

U.S. Department of the Interior
National Park Service

DRAFT

**Snowpack Monitoring Protocol for the Central Alaska Network
Denali National Park and Preserve, Yukon-Charley Rivers National Preserve,
and Wrangell-St. Elias National Park and Preserve**

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Important Note: This Snowpack Monitoring Protocol consists of this Protocol Narrative and the following Standard Operating Procedures (SOPs):

- SOP 1: Initiating Compliance and permitting
- SOP 2: Acquiring equipment for sites
- SOP 3: Installing a Snow Course
- SOP 4: Install an Aerial Snow Marker
- SOP 5: Preparing for the Field Season
- SOP 6: Collecting Data
- SOP 7: Maintaining the Snow Survey Sites
- SOP 8: Data Management
- SOP 9: Reporting
- SOP 10: Revising the Protocol

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Supplementary Materials**Appendix A.** List of Snowpack Monitoring Sites**Appendix B** Natural Resources Conservation Service**Appendix C.** Agreements CAKN Climate Site Evaluation Review Document 2004**Appendix D.** Map of Snowpack Monitoring Locations

This document is the narrative for the Snowpack Monitoring Protocol for the Central Alaska Network (CAKN). The narrative explains the rationale for monitoring snowpack and sets forth the objectives. The narrative discusses how snowpack will be monitored, a history of protocol development, and the inherent tie of this protocol to the CAKN Climate Monitoring Protocol. The CAKN Snowpack Monitoring Protocol has been developed based on a partnership with the Natural Resources Conservation Service (NRCS) who have a well established network of snow monitoring sites around the state of Alaska. This narrative will describe the sampling techniques of the NRCS program that have been adopted by the CAKN program and provide an overview of the standard operating procedures required to implement snowpack monitoring and report findings.

I. Background and Objectives

Issue being Addressed and Rationale for Monitoring Snowpack

Climate, by determining the temperature and precipitation regimes for any ecosystem, is widely recognized as one of the most fundamental drivers of ecological condition. A predominate feature of climate in high latitude regions is the presence of a seasonal snowpack. The snowpack is a major influence on hydrology, vegetation, and faunal communities (*Jones et al.*, 2001). Accordingly, the CAKN identified climate, and snowpack--as the dominating feature of the regional climate--as an important Vital Sign (*MacCluskie and Oakley*, 2003). Although snowpack is inherently related to climate the sampling methods for monitoring snow vary enough from those of climate monitoring to warrant a separate protocol. This protocol will focus on the programs jointly operated by the National Park Service (NPS) and the Natural Resources Conservation Service (NRCS). For information on climate monitoring within the CAKN please refer to the Climate Monitoring Protocol (*Sousanes*, 2004)

One of the most important outcomes of the winter climate of the subarctic is the creation of a snow cover. This snow cover protects and insulates the ground and low-lying plants, reduces desiccation, and maintains ground temperatures that range from 5° to 30°C higher than air temperatures. Active-layer thickness and spring snowmelt run-off, often the peak discharge of the year, all depend on the amount and distribution of the snow. (*Olsson, et. al.*, 2002). This seasonal snow cover, lasting up to eight months out of a year, is an important ecological factor for subarctic ecosystems. In the subnivean world, organisms and soil rely on the insulating capacity of snow for heat retention. This insulating capacity of the snow is determined by its depth and density. Snow cover dynamics and duration are controlled by physical metamorphism, phase changes, and chemical transformations, which themselves are driven by interactions with atmospheric and soil systems and plant and animal communities. (*Jones, et al*, 2001).

Snowpack information provides additional understanding of a large number of natural resource processes within the park including wildlife population density, birth survival rates, and herd movements. Larger animals exposed to conditions above snow must adapt their behavior, feeding habits and morphology accordingly, while smaller animals may be below, within or sometimes on the snow cover. Snow affects the plant species and ecosystem processes of numerous biomes including the boreal forest and tundra biomes prevalent in the CAKN. Snow has long been recognized as the single most important variable affecting the patterns of vegetation of alpine regions. At the plant level, the presence of a winter snow cover offers plants protection against frost damage, dehydration, and physical damage from wind and windblown particles (*Wardle*, 1968; *Tranquilini*, 1979). Changes in the extent, duration, and character of the seasonal snow cover can cause shifts in landscape processes. Therefore, strategic deployment of snowpack monitoring sites, along with climate stations with snow depth sensors (described in the CAKN Climate Monitoring Protocols), will provide data not heretofore available on the climate patterns in the

parks, which is necessary for understanding changes in the freshwater and terrestrial plant and animal communities. Snowpack data from the CAKN will contribute significantly to the understanding of Alaska climate by filling in some of the gaps in the existing multi-agency snow monitoring network, and by contributing accurate measurements of year-round precipitation.

Information on the depth and density of snow cover in NPS units is also useful for park managers who are tasked with making determinations of adequate snow cover for snowmobile use within park boundaries. Snowpack Monitoring sites offer quantitative data to managers on park wide snow cover conditions.

Development of Snowpack Monitoring

The Snowpack Monitoring Protocol was initially developed as part of the Climate Monitoring Protocol. Although snowpack is inherently part of climate, the methods for measurements were different enough that when it came time to writing protocols combining the two became confusing and overwhelming. The two monitoring efforts were separated in order to organize the different methodologies and to make each program as clear and concise as possible.

The conceptual models discussed in both the Central Alaska Network Vital Signs Monitoring Plan, Phase I Report (MacCluskie and Oakley, 2002) and Phase II Report (MacCluskie and Oakley 2003) are integral to understanding the complexity of elevational and latitudinal gradients within the parks. The CAKN encompasses strong climate gradients, from the maritime climates in the southern parts of Wrangell – St. Elias National Park and Preserve (WRST) where it borders the North Pacific Ocean, to the strongly continental climates found in northern parts of Denali National Park and Preserve (DENA) and Yukon –Charley Rivers National Preserve (YUCH). These climate gradients are intrinsic to the ecosystem patterns, and vegetative and faunal communities found in CAKN parks. Snowpack depths and densities vary among these gradients with deeper snowpacks in the southern extents of Wrangell – St. Elias and Denali south of the major mountain ranges and closer to the ocean influences, and lower snowpack depths in the subarctic interior. Snowpack is affected by microclimate influences more so than any other climate element. Wind deposition, scoured areas, slope aspects, and vegetation presence have a strong influence on the nature of the snowpack in any given area within all of the climatic gradients. This variability makes the extrapolation of snowpack measurements from one location to the next difficult.

Records of precipitation are especially important to documenting climate and understanding climate effects on ecosystems, but measuring precipitation, where most of the precipitation comes in the form of snow, and where it is windy, is technically quite difficult. While rainfall in summer is relatively easy to measure the transitional fall and winter precipitation events and the snowfall in winter are difficult to measure accurately, especially when a station is remote. Total annual precipitation is often greatly underestimated, and comparisons of precipitation patterns among years are difficult because estimates are biased. It has been well documented that wind-induced gauge undercatch of precipitation, among other known systematic errors, is the greatest source of bias in precipitation observation (*Yang et al*, 1999). To reduce the wind induced undercatch various types of shields, such as Nipher, Alter and Wyoming, can be used depending on the location and wind exposure.

Because of the inherently difficult task of accurately recording year round precipitation, and because a robust network of snow monitoring sites currently exists in the state of Alaska, the CAKN Snowpack Monitoring Protocol was developed in coordination with the Alaska Natural Resources

Conservation Service (NRCS). The NRCS installs, operates, and maintains an extensive, automated system to collect snowpack and related climatic data in the Western United States called SNOTEL (for SNOwpack TELemetry). The system evolved from the NRCS Congressional mandate in the mid-1930's "to measure snowpack in the mountains of the West and forecast the water supply." The programs began with manual measurements of snow courses; since 1980, SNOTEL has reliably and efficiently collected the data needed to produce water supply forecasts and to support the resource management activities of NRCS and others. The NRCS network complements the objectives of the snowpack monitoring program and provides opportunities for snow and climate data collection. The NRCS network also consists of snow courses and aerial snow markers.

The Snow Monitoring Protocol for CAKN was built on the existing foundation of snow monitoring found in all three of the CAKN parks. Snow survey sites were added to Denali as part of the Long-term Ecological Monitoring Program (LTEM) between 1993 and 1995. Snow monitoring sites were added to Wrangell-St. – Elias in 1993 and in Yukon –Charley in 2002. There are some existing sites, generally just outside park boundaries that have been in operation since 1980 or earlier. Additional long term information was available from the daily snowfall amounts recorded at National Weather Service Cooperative Weather Stations located in and near the park boundaries. The CAKN snow monitoring effort will add to this existing array of sites and continue to add more in order to refine the knowledge of variability of snow gradients across topographical gradients.

The development of the CAKN snowpack monitoring program, in conjunction with the climate monitoring protocol development took approximately two years, and included scoping workshops, regular meetings, site evaluations, documentation, and external reviews. The table below outlines the major milestones of the monitoring protocol development to date; italicized text indicates the item was a LTEM function prior to the formation of CAKN, but critical to the development of the program. This table is almost identical to the table outlining the development of the Climate Monitoring Protocol since the two components were developed simultaneously and involved many of the same processes.

Table 1 Milestones of the CAKN Snowpack Monitoring Program

Task/Action/Event/	Date	Outcome
<i>Denali Long –term Ecological Monitoring (LTEM) Weather program at Denali</i>	<i>1993-2001</i>	- <i>Development of weather monitoring protocols at watershed level, including snow measurements</i> - <i>Agreement between NPS and SCS signed in 1995 to cooperate on snow surveys</i>
<i>Denali LTEM meetings</i>	<i>October/November 2001</i>	- <i>Developed conceptual model of physical environment –Snowpack (and climate) came across as primary driver of ecosystem dynamics.</i> - <i>Expand spatially to determine how average climatic conditions vary throughout the park, and to provide a baseline from which to measure future climatic shifts affecting the Denali ecosystem.</i>
CAKN Scoping meeting	April 2002	- Presented physical monitoring strategy, including climate and snow monitoring, developed from Denali LTEM work and physical science staff work sessions. - Panel of experts convened to address sampling design and strategy for snowpack monitoring (as well as other physical components).
Integration of Denali	June 2002	- Synthesis report completed on snow monitoring at

LTEM program and CAKN		Denali, including recommendation for future monitoring efforts.
Equipment purchased for snow courses, aerial snow markers, and ultrasonic distance sensors for automated snow measurements	September 2002	- Data on physical science environment desired by all subject areas – CAKN technical committee prioritized these needs first.
Physical Science work group meeting	November 2002	- Discussions on instrument installation, additional equipment needs, snow monitoring ideas beyond traditional snow surveys, sampling frequency, sampling units, and equipment standards
CAKN Vital Signs Monitoring Plan Phase I Report Completed	December 2002	- Introductory and background material on CAKN, including goals and preliminary objectives, overview of existing information, development of plan, and conceptual models.
NOAA Climate Reference Network Workshop	March 2003	- NOAA presented background information on Alaska's climate (PRISM and ANUSPLIN) climate models and discussed ideas and asked for comments regarding implementation of network in Alaska. Measuring year-round precipitation discussed.
Installation of climate station "test farm" at Denali	May 2003	- Set-up new stations near Denali park headquarters to develop designs for added instrumentation, including ultrasonic snow depth sensors, work out programming bugs, and familiarize personnel with instrument nuances.
Site visits	June-August 2003	- Visited over 40 potential sites in DENA, WRST, and YUCH.
Site Evaluation Document	September – December 2003	- Compiled all site visit documentation into report titled, "Climate Monitoring Site Evaluation 2004". Report included site descriptions, photos, and location maps, as well as a summary of existing climate stations.
Site Evaluation review	January – March 2004	- Solicited substantial review of site evaluation from climate experts. Met individually with five review panels to present and discuss the climate monitoring program development, including Rick McClure at NRCS.
Final site evaluation document	May 2004	- Final report on site evaluation process with reviewer's comments and list of prioritized sites. Report also includes substantial background information on existing sites.
Climate Protocol Development Summary	June 2004	- Short summary on monitoring approach, objectives, schedule, budget and products. Climate and Snowpack combined in development summary.
Initial equipment deployment	June – September 2004	- Installed 2 new sites in WRST

Protocol Development	September – November 2004	- Start to develop protocols for the climate monitoring program, including snowpack
Protocol Development Take 2	October 2004	-Separate Climate and Snowpack protocols due to different approaches to monitoring.
Protocol review	December 2004 - ??	- Review of protocols

Snowpack Monitoring Objectives

A main objective of snowpack monitoring program is tied directly to the climate monitoring program objective, which is to monitor and record weather conditions at representative locations in order to quantify one of the drivers in Alaskan ecosystems, identify long and short-term trends, provide reliable climate data to other researchers, and to participate in larger scale climate monitoring and modeling efforts.

Specific monitoring goals for snowpack monitoring are:

1. Record long term trends in snowpack by engaging in an interagency agreement with the Natural Resources Conservation Service (NRCS) to place snow courses, aerial snow markers, and recording precipitation gauges (as part of the SNow Telemetry (SNOTEL) network) in all three parks. The SNOTEL sites have proven to be the most accurate instrumented sites to document all forms of precipitation in Alaska, including the elusive snowfall amount. *Justification: NRCS has a well designed system in place for recording year-round precipitation and these stations can easily be placed at carefully selected locations within the network. Additional snow course and aerial snow markers will augment the fully instrumented sites. The initial plan is to place 2 SNOTEL sites in WRST, 2 in DENA, and 1 in YUCH. Monitoring snowpack might be further enhanced in future years to include remote sensing to assess the general snow cover on a larger spatial scale and the installation of cameras at selected existing snow course sites to document snow on/off dates.*
2. Monitor snowpack depths at existing climate stations in CAKN by adding ultrasonic distance sensors to the automated stations. *Justification: Automated snow depth measurements can be made at all existing automated climate stations by adding a sensor. The investment is small, but the outcome is substantial, resulting in daily information of snowpack conditions at representative sites around the network.*
3. Maintain the integrity of existing National Resource Conservation Service (NRCS) sites and National Weather Service sites with long-term snowpack and precipitation records. *Justification: Long-term records are valuable data resources that will play a critical role in determining status and trends of CAKN ecosystems in the first decade of the program. Every effort should be made to preserve these datasets and add to them indefinitely.*
4. Evaluate the influence of local and global climate cycles on resources within the ecosystem. *Justification: The CAKN has prioritized the need to monitor the potential of global climate change and climate patterns to influence species and ecosystems within the parks. The existing long-term dataset at a number of NRCS and NWS sites in and around DENA, WRST, and YUCH offer a substantial history and a head start toward meeting this objective, additional stations will provide*

more information in the remote areas that lack basic data. These sites, once established, will provide critical climate information with the intent of operating undisturbed for the next 50-100 years.

II. Sampling Design

Existing Suite of Information

There are 31 SNOTEL sites and 200 snow course and precipitation gauges (both NRCS and NWS) in operation around Alaska. Many of these sites are located in or adjacent to the parks of the Central Alaska Network. These sites are listed in Appendix A, “List of Snowpack Monitoring Sites”. It will be a priority for the network to ensure that sites with long-term records continue to operate indefinitely so that valuable datasets are not compromised. These stations are part of larger network with existing operating procedures and protocols. As part of the Central Alaska Network they will continue to operate under the same guidelines.

The National Weather Service (NWS) cooperative observation stations are manually operated sites that collect daily snowfall information. These sites are located near cities, towns, villages, and some remote sites that have caretakers. These sites offer the longest records of snowfall in the state. There are a number of these sites located within and adjacent to the three parks in the network. These records are extremely valuable for detecting changes within an ecosystem, and relating current snowfall values with 80 – 100 year records for detecting trends.

Critical Partnership for Snowpack Monitoring

In order to accurately measure year-round precipitation and snowpack CAKN will work cooperatively with the NRCS. NRCS has a robust program in place which includes annual maintenance of sites and data quality control and quality assurance as well as internet data dissemination. NRCS has worked with the National Park Service (NPS) for years with snow courses and aerial snow markers and have recently engaged in an interagency cooperative agreement to install SNOTEL sites within the three CAKN parks. In order to best record changes in precipitation over the next 50-100 years a robust program with proven methods seemed necessary. Measuring accurate precipitation in Alaska has been a challenge, especially when the gauges are remote. The NRCS network has overcome many of these challenges. In addition to the SNOTEL sites the three parks will continue to work with the NRCS to survey the existing snow courses and aerial snow markers. The NRCS Agreements for the installation of one SNOTEL site, a five-year maintenance agreement between NRCS and NPS, and an example of a 10 year agreement to cooperate on snow surveys is included as Appendix B, “Natural Resources Conservation Service Agreements”. The success and longevity of this program is dependent on these agreements. They will need to be re-established every 5-10 years depending on the language of the existing agreement.

Site Selection

New sites will be selected based on an evaluation process completed in 2004, and included as Appendix C – Climate Site Evaluation 2004. This document evaluated potential climate and snowpack monitoring sites for the network. Briefly, new sites will be selected based on a list of criteria developed by NPS staff based on recommendations of NPS scientists and NRCS experts. The original site selection for the Central Alaska Network process took 2 years for planning, evaluation, documentation, and review. Additional sites were identified through this process that could be added in future years as the budget and

staffing requirements permits. Maps showing the locations of the new sites selected are in Appendix D, “Snowpack Monitoring Locations”. Standard Operating Procedure (SOP) #1, “Initiating Compliance and Permitting” addresses the issue of permitting and compliance within NPS guidelines. New sites require an internal park review. The permitting and compliance for each park is currently handled separately by each park.

The objective of site selection is to find locations where snowpack redistribution is insignificant or relatively minor. Often a combination of terrain, forest and/or dense brush can produce the desired effect. Locations where snow scouring, loading, and/or drifting occur should be avoided. The measurements are likely to be more associated with how much the wind blew rather than how much snow fell. The CAKN topography puts much of the area under study above treeline and therefore in areas where the wind will indeed blow. We are experimenting with a number of sites at higher elevations that are in protected cirques or in other protected high elevation areas.

For aerial snow marker placement the sites must be near readily distinguishable terrain features in order to be easily located from the air. Most important is the consideration for safe airplane operations. There needs to be room for a safe low-elevation approach and recovery, plus plenty of turn around room for a second fly-by.

Parameters being monitored

The parameters measured depend on the level of instrumentation at the site. The CAKN snowpack monitoring program up to this point is based on the existing NRCS nested tiered system. The most intensive is the NRCS SNOTEL site which includes a climate station that measures air temperature, relative humidity, solar radiation, rainfall, snow depth, and wind speed and direction, as well as a year-round recording precipitation gauge that measures both rainfall and snowfall. The next level of monitoring is the NRCS snow course which is visited once a month from November through May to determine the depth and density of the snow across a five point transect. The least intensive monitoring is an aerial snow marker, which is also the most efficient monitoring tool. This requires a flight via fixed-wing aircraft on the same frequency as snow course monitoring. The depth of the snow is determined by observing the snow depth on a permanent marker of known height. The CAKN climate monitoring stations and the Remote Automated Weather Stations (RAWS) located within the three parks will be equipped with snow depth sensors which will provide real-time snowpack data as part of those programs.

SNOTEL Sites

Each SNOTEL station will include a 10' tripod with meteorological sensors attached, a rocket type year-round precipitation gauge and a small shelter (4' x 4' x 8') with a 20' tower attached for a solar panel and telemetry antenna. The precipitation gauge would be constructed from irrigation pipe with a pressure transducer in the bottom of the device. The gauge will have an Alter shield attached to the top. A mixture of propylene glycol would be used in the reservoir to melt the falling snow (the glycol and precipitation would be contained in the system). The shelter will sit on 16" x 16" concrete pads at each corner. The precipitation gauge will also be anchored on a 16" x 16" concrete pad. The precipitation gauge height would be 2-3' above the average snow depth. The equipment will be painted brown to blend in as much as possible with the surroundings. Figure 1 shows an example of a SNOTEL site at Coldfoot, Alaska located on the southern slopes of the Brooks Range. Individual site specifics, including maximum annual snowfall, will ultimately determine the final design of the station. Data from aerial snow markers in the area will be

used to determine the height of the gage. At least 3-4 years of data are necessary to determine the gauge height.



Figure 1 Example of SNOTEL site at Coldfoot

Snow Courses

Snow surveys in the West date back to around 1906, when the University of Nevada's Dr. James Church laid out the first western snow course. Dr. Church also invented key sampling procedures and equipment. These manual surveys require two-person teams to measure snow depth and water content at designated snow courses. A snow course is a permanent site that represents snowpack conditions at a given elevation in a given area. The snow course is generally a 100' long transect with five sampling points. The information collected for the snow surveys includes snow depth, length of snow core, and sample weight. Snow density and snow water equivalent (SWE) are calculated from the collected data. Figure 2 shows an example of a snow course within Denali National Park and Preserve.



Figure 2 Example of Snow Course at Stampede, Denali, AK

Aerial Snow Markers

An aerial marker is essentially a one-point snow course. An aerial marker consists of a vertical support or post to which crossbars are attached at predetermined intervals (see Figure 3). An aerial observer counts the cross pieces on the marker and draws a line across the diagram on the field data sheet. Observing snow depth markers from low flying aircraft provides a means to rapidly collect snow depth at many points in a watershed. Reading aerial markers is a comparatively safe and rapid method of collecting snow data over a wide area at minimum unit costs. A number of aerial markers can be observed in the time required for one ground measurement. The snow water equivalent is calculated by the Snow Survey Data Collection Officer by multiplying snow depth by the estimated density. The density at the marker is determined by comparing the density of that course with the density of another course that has a concurrent record of ground measurements near the same dates. The snow course selected should be as comparable as possible in elevation, aspect, exposure, snow depth, and density. Ten or more satisfactory comparable density measurements are required.



Figure 3 Example of an aerial snow marker

II. Deploying Snowpack Monitoring Sites and Conducting Surveys (Methods)

In this section of the narrative we provide an overview of how snowpack monitoring sites are deployed and operated. The description includes the equipment that is needed for each type of site, the survey methods, and maintenance requirements.

Equipment Purchase

Equipment has been acquired for the CAKN Snow monitoring program for the three levels of monitoring described above. Campbell Scientific, Incorporated (CSI) research-grade meteorological instrumentation is being used for the CAKN climate monitoring stations. The CSI equipment used in the standard climate station set-up will also be used at the intensive SNOTEL sites to record the meteorological parameters (air temperature, relative humidity, wind speed and direction, precipitation, and snow depth). SOP #2, “Acquiring Equipment for Sites” identifies the details of equipment procurement for SNOTEL sites, snow courses, and aerial snow markers acquired by NPS for this program. The additional equipment for the intensive SNOTEL site is provided by NRCS according to the terms of the 2004 agreement. The equipment list could potentially change with the initiation of another agreement.

Equipment Deployment

The deployment of a SNOTEL site will take place under an individual NRCS agreement. NRCS staff and technicians along with NPS personnel will jointly install the SNOTEL site under the guidelines provided by the NRCS.

Deployment of snow courses and aerial snow markers will be done by NPS staff. NRCS Guidance on the placement of the sites will be sought before the equipment is installed. The equipment necessary for

a snow course installation involves five brown Carsonite markers and a yellow placard used for signing the site. The tools used for installation of a snow course and the details outlining the process are described in SOP #3, “Installing a Snow Course”. An aerial marker site requires a steel pipe with attached metal crossbars. The details of an aerial marker installation, including the engineering drawings that describe the specifications for a 10’ or 12’ aerial snow marker are included in SOP #4, “Installing an Aerial Snow Marker”.

Snow Survey

In November the NRCS will circulate a schedule to prepare surveyors for the upcoming season. This will list the snow course you are responsible for as well as the sampling frequency that is proposed. It also advises you to check on your snow sampling equipment prior to the start of the field season. SOP# 5, “Preparing for the Field Season” describes this process. It also describes the list of survival equipment that will be necessary on all snow survey field trips. Manual snow surveys require two-person teams to measure snow depth and water content at designated snow courses. A snow course is a permanent site that represents snowpack conditions at a given elevation in a given area. Generally, the courses are about 100 feet long and are situated in small meadows protected from the wind. The sampling window for snow surveys attempts to capture the conditions of a snowpack for the first of the month during the winter months from December through May. SOP #6, “Collecting Data” describes the methods for surveying snow courses and aerial snow markers. Methods for the Alaska Cooperative Snow Survey are presented in the Snow Survey Sampling Guide (Handbook No. 169) available in hardcopy from the Natural Resources Conservation Service in Anchorage, AK. Data sheets for the surveys are provided by NRCS

Each park and adjacent land owner follows different protocols or guidelines for flights within their jurisdiction. All proper protocols need to be followed. Make all logistical arrangements well before the trip is scheduled to take place. This will require inquiries as to the conditions of remote airstrips, fuel locations and availability, potential hazards, required OAS training, the required Personal Protective Equipment (PPE). On the day of the trip, flight plans should be filed with the appropriate authority involved whether it is the park communication center or the Federal Aviation Administration.

Maintenance and Calibration

Although the SNOTEL systems are automated they need human oversight and continued attention to provide the quality of data that will be useful to a long term climate record. The NPS has entered into a five year agreement to maintain the first SNOTEL site that will be installed in Kantishna in Denali National Park, AK in June of 2005. The maintenance agreement is included in Appendix D, “NRCS Maintenance Agreement”. Each additional SNOTEL sites installed in the CAKN parks should also include a separate maintenance agreement.

The snow courses and aerial markers should be maintained as necessary, which might require brushing of the snow course or marker, repainting the markers and periodically replacing equipment when necessary. The Carpenter snow tubes used for sampling the snow courses can be sent to NRCS for calibration and refurbishing. This should be done well in advance of the first sampling date at the end of November. If it is necessary to purchase additional snow tubes contact NRCS to request information on where they are currently purchasing the equipment. The snow tubes procured for CAKN were custom made at Carpenter Machine Works, Inc. located in Seattle, Washington. The details for maintaining the sites are described in SOP #7, “Maintaining the Snow Survey Sites”.

IV. Data Management

Data Collection

The monthly snow survey datasheets from the snow courses and the aerial snow markers are faxed to the data collection officer at NRCS within the first three days of the month from December through May. The original data sheets are also sent to the same office in a timely manner. Copies from the fax transmission are stored onsite at each park as backup. The data are processed in Anchorage and posted and available at http://www.ambcs.org/pub/sc_sum_ak/. See SOP #8, "Data Management" for a description of this process.

The data collected from the NRCS SNOTEL sites and manual snow surveys are either transmitted via meteor burst technology or sent in to the NRCS Anchorage office. SNOTEL uses meteor burst communications technology to collect and communicate data in near-real-time. VHF radio signals are reflected at a steep angle off the ever present band of ionized meteorites existing from about 50 to 75 miles above the earth. Satellites are not involved; NRCS operates and control the entire system. Sites are designed to operate unattended and without maintenance for a year. They are battery powered with solar cell recharge. The condition of each site is monitored daily when it reports on 8 operational functions. Serious problems or deteriorating performance trigger a response from the NRCS electronic technicians located in 6 Data Collection Offices. The SNOTEL sites are polled by 2 master stations operated by NRCS in Boise, Idaho, and Ogden, Utah. A central computer at NRCS National Water and Climate Center (NWCC) in Portland, Oregon controls system operations and receives the data collected by the SNOTEL network.

All data are received by the SNOTEL central computer, which in turn is linked to the Centralized Forecasting System (CFS) in the NWCC where data can be accessed. Once on CFS, the data are in a relational database, where various analysis and graphics programs are available. Current and historical data and analyses are available by dialing in to the CFS, by disk or tape media, paper copy, or more recently via NWCC homepage and internet. These data are available at <http://www.wcc.nrcs.usda.gov/snotel/Alaska/alaska.html>.

Data Quality Assurance/Quality Control

NRCS provides the data verification and validation through system operations in Portland, Oregon. The data verification and validation for the manual snow surveys is provided by the NRCS Data Collection Officer in Anchorage, Alaska.

Metadata Procedures

Metadata is the responsibility of both the snowpack monitoring personnel at each park and the NRCS data collection officer. Complete documentation of the site is required including; details on the location, aspect, elevation, method of transport needed to access the site, site equipment, and site description. This information is forwarded to the NRCS office in Anchorage where it is compiled and archived. Site photos are filed with the program manager under the program file format described in the CAKN Data Management Protocol 2002 (Wilder, 2004).

Data Archive

It is imperative that the snowpack data are assimilated into national databases so that these data can be accessed by the public. All snow monitoring data will automatically be archived with the NRCS, the Western Regional Climate Center (WRCC) and the National Climatic Data Center (NCDC). WRCC and NCDC can automatically upload the files from the SNOTEL system for archiving purposes NRCS has an existing database and web site for data archiving, data security, dissemination and database design.

V. Analysis and Reporting

Analysis

The Natural Resources Conservation Service (NRCS) has operated the Federal-State-private Cooperative Snow Survey Program in the western United States since 1935. Utilizing a network of automated SNOTEL (SNOpack TELemetry) data collection sites, manual snow course and storage precipitation gauges, NRCS collects, analyzes, and manages snowpack and climatic data in support of water supply forecasting and other resource management activities. The current network consists of approximately 800 active snow courses. NRCS provides the data verification and validation, as well as data summary, analysis and reporting. NRCS has an existing database and web site for data archiving, data security, dissemination and database design. Automated data charts and reports are available for the public at the following website: <http://www.wcc.nrcs.usda.gov/snow/snotel-reports.html>. The data network products include basin snow water content maps, aerial extent of snowcover, daily and weekly reports and graphs on all parameters, Water year graphs, snow equivalent reports and graphs. These data are also posted at the Western Regional Climate Center at <http://www.wrcc.dri.edu/snotel.html>.

Reporting

NRCS produces monthly basin reports from December through May which include the compilation of Alaska statewide data by basin and a general overview of snowpack, precipitation, and temperature conditions related to a 30-year normal. The three CAKN parks fall within the Matanuska-Susitna, Tanana, Copper River, Central-Yukon, and Upper Yukon basins. NRCS also produces a report titled *Alaska Annual Data Summary Water Year XXXX*. This report summarizes the snow water equivalent and precipitation data collected during the current water year. Copies of both of these reports are sent to the parks where snow survey operations occur. They are also available from NRCS in Anchorage at 510 L Street, Suite 270, Anchorage, Alaska, 99501-1949.

In addition to the NRCS report, Denali National Park and Preserve has reported annually on the snow conditions within and just outside park boundaries. Appendix E is included as an example of an annual report for snow monitoring. This level of reporting will continue to occur, however it will include all parks in the network and not only Denali. The program manager will need to contact the personnel at the other parks that will collect the snow survey data for the winter to get an account of which surveys were completed, why some were not, verification that the data in the NRCS files are correct, and any other observations that would be useful in an annual report. SOP #9, "Snowpack Monitoring Reporting" will address the procedures for an annual summary report for CAKN snowpack monitoring.

VI. Personnel Requirements and Training

Roles and Responsibilities

The Principal Investigator (PI) is the climate monitoring specialist at Denali and the lead for implementing this monitoring protocol. The position is supervised by the Physical Scientist at Denali National Park and Preserve. Because of the cooperative nature of snowpack monitoring, the data collection officer for the Natural Resources Conservation Service will play a primary role in the installation and the yearly maintenance of the equipment. It will be the role of the PI to work closely with NRCS to ensure data continuity. Monthly maintenance checks will be performed by the project manager during the routine monthly snow surveys. The data management aspect of the monitoring effort is the shared responsibility of the PI and the NRCS data manager. The PI is responsible for verifying that the data from the CAKN sites is being incorporated into the national system.

The PI and park staff at WRST and YUCH will play a primary role in the snow course and aerial snow marker monthly survey. The PI or staff involved in the survey is responsible for the logistics of each monthly survey including the coordination of aircraft availability to coincide with the data collection window. It is the responsibility of the survey personnel to know the position of the sites and be able to guide the pilot to the locations. Some of the sites are only accessible by skis or snowshoes. The personnel who conducted the survey are responsible for faxing the datasheets immediately to the NRCS data collection officer so that he can compile the monthly forecasts for the state. It is also the responsibility of the PI (or park staff involved in the surveys) to ensure that the originals are sent to NRCS and copies are filed at the park. The PI will coordinate with NPS staff at WRST and to ensure that snow surveys will occur during the preferred survey window. The geologist at WRST and a wildlife biologist at YUCH are currently conducting the snow surveys within their parks.

Qualifications and Training

The most essential component for the collection of credible, high-quality data on snowpack is the human component. Although the SNOTEL systems are automated they need human oversight and continued attention to provide the quality of data that will be useful to a long term record. Field observers must be able to perform the survey according to the NRCS guidelines and record accurate data under adverse conditions. Under the NRCS cooperative agreement it is recommended that NPS personnel involved in snow surveys attend the NRCS West Wide Snow Survey School. Snow survey work requires that personnel be comfortable traveling by fixed-wing aircraft during the winter. This involves landing at remote airstrips on skied aircraft, flying at low levels, traveling in extreme weather conditions, and conducting surveys at temperatures down to -40°F. The data collection window for performing snow surveys is the last three days of the month from November through May, this requires that personnel are flexible and able to work weekends if required.

VII. Operational Requirements

Annual Workload and Field Schedule

Snow surveys will begin the last three days of November for the December 1 survey and continue on a monthly basis until the last three days in April for the May 1 survey. There is no survey scheduled during the holiday period between December and January. The timing of the surveys is specific and needs

to be adhered to, which might require working on weekends. Inclement weather needs to be evaluated and if it persists during the survey timeframe the data may not be collected for the month. All of the snow courses and aerial markers must be surveyed during this period.

Facility and Equipment Needs

The nature of snow survey work does not require special facilities beyond normal office space and equipment storage needs. However, adequate winter survival gear and winter travel gear is necessary for each person involved in a snow survey. The equipment will need to be replaced periodically. The greatest equipment expense is the snow tubes which are made to order, and at 2001 prices cost \$2500 per set.

Startup Costs and Budget

The snow monitoring program is based on an interagency cooperative agreement between the NRCS and NPS. The installation costs for a single new SNOTEL site ranges from \$15,000 and \$20,000 depending on the site. Installations will occur at the rate of 1 -2 per year for the start-up years. The annual maintenance cost for a SNOTEL site is \$2,000. Equipment will need to be replaced as necessary and is estimated for budget purposes.

Personnel expenses for field work are based on a crew of one person: during the flights the person will always be accompanied by a pilot so it is not necessary to have a second person on the monthly snow surveys. Three days per month from November through May should be planned for the survey. Flight costs will vary depending on the availability of a park pilot and the current cost of a contracted air service. The flight times will vary depending on the park being flown and where the flight originates from, whether any other work can be coordinated with the survey to share costs, and how the weather affects the flight path. Startup costs for equipment reflect the cost of the NRCS SNOTEL installation agreement. Annual equipment and supply costs include maintenance supplies, tools, and replacement equipment when necessary.

Table 2 Estimated operational cost of snowpack monitoring program

Estimated Costs	DENA	WRST	YUCH
Interagency Maintenance Agreement	2,000	2,000	2,000
OAS Cost	8,000	8,000	8,000
Startup Equipment Costs	15,000	15,000	15,000
Annual equipment/supplies	2,000	2,000	2,000
Total	27,000	27,000	27,000

Procedures for making Changes to and Archiving previous Versions of the Protocol

Over time, revisions to both the Protocol Narrative and to specific Standard Operating Procedures (SOPs) are to be expected. Careful documentation of changes to the protocol, and a library of previous protocol versions are essential for maintaining consistency in within the program.

The rationale for dividing a sampling protocol into a Protocol Narrative with supporting SOPs is based on the following:

- The Protocol Narrative is a general overview of the protocol that gives the history and justification for doing the work and an overview of the sampling methods, but that does not provide all of the

methodological details. The Protocol Narrative will only be revised if major changes are made to the protocol.

- The SOPs, in contrast, are very specific step-by-step instructions for performing a given task. They are expected to be revised more frequently than the protocol narrative.
- When a SOP is revised, in most cases, it is not necessary to revise the Protocol Narrative to reflect the specific changes made to the SOP.
- All versions of the Protocol Narrative and SOPs will be archived in a Protocol Library.

The steps for changing the protocol (either the Protocol Narrative or the SOPs) are outlined in SOP #10, “Revising the Protocol”. Each SOP contains a Revision History Log that should be filled out each time a SOP is revised to explain why the change was made, and to assign a new Version Number to the revised SOP. The new version of the SOP and/or Protocol Narrative should then be archived in the CAKN Protocol Library under the appropriate folder. (Peitz, *et al.*, 2002)

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Appendix A

Snowpack Monitoring Protocol for Central Alaska Network

Existing Snowpack Monitoring sites Denali National Park and Preserve, Wrangell – St. Elias National Park and Preserve, and Yukon-Charley Rivers National Preserve.

Table 1. Existing snow monitoring sites in and around Wrangell-St. Elias National Park and Preserve.

Station	Type	Years of Record	Elev (ft)	Latitude North	Longitude West
<i>Inside Park/Preserve Boundary</i>					
McCarthy	NWS	1984 - present	1250	61° 25'	143° 00'
Nabesna	NWS	1967 - present	2900	62° 24'	143° 00'
Chisana	NWS	1966 - 1972	3175	62° 05'	142° 00' 59"
Chisana	Snow Course	1993 - present	3320	62° 04' 19"	142° 03' 55"
Chokosna	Snow Course	1993 - present	1550	61° 28'	143° 50'
Dadina Lake	Snow Course	1985 - present	2160	61° 51'	144° 49'
Lost Creek	Snow Course	1993 - present	3020	62° 31'	143° 10'
May Creek	Snow Course	1993 - present	1650	61° 20'	142° 41'
Sanford River	Snow Course	1967 - present	2280	54"	39"
<i>Surrounding Area Outside Park/Preserve Boundary</i>					
Chitina	NWS Coop	1950 - 1971	600	61° 31'	144° 26'
Glennallen	KCAM	1965 - 2001	1456	62° 07'	145° 32'
Kenny Lake	NWS Coop	2000 - present	1280	61° 44'	144° 56'
Paxson	NOAA	1975 - present	2700	63° 02'	145° 30'
Slana	NOAA	1957 - present	2192	62° 42'	143° 59'
Snowshoe Lake	NOAA	1963 - present	2300	62° 02'	146° 42'
Tok	NOAA	1954 - present	1620	63° 21'	143° 03'
Tonsina Lodge	NOAA	1963 - present	1500	61° 39'	145° 11'
Valdez	NWS Coop	1964 -	50	61° 04'	146° 09'

		present 1949 - present		48"	
Yakutat	NWS Coop		30	59° 31'	139° 40'
Beaver Creek	Snow Course	1975 - present	2150	62° 25'	140° 51'
Chair Mountain	Snow Course	1988 - present	3800	62° 04'	140° 48'
Chistochina	Snow Course	1985 - present	2300	62° 33'	144° 36'
Haggard Creek	Snow Course	1964 - present	2400	62° 42'	145° 27'
Jatahmund Lake	Snow Course	1993 - present	2300	63° 37'	141° 58'
Kenny Lake	Snow Course	1980 - present	1300	61° 44'	144° 59'
Mentasta Pass	Snow Course	1962 - present	2430	62° 54'	143° 40'
Paradise Hill	Snow Course	1992 - present	2200	62° 48'	141° 18'
Paxson	Snow Course	1982 - present	2650	63° 01'	145° 30'
Tazlina	Snow Course	1996 - present	1225	62° 02'	145° 25'
Tok Junction	Snow Course	1960 - present	1650	30"	145° 25'
Tolsona Creek	Snow Course	1985 - present	2000	63° 18'	143° 00'
Tsaina River	Snow Course	1972 - present	1650	62° 06'	146° 03'
Worthington Glacier	Snow Course	1958 - present	2100	61° 12'	145° 30'
				61° 11'	145° 41'

Table 2. Existing snow monitoring sites in and around Yukon-Charley Rivers National Preserve.

Station	Type	Years of Record	Elev (ft)	Latitude North	Longitude West
<i>Inside Preserve Boundary</i>					
Coal Creek	Snow Course	2002 - present	1000	65° 19'	143° 10'
Cathedral Mountain	Aerial Snow Marker	2002 - present	1800	65° 10'	141° 09'
Copper Creek	Aerial Snow Marker	2002 - present	2000	64° 52'	143° 24'
Crescent Creek	Aerial Snow Marker	2003 - present	2600	64° 51'	143° 56'
Tacoma	Aerial Snow Marker	2002 - present	1450	65° 26'	143° 44'
Three Fingers	Aerial Snow Marker	2002 - present	3350	64° 32'	143° 09'
<i>Surrounding Area Outside Preserve Boundary</i>					
Eagle	NWS Coop	1949 - present	810	64° 46'	141° 12'
Mission Creek	Snow Course	1989 - present	900	64° 47'	141° 12'
Step Mountain	Aerial Snow Marker	2002 - present	2850	65° 27'	141° 33'

Table 3. Existing snow monitoring sites in and around Denali National Park and Preserve.

Station	Type	Years of Record	Elev (ft)	Latitude North	Longitude West
<i>Inside Park/Preserve Boundary</i>					
HQ Weather	NWS Coop	1922 - present	2070	63° 43' 10.26"	148° 57' 56.39"
Rock Creek Air Quality	NADP	1987 - present	2162	63° 43' 23.59"	148° 58' 02.56"
Rock Creek Bottom	Snow Course	1993 - present	2100	63° 43' 24.6"	148° 57' 53.5"
Rock Creek Ridge	Snow Course	1993 - present	2600	63° 43' 39.91"	149° 00' 02.39"
Stampede	Snow Course	2002 - present	1800	63° 44' 58.60"	150° 19' 41.67"
Dunkle Hills	Snow Course, Aerial Snow Marker		2770	63° 16' 5.66"	149° 32' 19.92"
Kantishna	Snow Course, Aerial Snow Marker	1995 - present	1670	63° 32' 18.43"	150° 59' 01.14"

***Surrounding Area Outside Park/Preserve
Boundary***

Cantwell	NWS Coop	1983 - present	2150	63° 24'	148° 54'
Chulitna River Lodge	NWS Coop	1971 - present	1250	62° 53'	149° 50'
Healy 2 NW	NWS Coop	1976 - present	1490	63° 53'	149° 01'
Minchumina	Snow Course	1967 - present	730	63° 53' 13.37"	152° 18' 09.92"
Purkey Pile	Snow Course	1980 - present	2025	62° 56' 43.55"	152° 15' 26.81"
Chelatna Lake	Aerial Snow Marker	1964 - present	1650	62° 27' 52.40"	151° 27' 39.71"
Dutch Hills	Aerial Snow Marker	1980 - present	3100	62° 36' 18.56"	150° 51' 18.34"
Nugget Bench	Aerial Snow Marker	1968 - present	2010	62° 31' 4.16"	150° 56' 23.87"
Ramsdyke Creek	Aerial Snow Marker	1980 - present	2220	62° 37' 0.63"	150° 48' 30.89"
Tokositna River	Aerial Snow Marker	1980 - present	850	62° 37' 45.92"	150° 46' 32.80"

Appendix B
Snowpack Monitoring Protocol for Central Alaska Network

NRCS Agreement No. _____
National Park Service - Central Alaska Network

**AGREEMENT BETWEEN THE
U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
AND THE
National Park Service - Central Alaska Network**

This Agreement is made and entered into upon last signature, by and between the National Park Service (NPS) Central Alaska Network (CAKN) which includes Denali National Park and Preserve, Wrangell – St. Elias National Park and Preserve, and Yukon-Charley Rivers National Preserve, hereinafter referred to as the Sponsor, and the Natural Resources Conservation Service of the United States Department of Agriculture, hereinafter referred to as NRCS.

This Agreement will facilitate installation of SNOTEL equipment at Kantishna, Alaska.

Purpose:

The purpose of this Agreement is to set out the terms and conditions for installation of SNOTEL equipment at Kantishna, Alaska.

Objectives:

NPS CAKN has a need to receive precipitation, snow water equivalent, snow depth, solar radiation, relative humidity and maximum, minimum, and average daily air temperature used for climate conditions on the north side of Denali National Park. Installation of SNOTEL equipment at Kantishna, Alaska will provide NPS CAKN with data as outlined above.

Terms and Conditions:

The Sponsor and NRCS agree as follows:

I. NRCS AGREES TO:

- (1) Establish a new SNOTEL site at Kantishna. See Attachment B.
- (2) Utilize equipment previously purchased by the National Park Service for the climate site.
- (3) Activities described in (1) will be completed in return for a reimbursement in the amount of \$15,470.00 from the Sponsor to NRCS to be paid upon receipt of periodic invoicing through September 30, 2004. See Attachment B.
- (4) Accept from the Sponsor requests to install non-standard sensors [those not listed in (a)]. Requests will be evaluated by NRCS and NRCS will test the proposed sensors to assess their reliability. Purchase, installation and maintenance of non-standard sensors may require adjustment of the installation costs.
- (5) Installation priority of nonstandard sensors will be secondary to the normal SNOTEL operations.
- (6) Provide instructional training to Sponsor personnel in proper snow survey and data retrieval methods.

II. THE SPONSOR AGREES TO:

- (1) Reimburse the NRCS, upon receipt of an invoice from NRCS dated prior to September 30, 2004. Any required adjustment of the installation costs may be made through mutual agreement of the two agencies involved. Costs involved with installation of Sponsor requested nonstandard sensors will be negotiated per item.
- (2) Agrees that the equipment installed at the site has an average depreciation life of 10 years. At the term of depreciation all equipment will revert to NRCS ownership. At this time the Sponsor will have first option of continuing sponsorship of these sites. If the Sponsor chooses not to continue sponsorship, NRCS will have the right to retain, move or otherwise dispose of the equipment. In the case of catastrophic event, such as fire, vandalism, and theft, or major component failure that might involve partial or complete damage or major replacement, the NRCS will not be held fully responsible.

Instead, the Sponsor and the NRCS will reevaluate the program and decide on a course of action.

- (3) Pay for equipment and personnel access to the site by helicopter or fixed wing aircraft if necessary. This cost is not included in the annual maintenance fee.
- (4) Comply with the provisions that apply in Attachment A, Special Provisions.

III. IT IS MUTUALLY AGREED:

- (1) SNOTEL is a continuous, long term program designed to collect climatologic data from remote locations. A period of record greater than 10 years is essential for establishing accurate averages for water supply forecasting. It is the intent of both NRCS and the Sponsor to cooperate in maintaining and upgrading the proposed system for as long as mutually appropriate and cost effective.
- (2) It is the intent of the NRCS to fulfill its obligations under this Agreement. However, the NRCS cannot make commitments in excess of appropriated funds authorized by law or administratively made available. If the NRCS cannot fulfill its obligations because of lack of appropriated funds, this Agreement will automatically terminate.
- (3) This Agreement may be amended by the State Conservationist, representing NRCS, and the NPS Central Alaska Network Coordinator, representing the Sponsor.
- (4) This Agreement and its Attachments, in addition to Co-op Agreement No. _____ pertaining to maintenance provisions of the herein referenced SNOTEL sites, contain all understandings between the parties, and there are no other agreements, understandings, or representations set forth or incorporated by reference herein. No subsequent modifications(s) or amendment(s) of this Agreement are of any force or effect unless in writing, signed by authorized representatives of the parties, and made a part of this Agreement.
- (5) The effective period of this Agreement is from date of last signature to September 30, 2004. The total cost of this Agreement will not exceed \$15,470.00 for the period stated above.
- (6) This Agreement may be renewed for subsequent periods by an exchange of correspondence between the State Conservationist representing NRCS and the NPS Central Alaska Network Coordinator, representing the Sponsor.

(7) Each party shall be responsible for the activities of its own employees and agents.

IN WITNESS WHEREOF, the parties hereto have executed this Cooperative Agreement on the dates indicated.

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION
SERVICE

U.S. Department of Interior
National Park Service - Central Alaska
Network

SHIRLEY GAMMON
STATE CONSERVATIONIST, ALASKA NRCS

Maggie MacCluskie
Central Alaska Network Coordinator

DATE: _____

DATE: _____

NRCS CONTACT:

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SPONSOR CONTACT:

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Denali National Park and Preserve
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(907) 683-9573
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ATTACHMENT A - SPECIAL PROVISIONS

The signatories agree to comply with the following special provisions which are hereby attached to this agreement.

I. Drug-Free Workplace

By signing this agreement, the sponsors are providing the certification set out below. If it is later determined that the sponsors knowingly rendered a false certification, or otherwise violates the requirements of the Drug-Free Workplace Act, the Service, in addition to any other remedies available to the Federal Government, may take action authorized under the Drug-Free Workplace Act.

Controlled substance means a controlled substance in Schedules I through V of the Controlled Substances Act (21 U.S.C. 812) and as further defined by regulation (21 CFR 1308.11 through 1308.15);

Conviction means a finding of (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the Federal or State criminal drug statutes;

Criminal drug statute means a Federal or non-Federal criminal statute involving the manufacturing, distribution, dispensing, use, or possession of any controlled substance;

Employee means the employee of a grantee directly engaged in the performance of work under a grant, including: (i) All direct charge employees; (ii) All indirect charge employees unless their impact or involvement is insignificant to the performance of the grant; and, (iii) Temporary personnel and consultants who are directly engaged in the performance of work under the grant and who are on the grantee's payroll. This definition does not include workers not on the payroll of the grantee (e.g., volunteers, even if used to meet a matching requirements; consultants or independent contractors not on the grantees' payroll; or employees of subrecipients or subcontractors in covered workplaces).

Certification:

A. The sponsors certify that it will or will continue to provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing an ongoing drug-free awareness program to inform employees about--

(1) The danger of drug abuse in the workplace;

(2) The grantee's policy of maintaining a drug-free workplace;

(3) Any available drug counseling, rehabilitation, and employee assistance programs; and

(4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will --

(1) Abide by the terms of the statement; and

(2) Notifying the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such a conviction;

(e) Notifying the Service in writing, within ten calendar days after receiving notice under paragraph (d)(2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer or other designee on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification number(s) of each affected grant;

(f) Taking one of the following actions, within 30 calendar days of receiving notice under paragraph (d)(2), with respect to any employee who is so convicted --

(1) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or

(2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a), (b), (c), (d), (e) and (f).

(h) Agencies shall keep the original of all disclosure reports in the official files of the agency.

B. The sponsors may provide a list of the site(s) for the performance of work done in connection
with a specific project or other agreement.

II. Certification Regarding Lobbying (7 CFR 3018) (Applicable if this agreement exceeds \$100,000) - The sponsors certify to the best of their knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the sponsors, to any person for influencing or attempting to influence an officer or employee of an agency, Member of Congress, and officer or employer of Congress, or a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress, in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form - LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The sponsors shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

III. Certification Regarding Debarment, Suspension, and Other Responsibility Matters - Primary Covered Transactions, (7 CFR 3017)

(1) The sponsors certify to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, state or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal has one or more public transactions (Federal, State or local) terminated for cause or default.

(2) Where the primary sponsor is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this agreement.

IV. Clean Air and Water Certification

(Applicable if this agreement exceeds \$100,000, or a facility to be used has been the subject of a conviction under the Clean Air Act (42 U.S.C. 1857c-8(c)(1)) or

the Federal Water Pollution Control Act (33 U.S.C. 1319(c)) and is listed by EPA, or is not otherwise exempt.)

The project sponsoring organization(s) signatory to this agreement certifies as follows:

(a) Any facility to be utilized in the performance of this proposed agreement is _____, is not _____, listed on the Environmental Protection Agency List of Violating Facilities.

(b) To promptly notify the Assistant State Conservationist (Administration) prior to the signing of this agreement by the Service, of the receipt of any communication from the Director, Office of Federal Activities, U.S. Environmental Protection Agency, indicating that any facility which he proposes to use for the performance of the agreement is under consideration to be listed on the Environmental Protection Agency List of Violating Facilities.

(c) To include substantially this certification, including this subparagraph (c), in every nonexempt subagreement.

CLEAN AIR AND WATER CLAUSE

(Applicable only if the agreement exceeds \$100,000, or a facility to be used has been the subject of a conviction under the Clean Air Act (42 U.S.C. 1857c-8(c)(1)) or the Federal Water Pollution Control Act (33 U.S.C. (1319(c)) and is listed by EPA or the agreement is not otherwise exempt.)

A. The project sponsoring organization(s) signatory to this agreement agrees as follows:

(1) To comply with all the requirements of section 114 of the Clean Air Act as amended (42 U.S.C. 1857, et seq., as amended by Public Law 91-604) and section 308 of the Federal Water Pollution Control Act (33 U.S.C. 1251 et. seq., as amended by Public Law 92-500), respectively, relating to inspection, monitoring, entry, reports, and information, as well as other requirements specified in section 114 and section 308 of the Air Act and the Water Act, respectively, and all regulations and guidelines issued thereunder before the signing of this agreement by the Service.

(2) That no portion of the work required by this agreement will be performed in a facility listed on the Environmental Protection Agency List of Violating Facilities

on the date when this agreement was signed by the Service unless and until the EPA eliminates the name of such facility or facilities from such listing.

(3) To use their best efforts to comply with clean air standards and clean water standards at the facilities in which the agreement is being performed.

(4) To insert the substance of the provisions of this clause in any nonexempt subagreement, including this subparagraph A.(4).

B. The terms used in this clause have the following meanings:

(1) The term "Air Act" means the Clean Air Act, as amended (42 U.S.C. 1857 et seq., as amended by Public Law 91-604).

(2) The term "Water Act" means Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq., as amended by Public Law 92-500).

(3) The term "clean air standards" means any enforceable rules, regulations, guidelines, standards, limitations, orders, controls, prohibitions, or other requirements which are contained in, issued under, or otherwise adopted pursuant to the Air Act or Executive Order 11738, an applicable implementation plan as described in section 110(d) of the Clean Air Act (42 U.S.C. 1857c-5(d)), an approved implementation procedure or plan under section 111(c) or section 111(d), respectively, of the Air Act (42 U.S.C. 1857c-6(c) or (d)), or an approved implementation procedure under section 112(d) of the Air Act (42 U.S.C. 1857c-7(d)).

(4) The term "clean water standards" means any enforceable limitation, control, condition, prohibition, standard, or other requirement which is promulgated pursuant to the Water Act or contained in a permit issued to a discharger by the Environmental Protection Agency or by a State under an approved program, as authorized by section 402 of the Water Act (33 U.S.C. 1342), or by a local government to ensure compliance with pretreatment regulations as required by section 307 of the Water Act (33 U.S.C. 1317).

(5) The term "compliance" means compliance with clean air or water standards. Compliance shall also mean compliance with a scheduled or plan ordered or approved by a court of competent jurisdiction, the Environmental Protection Agency or any air or water pollution control issued pursuant thereto.

(6) The term "facility" means any building, plant, installation, structure, mine, vessel or other floating craft, location or site of operations, owned, leased, or supervised by a sponsor, to be utilized in the performance of an agreement or subagreement. Where a location or site of operations contains or includes more

than one building, plant, installation, or structure, the entire location shall be deemed to be a facility except where the Director, Office of Federal Activities, Environmental Protection Agency, determines that independent facilities are colocated in one geographical area.

V. Assurances and Compliance

As a condition of the grant or cooperative agreement, the recipient assures and certifies that is in compliance with and will comply in the course of the agreement with all applicable laws, regulations, Executive Orders and other generally applicable requirements, including those set out in 7 CFR 3015, 3016, 3017 and 3018 which hereby are incorporated in this agreement by reference, and such other statutory provisions as are specifically set forth herein.

VI. Examination of Records

Give the Service or the Comptroller General, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to this agreement. Retain all records related to this agreement for a period of three years after completion of the terms of this agreement in accordance with the applicable OMB Circular.

ATTACHMENT B

SNOTEL SITE INSTALLATION TASKS

TASK: Establish a new SNOTEL site at Kantishna, including:

Quantity	Description	Approximate Cost	
1	Shelter 8'	2500.00	
1	Precipitation Gauge (10's storage)	1500.00	
1	Precipitation Gauge (Tipping Bucket)	NPS	
1	Antenna Tower (20')	400.00	
1	Antenna (MBY3)	800.00	
1	Met tower (10')	NPS	
1	Solar radiation	NPS	
1	Relative humidity/air temperature	NPS	
1	Snow depth sensor	NPS	
1	Batteries	300.00	
1	Solar panel (MSX60)	350.00	
1	Solar panel regulator	100.00	
1	NEMA 4 enclosure	500.00	
1	550-Micromet transmitter	2500.00	
1	CR10X datalogger	NPS	
1	Misc. electrical and plumbing	100.00	
1	Installation, Travel and Per Diem	4000.00	
	Total Estimated Installation Cost	\$13,000.00	\$13,000.00
TOTAL OF ALL TASKS:			
NRCS Administrative overhead (x.19)			<u>2,470.00</u>
TOTAL OF TASKS PLUS NRCS OVERHEAD			<u>\$15,470.00</u>

NRCS Agreement No. _____
National Park Service – Central Alaska
Network

**AGREEMENT BETWEEN THE
U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
AND THE
National Park Service - Central Alaska Network**

This Agreement is made and entered into upon last signature, by and between the National Park Service (NPS) Central Alaska Network (CAKN) which includes Denali National Park and Preserve, Wrangell-St. Elias National Park and Preserve, and Yukon-Charley Rivers National Preserve, hereinafter referred to as the Sponsor, and the Natural Resources Conservation Service of the United States Department of Agriculture, hereinafter referred to as NRCS.

This Agreement will facilitate operation and maintenance provisions as outlined within the SNOTEL Installation Cooperative Agreement No. _____ between NPS CAKN and NRCS.

Purpose:

The parties hereto desire a five (5) year agreement covering certain special snow measurements and operating and servicing of automatic telemetry and reimbursements thereof, for the site at Kantishna, Alaska.

Objectives:

Provide continuous long term climatic data to the Denali National Park and agencies for water supply forecasting.

Terms and Conditions:

\$2,000.00 per year not to exceed \$10,000.00 in five years.

The Sponsor and NRCS agree as follows:

I. NRCS AGREES TO:

- (1) Calibrate and maintain all standard equipment and sensors necessary to measure snow water content, snow depth, precipitation and temperature, automatically, on a routine schedule of hourly readings. The data are available to the Sponsor through a computer link.

- (2) Gather data from the SNOTEL sites along with any manual measurements provided by the Sponsor. These data will be checked for quality and stored in the Centralized Forecasting System (CFS) database in Portland, Oregon.
- (3) Provide fall service trip to check instrumentation and obtain water-year change-over ground truth of precipitation gauges, plus some maintenance
- (4) Activities described in (1) (2) and (3) will be completed in return for a \$2,000 per year reimbursement from the Sponsor to NRCS.
- (5) Accept from the Sponsor requests to install non-standard sensors [those not listed in (a)]. Requests will be evaluated by NRCS and NRCS will test the proposed sensors to assess their reliability. Purchase, installation and maintenance of non-standard sensors may required adjustment of the annual fee as allowed for in III(4).
- (6) Installation and maintenance priority of nonstandard sensors will be secondary to the normal SNOTEL operations.
- (7) Obtain, and keep in force, the necessary permits, rights-of-way, and access for the site. Two (2) copies of all permit correspondence will be provided to the Sponsor.
- (8) Provide the Sponsor with site plan maps, snow sample collection notes and reference materials as needed.
- (9) Provide a trained snow surveyor to collect ground truth measurements cooperatively with the Sponsor.
- (10) Provide instructional training to Sponsor personnel in proper snow survey and data retrieval methods.

II. THE SPONSOR AGREES TO:

- (1) Reimburse the NRCS, upon annual receipt of NRCS-FNM-15, the annual maintenance fee of \$2,000.00 per year for standard sensors and site configuration. Standard maintenance activities are described in Attachment B. Any required adjustment of these costs may be made through mutual agreement of the two agencies involved (see III(4). Costs involved with installation and maintenance of Sponsor requested nonstandard sensors will be negotiated per item and are not covered by the annual maintenance fee.

- (2) Agrees that the equipment installed at the site has an average depreciation life of 10 years. At the term of depreciation all equipment will revert to NRCS ownership. At this time the Sponsor will have first option of continuing sponsorship of these sites. If the Sponsor chooses not to continue sponsorship, NRCS will have the right to retain, move or otherwise dispose of the equipment. In the case of catastrophic event, such as fire, vandalism, and theft, or major component failure that might involve partial or complete damage or major replacement, the NRCS will not be held fully responsible. Instead, the Sponsor and the NRCS will reevaluate the program and decide on a course of action.
- (3) Provide for one person trained in winter travel and survival to accompany NRCS personnel to the site winter maintenance if needed.
- (4) Provide: three (3) scheduled snow survey trips on or about the first of December, March and April to measure snow/read precipitation gauges at Kantishna, Alaska. See Attachment B. Data will be promptly delivered to the Anchorage NRCS Data Collection Officer at the address indicated for the NRCS contact.
- (5) Consider sending personnel who will be conducting cooperative snow survey sampling to the NRCS West Wide Snow Survey School.
- (6) Pay for helicopter or fixed wing aircraft access to the site. This cost is not included in the annual maintenance fee.
- (7) Use the computer protocol and procedures as outlined in Attachment C.
- (8) Comply with the provisions that apply in Attachment A, Special Provisions.

III. IT IS MUTUALLY AGREED:

- (1) SNOTEL is a continuous, long term program designed to collect climatologic data from remote locations. A period of record greater than 10 years is essential for establishing accurate averages for water supply forecasting. It is the intent of both NRCS and the Sponsor to cooperate in maintaining and upgrading the proposed system for as long as mutually appropriate and cost effective.
- (2) It is the intent of the NRCS to fulfill its obligations under this Agreement. However, the NRCS cannot make commitments in excess of appropriated funds authorized by law or administratively made available. If the NRCS cannot fulfill its obligations because of lack of appropriated funds, this Agreement will automatically terminate.

- (3) This Agreement may be amended by the State Conservationist, representing NRCS, and the NPS Central Alaska Network Coordinator representing the Sponsor.
- (4) This Agreement and attachments contain all understandings between the parties, and there are no other agreements, understandings, or representations set forth or incorporated by reference herein. No subsequent modifications(s) or amendment(s) of this Agreement are of any force or effect unless in writing, signed by authorized representatives of the parties, and made a part of this Agreement.
- (5) The effective period of this Agreement is from date of last signature to September 30, 2009 with renewability as stated in III(6). The total cost of this Agreement will not exceed \$10,000.00 for the period stated above. This Agreement may be terminated by either party hereto by written notice to the other party at least 90 days in advance of the effective date of the termination.
- (6) This Agreement may be renewed for subsequent periods by an exchange of correspondence between the State Conservationist representing NRCS and the NPS Central Alaska Network Coordinator representing the Sponsor.
- (7) Cooperatively collect ground truth data from snow tube measurements and as outlined in II(4). NRCS and the Sponsor shall provide one person each, trained in snow surveys and winter survival, to collect winter data. These data will be collected once per year minimum. Ideally, three visits will be made for ground truth data.
- (8) Each party shall be responsible for the activities of its own employees and agents.

IN WITNESS WHEREOF, the parties hereto have executed this Cooperative Agreement on the dates indicated.

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION
SERVICE

U.S. Department of Interior
National Park Service - Central Alaska
Network

SHIRLEY GAMMON
STATE CONSERVATIONIST, ALASKA

Maggie MacCluskie
Central Alaska Network Coordinator,

NRCS

DATE: _____

DATE: _____

NRCS CONTACT:

Richard McClure
Data Collection Officer
Natural Resources Conservation Service
510 L Street, Suite 270
Anchorage, AK 99501-1949
(907) 271-2424, ext. 113
e-mail: rmclure@ak.usda.gov

SPONSOR CONTACT:

Pamela Sousanes
Environmental Specialist
Denali National Park and Preserve
PO Box 9
Denali Park, AK 99755
(907) 683-9573
e-mail: pam_sousanes@nps.gov

ATTACHMENT A - SPECIAL PROVISIONS

The signatories agree to comply with the following special provisions which are hereby attached to this agreement.

I. Drug-Free Workplace

By signing this agreement, the sponsors are providing the certification set out below. If it is later determined that the sponsors knowingly rendered a false certification, or otherwise violates the requirements of the Drug-Free Workplace Act, the Service, in addition to any other remedies available to the Federal Government, may take action authorized under the Drug-Free Workplace Act.

Controlled substance means a controlled substance in Schedules I through V of the Controlled Substances Act (21 U.S.C. 812) and as further defined by regulation (21 CFR 1308.11 through 1308.15);

Conviction means a finding of (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the Federal or State criminal drug statutes;

Criminal drug statute means a Federal or non-Federal criminal statute involving the manufacturing, distribution, dispensing, use, or possession of any controlled substance;

Employee means the employee of a grantee directly engaged in the performance of work under a grant, including: (i) All direct charge employees; (ii) All indirect charge employees unless their impact or involvement is insignificant to the performance of the grant; and, (iii) Temporary personnel and consultants who are directly engaged in the performance of work under the grant and who are on the grantee's payroll. This definition does not include workers not on the payroll of the grantee (e.g., volunteers, even if used to meet a matching requirements; consultants or independent contractors not on the grantees' payroll; or employees of subrecipients or subcontractors in covered workplaces).

Certification:

A. The sponsors certify that it will or will continue to provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing an ongoing drug-free awareness program to inform employees about--

(1) The danger of drug abuse in the workplace;

(2) The grantee's policy of maintaining a drug-free workplace;

(3) Any available drug counseling, rehabilitation, and employee assistance programs; and

(4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will --

(1) Abide by the terms of the statement; and

(2) Notifying the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such a conviction;

(e) Notifying the Service in writing, within ten calendar days after receiving notice under paragraph (d)(2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer or other designee on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification number(s) of each affected grant;

(f) Taking one of the following actions, within 30 calendar days of receiving notice under paragraph (d)(2), with respect to any employee who is so convicted --

(1) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or

(2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a), (b), (c), (d), (e) and (f).

(h) Agencies shall keep the original of all disclosure reports in the official files of the agency.

B. The sponsors may provide a list of the site(s) for the performance of work done in connection
with a specific project or other agreement.

II. Certification Regarding Lobbying (7 CFR 3018) (Applicable if this agreement exceeds \$100,000) - The sponsors certify to the best of their knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the sponsors, to any person for influencing or attempting to influence an officer or employee of an agency, Member of Congress, and officer or employer of Congress, or a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress, in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form - LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The sponsors shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

III. Certification Regarding Debarment, Suspension, and Other Responsibility Matters - Primary Covered Transactions, (7 CFR 3017)

(1) The sponsors certify to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, state or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal has one or more public transactions (Federal, State or local) terminated for cause or default.

(2) Where the primary sponsor is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this agreement.

IV. Clean Air and Water Certification

(Applicable if this agreement exceeds \$100,000, or a facility to be used has been the subject of a conviction under the Clean Air Act (42 U.S.C. 1857c-8(c)(1)) or

the Federal Water Pollution Control Act (33 U.S.C. 1319(c)) and is listed by EPA, or is not otherwise exempt.)

The project sponsoring organization(s) signatory to this agreement certifies as follows:

(a) Any facility to be utilized in the performance of this proposed agreement is _____, is not _____, listed on the Environmental Protection Agency List of Violating Facilities.

(b) To promptly notify the Assistant State Conservationist (Administration) prior to the signing of this agreement by the Service, of the receipt of any communication from the Director, Office of Federal Activities, U.S. Environmental Protection Agency, indicating that any facility which he proposes to use for the performance of the agreement is under consideration to be listed on the Environmental Protection Agency List of Violating Facilities.

(c) To include substantially this certification, including this subparagraph (c), in every nonexempt subagreement.

CLEAN AIR AND WATER CLAUSE

(Applicable only if the agreement exceeds \$100,000, or a facility to be used has been the subject of a conviction under the Clean Air Act (42 U.S.C. 1857c-8(c)(1)) or the Federal Water Pollution Control Act (33 U.S.C. (1319(c)) and is listed by EPA or the agreement is not otherwise exempt.)

A. The project sponsoring organization(s) signatory to this agreement agrees as follows:

(1) To comply with all the requirements of section 114 of the Clean Air Act as amended (42 U.S.C. 1857, et seq., as amended by Public Law 91-604) and section 308 of the Federal Water Pollution Control Act (33 U.S.C. 1251 et. seq., as amended by Public Law 92-500), respectively, relating to inspection, monitoring, entry, reports, and information, as well as other requirements specified in section 114 and section 308 of the Air Act and the Water Act, respectively, and all regulations and guidelines issued thereunder before the signing of this agreement by the Service.

(2) That no portion of the work required by this agreement will be performed in a facility listed on the Environmental Protection Agency List of Violating Facilities

on the date when this agreement was signed by the Service unless and until the EPA eliminates the name of such facility or facilities from such listing.

(3) To use their best efforts to comply with clean air standards and clean water standards at the facilities in which the agreement is being performed.

(4) To insert the substance of the provisions of this clause in any nonexempt subagreement, including this subparagraph A.(4).

B. The terms used in this clause have the following meanings:

(1) The term "Air Act" means the Clean Air Act, as amended (42 U.S.C. 1857 et seq., as amended by Public Law 91-604).

(2) The term "Water Act" means Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq., as amended by Public Law 92-500).

(3) The term "clean air standards" means any enforceable rules, regulations, guidelines, standards, limitations, orders, controls, prohibitions, or other requirements which are contained in, issued under, or otherwise adopted pursuant to the Air Act or Executive Order 11738, an applicable implementation plan as described in section 110(d) of the Clean Air Act (42 U.S.C. 1857c-5(d)), an approved implementation procedure or plan under section 111(c) or section 111(d), respectively, of the Air Act (42 U.S.C. 1857c-6(c) or (d)), or an approved implementation procedure under section 112(d) of the Air Act (42 U.S.C. 1857c-7(d)).

(4) The term "clean water standards" means any enforceable limitation, control, condition, prohibition, standard, or other requirement which is promulgated pursuant to the Water Act or contained in a permit issued to a discharger by the Environmental Protection Agency or by a State under an approved program, as authorized by section 402 of the Water Act (33 U.S.C. 1342), or by a local government to ensure compliance with pretreatment regulations as required by section 307 of the Water Act (33 U.S.C. 1317).

(5) The term "compliance" means compliance with clean air or water standards. Compliance shall also mean compliance with a scheduled or plan ordered or approved by a court of competent jurisdiction, the Environmental Protection Agency or any air or water pollution control issued pursuant thereto.

(6) The term "facility" means any building, plant, installation, structure, mine, vessel or other floating craft, location or site of operations, owned, leased, or supervised by a sponsor, to be utilized in the performance of an agreement or subagreement. Where a location or site of operations contains or includes more

than one building, plant, installation, or structure, the entire location shall be deemed to be a facility except where the Director, Office of Federal Activities, Environmental Protection Agency, determines that independent facilities are colocated in one geographical area.

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As a condition of the grant or cooperative agreement, the recipient assures and certifies that is in compliance with and will comply in the course of the agreement with all applicable laws, regulations, Executive Orders and other generally applicable requirements, including those set out in 7 CFR 3015, 3016, 3017 and 3018 which hereby are incorporated in this agreement by reference, and such other statutory provisions as are specifically set forth herein.

VI. Examination of Records

Give the Service or the Comptroller General, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to this agreement. Retain all records related to this agreement for a period of three years after completion of the terms of this agreement in accordance with the applicable OMB Circular.

ATTACHMENT B

STANDARD ANNUAL MAINTENANCE

NRCS RESPONSIBILITIES:

Standard annual maintenance of a SNOTEL site by NRCS includes:

One annual site visit by overland travel during the summer to drain and recharge precipitation can, load test transducers, batteries and solar panels for reliability, and repair or replace if defective.

Repair any normal winter or minor vandal damage and perform general clean up and vegetation management.

Management and maintenance of the site specific data within the Centralized Forecasting System (CFS) and Centralized Database System (CDBS).

The annual site visit to maintain the one SNOTEL site would require one NRCS technician to spend one day for testing/preparing equipment and one day for site visit, and 10 gallons of propylene glycol.

As needed, visits for maintenance will be made throughout the year if problems arise from normal wear and tear, minor human/wildlife vandalism or storm damage. This type of visit would be conducted as soon as feasible after a problem is detected or reported. As-needed visits will not be made to repair or maintain non-standard sensors. These will be addressed during regular summer visits or other as-needed visits outlined under NRCS Responsibilities above.

SPONSOR RESPONSIBILITIES:

Sponsor is responsible for helicopter expense for access to the SNOTEL site.

In the case of catastrophic event, such as fire, severe vandalism and theft, or major component failure that might involve partial or complete damage or major replacement, the NRCS will not be held fully responsible. Instead, the Sponsor and the NRCS will reevaluate the program and decide on a course of action.

ATTACHMENT C

PROCEDURAL INSTRUCTIONS TO USER FOR ACCESS TO SNOTEL DATA

TERMINAL OPERATIONS:

The log in ID and password required to log onto the Centralized Forecasting System (CFS) has been provided to SPONSOR per completed Computer Facility Access Agreement (Attachment D).

The NRCS Snow Survey and Water Supply Products reference manual and Centralized Database System Reference Card have been provided for user reference. In addition to information provided in the reference materials, the following procedures shall be followed.

Daily and hourly report formats are also available via internet home page and FTP server at the following addresses:

1. <http://www.wcc.nrcs.usda.gov>
2. <ftp.wcc.nrcs.usda.gov>
3. <http://www.ambcs.org>

During regular weekday business hours, the Alaska Data Collection Officer may be contacted at (907) 271-2424 ext. 113, e-mail rmcclure@ak.usda.gov.

ATTACHMENT D

COMPUTER FACILITIES ACCESS AGREEMENT

This Computer Facilities Access Agreement, hereinafter "Access Agreement", is subject to periodic review and will remain in force until cancelled or revised by a thirty (30) day written notice by either party and is subject to the following conditions:

1. There will be no reimbursement to NRCS for computer access.
2. NRCS guarantees no minimum level of access to its facilities.
3. NPS CAKN will access the NRCS/NWCC computer facilities for purposes relating to water supply, hydrologic, climatological studies, or related applications. The products available may not be copyrighted and must be considered provisional and subject to change. Any secondary distribution of data other than under the terms of this Agreement is forbidden.
4. NPS CAKN will hold the government harmless for any losses, damages, or liability, including claims of any nature arising from use of any data or information acquired.
5. The NRCS, as well as the Sponsor, reserves the right to archive and distribute data generated under the terms of this Agreement.
6. Questions regarding log in procedures and other technical aspects of the provided services should be referred to the System Support Team, Water Supply Forecasting Staff, Portland, Oregon, telephone number (503) 414-3042.
7. Access to NRCS/NWCC facilities is available via dial-up at 300 through 9600 baud. Operator services are available only during office hours, 0630-1600 Pacific Time, Monday through Friday. A system status phone recording is available at (503) 414-3199.

|

Example of 10 year maintenance agreement between the NRCS and NPS to cooperate on Snow Surveys

Find this document!!!!

Appendix C

Snowpack Monitoring Protocol for the Central Alaska Network



Climate Monitoring Site Evaluation 2004



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**National Park Service
Inventory and Monitoring Program**

**Central Alaska Network
Potential Climate Monitoring Site Evaluation**

Introduction

The Inventory and Monitoring Program is the result of the National Parks Omnibus Management Act, which was passed by Congress in 1998. This act directs the National Park Service “to establish baseline [resource] information and to provide information on the long-term trends in the condition of National Park System resources.” To accomplish this formidable task, the NPS has grouped parks into 32 networks which are characterized by their ecological similarities. Four of these networks are in Alaska. Denali National Park and Preserve, Wrangell-St. Elias National Park and Preserve and Yukon-Charley Rivers National Preserve have been organized into the Central Alaska Network (CAKN). One objective of the program is to monitor and record weather conditions at representative locations in order to identify long and short-term trends, provide reliable climate data to other researchers, and to participate in larger scale climate monitoring and modeling efforts.

The three park units of the Central Alaska Network together span an enormous area measuring approximately 650 km from north to south and 650 km from east to west. Elevations range from sea level to 6194 m (20,320’); latitudes reach to more than 65 degrees north. They contain 12 of the 32 unified ecoregions of Alaska, and include the highest mountain ranges and some of the largest rivers in North America (Figure 1). Climate in this vast area is extremely variable, ranging from strongly maritime to strongly continental, with large differences in temperature and precipitation (Figure 2).

In an attempt to better understand climate variation as well as possible long-term changes in ecosystems of the Central Alaska Network, new long-term climate monitoring stations will be installed throughout the three parks in the coming years. In the summer of 2003 numerous sites were visited at each of the parks to obtain specific information on the suitability of each site for climate station installation. The initial site selection process involved numerous conversations with park staff and climate experts. This report presents an evaluation of a number of sites identified within each of the three CAKN units for potential placement of these stations.

Existing Climate Monitoring Sites

A network of climate monitoring sites currently exists in and around all three parks (Tables 1–3, Figures 3–8). Most existing sites are located at relatively low elevations in settlements surrounding the parks, and records are commonly short-term or sporadic. There are long-term National Weather Service cooperative observer weather stations in or near each of the three parks with records of daily minimum and maximum temperatures, total precipitation, and snowfall.

The Remote Automated Weather Station (RAWS) sites were added in the 1990s as part of the fire monitoring network. Records for these stations were initially gathered during the summer fire months only, although attempts are now being made to keep them operating year-round.

Potential New Sites

In an effort to fill some of the holes in the existing climate monitoring network and increase our knowledge of climate variability across the three CAKN parks, a number of potential new sites were identified and evaluated during the summer of 2003 (Tables 4–6). The main criteria in locating sites were 1) to get the best possible coverage across each park, 2) to sample different ecoregions within each park, and 3) to get a good elevational gradient between sites. Additionally, we considered the issue of access: a site must not be too difficult and/or costly to access for routine maintenance over the next many decades. Criteria used in locating sites varied by park. Each park had to be evaluated differently due to their many differences, including, for example, wilderness and historic district designations, helicopter compliance regulations, and variations in landscapes and ecoregions.

Wrangell-St. Elias National Park and Preserve

Wrangell-St. Elias NP&P contains both coastal and interior climatic regimes as well a transition zone. Two high elevation mountain ranges disrupt movement of weather systems resulting in numerous localized climatic conditions. Because of the immensity of Wrangell-St. Elias NP&P, the extensive amount of high elevation terrain and large number of climatic regimes, a model to characterize the area will be based upon a transect of sites perpendicular to the coast. This transect will contain south and north facing mountain range aspects, sites at high and low elevation, sites in both the coastal and interior regimes, as well as sites within the transition zone. This transect will by necessity incorporate Remote Automated Weather Stations that exist outside the park boundary. Geologist Danny Rosenkrans provided extensive knowledge and expertise in identifying different climatic regimes and representative areas, and locating potential sites within the park. Sites were located along a general north-south transect through the park, utilizing several existing stations along this transect (Chisana, McCarthy, and May Creek). These existing stations are at relatively low elevations, so sites for proposed new stations were located mostly in higher areas in order to get an elevational as well as latitudinal gradient between sites. A number of possible sites were located in each identified area (Chisana, McCarthy, and Tana River). In addition, several other areas outside the transect but representing different ecoregions and/or climatic regimes, or enhancing the spatial extent of the network were identified (Upper Chitina Valley, Tebay Lakes, and Cheshnina areas). Table 4 lists all potential sites and summarizes key points for each; Figures 3 and 4 show locations of potential areas and sites, as well as the relation to existing sites, wilderness boundaries, and ecoregions.

On-the-ground evaluations of each site were conducted with dedicated helicopter support on 22–25 July 2003 by Rosenkrans, accompanied by Geoffrey Bleakley (Wrangell-St. Elias NP&P Historian), Pamela Sousanes (Denali NP&P Environmental Specialist) and Paul Atkinson (Denali NP&P Physical Science Technician). Topographic maps with site locations and descriptions and impressions of each site are included in Appendix A.

Yukon-Charley Rivers National Preserve

Yukon Charley Rivers encompasses three ecoregions including the Yukon – Old Crow Basin, the North Ogilvie Mountains, and the Yukon-Tanana Uplands. The Yukon-Tanana uplands have no existing representative climate station so potential siting in that area was a priority. Potential sites in Yukon-Charley were selected based on valuable information on the area supplied by Nikolina Guldager (Yukon-Charley Wildlife Biologist), Jay Martin (Yukon-Charley Park Pilot) and Rick Thoman (National Weather Service Meteorologist). Several factors influenced potential site locations including the ecoregions map and the annual precipitation pattern map, and the general climate pattern described by Rick Thoman. Thoman pointed out that a marked change in climate patterns seems to occur at the 144° West parallel with colder temperatures in the hills and valleys east of the parallel which is just west of the Yukon-Charley Rivers boundary.

Several other considerations were given to the area. Firstly, the few climate monitoring sites that currently exist in and around Yukon-Charley are at lower elevations, so an effort was made to find potential new sites at higher elevations within the preserve. Secondly, five new aerial snow markers were installed by Guldager within the preserve in 2001 and 2002, and an effort was made to locate sites near these markers for correlation with snow survey data. Finally, helicopter access in Yukon-Charley is subject to strict compliance regulations, so we attempted to locate sites proximal to existing airstrips for fixed-wing access. Table 5 lists the potential sites and summarizes key points for each; Figures 5 and 6 show the locations and the relation to existing sites and ecoregions.

Pamela Sousanes, Paul Atkinson, Jay Martin, and Guy Adema (Denali NP&P Physical Scientist) conducted on-the-ground surveys of Coal Creek and Three Fingers sites and fixed-wing overflights of the remaining sites on 27 August 2003. Topographic maps with site locations and descriptions and impressions of each site are included in Appendix B.

Denali National Park and Preserve

The climate of Denali National Park and Preserve (DNP&P) is characterized by great spatial variability, and includes both transitional maritime (influenced by the ocean) and continental (influenced by the Alaska Range) climate subtypes. The maritime climate on the south side of the Alaska Range is influenced by the prevailing weather patterns of the Gulf of Alaska, with milder air temperatures and less seasonal variation and more precipitation. On the north side of the range where park headquarters is located, temperatures are typical of a continental climate with strong seasonal variations. There is also less precipitation on the north side because of its location on the leeward side of a major mountain range.

Although Denali encompasses the boundaries of four ecosystems the Alaska Range ecoregion and the Tanana-Kuskokwim Lowlands ecoregion dominate the landscape. The Yentna river confluence in the southwest area of the park is part of the Cook Inlet Basin ecoregion, and small sections in the northwest corner of the park in the Minchumina Basin lie within the Kuskokwim Mountains ecoregion. Denali has had a Long-term Ecological Monitoring (LTEM) program in place for twelve years, and thus has a more extensive network of climate monitoring stations than either Wrangell-St. Elias or Yukon-Charley (although for most of the program, the climate

monitoring network was within Rock Creek, a small watershed near Park Headquarters). In 2001, three new locations within the park (Dunkle Hills, Stampede Airstrip, and Wigand Creek) were identified through an internal scoping process with park resource program managers. Standard stations were installed at these sites during the summer of 2003. In addition, Sousanes identified several other potential sites based on representative landscape, wilderness and access issues. These sites were visited for evaluation at various times during the summer by Sousanes, Paul Atkinson, and Rick McClure (NRCS). Table 6 lists the sites and summarizes key points for each; Figures 7 and 8 show the locations and the relation to existing sites, wilderness boundaries, and ecoregions. Topographic maps with site locations and descriptions and impressions of each site are included in Appendix C.

Basic Station Design

In a 2002 scoping meeting the physical science team met with Larry Hinzman of the University of Alaska Fairbanks to discuss instrumentation. Hinzman has been involved with the Long Term Ecological Research (LTER) areas at Bonanza Creek, Poker Flats and Toolik Lake in Alaska for many years. He made suggestions on instrumentation based on their study design and others like it around the country. Pamela Sousanes took the information and documented different potential phases of instrumentation. Through discussions with the CAKN technical committee it was decided that temperature and precipitation were the most important variables or drivers in the ecosystem context, followed by wind, solar radiation, and relative humidity.

The equipment for the new stations was purchased in 2002 and 2003. Three of these stations have already been deployed in a testing phase at remote locations in Denali; the remaining nine are currently set up near the Denali NP&P Visitor Center for testing and assessment prior to deployment in 2004 (Figure 9). This testing phase is an extremely valuable stage for the network. Inherent bugs in programming, instrumentation, power systems, and many other miscellaneous problems will be identified before these stations go remote. The stations were specifically designed for remote, high latitude, extreme cold conditions. Special consideration was taken to minimize visual and physical impacts by making the stations as compact as possible to comply with wilderness values within national park lands. The stations have a small footprint, low-impact anchoring systems, and wooden platforms to stand on while visiting the site to minimize vegetation disturbance. Stations are powered year-round by two solar panels. A sealed lead-acid battery is enclosed in an insulated cargo container and is the only hazardous material on site (Figures 10 and 11).

The standard tower is a ten-foot mast on a tripod base, and utilizes a Campbell Scientific, Inc. CR10X datalogger and Seimac High Data Rate GOES satellite data transmitter. Basic instrumentation includes air temperature, relative humidity, wind speed and direction, and incoming solar radiation. Additional instrumentation on an augmented station includes a tipping bucket rain gauge and acoustic snow depth sensor. With the assistance of Natural Resource Conservation Service (NRCS) Hydrologist Rick McClure, the possibility of using year-round recording precipitation gages at selected sites is being explored. There are inherent difficulties in measuring snowfall accurately; however the above mentioned gage is in use all over the state of Alaska and seems to be the preferred method. Figure 12 and 13 show examples of a snow telemetry site using the year round precipitation gage used by NRCS at Turnagain Pass in Alaska. The first photo is a fall shot, and the second is a photo of the same location with over 12 feet of snow. Site specifics will ultimately determine the final design and instrumentation of each station.

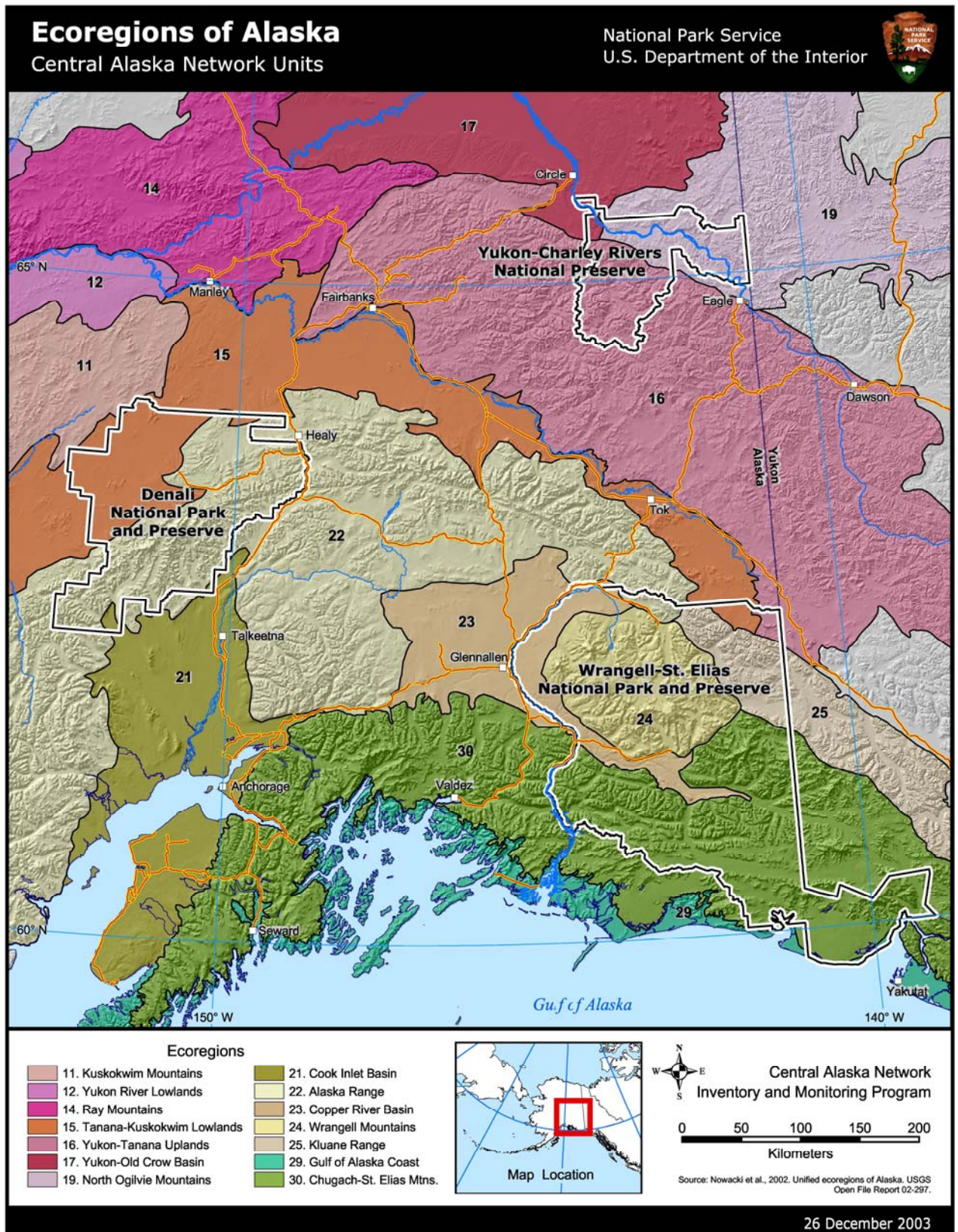


Figure 1. Ecoregions of Alaska with Central Alaska Network park boundaries

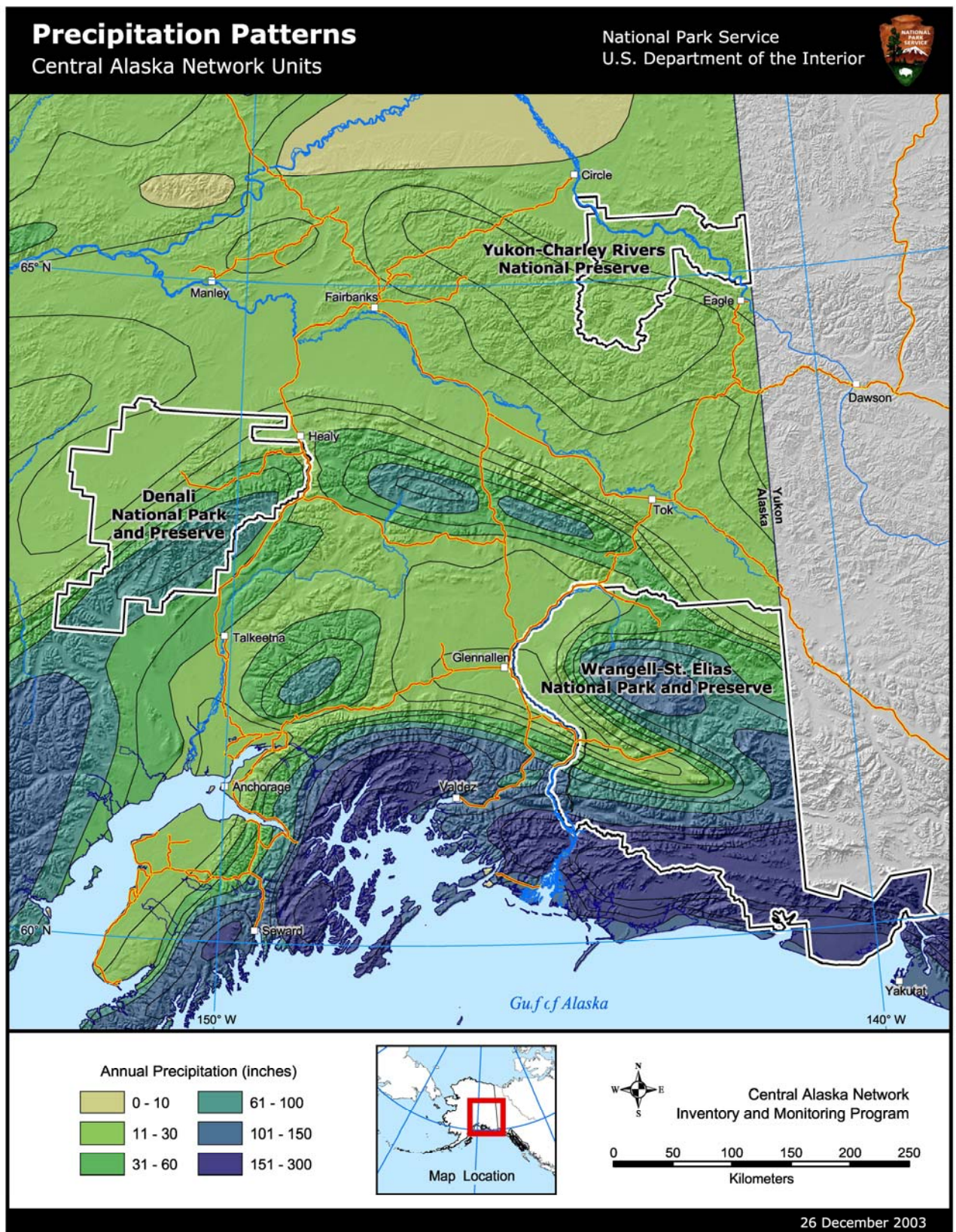


Figure 2. Precipitation Map of Alaska with Central Alaska Network park boundaries

Table 1 . Existing climate monitoring sites in and around Wrangell-St. Elias National Park and Preserve.

Station	Type	Years of Record	Elev (ft)	Latitude North	Longitude West
<i>Inside Park/Preserve Boundary</i>					
Chisana	RAWS	1988 - present	3320	62° 04' 39"	142° 03'
Klawasi	RAWS	1991 - present	3100	62° 04' 50"	144° 52' 15"
May Creek	RAWS	1990 - present	1650	61° 20' 53"	142° 42' 14"
McCarthy	NOAA	1984 - present	1250	61° 25'	143° 00'
Nabesna	NOAA	1967 - present	2900	62° 24'	143° 00'
Chisana	Snow Course	1993 - present	3320	62° 04' 19"	142° 03' 55"
Chokosna	Snow Course	1993 - present	1550	61° 28'	143° 50'
Dadina Lake	Snow Course	1985 - present	2160	61° 51'	144° 49'
Lost Creek	Snow Course	1993 - present	3020	62° 31'	143° 10'
May Creek	Snow Course	1993 - present	1650	61° 20' 54"	142° 41' 39"
Sanford River	Snow Course	1967 - present	2280	62° 13'	145° 04'
<i>Surrounding Area Outside Park/Preserve Boundary</i>					
Alaska Hwy Mile 1244	RAWS	1998 - 2003	1900	62° 49'	141° 28'
Bering Glacier	RAWS	1998 - present	75	60° 07' 07"	143° 17' 00"
Chistochina	RAWS	2001 - present	2300	62° 33' 55"	144° 39' 53"
Chitina	RAWS	1998 - present	581	61° 31' 55"	144° 26' 23"
Jatahmund Lake	RAWS	1990 - present	2300	62° 36'	142° 42' 14"
Paxson	RAWS	1996 - present	2670	63° 02' 04"	145° 29' 48"
Tok River Valley	RAWS	1999 - present	2300	62° 57' 26"	143° 20' 48"
Beaver Creek	Canadian	1968 - present	2130	62° 24'	140° 52'
Chisana	NWS Coop	1966 - 1972	3175	62° 05'	142° 00' 59"
Chitina	NWS Coop	1950 - 1971	600	61° 31'	144° 26'
Cordova	FAA	1949 - present	41	60° 30'	145° 30'
Glennallen	KCAM	1965 - 2001	1456	62° 07'	145° 32'
Gulkana	FAA	1949 - 2001	1570	62° 09'	145° 27'
Kenny Lake	NWS Coop	2000 - present	1280	61° 44'	144° 56'
Northway	FAA	1949 - 2001	1710	62° 58'	141° 56'
Paxson	NOAA	1975 - present	2700	63° 02'	145° 30'
Slana	NOAA	1957 - present	2192	62° 42'	143° 59'
Snowshoe Lake	NOAA	1963 - present	2300	62° 02'	146° 42'
Tok	NOAA	1954 - present	1620	63° 21'	143° 03'
Tonsina Lodge	NOAA	1963 - present	1500	61° 39'	145° 11'
Valdez	NWS Coop	1964 - present	50	61° 04' 48"	146° 09'
Yakutat	NWS Coop	1949 - present	30	59° 31'	139° 40'
Beaver Creek	Snow Course	1975 - present	2150	62° 25'	140° 51'
Chair Mountain	Snow Course	1988 - present	3800	62° 04'	140° 48'
Chistochina	Snow Course	1985 - present	2300	62° 33'	144° 36'
Haggard Creek	Snow Course	1964 - present	2400	62° 42'	145° 27'
Jatahmund Lake	Snow Course	1993 - present	2300	63° 37'	141° 58'
Kenny Lake	Snow Course	1980 - present	1300	61° 44'	144° 59'
Mentasta Pass	Snow Course	1962 - present	2430	62° 54'	143° 40'
Paradise Hill	Snow Course	1992 - present	2200	62° 48'	141° 18'
Paxson	Snow Course	1982 - present	2650	63° 01'	145° 30'
Tazlina	Snow Course	1996 - present	1225	62° 02' 30"	145° 25'
Tok Junction	Snow Course	1960 - present	1650	63° 18'	143° 00'
Tolsona Creek	Snow Course	1985 - present	2000	62° 06'	146° 03'
Tsaina River	Snow Course	1972 - present	1650	61° 12'	145° 30'
Worthington Glacier	Snow Course	1958 - present	2100	61° 11'	145° 41'

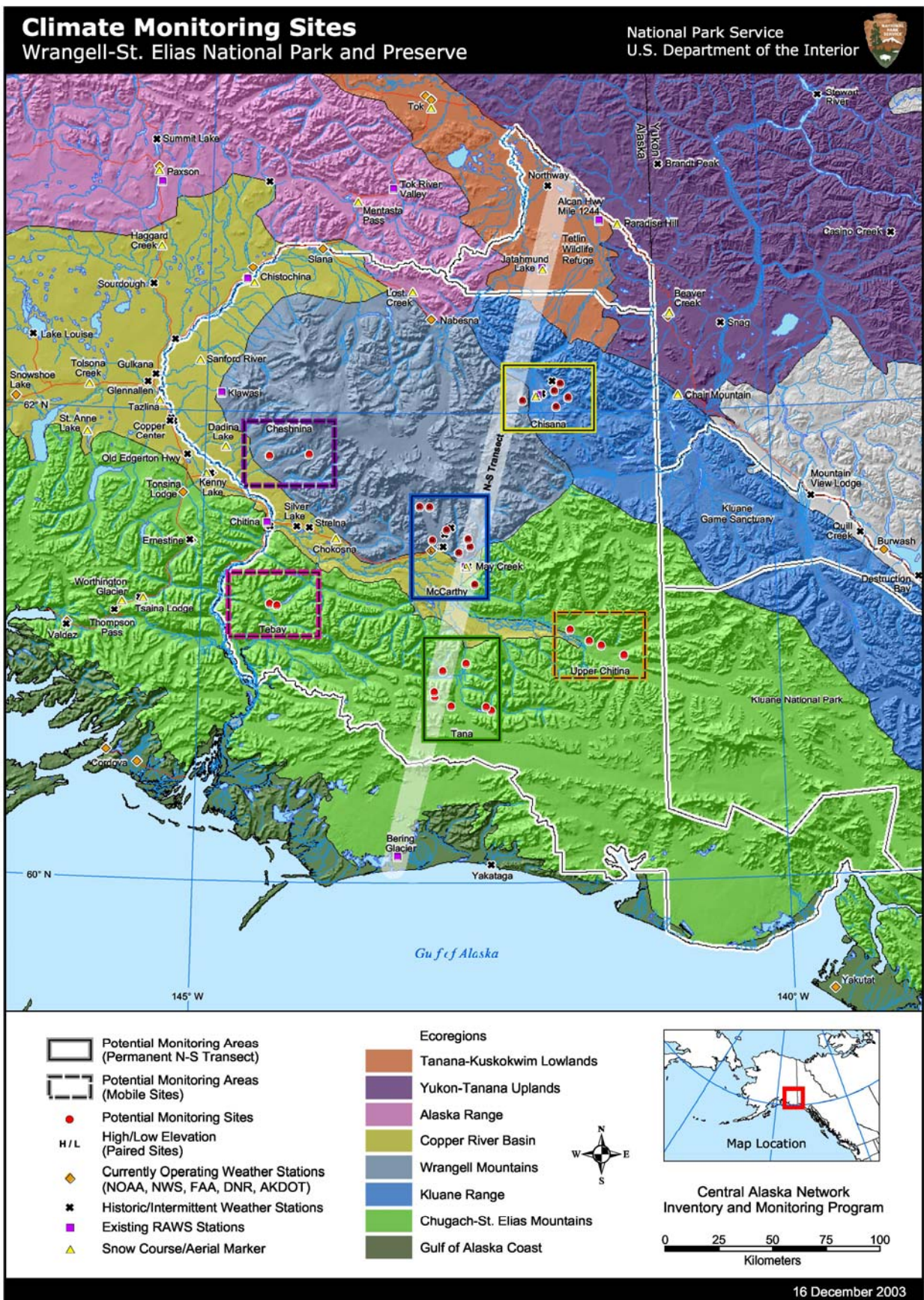


Figure 3. Location of existing and potential climate monitoring sites in relation to Alaska Ecoregions, Wrangell-St. Elias National Park and Preserve

Climate Monitoring Sites Wrangell-St. Elias National Park and Preserve

National Park Service
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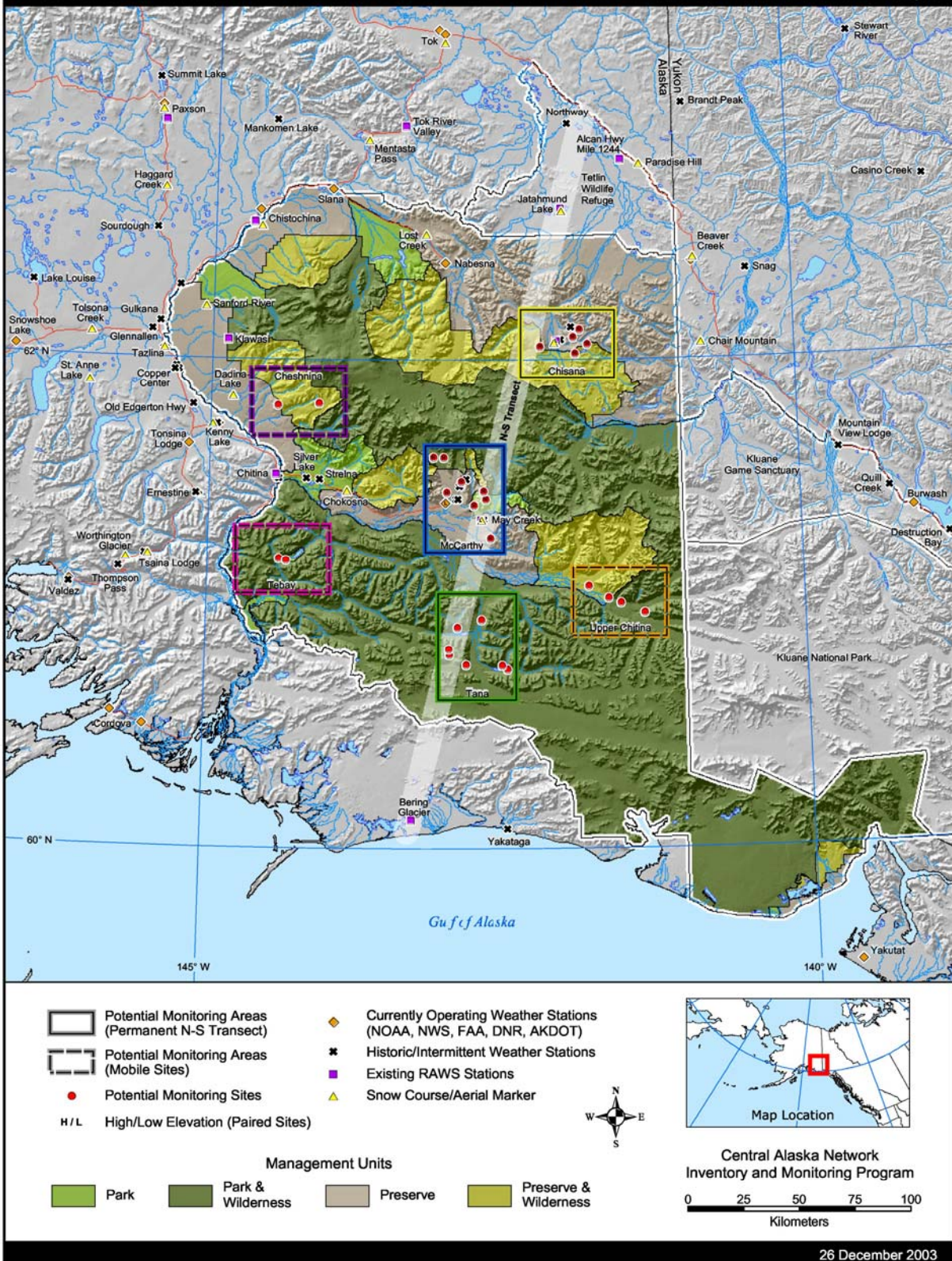


Figure 4. Location of existing and potential climate monitoring sites in relation to management units, Wrangell-St. Elias National Park and Preserve

Table 2 Existing climate monitoring sites in and around Yukon-Charley Rivers National Preserve

Station	Type	Years of Record	Elev (ft)	Latitude North	Longitude West
<i>Inside Preserve Boundary</i>					
Ben Creek	RAWS	1990 - present	1850	65° 17'	143° 04'
Coal Creek	Snow Course	2002 - present	1000	65° 19'	143° 10'
Cathedral Mountain	Aerial Snow Marker	2002 - present	1800	65° 10'	141° 09'
Copper Creek	Aerial Snow Marker	2002 - present	2000	64° 52'	143° 24'
Crescent Creek	Aerial Snow Marker	2003 - present	2600	64° 51'	143° 56'
Tacoma	Aerial Snow Marker	2002 - present	1450	65° 26'	143° 44'
Three Fingers	Aerial Snow Marker	2002 - present	3350	64° 32'	143° 09'
<i>Surrounding Area Outside Preserve Boundary</i>					
Birch Creek	RAWS	1998 - present	850	65° 35' 05"	144° 21' 49"
Eagle	RAWS	1992 - present	879	64° 46' 34"	141° 09' 43"
Eagle	NWS Coop	1949 - present	810	64° 46'	141° 12'
Mission Creek	Snow Course	1989 - present	900	64° 47'	141° 12'
Step Mountain	Aerial Snow Marker	2002 - present	2850	65° 27'	141° 33'

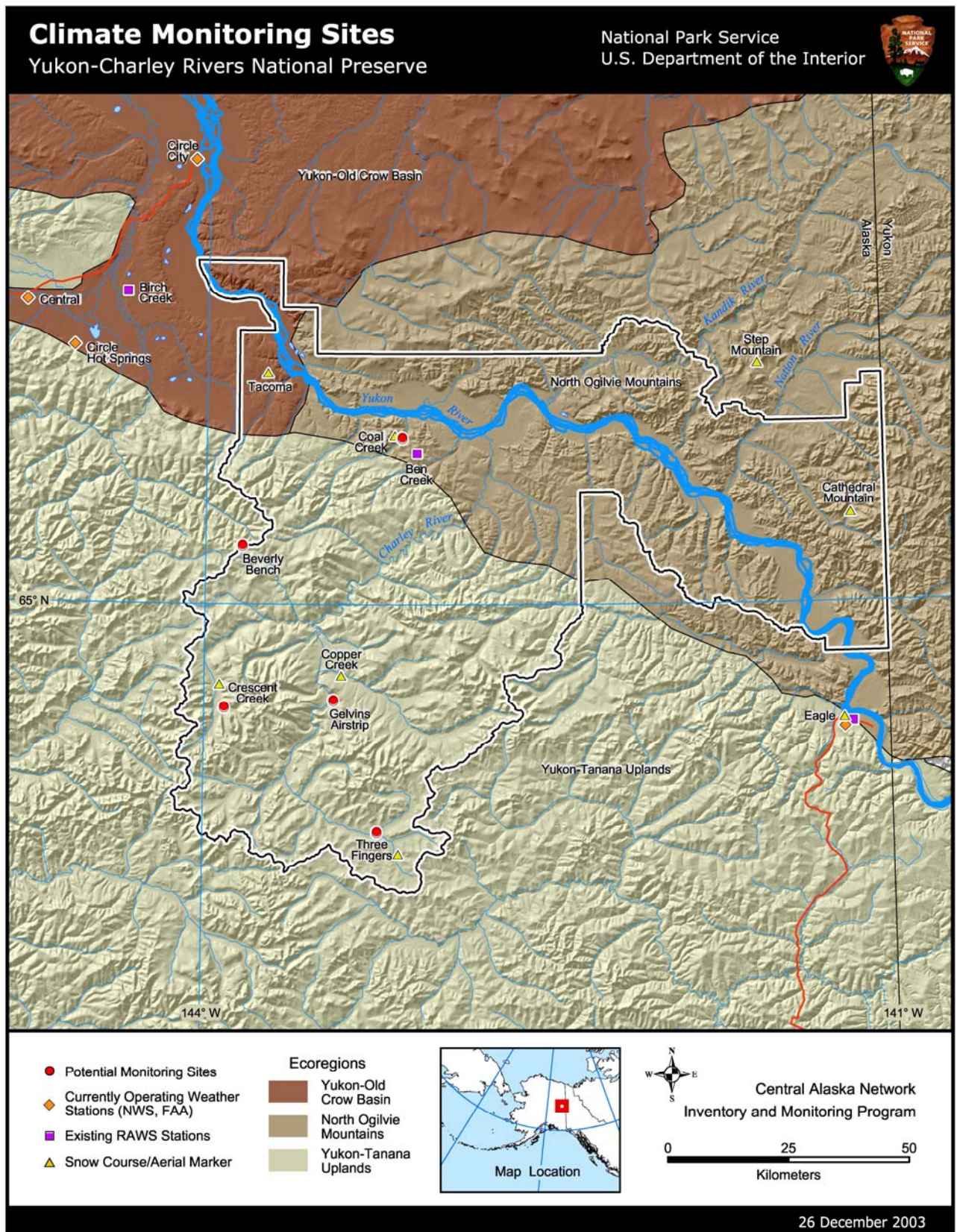


Figure 5. Location of existing and potential climate monitoring sites in relation to Alaska Ecoregions, Yukon-Charley Rivers National Preserve

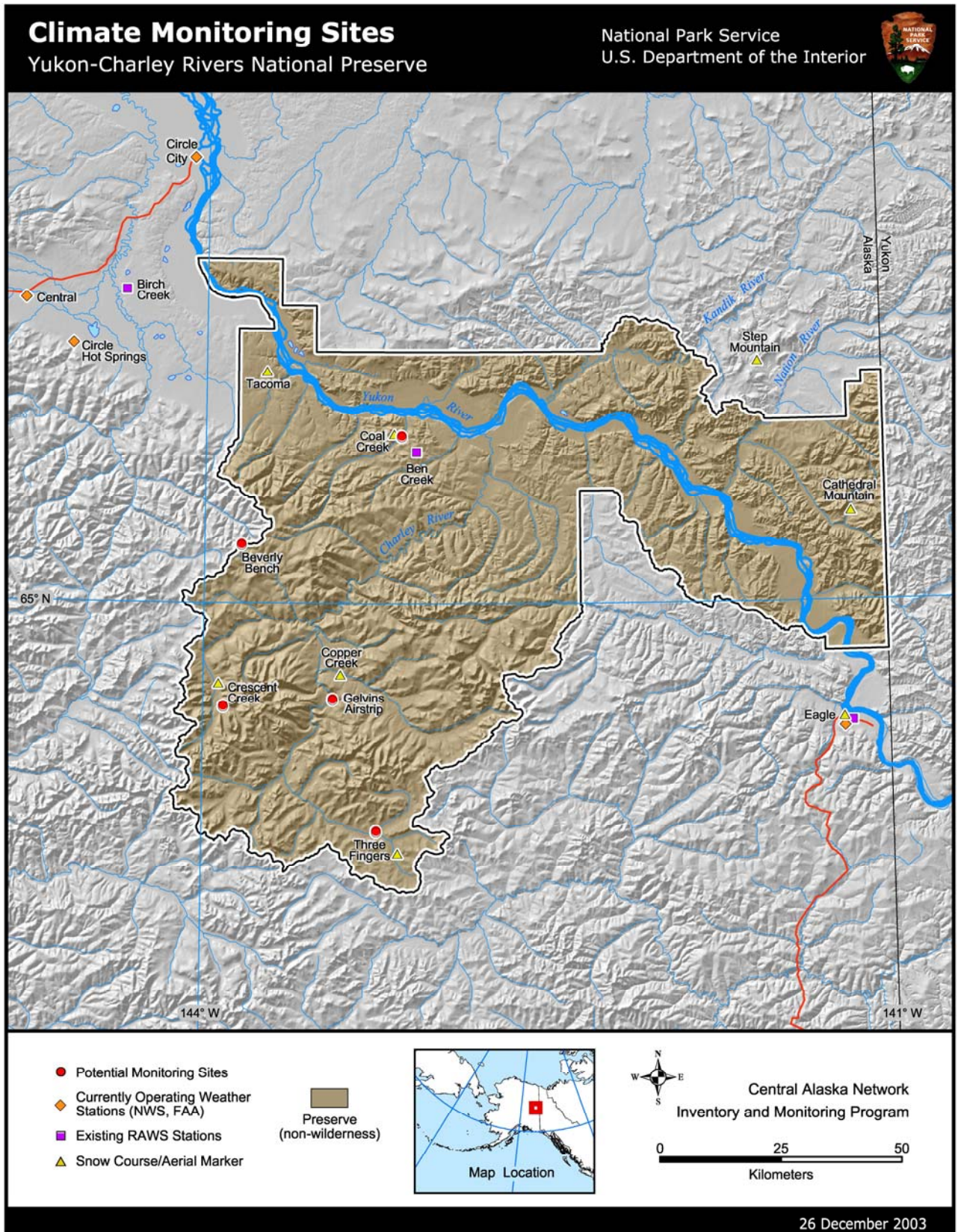


Figure 6. Location of existing and potential climate monitoring sites in relation to land management units, Yukon-Charley Rivers National Preserve

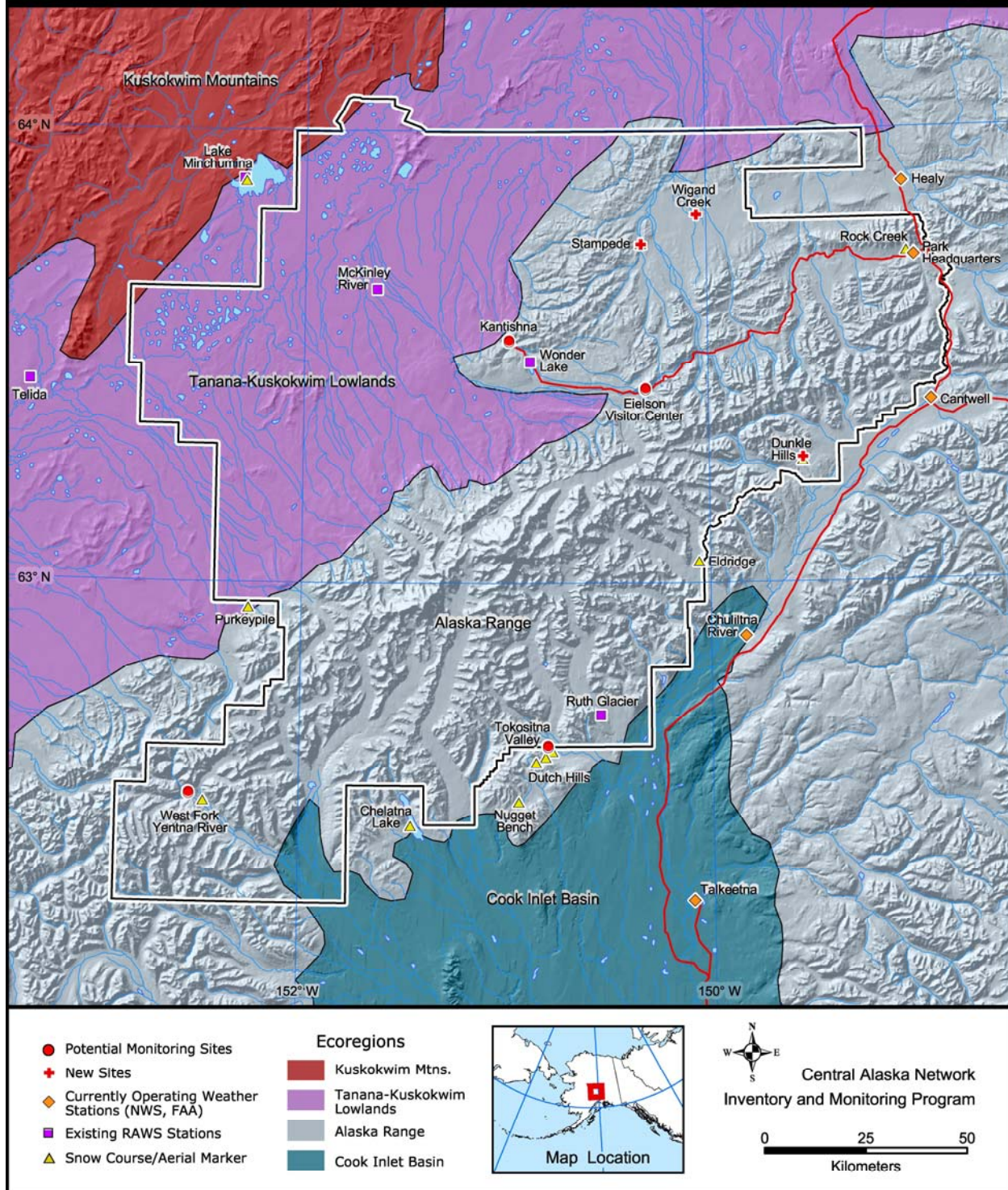
Table 3 Existing climate monitoring sites in and around Denali National Park and Preserve

Station	Type	Years of Record	Elev (ft)	Latitude North	Longitude West
<i>Inside Park/Preserve Boundary</i>					
McKinley River	RAWS	1992 - present	840	63° 38' 95"	151° 38' 23"
Ruth Glacier	RAWS	1998 - present	3300	62° 42' 35.86"	150° 32' 23.43"
Wonder Lake	RAWS	1995 - present	2119	63° 29' 24"	150° 52' 48"
Dunkle Hills	CAKN new	New 2003	2850	63° 16' 30"	149° 32' 21"
Stampede Airstrip	CAKN new	New 2003	1800	63° 44' 52"	150° 19' 41"
Wigand Creek	CAKN new	New 2003	5640	63° 48' 43.5"	150° 02' 59.2"
HQ Weather	NWS Coop	1922 - present	2070	63° 43' 10.26"	148° 57' 56.39"
Rock Creek Air Quality	NADP	1987 - present	2162	63° 43' 23.59"	148° 58' 02.56"
Rock Creek Forest	DENA LTEM	1994 - present	2411	63° 43' 53.53"	148° 58' 58.40"
Rock Creek Permafrost	DENA LTEM	1994- present	2375	63° 43' 36.01"	148° 58' 39.44"
Rock Creek Treeline	DENA LTEM	1994 - present	3215	63° 44' 07.41"	149° 00' 24.27"
Rock Creek Lower Ridge	DENA LTEM	1994 - present	3241	63° 44' 06.20"	149° 00' 32.33"
Rock Creek Upper Ridge	DENA LTEM	1994 - present	4390	63° 44' 48.19"	149° 00' 52.20"
Rock Creek Bottom	Snow Course	1993 - present	2100	63° 43' 24.6"	148° 57' 53.5"
Rock Creek Ridge	Snow Course	1993 - present	2600	63° 43' 39.91"	149° 00' 02.39"
Stampede	Snow Course	2002 - present	1800	63° 44' 58.60"	150° 19' 41.67"
Dunkle Hills	Snow Course, Aerial Snow Marker	New 2003	2770	63° 16' 5.66"	149° 32' 19.92"
Kantishna	Snow Course	1995 - present	1670	63° 32' 18.43"	150° 59' 01.14"
Eldridge	Aerial Snow Marker	2002 -present	3260	63° 02' 48.6"	150° 03' 22.6"
Upper W Fork Yentna	Aerial Snow Marker	2002 - present	900	62° 31' 00.75"	152° 27' 35.20"
<i>Surrounding Area Outside Park/Preserve Boundary</i>					
Farewell	RAWS	1996 - present	775	63° 43' 24"	154° 04' 36"
Minchumina	RAWS	1992 - present	740	63° 53' 36"	152° 18' 38"
Telida	RAWS	1991 - present	650	63° 26' 24"	153° 21' 24"
Wein Lake	RAWS	1988 - present	1050	64° 18' 54"	151° 05' 00"
Cantwell	NWS Coop	1983 - present	2150	63° 24'	148° 54'
Chulitna River Lodge	NWS Coop	1971 - present	1250	62° 53'	149° 50'
Healy 2 NW	NWS Coop	1976 - present	1490	63° 53'	149° 01'
Minchumina	Snow Course	1967 - present	730	63° 53' 13.37"	152° 18' 09.92"
Purkey Pile	Snow Course	1980 - present	2025	62° 56' 43.55"	152° 15' 26.81"
Chelatna Lake	Aerial Snow Marker	1964 - present	1650	62° 27' 52.40"	151° 27' 39.71"
Dutch Hills	Aerial Snow Marker	1980 - present	3100	62° 36' 18.56"	150° 51' 18.34"
Nugget Bench	Aerial Snow Marker	1968 - present	2010	62° 31' 4.16"	150° 56' 23.87"
Ramsdyke Creek	Aerial Snow Marker	1980 - present	2220	62° 37' 0.63"	150° 48' 30.89"
Tokositna River	Aerial Snow Marker	1980 - present	850	62° 37' 45.92"	150° 46' 32.80"

Climate Monitoring Sites

Denali National Park and Preserve

National Park Service
U.S. Department of the Interior



27 December 2003

Figure 7. Location of existing and potential climate monitoring sites in relation to Alaska Ecoregions, Denali National Park and Preserve

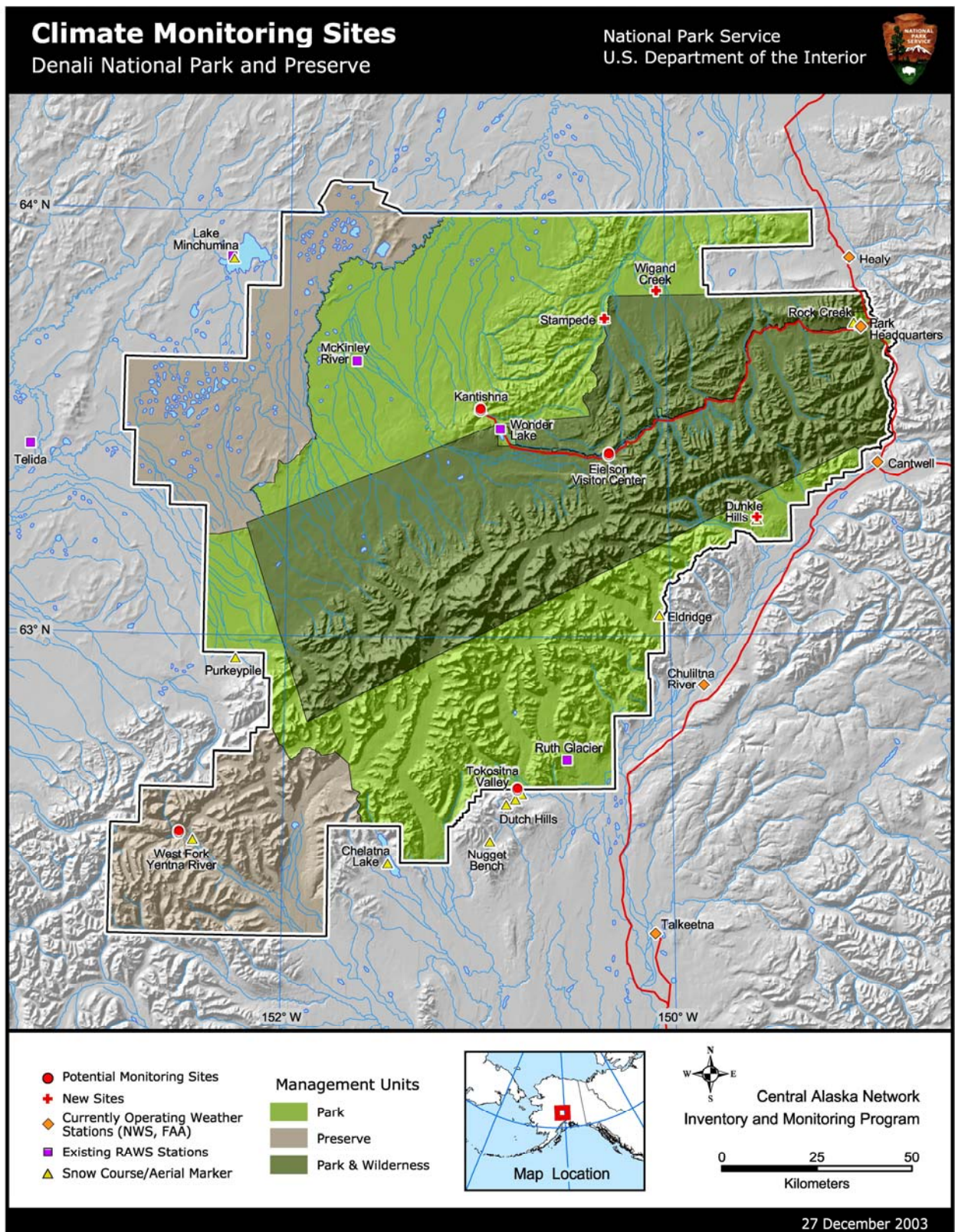


Figure 8. Location of existing and potential climate monitoring sites in relation to management units, Denali National Park and Preserve.

Table 4 Potential sites identified within Wrangell-St. Elias National Park and Preserve

Site	Area	Site Type	Elev (ft)	Latitude (NAD27)	Longitude (NAD27)	Ecoregion	Subsection	Access*	Wilderness?	Historic District?	Viewshed Concerns	Visitor Use
Gates Peninsula	McCarthy	high elevation	4060	61° 36' 10.41"	143° 00' 47.54"	Wrangell Mtns	McCarthy Mtns	H	Y	N	N	N
Kennicott Glacier	McCarthy	high elevation	3900	61° 36' 15.57"	143° 05' 59.34"	Wrangell Mtns	McCarthy Mtns	F/H	Y	N	N	L
Jumbo	McCarthy	high elevation	3700	61° 30' 20.36"	142° 51' 50.38"	Wrangell Mtns	McCarthy Mtns	Trail	N	Y	Y	M
Fireweed	McCarthy	high elevation	3770	61° 27' 40.06"	142° 59' 10.30"	Wrangell Mtns	McCarthy Mtns	H	N	N	L	L
Nikolai Mine	McCarthy	high elevation	4700	61° 27' 58.85"	142° 40' 33.26"	Wrangell Mtns	McCarthy Mtns	H	N	N	N	L
Nikolai Pass	McCarthy	high elevation	4400	61° 25' 58.88"	142° 39' 34.24"	Wrangell Mtns	McCarthy Mtns	F/H	N	N	L	L
Sourdough Ridge	McCarthy	high elevation	4160	61° 24' 29.07"	142° 45' 26.20"	Wrangell Mtns	McCarthy Mtns	H	N	N	L	L
Chititu	McCarthy	high elevation	4600	61° 16' 26.44"	142° 37' 08.71"	Chugach-St. Elias Mtns	W St. Elias Foothills	H	N	N	N	N
Iceberg Lake	Tana River	mod elevation	3300	60° 47' 44.55"	142° 58' 05.74"	Chugach-St. Elias Mtns	N Chugach Cirque-Glacier	F/H	Y	N	L	L
Iceberg Bench	Tana River	high elevation	3990	60° 49' 08.53"	142° 58' 17.17"	Chugach-St. Elias Mtns	N Chugach Cirque-Glacier	H/F	Y	N	N	N
Tana Glacier Seismic	Tana River	high elevation	4150	60° 45' 17.68"	142° 49' 43.18"	Chugach-St. Elias Mtns	N Chugach Cirque-Glacier	H©	Y	N	N	N
Ross Green Bench	Tana River	mod elevation	2520	60° 44' 08.47"	142° 29' 03.23"	Chugach-St. Elias Mtns	N Chugach Cirque-Glacier	H/F	Y	N	N	N
Twelvemile Ck	Tana River	mod elevation	3080	60° 45' 05.95"	142° 31' 40.96"	Chugach-St. Elias Mtns	N Chugach Cirque-Glacier	H/F	Y	N	N	N
West Fork Tana	Tana River	mod elevation	3450	60° 54' 29.79"	142° 53' 58.61"	Chugach-St. Elias Mtns	N Chugach Cirque-Glacier	H	Y	N	N	N
Tana River	Tana River	low elevation	1440	60° 56' 22.18"	142° 41' 51.68"	Chugach-St. Elias Mtns	Tana Valley	F	Y	N	Y	L
Euchre	Chisana	high elevation	6860	62° 03' 19.89"	142° 11' 04.36"	Kluane Ranges	S Nutzotin Hills & Mtns	H©/S	boundary	N	N	N
Chicken Airstrip	Chisana	high elevation	5260	62° 07' 27.64"	141° 50' 42.76"	Kluane Ranges	S Nutzotin Hills & Mtns	F/H/S	N	Y	Y	L
Gold Hill	Chisana	high elevation	5930	62° 05' 36.45"	141° 54' 00.48"	Kluane Ranges	S Nutzotin Hills & Mtns	H/F/S	N	Y	N	N
California Creek	Chisana	high elevation	5480	62° 03' 55.23"	141° 46' 42.63"	Kluane Ranges	S Nutzotin Hills & Mtns	H/F/S	boundary	N	N	N
Beaver Lake	Chisana	high elevation	5450	62° 01' 38.20"	141° 53' 04.86"	Kluane Ranges	S Nutzotin Hills & Mtns	H/F/S	Y	N	N	N
Chitina Glacier Seismic	Upper Chitina	mobile	4950	60° 57' 54.69"	141° 20' 16.28"	Chugach-St. Elias Mtns	University-Centennial Mtns	H©	Y	N	N	N
Notch Airstrip	Upper Chitina	mobile	2600	61° 00' 22.41"	141° 31' 55.89"	Chugach-St. Elias Mtns	Chitina & Logan Glaciers	F	Y	N	Y	L
Huberts	Upper Chitina	mobile	2200	61° 01' 36.96"	141° 38' 05.16"	Copper River Basin	Chitina Valley	F/H	Y	N	Y	L
Barnard Glacier	Upper Chitina	mobile	1900	61° 04' 31.91"	141° 47' 56.80"	Chugach-St. Elias Mtns	Chitina Moraines	H/F	Y	N	N	N
Tebay	Tebay Lakes	mobile	2000	61° 11' 17.33"	144° 24' 01.34"	Chugach-St. Elias Mtns	N Chugach Cirque-Glacier	F/H	boundary	N	N	L
Tebay Cabin	Tebay Lakes	mobile	1880	61° 10' 54.12"	144° 20' 15.95"	Chugach-St. Elias Mtns	N Chugach Cirque-Glacier	H/F	N	N	N	N
Cheshnina	Cheshnina	mobile	4940	61° 48' 46.41"	144° 25' 46.39"	Wrangell Mtns	Cheshnina Plateaus & Valleys	H	boundary	N	N	N
Long Glacier	Cheshnina	mobile	4820	61° 49' 19.84"	144° 04' 40.59"	Wrangell Mtns	Cheshnina Plateaus & Valleys	H/F	Y	N	N	N

Note – Only one site will be considered in each of the color coded areas.

* Access: (H) helicopter; (F) fixed-wing aircraft; (S) snowmachine/ATV; (H©) helicopter, co-located with seismic station or radio repeater, listed in order of most likely type of access

Table 5 Potential sites identified in Yukon-Charley Rivers National Preserve

Site	Area - Ecoregion	Site Type	Elev (ft)	Latitude (NAD27)	Longitude (NAD27)	Access*	Wilderness?	Historic District?	Viewshed High use?
Three Fingers	Yukon Tanana Uplands	high elevation	3180	64° 34' 32.47"	143° 14' 27.67"	F	N	N	Y
Crescent Creek	Yukon Tanana Uplands	high elevation	2850	64° 48' 31.53"	143° 54' 37.92"	F	N	N	Y
Golvins Airstrip	Yukon Tanana Uplands	mid elevation	2100	64° 49' 20.00"	143° 25' 57.00"	F	N	N	Y
Beverly Airstrip	Yukon Tanana Uplands	high elevation	4110	65° 06' 40.16"	143° 50' 12.20"	F	N	N	N
Coal Creek	Yukon Tanana Uplands	low elevation	870	65° 18' 50.05"	143° 07' 56.38"	F/S	N	Y	Y

*Access: (H) helicopter, (F) fixed-wing aircraft, (S) snowmachine/ATV

Table 6 Potential sites identified in Denali National Park and Preserve

Site	Area	Site Type	Elev (ft)	Latitude (NAD27)	Longitude (NAD27)	Ecoregion	Access*	Wilderness?	Historic District?	Viewshed High use?
West Fork Yentna River	South Side	low elevation	1840	62° 32' 07.80"	152° 31' 41.80"	Alaska Range	H	N	N	N
Tokositna Valley	South Side	low elevation	860	62° 38' 33.52"	150° 47' 46.90"	Alaska Range	H/S	N	N	N
Eielson Visitor Center	North Side	high elevation	3730	63° 25' 52.70"	150° 18' 34.00"	Alaska Range	R/H	N	N	Y
Kantishna	North Side	low elevation	1570	63° 32' 17.21"	150° 59' 06.17"	Alaska Range	R/F	N	N	Y

* Access: (H) helicopter, (F) fixed-wing aircraft, (S) snowmachine/ATV, (R) road



Figure 9. Station testing, Denali National Park and Preserve 2003

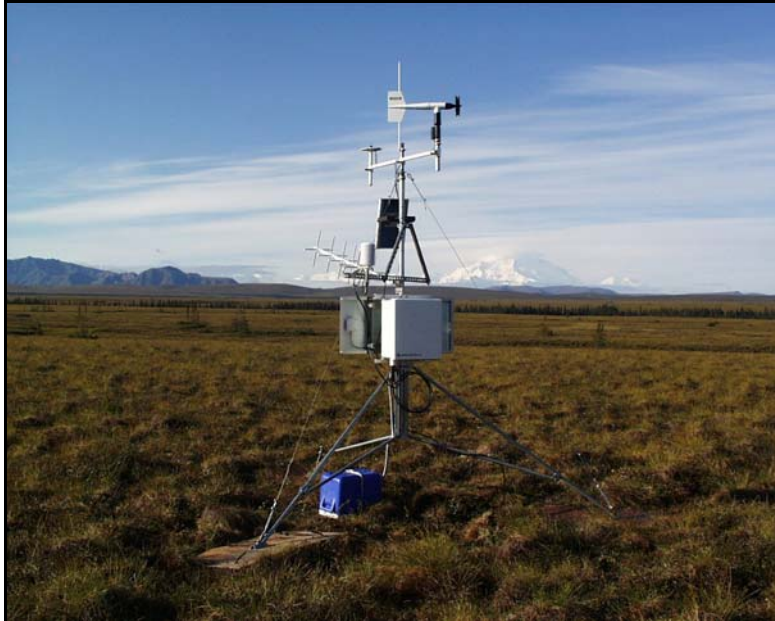


Figure 10. CAKN climate station, remote testing Denali National Park and Preserve



Figure 11. Battery and enclosure for CAKN station



Figure 12. Turnagain Pass snow telemetry (snotel) site in fall



Figure 13. Turnagain Pass site in spring with 12 ft of snow

Appendix A: Potential climate monitoring sites, Wrangell-St. Elias National Park and Preserve

Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites
McCarthy Area

Site: **Gates Peninsula**

Area: McCarthy High Elevation

Coordinates: 61° 36' 10.41" N, 143° 00' 47.54" W (NAD27)

Elevation: 4060'

Description: Several small, grassy knolls on ridge between Gates and Packsaddle Glaciers; wide open to glaciers to south, east and west; ridge rises to north.

Access: Helicopter only.

Notes:

- high elevation (higher than Wolverine Glacier climate station [3248'])
- possible local glacier effects
- fairly exposed, snow-blown?
- near candidate glacier monitoring/index site
- See Gates GL image
- See Kennicott GI image for setting
- Wilderness





Note Gate Glacier Setting



Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites
McCarthy Area

Site: **Kennicott Glacier**

Area: McCarthy High Elevation

Coordinates: 61° 36' 15.57" N, 143° 05' 59.34" W (NAD27)

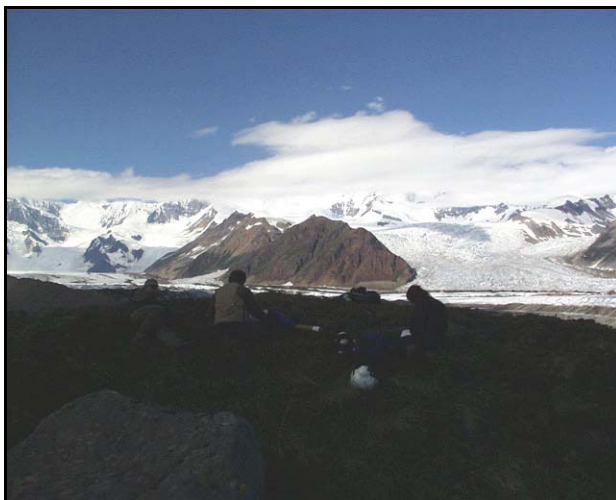
Elevation: 3900'

Description: Rolling, undulating hilly area adjacent to Kennicott Glacier; high mountains rise to west; open views of glacier in all other directions. Level site in dry tundra.

Access: Airstrip ~2 km down-glacier (steep ~200' climb on talus/scree from airstrip to site).

Notes:

- close to glacier index site
- exposed to high down-glacier winds
- steep mountains block weather from west
- on moraine/bedrock knob
- avalanche concerns
- may need anchors
- See attached Kennicott Glacier image
- See Kennicott Glacier Setting image
- Wilderness





Kennicott Glacier



Kennicott Glacier Setting

Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites
McCarthy Area

Site: **Jumbo Trail**

Area: McCarthy High Elevation

Coordinates: 61° 30' 20.36" N, 142° 51' 50.38" W (NAD27)

Elevation: 3700'

Description: Meadow ~22 x 25 m, on slight slope, surrounded by alder thickets 2–3 m high; at treeline in relatively protected bowl, north exposure blocked by 20 m high hill.

Access: Foot or ATV via trail from McCarthy (trail overgrown and brushy last half-mile).

Notes:

- good precipitation and snow (aerial marker) location
- good soil moisture/temperature location
- at treeline
- within historic district, but not visual from trail or McCarthy/Kennicott
- not very flat (on a slight slope)
- in semi-protected bowl, possible microclimate
- Some limited access to site by park visitors likely
- See Jumbo Setting image





Jumbo Setting

Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites
McCarthy Area

Site: **Fireweed Mountain**

Area: McCarthy High Elevation

Coordinates: 61° 27' 40.06" N, 142° 59' 10.30" W (NAD27)

Elevation: 3770'

Description: Rolling, open terrain on eastern flank of Fireweed Mountain, ~1700' above Kennicott Glacier. Low dwarf birch shrub and alpine tundra surrounding slightly sloping lichen/forb clearing.

Access: Possible to hike in from McCarthy Road (~4 km; through fairly thick spruce, alder and tundra – not easy); otherwise, helicopter only.

Notes:

- within McCarthy viewshed, but ~3 miles distant
- better regional representation than sites up in glacier valley
- out of glacier wind tunnels
- good potential precipitation data (with shield)
- Concerns about being a wind blown ridge
- See Fireweed image
- Some limited access to site by park visitors likely





Fireweed setting

Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites
McCarthy Area

Site: **Nikolai Mine**

Area: McCarthy High Elevation

Coordinates: 61° 27' 58.85" N, 142° 40' 33.26" W (NAD27)

Elevation: 4700'

Description: Rounded bedrock knob with rubble in middle of large bowl, protected on all sides by large mountains. Dry alpine tundra, no shrubs.

Access: Helicopter access only.

Notes:

- better shelter in bowl for precipitation and snow data than on more exposed ridgelines and glacier edges
- possible microclimate
- ground squirrel activity high
- Proximity to inactive private mine lands
- Snow avalanche
- Deep snow build up or windblown terrain
- Some limited access to site by park visitors likely

No photos (clouded in during visit).

Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites
McCarthy Area

Site: **Nikolai Pass**

Area: McCarthy High Elevation

Coordinates: 61° 25' 58.88" N, 142° 39' 34.24" W (NAD27)

Elevation: 4400'

Description: Large, round knob above Nikolai Pass; extremely large, level site. Dry tundra, no shrubs.

Access: Two airstrips ~3 km from site; helicopter.

Notes:

- probably very windy and snow-blown
- limited visitor use along nearby trail
- not directly in pass, but influenced by weather moving through
- option for aerial winter snow marker



Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites
McCarthy Area

Site: **Sourdough Ridge**

Area: McCarthy High Elevation

Coordinates: 61° 24' 29.07" N, 142° 45' 26.20" W (NAD27)

Elevation: 4160'

Description: Long ridgeline descending gradually to southwest with intermittent small, flat knolls; expansive, open views out to Chitina River valley. Dry tundra, somewhat stony ground.

Access: Possible to hike from McCarthy, but long (~13 km); otherwise helicopter only.

Notes:

- expansive views out to Chitina Valley, McCarthy
- more representative of regional winds than Jumbo or glacier sites
- probably snow-blown
- situated up ridge from radio repeater site
- some limited access to site by park visitors likely
- good high elevation counterpart with McCarthy NWS and May Creek RAWS climate sites
- see attached photo Sourdough to the West





Sourdough to the West

Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites
McCarthy Area

Site: **Chititu**

Area: McCarthy High Elevation

Coordinates: 61° 16' 26.44" N, 142° 37' 08.71" W (NAD27)

Elevation: 4600'

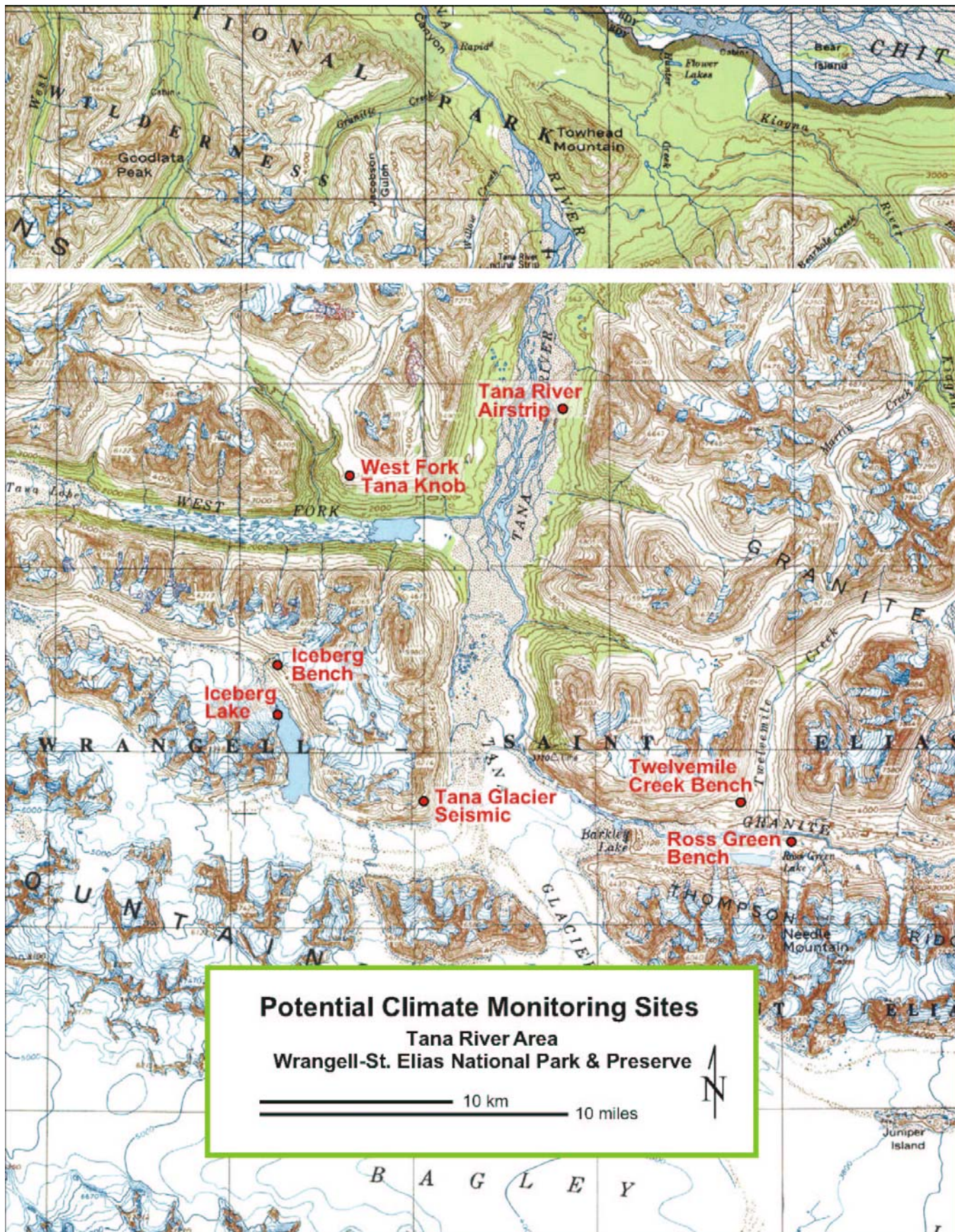
Description: Broad hilltop in rolling hills with open exposure in all directions; out of river wind corridors. Dry tundra, slightly hummocky but level ground.

Access: Helicopter only.

Notes:

- good high elevation counterpart to May Creek RAWs (in same drainage)
- headwaters area of potential I&M May Creek small watershed
- 360° views, good regional perspective
- very exposed, probably windy, but not in river corridor wind tunnel
- possibly windblown but probably not hammered
- access notes: quick helicopter flight from May Creek; away from McCarthy/Kennicott area





Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites
Tana River Area

Site: **Iceberg Lake**

Area: Tana

Coordinates: 60° 47' 44.55" N, 142° 58' 05.74" W (NAD27)

Elevation: 3300'

Description: Exposed moraine bench at about highest terrace above lake. Level, but very rocky (cobbles–small boulders).

Access: Fixed wing access on lake delta when not flooded (~1 km from site); otherwise, helicopter.

Notes:

- tourists fly into area, some limited access to site by park visitors likely
- embedded in Chugach Mountain ecoregion
- large rocks available for anchoring
- can tie to Iceberg Lake draining events
- windy and scoured, concerns about precipitation or snow location
- researcher familiar with area in summer says winds here are relatively light and temperature is typically warmer than surrounding sites (micro-climate)
- ground too rocky for soil temperature sensors (moraine)
- See attached Iceberg Lk image
- See attached Iceberg Lk Setting image
- wilderness





Iceberg Lake



Iceberg lake Setting

Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **Iceberg Bench**

Area: Tana

Coordinates: 60° 49' 08.53" N, 142° 58' 17.17" W (NAD27)

Elevation: 3990'

Description: Promontory on high bench to northeast of lake, across canyon from glaciers feeding lake; high moraine rises ~30 m to NE behind site, otherwise open to lake and glaciers. Level; tundra with low willow scrub.

Access: Fixed wing access on lake delta ~3 km from site.

Notes:

- bench here is probably more representative of Chugach ecoregion than Iceberg Lake site
- windy, winds are straight off glaciers
- concerns for snow, but possible to put aerial marker at lower elevation below site
- ground too rocky for soil temperature sensors
- See attached Iceberg Bench Setting image
- See attached Iceberg Bench image
- wilderness





Setting



Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **Tana Glacier Seismic**

Area: Tana

Coordinates: 60° 45' 17.68" N, 142° 49' 43.18" W (NAD27)

Elevation: 4150'

Description: Rocky knob at confluence of Tana Glacier and unnamed tributary; 1 km to cliffs behind (NW); exposed to major glaciers (Tana and Bagley Icefield). Flat, patchy tundra between bedrock outcrops; ~1 km down to glacier.

Access: Helicopter only, but co-located with long-term seismic station.

Notes:

- very open and exposed
- heavy wind influence from Bagley Icefield and glaciers on each side
- concerns for snow or precipitation (area scoured to bedrock in many places)
- co-located with long-term seismic station
- tower would need to be bolted to rock
- soil too shallow for soil temperature sensors
- wilderness



Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **Ross Green Bench**

Area: Tana

Coordinates: 60° 44' 08.47" N, 142° 29' 03.23" W (NAD27)

Elevation: 2520'

Description: Centrally located in Granite Creek valley on old medial moraine paralleling Ross Green Lake; representative of Chugach valley bottoms; level, good exposure. Completely covered with dwarf birch ~1 m high (would require extensive brushing).

Access: Ski or float plane to Ross Green Lake (~2 km from site). Airstrip 2 miles to west

Notes:

- potential for new snow course or aerial snow marker in area
- probably not windblown, good for snow and precipitation
- lower than other Tana sites (more medium than high elevation), possibly good for elevational gradient comparisons
- representative of Chugach valley bottom environment
- good ties to vegetation and wildlife studies
- good open central location in valley
- needs significant brushing
- See attached Ross Green Setting image
- See attached Ross Green image
- wilderness





Setting



Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **Twelvemile Creek**

Area: Tana

Coordinates: 60° 45' 05.95" N, 142° 31' 40.96" W (NAD27)

Elevation: 3080'

Description: Broad knoll across Granite Creek valley from Ross Green Lake, out of main Tana River wind corridor; representative of Chugach ecosystem. Large flat granite outcrops surrounded by willow and dwarf birch.

Access: Helicopter.

Notes:

- representative of Chugach ecoregion
- probably not too wind-blown, so good precipitation and snow potential
- would need to bolt tower to rock
- not suitable for soil temperature sensors
- wilderness
- See attached Twelvemile image





Twelvemile

Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **West Fork Tana**

Area: Tana

Coordinates: 60° 54' 29.79" N, 142° 53' 58.61" W (NAD27)

Elevation: 3450'

Description: Large, flat bench, ~1 km away from mountain to northeast, expansive and open in other directions; 2000' above river bottom; out of main Tana River wind corridor; at treeline. Slightly hummocky tundra (thin veneer over bedrock) mixed with dwarf birch and willow shrubs ~1 m high.

Access: Helicopter only.

Notes:

- at treeline, expansive bench
- ties in with wildlife and vegetation studies
- 360° views, more open and expansive than Granite Creek valley (Ross Green Lake and Twelvemile sites)
- out of main Tana valley
- rocky substrate may make anchoring difficult
- probably not suitable for soil temperature sensors
- potential aerial marker for snow
- See attached West Fork Tana image
- wilderness





West Fork Tana

Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **Tana River Airstrip**

Area: Tana Low Elevation

Coordinates: 60° 56' 22.18" N, 142° 41' 51.68" W (NAD27)

Elevation: 1440'

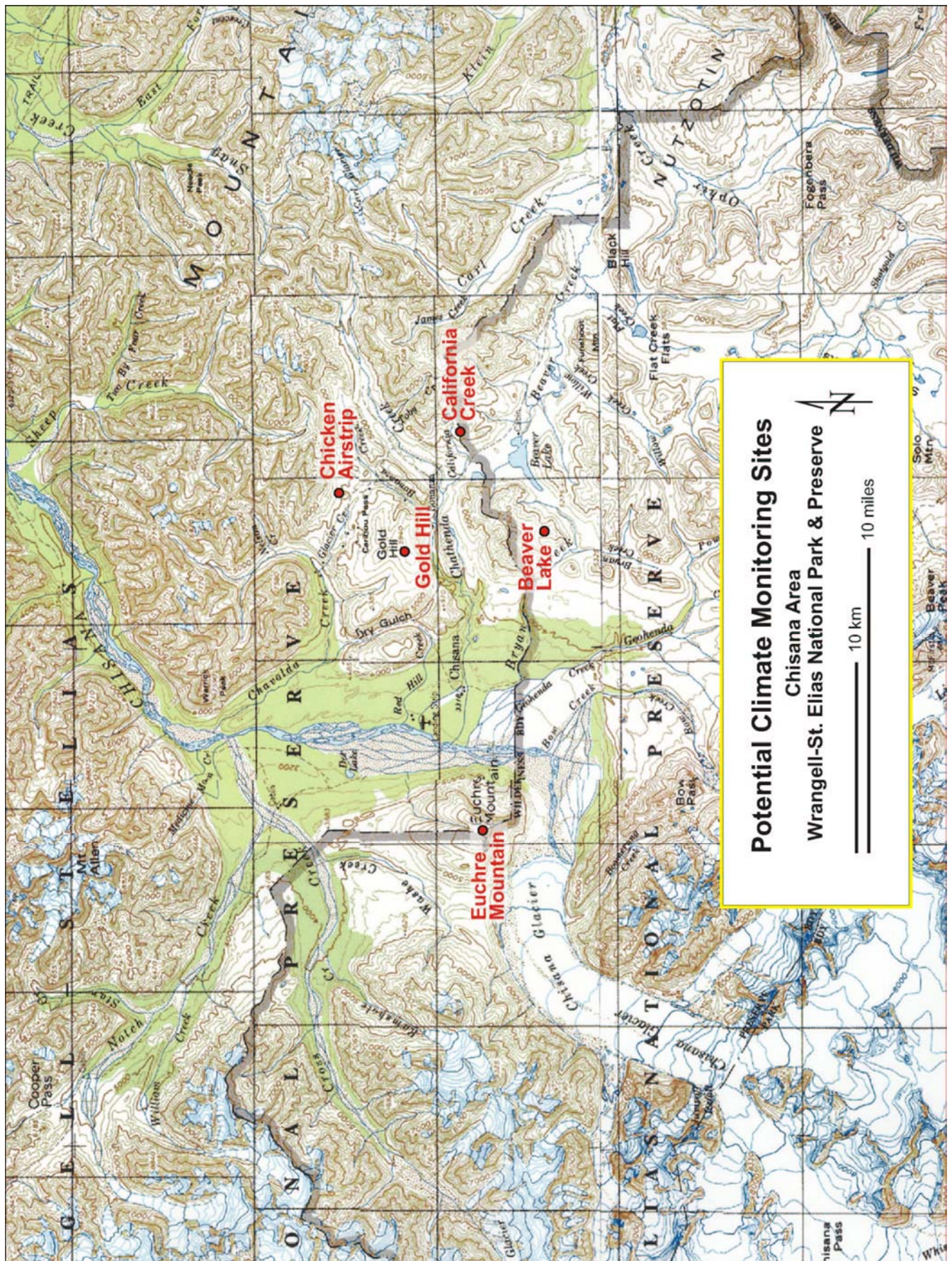
Description: Flat Tana River floodplain (lichen-covered silt), somewhat protected in broad "embayment" in adjacent spruce forest.

Access: Airstrip ~200 m from site.

Notes:

- good low-elevation valley bottom site
- next to significant game trail
- potential for flooding or even complete river re-route over the decades
- good site for all parameters (wind, precipitation, snow, etc)
- very easy access by fixed wing





Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **Euchre Mountain**

Area: Chisana High Elevation

Coordinates: 62° 03' 19.89" N, 142° 11' 04.36" W (NAD27)

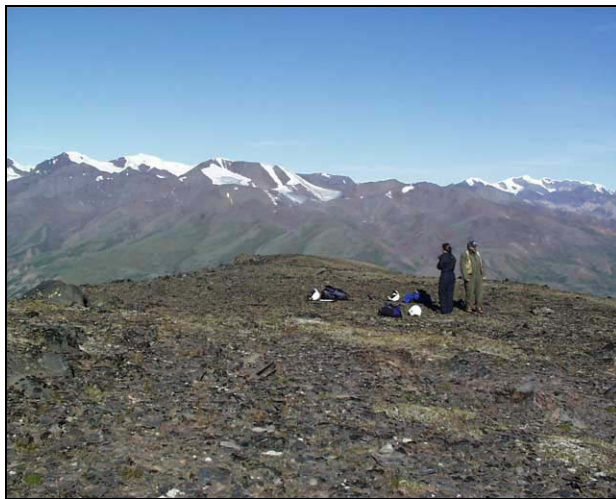
Elevation: 6860'

Description: Large, rounded summit located directly at terminus of Chisana Glacier and above Chisana townsite; completely open and exposed on all sides. Stony substrate with scattered grasses and forbs.

Access: Helicopter; snowmachine from Chisana in winter.

Notes:

- probably receives very high winds straight off the glacier \
- tower would need heavy modification and guying to withstand winds
- wind-blown, so poor precipitation and snow potential
- hobo datalogger for air temperature would work well here
- high elevation counterpart to Chisana
- collocated at NPS radio repeater site
- proximal to wilderness boundary



Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **Chicken Airstrip**

Area: Chisana High Elevation

Coordinates: 62° 07' 27.64" N, 141° 50' 42.76" W (NAD27)

Elevation: 5260'

Description: Broad, rolling hills on south side of Nutzotin Mountains; slightly hummocky dry tundra interspersed with low dwarf birch and willow shrubs.

Access: ~ proximal to Chicken airstrip, snowmachine.

Notes:

- within Chisana Historic District, in viewshed
- good high elevation counterpart to Chisana
- slightly more protected than Gold Hill or Beaver Lake sites — less windblown but more localized conditions?
- better than Gold Hill site for precipitation and snow
- probably best site for complete station that includes precipitation
- potential for aerial snow marker
- some limited access to site by park visitors likely
- See attached Chicken image





Chicken Airstrip

Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **Gold Hill**

Area: Chisana High Elevation

Coordinates: 62° 05' 36.45" N, 141° 54' 00.48" W (NAD27)

Elevation: 5930'

Description: Large, flat plateau; open in all directions above Chisana lowlands; dry, slightly hummocky tundra, no shrubs.

Access: ~7 km from Chisana airstrip; 2 km from chicken airstrip, possible snowmachine in winter.

Notes:

- within Chisana Historic District
- good high elevation counterpart to Chisana
- good regional wind patterns
- probably very windblown
- concerns regarding snow data, precipitation only with massive shield
- See attached Gold Hill Setting image





Setting

Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **California Creek**

Area: Chisana High Elevation

Coordinates: 62° 03' 55.23" N, 141° 46' 42.63" W (NAD27)

Elevation: 5480'

Description: Gentle, rolling hills above Beaver Lakes, all open. Level, slightly hummocky dry tundra, no shrubs.

Access: Float or ski plane to Beaver Lake (2-3 km) from site; ATV or snowmachine from Chisana (~11 km).

Notes:

- in wilderness area/along wilderness boundary
- windy, exposed
- open expanse, good regional perspective



Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **Beaver Lake**

Area: Chisana High Elevation

Coordinates: 62° 01' 38.20" N, 141° 53' 04.86" W (NAD27)

Elevation: 5450'

Description: Rounded, rolling hills with vast, open on all sides, with views of Chisana Glacier, Chisana lowlands, and Beaver Lake. Very level, dry alpine tundra with no shrubs.

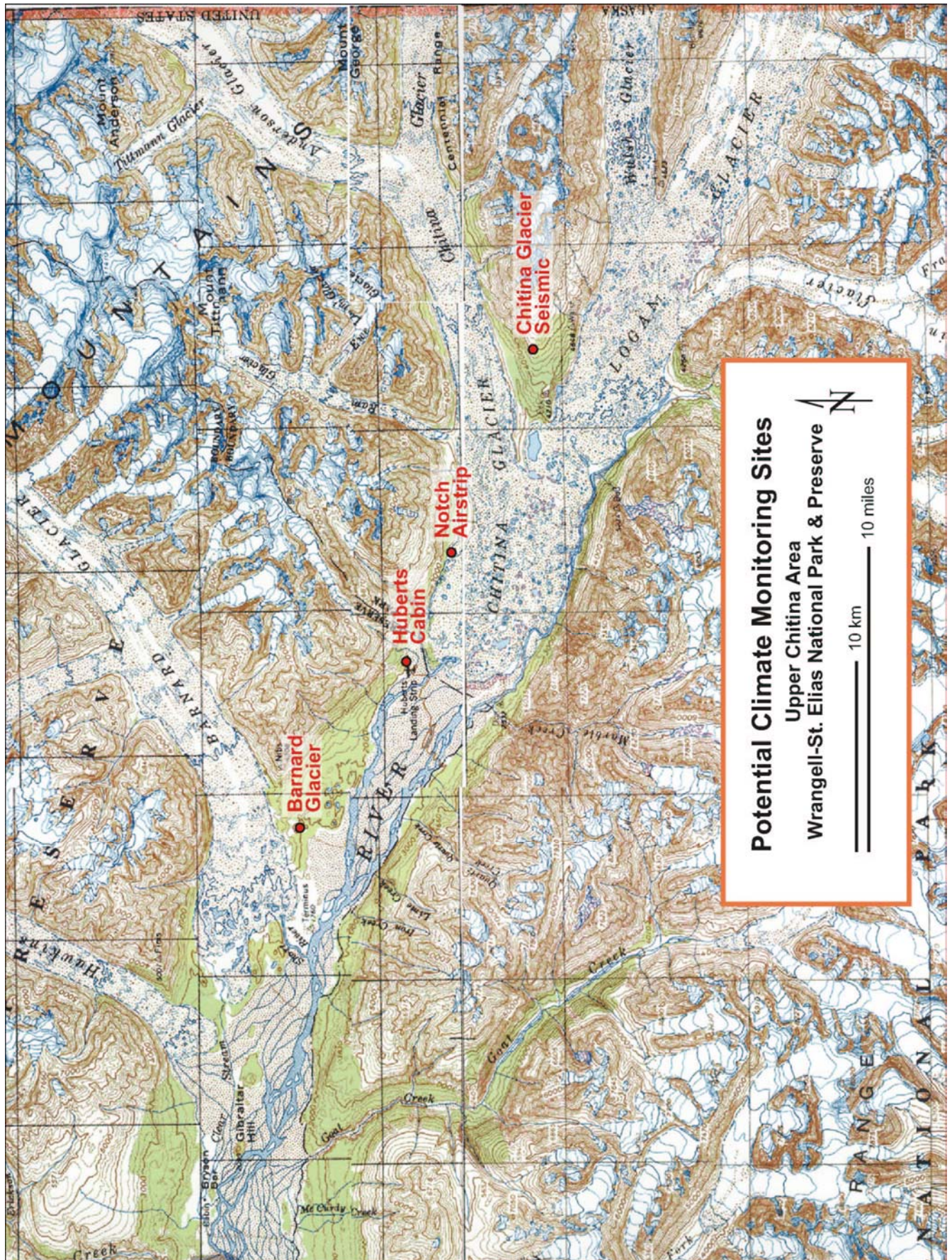
Access: Float or ski plane to Beaver Lake (~3 km) from site; ATV or snowmachine from Chisana (~15 km).

Notes:

- less protected than Chicken site
- flat
- windy, exposed; poor precipitation/snow potential
- no features to create microclimate
- wilderness



Note Euche in background



Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **Chitina Glacier Seismic**

Area: Upper Chitina Valley

Coordinates: 60° 57' 54.69" N, 141° 20' 16.28" W (NAD27)

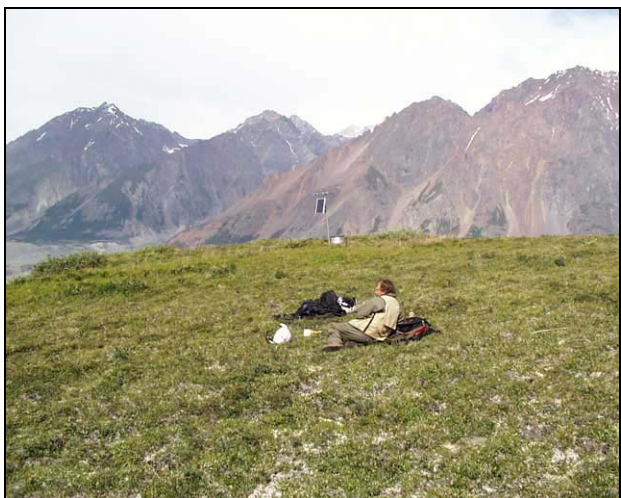
Elevation: 4950'

Description: Gently rounded, broad knob above confluence of Chitina and Logan Glaciers; wide open exposure to Chitina river valley and Chitina and Logan Glaciers; slightly hummocky but level site. Mostly dry tundra with sparse willow (<1 m high).

Access: Helicopter only, but co-located with long-term seismic station.

Notes:

- possibly windy and snow-blown
- probably representative of high-elevation winds, but rain and snow could be a challenge
- plenty of flat space
- good site for climate regime in eastern area of park nearest two highest mountains (Logan and St. Elias)
- highest elevation site on south side of Wrangell Mountain Range
- wilderness
- See attached Chitina GI W images





Chitina Glacier Seismic

Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **Notch Airstrip**

Area: Upper Chitina Valley

Coordinates: 60° 00' 22.41" N, 141° 31' 55.89" W (NAD27)

Elevation: 2600'

Description: Large, level, gravelly clearing, ~100 m across, surrounded by spruce forest; protected from Chitina Glacier on south by old moraines. (Old river channel skirting glacier, now long abandoned.)

Access: Located adjacent to airstrip.

Notes:

- representative of lower elevation riparian forest ecosystem
- limited potential for flooding
- well protected by spruce and surrounding moraines
- good precipitation and snow potential
- potential snow course or aerial marker site
- on game trail in high bear use area
- area used by hunters, game trails
- good eastern location in Park
- good access
- wilderness



Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **Huberts Cabin**

Area: Upper Chitina Valley

Coordinates: 61° 01' 36.96" N, 141° 38' 05.16" W (NAD27)

Elevation: 2200'

Description: Three possible sites on bluff above and downstream from cabin; good south exposure over Chitina Valley, sheltered by dense spruce forest to north (would require quite a bit of clearing).

Access: Airstrip ~300 m from cabin (farther to sites).

Notes:

- representative of lower elevation riparian forest ecosystem
- sites would require extensive clearing
- lots of bear sign
- area used by hunters
- cabin and surrounding structures are historic
- protected, good precipitation potential
- good access with cabin



Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **Barnard Glacier**

Area: Upper Chitina Valley

Coordinates: 61° 04' 31.91" N, 141° 47' 56.80" W (NAD27)

Elevation: 1900'

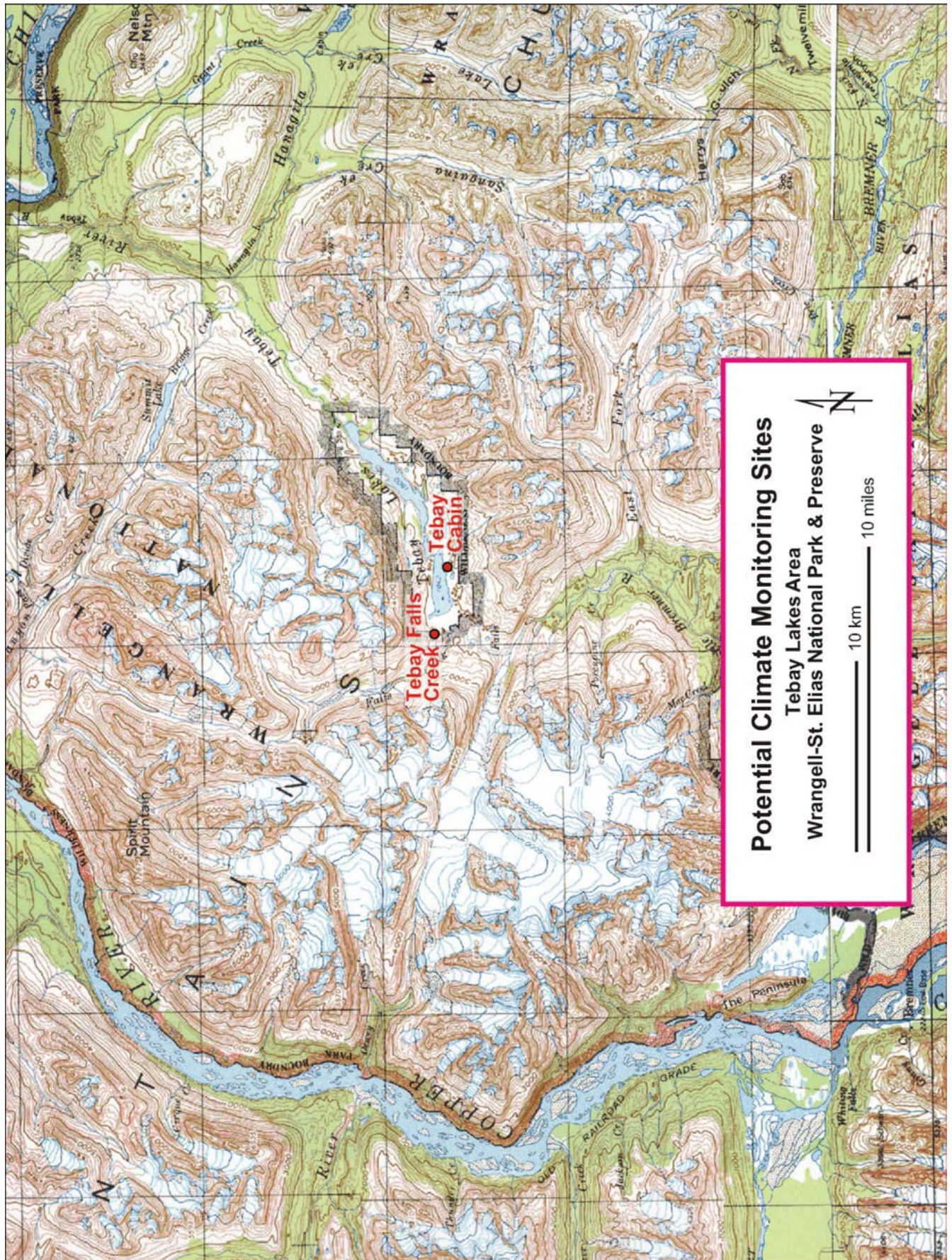
Description: Large, clearing on Barnard Glacier lateral moraine (old spillover channels, long abandoned); sheltered by surrounding spruce forest. Slightly sloping, but with some small flat areas.

Access: Possible fixed-wing landing on nearby Chitina gravel bars; otherwise, helicopter only.

Notes:

- well protected, open forest site
- good precipitation and snow potential
- potential snow course or aerial marker site
- not as far east as other Upper Chitina sites
- less flooding potential than Notch Airstrip site
- bison in area
- wilderness





Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **Tebay – Falls Creek**

Area: Tebay Lakes

Coordinates: 61° 11' 17.33" N, 144° 24' 01.34" W (NAD27)

Elevation: 2000'

Description: Large, level meadow areas in undulating terrain; protected by rocky outcrops and tall willow and alder thickets. ~1 km from Upper Tebay Lake, and 30 m above lake; out of lake wind corridor.

Access: Airstrip on lake delta (~1 km from site).

Notes:

- good western area of Park, in Chugach ecoregion
- semi protected and out of lake wind tunnel
- not tied to another station (high-low elevation)
- moderate elevation, yet surrounded by glaciers
- potential for avalanches
- aerial marker for snow
- bear trails
- wilderness



Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **Tebay Cabin**

Area: Tebay Lakes

Coordinates: 61° 10' 54.12" N, 144° 20' 15.95" W (NAD27)

Elevation: 1880'

Description: Open forest and meadow near treeline, nestled on vegetated alluvial between bedrock ridges. Mosaic of bark beetle killed spruce trees

Access: Fixed wing to strip on south end of lake (1 mile) as well float plane and skis to the lake, otherwise helicopter

Notes:

- good western area of Park, in Chugach ecoregion
- very protected
- not tied to another station (high-low elevation)
- moderate elevation, yet surrounded by glaciers
- aerial marker snow site
- flat with soils
- wilderness



Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **Cheshnina**

Area: Cheshnina

Coordinates: 61° 48' 46.41" N, 144° 25' 46.39" W (NAD27)

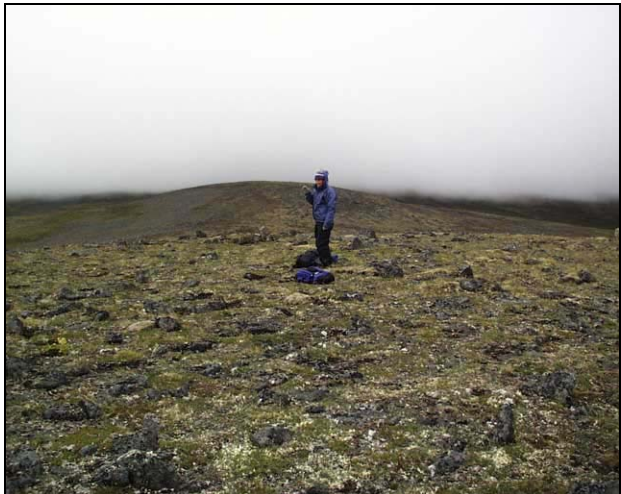
Elevation: 4940'

Description: Broad, flat plateau extending down off Mt. Wrangell (andesite flow), very exposed with expansive views in all directions. Stony dry tundra; high alpine windblown environment.

Access: Helicopter only.

Notes:

- very exposed and windy spot
- station would need modification to withstand high winds
- poor precipitation and snow potential
- probably not suitable for soil temperature sensors
- high-elevation counterpart to Kenny Lake and Chitina sites on west end of Park
- Wrangell Plateau climatic regime
- wilderness



Central Alaska Network
Wrangell-St. Elias National Park and Preserve
Potential Climate Monitoring Sites

Site: **Long Glacier**

Area: Cheshnina

Coordinates: 61° 49' 19.84" N, 144° 04' 40.59" W (NAD27)

Elevation: 4820'

Description: Broad, rolling hills on high plateau (old andesite flow) above Long Glacier and below Cheshnina Glacier; very open in all directions. Flat, high alpine windblown environment; dry tundra, a little hummocky, but not stony.

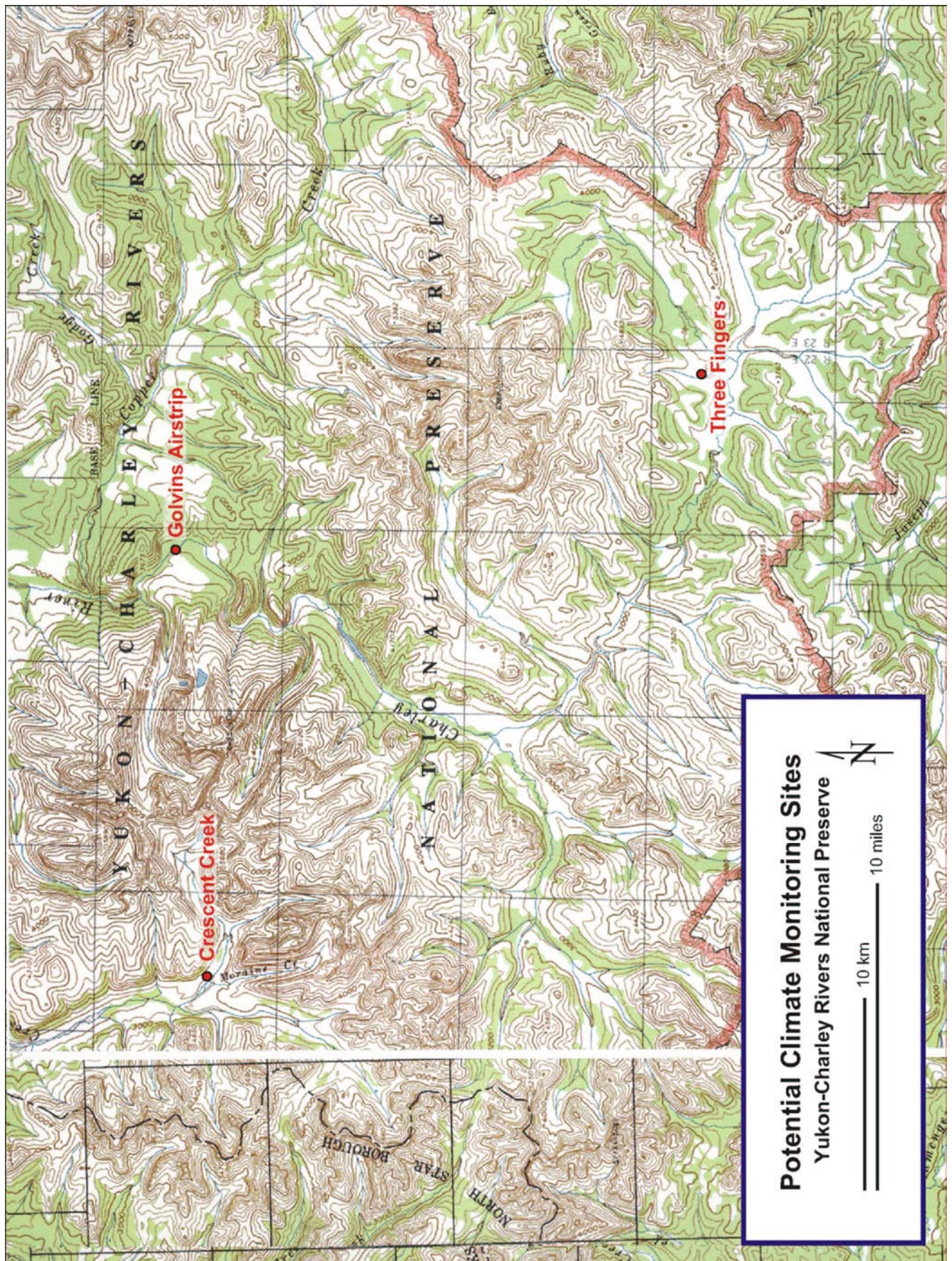
Access: Airstrip ~1 km from site.

Notes:

- very exposed and windy, although probably a little less so than Cheshnina site
- concerns regarding poor precipitation and snow potential
- heavily influenced by glacial winds blowing straight off Mt. Wrangell
- high-elevation counterpart to Kenny Lake and Chitina sites on west end of Park
- Wrangell Plateau climatic regime
- better access than Cheshnina site
- wilderness



Appendix B: Potential climate monitoring sites, Yukon-Charley Rivers National Preserve



Central Alaska Network
Yukon-Charley Rivers National Preserve
Potential Climate Monitoring Sites

Site: **Three Fingers**

Area: Yukon-Tanana Uplands Ecoregion

Coordinates: 64° 34' 32.47" N, 143° 14' 27.67" W (NAD27)

Elevation: 3180'

Description: Broad, open plain at headwaters of Charley River. Level, well-drained gravel with scattered dwarf birch on floodplain next to small creek. Bench above floodplain very tussocky with denser, higher dwarf birch. Site is ~5 km from existing aerial snow marker.

Access: Airstrip suitable for landing a 185; hunting camps frequently set up next to strip.

Notes:

- probably not too windswept — good for snow and precipitation data
- flat and anchorable ground on creek floodplain
- possible flooding and/or aufeis on floodplain
- huge tussocks on benches above creek floodplain — anchoring tower well there would be very difficult
- evidence of recent hunter use (campfire pits, fresh sawed bones) next to airstrip
- good sites across creek from airstrip (still on floodplain but away from hunter camps)
- relatively close to aerial snow marker (possible to relate data?)



Central Alaska Network
Yukon-Charley Rivers National Preserve
Potential Climate Monitoring Sites

Site: **Crescent Creek**

Area: Yukon-Tanana Uplands Ecoregion

Coordinates: 64° 48' 31.53" N, 143° 54' 37.92" W (NAD27)

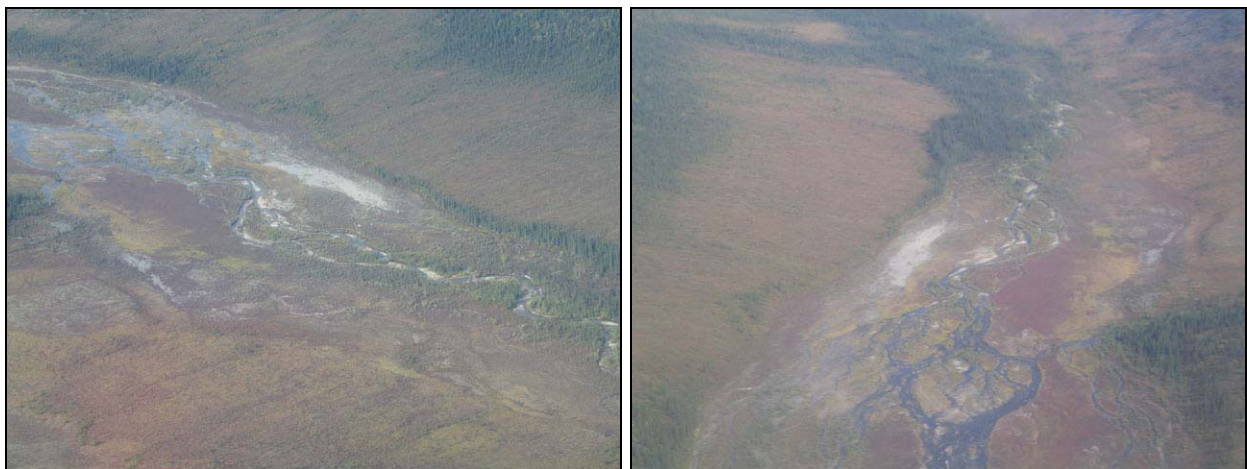
Elevation: 2850'

Description: Wide, open valley on western edge of Preserve, with sparse riparian vegetation. Site is near existing aerial snow marker.

Access: Airstrip suitable for Supercub (and possibly Husky) only; Fortymile Air uses strip; hunting camps frequently set up next to strip.

Notes:

- ground assessment needed
- far western edge of Preserve at 144° longitude line (perhaps different climatic regime per Rick Thoman)
- good Yukon-Tanana Uplands high elevation site
- doesn't appear to get too windblown or suffer from river wind corridor effects
- relatively close to aerial snow marker (possible to relate data?)
- hunting camp next to airstrip — should locate station some distance away



Central Alaska Network
Yukon-Charley Rivers National Preserve
Potential Climate Monitoring Sites

Site: **Gelvins Airstrip**

Area: Yukon-Tanana Uplands Ecoregion

Coordinates: 64° 49' 20.00" N, 143° 25' 57.00" W (NAD27)

Elevation: 2100'

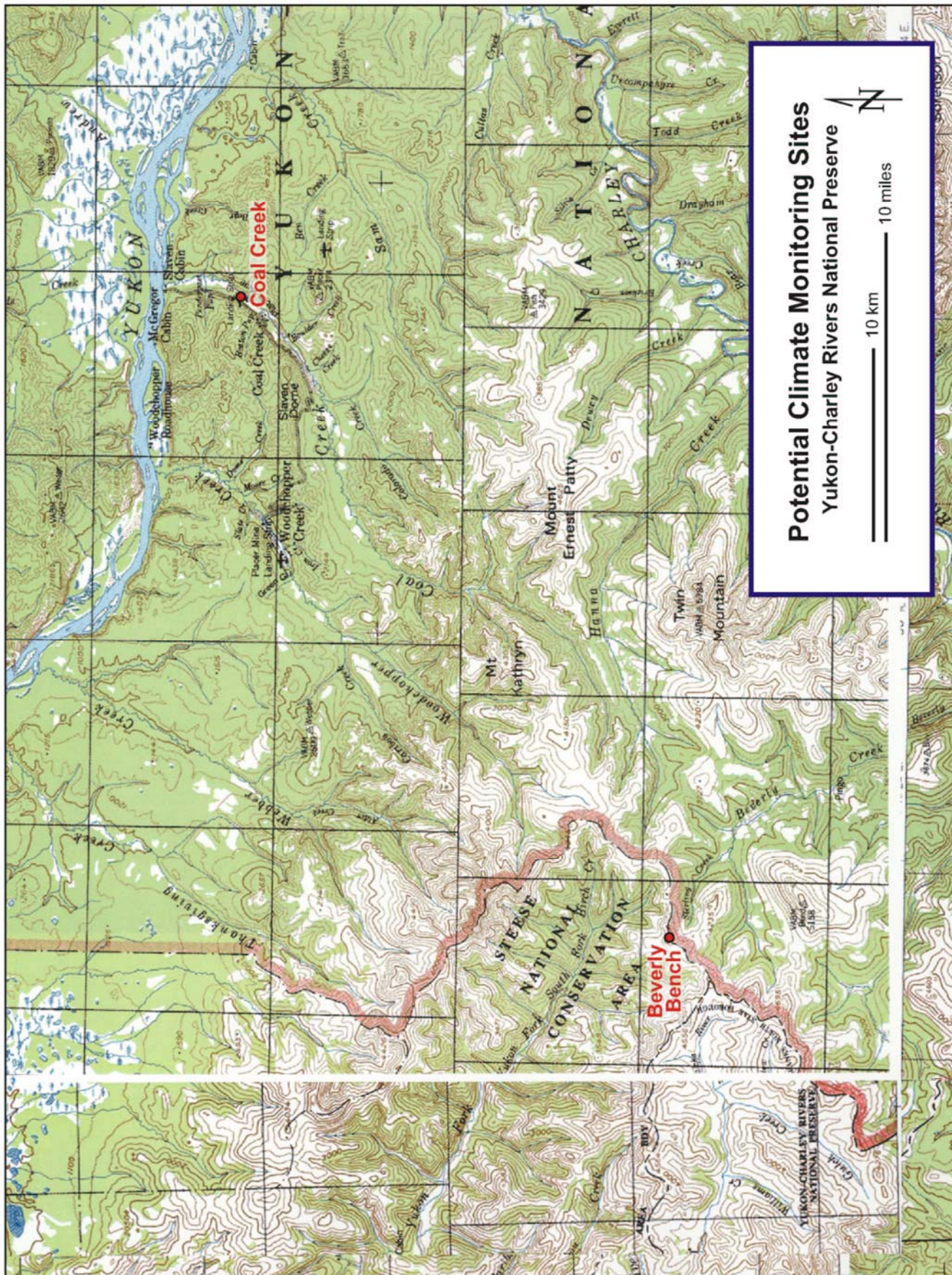
Description: Wide, open valley along Charley River. Gravel bars along river; spruce forest in valley bottom; meadowy oxbow slough clearings away from river.

Access: Airstrip suitable for 185 light loads only (2 people in, 1 person out); popular Charley River float put-in site.

Notes:

- ground assessment needed
- good mid-elevational site
- gravel bars subject to flooding and river corridor wind influence
- spruce forest in valley bottom would require some clearing
- meadowy oxbow slough clearings away from river are open yet protected from river effects
- how wet are meadowy areas? tussocky?





Central Alaska Network
Yukon-Charley Rivers National Preserve
Potential Climate Monitoring Sites

Site: **Beverly Bench**

Area: Yukon-Tanana Uplands Ecoregion

Coordinates: 65° 06' 40.16" N, 143° 50' 12.20" W (NAD27)

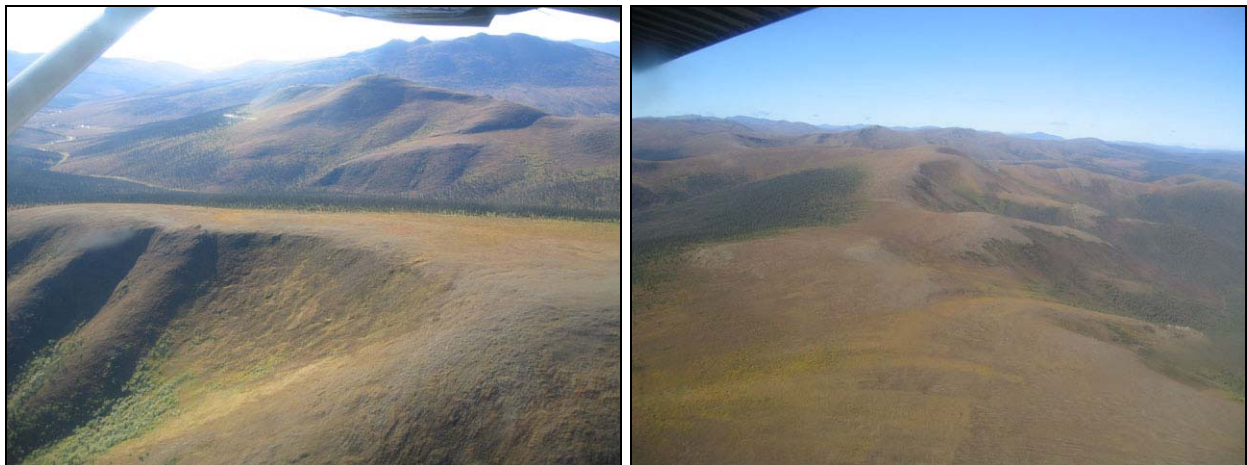
Elevation: ~4000'

Description: Flat, windswept ridgetop on western boundary of Preserve; low tundra.

Access: Airstrip probably suitable for Husky only (marginal for 185).

Notes:

- ground assessment needed
- far western edge of Preserve at magic 144° longitude line (perhaps different climatic regime per Rick Thoman)
- good Yukon-Tanana Uplands high elevation site
- probably too windswept to collect good snow and precipitation data
- very flat, but how tussocky?
- good hobo datalogger site



Central Alaska Network
Yukon-Charley Rivers National Preserve
Potential Climate Monitoring Sites

Site: **Coal Creek**

Area: Yukon-Tanana Uplands Ecoregion

Coordinates: 65° 18' 50.05" N, 143° 07' 56.38" W (NAD27)

Elevation: 870'

Description: Bottom of broad, open valley, ~4 km above confluence with Yukon River (170 feet higher than Yukon River). Occasional, protected openings in dense alder and willow thickets; rocky substrate (old gold dredge tailings)

Access: Adjacent to large, well-maintained airstrip near Coal Creek Camp.

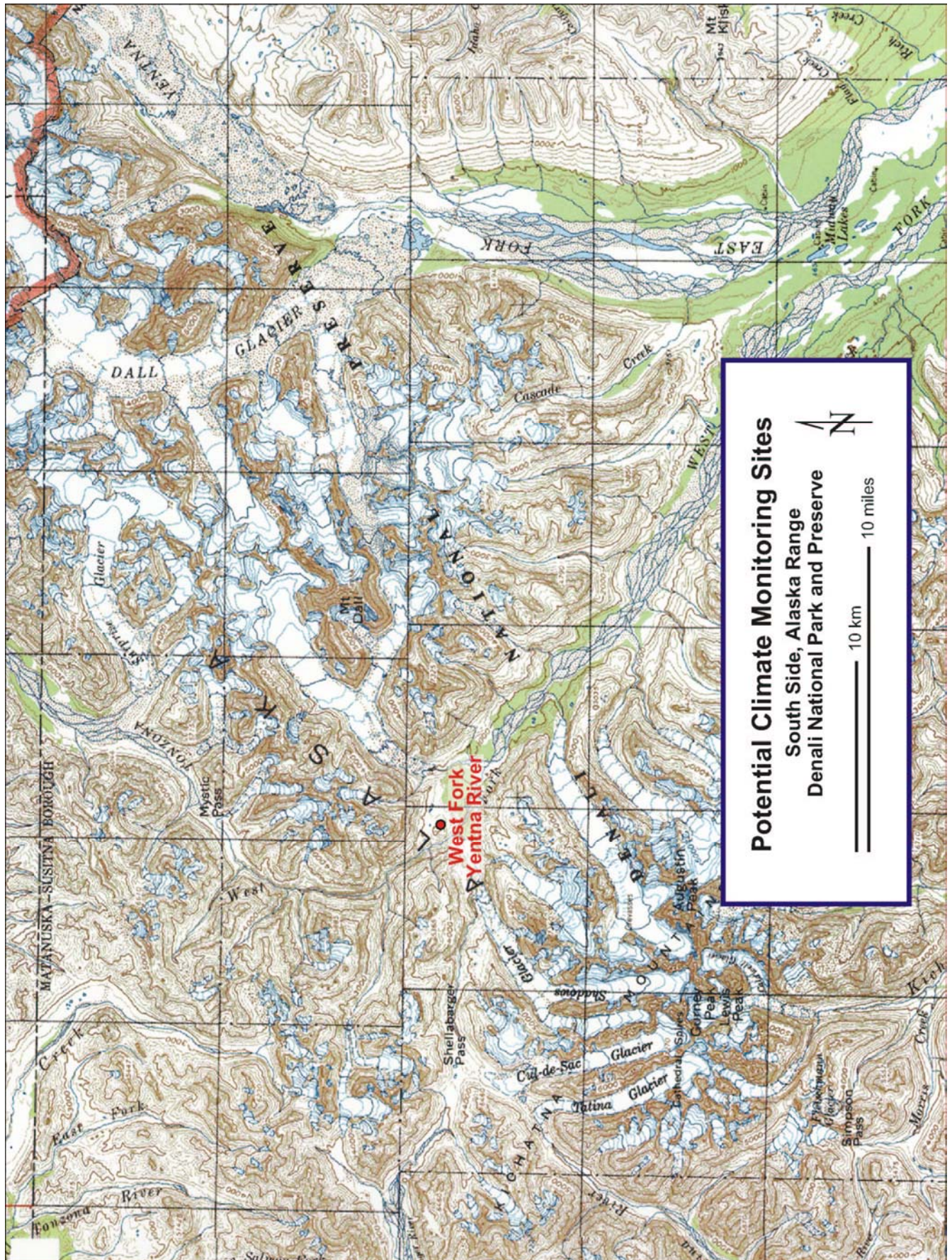
Notes:

- relatively protected, good precipitation and snow depth potential
- easy access by fixed-wing, frequent flights
- only 3.5 km from Ben Creek RAWS, but ~1000' lower in elevation
- in Coal Creek historic district
- poor soil temperature/moisture location (tailings); possibly better potential if located well off airstrip



(views of airstrip near potential site)

Appendix C: Potential climate monitoring sites, Denali National Park and Preserve



Central Alaska Network
Denali National Park and Preserve
Potential Climate Monitoring Sites

Site: **West Fork Yentna River**

Area: Denali South Side – Alaska Range Ecoregion

Coordinates: 62° 32' 07.8" N, 152° 31' 41.8" W (NAD27)

Elevation: 1840'

Description: Level clearing above small lake in undulating terrain on south side of Alaska Range; wide, open area at confluence of three major drainages, but protected by surrounding low hills and tall willow thickets. ~1000 feet above and 4 km up-valley from current snow marker in West Fork Yentna River floodplain.

Access: Helicopter only.

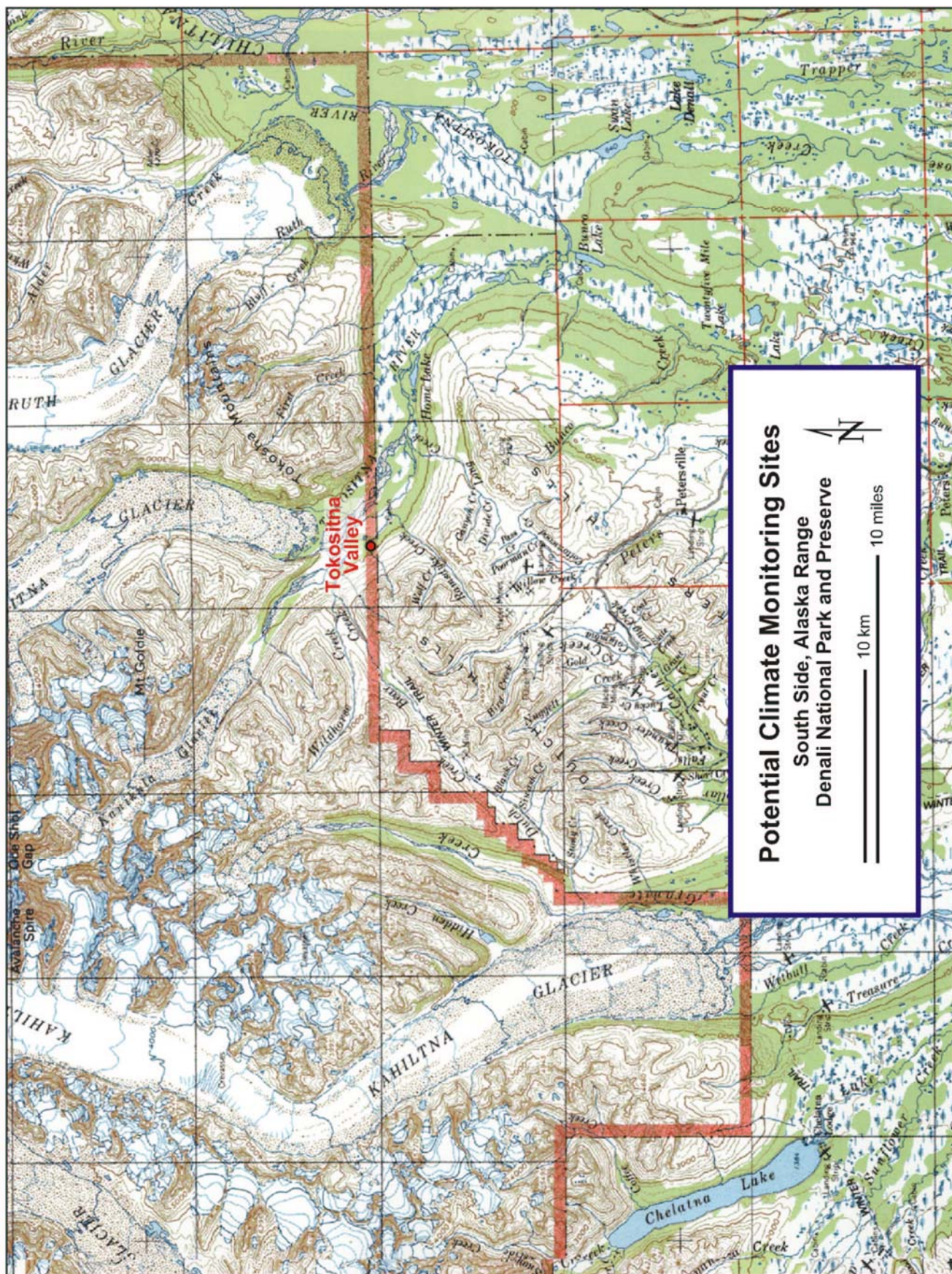
Notes:

- good regional representation (out of river floodplain)
- good snow and precipitation site
- good GOES and solar exposure
- near original aerial snow marker site (on floodplain)
- flat, anchorable ground
- great blueberries
- access is difficult — far and costly





West fork Yentna Setting



Central Alaska Network
Denali National Park and Preserve
Potential Climate Monitoring Sites

Site: **Tokositna Valley**

Area: Denali South Side – Alaska Range Ecoregion

Coordinates: 62° 38' 33.52" N, 150° 47' 46.90" W (NAD27)

Elevation: 860'

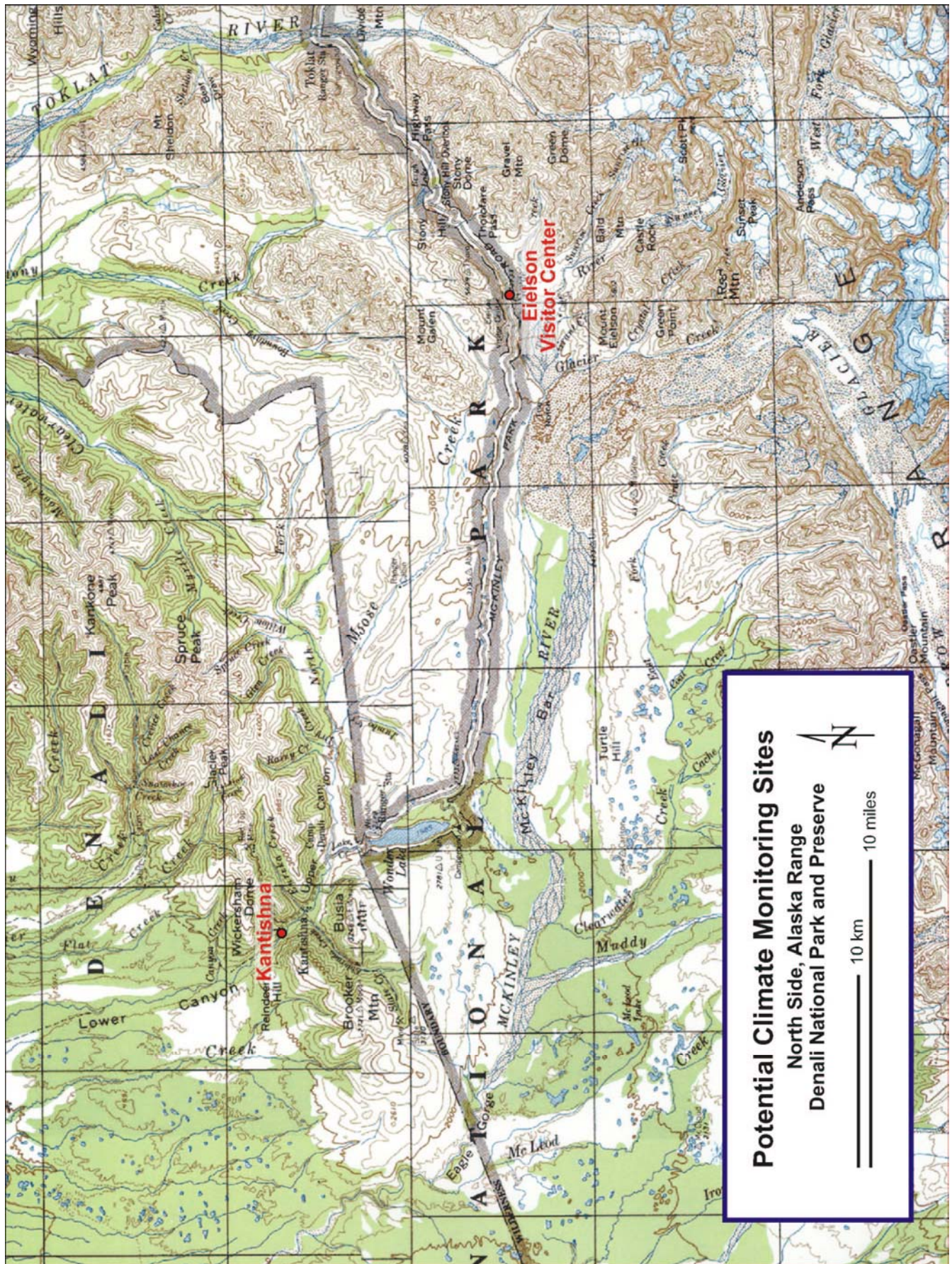
Description: Low elevation, wide river valley on south side of Alaska Range; large cottonwood and white spruce forest with alder in clearings. 100 feet above Tokositna River floodplain. Dry, tussocky ground, with devils club and other tall vegetation that would need to be cleared.

Access: Snowmachine access in winter; otherwise, helicopter only.

Notes:

- co-located with long-term aerial snow marker; good year-round precipitation site
- good representative site for low-elevation river valleys on south side of Alaska Range
- fifteen minute flight from Talkeetna
- could pair with high elevation site in Dutch Hills
- site reconnaissance done with Rick McClure of NRCS
- Potential to upgrade aerial marker to Snotel site for year round precipitation measurements





Central Alaska Network
Denali National Park and Preserve
Potential Climate Monitoring Sites

Site: **Eielson Visitor Center**

Area: Denali North Side – Alaska Range Ecoregion

Coordinates: 63° 25' 52.70" N, 150° 18' 34.00" W (NAD27)

Elevation: 3730'

Description: Sloping bench on south flank of Thorofare Mountain, with wide open views across Thorofare River to the Alaska Range (several miles to south). Dry tundra with a few low willows; ground slightly hummocky, but generally level sites available.

Access: Road access in summer; dogsled or helicopter only in winter.

Notes:

- very high visitor use area in summer
- good high-elevation counterpart to existing north-side sites (all of which are much lower elevation)
- relatively good regional perspective
- just below Thorofare radio repeater site (paired high elevation site)
- NWS forecasters interested in data from Visitor Center
- New Eielson Visitor Center design includes a climate monitoring station



(views of general Eielson area)

Central Alaska Network
Denali National Park and Preserve
Potential Climate Monitoring Sites

Site: **Kantishna**

Area: Denali North Side (Kantishna Hills) – Alaska Range Ecoregion

Coordinates: 63° 32' 17.21" N, 150° 59' 06.17" W (NAD27)

Elevation: 1570'

Description: Bottom of a northwest–southeast trending valley; open area in spruce forest, well protected by surrounding trees; level but hummocky tundra with scattered low brush.

Access: 0.5 km from airstrip; road access in summer.

Notes:

- fairly high-use area in summer months (near Denali Backcountry Lodge)
- good year-round access
- co-located with long-term snow course
- protected, good precipitation potential
- close to existing Wonder Lake RAWS – 5 miles
- Potential to upgrade snow course to Snotel site



Appendix D

Snowpack Monitoring Protocol for the Central Alaska Network

Central Alaska Network Snow Monitoring Locations

A number of new snowpack monitoring sites have been selected for the Central Alaska Network. This selection was based on the Climate Site Evaluation 2004 document (Appendix A) reviewed in 2004 by a panel of climate experts. The new sites (by park) are listed below. The maps that follow show the existing climate sites, snow monitoring sites, and potential new sites evaluated for the network in 2003 and 2004.

Prioritized snowpack monitoring sites in the Central Alaska Network

Park	Station Name	Ecoregion/ Subsection	Elev.	Latitude	Longitude	Installation Date	Type
WRST	Tebay	Chugach –St. Elias Mtns./ N. Chugach Cirque - Glacier	1880	61° 10' 54.12"	144° 20' 15.95"	7/2004	Aerial Marker/ SNOTEL (?)
	Long glacier	Wrangell Mountains Chesnina Plateaus & Valleys	4820	61° 49' 19.84"	144° 04' 40.59"	7/2004	Aerial Marker
	Gold Hill	Kluane Ranges /S. Nutzotin Hills & Mtns.	5930	62° 05' 36.45"	141° 54' 00.48"	2005	Aerial Marker
	Notch Airstrip	Chugach St. Elias Mtns. /Chitina and Logan Glaciers	2600	61° 00' 22.41"	141° 31' 55.89"	2005	Aerial marker
	Jumbo Trail	Wrangell Mtns./ McCarthy Mtns.	3700	61° 30' 20.36"	142° 51' 50.38"	2005	Aerial marker
	Tana Airstrip	Chugach-St.Elias / Tana Valley	1440	60° 56' 22.18"	142° 41' 51.68"	2005	Aerial marker
DENA	Upper West Fork Yentna	Alaska Range / West Fork Yentna Valley	1840	62° 32' 07.80"	152° 31' 41.80"	2003	Aerial marker
	Dunkle	Alaska Range/ Dunkle Hills	2770	63° 16' 5.66"	149° 32' 19.92"	2003	Aerial marker

	Eldridge glacier	Alaska Range / NE Tributary Eldridge Glacier	3260	63° 02' 48.6"	150° 03' 22.6"	2003	Aerial marker
	Kantishna	Alaska Range/ N. Alaska Range Kantishna Hills	1570	63° 32' 17.21"	150° 59' 06.17"	2005	SNOTEL
YUCH	Three Fingers	Yukon Tanana Uplands/ Upper Charley River drainage	3180	64° 34' 32.47"	143° 14' 27.67"	2007	SNOTEL

Climate and snowpack monitoring sites evaluated, reviewed and prioritized for CAKN in Wrangell – St. Elias National Park and Preserve:

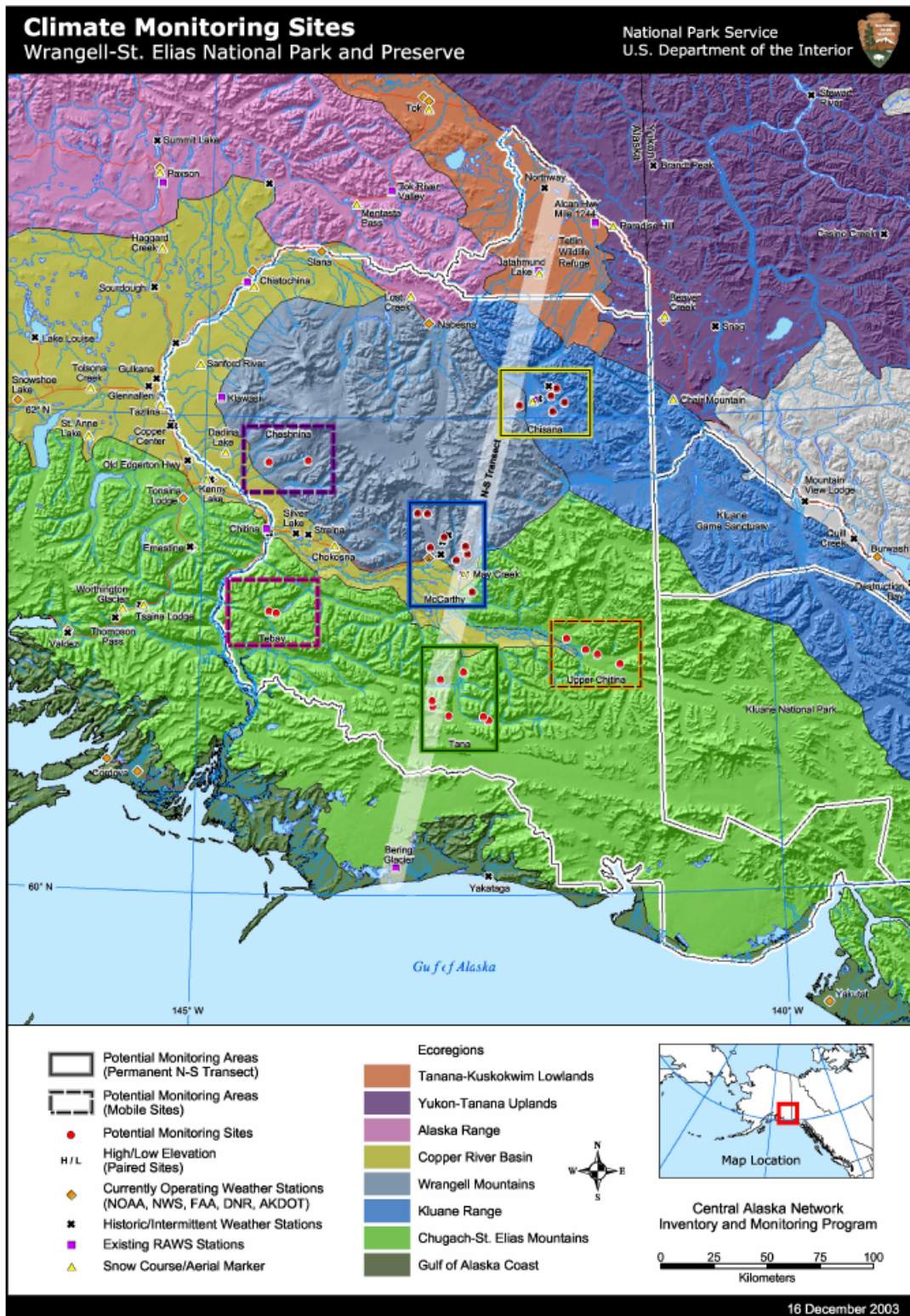


Figure 1 Wrangell St. Elias National Park and Preserve Snow Monitoring (and climate) stations.

Climate and snowpack sites evaluated, reviewed and prioritized for CAKN in Yukon – Charley Rivers National Preserve

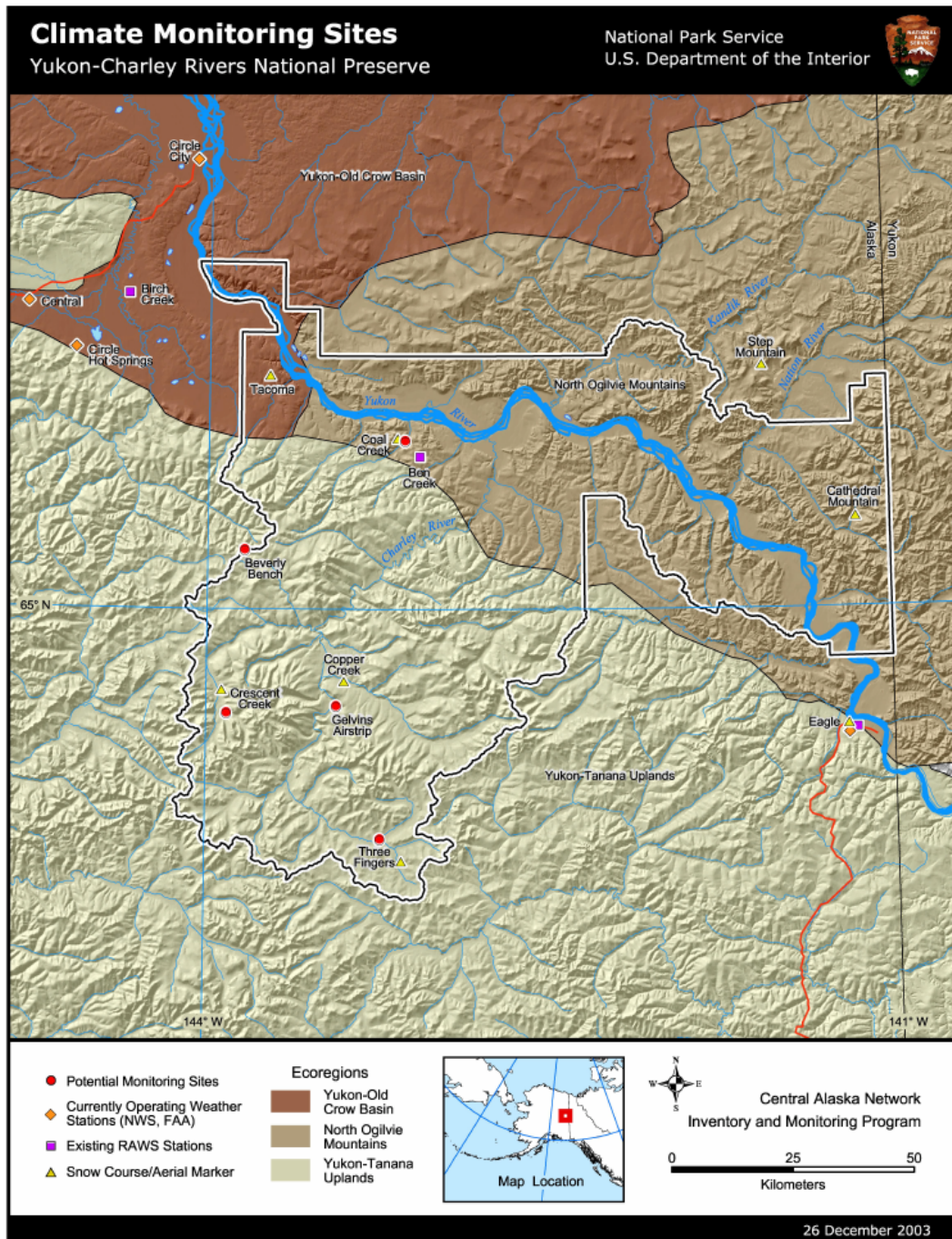


Figure 2 Yukon - Charley Rivers National Preserve snow monitoring (and climate) sites.

Climate and snowpack sites evaluated, reviewed and prioritized for CAKN in Denali National Park and Preserve

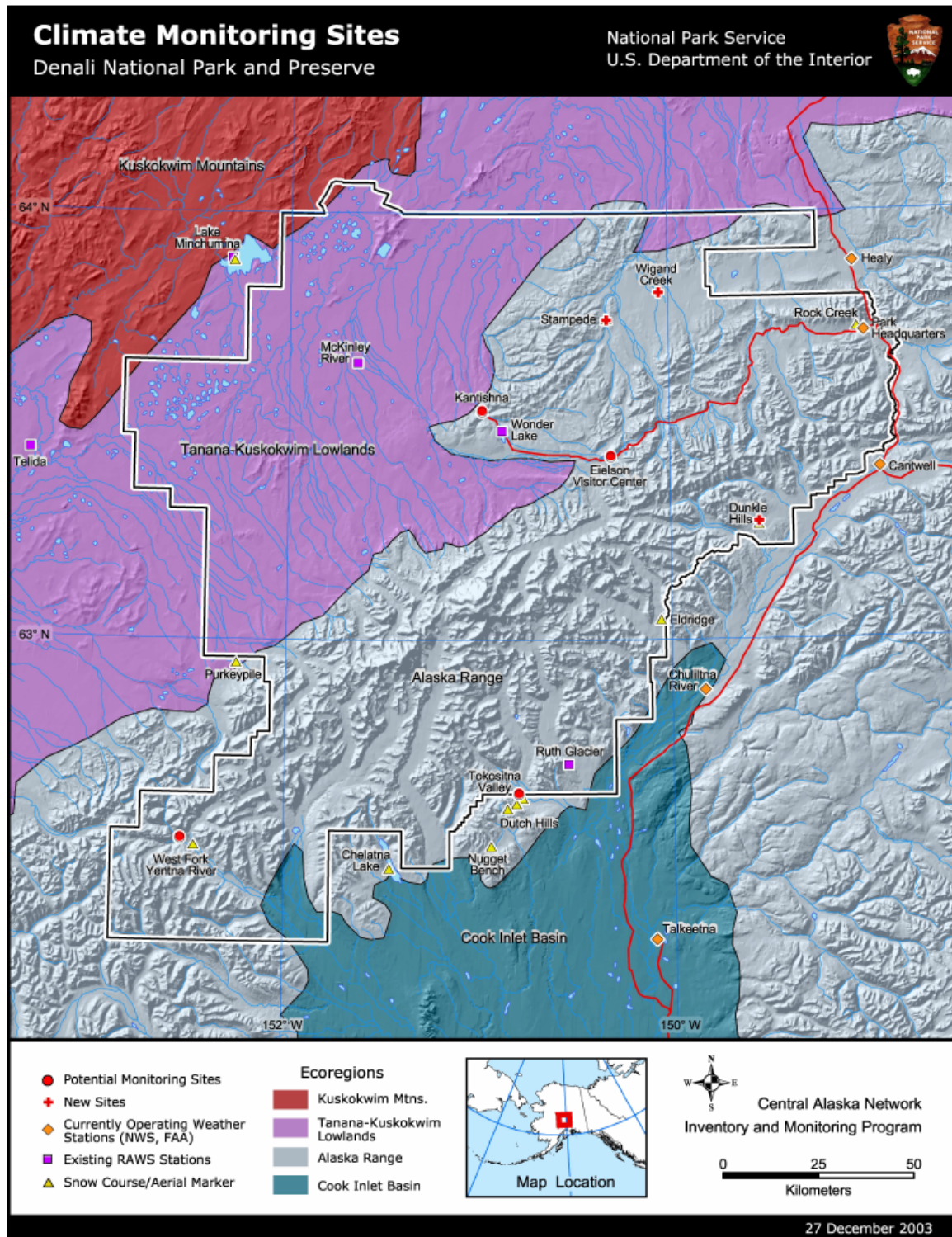


Figure 3 Yukon - Charley Rivers National Preserve snow monitoring (and climate) sites