Environmental Assessment of a Biocomplexity Study of the Response of Tundra Carbon Balance to Warming and Drying Across Multiple Time Scales, 2005-2008

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1. ABSTRACT

This project will examine how biological and physical processes interact to control carbon uptake, storage and release in Arctic tundra ecosystems building on decades of prior research by using an experimental approach to manipulate tundra moisture. Approximately 25% of the world's soil organic carbon reservoir is stored at high northern latitudes in permafrost and seasonally-thawed soils in the Arctic, a region that is currently undergoing unprecedented warming and drying, as well as dramatic changes in human land use. The objective of this study is to quantify linkages between soil moisture and carbon uptake, storage and release over multiple spatial (microbial to landscape) and temporal (minutes to decades) scales. Understanding how changes in annual and inter-annual ecosystem productivity interact and potentially offset the balance and stability of the Arctic soil carbon reservoir is of utmost importance to global climate change science. If there is a net loss of soil carbon to the atmosphere in the form of greenhouse gases (namely CO_2 and CH_4), greenhouse warming could be enhanced. This non-linear, potentially positive feedback response could very quickly cause Arctic terrestrial ecosystems to function in a manner not known to us from the late Holocene and with globally significant implications.

This study takes a multi-scale approach, from satellite remote sensing to a site-specific manipulation. The study region encompasses many long-term measurement sites that have been in place for 5 to 10 years. Building on past measurements, the project is focused on a soil moisture manipulation involving a 60-hectare tundra flooding/draining experiment near Barrow, Alaska on the Arctic Coastal Plain. The project is located within the Barrow Environmental Observatory (BEO). The BEO is 7,446 acres of land owned by the Ukpeagvik Inupiat Corporation (UIC) in a designated Conservation District that has been further zoned as a scientific research district for long-term, experimental studies such as this.

The project involves installation of overhead power lines, the use of temporary dikes for flooding and draining of the study site, and the installation of a communications tower, robotic sensor track system, two small removable raised buildings, raised boardwalks along the robotic sensor track and trail matting to protect the tundra at the study site. A permit has been acquired by the project from the U.S. Army Corps of Engineers for the manipulation of wetland tundra. The U.S. Fish and Wildlife Service issued a Biological Opinion finding of non-jeopardy through the Section 7 Consultation required by the Endangered Species Act regarding the two threatened species that may be encountered or displaced by the project, Steller's eiders and spectacled eiders.

This Environmental Assessment takes into consideration the potential of the project to impact the environment. These potential impacts were considered thoroughly during project planning and are considered to have no significant impact on the environment with the implementation of the associated mitigating measures defined in this documents and in the US ACOE permit.

2. PURPOSE AND NEED

This research project, "Biocomplexity Associated with the Response of Tundra Carbon Balance to Warming and Drying Across Multiple Time Scales" (OPP #0421588) was funded through the National Science Foundation (NSF) Biocomplexity in the Environment (BE) program. It is anticipated to be a leap forward in the field of biocomplexity and climate change and pushes the frontiers of available experimental and technological methods. Arctic terrestrial ecosystems are changing dramatically in response to recent persistent regional warming and drying trends. These changes are of critical importance to climate and the global carbon cycle because roughly 25% of the world's soil organic carbon reservoir is currently stored at high northern latitudes in permafrost and seasonally-thawed Arctic soils. Vegetation, soil moisture, active layer depth and drainage, biogeochemical cycling, temperature, and precipitation all interact in the Arctic to form a complex system that is sensitive to change. Arctic ecosystems function near the freezing point of liquid water, where relatively small changes in the thermal and hydrological regime can result in large, non-linear changes in ecosystem function (Le Dizes *et al*. 2003; Michaelson and Ping, 2003). The function of arctic tundra ecosystems exhibit biocomplexity in that underlying physical and biological processes appear to be hierarchical, self organizing, strongly interconnected, limited by threshold effects, and non-linear, which causes strong variation over multiple scales of space and time and are dependent upon historical conditions and micro-topographical variations (Figure 1). Large-scale and long-term experimental manipulations may be the optimal means to resolve the multiple interacting processes and components of arctic tundra ecosystems and understand how they function in order to reach a deeper understanding of the spatial and temporal dynamics of the arctic system as it responds to global change.

Recent increases in average air temperature and permafrost temperature are altering the carbon sink-source dynamics of arctic tundra ecosystems. The tundra is becoming warmer and drier (Chapman and Walsh, 1993; Oechel *et al.* 1993; 1995; 2000a; Serreze *et al*. 2000). Soil moisture variability is a major factor governing spatial patterns of tundra carbon cycle dynamics across multiple and interacting spatial, temporal and biological organizational scales. Soil carbon storage is greatest where microbial activity is limited by high soil moisture, as is the case where drainage is slight and the water table is held near the surface by permafrost and topography. However, current trends in permafrost degradation caused by both climatic and land use changes are increasingly being recognized as profoundly altering tundra hydrologic and carbon cycle processes. Soil hydrology also has a major influence on the soil thermal regime (Luthin and Guymon, 1974). Subtle differences in topography can significantly alter drainage and create cooler, saturated wetlands or warmer, drier uplands with concomitant effects on soil carbon storage.

Permafrost thaw and associated increases in soil active layer depth from warming can cause surface subsidence, reductions in soil water table, vegetation change (Hinzman *et al.* 2004, *in press*), and potentially, thermokarst erosion and drainage (Hinzman *et al.* 1997). Drainage can markedly increase soil decomposition and soil carbon loss (Oberbauer *et al.* 1991; 1996) but some of the carbon loss may be in the form of net primary productivity, plant growth. NPP has further confounding effects on hydrology, soil carbon loss and uptake, carbon respiration, and soil temperature, depending on the vegetation type.

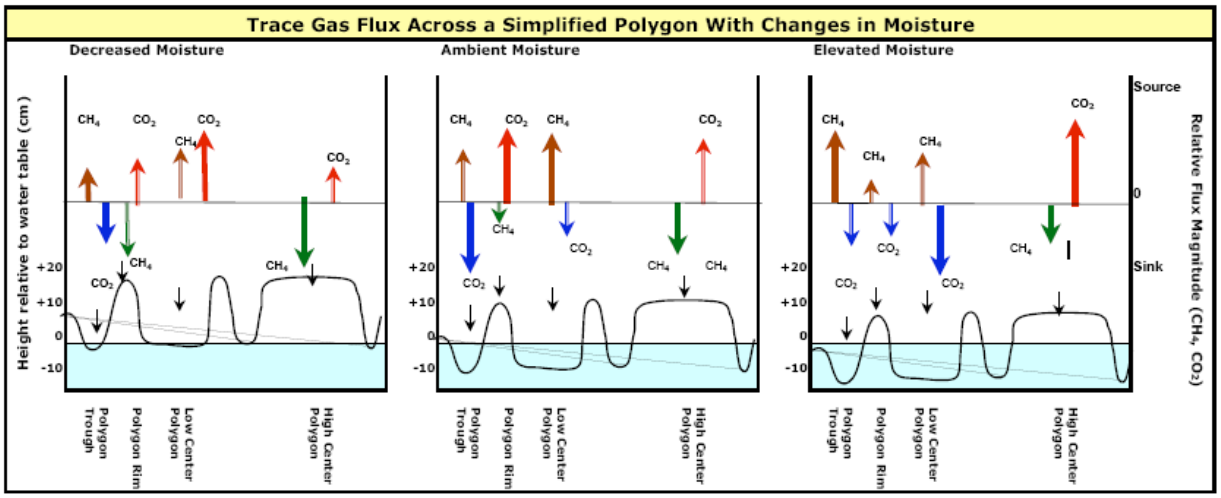

Figure 1: Hypothetical schematic of the effect of variation in water table on trace gas flux across a complex topographic gradient. The same change in soil moisture can differentially affect the magnitude and even the sign of CO_2 and CH_4 flux depending on antecedent conditions (topography). Areas within a meter or two can have different magnitudes and signs in CO_2 and CH_4 fluxes. Solid bars indicate the greatest source and sink activity for CO_2 and CH_4 flux under each moisture condition. Sources are brown (CH_4) and red (CO_2). Sinks are green (CH_4) and blue (CO_2).

Although tundra systems are often referred to as simple or model systems for ecosystem research, quantifying and understanding the impact of environmental change on ecosystem carbon flux at multiple spatial and temporal scales still remains a challenge to global change scientists. The temporal and spatial scales of previous field studies are poorly matched with the larger scale of arctic ecosystem modeling, making it difficult to advance or validate these models. The many non-linear, complex, interacting factors that comprise fluxes at hundreds to thousands of square kilometers and the technological difficulties in extrapolating observations and model output over time, space, and throughout different levels of biological organization in the Arctic have also been significant limitations to progress (Oechel *et al.* 2000b; 1998a).

This integrated, multi-scale approach will provide a comprehensive assessment of the range of complex, non-linear interactions among physical, biological, and human dimensions driving system behavior. Such an approach is critical to understanding and quantifying the mechanisms controlling patterns of carbon cycling spanning plot to regional and global scales and predicting the response of Arctic terrestrial ecosystems to changing temperature and moisture regimes. This approach is multidisciplinary and quantitative; utilizes a novel manipulative experimental design; employs advanced technology (e.g., mobile flux platform, wireless sensor array, and new air-borne and satellite technologies), and will benefit national and international research programs, education and public outreach, and several remote and largely indigenous communities in northern-most Alaska. This study will also form the basis of a long-term integrated multidisciplinary scientific endeavor that will continue to further our understanding of the arctic system and how it may respond to global change well beyond the life of the proposed study. This effort will lead to more accurate and efficient modeling of the carbon cycle from the level of a single plot to regional and circumpolar scales.

3. PROPOSED ACTIVITIES

This project examines the adaptability, linearity and predictability of biophysical interactions in response to variation in soil moisture at multiple spatial and temporal scales. The collaborators have carefully planned this study, working with federal regulators, land and wildlife managers in Barrow, doing outreach to the community and taking other steps to plan the research project in a way that minimizes impacts to the environment while allowing the investigators to conduct this important study of biocomplexity and climate change in the Arctic. This section of the document describes the preferred alternative; other alternatives are described in section 4 in conjunction with the evaluation of environmental impacts.

3.1 Project Location

The proposed study area is located in the Barrow Environmental Observatory (BEO; Figure 2), a reserve of land that has been set aside by the North Slope Borough and the Ukpeagvik Iñupiat Corporation. It is managed by the Barrow Arctic Science Consortium (BASC) for science and education. The BEO and nearby region have been used for scientific research intensively for over 50 years. Plans for the future of the BEO are described in the BEO Management Plan (Appendix 1).

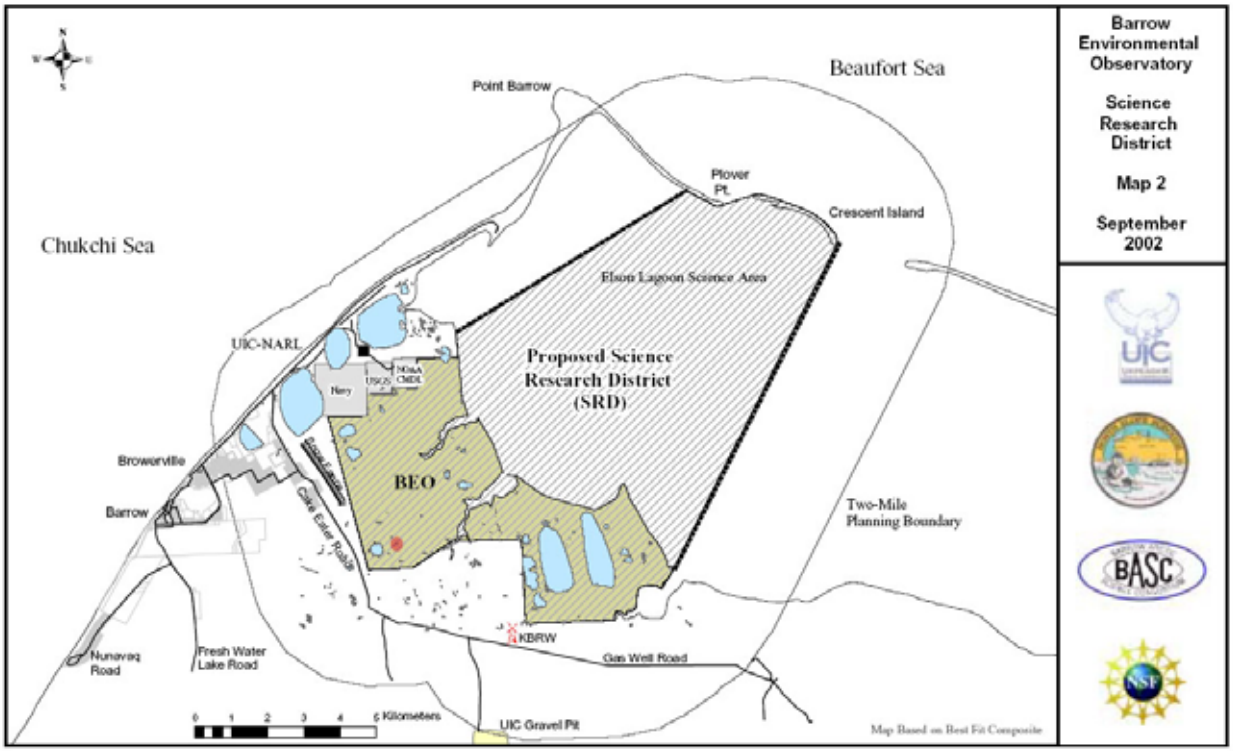

Figure 2: The Barrow Environmental Observatory (BEO). The small red circle indicates the proposed study site in the southwest portion of the BEO. Land used by the former Naval Arctic Research Laboratories (now UIC-NARL), NOAA and USGS are at the northern end of the BEO.

The manipulation will be well contained within approximately 4 km^2 and will not affect a larger area of tundra than is necessary. The hydrological manipulation concept has been approved and is strongly supported by the BASC SMAC, the Mayor of Barrow, North Slope Borough and the

Ukpeagvik Iñupiat Corporation. The study site is located 2 km south of the Arctic Ocean and is comprised of low- and high-centered polygons, ice wedges (polygon troughs), and drained lake tundra land forms (Brown *et al.* 1980). The area is close to road access, electrical power, and is within cell phone range of Barrow and within radio and RTK Differential Global Positioning System (DGPS) coverage distance from the BASC research laboratories. The manipulation will be near, but will not interfere with, existing research project infrastructure.

3.2 Experimental Flooding and Drying

Three water table levels will be established and maintained in an existing and naturally occurring drained lake basin (Figure 3). This manipulation will cause relatively minor alterations to the current wetland structure. The three levels will include one with enhanced soil moisture, one control (or natural condition), and one with reduced soil moisture. These soil moisture conditions

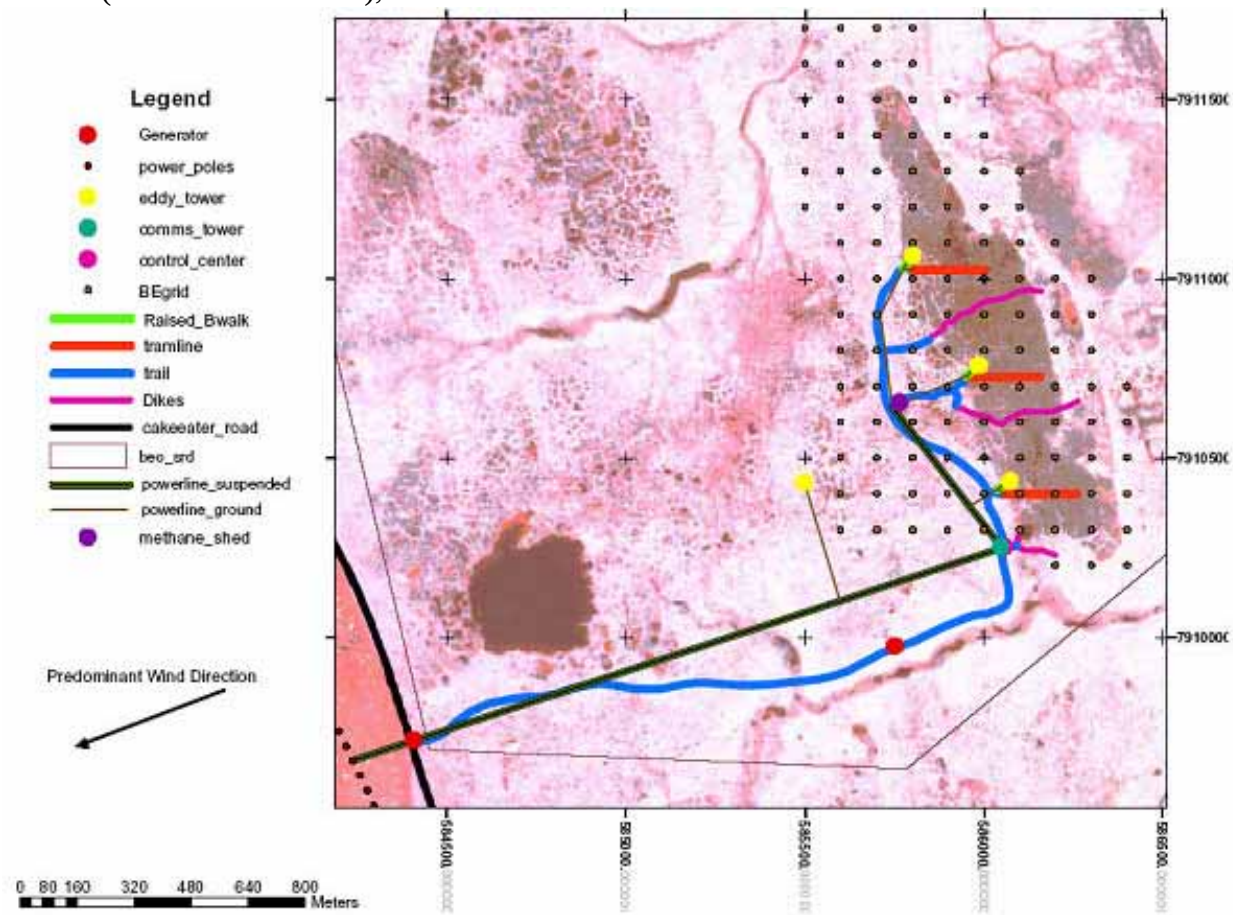

Figure 3: Diagram of sensors and supporting infrastructure for the research project.

will be maintained by introducing two dikes across the wetland (approximately 200-m long). One dike will create a flooded region of enhanced soil moisture by slowing the natural flow of water. The control region of natural soil moisture levels, down-slope from the first dike, will be maintained at the background level based upon comparison and calibration with water levels in adjacent, un-impacted wetlands and a reference lake. The drained region of depleted soil

moisture levels will be controlled with a weir leveled on a drainage ditch (a backup pump will also be installed).

Moisture levels in all three zones will be maintained by regulating the flow of water across the up-slope and down-slope dikes. Where necessary, water will be gravity fed from header tanks re-supplied from nearby water sources. All efforts will be made to reduce the impact of flooding and or drainage on water biogeochemistry, which will be monitored throughout the experiment. Soil moisture levels are strongly impacted by local weather, which cannot be controlled. Consequently, areas will be maintained with distinctly wetter and drier conditions relative to 'normal' and the control. Accordingly, the water levels in each treatment are expected to vary markedly seasonally and inter-annually with experimental treatments being maintained to be wetter and drier than the control. Although water levels will initially be managed on a daily basis by regulating pumps by hand during the snow-free period, investigators plan to apply '*smart'* software that will automatically trigger pumping/draining via a wireless network and near-real-time variability in a georeferenced water source. The first field season (summer 2005) will be used to establish altitude-corrected water level correlations between referenced water sources and the proposed manipulation area.

3.3 Temporary Buildings

A small building will serve as the 'control shed' or control center for the project. The control shed will house a wireless network and will link field instrumentation via radio connection to BASC, where remote access via high-speed internet will permit real-time status checking and control of field instrumentation. The shed was built by local high school students (6m x 2.5m x 2.5m) and is on skids to be dragged to the site while the tundra is frozen and snow-covered. This control building will be put on timbers (8"x8"x8'; 20cm x 20cm x 2.4m) to raise it off the tundra. Investigators will have this shelter available as a workspace to reduce the need to come and go from the site.

A small wooden 'methane shed' (2.5m x 2.5m x 2.5m) will be used to house sensors for measuring methane. The shed is on skids for dragging it across the snow to the site and will be put on timbers (8"x8"x8'; 20cm x 20cm x 2.4m) to raise it off the tundra. Sample collection tubes from the three eddy flux towers in the manipulation area will be suspended from wooden tripods (1m high) connecting to the methane shed. Suspension of the tubes requires a wooden support every three meters from each of the three eddy covariance towers back to the methane analyzer within the wooden box, for an approximate total number of 275 supports and a total distance of 825 meters. The supports should each be 1.2 m in height for adequate above ground suspension of the air tubes. Steel wire will be used to secure the tubes to each tripod.

3.4 Instrument Tram and Accompanying Boardwalk

A robotic tram system will be installed in the dry lakebed to collect data when the site is snow-free, reducing the need for investigators to visit the site to collect data. A line of tram extends into each of the three treatment areas. Data will be transmitted via a wireless internet signal and available to researchers from miles away. The tram will be suspended on supports that are removable or that can be cut down at ground level following the study. A raised (30 cm high) boardwalk will be installed along the tramline for maintenance and access to the research site.

The boardwalk will be removable, elevated enough to prevent alterations to the hydrology, but low enough not to cause snow drifting.

3.5 Sensor and Communications Towers

A communications tower will be installed to collect wireless data transmissions from the sensors located throughout the study site and to transmit the data via a wireless internet signal to the research team. The tower will transmit a wireless internet signal available for use at the research site. Three 3-m high eddy covariance towers, similar to the one near the site, will be installed downwind of the three treatment areas. These towers will measure methane flux from the tundra. Air samples collected automatically at each tower will be sent through tubing to the methane shed for further analysis.

3.6 Access to the Research Site

A 3-km matted trail will be installed using a synthetic material to protect the underlying tundra from excessive surface disturbance, ensure the safety of field personnel, and facilitate the transport of equipment to the manipulation by small cart (e.g. wheelbarrow) during the snow-free period.

3.7 Electrical Power to the Study Site

Power to the site is necessary to operate the instruments and instrument towers. In the first field season of the study, a 10kW diesel generator, with a second generator as backup, will be used to power the eddy flux and communications towers, instrument tram, gas analyzer and other instruments, wireless network, computers, and provide light and heat to the temporary buildings (Table 1). Year-round data collection is essential to the project. To provide the site with year-round sufficient power, an electrical power line will be installed in winter of 2005-2006. The power line will go to the control building adjacent to the trail from the existing line along Cakeeater Road, approximately 8000 m of overhead power line. Short sections of power line will run along the ground from the nearest pole to the existing eddy flux tower, the three towers that will be installed in this project and the communications tower.

Table 1: Power requirements for the project.

PI	Description	Peak Wattage	Duty Cycle
General	Transformer efficiency loss/ 10% of total	600w	24/7
Harazono	Methane Analyzer	500w	24/7
Harazono	GAST Pumps	600w	24/7
Harazono	Data Logger	50w	24/7
Control Shed	Repeater Station	50w	24/7
Control Shed	Lighting	150w	8hr/ day
Control Shed	Heat	1500w	8hr/ day
Control Shed	Battery Chargers	500w	24/7
Control Shed	Laptops (3 x 100w)	300w	2hr/day
Control Shed	VHF Radio base station	75w	24/7
Control Shed	Wireless Communications	125w	24/7
Tower	Wireless Communications	250w	
Oechel	Eddy Tower	300w	24/7
Oechel	Eddy Tower	300w	24/7

Oechel	Eddy Tower	300w	24/7
Gamon	Tram Lines	1000w	24/7
VPR	Gen Shed Loads	400 w	24/7
General	Multiply by 1.25 for 25% safety factor =	700w	
Total		**7700W**	

3.8 Project Data

All data from the project will be available in near real-time and will be archived at the Joint Office for Science Support (JOSS) soon after acquisition and then at the Arctic System Science (ARCSS) Data Coordination Center (ADCC) within the National Snow and Ice Data Center (NSIDC) for long-term access by interested scientists. In addition, the research team has an elaborate outreach plan that includes participation by the local community, outreach to the public and regional schools.

4. POTENTIAL ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTIVITY

4.1 Project Location

The study site is located 2 km south of the Arctic Ocean and is comprised of low- and high-centered tundra polygons, ice wedges (polygon troughs), and drained lake tundra land forms (Brown *et al.* 1980). Plant communities are primarily mixed graminoids that vary from moist to dry across microtopographic changes. The research area is limited to 4 km^2. This experimental manipulation of tundra moisture will alter the wetland tundra habitat relative to 'normal' conditions. The location, research infrastructure and experimental manipulation for the preferred alternative and other alternatives are addressed in this section. The impacts of the preferred alternative to the environment are insignificant due to deliberate planning by the project organizers with the goal of minimizing impacts to the environment.

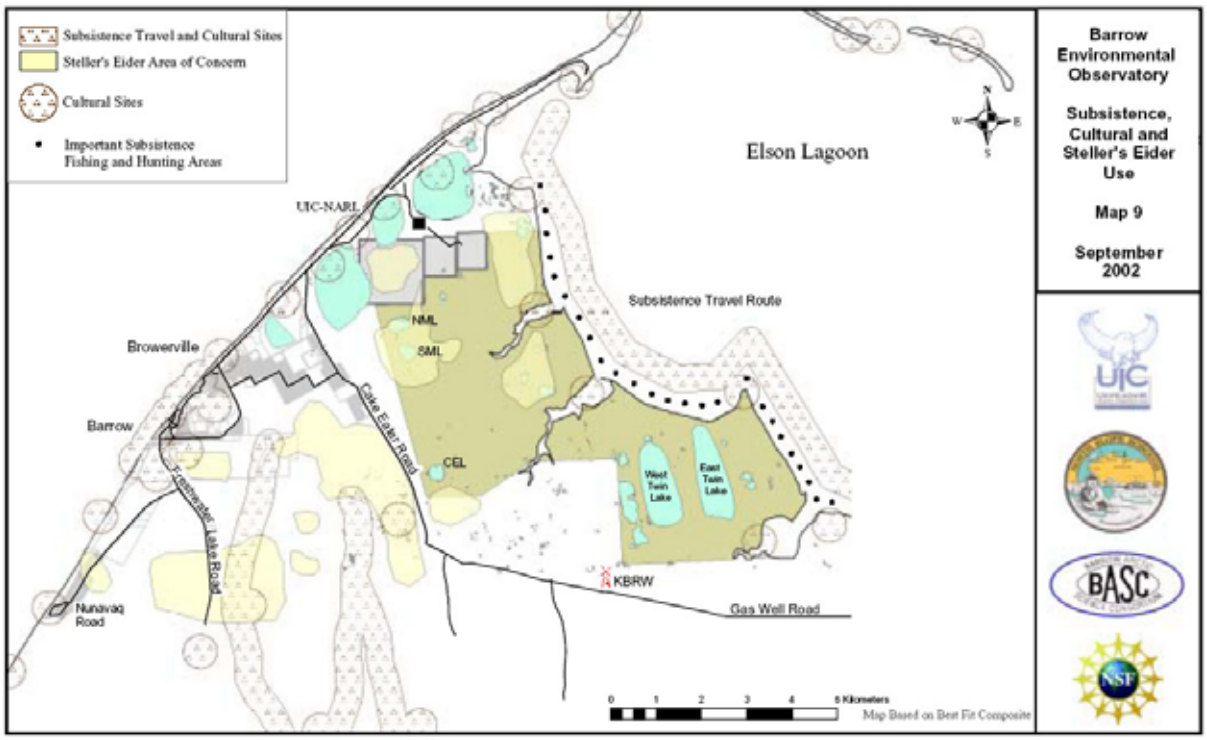

Figure 4: Location of the BEO with respect to subsistence activity and habitat use by Steller's eiders.

This habitat is likely to be used by collared lemmings (*Dicrostonyx torquatus*), brown lemmings (*Lemmus sibiricus*), arctic fox (*Alopex lagopus*), caribou (*Rangifer taranadus*), brown bears (*Ursus arctos*), polar bears (*Ursus maritimus*), and a wide variety of migratory birds including sandpipers and plovers, ducks, geese and swans, passerines, gulls, terns, and jaegers, sea birds, ptarmigan, ravens, and snowy owls (*Nyctea scandiaca*). Of particular note are Steller's eiders (*Polysticta stelleri*) and spectacled eiders (*Somateria fischeri*), two sea ducks that have been designated as Threatened under the Endangered Species Act (Figure 4).

The project site is approximately 5 miles from the town of Barrow, Alaska in the North Slope Borough. Barrow has a population of about 4500, 65% of whom are Inupiat Eskimo. Subsistence hunting and gathering are an important part of the culture and lifestyle in Barrow. Many people hunt birds, caribou, seals, polar bears and bowhead whales. Berry picking and fishing are also important subsistence practices. Much of the land near Barrow is owned by Ukpeagvik Inupiat Corporation (UIC), including the land used by this project. UIC has worked with BASC to establish the Barrow Environmental Observatory (BEO) and maintain it for scientific research purposes. The use of the land for research does not preclude subsistence hunting and gathering by local people.

The BEO Science Management Committee (SMAC) and Science Advisory Group (SAG) are highly supportive of integrated and collaborative scientific research, a principal objective of the BEO. This project is considered an appropriate and beneficial project for the long-term goals of the BEO. Required infrastructure (e.g., boardwalk, line power, long-range wireless internet connectivity) is commensurate with BASC, SAG, and SMAC goals for the BEO. The North Slope Borough Mayor has also indicated his support for the project in a letter accompanying the proposal to NSF.

4.1.1 Study Site

The site selected for this project has been used for environmental research for over 50 years (Norton, 2001) and contains one eddy flux tower for measuring gas fluxes from the tundra used by investigators in this project. This tower is used for research and as an education and outreach tool for the Long-term Ecological Research Schoolyard project involving local students in research. The study site is located at the southwestern access point to the BEO. The project is located near existing eddy flux towers and other scientific instruments, thus it has historically been used for environmental research purposes and is not a completely undisturbed site. The site has a dry lakebed suitable for the flooding/draining experiment and is near existing power lines, minimizing the length of power line that needs to be installed to supply the research site.

4.1.2 Permitting

The landowner, UIC, has granted the land use permit necessary for this project. Because the project involves manipulation of wetland habitat, the project sought and received a permit from the U.S. Army Corps of Engineers (USACE). The permit was issued to BASC (Appendix 2), which will oversee the compliance with stipulations specified under Nationwide Permit #12, Utility Line Activities and #5, Scientific Measurement Devices (see Additional Resources for further information). NSF has undertaken a Section 7 Consultation with U.S. Fish and Wildlife Service under the Endangered Species Act regarding Steller's and spectacled eiders. USFWS issued a final Biological Opinion stating a finding of non-jeopardy of the activity on eiders (Appendix 3). Mitigation and avoidance of impacts on eiders is discussed below.

4.1.3 Eider Mitigation

The Barrow Arctic Science Consortium (BASC) was designated to represent NSF in the formal consultation with USFWS. USFWS requested the project to make a number of mitigation efforts, which will be overseen by BASC and the project investigators to ensure compliance. Collision

avoidance markers will be installed on the overhead power lines to reduce bird strikes. USFWS has provided the specifications for the devices to be used in that area. The power line will be searched daily for any bird mortalities due to strikes. The project will conduct surveys for nesting pairs of eiders in all years of the project. In years of the project when eiders nest in the area, nests will be marked, monitored, and traffic near the nest will be reduced to avoid disturbance to the nest. Survey and nest avoidance requirements are described in detail in the Biological Opinion and will be carried out by trained personnel on behalf of the project. While human activity is likely to deter eiders from nesting in the immediate 4 km^2 study area, the site was chosen because it is not an area of concern for use by nesting Steller's eiders based on past observations reported by USFWS (Figure 4). This is not an undisturbed site and has previously been used for similar climate change research.

4.1.4 Alternatives to the Proposed Site

Barrow is the preferred location for the logistics hub for this project because of the infrastructure for research and long research history. Other sites were considered for the tundra manipulation project; however, no other site with infrastructure and environmental conditions comparable to BEO was available. While there is a vast expanse of tundra in the Arctic, it would take exceptional logistical support to access sites without existing infrastructure. This would increase the overall environmental impact of the project, requiring additional fuel, vehicles, and housing for researchers. Of primary importance was selecting a site in an area with a history of low visitation by and low density of Steller's eiders in years when they nest. Informal discussions with USFWS personnel surveying for eiders in Barrow led to the selection of the preferred site at BEO (Dr. Craig Tweedie, pers. comm.). The research site was selected because of the research history, current location of the eddy flux tower, and the suitability of the chosen lakebed for the flooding/drying manipulation. Additionally, the site is located near the road, reducing the tundra impacted by installing access to the site. The site is near a power line that can be extended to the site providing a low-pollution, high output power source. The 'no action' alternative would result in the project not taking place, which would prevent the collection of valuable information on the potential impacts of global climate change on the tundra environment and resulting change in carbon cycling between the tundra and the atmosphere.

4.2 Experimental Flooding and Drying

The flooding and drying treatment are intended to impact only the identified areas. The size of the area selected is sufficient to provide data on a variety of different topographic and pre-existing tundra conditions necessary to understand carbon cycling in the tundra under different moisture regimes. Dikes will be built with impermeable plastic sheeting placed in the ground with no permanent stabilizing structure (each approximately 200-m long). At the conclusion of the experiment, the aboveground portion of the dikes will be removed and effects will be confined to a 4km^2 area around the dry lakebed. Water for the flooding treatment will be captured from snowmelt in the spring and held until released on the study site. The integrity of the study site depends on not altering the surrounding hydrology. If additional water is needed, it will be pumped from the nearby large lake with minimal effect to the lake level. There are no fish in the lakes on the BEO. The dikes and drainage ditches will be constructed in late September 2005, prior to snowfall, when active layer depths are at their greatest. Comparative research will be initiated in summer 2006. Instrument trams and boardwalks will be elevated to

reduce alteration of the surface hydrology. Aboveground portions of these structures will be removable.

4.2.1 Alternatives to the Proposed Activity

The design of the flooding and drying experiment has been carefully considered. To create the three distinct treatment areas, sandbags were considered as a means of trapping and diverting water as needed. The fill from the sandbags could be expected to produce contaminants, including mineral and chemical leachates, which would damage the research site for this and future research experiments. Removable plastic sheeting inserted into the ground reduces contamination and disturbance to the surface vegetation and is the preferred option. The 'no action' alternative would eliminate the possibility of manipulating tundra moisture, which is the critical element of the research project to determine the behavior of carbon cycling under different tundra moisture regimes.

An alternative for providing water to the study area is to pump all the water from nearby lakes. This would require the use of additional pumps and is expected to result in greater fluctuation in water levels of nearby lakes than holding spring melt for release onto the site. The preferred option is to capture spring melt. The 'no action' alternative would prevent the inclusion of a treatment with tundra under elevated moisture, greatly decreasing the investigators' ability to determine the impact of moist soils on carbon exchange.

There are few reasonable alternatives for drying the tundra besides the preferred method of diverting surface and active layer hydrology from inputting moisture. Drying by heat or other mechanical means would alter the temperature, which would confound the study and could have impacts to the permafrost and vegetation. Using wind to cause drying would alter the current air pathway rendering the gas flux towers ineffective at measuring cross-site carbon flux. The 'no action' alternative would eliminate the dry soil treatment from the study, which is necessary to determine how carbon exchange is modified under different moisture regimes.

4.3 Temporary Buildings

Two small, portable buildings will be used on the site. These buildings have been used to support previous research, they are of a suitable design for reuse in this study. The 'control shed' (6m x 2.5m x 2.5m) will house instrumentation and a wireless internet network for transmission of data. The 'methane shed' (2.5m x 2.5m x 2.5m) is a very small structure to house the methane gas analyzer that will analyze gas samples collected across the study site and transported via tubing. Both are small structures designed on skids so they may be relocated for a variety of uses. They will be dedicated to this project for its duration. The buildings will be pulled into place while the tundra is frozen and covered with snow to reduce impact to the tundra vegetation. Both structures will be supported by timbers (8"x8"x8'; 20cm x 20cm x 2.4m) to reduce the area of tundra impacted and prevent disturbance of the soil temperature regime and surface hydrology. The buildings provide heated shelter to investigators. This will allow project personnel to remain on-site and reduce daily trips across the tundra to the road.

4.3.1 Alternatives to the Proposed Activity

The ‘no action’ alternative for the control shed will not prevent the project from taking place. Without the control shed as shelter and to house the wireless network and other instruments, investigators will need to increase the number of trips they make to the study site to transport data and materials or shelter. This could increase impacts to the tundra, wildlife including eiders and increase traffic on Cakeeater Road.

The loss of the methane shed would eliminate the ability to sample and analyze methane gas from the study area. These data are critical to the study of carbon flux across the tundra. Losing either structure would significantly alter the data collected on the project and increase traffic to and across the research site. For these reasons, the addition of the two temporary buildings is the preferred alternative.

4.4 Instrument Tram and Accompanying Boardwalk

The manipulation site will be traversed by an automated tram system for unattended sampling of surface optical and thermal properties. A boardwalk for tram maintenance will be installed next to the tram, raised about 30cm, to prevent damage to the tundra and interruption of the surface hydrology. The boardwalk will have reflective strips attached to make it more visible to people traveling on the tundra. The instrument tram will greatly reduce foot traffic across the manipulation site, allowing measurements to be collected without impacting the tundra vegetation. This is a new technology being deployed for the first time in the arctic specifically to reduce environmental impacts while providing high quality data. The tram system and boardwalk will be held in place using removable posts made of steel or wood. The field measurements from the tram will also provide essential validation for aircraft and satellite remote sensing, to enable use of past satellite imagery as well as future imagery.

4.4.1 Alternatives to the Proposed Activity

In this case, the ‘no action’ alternative is to have people collect samples on foot, traversing the tundra multiple times per day to collect samples. This is considered to have much greater impact than the tram system with boardwalks in place for equipment maintenance and occasional sampling. Without boardwalks, the tundra would be severely impacted by foot traffic. Raising the maintenance boardwalk off the tundra further minimizes impacts.

4.5 Sensor and Communications Towers

Three eddy covariance towers (3m high, with three 3-m guy wires) will be installed downwind from the manipulation site to assess whole-ecosystem carbon balance. The site will have a high-speed wireless connection that allows investigators to communicate remotely with instruments, other investigators, BASC, and the world wide web, reducing the need for visits and facilitating year-round data collection.

A tower – 8m high, with nine guy wires up to 8m from the base – will hold the communications equipment for this project. Guy wires for all towers will be equipped with orange piping on the lower end of the wires to prevent humans and animals from colliding with them. The

communications tower will have a flashing light to increase visibility for helicopters. Towers will also have spinning, reflective bird deterrents to reduce bird collisions with towers or wires.

4.5.1 Alternatives to the Proposed Activity

The ‘no action’ alternative for the eddy covariance towers would prevent the sampling and analysis of gas fluxes across the treatment area. These data are essential to the project, thus the ‘no action’ alternative would prevent the project from taking place.

The communications tower enables the remote collection and transmission of data, reducing the need for investigators to visit the site and to collect data manually from across the site. The ‘no action’ alternative would greatly increase the impact to the study site and reducing the quality of the data collected in the study.

4.6 Access to the Study Site

About 3000 m (10,000 ft) of plastic matted trail will be laid onto the tundra to protect it from foot traffic. The trail path has been planned on the highest, driest ground available to reduce impact to soft, wet tundra. The trail material will not impact surface hydrology, will minimize destruction of surface vegetation and hence alteration of permafrost and soil stability.

4.6.1 Alternatives to the Proposed Activity

Alternative methods of access were considered that would allow for motorized access to the research site for carrying equipment but that would not create an ‘attractive nuisance’ to off-road vehicle enthusiasts. It is likely that a path wide enough for all-terrain vehicles (ATVs) would attract ATV traffic from nearby Barrow that would further impact eiders and habitat. Various motorized vehicles have been investigated that might fit on a narrow path. None have been selected, thus the research team will haul equipment, such as computers, instruments, heaters, chairs and other items used on the site and in the temporary buildings using narrow hand carts (e.g., wheelbarrows) and backpacks. Boardwalks could be installed rather than the plastic matting, but recent experiments by USFWS with the proposed synthetic trail material have been successful. The material is durable, plants are able to grow up through the spaces in the material, and there is little disturbance to hydrology and soils.

4.7 Electrical power to the study site

For the first year of the project, two 10kW diesel generators will be used while the full instrument package is tested and brought online. Power will terminate at the control shed and each eddy covariance tower with a transformer and a weather-tight breaker box with a single breaker providing 100 watts of 120 VAC power mounted on a wooden post. The breaker will act as a switch should the researcher team need to work on equipment; alternately, devices can simply be unplugged. The power cable will lie on the tundra until the matted trail meets the boardwalk, at which point the cable will be attached to the side of the boardwalk deck. The trunk line and spurs will be laid on the tundra. The cable is armored liquid tight and considered the best in class technology for this application. It has a flexible steel jacket and three plastic layers of protection covering the wires. It can lay in water with no threat to the system or the environment. Initially the cable will be placed on the snow. As the snow melts it will settle into

the tundra amongst the vegetation. This cable has been used as part of an autonomous power system operating an eddy covariance tower at the Ivotuk airstrip on the North Slope. This type of cable is flexible and will lie down whereas some other types of cable buckle and are not flexible.

The generators will operate continuously (24/7) from spring through fall 2005. They will run alternately with each generator being shut off for service and refueling every two weeks. They will be installed fully fueled with a 350-gallon double-walled auxiliary fuel tank. The generators and fuel tank will be kept in a containment structure sufficient for the fuel capacity. The generator system will be located next to the matted trail approximately ½ mile from Cakeeater road where the investigators on site can visually inspect the generators daily for leaks or malfunctions. To resupply the generators with fuel, each month a helicopter will sling-load 55-gallon drums of fuel to the site ½ mile from Cakeeater Road. The fuel drums will also be stored in a containment structure sufficient for 110% of the fuel capacity. If eiders are nesting in the area, the project team will re-evaluate the use of helicopters and consult with USFWS to determine the best course of action for refueling. The generators, fuel tank, fuel cache and containment vessels will be removed from the site with minimal impact to the tundra vegetation (either by helicopter or over snow-covered tundra) when they are no longer needed to power the project.

In spring 2006 year-round power for the project will be supplied by installing 8000m of overhead power line from the existing line parallel to Cakeeater Road. Several short sections of power line will be connected to the line powering the towers, instruments and temporary buildings installed in 2005. Collision avoidance devices, as specified by USFWS, will be installed on the power lines to reduce the chances of birds flying into the overhead lines. Barrow Utilities and Electric Cooperative Inc. (BUECI) will install the power lines in accordance with industry standards for work in permafrost tundra. The holes for the poles will be drilled in winter 2005/2006 and installation completed in spring 2006. This infrastructure is meant to support research at this site for the long-term. When power to this quadrant of the BEO is no longer needed to support science, the line can be removed and the poles can be cut at ground-level.

4.7.1 Alternatives to the Proposed Action

The existing eddy flux tower is powered by a combination of wind and solar power, which has historically failed every 2-3 days, creating large and frequent gaps in data sets (Dr. Craig Tweedie, pers. comm.). These alternative energy sources are still experimental and not sufficient for the power requirements of this project (Table 1). The ‘no action’ alternative of providing no power line or using only generator power at the site would prevent the project from occurring, or greatly increase the physical impact on the site.

Generators are not a long-term option because of the noise, carbon exhaust and potential for hydrocarbon spills. Although they are positioned downwind of the study site, generators have the potential to alter measurements of the small fluxes in CO_2 and CH_4 crucial for the project. The alternative to installing the generators is to postpone the project for a year until overhead power lines are installed. The benefits of installing and testing the instruments in 2005 are considered greater than the potential impact of having the generators in operation for one field season. The

generators are expected to have little or no impact on the site, and their presence on site for the first year of the study is not expected to impact data collected on site in future years.

Year-round power necessary to complete the study can only be supplied by power lines. Overhead power lines are considered preferable to surface or buried power lines to reduce the potential for injury to humans and damage to the tundra, respectively. Burying the lines would disturb the tundra vegetation and soils, which would impair the project and increase the impact of the project on the site. Line power is a preferable alternative to using diesel generators long-term. Line power reduces traffic to the area that would be necessary for refueling generators. The short sections of power line on the ground will not be loose enough to cause a hazard to people or animals traveling over the tundra or snow during winter. The lines will be marked for safety.

4.8 Conclusion

The infrastructure to support the project has been carefully reviewed and the preferred alternatives minimize impact to the environment. An area of only 4 km^2 will be altered in the manipulation designed to simulate potential changes of tundra under wetter and drier conditions. The area is small portion of the North Slope Borough, the largest municipality in the U.S. covering over 230,000 km^2 (89,000 mi^2). At the end of the project, all sensors and infrastructure can be removed. Power poles and other items anchored into the permafrost can be cut down at surface height when they are no longer needed. This research project is the first study to simulate conditions at an appropriate scale for understanding the physical and biological processes regulating the release and uptake of carbon in tundra. Because northern tundra ecosystems store approximately 25% of the world's carbon, it is important to understand how carbon cycling in tundra will react to changing climate conditions. The impacts of the project are expected to be environmentally insignificant.

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ADDITIONAL RESOURCES

Barrow Arctic Science Consortium
http://www.arcitcscience.org

Barrow Area Information Database – Internet Map Server (BAID-IMS)
http://ims.arcticscience.org

USACE Nationwide Permit Stipulations:
Scientific Measurement Devices #5:
http://www.poa.usace.army.mil/reg/nwp5.pdf
Utility Line Activities #12:
http://www.poa.usace.army.mil/reg/nwp12.pdf

6. POINTS OF CONTACT

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Barrow Environmental Observatory

BEO

Master Plan

September 2002

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Introduction

Background

The Barrow Environmental Observatory (BEO), 7,466 acres of arctic tundra near Barrow, Alaska, was permanently set aside in 1992 by the Ukpeagvik Iñupiat Corporation (UIC – the Barrow Village Corporation) (Appendix A). The BEO research reserve is a unique testament to the commitment of North Slope residents to the advancement of science and to collaboration between local people and scientists. Iñupiat Eskimo people have taken a sizable portion their own land and dedicated it to scientific research; an action unique in the world, where long-term ecological research stations are created by national governments or multinational agencies, but never before by a local Native community. This land had previously been used by researchers at the Naval Arctic Research Laboratory (NARL) beginning in the 1940s.

The Barrow Arctic Science Consortium (BASC), a nonprofit organization dedicated to scientist/community collaboration, was designated by UIC to manage the BEO. The BASC Board of Directors established the BEO Management Committee (BEO MC) to develop and manage the reserve (Appendix B). In 1997, the National Science Foundation's (NSF) Office of Polar Programs implemented the first three-year Cooperative Agreement with BASC to support management of the BEO and research in the Barrow area. A second, three-year agreement supports the continuation of the BEO planning.

During the Barrow Area Research Support Workshop held in Marshall, California, in December 1998 (published as The Future of an Arctic Resource, ARCUS 1999), the BEO MC met and recommended the development of a Master Plan for the BEO. The North Slope Borough (NSB) Assembly enacted an ordinance to allow for creating a Science Research District (SRD) zoning status at their December 2000 meeting. Upon approval of a Master Plan, the BEO will be eligible for designation as a Science Research District, thus providing a higher degree of long-term protection. Under provisions of the SRD ordinance, the Master Plan will serve as the vehicle for a single, multi-year land-use permit. This will simplify the land-use permitting process, as individual projects normally will not be required to obtain NSB permits for research on the BEO. Equally important is the fact that the Master Plan will provide for the logical and planned growth of services in and around the BEO. During the week of April 22, 2002, both the BASC and UIC Boards approved the draft Master Plan with the understanding it would be submitted to the Borough once final changes were made.

Location

The Barrow Environmental Observatory is located on the North Slope of Alaska, within the boundaries of the North Slope Borough, approximately six kilometers east of the City of Barrow, the northern most city in the United States of America (Map 1). The BEO is bordered on the north by federal lease holdings of the U.S. Navy, U.S. Geological Survey (USGS), and the National Oceanic and Atmospheric Administration (NOAA). The former Naval Arctic Research Laboratory (NARL), which is now owned by the Ukpeagvik Iñupiat Corporation and operated as the UIC-NARL Facility, lies to the north of both the BEO and federal lands along the shores of the Chukchi Sea.

The BEO is bordered on the west by mostly vacant residential land, vacant land owned by the UIC, and the Cake Eater Road. The southern border of the BEO is occupied by the Borough's actively operated natural gas fields and the transmission tower for Barrow's only radio station, KBRW, and

vacant UIC lands. The gas fields were originally developed by the U.S. Navy for NARL, but have since been retrofitted to serve the community of Barrow with natural gas. The fields are owned and operated by the NSB. Elson Lagoon, the barrier islands, and the Beaufort Sea form the eastern boundary of the land-based portion of the Proposed BEO Science Research District

BEO Science Research District

Currently, the BEO lies within an NSB Conservation District, which is the most restrictive of district uses and discourages most land uses and activities. In 2000, BASC undertook an effort to ensure that scientific research in the BEO enjoyed the highest priority of use allowed under Alaskan law. BASC worked with the NSB Planning Department and the NSB Assembly to create and enact a new zoning district classification entitled the Science Research District (SRD). The ordinance (NSB Ordinance Serial No. 75-6-40) that enacted the SRD was adopted by the NSB Assembly in December 2000.

The proposed SRD boundary is shown on Map 2 of the Master Planning Maps. This area incorporates the entire BEO. A second research area is proposed that includes portion of Elson Lagoon and Crescent Island. The lagoon research area is shown by dashed lines. Its inclusion will greatly enhance research without placing any limits upon other subsistence and recreational uses. These boundaries were drawn to capture the full range of research opportunities available from the BEO.

Also as a part of this planning effort, we are required by the NSB to be aware of other uses within two miles of the BEO. This two-mile planning boundary that we are required to consider under this Master Plan is shown on Map 2. This two-mile zone is not part of the BEO or SRD.

Three major types of research will utilize the BEO Science Research District:

* Process and Experimentation
* Population Biology and Biodiversity
* Environmental Monitoring

Master Plan

The Master Plan document is divided into five sections and appendices:

Part I Terrain Components of the BEO
Part II Current Uses of the BEO and Surroundings
Part III Proposed Uses of the BEO and SRD
Part IV Master Plan
Part V Map Section

Part I Terrain Components of the BEO

The following four maps present the natural components of the Barrow Environmental Observatory. (Maps 3-6).

IKONOS Satellite Imagery

Map 3 contains a mosaic of satellite images that serves as a base for the Master Plan. Current mapping-quality aerial photography of the BEO has not been obtained for the past several decades. Since the cost of obtaining this photography was beyond the scope of this plan, BASC contracted for the satellite imagery in summer 2000 to serve as a base map of current features. The commercial satellite (IKONOS) product when used in conjunction with the available 1/2-meter contour maps provides one-meter ground resolution. Because of cloud coverage over the BEO, two images acquired in July and August were mosaiced to create the photographic base image on Map 3. Additional processing of the images was performed and ground checking was undertaken in summers 2001 and 2002 by personnel of the Arctic Ecology Laboratory from Michigan State University.

The resolution is of sufficient quality to allow ground location of infrastructure features such as the NARL airstrip, buildings, the snow fence, and Cake Eater Road. If viewed at an enlarged scale, shadows from the CDML building can be seen on the ground. The IKONOS image was used as the base map to assess erosion along Elson Lagoon using historical aerial photographs. As an example a total of 28.2 hectares of land have been lost to erosion since 1979 along the 11-km long Elson Lagoon-BEO boundary (Brown et al, 2003).

Topography and Hydrography

Map 4 presents the topography and surface waters of the BEO and is based on the topographic map prepared in the 1960s by the Cold Regions Research and Engineering and Laboratory (CRREL) at a scale of 1:5000 (total of 26 map sheets), and as a photo base at a scale of 1:25,000 and 1/2 meter contour interval (Brown and Johnson 1966). The majority of the original 26 sheets were recently digitized and subsequently compiled on a CD-ROM for the Barrow landfill project. The BEO boundaries were officially surveyed in 1995 by BTS/LCMF Joint Venture. Aluminum-capped monuments and posts mark all corners; the land perimeter of 19.53 km is posted at approximately 150-meter intervals by Carsonite witness posts.

The main topographic feature of the BEO is the crescent shaped, old raised beach ridge that extends from the North Meadow Lake across the Navy-USGS-NOAA lands and re-enters the BEO extending to Central Marsh Slough. Beach ridge elevations range between 4.5 and 7.0 meters above sea level. Elevations along Elson Lagoon range from close to sea level to a maximum of 4.6 meters.

Central Marsh Slough and Ikpik Slough, two small estuaries or sloughs, encroach upon the BEO as inland extensions of Elson Lagoon. Mayoeak Creek, a third estuary and small stream, forms the southeast boundary of the BEO. Two, long (2 km) shallow lakes are located in this southeastern section of the BEO (East and West Twin Lakes). Two smaller, shallow lakes are found at the northwestern section of the BEO (North and South Meadow Lakes; NML and SML). North Meadow Lake was the site of intensive research during the 1960s and 1970s and was serviced by a power line from NARL (Kelley and Weaver 1969). A third small lake is located in the

southwest potion of the BEO and is named Cake Eater Lake (CEL) for present purposes. Numerous small shallow ponds are randomly distributed in former lake basins and low centered polygons.

Other than the small streams at the headwaters of these estuaries, there are no well-defined drainage networks. Revegetated drained lake basins cover the landscape. Wet swampy areas interconnect many of these basins. During spring snowmelt these low wet areas carry the runoff waters to Elson Lagoon. The remaining snowmelt and majority of the summer precipitation remains on the tundra and in polygon ponds and subsequently evaporates or is absorbed into the thawing soil. The summer water balance of a small BEO basin draining into Central Marsh Creek was studied in the 1960s (Brown et al. 1968).

Vegetation Classification

Map 5 for the BEO vegetation was produced from a supervised classification of the IKONOS satellite imagery mosaic of July 16 and August 16, 2000 coverage of the BEO area. Table 1 summarizes the land cover breakdown for the entire image area (Map 4) and for the BEO. Land cover statistics have been calculated in two different ways. The statistics for "% Area" are taken from all classes in the land cover map; those for "% Land" do not include surface water in any of the calculations.

The most dominant vegetation type in the BEO is wet graminoid tundra, composing 38% of the entire BEO and 44% of its land area (Table 1). The next most dominant land cover types are dry meadow, moist meadow dominated by *Carex* spp. and emergent aquatic vegetation dominated by *Carex* spp. These rankings remain the same in the entire image area.

Although, upon visual inspection, the Arctic Ecology Laboratory (AEL) at Michigan State University (MSU) believes the vegetation classification to be a good representation of actual ground conditions, it has not formally been assessed for accuracy. Accuracy assessment was conducted during the 2002 field season. Statistical accuracy figures for the vegetation classification will be available upon the completion and analysis of this fieldwork.

Table 1: Vegetation Class distribution in the BEO and the entire classified area.

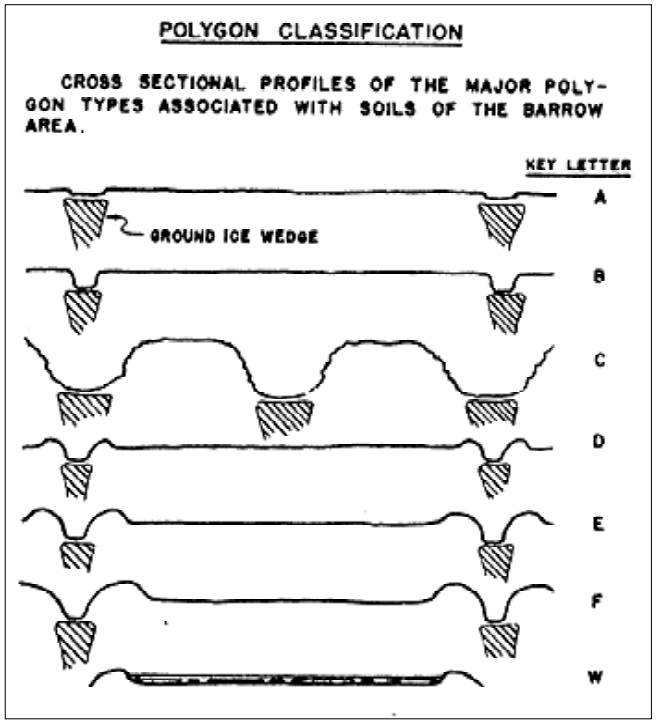
Land Cover	% Area in BEO	% Land in BEO	% Area in Total	% Land in Total
Dry Heath – Lichen-dominated	2.3	2.8	2.3	2.9
Dry Heath —*Salix* spp.-dominated	4.2	5.1	4.0	5.0
Dry Heath - Mixed	0.3	0.3	0.3	0.3
Dry Meadow	9.8	11.9	8.7	10.9
Moist Meadow - Forb-dominated	4.1	5.0	4.1	5.1
Moist MeadowÃ—*Carex* spp.-dominated	7.6	9.2	7.1	8.9
Moist Meadow - Mixed graminoid-dominated	4.3	5.2	4.7	5.9
Wet Graminoid	36.7	44.4	35.0	43.8
Emergent Aquatic – *Arctophila fulva*-dominated	2.2	2.6	2.2	2.7
Emergent Aquatic —*Carex* spp.-dominated	6.8	8.2	6.3	7.9
Emergent Aquatic - Mixed	0.1	0.1	0.1	0.1
Water	17.3	NA	20.1	NA
Urban / Gravel	1.2	1.4	1.8	2.2
Barren Ground	0.4	0.5	0.9	1.1
Cloud	2.7	3.2	2.4	3.0

Soils

Map 6 represents the soils of the Barrow region. The original map was prepared in the late 1950s as part of a doctoral dissertation (Drew 1957). The paper version of the map has been geo-referenced by Resource Data, Inc., of Anchorage, Alaska, and a digital product produced. Soils are classified primarily on the basis of moisture; the Table 2 contains the names of the major soils and polygon types. The driest soil is termed Arctic Brown and is only found on the raised beach ridge near CMDL. Moisture and surface organic matter increases from Upland Tundra to Meadow Tundra and finally to Half Bog soils. The major polygon types are classified based on surface relief and size. These are flat topped with raised rims, high-centered (generally composed of peat and found near drained lake shores or other drainages), and depressed or low-centered generally filled with water. For the soils of the Barrow peninsula (map area shown), 75% of the soils are Meadow Tundra, and Half Bogs and open water (lakes) each occupy about 10% (Bockheim et al. 1999). Both Footprint and Dry Lakes as shown on Map 6 were drained in 1950.

Table 2: Soil Classification

Beach Gravel along coast
Arctic Brown: shallow; normal imperfectly drained
Upland Tundra: dry; normal
Meadow Tundra: dry ; normal; wet
Half Bog: dry ; normal
Polygon Classification
Flat topped (A, B)
High Centered (C)
Raised rims (D,E ,F)
Low centered with water (W)



Part II Current Uses of the BEO and Surroundings

Maps 7-9 contain information on the current uses of the BEO and adjacent lands. The major concerns that relate to the use of the BEO lands for research are reviewed in this section.

Land ownership

Map 7 shows the location of the federal lease holdings on the northern boundary of the BEO: U.S. Navy, U.S. Geological Survey (USGS), and the National Oceanic and Atmospheric Administration (NOAA). The NOAA Climate Monitoring and Diagnostic Laboratory (CMDL) is located here as is the Department of Energy's Atmospheric Radiation Monitoring (ARM) station. The NOAA and USGS lands are used for research including the clean air sector which is shown on Map 8. The remaining adjacent lands are owned either privately or by the Ukpeagvik Iñupiat Corporation for residential and commercial use. The UIC-NARL includes the Ilisagvik College, the NSB Department of Wildlife Management, BASC logistical facilities, the NARL Hotel and several residential and commercial complexes. Platting of the UIC land and subsequent home construction on residential lands to the west of the BEO began along Cake Eater Road in the early 1990's.

Roads, Utilities, Access and Other Infrastructure

Map 7 shows the main roads in and around Barrow, Browerville and UIC-NARL, electrical distribution lines and the elevated natural gas pipeline. The NSB Geographic Information System (GIS) Division provided the majority of the data and information for the approximate locations of these facilities. Additional locations were positioned with the GPS systems available at BASC.

The BEO has limited access by existing roads. Cake Eater and Gas Well roads border the west and southern boundaries of the BEO. The northern border of the BEO has very limited road access, and is not likely to have public physical access available in the near future. The southern boundary has very limited road access due to the positioning of the elevated natural gas pipeline. KBRW has the main access from the Gas Well Road over the natural gas pipeline and an agreement would be required if a permanent BEO access was to be established at this site. The eastern boundary may only be accessed by boat or on foot in the summer or by snow machine during the winter.

The Beach Road (locally named Stevenson) serves as the main access to UIC-NARL and periodically suffers major coastal erosion resulting in costly repairs and maintenance.

The southwest corner of the BEO is within 25 meters of the Cake Eater Road, and the nearby electrical distribution line and natural gas main pipeline. Because of its close proximity to these utilities and the road, this part of the BEO is well suited for development of a permanent facility located on the BEO. This is the only location in the BEO that has close proximity to publicly available road and utilities.

Subsistence and Cultural Use Areas of Concern

Map 8 shows some of the areas (gathering areas and travel corridors) that are important to the Iñupiat (indigenous residents of the North Slope) for hunting and fishing for traditional foods as well as areas that are known to have archeological significance.

The North Slope of Alaska is known to have been inhabited by the Iñupiat and their predecessors for over 10,000 years. Although such early sites have not yet been found in the Barrow area, artifacts have been recovered which have been identified as Arctic Small Tool Tradition (ASTT), which dates

back approximately 4,200 years. The BEO includes landforms which have relatively high potential to contain such early sites.

No archaeological research has been carried out on the BEO. The general location has been in use for thousands of years. The BEO is known to contain pre- and post-contact archaeological sites, as well as historic (scientific) sites, all of which are potentially eligible for the National Register of Historic Places.

When federal funds are used for activities on the BEO the following laws and regulations mandate cultural resource investigations prior to any potential ground disturbances: National Historic Preservation Act; National Environmental Policy Act; Archeological and Historic Preservation Act; Archeological Resource Preservation Act; Native American Graves Protection and Repatriation Act; Executive Order 11593. In addition, Title 19 of the North Slope Borough Municipal Code and the Alaska Coastal Management Program applies to any activities, regardless of the source of funding, that take place on the BEO. No ground disturbances (either as part of the research or incidental to the research) can take place without prior review by the UIC Science Division archeologist. Such reviews may require surface inspection or subsurface testing, so activities should be planned far enough in advance to allow time and suitable conditions for these reviews to be conducted.

Steller's Eider Areas of Concern

The Steller's Eider is a species of waterfowl that appears to nest almost exclusively in the Barrow area. No other nesting populations have been found elsewhere in North America. The Steller's Eider was listed by the Federal Government as a Threatened Species under the Endangered Species Act in 1997. As such there are consultation protocols that are required by federal law for any activity (including field research) that might interfere with continued viability of this species. The shaded polygons shown on Map 9 indicate areas that the U.S. Fish and Wildlife Service considers critical areas of importance to the continued existence of the Steller's Eider. These areas will likely be limited to access only when Steller's Eider are present (summer months are nesting and rearing times for the Steller's Eider) and will probably preclude the construction of any permanent facilities within those areas of concern.

Research Stations, Areas and Sites

Map 8 shows locations of the research facilities, and clusters of high density research sites in and adjacent to the BEO. Information is based on available information from BASC, previous NARL records, publications and information provided by investigators (see Norton 2001 for the most current history of research at Barrow).

Starting in the early 1970s NOAA established the Clean Air Sector to measure properties of the atmosphere related to air quality, the ozone layer and greenhouse gases (global warming). To continue to operate from this location NOAA's Climate Monitoring Diagnostic Laboratory requires the maintenance of the Clean Air Sector that requires emissions to be at an absolute minimum, preferably at zero. Co-located on the federal lands are the USGS Magnetic Observatory and the DOE Atmospheric Radiation Observatory (Area 1).

During the past three summers, students from Michigan State University undertook field identification and Global Positioning Satellite documentation of known research sites in the BEO, including sites such as the International Tundra Biome Project (IBP) located on the west side of Cake Eater Road outside of the BEO. These sites are documented in the BEO Metadata Database in ACCESS format. The database contains approximately 1500 sites, plots and other notable positions. Over 325 sites are permanently marked in the field with a numbered survey marker. This database captures critical historic and current information and data about research on the BEO that would likely have been lost without this effort. This database also provides information vital to the reasonable management of the BEO and the protection of historical and on-going research. The current database is available as a CD and will also be Internet accessible. The database and the IKONOS vegetation project (Map 5) adopted a uniform data standard for the collection and input of data into this database and the BEO Master Plan. The standard reference datum used is NAD 1983 UTM 4.

Research sites within and adjacent to the BEO are clustered in three general areas (Area 1) in the immediate vicinity of CMDL since road access and line power have been available to non NOAA researchers; (Area 2) the area between CMDL and Central Marsh Creek where intensive research took place by the Cold Regions Research and Engineering Laboratory researchers in the 1960s; and (Area 3) the North Meadow Lake site which was occupied in the 1960s and early 1970s the by University of Washington and CRREL projects. Area 2 is presesntly occupied by the experiments of the International Tundra Experiment (ITEX) and the Arctic System Science (ARCSS) grid (1 km × 1 km) and including the CRREL study area and transect. Area 3 is now the official location of the Permafrost Observatory and its two 50-m deep boreholes supported by the International Arctic Research Center (IARC). In summer 2002, the NASA Bigfoot project established 1-km and 5-km grids containing 100 vegetation plots and centered in the BEO to the east of Cake Eater Lake (Area 4). At the same site the San Diego State University established a tower to measured trace gases supported on site by a wind/solar/battery power supply.

Other individual research sites and sample locations and plots dating back to the 1940s are dispersed throughout the BEO. A series of 14 transects are located along Elson Lagon from Brant Point to Mayoeak Creek to measure rates of coastal erosion. Approximately 20 air-soil temperature, year round recorders are positioned across the BEO to measure temperature gradients

During the 1970s an area immediately west of the BEO Cake Eater Road boundary was occupied by a major international ecological program; the International Biological Program's (IBP) Tundra Biome project (Brown et al. 1980; Hobbie 1980). The sites (Area 5) are bounded on the east and north by residential property. Most of the area and its research plots and ponds are unplatted and offer important sites for comparisons of research results within the BEO and data from the 1970s. These sites were recognized in the UIC Board's resolution that established the BEO (see Appendix A).

Also adjacent to the BEO on the east side of Cake Eater Road is a current series of research projects associated with the snow fence.

Part III Proposed Uses of the BEO and SRD

Proposed Access Points

Map 10 shows proposed access locations under consideration for the BEO. The BASC Science Management Committee developed this information.

There are no roads in or into the BEO. Snow machines offer the only off road access during the snow year. All summer access by researchers is by foot or helicopter. There are currently three, new land access points under consideration. The existing limited access from NOAA CMDL is over used and future research and developments in the BEO are required to find new access.

The Northwest access point is close to North Meadow Lake research area. There are plans to construct a road from the rear portion of UIC-NARL following in a southwesterly direction along the west boundary of the Navy property on Middle Salt Lagoon, and connecting with the Cake Eater Road. The approximate alignment of this road is shown on Map 10 (location of the road was provided by LCMF). The new road is intended to provide an alternative route for the Beach Road (Stevenson Road, locally known at the Beach Road) which is periodically eroded by storm events that commonly occur in late summer and the Fall. This proposed road would provide convenient access for researchers to the North Meadow Lake area of the BEO. Presently off road summer access is along the old power line south from UIC-NARL or along the gravel beach on the east side of Middle Salt Lagoon. Although this road may not be built in the foreseeable future, once it is available then a limited access, vehicular trail will be proposed to the corner of the BEO. This will facilitate further development of a research facility on the high ground of the North Meadow Lake site and additional utilization of the lake for aquatic research. Access from the corner point of the BEO will be either by foot or boardwalk.

The Southwest Access is the best point to establish physical access to and facilities within the BEO. It is close to Cake Eater Road, as well as natural gas and electric services. A small gravel pullout was installed along the road in June 2002, and a power line survey was completed in spring 2002. A system of boardwalks and protected trails will be established to outlying field sites.

The Southeastern Access along Gas Well Road is a difficult area for establishing access. The closest distance from the road to the BEO boundary is about 750 m as well as crossing very wet terrain. There is limited access from the Gas Well Road due to the elevated natural gas line (it would require the addition of an expansion loop to provide access either under or over the gas line).

Using the more distant KBRW site would require an agreement. Present planning includes a gravel parking pad along Gas Well Road, a pipe crossing and trail into the BEO.

Summer access from Elson Lagoon to the BEO is limited to shallow draft boats. Stationing of small hand-propelled boats along the three sloughs and small foot bridges across the narrow part of the sloughs will greatly facilitate foot access from the east; particularly when helicopters are not available. Larger boat access to the Elson Lagoon Research Area can be launched from the present Niksiuraq boat harbor.

Proposed BEO Facilities

Map 10 indicates three facilities proposed within the BEO, one at North Meadow Lake (NML), one at the Southwest access to the BEO (known as the Cake Eater Road facility) and one at the Southeast access. The Cake Eater facility would be undertaken first, based on available resources.

The Cake Eater Road facility is proposed to be a year-round multipurpose science and field laboratory complex. It is proposed to locate a multi-purpose building (approximately 15 × 15 meters) on piles or blocks near the BEO corner on the high centered polygon area. The building will be used for field research, communication and data access, and educational purposes. Year-round power would be provided from an extension of the Gas Field power line. The pole line has been surveyed to the existing pullout and building site.

The North Meadow Lake (NML) facility as envisioned here would be on an existing research site that was occupied year round in the 1960s for pioneering research on micrometeorology, atmospheric chemistry and tundra thermal regimes (Kelley and Weaver, 1969). A building approximately 10 × 10 m would be placed on piles or blocks and used for field studies and communication. Year-round power would be supplied via the existing power line or by portable power generators.

Future development of the Southeast site includes a small building (5 × 5 m) placed at the entrance of the BEO for shelter, equipment, and wireless communication.

Other small temporary small buildings (3 × 4 m) would be deployed within the BEO for specific short-term projects to provide shelter for personnel and equipment.

Ultimately wireless data transmission would service all sites within the BEO. This would include WebCam monitoring systems to provide real-time visual and data access.

Establishment of all facilities will require consultation with the USFWS to ensure that activities and facility placement do not impede Steller's Eider productivity in the area. Both the NML and Cake Eater sites occupy high ground and are presumably less preferable as nesting and feeding areas.

Scientific Uses of the BEO

The BEO and surrounding lands and waters have provided the locations for research over the past half century (Norton 2001). These studies varied from single plants and animals to complex experiments and long-term monitoring. We foresee continuing research using advanced data collection and transmission capabilities. The exact locations of study sites cannot be forecast in advance; but will depend on the scientific questions to be studied, access and site charateristics. The following categories of investigation represent the principal future uses of the BEO.

Process and Experimentation (manipulations): Studies of undisturbed ecosystems and plant populations accompanied by controlled manipulations to improve our understanding of ecosystem function and allow for forecasts of future states under different environmental conditions. Small mammal exclosures and tundra fertilization experiments date back to the 1950s. The current BEO ITEX project is an example of plant response to experimental warming (Hollister and Webber 2000). The water table manipulation study by Oechel and the snow fence experiments by Hinkel are other examples.

Population Biology and Biodiversity: Studies of fish, birds and small mammal populations are ideally suited to the relatively undisturbed tundra and adjacent waters of the BEO. These studies include changes in species diversity and density, controls of breeding success of birds, year-round studies of small mammals, and experimental studies of captive animals. Included is the need for wader/shorebird studies as there is a significant history of shorebird research in the Barrow area. Research on the biodiversity of the BEO fauna and flora provides a baseline against which to compare future changes.

Environmental Monitoring: In order to establish and interpret changes in a relatively undisturbed ecosystem, repetitive and reproducible measurements are required over long periods of time. Numerous parameters, measured over variable spatial and temporal scales, are amenable to the establishment of such time series. These include among others: first occurrence of ice and snow cover, melt and runoff; phenological events associated with plants and animals; coastal and lake erosion; permafrost temperatures; thickness of snow cover and active layer thaw; soil moisture; and contaminant concentrations in flora, fauna, air, soil, snow, ice and water. The NOAA CMDL and ARM monitoring programs exemplify the value of long-term atmospheric measurements. Similar long-term observations on terrestrial, fresh water and marine ecosystems are required.

As an example of a new monitoring program a permafrost-climate observatory was established at the North Meadow Lake site during spring and summer 2002 with support from the International Arctic Research Center (IARC). Observations are measured and recorded year round for above-ground climate and soil and ground temperature to a depth of 50 meters and compared with measurements made in the 1950s.

Elson Lagoon Research Area

Research in the Elson Lagoon Research Area requires platforms for sampling ice, water, and underlying sediments, and buoys or fixed stations to monitor waves, water levels and other marine measurements. Boats of various sizes would be employed during the ice-free season. Fixed, moored platforms for seasonal or year-round measurements may be deployed. Locations will be well marked and avoid local boat traffic. Sampling and drilling from the ice cover are used in winter, with access by snow machines or other tracked equipment. Reinstallation of the early 1960s tide gauge in the vicinity of Plover Island is required.

Part IV The Master Plan

Master Plan Process

The BEO Master Plan is intended to document the existing conditions that may limit or enhance current or future scientific research efforts. As with any master plan and especially to fully utilize the master plan permit by the NSB, an effort was undertaken to document what future uses of the BEO should be anticipated.

Planning Future Use of the BEO - The Interest Questionnaire

A series of questions were developed to determine what additional uses of land the Master Plan should contain in order to provide the most comprehensive plan possible for consideration by the NSB. The Barrow Environmental Observatory User Interest Questionnaire was developed and sent to approximately 160 arctic researchers and associates. Of the 160 sent out, we received 22 responses, 95% of whom were either past or present researcher in the Barrow area. The respondent's research experience started in the late 1950s. Climate change was the highest priority area of research interest by the respondents. A copy of this questionnaire, and the tabulation of responses are contained in the attached Appendix C.

Researchers identified special needs for improved access (by 4-wheeler, boat and foot) to the BEO, followed by the need for electric power (at least 2 KW), shelter where researchers may be protected from the weather, and communications (at least 756 kbps) for telephone, wireless and data transmission. There was interest expressed in preserving older sites such as the International Biome Project (IBP), the U.S. Army Corps of Engineers' Cold Regions Research and Engineering Laboratory (CRREL) plots, and the active International Tundra Experiment (ITEX) sites and Arctic System Science (ARCSS) grid because of the importance they may have in future climate change investigations. Old weasel trails made by NARL researchers were also of interest because of the impact on vegetation and caribou behavior and recovery. Many researchers indicated the BEO should be maintained with minimal impacts on its environment. In summary, three items came through very clearly for improving research opportunities in the BEO:

- the need to make improved access,
- the need to provide shelter with a reliable power supply, and
- the need to provide significantly better communications with high speed data transmission capabilities.

Boardwalks and Protected Trails

Methods of improving access and diminishing impacts to the tundra where use is intense would be the installation of boardwalks and other protective materials. Some boardwalks could be built wide enough for a 4-wheeler (approximately 1.5 meters in width would be needed) to drive on and could also contain all weather electric outlets connected by power conduit to a power source. This type of constructed access could be built in a modular fashion (in 5- or 10-meter sections) and placed on broad-based skids or placed on pilings, depending upon the terrain covered. Other commercially available fabrics and materials can be employed to protect the tundra from human impacts.

Field Facilities with Power

It is clear there is a need for both fixed and small mobile facilities based on this interest survey. Modular structures on skids could be constructed in Barrow or procured commercially and towed in the winter to their intended

sites of use. Portable power plants are available now that would meet the low emissions requirement of many researchers. Small wind/solar/battery power supplies would be ideal in most cases and are readily available. There are also fuel cell power plants that release almost no emissions.

Communications

High-speed data transmission would be required from permanent facilities. Currently the only viable solution for high-speed data transmission in Barrow is by T1 lines or better connection via satellite.

Communications and data transmission can be provided by installing a digital cellular or wireless network that covers the BEO in its entirety. This is also needed for emergency communications for the safety of researchers. Currently there is limited cellular telephone coverage of the BEO.

Site Analysis

The Master Plan is based on a site analysis, identifying areas where development should occur, where seasonal use is recommended, and where essentially limited use is recommended. The site analysis uses all data layers previously discussed and assigns land use values for scientific research purposes (Map 11).

The analysis identified three distinct land types to be used for the purpose of classifying land uses:

* Land subject to periodic use based on sensitive environmental considerations such as the presence of nesting Steller's Eiders. In most cases these areas are not likely to be suited to the placement of buildings, either temporary or permanent;
* Land suitable for year-round use, but still considered environmentally sensitive based on concerns about damage to the tundra from any kind of mechanized traffic and susceptibility of slopes to riverine and coastal erosion. These areas may tolerate movement of temporary buildings or structures only during the fall and winter months when the frost depth has reached 12 inches or more below the tundra and there is at least 12 inches of snow covering the tundra; and
* Land suitable for year-round use, but still moderately susceptible to tundra damage. These areas can likely tolerate vehicular traffic during the winter with at least six inches of snow covering the tundra and very limited, summer-time traffic in late July and August. Permanent buildings would be best located on this type of land.

Master Plan

The Master Plan Map 11 shows all current and future planned uses of the BEO. Many of the following uses were identified and endorsed in the recently completed report on recommendations for future science facilities in the Barrow region (BASC 2002). The three classes of land use for research are symbolically represented as any one site could have multiple uses. As a project is designed and evaluated the site analysis criteria will be applied and the optimal location selected according to the following land classification:

<u>Process and Experimentation</u> (PE) land classification is the most intensive classification and will occur on those lands where manipulation will have the least impact on areas important for land values identified for protection under this plan. Some manipulations may be permitted in less intensive use areas if the manipulation proposes to use a natural process (such as a storm event causing erosion or a lake draining because of erosion).

Population Biology and Biodiversity (PBB) land classification is the next most intensive classification, however it requires no manipulation or significant alteration of the land to accomplish. This class of land will be located where it is likely to have the greatest success (because of land characteristics uniquely associated with a mammal, bird or fish) and will create the least impact to those areas of the BEO requiring more pristine conditions.

Environmental Monitoring (EM) land classification is the least intensive classification and is suitable for the most sensitive BEO lands. This class will likely be on land requiring long-term observation.

Management Considerations

The purpose of the Master Plan is to provide for a NSB permit to develop BEO access and infrastructure, and to provide researchers with a one stop approval process for establishing and conducting research. The UIC has tasked BASC with the management of the BEO. Under the approved Master Plan and the establishment of the Science Research District, the BEO Manager would review project plans and grant approvals for a wide range of activities taking into consideration all applicable rule and regulations. The following are the types of activities and infrastructure developments that would be the BEO Manager's responsibilities.

Sampling: soil, fauna, flora, water, sediment and shallow permafrost sampling; including placement of and removal of permanent or temporary stakes.

Monitoring installations:

- Towers for air and weather
- Piles for instrumentation (cameras, video, etc.)
- Shallow and deep boreholes for deployment of sensors
- Shallow burial of pipe, tubes and other instrumentation
- Below snow sampling devices

Experimental manipulations:

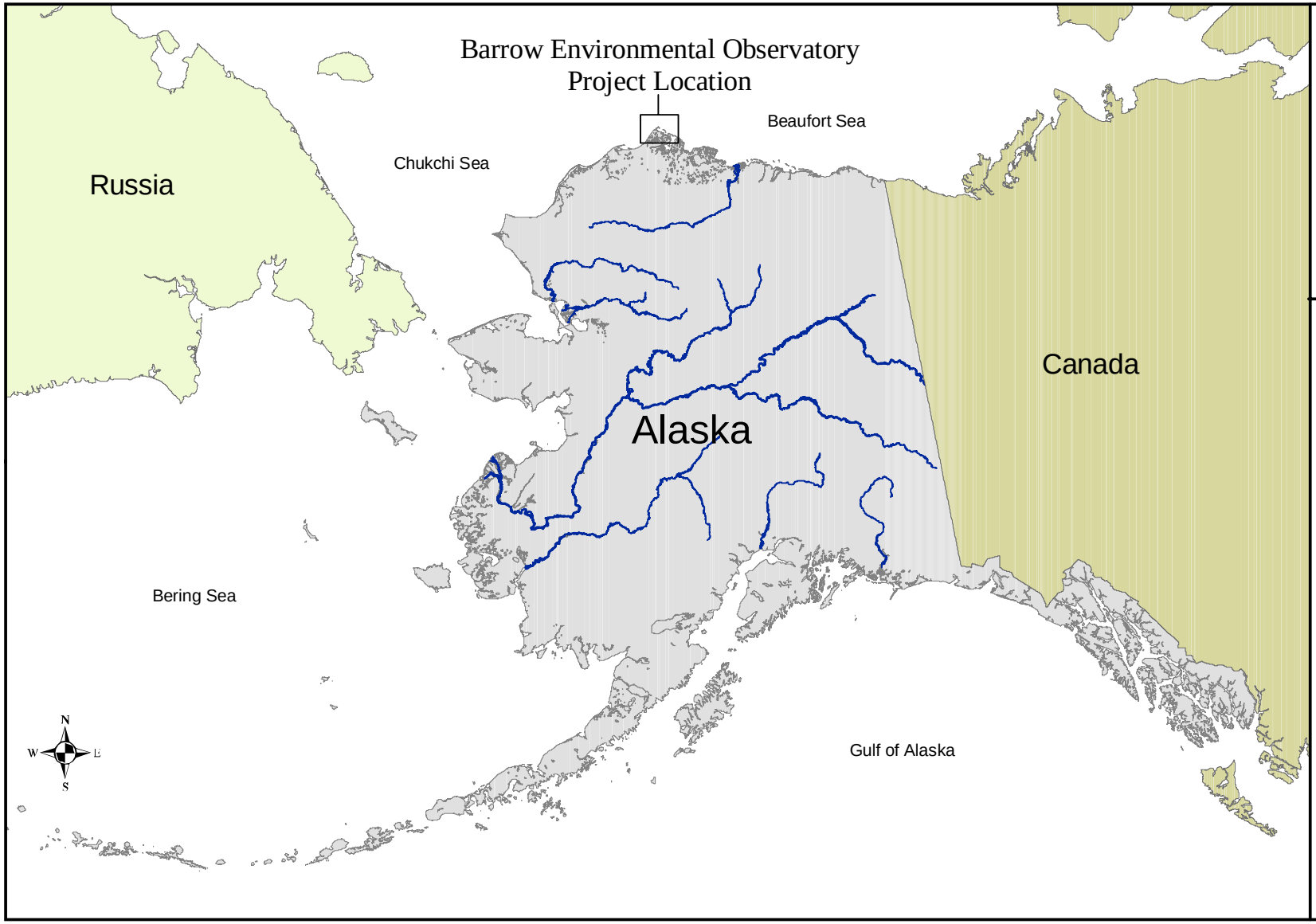
- Surface and water table modifications on plots to landscape scale
- Surface disturbance of vegetation and soils
- Construction and placement of semi-permanent objects including: snow fences, chambers, inclosures, exclosures, etc

Facilities:

- Placement of temporary buildings, shelters, and power lines
- Trenching and excavating to place equipment and related accessories including power lines with good practice and/or with zoning employed outside the BEO.
- Development of permanent facilities as described in Master Plan
- Walkways: installation of wooden and fabric materials across sensitive terrain
- Posting of signs and other markers.

Part V Map Section

1. Project Location
2. Barrow Environmental Observatory/ Science Research District
3. IKONOS Satellite Imagery
4. Topography and Hydrography
5. Vegetation Classification
6. Soils
7. Existing Roads, Utilities and Other Infrastructure
8. Existing Research and Monitoring Areas
9. Subsistence,Cultural and Steller's Eider Use
10. Proposed BEO Access Points and Facilities
11. Site Analysis and Master Plan

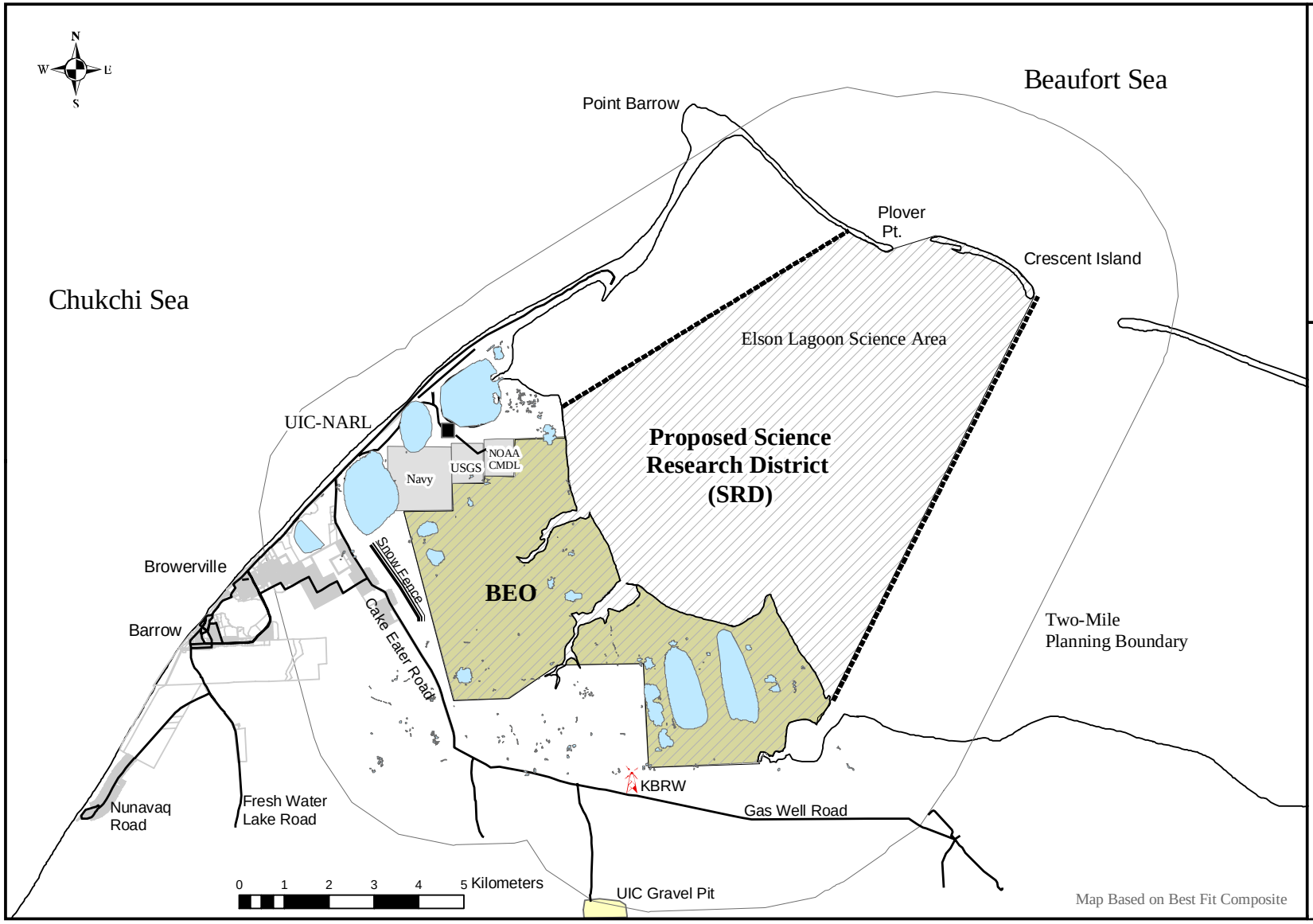


Barrow Environmental Observatory

Project Location

Map 1

September 2002



Barrow Environmental Observatory

Science Research District

Map 2

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Barrow Environmental Observatory

IKONOS Satellite Imagery

Map 3

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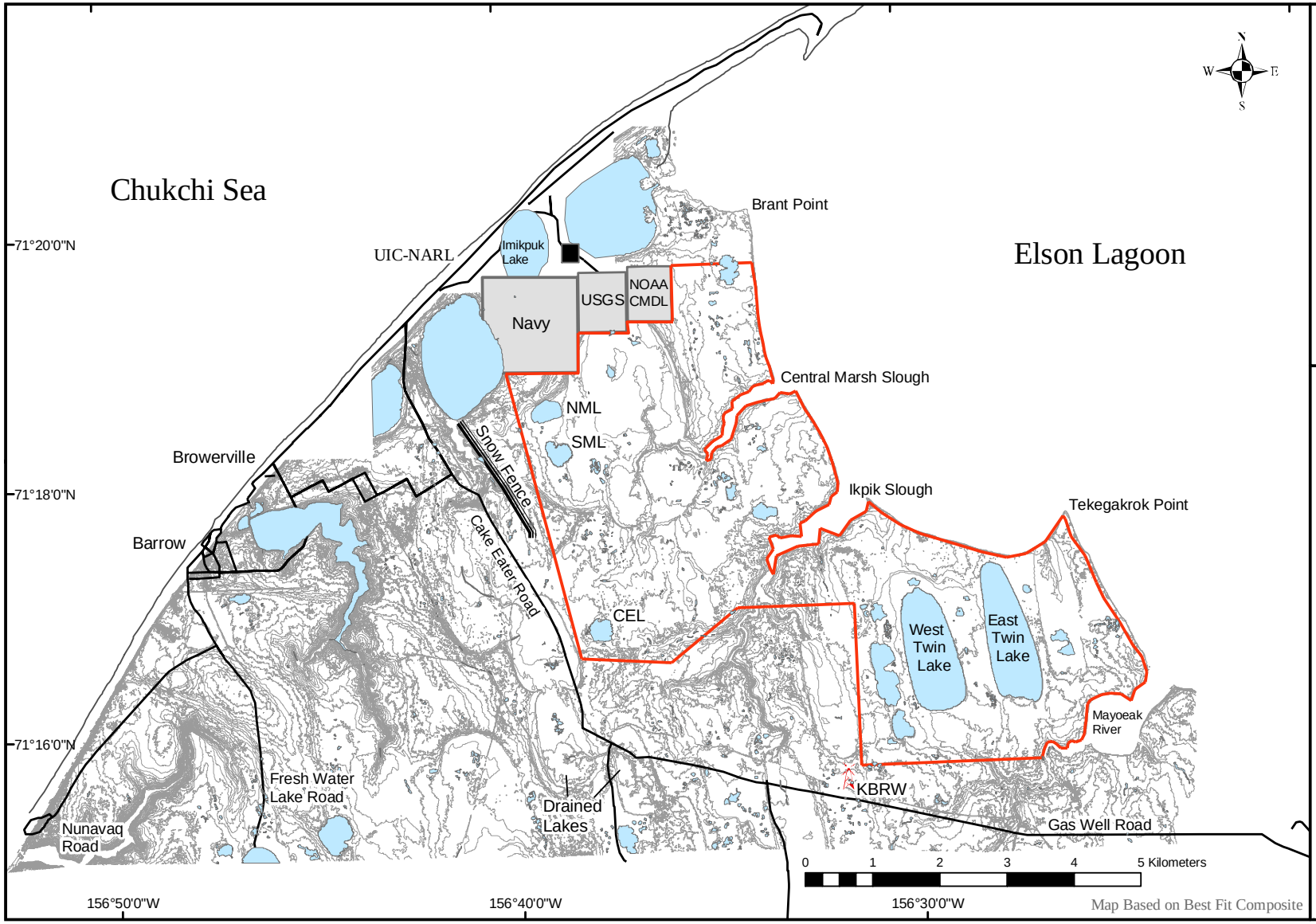

Barrow Environmental Observatory

Topography and Hydrography

Map 4

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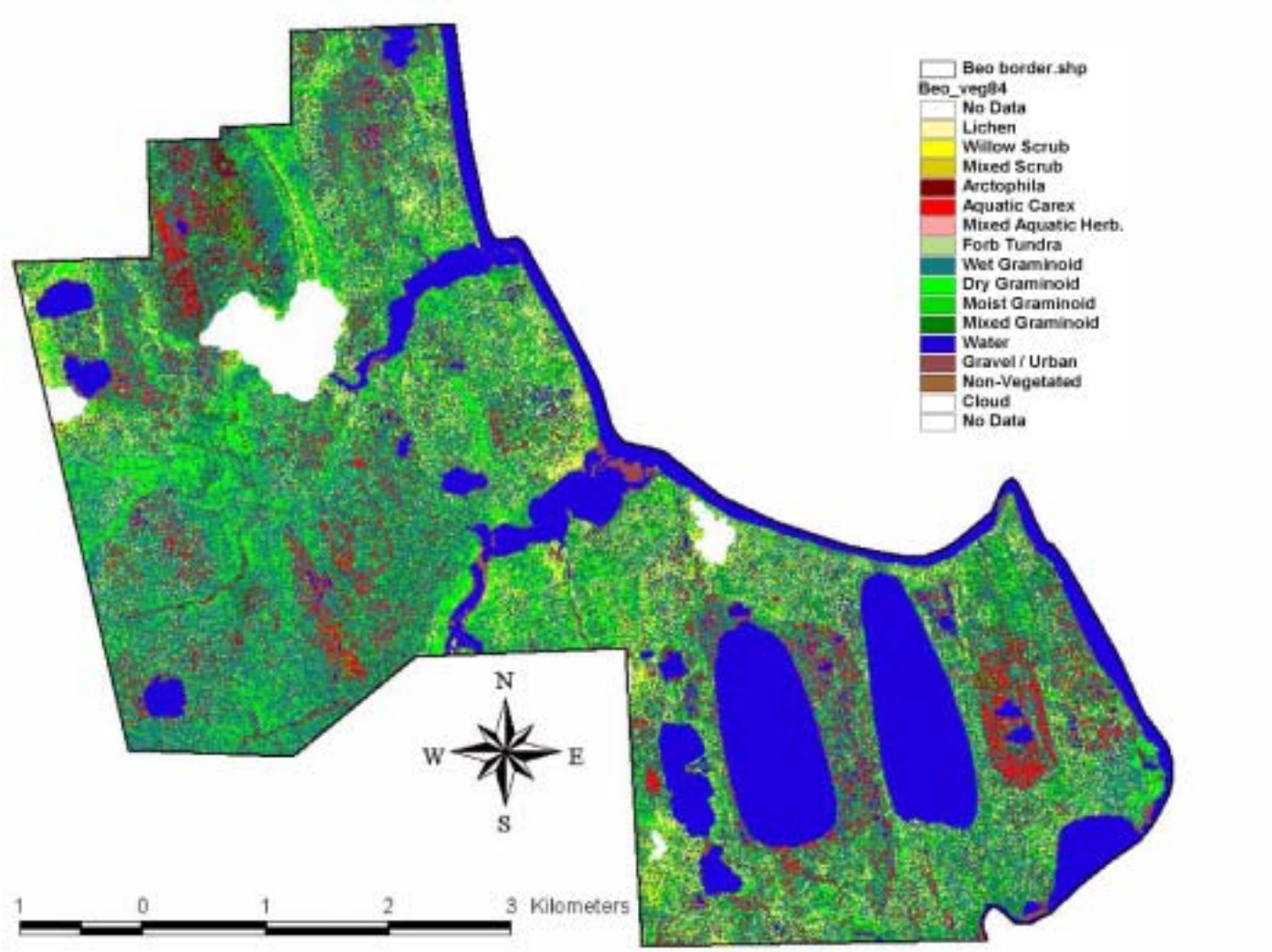

Barrow Environmental Observatory

Vegetation Classification

Map 5

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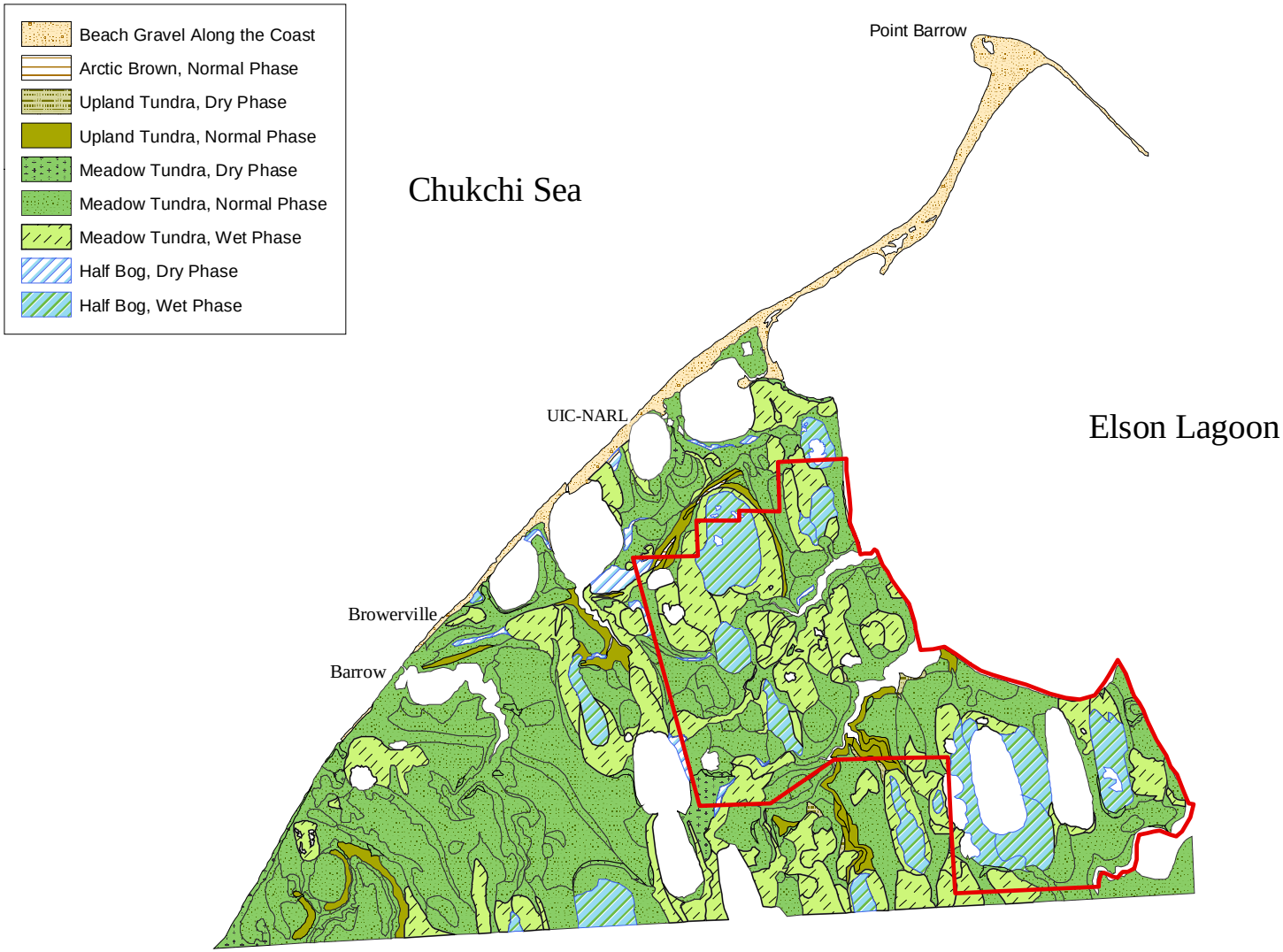

Barrow Environmental Observatory

Soils

Map 6

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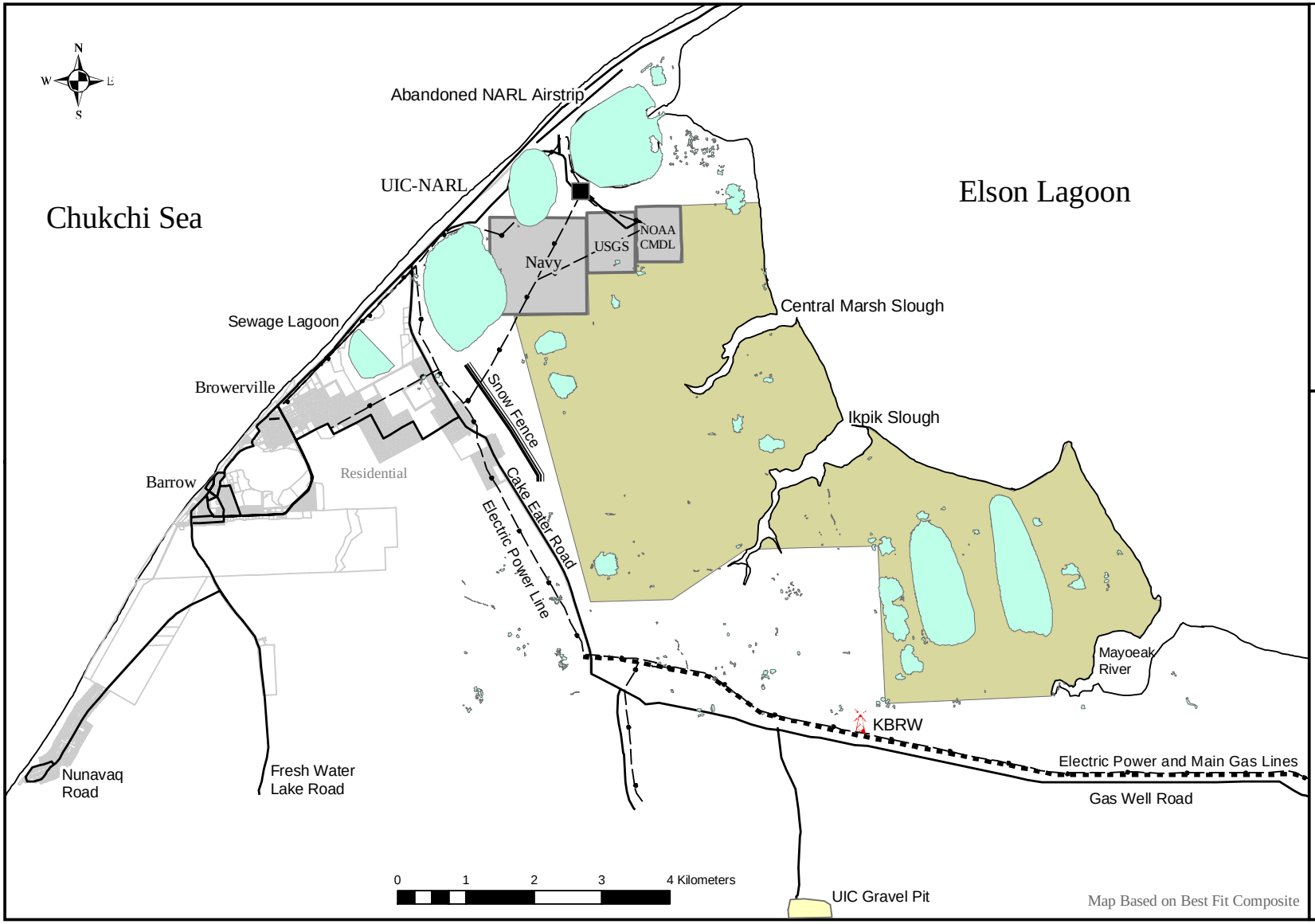

Barrow Environmental Observatory

Existing Roads, Utilities and Other Infrastructure

Map 7

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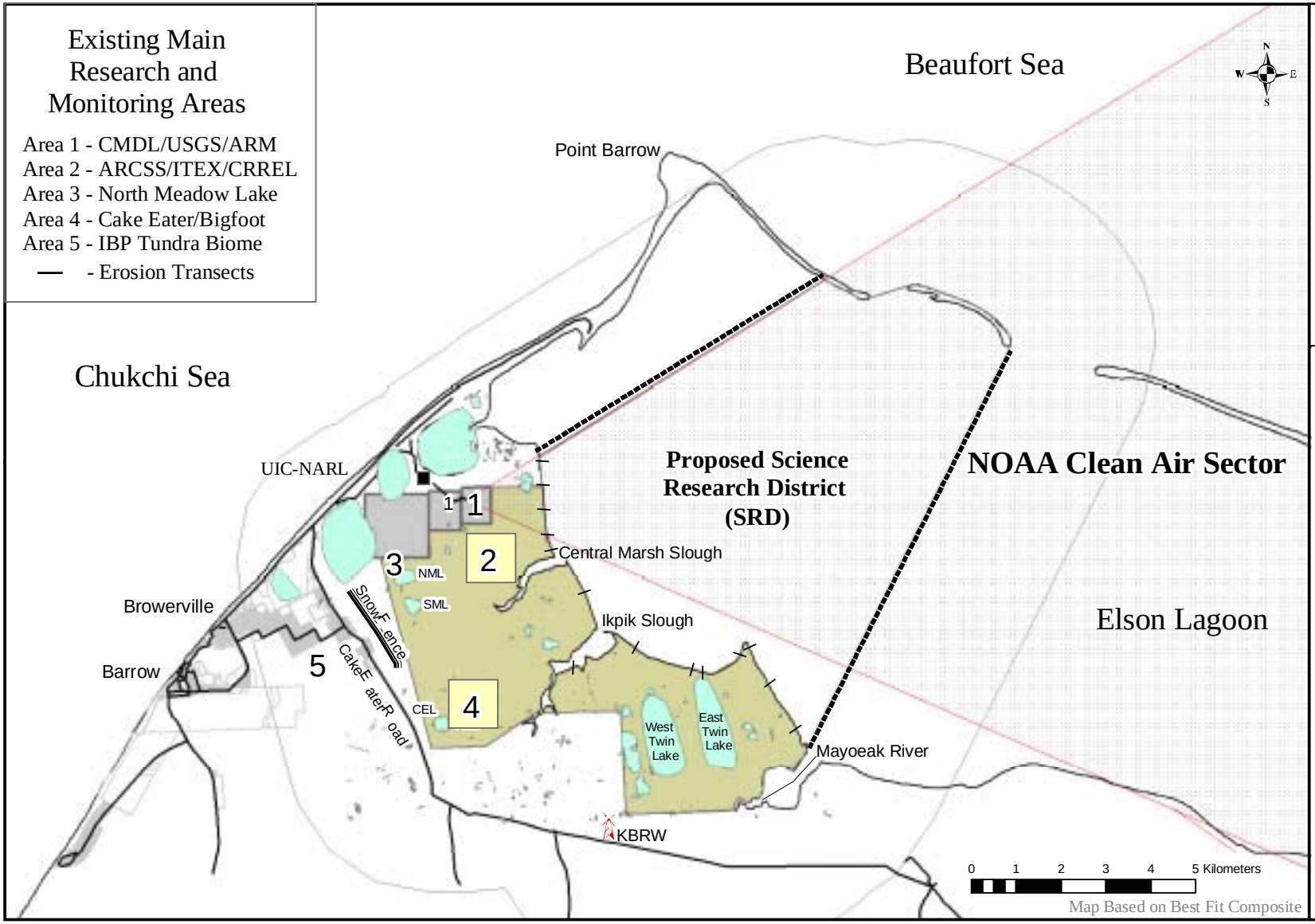

Barrow Environmental Observatory

Existing Research and Monitoring Areas

Map 8

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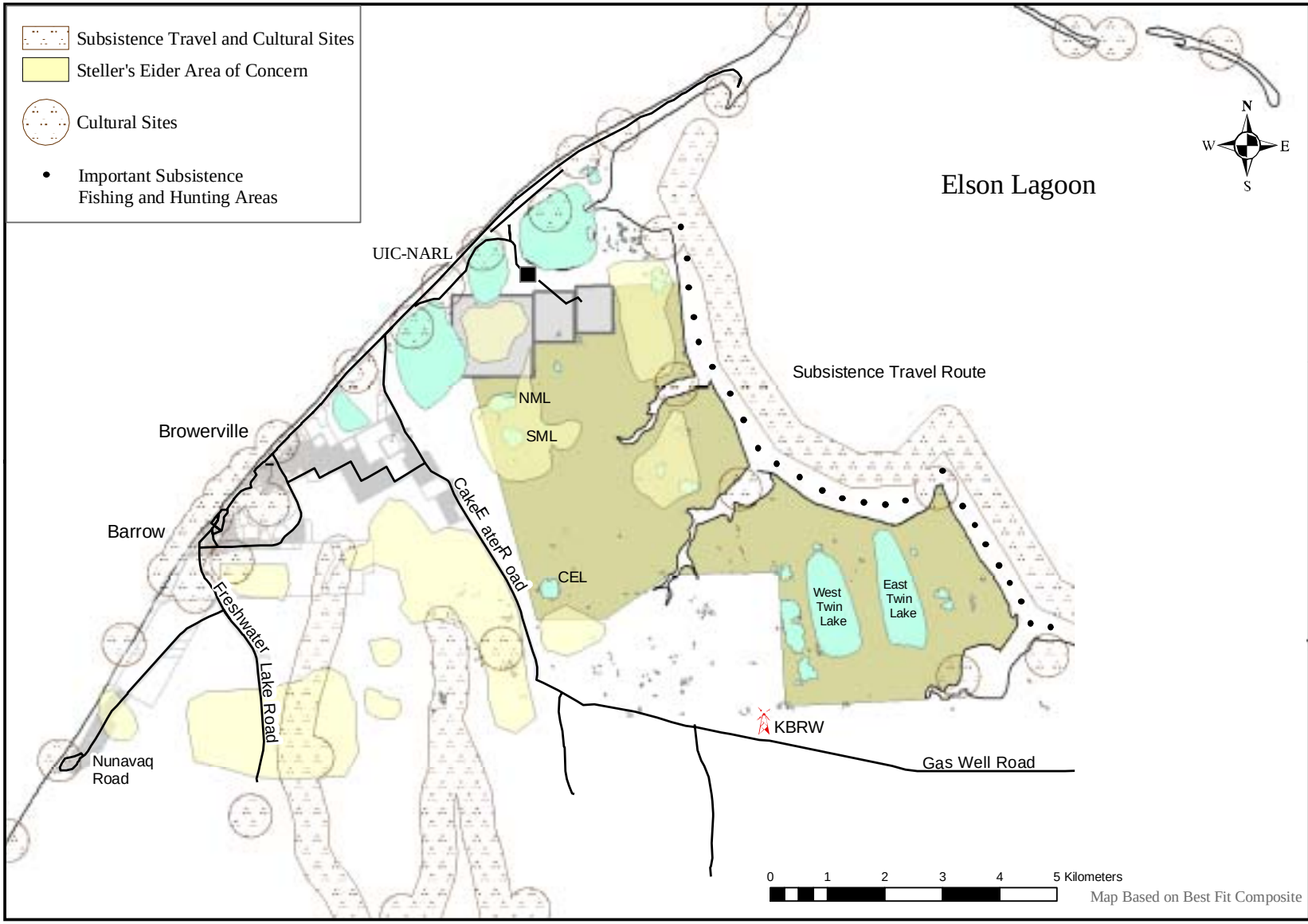

Barrow Environmental Observatory

Subsistence, Cultural and Steller's Eider Use

Map 9

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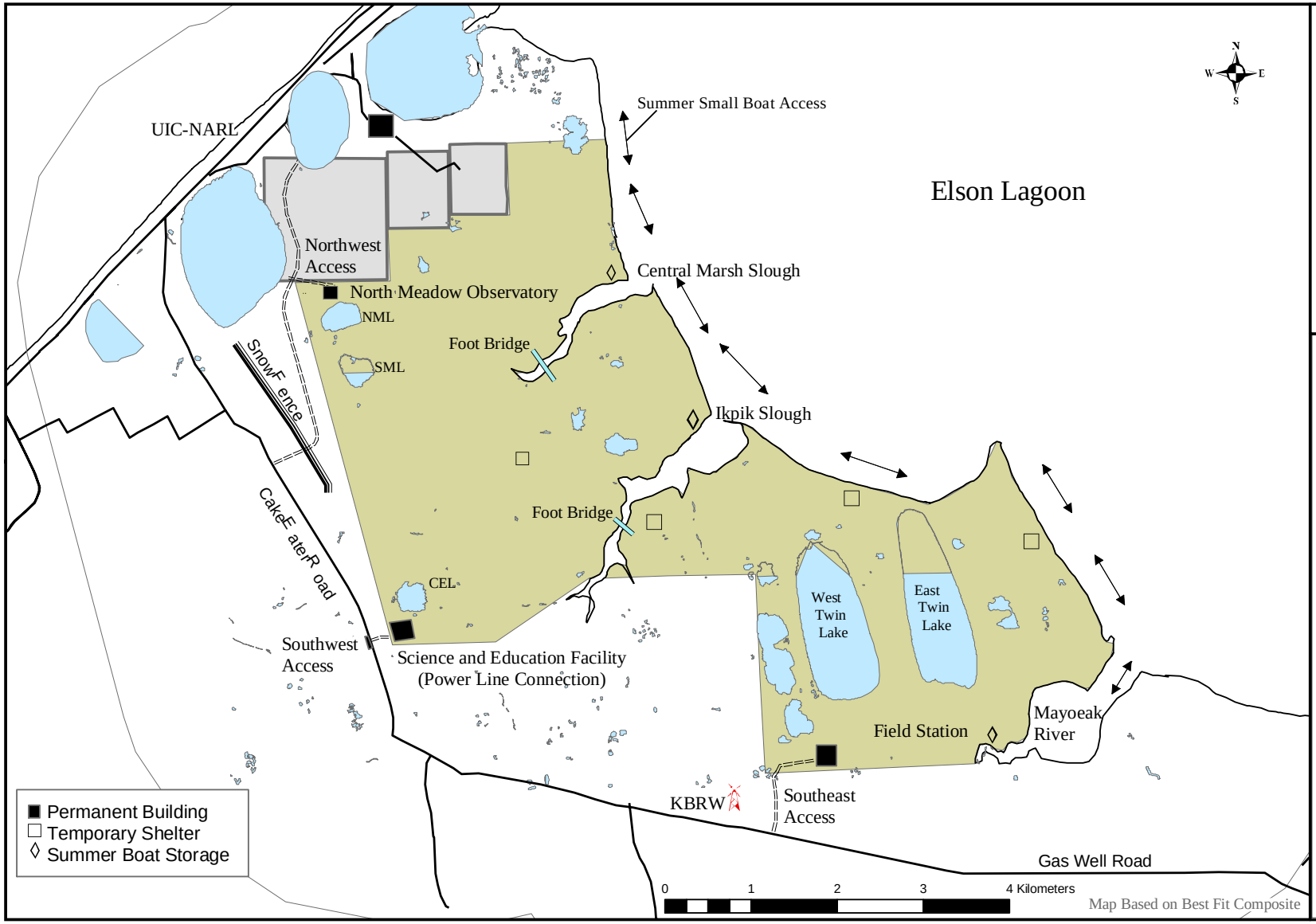

Barrow Environmental Observatory

Proposed BEO Access Points and Facilities

Map 10

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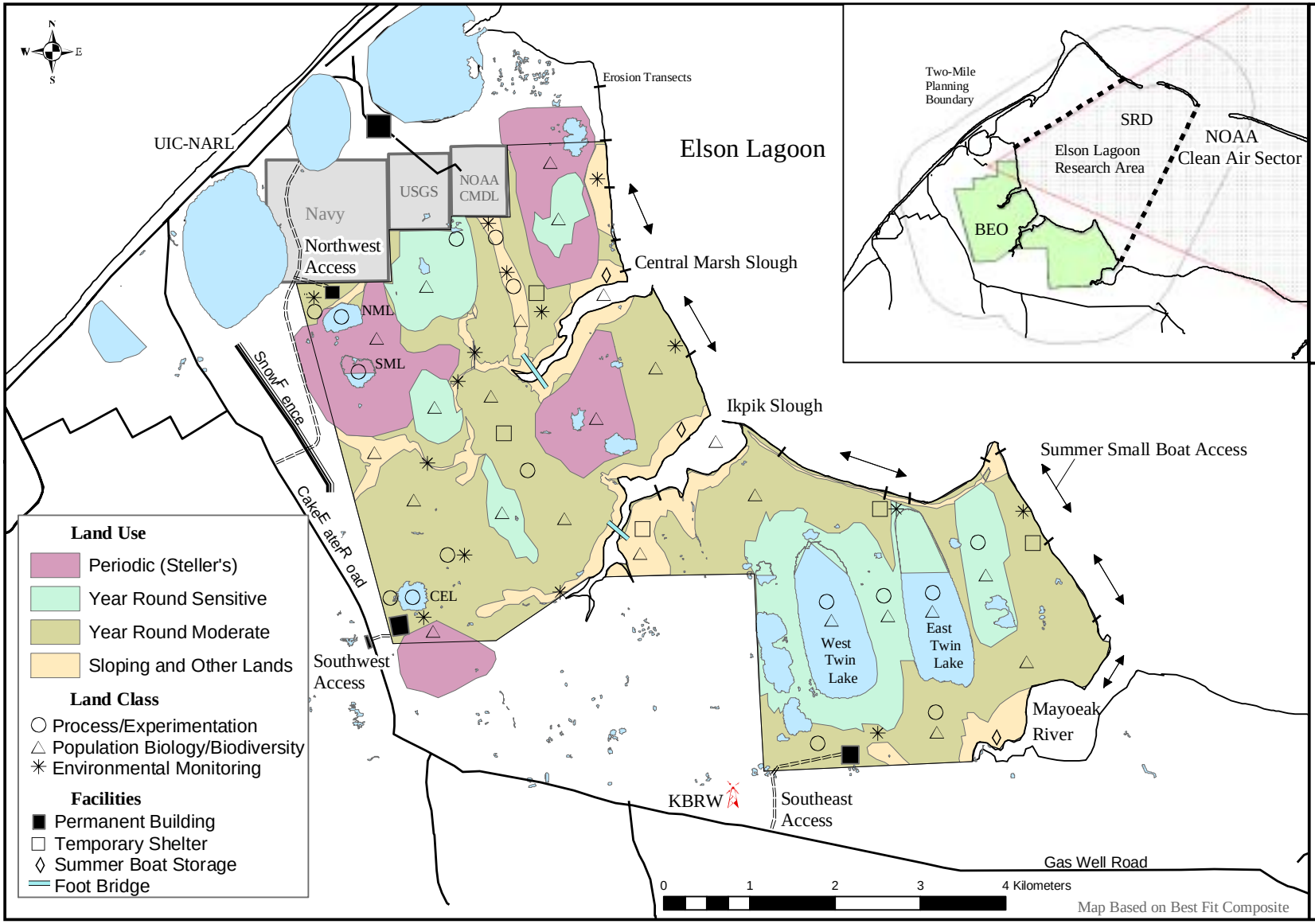

Barrow Environmental Observatory

Site Analysis and Master Plan

Map 11

September 2002

Acknowledgements

The Barrow Environmental Observatory Master Plan was prepared by Jon Dunham, Terratechnika, Anchorage, Alaska, under contract to the Barrow Arctic Science Consortium. The BASC Science Management Committee (formerly the BEO Management Committee), chaired by Dr. Jerry Brown, provided valuable assistance in both the preparation of the Plan and its review. Dr. Glenn Sheehan, BASC Executive Director, provided valuable support and advice throughout the project. The National Science Foundation provided the funding for the Master Plan and related field and office documentation under the Cooperative Agreements with BASC (OPP 9706494 and OPP 0004401).

The NSB GIS Division provided boundary, road and utility, information for these maps. Data for the subsistence and cultural use areas of concern was provided by the NSB Department of Wildlife Management and the NSB GIS Division. Information on the Steller's Eider were provided by Tim Obritschkewitsch and Philip Martin of the US FWS, and Robert Suydam of the North Slope Borough's Department of Wildlife Management.

Space Imaging Corporation provided the IKONOS satellite images that were initially processed by Ron Brooks, Fairbanks, Alaska for BASC. The Michigan State University, under the direction of Drs. Pat Webber and Craig Tweedie, and Brian Noyles enhanced the digital product for purposes of vegetation classification and mapping.

Digitizing of the 1:5000 map sheets (26) started at the NSB GIS Division in the early 1990s at the request of Jerry Brown, formerly of CRREL. The majority of the sheets were later digitized under the supervision of Christopher Kroot, TREESystems, Bangor, Maine, for both the BEO and new landfill projects. RDI and Montgomery Watson compiled the files. Leanne Lestak, University of Colorado, provided additional updated files.

The BEO site registration projects during summers 2000 and 2001 were conducted by Frank Lepera and Eric Hammerbacher, undergraduate students from Michigan State University, under the direction of Craig Tweedie (MSU). The final maps were prepared by Greg Fiske, Woods Hole Research Center, under the direction of Jerry Brown.

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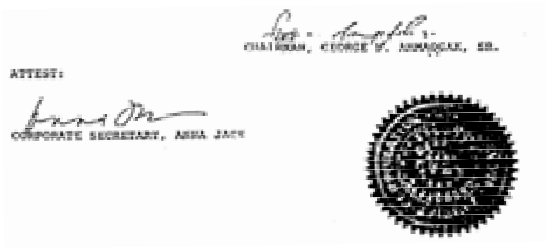
Appendix A: UIC Board Establishment of BEO

REGULAR BOARD MEETING
AUGUST 25, 1992

BARROW ENVIRON-MENTAL OBSERVATORY	Dr. Thomas Albert of the North Slope Borough Department of Wildlife said he is here to talk a little bit of establishing a study site around Barrow. One is to set up a site of land around NARL with a long history of study and they are here because UIC owns the land. He advised the Board that there is a lot of interest from the scientific arena to establish a study site with the objectives being: year-round access to designated and protected land sate, availability of long-term data sets, location for contaminant baseline monitoring, Arctic residents' involvement in research and education, and graduate fellowship program. After thorough review of the scientific sites, the area the scientists have selected is south of the NOAA Observatory as the principle protected area for the BEO. It includes the area west of the gas line from North Meadow Lake through Central Marsh and the Beach Ridge and across to Elson Lagoon and south to Ikpik Lagoon; an area approximately 2 by 3 miles. The northern portion of the site includes lands already held by the federal government. In addition to this site, the BEO includes the adjacent ocean, lagoon and overlying atmosphere.
MOTION	Delbert Rexford moved to approve the propose Barrow Environmental Observatory site and to include the two other sites which are the Britton Manor, Voth Creek and adjacent IBP study areas. Seconded by Charles Brower. Question called for. Motion carried.
ADJOURNMENT	Max Ahgeak moved to adjourn the meeting. Seconded by Charles Brower. Question called. Motion carried.



Appendix B: BASC Board's Resolution Establishing BEO Management Committee

BASC Board RESOLUTION
Terms of Reference: Barrow Environmental Observatory Management Committee

WHEREAS the Ukpeagvik Inupiat Corporation (UIC) has charged the Barrow Arctic Science Consortium (BASC) with managing the Barrow Environmental Observatory, and
WHEREAS the National Science Foundation's Office of Polar Programs (OPP), has entered into a Cooperative Agreement with BASC for "Facilitation of Arctic Research in the Barrow Environmental Observatory,"
THEN BE IT RESOLVED that the Board of Directors of BASC hereby establishes a Barrow Environmental Observatory (BEO) Management Committee, as follows:

DUTIES
The BEO Management Committee, by consensus, or in the event of necessity by majority vote of the Committee, shall

1. Set policy for the proper scientific use of the BEO and for the protection of the BEO as a resource and for the protection of research projects on the BEO;
2. Solicit and act upon recommendations for science support activities from the scientific community aimed at making the BEO and its associated infrastructure an attractive location for research pro≠jects;
3. Set policy for the sharing of research results by BEO users, so that final products are made available on the North Slope and so that researchers are held accountable to making raw and meta data available in a timely manner to the North Slope community and to the scientific community;
4. Specify technical protocols for data sharing;
5. Identify & prioritize science support activities to be accomplished by BASC or others.

COMPOSITION
The Committee shall be made up as follows, the BASC Board reserving the right to expand or alter the composition from time to time. Ex officio members shall not vote.

Richard Glenn, President, BASC
Bart Ahsogeak, Director, UIC Real Estate Department
Dan Endres, Researcher
Pat Webber, Researcher
Jerry Brown, Researcher
John Kelley, Researcher
Kurt Jacobsen, NSB GIS
Michael T. Ledbetter, ex officio, OPP, and Glenn W. Sheehan, ex officio, BASC

ADOPTED this 16th day of January 1998 by the Board of Directors.

Appendix C: Questionnaire and Results

Date: August 15, 2001
To: Current and Potential Users of the Barrow Environmental Observatory (BEO)
From: Jerry Brown, Chair, BASC Science Management Committee, and Glenn Sheehan, BASC Executive Director
Subj.: Important Questionnaire Regarding Current and Future Use of the BEO

Your help is needed to ensure the success of Arctic Research in Barrow!

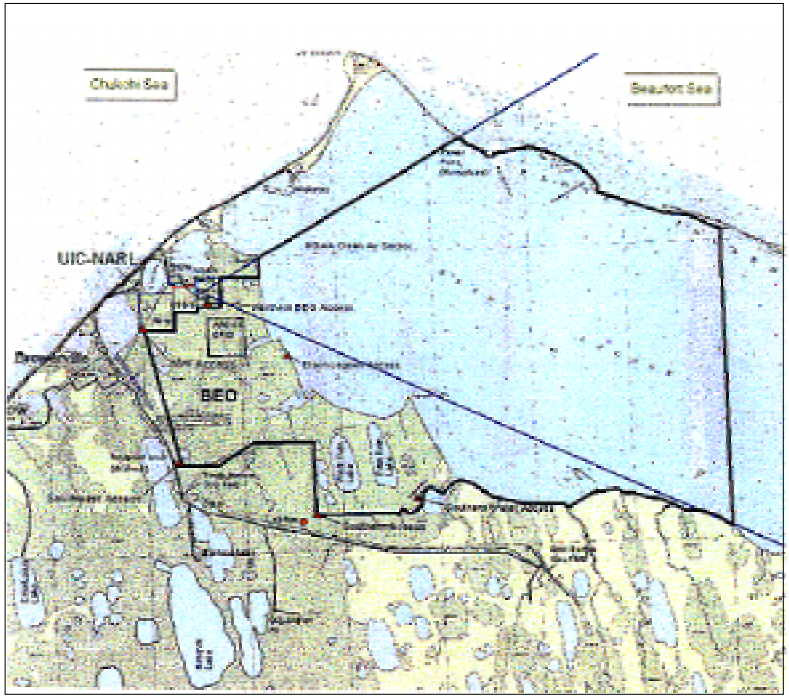
The Barrow Arctic Science Consortium (BASC) has been working on the development of the comprehensive Master Plan that accounts for past, present and future use of the BEO (see attached index map). The area has a scientific history covering a period of more than 50 years and closely associated with the presence of the former Naval Arctic Research Laboratory (NARL). The Master Plan process requires us to assess what new research opportunities and infrastructure can be accommodated in the general area of the BEO. We need your help to identify those uses of land and facilities that will encourage and improve continued use of the BEO for research and education. The BEO map shows both terrestrial and marine envi≠ronments.

IIn December 1998, Arctic researchers met in Marshall, California, and developed recommendations for Barrow area scientific research. The findings of that meeting are presented in "The Future of an Arctic Resource," a publication funded by the National Science Foundation and published by the Arctic Research Consortium of the United States (ARCUS). The report may be found at www.arcus.org . Among the findings was the recom≠mendation to develop a Master Plan for the Barrow Environmental Observatory (BEO).

To accomplish the task of developing the Master Plan, BASC has engaged Terratechnika, a consulting firm in Anchorage, Alaska, owned by Jon Dunham. Mr. Dunham is a former deputy Planning Director with the North Slope Borough Planning Department and was hired for his expertise and experience in developing master plans and working with the North Slope Borough, as well as State and Federal agencies. Please fill out the attached questionnaire and return it by email or US Mail to:

Terratechnika 7071 Whitehall St. Anchorage, AK 99502
terratechnika@gci.net

Mr. Dunham will compile and analyze the information in preparation of the BEO Master Plan.



Barrow Environmental Observatory (BEO)
User Interest Questionnaire

Name:_____

Institutional affiliation: _____

Address: _____

City: _____State/Province: _____

Postal Code: _____ Country: _____

Tel: _____ Fax: _____

Email: _____

1. Are you currently conducting research in the Barrow area? ____ yes / ____ no

2. If you have conducted research in the past in the Barrow area, please list the approximate periods.

3. Briefly describe the nature of research indicated in #2.

_____

_____

_____

_____

4. Please indicate the type(s) of research you have conducted in the Barrow area, or propose to conduct in the future. Check all that are applicable.

Marine and Coastal Research

____ terrestrial mammals ____ marine mammals ____ birds of prey
____ fish ____ biodiversity ____ anadromous fish
____ ecological investigation ____erosion/sediments ____ geomorphology
____ geothermal ____ permafrost ____ soils
____ hydrology ____ vegetation ____ lichens
____ hydrocarbon ____contaminants/food chain ____ sea/ice
____ geophysics ____ biogeochemistry ____ engineering
____other-describe

Terrestrial and Freshwater Research

____ migratory birds ____ fish ____ invertebrates
____ biodiversity ____ anadromous fish ____ respiration
____ ecological investigation ____erosion/sediments ____ geomorphology
____ geothermal ____ permafrost ____ soils
____ hydrology/snow cover/lake ice ____ vegetation ____ lichens/mosses
____ hydrocarbon ____contaminants/food chain ____ plant respiration
____ vertebrates ____ biogeochemistry ____ engineering
____other-describe

Atmospheric Research

____ climate change ____ engineering ____fluxes (gases,nutrient)
____upper atmosphere ____ respiration ____ biogeochemistry
____ space physics ____atmospheric chemistry ____other-describe

Social Science Research

____ archaeology ____ anthropology ____ traditional/cultural use
____ education ____ other - describe

5. If you are a current or potential user of the BEO or a researcher in the Barrow area, please mark on the attached map to show locations where you have conducted research in and around the BEO, and indicate locations where you might conduct research in the future.

a. Does your research have special needs (e.g. vehicular access, electrical power, shelter for researchers, etc.)? If so, please list those below.

_____

_____

b. Are there other types of research that you would undertake in the BEO, but haven't because of some restriction or limitation? If so, please describe with proposed locations.

_____

_____

c. Does the research you are conducting require a specific site(s) and long-term research monitoring (5-10 years)? Please list these sites below.

_____

_____

d. Are there areas in or adjacent to the BEO that require dedicated use to ensure future viability of your research? If so, please identify those site(s), the area needed and the specific use.

6. What infrastructure improvements might benefit your potential or current research on the BEO (e.g. access, power, shelter, etc.)?

_____

_____

7. In your opinion, what conditions are needed to exist to provide advanced technological research use(s) (e.g. remote power supply, high-speed data trans≠mission, voice/satellite communications, differential GPS, etc.) in the BEO and surrounding area?

_____

_____

8. What mechanisms would you suggest for sharing data and information about research conducted in the Barrow area?

_____

_____

Questionnaire Results

1. Are you currently conducting research in the Barrow area?

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y

85.7% of researchers responding are currently conducting research in the Barrow area.

2.If you have conducted research in the past in the Barrow area, please list the approximate periods.

1	2	3	4	5	6	7	8	9	10	11
1999-–2002	Na*	1900, 1992, 2000 & 2001	1999-present	Na*	1990-1994; 1997-present	1993-present	1995-present	1984, 1986, 1994-present	1997-present	1968-1973; 1975-1982, 1990-present

12	13	14	15	16	17	18	19	20	21
1972-75; 1980s; 1990-	No	1978-1980	1992-present	1974-present	Na*	2000-present	1971-1978, 1994 to present	1968-1995	1992-present

*- no answer provided.

95% of researchers responding are currently conducting research or have conducted research in the past in the Barrow area.

3. Briefly describe the nature of research indicated in #2.
15 of the 21 researchers indicated their research lies in the following areas:
Landscape Ecology - 40% ; Climate - 13% ; Ice Dynamics - 13% ; Environmental Contaminants - 13% ; Archeology - 7% ; Animal and Bird Ecology - 7%.

Marine and Coastal Research

____ terrestrial mammals
_3__ fish
_5__ ecological investigation
____ geothermal
_1__ hydrology
____ hydrocarbon
_2__ geophysics
____ marine mammals
_1__ biodiversity
_1__erosion/sediments
_2__ permafrost
_2__ vegetation
_2__contaminants/food chain
_4__ biogeochemistry
_1__ birds of prey
_2__ anadromous fish
_1__ geomorphology
_2__ soils
_2__ lichens
_4__ sea/ice
_2__ engineering
_2__other-primary production of ice, water and sea floor; climate and meteorology

Interest in fields of study from responding researchers are as follows:

high interest areas	medium interest areas	low interest areas	no interest areas
ecological investigations	engineering	hydrology	terrestrial mammals
sea/ice	geophysics	biodiversity	geothermal
biogeochemistry	other	erosion/sediments	hydrocarbon
fish	permafrost	vegetation	marine mammals
	contaminants/food chain	birds of prey	
	soils	geomorphology	
	anadromous fish/amphidromous fish		
	lichens/mosses		

Terrestrial and Freshwater Research

_1__ migratory birds
_4__ biodiversity
_9__ ecological investigation
_1__ geothermal
_4__ hydrology/snow cover/lake ice
_7__ lichens/mosses
_4__ plant respiration/photosynthesis
_4__ biogeochemistry
_3__ fish
_3__ anadromous fish
____erosion/sediments
_5__ permafrost
_5__ vegetation
____ hydrocarbon
_1__ vertebrates
_2__ engineering
____ invertebrates
_1__ respiration
_6__ geomorphology
_5__ soils
_2__contaminants/food chain
_1__other-effects of global warming, vegetation change

Interest in fields of study from responding researchers are as follows:

high interest areas	medium interest areas	low interest areas	no interest areas
ecological investigation	biodiversity	vegetation change	invertebrates
lichens/mosses	hydrology/snow cover/lake ice	geothermal	erosion/sediments
geomorphology	permafrost	migratory birds	vertebrates
	soils	respiration	hydrocarbon
	vegetation	engineering	
	plant respiration/photosynthesis	contaminants/food chain	
	biogeochemistry	effects of global warming	
	fish		
	anadromous /amphidromous fish		

Atmospheric Research

_13_ climate change
_2__ upper atmosphere
_1__ space physics
_2__ engineering
_3__ respiration
_4__ atmospheric chemistry
_4__ fluxes (gases,nutrient)
_2__ biogeochemistry
_3__ other-Climatology-basic meteorological measurements & studies;
-Atmospheric corrosion research;
-Solar radiation, magnetic, snow chemistry, atmospheric deposition, visibility & related studies

Interest in fields of study from responding researchers are as follows:

high interest areas	medium interest areas	low interest areas	no interest areas
climate change*	fluxes	space physics	none
	respiration		
	atmospheric chemistry		
	other		
	upper atmosphere		
	engineering		
	biogeochemistry		

*-highest interest area of this survey

Social Science Research

_1__ archaeology
_3__ education
_1__ anthropology
____ other - describe
_7__ traditional/cultural use

Interest in fields of study from responding researchers are as follows:

high interest areas	medium interest areas	low interest areas	no interest areas
traditional/cultural use	archaeology	none	none
education	anthropology		

Areas of research interest are (in order of interest):

1. climate change (atmospheric)
2. ecological investigation (terrestrial and freshwater)
3. lichens/mosses (terrestrial and freshwater)
4. traditional/cultural use(social science)
5. geomorphology (terrestrial and freshwater)
6. soils(terrestrial and freshwater)
7. vegetation(terrestrial and freshwater)
8. permafrost(terrestrial and freshwater)
9. ecological investigation(marine and coastal)
10. sea/ice(marine and coastal)
11. biogeochemistry(marine and coastal)
12. biodiversity (terrestrial and freshwater)
13. hydrology/snow cover/lake ice (terrestrial and freshwater)
14. plant respiration/photosynthesis (terrestrial and freshwater)
15. biogeochemistry (terrestrial and freshwater)
16. atmospheric chemistry (atmospheric)
17. fluxes-gases,nutrient (atmospheric)
18. fish (marine and coastal)
19. fish (terrestrial and freshwater)
20. anadromous fish/amphidromous fish (terrestrial and freshwater)
21. respiration (atmospheric)
22. climatology-basic meteorlogical measurements & studies (atmospheric)
23. education (social science)
24. geophysics (marine and coastal)

25. primary production of ice, water and seafloor; climate and meteorology (marine and coastal)
26. permafrost (marine and coastal)
27. vegetation (marine and coastal)
28. contaminants/food chain (marine and coastal)
29. anadromous fish (marine and coastal)
31. lichens (marine and coastal)
32. engineering (marine and coastal)
33. engineering (terrestrial and freshwater)
34. contaminants/food chain (terrestrial and freshwater)
35. upper atmosphere (atmospheric)
36. engineering (atmospheric)
37. biogeochemistry (atmospheric)
38. hydrology (coastal and marine)
39. biodiversity (coastal and marine)
40. erosion/sediments (coastal and marine)
41. birds of prey (coastal and marine)
42. geomorphology (coastal and marine)
43. migratory birds (terrestrial and freshwater)
44. geothermal (terrestrial and freshwater)
45. respiration (terrestrial and freshwater)
46. vertebrates (terrestrial and freshwater)
47. effects of global warming, vegetation changes (terrestrial and freshwater)
48. space physics (atmospheric)
49. archeology (social science)
50. anthropology (social science)

5. If you are a current or potential user of the BEO or a researcher in the Barrow area, please mark on the attached map to show locations where you have conducted research in and around the BEO, and indicate locations where you might conduct research in the future.

a. Does your research have special needs (e.g. vehicular access, electrical power, shelter for researchers, etc.)? If so, please list those below.

Special needs identified by researchers	
Access	
Pedestrian	6%
Vehicular (4-wheeler & snow machine)	26%
Boat with jet drive outboard	10%
Communications - 756 kbps minimum	
(Telephone, Wireless & Data Transmission)	16%
Shelter	18%
Electrical power (2 kw minimum)	18%
Radar	2%
DGPS	2%
Security for towers	2%

b. Are there other types of research that you would undertake in the BEO, but haven't because of some restriction or limitation? If so, please describe with proposed locations.

1 talked about doing river-based research which might require a bigger boat and a means to get through thick ice.
2 na.
3 na.
4 would like to undertake more spatially extensive analysis of the controls in carbon exchange in the BEO region. Access, time and resources (human and financial) remain key limitations for this work.
5 na.
6 wireless communications would resolve many of the problems with respect to our limitations. Power is another large problem but is likely a difficult one to resolve for all of the BEO.
7 none.
8 None. There is a need to do more manipulative types of research. The BEO may not be the best place for this type of research. Should be a provision to do this in the BEO.... should be well documented and diminish over time.

9 I'd like to map the archaeological sites, both precontact and postcontact, including those from the science itself. The limiting factor so far has been time and money.
10 no.
11 na.
12 Education shelter for outreach with computers and links to near real time data from throughout the arctic highlighting NSF research in Barrow, the Alaskan arctic, and throughout the arctic (e.g. Russia, Svalbard, Greenland, etc. with comparisons to the Antarctic and elsewhere on the planet). Lack of helicopter support has limited our ability to test aircraft flux transects and to investigate "hot spots" of sink and source activity. A hangar would increase our productivity and extend our season. Communications in the field at Atqasuk would improve our data communication and "uptime." High speed internet communication would improve our productivity. Lack of boardwalks, elec≠tricity and wireless backbone for communications is a major limitation for continuing and expanding our research. Lack of vehicles for short term use (not an all day rental) is a limitation.
13 Without power can not locate equipment in the BEO.
14 Atmospheric corrosion. One near beach and one at BEO.
15 na.
16 The map shows access to the BEO across the southern perimeter of the CMDL Baseline Station property. This infers crossing the protected area of CMDL. There is no road or path there at present nor will there be allowed one in the future. There are tundra experimental plots and data lines crossing the area south of the observatory. Foot traffic is not even allowed to cross this area for these reasons. Please remove that phantom access point from the map before it is taken as being real
17 na.
18 None. There is a need to do more manipulative types of research. The BEO may not be the best place for this type of research. Should be a provision to do this in the BEO....should be well documented and diminish over time.
19 None. There is a need to do more manipulative types of research. The BEO may not be the best place for this type of research. Should be a provision to do this in the BEO... should be well documented and diminish over time.
20 na.

c. Does the research you are conducting require a specific site(s) and long-term research monitoring (5–10 years)? Please list these sites below.

1 Not specifically—except to be working where native people fish.
2 We would like to occupy a small number of sites on the sea/lagoon/lake ice over a longer period (depends also on funding) to continue a 3-year record available so far. Because these sites are located in the seasonal ice, there is no special requirement other than that they not be disturbed once the ice has formed. We would like to occupy a small number of sites on the sea/lagoon/lake ice over a longer period (depends also on funding) to continue a 3-year record available so far. Because these sites are located in the seasonal ice, there is no special requirement other than that they not be disturbed once the ice has formed.
3 Ikoravik Lake.
4 Ideally would continue long-term monitoring at present site indefinitely. This work is linked to the flux towers run by SDSU (Oechel and company).
5 na.
6 We presently have a long-term research site just south of the CMDL, an eddy covariance tower. It has both power and communication and we anticipate running it for 510 years in the future (it has been running since 1998). In the future, additional long-term sites may decided upon by groups of researchers but presently has not been done except possibly the ARCSS grid and any thaw grids that may have been laid out. I suspect other researchers do have specific sites that they hope to use for long-term research.
7 The ARCSS grid and the snow fence along Cakeeater Rd.
8 Plant ecology is very site specific. ITEX, former CRREL sites, all former disturbances such as old roads. Caribou following old cat trails was an example of landscape change that also changed animal behavior.
9 It requires that existing sites not be destroyed by other researchers prior to their being identified and recorded or excavated (for precontact sites).
10 Primarily the ARCSS grid and CRREL Plots, but we've also established some new sites as indicated on the 2nd map. In addition, I would urge that older sites be preserved as we've had some very interesting work result from occu≠pying the CRREL plots and comparing past and present measurements.
11 Potentially for Elson Lagoon.

12 All of our tower work is intended to be long-term (central marsh, NOAA tower sites). Would like to do long-term FACE elevated CO2 research on the BEO. Will need boardwalk, power, access to the natural gas pipeline.
13 Long-term (> 11 years).
14 Atmospheric corrosion test sites.
15 na.
16 na.
17 na.
18 Plant ecology is very site specific. ITEX, former CRREL sites, all former disturbances such as old roads. Caribou following old cat trails was an example of landscape change that also changed animal behavior.
19 Plant ecology is very site specific. ITEX, former CRREL sites, all former disturbances such as old roads. Caribou following old cat trails was an example of landscape change that also changed animal behavior.
20 There are a few good locations in the lagoon where one can collect oriented sea ice.
21 na.

d. Are there areas in or adjacent to the BEO that require dedicated use to ensure future viability of your research? If so, please identify those site(s), the area needed and the specific use.

1 na.
2 na.
3 na.
4 Currently, a flight line from the BEO region to Atqasuk is part of our study region (SDSU Sky Arrow Transect).
5 na.
6 None to list at present time.
7 No.
8 See #5c
9 No. There are some I'd like to see protected, but I can still do research without them.
10 If by dedicated use you mean that we could limit access and use of the area surrounding our sites to undisruptive, low impact scientific use, then I would answer yes. Some protection for what is left of the IBP site would be wonderful as well.
11 na.
12 IBP site 2 is critical to our long-term data base. IBP site 2 must be protected for the long haul with sufficient surrounding area to protect the integrity of the site.
13 na.
14 na.
15 na.
16 na.
17 na.
18 see #5c
19 see #5c
20 na.
21 na.

6. What infrastructure improvements might benefit your potential or current research on the BEO (e.g. access, power, shelter, etc.)?

1 Reliable freezer space, clean room for storage and processing samples.
2 A wireless network for data transmission to a central storage/interneta c c e s s . Site; power on one of the barrier islands to run out to the lagoon and Beaufort fast ice.
3 na.
4 Improved access, power station (outlets for power or for charging equipment) & limited shelter could all help. Improved boardwalk access and small vehicles could be a big help.
5 Running sea water is most essential for marine ecological studies! Secondly, outdoor huts with power supply, indoor and outdoor aquaria of various sizes (up to 10 cubic meters)
6 Definitely access, power, communication and shelter would increase our use of the BEO.
7 None. Just keep the sites and BEO as pristine as possible.

8 Shelter, power and a new access road. A trail or boardwalk system for alternative access and to protect the tundra. Try to use old roads when available. Low impact tires on four-wheelers.
9 Good 4-wheeler access (perhaps on boardwalks following some existing cat trails) and some type of shelters.
10 Access might be helpful in terms of parking spaces along the road. However, I think that any further development should be extremely limited in scope and restricted to areas directly adjacent to the road, whether it is at the Southwest Access or the CMDL.
11 na.
12 Electrical power, wireless backbone, communications, security, protection for equipment and towers. High speed data communication from field and lab.

We have two major new initiatives that we would like to propose.
1. Large scale alteration of water table by flooding drained lake basins and draining current lakes. By manipulating the water table on the landscape level, we can confirm the effects of changes in the water table on the ecosystem function. Since lakes have a gradient in elevation, we will have a gradient in water table manipulation to work with. This could be combined with subplots of other factor manipulations.
2. State of the art CO_2, temperature, water table, nutrient manipulations. Provision of boardwalks, wireless backbone and natural gas line and electrical power, in the southern part of the BEO could open the opportunity for a world class experiments on the impacts of interaction of factors on the structure, function, CO_2 balance, and CH_4 balance, and energy balance. The natural gas would be combusted to provide CO_2 for elevated CO_2 mini FACE experi≠ments, and heat for warming experiments. Electrical power would be used for instruments and communication to the wireless experiments. We would be able to do CO_2 X water table X temperature X nutrient manipulations.
13 Road access, power, a building for our equipment and communications.
14 Pilot scale laboratory to work on processes and products.
15 Access, power and shelter.
16 na.
17 na.
18 Shelter, power and a new access road. A trail or boardwalk system for alternative access and to protect the tundra. Try to use old roads when available. Low impact tires on four-wheelers.
19 Shelter, power and a new access road. A trail or boardwalk system for alternative access and to protect the tundra. Try to use old roads when avail≠able. Low impact tires on four-wheelers.
20 Need upgrade on the cold rooms & more heated laboratory space.
21 na.

7. In your opinion, what conditions are needed to exist to provide advanced technological research use(s) (e.g. remote power supply, high-speed data transmis≠sion, voice/satellite communications, differential GPS, etc.) in the BEO and sur≠rounding area?

1 The following are essential: GPS, availability to GIS maps, voice/satellite phone, better internet access in Barrow, availability of long-term weather data, and logistics coordination.
2 Wireless, highspeed data transmission between remote sites and hub in Barrow; reliable mediumto highspeed data transmission (i.e., anything better than what's currently offered); DGPS, set/small network of automatic weather stations to provide surface meteorological conditions in this complex coastal area
3 Better internet access (faster, more stable), DGPS
4 All of the items listed above would be useful. If I manage to continue to my monitoring studies, they would benefit from some form of radio link to a base station & a high speed data link to distant sites (e.g. So. Calif.) In general, the limited communications speed and bandwidth in & out of Barrow is a big restriction. Improved access to base resources (radios, phones, vehicles, etc.) for non-NSF-funded projects would also help.
5 Access to internet libraries.
6 Remote power supply and high-speed data transmission.
7 High-speed data transmission, differential GPS.
8 T1 line, real time satellite link, wireless network around the NARL complex and all of the BEO, full time year-round differential GPS.
9 DGPS would be really good. Usable remote power supplies would be helpful too.

10 DGPS would dramatically improve the quality of some of the research we are trying to do on soil heave, and the resolution of all of our other projects. I think that the cell phones and radios that have been available the last few years are a wonderful safety measure. Highspeed data transfer would allow us to develop some new research projects that are simply not currently feasible.
11 DGPS, radar, improved data transmission.
12 Remote power (fuel cells, small nuclear generators). High speed wireless backbone for data communication. Helicopter support. Skilled technicians for winter support.
13 Of the utmost importance is power and reasonable communications.
14 na.
15 DGPS& satellite communications.
16 In the interests of maintaining the integrity of the atmospheric and radiative measurements at the CMDL site, the further south and east from the CMDL site that BEO development occurs, the better it will be for maintaining the pristine nature of the CMDL site.
17 na.
18 T1 line, real time satellite link, wireless network around the NARL complex and all of the BEO, full time year-round differential GPS.
19 T1 line, real time satellite link, wireless network around the NARL complex and all of the BEO, full time year-round differential GPS.
20 All of the above would be useful.
21 na.

8. What mechanisms would you suggest for sharing data and information about research conducted in the Barrow area?

1 Internet, real time data if available.
2 While a Barrow area research web site might be helpful to just point people in the right direction and provide information on goings on, other projects etc., ultimately the data collected in Barrow need to be integrated into the existing data base infrastructure (i.e., NSF ARCSS or NSIDC data bases). Also, a searchable project title and publication data base would be useful for a lot of people. Finally, integration of data sets into a GIS (with appropriate links to the other sources of information referred to above would be important).
3 Standing time/place for researchers in town to tell about their work to the community.
4 Some kind of BEO-based database (data archiving facility, web-based) would be a big help in making basic info available and providing a foundation for integrating multiple data sets (would embrace interdisciplinary research).
5 Library and reports of ongoing projects at Barrow; Collection of publications dealing with Barrow area; One Barrow science web page with links to more or less all projects.
6 Definitely a web page would be most useful to other and me in my opinion. This could accommodate data, maps and documents to be downloaded as well as databases on past research, ongoing activity and planned activity.
7 Web site
8 BASC should have reference where all of the metadata is stored, but should not be a repository for data.
9 Try to get a functional library in the new building and lean on people to deposit their publications, use the Web to list projects (perhaps expand the BEO database Michigan State is working on) and set up links to the projects' sites (if they exist) and to whatever data center the project data winds up in, continue BASC talks and try to encourage researchers to attend each others, keep up the poster display and make sure there's lots of room for that in the new building.
10 The BASC web site would be a great place to house links to other web pages belonging to the individual research projects. I don't know that it needs to store the data itself, as much NSF-funded data is required to be archived, whether through the NSIDC, or some other facility.
11 A quarterly newsletter, paper and electronic forms, published by BASC data. A data-sharing policy similar to NASA's should be developed. There should be copies of all reprints for work done at Barrow and on the BEO available at Barrow. Where possible, PDF versions should be posted on-line in a database.
There should be GIS database for commonly needed information, available by ArcView or newer interactive programs. These data layers should include photos, DEMs, remotely sensed imagery including NDVI, SAR, IKONOS, etc. Where datais not being reported elsewhere, it should be made available through a BEO server. Ancillary data should also be provided for the region (e.g. from the CMDL).

13 The best forum is an annual meeting to present recent results and current research.

14 For greater/broader contacts I suggest you start working with engineering societies and associations such as ASME, ASCE, NACE, etc. Have people attend their meetings, present relevant papers etc. Work their research committees.

15 Central Data depository.

16 CMDL prints a semiannual report covering all research conducted at the CMDL site and puts similar information on the web under www.cmdl.noaa.gov. This appears to be a good way to share information.

17 na.

18 BASC should have reference where all of the metadata is stored, but should not be a repository for data.

19 BASC should have reference where all of the metadata is stored, but should not be a repository for data.

20 Authors should publish their results in qualified journals (reviewed).

21 na.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, ALASKA
P.O. BOX 6898
ELMENDORF AFB, ALASKA 99506-6898

REPLY TO
ATTENTION OF:

MARCH 0 2 2005

Regulatory Branch
North Section
POA-2005-139-D

Dr. Glenn W. Sheehan
Barrow Arctic Science Consortium
P.O. Box 577
Barrow, Alaska 99723

Dear Dr. Sheehan:

This is in response to your January 25, 2005, application for a Department of the Army (DA) permit, to fill wetlands for the purpose of installing two dikes, a tramline, eddy towers, overhead power line, and a communications tower. It has been assigned number POA-2005-139, which should be referred to in all future correspondence with this office. The project is located in sections 1, 2, 11, and 12, T.22N., R.18W., Umiat Meridian; Latitude 71.2801°N., Longitude 156.5947°W.; near Barrow, Alaska.

DA permit authorization is necessary because your project would involve work in and placement of fill material into waters of the U.S. under our regulatory jurisdiction. Specifically, the work would involve:

a. Constructing an overhead power line, and

b. constructing infrastructure for the Barrow Tundra Manipulation Research Project.

Based upon the information and plans you provided, we hereby verify that the work described under item "a" above, which would be performed in accordance with the enclosed plan (sheets 1-10), dated January 25, 2005, is authorized by Nationwide Permit (NWP) # 12, Utility Line Activties. Additionally, the work described under item "b" above, is authorized by NWP # 5, Scientific Measurement Devices. NWPs 12 and 5 and their associated Regional and General Conditions can be accessed at our website at www.poa.usace.army.mil/reg or, at your request, a paper copy will be provided to you. Regional Conditions A, B, C, D, E, F, I, K, L, M, N, and O apply to your project. You must comply with all terms and conditions associated with NWPs 12 and 5, as well as with the special conditions listed below: Since the project area is in a habitat known to be used by Steller's eiders, *Polysticta stelleri*, a threatened species, work shall not be authorized under this verification letter until the Corps has received written documentation that consultation pursuant to Section 7 of the Endangered Species Act has been completed.

Further, please note that General Condition 14 requires that you submit a signed certification to us once any work and required mitigation are completed. Enclosure 1 is the form for you to complete and return to us.

This verification will be valid for two years from the date of this letter, unless the NWP authorization is modified, suspended, or revoked.

Please take a moment to complete and return the enclosed questionnaire. Our interest is to see how we can continue to improve our service to you, our customer, and how best to achieve these improvements. Upon your request, you may also provide additional comments by telephone or a meeting. We appreciate your efforts and interest in evaluating the Regulatory Program.

Nothing in this letter shall be construed as excusing you from compliance with other Federal, State, or local statutes, ordinances, or regulations which may affect this work.

Please contact me at the letterhead address, ATTN: CEPOA-CO-R-N, at (907) 753-2716, toll-free from within Alaska at (800) 478-2712, or by FAX at (907) 753-5567, if you have any questions or to request a paper copy of the terms and conditions of NWPs 12 and 5. For additional information about our Regulatory Program, visit our web site at www.poa.usace.army.mil/reg.

Sincerely,

Robert W. Jobson, Jr.
Project Manger

Enclosure(s)

APPLICATION FOR DEPARTMENT OF THE ARMY PERMIT
(33 CFR 325)

ORIGINAL

OMB APPROVAL NO. 0710-0003
Expires December 31, 2004

The Public burden for this collection of information is estimated to average 10 hours per response, although the majority of applications should require 5 hours or less. This includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Service Directorate of Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302; and to the Office of Management and Budget, Paperwork Reduction Project (0710-0003), Washington, DC 20503. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. Please DO NOT RETURN your form to either of those addresses. Completed applications must be submitted to the District Engineer having jurisdiction over the location of the proposed activity.

PRIVACY ACT STATEMENT

Authorities: Rivers and Harbors Act, Section 10, 33 USC 403; Clean Water Act, Section 404, 33 USC 1344; Marine Protection, Research and Sanctuaries Act, 33 USC 1413, Section 103. Principal Purpose: Information provided on this form will be used in evaluating the application for a permit. Routine Uses: This information may be shared with the Department of Justice and other federal, state, and local government agencies. Submission of requested information is voluntary, however, if information is not provided the permit application cannot be evaluated nor can a permit be issued.

One set of original drawings or good reproducible copies which show the location and character of the proposed activity must be attached to this application (see sample drawings and instructions) and be submitted to the District Engineer having jurisdiction over the location of the proposed activity. An application that is not completed in full will be returned.

(ITEMS 1 THRU 4 TO BE FILLED BY THE CORPS)

1. APPLICATION NO.	2. FIELD OFFICE CODE	3. DATE RECEIVED	4. DATE APPLICATION COMPLETED

(ITEMS BELOW TO BE FILLED BY APPLICANT)

5. APPLICANT'S NAME Barrow Arctic Science Consortium (BASC), attn: Glenn Sheehan	8. AUTHORIZED AGENT'S NAME AND TITLE *(an agent is not required)* N/A
6. APPLICANT'S ADDRESS POB 577, Barrow, AK 99723	7. AGENT'S ADDRESS
7. APPLICANT'S PHONE NOS. W/AREA CODE	10. AGENT'S PHONE NOS. W/AREA CODE
a. Residence 907/852-5946 b. Business 907/852-4881	a. Residence b. Business

11. STATEMENT OF AUTHORIZATION

I hereby authorize _____ to act in my behalf as my agent in the processing of this application and to furnish, upon request, supplemental information in support of this permit application.

_____

APPLICANT'S SIGNATURE DATE

NAME, LOCATION AND DESCRIPTION OF PROJECT OR ACTIVITY

12. PROJECT NAME OR TITLE *(see instructions)*

Barrow Tundra Manipulation Research Project

13. NAME OF WATERBODY, IF KNOWN *(if applicable)* none	14. PROJECT STREET ADDRESS *(if applicable)* east of Cakeater Road in the Barrow Environmental Observatory (BEO) which is zoned as a **Scientific Research District** by North Slope Borough Ordinance Serial No. 75-6-40
15. LOCATION OF PROJECT North Slope Borough — COUNTY Alaska — STATE	Sheet 1 of 10: POA-2005-139-D 25 Jan 2005

16. OTHER LOCATION DESCRIPTIONS, IF KNOWN (see instructions)

southwest corner of the Barrow Environmental Observatory

17. DIRECTIONS TO THE SITE

follow the beach road north from Barrow, turn inland (south) on Cakeater Road and continue south on Cakeater until reaching a pullout on the lefthand (east) side, there is a BEO billboard standing in the pullout. Walk east perpendicularly from the road, you'll be following the proposed powerline path & footpath & when you reach a large (4000 ft long) drained lake, that is the experimental site (**see attached map**).

18. Nature of Activity *(Description of project, include all features)*

This is a climate change scientific research activity measuring the fluxes of carbon dioxide & methane gases under varying hydrologic regimes. A naturally drained lake that is tundra covered will have 1/3 of the basin receiving a water treatment, 1/3 will remain "as is" and 1/3 will become drier than usual, they are to be separated by 2 dikes totalling about 2600 ft in length within the drained lake basin. Trenches under the dikes will be narrow (less than 1 foot wide) & less than 2 feet deep, lined with impermeable material and backfilled with the original material removed from the trench. The above-ground part of the dikes will be self-contained (for instance, "jersey barriers"). No discharge of dredged or fill material is involved. Structures are a sled shed & a tent, both of which sit directly on the tundra with no fill or ground preparation. **See attachments** (following the map) titled "Block 18, Block 19 & other additional notes, including possible impacts & suggested mitigations" and "Coastal Project Questionnaire."

19. Project Purpose *(Describe the reason or purpose of the project, see instructions)*

Scientific data from the research will be used to correct global climate change models (GCMs). The GCMs currently have no accurate "real" data on tundra gas fluxes under varying future potential conditions. We hope to start work in March 2005 by working on bringing the electric power lines to the projects. We hope to end the infrastructure work roughly in late winter 2005-2006 by emplacing the dikes. The research measurements are funded through 2007, but we expect the scientists to ask for additional funds to continue past that date. **See attachment** (following the map) titled "Block 18, Block 19 & other additional notes, including possible impacts & suggested mitigations" and "Coastal Project Questionnaire."

USE BLOCKS 20-22 IF DREDGED AND/OR FILL MATERIAL IS TO BE DISCHARGED

20. Reason(s) for Discharge

N/A

21. Type(s) of Material Being Discharged and the Amount of Each Type in Cubic Yards

22. Surface Area in Acres of Wetlands or Other Waters Filled *(see instructions)*

23. Is Any Portion of the Work Already Complete? **No** x IF YES, DESCRIBE THE COMPLETED WORK

24. Addresses of Adjoining Property Owners, Lessees, Etc., Whose Property Adjoins the Waterbody (if more than can be entered here, please attach a supplemental list).

The project lies completely within lands owned by the Ukpeagvik Iñupiat Corporation (UIC) and the project is completely surrounded by lands owned by UIC. UIC is the local village corporation. The land of the BEO Scientific Research District is managed by BASC with the consent of UIC under North Slope Borough Ordinance Serial No. 75-6-40, which zoned the BEO as a Scientific Research District & which approved a Master Plan for scientific research infrastructure development.

25. List of Other Certifications or Approvals/Denials Received from other Federal, State, or Local Agencies for Work Described in This Application

AGENCY	TYPE APPROVAL*	IDENTIFICATION NUMBER	DATE APPLIED	DATE APPROVED	DATE DENIED
North Slope Borough	re-zoning to Scientific Research District	Ordinance Serial No. 75-6-40	2003	1 July 2003	N/A

*Would include but is not restricted to zoning, building and flood plain permits

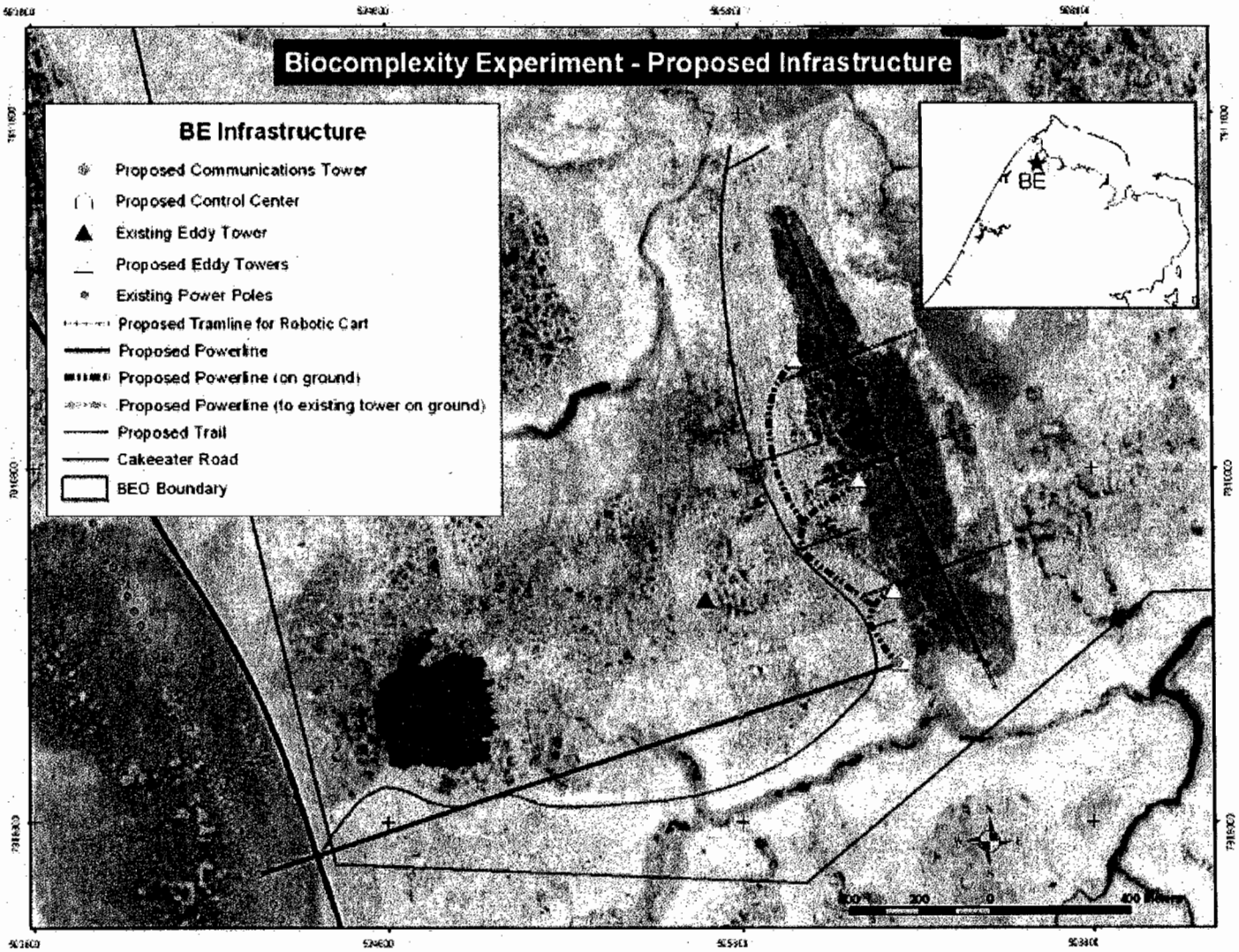
26. Application is hereby made for a permit or permits to authorize the work described in this application. I certify that the information in this application is complete and accurate. I further certify that I possess the authority to undertake the work described herein or am acting as the duly authorized agent of the applicant.

Sheet 2 of 10: POA-2005-139-D
25 Jan 2005

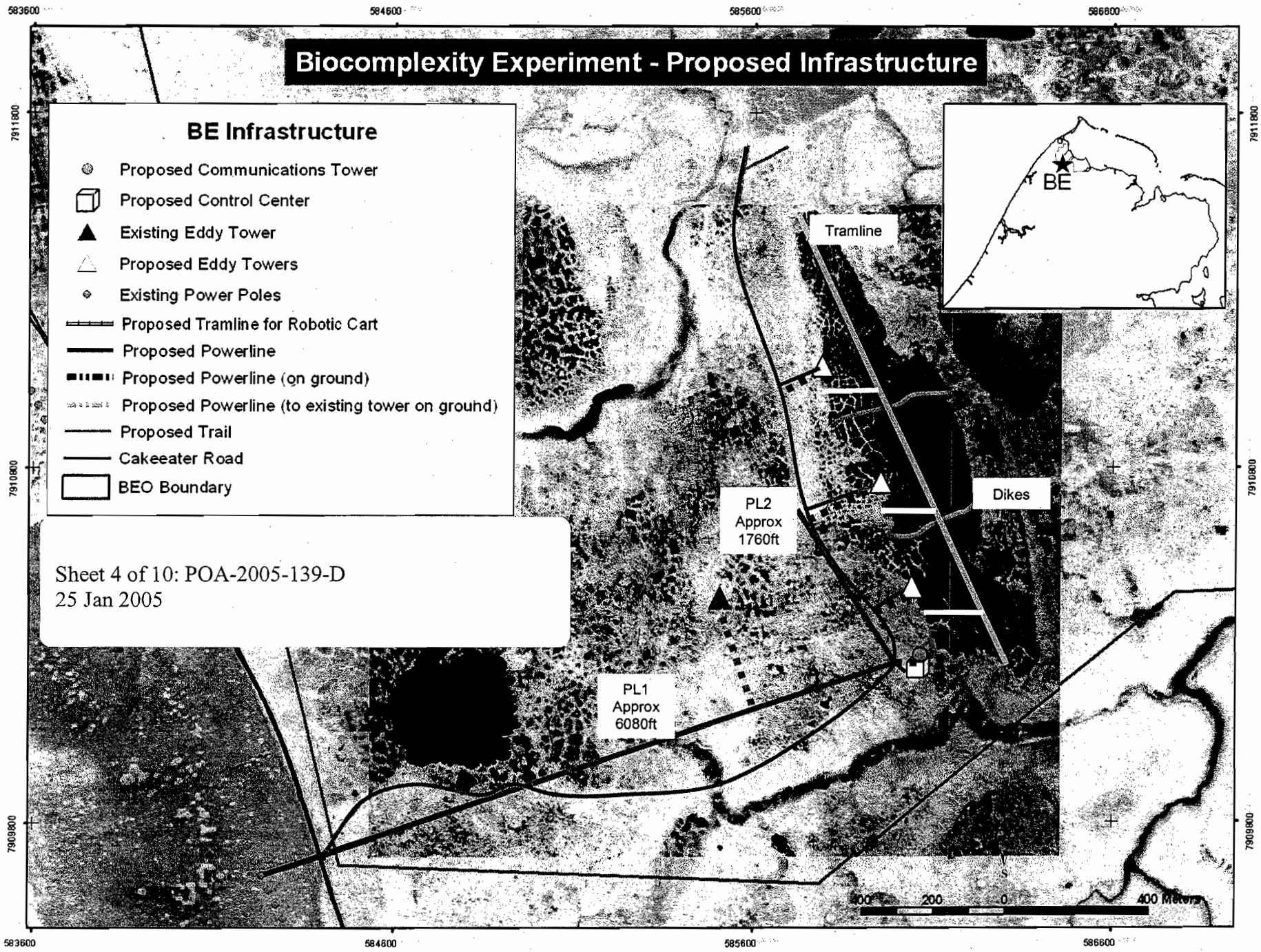
SIGNATURE OF APPLICANT	DATE	SIGNATURE OF AGENT	DATE
	25 January 2005		

The application must be signed by the person who desires to undertake the proposed activity (applicant) or it may be signed by a duly authorized agent if the statement in block 11 has been filled out and signed.

18 U.S.C. Section 1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of the United States knowingly and willfully falsifies, conceals, or covers up any trick, scheme, or disguises a material fact or makes any false, fictitious or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious or fraudulent statements or entry, shall be fined not more than $10,000 or imprisoned not more than five years or both.



Sheet 3 of 10: POA-2005-139-D
25 Jan 2005


Biocomplexity Experiment - Proposed Infrastructure
BE Infrastructure
Proposed Communications Tower
Proposed Control Center
Existing Eddy Tower
Proposed Eddy Towers
Existing Power Poles
Proposed Tramline for Robotic Cart
Proposed Powerline
Proposed Powerline (on ground)
Proposed Powerline (to existing tower on ground)
Proposed Trail
Cakeeater Road
BEO Boundary
Sheet 4 of 10: POA-2005-139-D
25 Jan 2005
Tramline
Dikes
PL2
Approx
1760ft
PL1
Approx
6080ft
BE
400 200 0 400 Meters
583600
584600
585600
586600
7911800
7910800
7909800

Block 18, Block 19 & other additional notes, including possible impacts & suggested mitigations

Permit Request to Army Corps of Engineers from the Barrow Arctic Science Consortium
Barrow Tundra Manipulation Research Project

25 January 2005

PROJECT SUMMARY:

The federally funded research project will develop physical infrastructure and increase researcher visits to a part of the Barrow Environmental Observatory (BEO). The entire location can be considered wetlands and there are 2 species of endangered ducks known in the vicinity, Steller's Eiders and Spectacled Eiders. The project location within the BEO was selected to avoid Eider "hotspots" to the extent we understand them.

The entire project takes place on private land. No state or federal land is impacted.

Extensive discussions with the Army Corps & with the US Fish & Wildlife Service (USFWS) have identified potential impacts of the project and potential mitigations, all of which are described here. Any or all of the potential mitigations are acceptable to BASC.

Mitigations are proposed for the infrastructure aspects of the project, for the operational aspects, and for the longterm impacts such as the potential to attract new projects and researchers as a result of the presence of power & trails developed for this project. This mitigation would institutionalize the connection between USFWS & BASC so that information on all future BASC-supported research projects will be provided to USFWS on a regular basis.

There will be no mechanized land clearing or land leveling for this project. There will be no temporary fills or permanent fills, with two exceptions: 1) a narrow dike trench will be lined and then backfilled with what was dug out of it (liner to be removed at and of project); 2) power pole holes will be backfilled with what is dug out of them. No access roads or other vehicular paths will be created and heavy equipment operations will be confined to hard ground in winter.

OUR REQUEST:

That permitting be processed so that the time-sensitive part of the project, installation of electric power poles, can be accomplished during the March/early April period when the tundra is frozen and protected by the dense winter snow pack.

That a jurisdictional letter be provided that indicates which activities that can be undertaken while awaiting the permit. Specifically, we would like to know if holes for the power poles can be bored prior to permit receipt (of course, if the poles also can be put in place, that would be ideal). We would like to know if trail materials can be pre-positioned and if the Control Shed (a sled-mounted shed) and Methane Shed (a Weatherport) can be put in place.

FUNDING:

Federal funds are provided by the National Science Foundation (NSF)

NON-FEDERAL REPRESENTATIVE appointed by NSF for permitting:

Barrow Arctic Science Consortium (BASC)
Glenn W. Sheehan, tele 907/852-4881, fax 4882, email basc@arcticscience.org

LOCATION:

On the BEO Scientific Research District in Barrow, Alaska, just south of the old Naval Arctic Research Laboratory (see attached map)

LAND MANAGER:

BASC

LANDOWNER:
Ukpeagvik Iñupiat Corporation (UIC).

ZONING:
Scientific Research District per North Slope Borough (NSB) ordinance; Master Plan for scientific research infrastructure development has been submitted to and approved by the NSB with the concurrence of the land owner.

RESEARCH ACTIVITIES:
A naturally drained lake that currently does not hold water and is tundra covered has been identified that will be manipulated to measure the flux of carbon dioxide & methane gases under varying hydrologic regimes. This climate change study will provide data on the influence of water table on trace gas fluxes, an important parameter for global climate change models. One-third of the lake basin will receive a water treatment, one third will remain "as is," and one-third will become dryer than usual. The drained lake is about 4,000 feet long.

Any ground disturbance in or near the project area can artificially alter gas fluxes from the tundra, so a requirement of the project is for minimal ground disturbance.

Who

About 12 scientists and BASC support personnel will go to and from the location each day during the summer. Less frequent winter visits will primarily be for instrument maintenance & monitoring.

When

The research is funded for 3 years. It is expected that the researchers will seek additional funds to continue the research after this first project period. Some of the infrastructure developed for the project (trails & line power) is expected to attract new research projects to the BEO.

The scientists will establish baseline measurements in 2005. Hydrological experiments will start in 2006.

2005 – March/April – this is the only season for placing power poles in Barrow
2005 – March – placement of shed and tent, prepositioning of trail materials
2005 – May/June – placement of trails after snow melt
2005 – May & later in the year – placement of overhead instrument trams
2005 – August – final engineering design of dikes
2006 – March – construction of dikes

POTENTIAL IMPACTS:
1) Development of infrastructure
   Line power (permanent)
   Trails (removable, most are temporary)
   Instrument trams (temporary)
   Tents & sled sheds (temporary)
   Eddy & communications towers (temporary)
   Dikes (temporary)
2) Increased researcher activity on the tundra
3) Threatened and endangered species nearby: Steller's Eiders, Spectacled Eiders

INFRASTRUCTURE & OPERATIONAL DETAILS (see accompanying map "Biocomplexity Experiment – Proposed Infrastructure):

Dry lake

The tundra manipulation is taking place in a naturally drained dry lake bed. One part of the lake bed will be made wetter than usual, one part will be left "as is" and one part will be made dryer than usual.

Powerlines & poles

Approximately 8,000 feet of powerlines are to be placed, with poles about every 140 feet (about 57 poles)

Foot Trails

Approximately 10,000 feet of plastic matted trail will be laid approximately parallel to the powerlines and extending past the end of the powerlines to the end of the drained lake. This trail material lies on the ground & presents no barrier to flowing groundwater. It is used by the National Park Service throughout Alaska and is in use in Barrow in joint USFWS/North Slope Borough projects and also by the City of Barrow. There is no fill used with this trail, it is just laid down on the ground.

Elevated walkways will be set up parallel to and for the servicing of the instrument trams. Supports for these trails will be augered into the ground so that there will be no fill removal or fill emplacement.

Trams

Instrumented trams will be set up within the drained lake basin. They will be on a raised "track" emplaced on wooden or other supports that are expected to be augered into the ground so that there is no fill removal or fill emplacement.

Tents & sled sheds

A "Control Shed" consisting of a sled shed will be placed at the south end of the drained lake. This shed's skids will be placed directly on the tundra, with no fill or ground alteration.

A "Methane Tent" consisting of an insulated Weatherport will be placed directly on the tundra, with no fill or ground alteration.

Eddy & communications towers

One eddy tower is already present in the project area, 3 more will be added and 1 communications tower. They are about 30 feet or less in height and are anchored to the ground with augered supports, so there is no ground preparation & they can be removed at the end of the project.

Dikes

Two dikes will be erected across the drained lake. The dikes are intended to prevent water from moving within the drained lake; they and all their components need to be nontoxic and nonleaching, and they need to barricade water within the lake. The parameters for designing the dikes are as follows:

Base – slit trench about 2 feet into the tundra to be lined with an impermeable fabric and then backfilled with the material taken from the trench. At the end of the project this fabric will be removed and the original fill will be placed back into the slit trench.

Above ground – the scientists will not allow use of any materials that can leach into the experiment. The dike barricade will probably be a "jersey barrier" or something similar that can be filled with water or an inert substance and totally contained within the barrier. This above ground portion will be removed at the end of the experiment. The above ground portion is expected to be about 2 feet high.

Operations

Water from spring run off will be used to "fill" the wet third of the lake. A pump will maintain the water level through the summer, either by removing or adding water.

Another pump will maintain a lower than usual level of water in the "dry" third of the lake.

The middle "normal" part of the lake will remain "as is." (This drained lake basin is naturally drained and the land does not impound water.)

Gas flux measurements will be taken 365 days a year. During summer, up to 12 scientists will be onsite. During winter sporadic visits will be made, primarily for instrument maintenance.

IMPACTS & PROPOSED MITIGATIONS

Extensive informal discussions have been held between BASC and staff members of the USFWS and the Army Corps of Engineers. We have tried to identify potential impacts of the research project and reasonable methods of mitigating the impacts. Here we repeat the main points of these discussions and propose mitigating activities that we are willing and able to undertake:

Impact: Construction projects using heavy equipment can damage the tundra.
Mitigation: Heavy equipment use restricted to winter, with power pole placement scheduled for March/April 2005 & dike placement scheduled for winter 2006.

Impact: Powerlines may be hazards to flying ducks.
Proposed mitigation: Install "collision avoidance markers/diverters" on the lines, USFWS to designate manufacturer, intervals, etc. Monitor the ground below the powerlines & collection location information & carcasses for all collisions, report to USFWS.

Impact: Researcher movement to and from the site and around the site can degrade the tundra.
Mitigation: Install a trail system and confine most researcher & support personnel movement to the trails.

Impact: Local residents & tourists could be attracted to the trail system.
Mitigation: Trail width to be narrower than an ATV so that the trail is not an "attractive nuisance." Tourists can be restricted to the Cakeater Road pulloff during nesting season.

Impact: Trails & trams could impede flow of ground water.
Proposed mitigation: All trails to either be "flat" on the ground (the majority of the trails) or elevated on "posts." No use of fill for any trails or trams.

Impact: Supports for elevated trails and trams could create backdirt.
Proposed mitigation: Auger the supports into the ground so that no dirt is removed.

Impact: Sled sheds and tents could effect the tundra.
Proposed mitigation: Minimize effect by no site preparation (no fill), just set them directly on the ground.

Impact: Dikes could alter waterflow outside the drained lake basin.
Proposed mitigation: Confine dikes to the drained lake basin & remove them at end of experiment.

Impact: Dikes could leach.
Proposed mitigation: Use only impermeable materials for containers and water or other innocuous materials inside containers.

Impact: Subsurface preparation of slit trench for dikes creates backfill.
Proposed mitigation: Use the backfill to re-fill the trench so that it remains onsite and so that it is available for use to re-fill the trench at the end of the experiment.

Impact: Final engineering design of the dikes could present something unanticipated.
Proposed mitigation: Submit final engineering design of dikes to Army Corps (currently anticipated in late summer or early fall 2005).

Impact: Incidental take could occur through nest site disturbance. Onsite consultation is highly useful between BASC & USFWS, as it helps to determine if nesting pairs are present, and if so, what steps can be taken to mitigate potential researcher disturbances to the pairs.

Onsite consultation is limited by logistical constraints on USFWS which can limit the availability of USFWS field parties in Barrow during the season. In order to mitigate operational impacts on an annual basis, BASC, as permit holder and BEO manager, needs to know whether or not endangered Eiders are in the vicinity of the research activities. Nesting typically takes about 4 weeks, starting not much earlier than 5 June & ending not much later than the end of July.

Proposed mitigation: BASC already cooperates annually with both USFWS and BLM on Eider research projects & there is a Cooperative Agreement between USFWS & BASC. BASC will continue this cooperation and also will provide one or more of the following to the USFWS field teams as identified by USFWS on an annual basis: assistance with Information Technology including high speed internet access & technical help with field monitoring devices; provide field laboratory space; access to breakout space in warehouse; provision of some lodging and other assistance. See also "annual consultation," below.

Impact: Increase in personnel coming & going onto the BEO can affect Eiders during nesting by chasing them off the nest (incidental take). This might occur during this specific project & it could occur in the future because the existence of powerlines & trails may attract new research projects to this part of the BEO.

Proposed mitigation: Maintain flexibility on the part of the scientists and their movements. This flexibility on the part of the scientists is enhanced by BASC's role of logistics supplier for NSF scientists, and as NSF's designated non-federal representative for purposes of this permit, and as manager of the BEO. Currently, an annual logistics form is completed by each project and that information is reviewed by BASC prior to approval of field support.

#1 PERSONNEL MOVEMENT CONTROL

a. AVOIDANCE

Nesting pairs should be avoided so that they are not chased off the nest. This means re-routing traffic that can be re-routed and minimizing any traffic that cannot be re-routed. For instance, if a pair is located near the main trail, we would put a temporary "loop" in the trail on the opposite side & temporarily close that section of the main trail. Using the loop, we would stay about 200 meters from the nest, with a closer approach (no closer than 100 meters) limited to once a day.

The researchers & support personnel are entirely flexible in diverting traffic for the stretch of trail from Cakeater Road to the Control Shed, which is about 6,000 feet long (the longest part of the trail). A temporary "loop" can be installed to divert traffic. Farther on, at most locations on the part of the trail that parallels the drained lake, a similar diversion is feasible. There is less flexibility on the short stretches of trail that lead into the drained lake basin and on the trail sections parallel to the trams within the drained lake.

In the cases of "less flexibility," foot traffic may be difficult to divert, but the volume of traffic (number of visits) can be diminished for the 4 week nesting period. The actual number of visits is in part dependent upon the need to troubleshoot automatic reporting equipment.

b. MINIMIZING VISITS

Non-essential personnel will be restricted from going into the vicinity of nests. Passages by essential personnel will be minimized by having scientists take their meals with them to the field so that they do not return to camp for meals.

#2 ANNUAL CONSULTATION BETWEEN USFWS & BASC

New projects attracted to the BEO could increase researcher activities and therefore increase the potential for incidental take. BASC proposes to use an electronic questionnaire (to be approved by USFWS) to gather data on all BASC-supported research projects and to provide to USFWS the questionnaires and any requested additional data on any terrestrial research projects that will operate during the June-August timeframe.

BASC will serve as the interface for the individual research projects in providing information to USFWS and in implementing any necessary mitigations. When necessary, BASC also will facilitate direct contact between the BASC-supported researchers and USFWS. BASC will ensure that agreed-upon mitigations are undertaken. As a note, NSF agrees that this is the most efficient approach for future projects. Mitigation

activities and associated costs will be viewed as logistical costs, which are a BASC responsibility under the NSF/BASC Cooperative Agreement, and not a responsibility of the individual research project.

USFWS will determine whether they choose to have projects reports from BASC on an annual basis or more frequently. Project reporting data will be gathered by BASC as part of BASC's online Logistics Help Form, a copy of which in its current form can be accessed through the BASC website or directly at http://lhf.arcticscience.org

Impact: Increase in personnel coming & going on the BEO can affect Steller's & Spectacled Eiders after hatching.

Proposed mitigation: Scientists will be briefed to be observant for ducks & ducklings on the tundra and to avoid them. If they are spotted, scientists will use BASC radios to alert all other personnel on the BEO to avoid these moving birds.

#END#

Enclosure 1

US Army Corps of Engineers
Alaska District

Permit Number: POA-2005-139-D

Name of Permittee: Barrow Arctic Science Consortium

Date of Issuance: MARCH 0 2 2005

Upon completion of the activity authorized by this permit and any mitigation required by the permit, sign this certification and return it to the following address:

U.S. Army Corps of Engineers
Alaska District
Regulatory Branch, North Section
Post Office Box 6898
Elmendorf AFB, Alaska 99506-6898

Please note that your permitted activity is subject to a compliance inspection by an U.S. Army Corps of Engineers representative. If you fail to comply with this permit you are subject to permit suspension, modification, or revocation.

I hereby certify that the work authorized by the above-referenced permit has been completed in accordance with the terms and conditions of the said permit, and required mitigation was completed in accordance with the permit conditions.

_____ _____
Signature of Permittee Date

MARCH 0 2 2005

Customer Comments

The Regulatory Program of the Alaska District, Corps of Engineers is interested in receiving constructive feedback from you, our customers. Please take a few minutes to complete the following survey questions, then use the enclosed pre-paid envelope to forward your answers to our District Office. Your thoughtful responses will make a difference!

On a scale of 5 (highest) to 1 (lowest), please circle your answers to the following:

What is your overall opinion of the Corps of Engineers' Regulatory Program?	5	4	3	2	1	N/A
When you first made contact with our office, were you treated courteously?	5	4	3	2	1	N/A
When a project manager was assigned to your questions or case, were the instructions and guidance presented clearly?	5	4	3	2	1	N/A
If you visited our office, what were your impressions of the office's appearance and professional atmosphere?	5	4	3	2	1	N/A
Were your needs met in a timely fashion?	5	4	3	2	1	N/A
How would you rate the usefulness of the Regulatory toll-free number 1-800 478-2712?	5	4	3	2	1	N/A
How would you rate the usefulness of the Regulatory Web Page (www.poa.usace.army.mil/reg)?	5	4	3	2	1	N/A

Please check the appropriate box(es):

How did you learn about the Corps of Engineers' Regulatory Program?

( ) News media
( ) Friend/neighbor
( ) Letter/Telephone call from us
( ) Past experience
( ) State or Federal Resource Agency (e.g., Alaska Department of Fish and Game, Environmental Protection Agency, etc.)
( ) Other_____

What service(s) did you seek from us?

( ) General Information
( ) Pre-application coordination
( ) Verified Nationwide Permit or General Permit authorization
( ) Resolution of violation/ noncompliance
( ) Jurisdictional determination
( ) Wetland delineation
( ) Evaluated your application or delineation

Any additional comments? _____

_____

_____

_____

If you would like someone from our office to contact you, please provide us with your name, phone number, and the best time of day for us to call.

_____

Thank you for helping us improve our responsiveness to your needs.

Larry L. Reeder

Larry L. Reeder
Chief, Regulatory Branch

United States Department of the Interior

U.S. FISH AND WILDLIFE SERVICE
Fairbanks Fish and Wildlife Field Office
101 12th Avenue, Box 19, Room 110
Fairbanks, Alaska 99701
March 18, 2005

Memorandum

To: Renne D. Crain, Assistant Program Officer – National Science Foundation, Office of Polar Programs,
Glenn W. Sheehan, Executive Director - Barrow Arctic Science Consortium
Robert W. Jobson, Project Manager – U.S. Army Corps of Engineers, Alaska District.

From: Steve Lewis, Field Supervisor – U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Office

Subject: Endangered Species Act, Section 7 Biological Opinion for the proposed tundra manipulation experiment at Barrow, Alaska.

This document transmits the U.S. Fish and Wildlife Services (Sevice's) final biological opinion (BO) based on our review of the National Science Foundation's (NSF) proposed tundra manipulation experiment on the Barrow Experimental Observatory at Barrow, Alaska. This document examines the effects of the proposed project on Steller's eiders (*Polysticta stelleri*) and spectacled eiders (*Somateria fischeri*) in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.).

The proposed project is within the breeding ranges of spectacled and Alaska-breeding Steller's eiders, both listed as threatened under the Endangered Species Act (ESA). Although spectacled eiders are more abundant across the Arctic Coastal Plain, Steller's eiders are more numerous in the immediate vicinity of Barrow. Steller's eiders appear to nest with greater regularity and in greater abundance near Barrow than elsewhere on the coastal plain. Both species have been observed in the vicinity of the proposed tundra manipulation experiment.

Based on the information provided on the proposed and potential activities, and the information currently available on listed and proposed species and designated and proposed critical habitat, the Service has determined that it is unlikely that the action will violate section 7(a)(2) of the Act. A complete administrative record of this consultation is on file at the Fairbanks Fish and Wildlife Field Office, 101 12th Ave., Room 110, Fairbanks, Alaska 99701. A chronology of the consultation history is provided in the Appendix 1.

The incidental take statement for this non-jeopardy BO includes reasonable and prudent measures and terms and conditions that are mandatory for the NSF and their agent (BASC) to implement. These reasonable and prudent measures and implementing terms

and conditions address take from habitat loss and disturbance associated with construction and operation of the tundra manipulation experiment.

Over the last several months the Service, and the applicants agent have worked closely together in reviewing and revising the document. We look forward to working collaboratively with your staff in implementing the terms and conditions of the BO. If you have any comments or concerns regarding this BO, please have your staff contact Ted Swem, Endangered Species Branch Chief, Fairbanks Fish and Wildlife Field Office at 907/456-0441.

Attachment: Final Biological Opinion

FINAL BIOLOGICAL OPINION

NSF / BASC TUNDRA MANIPULATION EXPERIMENT

BARROW, ALASKA

March 18, 2005

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1.0 INTRODUCTION

This document transmits the U.S. Fish and Wildlife Service's (Service's) final biological opinion (BO) on our review of the National Science Foundation (NSF) and Barrow Arctic Science Consortium (BASC) proposal to conduct a tundra manipulation experiment, near Barrow, Alaska. The effects of the proposed action on threatened Steller's eiders (*Polysticta stelleri*) and spectacled eiders (*Somateria fischeri*) were detailed per section 7 of the Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 et seq.). On October 18, 2004 NSF's sent a letter requesting formal consultation for the proposed action. November 15, 2004, the Service responded on November 15, 2004 stating that all information required to initiate consultation had been received or was otherwise accessible for our consideration and reference. This letter also stated that we hoped to deliver our final BO on or before March 30, 2005.

The proposed tundra manipulation experiment is to take place on the Barrow Experimental Observatory. The Service believes that the proposed action may adversely affect both spectacled and Steller's eiders that breed on Alaska's Arctic Coastal Plain (ACP) near Barrow, Alaska. Across the Barrow Area (defined here as the area north of 70^0 50' N, between Dease Inlet and the Chukchi Sea), Steller's and spectacled eiders are unevenly distributed. Spectacled eiders show a general gradient in density from higher in the southern and western portions of the Barrow Area, to lower in the northern and eastern portions. Steller's eiders show a general gradient in density from higher in the northern portion of the Barrow Area, to lower in the southern portion. The Service's annual breeding pair surveys and nest searches within the Barrow Area from 1991-2004 found that both species have been found nesting close to the proposed experimental area.

The following document assesses effects of the proposed action on the threatened Steller's and spectacled eider, in accordance with section 7 of the Act. This BO is based on information provided in NSF's initiation of consultation letter, and BASC's permit application package to the U.S. Army Corps of Engineers and the Alaska Coastal Zone Management program dated January 25, 2005. The proposed action includes activities that may adversely affect listed eiders through habitat loss, disturbance, and bird strikes to infrastructure. Based on the information provided on the proposed and potential activities, and the information currently available on listed and proposed species and designated and proposed critical habitat, the Service has determined that it is unlikely that the proposed action will violate section 7(a)(2) of the Act. Section 7(a)(2) of the Act states that Federal agencies must ensure that their activities are not likely to: 1) jeopardize the continued existence of any listed species, or 2) result in the destruction or adverse modification of designated critical habitat. To arrive at this "non-jeopardy" determination, we used a five-step approach for applying the section 7(a)(2) standards.

These steps were:

1. Define the biological requirements and current status of listed eiders,
2. Evaluate the relevance of the environmental baseline to the current status of listed eider populations,
3. Determine the effects of the proposed or continuing action on the species,

4. Determine whether the species can be expected to survive with an adequate potential for recovery under the effects of the proposed or continuing action, the effects of the environmental baseline, and any cumulative effects, and considering measures for survival and recovery specific to other life stages, and
5. Identify reasonable and prudent alternatives (RPAs) to a proposed or continuing action when that action is likely to jeopardize the continued existence of a listed species. Thus, this step is relevant only when the conclusion of the previously described analysis for Step 4, above, is that the proposed action would jeopardize listed species. The RPA would have to reduce the mortality associated with the proposed action to a level that does not jeopardize the species.

In addition to listed eiders, the Barrow Area may now, or hereafter contain plants, animals, or their habitats determined to be threatened or endangered. The Service, through future consultation may recommend alternatives to future developments within Barrow Area to prevent activity that will contribute to a need to list such a species or their habitat. The Service may require alternatives to proposed activity that is likely to result in jeopardy to the continued existence of a proposed or listed threatened or endangered species or result in the destruction or adverse modification of a designated or proposed critical habitat. The NSF should not approve any activity that may affect any such species or critical habitat until it completes its obligations under applicable requirements of the Endangered Species Act as amended (16 U.S.C. 1531 et seq.), including completion of any required procedure for conference or consultation.

A chronology of consultation actions is provided in Appendix 1. A complete administrative record of this consultation is on file at the Fairbanks Fish and Wildlife Field Office, 101 12th Ave., Room 110, Fairbanks, Alaska 99701. If you have any comments or concerns regarding this BO, please contact Ted Swem, Endangered Species Branch Chief, Fairbanks Fish and Wildlife Field Office at (907) 456-0441.

2.0 DESCRIPTION OF THE PROPOSED ACTION

2.1 Background

Section 7(a)(2) of the Endangered Species Act, (16 U.S.C. § 1531 et seq.), requires that each Federal agency shall insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any threatened or endangered species, or result in the destruction or adverse modification of critical habitat of such species. When the action of a Federal agency may adversely affect a protected species, that agency (i.e., the "action" agency) is required to consult with either the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (Service), depending upon the protected species that may be affected.

For the actions described in this document, the lead action agency is the National Science Foundation (NSF), and their agent is the Barrow Arctic Science Consortium (BASC).

The U.S. Army Corps of Engineers (COE) is a cooperating agency. Due to the protected species involved, the consulting agency is the Service.

Section 7(b) of the Act requires that the consultation be summarized in a Biological Opinion (BO) detailing how the proposed action may affect protected species. The purpose of this BO is to fulfill the section 7 requirements for consultation on the construction and operation of an experiment called "Barrow Tundra Manipulation Research Project". This BO focuses on the potential effects of proposed project on the threatened Steller's eider (*Polysticta stelleri*) and spectacled eider (*Somateria fischeri*).

2.2 Proposed Project

The NSF has funded a scientific research project that proposes to examine the fluxes of carbon dioxide and methane gases under varying hydrologic regimes. The experiment is to be located in a naturally drained lake within the Barrow Environmental Observatory (BEO), near Barrow, Alaska. The data collected by the project will be used to correct global climate change models (GCMs). The GCMs currently have no accurate "real" data on tundra gas fluxes under varying future potential conditions.

Two impervious barriers will divide the 4,000-foot long lake area. One-third of the basin will be flooded, one-third will remain "as is", and one-third will be drained or pumped to become drier. This experiment requires considerable infrastructure for support. Work on the facilities associated with this project is due to commence in the spring of 2005, with research funded from 2005 through 2007.

2.3 Action Area

The action area is defined by the direct and indirect effects of the action. The proposed project would take place on the Barrow Experimental Observatory (BEO) east of Cakeeater road. The area directly affected includes the footprint of the lake, trail system, power line, equipment sheds and tents, trams and towers. Around this infrastructure is a zone of influence within which eiders will be affected indirectly by disturbance resulting from site activities. The size of this zone is harder to quantify. The level of activity is not constant throughout the proposed facility. As such, the Service feels that the action area includes an area of 100m on either side of the power line and access trail. Brief and infrequent activities are expected to occur in this area. The action area at the lake and experimental sites, is considered to be 300m around the active project footprint. Sustained and repeated activities (more than once per day) are expected to occur in this area. The size of the zone of influence is consistent with the Service's published guidelines to scientists (USFWS 2002). Based on this zone of influence the action area is approximately 301 acres in size.

2.4 Project Actions

Each of the facets of the project, and efforts to reduce their impacts to listed species, are described below:

(a) Dike & Lake

Action - As described above, the lake is to be divided into three discrete cells. Two impervious dikes constructed of nontoxic, non-leaching materials will separate the cells. The final design and exact location for these barriers has not yet been developed. At the base of the barrier, a two-foot deep slit trench will be dug into the tundra. The trench will be lined with impermeable fabric and backfilled with the trench material. Above ground, the dike barricade will probably consist of a jersey barrier type material filled with inert material such as water.

Avoidance / Minimization Efforts – Dikes will be confined to the lake to minimize hydrologic effects outside the lake basin. The aboveground portion of the barrier will be removed once the experimental work is completed allowing the natural hydrology to return.

(b) Pumps

Action – Maintaining the water level within each cell in the lake is critical to the experiment. To do this, two pumps will be installed, one to pump water into the "wet" cell, and one to pump water out of the "dry" cell.

(c) Power line

Action - The pumps that control water level will be large to allow rapid response to changes in water level. As a result, they require a large amount of power on "short notice." The proposed design supplies power for pumps and other equipment via overhead electrical lines. A total of 8,000 feet of new line is required. This would run from the existing power line on Cakeeater Road east, northeast to the lake area. Power poles would support the line at approximately 140-foot intervals (requiring an estimated 57 poles).

Avoidance / Minimization Efforts – The possibility of burying the power line was evaluated. However, given the nature of the experiment, the high power demands of the pumps, and logistical constraints of the area, this is not possible. Collision avoidance markers will be installed on the overhead wires to reduce bird strikes.

(d) Instrument Trams

Action - It is proposed to mount instruments on a "tram system" above the lake area to measure the gas fluxes and other information. The track system for this will be raised above ground level, and supported on a series of posts that will be augered into the ground. Approximately every 20-feet supports will be installed. These will be approximately 5-inches in diameter.

Avoidance / Minimization Efforts – To prevent the trams impeding surface water movement and altering the surrounding hydrology, they will be elevated as described.

By using posts to support the rails no fill will be required. When they are no longer required, the tram system will be removed. By using trams, minimal long-term habitat loss will occur compared to the loss associated with gravel fills.

(e) Tents & Instrument Sheds
Action - Two sheds are required for this experiment, a "control shed", and an insulated Weatherport to be used as a "methane tent".

Avoidance / Minimization Efforts – No fill will be used at the sites for these structures reducing long-term habitat loss. Instead, they will be placed directly on undisturbed tundra. Equipment will be removed when it is no longer required allowing the underlying vegetation to re-grow.

(f) Flux and Communication Towers
Action - Three new flux towers and one communication tower are to be constructed. The exact locations have yet to be determined but flux towers will be close to the lake and correspond to each treatment cells. It is anticipated that the communication tower will be located close to the control shed. The towers will be less than 30 feet in height and have a hollow lattice type construction. They are anchored by 4 guy wires, one at each corner.

Avoidance / Minimization Efforts – Guy wires supporting towers will be marked with an appropriate collision avoidance system. Towers and guys will be removed once the experiments are complete.

(g) Trails
Action – A foot trail will provide access to the facility and its associated structures. This trail will consist of approximately 10,000 feet of plastic matted trail (Figure 1) which will be laid directly onto the tundra. The trail will roughly parallel the power line route, then continue to the lake, where it will follow the tram system to allow access and maintenance. The trail will be elevated and supported on posts augered into the ground in areas subject to flooding.

Avoidance / Minimization Efforts – As described above, the trail will be made of a plastic matting material that allows the movement of surface water and protects underlying vegetation. The trail will not be wide enough to support 4-wheelers or other off-road vehicles (ORVs), reducing noise impacts from motorized vehicles.

Figure 1 – Example of Trail Material

(h) Construction

Action - Construction will take place in phases. The power line will be installed in March / April 2005. The methane tent and control shed will be installed either by lifting them using the heavy equipment working on the power line, or by sledging them to the site. The plastic trail panels will be stockpiled at intervals along the route for installation as the snow melts. The tram supports and rails will be installed in two phases. The cross-lake system will be constructed in early 2005, with the longitudinal sections installed in winter 2005 / 2006. At this time the dikes in the lake will be built.

Avoidance / Minimization Efforts – Construction requiring heavy equipment, will take place during winter to reduce impacts to the fragile tundra vegetation.

(i) Operations & Maintenance

Action - Instruments will record Gas flux measurements 365 days a year. Sporadic visits to the site will occur for instrument maintenance during winter. Starting in the summer of 2005 up to 12 scientists will be on site collecting baseline and other data. The research is funded through 2007, but it is anticipated that it may continue longer if funds become available.

Avoidance / Minimization Efforts – Modifications to daily operations at the site will be made to reduce impacts on nesting eiders. These modifications are only appropriate if eider nests are present in the action area. Studies have documented large differences in abundance of birds and breeding effort from year to year (Quakenbush & Suydam 1999, Quakenbush et. al. 1995). A nest survey would only be required if the pair observations indicate that it is a nesting year. The following protocol will be followed:

Level 1 – Breeding Pair Surveys (All years)

(i) BASC is responsible for conducting a nest survey throughout the tundra manipulation experiment.

(ii) The survey will be conducted on foot, by a trained observer.

(iii) Based on the average dates for Service nest surveys in Barrow from 1999 to 2004, the survey should commence on June 13, each year, and last 10 days.

(iv) Observations will be collected on alternate days, for a minimum of 5 days of observations.

(v) The survey is to take place along all trails and other areas of activity. It will include the length of the access trail, the trails beside the trams, to the ends of the lake, flux towers, and equipment sheds / tents.

(vi) Observations will cover an area of 150m on either side of the observer.

(vii) The observer will record the gender and location of all Steller's and spectacled eiders identified during the survey.

(viii) The Service shall be informed of the survey results immediately upon completion of the work (Tel. 907-456-0441). Based upon Level 1 survey results, the Service and BASC will cooperatively decide if Level 2 surveys are warranted.

Level 2 – Nest Surveys (Nesting Years Only)

The action area is divided into two main areas based on proposed use, and hence potential to disturb nesting eiders:

1. The access trail from Cakeeater Road to the control center at the southern tip of the lake. Activities are limited to pedestrians accessing the lake work area. The nest survey will cover an area of 60m on either side of the trail from Cakeeater Road to the control shed.
2. The lake and surrounding area, including flux towers, instrument trams, and their access trails. Scientists and staff may have prolonged presence in this area, hence there is potential to disturb nesting eiders over a larger distance. Based on this risk, the survey will encompass the area between the power line and trail and the west shore of the lake, and all ground 100m west (away from the lake) of the access trail / power line. Nest searches will also be made from the walkways alongside the tram-lines within the lake area.

The following nest survey protocol will be followed:

(i) BASC will conduct nest surveys in area one (trail) and area two (lake).

(ii) Searchers should spaced 20m apart (each searcher can observe an area of 10m on either side of themselves).

(iii) If nests are observed their position should be recorded using GPS.

(iv) If the hen flushes from the nest, the number of eggs and the presence of down should be recorded. Bowman (2004) developed a photographic field guide to aid in identification of nests and birds.

(v) The eggs and nests should not be touched, if however down is present it should be placed over the eggs using a latex gloved hand.

(vi) The searchers should leave the nest area as soon as possible to allow the hen to return.

(vii) The Level 2 survey should commence as soon as the Level 1 survey is completed (23rd of June).

The results, and locations of nests (if applicable) should be reported to the Service as soon as the survey is complete (Tel. 907-456- 0441 or Fax 907-456-0208).

Level 3 – Modifications to Facility Operations
If nests are discovered along the access trail, warning signs will be placed 200m on either side of the nest to start and end a 400m-long nest protection area (Figure 2). Signs will indicate that an eider nest is present, and that personnel should move through the nest protection area as quickly and quietly as possible without stopping.

If nests are discovered within area two (intensive study area at the lake), staff and scientists will be informed of their location. Access to the area will be minimized to the extent possible, and operations such as repairs or instrument calibration will take place as far as possible from the nest site.

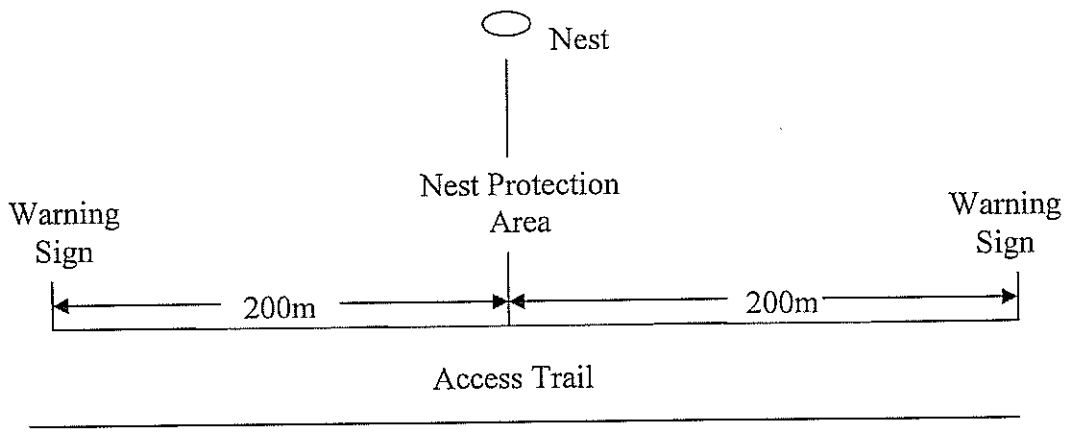

Figure 2 – Warning Sign Layout for Access Trail

3.0 STATUS OF THE SPECIES

3.1 Steller's eider

Range & Population Estimates
The Alaska-breeding population of Steller's eider was listed as threatened on June 11, 1997 (Federal Register 62(112): 31748- 31757). This action was based on a substantial decrease in the species' nesting range in Alaska, a reduction in the number of Steller's eiders nesting in Alaska, and the resulting increased vulnerability of the remaining breeding population to extirpation. Historically, Steller's eiders nested in Alaska in two general regions: western Alaska, where the species has been nearly extirpated, and the North Slope, where the species still occurs. In western Alaska, Steller's eiders occurred primarily in the coastal fringe of the Yukon-Kuskokwim Delta, where the species was

common at some sites in the 1920s, was still present in the 1960s, but was not recorded as breeding from 1976-1994 (Kertell 1991, Flint and Herzog 1999). In 1994, and 1996-1998, 1-2 nests were found at either or both the Tutakoke River and Hock Slough study sites on the Yukon-Kuskokwim Delta (Flint and Herzog 1999).

On the North Slope, Steller's eiders historically occurred from Wainwright east, nearly to the United States-Canada border (Brooks 1915). The species may have abandoned the eastern North Slope in recent decades, but it still occurs at low densities from Wainwright to at least as far east as Prudhoe Bay. The majority of sightings in the last decade have occurred east of Point Lay, west of Nuiqsut on the Colville River, and within 90 km (56 miles) of the coast. Near Barrow, Steller's eiders still occur regularly, though they do not nest annually. In some years, up to several dozen pairs may breed in a few square kilometers.

The Service conducts aerial breeding pair surveys on the arctic coastal plain every year in late June. The survey results indicate a fluctuating population of approximately 1,000 birds (Mallek et. al. 2003). A more specific aerial eider population survey of the arctic coastal plain takes place in late June / early July. This survey indicates a smaller population, averaging about 150 birds from 1992-2003 (Larned et al. 2003). Both surveys likely underestimate actual population size, however, because an unknown proportion of birds are missed when counting from aircraft, and no species-specific correction factor has been developed and applied. Nonetheless, these observations indicate that hundreds or low thousands of Steller's eiders occur on the North Slope.

The surveys do not demonstrate a significant population trend over the last decade. However, based on the observed inter-annual variability, it is estimated that it would take 14 years to detect a trend equivalent to a 50% change over 10 years (Larned et al. 2001). Thus, current sampling intensity is too low to provide useful trend detection over short time intervals for this very rare species. There is some support for the belief that Steller's eiders have abandoned formerly occupied areas and have reduced their breeding frequency in eastern portions of the North Slope; if true, this suggests that the Alaska-breeding population has declined on the North Slope in recent decades (Quakenbush et al. 2002).

Marine Environment & Spring Migration

Steller's eiders spend most of the year in marine habitats. During winter, most Steller's eiders concentrate along the Alaska Peninsula from the eastern Aleutian Islands to southern Cook Inlet in shallow, near-shore marine waters (Jones 1965, Petersen 1980). They also occur in the western Aleutian Islands and along the Pacific coast, occasionally to British Columbia, along the Asian coast (from the Commander Islands to the Kuril Islands), and some are found along the north Siberian coast west to the Baltic States and Scandinavia (Cramp et al. 1977). In spring, large numbers concentrate in Bristol Bay before migration. In 1992, an estimated 138,000 Steller's eiders congregated there before sea ice conditions allowed movement northward (Larned et al. 1994). Spring migration of Alaska-breeding birds typically involves small flocks following offshore ice leads north through the Bering Strait as early as mid-May and reaching Pt. Barrow by early

June. In contrast, southerly migration begins in mid-July with brood-rearing females and broods leaving nesting areas from late August to mid-September. Anecdotal information suggests that Steller's eiders migrate south in small flocks along the coast.

Breeding

Steller's eiders arrive in pairs on the North Slope in early June. Nesting effort varies widely from year to year. In the 15 years from 1991-2004, there were 6 "nesting years" (1991, 1993, 1995, 1996, 1999, 2000) when typical breeding activities occurred, and 7 "non-nesting years" (1992, 1994, 1998, 2001, 2002, 2003, and 2004). In non-nesting years birds appeared in early summer, but no nests were found and Steller's eiders are believed to have not nested (Quakenbush et al. 1995, Obritschkewitsch et al. Service, unpublished data). Four nests were found in 1997, but these were initiated late (early July) and none survived past mid-incubation (Service and NSB, unpublished data). The reasons for the observed variation in nesting effort are unknown, but an association has been noted between nesting years and years of lemming abundance. Nest success could be enhanced in years of lemming abundance because predators are less likely to prey on eider nests when small mammals are abundant. It has also been hypothesized that avian predators such as pomarine jaegers (*Stercorarius pomarinus*) and snowy owls (*Nyctea scandiaca*), which nest at high densities only when lemmings are abundant, may provide protection for nearby eider nests incidental to defense of their nesting territories (Quakenbush and Suydam 1999). If this hypothesis is correct, the presence of avian predators is an essential element of breeding habitat.

In nesting years, initiation dates are typically in the first half of June (Quakenbush et al. 1995), and hatching dates range from 7 July to 3 August (Quakenbush et al. 1998). Nests in Barrow are located in wet tundra, in areas of low-center polygons or low (indistinct flat-centered) polygons, frequently within drained lake basins (Quakenbush et al. 1998). Average clutch sizes at Barrow ranged from 5.3-6.3 in five different years, with clutches up to 8 reported (Quakenbush et al. 1995). Nest success (proportion of nests at which at least 1 egg hatched) at Barrow averaged approximately 17% from 1991-2002 (Service, unpublished data). Egg loss was attributed mostly to predation by predators, including jaegers, common ravens (*Corvus corax*), and possibly glaucous gulls (*Larus hyperboreus*) and arctic foxes (*Alopex lagopus*) (Quakenbush et al. 1995, Obritschkewitsch et al. 2001). Fledging is estimated to occur at 37 days (Obritschkewitsch et al. 2001). Broods most often used ponds with emergent grass (*Arctophila fulva*) (Quakenbush et al. 1998). Broods were reared close to their nest site; 8 broods tracked near Barrow in 1995 remained within 650 meters of their nest sites during the first 32 days after hatching (Quakenbush et al. 1998).

Winter Migrations

Males typically depart the breeding grounds after females begin incubating. Based on observations in the Barrow area, and on a small sample of birds equipped with satellite transmitters, males depart Barrow around the end of June or early July (Quakenbush et al. 1995, Obritschkewitsch et al. 2001, Service, unpublished data). Both males and females tracked with satellite transmitters in a non-breeding year dispersed across the area between Wainwright and Admiralty Inlet in late June and early July, with most birds

entering marine waters by the first week of July. The satellite-tracked birds used coastal locations from Barrow to Cape Lisburne, and made extensive use of lagoons and bays on the north coast of Chukotka (Service, unpublished data). Visual observations in other years confirm the use of nearshore areas of the Chukchi Sea; small groups of males (less than 10) have been observed in July near Barrow (Service, unpublished data). Females that fail in breeding attempts may remain near Barrow later in the summer; a single failed-breeding female equipped with a transmitter in 2000 remained near the breeding site until the end of July, and stayed in the Beaufort Sea off Barrow until late August. Females and fledged young depart the breeding grounds in early to mid-September.

In mid-August, Alaska-breeding Steller's eiders migrate to molting areas, where they congregate in large flocks in protected waters. Concentrations of molting Steller's eiders have been noted in Russia on the Chukchi and Bering seacoasts, near Saint Lawrence Island in the Bering Sea, and along the northern shore of the Alaska Peninsula (Fay 1961, Jones 1965, Petersen 1981). Satellite-tracked birds from Barrow molted at Nunivak Island, Cape Avinof (Kuskokwim Shoals), Nelson Lagoon/Port Moller, and Izembek Lagoon (Service, unpublished data).

Population Decline & Recovery Efforts

Causes of suspected population declines are not known. Possible causes of decline in the Barrow area include artificial increases in predator populations, subsistence harvest and ingestion of lead shot. In 2003, a Recovery Plan was finalized by the Service that provided strategies to recover the Alaska-breeding population of Steller's Eiders to the point that protection under the Act is no longer required (i.e., "delisting" is appropriate). Interim objectives identified were: 1) to prevent further declines of the Alaska-breeding population (including both the northern and western Alaska subpopulations); 2) to protect Alaska-breeding Steller's Eiders and their habitats; 3) to identify and alleviate causes of decline and/or obstacles to recovery; and 4) to determine size, trends, and distribution of the northern and western Alaska-breeding subpopulations. The Recovery Plan also outlined tasks as being high priority actions needed to achieve the ultimate and interim objectives listed above. The tasks include: 1) reduce exposure to lead; 2) reduce nest predation; 3) reduce hunting and shooting mortality; 4) elucidate distribution and abundance; 5) acquire information on marine ecology; 6) acquire information on breeding ecology; 7) acquire demographic information needed for population modeling efforts; 8) maintain or re-establish subpopulation on Yukon-Kuskokwim Delta; and 9) develop partnerships for recovery efforts.

3.2 Spectacled eider

Distribution & Spring Migration

The spectacled eider was listed as a threatened species under the Act in May 1993. Currently, primary nesting grounds are the Yukon-Kuskokwim Delta, the North Slope (Cape Simpson to the Sagavanirktok River) of Alaska, and in the Chaun Gulf and the Kolyma, Indigirka, and Yana river deltas of arctic Russia. Post-breeding flocks of staging and molting spectacled eiders have been observed in Mechigmenan Bay (on the eastern coast of Russia's Chukotsk Peninsula), Alaska's Ledyard Bay (southwest of Point

Lay), Peard Bay, Norton Sound, and 80 km south of Saint Lawrence Island. An estimated 7,149 spectacled eiders occupied the Arctic Coastal Plain of Alaska in June 2003 (Larned et al. 2002), about 2% of the estimated 375,000 world population (Larned and Tiplady 1999).

From late December to early April, the only known wintering area of spectacled eiders is within leads in the pack ice southwest of St. Lawrence Island in the Bering Sea (Larned and Tiplady 1997, Petersen et al. 1999). Leads in ocean ice are important pathways for marine bird and mammal species migrating along the Beaufort Sea coast in Alaska and Canada. All species of eiders use this lead system, typically flying at altitudes less than 30 meters (Johnson and Richardson 1982). Very little is known about migratory routes east of Barrow because the definitive lead system transforms into numerous branches varying in location and extent from year-to-year. Because few spectacled eiders are observed in marine areas along the Beaufort coast in spring, a majority may migrate to nesting areas overland from the Chukchi Sea (TERA 2003). Migration of eiders (the majority of which are king and common eiders) along Alaska's northern coast has been described in several studies (Thompson and Person 1963, Johnson 1971, Woodby and Divoky 1982). Spectacled eiders are observed in mixed flocks of king, common, and sometimes Steller's eiders, but the proportion of spectacled eiders is quite small.

Spectacled eiders arrive on North Slope breeding grounds paired, often in small flocks, in late May to early June. Spectacled eiders nest mainly from the Sagavanirktok River to the Chukchi Sea, and only sparsely to the east (Larned et al. 2001). Based on Service aerial surveys (1998-2002, Arctic Coastal Plain east to the Arctic National Wildlife Refuge), the highest densities were found south of Barrow, with smaller areas of concentration east of Teshekpuk Lake, on the Colville River Delta, and near western Simpson Lagoon.

Winter Migration

Male spectacled eiders begin to depart breeding areas during incubation, which is during late June on the North Slope. On the North Slope, pair numbers peak in mid-June and the number of males declines 4-5 days later (Smith et al. 1994, Anderson and Cooper 1994, Anderson et al. 1995). Following their late June departure from the nesting areas, males apparently make little use of the Beaufort before migrating to the Chukchi Sea. During late June the Beaufort Sea has little open water, hence males present at breeding grounds east of Barrow normally do not use marine habitats and fly directly overland (most heading to a molting/staging area in Ledyard Bay) (TERA 2003). Later in the season (late June through September), when females depart the North Slope, much more of the nearshore zone is ice-free. Open water in marine habitat allows for extensive use of the western Beaufort Sea. Radio telemetry studies have shown that most female spectacled eiders that migrate west toward Barrow use the near shore zone of the Beaufort Sea as they transit to their molting/staging areas. In 2000, 13 female spectacled eiders tracked via radio telemetry primarily used the western Beaufort (71% of all bird-days) while areas near Stockton Island were also extensively used (17% of all bird-days) (TERA 2003). The females remained in the Beaufort Sea near shore zone for an average of about two weeks (range 6-30 days).

Breeding

Spectacled eider incubation lasts 20-25 days (Kondratev and Zadorina 1992, Harwood and Moran 1993, Moran and Harwood 1994, Moran 1995). Average clutch sizes on the North Slope average 3.2-3.8, with clutches up to 8 reported (Quakenbush et al. 1995). Hatching on the North Slope occurs from mid- to late July (Warnock and Troy 1992). Fledging occurs approximately 50 days after hatching. At this time, females with broods move directly from freshwater to marine habitats.

Predators of spectacled eider eggs include gulls, jaegers, and foxes. In arctic Russia, apparent nest success has been calculated to be as low as <2% in 1994 and 27% in 1995; foxes, gulls, and jaegers are suspected to have depredated most of the nests (Pearce et al. 1998). On Kigigak Island in the Yukon-Kuskokwim Delta, nest success ranged from 20-95% in 1991-1995 (Harwood and Moran 1993, Moran and Harwood 1994, Moran 1995, Moran 1996). Nest success may have been higher in 1992 than in other years of observation, because foxes were eliminated from the island prior to the nesting season that year. Apparent nest success in 1991 and 1993-1995 in the Kuparuk and Prudhoe Bay oil fields on the North Slope ranged from 25-40% (Warnock and Troy 1992, Anderson et al. 1998).

Food Preferences

On the nesting grounds, spectacled eiders feed by dabbling in shallow freshwater or brackish ponds, or on flooded tundra. Food items include mollusks, insect larvae such as Tipulidae (craneflies), trichopterans (caddisflies), and chironomids (midges); small, freshwater crustaceans, and plants or seeds (Kondratev and Zadorina 1992; Fredrickson 2001). Spectacled eiders in the marine environment feed predominately on clams and small amounts of snails, amphipods, and other bivalves. In March-April 1999 and 2001, studies within the spectacled eider wintering areas showed that the esophagi of collected eiders contained only clams, almost entirely *Nuculana radiata* with no trace of the once dominant and preferred *Macoma calcarea* (Lovvorn 2002). Changes in the density of *Macoma calcarea* in the Bering Sea are coincident with an oceanic regime shift to warmer conditions in 1976-77 (Lovvorn et al. 2003). Exceptional climate change in the arctic and subarctic, and associated changes in marine communities and ice dynamics in spring, may have had important impacts on spectacled eiders.

Population Decline

The range-wide population of spectacled eiders is estimated at 375,000 (Larned and Tiplady 1999). From the early 1970s to the early 1990s, numbers of pairs on the Y-K Delta declined by 96% from 48,000 to 2,000, apparently stabilizing at that low level (Stehn et al. 1993, Petersen et al. 1999). This dramatic decline on the Y-K Delta was the primary reason the species was listed as threatened in 1993. On the North Slope, however, trends in population size are much less clear. Abundance indices from North Slope eider surveys in 1993-2003 do not show a statistically significant trend (Larned et al. 2001, Larned et al. 2003), and data from prior to 1993 are not suitable for trend analysis.

Factors known or suspected to affect survival of spectacled eiders have been identified but the relative importance of these factors to the species' decline and recovery are not known. The extent and causes of population decline are difficult to assess because historical data are lacking for many locations. Several of the following factors are known to affect survival during the nesting season, but it is not clear whether they contributed to the decline of the spectacled eider population.

Lead poisoning is a confirmed cause of mortality of eiders that ingested lead shot on the breeding grounds in the Yukon-Kuskokwim Delta. Spent shot pellets are eaten, either as grit or by eiders foraging in sediments for food. The grinding action of the eider's gizzard, in combination with the acidic environment of its digestive tract, causes toxic lead salts to be released into the body. The proportion of spectacled eiders on the Y-K Delta's lower Kashunuk River drainage that contained lead shot in their gizzards is high (11.6%, n=112) compared to other waterfowl in the lower 48 states from 1938-1954 (8.7%, n=5088) and from 1977-1979 (8.0%, n=12,880). The lead exposure rate in spectacled eiders (based on X-rays) is likely biased low (Flint et al. 1997), because lead is retained in the gizzard for only about three weeks (Elder 1954, and Dieter and Finley 1978). Blood analyses of spectacled eiders indicate elevated levels of lead in 13% of pre-nesting females, 25.3% of females during hatch, and 35.8% during brood rearing. Nine of 43 spectacled eider broods (20.9%) contained one or more ducklings exposed to lead by 30 days after hatch (Flint et al. 1997). Spent lead shot in the lower Kashunuk River area and on Kigigak Island is causing additive mortality in spectacled eiders, that is, mortality over and above that caused by natural circumstances (Grand et al. 2003). It is possible that exposure to lead occurs in small, localized hunting areas on the North Slope as well, however, there are no site-specific data on lead contamination in this region.

Predation pressure on spectacled eider eggs, young, and adults may have increased in recent decades. Predators include arctic foxes, red foxes (*Vulpes fulva*), large gulls (*Larus spp.*), jaegers, and snowy owls. Native elders on the North Slope believe that fox numbers have increased in recent decades because of reduced trapping. Wastes made available from the commercial fishing industry in the Bering Sea and North Pacific, along with an increase in the garbage generated by coastal communities, have increased the year-round food supply for gulls. Glaucous gull populations could have increased in response to this increased food supply.

Subsistence harvest of spectacled eider eggs and adults is another potential factor in the decline of the spectacled eider population. Alaska Natives have traditionally harvested eiders and their eggs in coastal villages during spring and fall. Subsistence harvest surveys for the North Slope indicate that an average of 155 spectacled eiders were taken at Wainwright during1988-1989 and only 2 spectacled eiders were reported taken at Barrow during 1987-1990 (Braund et al. 1993). Yup'ik Eskimos on the Y-K Delta have traditionally harvested spectacled eiders for subsistence purposes (Klein 1966). Although the human population on the Y-K Delta has grown substantially, changes in the numbers of active hunters are unknown. Similarly, available harvest technologies have become increasingly efficient, but the actual effects of new technologies on harvest levels are unknown. The estimated harvest of spectacled eiders on the Y-K Delta from 1992-95

averaged 272 birds/year (Service, unpublished); the 1992-2001 average is 123 birds/year (Service, unpublished).

Other sources of take include disturbance from research activities, and loss of habitat in growing communities and oilfields. Their overall impacts to the spectacled eider population are unknown.

Other potential factors that may affect spectacled eider survival have been suggested but not investigated. These include changes in the invertebrate community structure in their winter habitats, bioaccumulation of contaminants in the marine environment, human harvest for sport and subsistence outside their breeding grounds, disease, parasites, and accidental strikes and/or disturbance of benthic feeding areas by commercial fishing activity.

Recovery Efforts

In 1996, a Recovery Plan was finalized by the Service that provided strategies to recover the Alaska-breeding spectacled eiders to the point that protection under the Act is no longer required (i.e., "delisting" is appropriate). Objectives identified were:

1) Prevent further declines of the Alaska-breeding population (including both the northern and western Alaska subpopulations).
2) Determine size, trends, and distribution of the northern and western Alaska-breeding subpopulations.
3) Investigate population dynamics by conducting population viability analysis (PVA).
4) Determine if population declines and/or reproductive failures result from accumulation of environmental contaminants.
5) Investigate the habitats used and prey items selected by foraging spectacled eiders away from breeding grounds.
6) Assess the contribution of subsistence harvest to population trends.
7) Investigate whether predator-prey relationships can account for population declines.
8) Determine genetic profile of the three major populations.
9) Collect data on the impacts of diseases and parasites.

4.0 ENVIRONMENTAL BASELINE

Regulations implementing the ESA (50 CFR §402.2) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the Barrow Area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress.

Status of listed eiders within the Barrow Area

Between 1999 and 2004 the Service has conducted surveys to detect pre-nesting / nesting eiders near Barrow. The results were used to develop a mean density of each species in the area. These are 0.60 birds/km^2 for Steller's eiders, and 0.32 birds/ km^2 for spectacled eiders. Figure 3 shows the historic distribution of both listed eider species in the project

area. Steller's eiders have been recorded nesting close to, and spectacled eiders within the action area.

Spectacled eiders are a widely distributed summer resident throughout much of the Barrow area with a trend toward higher abundance inland. Steller's eiders are sparsely distributed across the Barrow area while breeding pair density is greatest near town (Obritschkewtch et al. 2001). Both species are essentially absent from the area from October to May (Larned et al. 2001). Although the breeding frequency has decreased for Steller's eiders on the North Slope, except near Barrow, no trend is discernible in spectacled and Steller's eider population sizes Slope-wide (Quakenbush et al. 2002). Furthermore, the factors that limit population size on the North Slope have not been identified. Therefore, it is impossible to determine whether human activity and habitat alteration have affected the status of the species in the project area. However, factors that may have affected the status of the species in the project area include loss of breeding habitat, disturbance from research efforts, disturbance from motor vehicle traffic, ingestion of lead shot, increases in predator populations, and subsistence harvest.

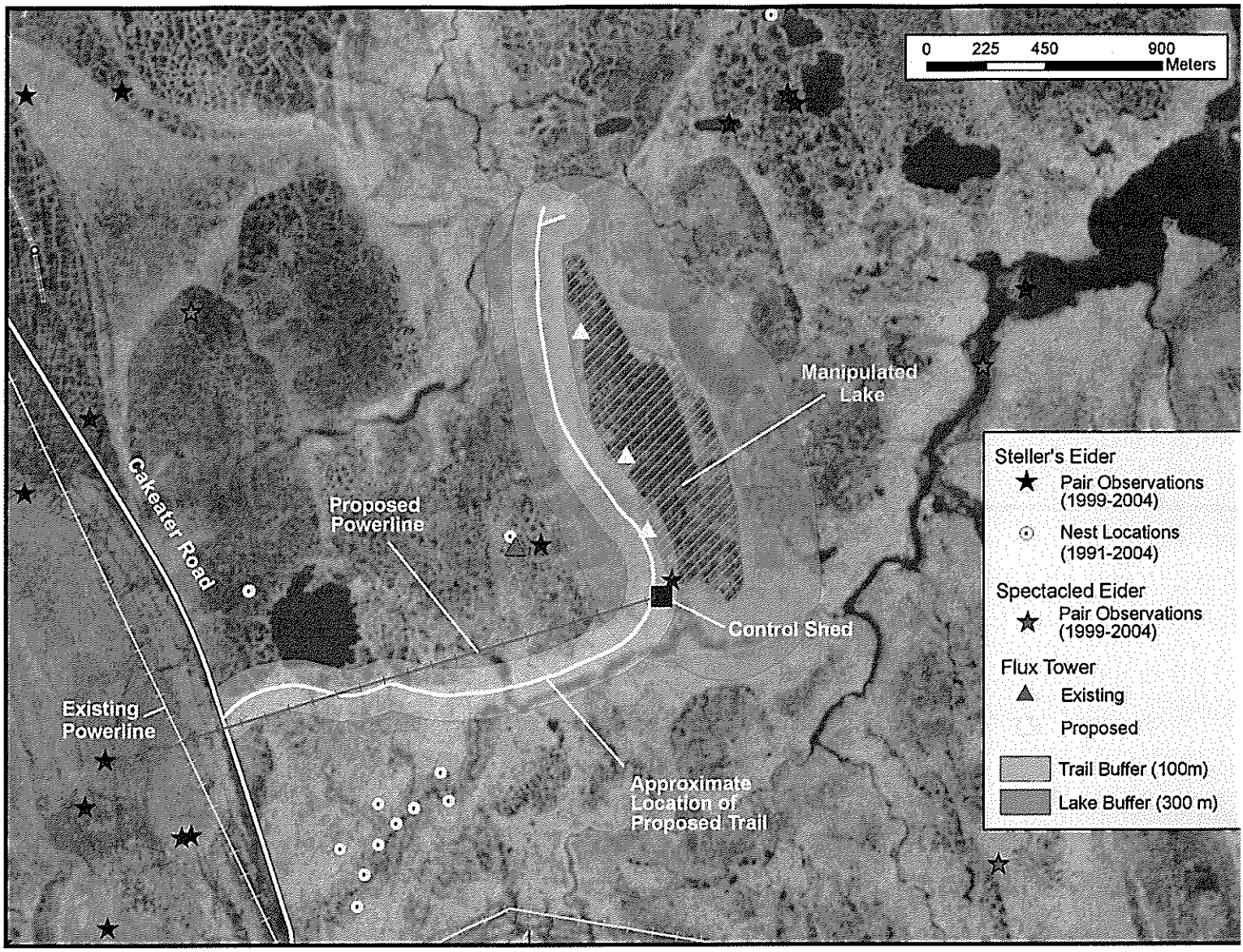

Figure 3. Location of proposed Tundra Manipulation Project in relation to historic Steller's and spectacled eider observations.

Factors affecting species environment within the Barrow Area

Breeding habitat on the North Slope has remained largely unaltered and uninhabited by humans. A portion of the species' potential breeding range has been altered by oil and gas exploration/development. Within the last decade oil and gas exploration/development has occurred from the Arctic Coastal Plain (ACP) near Prudhoe Bay north to offshore islands in the Beaufort Sea, east to the borders of the Arctic National Wildlife Refuge and west to Teshekpuk Lake. With the recent discoveries of oil in NE National Petroleum Reserve-Alaska (NPR-A) and the prospect for development there, lands to the west in NW NPR-A have become of greater interest for oil exploration. The discoveries suggest there is oil potential for certain geological structures in parts of the NW NPR-A, particularly near the coast as it stretches west-northwest across the Arctic Coastal Plain toward Barrow. Impacts of oil development in the Barrow Area could include disturbance from construction, accidental spills of toxic materials, a potential new road, off-road vehicle use, wetland filling, increases in predator populations, and indirect effects of human presence in areas previously uninhabited.

Human population growth in the vicinity of Barrow and other North Slope communities is leading to the on-going development of infrastructure. This results in a localized loss of habitat and a larger area of disturbance. Table 1 shows recent major construction activities for which biological opinions were developed in Barrow.

Table 1 – Projects in the Barrow Area for which a Biological Opinion was Developed and the amount of incidental take expected

Project Name	Area Impacted	Predicted Incidental Take
Airport Runway & Apron Paving	100 acres (includes material site)	None
Barrow Hospital	20 acres	10 spectacled & 17 Steller's
Barrow Landfill	55 acres	1 spectacled & 1 Steller's each year of operation
Barrow Artificial Egg Incubation	No loss of habitat	Maximum of 24 eggs
Proposed Climate Change Facility near NARL	Estimated at 4.75 acres - future expansion likely	Unknown – consultation in progress

Population growth also results in increased on-road and off-road vehicle traffic which are potential sources of additional disturbance. Steller's eider research conducted in the Barrow area jointly by the Service and NSB is also a source of disturbance, because those activities are oriented toward locating nests and broods. One nest was depredated in 2000 as a likely result of nest-search disturbance, when a nest was left exposed to a jaeger because of the proximity of the researcher (Obritschkewitsch et al. 2001). Investigator disturbance studies on spectacled eider nests on the Yukon-Kuskokwim Delta found that routine visitation to nests resulted in a 0.08% additional loss of egg production for the average year from 1994-2002 (Bowman and Stehn 2003). Nest abandonment, in the absence of predation, has only been documented as a result of research-related trapping and handling of an incubating hen; it is possible, however, that chronic human disturbance close to a nest could cause abandonment.

Lead or other sources of contamination of habitat or prey species are possible in localized areas within the range of spectacled and Steller's eiders. Spectacled and Steller's eiders may swallow lead shot pellets when they probe the bottom for food. While on breeding grounds, these eiders typically dig in the bottom of lakes and ponds for their food and are therefore at great risk for lead contamination. Although ingestion of lead is thought to take place primarily on the breeding grounds, exposure in marine molting and wintering areas has not been definitively excluded. Exposure of waterfowl to lead has been documented in the range of both spectacled and Alaska-breeding Steller's eiders. Elevated blood and tissue lead levels, morbidity, and mortality from lead poisoning were found in spectacled and common eiders (*Somateria fischeri* and *S. mollissima*) on the Yukon-Kuskokwim Delta (Franson et al. 1995, Flint et al. 1997, Flint and Herzog 1999). On the breeding grounds near Barrow, one Steller's eider found dead in June had liver and kidney lead concentrations suggestive of lead poisoning, although several other Steller's eiders examined at the same time of year had lower lead tissue concentrations (Trust et al. 1997; Service, unpublished). Blood samples from nesting hens trapped near Barrow in 1999 and 2000 showed that all (8 of 8) had concentrations exceeding the clinical threshold for lead exposure and 7 of 8 exceeded thresholds for lead poisoning in waterfowl.

Often, with increases in human presence, there is a concomitant increase in nest predator populations such as gulls, ravens, and foxes. Residents of Barrow and other North Slope communities have observed an increase in populations of gulls and arctic foxes. There is very little information on predation of Steller's eider nests throughout most of the species' range in Alaska. Near Barrow, however, Steller's eider nest success in recent years has been very poor. Of 186 nests found from 1991-2000, only 15-18% survived until hatching, with predation thought to be the primary factor causing nest failures (Quakenbush et al. 1995, Obritschkewitsch et al. 2001). In addition to causing complete nest failures during incubation, predators at Barrow further reduced productivity through partial predation (where some but not all eggs in a nest were eaten) and by killing ducklings that survived the incubation period (Obritschkewitsch et al. 2001). Studies of nest predation in other areas have reported mixed results. For example, apparent nest success on the Indigirka River Delta, Russia in 1971 was 10-15%, and eiders nesting near gull nests had higher nesting success (Kistchinski and Flint 1974, Mayfield 1975). However, in 1994 nest success was <2% and nest predators such as arctic foxes, glaucous and herring gulls, and parasitic and pomarine jaegers are suspected to have depredated most of the nests (Pearce et al. 1998). Predation by gulls, jaegers, and arctic foxes probably affects the survival of Steller's eider eggs and ducklings throughout the species' range.

Sport hunting for spectacled and Steller's eiders was closed in 1991 by Alaska State regulations and Service policy. Outreach efforts have been conducted by the NSB and the Service to inform hunters of these closures. In 2003, a spring subsistence hunting season for migratory birds in Alaska was proposed. Although killing of spectacled and Steller's eiders is not permitted by the spring hunting regulations, many hunters cannot identify birds on the wing and will likely mistake their quarry, killing prohibited species. An ESA consultation for this spring subsistence hunt has been completed and the adverse

impacts identified in the BO are considered here and will be considered in future consultations concerning listed eiders in Alaska. Accurate information on current harvest rates is not available, but hunter surveys and other observations indicate that both intentional and unintentional shooting of listed eiders likely continues in Northwest Alaska (Paige et al. 1996, Georgette 2000).

All of the factors discussed here may have influenced populations of threatened Steller's and spectacled eiders in northern Alaska. However, it is unknown if these factors played a major role in either species' decline.

5.0 EFFECTS OF THE ACTION ON LISTED SPECIES

5.1 Introduction

This section of the BO provides an analysis of the effects of the action on listed species and, where appropriate, critical habitat. Both direct effects, i.e. those immediately attributable to the action; and indirect effects, i.e. those caused by, or which will result from, the proposed action later in time are considered. Interrelated and indirect effects of the action are also discussed in this section.

Based upon the description of the proposed action, the Service feels that effects on Steller's and spectacled eiders can be divided into three discrete types. These are:

1. Habitat loss
2. Disturbance
3. Collisions with structures

The mechanisms for how the proposed actions would impact listed species, and an estimate of the levels of impacts, are provided below.

5.2 Habitat Loss

The effects of this habitat loss can be estimated using the Steller's and spectacled eider densities derived from a multi-year foot-survey data set (1999-2004). This data was collected by the Service and was designed specifically to detect pre-nesting/nesting eiders near Barrow. The density values observed varied considerably among years; therefore,. the mean density from all years was used to correct. These densities are:

- 0.60 birds/km^2 for Steller's eiders
- 0.32 birds/km^2 for spectacled eiders

Direct loss of habitat would occur by placement of equipment and structures onto the tundra.

As proposed the project would result in the following loss of habitat:

Trails – 10,000 ft. x 19 inches	≈ 0.363 acres
Methane Shed – dimensions less than 20 ft. x 20 ft.	≈ 0.009 acres
Control Shed – 20 ft. x 14 ft.	≈ 0.006 acres
Four Towers – unknown, estimated as <100sq. ft. each	≈ 0.009 acres
Trams – unknown (length = 7,600ft x 1ft. wide)	≈ 0.175 acres
Total	= 0.562 acres

This was converted to square kilometers to allow comparison with the eider density figures. The total area lost resulting from direct project footprint is $0.0023km^2$.

The proposed project centers round the manipulated lake. This approximately 110 acre ($0.445Km^2$) area will be divided into three cells with different moisture regimes. The potential use of this area by listed species is unknown. The area is currently dry, while two cells will remain in this state or drier, one will become a wet pond area.

In a multi-year study at Barrow, Quakenbush et. al. (1997) found that Steller's eiders showed a preferential use of *Arctophila* ponds and stream habitat. Nests were found within 5 meters of all habitat types except deep open lakes, but the majority occurred on the rims of low-centered polygons. These polygons also appeared to be the most successful nesting habitat. Observed broods spent the majority of their time in *Arctophila* ponds.

Spectacled eiders, which are described as occasional breeders at Barrow, show a preference for shallow *Arctophila* and *Carex* ponds. Nests are most common on low islands or ridges close to these water bodies (USFWS 1996, Derksen et. al. 1981). The wet cell in the lake may resemble a small pond. However, the vegetation and aquatic invertebrates upon which the birds feed will not initially be present. As it is not clear that listed species will utilize this modified habitat for the purposes of this BO, the entire lake area is considered a loss of habitat.

Therefore, the total loss of habitat associated with this project is estimated as $0.447km^2$. The project would be constructed in 2005 – 2006 and research is funded for four years after which time much of the habitat will be restored to some level of use. Based upon this, and the average densities of eiders in the Barrow area, the Service has estimated that the level of incidental take associated with habitat loss would be one Steller's eider, and one spectacled eider. These numbers were calculated using the formula below, and rounded to the nearest "whole bird".

(Area of habitat lost x density of birds from survey) no. of years = total incidental take

5.3 Disturbance

The development of this facility will increase human activity in this portion of the BEO and along Cakeeater Road. The majority of the construction of infrastructure at the site will take place during winter, when eiders are not present. During summer 12 scientists

will be working at the facility every day. The pumps and trams at the lake will operate on an as-needed basis and will generate additional noise and disturbance.
In a non-nesting year disturbance to individuals may lead to increased energetic costs with the bird moving away from disturbance, and a reduction in foraging efficiency and feeding time. The disturbance activities associated with this project are relatively discrete, allowing eiders to move into undisturbed areas. Therefore, this mechanism is unlikely to cause a significant reduction to the survival of individuals.

In a nesting year the effects of disturbance on an individual and the species are potentially much more severe. There are two principal mechanisms by which disturbance can adversely affect reproductive success:
1. Displacing adults and/or broods from preferred habitats during pre-nesting, nesting, brood rearing, and migration.
2. Displacing females from nests, exposing eggs or small young to inclement weather or predators.

Several studies demonstrate negative effects of investigator disturbance on waterfowl nesting success. Infrequently, waterfowl will permanently abandon nests after they are disturbed. On the YKD, investigators estimated that nest trapping resulted in a loss of 5% of cackler geese eggs due to desertion (Mickelson 1975). A single search of study plots for an investigator disturbance study done for spectacled eiders on the YKD caused the loss of 0.08% of egg production (Bowman and Stehn 2003). Gulls were attracted to, and more nests were destroyed at, eider nesting islands after disturbance (Ahlund and Gotmark 1989). However, in 1997 investigators marked and visited spectacled eider nests at varying schedules and found no difference in survival rates due to observer impact (Grand and Flint 1997).

Steller's and spectacled eider behavior appears to change with changing environmental conditions. The behavioral response of listed eiders to nesting disturbance is unknown. Some Steller's eiders nest and rear broods near the Barrow Airport and spectacled eiders have been seen nesting near the Deadhorse Airport (Service unpublished data). Quakenbush et. al. (1997) documented successful Steller's eiders nests within 40m of ATV trails at Barrow. These data suggest that some individuals may tolerate or habituate to disturbances such as frequent aircraft noise. However, individual tolerances are likely to vary and the intensity of disturbance associated with the proposed action would, in most cases, be more variable and potentially more disturbing than that experienced by birds near the Barrow and Deadhorse airports. We do not expect total abandonment of nesting areas as a result of the proposed experiment. However, the Service anticipates some negative impacts on reproductive success due to human activities at the site.

As described in section 2.3, the action area for this project is approximately 301 acres ($1.218 km^2$) in size. Historical nesting data (Service and others) suggest that there has been nesting activity by both species close to and within the action area (Figure 3). Based on the average densities of eiders 1994 – 2004 (0.60 birds/km^2 for Steller's eiders, and 0.32 birds/km^2 for spectacled eiders), the proposed project could potentially disturb 0.731 Steller's eiders (0.365 pairs), and 0.39 spectacled eiders (0.19 pairs) each year.

The nest surveys carried out by the Service indicated that these species nests in roughly half of the years in the Barrow area. Therefore, over the four year life of the proposed experiment a total of 0.731 Steller's eider nests, and 0.39 spectacled eider nests would be disturbed. For the purposes of calculating the incidental take, the Service assumes that all nests within the action area would fail due to disturbance. The average recorded clutch size for successful Steller's eider nests at Barrow was 5.8 eggs (USFWS 1999), while spectacled eider clutch size varies in the wild from one to eleven, with an average of 3.5 ± 0.3 in northern Alaska (Petersen et. al. 2000). However, Larned (2003) use a figure of 3 eggs / pair for spectacled eider to compensate for non-breeding pairs. For the same reasons, Mallek (2001) suggests a 3 eggs / pair for Steller's eiders. Quakenbush et. al. (1995) found an average of 3.2 – 3.8 eggs per nest on the North Slope. Based upon these generalizations the Service estimates that the incidental take related to disturbance at this site would be a maximum of 2.2 Steller's eiders eggs or chicks, and 1.2 spectacled eider chicks or eggs. These figures were calculated as follows:

Incidental take as a result of disturbance = number of nests affected x 3 eggs

5.4 Collision with Structures

Migratory birds suffer considerable mortality from collisions with man-made structures. Of particular concern are towers, power lines, and wind turbines (Manville 2004). Birds are particularly at risk of collision with objects in their path when visibility is impaired during darkness or inclement weather, such as rain, drizzle, or fog (Weir 1976).

The proposed project will results in the installation of four towers and 8,000 feet of overhead power line. These structures pose a collision threat to listed eiders and other bird species.

Tower Collisions

Manville (2004) cautions that all towers have the potential to kill birds. He continues that the towers that cause the most problems are tall (>305m), illuminated at night (especially with solid or pulsating incandescent red lights), are guyed, are near wetlands and migration routes, and occur in areas with frequent inclement weather during migration.

Three flux towers and one communication tower are to be installed as part of this project. All are less than 30 feet in height, and none will be lit. They are however, located within wetland areas. The towers will be located near the lake where human activities will be concentrated; this activity may reduce use of the lake by birds which could reduce collision risk.

Power Line Collisions

At present there is approximately 37 km of over head power line in the Barrow area (excluding in-town lines) (North Slope Borough 2003). The proposed project would add 2.44 km to an undeveloped area.

Although there have been a number of studies document significant bird mortality associated with power line strikes, none focus exclusively on spectacled or Steller's eiders, and few have been conducted in this area of Alaska.

Anderson & Murphy (1988) monitored bird behavior and strikes to a 12.5km power line in the Lisburne area (the southern portion of the Prudhoe Bay oil fields) during 1986 and 1987. They observed 25 different species of birds including Spectacled eiders. In their analysis birds were grouped, and the Spectacled and other eiders were within the "duck" group. Results indicated that strike rate was related to flight behavior, in particular the height of flight. Observations suggested that most ducks flew over lines (lines were at 50 feet and 84 feet). Crossings were also more common in wet tundra areas, and ducks were observed to change their flight in order to avoid lines suggesting in good weather they could see and avoid lines. One king eider was seen to strike lines as it was descending to land. Spectacled eiders have collided with utility wires on St. Lawrence Island and at Prudhoe Bay (Service, unpublished data).

Data on bird strikes with overhead lines in Barrow is limited. However, five spectacled eiders were killed or injured by wire collisions in Barrow during 2003-2004 (Service, unpublished data).

Size and maneuverability are important factors in evaluating a species' vulnerability to colliding with overhead wires. Many species of ducks are at high risk as they generally fly at low altitudes and at relatively high speed. The habitat crossed by the power line is also a key factor. If birds frequently cross a line, for example from roost sites to feeding sites, strike incidence increases (APLIC 1994). The proposed power line is located in wetlands typical of much of the North Slope of Alaska. There are a number of small ponds and stream systems on either side of the power line route that are favored habitats for both listed species (USFWS 2002).

Based on this limited information it is clear that listed eider species are at risk from power line collisions at the experimental site, particularly in bad weather. Studies on a variety of species in different habitat types have shown that making wires more visible can dramatically reduce collision frequency (Beaulaurier 1981). In a review of five different marking efforts from 1972 – 1980, Beaulaurier (1981) found an average avian mortality reduction of 45%. Alonso et. al. (1994) found a 60% - 61% reduction when ground wires were marked with colored PVC spirals. A study in the Netherlands by Koops (1993) cited by APLIC (1994) found a 57% - 89% reduction in mortality when lines were marked, depending upon the type and spacing of markers. In the U.S., Brown & Drewien (1995) showed that both swinging plate and spiral vibration markers significantly decreased collision mortality of cranes and waterfowl.

Studies show that markers on lines reduce strikes by many avian species. The efficacy of markers for listed species has not been quantified but is anticipated to be similar to other eiders and duck species. For the purposes of this B.O. we are estimating the markers will reduce mortality by 60%. The project would add 2.44 km of marked overhead lines to the existing 37 km of unmarked lines in the Barrow area. Five fatalities to listed species

from strikes to overhead lines were recorded in Barrow in a two-year period. However, this is likely to be a gross underestimate. Due to removal by predators and domestic animals, and with few lines being accessible by road it is very rare to recover carcasses. Manville (2004) notes that estimates of mortality from avian collisions with power lines vary considerably and are often based on extrapolations.

Using the very limited data from Barrow, a mortality rate of 0.068 birds / km / year is anticipated. Hence, 2.44 km of unmarked wire could be expected to kill 0.166 birds / year. With a 60% reduction in mortality from the markers, this take would be reduced to 0.1 birds / year. The Service pair survey and nest data suggest that Steller's eiders are twice as abundant as spectacled eiders in the Barrow area. Therefore, the incidental take from collisions with the proposed power-line has been portioned in the same way. The project is funded for four years, hence we estimate 0.24 Steller's eiders, and 0.14 spectacled eiders would be involved in fatal collisions with power line. No data on mortality rates at comparable towers was identified. However, as the guys wires are to be marked, the towers will not be lit, and they are comparatively few collisions are anticipated. Therefore, the total amount of incidental take resulting from collisions with project infrastructure is one Steller's and one spectacled eider.

These estimates of incidental take are based on very crude data. Re-initiation of consultation, and amendments to these figures may be required if monitoring of the power line and guy wires indicate higher mortality rates.

5.5 Interrelated and Interdependent Actions

This project will install infrastructure to a previously undeveloped portion of the BEO. Although the tundra manipulation experiment is funded through 2007, it is likely further funding may be available and the work would continue. This would result in the infrastructure such as trams, dikes and flux towers remaining in place for an undetermined number of years.

The power line will become the property of the local utility corporation (BUECI) and is likely to remain *in situ* for the foreseeable future. The availability of power and other infrastructure increases the potential for additional scientific research in the area, which may increase disturbance to listed species.

6.0 CUMULATIVE EFFECTS

Under the Act cumulative effects refer to the effects of future actions that are reasonably certain to occur within the action area. Actions with a federal nexus (projects conducted, funded, or permitted by the federal government) are not considered as they will be evaluated through future section 7 consultations.

When analyzing cumulative effects of a proposed action, it is important to define both the spatial (geographic), and temporal (time) boundaries. Within these boundaries, the types of actions which are reasonably foreseeable are considered. This cumulative effects analysis related only to the action area, as described in section 2.3 of this BO.

The action area and surrounding lands are owned by the local village corporation - Ukpeagvik Inupiat Corporation (UIC). The action area is within the Barrow Experimental Observatory (BEO) Scientific Research District. This 7,000 acre parcel has been zoned as a Scientific Research District by the North Slope Borough, and is managed by BASC. Based upon this zoning, it can be reasonably suggested that future activity in the action area will be primarily limited to scientific research, and developing infrastructure to support it.

Future development by the State of Alaska or the North Slope Borough may occur in the area through developments like improved roads, and transportation facilities, housing or utilities or other infrastructure. However, the entire action area is classed as wetlands and is therefore subject to Section 404 permitting requirements by the U.S. Army Corps of Engineers. This permitting process would serve as a federal nexus and hence trigger a review of any major state or borough construction project in the area.

As described above, the BEO is located on UIC lands, and is privately owned. Actions could occur on these lands that would not necessarily require a federal permit but there is currently no indication that UIC intends to change the use of this parcel. As such it is likely to remain an area designated for scientific research.

The tundra manipulation experiment is funded until the end of 2007. However, it is anticipated that the work may continue if funds become available. Infrastructure developed at this site (such as the power line) is likely to draw further, unspecified research activities to the area. It is not clear what form future research may take and hence how it may affect listed species. As BASC is primarily funded by the National Science Foundation, we suggest that the majority of future research activities associated with this site would be federally funded, and hence subject to future section 7 review.

Based upon the North Slope Borough's zoning of the action area, and the management goals and funding structure of BASC, the Service feels there is little potential for cumulative impacts in the action area that will not have a federal nexus. As described in the effects of action section of this BO, these future research activities are reasonably foreseeable and may have a significant effect on listed species.

7.0 CONCLUSION

After reviewing the proposed action, the current status of spectacled and Steller's eiders, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that development and operation of the tundra manipulation experiment is not likely to jeopardize the continued existence of the spectacled and Steller's eider. Critical habitat has been designated for these species, however, the proposed action does not affect that area and no destructive or adverse modification of that critical habitat is expected. This BO's determination of non-jeopardy is based on the assumption that the NSF will consult with the Service on future experiments and operations at this site that are not discussed in this BO.

Regulations (51 FR 19958) that implement section 7(a)(2) of the Act define "jeopardize the continued existence of" as "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species." In evaluating the impacts of the proposed tundra manipulation experiment to Steller's and spectacled eiders, the Service identified a series of direct and indirect impacts that could result from habitat loss. However, the Service believes that the impacts to these species will be minimal for the reasons given in the *Effects of the Action* and *Cumulative Effects* sections of this BO.

Using methods and logic explained in the Incidental Take Statement below, the Service estimates that incidental take of spectacled eider's would be 2 adults and 1.2 eggs / chicks. For Steller's eiders an incidental take of 2 adults and 2.2 eggs / chicks is anticipated. Using Larned's (2003) data the population of spectacled eiders is estimated at 7149 adults this incidental take represents approximately 0.028% of the breeding population. Mallek's (2001) data for Steller's eider suggests a north slope breeding population size of 1200 adults. Thus the incidental take associated with this BO represents approximately 0.167% of the population. The Service believes that this level of loss will not significantly affect the likelihood of survival and recovery of listed eiders.

8.0 INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. "Harm" is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. "Harass" is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action, is not considered a prohibited taking provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement (ITS).

The measures described below are non-discretionary, and must be undertaken/required by the NSF and its agent, BASC, so that they become binding conditions of any grant or permit issued to an applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The NSF and BASC have a continuing duty to regulate the activity covered by this Incidental Take Statement. If the NSF and BASC (1) fail to assume and implement the terms and conditions or (2) fail to require any applicant to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse.

Through the placing of infrastructure the proposed project would involve a habitat loss of $0.0023km^2$. The lake area is also considered to be a loss of habitat and covers an area of $0.445km^2$. This is a very small percentage of the total habitat available in the Barrow area. The action area, which can also be described as the area of direct and indirect effects of the proposed project is estimated to be 301 acres, or $1.218km^2$.

Estimating take of listed eiders from the proposed project activities such as filling of wetlands, collisions with power line and towers, and disturbance from operation of the site is extremely difficult. There is little information on tolerance of sea ducks to disturbance as a result of these types human activities and their ability/willingness to relocate successfully to other areas once disturbed. The incidence of power line strikes in the Barrow area is not well understood, particularly for these listed species. The Service anticipates that incidental take of listed eiders will be difficult to detect because injury or death to eggs, young, or adults may not be directly observed.

Incidental take as a result of this project is anticipated from three sources: direct loss of habitat, disturbance, and bird strikes to power lines and towers. Section 5 describes the methods used to estimate incidental take for each of these. Table 2 provides a summary of the Service's incidental take estimates.

Table 2 – Service's estimates of incidental take for each facet of the project by species

Method / Species	Spectacled Eider	Steller's Eider
Habitat loss	1 adult	1 adult
Disturbance	2.2 eggs/ chicks	1.2 eggs / chicks
Bird strikes	1 adult	1 adult
Total	**2 adults & 2.2 eggs/chicks**	**2 adults & 1.2 eggs/chicks**

Despite the predicted incidental take the Service does not foresee that the proposed project would adversely impact listed eider populations. It is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat. We believe that the applicant and action agency would construct and operated the project in a manner that minimizes impacts to listed species. The level of incidental take will be reduced further by implementing the terms and conditions of this B.O. However, the estimates of incidental take are based on crude data and consultation may need to be re-initiated, and the B.O. amended if monitoring indicates that incidental take is higher than predicted.

While the incidental take statement provided in this consultation satisfies the requirements of the Act, it does not constitute an exemption from the prohibitions of take of listed migratory birds under the more restrictive provisions of the Migratory Bird Treaty Act. However, the Service will not refer the incidental take of any migratory bird or bald eagle for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §§ 703-712), or the Bald and Golden Eagle Protection Act of 1940, as

amended (16 U.S.C. §§ 668-668d), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

9.0 REASONABLE AND PRUDENT MEASURES

The Service considers three types of impacts which may result in incidental take. These are:

(a) Loss of habitat through the project footprint (trails, equipment sheds, tram lines etc.)
(b) Disturbance of eiders due to increased human activity during operation of this project, and in the future due to the improved science infrastructure.
(c) Bird collisions with overhead power lines and towers (three flux towers, one communication tower).

There are a number of techniques described in the description of the proposed action which will reduce incidental take. In addition Service believes that the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize the level of incidental take of spectacled eiders:

(a)To reduce habitat loss:

- Minimize the footprint of the experimental area and its operation.
- Where possible, remove equipment and infrastructure from the area once its use is completed.

(b) To reduce disturbance (particularly of nests):

- Minimize noise, and human activity in the area to the extent possible.

(c) To reduce collision risk:

- Install collision avoidance markers on overhead power lines and tower guys lines.
- Remove towers, and if possible power lines, once they are no longer needed.

10.0 TERMS AND CONDITIONS

In order to be exempt from the prohibitions of Section 9 of the Act, the NSF and BASC must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

<u>(a) Habitat Loss</u>

(i) Structures should be co-located where possible. For example, the communications tower could be sited immediately adjacent to the control shed.

(ii) While working within the constraints of the ground type, trails and power lines should be as short as possible.

(iii) Site equipment, trails, and ancillary facilities on previously disturbed areas to avoid impacting new ground to the extent possible.

(iv) Equipment and facilities should be removed from the site once they are no longer being used.

(v) If water needs to be removed from the "dry" cell and cannot be added to the "wet" cell, direct it into a natural drainage channel. The water velocity at the pump outlet should be low enough, and the water dispersed enough, to prevent erosion of the channel.

(b) Disturbance
(i) As described in the proposed action section conduct a nest survey of the area, dependant upon result modify the operation of the facility.

(c) Bird Strikes
(i) Collision markers / bird flight diverters should be installed on all overhead lines and tower guy lines.

(ii) Once the experiment has been completed, and assuming that there is no further use of the flux and communications towers, they should be removed.

(e) Monitoring & Salvage
(i) BASC is responsible for conducting pair surveys, nest searches if appropriate and transmitting the results to FWS as described in section 2.4 of this BO.

(ii) Monitor the area around the four towers and overhead wires to locate any birds that have struck them. The monitoring protocol should be developed in cooperation with the Service.

(iii) If sick, injured or dead Steller's and spectacled eiders are encountered the "Protocol for Handling Sick, Injured, and Dead Spectacled and Steller's Eiders, USF&WS revised 1/25/02". A copy of this protocol is provided a Appendix B.

Summary
The Service believes that no more than 21 spectacled eiders and 21 Steller's eiders will be incidentally taken during the life of the proposed project. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action.

If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of reasonable and prudent measure provided. The action agency must immediately provide all available information on factors leading to take and review with the Service the need for possible modification of reasonable and prudent measures.

11.0 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. We recommend the following action be implemented:

1. The Steller's eider conservation plan for Barrow (USF&WS & NSB 2004) includes objectives and management plans for the Barrow area. The proposed project would result in the loss of approximately one acre of habitat in an area classified under this plan as high use. The plan recommends compensation on a 1.5:1 basis for unavoidable habitat loss in high use areas. If mitigation is in the form of revenue, the funds will be used for implementing Steller's eider conservation strategies.

2. In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

12.0 REINITIATION NOTICE

This concludes formal consultation on the actions outlined in the NSF's initiation letter, sent on October 18, 2004. As provided in 50 CFR 402.16, initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the action agency that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; 3) the agency action is subsequently modified in a manner that causes an effect to listed or critical habitat not considered in this opinion; or 4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending re-initiation. The NSF should also reinitiate consultation if it becomes evident that any additional development or activity not described in their project description may take place without separate consultation on that action.

Thank you for your concern for endangered species and for your cooperation in the development of this biological opinion. If you have any comments or require additional information, please contact Ted Swem at (907) 456-0441 with the Fairbanks Fish and Wildlife Field Office, Endangered Species Branch, Fairbanks, Alaska.

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APPENDIX A

BASC Tundra Manipulation Experiment – Consultation History

7/13/04	BASC e-mails FWS to inform them this project now had funding.
9/9/04	BASC e-mails FWS with a draft consultation initiation letter for comments.
9/9/04	FWS provides comments via e-mail.
10/18/04	NSF initiates formal consultation and designates BASC as their non-feral representative for consultation.
11/15/04	FWS confirms that consultation has been initiated, and a BO will be issued on or before March 30, 2005.
1/25/05	BASC e-mails FWS a copy of COE / Coastal Zone permit applications.
1/26/05	FWS e-mails BASC with some questions and comments.
1/26/05	BASC e-mails FWS with some clarification and answers to questions.
1/28/05	BASC e-mails FWS a picture showing the rubber trail panels proposed for use.
2/1/05	Teleconference between BASC and FWS.
2/17/05	Telephone call between FWS and BASC clarifying aspects of project.
2/17/05	BASC e-mails FWS a copy of the DNR Temporary Water Use permit for the project.
3/4/05	FWS & BASC teleconference to discuss the BO, in particular the terms and conditions and conservation recommendations.
3/10/05	FWS e-mails BASC and COE a copy of the Draft B.O.
3/11/05	BASC e-mails FWS confirming they will accept the terms and conditions and the Draft B.O.
3/15/05	COE phones FWS regarding B.O.