January 11, 2019

Nicole Hayes
Attn: Coastal Plain Oil & Gas Leasing Program EIS
222 West 7th Ave., Stop. #13
Anchorage, Alaska 99513

Submitted via U. S. Mail, including thumb drive.

Comments on Draft EIS for Coastal Plain Oil and Gas Leasing Program

Dear Ms. Hayes,

Please accept these comments on the draft EIS for the Coastal Plain Oil and Gas Leasing Program as well as the attached visibility analysis and fully consider them as you develop a final EIS and decision.

I. Introduction, Interests, & Qualifications

I have an abiding interest in natural resources, particularly regarding public land. I have been aware of the controversies facing the 1002 Area of the Arctic National Wildlife Refuge for some time. Based on my curiosity about the area, I traveled to Alaska's Arctic Coastal Plain in 2016, where I spent five days in Kaktovik. During that trip I was exposed to the land, its resources, and the people who call it home. I found the Coastal Plain to be a place of sublime superlatives, where things are as they should be, and as they have been for millennia.

On the return trip from Kaktovik I passed through Deadhorse, where I experienced the Industrial Arctic and witnessed the environmental cost of our incessant quest for cheaper oil and "maximized shareholder return." The transformation from Kaktovik's contemplatively quiet surroundings to the clanging industrial zone stretching to the horizon that is today's Prudhoe Bay was heartbreaking. I perceived this as the contrast between The Shire and Mordor that J. R. R. Tolkien was trying to warn us about in *The Lord of the Rings*. If nothing else, Prudhoe Bay has shown us that there is no middle ground; the scars will remain forever once the oil runs out and we look for the next vista to despoil.

Thus my concern that the BLM is developing an oil and gas leasing program for the Refuge's Coastal Plain. Based on my experience there and knowledge of the area, one of the many significant adverse impacts associated with oil and gas development of the Coastal Plain will be degradation of the area's exceptional wilderness, aesthetic, and recreational values. I am concerned about these impacts and wanted to understand their likely extent and severity. I have considerable experience with geo-spatial technologies and their application to natural resource management and, seeing that the DEIS fails to include such an essential analysis, I decided to perform a Geographic Information Systems (GIS) visibility analysis of how oil and gas development infrastructure would likely impact visual resources throughout the Coastal Plain and from the Wilderness to the south. The final EIS must include such an analysis in order to adequately consider the potential environmental impacts of the program.

Given my interest in and concern with potential development of the Coastal Plain and the lack of a visibility analysis in the draft EIS, I have made these comments and the data resulting from my visibility analysis available to other interested members of the public on my website at *www.truenorthgis.net* and shared it with interested friends and colleagues.

I am highly qualified to design and perform such a visibility analysis of the Coastal Plain area because I have been involved in the collection, analysis, and display of geo-spatial data for 31 years, focusing on natural resource topics. After receiving a Ph. D. (University of Nebraska, 1986) in Plant Ecology, I have held a variety of GIS-related positions as research scientist, analyst, program manager, and business owner, as follows:

2003 to date, GIS Business Proprietor, True North GIS, LLC

I started and own True North GIS, LLC, a full-service spatial analysis and consulting firm. Clients include:

Alaska Bird Observatory
Kenmore Air
Marine Mammal Research Consultants
Renewable Resources Coalition
The Wilderness Society
Trout Unlimited
Trustees for Alaska
University of California, Davis
Washington State Department of Archaeology and Historic Preservation

2014-2018 (Seasonal), GIS Analyst, Washington State Department of Transportation (WSDOT)

WSDOT recruited me to assist their Environmental Services Office with several complex data collection and analysis projects. This work involves analyzing a variety of vector- and raster-based datasets, providing the agency with answers and guidance regarding critical plant and wildlife habitat, wetland delineation, soils display, and wildlife migration corridors.

2002 - 2003, GIS Contractor, University of California, Davis, California

I provided contract GIS support to the Ecology and Evolution Department as part of a National Science Foundation-supported research project investigating the spread of an exotic plant species. This support involved GIS programming, analysis, and map production. I also supplied advice for analysis methodology.

2002, GIS Contractor, Northwest Crime and Social Research, Inc., Olympia, Washington

I provided GIS support in the development of a web-based crime analysis and reporting application for the City of Seattle. The contract required that I assemble a wide variety of tabular and spatial data from multiple jurisdictions into a single project framework, program routines to display a variety of maps, and perform geocoding analysis that explored city-wide crime trends and projections.

2001, GIS Contractor, Thurston Regional Planning Council, Olympia, Washington

I provided contract GIS support to the Thurston Regional Planning Council. This support involved GIS programming, analysis, and map production.

1996 - 2000, GIS Specialist, Washington State Department of Archaeology and Historic Preservation

Based on my work at the Department of Natural Resources (DNR, see below), I was recruited to initiate this office's GIS capability to ensure the protection of 60,000 prehistoric and historic sites that comprise Washington's cultural heritage. I was responsible for all aspects of GIS program development and implementation, including budgeting, determining resource needs, database design, data acquisition, hardware and software administration, and analytic strategy.

In its first test, my GIS efforts at this office successfully validated a predictive archaeological model. This GIS analysis, a first for the state, compared the presence of known archaeological sites to a spatial model (comprising over 600,000 polygons) that forecast the occurrence of additional sites. Knowing where undiscovered archaeological sites are most likely to occur will help prevent their future disturbance. I prepared a funding proposal, based upon the results of this analysis, that successfully acquired an additional $50,000 to expand the model across the rest of the state.

I conceived and designed a computerized system to link the archaeological GIS to DNR's GIS. This design allowed DNR users to determine if proposed forest activities would impact known archaeological sites, without compromising the security surrounding archaeological site locations.

I instituted several new mapping technologies at the department, including the use of Global Positioning System information as a GIS data source, the ARC Regions data model, the ARC GRID GIS raster analysis module, and the Arcview GIS display software.

I evaluated several disparate electronic databases, redesigning and consolidating them into a single GIS-based database. My research into these data also uncovered several thousand errors that had existed for years. I analyzed the extent of the problem, developed a repair process, and directed the correction actions. I established written procedures to minimize future data input errors.

I audited existing paper record systems and developed a process for digital replacement and calculated the additional GIS resources, including staffing, time, equipment, and funding required to complete the task. I recruited and trained the data entry staff, directed the data entry process, monitored its progress, and prepared status reports.

I guided the office's archaeologists through a prioritization of their data acquisition and analysis needs. I reviewed the security issues surrounding the politically-sensitive archaeological data, and developed technical standards and processes to assure that such digital data were secure from unwanted incursions.

I administered Unix workstation hardware by creating user accounts, backing up sensitive data, reorganizing the physical layout of data across multiple disk drives, and monitoring system usage. I assessed the office's GIS software and hardware needs, based on my forecast of its GIS growth. Using this assessment, I purchased additional equipment to assure that the growing user demands on the system would be met.

I conducted data analysis for in-house staff to determine the location and extent of known archaeological sites. The results of the analysis were used to prioritize the acquisition of additional archaeological site information.

I created and performed a series of GIS presentations as part of an effort to establish partnerships with other state and federal agencies and American Indian tribes.

1988 - 1996, GIS Manager, Washington State Department of Natural Resources

I managed the GIS, image processing, and computer networking programs within the Forest Practices Division. The division is responsible for enforcing the state forest practice environmental laws on 12 million acres of state and private forest lands across Washington.

I transformed a single GIS staff scientist position into a nine-person spatial analysis program providing GIS and remote sensing support to approximately 30 professional forestry staff statewide. I managed all aspects of staff work development, prioritization, and quality control.

I co-authored the development and implementation of a $2.5 million GIS project to automate the tracking and analysis of the approximately 15,000 annual forest practice activities statewide (the Mapping Application Planning System or MAPS). MAPS was the agency's highest priority technology project and was the first of its type anywhere in the United States. I co-wrote the legislative proposal that acquired the initial $1.75 million in project funding. My team was nominated for the 1995 Commissioner of Public Lands Award. MAPS is now in use statewide as the single method for collecting, disseminating, and analyzing forest practice activities.

I conceived the use of satellite imagery and GIS to determine timber harvest rates across Washington. I developed and implemented the project through a one-year trial period and established it as a permanent program. I obtained $200,000 per biennium in funding. I evaluated the analytic strategy, and reviewed and reported on the yearly results.

I was responsible for the integrity and functionality of 12 statewide GIS data layers worth approximately $6 million. I collaborated with public and private user groups to establish each layer's data structure and content. I oversaw the development of metadata for each layer, and controlled user access to layers containing sensitive information.

I created written and visual presentations about GIS to help lay people understand new mapping technologies and presented technical, program-specific issues to system users and developers.

1987-1988, GIS Applications Scientist, U. S. Geological Survey

The USGS contracted with me to develop GIS programs that analyzed a statewide soils database for plant productivity. An early stage in GIS development, this was part of a larger scientific study to determine if the complex nationwide soils databases maintained by the Soil Conservation Service (now the Natural Resources Conservation Service) could be imported into a GIS and subsequently analyzed to assist with regional and state planning efforts. The results validated the usefulness of GIS with this soils data, and the project (known as STATSGO) was expanded to all 50 states.

Additionally, I researched the availability and location of required GIS data and acquired it from outside sources. I modified data formats and projections to fit the in-house data structure, and incorporated those data into the agency database, making them available for subsequent analysis. I digitized additional data that were not available elsewhere.

I wrote computer programs that conducted spatial and tabular data analysis, and compared the results of these analyses to previous paper-based soils information. I created maps and reports that displayed the results of my analysis, and subsequently prepared and delivered presentations demonstrating the results of my work to the funding agency.

I trained federal GIS staff from across the nation on relational database theory.

II. Visibility analysis

The research, analysis and reporting that I describe here should easily be understood by BLM staff who are familiar with GIS and viewshed impacts. They will recognize that my efforts represent the best available methodology for conducting such an analysis and resulted in high-quality information that the agency can and should rely on.

This visibility analysis report is organized into the following sections:

1. Introduction

A. Purpose

I am concerned that one of the many significant adverse effects associated with oil and gas development on the Coastal Plain will be degradation of the area's wilderness, aesthetic, and recreational values. Therefore, this visibility analysis determines the extent and severity of that impact on visual resources throughout the Coastal Plain and into the adjacent Mollie Beattie Wilderness.

I selected three scenarios for analysis:

1. Many of the people who experience the Coastal Plain do so by rafting its numerous rivers. I therefore determined the extent of the 1002 Area that would be visible to rafters should oil extraction occur. I selected six of the major rivers commonly used by recreational rafters within, or directly adjacent to, the 1002 Area. All six of these were evaluated for eligibility in the wild and scenic river review that accompanied the 2015 revision of the Arctic National Wildlife Refuge Comprehensive Conservation Plan, with four out of the six found eligible for inclusion in the National Wild & Scenic Rivers System and the Hulahula also found suitable. These rivers are:
   - Aichilik
   - Canning
   - Hulahula
   - Jago
   - Okpilak
   - Sadlerochit

   All of the rivers have their origins in the Brooks Range, flowing north and crossing into the 1002 Area on their way to the Arctic Ocean.

2. In addition, the 1002 Area is potentially visible to individuals traveling through the Mollie Beattie Wilderness. Accordingly, I conducted an analysis of the 1002 Area that describes the degree to which oil extraction efforts would be visible to those ascending fifteen of the higher Wilderness points.

3. Finally, I wanted to understand how oil extraction in the 1002 Area would impact the viewshed of those people who call it home and those who, like myself, visit the area. Thus, I evaluated the degree to which the view from Kaktovik would be altered if development occurs in the 1002 Area.

B. Visibility Concepts

I determined visual impacts by conducting *visibility analysis*, where a hypothetical viewer records the ground surface area visible from a given location in a 360-degree sweep at a standardized viewing height of 1.6 meters (5' 3"). The resulting *viewshed* delineates the ground surface area visible to the viewer. The viewshed additionally contains an above-ground-level (AGL) value representing the minimum height that would be required to make a distant out-of-sight location visible. Consider, for example, viewing a distant mountain where the ground on its far side is not visible via direct line-of-site. If a tower was subsequently erected on the mountain's far side, and that tower was just tall enough to visibly protrude above the mountain's skyline, its height represents the AGL value. Thus, the AGL value is the minimum height that needs to be added to a distant location to make it visible to an observer.

AGL values range from zero (where the ground surface is visible), increasing as the ground surface becomes hidden with distance due to topography or to the earth's curvature. The resulting viewshed is thus a two-dimensional area representing those locations where the ground surface is visible to an observer (AGL equal to zero), or with positive AGL values for those locations where the ground surface is out-of-sight to the observer. The greater the AGL value, the higher an object rising up from the ground would have to be in order to be visible.

When the viewsheds from multiple observers are merged, the output value is the minimum of the AGL values from all of the individual observers (i.e., the minimum object height that would be visible to at least one of the individual observers).

In this project, the visibility analysis relied on a raster DEM with a 10-meter cell size; the output viewsheds were likewise rasters with 10-meter resolution.

For this study, AGL values were placed (lumped) into one of four groups. The groups were categorized to reflect the various types and sizes of equipment and facilities involved in oil extraction, as well as the permanent scars they create:

0:	Portions of the viewshed with an AGL value of zero are those where the ground surface was directly visible to the viewer. Within these areas, any equipment, facilities, or changes to the earth's surface, such as roads and pads, would be visible.
>0 - 15 meters:	Structures above the ground surface, up to 15 meters tall, would be visible in these areas. Infrastructure of this size include extraction and processing facilities, such as temporary and permanent buildings.
>15 - 30 meters:	Structures greater than 15 meters tall, up to 30 meters tall, are visible in these areas. Such structures include towers and derricks.
>30 - 45 meters:	These areas require a structure greater than 30 meters tall, up to 45 meters tall, to be visible. The maximum height of 45 meters was selected to be conservative. The Point Thompson EIS, created in 2012 for a development project just to the west of the 1002 Area, lists a height of nearly 55 meters for the mobile drill rig and up to 61 meters for communications towers. Thus, some structures may be visible even beyond the areas depicted in this analysis. The BLM should take this into account when considering viewshed effects in the final EIS.

Since oil production structures taller than 45 meters are not included in this analysis, areas not in one of the four groups above are assumed to be out of sight to the observer. Again, this is a conservative estimate, given the potential for taller infrastructure.

Although each group has an upper height value (0, 15, 30, 45), that does not preclude a taller object located within that group's area from being visible. Rather, it indicates the minimum height group required for visibility.

2. Materials and Methods

A. Standards:

a. Coordinate Reference System (CRS):

All data storage, analysis, and output display were conducted using the Alaska Albers Equal Area Conic projection, 1983 North American Datum, metric units (EPSG: 3338). This CRS is a recognized data standard for Alaskan geographic analysis and output. Input data that were not is this CRS were reprojected prior to any analysis.

For display and cartographic output, the CRS's Central Meridian was adjusted from -154 degrees to -145 degrees. This modification placed true north approximately in the center of the project area, resulting in boundaries (such as the 1002 Area) that more closely squared to north-south, east-west. The resulting output creates a more pleasing "north-up" view, rather than a skewed appearance.

b. Software:

Except where noted below, all analysis and output display were conducted using ESRI Arc Desktop software, version 10.6.1.

c. Data:

Both raster and vector data were used in this analysis. Raster data were stored as single-band, 32-bit, floating-point TIFF files. When used as a Digital Elevation Model (DEM), the raster data were displayed using bilinear resampling.

The vector data format was ESRI shapefiles.

B. Digital data sources:

a. Arctic National Wildlife Refuge 1002 Area boundary:

This vector layer was acquired from the U. S. Geological Survey website at https://agdc.usgs.gov/data/projects/anwr/datahtml/1002bnd.html. This layer's metadata states that it is the "...legal boundary for the Arctic National Wildlife Refuge as interpreted from the Federal Register."

b. Alaska coastal boundary:

This vector layer was acquired from the Alaska State Geo-Spatial Data Clearinghouse (http://www.asgdc.state.ak.us/) by selecting the layer *Alaska Coast 63,360 Excluding Small Islands*.

c. Terrain DEM:

DEM data were downloaded from the University of Minnesota's Polar Geospatial Center ArcticDEM website (https://www.pgc.umn.edu/data/arcticdem/). Six mosaic tiles (Release 7) with 10-meter resolution were required to cover the 1002 Area:

43_18
43_19
44_18
44_19
45_18
45_19

These data served four roles:

1) the terrain model for the visibility analysis
2) the background display hillshade
3) the hydrography source
4) the location of high mountain summits within the Mollie Beattie Wilderness.

d. Hydrography:

River and stream lines were derived by calculating thalwegs (the line of lowest elevation within a valley, thus delineating a watercourse) from the ArcticDEM data, utilizing the TauDEM extension from Utah State University (http://hydrology.usu.edu/taudem/taudem5/index.html). This approach - as opposed to utilizing a separate hydrography source such as the National Hydrography Dataset (NHD) - assured that river and stream lines would be coincident with their parent topography.

e. Background Data:

Basemaps, satellite imagery, and borders are courtesy of ESRI.

C. Data preparation:

a. 1002 Area Boundary:

For the on-river observation site analysis, this vector layer was modified in two locations (Figure 1):

1) its eastern border was buffered by 5 kilometers to accommodate the Aichilik River, which flows adjacent to, and just outside of, that border.

2) The southern border contains two right-angle stair-steps. To ensure that terrain outside these stair step areas was correctly included in the visibility analysis, those border steps were each expanded out to their respective hypotenuses, creating an uninterrupted view across the 1002 Area.

All visibility calculations, however, involved only the area within the original 1002 Area, without modification.

For the Wilderness observation sites, the 1002 Area vector layer was modified to incorporate sight lines for all fifteen sites, so that unimpeded visibility analysis into the 1002 Area could be conducted (Figure 1).

As with the on-river observations, the Wilderness site's visibility calculations involved only the area within the original 1002 Area.

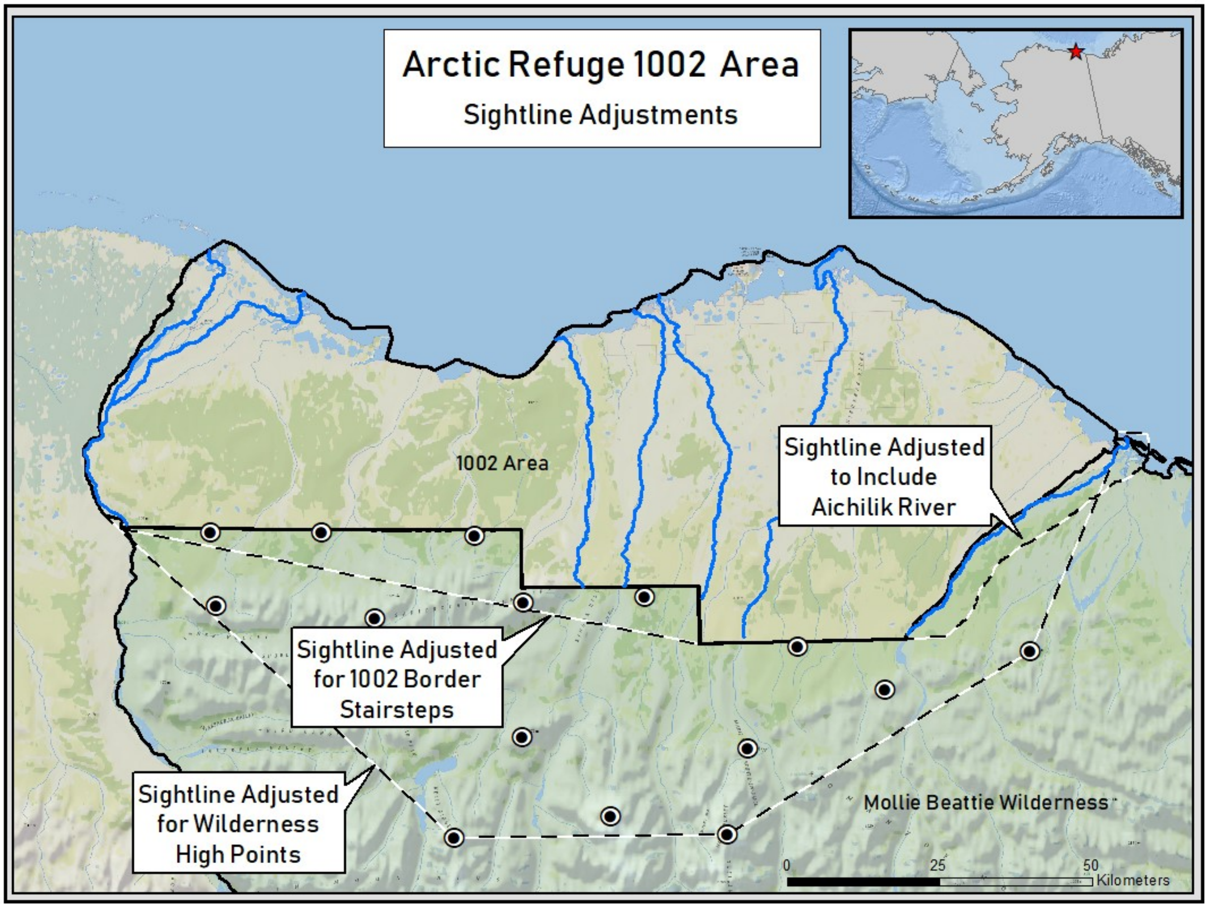

Figure 1, Arctic Refuge 1002 Area Border Adjustments

b. Terrain DEM:

The six ArcticDEM raster files were manually inspected to confirm that they aligned and edge-matched correctly. The inspection revealed that all six rasters were correctly aligned and edge-matched, thus no raster snapping was required. They were then mosaicked into a single raster, which was subsequently projected to the project CRS. The projected raster was then extracted to the 1002 Area boundary.

c. Rivers and Streams:

The TauDEM toolbox was utilized to create the streamlines from the projected DEM. The TauDEM tools define thalwegs within the study area, from which streams are derived. The six rivers of interest were manually selected from all the TauDEM-created streamlines, using the ESRI *Imagery* and *USA Topomaps* as basemap references. The streamlines output by TauDEM were in raster form, which was converted to vector lines.

Although the TauDEM tool created well-defined streamlines, as confirmed by the basemaps, it was unable to create a single continuous headwaters-to-ocean streamline for the Aichilik, Canning and Okpilak rivers, resulting in gaps. These gaps were connected using manual digitizing, with the *Imagery* basemap as a guide. There was one gap on the Aichilik, six on the Canning, and one on the Okpilak. Two observation sites (see below) occurred along the manually-digitized portions of the Aichilik, and four observation sites occurred along the Canning. None occurred in the Okpilak. The elevation along the digitized segments was manually inspected, and found to be never more than 0.2 meters higher than the connecting endpoints created by TauDEM. Given the small number of affected observation sites (six out of 481), along with the small potential elevation difference, they were retained for analysis.

d. Observation Sites:

The viewshed-creating software tool requires one or more sample observation sites, from which a viewshed is constructed. The following steps describe how the observation sites were established for each of the three analysis scenarios:

i. Sites Along Rivers:

This project assumes that river rafters would stop periodically along each of the six rivers and stand to view a 360-degree panorama. To maintain a balance between including sufficient sites for the analysis and discretizing lines to a computationally-feasible number of points, as required by the visibility analysis tool, observation sites were placed every kilometer along each of the six rivers. Ideally, each river's viewshed would incorporate the visibility from a continual analysis along the river, rather than sampling observation sites at 1-kilometer intervals. However, the software does not allow this, due to the infinite number of possible observation sites along a river's course. Reducing the distance between observation sites would theoretically increase the resulting viewshed detail and size, although at the cost of longer computing time. The 1-km observation site distance provides a conservative compromise, although it likely under-represents each river's viewshed size, as well as the ensuing single all-river viewshed (described below).

These equally-spaced 1-km river observation sites were created from the source river vector lines using the QChainage plugin with the QGIS (version 2.18.22) software package. The first site was positioned at the river's mouth, with the remainder equally spaced every kilometer upstream to the 1002 Area border. The number of observation sites for a given river was thus directly related to the river's length within the 1002 Area. The number of observation sites per river ranged from a low of 55 (Sadlerochit) to a high of 129 (Canning). For all six rivers, a total of 481 observation sites were established. A closeup example of the observation sites along the Jago River is shown in Figure 2.

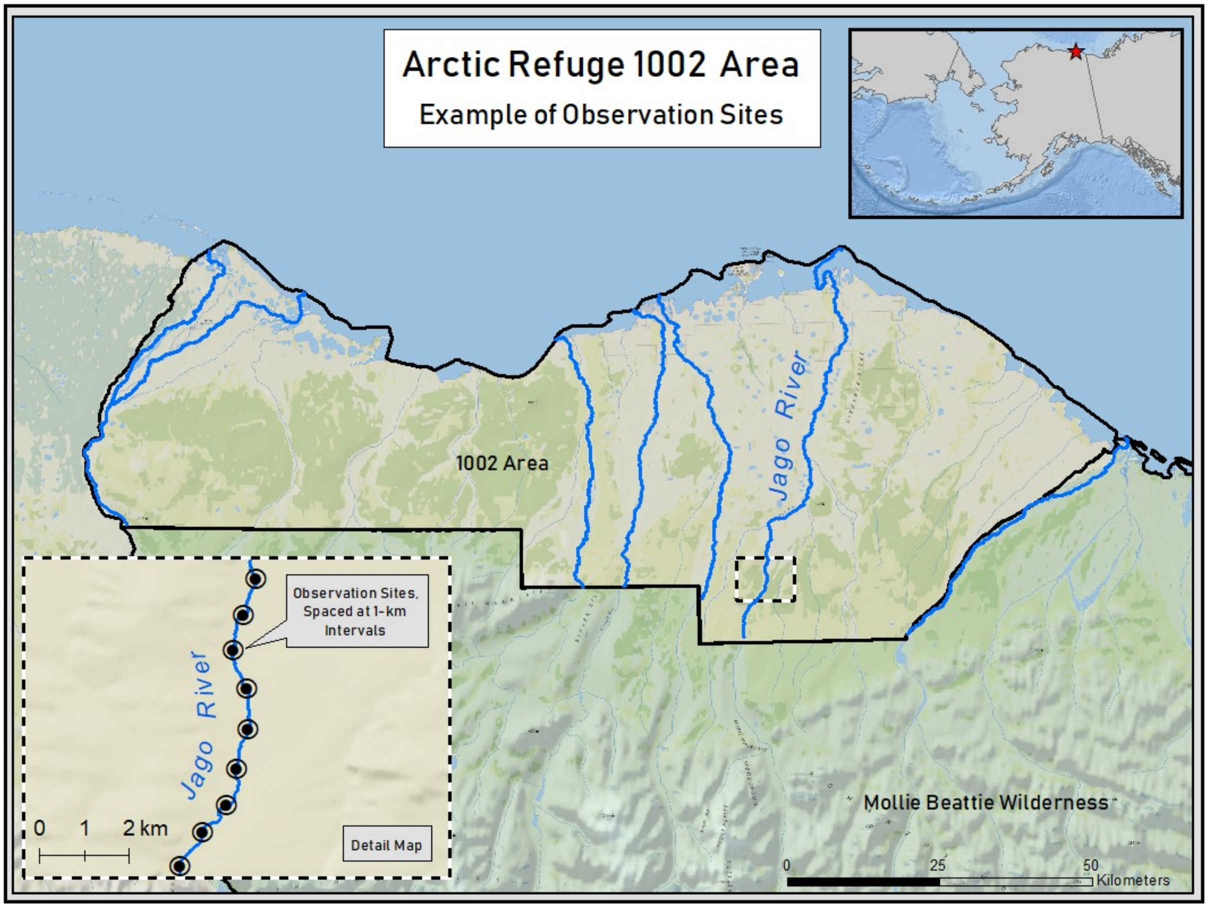

Figure 2. Closeup Example of Observation Site Locations

At each observation site, a viewshed within the 1002 Area was created, assuming an observer height of 1.6 meters (5' 3"). Each river's collection of observation site viewsheds were then merged into a single viewshed for that river. Where two or more observation site viewsheds overlapped, the minimal AGL value from any of the individual viewsheds was retained.

The resulting six individual-river viewsheds were then merged into a single all-rivers viewshed. Again, the minimal AGL cell value was retained where two or more viewshed cells overlapped. This final viewshed represents a composite visibility analysis of the entire 1002 Area from all six rivers.

ii. Sites on Wilderness Summits:

Fifteen observation sites were located within the Mollie Beattie Wilderness, south of the 1002 Area (Figure 3). Five of the sites were manually located on broad uplands just south (within 2 km) of the 1002 - Wilderness border, using the *USA Topomaps* basemap as a guide. Three additional sites were located on prominent summits in the Sadlerochit mountains, and the remaining seven sites were located on summits within the Romanzof Mountains. The Sadlerochit and Romanzof locations were selected due to their desirable mountain climbing status, including the second-highest (Mt. Hubley), third-highest (Mt. Chamberlin) and fourth-highest (Mt. Michelson) peaks in the U.S. Arctic (cited in https://www.the-cryosphere.net/10/1245/2016/).

The Sadlerochit and Romanzof summit locations were manually digitized by using the *USA Topomaps* basemap as a background reference. The final summit locations were programmatically determined by locating the single raster cell with the highest elevation within a 1-km radius of the manually-located approximate location.

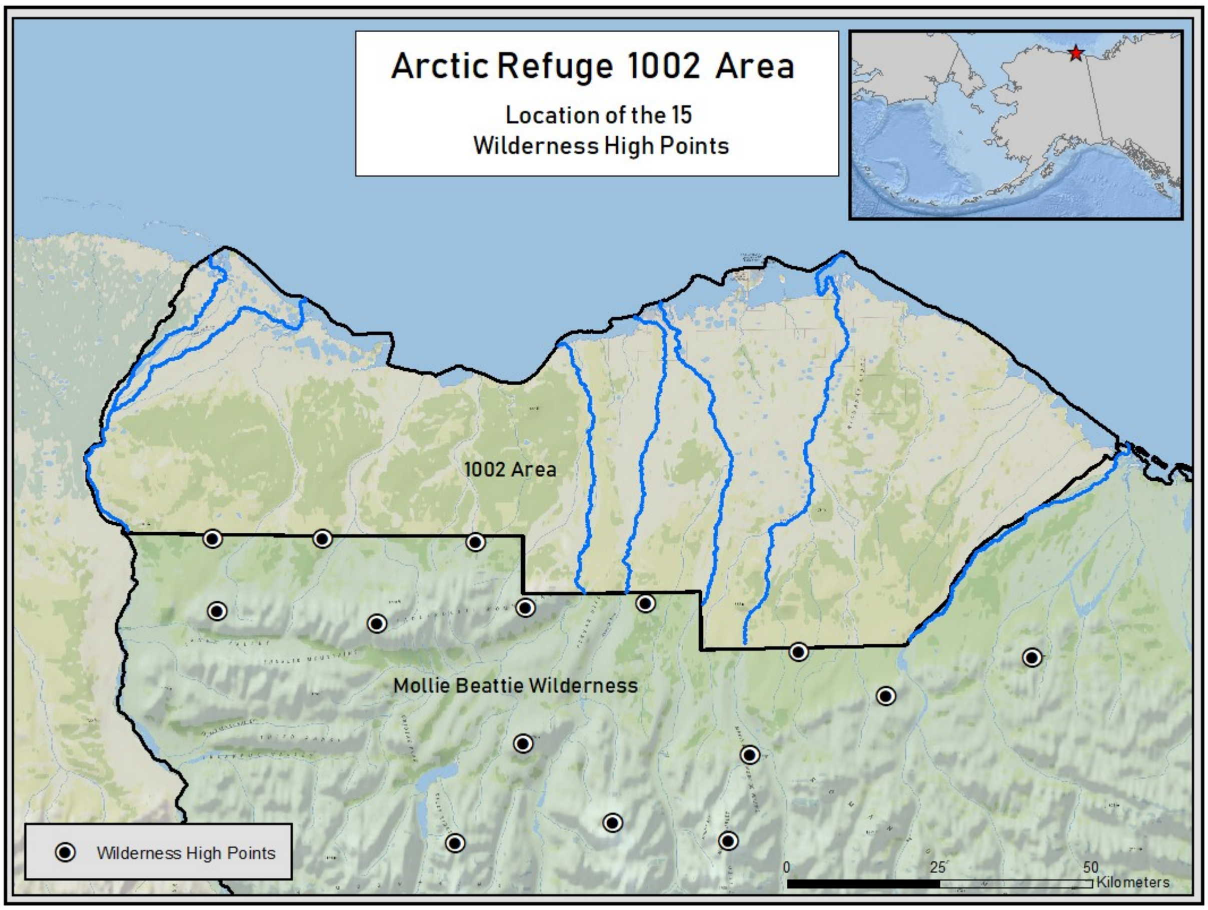

Figure 3: Location of the 15 Wilderness High Points

iii. Kaktovik Site:

This single site was manually digitized using the *Imagery* basemap as a background reference. The site was located at the center of the runup area at the east end of the village's new runway, 1.7 km southwest of the Harold Kaveolook school (Figure 4). This location was selected because it is just a short distance from Kaktovik, providing an unobstructed building-free view into the 1002 Area. Additionally, for visitors arriving by air, this is a likely location for their first Kaktovik ground view into the 1002 Area.

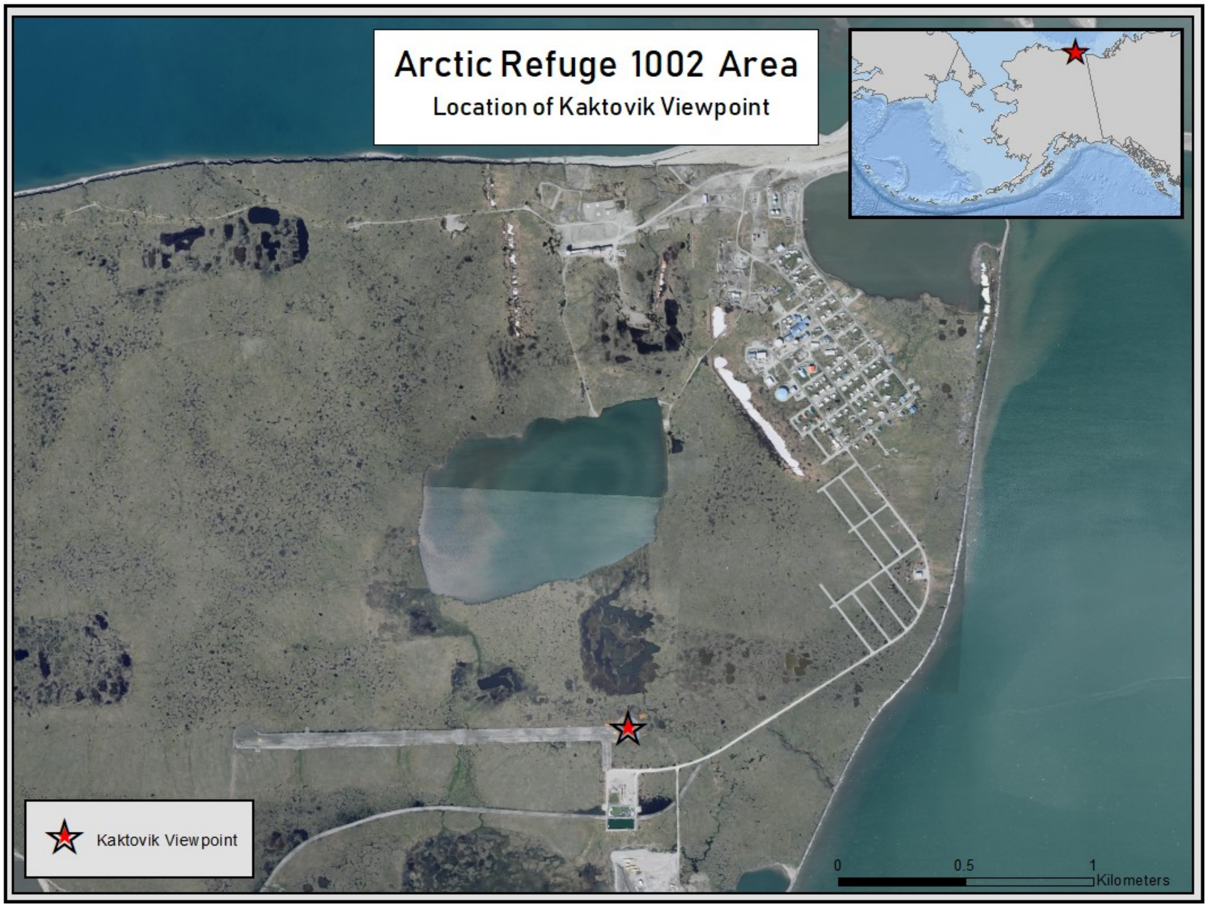

Figure 4, Location of the Kaktovik Observation Site

D. Analysis:

The Spatial Analyst *Visibility* tool was used to determine the viewsheds. Correction for the earth's curvature was included. Inputs were the vector points (along the six rivers, on the 15 summits, and at Kaktovik) and the raster terrain DEM. The outputs were raster viewsheds which included above-ground-level values for those areas where the ground surface was not visible.

Three separate visibility analysis categories were conducted:

a. Sites Along Rivers:

Seven separate viewsheds were created: one for each river, and a single combined view for all six rivers.

b. Sites on Wilderness Summits

From the fifteen Wilderness observation sites, a single 1002 Area-wide viewshed was created.

c. Kaktovik Site:

A single 1002 Area viewshed was created from the town of Kaktovik.

For every analysis, the output viewshed raster containing the above ground values was always a floating-point raster. In order to more effectively display it categorized, make selections, and perform statistical analysis, an integer format was required. Therefore, the floating-point output was converted to an integer raster with the following Raster Calculator formula:

```
Int("input_agl_floating_point_raster.tif" * 1000)
```

The purpose for multiplying the input raster by 1000 was to retain a level of precision in the output raster. Since the int() expression truncated the input value (for example, an input value of 2.995 was output to 2), multiplying the input by 1000 created an output with integer values in millimeters (again using the same example, an input floating-point value of 2.995 was converted to a fixed value of 2995). An attribute table was then created for the integer raster, and statistics were built. A double-type field was added to the attribute table and calculated to (value / 1000), which recreated the original input elevation value.

With an attribute table in place, classified display symbology was created, statistics determined, and areas calculated (via raster cells counts).

3. Results:

A. Sites Along Rivers:

Table 1 lists the viewshed size for each river, expressed as the percentage of the 1002 Area visible from the 1-km spaced observation sites. The visible ground surface area ranges from a low of two percent (Aichilik River) to 11 percent (Canning River). Viewshed sizes increase as theoretical structures are considered, ranging up to 51 percent of the 1002 Area (Okpilak River) when structures up to 45 meters tall (AGL) are considered. Percentages are rounded to the nearest percent.

In addition, Table 1 lists the single viewshed constructed by merging all six rivers. In this situation, 28 percent of the 1002 Area's ground surface is visible. The viewshed size increases to 97 percent of the 1002 Area when structures up to 45 meters tall are considered.

River:	Ground Visible	>0 - 15 Meter-tall Structure	>15 - 30 Meter-tall Structure	>30 - 45 Meter-tall Structure	>45 Meter-tall Structure	Total
Aichilik, km^2	112	624	165	120	5,687	6,708
Percent of 1002 Area	2	9	2	2	85	100
Cumulative percent	2	11	13	15	100	
Canning, both forks, km^2	739	1,095	245	194	4,435	6,708
Percent of 1002 Area	11	16	4	3	66	100
Cumulative percent	11	27	31	34	100	
Hulahula, km^2	417	1,265	489	367	4,170	6,708
Percent of 1002 Area	6	19	7	6	62	100
Cumulative percent	6	25	32	38	100	
Jago, km^2	371	1,403	645	589	3,700	6,708
Percent of 1002 Area	5	21	10	9	55	100
Cumulative percent	5	26	36	45	100	
Okpilak, km^2	529	1,792	528	546	3,313	6,708
Percent of 1002 Area	8	27	8	8	49	100
Cumulative percent	8	35	43	51	100	
Sadlerochit, km^2	292	942	606	458	4,410	6,708
Percent of 1002 Area	4	14	9	7	66	100
Cumulative percent	4	18	27	34	100	
All six rivers, km^2	1,859	4,007	457	156	229	6,708
Percent of 1002 Area	28	60	7	2	3	100
Cumulative percent	28	88	95	97	100	

Table 1, River Visibility Results

The following seven maps (one for each of the six rivers, plus a combined view of all six) visually display the riverine values from Table 1. Tabular data, appropriate to each river, is copied from Table 1 and displayed along with each map for easier comparison.

Symbology is identical for all seven maps. The darkest red pixels are those where the ground surface within the 1002 Area is visible from all of the 1-km-spaced observation sites located along the river(s). Lighter colored pixels represent areas that require a structure rising above the ground in order to be seen (that is, the AGL value is greater than zero). Furthermore, the lighter the color, the taller the structure must be in order to be seen: Structures 15 meters or less tall would be visible in the dark orange areas, while structures between 15 and 30 meters tall would be visible in the light orange areas. Structures greater than 30 meters tall, up to 45 meters, would be visible in the yellow areas. Non-colored areas require a structure greater than 45 meters tall in order to be seen.

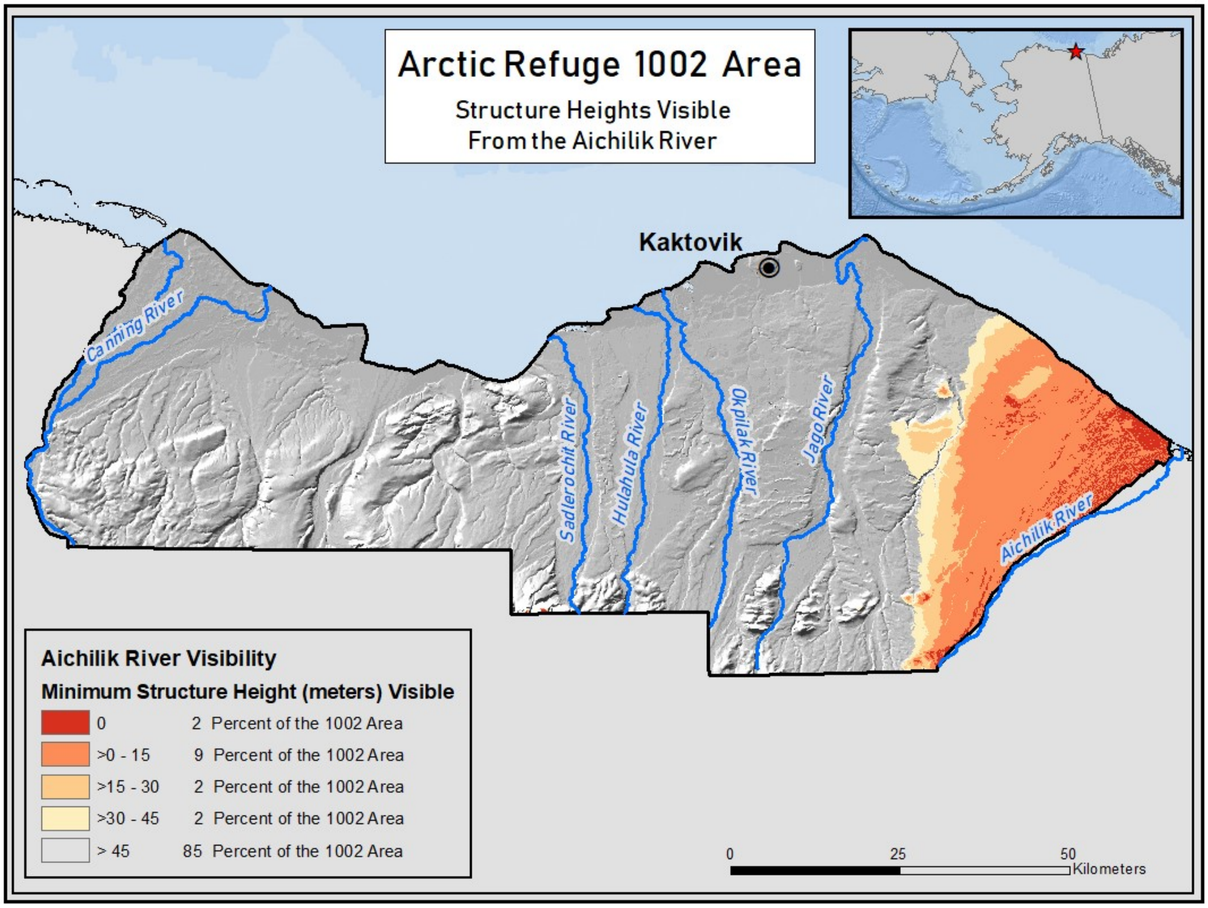

Figure 5: Aichilik River Visibility

River:	Ground Visible	>0 - 15 Meter-tall Structure	>15 - 30 Meter-tall Structure	>30 - 45 Meter-tall Structure	>45 Meter-tall Structure	Total
Aichilik, km^2	112	624	165	120	5,687	6,708
Percent of 1002 Area	2	9	2	2	85	100
Cumulative percent	2	11	13	15	100	

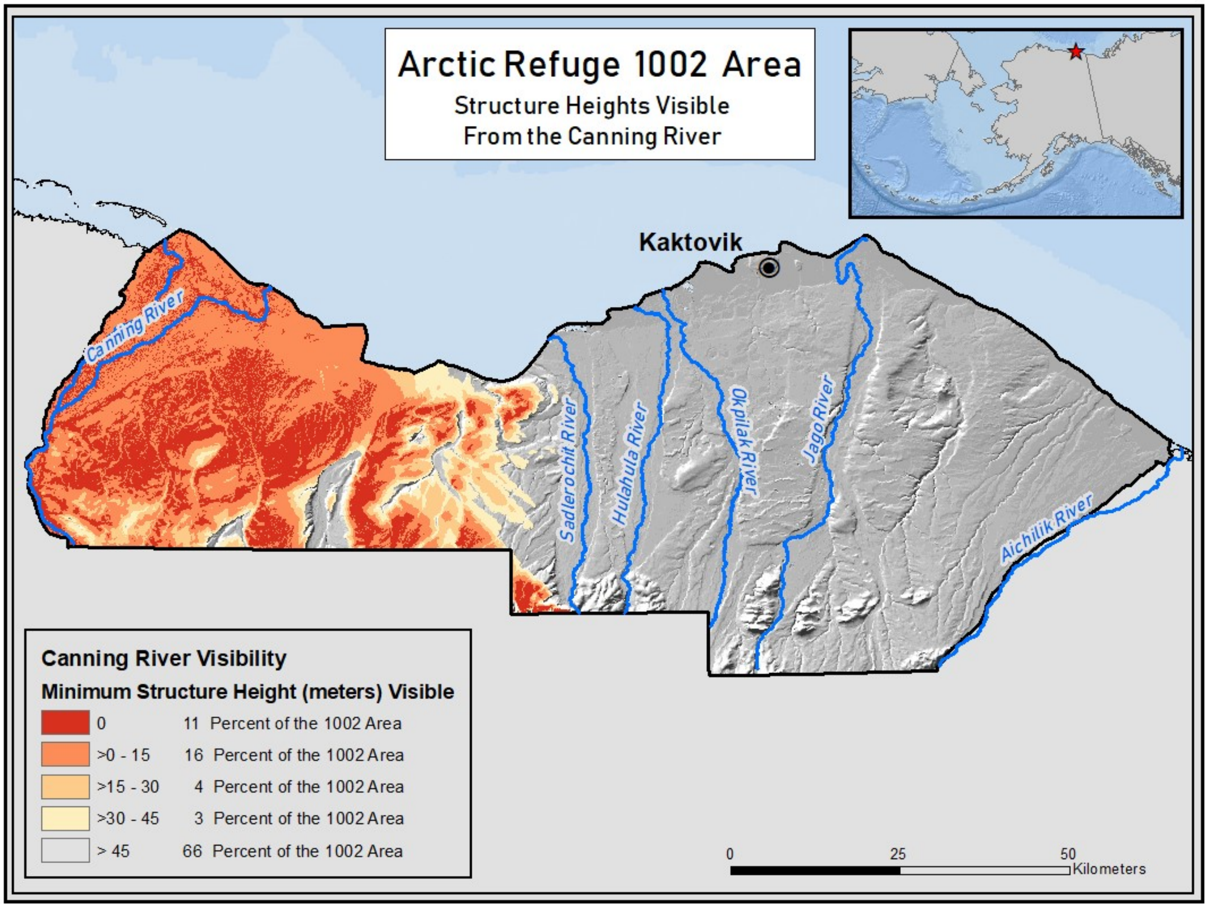

Figure 6: Canning River Visibility

River:	Ground Visible	>0 - 15 Meter-tall Structure	>15 - 30 Meter-tall Structure	>30 - 45 Meter-tall Structure	>45 Meter-tall Structure	Total
Canning, both forks, km^2	739	1,095	245	194	4,435	6,708
Percent of 1002 Area	11	16	4	3	66	100
Cumulative percent	11	27	31	34	100	

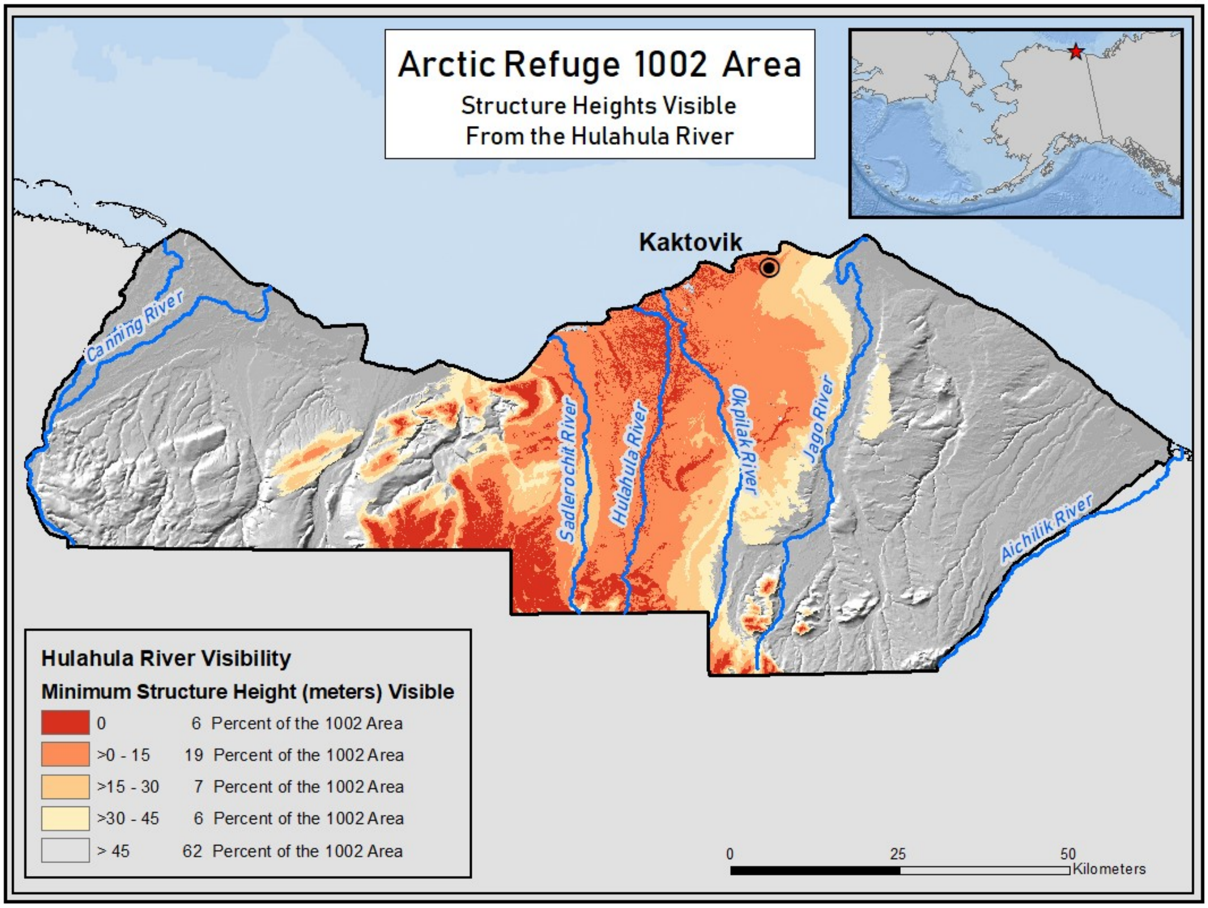

Figure 7: Hulahula River Visibility

River:	Ground Visible	>0 - 15 Meter-tall Structure	>15 - 30 Meter-tall Structure	>30 - 45 Meter-tall Structure	>45 Meter-tall Structure	Total
Hulahula, km^2	417	1,265	489	367	4,170	6,708
Percent of 1002 Area	6	19	7	6	62	100
Cumulative percent	6	25	32	38	100	

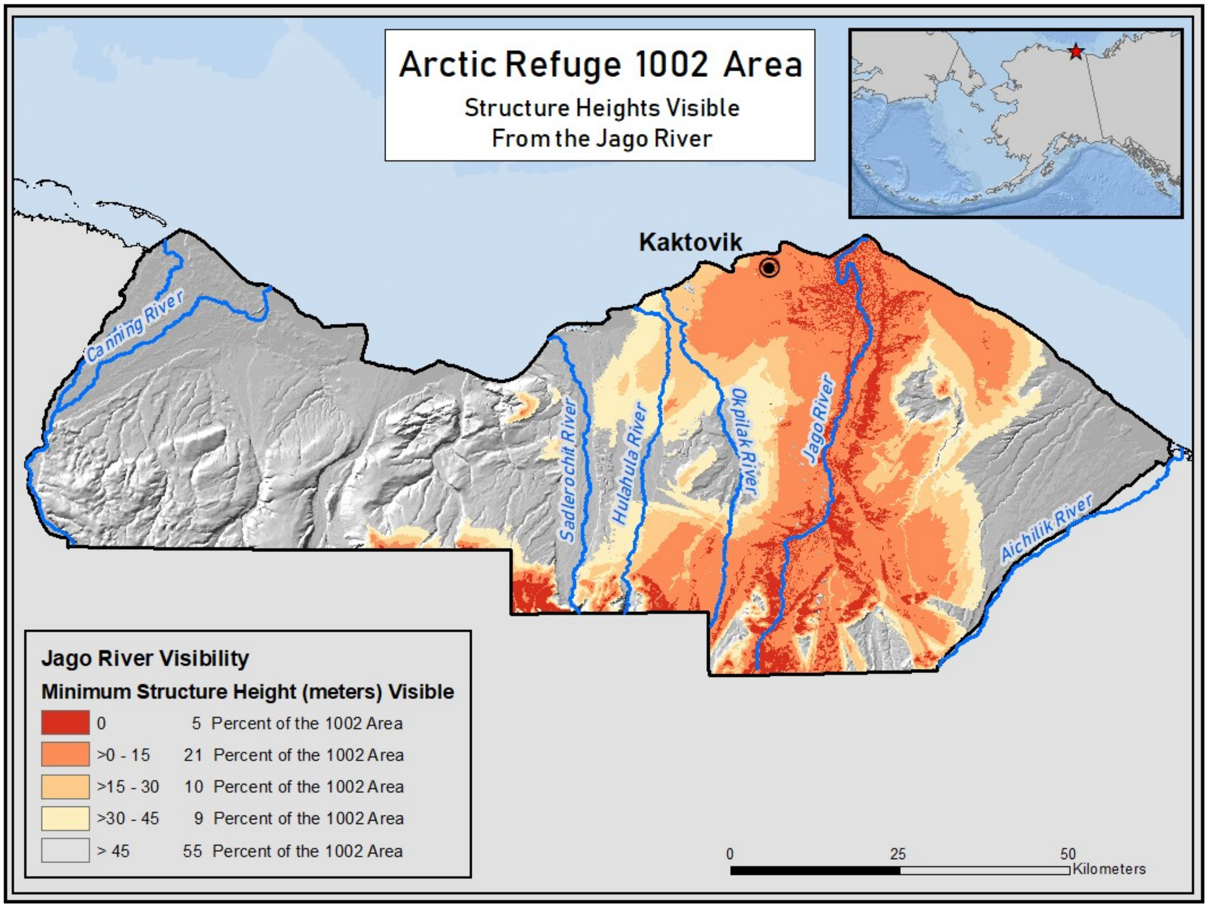

Figure 8: Jago River Visibility

River:	Ground Visible	>0 - 15 Meter-tall Structure	>15 - 30 Meter-tall Structure	>30 - 45 Meter-tall Structure	>45 Meter-tall Structure	Total
Jago, km^2	371	1,403	645	589	3,700	6,708
Percent of 1002 Area	5	21	10	9	55	100
Cumulative percent	5	26	36	45	100	

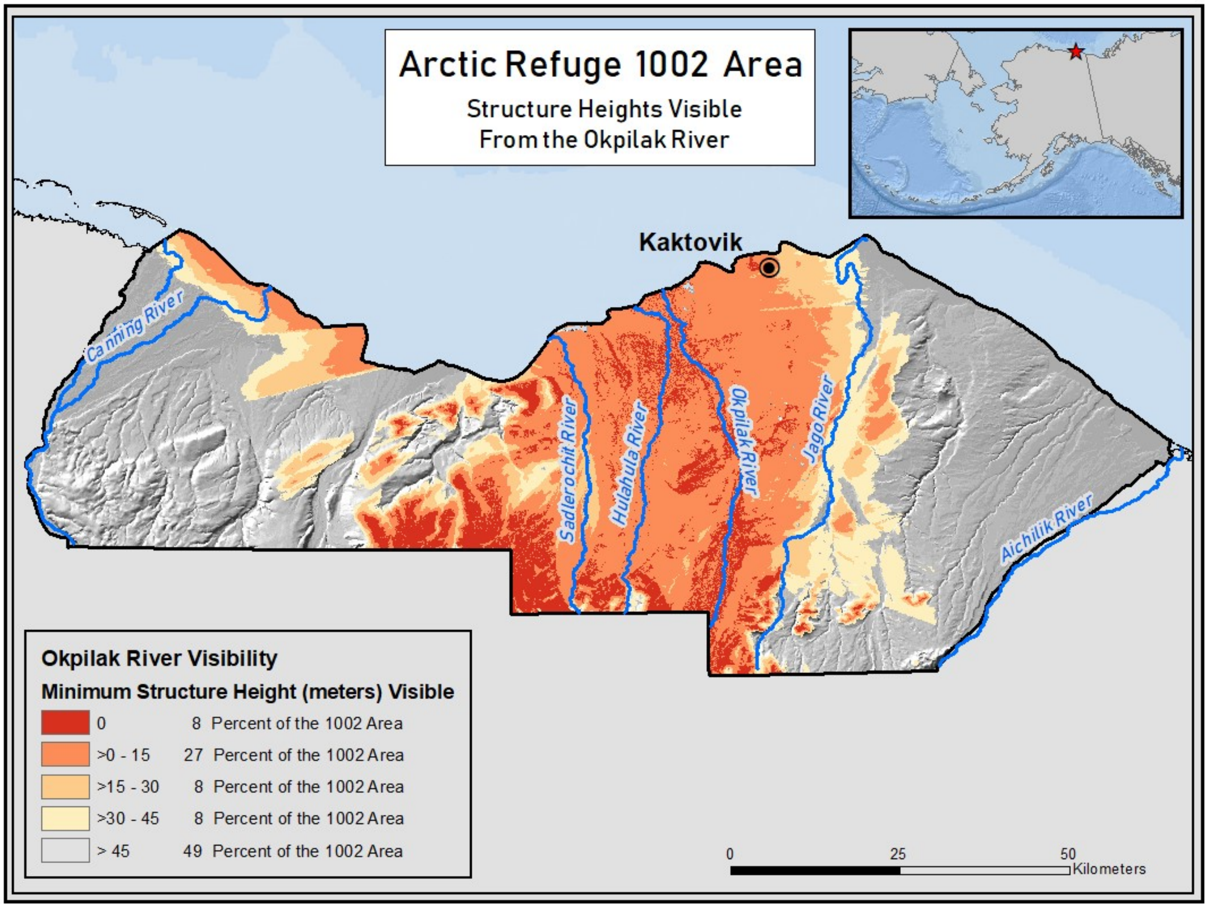

Figure 9: Okpilak River Visibility

River:	Ground Visible	>0 - 15 Meter-tall Structure	>15 - 30 Meter-tall Structure	>30 - 45 Meter-tall Structure	>45 Meter-tall Structure	Total
Okpilak, km^2	529	1,792	528	546	3,313	6,708
Percent of 1002 Area	8	27	8	8	49	100
Cumulative percent	8	35	43	51	100	

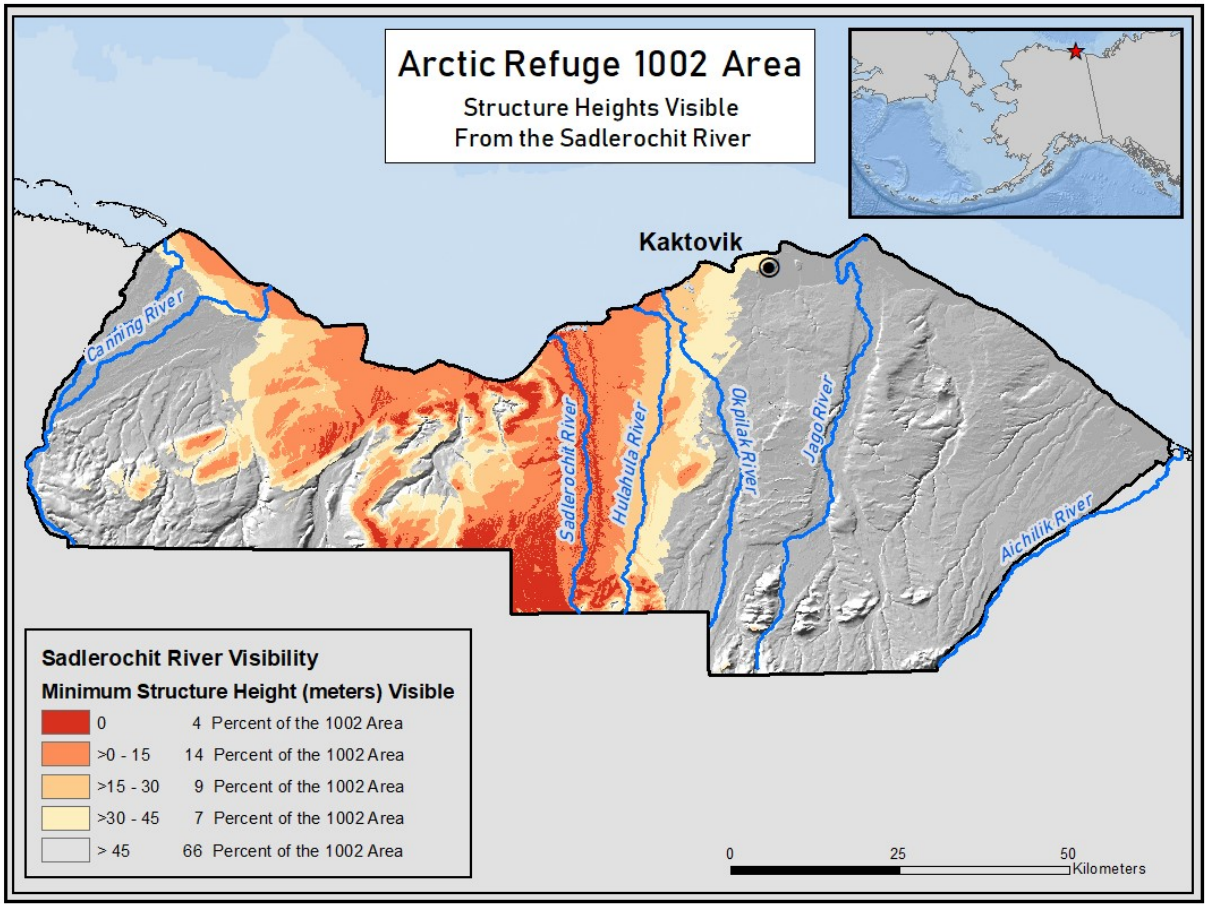

Figure 10: Sadlerochit River Visibility

River:	Ground Visible	>0 - 15 Meter-tall Structure	>15 - 30 Meter-tall Structure	>30 - 45 Meter-tall Structure	>45 Meter-tall Structure	Total
Sadlerochit, km^2	292	942	606	458	4,410	6,708
Percent of 1002 Area	4	14	9	7	66	100
Cumulative percent	4	18	27	34	100	

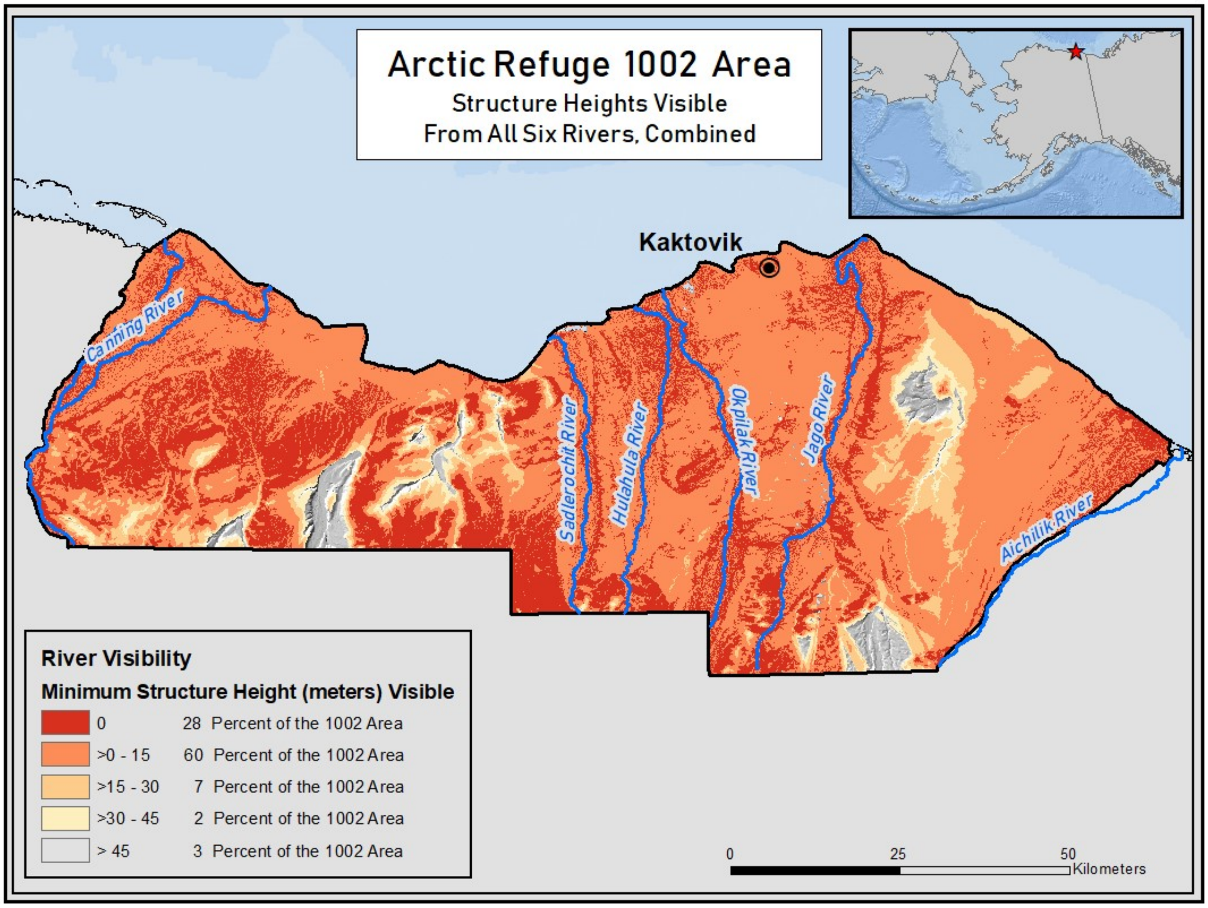

Figure 11: All six rivers combined

River:	Ground Visible	>0 - 15 Meter-tall Structure	>15 - 30 Meter-tall Structure	>30 - 45 Meter-tall Structure	>45 Meter-tall Structure	Total
All six rivers, km^2	1,859	4,007	457	156	229	6,708
Percent of 1002 Area	28	60	7	2	3	100
Cumulative percent	28	88	95	97	100	

B. Sites on Wilderness Summits:

The results of the wilderness summit analysis are displayed in Figure 12 and Table 2. The symbology in Figure 12 is identical to that of the river analysis above. Percentages are rounded to the nearest percent.

Ninety-five percent of the 1002 Area's ground surface is directly visible when all fifteen observation sites are merged into a single viewshed (Table 2). If structures up to 15 meters tall are included, 99.6% of the 1002 Area is visible, and when structure up to 45 meters are considered, 99.9% of the 1002 Area is visible.

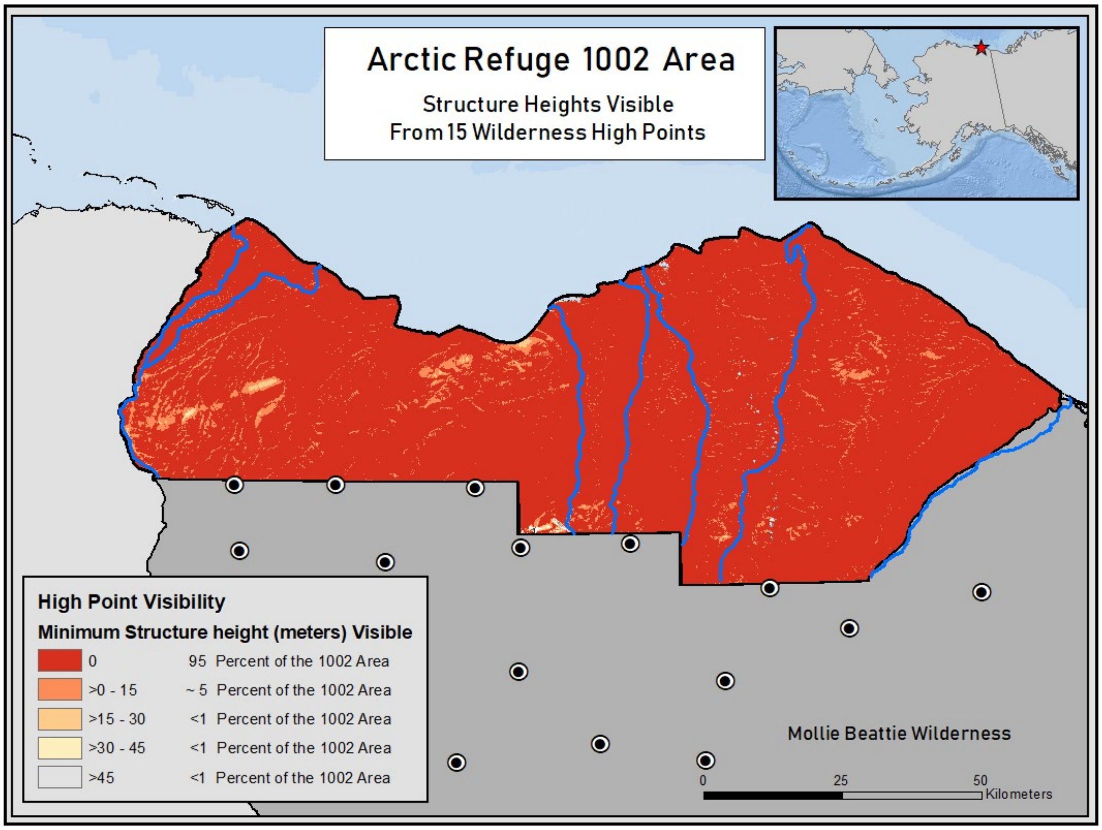

Figure 12: Wilderness High Point Visibility

	Ground Visible	>0 - 15 Meter-tall Structure	>15 - 30 Meter-tall Structure	>30 - 45 Meter-tall Structure	>45 Meter-tall Structure	Total
All fifteen sites, km^2	6,372	312	17	4	3	6,708
Percent of 1002 Area	95	~5	<1	<1	<1	100
Cumulative percent	95	>99	>99	>99	100	

Table 2. Wilderness Observation Site Visibility Results

C. Kaktovik Site:

The results of the wilderness summit analysis are displayed in Figure 13 and Table 3. The symbology in Figure 13 is identical to that of the river analysis above. Percentages are rounded to the nearest percent.

Eight percent of the 1002 Area's ground surface is visible from the Kaktovik observation site (Figure 13 and Table 3). This value increases to 30 percent if structures up to 15 meters tall are included, 38 percent for structures up to 30 meters tall, and 45 percent when structures up to 45 meters tall are involved.

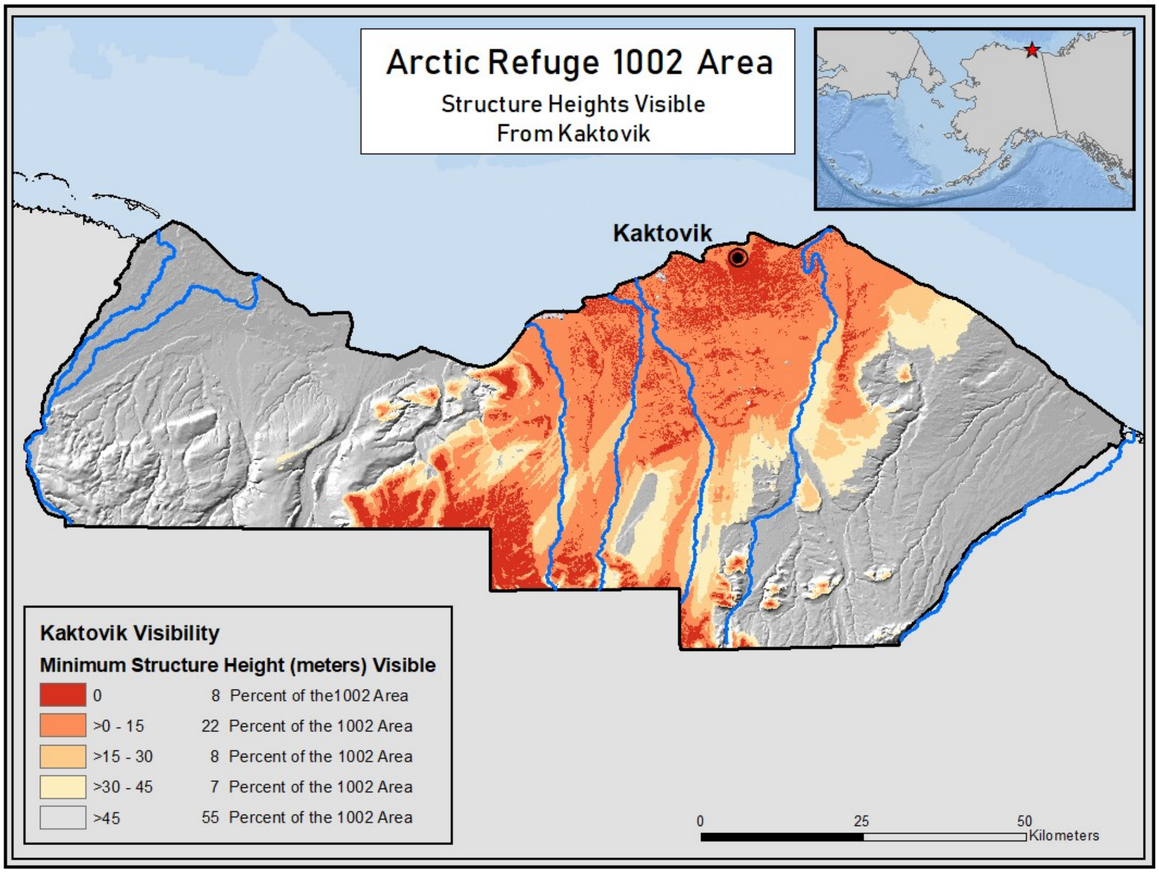

Figure 13: Kaktovik Visibility

	Ground Visible	>0 - 15 Meter-tall Structure	>15 - 30 Meter-tall Structure	>30 - 45 Meter-tall Structure	>45 Meter-tall Structure	Total
Kaktovik, km^2	514	1,464	537	455	3,738	6,708
Percent of 1002 Area	8	22	8	7	55	100
Cumulative percent	8	30	38	45	100	

Table 3: Kaktovik Visibility Results

4. Summary and Conclusions

I conducted a GIS-based visibility analysis of the 1002 Area that generated tabular statistics and maps depicting the extent and intensity of visual impacts from oil and gas extraction in Alaska's Coastal Plain. The analysis focused on three scenarios:

1. People rafting down six of the area's major rivers.
2. Visitors to the Mollie Beattie Wilderness, south of the 1002 Area.
3. Residents/visitors of Kaktovik, the area's only incorporated village.

The results, both tabular and spatial, are undeniable: the visual impacts of coastal plain development would be significant and wide-ranging. For example:

A. As shown in Figure 11, 88% of the 1002 Area would be visible from the six major rivers with structures up to 15m in height (which includes most permanent structures).

In other words, oil and gas development activity across a vast majority (88%) of the 1002 Area would potentially be visible to people rafting six of its major rivers, even when structures as low as 15m are in place. This height class includes a majority of permanent structures such as pipelines, roads, buildings and warehouses. Only a small fraction (12 percent) of the 1002 Area would escape this outcome.

B. Also shown in Figure 11, 97% of the 1002 Area would be visible from the six major rivers with structures between 30 and 45m in height (common heights for oil and gas extraction towers).

As with summary A above, profound degradation of the 1002 Area’s aesthetic characteristics, including wilderness and recreational values, would occur as a result of oil and gas development. People rafting rivers in the 1002 Area would most assuredly see wide-ranging and repeated instances of industrial-scale activity because there is almost nowhere that derricks and towers more than 30m tall *would not* be visible.

C. Visual impacts would carry over into the Congressionally-designated Wilderness to the immediate south of the Coastal Plain, with nearly 100% of the 1002 Area visible from high points within the Wilderness. This extent is depicted in Figure 12.

The visual impacts of oil and gas extraction activities would not be limited to just those people traveling within the 1002 Area. This analysis clearly shows that people far outside the 1002 Area boundary would suffer from industrial-based visual pollution occurring inside the 1002 Area.

D. Visual impacts from Kaktovik would also be extensive, affecting both residents and visitors. Thirty percent of the 1002 Area would be visible with structures up to 15m in height, and 45 percent visible with structures between 30 and 45m tall (see Figure 13).

To put this in perspective, from just one location, at Kaktovik's edge, the area potentially visible to extraction structures up to 45m tall (2,970 km^2) is larger in size than the area of 83 percent of the country's counties, and virtually all counties east of the Rockies (Figure 14).

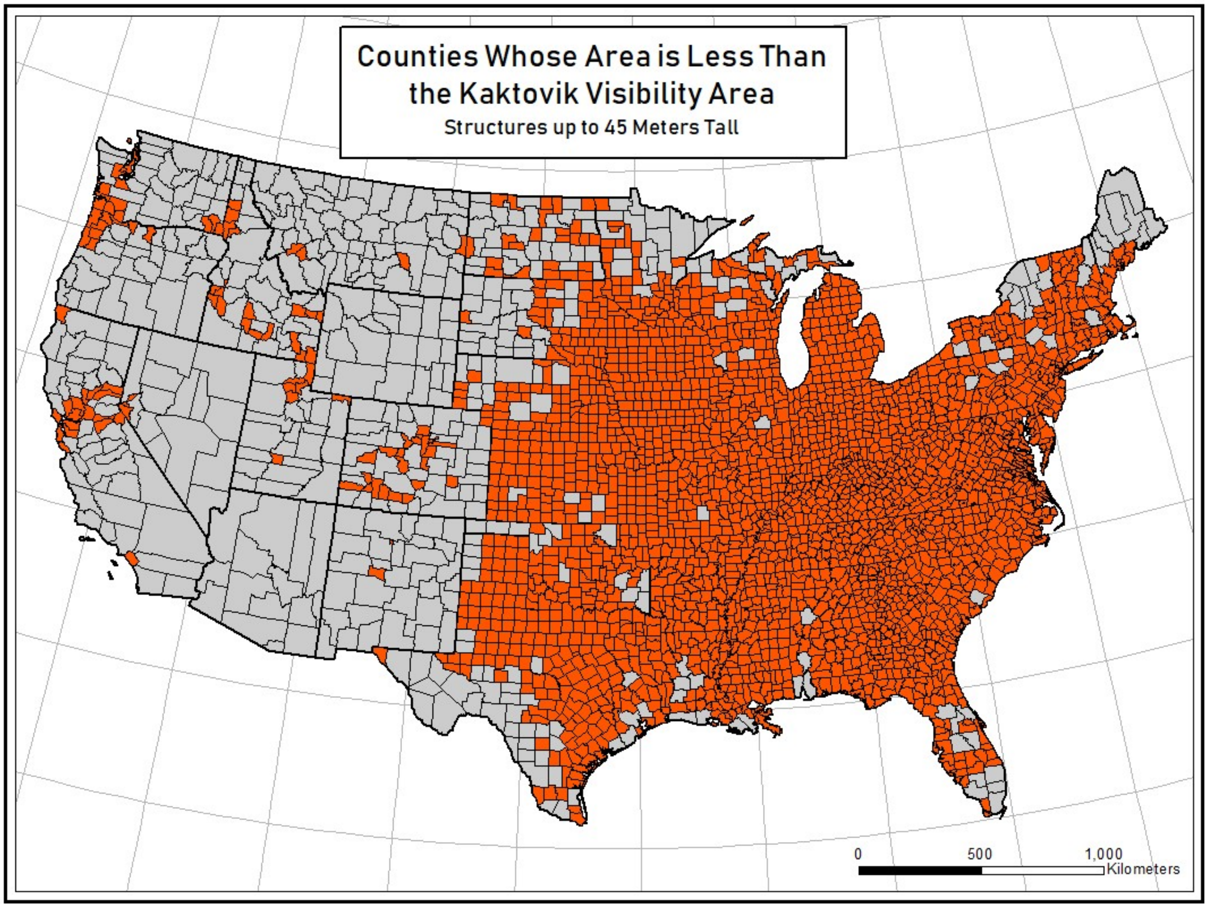

Figure 14: Counties Whose Area is Less Than the Kaktovik Visibility Area

E. The vast scale of Alaska's landscape is often difficult to comprehend. To help visualize the geographic extent of the aesthetic degradation that would occur within the 1002 Area due to oil and gas extraction, the raster image from Figure 11 has been draped, to scale, over Washington D. C. This comparison shows how an equivalent area from West Virginia to the Chesapeake Bay would similarly be impacted by oil and gas extraction (Figure 15).

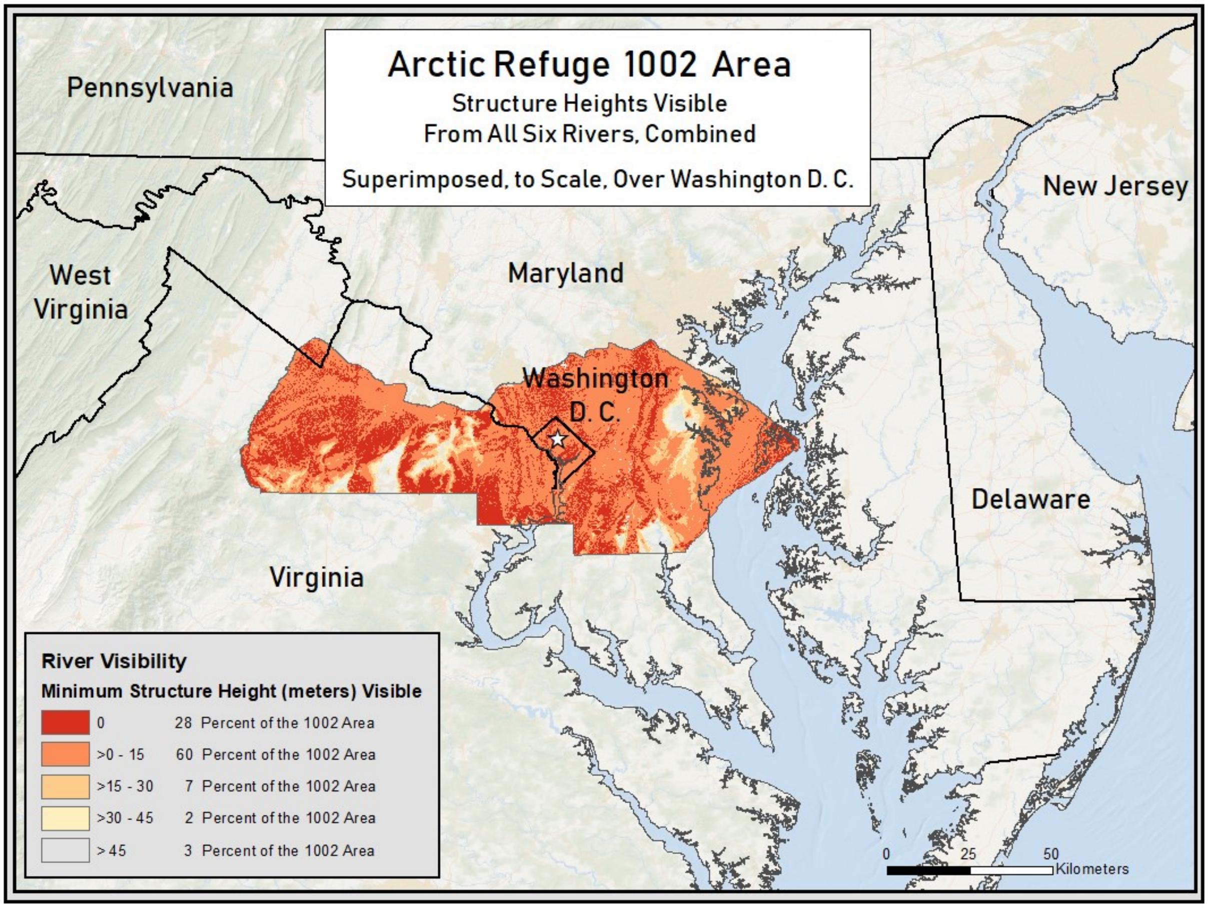

Figure 15: River Visibility, From Figure 11, Draped over Washington D. C.

III. Conclusion

In conclusion, I am deeply concerned with the proposal to develop an oil and gas program for the Coastal Plain, including, among other impacts, degradation of the area's outstanding and untouched scenery and wilderness. BLM should fully consider the visibility analysis I have prepared and ensure that the public and decision-makers are aware of the extensive and significant viewshed impacts associated with development.

To ensure the viewshed impacts of Arctic Refuge Coastal Plain development are fully considered in the EIS for Coastal Plain oil and gas leasing, I am sharing the viewshed raster results for all three sets of analyses described above to BLM via attachment to these comments. In addition, I will make this report (along with all supporting source data, analysis methodology, and output results) freely available to the public via my website at www.truenorthgis.net. Furthermore, I plan to actively share this report with other individuals and organizations who I know share my concerns about the effects of Coastal Plain development, and encourage them to further share with their contacts.

Please contact me with any questions about the analysis, maps, or data submitted.

Sincerely,

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360-951-5131
stu@truenorthgis.net

Attachments:
This document
Source vector and raster data
Viewshed raster data for all analyses completed