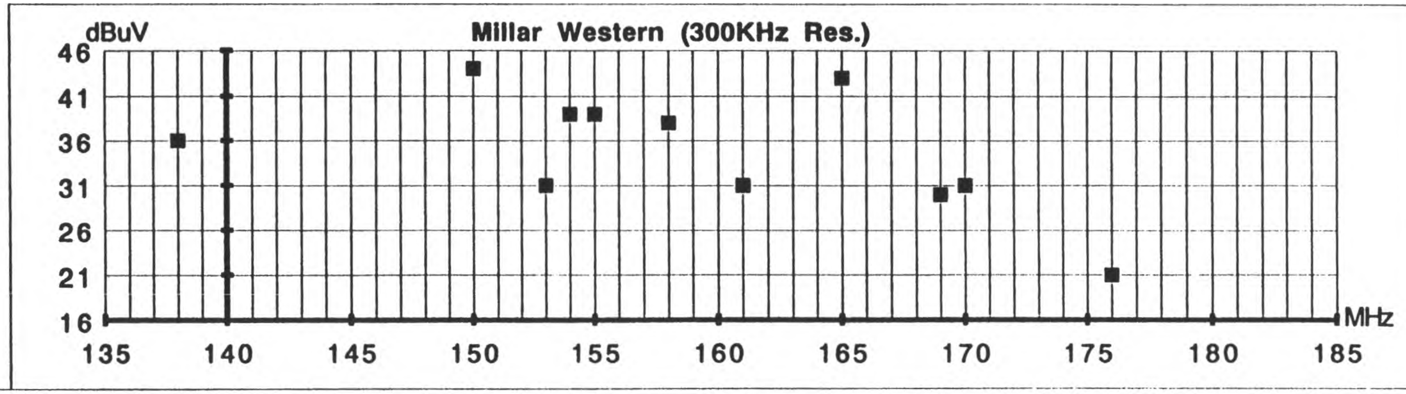
A8000 Parameters	Center Freq. MHz	Scan width MHz/cm	Resolution KHz	Sweep Rate mSec/cm	Gain dB/cm	RX Noise Lev dBuV
	150	0.5	3	200	10	-3

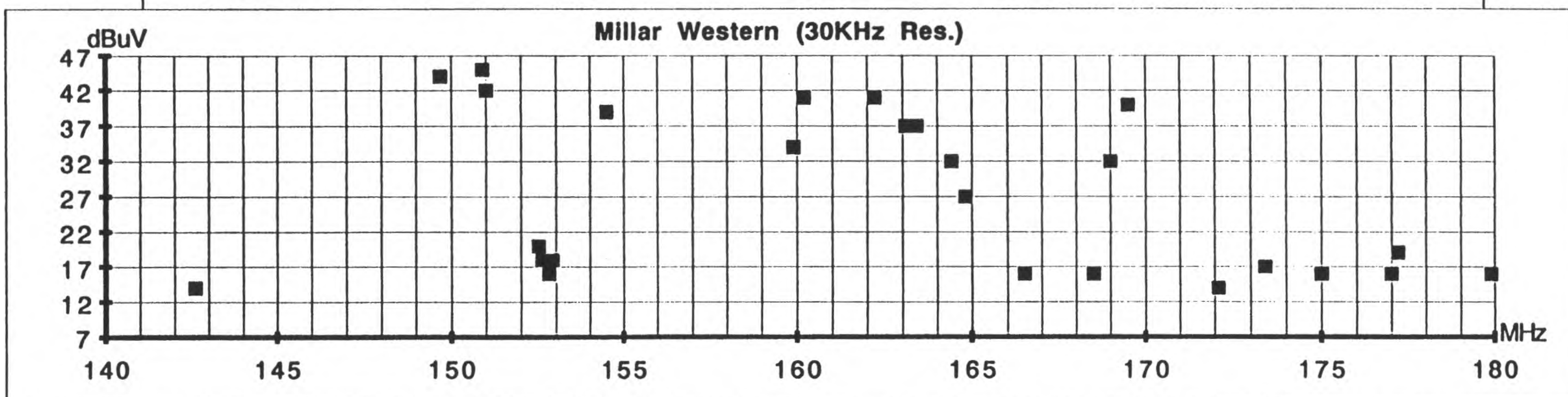
Frequency MHz	148.7	150	149.9
Level dBuV	12	7	7

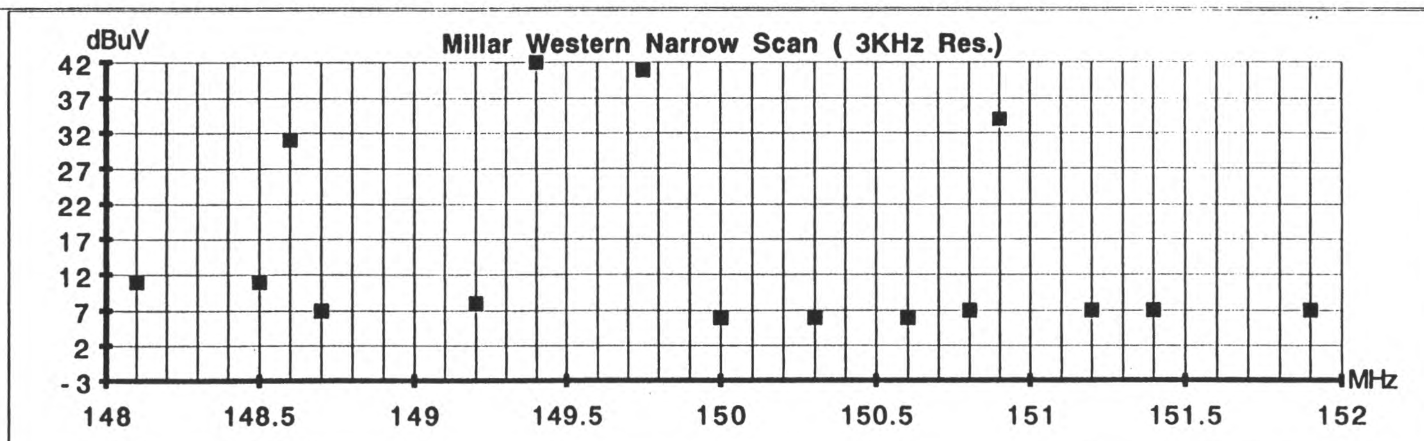

Weldwood (300KHz Res.)
dBuV
52
47
42
37
32
27
22
17
12
140
145
150
155
160
165
170
175
180
185
MHz

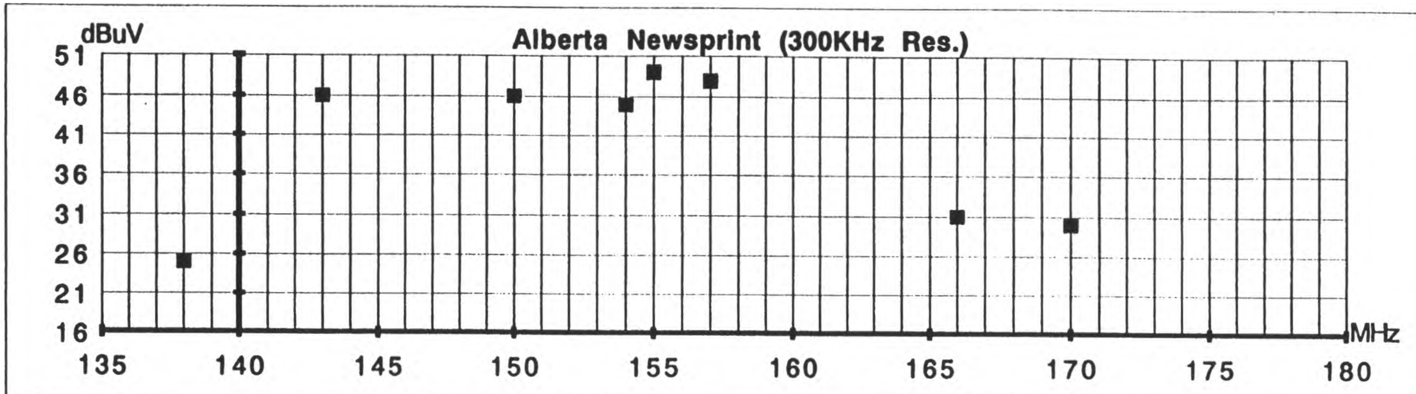

Weldwood (30KHz Res.)
dBuV
67
57
47
37
27
17
7
140
145
150
155
160
165
170
175
180
MHz

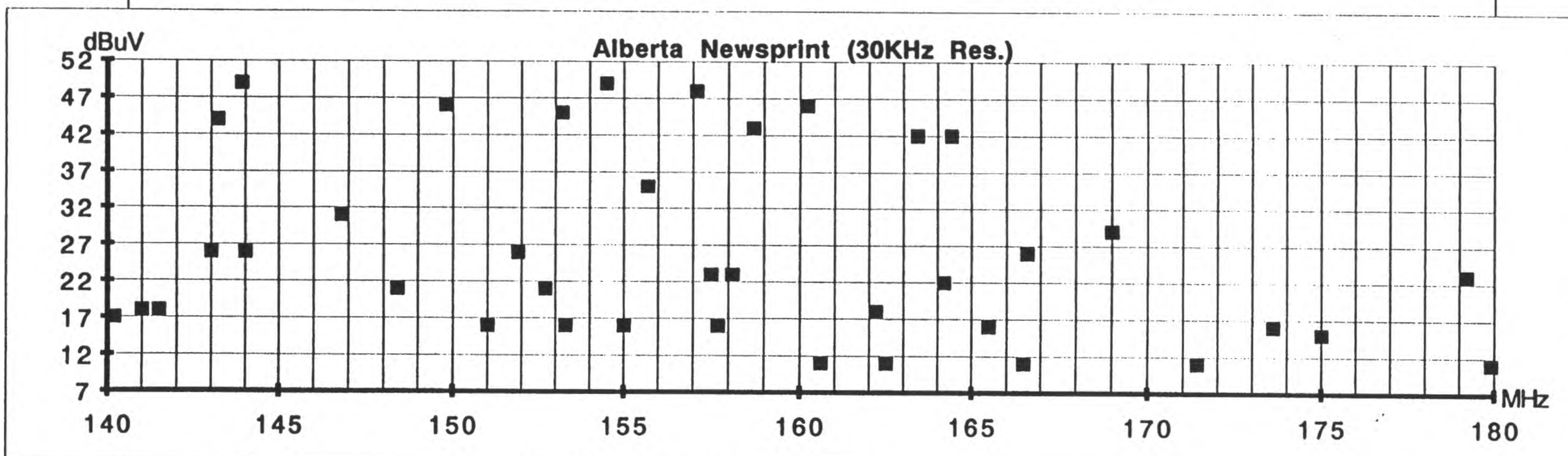
Radio Noise Scan Plot

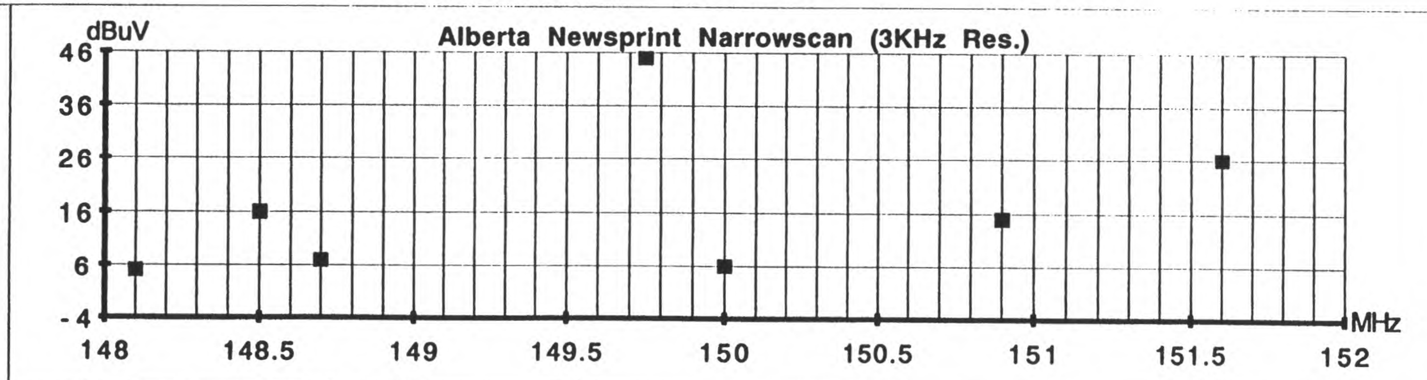


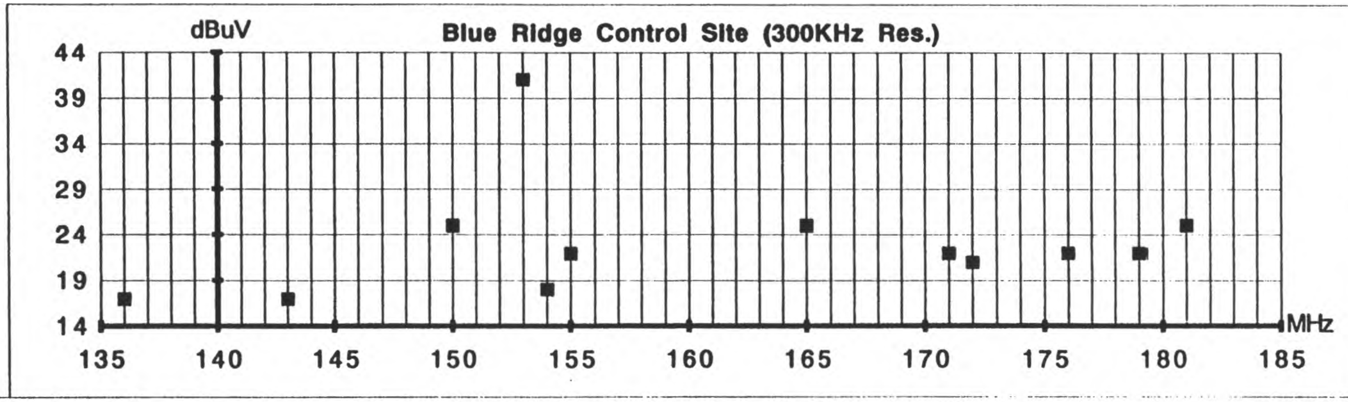


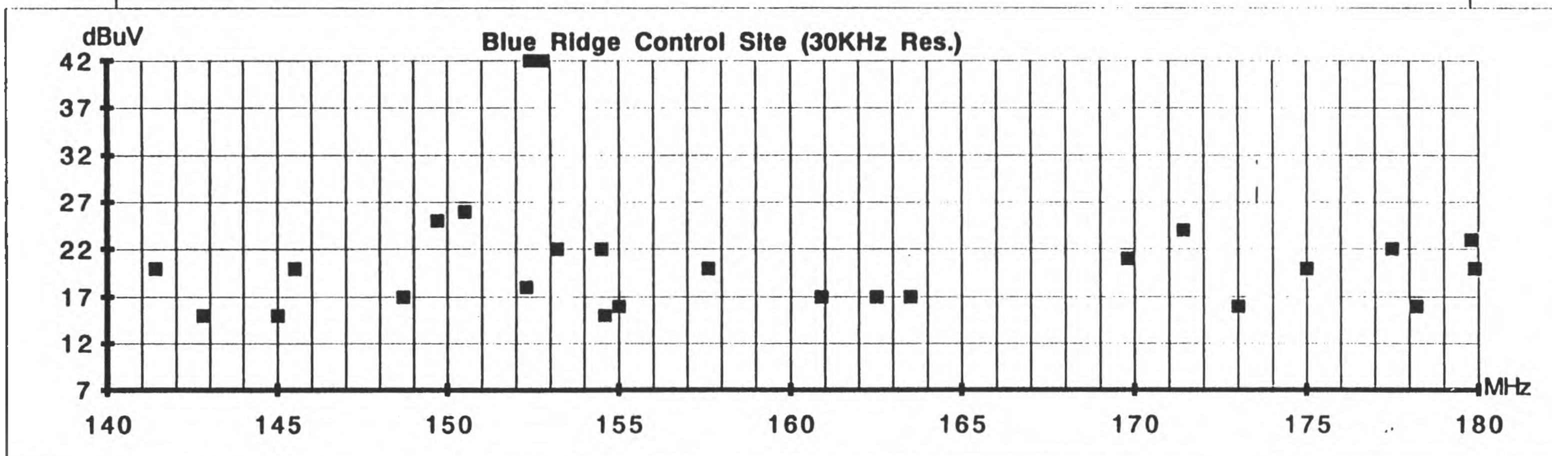


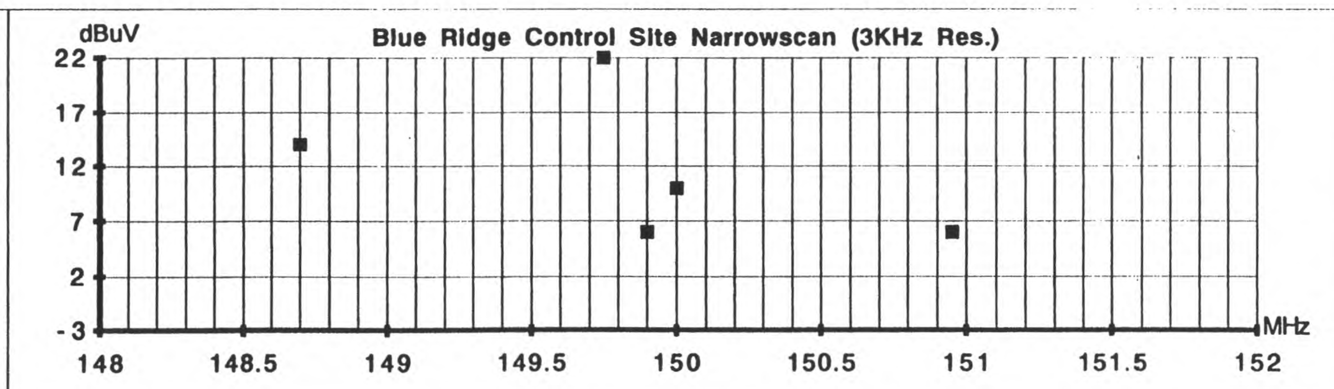

Alberta Newsprint (300KHz Res.)
dBuV
51 46 41 36 31 26 21 16
135 140 145 150 155 160 165 170 175 180
MHz


Alberta Newsprint (30KHz Res.)
dBuV
52 47 42 37 32 27 22 17 12 7
140 145 150 155 160 165 170 175 180
MHz

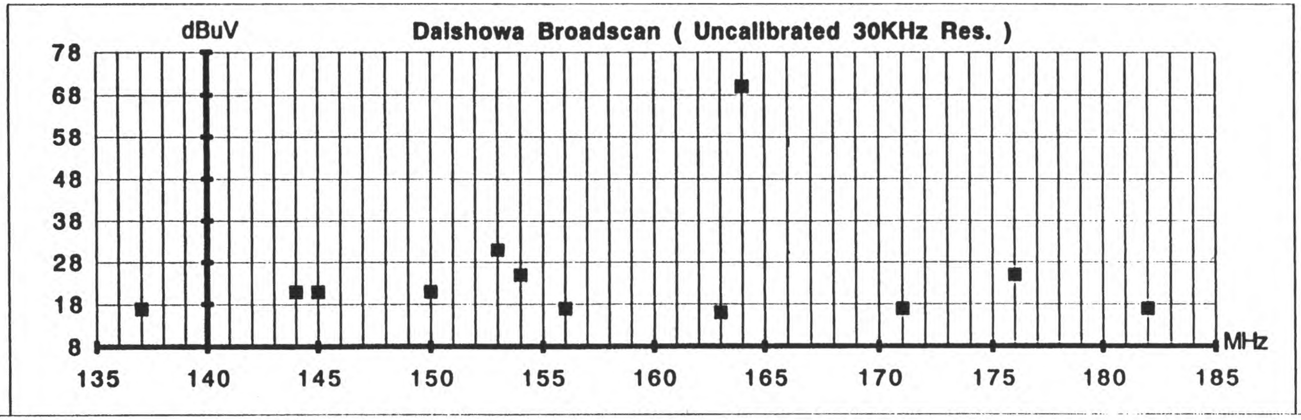

Alberta Newsprint Narrowscan (3KHz Res.)
dBuV
46 36 26 16 6 -4
148 148.5 149 149.5 150 150.5 151 151.5 152
MHz

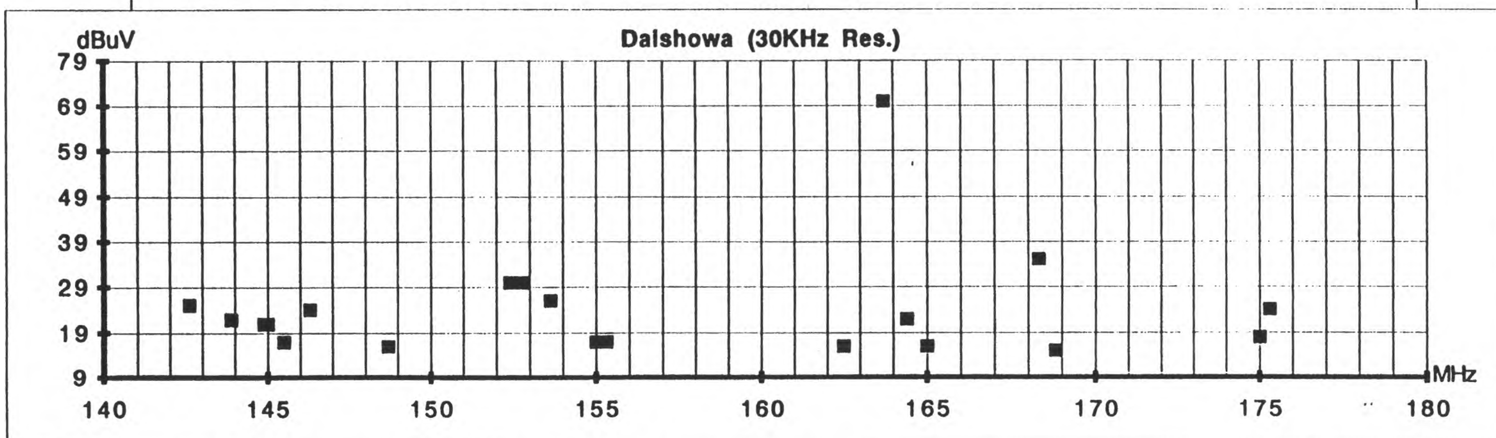

Blue Ridge Control Site (300KHz Res.)
dBuV
44
39
34
29
24
19
14
MHz
135
140
145
150
155
160
165
170
175
180
185

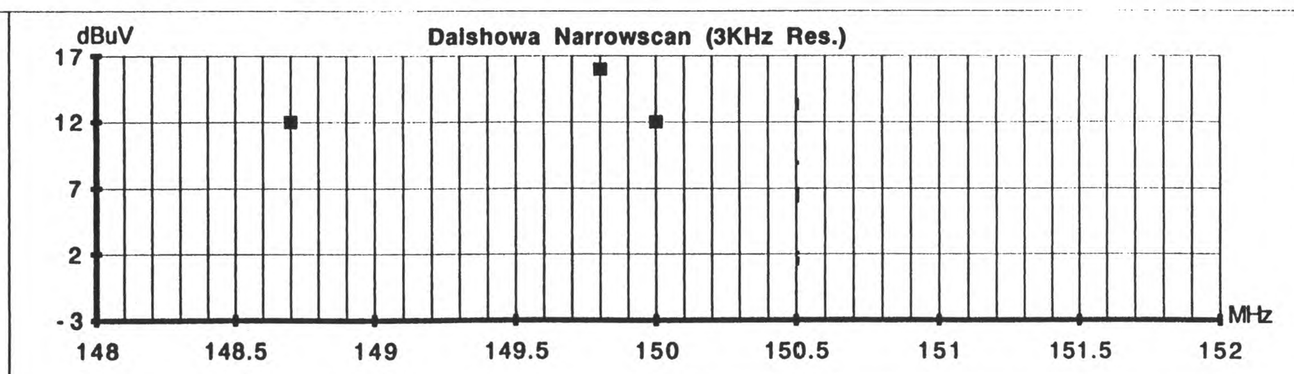

Blue Ridge Control Site (30KHz Res.)
dBuV
42
37
32
27
22
17
12
7
MHz
140
145
150
155
160
165
170
175
180

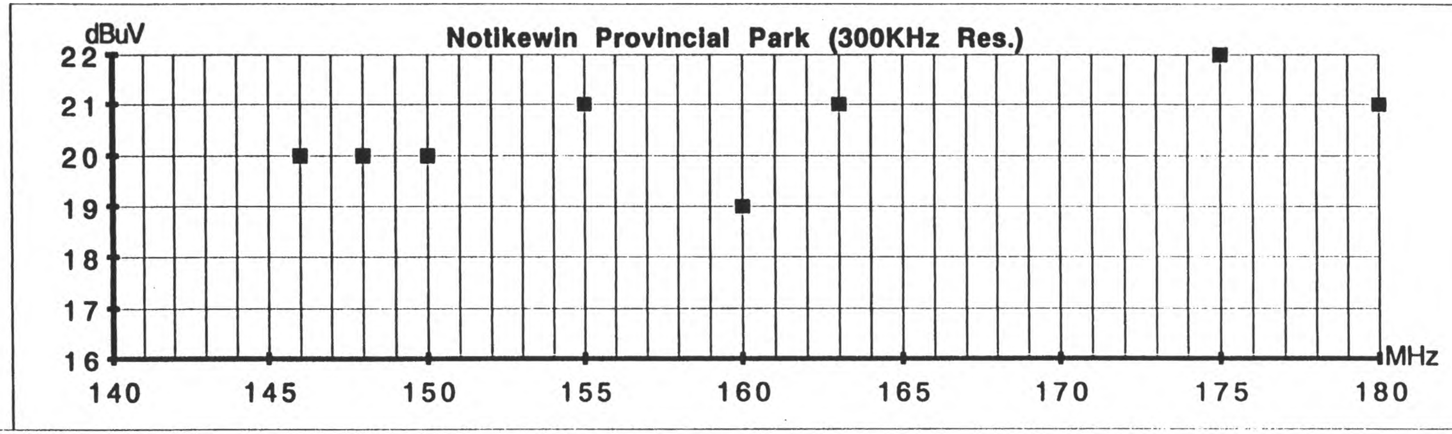

Blue Ridge Control Site Narrowscan (3KHz Res.)
dBuV
22
17
12
7
2
-3
MHz
148
148.5
149
149.5
150
150.5
151
151.5
152

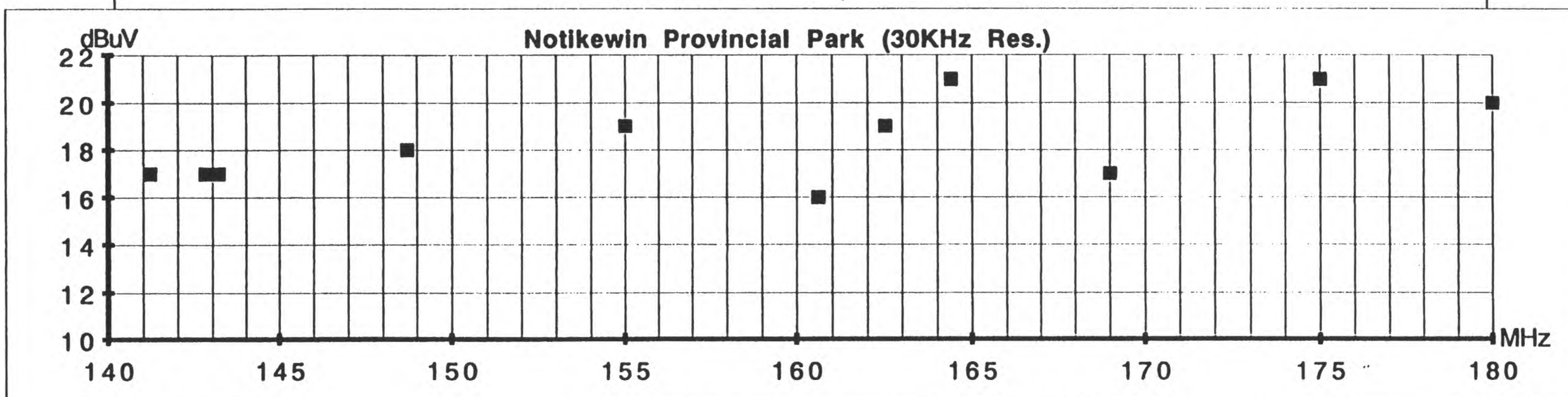
Radio Noise Scan Plot

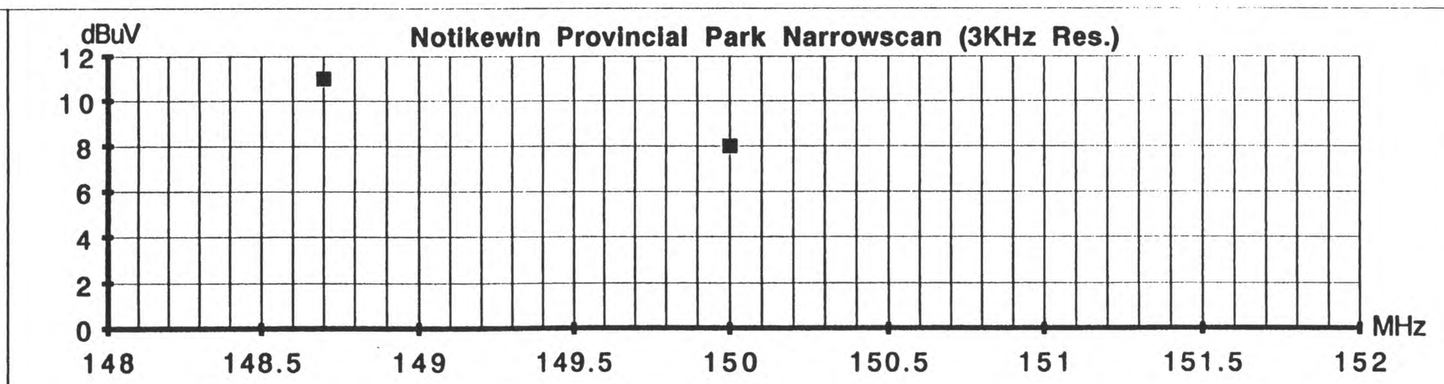




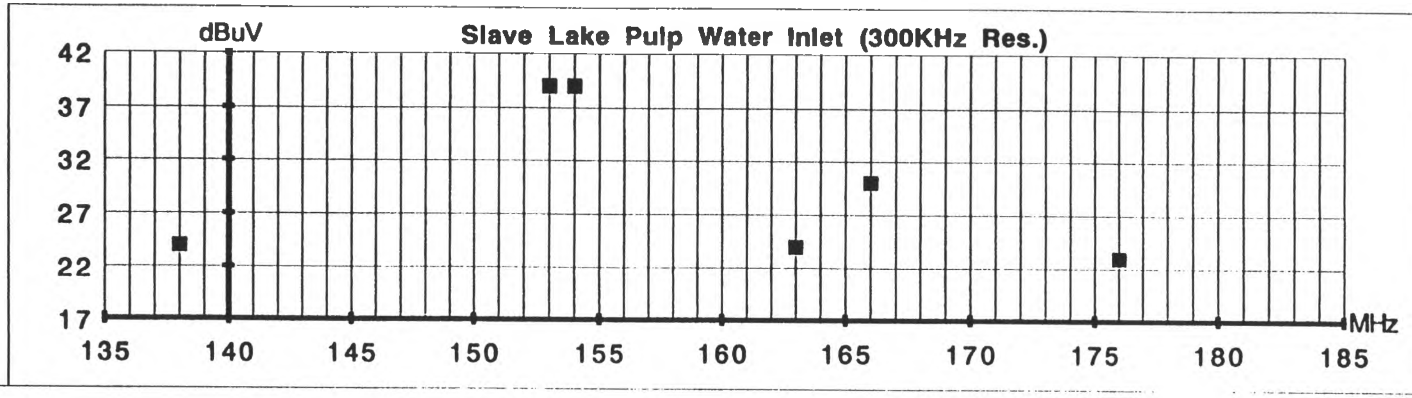


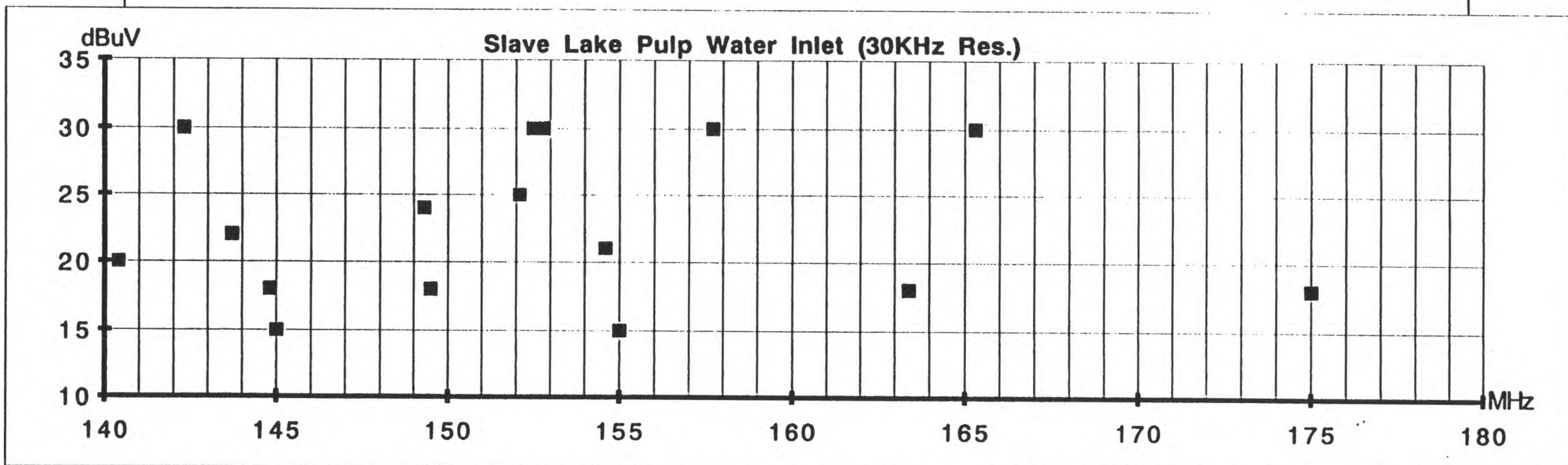

Notikewin Provincial Park (300KHz Res.)
dBuV
22
21
20
19
18
17
16
140
145
150
155
160
165
170
175
180
MHz

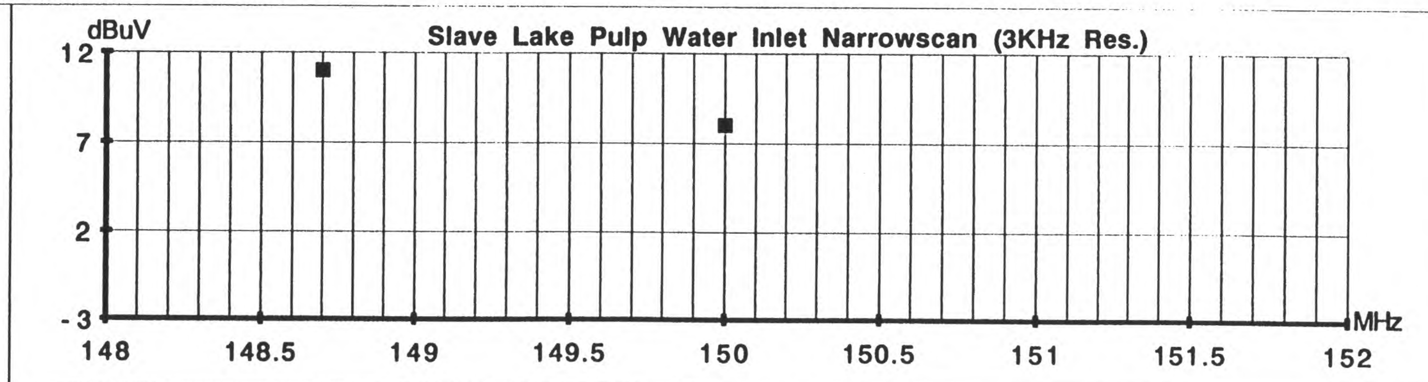

Notikewin Provincial Park (30KHz Res.)
dBuV
22
20
18
16
14
12
10
140
145
150
155
160
165
170
175
180
MHz

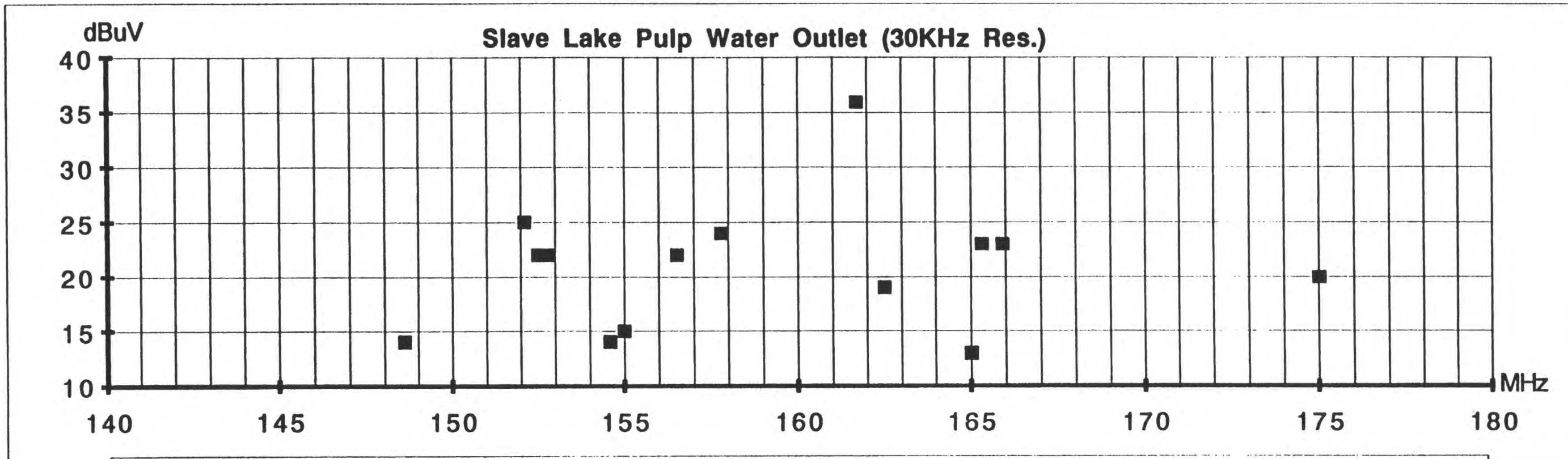

Notikewin Provincial Park Narrowscan (3KHz Res.)
dBuV
12
10
8
6
4
2
0
148
148.5
149
149.5
150
150.5
151
151.5
152
MHz

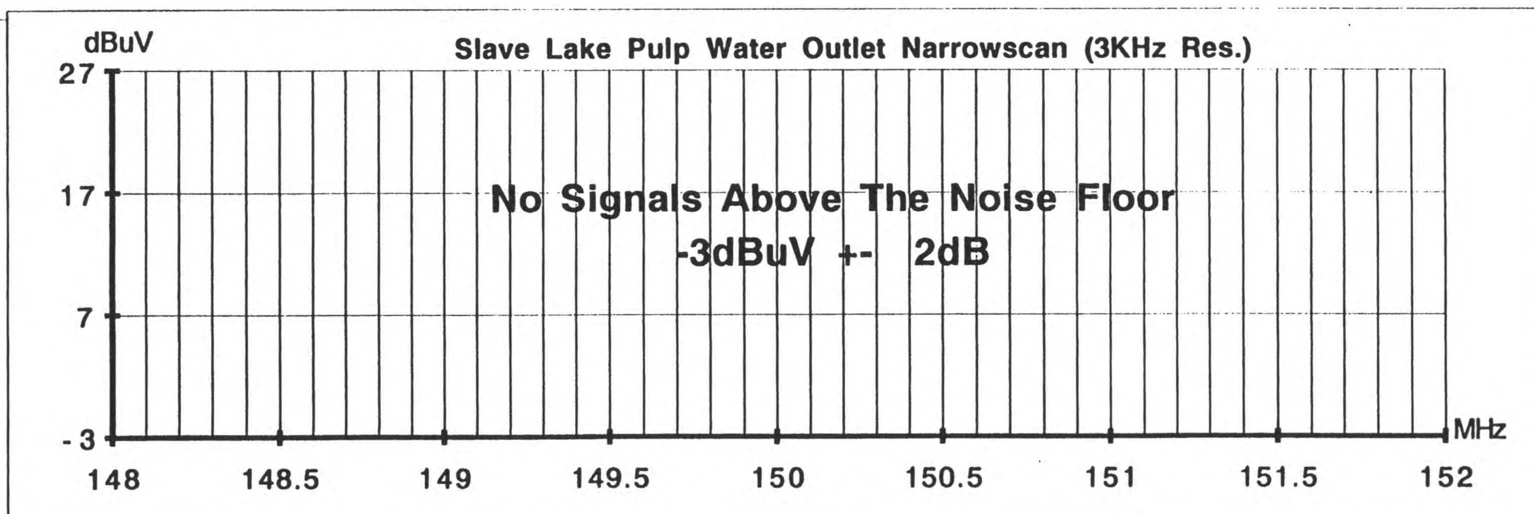
Radio Noise Scan Plot

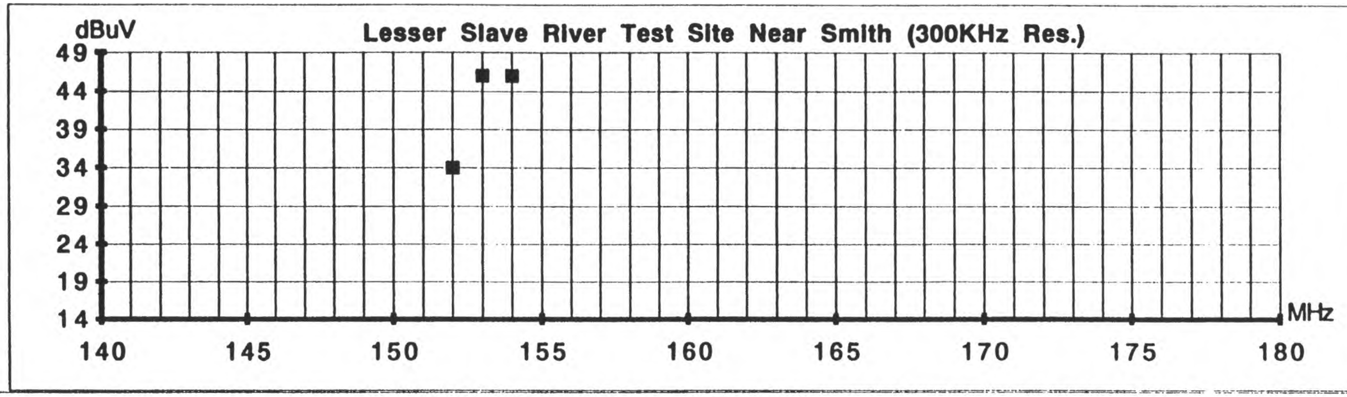


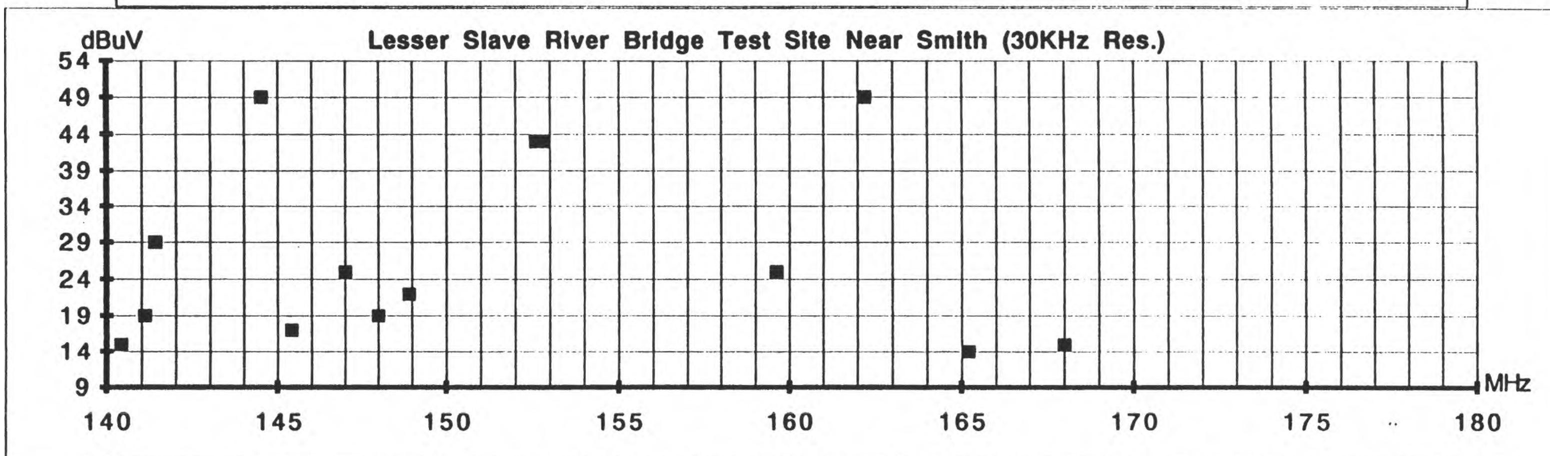


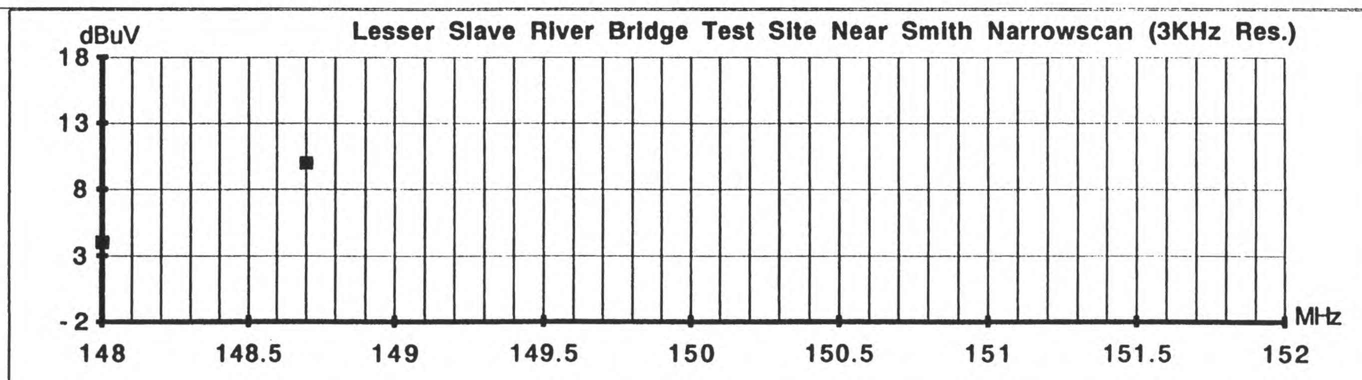


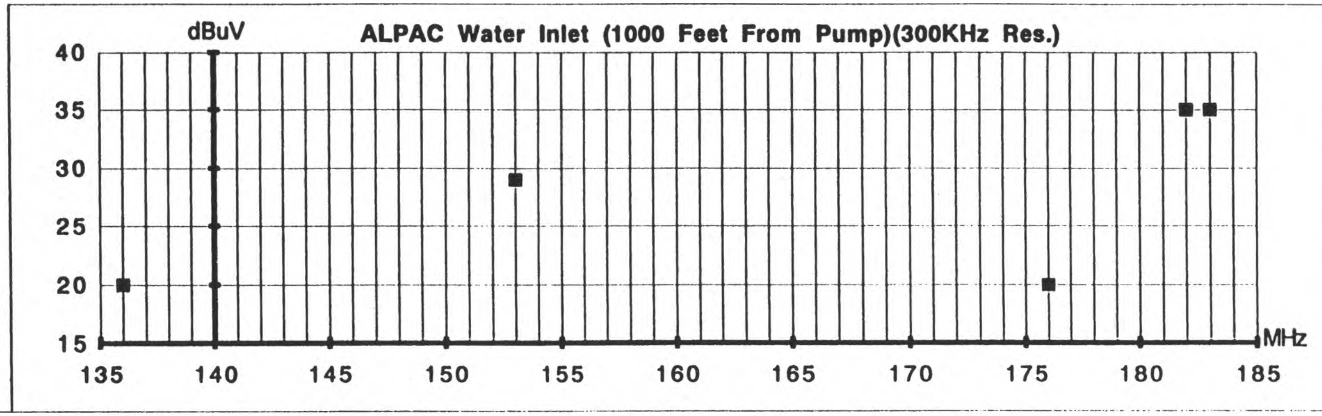

dBuV
Slave Lake Pulp Water Outlet (30KHz Res.)
40
35
30
25
20
15
10
MHz
140
145
150
155
160
165
170
175
180


dBuV
Slave Lake Pulp Water Outlet Narrowscan (3KHz Res.)
27
17
7
- 3
No Signals Above The Noise Floor
-3dBuV +- 2dB
MHz
148
148.5
149
149.5
150
150.5
151
151.5
152

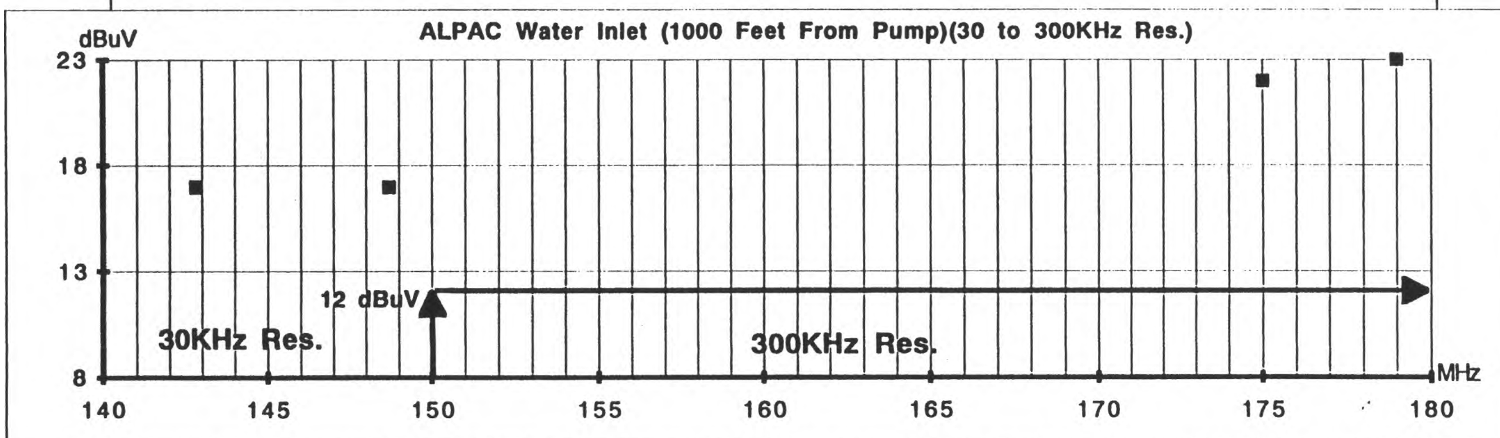

Lesser Slave River Test Site Near Smith (300KHz Res.)
dBuV
49
44
39
34
29
24
19
14
MHz
140
145
150
155
160
165
170
175
180


Lesser Slave River Bridge Test Site Near Smith (30KHz Res.)
dBuV
54
49
44
39
34
29
24
19
14
9
MHz
140
145
150
155
160
165
170
175
180

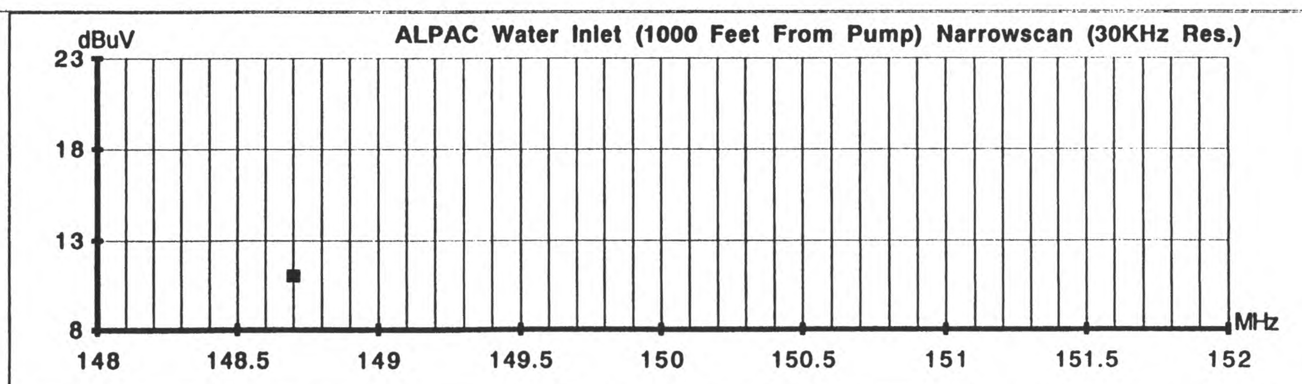

Lesser Slave River Bridge Test Site Near Smith Narrowscan (3KHz Res.)
dBuV
18
13
8
3
-2
MHz
148
148.5
149
149.5
150
150.5
151
151.5
152



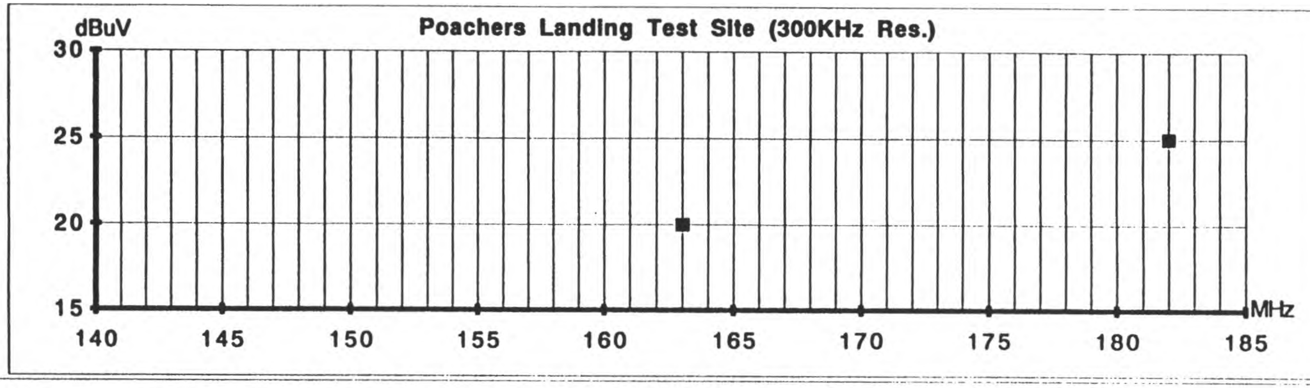
ALPAC Water Inlet (1000 Feet From Pump)(300KHz Res.)
dBuV
40
35
30
25
20
15
135
140
145
150
155
160
165
170
175
180
185
MHz

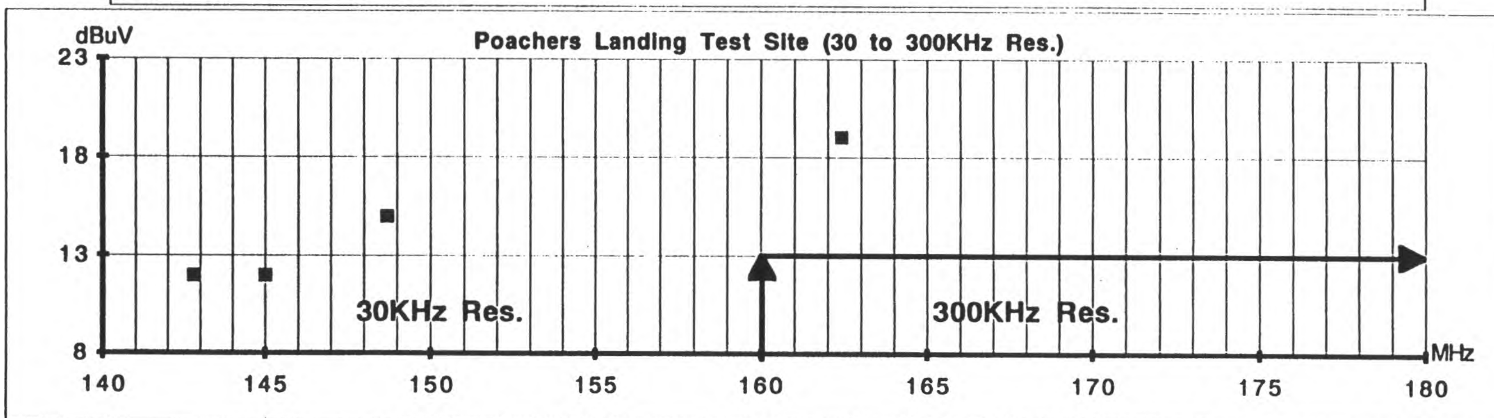


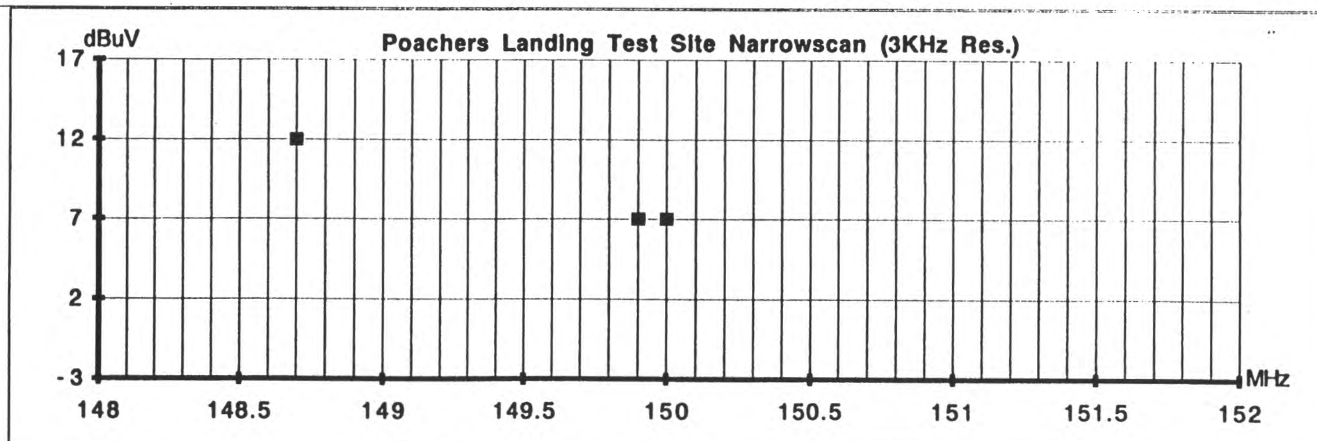
ALPAC Water Inlet (1000 Feet From Pump)(30 to 300KHz Res.)
dBuV
23
18
13
8
12 dBuV
30KHz Res.
300KHz Res.
140
145
150
155
160
165
170
175
180
MHz



ALPAC Water Inlet (1000 Feet From Pump) Narrowscan (30KHz Res.)
dBuV
23
18
13
8
148
148.5
149
149.5
150
150.5
151
151.5
152
MHz

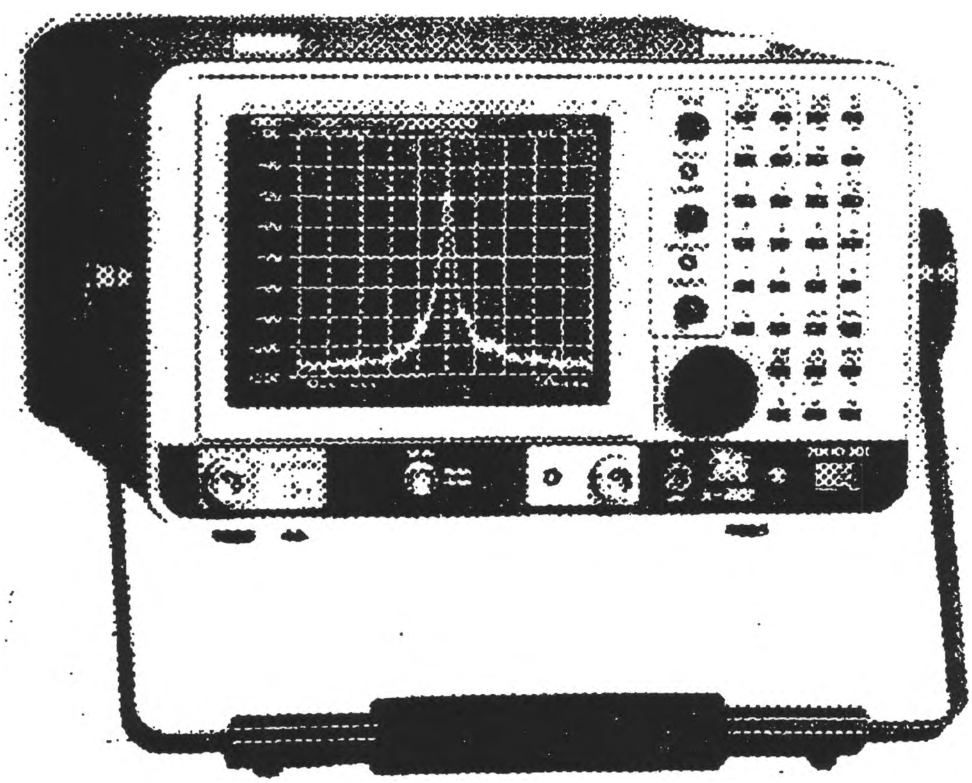

Poachers Landing Test Site (300KHz Res.)
dBuV
30
25
20
15
140
145
150
155
160
165
170
175
180
185
MHz


Poachers Landing Test Site (30 to 300KHz Res.)
dBuV
23
18
13
8
30KHz Res.
300KHz Res.
140
145
150
155
160
165
170
175
180
MHz


Poachers Landing Test Site Narrowscan (3KHz Res.)
dBuV
17
12
7
2
-3
148
148.5
149
149.5
150
150.5
151
151.5
152
MHz

APPENDIX 3
TECHNICAL SPECIFICATIONS

A-8000
SPECTRUM ANALYZER



APPENDIX 3 - A-8000 TEC PERFORMANCE SPECIFICATIONS

3.10 FREQUENCY

Frequency Range:	10 kHz to 2.6 GHz.
Frequency Span Width:	1 kHz / DIV to 200 MHz / DIV in 1-2-5 sequence, plus 0 scan, 250 MHz / DIV and full scan.
Frequency Display Linearity:	< 5% of the indicated frequency separation.
Center Frequency Readout Accuracy:	± 3% of frequency display span plus time base accuracy.
Resolution:	
Bandwidth Ranges: (at 3 dB)	300 Hz, 3 kHz, 30 kHz, 300 kHz and 3 MHz
Residual FM (typical):	<100 Hz peak-to-peak at scan / DIV settings below 200 kHz / DIV.
Noise Sidebands (3 kHz Resolution Bandwidth):	>65 dB below peak CW signal at 10X resolution bandwidth setting from CW signal. (With 300 Hz video filter).

3.11 AMPLITUDE

Measurement/Frequency Range:	-120 dBm to +30 dBm from 100 kHz to 2.5 GHz
Displayed Dynamic Range:	70 dB in 10 dB / DIV log scale. 16 dB in 2 dB / DIV log scale. 8 divisions with linear amplitude scale.
3rd Order Intermodulation Products:	-70 dBc for two signals displayed 10 dB down from top reference level.
Amplitude Units:	dBm, dBµW, dBV, dBmV, dBµV
Amplitude Scale Linearity:	10 dB / DIV log: ±0.15 dB / dB, but not more than 2.5 dB over 70 dB dynamic range. 2 dB / DIV log: ±0.4 dB/2 dB, but not more than 1.5 dB over 14 dB dynamic range. Linear: demodulation linearity within 2% of full scale.
Frequency Response:	±1.5 dB with 10 dB RF Attenuation.
Bandwidth Switching Error:	±1 dB for all resolution bandwidths except ±2 dB for 300 Hz Resolution Bandwidth.

3.12 INPUT

Impedance:	50 Ω nominal (adaptable to 75 Ω, optionally)
RF Attenuator:	60 dB range in 10 dB steps.
Accuracy:	± 0.5 dB or ±2%
Maximum Input Levels:	4 volts DC or +30 dBm with maximum input attenuation. +20 dBm for all other conditions.

3.14 OUTPUT

Time Base (TCXO):	
Accuracy:	0.5 ppm

3.15 GENERAL CHARACTERISTICS

Temperature Range:	0° to 50° C.
Power Requirements:	
Line:	106 to 266 VAC, 50 to 400 Hz. 60 watts typical at 115 VAC (no options).
External D.C.:	12 to 30 VDC nominal, 4.5 amps at 12V typical (no options). 2 Amps at 28V typical (no options).

3.16 TRACKING GENERATOR (OPTIONAL)

Frequency Range:	100 kHz to 2.5 GHz.
Output Level:	0 dBm to -70 dBm in 1 dB steps.
Flatness:	±2 dB
Residual FM:	<100 Hz peak to peak
Output Impedance:	50Ω nominal (adaptable to 75Ω, optionally)
Spurious:	Harmonics -20 dBc or lower. Non-harmonics -40 dBc or lower.

3.17 +20 dB TRACKING GENERATOR OUTPUT AMPLIFIER (OPTIONAL)

Frequency Range:	10 MHz to 1 GHz.

3.18 INTERNAL RECHARGEABLE BATTERY (OPTIONAL)

3.19 FM/AM/SSB RECEIVER

Range: 100 kHz to 2.5 GHz

Center Frequency Resolution: 100 Hz

Sensitivity: 2 µV typical.

Selectivity: (at 3 dB)

MODE	RECEIVER BANDWIDTH
FM 2	200 kHz
FM 1	15 kHz
SSB	6 kHz
AM 1	6 kHz
AM 2	15 kHz

Adjacent Channel Rejection:

RECEIVER BANDWIDTH (at 3 dB)	40 dB DOWN AT
200 kHz	±300 kHz
15 kHz	±27 kHz
6 kHz	±12 kHz

3.110 QUASI-PEAK DETECTOR (OPTIONAL)

Frequency Range	Bandwidth at 6 dB	Charge Time Constant (ms)	Discharge Time Constant (ms)
10 kHz to 150 kHz	200 Hz	TC1 45 mS	TC1 500
150 kHz to 30 MHz	9 kHz	TC2 1 mS	TC2 160
30 MHz to 1 GHz	120 kHz	TC3 1 mS	TC3 550

3.111 IEEE-488 INTERFACE BUS (GPIB) (OPTIONAL)

Equipped.

3.112 RS-232 INTERFACE BUS (OPTIONAL)

Not equipped.

3.113 CAMERA MOUNT ADAPTER (OPTIONAL)

Not equipped.

3.114 MAINTENANCE KIT (OPTIONAL)

Not equipped.

3.115 75 OHM ADAPTER (OPTIONAL)

Equipped.

3.20 RESOLUTION BANDWIDTH

Resolution Bandwidth is the width in Hertz (Hz), of a spectrum analyzer's response to a Continuous Wave (CW) signal. This width is the frequency difference at specific points on the response curve (see Figure D-1). The points are either 3 or 6 dB down from peak.

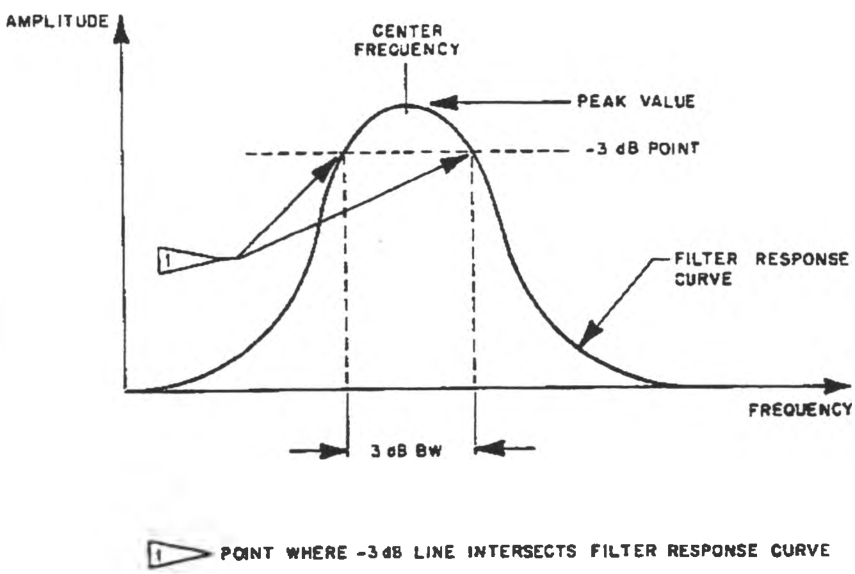


Figure D-1 Determining the Resolution Bandwidth on Filter Response Curve

The resolution bandwidth gives the capacity to resolve spectral lines. The smaller the bandwidth, the greater the analyzer's ability to detect closely spaced lines. The signal and the shape of the resolution bandwidth filter determine the shape of the signal displayed on the CRT.

EXAMPLE: Note the difference in the shape of the signal display at the following settings:

1. Resolution Bandwidth = 30 kHz
   Scan Width = 500 kHz / DIV
2. Resolution Bandwidth = 30 kHz
   Scan Width = 50 kHz / DIV

Spectrum Analyzers with microprocessors may automatically select optimum resolution bandwidths based on scan width selection. The scan width determines the frequency spectrum displayed on the spectrum analyzer CRT. If the resolution bandwidth is too wide for the scan width selected (Figure D-2), the ability to distinguish individual spectral components is lost. Notice, by changing only the resolution bandwidth parameter in Figure D-3, these spectral components become distinguishable. One of several bandwidth filters can be selected for most scan width or sweep rate settings. A usual resolution bandwidth is greater than 1/50th the scan width selection, where possible. The capacity to select these functions automatically or individually is a typical function of most spectrum analyzers (see Appendix E).

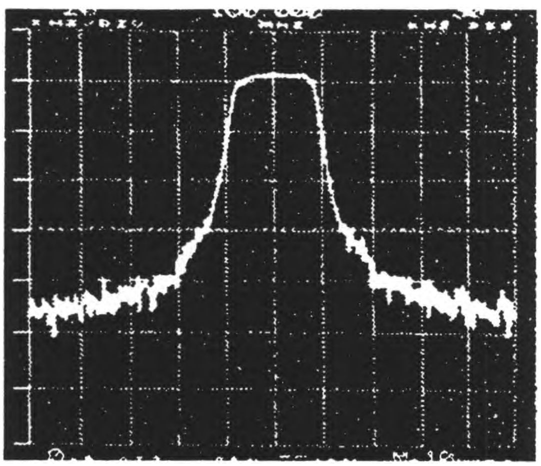


Figure D-2 Resolution Bandwidth Setting 30 kHz (20 kHz Sidebands Not Visible)

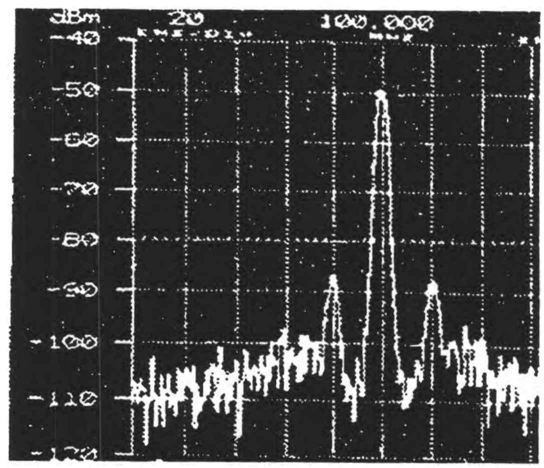


Figure D-3 Reset Resolution Bandwidth to 3 kHz (20 kHz Sidebands Visible)

By selecting a narrower resolution bandwidth, the bandwidth is normally reduced by a factor of 10 and the noise floor drops 10 dB. The combination of these occurrences allows signals to become visible and prominent. Figure D-4 is a composite of Figure D-2 and Figure D-3.

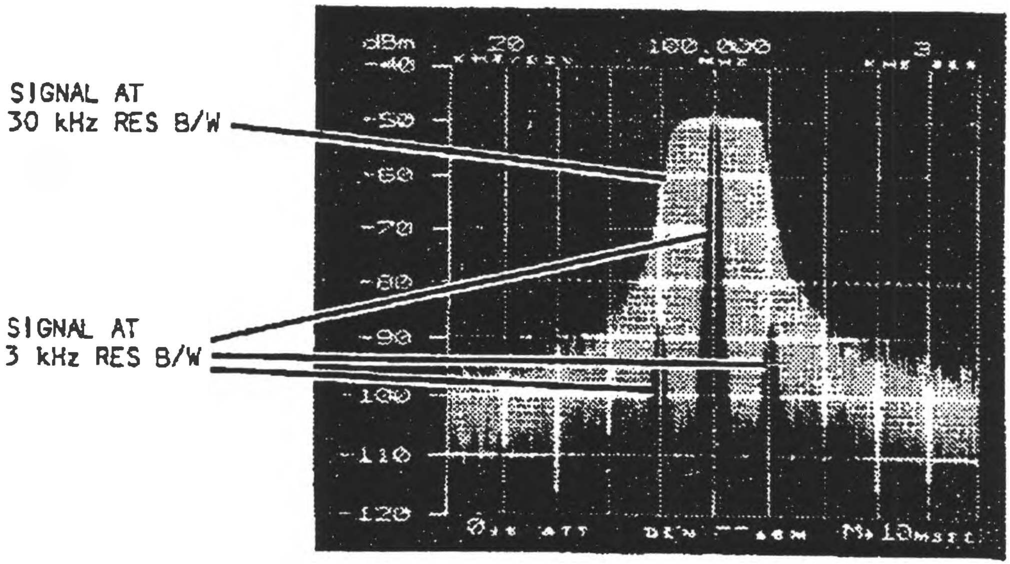


Figure D-4 Composite of Figures D-2 and D-3

NOTE

As the bandwidth becomes narrower, the sweep rate needs to be slower. This allows the signal to trace the correct amplitude through the filter.

3.30 OPTIMIZATION OF RESOLUTION BANDWIDTHS AND SWEEP RATES

Optimization allows the A-8000 to automatically select optimal Resolution Bandwidth and Sweep Rate for most Scan Width settings. The settings are based upon the behavior of the A-8000 Spectrum Analyzer. When active, the Scan Width setting determines the Resolution Bandwidth setting. The combination of the Center Frequency, the Scan Width and Resolution Bandwidth settings determine the Sweep Rate setting.

3.31 BANDWIDTH OPTIMIZATION

When Bandwidth Optimization is active, changing the Scan Width changes the Resolution Bandwidth per Table E-1. The Resolution Bandwidth can be reset to any of the available values on the A-8000.

SCAN WIDTH	RES B/W
0 kHz / DIV 1 kHz / DIV 2 kHz / DIV	300 Hz 300 Hz 300 Hz
5 kHz / DIV 10 kHz / DIV 20 kHz / DIV	3 kHz 3 kHz 3 kHz
50 kHz / DIV 100 kHz / DIV 200 kHz / DIV 500 kHz / DIV	30 kHz 30 kHz 30 kHz 30 kHz
1 MHz / DIV 2 MHz / DIV 5 MHz / DIV 10 MHz / DIV	300 kHz 300 kHz 300 kHz 300 kHz
20 MHz / DIV 50 MHz / DIV 100 MHz / DIV 200 MHz / DIV 250 MHz / DIV	3 MHz 3 MHz 3 MHz 3 MHz 3 MHz

Table E-1 Optimal Resolution Bandwidth Settings

3.32 SWEEP RATE OPTIMIZATION

When Sweep Rate Optimization is active, the Sweep Rate may change when any of the following conditions occur:

- The Scan Width is changed.
- The Resolution Bandwidth is changed.
- The Center Frequency is changed.

Table E-2 shows optimized Sweep Rate settings without video filtering. The Sweep Rates may be reset to any slower value. If a faster value is selected, an "UNCAL" condition occurs. The Uncal condition occurs because the Sweep rate is set too fast to accurately measure signal amplitudes or if too much RF is passed through the filters.

	BANDWIDTH				
SCAN WIDTH	300 Hz	3 kHZ	30 kHz	300 kHz	3 MHz
0 kHz / DIV	5 mSEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
1 kHz / DIV	10 mSEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
2 kHz / DIV	20 mSEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
5 kHz / DIV	50 mSEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
10 kHz / DIV	.1 SEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
20 kHz / DIV	.2 SEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
50 kHz / DIV	1 SEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
100 kHz / DIV	2 SEC	10 mSEC	5 mSEC	5 mSEC	5 mSEC
200 kHz / DIV	Uncal	20 mSEC	10 mSEC	5 mSEC	5 mSEC
500 kHz / DIV	Uncal	50 mSEC	20 mSEC	5 mSEC	5 mSEC
1 MHz / DIV	Uncal	.1 SEC	50 mSEC	5 mSEC	5 mSEC
2 MHz / DIV	Uncal	.5 SEC	.1 SEC	5 mSEC	5 mSEC
5 MHz / DIV	Uncal	Uncal	.2 SEC	5 mSEC	5 mSEC
10 MHz / DIV	Uncal	Uncal	.5 SEC	10 mSEC	5 mSEC
20 MHz / DIV	Uncal	Uncal	2 SEC	20 mSEC	5 mSEC
50 MHz / DIV	Uncal	Uncal	Uncal	50 mSEC	5 mSEC
100 MHz / DIV	Uncal	Uncal	Uncal	.1 SEC	10 mSEC
200 MHz / DIV	Uncal	Uncal	Uncal	.2 SEC	20 mSEC
250 MHz / DIV	Uncal	Uncal	Uncal	.5 SEC	20 mSEC
FULL (265 MHz / DIV)	Uncal	Uncal	Uncal	.5 SEC	20 mSEC

Table E-2 Sweep Rate Optimization with No Video Filter

Example: Select the following:

Scan Width = 500 kHz / DIV
Res B/W = 3 kHz
Sweep Rate = 10 mSec / DIV

"UNCAL" should now appear in the upper-left corner of the CRT instead of the graticule unit. Increase the Sweep Rate value until the "UNCAL" message is replaced by the graticule units. This is the fastest sweep rate setting that should be selected for measurements on the A-8000 using the specified Scan Width and Sweep Rate settings. (Find this value on Table E-2).

Table E-3 shows optimized Sweep rate settings with the 300 Hz Video Filter turned on. As in Table E-2, Sweep Rates may be reset to any slower value than the optimized setting. Faster Sweep Rate settings result in an "UNCAL" condition.

	BANDWIDTH				
SCAN WIDTH	300 Hz	3 kHZ	30 kHz	300 kHz	3 MHz
0 kHz / DIV	5 mSEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
1 kHz / DIV	10 mSEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
2 kHz / DIV	20 mSEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
5 kHz / DIV	.1 SEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
10 kHz / DIV	.2 SEC	10 mSEC	5 mSEC	5 mSEC	5 mSEC
20 kHz / DIV	.5 SEC	20 mSEC	5 mSEC	5 mSEC	5 mSEC
50 kHz / DIV	1 SEC	50 mSEC	5 mSEC	5 mSEC	5 mSEC
100 kHz / DIV	2 SEC	.1 mSEC	10 mSEC	5 mSEC	5 mSEC
200 kHz / DIV	Uncal	.2 mSEC	20 mSEC	5 mSEC	5 mSEC
500 kHz / DIV	Uncal	1 SEC	50 mSEC	5 mSEC	5 mSEC
1 MHz / DIV	Uncal	Uncal	.1 SEC	10 mSEC	5 mSEC
2 MHz / DIV	Uncal	Uncal	.5 SEC	20 mSEC	5 mSEC
5 MHz / DIV	Uncal	Uncal	1 SEC	50 mSEC	5 mSEC
10 MHz / DIV	Uncal	Uncal	Uncal	.1 SEC	10 mSEC
20 MHz / DIV	Uncal	Uncal	Uncal	.2 SEC	20 mSEC
50 MHz / DIV	Uncal	Uncal	Uncal	.5 SEC	50 mSEC
100 MHz / DIV	Uncal	Uncal	Uncal	Uncal	.1 SEC
200 MHz / DIV	Uncal	Uncal	Uncal	Uncal	.2 SEC
250 MHz / DIV	Uncal	Uncal	Uncal	Uncal	.5 SEC
FULL (265 MHz / DIV)	Uncal	Uncal	Uncal	Uncal	.5 SEC

Table E-3 Sweep Rate Optimization with 300 Hz Video Filter

Table E-4 shows optimized Sweep Rate settings with the 30 kHz Video Filter turned on. Again, Sweep Rates may be reset to any slower Sweep Rate value than the optimized setting. Faster Sweep Rate settings result in an "UNCAL" condition.

	BANDWIDTH				
SCAN WIDTH	300 Hz	3 kHZ	30 kHz	300 kHz	3 MHz
0 kHz / DIV	5 mSEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
1 kHz / DIV	10 mSEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
2 kHz / DIV	20 mSEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
5 kHz / DIV	.1 SEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
10 kHz / DIV	.2 SEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
20 kHz / DIV	.5 SEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
50 kHz / DIV	1 SEC	5 mSEC	5 mSEC	5 mSEC	5 mSEC
100 kHz / DIV	2 SEC	10 mSEC	5 mSEC	5 mSEC	5 mSEC
200 kHz / DIV	Uncal	20 mSEC	10 mSEC	5 mSEC	5 mSEC
500 kHz / DIV	Uncal	50 mSEC	20 mSEC	5 mSEC	5 mSEC
1 MHz / DIV	Uncal	.1 SEC	50 mSEC	5 mSEC	5 mSEC
2 MHz / DIV	Uncal	.5 SEC	.1 SEC	5 mSEC	5 mSEC
5 MHz / DIV	Uncal	Uncal	.2 SEC	5 mSEC	5 mSEC
10 MHz / DIV	Uncal	Uncal	.5 SEC	10 mSEC	5 mSEC
20 MHz / DIV	Uncal	Uncal	Uncal	20 mSEC	5 mSEC
50 MHz / DIV	Uncal	Uncal	Uncal	50 mSEC	10 mSEC
100 MHz / DIV	Uncal	Uncal	Uncal	.1 SEC	20 mSEC
200 MHz / DIV	Uncal	Uncal	Uncal	.2 SEC	50 mSEC
250 MHz / DIV	Uncal	Uncal	Uncal	.5 SEC	.1 SEC
FULL (265 MHz / DIV)	Uncal	Uncal	Uncal	.5 SEC	.1 SEC

Table E-4 Sweep Rate Optimization with 30 kHz Video Filter

3.33 MANUAL OPTIMIZATION

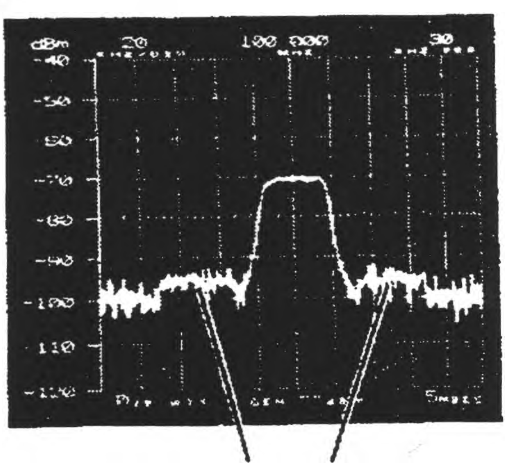
Optimization can be turned on or off via menu operation. Both the Resolution Bandwidth and the Sweep Rate Optimization functions can be set independently, as described in Paragraph 4-9.

Turning off Resolution Bandwidth Optimization affects only Resolution Bandwidth settings. That is, changing the Scan Width does not cause the Resolution Bandwidth to change. The Sweep Rate setting may still change. If Resolution Bandwidth Optimization is turned off, "M→" appears in the upper right corner of the CRT display. The arrow points to the Resolution Bandwidth display. If optimization is turned on, this block is blank.

Turning off Sweep Rate Optimization affects only Sweep Rate settings. That is, changing either the Scan Width or the Resolution Bandwidth does not cause the Sweep Rate to change. If Sweep Rate Optimization is turned off, "M→" appears in the lower-right corner of the CRT display. The arrow points to the Sweep Rate display. If optimization is turned on, the block is blank.

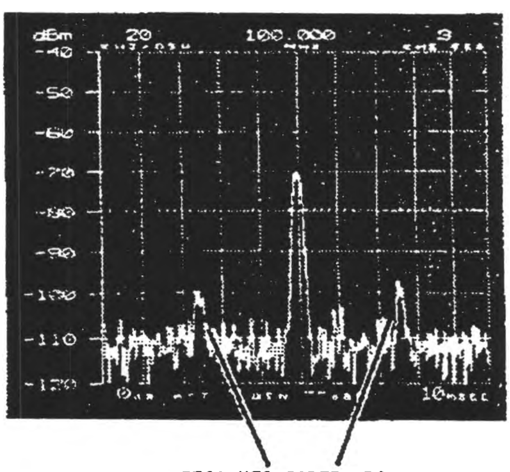
If Resolution Bandwidth Optimization and Sweep Rate Optimization are both turned off, then changing the Scan Width affects neither the Resolution Bandwidth nor the Sweep Rate settings. Also, changing the Resolution Bandwidth has no affect on the Sweep Rate. The "M→" is displayed in both applicable blocks on the CRT.

In some instances, low-level signals may be obstructed by the level of the noise floor (Figure D-5). Selecting a narrower resolution bandwidth causes the noise floor to drop, which allows obstructed signals to appear (Figure D-6).



UNRESOLVED SIDEBANDS

Figure 5 Obstructed Signal Due to Noise Floor



RESOLVED SIDEBANDS

Figure 6 Reducing Bandwidth Drops Noise Floor to Show Signals

APPENDIX 4 - SRX 400 TELEMETRY RECEIVER SPECIFICATIONS

GENERAL

Operating Voltage Range:	12-18 VDC
Operating Current:	less than 150 mA @ 12v
Battery Operated Lifetime:	40 hours @ 20°C
Memory Retention Battery:	10 years shelf life 6 months with main battery discharged
Operating Temperature Range:	-10°C to +50°C
Weight:	4.0 Kg (Lightweight option: 2.3 Kg)
Size:	22.0 x 20.4 x 8.8 cm

ELECTRICAL

Operating Frequency Range:		Any 4 MHz band between 30 and 220 MHz
Channel Spacing:		1 kHz
Frequency Stability:		5 ppm
Sensitivity:		Minimum discernable audio level -145 dBm Minimum discernable by software -125 dBm
Selectivity:		Adjacent channel selectivity 70 dB (10 kHz step)
Spurious Responses:		
	1/2 IF	70 dB
	Image	70 dB
	Other	70 dB
	Intermodulation	65 dB
RSSI Response:		
	-125 dBm min. signal level	
	-40 dBm max. signal level	
	resolution 0.25 dB	
Dynamic Gain Control Range:		90 dB

MEMORY

Program memory	64k
Data memory	64k

CONTROLS AND I/O

- 24 character by 2 line LCD display with back lighting
- 16-key weatherproof keypad
- on/off audio volume control
- speaker and headphone jack
- external power/battery charge jack
- BNC (50 ohm) antenna jack
- RS-232 port (DE-9P jack)

APPENDIX D

PHOTOS

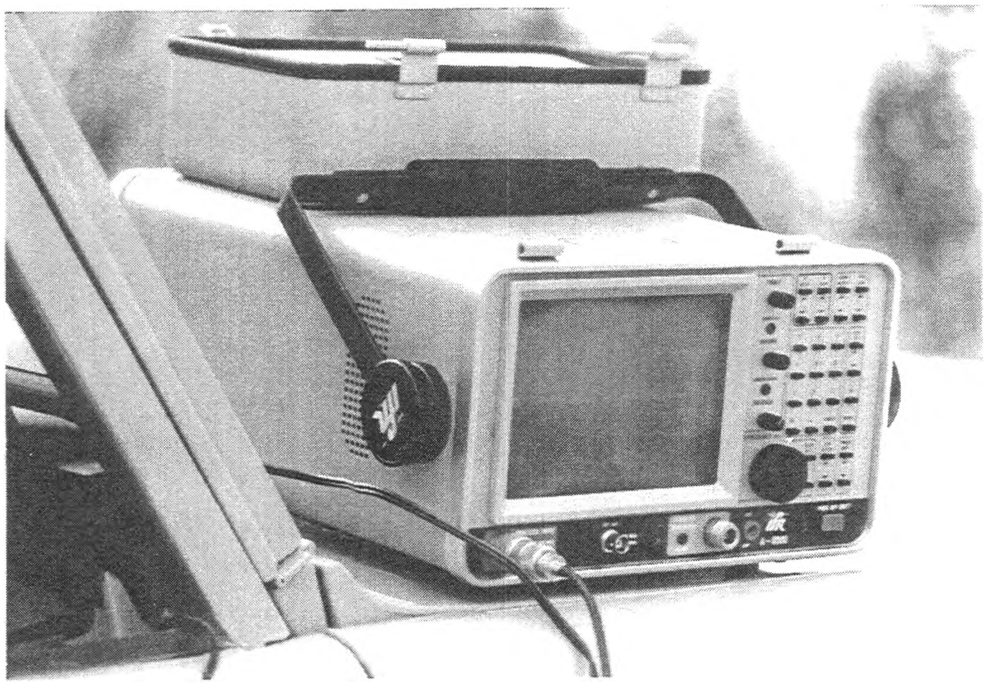


Photo #1 IFR Model 8000 portable spectrum analyzer used to conduct noise scans.

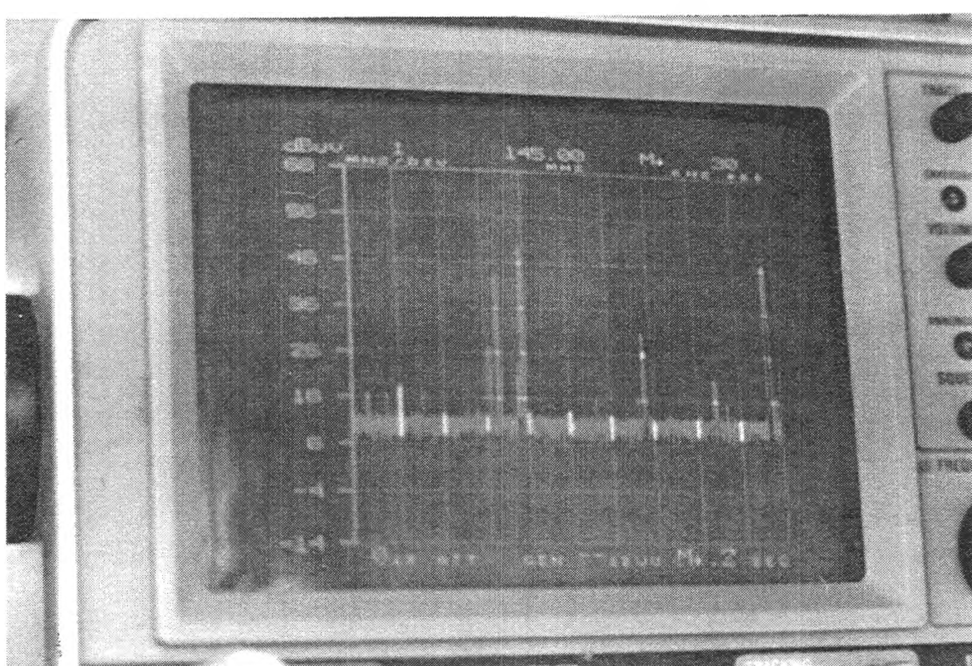


Photo #2 Typical display from the spectrum analyzer. This photo from ANC pumphouse, 140-150 MHz bandwidth at 30 KHz resolution on 26 March 1993.

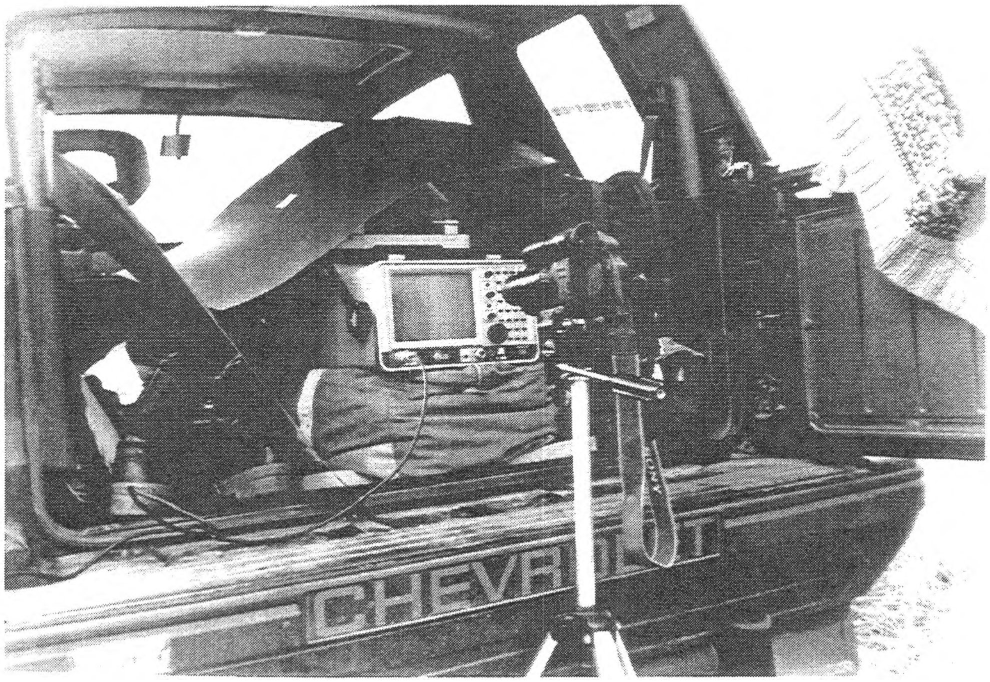


Photo #3 Spectrum analyzer and handicam set-up in back of vehicle.

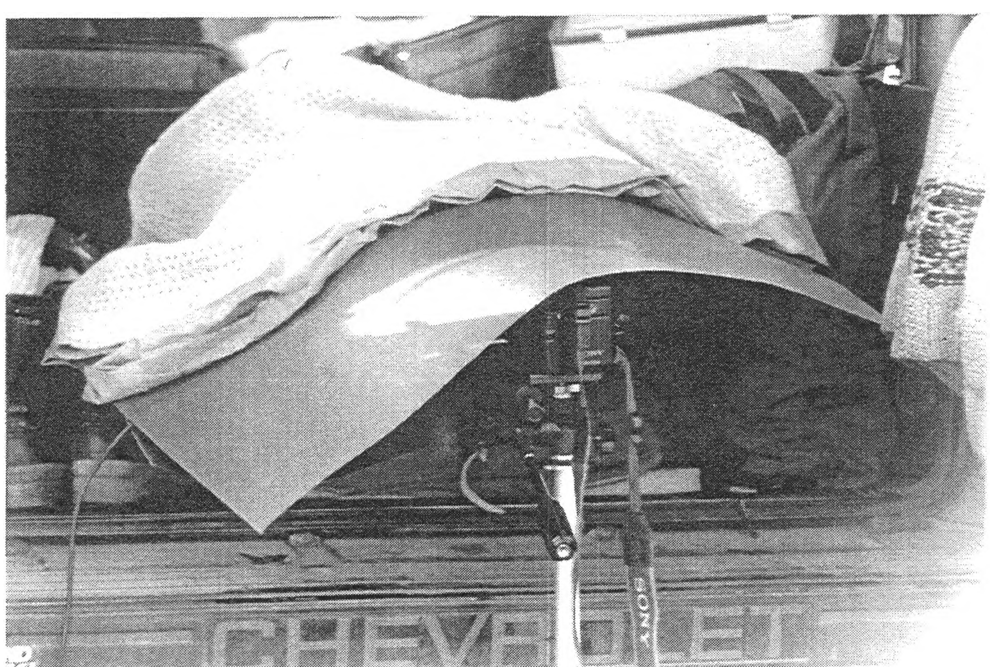


Photo #4 Equipment set-up in back of vehicle, Notikewin Provincial Park, 27 March 1993. Bristleboard used to reduce glare on spectrum analyzer display.

Photo #5 Hinton-Weldwood water intake site, 22 March 1993. Moderate river width and relatively high bank result in this site rated as having good potential as a telemetry ground station site.

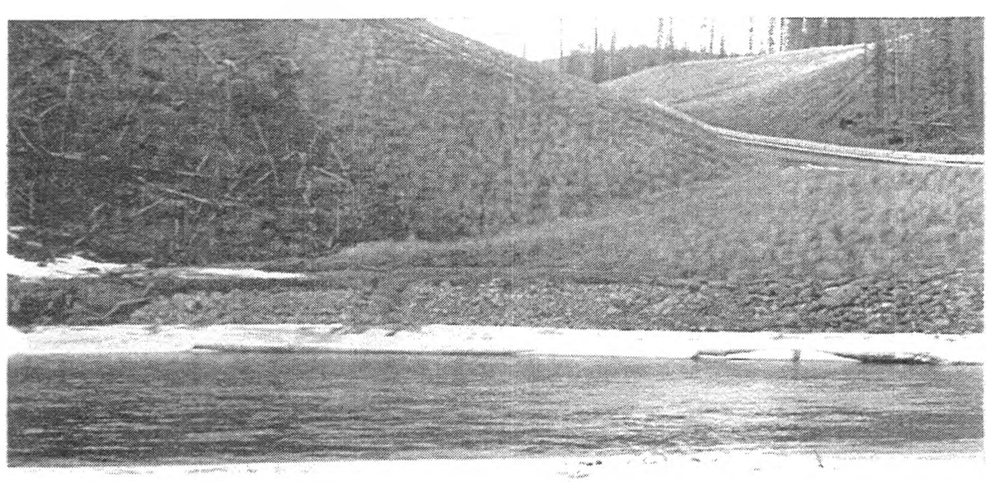


Photo #6 Obed Mountain Coal Bridge site, 22 March 1993. Bridge can be seen in top right corner, power lines directly overhead.

Photo #7 Athabasca River immediately downstream of confluence with McLeod River. View downstream showing left upstream bank. Note low bank height. 26 March 1993.

Photo #8 Athabasca River at Alberta Newsprint water intake pumphouse on 26 March 1993.

Photo #9 Blue Ridge Bridge, Whitecourt remote site. Photo from left upstream bank indicating excellent bank height. Bridge obstructs downstream line of sight. 26 March 1993.

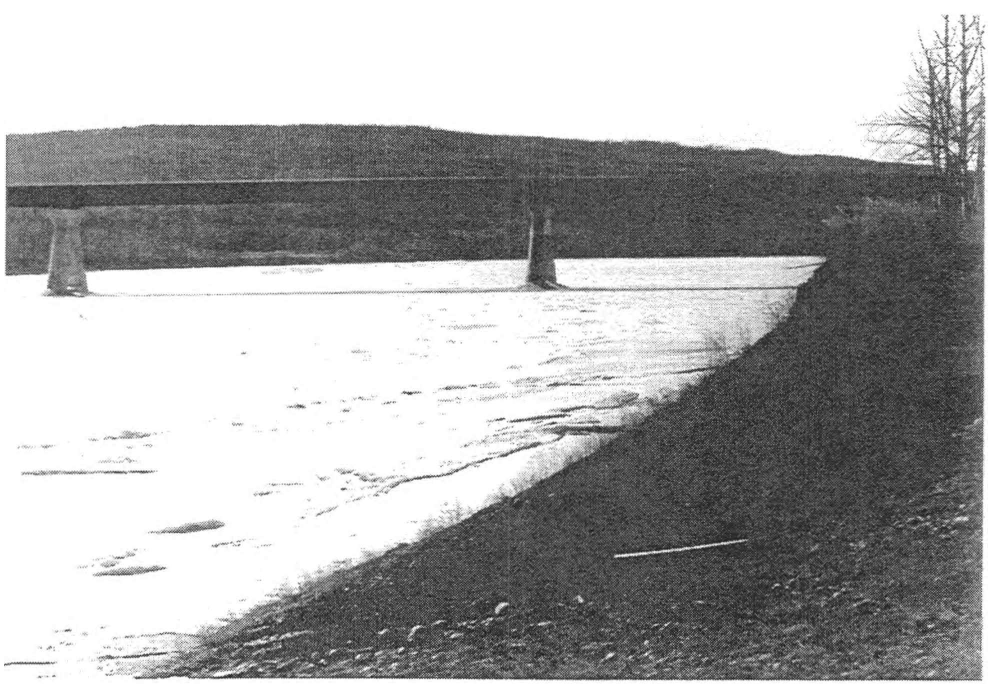


Photo #10 Daishowa at water intake pumphouse. Photo facing upstream. Note excellent bank height and wide channel width. 27 March 1993.

Photo #11 Peace River at Notikewin Provincial Park, 27 March 1993. Note wide river channel width, a major factor limiting suitability for a ground station site.

Photo #12 Lesser Slave River, facing upstream. Water intake structure in background. 28 March 1993.

Photo #13 Athabasca River at Smith, 28 March 1993. Note trees on top of bank, bank in repose.

Photo #14 Athabasca River at ALPAC, 29 March 1993. Note wide channel width and low bank height.

Photo #15 Athabasca River at Poacher's Landing, 29 March 1993. View facing upstream; note low bank height.

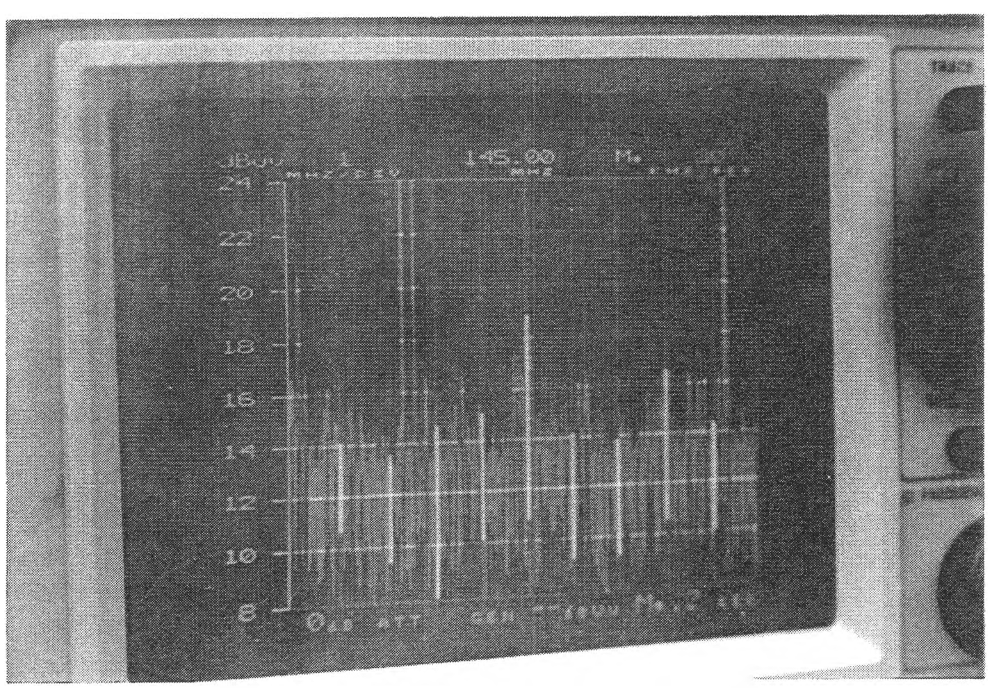


Photo #16 Spectrum analysis of 140-150 MHz band at Slave River Pumphouse, 28 March 1993. Many spikes are the result of strong fields around electrical transformers.