Arctic Air Quality Monitoring Site Evaluation Report:

A Report to the Air Resources Division, National Park Service

Arctic Network Natural Resource Technical Report
NPS/AKRARCN/NRTR-2006/03

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EXECUTIVE SUMMARY:

Bettles, Toolik Field Station (Toolik Lake, Alaska) and Anaktuvuk Pass, Alaska, were evaluated through on-site examinations in the spring of 2006 as potential locations for a long-term air quality sampling site representative of the air impacting the arctic national parks. The results of the evaluations are:

1) The areas around Bettles and the Toolik Field Station contain sites that meet or exceed the National Park Service air quality monitoring siting criteria. Although both locations contain sites that meet the siting criteria, we recommend that ARD relocate the Arctic Air Quality Site to the Toolik Field Station.

2) Anaktuvuk Pass is not a suitable location for a long-term air quality sampling site due to the large number of local emission sources surrounding the potential sites, the lack of qualified operators and the high potential for vandalism.

3) The Toolik Field Station sites are preferable to the Bettles sites for several reasons:

    a) The Toolik Field Station is north of the Brooks Range and will be more representative of air reaching the arctic national parks. This will be the only National Park Service long-term air quality monitoring site in the Arctic.

    b) The Toolik Field Station became permanently operational year-round as of April 2006. Bettles winter population in 2006 was 8. Many of the park rangers in Bettles are either seasonal or subject to furlough, therefore it is unclear whether or not ARCN will be able to obtain samples year-round for ARD at the Bettles site.

    c) The Toolik Field Station is logistically easier to reach than Bettles. Bettles is not road accessible all year round, hence aircraft would be needed to retrieve samples by backup operators located in Fairbanks. It is possible to drive to the Toolik Field Station via the Dalton Highway all year long.

    d) The site operators at the Toolik Field Station regularly collect scientific data and are very familiar with the continuity requirements for quality scientific data.

    e) The data collected at the Toolik Field Station has a much greater probability of being used by the scientific community to enhance their understanding of the long-term research projects being conducted at the Toolik Field Station. There is very little scientific research being conducted in Bettles.

4) Site 1 at the Toolik Field Station is preferable to site 2 because it is farther from and not visible from the Dalton Highway, is farther from and less visible from the Toolik Field Station and it does not require power to be run across a stream and up a hill.

5) Site 2 at Bettles is preferable to site 1 because it is accessed by a lightly traveled road and a short hike, instead of on a more frequently traveled road, is not near a shooting

range, is upwind of the town and has power and telephone at the site (due to the location of a BLM lightning detector on the site).

OVERVIEW:

The long-term air sampling site at Ambler, Alaska, was not collecting the required air quality measurements effectively. Therefore, a decision was made to move the air quality sampling site to a new Arctic location representative of the five Arctic National Parklands. Because none of the five Arctic Parklands are staffed year round, the only option is to find a representative site outside park boundaries that is logistically feasible to access all year round and scientifically valid. A preliminary discussion of sites available for use as a long-term air quality sampling sites was based on logistic and scientific criteria. This initial analysis limited the potential relocation sites to three sites: (1) Bettles, Alaska which is a village just south of Brooks Range and Gates of the Arctic Park and Preserve (GAAR); (2) the Toolik Field Station at the Toolik Lake Long Term Ecological Research Site (Toolik Lake LTER) just north of the Brooks Range and GAAR; and (3) Anaktuvuk Pass a village in the northern Brooks Range that is surrounded by GAAR. All three sites were visited by a team of scientists during the spring of 2006: the Toolik Field Station was visited April 26-28, 2006; Bettles was visited May 30-31, 2006; and Anaktuvuk Pass was visited on May 31, 2006. The results of on-site analyses of these three potential locations are provided in this report.

SITE SUMMARIES AND ANALYSES:

Toolik Field Station, Toolik Lake, Alaska

Overview:

The Toolik Field Station (Toolik Lake, Figure 1) is a University of Alaska Fairbanks Research Field Station located on the treeless northern foothills of the Brooks Mountain Range (http://www.uaf.edu/toolik/). It is located at 68 degrees 38'N and 149 degrees 36'W and is associated with the Arctic Long-Term Ecological Research (LTER) site. Scientists have been conducting research around Toolik Lake since 1975 (see http://ecosystems.mbl.edu/ARC/ for a history of research at Toolik Lake). The field station was designed to accommodate, support and provide laboratory facilities for field researchers during their field research season on the North Slope of Alaska. The field station contains housing, kitchens, laboratories, power generating stations, waste incineration facilities, garages, heliports, maintenance facilities, etc. Figure 2 shows a satellite image of the Toolik Field Station with the three potential sites (site 1 to the northwest, site 2 to the south and site 3 to the northeast of the field station) marked with yellow circles.

The population of the Toolik Field Station varies seasonally. The highest visitation is during the summer months (Figure 3). During previous years, the Toolik Field Station was not staffed during the winter. Starting in the winter of 2006, the Toolik Field Station will have personnel on site every week throughout the winter, indefinitely.



Figure 1. Toolik Lake Field Station during summer. The Northeastern Portion of GAAR can be seen in the background.

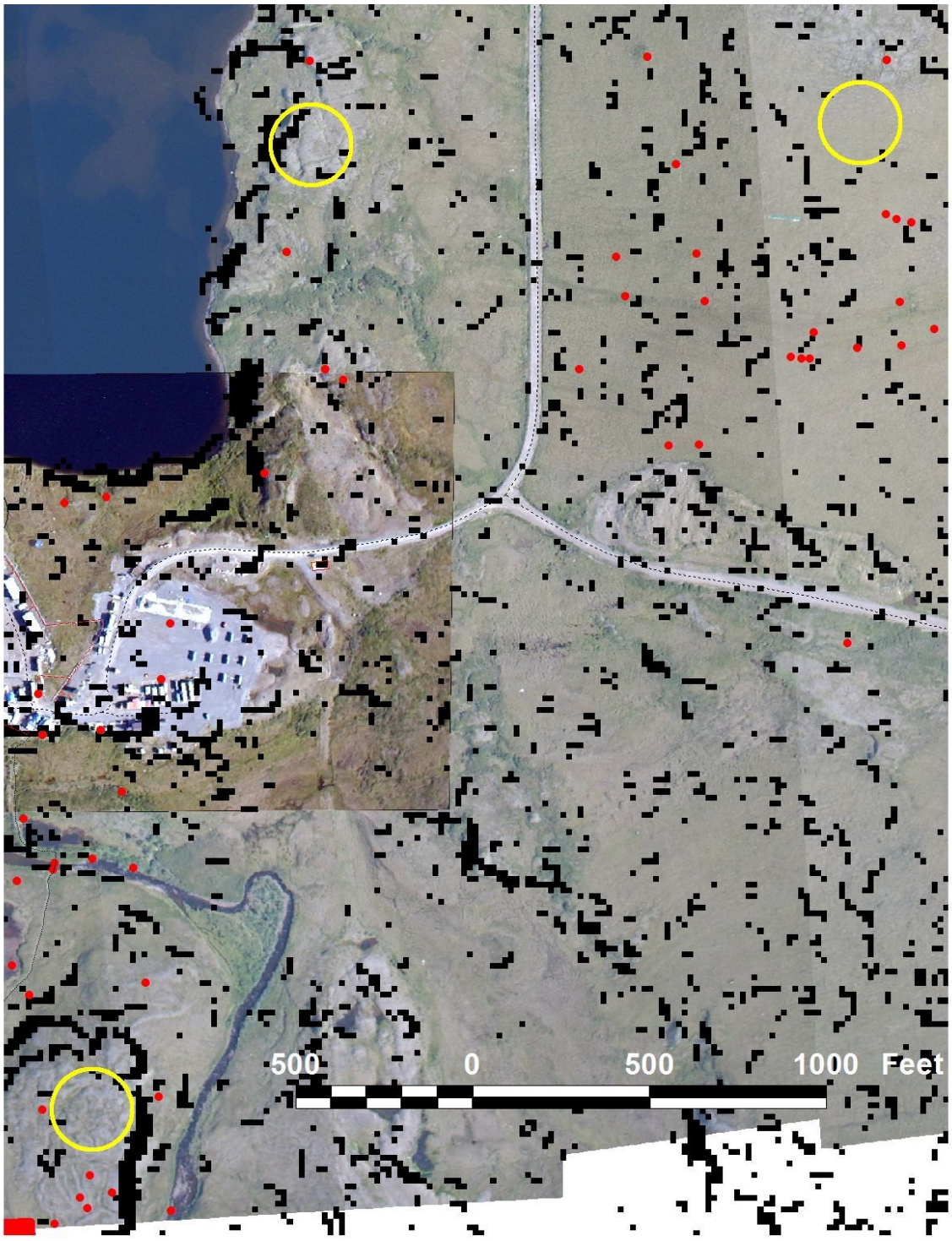


Figure 2. A satellite image of the Toolik Field Station with the three potential sites circled in yellow. Site 1, the preferred site, is slightly northeast of the station. Site 2, the second preference is to the south of the station. Site 3, in the northeast corner of the image, was deemed unacceptable.

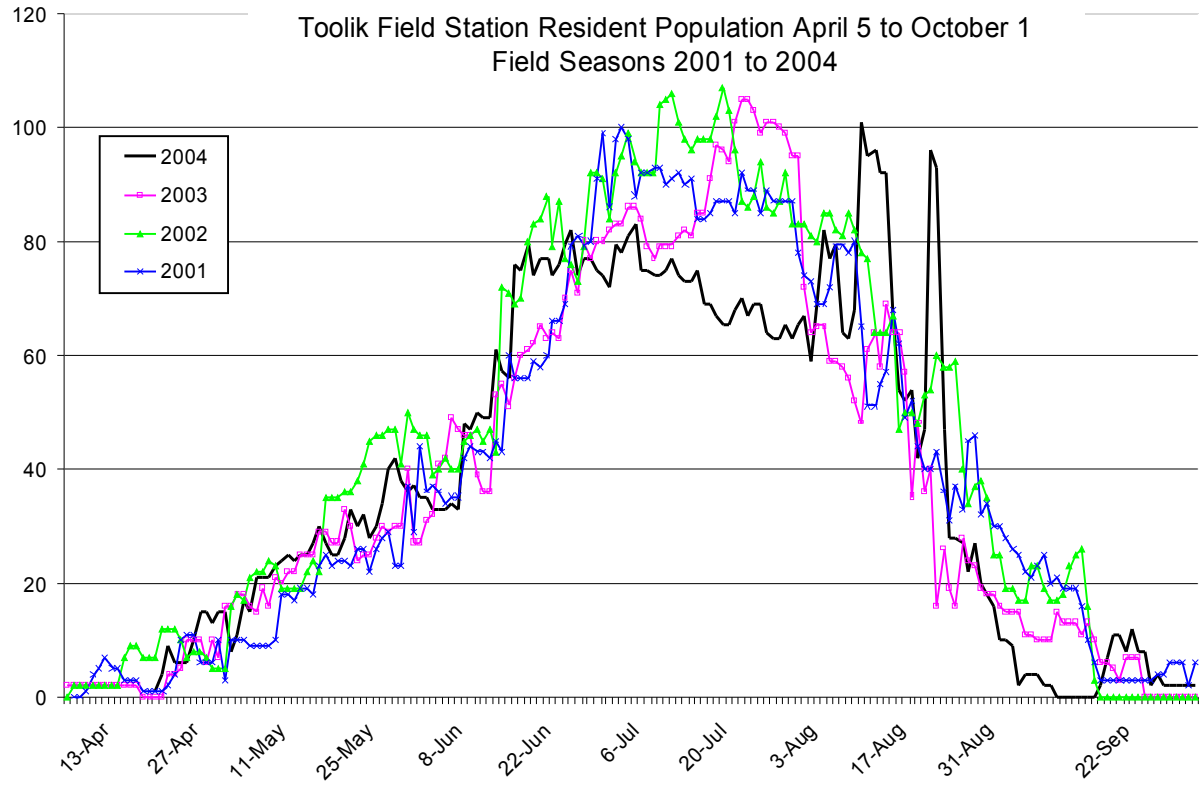


Figure 3. Toolik Field Station resident population. Modified from http://www.uaf.edu/toolik/Reports/Reports04/tfs-graphs-2004.ppt.

A physical description of the Toolik Lake region is posted at http://ecosystems.mbl.edu/ARC/. It states, "This area is typical of the northern foothills of the Brooks Range, with continuous permafrost, no trees, a complete snow cover for 7 to 9 months, winter ice cover on lakes, streams, and ocean, and cessation of river flow during the winter. Tussock tundra vegetation of sedges and grasses mixed with dwarf birch and low willows is the dominant vegetation type but there are extensive areas of drier heath tundra on ridge tops and other well-drained sites as well as areas of river-bottom willow communities." Figure 4 shows a vegetative map of the Toolik Field Station.

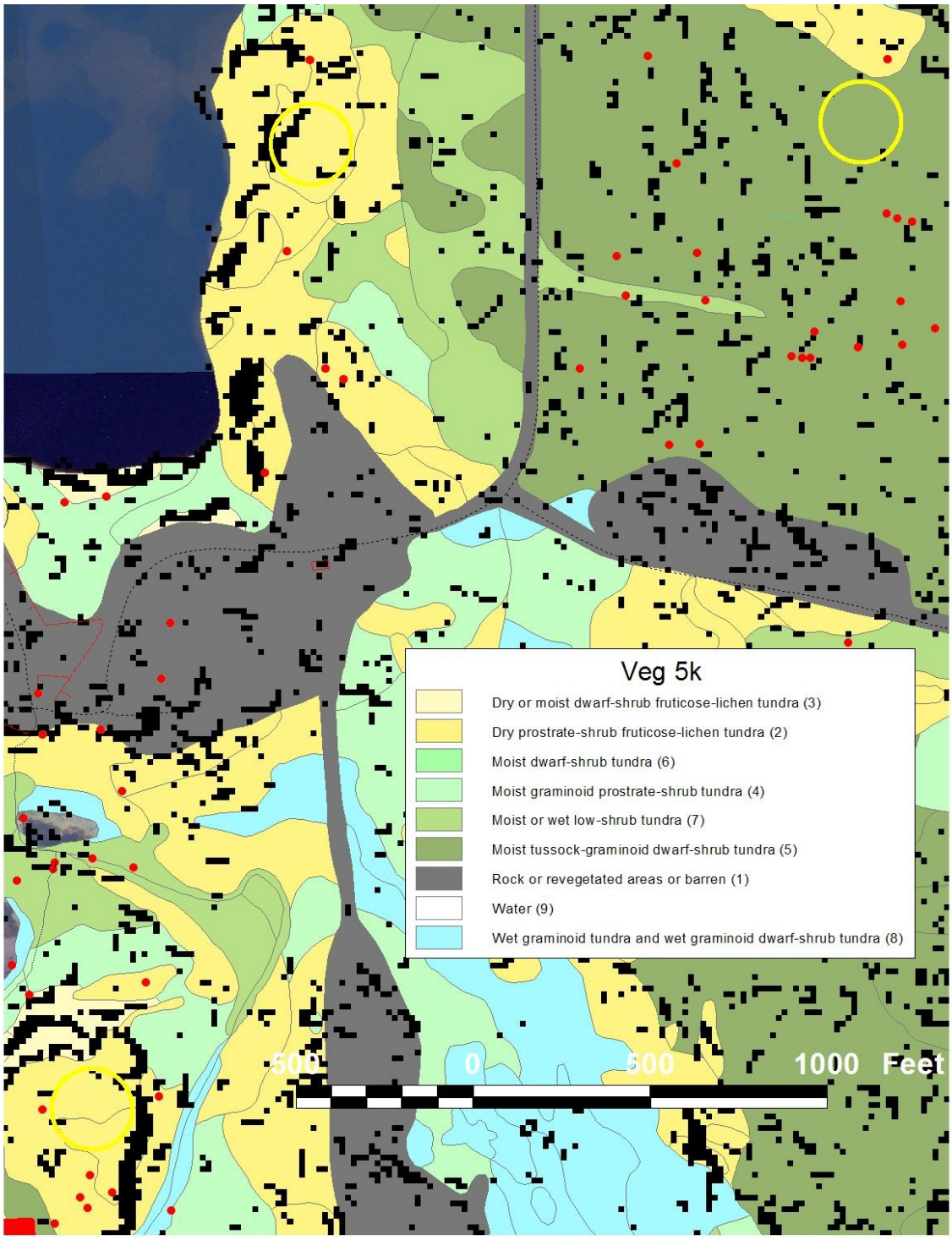


Figure 4. A vegetative map of the area surrounding the Toolik Field Station. Once again, the three sites investigated are circled in yellow.

The site, http://ecosystems.mbl.edu/ARC/, goes on to state, "The climate at the site is typical of arctic regions, with a mean annual air temperature of about -10°C and low precipitation (45% of the 20-40 cm of precipitation falls as snow). During the summer the

daily average air temperature is 7-12°C with the sun continuously above the horizon from mid-May to late July. The snow-free season can lasts from late May to mid-September, with below-freezing temperatures possible at any time. The entire region is underlain by continuous permafrost which exerts a major influence on the distribution, structure, and function of both terrestrial and aquatic ecosystems.

The wind at the Toolik Field Station as measured at the Toolik Lake Main Weather Station comes predominantly from the south (Figure 5).

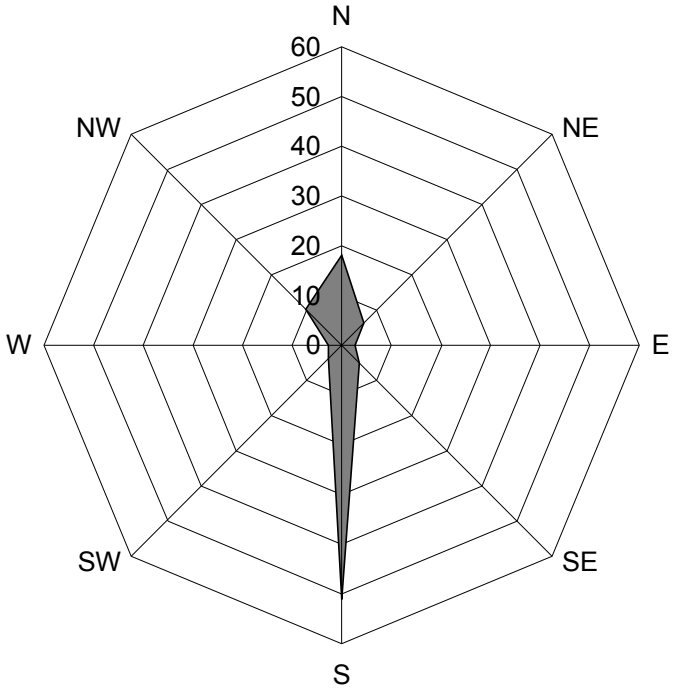


Figure 5. Percentage of time wind comes from a specific direction at the Toolik Lake Main Weather Station between September 14, 2004 and September 13, 2005. (This weather station has been collecting data since 1988 and the data is available at http://ecosystems.mbl.edu/ARC/)

Siting:

We have identified two suitable sites, approximately 400 m from the Toolik Field Station operations, one north of camp and one south of camp (Figures 6-18). Both sites are located on dry phrostrate-shrub fruticose-lichen tundra. Both sites are located over a km from the Dalton Highway, an unpaved road used for access to Prudhoe Bay and the Alaska Pipeline. The Dalton Highway is not visible from site 1 and barely visible from site 2 (Figure 13). Both sites will need to have power run to them although site 2's power will need to be run across a stream and up a hill. Both sites have year-round access via the Dalton Highway and will have operators on site capable of routine sampler maintenance. Also, both sites exceed the National Park Service siting criteria for all proposed network operations (see attached siting criteria lists for each network). We

evaluated a third site, but determined that it was too exposed to emissions from the Dalton Highway.

The Toolik Field Station is located in a remote part of Alaska. Therefore, it locally generates its own power. Figure 25 shows some of the power generating facilities at the field station. In addition, to save shipping expenses and keep the area clean, the burnable garbage produced by the field station is incinerated on site. The incinerator is shown in figures 26 and 27. The smoke produced by the incinerator on this day was not typical of normal incinerator operations; the incinerator was being serviced on the day the photos were taken. In addition to the generators and incinerators, vehicle exhaust, wood smoke and road dust are also produced by the Toolik Field Station activities. However, these emissions are not expected to significantly impact either potential air monitoring site.

Site 1 at the Toolik Field Station is preferable to site 2 because it is farther from and not visible from the Dalton Highway, is farther from and less visible from the Toolik Field Station and it does not require power to be run across a stream and up a hill. The primary advantage to site 2 is that it is usually in the upwind sector for the Toolik Field Station. Site 2's location places it away from the Toolik Field Station plume and at a higher elevation than the field station.

Site 1 (Preferred location) Photos



Figure 6. Looking northeast from the Toolik Field Station site 1.



Figure 7. Looking east from the Toolik Field Station site 1.



Figure 8. Looking southeast from the Toolik Field Station site 1.



Figure 9. Looking southwest from the Toolik Field Station site 1.



Figure 10. Looking west from the Toolik Field Station site 1.



Figure 11. Looking north from the Toolik Field Station site 1.

Site 2 (Second preference for Toolik Field Station) Photos



Figure 12. Looking north from the Toolik Field Station site 2.

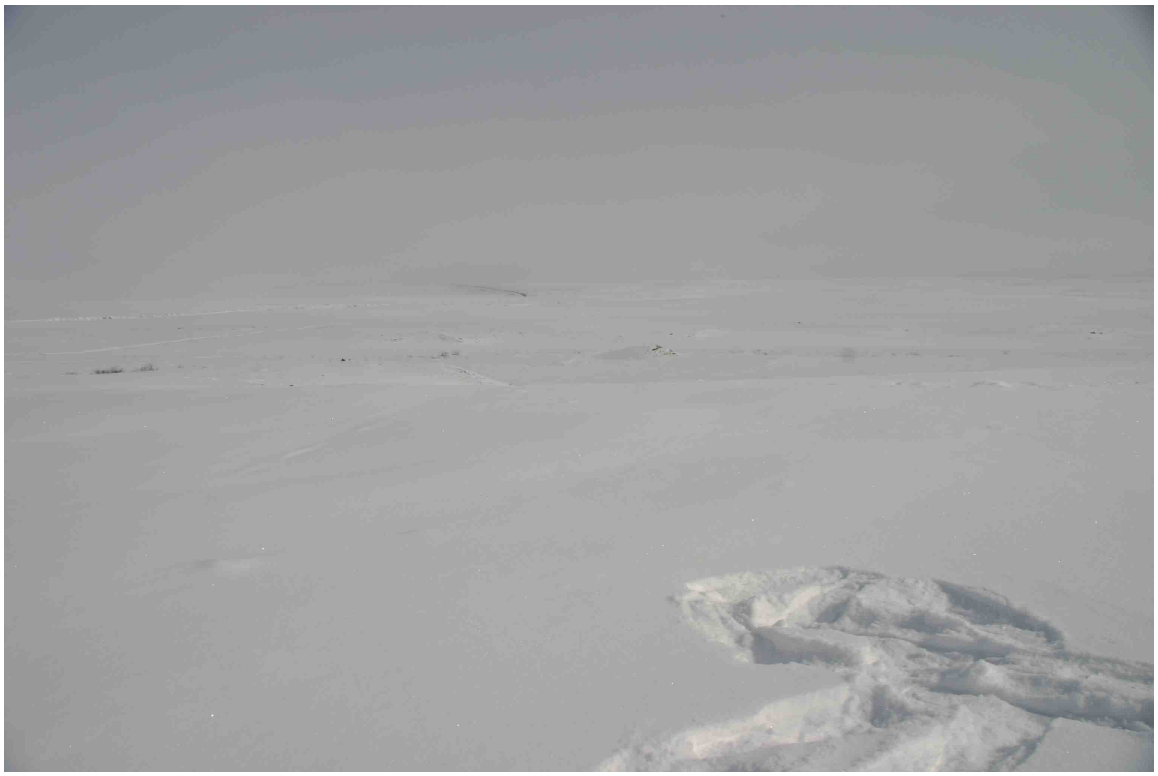


Figure 13. Looking east from the Toolik Field Station site 2.



Figure 14. Looking south from the Toolik Field Station site 2.



Figure 15. Looking southwest from the Toolik Field Station site 2.



Figure 16. Looking west from the Toolik Field Station site 2.



Figure 17. Looking northwest from the Toolik Field Station site 1.



Figure 18. Looking north from the Toolik Field Station site 2.

Supplemental Facilities

Meteorology

Toolik Field Station has been the base for meteorological measurements for much of its incarnation. For example, the Toolik Lake Main Weather Station has been collecting data since 1988. Figures 19 and 20 show some of the meteorological instrumentation available at the field station. This data is available on the web at: http://ecosystems.mbl.edu/ARC/.



Figure 19. Meteorological station at the Toolik Field Station.



Figure 20. Additional meteorological equipment at the Toolik Field Station.

Laboratory Facilities

The Toolik Field Station was established as a base for scientists to conduct ecological research. Therefore, the field station contains extensive laboratory space. This clean laboratory space could be used for sampler maintenance and trouble-shooting should the need arise. Figures 21-24 show laboratory space and buildings.



Figure 21. Inside of a laboratory at the Toolik Field Station.



Figure 22. Another view of laboratory space at the Toolik Field Station.



Figure 23. A laboratory building at the Toolik Field Station.



Figure 24. Additional laboratory buildings at the Toolik Field Station.

Emissions Sources



Figure 25. Generators at the Toolik Field Station.



Figure 26. The incinerator at the Toolik Field Station. Note: the emissions are not representative of normal incinerator operation; the unit was undergoing maintenance.



Figure 27. Incinerator plume from a distance. Note: the emissions are not representative of normal incinerator operation; the unit was undergoing maintenance.

NPS Siting Criteria for Each Network for the Toolik Field Station sites

Critical Site Criteria Applicable for All Monitoring Programs

- Year round site accessibility - Yes, supporting letter attached.

- Availability of a power supply nearby - Yes, will install above ground insulated cable from Toolik Lake LTER.

- Open space away from obstructions - Yes.

- Security from vandalism or damage due to animals - Yes.

- Proximity to a nearby town - 150 miles from Deadhorse, 100 miles from Wiseman, 330 m away from Toolik Field Station.

- Aesthetically pleasing and blending in with the surrounding environment - Not visible from Dalton Highway.

Logistical Questions/Site Documentation for All Selected Sites

- Is the site operator reliable, dedicated, and adequately trained? Yes, see three tiered description in the operational plan.

- What are the operator's name, mailing address, telephone number, and e-mail address? See attachment.

- Is there a trained alternate to the site operator? Yes, see attachment.

- Will the site operator be able to perform routine maintenance duties weekly? Yes, see attachment.

- Have the Universal Transverse Mercator (UTM) coordinates been provided? Yes.

- Is there a general description of the proposed site with its location on a map? Yes, see above and figures 2 and 4.

- Is a topographical map available of the general site area? Yes.

- Is a diagram of the site area available? Yes, see figures 2 and 4.

- Are there photographs showing the perspective site in the 4 cardinal directions? Yes, see attached photos.

- Is ground cover displayed in the photographs? Yes, see figures 6-27 for September through May/June ground cover and figure 1 for the summertime ground cover.

- Are there photographs of nearby air quality or meteorological monitoring equipment? Yes, see figures 19 and 20.

- Have vegetation, trees, buildings, and surrounding activities been identified? Yes, see photos and maps above.

- Who are the contact persons should problems arise during site operation? Diane Sanzone (Park Contact), ARS (equipment operations), Chad Diesinger (Supervisor, Toolik Field Station) and Scott Houghton (Manager, Toolik Field Station).

- Is there a photograph of the projected power source in relation to the proposed site? Yes, see attached photos of generators (figure 25) and maps.

- How will all sampler changes be documented (e.g., orientation, elevation, moves)? Reevaluation of site criteria.

IMPROVE/CASTNet Site Selection Criteria

On-Site Criteria

- Unrestricted air flow arc is ≥ 270° - Yes, 360°.
- Predominant wind direction is within the 270° arc - Yes.
- Obstacles to wind ≥ 10 times the obstacle height from sampler - None.
- Distance from sampler to obstacle ≥ 2 times height protruding above sampler - No obstacles, no barriers.
- Solid barriers within 10 meters (33 feet) of sampler must be ≥ 1 meter below inlet - No obstacles, no barriers.
- Sampler inlet is about 3.5 meters (11 feet) above bottom of shelter -ARS installation will account for this.
- Locate sampler ≥ 50 meters (165 feet) from tree line - > 50 miles north of treeline.
- ≤ 2 feet vegetative height within 10 meters of sampler - Yes, tundra.
- Site elevation is between highest and lowest elevations within nearest Class I area - N/A
- Approval needed to clear land for site installation? Yes, BLM.

Local Criteria

- 20 to 40 km (12.2 to 24.4 miles) from large point sources of air pollution - 150 miles south of Prudoe Bay (the largest point source in the region)
- ≥ 500 meters (1,650 feet) from heavily traveled roadways - Yes, at least 1000 m from the Dalton Highway.
- ≥ 2 km (1.2 miles) from major highways, airports, navigable waterways, and rail yards - Yes.
- ≥ 200 meters (660 feet) from lightly traveled roads - Yes.
- ≥ 500 meters from intensive agricultural operations - Yes.

- ≥ 200 meters from large parking lots Yes.
- ≥ 100 meters from small parking lots Yes.

Regional Criteria

- Site must be representative of the air mass to be monitored - Yes.
- Site must be representative of regional, not local visibility - Yes.
- ≤ 100 km (61 miles) from a Class I area - No.
- ≥ 40 km from cities with > 50,000 population - Yes.
- ≥ 10 km (6.1 miles) from cities with 10,000 to 50,000 population - Yes.
- ≥ 5 km (3.1 miles) from locations with 1,000 to 10,000 population - Yes.

NADP/NTN/MDN Site Selection Criteria

On-Site Criteria

- Naturally vegetated, level areas preferred, but grassed areas with slopes ≤ 15% OK - Naturally vegetated, level, tundra.
- Similar ground cover surrounds collector for ≥ 30 meters (100 feet) - Yes.
- ≤ 2 feet vegetative height within 10 meters (33 feet) of the collector -Yes.
- Undisturbed land with no agricultural tillage or crops on site - Yes.
- No objects projecting onto the collector with an angle > 30° from the horizontal - Yes.
- Distance from sampler to obstacle ≥ 2 times obstacle height - No obstacles.
- ≥ 20 meters (66 feet) vegetated buffer strip surrounding the collector in farm areas - No farm areas.
- Collector and rain gage located in an area representative of the region - Yes.
- ≥ 5 meters (16 feet) separation but ≤ 30 meters between the collector and rain gauge -ARS installation will meet this criteria.

- ≤ 1 foot height difference between the rain gage orifice and collector orifice - ARS installation will meet this criteria.

- 1 meter (3.3 feet) collector height on its aluminum base - ARS installation will meet this criteria.

- Objects ≥ 1 meter high that deflect wind are located ≥ 5 meters from collector or rain gauge - ARS installation will meet this criteria.

- Distance from collector and rain gage ≥ 2 times height of nearest residential buildings - 400 m from nearest structures.

- Residential structures ≤ 30 meters from collector must be located outside 30° cone of prevalent wind direction - N/A

- Install collector and rain gage on a platform no higher than maximum anticipated snowpack depth (if average annual snowfall > 20 inches) - ARS installation will meet this criteria.

- Approval needed to clear land for site installation? Yes, BLM.

Local Criteria

- Collector ≥ 100 meters from moving sources of air pollution (e.g., air, ground, or water traffic) - Yes.

- Collector ≥ 100 meters from grazing animals or pasture used by livestock - Yes.

- Collector ≥ 500 meters (1,650 feet) from feedlots, dairy barns, etc. that house animals - Yes.

- Collector ≥ 100 meters from surface storage of agriculture products, fuels, or vehicles - Yes.

- Collector ≥ 100 meters from parking lots, maintenance yards, roads, or railways - Yes.

- Collector ≥ 30 meters from residential structures, laboratories, or other buildings - Yes.

Regional Criteria

- Collector ≥ 10 km (6.1 miles) from industrial operations if sources not located upwind - Yes.

- Collector ≥ 20 km (12.2 miles) from industrial operations if sources located upwind -Yes.

- Collector ≥ 10 km from 10,000 – 75,000 population area if city is not located upwind -Yes.

- Collector ≥ 20 km from 10,000 – 75,000 population area if city is located upwind - Yes.

- Collector ≥ 20 km from >75,000 population area if city is not located upwind - Yes.

- Collector ≥ 40 km (24.4 miles) from >75,000 population area if city is located upwind - Yes.

- Collector ≥ 50 km (30.5 miles) from unlimited sources or population areas - Yes.

Meteorological Monitoring Station Site Selection Criteria

On-Site Criteria

- Standard exposure height of wind instruments is 10 meters (33 feet) - ARS installation will meet this criteria.

- ≥10 times the distance between the instruments and any obstruction - ARS installation will meet this criteria.

- Mount wind instruments on booms at 90° to the predominant wind direction (for up-valley and down-valley flows) - ARS installation will meet this criteria.

- Vertical heights for measuring temperature difference are 2 meters (6.6 feet) and 10 meters - ARS installation will meet this criteria.

- Site elevation is between the highest and lowest elevations within nearest Class I area - N/A

- Ventilate instruments with aspirated shields - ARS installation will meet this criteria.

- Temperature sensors located at a distance ≥ 4 times the height of any obstruction - No obstacles.

- Temperature sensors located ≥ 30 meters (100 feet) from large paved areas - Yes.

- Heat rain gages to properly measure frozen precipitation - ARS installation will meet this criteria.

- Locate rain gages on level ground so the mouth is horizontal to the sky - ARS installation will meet this criteria.

- Use wind shields where significant snowfall occurs - ARS installation will meet this criteria.

- Locate pyranometers (measures incoming solar radiation) where no shadows are cast -ARS installation will meet this criteria.

- Pyranometers have an unrestricted view of the sky from all directions in all seasons - ARS installation will meet this criteria.

- Approval needed to clear land for site installation? Yes, BLM.

Local Criteria

- ≥ 500 meters (1,650 feet) from heavily traveled roadways - Yes.

- ≥ 2 km (1.2 miles) from major highways, airports, navigable waterways, and rail yards - Yes.

- ≥ 200 meters (660 feet) from large parking lots - Yes.

- ≥ 500 meters from intensive agricultural operations - Yes.

- ≥ 100 meters from small parking lots - Yes.

- ≥ 200 meters from grazing animals or range used by livestock - Yes.

Regional Criteria

- Site must be representative of the air mass to be monitored - Yes.

- Site must be representative of regional, not local meteorological conditions - Yes.

Bettles

Overview

Bettles is a small town (winter population of 8 in 2006) located south of the Brooks Range (latitude and longitude: 66.906N and -151.683W; elevation: 630 feet.) on the Koyukuk River. According to the most recent census, the population is 76.7% White and

18.6% Alaskan Native with an average age of 31 years. The average income for the population is $49,375. The town's major employers are government and tourism. The town is used as a base for tourists entering Gates of the Arctic National Park and National Park Service staff responsible for overseeing the Arctic National Parks. The town contains a power generating station, an airport, hotels, residential areas, etc.

The predominant winds in Bettles are from the north northwest (Figure 28).

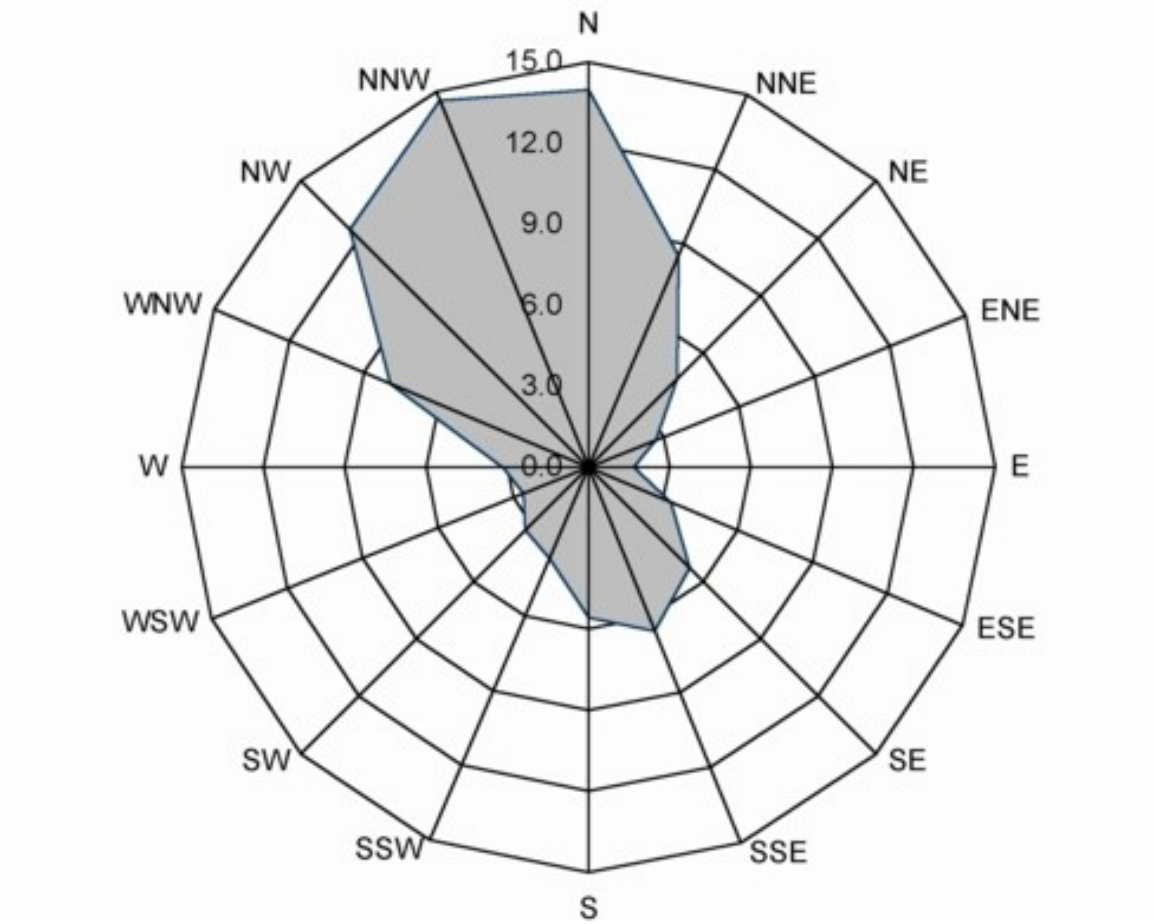


Figure 28. Percentage of time wind comes from a specific direction at the Bettles Field airport. Figure from the Alaska Climate Research Center (http://climate.gi.alaska.edu/Climate/Wind/Direction/Bettles/BTT.html).

Siting

We have identified two suitable sites, one site (site 1: 66.93107 N 151.49280 W) south of Bettles approximately 2000 m from the south end of the airport runway (Figure 29) and one site (site 2: 66.89327 N 151.56376 W) to the north of Bettles approximately 1600 m from the Bettles power generator (66.92323 N 151.50720 W). Site 1 is a cleared area in a mixed spruce-hard wood forest. It is located at the end of a gravel road used to access Bettles South Base Radio Towers. Site 2 is located on dry phrostrate-shrub fruticose-lichen taiga (black spruce). It is located approximately 100 m east of a very lightly used

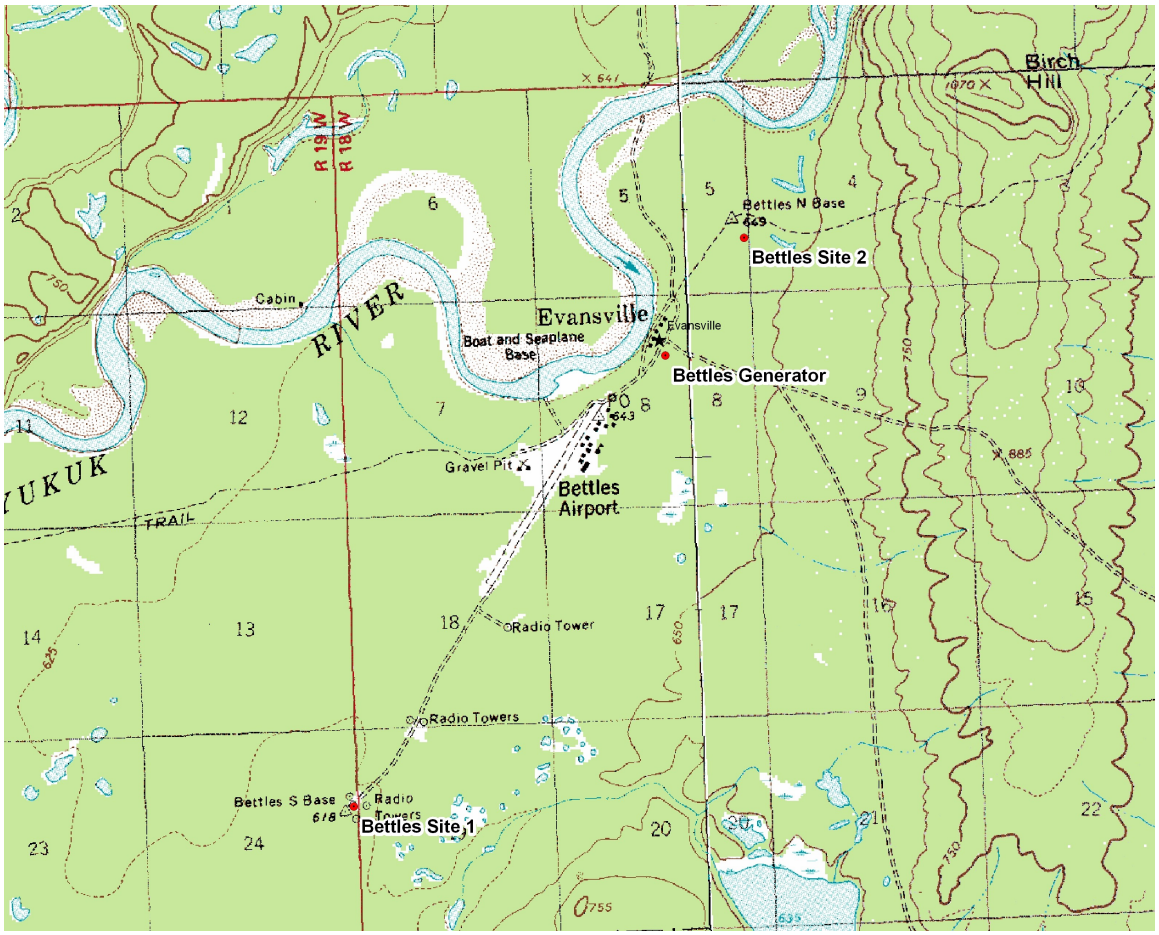


Figure 29. Topographic map of Bettles showing the location of the potential long-term air quality monitoring sites.

dead-end gravel road, approximately 30 m from a bladed trail/firebreak and contiguous to a BLM lightning detection site. Both sites have power according to Alaska Power and Telephone and site 2 has telephone access. Both sites have year-round access and will have operators on site capable of routine sampler maintenance. Both sites exceed the National Park Service siting criteria for all proposed network operations (see attached siting criteria lists for each network). Of the two sites, site 2 is preferable due to the limited access (cannot be reached by truck), distance from sources, not being close to a shooting range, prevailing winds being from the north (town should not influence the site on a regular basis) and telephone access. However, site 2 will require minor site clearing to meet the siting criteria. Backup operators in Fairbanks can access these sites by aircraft all year round. There is an ice road in winter some years but closure is common. The winter ice road is not a feasible means for back up operators to access the sites.

Site 2 (Preferred Site) Photos

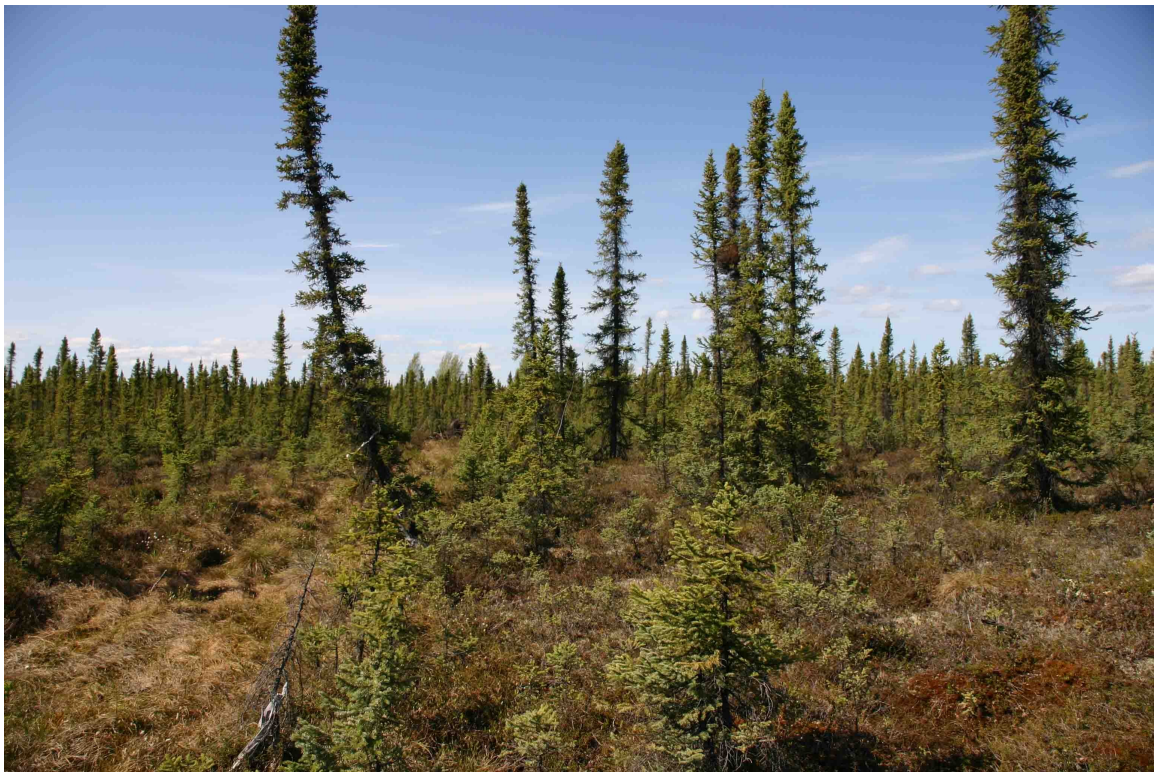


Figure 30. Looking north from Bettles site 2 (the preferred site).

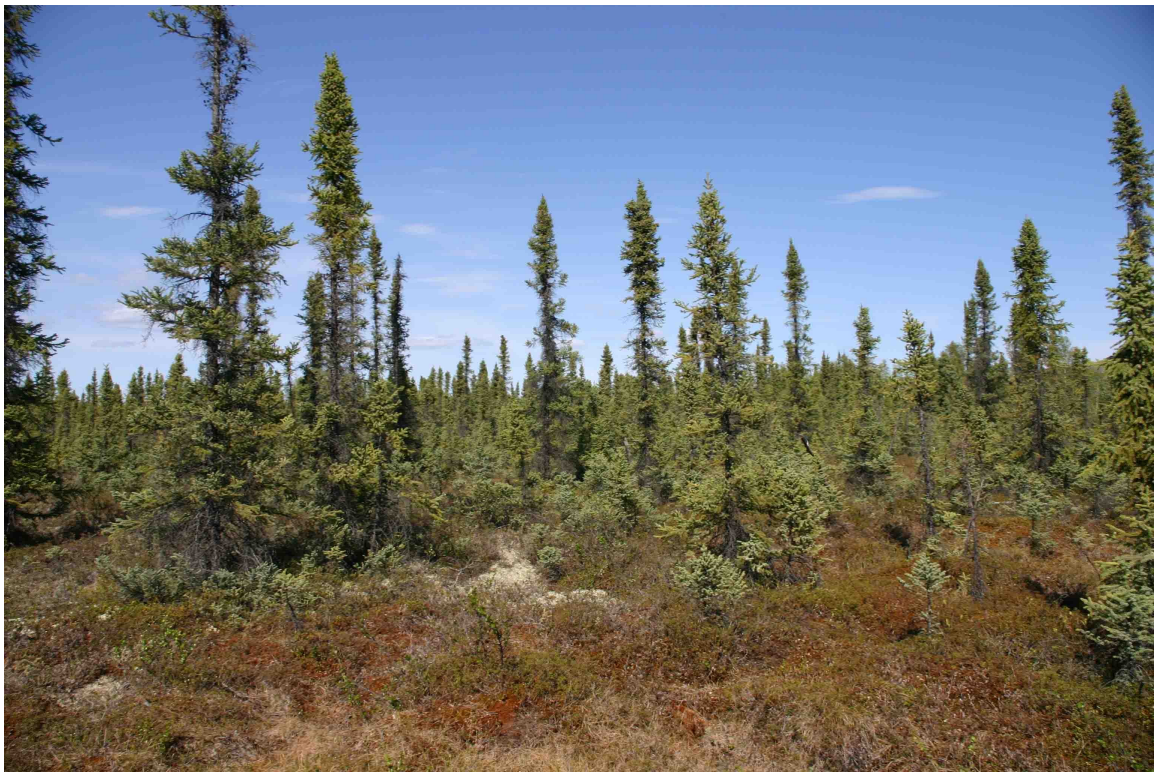


Figure 31. Looking northeast from Bettles site 2.

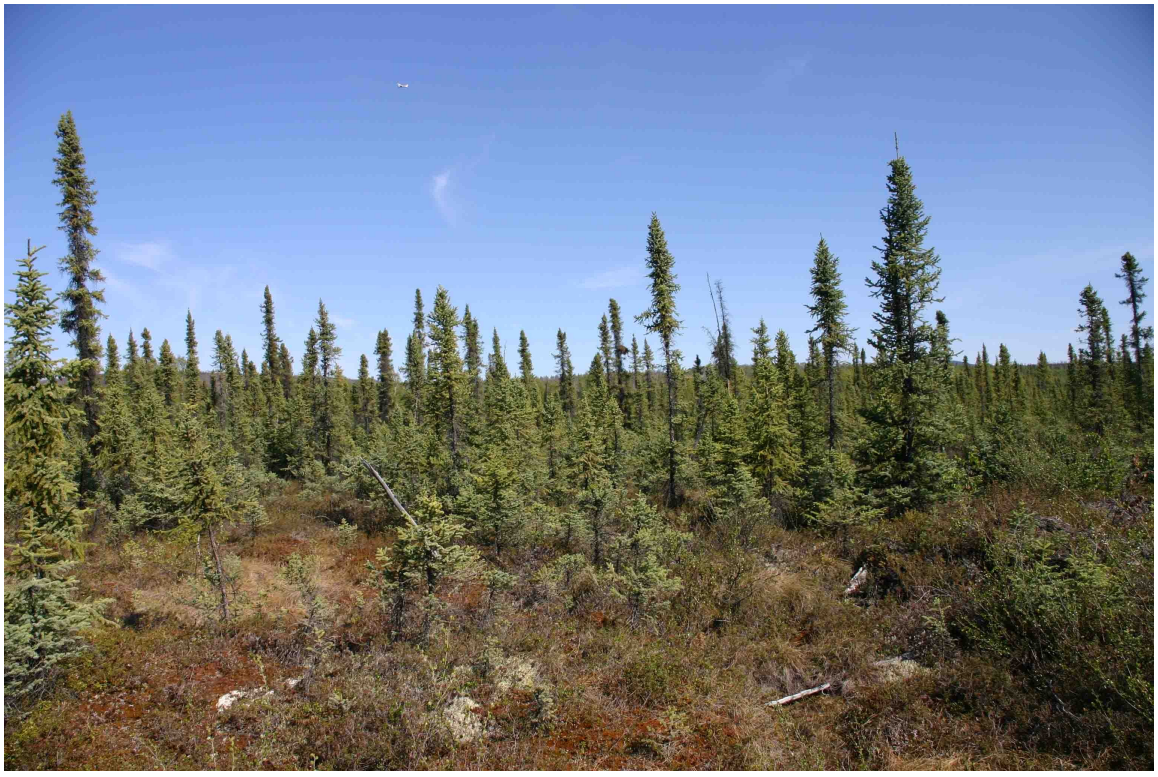


Figure 32. Looking southeast from Bettles site 2.



Figure 33. Looking south from Bettles site 2.



Figure 34. Looking southwest from Bettles site 2 (Note the BLM lightning detector).



Figure 35. Looking southwest from Bettles site 2.



Figure 36. Looking west from Bettles site 2.



Figure 37. Looking northwest from Bettles site 2.

Site 1 (Second Preference in Bettles) Photos



Figure 38. Looking northeast from Bettles site 1.



Figure 39. Looking east from Bettles site 1.



Figure 40. Looking southeast from Bettles site 1.



Figure 41. Looking southwest from Bettles site 1.



Figure 42. Looking west from Bettles site 1.



Figure 43. Looking northwest from Bettles site 1.



Figure 44. Looking north from Bettles site 1.

Supplemental Facilities

Meteorological

Bettles collects meteorological data at its airport, Bettles Field (figures 45 and 46). This data will put the meteorological data collected by the long-term monitoring site in context of the town's historical meteorological record.



Figure 45. Meteorological instrumentation at Bettles Field.



Figure 46. Additional meteorological instrumentation at Bettles Field.

Emission Sources



Figure 47. The power generating station in Bettles.

NPS Siting Criteria for Each Network for the Bettles sites

<u>Critical Site Criteria Applicable for All Monitoring Programs</u>

- Year round site accessibility - Yes.
- Availability of a power supply nearby - Yes.
- Open space away from obstructions - Yes, some small trees may need to be removed.
- Security from vandalism or damage due to animals - Locals believe damage due to humans is unlikely.
- Proximity to a nearby town - 2 km on site 2 and 1 km site 1 from a village of population 42.
- Aesthetically pleasing and blending in with the surrounding environment – N/A

Logistical Questions/Site Documentation for All Selected Sites

- Is the site operator reliable, dedicated, and adequately trained? Yes, see three tiered description in the operational plan.

- What are the operator's name, mailing address, telephone number, and e-mail address? See attachment.

- Is there a trained alternate to the site operator? Yes, see attachment.

- Will the site operator be able to perform routine maintenance duties weekly? Yes, see attachment.

- Have the Universal Transverse Mercator (UTM) coordinates been provided? Yes.

- Is there a general description of the proposed site with its location on a map? Yes, see above and figure 29.

- Is a topographical map available of the general site area? Yes, see figure 29.

- Is a diagram of the site area available? Yes, see figure 29.

- Are there photographs showing the perspective site in the 4 cardinal directions? Yes, see figures 30-44.

- Is ground cover displayed in the photographs? Yes, see attached photos (figures 30-44) for May through September ground cover.

- Are there photographs of nearby air quality or meteorological monitoring equipment? Yes, see figures 45 and 46.

- Have vegetation, trees, buildings, and surrounding activities been identified? Yes, see descriptions above and figures 30-44.

- Who are the contact persons should problems arise during site operation? Diane Sanzone (Park Contact), ARS (equipment operations), Gary Youngblood (Park Superintendent in Bettles).

- Is there a photograph of the projected power source in relation to the proposed site? Yes, see attached photos and maps (figures 29 and 47).

- How will all sampler changes be documented (e.g., orientation, elevation, moves)? Reevaluation of site criteria.

IMPROVE/CASTNet Site Selection Criteria

On-Site Criteria

- Unrestricted air flow arc is ≥ 270° - Yes
- Predominant wind direction is within the 270° arc - Yes
- Obstacles to wind ≥ 10 times the obstacle height from sampler - Yes
- Distance from sampler to obstacle ≥ 2 times height protruding above sampler – 1 km
- Solid barriers within 10 meters (33 feet) of sampler must be ≥ 1 meter below inlet – ARS installation will address this.
- Sampler inlet is about 3.5 meters (11 feet) above bottom of shelter– ARS installation will address this.
- Locate sampler ≥ 50 meters (165 feet) from tree line – Yes at site 1. No, but very small trees at site 2 (see figures 30-37).
- ≤ 2 feet vegetative height within 10 meters of sampler –Yes at site 1. No at site 2, but minor clearing required.
- Site elevation is between highest and lowest elevations within nearest Class I area – N/A
- Approval needed to clear land for site installation? – Yes, Evansville Native Corporation (site 1) or FAA (site 2) depending site selected.

Local Criteria

- 20 to 40 km (12.2 to 24.4 miles) from large point sources of air pollution - Yes
- ≥ 500 meters (1,650 feet) from heavily traveled roadways - Yes
- ≥ 2 km (1.2 miles) from major highways, airports, navigable waterways, and rail yards - Yes
- ≥ 200 meters (660 feet) from lightly traveled roads - Yes
- ≥ 500 meters from intensive agricultural operations - Yes

- ≥ 200 meters from large parking lots - Yes
- ≥ 100 meters from small parking lots - Yes

Regional Criteria

- Site must be representative of the air mass to be monitored - Yes
- Site must be representative of regional, not local visibility - Yes
- ≤ 100 km (61 miles) from a Class I area - No
- ≥ 40 km from cities with > 50,000 population - Yes
- ≥ 10 km (6.1 miles) from cities with 10,000 to 50,000 population - Yes
- ≥ 5 km (3.1 miles) from locations with 1,000 to 10,000 population - Yes

NADP/NTN/MDN Site Selection Criteria

On-Site Criteria

- Naturally vegetated, level areas preferred, but grassed areas with slopes ≤ 15% OK -Naturally vegetated, taiga (site 1) and mixed spruce-hardwood (site 2).
- Similar ground cover surrounds collector for ≥ 30 meters (100 feet) -Yes.
- ≤ 2 feet vegetative height within 10 meters (33 feet) of the collector - Yes for site 1, minor clearing required for site 2.
- Undisturbed land with no agricultural tillage or crops on site - Yes.
- No objects projecting onto the collector with an angle > 30° from the horizontal - Yes.
- Distance from sampler to obstacle ≥ 2 times obstacle height - Site 2 minor clearing required and site 1 has high open tower nearby.
- ≥ 20 meters (66 feet) vegetated buffer strip surrounding the collector in farm areas - No farm areas.
- Collector and rain gauge located in an area representative of the region - Yes.
- ≥ 5 meters (16 feet) separation but ≤ 30 meters between the collector and rain gauge - ARS installation will meet this criteria.

- ≤ 1 foot height difference between the rain gage orifice and collector orifice - ARS installation will meet this criteria.

- 1 meter (3.3 feet) collector height on its aluminum base - ARS installation will meet this criteria.

- Objects ≥ 1 meter high that deflect wind are located ≥ 5 meters from collector or rain gauge - ARS installation will meet this criteria.

- Distance from collector and rain gage ≥ 2 times height of nearest residential buildings - Yes.

- Residential structures ≤ 30 meters from collector must be located outside 30° cone of prevalent wind direction - N/A

- Install collector and rain gage on a platform no higher than maximum anticipated snowpack depth (if average annual snowfall > 20 inches) - ARS installation will meet this criteria.

- Approval needed to clear land for site installation? Yes Evansville Native Corporation (site 1) or FAA (site 2) depending site selected.

Local Criteria

- Collector ≥ 100 meters from moving sources of air pollution (e.g., air, ground, or water traffic) - Yes for site 2, no for site 1 (very lightly used road).

- Collector ≥ 100 meters from grazing animals or pasture used by livestock - Yes.

- Collector ≥ 500 meters (1,650 feet) from feedlots, dairy barns, etc. that house animals - Yes.

- Collector ≥ 100 meters from surface storage of agriculture products, fuels, or vehicles -Yes.

- Collector ≥ 100 meters from parking lots, maintenance yards, roads, or railways - Yes for site 2, no for site 1 (very lightly used road).

- Collector ≥ 30 meters from residential structures, laboratories, or other buildings - Yes.

Regional Criteria

- Collector ≥ 10 km (6.1 miles) from industrial operations if sources not located upwind - Yes.

- Collector ≥ 20 km (12.2 miles) from industrial operations if sources located upwind -Yes.

- Collector ≥ 10 km from 10,000 – 75,000 population area if city is not located upwind -Yes.

- Collector ≥ 20 km from 10,000 – 75,000 population area if city is located upwind - Yes.

- Collector ≥ 20 km from >75,000 population area if city is not located upwind - Yes.

- Collector ≥ 40 km (24.4 miles) from >75,000 population area if city is located upwind - Yes.

- Collector ≥ 50 km (30.5 miles) from unlimited sources or population areas - Yes.

Meteorological Monitoring Station Site Selection Criteria

On-Site Criteria

- Standard exposure height of wind instruments is 10 meters (33 feet) - ARS installation will meet this criteria.

- ≥10 times the distance between the instruments and any obstruction - ARS installation will meet this criteria.

- Mount wind instruments on booms at 90° to the predominant wind direction (for up-valley and down-valley flows) ARS installation will meet this criteria.

- Vertical heights for measuring temperature difference are 2 meters (6.6 feet) and 10 meters - ARS installation will meet this criteria.

- Site elevation is between the highest and lowest elevations within nearest Class I area - N/A

- Ventilate instruments with aspirated shields - ARS installation will meet this criteria.

- Temperature sensors located at a distance ≥ 4 times the height of any obstruction - ARS installation will meet this criteria.

- Temperature sensors located ≥ 30 meters (100 feet) from large paved areas - Yes.

- Heat rain gages to properly measure frozen precipitation - ARS installation will meet this criteria.

- Locate rain gages on level ground so the mouth is horizontal to the sky - ARS installation will meet this criteria.

- Use wind shields where significant snowfall occurs - ARS installation will meet this criteria.

- Locate pyranometers (measures incoming solar radiation) where no shadows are cast - ARS installation will meet this criteria.

- Pyranometers have an unrestricted view of the sky from all directions in all seasons - ARS installation will meet this criteria.

- Approval needed to clear land for site installation? Yes Evansville Native Corporation (site 1) or FAA (site 2) depending site selected.

Local Criteria

- $\geq$ 500 meters (1,650 feet) from heavily traveled roadways - Yes.

- $\geq$ 2 km (1.2 miles) from major highways, airports, navigable waterways, and rail yards - Yes.

- $\geq$ 200 meters (660 feet) from large parking lots - Yes.

- $\geq$ 500 meters from intensive agricultural operations - Yes.

- $\geq$ 100 meters from small parking lots - Yes.

- $\geq$ 200 meters from grazing animals or range used by livestock - Yes.

Regional Criteria

- Site must be representative of the air mass to be monitored - Yes.

- Site must be representative of regional, not local meteorological conditions - Yes.

Anaktuvuk Pass

Overview

Anaktuvuk Pass is small town (population 274 in 2003) located in a pass in the northern part of the Brooks Range (latitude and longitude: 68.143N and -151.735W; elevation:

2,175 feet). The town's population is 87.6% Native Alaskan and 9.6% White, with an average age of 29 years. The median household income is $52,500.

Siting

We have examined Anaktuvuk Pass and found it to be unsuitable for a long-term air monitoring site. The town lies in the center of a valley, with exposed tundra lying in all directions (see figures 48-55). The winds through the pass run along the valley (either from the NE or the SW depending on the season as determined by the meteorological station shown in figure 56). The power generator lies to the south of town, along the airstrip, while a gravel mining operation and the town dump/incineration area are to the north of town (figures 57-58). Trash burning (see figure 59), dust and aircraft exhaust from the airstrip running along the town, vehicle exhaust, emissions from home heating (mainly fuel oil) and dust from vehicles are potentially significant sources of emissions in town. If the site was located upslope to the northwest of town (the preferred siting if we had to locate an instrument at Anaktuvuk Pass), it would still receive emissions from the town when the wind switched from a predominant northeasterly flow to a southwesterly flow. The site would be very exposed wherever it was located. We feel the potential for vandalism is high. Power is available throughout town, but a line would need to be run to the site. Given the monitoring network siting criteria, this would be a fair distance since the power lines do not extend beyond the nearest residential structures. The town currently does not have any long-term, qualified operators or full time park service personnel and may suffer from the same operator issues as the Ambler site. In summary, we find this site unacceptable.

Photos



Figure 48. Looking north from the Anaktuvuk Pass museum (west side of town).



Figure 49. Looking northeast from the Anaktuvuk Pass museum.



Figure 50. Looking east from the Anaktuvuk Pass museum.



Figure 51. Looking southeast from the Anaktuvuk Pass museum.



Figure 52. Looking south from the Anaktuvuk Pass museum.



Figure 53. Looking southwest from the Anaktuvuk Pass museum.



Figure 54. Looking west from the Anaktuvuk Pass museum.



Figure 55. Looking east from the northeast corner of town (near the last power pole).

Meteorological Instrumentation



Figure 56. Meteorological equipment at the Anaktuvuk pass airport.

Emission Sources



Figure 57. The last power pole and the gravel mine on the northeast side of Anaktuvuk Pass.



Figure 58. The Anaktuvuk Pass power plant.



Figure 59. Local burning in Anaktuvuk Pass.

CONCLUSIONS:

Both the Toolik Field Station and Bettles offer sites that meet the National Park Service siting criteria and are appropriate for long-term air quality monitoring. Both can be reached year-round from Fairbanks, although the Toolik Field Station is more accessible due to its road access. This allows trained personnel in Fairbanks to serve as back-up operators or service the samplers in case of an emergency; this capability provides yet another level of operator redundancy and will help ensure a continuous sampling record. Anaktuvuk Pass is not a suitable location for a long-term air quality sampling site due to the large number of local emission sources surrounding the potential sites, the lack of qualified operators and the high potential for vandalism.

Given that sites at both Bettles and the Toolik Field Station are acceptable locations for the monitoring site, the key factors that differentiate between the sites are science and logistical concerns. A station at the Toolik Field Station will receive Arctic air masses more frequently than the site at Bettles and will be more representative of the air impacting the Arctic National Parks from the north. It would be the only National Park Service air monitoring site in the Arctic and north of the Brooks Range. The Bettles site is between the Brooks and Alaska Ranges and should receive air masses that are closer in origin to those received at the Denali Headquarters site, which is on the north side of the Alaska Range and also south of the Brooks Range. In addition, the long and continuing history of research at the Toolik Field Station means that the air quality measurements obtained from this long-term monitoring site can be put into a long-term research/climate context and that the operators are familiar with the importance of maintaining continuous scientific records. Also, the measurements made by the long-term monitoring site, if it is located at the Toolik Field Station, will be used by the scientists conducting research at the field station to interpret their results. If the monitoring site is located at Bettles, which has a very limited research agenda, the use of the data collected by the site will be more limited.

In addition, there are logistical concerns with Bettles. It may not be reachable except by aircraft during winter and may not have the staff available to consistently collect the samples.

The above reasons lead us to recommend the Toolik Field Station for the installation of the long-term air quality monitoring site.

If the Toolik Field Station is selected as the preferred site for the long-term air quality monitoring site, we recommend that the site be installed at site 1. Site 1 is preferable to site 2 because it is farther from and not visible from the Dalton Highway, is farther from and less visible from the Toolik Field Station and it does not require power to be run across a stream and up a hill.

If Bettles is selected as the preferred site for the long-term air quality monitoring site, we recommend that the site be installed at site 2. Site 2 is preferable to site 1 because it is accessed by a lightly traveled road and a short hike, instead of on a more frequently

traveled road, is not near a shooting range, is upwind of the town and has power and telephone at the site (due to the location of a BLM lightning detector on the site).

APPENDIX 1: Potential Site Operation Staffing Plan:

Oversight 1: Air Resources Division will oversee the interagency air quality site in the Arctic

Tier 1: ARS will maintain equipment and report findings directly to ARD

Tier 2: ARS will keep the Arctic Network Coordinator informed of problems with the site

Oversight 2 (local): The Arctic Network Coordinator will oversee local operations and report back to ARD.

Tier 1 Operators: Toolik Field Station Technicians (2) will be trained as site operator and backup operator, respectively. Technicians will report directly to the Toolik Field Station Manager and the NPS Arctic Network Coordinator for AQ Site Operations (25% of duties).

Tier 2 Operators (back up): Arctic Network staff (2 trained staff members) will serve as backup operators and report directly to the Arctic Network Coordinator.

Tier 3 Operators (secondary back up operators): Dr. Cathy Cahill (UAF) and her graduate students will serve as backup operators if the case arises that neither Toolik Field Station Operators or ARCN staff are available to serve as backup operators.