

ALASKA DEEP DRAFT ARCTIC PORTS STUDY

MULTI-CRITERIA DECISION ANALYSIS (MCDA) DEEP DRAFT PORT SITE SELECTION ANALYSIS

CRITERIA

It was determined that by using an independent tool for the port site(s) selection would lend credibility to the site selection process. The Multi-Criteria Decision Analysis (MCDA) tool developed by the Institute of Water Resources as part of the IWR-Planning suite is available to the public without charge and was determined the best tool for use with this evaluation. The Project Development Team held a day-long meeting on February 29, 2012 to determine the site selection. The final array of criteria for deep-draft port site selection is as follows:

Port Proximity

Port Proximity was measured in time and distance from the Outer Continental Shelf (OCS) oil and gas endeavors, mining operations and potential, existing oil spill response equipment, community resupply, and shipping lanes. Alaska DOT&PF Potential Places of Refuge Subarea Contingency Plans were used to determine oil spill response locations.¹ Scores for this category are the sum of all five sub-categories for port proximity to determine closest port to serve ALL five missions.

Table 1 Port Proximity Criteria

Sites Considered from NWT and Roads to Resources	Port Proximity to:					
	5=very good, 4=good, 3=medium, 2=low, 1=very low, 0=potential					
	Oil and gas (OCS)	Mining	Oil spill response existing	Community resupply	Shipping lanes	Total
St. Paul Island	1	0	1	1	5	8
St. Lawrence Island	0	0	1	2	5	8
Port Clarence/Teller	3	4	4	1	5	17
Nome	3	4	4	5	4	20
Cape Blossom (Kotzebue)	2	2	4	4	3	15
Mekoryuk (Nunivak Island)	0	1	2	2	2	7
Cape Thompson (Point Hope)	4	2	5	0	3	14
Wainwright	4	1	3	0	2	10
Point Franklin	4	0	0	0	2	6
Barrow	3	1	5	4	1	14
Prudhoe Bay	2	1	4	3	1	11
Mary Sachs Entrance	2	1	3	0	0	6
Bethel	1	2	3	5	0	11
Cape Darby	1	4	0	0	3	8

Note: Oil and gas proximity is based on Outer Continental Shelf locations as land-based oil and gas operations are already in place. In addition, mining proximity considerations include multiple mines and resource types.

¹ <http://dec.alaska.gov/spar/perp/index.htm>

Intermodal connections

Intermodal connections for jet service or C-130 – gravel runways – was measured within 100 miles of the communities. The Federal Aviation Administration airport facilities data was used to determine this criterion.² Consideration was also given to the potential for road and rail connections. And then a final category was added to indicate if there was any marine infrastructure existing with the understanding the existing harbors are not adequate for deep-draft vessels.

Table 2 Intermodal Connections Criteria

Sites Considered from NWTF and Roads to Resources	Intermodal Connections			
	4=scheduled jet/existing road, 3=planned jet/road,2=scheduled turbo prop, 1=scheduled air taxi/charter/limited road, 0=none/potential			
	Air Service (jet service ranked higher than gravel runway)	Road potential	Marine infrastructure existing	Total
St. Paul Island	2	0	4	6
St. Lawrence Island	2	0	1	3
Port Clarence/Teller	1	1	1	3
Nome	4	1	4	9
Cape Blossom (Kotzebue)	4	1	1	6
Mekoryuk (Nunivak Island)	1	0	0	1
Cape Thompson (Point Hope)	1	0	0	1
Wainwright	2	0	0	2
Point Franklin	1	0	0	1
Barrow	4	0	0	4
Prudhoe Bay	4	4	1	9
Mary Sachs Entrance	0	0	0	0
Bethel	4	0	2	6
Cape Darby	1	0	0	1

Note: Road and Rail potential are based on known planning efforts. Marine infrastructure is based on existing infrastructure and not necessarily the capability to support deep-draft efforts.

² http://www.faa.gov/airports/airport_safety/airportdata_5010/menu/index.cfm.

Upland Support

Upland support criterion reflects whether the community could be considered a hub – one that supports other communities in the area. Hubs were identified based on their ability to support other communities. A major hub supports many other communities while a regional hub supports the immediate geographic area, a minor hub support a couple of other communities, and the community designation means that most goods are consumed within the community in question.

Table 3 Upland Support Criteria

Sites Considered from NWTF and Roads to Resources	Upland Support	
	Based hub concept - major hub = 5, regional hub = 4, minor hub = 3, community = 1, none/potential = 0	
	Hub status	Total
St. Paul Island	Community	1
St. Lawrence Island	Community	1
Port Clarence/Teller	Minor	3
Nome	Regional	4
Cape Blossom (Kotzebue)	Regional	4
Mekoryuk (Nunivak Island)	Community	1
Cape Thompson (Point Hope)	Community	1
Wainwright	Community	1
Point Franklin	Community	1
Barrow	Regional	4
Prudhoe Bay	Major	5
Mary Sachs Entrance	-	0
Bethel	Regional	4
Cape Darby	-	0

Note: Current population numbers were obtained from the Alaska Department of Labor and Workforce Development. <http://labor.alaska.gov/research/pop/popest.htm>

Water Depth

Water depth was measured as a function of depth from shore. Minus 35-feet mean lower low water (MLLW) and minus 45-feet MLLW were deemed appropriate depth measures to capture suitability for various deep-draft port users. If the distance to deep water was less than ½ mile, the site ranked as 5, between ½ mile and 1 mile was 4, 1 to 2 miles was 3, 2 to 5 miles was 2, 5 to 10 miles was 1, and more than 10 miles was 0. Total ranking for these criteria was the sum of both ranks (minus 35-feet and minus 45-feet). National Oceanic and Atmospheric Administration (NOAA) maps were used for water depth estimates with population centers deemed as the most likely spot for a deep-draft port site.

Table 4 Water Depth Criteria

Sites Considered from NWTF and Roads to Resources	Water Depth				
	function of distance - $\leq 1/2$ mile = 5, $> 1/2$ and ≤ 1 = 4, > 1 and ≤ 2 = 3, > 2 and ≤ 5 = 2, > 5 and ≤ 10 = 1, > 10 = 0)				
	miles to minus 35' (5.8 fathoms)	miles to minus 45' (7.5 fathoms)	rank for miles to minus 35'	rank for miles to minus 45'	Total
St. Paul Island	0.18	0.5	5	4	9
St. Lawrence Island	0.92	1.15	4	3	7
Port Clarence/Teller	0.08	1.67	5	3	8
Nome	0.24	0.54	5	4	9
Cape Blossom (Kotzebue)	1.7	4.6	3	2	5
Mekoryuk (Nunivak Island)	4.3	7.1	2	1	3
Cape Thompson (Point Hope)	1.7	2.2	3	2	5
Wainwright	0.92	1.27	4	3	7
Point Franklin	1.3	2.2	3	2	5
Barrow	0.7	1	4	3	7
Prudhoe Bay	6.9	7.8	1	1	2
Mary Sachs Entrance	4.25	5.1	2	1	3
Bethel	120	130	0	0	0
Cape Darby	0.08	0.13	5	5	10

Navigation Accessibility

Navigation accessibility measured as very good, good, medium, low, very low, and potential for ice season (months free of ice) and other natural considerations (weather, wind, wave, tides, and currents). Engineers familiar with Alaska conditions were queried on each of the fourteen sites in order to assign values to this criterion.

Table 5 Navigation Accessibility Criteria

Sites Considered from NWTF and Roads to Resources	Navigation Accessibility		
	5=very good, 4=good, 3=medium, 2=low, 1=very low, 0=potential		
	Ice conditions	Operational Considerations	Total
St. Paul Island	4	1	5
St. Lawrence Island	4	3	7
Port Clarence/Teller	3	4	7
Nome	3	4	7
Cape Blossom (Kotzebue)	2	4	6
Mekoryuk (Nunivak Island)	4	4	8
Cape Thompson (Point Hope)	2	3	5
Wainwright	2	3	5
Point Franklin	3	3	6
Barrow	1	4	5
Prudhoe Bay	1	4	5
Mary Sachs Entrance	1	4	5
Bethel	3	4	7
Cape Darby	3	3	6

Other Factors

Other factors that were considered initially as Arctic deep-draft port siting criteria include Sovereignty (which later became a port purpose), roads, National Environmental Protection Act (NEPA) considerations, future maintenance, harbor of refuge (also later became part of the port purpose), and land ownership issues. The team had a lengthy discussion of including cost as one of the criteria, but at this point in the study there is insufficient information available for accurate cost estimates. Once site(s) are selected and construction alternatives are developed, then cost should and will be used as a criterion in final selection for the “best” alternative(s) for consideration. Distance to deep water was deemed a suitable proxy for cost and in the final array, this criterion was given additional weighting in order to capture the cost element.

The following table summarizes the criteria and the qualitative or quantitative input values that were assigned for running the MCDA tool.

Table 6 Summary of Decision Criteria

Criteria	Qualitative Value	Quantitative Value
Port Proximity	very good = 5, good = 4, medium = 3, low =2, very low = 1, potential = 0	time and distance from OCS oil and gas endeavors, mining operations and potential, oil spill response existing, community resupply, and shipping lanes
Intermodal Connections	2=existing, 1=planned, 0=none/potential	air service within 100 miles, jet service assumes 4,000' runway needed, gravel runway for C-130, road and rail potential is to Railbelt or other communities, harbors constitute existing marine infrastructure
Upland Support	Based hub concept - major hub = 5, regional hub = 4, minor hub = 3, community = 1, none/potential = 0	based on hub concept where a major hub serves many communities, a regional hub serves a geographic region, minor hub serves some nearby communities, and a community has very little transfer of goods to areas outside its home
Water Depth	function of distance - <=1/2 mile = 5, >1/2 and <=1 = 4, >1 and <=2 = 3, >2 and <=5 = 2, >5 and <=10=1,>10 = 0)	-35 (5.8 fathoms) or -45 (7.5 fathoms) Function of distance from shore
Navigation Accessibility	very good = 5, good = 4, medium = 3, low =2, very low = 1, potential = 0	months ice conditions allow traffic, and engineering considerations (wind, wave, tides, currents)

ANALYSIS

Initially, the Study Team used the MCDA software weighting all criteria equally to see which locations bubbled up to the top for consideration. The water depth criterion included ranking for distances to minus 35-ft and minus 45-ft which is a criterion that we modify in subsequent runs.

For the next round of runs using the MCDA software, we applied more weight (i.e. importance) to the distance to deep water before running the model. Distance to deep water was assumed a proxy for cost, as annual or periodic dredging to maintain a necessary depth would be very expensive. Again, we ran all the port missions as one run to determine if there was one site that would best meet all needs. The top five results from each of those runs are displayed in the following tables. We also ran the model applying more weight to “Navigation Accessibility” because that criterion determines the number of months the port could be used throughout the year. Of all the criteria, “Distance to Deep Water” and “Navigation Accessibility” were determined more important in port siting.

Nome, Cape Blossom (Kotzebue), and Port Clarence (Teller) are the top choices when all criteria are weighted the same. Nome remains in the top spot when water depth as a proxy for cost is given additional weight followed by either Port Clarence (Teller) or Cape Darby.

Table 7 - First Round of Evaluation – All locations, all criteria

Rank	Equal Wts		5X water depth		10X water depth		5X water, 2X navigation		2X water, 5X navigation	
	Port	Score	Port	Score	Port	Score	Port	Score	Port	Score
1	Nome	0.9150	Nome	0.9083	Nome	0.9054	Nome	0.9050	Nome	0.8975
2	Cape Blossom (Kotzebue)	0.6933	Port Clarence (Teller)	0.7398	Cape Darby	0.8222	Port Clarence (Teller)	0.7533	Port Clarence (Teller)	0.7758
3	Port Clarence (Teller)	0.6167	Cape Darby	0.7235	St Paul Island	0.7780	Cape Darby	0.7511	Cape Darby	0.7511
4	Prudhoe Bay	0.6750	St Paul Island	0.7102	Port Clarence (Teller)	0.7613	St Paul Island	0.7017	Cape Blossom (Kotzebue)	0.6967
5	Barrow	0.6539	Barrow	0.6744	Barrow	0.6835	Barrow	0.6694	St Lawrence Island	0.6708

Note: The scores depicted in these tables are a percent of the total.

For the second round of runs using the MCDA tool, we narrowed the potential sites to those closest in proximity to serve Outer Continental Shelf (OCS) oil/gas and the mining missions. The Study Team consulted with DOT&PF personnel most familiar with oil and gas and mining potential in the state and the Commissioner for the Department of Natural Resources to look at the list of 14 potential sites and indicate which sites would be appropriate locations for support infrastructure. Table 8 shows the port sites with the greatest potential to support Oil/Gas and Mining.

Table 8 – Sites Considered by Port Purpose for Oil and Gas and Mining

Sites Considered from NWTF and Roads to Resources	Oil and Gas (OCS) potential	Mining potential
St. Paul Island		
St. Lawrence Island		
Port Clarence (Teller)	X	X
Nome	X	X
Cape Blossom (Kotzebue)		X
Mekoryuk (Nunivak Island)		X
Cape Thompson (Point Hope)		X
Wainwright	X	X
Point Franklin	X	
Barrow	X	
Prudhoe Bay	X	
Mary Sachs Entrance	X	
Bethel		X
Cape Darby		X

Seven sites were deemed appropriate for Oil and Gas support for the Outer Continental Shelf locations and eight sites were deemed appropriate for mining support. Again, we ran these sites through the MCDA software using the criteria with equal weights, then added weight to the distance to deep water, and then added weight to navigation conditions and water depth. Results are displayed in the following tables. For Oil and Gas, the Study Team determined that the water depth needed was minus 35-feet and for Mining the desired water depth was minus 45-feet. So this criterion was limited for these two runs of MCDA. Some mining endeavors would not need water to minus 45-feet but at this point in the analysis, the team attempted to encompass all mining potential for the region.

Table 9 - Second Round of Evaluation – Oil and Gas locations, all criteria

Rank	Equal Wts		5X water depth		10X water depth		5X water, 2X navigation		2X water, 5X navigation	
	Port	Score	Port	Score	Port	Score	Port	Score	Port	Score
1	Nome	0.9600	Nome	0.9778	Nome	0.9857	Nome	0.9800	Nome	0.9800
2	Port Clarence (Teller)	0.7567	Port Clarence (Teller)	0.8648	Port Clarence (Teller)	0.9131	Port Clarence (Teller)	0.8783	Port Clarence (Teller)	0.8783
3	Prudhoe Bay	0.6929	Barrow	0.7399	Barrow	0.7613	Barrow	0.7373	Barrow	0.7116
4	Barrow	0.6917	Wainwright	0.6263	Wainwright	0.6883	Wainwright	0.6351	Prudhoe Bay	0.6521
5	Wainwright	0.4873	Point Franklin	0.4965	Point Franklin	0.5334	Point Franklin	0.5325	Point Franklin	0.6097
6	Point Franklin	0.4137	Prudhoe Bay	0.4738	Prudhoe Bay	0.3676	Prudhoe Bay	0.4979	Wainwright	0.6094
7	Mary Sachs Entrance	0.2829	Mary Sachs Entrance	0.3349	Mary Sachs Entrance	0.3582	Mary Sachs Entrance	0.3729	Mary Sachs Entrance	0.4671

Note: The water depth criterion for the Oil and Gas locations is minus 35 feet.

Nome, Port Clarence (Teller), and Prudhoe Bay are the top sites for Oil and Gas support when all the criteria is weighted equally. Barrow becomes the number three choice replacing Prudhoe Bay when water depth is given additional weight.

Table 10 - Second Round of Evaluation – Mining locations, all criteria

Rank	Equal Wts		5X water depth		10X water depth		5X water, 2X navigation		2X water, 5X navigation	
	Port	Score	Port	Score	Port	Score	Port	Score	Port	Score
1	Nome	0.9350	Nome	0.8750	Nome	0.8482	Nome	0.8750	Nome	0.8975
2	Cape Blossom (Kotzebue)	0.7133	Cape Darby	0.6957	Cape Darby	0.8044	Cape Darby	0.7011	Port Clarence (Teller)	0.7508
3	Port Clarence (Teller)	0.6817	Port Clarence (Teller)	0.6454	Port Clarence (Teller)	0.6292	Port Clarence (Teller)	0.6683	Cape Blossom (Kotzebue)	0.6967
4	Bethel	0.6183	Cape Blossom (Kotzebue)	0.5741	Wainwright	0.5427	Cape Blossom (Kotzebue)	0.5917	Bethel	0.6592
5	Cape Darby	0.4522	Wainwright	0.5108	Cape Blossom (Kotzebue)	0.5119	Wainwright	0.5222	Cape Darby	0.6261
6	Wainwright	0.4394	Cape Thompson (Point Hope)	0.4096	Cape Thompson (Point Hope)	0.4062	Cape Thompson (Point Hope)	0.4311	Mekoryuk (Nunivak Island)	0.6111
7	Cape Thompson (Point Hope)	0.4172	Bethel	0.3435	Mekoryuk (Nunivak Island)	0.2651	Bethel	0.3967	Wainwright	0.5297
8	Mekoryuk (Nunivak Island)	0.3822	Mekoryuk (Nunivak Island)	0.3012	Bethel	0.2208	Mekoryuk (Nunivak Island)	0.3711	Cape Thompson (Point Hope)	0.4986

Note: The water depth criterion for the Mining locations is minus 45 feet.

Nome, Cape Blossom (Kotzebue), and Port Clarence (Teller) assume top spots for mining support when all criteria are weighted equally. Cape Darby replaces Cape Blossom (Kotzebue) when water depth is given additional weighting for the criteria.

For the third round of runs using the MCDA tool, “port proximity” criterion was limited to existing oil spill response, community resupply, and shipping lanes. It was thought that by including Oil and Gas and Mining in this criteria that there might be double-counting. Results are displayed in the following tables. The results from this evaluation are consistent with the results from Table 9. The scoring changed somewhat but the order of the port sites remains the same.

Table 11 Results –Third Round of Evaluation – Oil and Gas locations, port proximity criteria limited

Rank	Equal Wts		5X water depth		10X water depth		5X water, 2X navigation		2X water, 5X navigation	
	Port	Score	Port	Score	Port	Score	Port	Score	Port	Score
1	Nome	0.9600	Nome	0.9778	Nome	0.9857	Nome	0.9800	Nome	0.9800
2	Port Clarence (Teller)	0.7405	Port Clarence (Teller)	0.8558	Port Clarence (Teller)	0.9073	Port Clarence (Teller)	0.8703	Port Clarence (Teller)	0.8703
3	Prudhoe Bay	0.7059	Barrow	0.7476	Barrow	0.7663	Barrow	0.7442	Barrow	0.7185
4	Barrow	0.7056	Wainwright	0.6135	Wainwright	0.6801	Wainwright	0.6235	Prudhoe Bay	0.6587
5	Wainwright	0.4642	Prudhoe Bay	0.4811	Point Franklin	0.5230	Point Franklin	0.5179	Wainwright	0.5978
6	Point Franklin	0.3844	Point Franklin	0.4802	Prudhoe Bay	0.3807	Prudhoe Bay	0.5044	Point Franklin	0.5951
7	Mary Sachs Entrance	0.2690	Mary Sachs Entrance	0.3272	Mary Sachs Entrance	0.3532	Mary Sachs Entrance	0.3659	Mary Sachs Entrance	0.4602

Note: The water depth criterion for the Oil and Gas locations is minus 35 feet.

Table 12 Results - Third Round of Evaluation – Mining locations, port proximity criteria limited

Rank	Equal Wts		5X water depth		10X water depth		5X water, 2X navigation		2X water, 5X navigation	
	Port	Score	Port	Score	Port	Score	Port	Score	Port	Score
1	Nome	0.935	Nome	0.8750	Nome	0.8482	Nome	0.8750	Nome	0.8975
2	Cape Blossom (Kotzebue)	0.732	Cape Darby Port	0.6769	Cape Darby Port	0.7923	Cape Darby Port	0.6842	Port Clarence (Teller)	0.7428
3	Port Clarence (Teller)	0.665	Clarence (Teller)	0.6364	Clarence (Teller)	0.6234	Clarence (Teller)	0.6603	Cape Blossom (Kotzebue)	0.7063
4	Bethel	0.631	Cape Blossom (Kotzebue)	0.5848	Wainwright Cape Blossom (Kotzebue)	0.5344	Cape Blossom (Kotzebue)	0.6013	Bethel	0.6657
5	Cape Darby	0.418	Wainwright Cape Thompson (Point Hope)	0.4980	Cape Thompson (Point Hope)	0.5188	Wainwright Cape Thompson (Point Hope)	0.5107	Mekoryuk (Nunivak Island)	0.6223
6	Wainwright	0.416	Hope)	0.4002	Hope)	0.4001	Hope)	0.4226	Cape Darby	0.6092
7	Mekoryuk (Nunivak Island)	0.4045	Bethel	0.3508	Mekoryuk (Nunivak Island)	0.2730	Bethel	0.4032	Wainwright	0.5181
8	Cape Thompson (Point Hope)	0.4003	Mekoryuk (Nunivak Island)	0.3133	Bethel	0.2256	Mekoryuk (Nunivak Island)	0.3823	Cape Thompson (Point Hope)	0.4901

Note: The water depth criterion for the Mining locations is minus 45 feet.

The results from this evaluation are consistent with the results from Table 10. The scoring changed somewhat but the order of the port sites remains the same except that Mekoryuk (Nunivak Island) and Cape Thompson (Point Hope) switched positions for the equal weights run. Mekoryuk was in the 8th rank and moved to the 7th while Cape Thompson was in the 7th and moved to the 8th position on the table.

COMMENTS

Below is a summary of top three sites for a deep-draft Arctic port for all purposes and then also for Oil & Gas and Mining purposes. From our stakeholder interviews, we know Water Depth and Navigation are the most important criteria so in looking at the results with those factors receiving additional weight is most relevant. It is notable that Nome and Port Clarence (Teller) are listed in the top spots in nearly all the runs through the MCDA model. Cape Darby with its naturally deep water also gets high marks and Barrow with its upland support system ranks high as well.

All purposes, all criteria, equal weights

1. Nome
2. Port Clarence (Teller)
3. Cape Darby

Oil & Gas Sites – water depth limited to minus 35-feet

1. Nome
2. Port Clarence (Teller)
3. Barrow

Mining Sites – water depth limited to minus 45-feet

1. Nome
2. Cape Darby
3. Port Clarence (Teller)