

(d) The protection of the delicate Arctic ecology. (The precipitation in the area is such that in the temperate zone it would produce desert conditions and is equivalent to only about seven inches of rainfall a year. Growth is slow and damage to the environment is only gradually repaired. For this reason, if oil were to be piped from Prudhoe Bay to Babbage Bight for shipment, an underwater pipeline along the Arctic coast would be preferable to one built overland. Offshore sandbars would offer protection to such a pipeline.)

(e) Essential to the success of any such operation is the ability of the shipbuilding industry to produce super tankers with ice-breaking capacity capable of operating in the Arctic the year round. (The report assumes that it would be possible to build such ships of 360,000 deadweight tons, able to carry 2 million barrels of oil on every voyage.)

The report envisages as a practical means of transferring oil from shore tank-farms to loading facilities about three miles offshore, not a conventional wharf, but two concrete mooring structures or "dolphins", spaced so that a large tanker could be secured fore and aft to the pair.

These cylindrical "breasting dolphins", as they are called, would rest on rock-fill foundations in 90 feet of water, topped by octagonal platforms 40 feet above the surface, which would provide space for helicopter platforms and oil-transfer machinery and loading arms. The helicopter platforms would enable operating personnel to be transferred to and from shore, regardless of sea conditions or foul weather.

The octagonal platforms, measuring 150 feet across, would have space for machinery, services and crew, directly below the upper deck. The substructure is two concrete caissons, each 100 feet in diameter, which would be towed to the site.

Design of the pipeline, which would extend three miles or so over the seabed from the tank-farm on shore, has to take into consideration the melting of the permafrost beneath it. It is considered that the specific gravity could be adjusted to impose very little weight on the surface carrying the pipe. There should be adequate warning of the approach of drifting ice island fragments, which might drag along the bottom and sever the pipeline. In such an emergency, the oil would be pumped back into shore tanks and the line filled with seawater.

Overland sections of pipeline would be built well above ground level except for the short section right at the shoreline, which might be damaged by ice. It would be buried, encased in a refrigerated jacket.

SITES

The sites considered as potentially useful for marine oil terminals lie south of the clockwise circulation

of heavy drift ice and ice islands or their remnants in the Beaufort Sea. The Herschel Island and Babbage Bight locations have the further advantage that the land-fast ice forming in Mackenzie Bay in early winter offers a barrier against the heavy drift ice.

The two other sites considered suitable for marine structures, at Horton River on Franklin Bay and Clapperton Island in Darnley Bay, are some 300 miles to the east of Herschel Island. Because of the intervening terrain, in particular the Mackenzie River delta, a pipeline from Prudhoe Bay would not be practical. However, such sites could usefully serve oil fields on the Tuktoyaktuk Peninsula, where a discovery has already been made and could be used to tranship oil, from the Arctic islands, where intensive exploration is underway and natural gas discovered.

HERSCHEL ISLAND

The major oil-strike at Prudhoe Bay on the north slope of Alaska, which took place towards the end of the Sixties, brought a new urgency to the problem of getting crude oil out of the Arctic to supply southern markets.

Ken A. Rowsell, project manager of the Herschel Island study conducted by the federal Department of Public Works into the practicability of establishing a marine oil terminal at the edge of the Beaufort Sea, points out that the most dramatic and exciting of the various proposed solutions to the oil transportation problem was the "Manhattan Project". This envisaged powerful icebreaking supertankers battering their way through the polar ice pack in the dead of winter on a clockwork schedule.

"Long before the *Manhattan* made her final Arctic cruise, the early optimism was clouded somewhat by the realization that the north coast of Alaska was far from being an ideal location for a deep-water terminal," Mr. Rowsell observes.

"On the shallow continental shelf fringing the north shoreline of Alaska, the required water-depth for large tankers does not exist at points closer to the shore than about 30 miles. A terminal at any location off this shoreline would therefore be in waters where vessels would be at the mercy of the permanent polar ice pack which continuously rotates in clockwise direction in the Beaufort Sea.

"No surface vessel has ever sailed these waters in the dead of winter and no structure has ever been built in them. The construction and dependable operation of an ocean terminal under these conditions is difficult to imagine, to say nothing of piping crude from the north slope some 30 miles under the ice-pack where the ocean-floor is deeply scored and gauged by drifting ice masses, whether they be ice-island fragments or pressure-ridge remnants.

"The only bright spot in this otherwise dismal