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THE 1991 GREENLAND FIELD SEASON AFTER OPERATIONS REPORT FOR NSF-SPONSORED PROJECTS

for

Division of Polar Programs
National Science Foundation
Washington, D.C. 20550

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ACKNOWLEDGMENTS

On behalf of the National Science Foundation (NSF) Division of Polar Programs and all NSF-sponsored participants, the Polar Ice Coring Office at the University of Alaska Fairbanks (PICO/UAF) extends its appreciation to the many individuals, organizations and colleagues for their continued support and assistance. The success of the 1991 Greenland field season is largely due to support provided by the following groups and organizations:

Commission for Scientific Research in Greenland
Headquarters United States Air Force (HQ USAF)
Headquarters Military Airlift Command (HQ MAC)
Headquarters USAF Space Command (HQ AFSPACECOM)
The 109th Tactical Airlift Group (109th TAG)
Sondrestrom Air Base, Greenland (1015th ABS)
Thule Air Base, Greenland (1012th ABG)
McGuire Air Force Base, NJ (WRI)
Alaska Air Command, Eielson AFB
U.S. Army, Fort Wainwright
U.S. Army CRREL
4700 Operations Support Squadron (4700 OSS)
Felec Services, Inc. (FSI)
DEW Line Station Dye 3 (Dye 3)
GreenlandAir (GLAIR)
GreenlandAir Charter A/S (GLACE)
The Royal Greenland Trade Department (KNI)
The Danish Meterological Institute
STATOIL
Science Management Office (SMO)

A special acknowledgment goes to the GRIP Operations Center for assistance both in Sondrestrom and in the field.

PICO would also like to thank IMS Publications for their assistance in the final compilation of this report.

INTRODUCTION

The "1991 Greenland Field Season After Operations Report for NSF-Sponsored Projects" has been prepared to summarize the field activities of, and logistical support for, 1991 National Science Foundation-Division of Polar Programs (NSF-DPP) sponsored research projects in Greenland.

The Polar Ice Coring Office (PICO) at the University of Alaska Fairbanks (UAF) provides administrative support, field operations management and coordination of logistical requirements for NSF-sponsored projects.

PICO Greenland operations include:

- arrangements for transportation of personnel and equipment between Greenland and the U.S.
- distribution of supplies and equipment received from coordinators at UAF to the proper research locations
- response to and support of the needs of the GISP2 Field Camp
- on-site coordination of field activities originating at Sondrestrom Air Base
- control and maintenance of an inventory of field camp equipment that includes: oversnow vehicles, shelter/tents, kitchen supplies, radios, generators and fuels
- liaison between NSF, scientists, and civilian and military support subcontractors

PICO also provides:

- ice core and hot water drilling services
- the loan of non-technical drilling equipment
- borehole logging equipment and services to NSF-DPP glaciological and geophysical projects

A location map of Greenland is provided as Figure 1. Coastal sites of NSF-sponsored research include Sondrestrom Air Base, Thule Air Base, Ilulissat (Jakobshavns), Nuuk (Godthaab), and Kangerdlugssuaq Fjord and Angmagssalik on the north and east coasts. Sites on the ice sheet include GISP2 on the Summit Region of central Greenland and Dye 2.

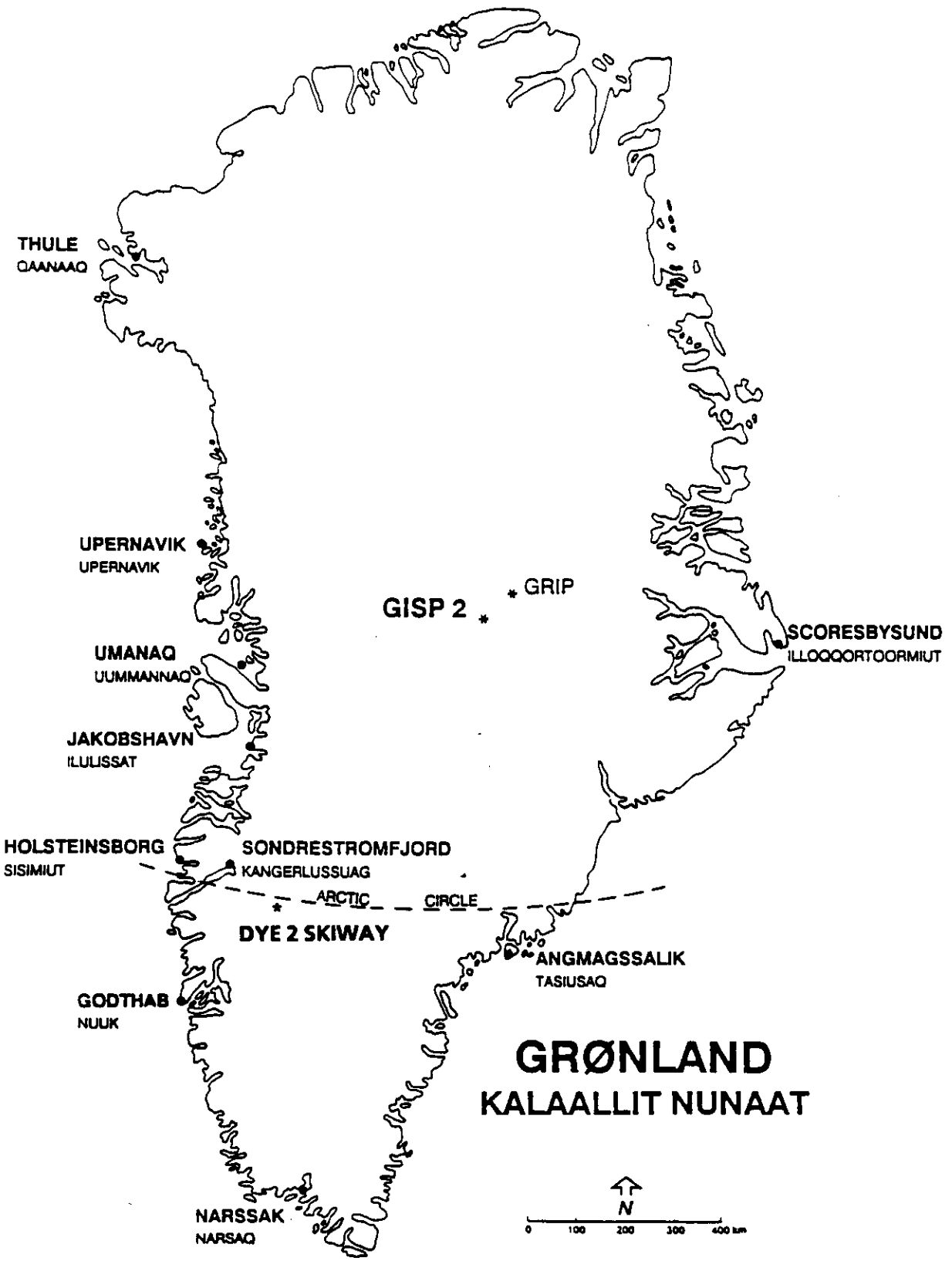

Figure 1. Location map of Greenland

NSF-SPONSORED PROJECTS

There were several NSF-sponsored field projects taking place during the 1991 Greenland season. Included was the Greenland Ice Sheet Project II (GISP2). A total of 170 individuals were involved in field activities. Table 1 provides a list of projects (see also Table 2) by the following categories:

A. NSF-DPP-Sponsored Polar Coordinated Science Programs
B. NSF-DPP-Sponsored Polar Glaciology Programs
C. NSF-DPP-Sponsored Polar Earth Sciences Programs
D. Other NSF-Sponsored Programs
E. Reimbursable Support

Table 3 presents a timetable for NSF-sponsored projects fielded during the period April through September.

NSF-DPP POLAR GLACIOLOGY PROJECTS

1991 marks the third field season of the GISP2 project. The major thrust of the GISP2 project is to drill and recover an ice core from the entire thickness of the Greenland Ice Sheet, over 3000 m. This is the most ambitious ice core drilling program in Greenland to date and will provide researchers with the longest paleoenvironmental record ever achieved in the northern hemisphere. GISP2 shares similar goals with the European "Greenland Ice Core Program" (GRIP) deep drilling effort. The GRIP camp and drilling operations are located approximately 30 km east of the GISP2 site and began operations in 1989.

Science activities at GISP2 this season involved researchers from several universities or institutes across the United States. Institutions involved include: University of New Hampshire, University of Wisconsin, University of Washington, Desert Research Institute, New York Institute of Health, University of Miami, University of Rhode Island, Carnegie-Mellon University, University of Colorado, Cold Regions Research Engineering Lab (CRREL), and Pennsylvania State University. The GISP2 Science Management Office (SMO) is housed at the University of New Hampshire (UNH) with drilling and operations support provided by PICO at the University of Alaska Fairbanks (Table 4). The point of contact for SMO is Dr. Paul Mayewski and for PICO, Dr. John Kelley.

Ice core samples, along with other surface, snow pit and atmospheric samples, were returned to the Continental United States (CONUS) for detailed chemical and physical studies. The last hole drilled in 1989 to 90 m was re-entered in 1991 to begin deep drilling operations expected to continue on a seasonal basis through the summer of 1992. A report on the drilling activities is available from PICO at 205 O'Neill Building, Fairbanks, Alaska 99775-1710.

NON-U.S. PROJECTS

Non-U.S. collaborative or cooperative projects that received PICO support include ETH-Zentrum with communications and information transfer between their field camp and Ziruch. PICO support to the GRIP program includes the coordination of U.S. Air Force air support provided by the 109th TAG, as well as other minor base services provided by the 1015th ABS, Sondrestrom AB, Greenland.

Table 1. NSF-DPP, Other NSF-Sponsored Projects and Non-U.S. Projects, Greenland 1991

Institution/ Principal Investigator	Project Title	Project Summary
A. NSF/DPP Polar Coordinated Science Projects		
Polar Ice Coring Office University of Alaska Fairbanks (PICO/LG) Dr. Luis Proenza	Coordination of Greenland 1991 Operations and Logistics	Coordination of field operations for DPP- and non-DPP-sponsored field programs (20 April -24 September)
B. NSF/DPP Polar Glaciology Projects		
Institute for the Study of Earth, Oceans & Space (GISP2) Dr. Paul Mayewski	GISP2	A group of individual projects conducting paleoclimatic atmospheric and glaciological studies from ice cores obtained in central Greenland (7 May-18 September). See Table 2 for complete list of GISP2 Principal Investigators and projects
C. NSF/DPP Polar Earth Sciences		
Boise State University Department of Geology/ Geophysics Dr. Craig White	A study of co-existing mafic and silicic magmas in the Vandfaldsdalen macrodike, East Greenland	A continuation of petrologic study of one of the three very large dikes; to address the mechanism by which silicic magmas overlie magic magmas, compositional zoning, and mixing between silicic magmas and mafic liquids (1-20 August)
Harvard University Geology and Paleontology Dr. Farish Jenkins	Vertebrate Paleontological expedition	The Late Triassic tetrapod fauna of the Fleming Fjord Formation, East Greenland
Stanford University Department of Geology Dr. Dennis Bird	Geochemical and structural evolution of gabbro-hosted magma-hydro-thermal systems: East Greenland	A continuation of studies of metamorphism, hydrothermal alteration, and the possible influence of magmatism during early stages of continental rifting (TBA)
D. Other NSF-Sponsored Projects		
The University of Michigan Department of Atmospheric, Oceanic, and Space Sciences Dr. Robert Clauer	MAGIC	Magnetometer data collection systems

Table 1. NSF-DPP, Other NSF-Sponsored Projects and Non-U.S. Projects (continued)

Institution/ Principal Investigator	Project Title	Project Summary
E. Reimbursable Support		
5099 Civil Engineering Elmendorf AFB, AK Danny Collins	HAZ. RETRO Dye 2 and Dye 3 Stations	Hazardous material removal and environmental cleanup at Greenland Ice Sheet sites Dye 2 and Dye 3
NASA Project Ohio State University Byrd Polar Research Center Dr. Kenneth Jezek	Validation Project	Snow surface characterization and leveling for validation on the Jakobshaven Ice Stream 69 °50' 58.3" Lat 47 °06' 45.4" Long
Ocean Processes Branch NASA Headquarters Dr. Robert H. Thomas	Validation Project	Snow surface characterization and leveling for validation on the Jakobshaven Ice Stream
University of Colorado W.T. Pheffer	Infiltration and Runoff in Greenland	Field investigation of melt water infiltration and runoff in Greenland
University of Arizona Dr. Alex Wilson	Micrometeorite Dating	Isotope measurements of micrometerorites in the Greenland Ice Sheet. Purpose is to date the ice beyond ^{14}C dating

Table 2. 1991 GISP2 Principal Investigator List

Investigators	Institution/Address	Projects
Alley, Richard	Penn State University 248 Deike Building University Park, PA 16802	Physical properties of core. Continuous visual logging of core, density, texture, and fabric
Barry, Roger Armstrong, Richard	University of Colorado Campus Box 449 Boulder, CO 80309-0449	Data management
Bender, Michael	University of Rhode Island School of Oceanography Narragansett, RI 02882-1197	Occluded gas analysis. $\delta^{18}O$ of O_2, $\delta^{15}N$ of N_2, O^2/Ar ratio, N_2/Ar ratio
Bolzan, John	Ohio State University Byrd Polar Research Center 125 South Oval Mall Columbus, OH 43210	Surface strain net, velocity, accumulation, ice flow modeling
Borys, Randy	Desert Research Institute Atmospheric Sciences Center P.O. Box 60220 Reno, NV 89506	Crystal habits and rime chemistry
Boyle, E.	E34-200 MIT Department of Earth, Atmospheric and Planetary Sciences Cambridge, MA 02139	Trace metal chemistry
Davidson, Cliff	Carnegie Mellon University Department of Civil Engineering Pittsburgh, PA 15213	Major ions and trace metals of aerosols and snow
Dibb, Jack	University of New Hampshire Durham, NH 03824-3525	Radionuclides in aerosol and snow
Gow, Tony Meese, Debra	Cold Regions Research and Engineering Laboratory 72 Lyme Road Hanover, NH 03755	Physical properties of core. Annual layering, core relaxation mechanisms, and precision density measurements
Grootes, Pieter Stuiver, Minze	University of Washington Quaternary Isotope Laboratory Seattle, WA 98195	$\delta^{18}O$ record of ice
Hodge, Steve	U.S. Geological Survey University of Puget Sound Tacoma, WA 98416	Airborne ice radar determination of the surface and bed topography
Mayewski, Paul Spencer, Mary Jo Lyons, Wm. Berry	University of New Hampshire Durham, NH 03824-3525	Major anions and cations, total acidity, and ionic balance

Table 2. 1991 GISP2 Principal Investigator List (continued)

Investigators	Institution/Address	Projects
Mayewski, Paul	University of New Hampshire Science Management Office Durham, NH 03824-3525	GISP2 Science Management Office
Mosher, Byard	University of New Hampshire Durham, NH 03824-3525	INAA analysis of aerosols and snow
Palais, Julie	University of New Hampshire Durham, NH 03824-3525	Insoluble particulates. Mass concentration, size distribution, chemical composition, and morphology
Ram, Michael	State University of New York Department Physics and Astronomy Buffalo, NY 14260	Continuous particulate concentrations
Salzman, Eric	University of Miami 4600 Rickenbacker Cswy. Miami, FL 33149	Methanesulfonic acid (MSA) and iodine(Iodidie and Iodate) in ice
Stearns, Charles	University of Wisconsin Department of Meteorology 1225 West Dayton Street Madison, WI 53706	Automatic Weather Station
Taylor, Ken	Desert Research Institute P.O. Box 60220 Reno, NV 89506-0220	Continuous electroconductivity of core
Wahlen, Martin Broecker, Wallace	Wadsworth Center for Labs and Research NY State Department of Health P.O. Box 509 Albany, NY 12201	CO_2/Air ratios, $\delta^{13}CO_2$ in occluded gas,total gas content, CH_4 and N_2O concentrations, bubble volume
White, James	University of Colorado Institute of Arctic and Alpine Research Campus Box 450 Boulder, CO 80309	D ($^2H/^1H$ ratio) of ice
Wilson, Alex Donahue, D.J.	University of Arizona Department of Geosciences Tucson, AZ 85721	^{14}C dating of core from occluded CO_2
Wilson, Alex	University of Arizona Department of Geosciences Tucson, AZ 85721	Concentration and $\delta^{13}C$ of CO_2 in in occluded gas

Table 3. 1991 Greenland Field Schedule

PICO Logistics	26 March - 17 September
GISP2	13 April - 12 September
Dye 2 Skiway	11 April - 17 August
4700/5099 Dye 2/Dye 3 HAZ-RETRO	30 April - 30 July
NASA/Crawford Point	3-22 June; 12 Aug. - 4 Sept.
Harvard University	10 June - 18 August
Woods Hole	29 July -23 Aug.
Colorado/Phefer	29 July - 23 Aug.
109th TAG	See Flight Schedule (p. 25)

Table 4. Polar Ice Coring Office Staff

Coordination of Greenland 1991 Operations and Logistics
Polar Ice Coring Office
University of Alaska Fairbanks

Principal Investigator:
Dr. Luis Proenza

Permanent Field Staff:
Bruce Koci, Engineering
Mark Wumkes, Engineering
Jay Klinck, Logistics
Steven Peterzen, Logistics
Terry Gacke, Engineering
Kerry Stanford, Engineering
Harm DeBoer, Engineering

UAF Office Personnel:
John Kelley, Director
Jay Sonderup, Assistant Director
Bonnie Hughes
Michelle Johnson
Lori Smith
Jeanne Wollman
Mary Jo Knabe
Bob Moch

Seasonal Field Staff:
Walt Hancock
Sarah Sturgis
Bill Barber
Pat Smith
Karyn Martin
Paul Stoner
Steven King
Bill Danford
Rob Coates
John Giles
James Goranson
Dave Koester
Sam Lamont
Catherine Melville
Paul Saulnier
Barb Prescott
David Dausel
David Ramey
Alice Danilson
Julie Danford

Dates in Field:
26 March - 17 September

Location:
Sondrestrom AB, Thule AB, Dye 2, Dye 3, Summit Region, Jakobshavn, Keflavik, Constable Pynt, Crawford Point

LOGISTICAL COORDINATION AND MANAGEMENT

In September of each year, PICO establishes a field operations management schedule which outlines the administrative process and the requirements for the coordination of the following Greenland field season.

The 1991 schedule was supported by the distribution or transmittal of the following documents:

- "1991 Greenland Field Requirements and Personnel Information" memorandum and the "Facilities and Services Available to NSF-Sponsored Projects in Greenland" were distributed by PICO to all Principal Investigators (PIs) who submitted proposals to NSF-DPP involving Greenland fieldwork.

- "Preliminary Logistics Support Requirements and Cost Projections for 1991 NSF-Sponsored Greenland Research" was transmitted by PICO to the NSF-DPP Program Manager, Polar Earth Science Programs in January 1991. The document presents PICO's preliminary support requirements and cost projections for the non-GISP related research grants proposed for 1991.

- PICO submitted in February 1991 a proposal and budget to provide logistical support for Greenland fieldwork in response to NSF-DPP tasking letters.

Administration of field operations and support functions provided by PICO include the following activities:

- Clearances for individuals to work within and travel through U.S. military installations. These include Military Airlift Command (MAC) travel authorizations, Foreign National Clearances, DEW Line Clearances and Sondrestrom and Thule Air Base Clearances;

- Coordination of personnel and cargo movements to, from and within Greenland with regular updates to agencies and personnel utilizing both scheduled and chartered air service;

- Distribution of briefing packets which include clearances, physicals, itineraries and general travel information to all participants prior to departure to the field;

- Research and procurement of field equipment and supplies to include shelters, oversnow and wheeled vehicles, generators, camp support and communications equipment; and

- Maintenance of third-party support documents between NSF-DPP and the U.S. Air Force and the subcontracted agents, as well as applications for single-side band and other radio frequency clearances from Danish authorities.

- PICO stations one Field Operations Manager (FOM) and two assistant Field Operation Managers (AFOHS) at Sondrestrom AB to provide project and air support coordination of cargo and personnel, expedite resupply requests and maintain remote field party communications. In addition, PICO serves as a liaison between various NSF science groups and base support functions.

- An administrative assistant remains at PICO/UAF to provide project coordination of military passengers and cargo arrangements for projects between the Continental United States (CONUS) and Greenland.

LOGISTICAL SUPPORT FACILITIES

SONDRESTROM AIR BASE

Sondrestrom Air Base has been the primary staging area for the majority of NSF-sponsored projects in Greenland over the past 16 years. The air base and the accompanying civilian community offer the widest range and greatest availability of logistical support materials and services in Greenland.

- 1015th Air Base Squadron (1015th ABS)

  The 1015th ABS provides NSF-sponsored projects with the majority of required materials, supplies and services. This support is provided under an Interservice Support Agreement (ISSA) between the U.S. Air Force Headquarters Space Command (HQ AFSPACECOM) and the NSF-DPP. The Sondrestrom AB ISSA became effective 1 September 1985 and will remain the active document of support authority through September 1992 unless otherwise renegotiated under the provisions stated within the ISSA.

  1992 will see the transition of the 1015th ABS from U.S. military control to civilian control under the Greenland Home Rule Government. After the transition in October of 1992, all services available to PICO and NSF-sponsored projects are expected to remain intact.

  The United States Air Force has operated the Sondrestrom AB since its beginning in 1941 as a North Atlantic military refueling site and in support of the DEW Line across Greenland.

  Under the guidelines of the ISSA, the 1015th ABS and its civilian contractors provide third-party reimbursable support to NSF-sponsored programs which includes: space-available billeting, open mess privileges, commissary services, equipment rental, cargo handling, vehicle maintenance, base supply items, fuels and warehouse/office space.

  Field operations during 1991 utilized the following major reimbursable support items:

  – Petroleum/Oil/Lubricants (POL):

Shop-vehicle use		
MOGAS	657 gal	
DFA	1,847 gal	(1,429 for heating oil)

GISP2 fuel from Sondrestrom	
MOGAS	2,741 gal
DFA	12,208 gal
Kerosene	41 gal

Other remote camp/field use	
MOGAS	940 gal
DFA	255 gal

- Commissary: food was procured to supply GISP2 and central Greenland operations to support 4,861 personnel days on site.

- Base supply: materials and supplies procurements in support of the NSF-sponsored research programs.

- PICO Support Facilities

PICO continues to maintain two support facilities provided by the USAF at Sondrestrom AB. Since 1974, PICO has maintained the old fire station (Building T-436) as a staging and warehouse space. PICO has been utilizing Building 387 as the primary support facility and field center since 1988. Administrative offices, storage, communications center and maintenance shop are the primary uses of this building.

Upgrades of the Sondrestrom facilities include the finishing of the deck and loading area in the rear of Building 387, continued work on the kitchen area including the installation of a stove and walls to keep the area somewhat separate from the rest of the building, and installation of a flammable container cabinet in the shipping and receiving room.

PICO again used the freezer facility in Sondrestrom for the storage of ice core in transit from the GISP2 station to CONUS. This facility has been used for several seasons and has proved invaluable but is getting older and its future questionable. In anticipation of the increased demand for ice storage in Sondrestrom for 1992, alternative storage and transport methods will be investigated.

- PICO Vehicles

PICO maintains three wheeled vehicles: a 1987 Ford 3/4-ton crew cab pickup, a 1976 Ford 1/2-ton pickup and a 1956 Dodge M-37, 4-wheel drive personnel carrier. During the first few weeks of the 1991 season, the 1976 Ford was brought back to life and functioned quite well throughout the season. Problems continued to plague the '56 M-37, but by season's end, most of the problems were found and corrected. PICO may procure additional vehicles to support the increased demand for dependable transportation.

Forklifts: PICO maintains a 4,000-lb forklift that was acquired from the USAF. This piece of equipment remains in the warehouse for light duty work.

GRIP Operations owns a 15-k Taylor forktruck which is intended for joint general use and ground support of Sondrestrom-based air operations. Maintenance and general upkeep are shared by PICO and GRIP Greenland Operations Center (GOC).

The 1640 series Tucker Sno-Cat and the two 2-ton cargo sleds remain in operation supporting central Greenland operations. This vehicle remains at GISP2 to support camp, skiway and remote traverse operations.

The Caterpillar LGP 931 was deployed to GISP2 in May of 1989 to support camp construction and skiway development. After a full season of operation in 1989, electrical and hydraulic problems persisted throughout the season requiring continued maintenance. The 1990 season saw a substantial increased demand of

the 931, making it necessary to go over the machine, replacing worn parts at the beginning of the 1991 season. The vehicle was left at the GISP2 site after the 1990 season. A new 931 LGP caterpillar track loader was procured and sent to the GISP2 station in 1991. These remain at the GISP2 location and are used to load and download the aircraft, load snow into the snowmelter for a water source, skiway operations, and general operations around the station.

The Bombardier SkiDozer remains in Sondrestrom. This vehicle has not been actively used on the ice since the conclusion of GISP1 operations at Dye 3 in 1982. This vehicle will require a complete inspection and rebuild prior to its upgrade in status to a field-worthy vehicle. There are no current requirements at GISP2 or any other site for this vehicle. A cost analysis was done, and this vehicle will be rebuilt in 1992.

In 1990 a Thikol Spryte was purchased in support of the Dye 2 skiway facility. At the close of this facility each season, this vehicle is brought back into Sondrestrom for inspection and necessary repairs.

Snowmachines: During the 1991 season, the crew at Sondrestrom rebuilt four SkiDoo Elans. These machines are now back in the "work force" and were used this past season in support of GISP2, the Dye 2 skiway facility, and the 4700th/5099th recovery teams at Dye 3 and Dye 2.

Four new SkiDoo Cheyennes were procured in support of the GISP2 activities in 1991. In addition, GISP has two SkiDoo Alpines and Four SkiDoo Skandics.

Sondrestrom field office also maintains four bicycles for use by the Sondrestrom staff and visiting personnel.

- Field Camp Equipment

Additional field camp equipment included the usual replacement items: sleeping bags, clothing, boots, etc., for issue to the PICO field staff. Any large equipment purchases for the field camps are listed under each respective section in this report.

- Sondrestrom Baseloading

In past seasons, Sondrestrom AB has been faced with severe overcrowding during the summer months. However, since the phase-down of USAF-sponsored personnel, beginning in 1988, berthing of NSF-sponsored personnel on base has not been a concern, nor is it likely to be so in the future. The transition of the 1015th ABS did not affect the berthing for NSF-sponsored individuals nor will there be any change for the 1992 season.

- Off-Base Support

Off-base support for 1991 was provided by the Greenland Trade Department-KNI (materials handling, civilian sealift), STATOIL (POL products and containers), GreenlandAir-GLAIR (passenger and air cargo service), Scandinavian Airlines-SAS (passenger and air cargo service, ground equipment repair), NUNA-TEK, and Danish Arctic Contractors-DAC (heavy equipment services).

THULE AIR BASE

Thule AB, located on the northwest coast, is the larger of the two U.S. air bases in Greenland. Equally equipped as Sondrestrom to provide bulk products and support services to field research teams, Thule has often been a staging point for NSF-sponsored projects conducting studies in North Greenland. Moreover, because of its ample hangar space and related services, Thule is often the preferred location to base research aircraft. However, lacking commercial scheduled air service, Thule is more isolated in terms of commercial and governmental services, with charter air services limited to a permanently stationed GreenlandAir Bell 212 helicopter.

Logistical support at Thule is provided to NSF-sponsored projects under the same provisions governing the Sondrestrom ISSA. A separate support document for Thule is still under consideration.

DYE 2 OPERATIONS

PICO established, maintained, and manned a skiway (Figure 2), remote camp as a training facility for the 109th TAG. This facility was located at the closed Dye 2 Station. The skiway was maintained during flight periods at which time the 109th TAG was air supporting the GISP2 project. This is a mobile camp consisting of one 15'x20' weatherport and support equipment. At the end of the season, the camp is transported to and stored in Sondrestrom.

During the 1991 season, PICO supported an effort by the 5099th out of Elmendorf AFB under contract for the 4700th from Langley AFB. This was a contract to remove hazardous materials from the Dye 2 and Dye 3 stations. The project involved the movement of over 40,000 lbs and the transport of ten personnel. Working from May through August, all the hazardous material was removed from the two Dye sites on the Greenland Ice Sheet. The group received support from PICO/Sondrestrom and PICO field support at the Dye sites.

PICO also assisted in winter survival exercises operated by the New York Air National Guard (NYANG) near the Dye 2 location.

The Dye 2 site was also visited by expeditions crossing the Greenland Ice Sheet by dog teams and skis. These expeditions would "stop by" for a welcome break, warm food, and a change in scenery before continuing on to the coast.

GISP2 SITE (Figure 3)

The GISP2 site (N 72° 34' 35"; W 38° 27' 47") was established 22 May 1989, after put-in by the PICO field crew. The exact deep drilling site was located by a PICO survey team using Doppler satellite survey techniques based on coordinates supplied by the GISP2 Science Management Office (SMO). The following facilities and equipment are located at the camp in support of the 1991 field season.

- Flight Service

  GISP2 is served mainly by the USAF Air National Guard, 109th TAG from Scotia, New York. The European camp, GRIP, has also made available their Twin Otter in emergency situations.

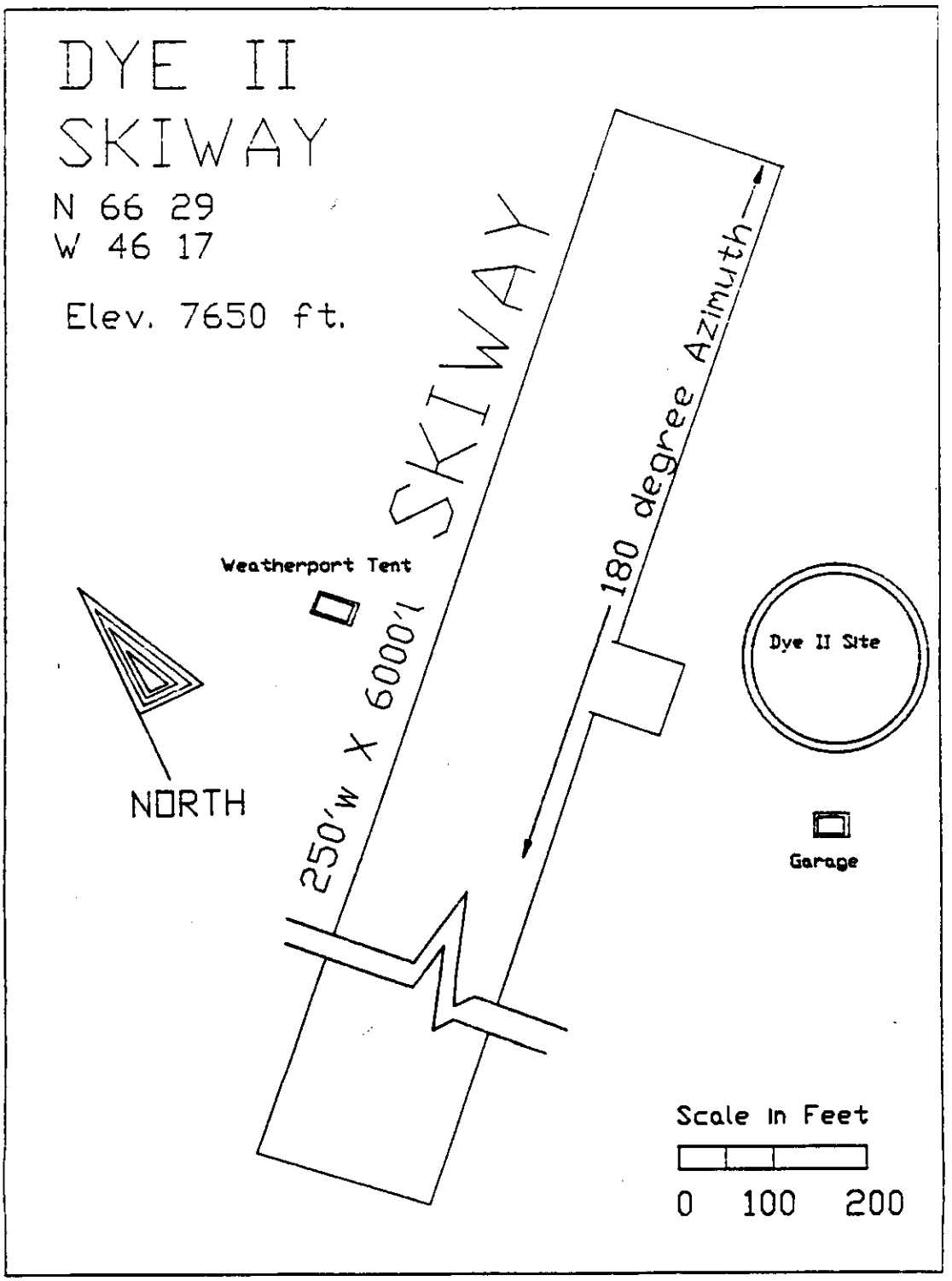

Figure 2. Dye 2 skiway

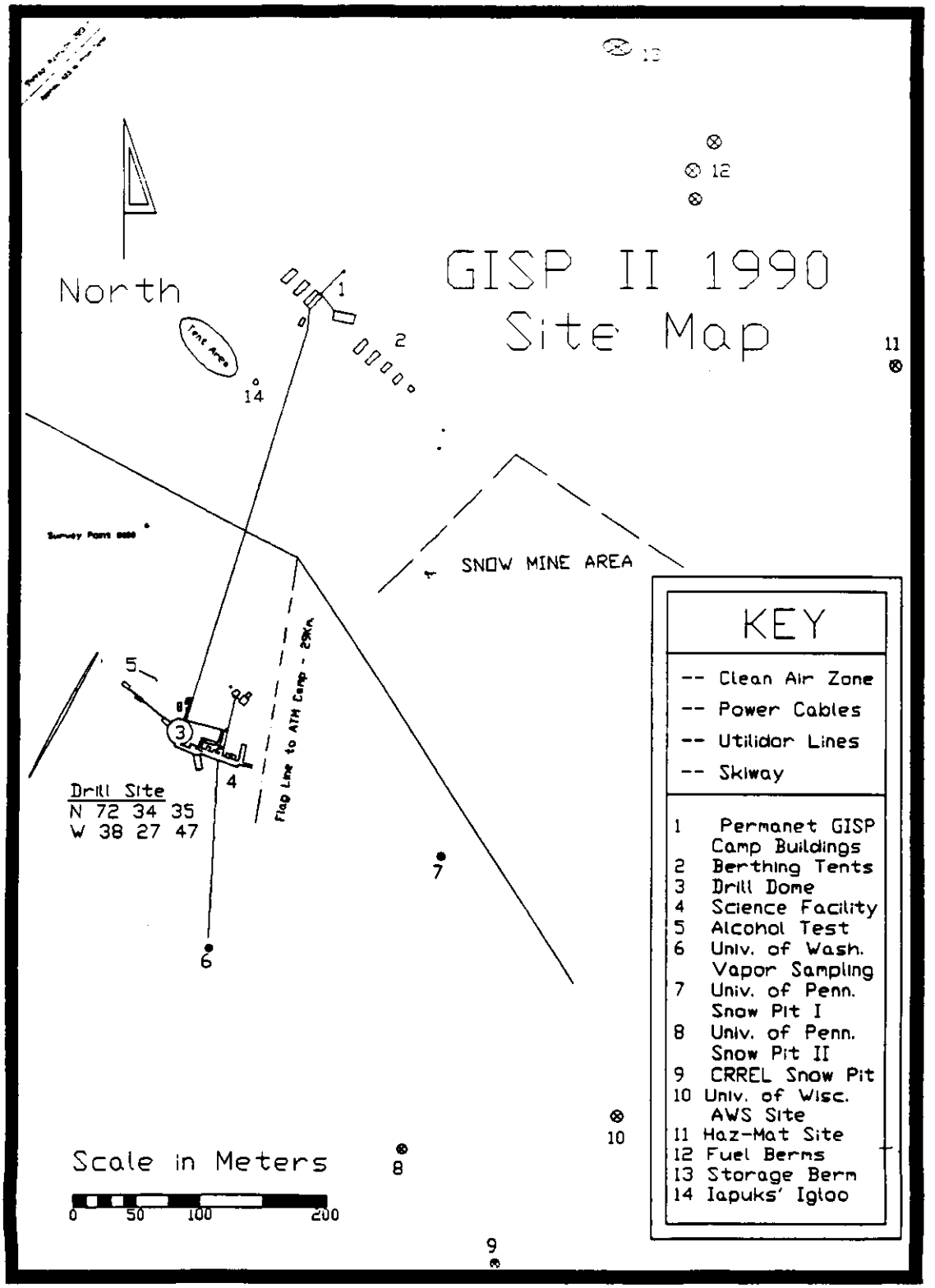

Figure 3. GISP2 1990 site map

- Flight Line

  This is a prepared landing area 200'x 10,000' for skied aircraft. It is flagged and has turn-around areas at both ends plus an 800' diameter turnaround in the middle (Figure 4).

- Permanent Facilities and Structures:

  - The "Big House": This paneled structure 26'x56' stands on stilts about 7' above the snow. This facility is the main hub of the camp where the dining facility, the meeting room, and the PICO camp manager's office are located. There is also a complete bath as well as a washer/dryer.

  - The Bath and Generator Modules: The bath house has a shower, two wash basins, two stools and a washer/dryer. The generator module has two 3116, 90KW Caterpillar generators that power the camp and the drill. Only one generator operates at a time. These modules are placed back to back but have separate entrance doors.

  - The Shop and Storage Module: These are both 15'x30' weatherports and are the only temporary structures that are not dismantled at the end of each season. The storage module is used for food and general storage in the summer season and general camp supply storage in the winter. The shop serves as a work area for the mechanic, the carpenter and the general field assistants. It is also a storage area for many of the general mechanic supplies and spare parts. The snow around them is removed completely down to the base of each structure at the onset of each field season.

  - The Drill Dome: A 52' diameter geodesic dome with a 100' drill tower houses the drill rig and carousel. The dome is interconnected with the trench network by a service elevator that lowers the ice core.

  - The Lab Van: An 8'x32' laboratory where most of the on-site chemistry analytical work takes place. This structure is buried in the snow and connects to the core processing lab (CPL) entrance and snow surface via a snow tunnel.

  - Underground Trenches: There are a number of underground trenches that are maintained during the season and are closed off to the weather during the time the station is closed. The trench network consists of the CPL trench that is 100'x10'x14', a core storage trench that is 32'x12'x28' for storing the core prior to it being processed. There is a trench 60'x12'x12' for storing the processed core at the end of the CPL. There is a trench connecting the drill dome to the CPL, which contains a roller conveyor and a walk-in freezer for holding core while the evaporation of drilling fluid from the core takes place.

- Seasonal Structures: Structures dismantled at the conclusion of each season are:

  - Two 15'x40' Berthing Weatherports: These are for general open berthing during the media and distinguished visitors. They can be quite crowded with up to 16 people in each weatherport. Normal occupancy load is 10 to 12 people.

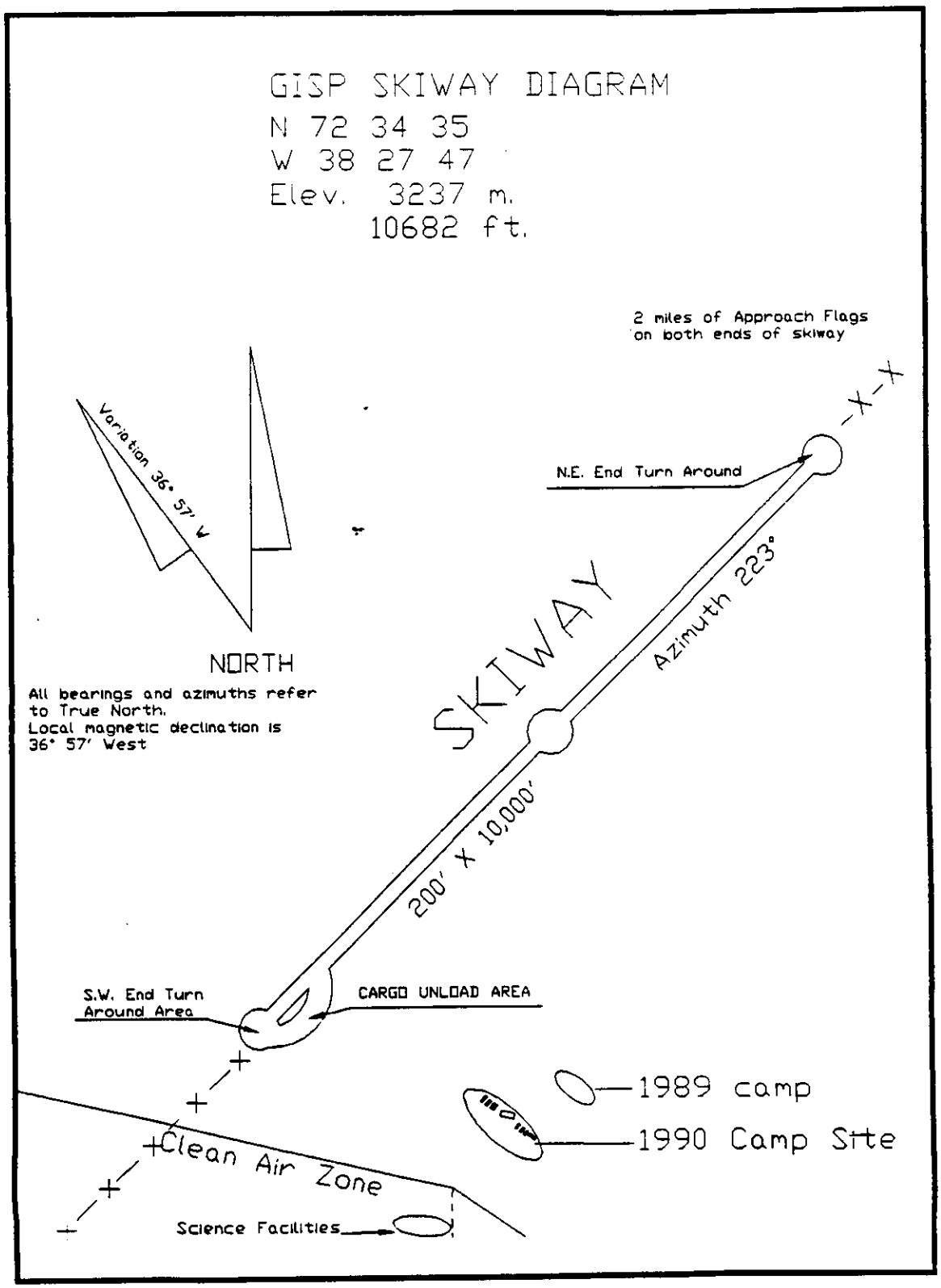

Figure 4. GISP skiway diagram

- One 15'x30' Berthing Weatherport: This structure has been used mostly for those who come for the entire season and houses 6 to 7 people.

- Two 15'x20' Berthing Weatherports: Both are for driller and core handler (day/night) shift workers.

- Tents: There were 22 unheated tents used by different people throughout the season. These were both personal tents and those supplied either by PICO or the Science Management Office. PICO has two Scott tents (teepee type) and six Arctic Ovens (7.5'x7.5'x5').

- One 12'x16' Boonie Barn: These are used for changing rooms for the drillers and core handlers. Their work clothes and boots that may have drill fluid on them are stored here for airing and warmth.

- One 12'x16' Weatherport: This is used to shelter the 4,000-m winch attached to the side of the drill dome.

- One 12'x16' Boonie Barn: An enclosure that protects the prime mover from the weather.

- One 15'x20' Science Weatherport: A computer lab for working on reports and entering data.

- One 8'x12' Uninsulated Weatherport: This serves as a protected area for working on equipment from the trench plus a tool storage facility and is attached to the Science Weatherport.

- One 16'x16' Science Lab Jamesway: Used for analyzing snow and air samples taken from both the GISP2 camp and the ATM, the atmospheric sampling site.

- Vehicles:

Type	Quantity	Use
Scandik SkiDoo	4 ea	Camp use
Cheyenne SkiDoo	4 ea	Traverses and camp use
Alpine SkiDoo	2 ea	Almost exclusively for ATM
Tucker snow Cat	1 ea	Traverses and camp use
Caterpillar 931C	2 ea	Snow moving around camp, loading and down loading aircraft
Sled two-ton	2 ea	Traverses
Maxey Groomer	1 ea	Skiway and flight line grooming

- Fuel Usage:

GISP2 fuel from Sondrestrom

MOGAS	2,741 gal
DFA	12,208 gal
Kerosene	41 gal

1991 GISP2/central Greenland programs fuel consumption

MOGAS	3,351 gal
DFA	27,339 gal

GISP2 on-site fuel inventory

MOGAS	440 gal
DFA	3,869 gal

- Services:

  - Food Services: Three hot meals were prepared each day and two meals on Sunday for approximately fifty people. PICO staff handled all the food preparation and ordering. The menus were made up daily by the staff cooks. Approximately 90% of the food supplies were ordered through the commissary at Sondrestrom AB. A few items including food and household supplies not available from the commissary were purchased from private sources in Sondrestrom and the U.S.

  - Health: A qualified medic was at GISP2 for the duration of the season. The medic provides primary and emergency care to all in camp 24 hrs a day. The medic also interfaces and assists in the camp office with weather, radio communications and the telexes as well as in the kitchen helping with the dishes and general cleaning on a daily basis.

  - Safety: Scheduled meetings were conducted to review camp safety concerns throughout the season. There was an assigned safety officer for the camp and another for the drill area. Full, protective safety gear is worn by those exposed to the drilling fluid or working around the drill tower assembly. Safety training is ongoing throughout the season.

  - Waste: All solid waste was retrograded to Sondrestrom AB. All effluent and gray water is directed to a drilled pit to a depth of approximately 150'. All hazardous waste such as petroleum products, glycol, etc., is sealed in drums, labeled and retrograded to Sondrestrom.

  - Water Production: This was accomplished by melting snow. There is a designated area where snow is mined using the 931 CAT. The snow is then transferred to a melter bin on the south side of the generator module. When melting is completed (melting speed varies with outside temperature), the water is transferred to storage tanks in the bath house and the Big House for future use. The average daily usage was 13 gal per day per person. This daily consumption figure included water for toilets, bathing, clothes washing and cooking.

- Communications: Our main link this season was the telex and high-frequency HF radio. The antenna mast was replaced with a 50' tower that one could climb up and attach antennas and/or weather equipment. The sun spot activity was very high this year, and we were not able to make contact with Sondrestrom for approximately two months with the HF radio. The telex worked very well and was the main method of contact. For local communications, VHF hand-held and base stations were in the Big House and in the vehicles. VHF connected us with ATM and GRIP (both camps were about 30 km away).

- Construction Projects or Upgrades Completed:

  - Portable or Towable 8'x12' Weatherport: This was used for a shop on the back of the Science Weatherport. It was mounted on skis enabling it to be towed with a SkiDoo.

  - 16'x16' Science Jamesway: This was erected on 2' knee walls rendering a more usable structure. Interior walls, shelving and work areas were assembled for scientific equipment and computers.

  - Fresh Air (ATM): This is an atmospheric sampling site located 28 km to the south of the GISP2 camp. It is supported from GISP with respect to food, transportation and construction requests. All food sent to ATM is pre-prepared, bagged and frozen. Upgrades included shelving, seating and storage areas in the 16'x16' weatherport. The zipper door was replaced with a wooden-hinged door, and two additional sky lights were installed.

  - Dog House: This was added to the ATM trench entrances for a safer and easier access to the battery and pump rooms located beneath the surface.

  - Solar Panel Stands: These were assembled and rebuilt at GISP2, reconfigured using only one piece of plywood instead of two sheets.

  - The CPL Entrance: This was connected via a tunnel from the lab van to the CPL entrance, thus allowing access to both places without going outside or having to maintain shoveled pathways.

  - CPL Dog House: Constructed on the snow surface allowing access down to the lab van. This dog house was removable to avoid drifting.

  - Weatherport and Jamesway: These were the initial erections at the camp and were dismantled at the end of the season.

  - Walk-In Freezer: This was enlarged and repositioned to accept additional core. This unit was installed to ventilate the drill fluid fumes from the core to the outside.

  - Compressor: This was installed in the CPL trench along with hose lines leading to separate stations. This was in an insulated box containing a heater to ensure trouble-free starts.

  - Stairway: This was constructed leading to the drillers control booth with a ladder leading on up to the carousel catwalk.

- Relaxation Trench: A new trench was excavated 30'x12'x30' and roofed.

- Core Trays and Racks: Additional core trays and racks were constructed to handle and store the core from the brittle ice zone. This is the core from approximately 350 to 1,200 m and is currently in the relaxation room awaiting processing during the 1992 season.

- Food Trench: The entrance was changed from a ramp to a stairwell with a low profile to avoid drifting. The ramp was covered and groomed flat.

- Storage Units: These were constructed to hold all the metal pieces for each size weatherport. This will be much easier having only one storage unit for each structure.

- Shipping Containers: A variety of shipping containers and crates were constructed for retrograding various items back to CONUS.

- Other Projects: Other projects in which there were no more than 15 man hours per project expended were: installation of the side lab strip doors, blower relocation, gear locker for core handlers, butyl ice chip container and the Science Weatherport shelves and storage racks.

- Traverses

There were two traverses of 150 km each, one to the east and one to the north. On each traverse, a magnetometer and an automatic weather station (AWS) were installed utilizing the same flag line for the first 100 km. PICO employees completed both installations for the AWS and assisted with the magnetometer installations. Each traverse took four days to complete; this included four people, two SkiDoos and four sleds carrying approximately 4,000 lbs of supplies and equipment. The magnetometer installation was for measuring the magnetic flux at a specific location. Each included a data logger that will be downloaded each summer when checking the installation. The two automatic weather stations were the last of six units up-linking data through an ARGUS satellite, which in turn transmits the information to a ground station in the USA.

COMMUNICATIONS

- Telecommunications

The NSF/PICO administrative office at Sondrestrom is serviced by both commercial and USAF telephone systems. These systems provide internal communications within Greenland, including ship-to-shore, as well as long distance service to the U.S. and Europe. NSF-sponsored personnel in Greenland can be accessed as follows:

DSN:	834-1211 Extension 2565
Commercial:	Country Code (299) 11153 (recording) dial Extension 2565 or 2264
Telefax:	Country Code (299) 11127OMNET:PICO.GLOPS
Internet:	FNSEP@ACAD3.Alaska.edu
Telex-Sondy:	(AC: 23, TLX: 7402861, ANS: PICO UC)
Telex-GISP:	(AC: 804, TLX: 493134010, ANS: GISP X)

- High Frequency Single Side Band (HF-SSB)

  At present, PICO maintains an HF radio inventory of six Southcom SC-120 crystallized field radios, and one Southcom SC-130 synthesized field radio. The base station in Sondrestrom is an ICOM M-700 providing base camp communications for GISP2.

  Several efforts have been made to improve HF communications in support of NSF-sponsored programs in Greenland. The most significant improvements were made in 1989 with the installation of new multi-band dipole and trapped vertical antennas in Sondrestrom, and the construction of new field dipole antennas and porta-masts for remote camps. Both the base station and field dipole antennas are configured as inverted Vs erected on a single fiberglass mast. These configurations have provided a remarkable improvement in field communications, especially for camps along the west coast. At the end of the 1990 season an additional multi-band dipole was erected in Sondrestrom for the 1991 season.

- VHF-Band

  PICO continues to maintain both Terra and ICOM VHF-band radios. Each field party is issued a minimum of two VHF-band radios.

- VHF-Land Mobile

  VHF land mobile systems comprised of both hand-held and base station radios make up the "local" network for GISP2 communications. Direct communications are provided between GISP2, the ATM site, GRIP and the Tucker traverse vehicle through 45-watt base stations. Hand-held radios are also available to other projects that require line-of-site communications.

- Emergency Locator Transmitters

  All NSF-sponsored programs are issued Emergency Locator Transmitters (ELT or EPIRB) operating on 121.5 and 243 MHz.

- Satellite Communications

  After successful field trials of the new INMARSAT Standard C format in 1989, a Standard C terminal was deployed at GISP2 to provide store forward telex capability from site. (See #1 Telex-GISP for number.)

- Equipment Upgrades

  Originally planned to be operational for the 1991 season was a dedicated communication system comprised of a PACKET radio and telex. However, this system failed throughout the season and is undergoing testing prior to the 1992 season to evaluate its capability. It was intended to be used for text and non-text data communication.

FIELD OPERATIONS AND LOGISTICS

PERSONNEL IN GREENLAND

Actual personnel days spent were: 1,716 at Sondrestrom AB, 220 at Dye 2, 40 at Dye 3, 4,861 at GISP2, and at remote camps in Jakobshavn, east Greenland and Nuuk, a total of 129, figured as number of persons at each location per day.

AIR OPERATIONS

Air support for the 1991 Greenland field season was provided by MAC Channel, 109th TAG, GreenlandAir Commercial, GreenlandAir Charter, Scandinavian Airlines, Flugverlag Nordlands and the British Antarctic Survey. Air cargo transported nearly 1,000,000 lbs during the 1991 season (Table 5).

- MAC Channel

  The MAC Channel system was used by PICO to support the majority of personnel and cargo transported between McGuire AFB and Sondrestrom and Thule Air Bases.

- 109th TAG (Table 6)

  The 109th TAG provided LC-130 transport to NSF-sponsored projects between CONUS, Sondrestrom, Thule, and GISP. A total of 132 passengers and over 680,000 lbs of cargo were transported by the 109th TAG.

- GreenlandAir Commercial (GLAIR)

  GLAIR flew transient support for coastal operations via regularly scheduled passenger and cargo flights.

- GreenlandAir Charter A/S (GLACE)

  GLACE provided NSF-sponsored projects with both fixed-wing and helicopter support. KingAir support was provided between Sondrestrom and Nuuk. Helicopter charter include Bell 206, Bell 212, and Sikorsky 61.

- Commercial Air and Ship Transport

  SAS and Icelandair provided passenger and cargo movements to both Sondrestrom and Keflavik. Local KNI ship transport was utilized to ship nominal amounts of cargo to coastal villages in support of west coast programs.

- British Antarctic Survey

  Twin Otter air support was utilized by the GRIP Operations Center from 16 June through 3 August between the GRIP camp and Sondrestrom. Through the generosity of GRIP, PICO utilized the Twin Otter to move camp medical staff and emergency equipment between Sondrestrom and GISP2.

Table 5. 1991 Cargo Movement

To Sondrestrom:

170,938	lbs via *Greenwave* (Ship)
55,520	lbs via 109th TAG (New York Air National Guard)
39,816	lbs via MAC (Military Airlift Command)
266,270	lbs TOTAL

From Sondrestrom to Field Locations:

396,143	lbs to GISP
44,210	lbs to Dye 2
10,150	lbs to Crawford Point
450,503	lbs TOTAL

From Field Location to Sondrestrom (RETRO):

118,788	lbs from GISP
51,000	lbs from Dye 2 and Dye 3
2,800	lbs from Crawford Point
172,588	lbs TOTAL

RETRO from Sondrestrom to CONUS:

21,000	lbs science equipment
24,000	lbs PICO drill equipment
20,000	lbs ice core RETRO
65,000	lbs TOTAL

954,361 TOTAL Pounds Transported

Table 6. 109th TAG - Greenland 1991 Flight Schedule

	Dye 2	GISP	GRIP
APRIL			
Arrive 13th	Open 14th	Open 15th -18th	
Leave 19th	↓	3 Flights	
MAY		↓	
Arrive 6th	Training	3 Flights	Open 14th
Leave 11th			2 Flights
Arrive 12th		Begin Drilling	↓
Leave 18th		↓	
Arrive 19th			
Leave 24th	↓	↓	↓
JUNE			
Arrive 3rd	Training	3 Flights	2-3 Flights
Leave 8th	Out to Sondy		
Arrive 24th	Training	2 Flights?	?
Leave 28th	Training	↓	↓
JULY	↓		
Arrive 22nd	Training	3 Flights	2 Flights
Leave 28th	Back into Dye	↓	↓
AUGUST	↓		
Arrive 12th	Close 17th	3 Flights	Close
Leave 18th		↓	15th - 17th
SEPTEMBER			
Arrive 9th		4-5 Flights	
Leave 15th		Close	

SHIP OPERATIONS - SEALIFT

A total of 170,938 lbs was transported to Sondrestrom in 1991 through the WPLO (Water Port Logistics Office), Bayonne, New Jersey.