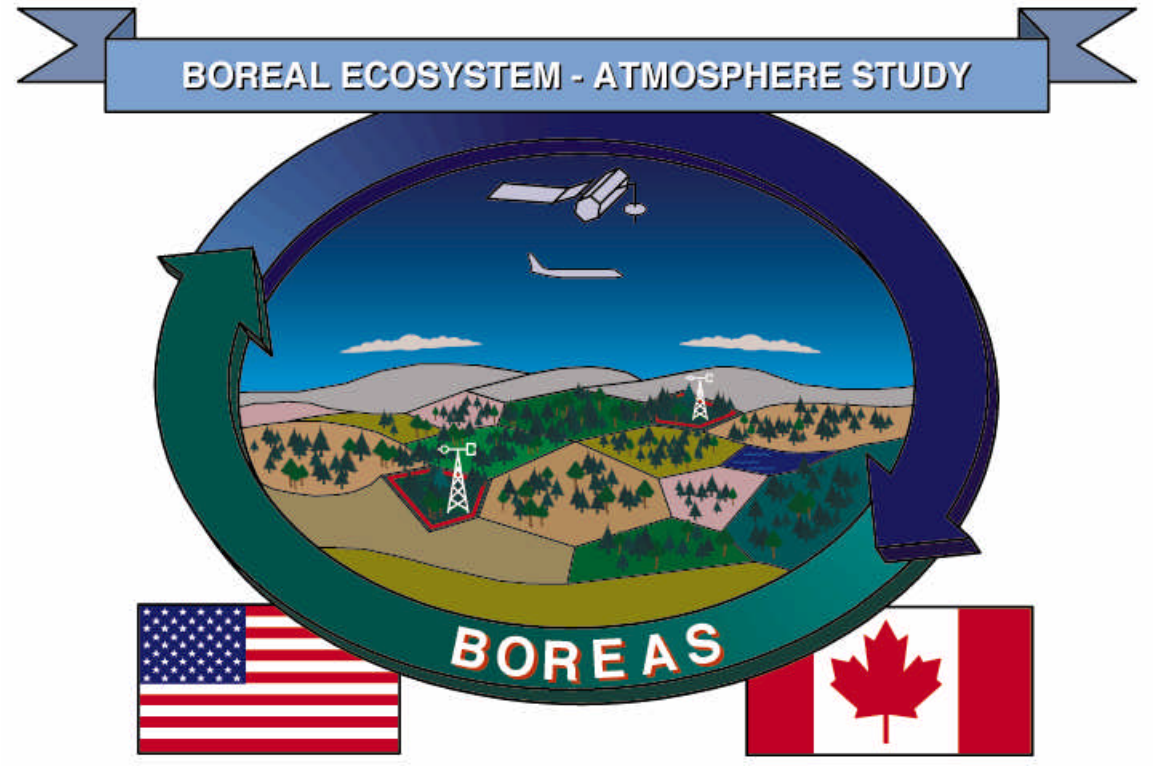
BOREAS
Experiment Plan



Chapter 4
Operations, Facilities, Schedules

May 1996 Version 2.0

BOREAS Executive Summary

This document is the Experiment Plan (EXPLAN-96) for BOREAS field operations to be conducted in 1996 (BOREAS-96). This work will consist primarily of a set of extended eddy correlation (H, LE CO_2) measurements at a number of tower flux sites from March through November 1996, supported by ecophysiological, hydrological, and biogeochemical observations. There will be a small winter campaign (FFC-W) to explore the physics of remote sensing over snow-covered forests, and three growing season field campaigns (thaw, midsummer, fall) in which the bulk of the in situ measurements and aircraft operations (airborne remote sensing and flux measurements will be concentrated.

Chapter 1 reviews the science issues and objectives of BOREAS; the overall design of the field observation component of BOREAS; the field operations and some preliminary results from BOREAS-94; and the shortcomings of the BOREAS-94 data set. The last item provides the motivation for the return to the field; i.e. for BOREAS-96.

Chapter 2 reviews the analyses and planning activities that took place in the period 1994-1995. These resulted in three white papers which are summarized in the text.

Chapter 3 describes the field operations planned for BOREAS-96. These are based directly on the requirements from the white papers summarized in Chapter 2. Chapter 3 is divided into six sections: overview; monitoring; NSA growing season studies; SSA growing season studies; and AFM and RSS growing season activities.

Chapter 4 describes operations procedures; the facilities to be made available by the project; and the schedules for site support.

Chapter 5 describes the aircraft operations. Complete summaries of all the mission plans for all the BOREAS-96 aircraft are included.

Chapter 6 provides a "quick look" summary of field campaign objectives, including tables showing which teams and aircraft will be present during IFC's.

Chapter 7 describes emergency procedures in case of accidents in the field.

Appendices A-H contain further details on investigator contact information; shipping and customs; data documentation; references; satellite overpass schedules; team activity write-ups; directions to BOREAS auxiliary sites, and an acronym list.

BOREAS Experiment Plan 1996

Table of Contents

Appendices A-H

4.0 OPERATIONS, FACILITIES, SCHEDULES

This chapter describes operations management, project resources and schedules for BOREAS-96. Basically, BOREAS-96 will be managed as a down-scaled version of BOREAS-94. The key components are as follows:

Operations HQs: SSA Ops will be manned during FFC-W. Both NSA and SSA Ops will be manned during IFC-1, IFC-2 and IFC-3. Also, there will be a BOREAS staffer at each study area prior to IFC-1, to assist the TF crews and others in getting installed. The Ops centers will be equipped with ground and air radio networks, telephones, faxes, etc., see 4.2.2.

Laboratories: Lab space will be available in the NSA and SSA, see 4.2.2.

Mission Management: A mission manager (MM) should be present during all periods of active airborne operations. The MM will work with the investigators to draw up mission schedules, work with local air traffic and assess weather over the study areas, see 4.1.

Details on BOREAS-96 operations are addressed in the subsections in this chapter.

Field investigators must be at least familiar with reporting procedures in Section 4.1.3.8, safety information in Section 4.1.7, and emergency procedures in Chapter 7.

4.1 Management of Experiment Operations

4.1.1 Overview

The day-to-day management of BOREAS is overseen and implemented by the BOREAS Operations Group (BOG) which consists of agency representatives (BOREAS Executive or BEX) and science team representatives (science steering group or SSG). BOG members are listed in Table 4.1.1.

During field campaigns, experiment operations will be managed from two Study Area Headquarters (SAHQ); one in the Snodrifters Lodge in Candle Lake (SSA) and one at Manitoba Provincial hangar (next to RCMP hangar) in Thompson Airport (NSA), see Section 4.2. Contact telephone numbers and radio frequencies are given in Section 4.1.6. Each SAHQ will be manned during most of the day by a Study Area Manager (SAM) plus backup, who will coordinate activities among investigators and staff, work logistics problems and receive and transmit reports on the status of activities within the study area. The SAM will usually be assisted by one other person and will be in radio contact with the TF site captains and others within the study area and in telephone contact with the other SAHQ.

Table 4.1.1.
BOREAS Operations Group Membership

BOG Members			
BEX Membership		**SSG Membership**	
Name	**Agency**	**Name**	**Science Team**
Sellers	NASA	MacPherson	AFM
Hall	NASA	Black	TF
Newcomer	NASA	Berry	TE
Cihlar	CCRS	Crill	TGB
Halliwell	CFS	Lettenmaier	HYD
Goodison	AES	Ranson	RSS
Baldocchi	NOAA		

The BOG is supported by staff scientists from the participating agencies who help with logistics, operations management and BORIS. The staff organization is shown in figure 4.1.1. Note that the underlined people are first points of contact.

At any one time, one study area may be the focus of more aircraft and/or specialized ground-based activities than the other. The Mission Manager (MM) will be based at this 'hot' study area, and will coordinate all BOREAS aircraft activities from the 'hot' SAHQ, including those at the 'cool' study area. Sometimes, the MM may choose to delegate oversight of some local flight activities at the cool study area (SA) to the SAM there.

During active periods, the MM will hold nightly meetings of the BOREAS Operations Group (BOG) to organize the next day's activities in detail and follow-on activities (two or three days) in broad strokes, see Section 4.1.4.

The next few subsections cover:

- Decision Making 4.1.2
- Operations management roles and responsibilities 4.1.3
- Meeting schedules and formats 4.1.4
- Aircraft operations planning 4.1.5
- Communications 4.1.6
- Safety 4.1.7

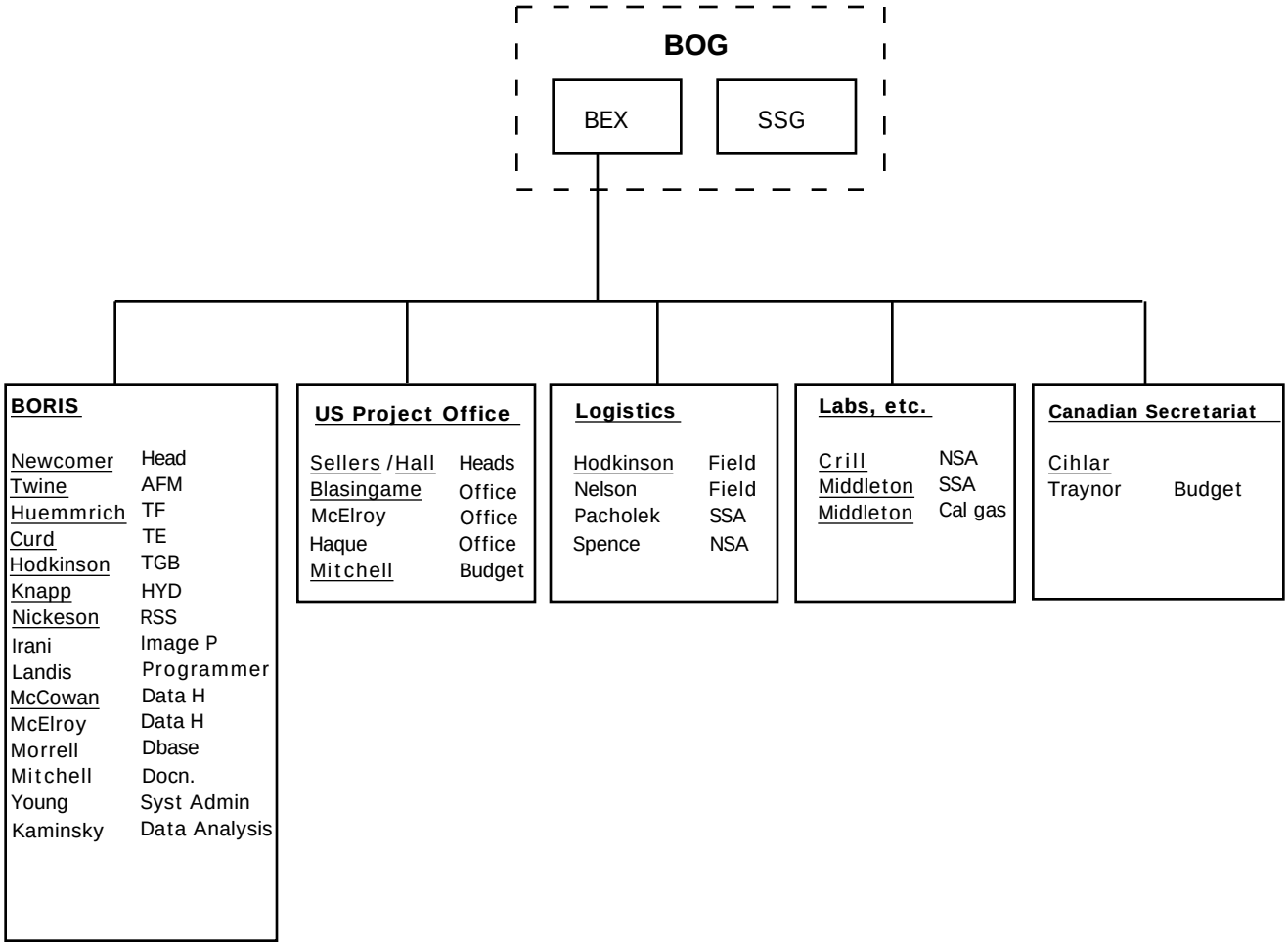


Figure 4.1.1 BOREAS Staff Organization: Underlined names denote first points of contact. 'Data H' denotes Data Handling; 'Image P' denotes Image Processing; 'Dbase' denotes Database Design and Development; 'Docn' denotes Documentation Oversight.

4.1.2 Decision Making

There are three principal authorities for making decisions that affect BOREAS field operations and prioritization of follow-on analyses by staff. These are:

(i) The Experiment Plan: This document (EXPLAN-96) sets out the strategic framework for the experiment and will be taken as the basis for decision making by the BOREAS Operations Group (BOG = BEX + SSG) and mission managers. Procedures documented in this chapter have precedence over procedures documented elsewhere.

(ii) BOREAS Meetings: BOREAS workshops, science team meetings and workshops, and BOG meetings will be tasked with refining the experiment design and modifying and ratifying the experiment plan. In general, the outcome of any of these meetings should be a written brief to be transmitted to the BOG. This is absolutely essential if the Experiment Plan is to be modified. Any scientist wishing to modify some aspect of the plan is strongly encouraged to air the proposal with his or her group, if time allows, or at least with their group chair prior to bringing it to BOG.

During field campaigns, there will be a nightly BOG meeting to which all participating scientists and staff are encouraged to attend. This meeting will be chaired by the mission manager who will solicit reports from those managing equipment essential to the mission, e.g. group chairs, TF site captains, aircraft managers, etc. For brevity, these reports and a weather briefing will follow a set format. During FFC-W and IFC-2, the briefing will include a presentation of proposed aircraft mission options and fallbacks for the next day and an outline of possible missions for the next three days. This proposal will be discussed and modified by those present and the coordination of the next days activities will be subsequently arranged.

The final schedule of aircraft missions and planned ground activities will be posted at each SAHQ and at the laboratory of each study area. Additionally, the proposed flight schedules will be faxed to participating aircraft base airfields on request. Aircraft Managers should either be present or be represented at the BOG meetings, or make arrangements to otherwise receive the flight planning information.

(iii) Mission Manager: The Mission Manager (MM) will be on duty from the beginning of one BOG meeting to the next, i.e. a 24-hour cycle. The MM will be a BEX member with some experience of coordinating field and aircraft operations. Roles and responsibilities of the MM and other operations staff are laid out in Section 4.1.3.

The MM will use this experiment plan and the missions plus fallbacks proposed by the BOG meeting to guide the management of experiment operations over the next 24-hour duty cycle. All decisions to launch, cancel or modify airborne

missions or significant ground operations (i.e. involving a substantial commitment of project personnel or project resources) must be routed through the MM who will be located near the most active Study Area with communication links to the aircraft, key investigators and staff. If, because of changing conditions, the MM thinks it is necessary to drastically diverge from the BOG plan, he/she will attempt to consult with the BOG or the affected investigator or, if time or communications do not allow for this, he/she will go ahead and implement the action. The action will be discussed with the BOG and affected scientists as soon as possible thereafter.

4.1.3 Operations Management Roles and Responsibilities

4.1.3.1 BOREAS Mission Manager (MM)

The MM will be a BEX member who has overall responsibility for coordinating all BOREAS activities during a 24-hour duty cycle within the FFC or IFC. Specifically, the MM is responsible for:

- Chairing the nightly BOG meeting and allocating subsequent action items;
- Oversight of aircraft mission planning, coordination and execution;
- Resolution of disagreements among investigators beyond what cannot be handled by the SAM (see below).
- At the end of the duty cycle, the MM must modify the mission plans prepared for that day to record the missions and activities actually completed. These records (see Figures 4.1.4.b and c) must be filed at the SAHQ and returned to the BOREAS US Project Office at NASA/GSFC at the end of the IFC/FFC.
- Turning on and turning off the intensive Upper Air Sounding Program (AFM-5).
- Approving significant expenditures of project reserve funds.

Generally, an MM will be on duty continuously for a 24-hour cycle, from the beginning of one BOG meeting to the next. Handover to the next MM must be accompanied by a comprehensive briefing. The MM will work out of (or be in direct contact with) the SAHQ alongside or in place of the SAM.

4.1.3.2 Study Area Manager (SAM)

The SAM will be a BOREAS staff member who will manage day-to-day ground operations at a study area. He/she will be assisted by one other person. The responsibilities of the SAM are:

- Be aware of activities ongoing at the SA.
- Maintain communications between investigators and with the MM and the other SAM.

- Elicit reports from site captains, team representatives and staff in the study area. These reports are to summarize the status of activities within the study area and state special requests, e.g. specific aircraft missions. These reports are to be documented in the team chart (see Figure 4.1.4.c) and passed on to the MM and the other SAM by 2300Z (1700 local in SSA and 1800 in NSA (summer.)
- Ensure collection and filing of investigator activity reports, see figure 4.1.3.8. Chase up delinquent investigators.
- Document events in the mission log. The events should be logged as a separate file for each day with exact local times; e.g.,

  '1300 : FT calls site entry into SSA.
  Ground teams informed by radio.
  1303 : FT calls start on first flight line'

  Aircraft take-off, site entry, site exit and landing times must be logged.
- Follow the progress and supervision of tasks handled by local labor, liaising with Dan Hodkinson and the site manager as necessary.
- Participate in the nightly BOG meetings, either in person, if at the hot SA, or by speaker phone, if at the cool SA. The SAM at the cool SA is encouraged to have other key BOREAS people participate in these meetings or at least have their reports at hand.
- The SAM at the cool SA is encouraged to convene meetings or otherwise communicate with the investigators to plan future activities or to discuss the requests to be sent to the MM in more detail. If investigator teams or other groups wish to hold large meetings, the SAM should be informed and provide assistance as necessary.
- Inform investigators and staff of the next days plan as finalized by the BOG. This plan, and associated action items, may be broadcast over the radio net when the SAHQ opens for business the next day.
- Ensure that the required sun photometry measurements are being made on clear days at the time of satellite overpasses or remote sensing aircraft flights.
- Induct and brief arriving investigators. Provide them with the briefing handouts and issue radios, etc. Debrief investigators leaving the area; recover loaned equipment.
- Maintain a file on investigator movements and plans. Before setting out for the field, investigators should contact the SAHQ with their intentions for the day -- sites to be visited, activities planned, and expected time of return. The SAM will maintain a file in the format provided, see Figure 4.1.4.c.

If the investigator is more than three hours late, the SAM will initiate a search. The SAM may initiate a search before this time on his/her own initiative.

The provisional schedule for SAMs and MMs is shown in Table 4.1.3.2.

Table 4.1.3.2
SAM and MM Schedule

	Dates	NSA-SAM	SSA-SAM	MM
FFC-W	2/27-3/15	--	Knapp/Morell	Sellers/Hall/ Irons
Pre-Thaw	3/10-4/02	Hodkinson/Nelson	Hodkinson/Nelson	--
IFC-1	4/02-4/28	McCowan/Landis	Huemmrich/Twine/Curd	Sellers/Hall
IFC-2	7/09-8/09	Newcomer/Kaminsky/ Nickeson/Herring	McCowan/Morell/ Huemmrich/Young	Sellers/Hall
IFC-3	10/01-10/22	Curd/Twine/Mitchell	Nickeson/Herring/ Kaminsky	Sellers/Hall

4.1.3.3 Team Chairs/Representatives

Each study area will have a set of nominated science team representatives to represent each of the science teams working there. The group chairs will ensure that a team representative is present or will show up themselves unless otherwise arranged with the SAM or MM. The exception is the AFM team who only need report to the MM or the SAM at the hot site. If no team representative has been nominated by the beginning of the IFC, the SAM or MM will work with team members in the field to identify a nominee. At the cool site, representatives are responsible for giving team reports for that SA to the SAM by 2100Z. This report and associated requests should be brief and may be given to the SAM verbally over the radio net.

The team representatives' report should cover the following:

- Team activities carried out that day, particularly changes from the scheduled activities discussed at the previous nights BOG meeting.
- Team activities planned for the next day.
- Needs or requests, particularly any requests for special aircraft flights for the next day.

Team representatives may be given action items by the MM following the BOG.

4.1.3.4 TF Site Captains

The TF principal investigators at each TF site or their nominees are the TF site captains. These site captains are responsible for maintaining the quality of their sites, for overseeing the use of resources and for overseeing safety-related procedures on-site. Specifically, the site captains are responsible for:

- Delineating go- or no-go areas around each site. Normally, the TF site WABs will be no-go areas.
- Approving the use of site power for other investigators, likewise the use of huts and other facilities.
- Ensuring continuous radio contact between the TF site and SAHQ.
- Informing the SAHQ when balloons are to be deployed with as long advance notice as possible; and then re-informing SAHQ when actual deployment and take down occurs.
- Checking the presence and serviceability of essential equipment on site: medical kits, fire extinguishers, radio gear, tower climbing gear; informing Ops immediately of shortfalls in essential equipment.
- Reporting on the status of the TF site to SAHQ by 2100Z each day.
- Ensuring that investigators who wish to ascend the tower are properly equipped, trained and briefed.
- Ensuring that investigators working near the tower are wearing hard hats.
- Maintaining the site log. All the TF sites must keep a site log. This is a log book plus a chart with experiment site locations marked in degrees/distance from a reference point (generally the tower base). The aim is to (i) document investigator experiment locations and (ii) prevent interference between experiments. Logs and formats are available from BORIS (Dave Knapp), see also figures 4.2.1.

Any investigator who wishes to work on or close to a TF site must first consult with the site captain or his/her representative. The site captain may deny access to certain parts of the site. If necessary, a potentially aggrieved investigator or site captain can appeal to the SAM or MM if there is a conflict that cannot be easily resolved.

Table 4.1.3.4
TF site Captains

NSA		**SSA**	
TF Sites	**TF Captains**	**TF Sites**	**TE Captains**
OBS	Wofsy/Goulden	OBS	Jarvis
OJP	Fitzjarrald	OA	Black
Fen	Jelinski		
YJP	McCaughey		

4.1.3.5 Field Liaison and Site Managers/Contacts

Dan Hodkinson (US) is the first point of contact for investigators who wish to get some significant infrastructure task completed. He will work with the PANP Site Manager or Paula Pacholek (SSA), Carl Spence (NSA) and others as necessary to get approved work done. Investigators should not attempt to task any of the site support staff without contacting Dan Hodkinson or the SAM/MM on duty.

4.1.3.6 Laboratory Chiefs

Betsy Middleton (SSA) and Patrick Crill (NSA), or their nominees, will oversee the allocation of space and other resources at the Paddockwood School (SSA), and Heritage Museum facility (NSA), respectively. Betsy Middleton will pull the calibration gas requirements together for all BOREAS-96 teams. CCRS (Gill Traynor) and NASA (Dan Hodkinson) will arrange for purchase and study area distribution of cal gas cylinders.

4.1.3.7 Aircraft Managers

All proposed aircraft missions must be approved by the MM. Aircraft managers are responsible for maintaining and executing the flight operations planned by their PI's or requested by the BOG through the MM. The aircraft manager or the associated aircraft PI should report to the MM by 2100Z each day with the following information.

- Intentions/requests for the next day's operation, including details of flight plans and statement of necessary decision times (e.g. aircraft prep times, etc.).
- Remaining research hours
- Status of aircraft and crew readiness; e.g. '30 hours remaining for the IFC; 10 hours before an inspection; two days before a mandatory crew rest day.'

The aircraft management/PI should attend the BOG if based near the hot site, sit in on the BOG by speakerphone with the SAM at the cool site or arrange immediate contact with the AFM representative or MM after the BOG. It is essential that the aircraft manager be aware of the BOG plans during or immediately after the BOG: he/she should get hold of a copy of the next days mission schedule by fax if all else fails. The aircraft manager/PI is then responsible for:

- Scheduling the aircraft preparation and launch.
- Briefing the aircrew on the plans, including the flight activities of other BOREAS aircraft.
- Contacting (or ensuring that the pilot contact) the MM at the target SAHQ by telephone or radio at the following times/events:

-- prior to setting out to the airport to prepare the aircraft
-- prior to engine start
-- 'wheels up' (if in radio range)
-- 'site approach', when within radio range of the SAHQ, giving aircraft position, altitude, intentions and ETA on-site. (The MM or SAM will respond with information on relevant aircraft and surface activities).
-- 'start of work' in the study area
-- movement from one surface target to another
-- 'site exit'
-- 'down safe'

- The 'down safe' call should include information on:
  -- flight take-off time, landing time
  -- mission type
  -- accomplishments/problems
  -- readiness for repeat mission

Aircraft managers and pilots must also be familiar with sections 4.1.6.1 and 5.1.2.

4.1.3.8 Investigators

All investigators must:

(i) Check in by telephone or in person with the SAHQ when arriving in a study area for an IFC and when leaving for home. On arrival, field investigators will get an update briefing, radios, contact materials, etc.
(ii) Tell their group representative their plans for the next day, also special needs or requests, by noon of each day. (Sometimes SAM'S will collect these reports directly from investigators on behalf of the group representative.) Be sure to notify SSA-SAHQ the day before you intend to visit sites in PANP.
(iii) Be familiar with the emergency procedures, see Section 4.1.7.
(iv) When entering the field, notify the SAHQ; keep the radio ON all day; and when leaving the field notify the SAHQ. Be familiar with the radio procedures described in 4.1.6.2.
(v) Contact the TF site captain when visiting a TF site, especially if you intend to set up an experiment nearby or want to use the tower.
(vi) Investigators must fill in the activity log sheet, see figure 4.1.3.8 for example, and give a copy to the SAM prior to leaving the study area. There should be at least one entry per day.

Group: **Team Members:**
PI:

Date	Site	Start Time	End Time	Measurements	Notes

Figure 4.1.3.8: Investigator Log. Investigators should collect blank forms from Ops and complete at least one line per day in the field (even if no work was done). Completed sheets must be handed in to the SAM prior to leaving the study area.

4.1.3.9 Meteorological Forecaster/Briefer

There will be three sources of meteorological forcast support for BOREAS.

ECMWF: ECMWF have agreed to fax forcast materials to the SSA-Ops once a day during FFC's and IFC's. They will provide time-line forcasts for gridpoints representative of the NSA and SSA.

National Meteorological Center: NMC will supply forcast materials to the SSA-Ops once a day during most FFC and IFC days.

Saskatoon Regional Center: Saskatoon Center provides the operational aviation forcast for the province. AES has arranged for them to provide support and to fax SSA-Ops the briefing materials. The best times to contact Saskatoon for verbal briefings and updates are:

am:	0600-0615 LT
	0830-0900 LT
pm:	1800-1815 LT
	1900-1915 LT

Contact phone numbers are in section 4.1.6.3.

The gridpoint forecasts will be in a form similar to an aviation forecast (FT). Current and 24-hour forecast conditions will be provided for points:

WIN	55˚ 40'N,	98˚ 40'W (Center of NSA)
WIP	53˚ 40'N,	106˚ 15'W (PANP in SSA)

4.1.4 Meeting Schedules and Formats

During FFC-W and IFC-2 there will be a BOG meeting every night. During IFC-1 and IFC-3 BOG meetings may be held at less frequent intervals, in which case the SAMs and MM should catch up on the project documentation for the preceding period at that time. The radio net will be used to advertise meetings.

The BOG meetings will start at 0200Z (2000-SSA; 2100-NSA) chaired by the MM from the hot study area. All BOREAS team members are encouraged to attend, but the following must be represented:

Mission Manager (chair)
Outgoing Mission Manager
Forcaster or representative
Team representatives, unless released by arrangement with the MM
Key aircraft representatives

The steps leading up to the BOG meeting are shown in Figure 4.1.4.a.

The format of the meeting will be as follows:

• Weather forecast: 24-hour prog, 3-day outlook	(5 minutes)
• Outgoing mission manager report - Aircraft missions completed - Other significant events	(5 minutes)
• Study area manager reports/updates (2)	(2 minutes each)
• Team representative reports/requests (6)	(2 minutes each)
• Aircraft status and plans	(5 minutes)
• Incoming mission manager mission proposals	(5 minutes)
• Discussion	(5 minutes)
• Finalization of plans for next day, distribution of of action items	(5 minutes)
TOTAL	46 minutes

These BOG meetings will start promptly at 0200Z at:

2000 LT: Snodrifters Lodge, Candle Lake (SSA)
2100 LT: Inco Training Center or TBD site (NSA)

There will be a telephone tie-in to the Marlboro Inn in Prince Albert so as to include C-130 crews and PA-based investigators.

The formal BOG business may be followed by a variety of follow-up science or operations meetings.

Figures 4.1.4b and c show examples of mission summary charts.

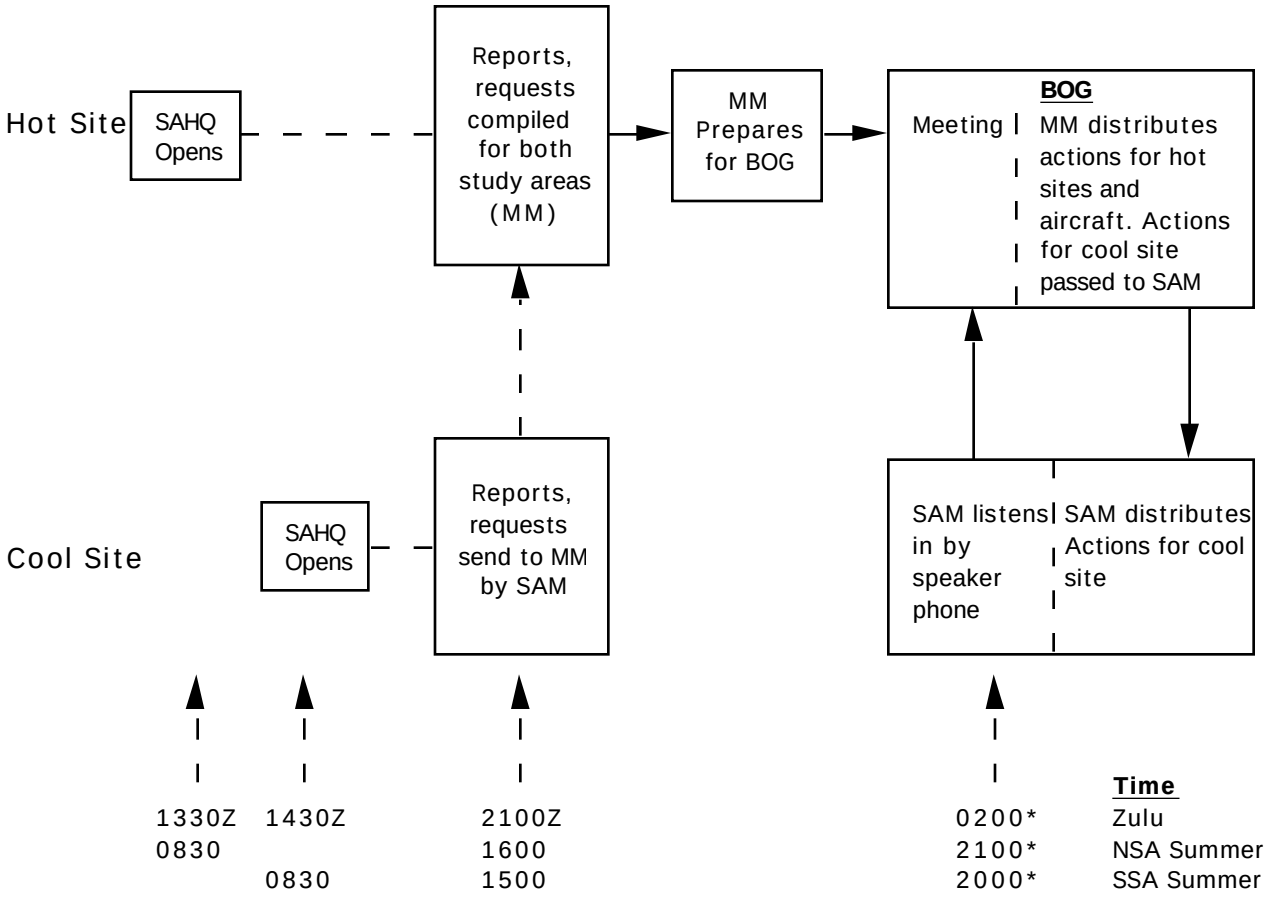
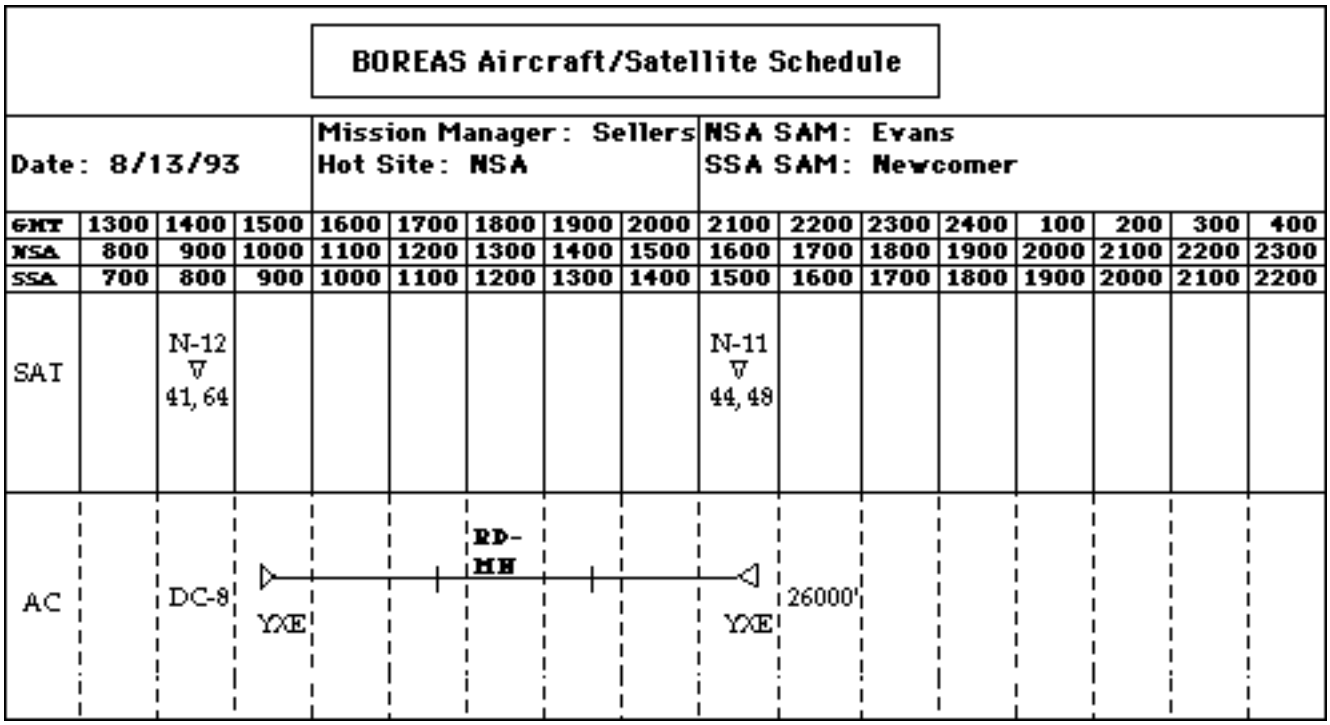


Figure 4.1.4a Steps leading up to the BOG meeting showing flow of reports from SAHQ's to the MM.



Satellite Legend

N = NOAA AVHRR

L = Landsat

S = Spot

N-12 . . . . . .Satellite type - number

∇

41,45 . . . . . .Satellite views zenith, solar zenith angles

Symbol '∇' at top of row denotes NSA, near base denotes SSA.

Aircraft Legend

RD-MN

DC-8 **YXE** **YXE** **26000'**

↑ ↑ Altitude

Aircraft Type

Mission type
see Table 5.2.1.

↓ ↓

Takeoff time,
Airport
(see Table 5.1.4b)

Landing time,
Airport

Figure 4.1.4b Aircraft/Satellite mission summary chart. Legend explains abbreviations. These charts will be prepared and presented at the BOG meeting to brief BOREAS participants on the next day's activities. At the next BOG, a version of the chart reflecting the actual activities completed for that day will be finalized and filed.

BOREAS Daily Team Participation Form

Mission Manager: Sellers NSA SAM: Evans

DATE: 08-13-93 Hot Site: NSA SSA SAM: Newcomer

Team	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
AFM					P P none *																		
TF								* W OJP AD		* W YJP Fen AD	P Fen AD *												
TE		P OA AD *			P PW AD *			W OA OBS AD *	* P BS AD	P FW AD *		P FW AD *											
TGB					* W leaf rapid AD																		
HYD									nhrj AD *														
RSS				P YJP AD *			* W OJP OBS AD				* ? flin flon	W CL visit AD *				W YA OBS AD *	W OA YJP PM *		W ?WX AD *				

*	.....NSA site
*	.....SSA Site

Location	.....e.g. SSA - OA
Activity	.....W = working, P = preparation
Time	.....am = morning, AD = all day

Figure 4.1.4c Investigator activity summary. Legend explains abbreviations. These will be prepared and presented at the BOG meeting to brief BOREAS participants on the next day's activities. At the next BOG, a version of the chart reflecting the actual activities completed for that day will be finalized and filed.

The people listed at the beginning of this section must be represented at BOG meetings unless specific arrangements have been made with the MM or SAM. While all investigators are encouraged to attend any BOG meeting, every few days there will be a call for investigators to show up and participate on a particular evening. These bigger meetings are intended to open up communication between investigators; refreshments (beer, snacks, etc.) should be available.

4.1.5 Aircraft Operations Planning

The following procedures for the submission and approval of aircraft mission plans, monitoring of flight operations and communications have been set up to ensure flight safety and efficient coordination in BOREAS.

Proposed aircraft missions must be communicated to the MM in time for their incorporation into the evening BOG briefing held the day before the mission is executed. It is preferred that each aircraft have a representative (P.I., aircraft manager or pilot) at the BOG meeting. Any changes to the missions as described in Chapter 5 must be communicated to the MM as soon as practicable.

The MM will formally approve proposed mission plans at the BOG meeting in which the schedule for the next days missions will be set out in the Ops chart (Satellite/Aircraft) as shown in figure 4.1.4.b; copies will be made available and/or faxed to aircrews on request. For safety reasons, the following protocols have been established:

- Aircraft missions will be separated by time and/or altitude. The exceptions will be some combined flux missions in which case aircrews will confer with each other beforehand. The Aircraft Ops chart will show aircraft missions by altitude from top to bottom.

- Any departure from mission profiles (take-off times, site-entry times, altitudes, etc.) must be communicated to the MM as soon as possible.

- The SSA flux aircraft low-level routes are one-way only at any given time. The direction and clearance to enter these routes will be handled by BOREAS Ops.

- All BOREAS aircraft will communicate with BOREAS-Ops and each other on 122.7. Some calls are mandatory, see 4.1.6.1 and 5.1.2.

- Flight plans must be filed for each flight.

- Significant BOREAS/aircraft activity will be NOTAM'd by the MM.

If, for some reason, an aircraft team wishes to execute an unscheduled mission at short notice (i.e., not advertised at the previous BOG meeting) they must first contact the MM or his/her representative for approval. At this time, the MM will bring the team up to date with respect to other aircraft operations.

More details on aircraft operations management may be found in Section 5.1.2.

4.1.6 Communications

4.1.6.1 Aircraft Radio Net

The BOREAS-96 aviation radio frequency is 122.7. The NSA and SSA Ops Centers are equipped with aviation radio base stations which are FM-linked to booster-repeaters to enhance communication with low-flying aircraft in the study areas. Aircraft on the ground at Thompson Airport can reach Ops directly; aircraft at Prince Albert Airport generally need to be at ~ 200' altitude to make contact, so a 'wheels-up' call is requested.

Low-flying BOREAS aircraft should monitor Thompson radio (118.8) and Prince Albert radio (122.3) when operating in the NSA and SSA, respectively.

Radio calls should be made to the Ops Centers following the protocols outlined in 5.1.2.2. On first contact, Ops will advise of local conditions, traffic, tethered balloon operations and any other significant news. Ops will be the only ground-to-air contact point between BOREAS investigators and BOREAS aircraft. Any requests for information between the two groups should therefore be channeled through Ops, who have both air and ground radio sets.

The call-signs are 'BOREAS-Ops' for the study area headquarters and 'Eyeball' for the support aircraft (FB) used for weather reconnaissance/birddogging.

4.1.6.2 Ground Radio Net

Ground radio nets will be in place in both the NSA and SSA. These will allow conversations between the SAHQ, TF Site Captains, TE Site Captains and other key investigators. It is desirable that ground radio communication follow normal radiocommunications format:

- On the first transmission/contact, say:
  -- Person or place to be contacted
  -- Name of person, team number and position of person transmitting

  e.g. 'BOREAS Ops; this is Joe Bloggs, TF-20 at the Young palm-tree site.'

- Keep transmissions as short as possible, i.e. no rambling, no long lists or monologues. If you have a list of items to transmit; break it up into messages of 15 seconds or less. This gives someone else a chance to cut in if necessary.

- At the end of the conversation say:
  -- Name of person transmitting - clear

  e.g. 'Joe Bloggs, clear'.

- At the end of transmission, ensure that the radio is not still transmitting; i.e. no stuck button. Otherwise, no one else can hear anything anywhere.

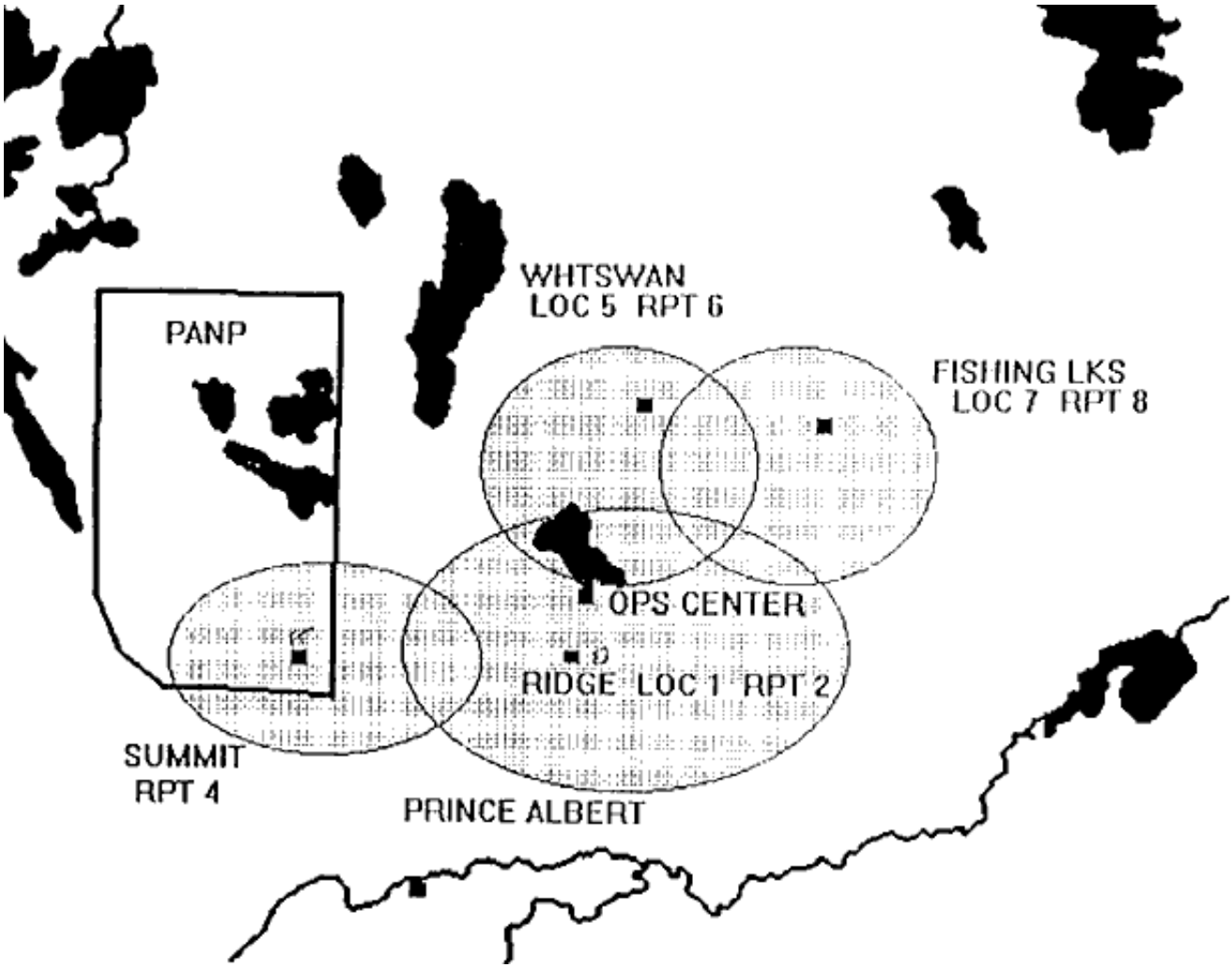
- TF site captains in particular, but everyone in general, keep your radios ON. TF site Captains perform a radio check with the SAHQ when turning the radio on in the morning and prior to turning off in the evening. When driving in a vehicle, ensure that the radio is not lying on its transmit button; i.e. is not jammed on.

- Radios can be drawn from the SAM in each study area; these sets must be returned when the investigator leaves the study area (even if he/she is moving to the other study area). Investigators can rent their own radios for the season from the supplier; contact Gill Traynor for details.

- Investigators should get a briefing on channels to use, etc., when picking up their sets; see below for a summary. They should also be familiar with the emergency procedures listed in Chapter 7.

- If investigators want to use their radios in 'local' mode for on-site crew-to-crew conversations, they should advise Ops before switching to 'local', and also when they come back onto the BOREAS frequency.

The FM radios issued to BOREAS participants have channel selectors. In the NSA, channel 10 is used on-site while channel 09 can be used to contact BOREAS Operations or the Lab from town or on the stretch of Route 391 leading out to the study area from the airport or for local crew-to-crew conversations. In the SSA, users should select the channel denoted by the repeater number (e.g. RPT 4 for the PANP area) as shown in Figure 4.1.6.2. The radios can be used to contact BOREAS Operations from Prince Albert Airport from the Athabaska tower (Channel 02). For on-site crew-to-crew converstaions, users should select the channels marked 'local' for each location as marked on figure 4.1.6.2, (e.g. LOC 5 for the Whiteswan area). The radios have a complete list of channel numbers taped onto their backs; remove the radio from its sleeve to see this.



ure 4.1.6.2 Ground radio net repeater coverage in SSA. Users should select channels denoted by RPT.

4.1.6.3 Telephone/Faxes

The following telephone numbers are useful.

Southern Study Area

SSAHQ - , Candle Lake Snodrifters Lodge	(Voice)	306-929-2214
		306-929-2215
	(Dataline)	306-929-2216
	(FAX)	306-929-2217
Snocastle Lodge, Candle Lake	(Voice)	306-929-2174
Ships Lantern, Candle Lake	(Voice)	306-929-4555
PANP Park HQ (also sunphotometer)	(Voice)	306-663-5322
SRC (AMS Network)	(Voice)	306-933-5437
Paddockwood School		306-989-4448
	(FAX)	306-989-4449
Prince Albert Airport, Weather Services		306-953-8640
Prince Albert Weather Office (taped message)		306-953-2114
Prince Albert Airport, Flight Service Station	(Voice)	306-953-8625
LaRonge, Flight Service Station	(Voice)	306-425-2368
Saskatoon, Flight Service Station	(Voice)	306-242-8227
Prince Albert Aviation (Eyeball)	(Voice)	306-764-4077
Prince Albert Airport ASAS Room (C-130/Ops)	(Voice)	306-922-3775
Prince Albert Airport, Athabaska Airways	(Voice)	306-922-3775
	(FAX)	
Prince Albert Inn	(Voice)	306-922-5000
Marlboro Inn	(Voice)	306-763-2643
	(FAX)	306-763-6336
Comfort Inn	(Voice)	306-703-4466

Northern Study Area

NSAHQ - Provincial Hangar, Thompson Airport	(Voice)	204-677-4619
	(Speaker)	204-677-4633
	(FAX)	204-677-6414
	(Dataline)	204-677-4693
Inco Meeting Room	(Voice)	204-778-6230
	(FAX)	204-778-6261
Inco Plant Laboratory	(Voice)	204-677-6450
Thompson Airport Flight Services	(Voice)	204-677-4043
Thompson Airport Weather Office	(taped message)	204-677-6900
Keewatin Community College	(Voice)	204-677-6450
	(Payphone)	204-778-6119
Heritage North Museum	(Voice)	204-677-4431
	(FAX)	204-677-4462
Jo Lutley (Sunphotometer)	(Voice)	204-778-7669
Burntwood Hotel	(Voice)	204-677-4551

Meridian Hotel	(Voice)	204-778-8387
Country Inn	(Voice)	204-778-8879
Mystery Lake Hotel	(Voice)	204-778-8331
AES Radiosonde Network-Thompson Zoo	(Voice)	204-677-7078
(AES Observer)	(Voice)	204-677-7982

Weather Forecast Support

ECWMF (Brian Norris)	(switchboard)	44 1734 499000
	(direct)	44 1734 499423
	(fax)	44 1734 869450
Saskatoon Wx Briefer	(Voice)	306-975-6699
	(Fax)	306-975-6516
Paul Malinson	(Voice)	306-975-6912
Joe Eley	(Voice)	306-975-5685
NMC (Hua-Lu Pan or Ken Mitchell)	(Voice)	301-763-8301
	(Fax)	301-763-8545

4.1.7 **Safety**

Chapter 7 describes procedures for getting emergency medical and/or fire assistance. This section describes what is available on site and routine safety procedures.

4.1.7.1 Fire and Accident

Fire: There are fire extinguishers at each TF hut. Additionally, in the NSA, there are fire extinguishers at each generator hut. In case of fire at the TF site, call for assistance by radio immediately. If you see a fire out in the bush, call in its location immediately - you may be the first to see it.

Accident: There are first aid kits in each TF site hut. Call SAHQ to arrange medevac, if necessary. The ground net radio can also be used to place an emergency phone call (see Chapter 7). All TF sites are close to potential medevac helicopter landing sites. (In the case of the OA-SSA, the two clearings back down the trail are adequate for this). More details on medevac procedures can be found in the last section in Chapter 7; all investigators should read this prior to entering the field for the first time.

4.1.7.2 Safety on site

Investigator plans for the day: Investigators must tell SAHQ where they will be on any given day. This is especially important for 'roving' investigators in TE, TGB and HYD teams. On leaving for the field, call in to SAHQ with a brief message of where you are going and expected time of return (ETR). The SAM

will maintain a file on your plans. This information should also be given to your team representative. If you do not report back in (by radio, phone or in person), the SAM will initiate a search no later than three hours after your ETR. TF teams should contact the SAHQ by radio each morning upon entering their site and also prior to leaving. Investigator teams are also advised to have a copy of the EXPLAN with them in the field.

Tower climbing: All tower climbing must be cleared by the TF or TE site captains or his/her representative. Caution should be used when climbing the scaffold towers - under some conditions the steps and walkways can be slippery. The Rohn Towers should not be climbed without a tower training course, safety harness, and at least one other person present on the ground. If only one other person is present, he/she must have a radio. If two or more others are there, a radio is still strongly advisable. Tower climbers and backups must be familiar with the basics of climbing and rescue techniques, i.e., lowering an injured person from the top of the towers. Hard hats must be worn in the vicinity of the TE and TF towers.

1. TF towers (scaffold and Rohn): Site Captains control access and work on their towers. They are responsible for the placement of safety equipment, and (especially in case of Rohn towers) for ensuring that people who are to climb the tower have received the necessary training.

2. TE Canopy Access towers: Site Captains control access and work on their towers. They are responsible for the availability of safety equipment and for checking that people who are to climb the tower have received the necessary training. There will be training courses held close to the beginning of IFC-1 which will be arranged by Dan Hodkinson (US Staff 301-286-3621). Dan Hodkinson will arrange subsequent training as necessary. Anyone wishing to use a TE tower should contact Joe Berry or Dan Hodkinson.

3. SRC (AFM-7) Meteorological towers: Only SRC personnel or their nominees are to climb these towers.

Insurance: Investigators are responsible for their own insurance while working on the project. This should cover medical expenses, third party injury, etc.

4.2 Facilities

Figure 4.2 shows the schedule of facilities availability in BOREAS-96.

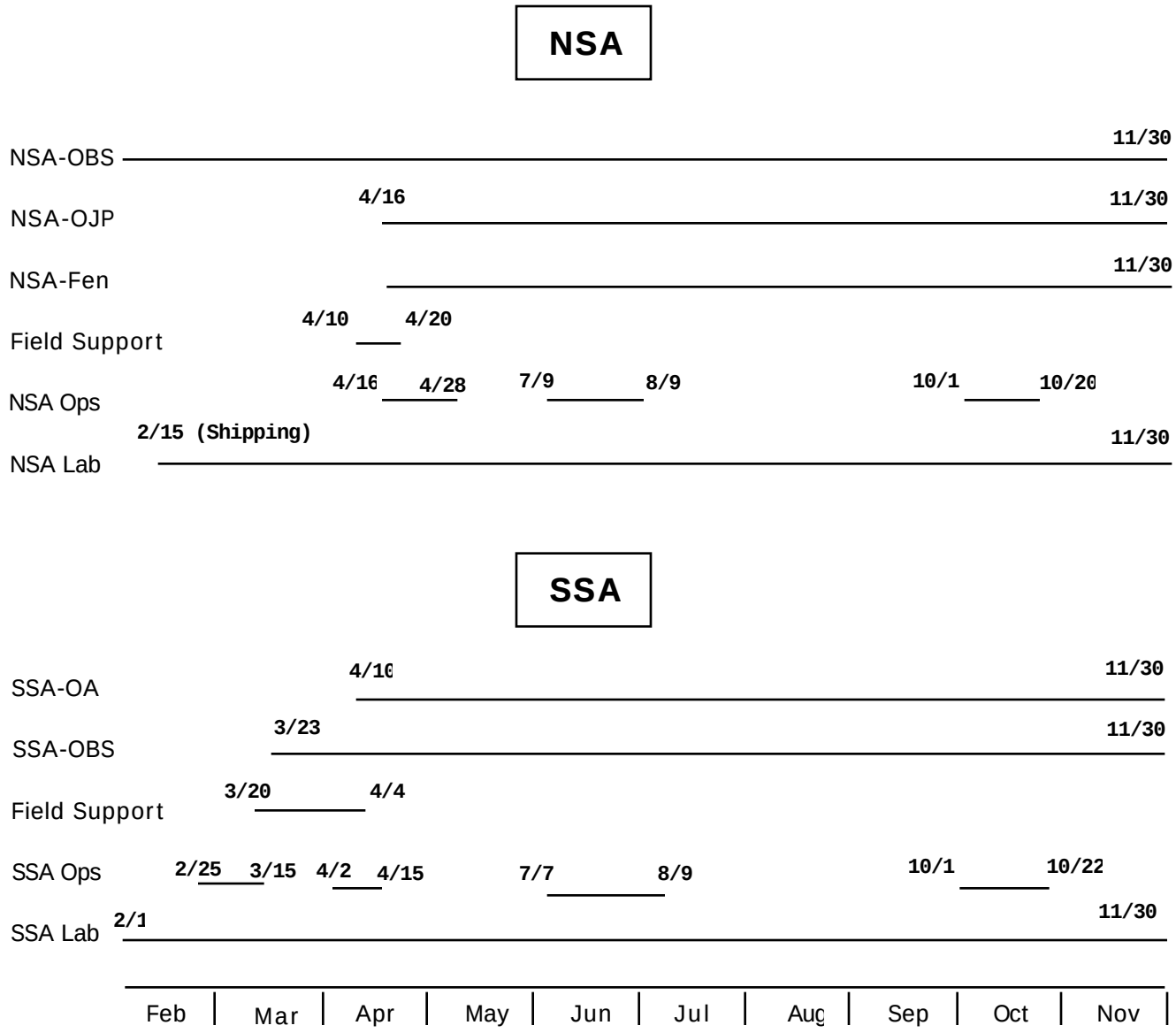


Figure 4.2 Schedule of BOREAS Facilities. Note that labs will be continuously available from their start dates onwards, but Ops centers will not.

4.2.1 Study Area Layout; Site Locations

Figure 5.1.2.2 shows the SSA and NSA with the aviation NAVAID grid overlaid. Figures 4.2.1 show the TF sites layouts individually, together with a (true) bearing and range grid overlaid on each one, with the point of origin being the TF tower base. This reference grid should be used to identify experiment locations around TF site.

Table 4.2.1 lists site locations as of the GPS field reconnaissance of BOREAS-94.

4.2.2 Ops Centers, Labs, Radio Nets, Telephones

The Ops Centers in the SSA (Snodrifters Lodge in Candle Lake) and NSA (Provincial Hangar, Thompson Airport) will be manned during the field campaigns. Each Ops Center is equipped with ground and air radio equipment and telephones (see 4.1.6).

Some limited laboratory facilities will be provided by the project, to permit analyses of samples that need to be performed within a few hours of sample collection or which would be impractical to perform at investigators home institutions. These facilities will be operated during the BOREAS-96 IFC's, and at a reduced level during the Winter campaign (FFC-W) and between IFC's. The labs will also be used for equipment receiving and storage between IFC's. The project will be providing space, power, running water, and a few items of equipment for shared use, as well as helping to coordinate investigator access to consumables such as gas cylinders. The project will not directly purchase expensive laboratory instruments or other capital equipment which are expected to have a useful life well beyond the duration of the BOREAS experiment. It is vital that investigator teams and groups who require such equipment arrange for it to be available and shared as appropriate. Each lab will be equipped with telephones and faxes, enabled for local calls only (i.e. you must have a phone card to make a long distance call).

NSA Lab: Heritage North Museum

Part of this Museum will be modified to meet the lab space requirements of all investigators in the NSA, see figure 4.2.2a. The size of the lab space has been greatly scaled down from 1994 because of fewer participants in 1996. One high precision balance and one high capacity balance will be provided by the project. The project will also provide a drying oven, a refrigerator and an upright freezer. In addition to the main lab area, there is a storage area in the museum annex. Currently this storage area is not heated, but that may change before the IFC's. Benches and tables will be added for sample preparation, computer stations, and work space. The building will be rewired with ample 110v outlets. Patrick Crill (TGB-1) is the lab chief.

SSA Lab: Paddockwood School

This modern elementary school is no longer used for classes and has been leased by the project, see figure 4.2.2b. Each classroom is equipped with some bench space and a sink. There will be an area of common use, where two medium sized drying ovens and a dual range balance will be located. The project will also provide a chest freezer and a refrigerator in the common area. Because of an excess of space, we will not lease the gym and kitchen area of the school in 1996. We will also not assign areas to certain groups before the field season, as was done in 1994. All assignments will be worked out with the lab chief upon arrival at the SSA. Betsy Middleton (TE-10) is the lab chief.

Figures 4.2.2c,d show the locations of the Ops Centers and Labs in the NSA (4.2.2c) and SSA (4.2.2d).

4.2.3 Field resources; huts, generators, transport

All the BOREAS huts will be available for use in BOREAS-96; however, only the active ones (SSA-OBS; SSA-OA; NSA-OBS, NSA-YJP, NSA-OJP, NSA-Fen) will have the full complement of medical, tower climbing and fire equipment available. Generators in the NSA for the three active sites will be on-line well before the start date of 4/16/96. (NSA-OBS runs continuously). All investigators should arrange for their own transport; the Ops Center staff transport is not for general use but may be used to help investigators out, at the staff's discretion.

The schedule for SAM duties is given in section 4.1.2

Name	Notes	Category	BORIS X	BORIS Y	West Longitude	North Latitude	UTM Easting	UTM Northing	UTM Zone	Source of Location
Flux Tower Sites										
C3B7T	SSA OA	1	317.3	303.4	-106.197	53.629	420,874	5,942,688	13	GPS
F0L9T	SSA Fen	1	419.5	320.6	-104.619	53.799	525,101	5,961,204	13	Air photo
F8L6T	SSA YJP	1	416.9	538.9	-104.647	53.875	523,201	5,969,705	13	Air photo
G6I4T	SSA OBS	1	394.8	348.4	-105.122	53.985	492,000	5,981,904	13	Air photo
G2L3T	SSA OJP	1	413.6	543.2	-104.691	53.916	520,314	5,974,015	13	GPS
D6H4T	SSA YA	1	374.8	316.7	-105.312	53.709	479,400	5,951,000	13	Map
T7O8T	NSA OJP	1	768.5	617.1	-98.624	55.927	523,501	6,197,997	14	Air photo
T3R8T	NSA OBS	1	778.1	613.3	-98.484	55.879	532,301	6,192,700	14	Air photo
T7S1T	NSA Fen	1	781.2	617.6	-98.422	55.914	536,103	6,196,703	14	Air photo
T9S9T	NSA YJP	1	789.6	616.2	-98.288	55.903	544,499	6,195,502	14	Air photo
T4U6T	NSA Beaver Pond	1	806.9	614.8	-98.026	55.845	561,000	6,193,000	14	Map
Mesonet Stations										
SSA OA AMS Tower	Suite A		317.3	303.5	-106.196	53.629	420,938	5,942,576	13	GPS
SSA OA Flux Tower	Suite B		317.3	303.4	-106.197	53.629	420,874	5,942,688	13	GPS
SSA OA AFM	Precip		317.3	303.1	-106.196	53.626	420,934	5,942,353	13	GPS
SSA OJP AMS Tower	Suite A		413.7	343.3	-104.685	53.916	520,445	5,974,041	13	GPS
SSA OJP Flux Towel	Suite B		413.6	343.2	-104.690	53.916	520,391	5,973,998	13	GPS
SSA OJP AFM	Precip		413.7	343.3	-104.689	53.916	520,456	5,974,043	13	GPS
The Pas AMS Tower	Suite A		649.7	376.7	-101.056	53.968	965,158	5,981,696	14	GPS
The Pas AFM	Precip		649.7	376.7	-101.056	53.968	965,158	5,981,696	14	GPS
NSA OJP Flux Tower	Suite A		768.6	617.2	-98.622	55.928	523,637	6,197,905	14	GPS
NSA Fen-Hut AMS Tower	Suite B		781.3	618.1	-98.420	55.916	536,270	6,196,657	14	GPS
NSA OJP AFM	Precip		768.5	617.3	-98.623	55.929	523,574	6,198,016	14	GPS
Thompson Airport AMS Tower	Suite A		817.1	512.1	-97.874	55.804	570,598	6,184,614	14	GPS
Thompson Airport AFM	Precip		817.2	512.0	-97.873	55.803	570,663	6,184,503	14	GPS
Lynn Lake AMS Tower	Suite A		601.2	698.4	-101.093	56.888	372,492	6,306,422	14	GPS
Lynn Lake AFM	Precip		601.2	698.6	-101.093	56.888	372,499	6,306,644	14	GPS
Fin Flon AMS Tower	Suite A		598.1	446.6	-101.690	54.671	326,559	6,061,281	14	GPS
Fin Flon AMS Trestle	Suite B		598.2	446.8	-101.689	54.672	326,626	6,061,390	14	GPS
Fin Flon AFM	Precip		598.2	446.8	-101.689	54.672	326,626	6,061,390	14	GPS
La Ronge AMS Tower	Suite A		363.2	474.0	-105.293	55.124	481,357	6,108,407	13	GPS
La Ronge AFM	Precip		363.2	474.1	-105.293	55.125	481,336	6,108,516	13	GPS
Meadow Lake AMS tower	Suite A		162.7	350.9	-108.509	54.127	662,824	6,000,295	12	GPS
Meadow Lake AFM	Precip		162.7	350.9	-108.509	54.127	662,824	6,000,295	12	GPS
Saskatoon (SRC-CRS) AMS Tower	Suite A		301.1	137.4	-106.600	52.150	390,530	5,778,711	13	Map
Saskatoon AMS Trestle	Suite B		301.1	137.4	-106.600	52.150	390,530	5,778,711	13	Map
Saskatoon AFM	Precip		301.1	137.4	-106.600	52.150	390,530	5,778,711	13	Map
Upper Air Stations										
Existing Regular										
Baker Lake UA, NWT	YBK		730.0	1559.6	-96.000	64.317	645,032	7,135,725	14	Catalogue
Fort Smith UA, NWT	YSM		-52.1	1006.4	-111.933	60.033	447,894	6,655,490	12	Catalogue
Churchill UA, MB	YYQ		970.4	979.9	-94.083	58.733	437,281	6,510,866	15	Catalogue
The Pas UA, MB	YQD		646.9	376.2	-101.100	53.967	382,245	5,981,855	14	Catalogue
Edmonton-Stony Plain, AB	WSE		-205.2	288.2	-114.100	53.550	692,114	5,937,369	11	Catalogue
Saskatoon, SK	YXE		294.1	136.8	-106.700	52.167	383,732	5,780,938	13	Catalogue
Pickle Lake, ON	YPL		1424.9	264.3	-90.217	51.450	693,383	5,703,543	15	Catalogue
Great Falls, MT	GTF		-27.8	-389.4	-111.367	47.483	472,437	5,258,947	12	Catalogue
Glasgow, MT	GGW		327.4	-288.2	-106.617	48.217	379,856	5,341,643	13	Catalogue
Bismark, ND	BIS		786.8	-410.5	-100.750	46.767	366,409	5,180,722	14	Catalogue
International Falls, MN	INL		1292.9	-105.3	-93.383	48.567	471,731	5,379,364	15	Catalogue
Existing DND										
Primrose Lake, AB	WKO		61.1	417.8	-110.050	54.750	561,146	6,067,886	12	Catalogue
Shilo, MB	WLO		816.4	-66.3	-99.650	49.783	453,234	5,514,744	14	Catalogue
BOREAS Sites										
Thompson Zoo, MB	YTH		618.7	505.3	-97.867	55.750	571,137	6,176,837	14	Map
Candle Lake, SK	WLZ		377.6	319.6	-105.267	53.733	482,409	5,953,886	13	Map
Key Lake, SK	YKJ		324.3	706.6	-105.617	57.250	462,791	6,345,384	13	Map
Cooperative Sites										
Quill Lake, SK	WQH		452.9	138.2	-104.400	52.050	541,144	5,766,769	13	Catalogue
Lynn Lake, MB	YYL		602.1	696.8	-101.083	56.867	373,001	6,304,478	14	Catalogue
Other points of interest:										
SAHQ			378.0	319.7	-105.252	53.734	482,750	5,953,900	13	Map
Prince Albert Airport			354.6	259.9	-105.660	53.220	454,370	5,896,374	13	Map
Thompson Airport & NAHQ			817.7	511.6	-97.870	55.800	571,048	6,184,190	14	Map
SSA LIDAR			414.8	358.3	-104.650	54.050	522,916	5,988,925	13	Map
SSA Profiler			415.2	342.6	-104.667	53.909	521,896	5,973,232	13	Map
SSA RADAR			769.1	618.0	-98.612	55.934	524,262	6,198,576	14	Map
AVIRIS Sensor Calibration Site			354.5	250.8	-105.686	53.133	453,468	5,887,107	13	Unknown
AVIRIS Sensor Calibration Site			352.7	274.8	-105.686	53.350	453,701	5,911,210	13	Unknown

Table 4.2.1 Coordinates for selected features in the BOREAS Region

Name	Notes	Category	BORIS X	BORIS Y	West Longitude	North Latitude	UTM Easting	UTM Northing	UTM Zone	Source of Location
Auxiliary sites:										
Southeast of SSA:										
A1A	Saloche	3	328.3	205.2	-106.134	52.742	423,500	5,844,000	13	Map
A2P	Nisbet	3	317.9	255.4	-106.237	53.198	417,400	5,894,800	13	Map
SSA:										
B9B7A	AIM-13	2	317.7	299.2	-106.195	53.591	420,942	5,938,470	13	GPS
D9G4A	AMH-16	2	364.4	319.5	-105.486	53.741	469,282	5,954,618	13	GPS
D0H6S	BMM-1	3	376.8	310.6	-105.291	53.653	480,824	5,944,699	13	GPS
D9I1M	AIH-3	2	361.6	319.3	-105.207	53.727	486,366	5,952,968	13	GPS
D6L9A	ADH-2	3	419.5	316.1	-104.639	53.669	523,888	5,946,556	13	GPS
E7C3A	AMM-12	3	323.2	327.5	-106.061	53.841	428,916	5,966,173	13	GPS
F5I6P	JIH-4	3	386.6	335.3	-105.111	53.666	492,737	5,968,441	13	GPS
F7J0P	JMH-5	3	390.6	337.6	-105.048	53.884	496,881	5,970,405	13	GPS
F7J1P	JMH-A1	3	391.7	337.4	-105.031	53.881	497,992	5,970,082	13	GPS
F7J1P	JMH-A2	3	391.7	337.4	-105.031	53.881	497,992	5,970,082	13	GPS
G2I4S	BMH	3	384.3	342.2	-105.137	53.930	491,027	5,975,486	13	GPS
G2I4S	BIH	5	384.3	342.2	-105.137	53.930	491,027	5,975,486	13	GPS
G4I3M	MW-1	3	383.4	344.1	-105.149	53.947	492,276	5,977,457	13	GPS
G1K9P	JMM-5	3	409.9	342.0	-104.749	53.908	516,552	5,973,092	13	GPS
G5K8S	BMH-9	2	408.6	346.3	-104.768	53.948	515,591	5,977,484	13	GPS
G7K9P	JMM-6A	3	409.1	347.3	-104.769	53.958	515,239	5,978,595	13	GPS
G8K8P	JMM-8B	3	408.4	348.2	-104.762	53.965	515,817	5,979,387	13	GPS
G2L7S	BPL	3	417.3	342.1	-104.637	53.904	523,899	5,972,524	13	GPS
G6L6P	JDM-8	3	416.7	348.5	-104.637	53.961	523,846	5,979,032	13	GPS
G9L0P	JMH-10	2	410.2	349.4	-104.733	53.974	517,522	5,980,417	13	GPS
H2D1M		3	331.3	353.2	-105.931	54.066	439,100	5,991,000	13	Map
H2D1S		3	331.7	352.7	-105.925	54.061	439,500	5,990,500	13	Map
H3D1M		3	331.2	353.6	-105.931	54.069	439,100	5,991,400	13	Map
H1E4S		3	344.4	351.3	-105.733	54.040	452,000	5,988,000	13	Map
I2I8P	JIH-7	2	388.3	361.9	-105.051	54.112	496,702	5,995,729	13	GPS
G9I4S	BDL-20	2	384.7	349.5	-105.121	53.995	492,084	5,982,703	13	Map
G4K8P	JMM-5	3	408.5	344.5	-104.767	53.932	515,344	5,975,797	13	Map
F1N0M	Jail Site	3	430.9	332.0	-104.447	53.801	536,468	5,961,343	13	Map
E7B7C	HYD-5 Tower	3	317.3	327.9	-106.171	53.848	423,000	5,967,000	13	Map
E6C5W	HYD-5 Tower	3	325.9	326.6	-106.041	53.831	431,500	5,965,000	13	Map
Transect:										
O1P		3	514.5	499.7	-102.886	55.219	634,500	6,121,000	13	Map
O2S		3	515.1	499.2	-102.879	55.215	635,000	6,120,500	13	Map
O3S		3	519.5	500.1	-102.808	55.218	639,500	6,121,000	13	Map
O4P	Deleted									
O5P		3	514.5	500.2	-102.886	55.224	634,500	6,121,500	13	Map
O6P		3	513.1	499.1	-102.910	55.215	633,000	6,120,500	13	Map
O7S		3	517.0	499.9	-102.847	55.219	637,000	6,121,000	13	Map
O8W		3	796.1	542.8	-98.403	55.227	538,000	6,120,000	14	Map
O9P		3	744.1	608.1	-99.034	55.885	497,900	6,193,100	14	Map
NSA:										
P7V1A	AMH-1	3	811.2	577.4	-98.069	55.508	558,800	6,151,500	14	Map
Q1V2M	MW-2	3	812.3	581.9	-98.039	55.546	560,629	6,155,735	14	GPS
Q3V3P		3	813.0	583.3	-98.024	55.557	561,600	6,157,000	14	Map
R8V8A		3	818.9	598.6	-97.887	55.692	570,000	6,171,000	14	Map
S9P3A	AIH-14	3	753.8	609.8	-98.877	55.866	507,724	6,193,162	14	GPS
S8W0P		3	820.2	608.7	-97.837	55.758	573,000	6,180,700	14	Map
T0P5M	MW-1	3	755.0	610.5	-98.855	55.890	509,093	6,193,599	14	GPS
T0P7S	BMM-8	3	757.1	610.1	-98.824	55.883	511,059	6,192,847	14	GPS
T0P8S	BMH-7	3	758.4	610.4	-98.802	55.894	512,423	6,192,928	14	GPS
T2Q6A	TE Carbon	1	766.1	612.2	-98.676	55.888	520,267	6,193,392	14	Sat. Image
T5Q7S	BMH-6	3	767.7	615.7	-98.641	55.916	522,450	6,196,563	14	GPS
T8Q9P	JIH-2	3	769.9	618.6	-98.597	55.938	525,174	6,199,016	14	GPS
T9Q8P	JIL-1	2	768.9	619.8	-98.610	55.951	524,404	6,200,425	14	GPS
T6R5S	BIH-9	2	775.4	616.2	-98.519	55.908	530,101	6,195,719	14	GPS
T7R9S	BDH-3	3	779.6	617.6	-98.448	55.914	534,534	6,196,454	14	GPS
T7S9P	JIM-4	3	789.1	617.3	-98.300	55.896	543,824	6,194,546	14	GPS
T8S4A		3	784.4	619.0	-98.368	55.919	539,500	6,197,000	14	Map
T8S9P	JDH-3	3	789.9	618.5	-98.284	55.905	544,808	6,195,513	14	GPS
T6T6S	BIL-2	3	795.4	616.8	-98.186	55.880	550,943	6,192,742	14	GPS
T7T3S	BML-21	3	793.7	617.9	-98.225	55.894	548,492	6,194,272	14	GPS
T8T1P	JDM-1	3	791.2	618.8	-98.262	55.906	546,151	6,195,583	14	GPS
T3U9S	BIM-12	3	810.0	613.6	-97.992	55.631	563,817	6,167,459	14	GPS
T4U5A	AIM-1	3	806.0	614.9	-98.041	55.647	560,071	6,169,197	14	GPS
T4U91-S	BIM-1	3	809.4	614.5	-97.999	55.638	563,367	6,169,231	14	GPS
T4U92-S	BIH-1	3	810.0	614.3	-97.990	55.635	563,934	6,167,972	14	GPS
V5X7A	AIH-30	3	837.7	635.3	-97.480	55.973	594,911	6,208,870	14	GPS
W0Y5A	AIM-20	2	945.9	640.5	-97.336	56.004	603,801	6,207,559	14	GPS
U6W5S	BIL-21	2	925.9	637.0	-97.693	55.920	581,700	6,197,712	14	Map

Table 4.2.1 (cont) Coordinates for selected features in the BOREAS Region

Name	Notes	Category	BORS X	BORS Y	West Longitude	North Latitude	UTM Easting	UTM Northing	UTM Zone	Source of Location
AES Surface Weather Station Collecting15 Minute Data for BOREAS										
15 minute Data for '93 and '94										
Collins Bay	WWC		428.5	622.6	-103.700	56.183	576,449	6,449,648	13	
Lucky Lake	WLE		270.6	1.9	-107.150	50.950	348,976	5,646,247	13	
Meadow Lake	WLJ		162.1	351.5	-108.517	54.133	270,258	6,003,857	13	
Melfort	WFF		430.8	221.8	-104.600	52.817	526,959	5,851,734	13	
Nipawin (AES)	WBU		465.3	283.0	-104.000	53.333	566,594	5,909,601	13	
Rosetown East	WRJ		213.9	67.7	-107.917	51.567	297,855	5,716,657	13	
Southend	WJH		475.7	620.3	-103.283	56.333	606,139	6,244,290	13	
Spiritwood West	WSR		229.4	268.9	-107.550	53.367	330,332	5,915,874	13	
Waskesiu Lake	WLV		323.6	336.0	-106.067	53.917	429,940	5,974,561	13	
Watrous East	WIW		387.3	89.7	-105.400	51.667	472,335	5,723,822	13	
Bachelors Island Marina	WBL		763.9	144.4	-99.900	51.750	487,869	5,733,398	14	
Fin Flon	WFO		598.4	450.0	-101.683	54.683	327,017	6,062,645	14	
Gillam	WGK		996.9	714.9	-94.700	56.367	765,550	6,254,979	14	
Hunters Point	WHH		672.7	274.9	-100.933	53.033	370,356	5,877,509	14	
15 min. Data during IFC's only (hourly otherwise)										
Buffalo Narrows	WVT		160.6	541.1	-109.433	55.833	284,990	6,192,649	13	
Uranium City	WDC		142.4	956.7	-108.483	59.567	303,224	6,608,108	13	
Wynyard Lake	WOY		469.0	106.1	-104.200	51.767	555,207	5,735,171	13	
Fisher Branch	WSZ		938.0	100.2	-97.550	51.083	601,565	5,659,873	14	
Grand Rapids	WJD		780.3	306.8	-99.267	53.183	482,179	5,892,481	14	
Swan River	WEQ		667.1	171.0	-101.283	52.117	347,064	5,776,149	14	
Hudson Bay	YHB		583.8	236.5	-102.317	52.817	680,830	5,855,034	13	
Key Lake	YKJ		324.3	708.6	-105.617	57.250	462,789	6,345,172	13	
Dauphin	YDN		764.9	71.4	-100.050	51.100	426,479	5,661,251	15	
A complete set of AES Surface Weather and Climate Stations in the region are in an appendix.										
BOREAS Regional Grid	NW		0.0	1000.0	-111.000	59.979	500,100	6,648,824	12	
	NE		1000.0	1000.0	-93.502	58.844	471,015	6,522,585	15	
	SE		1000.0	0.0	-96.970	50.089	645,272	5,550,297	14	
	SW		0.0	0.0	-111.000	51.000	500,050	5,649,599	12	
Northern	NW		750	650	-98.82	56.247	510884	6233585	14	N/A
Study	NE		850	650	-97.24	56.081	609930	6216458	14	N/A
Area	SE		850	570	-97.49	55.377	595766	6137770	14	N/A
	SW		750	570	-99.05	55.54	497150	6154889	14	N/A
NSA	NW		760	630	-98.72	56.055	517312	6211970	14	N/A
Modeling	NE		800	630	-98.09	55.99	556757	6205124	14	N/A
Sub-Area	SE		800	600	-98.18	55.726	551608	6175619	14	N/A
	SW		760	600	-99.81	55.79	512162	6182466	14	N/A
Extension	SE		750	615	-99.92	55.938	504876	6198930	14	N/A
of NSA	SW		760	615	-98.76	55.922	514737	6197218	14	N/A
Modeling	NW		760	605	-98.79	55.834	513020	6187383	14	N/A
Sub-Area	NE		750	605	-98.95	55.849	503159	6189095	14	N/A
Southern	NW		310	360	-108.23	54.319	420187	6019734	13	N/A
Study	NE		440	380	-104.24	54.223	549799	6008564	13	N/A
Area	SE		440	290	-104.37	53.419	542029	5919013	13	N/A
	SW		310	290	-106.32	53.513	412468	5930178	13	N/A
SSA	NW		380	360	-105.16	54.093	488258	5993612	13	N/A
Modeling	NE		430	360	-104.42	54.053	536103	5989312	13	N/A
Sub-Area	SE		430	320	-104.48	53.695	534652	5949512	13	N/A
	SW		380	320	-105.23	53.735	484815	5953813	13	N/A
Coordinates are based on NAD83 datum, except for UTM coordinates.										
UTM Coordinates are based on the NAD27 datum.										

Table 4.2.1 (cont) Coordinates for selected features in the BOREAS Region

Northern Study Area – Old Black Spruce site (NSA-OBS)

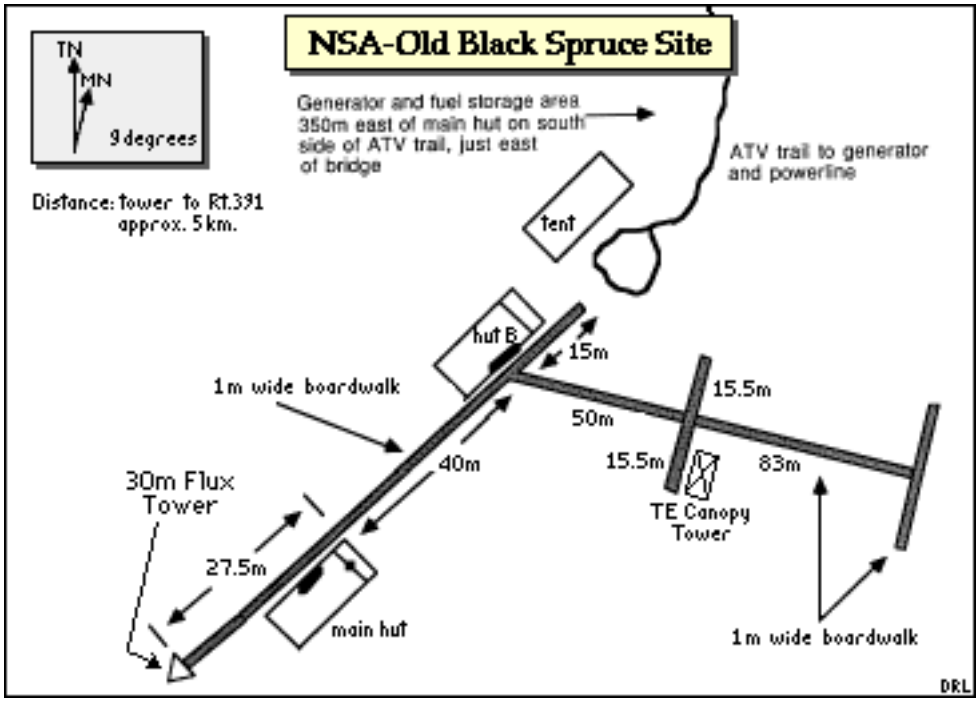


Figure 4.2.1a: TF-3 Site Map (NSA-OBS)
i) Site Layout and Infrastructure

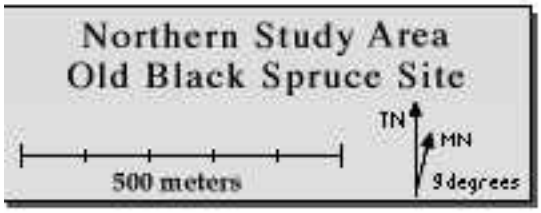
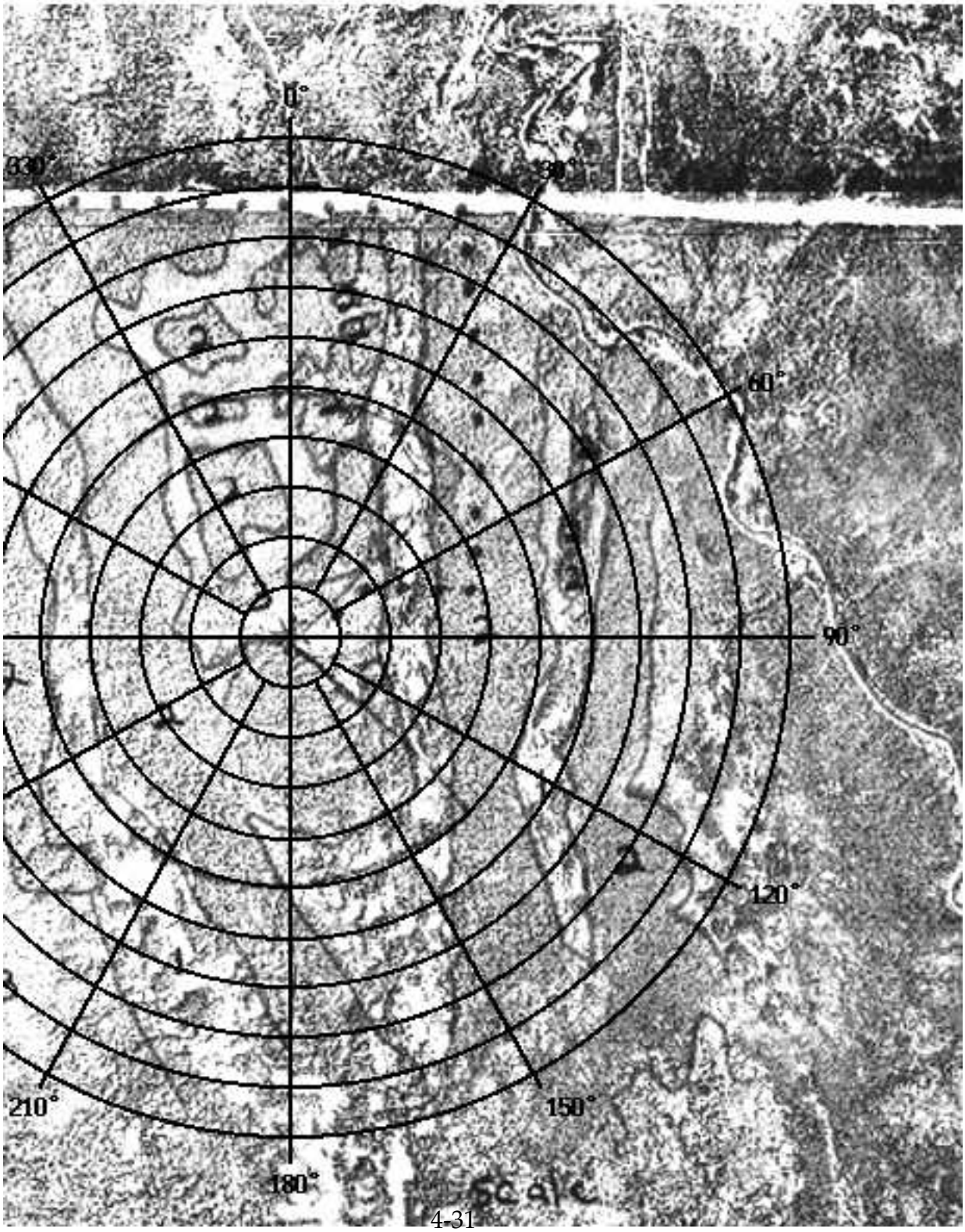


Figure 4.2.1a: TF-3 Site Map (NSA-OBS)
(ii) Orientation of WAB



Northern Study Area – Old Jack Pine site (NSA-OJP)

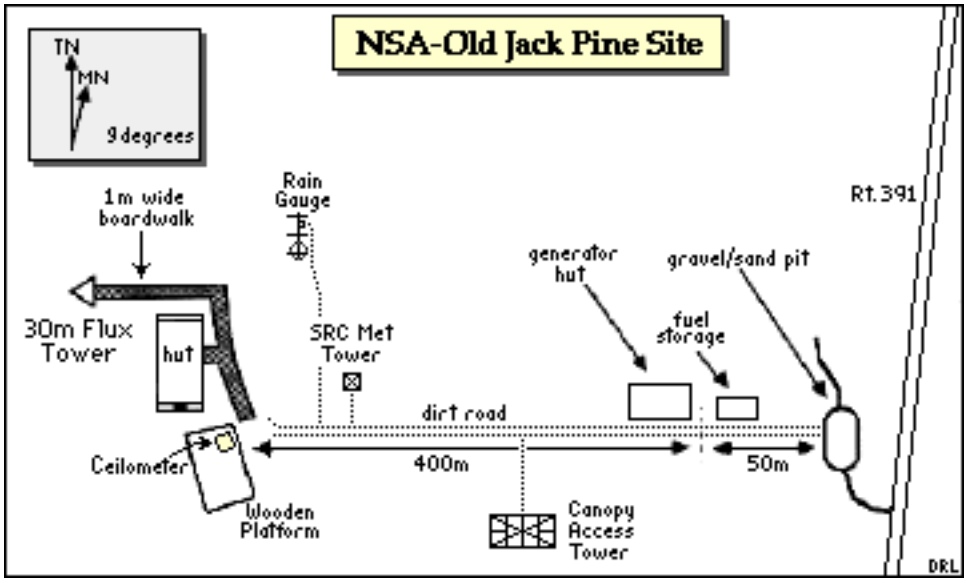


Figure 4.2.1b: TF-8 Site Map (NSA-OJP)
(i) Site Layout and Infrastructure

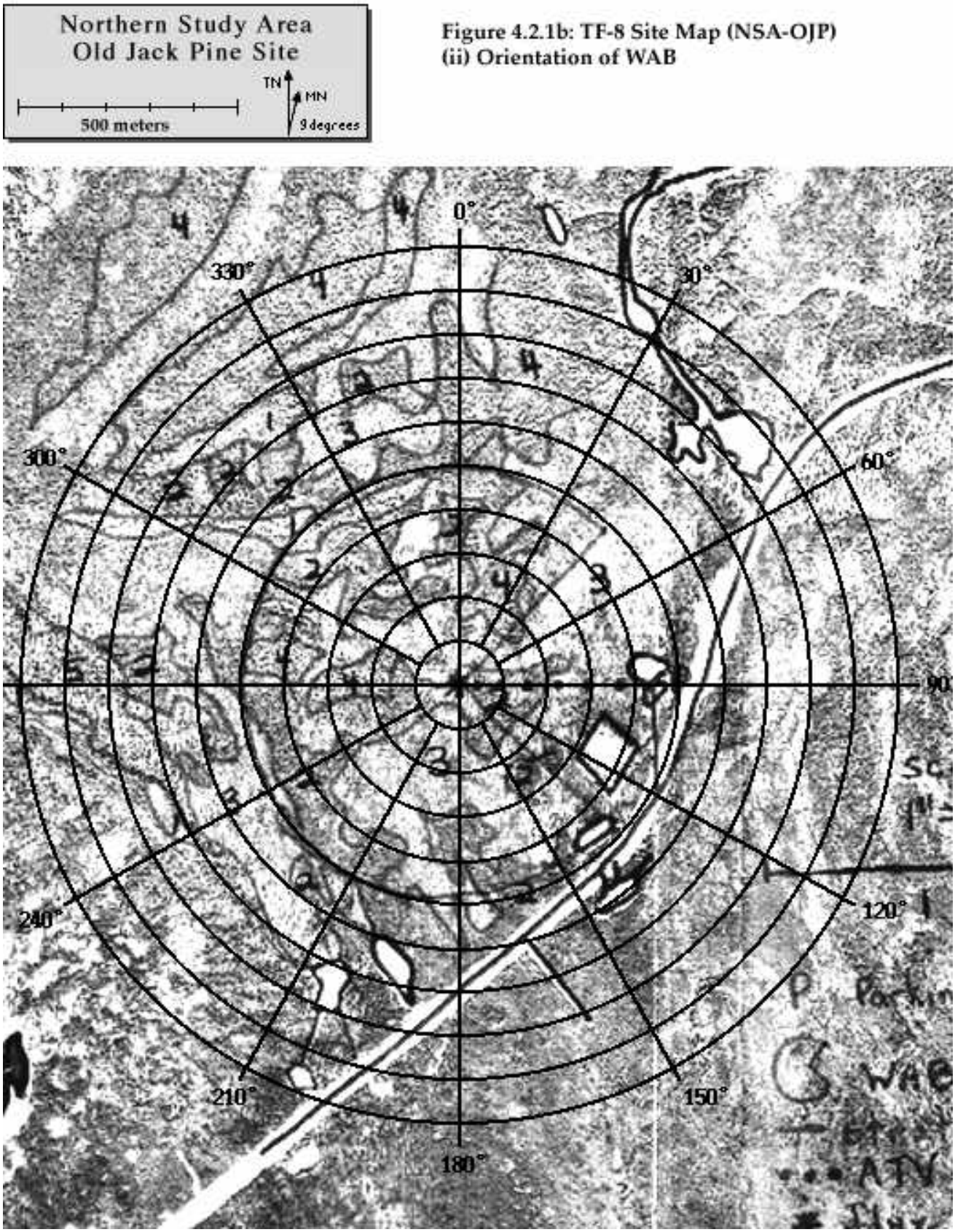


Figure 4.2.1b: TF-8 Site Map (NSA-OJP)
(ii) Orientation of WAB

Northern Study Area – Young Jack Pine site (NSA-YJP)

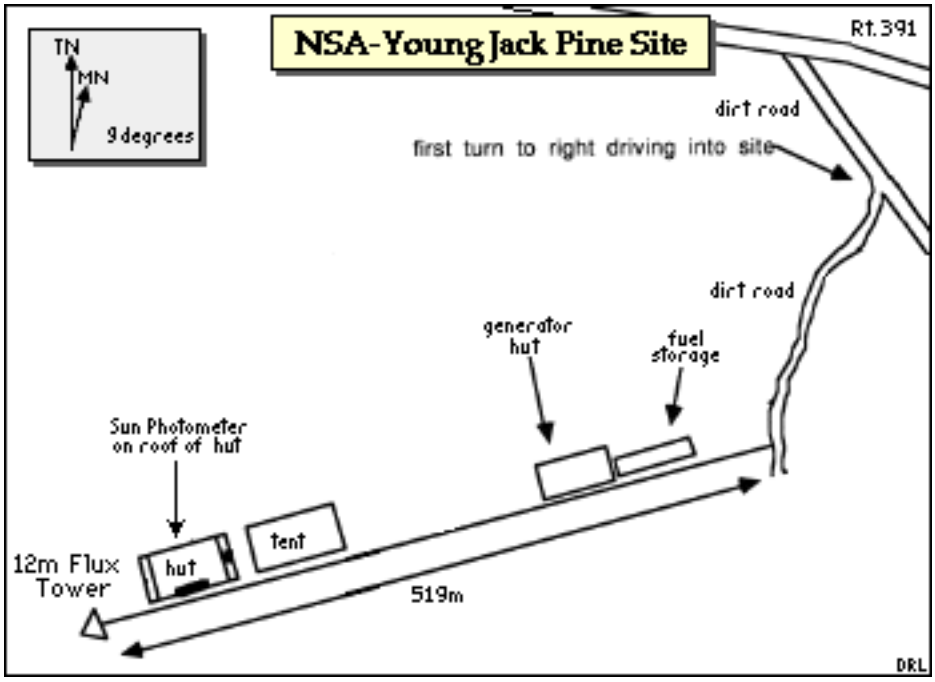


Figure 4.2.1c: TF-10 Site Map (NSA-YJP)
(i) Site Layout and Infrastructure

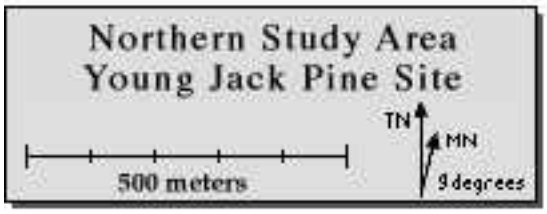


Figure 4.2.1c: TF-10 Site Map (NSA-YJP)
(ii) Orientation of WAB

Northern Study Area – Fen site (NSA-Fen)

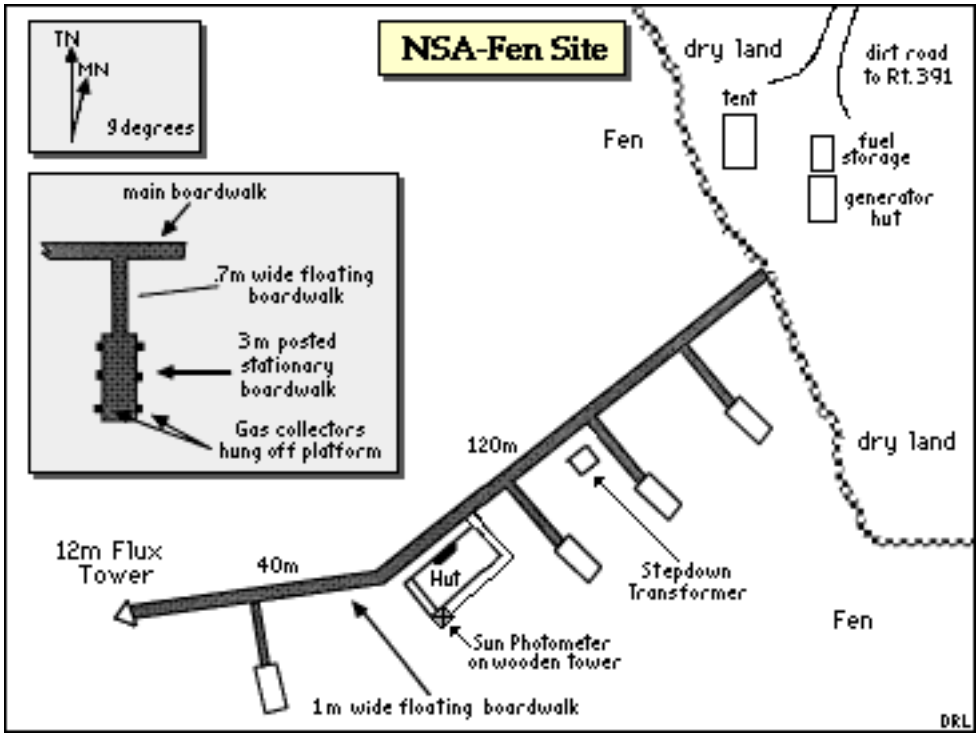


Figure 4.2.1d: TF-10 Site Map (NSA-Fen)
(i) Site Layout and Infrastructure

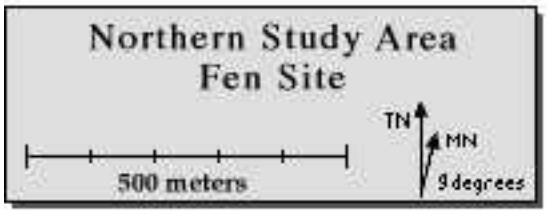
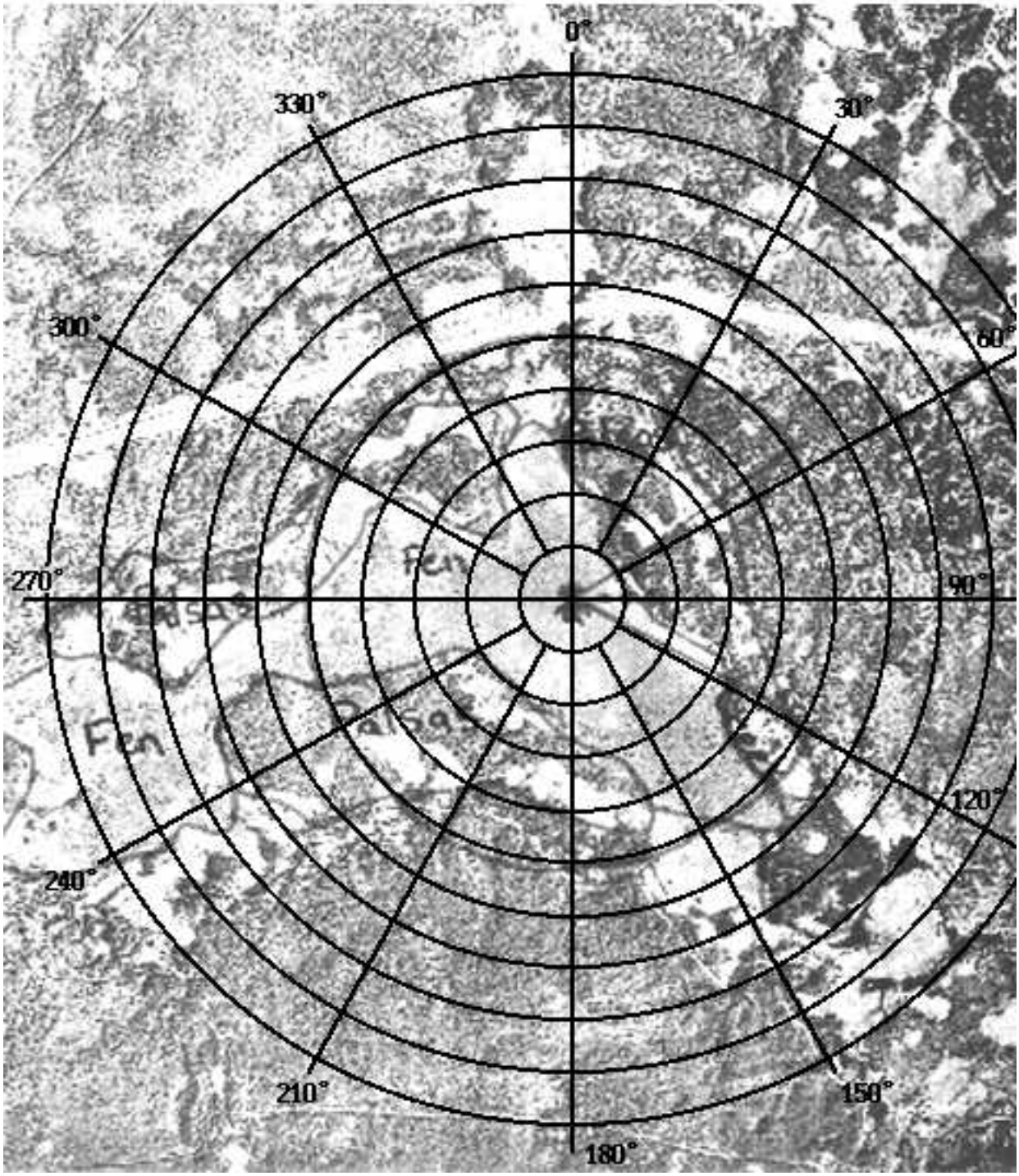


Figure 4.2.1d: TF-10 Site Map (NSA-Fen)
(ii) Orientation of WAB



Northern Study Area – Beaver Pond site (NSA-BP)

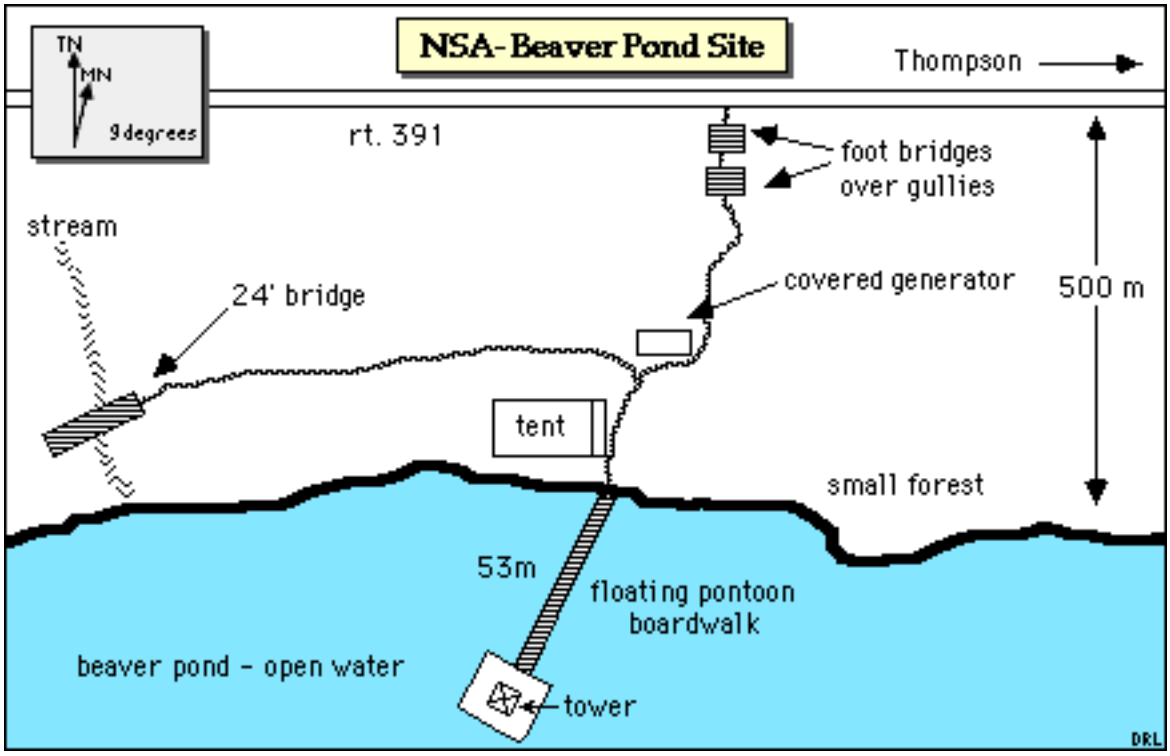
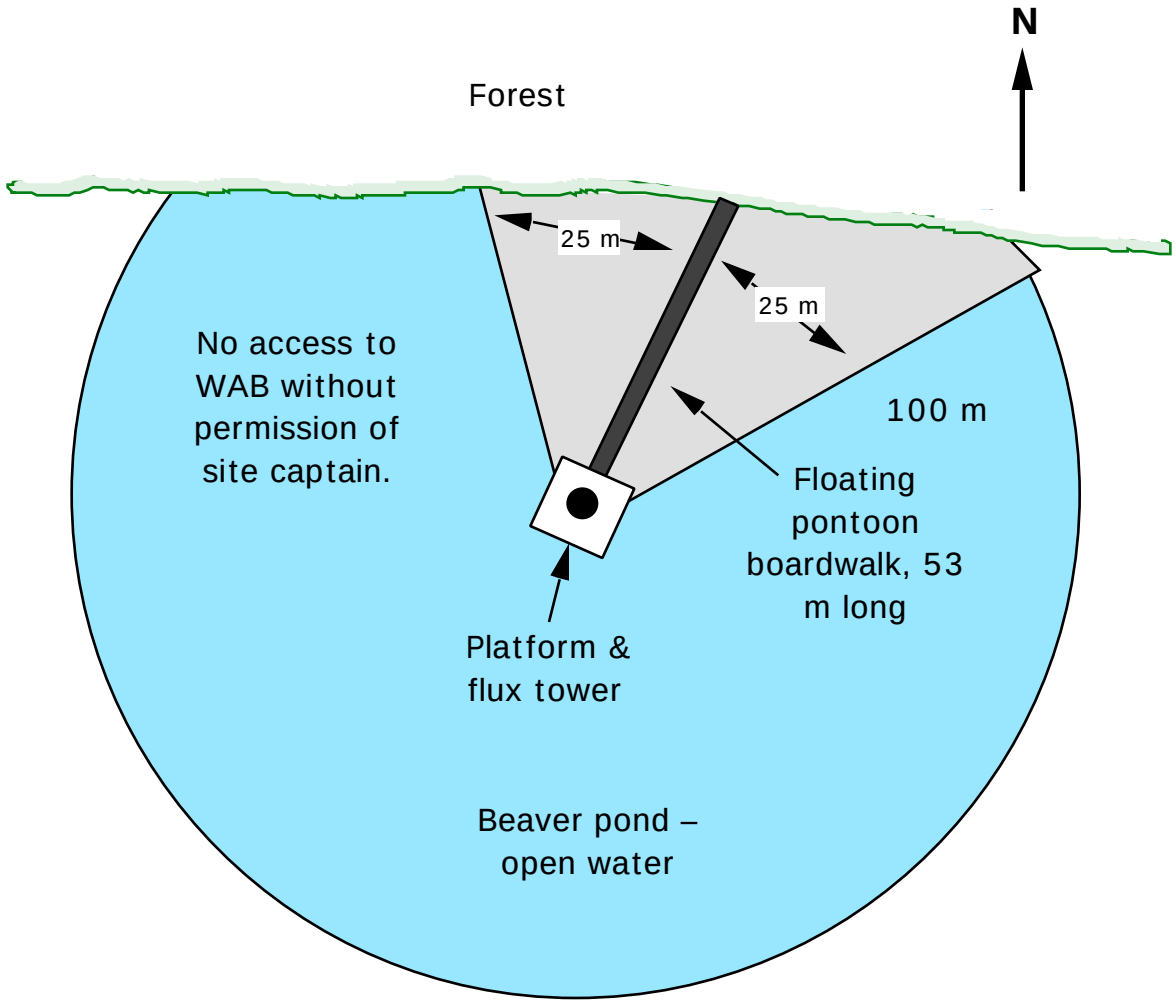


Figure 4.2.1e: TGB-4 Site Map (NSA-BP)
(i) Site Layout and Infrastructure

Northern Study Area – Beaver Pond site (NSA-BP)



No access to WAB without the specific permission of the site captain.

Site Captain: Nigel Roulet

Figure 4.2.1e: TGB-4 Site Map (NSA-BP)
(ii) Orientation of WAB

Southern Study Area – Old Aspen site (SSA-OA)

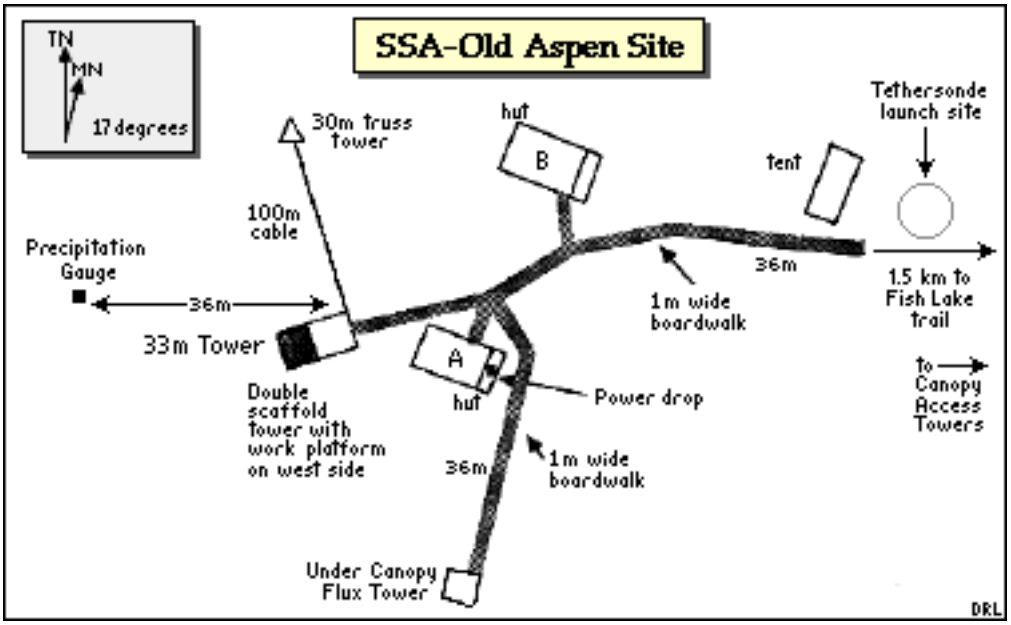


Figure 4.2.1f: TF-1 and TF-2 Site Map (SSA-OA)
(i) Site Layout and Infrastructure

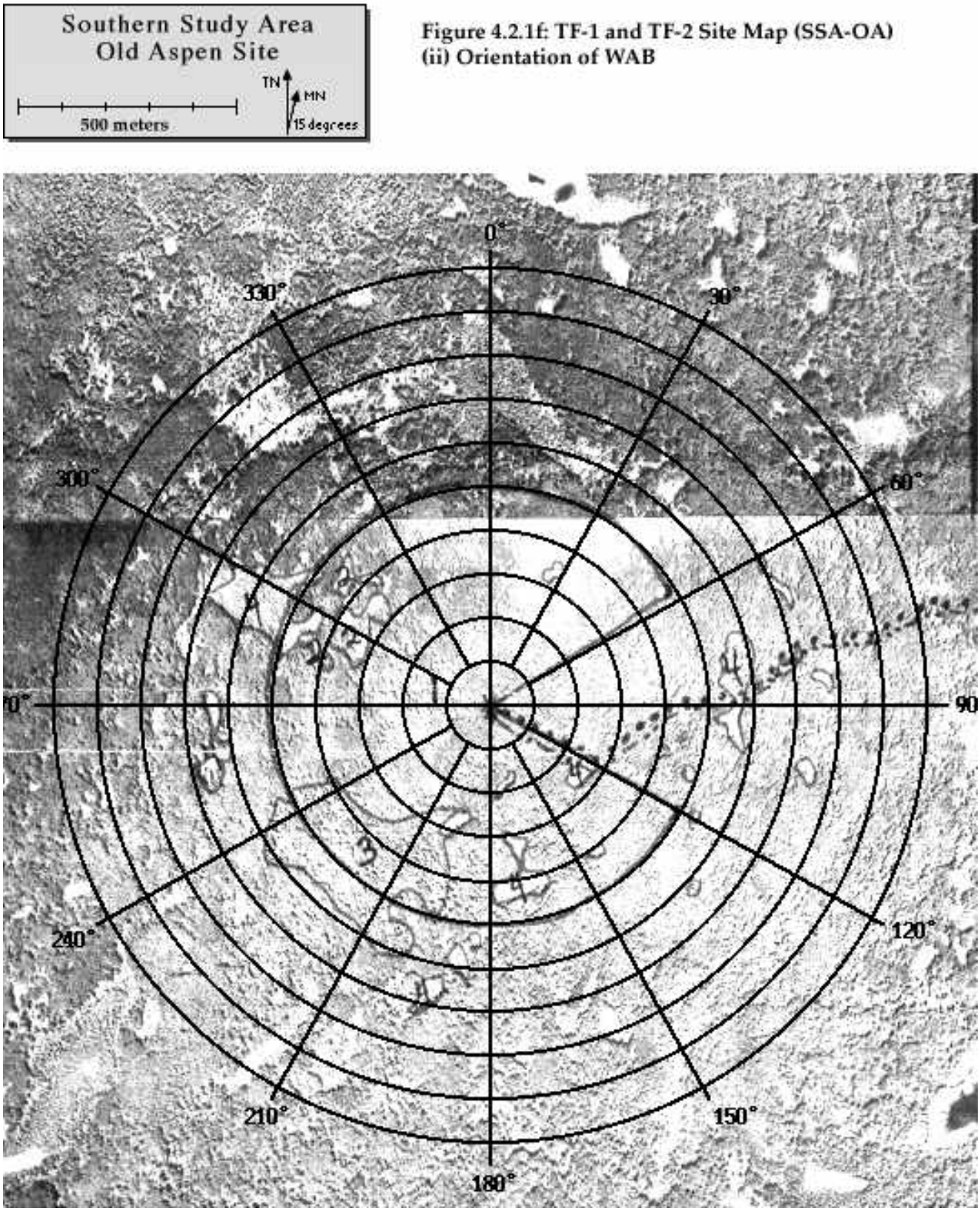


Figure 4.2.1f: TF-1 and TF-2 Site Map (SSA-OA)
(ii) Orientation of WAB

Southern Study Area – Young Jack Pine site (SSA-YJP)

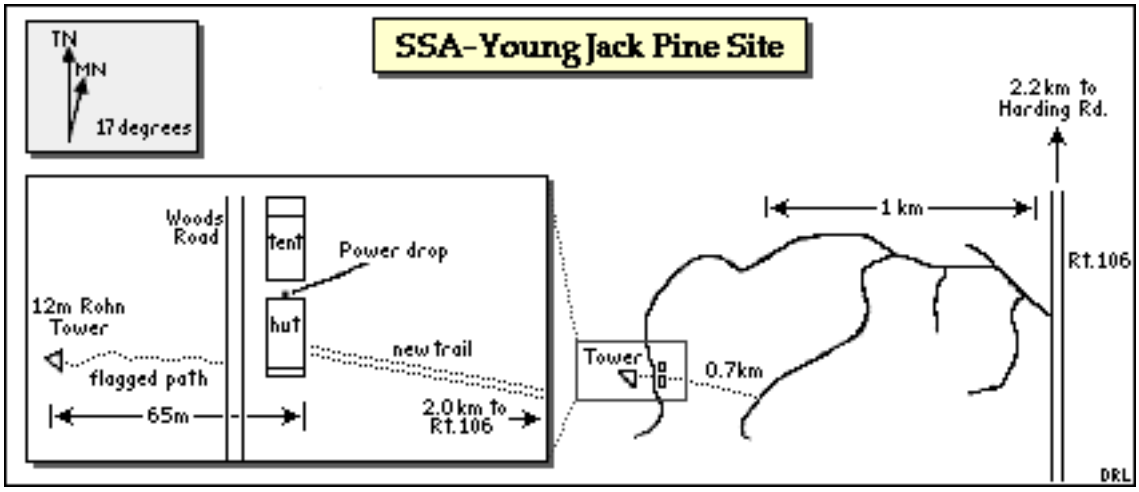


Figure 4.2.1g: TF-4 Site Maps (SSA-YJP)
(i) Site Layout and Infrastructure

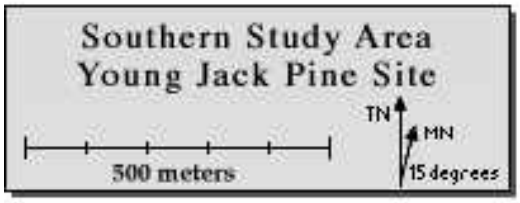
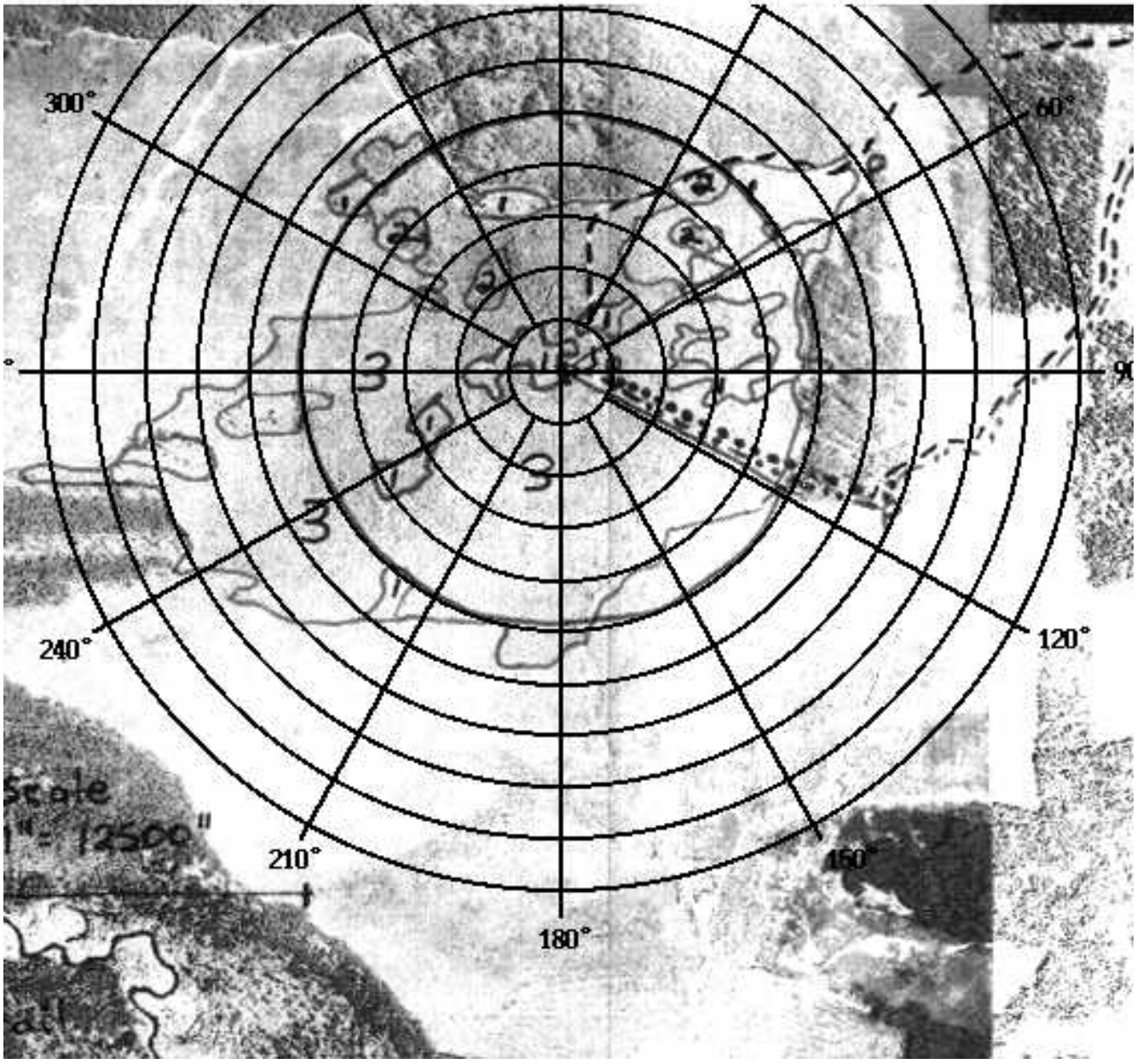


Figure 4.2.1g: TF-4 Site Map (SSA-YJP)
(ii) Orientation of WAB



Southern Study Area – Old Jack Pine site (SSA-OJP)

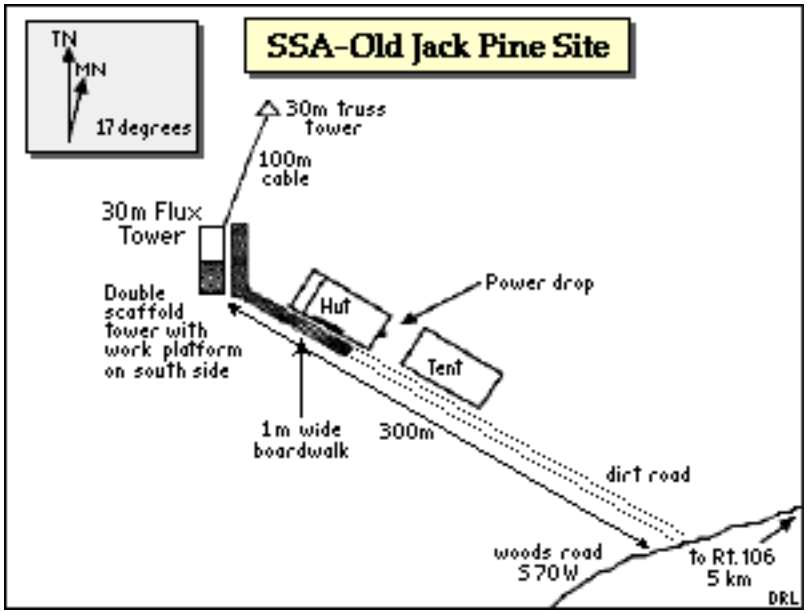


Figure 4.2.1h: TF-5 Site Maps (SSA-OJP)
(i) Site Layout and Infrastructure

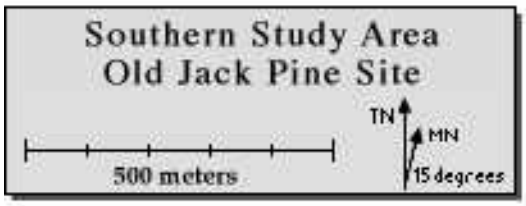
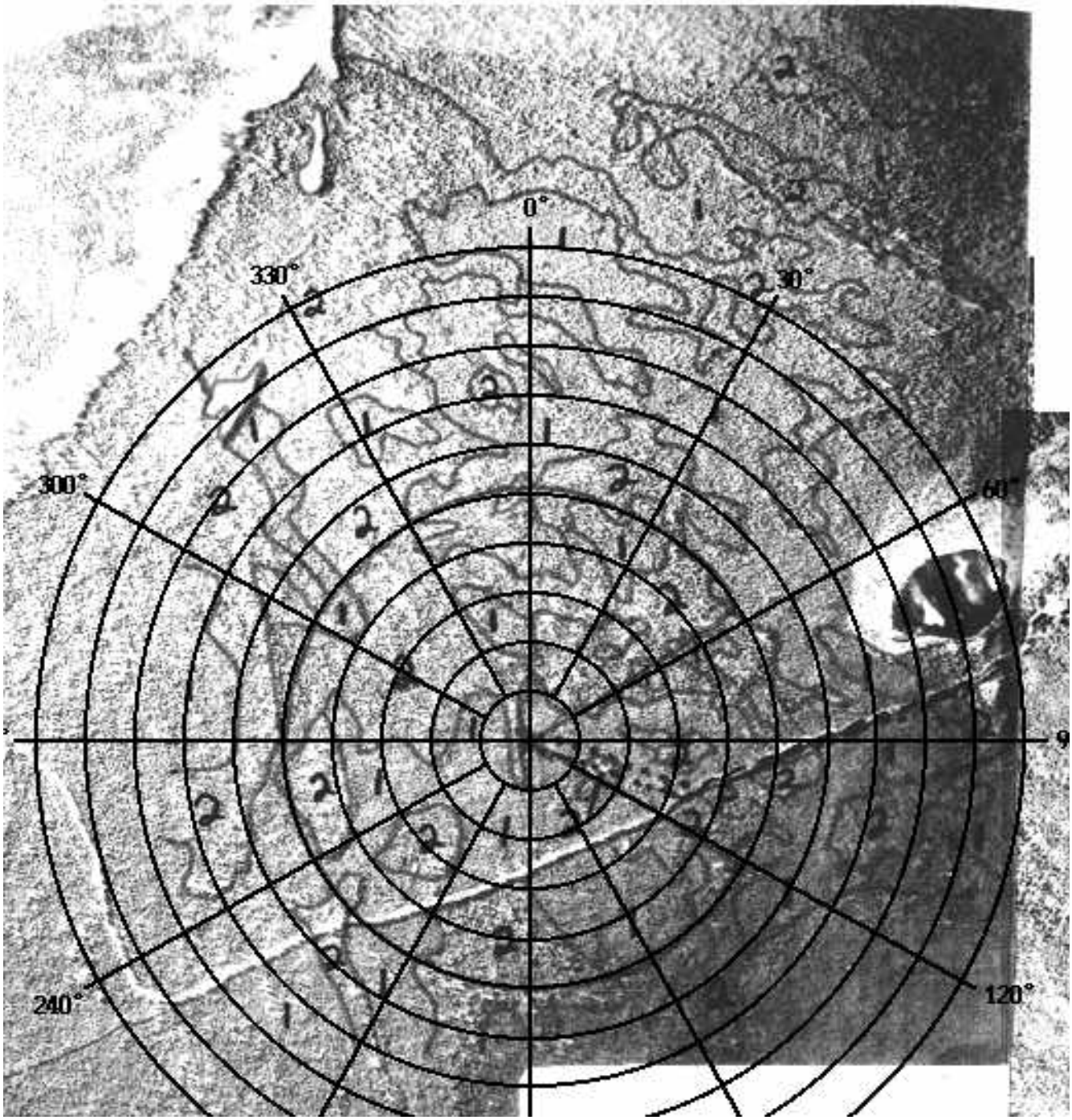


Figure 4.2.1h: TF-5 Site Map (SSA-OJP)
(ii) Orientation of WAB



Southern Study Area – Old Black Spruce site (SSA-OBS)

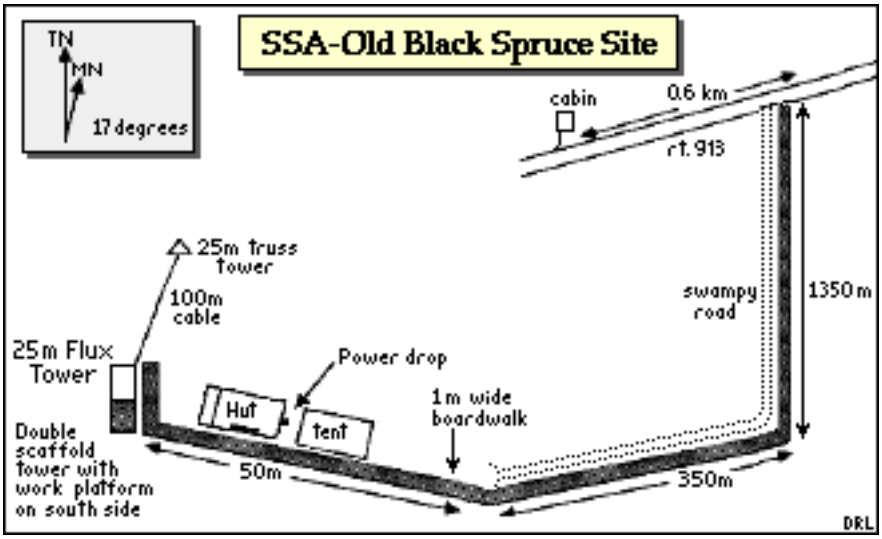


Figure 4.2.1i: TF-9 and TF-7 Site Map (SSA-OBS)
(i) Site Layout and Infrastructure

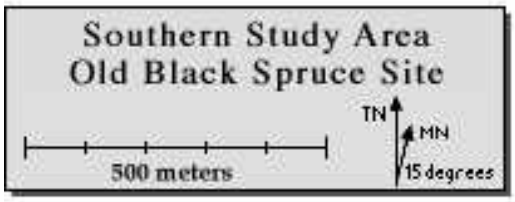
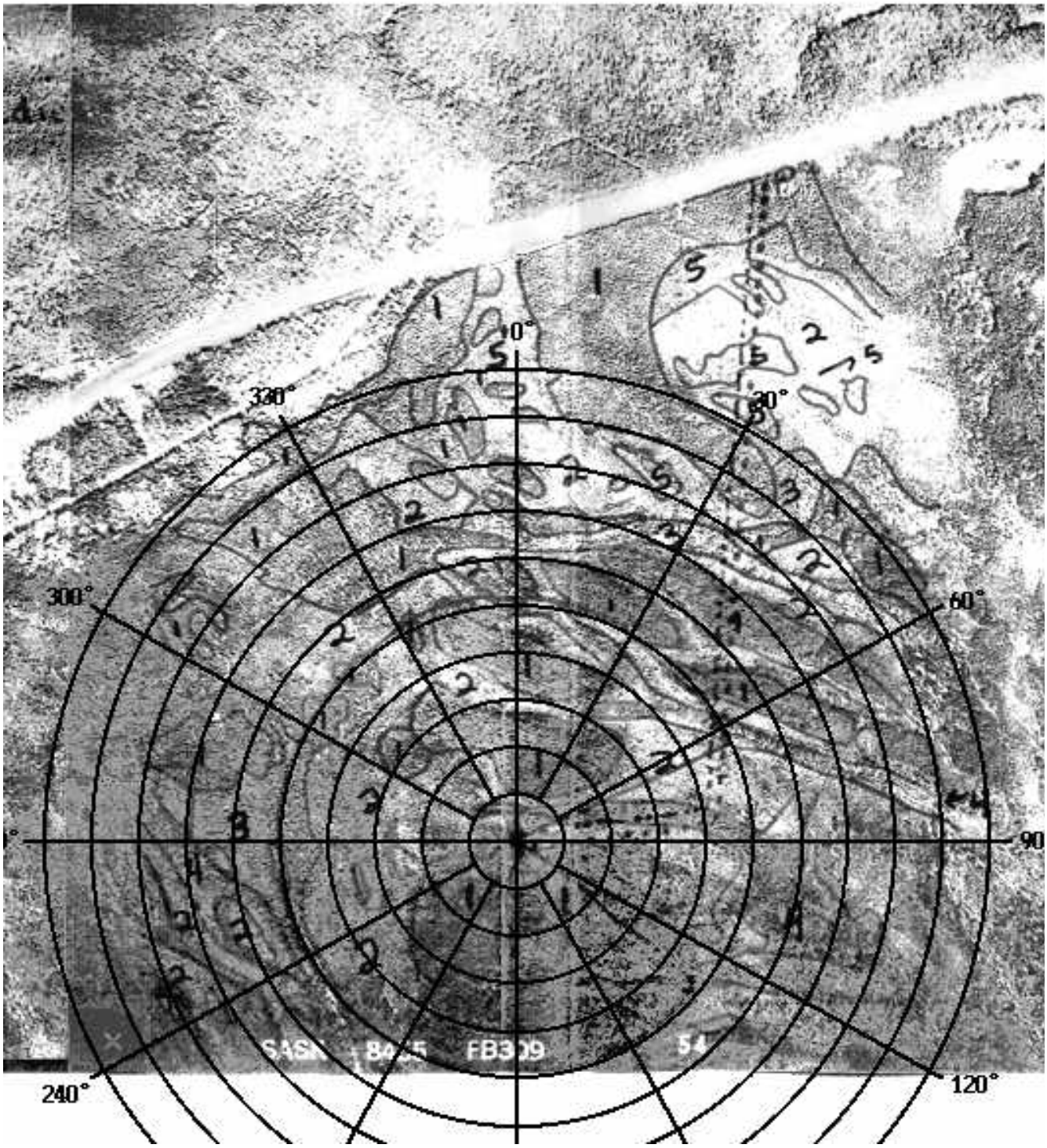


Figure 4.2.1i: TF-9 and TF-7 Site Map (SSA-OBS)
(ii) Orientation of WAB



Southern Study Area – Fen site (SSA-Fen)

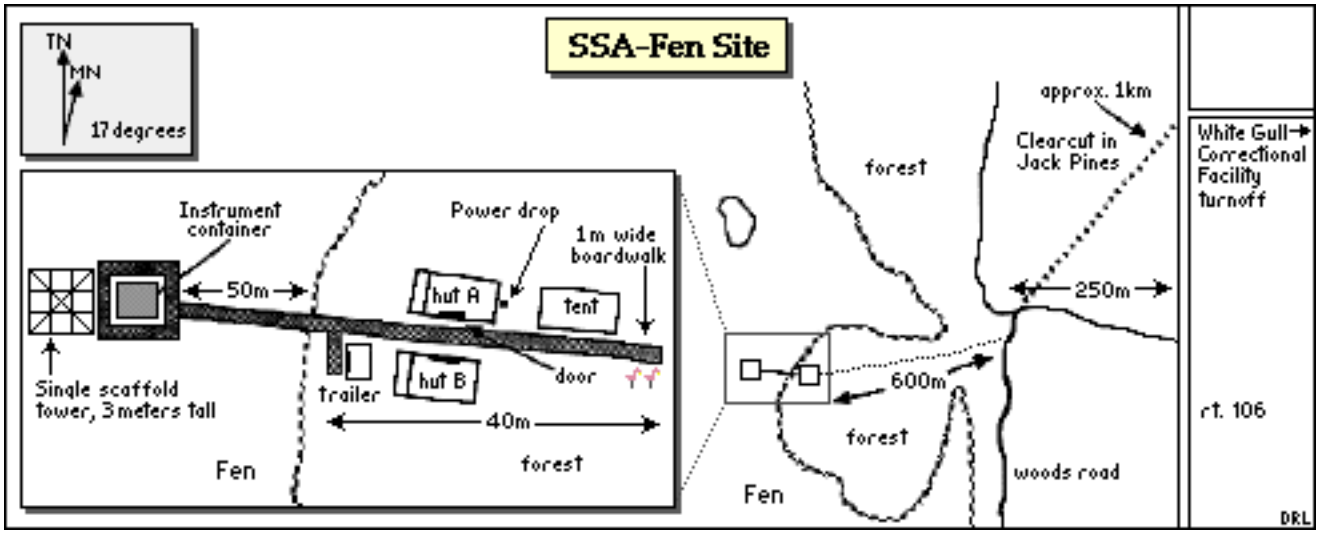


Figure 4.2.1j: TF-11 Site Map (SSA-Fen)
(i) Site Layout and Infrastructure

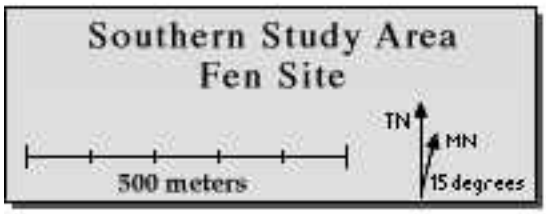


Figure 4.2.1j: TF-11 Site Map (SSA-OBS)
(ii) Orientation of WAB

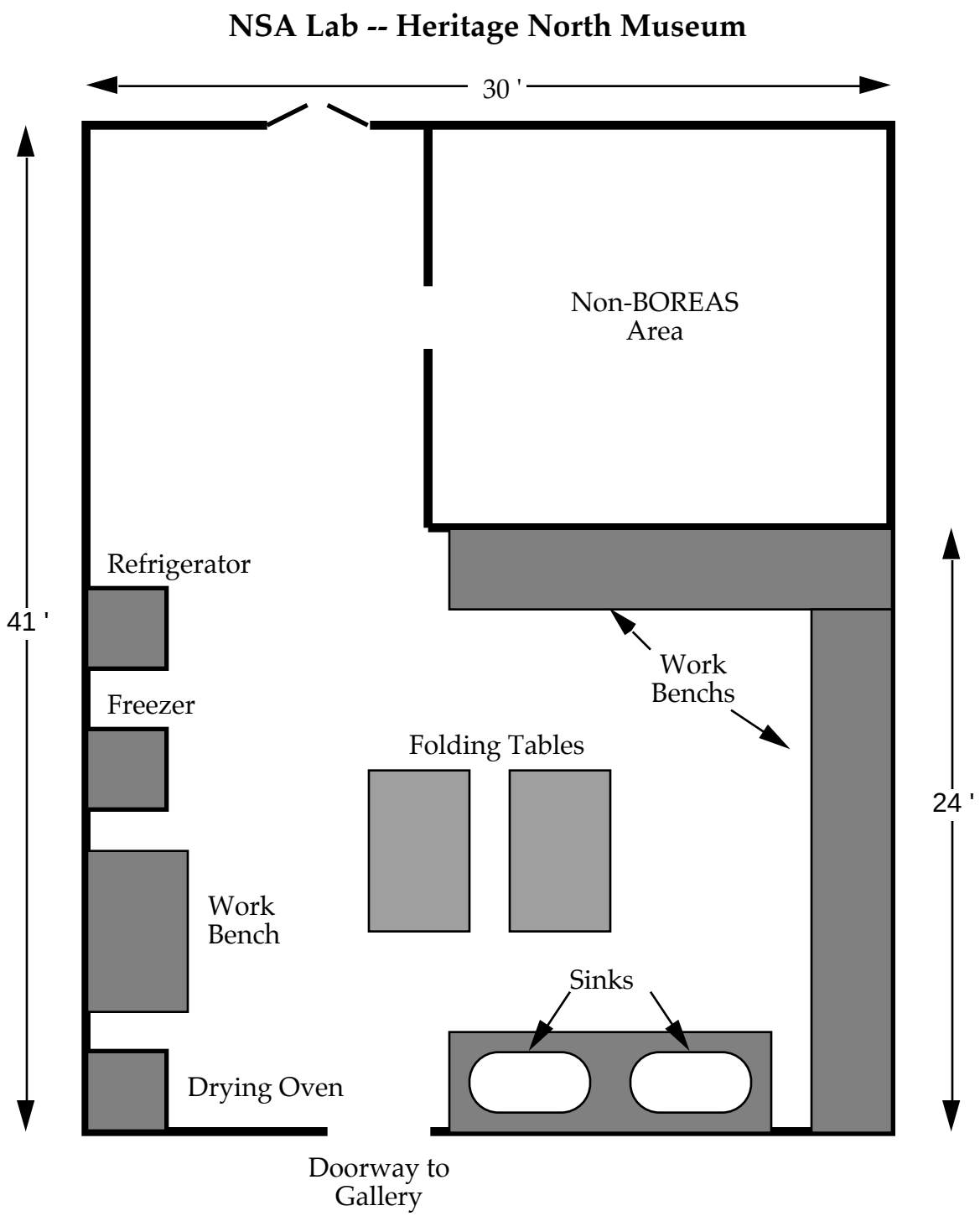


Figure 4.2.2a Layout of NSA Lab

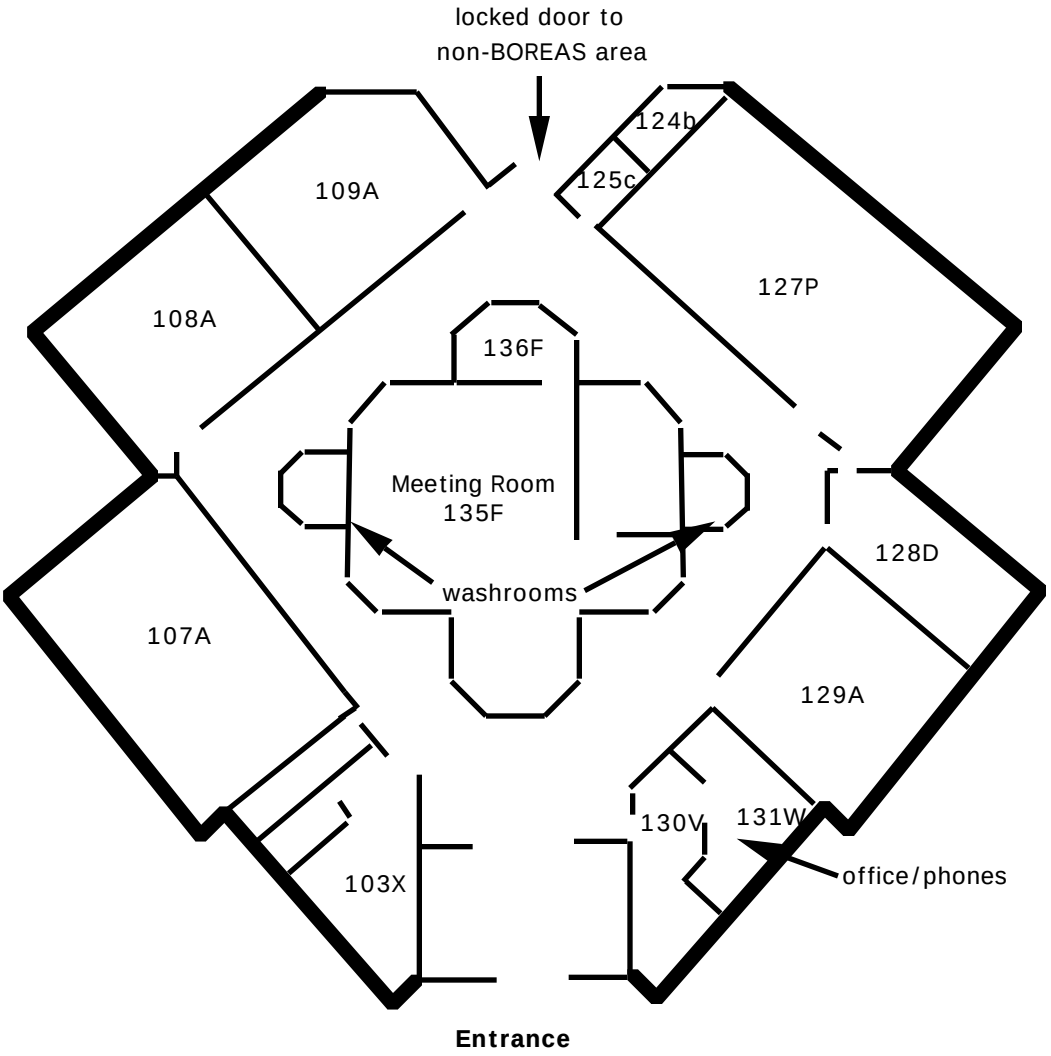


Figure 4.2.2b Layout of SSA Lab at Paddockwood School

NSA Operations Center and Lab

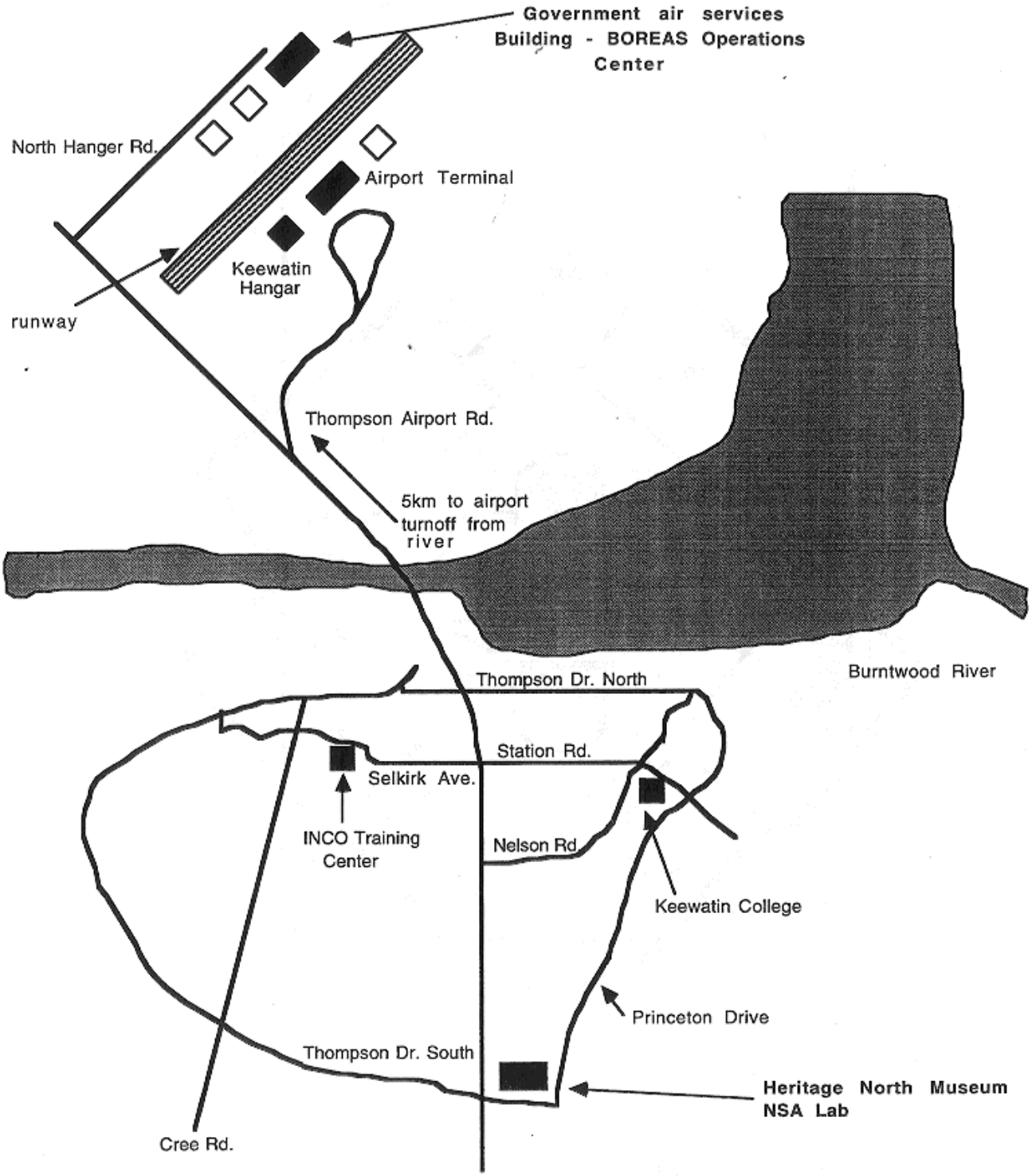


Figure 4.2.2c Location of NSA Ops and NSA Lab

SSA Operations Center and Lab

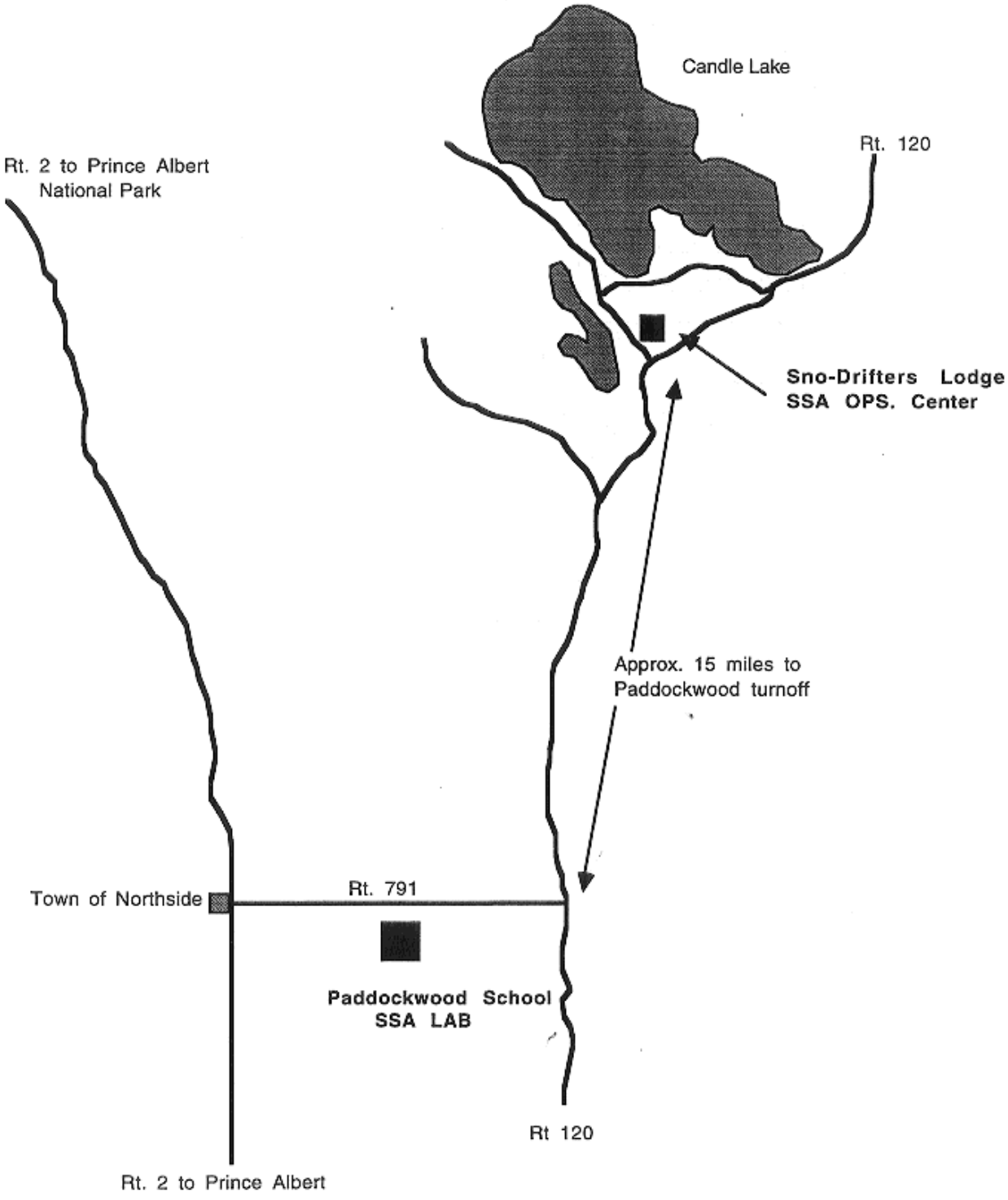


Figure 4.2.2d Location of SSA Ops and SSA Lab