

Paper #7-17

CONSTRUCTION MATERIALS BETWEEN THE CHUKCHI SEA AND DALTON HIGHWAY

Prepared for the
Technology & Operations Subgroup

On March 27, 2015, the National Petroleum Council (NPC) in approving its report, *Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources*, also approved the making available of certain materials used in the study process, including detailed, specific subject matter papers prepared or used by the study's Technology & Operations Subgroup. These Topic Papers were working documents that were part of the analyses that led to development of the summary results presented in the report's Executive Summary and Chapters.

These Topic Papers represent the views and conclusions of the authors. The National Petroleum Council has not endorsed or approved the statements and conclusions contained in these documents, but approved the publication of these materials as part of the study process.

The NPC believes that these papers will be of interest to the readers of the report and will help them better understand the results. These materials are being made available in the interest of transparency.

The attached paper is one of 46 such working documents used in the study analyses. Appendix D of the final NPC report provides a complete list of the 46 Topic Papers. The full papers can be viewed and downloaded from the report section of the NPC website (www.npc.org).

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Topic Paper

(Prepared for the National Petroleum Council Study on Research to Facilitate Prudent Arctic Development)

7-17	Construction Materials between the Chukchi Sea and Dalton Highway
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Date: December 2014	Revision: Final
SUMMARY There is high degree of uncertainty on the quantity and quality of sand, gravel and rock resources between Chukchi Sea and Dalton Highway. There is very little publicly available data on the quantity and quality of materials of these various deposit types; however, geologic formations are present in the NPRA and Chukchi Sea areas that elsewhere contain usable construction materials. This suggests that exploration may be able to locate sufficient materials to support oil and gas development, but at this point the level of information is insufficient to say whether or not the resources are present. The availability of more complete information would greatly inform this discussion.	

INTRODUCTION

When considering the need for sand and gravel for pipeline construction it should be noted that TAPS is only buried where foundation soils are suitable for a buried pipeline, elsewhere it is above ground. The majority of the coastal plain west of the Colville River is covered by thaw lake complexes, which suggests that a pipeline traversing this region will largely be above ground. An above-ground line would require less sand and gravel.

Road embankments need not be constructed entirely of high-quality materials. The lower sections of highway embankments can be constructed of fine-grained and frost-susceptible materials, with just the upper foot or two made up of better-draining and more durable materials. This, or other similar techniques employed with the specific intent to limit the volume of higher quality materials required, would be beneficial if sand and gravel are limited in availability.

There is a fair body of work indicating that east of the Colville River, construction resources are sufficiently abundant and of high-enough quality to support development activities. Construction materials in this area are located in modern alluvial valleys and along modern rivers, and in young, unconsolidated bedrock units, as well as in glacial outwash deposits closer to the Brooks Range.

Little is known of the availability of sand and gravel between the Chukchi Sea and the Dalton Highway corridor. This area includes several geologic formations with potential to be sources of rock or sand and gravel for natural resource development, as well as associated infrastructure needs. Unfortunately, we are aware of only very limited hard data on the quality and potential volumes of materials available within these formations.

Generally the surficial geology within the NPRA transitions, from south to north, from shallow bedrock to windblown silt to marine sand, and then marine silts closest to the modern coastline. The types of material sources potentially available between the Chukchi Sea and TAPS transition fairly systematically from bedrock sources near the Brooks Range through alluvial to beach deposits and finally marine deposits in the Chukchi and Beaufort Seas.

BEDROCK POTENTIAL

East of the NPRA, widely distributed bedrock deposits of poorly consolidated sandstone and conglomerate of the Sagavanirktok Formation underlie the White Hills, approximately 12 to 35 miles west of the Sagavanirktok River and 45 miles southwest of Prudhoe Bay, where about 160 feet of these deposits are exposed (Mull and others, 2003). Poorly consolidated sandstone and conglomerate of the Sagavanirktok Formation (Franklin Bluffs Member) are also present along the Sagavanirktok and Colville River valleys. These deposits contain significant volumes of materials and represent potential sources of sand and gravel for construction use.

In the NPRA, possible opportunities for bedrock sources are limited to the southern portion of the reserve. Within this broad area the rocks have been more deeply buried and are harder toward the south and west.

In the southeastern NPRA the Upper Cretaceous Prince Creek and Schrader Bluff Formations are discontinuously exposed along river cuts and represented by rubble traces along the crests and flanks of east–west-trending hills. These formations comprise laterally extensive bluff exposures along the Colville River in the vicinity of Umiat and downstream of that location. These consist of interbedded mudstone, sandstone, and minor conglomerate; thick accumulations of sandstone are relatively common. These units are not well indurated and will only locally be suitable for use.

Toward the west, but still in the southern NPRA, these units give way to older, harder mudstone and sandstone of the Nanushuk Formation. At Corwin Bluffs on the Chukchi Sea coast, the Nanushuk includes many hundreds of feet of pebble, cobble, and boulder conglomerate. These units will be more suitable for construction use, and may require quarrying and crushing prior to use. Nanushuk units, where adequately indurated, may have potential as a source for larger rock products such as riprap.

On the Chukchi coast, near Cape Lisburne, abundant well-indurated limestone may, depending on its quality, have potential to produce large quantities of aggregate and larger rock suitable for riprap or armor stone. This material would require quarrying and crushing prior to use.

ALLUVIAL DEPOSITS

Along, and east of the Colville River, alluvial gravels are abundant and high quality. There is generally little difficulty finding sand and gravel between the Colville River and the Dalton Highway. Sand and gravel alluvium is abundant along most of the larger rivers crossing this area. These rivers have their headwaters in the Brooks Range and move large quantities of sand and gravel. Sand and gravel underlie adjacent lightly vegetated abandoned floodplains and low terraces (Mull and others, 2004, 2005).

In the NPRA, rivers and streams west and north of the Colville River generally have lower gradients, do not source in the Brooks Range, and are not associated with significant gravel deposits. However, available maps indicate the upper reaches of many of the larger drainages contain fine, sandy gravel and gravelly sand, which transitions downstream into sand with minor gravel or silt. Williams and others (1977) describe the alluvial deposits being of small volume, commonly resting directly on bedrock in major streams west of 156°W; east of 156°W, the alluvial deposits on the coastal plain are described as sandy, with gravel lacking in most of the area. Alluvial sand with minor gravel is mapped as widespread between Teshekpuk Lake and the Topagoruk River (south of Admiralty Bay; Williams and others, 1977).

Paleo-Beach Deposits

Surficial geology maps indicate several old beach lines occur between the Brooks Range foothills and the coast. Near Barrow, recent work indicates beach deposits along one of these old beach lines contain sandy gravel to gravelly sand, suitable for construction use. The Barrow airport is constructed on and out of the material from one of these old beach deposits. These deposits are described as “Chiefly coarse to fine sand, granule and pebble gravel. Cobbles as large as 12 cm diameter occur commonly as a surface layer, but also occur as stratified beds and lenses in the finer gravel deposits” (Williams and others, 1977). The authors considered this material to be generally good for construction, but it may require binder or stabilization for use as fill, base course, or surface course. The deposit may not be suitable as concrete aggregate due to the presence of chert and coal fragments. Little is known of the nature of these deposits at other locations on the Arctic Plain, but they would make attractive locations to investigate as potential material sources.

MODERN BEACHES AND OFFSHORE SAND AND GRAVEL DEPOSITS

Marine sands and gravels are most typically concentrated in features such as modern beaches, shoals, modern/relict deltas, submerged coastlines, submerged valleys, and glacial outwash plains; all are present on the Beaufort and Chukchi coastal shelves. Stauffer (1987) estimated modern beach deposits alone along the Chukchi Sea coast to host 2×10^8 m³ of sand and gravel.

The Beaufort coastline has a narrow shelf with active sedimentary processes dominated by an abundance of silt and mud; this suggests there is a fair amount of overburden overlying any coarse material deposits in this region. On the Chukchi coast, swift prevailing currents, a coarser active sediment regime, and a wider continental shelf make it a more favorable setting for the existence and identification of sand and gravel resources on the seafloor.

Little work has been done to map marine aggregate deposits in these regions; the last comprehensive assessment was by Stauffer in 1987. New surveys in these regions could provide multiple benefits including (1) identifying marine aggregate borrow areas, (2) improving navigational charting along growing shipping corridors, and (3) generating near-shore surface models critically needed to improve coastal flood and erosion vulnerability assessments, and (4) assessing the effects of marine mining, all important for future development.

In the most general terms, while both coastal areas may have significant sand and gravel deposits, it appears the Chukchi has the higher potential.

RIPRAP AND ARMOR STONE AVAILABILITY

These materials are needed for erosion control measures at stream and river crossings and marine developments. Both of these products are in short supply along the Arctic coast and coastal plain. Currently the closest source to Prudhoe Bay is 150 miles south on the Dalton Highway. The closest developed coastal source is 900 miles away at Cape Nome in Norton Sound. It is unlikely to find a source of these materials inland between the Chukchi Sea coast and the Dalton Highway north of the Brooks Range. The closest alternative to the Cape Nome quarry are where the Lisburne group limestones and Nanushuk sandstones intersect the coast near Cape Lisburne. A quarry developed in this location would be about 400 miles closer to any development to the north than Cape Nome, and also be able to supply coarse material to northwestern coastal communities.

SUMMARY

Considering this information, sand and gravel and rock resources are not obviously abundant. Finding and developing these resources will not be without challenges. The materials will be more expensive than in locations where they are more abundant and easier to locate and develop. Additionally, there is very little publicly available data on the quantity and quality of materials of these various deposit types. The availability of more complete information would greatly inform this discussion.

In summary, while little has been done to identify sand and gravel resources in this part of the state, geologic formations are present in the NPRA and Chukchi Sea areas that elsewhere contain usable construction materials. This suggests that exploration may be able to locate sufficient materials to support oil and gas development, but at this point the level of information is insufficient to say whether or not the resources are present.

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