Little Diomede Island Seawater Intake Feasibility Report

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VECO Polar Resources

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1. Executive Summary

This report presents the feasibility of the installation of a seawater intake located at the City of Diomede on Little Diomede Island, Alaska. Several seawater intake installation methods were investigated: horizontal directional drilling (HDD); a blasted trench and anchored casing pipe; excavated trench and anchored pipeline (winter construction); excavated trench and anchored pipeline (summer construction); and anchored pipeline without an excavated trench. The feasibility of each installation method focused on constructability, logistics, construction risk, operational risk, estimated longevity and cost. The preferred installation method, HDD, was selected based upon these criteria.

Subsurface explorations, laboratory testing and geotechnical engineering studies were conducted to obtain actual on-site conditions which were used to develop the feasibility report. The subsurface explorations, laboratory testing and geotechnical engineering studies were conducted by Peratrovich, Nottingham and Drage and are presented in the Appendix of this report.

2. Introduction

Little Diomede Island is located 135 miles northwest of Nome in the middle of the Bering Strait. The village, located on the west side of the island has 133 residents who live a subsistence lifestyle. Access to the island is by helicopter during the ice-free months and by small fixed wing aircraft during the period when the sea ice is stable enough to construct a runway, usually from February into May.

The Arctic Environmental Observatory is located at the high school on the north end of the village. A temporary seawater intake line was installed in the summer of 2000 and 2001. The line was incased in a 4” ABS pipe through the surf zone and laid on the seafloor out to a distance of a 130 feet from the shore in 10 feet of water. This method of installation was not reliable, requiring maintenance after summer storms and was vulnerable to damage by sea ice. To reduce the risk of damage to the seawater intake lines and create a long term, low maintenance installation several options have been proposed. The proposed permanent intake is to be located in 26± feet of water, 600± feet from shore to ensure that it is operable through the winter.

This report addresses the feasibility of four intake structure concepts, the logistics of each option will be described, comparisons of the risk and cost of each will be presented. From these comparisons, one option will proposed as the recommended intake structure.

3. Site Information

General Site Conditions

Little Diomede Island is approximately two square miles in area and rises 1300’ above the Bering Strait. The island is composed of talus and bedrock of porphyritic granite. The shoreward end of the proposed seawater intake line is at the base of a talus slope that has been benched for construction of the Diomede High School, the school heat plant and water storage tanks. The bench is 15'-20' above and 35' back from the shore. The slope down to the shore consists of 2-4' sub-angular boulders that become smaller and more rounded toward the shore. This armor slope poses difficult access to the start of the intake at the school.

Underwater video of the temporary intake line on the seafloor out to 150 ft off shore shows rounded cobbles covered in seaweed. At 300 ft, sand and boulders were found at the surface. At 500 ft offshore, a three-foot layer of sand and broken shells were found at the surface of the seafloor. Local residents indicated that sediment from landslides into the sea occurring on the north end of the island, is transported through the area. At 600 ft offshore bedrock was exposed at the surface.

Geotechnical Investigation

PN&D conducted a subsurface investigation at the site from March 6 to April 5, 2002. The investigation consisted of seven testholes to depths of 15 to 49 feet from the ice surface. The complete Geotechnical Report is located in Appendix C.

General Subsurface Conditions

Prior to this project, no subsurface investigations near the proposed landing site of the seawater intake line had been completed. Local residents who worked on construction of the high school just south of the site said that sand and boulders were encountered when excavating for the foundation. Larsen Engineering performed a site investigation for the school foundation. Approximately 150 ft south of the site, three test holes were dug to a depth of up to 6 ft. The hole located nearest the shore had medium-course sand cobble and boulders up to 3 ft diameter. The two holes inshore had fewer cobbles and boulders with sand and fines. Frozen soil was encountered 2.5 to 3 ft deep.

Bedrock is found at an average elevation of 933 ft (arbitrary datum of 1,000 feet at the high school foundation), approximately 40 feet below the sea ice surface. The top of bedrock is relatively flat, with elevations in most testhole locations ranging from 928 ft to 940 ft. Material overlaying the bedrock ranged in thickness from 38 ft inshore to 0.5 ft furthest off-shore. The rock cores obtained from testholes have Rock Quality Designations (RQD's) ranging from 23% to 70% and compressive strength of 19,000 to 21,000 psi .

4. Design Criteria

Ice Design Criteria

Based upon experience in the area and ice design criteria studies at nearby locations, PN&D has produced statistical estimates of level ice thickness for Kotzebue station, approximately 180 miles away. The results of the study should be directly applicable to the Little Diomede facility. The 2, 10 and 100 year design ice thicknesses are 49, 56 and 63 inches respectively. If exposed, the structure should be designed to withstand the ice sheet resting, grinding or crushing against it. Design sea ice strength values of 50 psi for bending strength and 280 psi for compressive strength (crushing) should be used.

As the level ice sheet forms during winter, it freezes around any near shore objects such as armor stone, debris or exposed structures. When the ice sheet moves due to a storm, currents, impacts, etc. any object encapsulated within the ice sheet will likely be moved or along with the ice floe and plucked from its original location. Therefore any exposed structures should be designed to be protected from or to resist these plucking forces.

In addition to the ice conditions discussed above, single-year and multi-year rubble ice or rafted ice will occur as moving floes of level ice collide, ride up over and freeze to each other creating a much thicker ice mass. This process creates sails (above the level ice thickness) and keels (below the level ice thickness). The keels of rubble ice have been measured to be up to 35 feet deep in the general area (near Kotzebue). Therefore, if exposed, the intake structure must be capable of withstanding ice gouging and crushing forces along it's entire length.

View to the north of Diomede High School and steep rock slope at the shore. The Science Shack is underneath the building at the far end of the school.

Ocean Waves

Due to the exposed location of Diomede Island wave heights can be very high. The size of stones on the beaches in the area are an indication of the high wave energy. Any structure in the surf zone must be designed to resist these forces or be protected from them.

Environmental
The above water portions of the intake structure will be operating in temperature extremes of +70°F to –60°F. The underwater portions will be exposed to a more limited range of temperatures of approximately +40°F to +27°F. The Bering Sea supports a tremendous variety of plant and animal life, especially during the summer months. The intake structure must be designed to accommodate the bio-fouling or be easily serviced or cleaned periodically. Methods such as hot water back-flushing have been used successfully for similar intakes at other locations.

5. Intake Structure Concepts

Five intake structure concepts were examined to determine the feasibility, logistics, rough order of magnitude (ROM) costs, and associated construction and operation risks. The concepts investigated were horizontal directional drilling (HDD), excavated trench and buried casing pipe (summer construction), excavated trench and buried casing pipe (winter construction), blasted trench and buried casing pipe, and exposed casing pipe anchored to the sea floor. The results of the investigation and research indicate that the HDD concept appears to have the highest chance of installation success with the least long-term risk, resulting in the lowest annualized cost. Therefore HDD is the recommended intake structure, it will be discussed in more detail than the other alternatives.

5.5 Horizontal Directional Drilling (HDD)

Description
HDD is a specialized type of drilling which can drill through most any type of material including cobbles and high quality granite rock which are found at this site. The direction of the drill bit is controlled at the surface by an operator on the drill rig. A transmitter/receiver apparatus or a wireline are used to communicate with the bit. The radius which can be drilled by HDD depends on the stiffness of the drill stem, type of equipment and subsurface conditions. A general rule of thumb for radius of curvature is 100 ft per inch diameter of drill stem, (approximately 600 ft radius for this project). Bentonite drilling mud is used to lubricate the drill stem, help hold the drill hole open in soft soils, and to transport the drill cuttings out of the hole.

Based upon the geotechnical report and discussions with HDD contractors, the drilling portion of the project is considered to be difficult but well within normal realms of risk for the industry. Drilling through cobbles and boulders can be challenging as the drill bit may try to wander off course and the drilled hole can collapse as cobbles shift. The high quality bedrock (20,000 psi) found at this site is regularly drilled in the industry, several contractors noted drilling up to 40,000 psi rock. Specialized hard rock drilling equipment will be required but it should not pose great difficulty.

Discussions with several experienced HDD contractors have resulted in the recommendation of recently developed equipment for this project, the JT4020 All Terrain manufactured by Ditch Witch. This equipment is much smaller than typical

HDD machines yet develops high thrust of 40,000 lb. This small self-propelled drill rig is designed specifically for drilling the type of hard rock and cobbles found at this site. The size, mobility and weight of the rig make it ideal for transportation and accessing difficult and remote sites. Information on this equipment has been included in Appendix B.

The Ditch Witch JT4020 and an experienced drilling crew will be used in September 2002 to drill up to three 800-ft long holes in fractured volcanic rock at Ascension Island in the South Atlantic Ocean for the Navy. While the transportation and logistics at Ascension Island are not as difficult as Little Diomede, it is a very remote location with minimal on-site support. Steps are being taken to anticipate foreseeable problems and ensure that all necessary supplies, parts and equipment are available should they be necessary. The lessons learned during the Ascension Island installation should be reviewed, evaluated and applied to the Little Diomede project.

The proposed drilled bore at Little Diomede will be approximately 10 inches in diameter, allowing a 6 inch inside diameter (7 in outside diameter) HDPE pipe to be installed in the bore. This should provide more than ample space for water sampling lines, fiber optics, heat trace and electrical conduits as well as room for expansion in the future.

Due to the drill angle of incidence with the fairly shallow bedrock, the drill bit could skid along the gravel / bedrock interface and have difficulty starting the penetration into bedrock. Slow, careful drilling and an experienced crew will minimize the possibility of this situation. However, it is conceivable that bedrock penetration may not be possible due to bedrock slope, etc. This would make the drilling operation more difficult as the entire bore would be through the gravel / cobble layer. Additionally, the bore may surface at a distance or water depth less than that desired if there is exposed bedrock on the sea floor less than 600 ft off-shore. While this scenario is unlikely, the scientific effects of a seawater intake located closer to shore should be considered and evaluated.

Approximately 60 tons of equipment and supplies are required (not including water for drilling mud). The required equipment includes a self-propelled, track mounted drilling unit; skid or trailer mounted units consisting of mud mixing tanks; a mud recycling system; drill pipe racks; and cuttings pit.

A significant amount of set-up room is required for the drill rig and supporting equipment. A bare minimum of 50 ft by 50 ft has been suggested by knowledgeable contractors. This presents a major problem for drilling from the school site, as the available set-up area is approximately 25 ft x 70 ft, with less than ideal orientation of the space. Access up the steep armor rock slope will be very difficult in the winter, and nearly impossible in the summer (no access at base of slope).

Proposed alternative drilling sites closer to the heliport and should be thoroughly investigated. Discussions with FAA (for helipad clearance) and local residents are needed to investigate the impacts of moving the drill site to an alternate location. If an alternate drilling location is acceptable, the intake structure could be drilled in two sections, one from the drill site to the intake location, the other from the drill site to the science center (at it's existing location). This would provide more set-up area, and possibly a better angle of incidence for bedrock penetration. Due to existing infrastructure (i.e. power, communication links, etc.) as well as the educational benefits for the students at the school, it is undesirable to move the location of the science shack.

Once the hole has been initially drilled, divers will be required to remove the cutting head from the drill-string, install the back-reamer and attach the HDPE casing pipe to the back-reamer. A barge anchored offshore would hold the spool of casing pipe as the drill back-reams and pulls the casing pipe back through the bore to shore. This method is used successfully for installing pipelines and outfalls throughout the world and eliminates the risk of the open drill hole collapsing after the drill-string has been removed.

The use of conventional drilling mud presents a significant problem at Little Diomede. The drill hole is expected to require about 40,000 gallons of water, much more than what is available at the village which is supplied by natural run-off and typically has little surplus. This requires that either 40,000 gallons of fresh water be brought from another location or use of drilling muds designed for saltwater applications. Drilling muds designed for salt water applications, such as Wyo-Ben SW 101(information is included in Appendix B) is the preferred choice for logistical reasons. However, these drilling muds are relatively new and should only be used with experienced drillers that are comfortable with the mud performance. The seawater drilling muds cost more than twice that of conventional muds and must be used in greater concentration, however these cost differences are insignificant in the total cost of the project.

Equipment and portable tanks will be required to transport the drill cuttings and the used drilling muds off the island for disposal off-site. It is expected that about 20 cubic yards of cuttings and up 40,000 gallons of used drilling mud will be generated. The drill cuttings and muds are not considered hazardous materials and may be able to be disposed of near the project site.

Possible U.S. Navy Cost Sharing

In the past, the U.S. Navy has indicated interest in the project. Possible Navy involvement consisted of training personnel during construction; using an older prototype of water jet drilling equipment at reduced cost; and extensive logistical and air transportation support which could be provided at reduced cost. However, recent conversations with Wayne Tausig, director of the Ocean Engineering Division of the Naval Facilities Engineering Service Center in Port Hueneme, California have revealed that the Navy's interest in the project has dwindled due to recent world events. It appears that cost sharing of the installation, logistics or transportation is unlikely.

Logistics

The construction at Little Diomede should be approached as a fully self-sufficient operation. All drilling supplies, equipment, spare parts, drilling muds and additives, as well as accommodations for room and board should be brought to the site.

From all aspects, it is advantageous to perform the drilling during the summer months. The equipment will operate better with lower maintenance, worker efficiency will be higher, longer daylight hours, equipment is not required to over-winter, and the school will not be in session. For all of these reasons, this report does not address the logistics of a winter drilling operation.

The complicating factors which must be addressed are: mobilization of men and equipment; operation of equipment in an extremely remote site; water for drilling muds (40,000± gallons); on-site disposal or transportation and off-site disposal of used drilling muds (40,000± gallons); and permitting for the project (fisheries, marine mammal concerns, etc.).

The equipment (most likely located in the lower 48 states) would travel by truck or rail to a port site such as Seattle, Washington. Along with the drilling equipment, supplies and fuel, a mid-size front end loader (Cat 966) and a smaller mobile forklift (Bobcat) would be brought to the site to support the drilling equipment. A commercial barge would transport the equipment and materials to a port in Alaska near to the project site such as Nome, where a smaller landing craft type barge would complete the final leg of the mobilization. A smaller tug boat will likely be required (depending on type of landing craft) for the leg to the project site and during construction. The smaller tug boat and landing craft could be hired locally to reduce project cost if possible.

The area around Little Diomede usually becomes ice free at the end of June or early July. Upon arrival to the site, and pending calm weather, the landing craft barge would be nosed into the beach and unloaded. The front-end loader would be used to build an unloading ramp for the drilling equipment and to perform the site preparation for drilling. The drilling, mud mixing and recycling equipment would be set-up on the prepared pad and drilling would then begin. The Bobcat or loader would be used to load the rack with drill pipe, move pallets of drilling mud and perform other miscellaneous tasks.

The entire drilling operation (drill and pull casing) is expected to take 4 to 8 weeks to drill two holes (drill site to intake and drill site to science shack) depending on difficulty of drilling. The area around Diomede usually stays ice free until November, however fall storms are noted to be fierce.

It is very important to the success of the project to have a team of qualified people experienced with the logistics of working in remote areas of Alaska, plan and coordinate the details of the project.

Construction Risks

- Drill may follow contour of bedrock – intake may be exposed at less than 600 ft off-shore.
- Equipment failure – no access to parts, etc.

- Complications due to seawater compatible drilling muds
- Difficulty attaching back-reamer and casing pipe to drill head
- Fierce storms could delay project or damage construction barge
- Disposal of drilling muds and cuttings (off-site disposal eliminates this risk)

Operational Risks

- Very low risk of damage from external forces (ice, waves, ship, etc.)
- Risk of bio-fouling or debris clogging is same as other options

Expected Life of Structure

- Indefinite (Estimated 25 to 50 years)

ROM Cost - HDD

	Project Component	Quantity		Unit Cost ($)	Total Cost ($)
1	Mobilize Equipment to Dock (Seattle)	1	LS	$20,000	$20,000
2	Commercial Tug and Barge to Mobilize Equip. to Nome	150,000	lbs.	$0.30	$45,000
3	Purchase Supplies For Project (Muds, parts, etc)	1	LS	$100,000	$100,000
4	Purchase Intake pipeline	28,000	lbs.	$1.50	$42,000
5	Landing Craft (Nome to/from Diomede & Constr.)	50	days	$6,000	$300,000
6	Small Tug Boat (Nome to/from Diomede & Constr.)	50	days	$6,000	$300,000
7	Mobilize Drilling Crew to Site (Helicopter)	7	ea.	$4,000	$28,000
8	Room and Board on barge (for 7 man crew)	50	days	$350	$17,500
9	Standby for drilling and support equip. during transport	40	days	$5,000	$200,000
10	Drilling Operation	42	shifts	$18,000	$756,000
11	Standby for drilling team during construction	8	shifts	$8,000	$64,000
12	Mobilize Dive Team and equipment	1	LS	$20,000	$20,000
13	Dive team to connect casing pipe to drill stem	3	shifts	$4,000	$12,000
14	Dive Team Standby	7	shifts	$2,000	$14,000
15	Dive Team to install intake structure	3	shifts	$3,500	$10,500
16	Demob Dive Team	1	LS	$20,000	$20,000
17	Demob Drilling Crew from Site (Helicopter)	7	ea.	$4,000	$28,000
18	Off-Site disposal of drilling muds (40,000 gallons)	1	LS	$40,000	$40,000
19	Commercial Tug and Barge Demob from Site	150,000	lbs.	$0.30	$45,000
	Total ROM Construction Cost (+/- 25%)				**$2,100,000**
	Technical Support				
1	Design Engineering, Logistics, Technical Support (7%)				$147,000
2	Eng. Construction Inspection & Tech Support (30 days at 12 hours/day plus travel)				$50,000
	Total with ROM Technical Support Costs				**$2,300,000**
	Contingency (25%)				**$575,000**
	Total Project Cost				**$2,900,000**

5.5 Blasted Trench and Anchored Casing Pipe

Description

Many municipal and private outfall lines throughout Alaska have been constructed by blasting. The blasted trench allows the top of casing pipe to rest below the surrounding area. The pipe is essentially shielded from damage by the surrounding sediments. Along the casing pipe and especially in the surf zone the pipe would be rock bolted or otherwise anchored to large boulders and the trench would be back filled with large cobbles and boulders as protection from wave action and ice. In the areas further off-shore, the excavated trench acts as a shield from the plucking and gouging effects of the ice. The trench prevents the pipe from being pushed or rolled as the top of the casing pipe is below the surrounding area. Heavy weights would be bolted to the flanges to provide additional ballast to prevent movement.

The construction would take place during the winter months when the ice can be used as a working surface, divers can work in fairly calm seas and few marine mammals and other animals are present. A trench approximately 4 feet deep would be excavated from the school through the tidal zone to a water depth of about 10 feet (150 feet off-shore), the excavation limit of a standard backhoe. The remaining portion of the trench would be at least 3 feet deep and excavated using explosives. Divers trained and licensed to performing such work would drill holes into the boulders or overburden, place the explosives in the holes and detonate from a safe distance away. This process would be repeated if necessary to provide adequate trench depth. Due to the damping effects of the water, it is possible that portions of the trench would have to be cleaned out and prepared for the pipe casing by additional blasting or with long reach excavation equipment.

A heavy wall, high density polyethylene (HDPE) pipe (8 in diameter x 0.5 in thick or similar) prefabricated in sections with flanged ends and bolted connections would be assembled on the ice surface. The short sections of fairly light weight pipe would be used to accommodate transportation in a small fixed wing aircraft. After the trench has been successfully excavated, and the casing pipe and weights assembled, it would be lifted and rolled into place using a backhoe with a sling starting from the shore-side. Controlled flooding of the casing pipe with water will aid in sinking and controlling its placement in the trench. Various types of elbows would be used to allow the pipe to conform to shape of the trench as it travels up the steeply sloped section near the school. The HDPE material is well suited for this environment as it is corrosion resistant, more flexible than steel at low temperatures, does not easily fatigue, joints and connections can be fabricated in the field, and it is readily available and fairly inexpensive.

Logistics

The construction would take place in the winter. The crew and equipment would mobilize to the site in February, after the ice runway has been constructed. It unlikely that a reliable backhoe with a thumb attachment for handling armor stone and performing near shore excavation would be available locally. This equipment would need to be mobilized to the site by barge the previous summer and demobilized the following summer.

Mobilization of crew and equipment will take about one week. The near-shore excavation is expected to take approximately two weeks to complete as work will be slow due to the frozen soils. The off-shore blasting excavation (approximately 450 ft of trench) is expected to take approximately 5 weeks. Casing pipe assembly can be completed simultaneously. Installation of the pipe in to the trench will occur within a few days. The anchoring of the casing pipe to submarine boulders and burial of the near shore portion will likely take two weeks. Total project time is estimated to be nine weeks.

Construction Risks

- Blasting plan must be permitted and approved by local residents – could be difficult to obtain approval.
- Blasting may damage ice sheet making placement of casing pipe more difficult.
- Winter operation of equipment carries high risk of maintenance and other breakdowns which could cause project delays.
- Blasting alone may not be effective in removing all debris from excavated trench. Additional excavation equipment such as a long reach backhoe may be required.

Operational Risks

- Significant risk of damage from external forces (ice, waves, ship, etc.)
- Risk of bio-fouling or debris clogging is same as other options
- If pipe anchors or ballast weights break, casing pipe can be moved around by ice and/or wave action and damaged or destroyed.

Expected Life of Structure

- Unknown (likely two to ten years)

ROM Cost - Blasted Trench and Anchored Casing pipe

	Project Component	Quantity	Unit Cost ($)	Total Cost ($)
1	Purchase large backhoe to use at the site	1 ea.	$350,000	$350,000
2	Tug and Barge to Mob. Equip. and mat'ls - Seattle to Site	20 days	$12,000	$240,000
3	Mobilize Crew (10 man) to site (from Anchorage)	10 ea.	$3,000	$30,000
4	Blasting Consumables	1 LS	$100,000	$100,000
5	Room and Board on site (for 7 man crew)	63 days	$1,050	$66,150
6	Blasting, Excavation, Installation Operation	63 shifts	$15,000	$945,000
7	Storage fee for equipment and materials	11 mo	$1,000	$11,000
8	Intake pipeline HDPE 8 inch diameter (w/ hardware)	650 ft	$4.00	$2,600
9	Demob Crew from Site	10 ea.	$3,000	$30,000
10	Tug and Barge Demob. Equip. and mat'ls from Site	20 days	$12,000	$240,000
			Total	**$2,000,000**
	Technical Support			
1	Design Engineering, Logistics, Technical Support (7%)			$140,000
2	Eng. Construction Inspection & Tech Support (30 days at 12 hours/day plus travel)			$50,000
	Total with ROM Technical Support Costs			**$2,190,000**
	Contingency (25%)			**$547,500**
	Total Project Cost			**$2,700,000**

5.5 Excavated Trench and Anchored Casing pipe – Winter Construction

Description

This scenario is similar to the blasted trench and anchored casing pipe except the trench is excavated entirely with mechanized equipment. The section of the pipe on and near-shore would be trenched using a conventional backhoe. As the depth of the trench exceeds the reach of the backhoe, a specialized extended reach backhoe would complete the excavation of the remaining portion of the trench. A trenching machine would be required to saw through the ice sheet creating a slot in the ice about 8 ft wide.

These specialized backhoes were used successfully in a similar capacity for the installation of the 32,000 ft Northstar oil pipeline in the Beaufort Sea a few years ago. Three of these backhoes exist on the North Slope of Alaska and are currently available for use. They have a reach of up to 55 feet and are equipped with very large track systems which distribute the load and allow them to float in emergency situations. Due to the very long boom, the excavating bucket is small about 1.5 cy. A thumb attachment would be needed to manipulate underwater boulders and cobbles, however large boulders would have to be removed using divers and a sling system or explosives.

The excavated material would have to be hauled in dump trucks to a temporary stockpile area near shore where the ice is grounded. A crew of men would work behind the backhoe assembling the flanged sections of casing pipe and attaching the ballast weights. After the trench has been successfully excavated, the pipe would be lowered into the trench starting from the shore-side. A team of divers would work to assist in the final placement and anchor the casing pipe to large boulders. After placement is complete, the stockpiled excavation spoils would be placed back in the trench, on top of the casing pipe.

Logistics
The construction would take place in the winter. During the previous summer, a barge would be used to mobilize the casing pipe and ballast materials, the long reach backhoe, standard backhoe, dump trucks, ditch witch trenching machine and other miscellaneous equipment. The equipment would then be stored on the island until the following spring. The crew and equipment would mobilize to the site in February, after the ice runway has been constructed.

Long reach amphibious backhoe used for the construction of the Northstar production pipeline, Beaufort Sea, Alaska.

The near-shore excavation is expected to take approximately two weeks to complete as work will be slow due to the frozen soils. Blasting the frozen soil will likely not be desirable due to the close proximity of buildings. The off-shore excavation (approximately 450 ft of trench) is expected to take approximately 3 weeks. Casing pipe assembly can be performed as the trench is completed. Installation of the pipe into the trench will occur within a few days. The anchoring of the casing pipe to submarine boulders and burial of the near shore portion will likely take an additional two weeks. Total project time is estimated to be six weeks. A barge would be mobilized the following summer to retrieve the backhoe, trencher and other equipment.

Construction Risks

- Excavation plan must obtain permit agency approval and be acceptable to local residents
- Equipment vulnerable to damage during long term storage on site
- Winter operation of equipment carries high risk of maintenance and other breakdowns which could cause project delays.
- Excavation of large boulders will be tedious, time consuming work
- If exposed bed rock or very large boulders are encountered, other excavation methods such as blasting will be required.

Operational Risks

- Moderate risk of damage from external forces (ice, waves, ship, etc.)
- If casing pipe anchors or ballast weights break, the pipe can be moved around by ice and/or waves and likely damaged or destroyed.
- Risk of bio-fouling or debris clogging is same as other options.

Expected Life of Structure

- Unknown (likely two to ten years)

ROM Cost - Excavated Trench and Anchored Casing Pipe – Winter Construction

	Project Component	Quantity		Unit Cost ($)	Total Cost ($)
1	Mobilize Equipment to Anchorage, Alaska	1	LS	$20,000	$20,000
2	Purchase steel pipe materials	28,000	lbs.	$1.50	$42,000
3	Tug and Barge to mob materials and equipment to site	12	days	$12,000	$144,000
4	Storage fee for materials and equipment on the island	11	mo.	$1,000	$11,000
5	Assemble long reach backhoe	1	LS	$50,000	$50,000
6	Standby charge for equip. (backhoes, trenchers, etc.)	10	mo.	$25,000	$250,000
7	Mobilize crew to site	10	ea.	$3,000	$30,000
8	Diver crew standby charge (two teams)	20	days	$3,500	$70,000
9	Diver crew dive charges (two teams)	15	days	$7,000	$105,000
10	Room and Board on site (for 12 man crew)	40	days	$1,800	$72,000
11	Long reach backhoe charges (w/ operator)	35	shifts	$3,500	$122,500
12	Other equipment (std. Backhoe, trencher, etc.) w/ oper.	35	shifts	$10,000	$350,000
13	Demob Crew from site	1	LS	$30,000	$30,000
14	Tug and Barge to demob materials, equip. from site	12	days	$12,000	$144,000
				Total	**$1,400,000**
	Technical Support				
1	Design Engineering, Logistics, Technical Support (7%)				$98,000
2	Eng. Construction Inspection & Tech Support (30 days at 12 hours/day plus travel)				$50,000
				Total with ROM Technical Support Costs	**$1,550,000**
				Contingency (25%)	**$387,500**
				Total Project Cost	**$1,900,000**

5.5 Excavated Trench and Anchored Casing Pipe – Summer Construction

Description

This scenario is similar to the previous excavated trench and anchored casing pipe except the trench is excavated with mechanized equipment from a barge during the summer months. The section of the casing pipe on and near-shore would be trenched using a conventional backhoe on shore. The area which cannot be reached from the barge with the long reach backhoe or from the shore with a conventional backhoe would have to be excavated in the winter by a backhoe or by an other method such as blasting.

A large landing craft or barge with a heavy duty four point anchoring system would be required for the off-shore construction. The long reach backhoe would work off the deck of the barge allowing excavation to about forty foot depth, sufficient for this project. According to the Coastal Pilots Association, heavy seas occur less than 5% of the time, with high wind (40 knots plus) occurring at about the same frequency during the summer. The average summer sea state has a 1-3 ft swell. Dense fog during the summer months which can hinder transportation, would not impact the construction once underway. If a storm or large swell arose the barge would have to be moved out to deeper water and wait for calmer weather. Project weather delays could be significant. An incomplete excavated trench could be partially filled by a storm or large swell, however it is unlikely that all work would be lost. Portions of the trench filled in by storms would have to be re-excavated.

The excavated material would not need to be removed from the water and could be mounded adjacent to the trench if permitting agencies allow. After the trench has been successfully excavated, the flanged sections of pipe would be assembled, ballast weights attached, and lowered into the trench starting from the shore-side. A team of divers would work to assist in the final placement and to anchor the casing pipe to large submarine boulders. After placement is complete, the mounded excavation spoils would be pushed back in the trench, on top of the pipe.

Logistics

The mobilization, construction and demobilization would take place over one year. The first summer a large backhoe would be mobilized to the site to be used the following winter for the near shore excavation. The second summer, the mobilization would include all materials and equipment needed for the construction. The tug and construction barge would also provide the food and lodging for the crew during the project.

The on and near-shore excavation would be completed during the spring with the large back hoe. The near shore work is expected to take approximately two weeks to complete as work could be slow due to the frozen soils. During the summer the construction barge will the work platform from which the long reach back would excavate the off-shore portion of the trench. The off-shore excavation (approximately 450 ft of trench) is expected to take approximately four weeks. Partial casing pipe assembly and ballast weight attachment can be completed simultaneously on the barge. Installation of the pipe into the trench will occur within a few days of trench completion. The anchoring of the entire casing pipe to submarine boulders and burial of the near shore portion will likely take an additional two weeks. Total project construction time (summer phase) is estimated to be about seven weeks.

Construction Risks

- Summer storms could cause significant delays in excavation from barge
- Excavation plan must obtain permit agency approval and be acceptable to local residents
- If exposed bed rock or very large boulders are encountered, other excavation methods such as blasting will be required.

Operational Risks

- Moderate risk of damage from external forces (ice, waves, ship, etc.)
- If casing pipe anchors or ballast weights break, the pipe may be moved around by ice and/or wave action and likely damaged or destroyed.
- Risk of bio-fouling or debris clogging is same as other options.

Expected Life of Structure

- Unknown (likely two to ten years)

ROM Cost - Excavated Trench and Anchored Casing Pipe – Summer Construction

	Project Component	Quantity		Unit Cost ($)	Total Cost ($)
1	Purchase backhoe for near shore excav. (winter)	1	LS	$250,000	$250,000
2	Tug and Barge to mobilize backhoe to site	20	days	$12,000	$240,000
3	Winter excavation of near shore trench	14	shifts	$2,500	$35,000
4	Mobilize Equipment to Anchorage, Alaska	1	LS	$20,000	$20,000
5	Purchase steel pipe and ballast materials	50,000	lbs.	$1.50	$75,000
6	Tug and Barge to mob materials, equip. to site	20	days	$12,000	$240,000
7	Assemble long reach backhoe	1	LS	$50,000	$50,000
8	Mobilize crew to site	1	LS	$30,000	$30,000
9	Tug and Barge on Site for Construction	42	days	$12,000	$504,000
10	Diver crew standby charge	14	days	$2,000	$28,000
11	Diver crew dive charges	14	days	$5,000	$70,000
12	Room and Board on Tug / Barge	42	days	$1,050	$44,100
13	Long reach backhoe charges (w/ operator)	21	shifts	$3,500	$73,500
14	Other equipment (std. Backhoe, etc.) w/ oper.	10	shifts	$2,500	$25,000
15	Demob Crew from site	1	LS	$30,000	$30,000
16	Standby charge for equipment	2	mo.	$20,000	$30,000
17	Tug and Barge to demob equipment from site	20	days	$12,000	$240,000
				Total	**$1,500,000**
	Technical Support				
1	Design Engineering, Logistics, Technical Support (7%)				$105,000
2	Eng. Construction Inspection & Tech Support (30 days at 12 hours/day plus travel)				$50,000
	Total with ROM Technical Support Costs				**$1,660,000**
				Contingency (25%)	**$415,000**
				Total Project Cost	**$2,100,000**

5.5 Anchored Casing pipe (no trench) – Summer Construction

Description
This scenario eliminates the logistics and costs of a submarine excavated trench and uses only an anchored casing pipe, thereby reducing construction risk. However it results in substantially increased operating risk from wave and ice damage.

The construction would take place during the summer using a barge. Heavy excavating equipment would not be required. The casing pipe would be flanged heavy-wall steel pipe, providing as much self weight and durability as possible. The pipe would be assembled and ballast weights attached on the deck of the barge. The assembly would then be placed on the ocean bottom. Divers would be used to aid in the placement of the casing pipe, help to avoid obstacles and install pipe anchors to large boulders. The spacing of the ballast weights and anchors would be increased in the near shore area to help resist the large breaking wave forces.

Logistics
The mobilization, construction and demobilization would take place in the summer, eliminating the need and cost of multiple mobilizations. The mobilization would include all materials and equipment needed for the construction. The tug and construction barge would also provide the food and lodging for the construction crew.

The near shore work is expected to take approximately two weeks to complete as work could be slow due to breaking waves. Off-shore casing pipe installation and anchoring to submarine boulders can occur simultaneously and will likely take about three weeks. Total project construction time is estimated to be about 30-days.

Construction Risks
- Summer storms could cause significant delays in casing pipe installation
- Ocean bottom may not provide adequate structure to anchor casing pipe

Operational Risks
- High risk of damage from external forces (ice, waves, ship, etc.)
- If casing pipe anchors or ballast weights break, the pipe will be moved around and likely damaged or destroyed.
- Risk of bio-fouling or debris clogging is same as other options.

Expected Life of Structure
- Unknown (likely one to five years)

ROM Cost - Anchored Casing Pipe (no Trench)– Summer Construction

	Project Component	Quantity		Unit Cost ($)	Total Cost ($)
1	Purchase steel pipe materials	50,000	lbs.	$1.50	$75,000
2	Tug and Barge to mob materials, equip. to site	25	days	$10,000	$250,000
3	Mobilize crew to site	10	ea.	$4,000.0	$40,000
4	Tug and Barge on Site for Construction	30	days	$12,000.00	$360,000
5	Diver crew standby charge	7	days	$2,000.0	$14,000
6	Diver crew dive charges	21	days	$5,000.0	$105,000
7	Room and Board on Tug / Barge	21	days	$1,000	$21,000
8	Light equipment (Dive gear, misc. equip., etc)	30	days	$1,000	$30,000
9	Heavy equipment (small crane to place casing, etc.)	75	days	$1,500	$112,500
10	Demob Crew from site	1	LS	$40,000	$40,000
11	Tug and Barge to demob mat'ls, equip. from site	20	days	$10,000	$200,000
				Total	**$1,200,000**

Technical Support

1	Design Engineering, Logistics, Technical Support (7%)	$84,000
2	Eng. Construction Inspection & Tech Support (30 days at 12 hours/day plus travel)	$50,000
	Total with ROM Technical Support Costs	**$1,330,000**
	Contingency (25%)	**$332,500**
	Total Project Cost	**$1,700,000**

Risk Comparison

Possible risks during the construction and operation of the project were evaluated for each intake structure alternative and ranked in comparison to the other structure types. The risks listed do not all have the same probability or the same impact to the project, therefore the risk totals should not be considered absolute, however they do provide a good comparison relative to each other. Risk ranking: 3-high; 2- moderate; 1-low; and 0-none.

Risk Description	HDD	Blasted Trench	Excavated Trench	Anchored Pipeline
Construction Risks				
Exposed Bedrock in shallow water	1.5	1	1	1
Denial of Construction Permit	1	3	2	1
Equipment Failure During Construction	2	2	2	1
Damage to Construction Barge	2	0	2.5	2.5
Delays Due to Poor Weather / Storms	1	1	3	3
Constructability Risks	1	3	2	1
Construction Risk Sub-Total	**8.5**	**10**	**12.5**	**9.5**
Operational Risks				
Damage from Large Waves / Storms	0	2	2	3
Damage from Ice Floe Attack	0	1	1	3
Difficulty of Inspecting Pipeline	3	2	2	1
Affected by Extreme Temperatures	1	2	2	3
Operational Risk Sub-Total	**4**	**7**	**7**	**10**
Total Combined Risk	**12.5**	**17**	**19.5**	**19.5**

4 Annualized Cost

Based upon the R.O.M. construction cost and the estimated usable life of each alternative individual annualized costs were developed. It is important to note that the usable life of each structure is estimated, however it does give a good idea of relative annualized costs. The average expected useful life was used to determine the annualized cost.

Annualized Cost Comparison

	HDD	Blasted Trench	Excavated Trench	Excavated Trench	Anchored Pipeline
ROM Cost ($MM)	**$2.9**	**$2.7**	**$1.9 (winter)**	**$2.1 (summer)**	**$1.7**
		Expected Useful Structure Life (years)			
Minimum	25	2	5	5	1
Average	37.5	6	7.5	7.5	3
Maximum	50	10	10	10	5
Annualized Cost (Ave Exp. Life)	**$77,000**	**$450,000**	**$253,000**	**$280,000**	**$567,000**

5 Conclusions

Based upon cost, longevity, construction and logistics, HDD is the recommended intake structure. While it does not have the lowest initial construction cost, the annualized cost is by far the lowest due to the expected long life of the structure. Correspondence with numerous HDD contractors and remote operations logistical experts have instilled confidence that this project is feasible with the right people and equipment for the job. The following execution plan outlines the technical tasks required to complete the project.

6 Project Execution Plan - HDD Intake

Design Phase

- Determine if alternate HDD location shown in Figure 1 (in Appendix A) is acceptable to all parties (including the FAA).
- Review results of HDD operation at Ascension Island, incorporate applicable lessons learned in to this project.
- Design / specify all components to be installed in seawater intake casing (i.e. fiber optics, heat trace, environmental sensors, seawater intake pump and sample line, etc.)
- Develop permitting documents, submit to Agencies, obtain permit approval
- Design HDD seawater intake (exact start / end locations, size of casing pipe, fabricated intake structure, mechanical / electrical components, etc.)

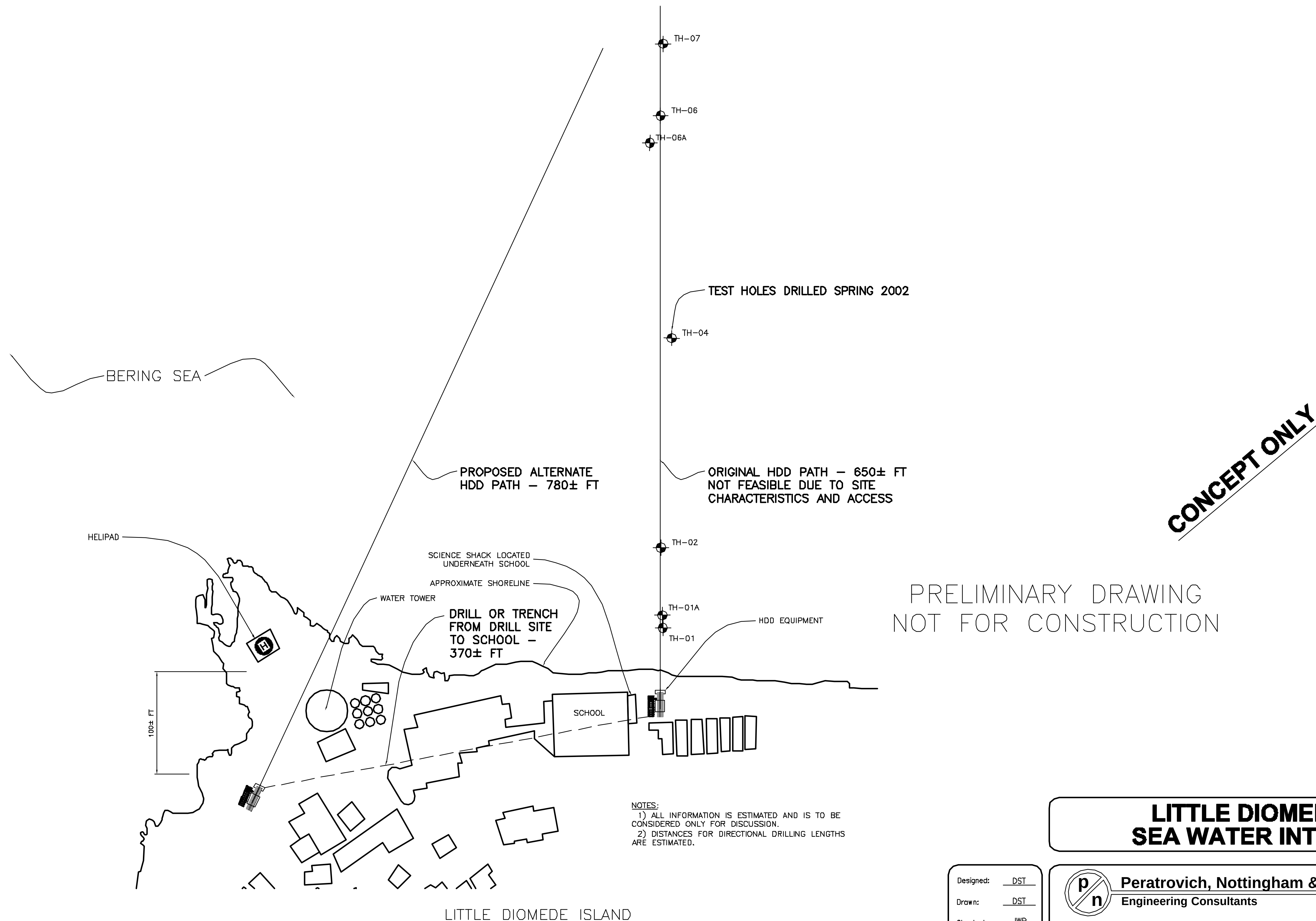
Execution Phase

- Establish contact and begin project planning with logistical, drilling and engineering experts familiar with the area.
- Select team of drilling personnel for the project
- Complete planning and preparations
- Compile equipment and materials for the project
- Mobilize to project site
- Install HDD intake structure
- Install and test instruments, pumps and components
- Demobilize from site

Appendix A

Little Diomede Site Plan

And Alternate Drill Site Location



LITTLE DIOMEDE SEA WATER INTAKE

Designed: DST
Drawn: DST
Checked: JWP
Project No: 01013

Peratrovich, Nottingham & Drage, Inc.
Engineering Consultants
1506 West 36th Avenue,
Anchorage, Alaska 99503
(907) 561-1011 FAX (907) 563-4220

Date: SEPT 2002
Scale: NTS

HDD CONCEPT PLAN

sheet 1 of 1

CAD File: J:\2001\01013 Little Diomede Is\Feasibility Report\HDD Concept Plan.dwg, [Plotted: Wed, 11 Sep 2002 - 3:20pm]

Appendix B

Ditch Witch JT4020

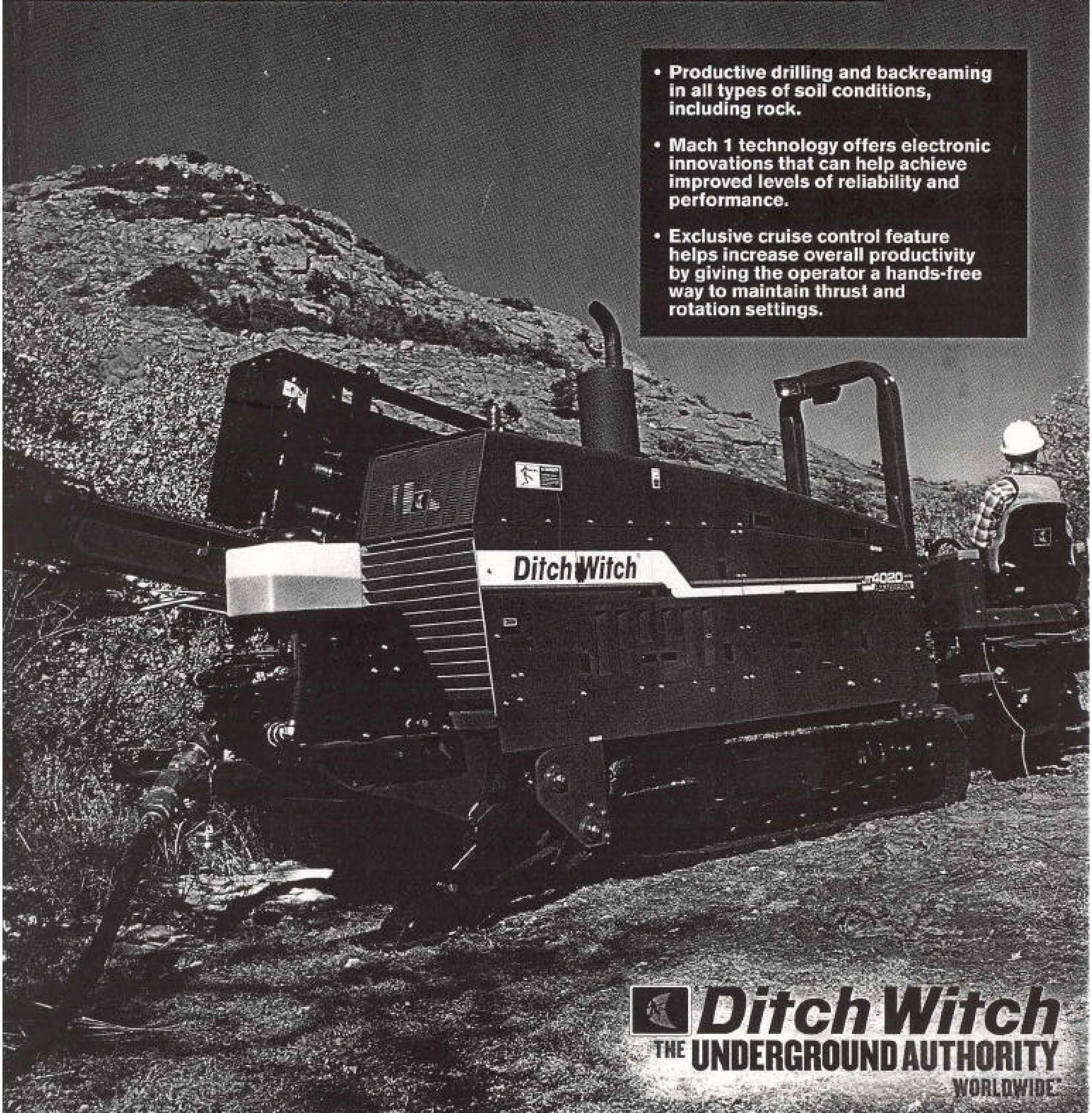
Equipment and Materials Information

Ditch Witch®

JT4020 All Terrain

Horizontal Directional Drilling System

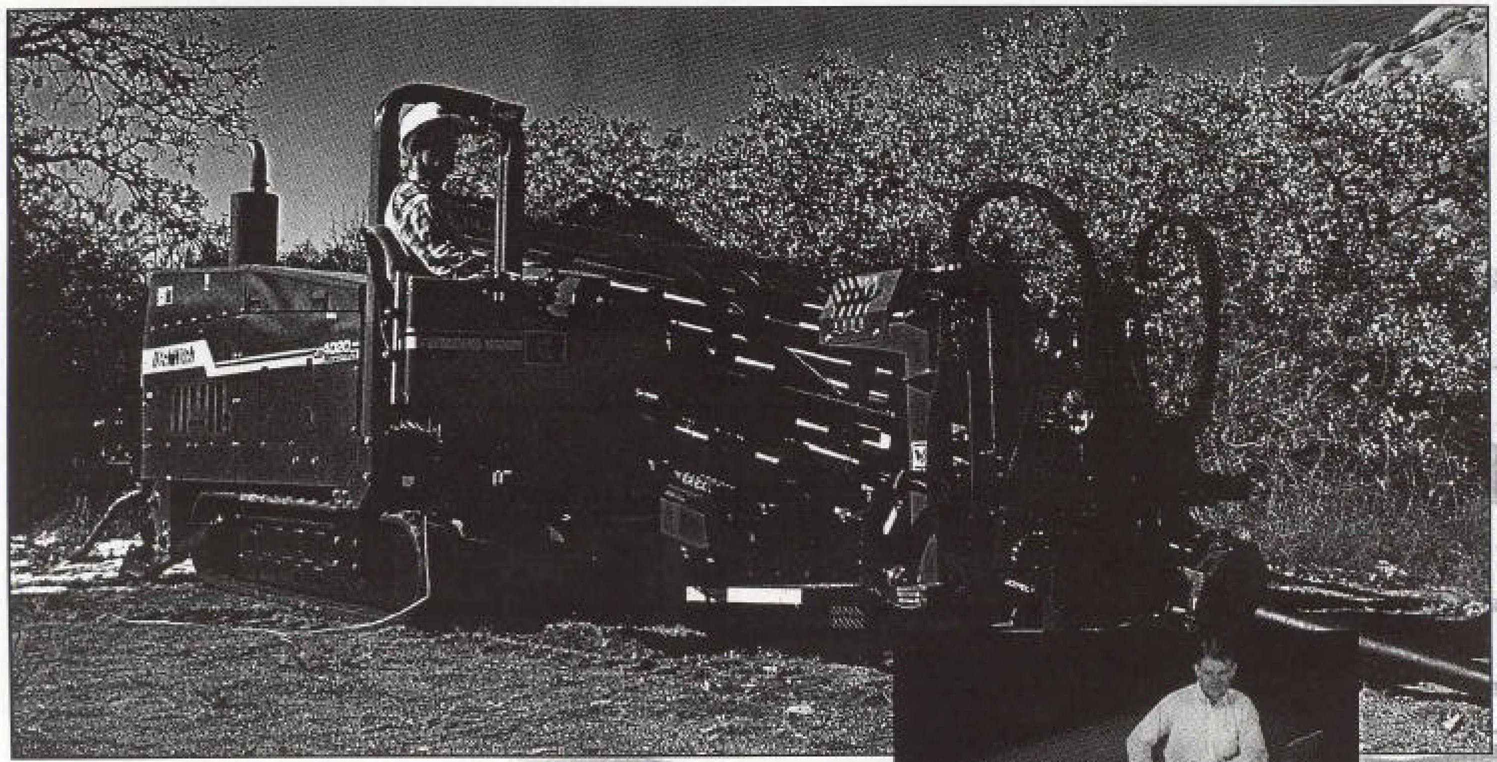
The next generation in horizontal directional drilling innovation.



- Productive drilling and backreaming in all types of soil conditions, including rock.
- Mach 1 technology offers electronic innovations that can help achieve improved levels of reliability and performance.
- Exclusive cruise control feature helps increase overall productivity by giving the operator a hands-free way to maintain thrust and rotation settings.

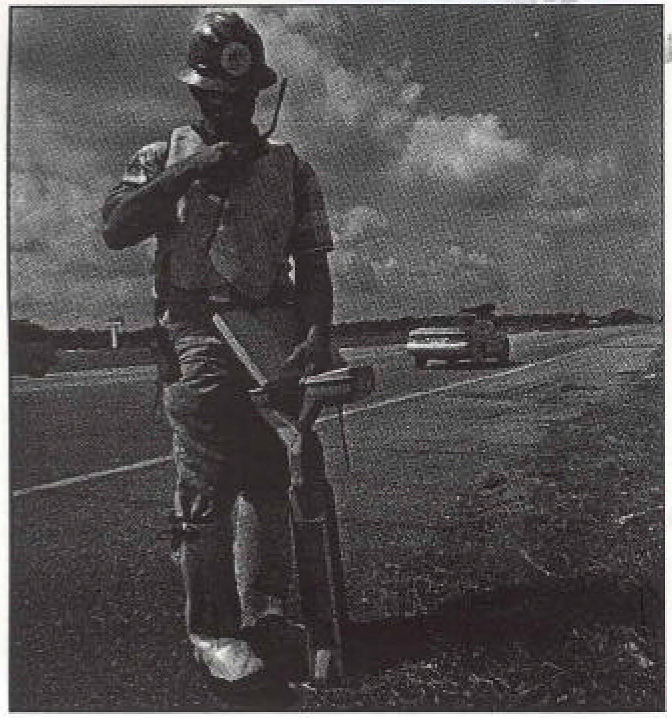
Ditch Witch
THE UNDERGROUND AUTHORITY
WORLDWIDE™

A Systems Approach to Dependable Power and Performance



Training and Support

- Your local Ditch Witch dealer has the knowledge and experience to prepare you and your crew for equipment operation.

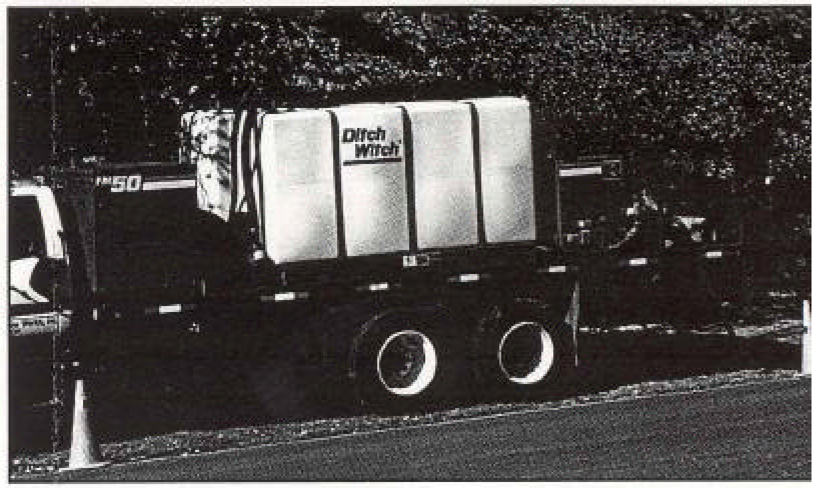


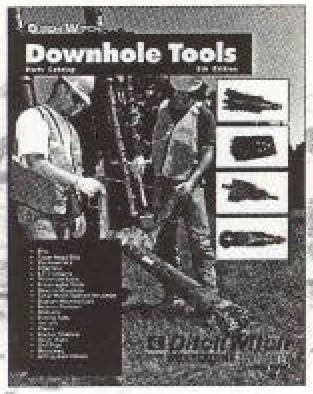
Ditch Witch Subsite® Tracking Systems

- No other tracking system on the market today is more advanced than the Ditch Witch Subsite 750 Tracker and 750 Display.
- Innovative Trac Management System Plus lets you plan or plot every bore you make.

Fluid Mixing Systems

- Ditch Witch fluid mixing systems feature self-feeding venturi hoppers.
- Totally compatible with the drilling unit's onboard fluid pump for maximum pressure and flow.





Downhole Tool Parts Catalog

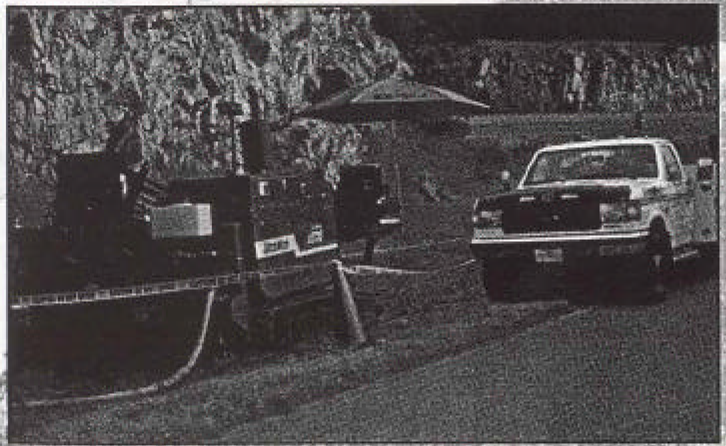
- A broad selection of downhole tools for efficient productivity in virtually every soil condition.
- Downhole tools can be custom-built to accommodate special needs and applications.

Drill Pipe

- Ditch Witch drill pipe balances strength and flexibility to gain maximum performance from the drilling unit.
- Features a composite design that utilizes the best type of metal for each component of the pipe.

Vacuum Evacuation Systems

- A variety of configurations and components offer the ability to handle many types of jobs.
- Two sizes of vacuum tanks available: 500 gal (1893 L) or 800 gal (3028 L).
- FX30 vac system features a 28 gross hp (20.9 kW) Kubota diesel engine.
- Enclosed and insulated power pack makes it the quietest running vac system in the industry.
- Designed to achieve up to 40% greater filtration over competitive systems.
- Controls are conveniently located in one lockable, lighted, curbside operator station for convenience.



Dealer Service

- The Ditch Witch advantage means rapid parts availability and convenient, high-quality repair servi
- Reliable dealer service and support is available worldwide, wherever your job takes you next.

JT4020 All Terrain

Horizontal Directional Drilling System

1. Mechanical rock drilling system

The JT4020 All Terrain patented rock drilling system provides more power to the bit than any other rock drilling system in its class:

- Uses an outer pipe for steering and backreaming, and an inner pipe for mechanically powering the bit during the pilot bore.
- Averages only 15-20 gpm (60-80 L/min) of drilling fluid flow while drilling; which means a reduced opportunity for environmental impact and less cleanup than a conventional mud motor rock drilling system.
- This compact system can drill more rock, more efficiently, than larger, more expensive rock drilling systems.

2. Industry standard pipeloader.

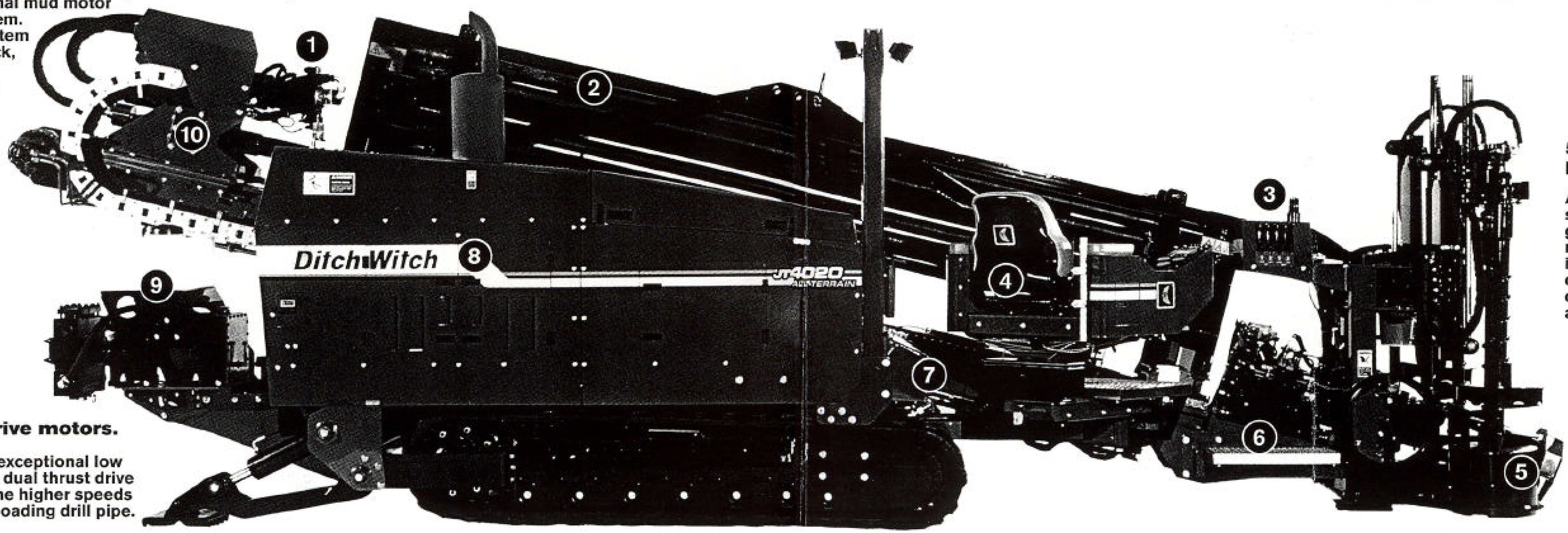
Hydraulic pipe grippers, single pipe loading, hydraulic shuttle stops, and automated thread lubrication set the industry standard for speed and efficiency.

3. Tracker control.

Gives the tracker operator the ability to disable power to the drilling unit's thrust and rotation when desired, such as before changing downhole tools.

4. Operator comfort and control.

Instrument panel gauges are positioned for visibility and touch-sensitive controls are placed where you would expect them to be. A single-lever control allows drilling/backreaming adjustments. The exclusive cruise control gives the operator a hands-free way to maintain desired thrust and rotation settings. This highly productive feature helps operator comfort and concentration over a long day of drilling.



5. Hydraulic, four-point anchor system.

Allows the unit to be firmly secured in all types of ground conditions, even in rock. Heavy-duty design includes 2.5-inch (65-mm) diameter stakes, large hex coupler and reinforced anchor slides.

10. Dual thrust drive motors.

Not only do they give exceptional low speed drilling control, dual thrust drive motors also provide the higher speeds necessary for rapidly loading drill pipe.

9. High drilling fluid flow.

Onboard pump enables productive drilling at extended distances. Normal flow rate can be operated simultaneously with thrust/pullback and rotation.

8. Plenty of power.

The 185 gross horsepower (138 kW) 6068T diesel engine and beefed-up hydraulics deliver 40,000 pounds (178 kN) of pullback and up to 5000 ft•lb (6780 N•m) torque with 0-240 rpm spindle speed. The unit is capable of pulling multiple conduits up to 1000 feet (300 m) in a single pass. The enhanced cooling system and improved airflow offer extended operation in warm weather conditions.

7. Adjustable drill frame.

Exclusive design allows setup at normal drilling angles without raising the tracks off the ground.

6. Heavy-duty vise breakout system.

Radius cut wrench jaws provide a full, secure grip on pipe, which can increase the service life of the jaw inserts and drill pipe tool joints. This breakout system is positioned to give the operator a clear view of the drill pipe during makeup and breakout.

JT4020 All Terrain

The next generation in horizontal directional drilling innovation.

The JT4020 All Terrain system was designed and built to steer and backream through virtually any type of soil – at distances to 1000 feet (300 m). This includes the ability to drill not only through rock, but through cobblestone, broken rock, gravel, and soil and rock mix as well.

The unit's remarkable drilling capacity is largely due to its advanced dual-drive system. This unique system features an inner pipe with strong hex-shaped collar ends for easy make-up and breakout. The inner pipe powers a downhole motor that drives the bit during the bore, producing an efficient power transfer system that delivers maximum performance in a small package. The inner pipe also delivers drilling fluid, while the outer pipe thrusts the bit forward, steers the drill string, and works to transmit full machine torque during backreaming.

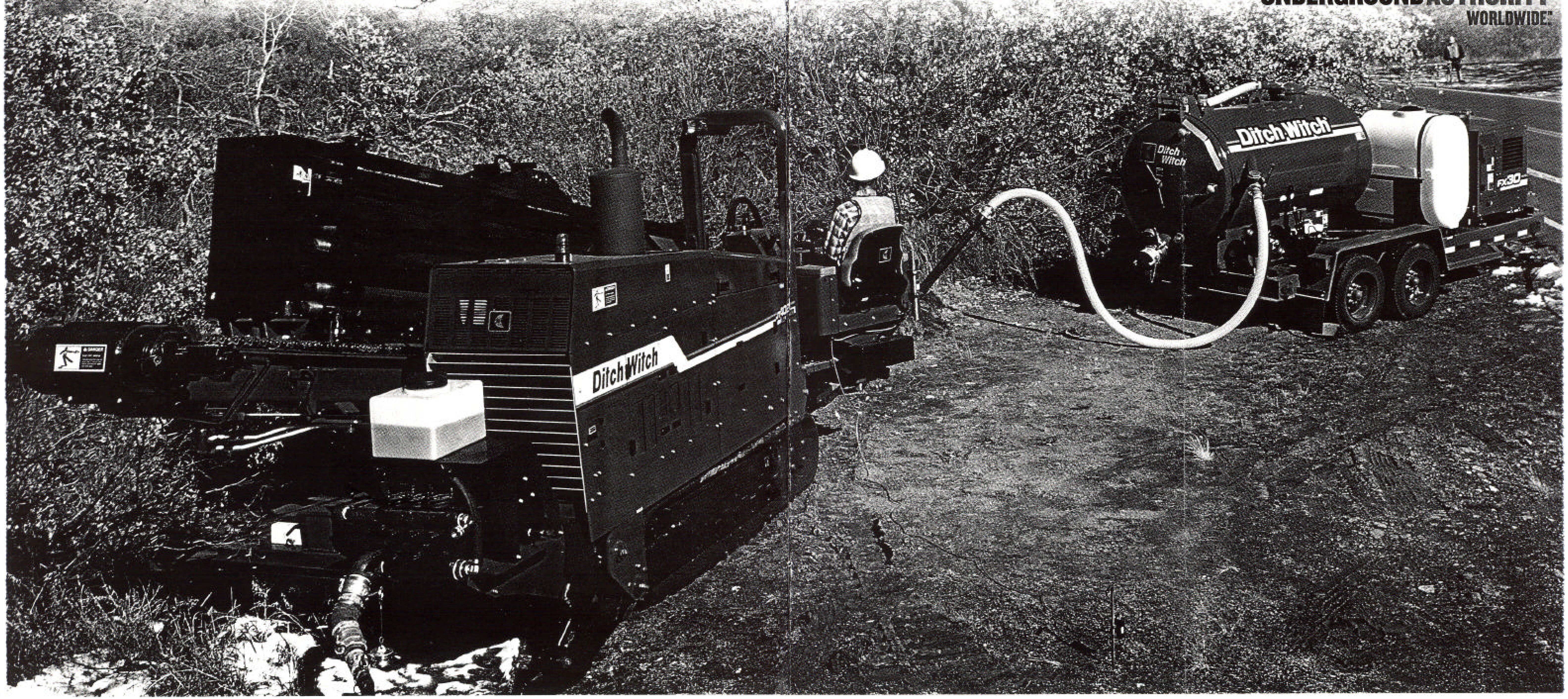
The dual-drive system of the JT4020 All Terrain greatly expands your capacity to drill in tough ground conditions. And because it accomplishes most bores with a minimal amount of drilling fluid flow, environmental impact and expense are dramatically reduced.

This productive HDD system incorporates Ditch Witch Mach 1 technology, which includes an onboard processor that controls the ground drive and pipeloader, as well as all drilling functions. It also includes a highly productive cruise control feature; just set the control for ground conditions, and it maintains desired thrust, pullback and rotation settings. Cruise control helps increase overall performance by giving the operator greater freedom to focus on the whole job; operators also tell us it helps make long work cycles seem just a little shorter.

Powered by a John Deere liquid-cooled 6068T diesel engine generating 185 gross horsepower (138 kW), the JT4020 All Terrain boasts 40,000 pounds (178 kN) of pullback and up to 5000 ft•lb (6780 N•m) of torque with 240 rpm spindle speed.

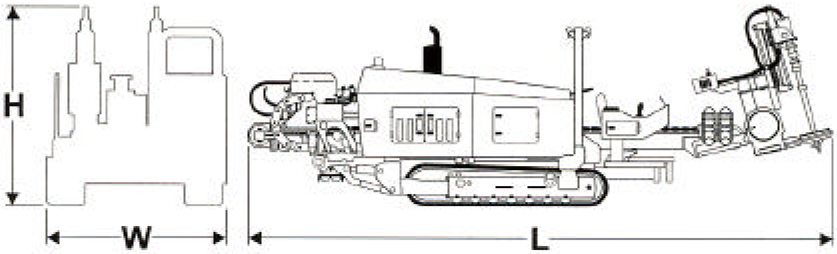
Read more about this exciting "next generation" HDD system. Then visit your Ditch Witch dealer, and see for yourself how the JT4020 All Terrain HDD system will give you the ability to drill in almost any ground condition.

Ditch Witch®
THE UNDERGROUND AUTHORITY WORLDWIDE®



SPECS

JT4020 All Terrain



DIMENSIONS

DIMENSIONS	U.S.	METRIC
Length	313 in	7.9 m
Width	87 in	2.2 m
Height (over exhaust stack)	96 in	2.4 m
Weight (AT w/ full pipe box, 120 gpm drilling fluid pump)	27,960 lb	12 682 kg
Weight (AT w/ full pipe box, 70 gpm drilling fluid pump)	27,400 lb	12 428 kg

DRILL PIPE

AT Pipe capacity	18 pipe	18 pipe
JT Pipe capacity	32 pipe	32 pipe

AT POWER PIPE

Length (w/o inner pipe)	171.1 in	4.3 m
Joint diameter	4.125 in	105 mm
Tubing diameter	3.625 in	92 mm
Min. bend radius	300 ft	91.4 m
Weight (w/ inner pipe)	264 lb	119.7 kg
Weight (large AT pipe box w/18 pipe)	5580 lb	2531 kg
Weight (small AT pipe box w/9 pipe)	3150 lb	1429 kg

JT POWER PIPE

Length	177.17 in	4.5 m
Joint diameter	3.50 in	89 mm
Tubing diameter	2.81 in	71 mm
Min. bend radius	190 ft	58 m
Weight (lined)	158 lb	71.2 kg
Weight (large JT pipe box w/32 pipe)	6000 lb	2721 kg
Weight (small JT pipe box w/16 pipe)	3100 lb	1406 kg

OPERATIONAL

Spindle speed (inner pipe)	0-250 rpm	0-250 rpm
Spindle speed (outer pipe)	0-240 rpm	0-240 rpm
Spindle torque (inner pipe, max)	2000 ft•lb	2712 N•m
Spindle torque (outer pipe, max)	5000 ft•lb	6780 N•m
Carriage speed	0-120 fpm	0-37 m/min
Pullback		
Actual	40,000 lb	178 kN
Thrust		
Actual (when drilling in AT mode)	25,000 lb	111 kN
Thrust		
Actual (when drilling in JT mode)	36,000 lb	160 kN
All Terrain bore diameter (w/ roller cone bit)	6.25 in	159 mm
JT minimum bore diameter (w/ soil bit)	5.25 in	133 mm
Backream diameter	Variable	Variable
Ground drive speed (forward)	0-2.5 mph	0-4.0 km/h
Ground drive speed (reverse)	0-2.5 mph	0-4.0 km/h

POWER

Engine: John Deere Model #6068TF250 (turbocharged)
Fuel: Diesel
Cooling medium: John Deere Cool-Gard
Number of cylinders: 6

Displacement	414 in³	6.8 L
Bore	4.19 in	106 mm
Stroke	5.00 in	127 mm
Intermittent power (@ 2400 rpm)	185 hp	138 kW
Maximum governed speed (no load)	2450 rpm	2450 rpm

DRILLING FLUID

DRILLING FLUID	U.S.	METRIC
120 gpm (454 L/min) drilling fluid pump		
Free flow with water	120 gpm	454 L/min
@ 1000 psi (69 bar)	100 gpm	378 L/min
70 gpm (265 L/min) drilling fluid pump		
@ 1200 psi (83 bar)	70 gpm	265 L/min

FLUID CAPACITIES

Fuel tank	55 gal	208 L
Hydraulic reservoir	36 gal	136 L
Engine lubrication oil, including filter	24 qt	23 L
Engine cooling system	30 qt	28 L

BATTERY

SAE reserve capacity 120 min. 12 volt, negative ground, SAE cold crank @ 0° F (-18 C)
2 batteries @ 800 amps each

NOISE LEVELS

Operator sound pressure per ISO 6394, 91 dbA
Exterior sound power per ISO 6393,113 dbA

Specifications are general and subject to change without notice. If exact measurements are required, equipment should be weighed and measured. Due to selected options, delivered equipment may not necessarily match that shown.

ISO-9001 Quality System Certified

AUTHORIZED DEALER:

Ditch Witch®
THE UNDERGROUND AUTHORITY WORLDWIDE.

The Charles Machine Works, Inc.
Ditch Witch® Worldwide Headquarters
Perry, OK 73077-0066 U.S.A. • (800) 654-6481 • (580) 336-4402
Fax: (580) 336-3458 • International Fax: (580) 336-3526
Internet: www.ditchwitch.com
E-mail: info@ditchwitch.com

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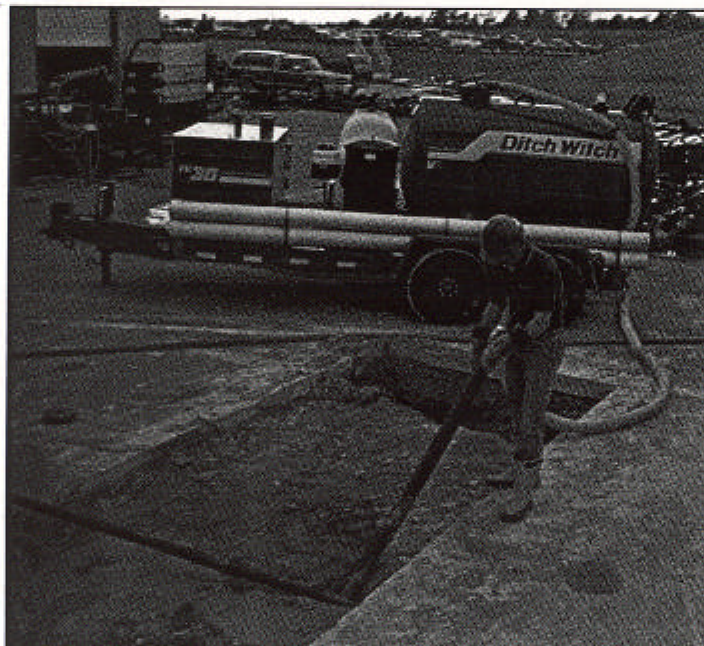
DITCH WITCH®

FX30 Vacuum Excavation System



Key Features

- With excavation and potholing capabilities, the FX30 supports and enhances virtually every HDD application.
- Water pump with exclusive autoclutching feature disengages the pump when water is not in use, allowing full system power to the blower.
- A single element filter with 33% more surface area than competitive systems results in 40% greater filtration capacity.
- A fully-enclosed and insulated power pack makes this the industry's quietest vacuum system.
- Water system delivers more than twice the pressure normally required to pothole.
- Contols are located in one lockable, lighted, curbside operator station for convenience.

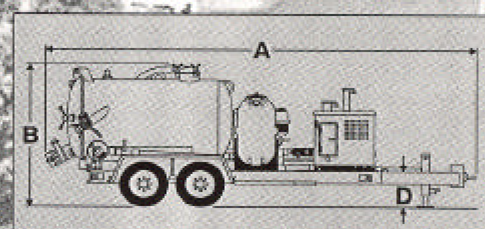
SPECIFICATIONS

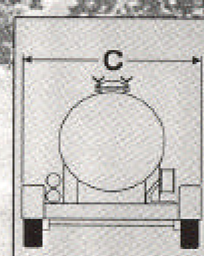
Dimensions	U.S.	Metric
A Length	233 in	5.9 m
B Height	92 in	2.3 m
C Width	100.5 in	2.55 m
D Deck height	23 in	584 mm
Dry weight	8190 lb	3715 kg
Weight with full tanks (water)	14,940 lb	6777 kg

Tank		
Capacity	800 gal	3028 l
Length	98 in	2.5 m
Diameter	50 in	1.3 m
Drain valve size	6 in	152 mm
Inlet valve size	4 in	102 mm

Engine		
Engine:	Kubota D1105-B diesel	
Cooling medium	antifreeze	
Number of cylinders	3	
Injection	1991 lbw/in²	140 kgf/cm²
Displacement	68.53 in³	1123 cm³
Bore	3.07 in	7.70 cm
Stroke	3.09 in	7.86 cm
*Maximum tilt angle fore & aft	30°	30°
*Maximum tilt angle side	30°	30°
Engine manufacturer's gross power rating @ 3150 rpm	28 hp	20.9 kW
Maximum governed speed as installed (no load)	3000 rpm	3000 rpm
Flywheel power (full load)	22 hp	16.4 kW

*Exceeding these operating angles will cause engine damage. This DOES NOT IMPLY machine is stable to maximum angle of safe engine operation.





Ditch Witch
THE UNDERGROUND AUTHORITY WORLDWIDE

SPECIFICATIONS cont.

HYDRAULIC TILT SYSTEM	U.S.	Metric
Pressure	2500 psi	172 bar
Drive type 12 volt DC power		
Cylinder size (2)	3 in	76 mm
Maximum tilt angle	45°	45°
Time to tilt fully up	44 sec	44 sec
Time to tilt fully down	38 sec	38 sec

BATTERY:
SAE cold crank @ 0°F (-18°C) 800 amp, 12 volt

NOISE LEVELS

Operator 73 dbA sound pressure per ISO 6394, at operator ear 10 ft (3 m) behind vacuum tank.
Exterior 103 dbA sound power per ISO 6393, at vacuum relief.

VACUUM SYSTEM

Drive type	coupler	
Displacement	500 cfm	14.1 m³/min
Maximum vacuum	15 in Hg	380 mm Hg
Vacuum tank door diameter	52 in	1.3 m
Drain valve size	6 in	152 mm
Inlet valve size	4 in	102 mm
Primary shutoff valve size	12 in	305 mm
Filter type	washable polyester	
Filter area	100 ft²	9.3 m²
Water trap capacity	8 gal	30.3 L
Suction hose size	3 in	76 mm
Suction hose length (total)	30 ft	9.1 m

PRESSURE WASHER SYSTEM

Maximum pressure	3000 psi	207 bar
Flow	4.2 gpm	15.9 L/min
Hose reel capacity with wash wand	50 ft	15.2 m
Antifreeze	50/50 antifreeze/fresh water	
Clutch type	electric with auto de-clutch	

FLUID CAPACITIES

Engine oil with filter	4.2 qt	4 L
Fuel tank	15 gal	57 L
Vacuum pump	22.8 oz	674 mL
DC hydraulic reservoir	2.5 gal	9.5 L
Pressure washer pump	14 oz	414 mL
Water tank	200 gal	757 L

TRAILER

Dimensions		
Bed length	177.3 in	4.5 m
Clearance (at jack foot pad)	12 in	305 mm
Adj. coupler heights	17-26 in	432-660 mm
Width between fenders	80.5 in	2 m
Width outside fenders	100.5 in	2.6 m
Bed height (at full load)	22.3 in	566 mm
General		
Number of axles	2	
Coupler (square mount drawbar)	3 in or 2.5 in	76 mm or 64 mm
Type of brakes	electric	
Lug nut torque	300 ft•lb	407 N•m
Hitch bolt torque	200 ft•lb	271 N•m
Electrical system	12 volt DC	
Tire Option		
LT215/75R17.5 load range H	125 psi	8.6 bar
Load Rating		
Tongue weight (empty)	1930 lb	876 kg
Tongue weight (full water)	1440 lb	654 kg
Max. tongue load	2700 lb	1225 kg
GVWR (gross vehicle weight rating)	18,000 lb	8165 kg
GAWR (gross axle weight rating)	16,000 lb	7257 kg
MLWR (max load weight rating @ max tongue load)	14,125 lb	6407 kg

Load ratings for speeds up to 65 mph (104 km/h)

Ditch Witch of Oregon
7909 N. Upland Drive
Portland, OR 97203
(503)286-6400

SW 101

The product of choice for seawater exposure and salt contaminated environments.

Wyo-Ben's unique SW 101 is an innovative breakthrough in drilling fluids and containment slurries. This contamination resistant bentonite is engineered for use in slurry cutoff walls and drilling operations where exposure to seawater is expected. It is highly recommended for use in well drilling, caisson drilling, horizontal boring and slurry wall application where traditional bentonite fluids will not perform.

SW 101

- Hydrates easily in fresh water, brackish water, seawater or a combination
- Displays excellent fluid loss control so formation sloughing is minimized
- Costs less than CMC polymer systems and builds a superior wall cake
- Has superior flow properties due to excellent bore hole stability

The salinity of typical seawater is such that conventional fresh water components cannot function properly. Similarly, materials used in saturated salt muds are not able to respond properly in the limited saline environment of seawater. The table below illustrates the properties achieved by various mud systems mixed in seawater. SW101 demonstrates superior performance and durability and is very cost effective.

Product	Percent Weight	Funnel Viscosity	600 Fann Rdg.	Fluid Loss
SW 101	6	34	15	13.7
	7	36	19	11.5
	8	38	24	9.5
API Grade Hydrogel	6	28	5	92
	7	28	5	87
	8	29	6	81
Extended Extra High Yield	6	30	11	109
	7	32	13	101
	8	34	17	95
Attapulgite Clay	6	35	24	144
	7	38	34	129
	8	44	48	120

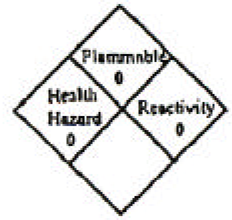
In most operations, adding SW101 at a 7% rate to seawater is ideal (four 50# bags per 300 gallons of make-up water). For best results, establish and maintain a 45 sec/quart marsh funnel viscosity. Drilling in unconsolidated formations may require increased addition rates.

SW 101 is available in 50 pound & 100 pound bags, bulk bags and bulk.

WYO-BEN, INC. 550 S. 24th St. West P.O. Box 1979 Billings, Montana 59103 USA
406~652-6351 Fax: 406~656-0748 Toll Free: 1~800-548-7055 www.wyoben.com email@wyoben.com

WYO-BEN, INC.

MATERIAL SAFETY DATA SHEET



NFPA FIRE HAZARD IDENTIFICATION SYSTEM

I. PRODUCT IDENTIFICATION

Trade Name(s): **SW 101**

Generic Name(s): Wyoming (Western) Bentonite; Bentonite Clay (CAS No. 1302-78-9) and other proprietary ingredients

Chemical Name(s): Sodium Montmorillonite (CAS No. 1318-93-0) and other proprietary ingredients

Manufacturer: **WYO-BEN, INC.** Address: P.O. Box 1979 Billings, Montana 59103	Telephone Numbers: Information: (406) 652-6351 EMERGENCY: (406) 652-6351

II. HAZARDOUS INGREDIENTS

Ingredient	CAS NO.	%	Hazard
Crystalline Silica (SiO_2) as Quartz	14808-60-7	See Note	Low concentrations of crystalline silica (SiO_2) in the form of quartz may be present in airborne bentonite dust. See Section VI for discussion of health hazard.

Note 1: The specific chemical identity of this product is being withheld as a trade secret. In the event of a medical emergency it will be provided to a treating medical professional under the provisions of 29 CFR 1910.1200(i).

Note 2: Although the typical quartz content of western bentonite is in the range of 2 to 6% most of the quartz particles are larger than the 10 µ respirable threshold size. The actual respirable quartz concentration in airborne bentonite dust will depend upon bentonite source, fineness of product, moisture content of product, local humidity and wind condition at point of use and other use specific factors.

III. PHYSICAL DATA

Boiling Point (°F): NA	Specific Gravity (H_2O=1): 2.45-2.55
Vapor Pressure (mm. Hg): NA	Melting Point: Approx. 1450°C
Vapor Density (Air = 1): NA	Evaporation Rate (Butyl Acetate = 1): NA
Solubility in Water: Insoluble, forms colloidal suspension.	pH: 8-10 (5% aqueous suspension)
Density (at 20° C): 55 lbs./cu.ft. as product.	

Appearance and Odor: Bluegray to green as moist solid, light tan to gray as dry powder. No odor.

IV. FIRE AND EXPLOSION DATA

Flash Point: NA	Flammable Limits: LEL: NA UEL: NA

Special Fire Fighting Procedures: NA

Unusual Fire and Explosion Hazards: None. Product will not support combustion.

Extinguishing Media: None for product. Any media can be used for the packaging. Product becomes slippery when wet.

V. REACTIVITY

Stability: Stable

Hazardous Polymerization: None

Incompatibility: None

Hazardous Decomposition Products: None

NA = Not Applicable ND = Not Determined

Date Prepared: August 30, 2001

Doc #: 4360-00

VI. HEALTH HAZARD INFORMATION

Routes of Exposure and Effects:

Skin: Possible drying resulting in dermatitis.

Eyes: Mechanical irritant.

Inhalation: *Acute* (short term) exposure to dust levels exceeding the PEL may cause irritation of respiratory tract resulting in a dry cough. *Chronic* (long term) exposure to airborne bentonite dust containing respirable size ($\leq 10\ \mu$) quartz particles, where respirable quartz particle levels are higher than TLV's, may lead to development of silicosis or other respiratory problems. Persistent dry cough and labored breathing upon exertion may be symptomatic.

Ingestion: No adverse effects.

Permissible Exposure Limits: (for air contaminants)	OSHA PEL (8hr. TWA)	ACGIH TLV
Bentonite as "Particulates not otherwise regulated" (formerly nuisance dust)		
Total dust	15mg/m^3	ND
Respirable dust	5mg/m^3	ND
Crystalline Quartz (respirable)	0.1mg/m^3	0.1mg/m^3

Carcinogenicity: Bentonite is not listed by ACGIH, IARC, NTP or OSHA. IARC, 1997, concludes that there is sufficient evidence in humans for the carcinogenicity of inhaled crystalline silica from occupational sources (IARC Class 1), that carcinogenicity was not detected in all industrial circumstances studied and that carcinogenicity may depend on characteristics of the crystalline silica or on external factors affecting its biological activity. NTP classifies respirable crystalline silica as "known to be a human carcinogen" (NTP 9th Report on Carcinogens – 2000). ACGIH classifies crystalline silica, quartz, as a suspected human carcinogen (A2).

Acute Oral LD_{50}: ND	Acute Dermal LD_{50}: ND	Aquatic Toxicology LC_{50}: ND

Emergency and First Aid Procedures:

Skin: Wash with soap and water until clean.

Eyes: Flush with water until irritation ceases.

Inhalation: Move to area free from dust. If symptoms of irritation persist contact physician. Inhalation may aggravate existing respiratory illness.

VII. HANDLING AND USE PRECAUTIONS

Steps to be Taken if Material is Released or Spilled: Avoid breathing dust; wear respirator approved for silica bearing dust. Vacuum up to avoid generating airborne dust. Avoid using water. Product slippery when wetted.

Waste Disposal Methods: Product should be disposed of in accordance with applicable local, state and federal regulations.

Handling and Storage Precautions: Use NIOSH/MSHA respirators approved for silica bearing dust when free silica containing airborne bentonite dust levels exceed PEL/TLV's. Clean up spills promptly to avoid making dust. Storage area floors may become slippery if wetted.

VIII. INDUSTRIAL HYGIENE CONTROL MEASURES

Ventilation Requirements: Mechanical, general room ventilation. Use local ventilation to maintain PEL's/TLV's.

Respirator: Use respirators approved by NIOSH/MSHA for silica bearing dust.

Eye Protection: Generally not necessary. Personal preference.

Gloves: Generally not necessary. Personal preference.

Other Protective Clothing or Equipment: None

IX. SPECIAL PRECAUTIONS

Avoid prolonged inhalation of airborne dust.

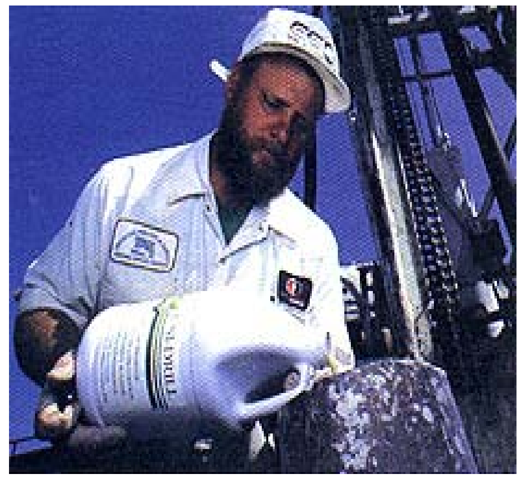
DEPARTMENT OF TRANSPORTATION HAZARDOUS MATERIAL INFORMATION

Shipping Name: NA (Not Regulated)	Hazard Class: NA
Hazardous Substance: NA	Caution Labeling: NA

Date Prepared: August 30, 2001 Doc #: 4360-00

UNI-DRILL®

UNI-DRILL® is a unique proprietary liquid polymer designed for use in rotary drilling and horizontal directional drilling operations. It conditions drilling fluids to control fluid loss, prevent formation clays from swelling, and will keep tools clean by preventing bit balling. Unlike many commonly used polymers, UNI-DRILL® actually aids in the effective operation of solids control equipment by dropping silts and sands from the fluid. Similarly it is tolerant of brackish and harsh water conditions which adversely affect many other polymers. UNI-DRILL® is environmentally safe and non-fermenting.



UNI-DRILL® ADVANTAGES:

- Safe: Non-polluting, Non-fermenting
- Controls fluid loss
- Coats and inhibits clays
- Builds viscosity
- Mixes easily
- Performs in saline environments
- Reduces friction — drag and torque

3 EASY STEPS FOR EFFECTIVE DRILLING FLUIDS:

1. Treat make-up water with soda ash to a pH of 8 to 9.
2. Add bentonite product—EXTRA HIGH GEL or TRU-BORE
3. Add UNI-DRILL®

In air-drilling operations, UNI-DRILL® can be added to stabilize shale and clay formations. Add 1 pint per 100 gallons of water upstream from AIR FOAM or WYO-FOAMER injection.

Below are typical application rates for UNI-DRILL® and other products for use in certain drilling conditions.

For 500 Gallons of Make-up Water:
Add approximately ¼ pound of soda ash to bring water a pH of 8 to 9
In any fluid, always add bentonite products before adding the polymer.

Clay — 40-45 Sec./Qt.
Extra High Yield Gel & UNI-DRILL® — 1½ ± Bags & 5 Qts. UNI-DRILL®
Tru-Bore & UNI-DRILL® — 1½ ± Bags & 3 + Qts. UNI-DRILL®

Sand — 55-65 Sec/Qt.
Extra High Yield Gel & UNI-DRILL® — 2¼ - 3 ± Bags & 3 + Qts. UNI-DRILL®
Tru-Bore & UNI-DRILL® — 2¼ ± Bags & 1½ ± Qt. UNI-DRILL®

Unknown or Medium Soils — 45-55 Sec./Qt.
Extra High Yield Gel & UNI-DRILL® — 2¼ ± Bags & 6.5 Qts. UNI-DRILL®
Tru-Bore & UNI-DRILL® — 1½ ± Bags & 5 Qts. UNI-DRILL®

PLUGZ-IT/Max

PLUGZ-IT/Max is a lost circulation material designed to mix and pump with a drilling fluid into cobble, gravel, or fractured zones to restore mud circulation. Based on the original Plugz-It material, Plugz-It/Max is a coarser product engineered specifically for use in vertical drilling operations. It readily seals off coarse gravels, fractured formations, and other profiles where mud-loss is a problem. PLUGZ-IT/Max can be placed directly through the jets in the bit provided they are a minimum of 3 mm or 1/8" in size. PLUGZ-IT/Max is environmentally safe and non-toxic.

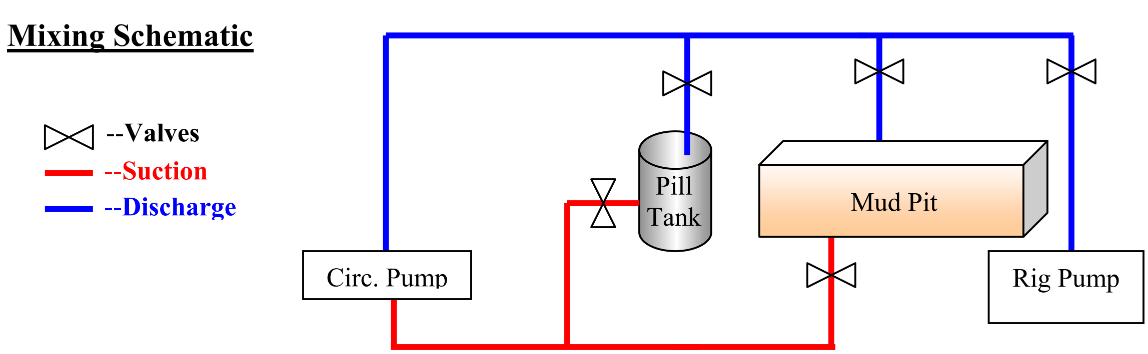
APPLICATIONS:

As a **Pill:** In a separate ("pill") tank, mix Extra High Yield Gel to a Marsh Funnel Viscosity of 45 to 65 seconds. Add PLUGZ-IT/Max at a rate of 20 to 40 pounds per 100 gallons. Mix in small batches, 50 to 100 gallons at a time.

1. Add PLUGZ-IT/Max slowly into "Pill" tank and circulate for 1 to 2 minutes.
2. Once the appropriate quantity is added, quickly pump from the "Pill" tank into place, pulling the drill steel back slowly as the mixture is pumped into the loss zone.
3. Pump pressure should remain elevated while pumping to insure PLUGZ-IT/Max is being squeezed into fractured or unconsolidated zones.
4. Once all the material is in place, pullback 5 to 10 feet and continue to pump in order to purge the drill string. Once in place the PLUGZ-IT/Max pill should set for 20 to 30 minutes, allowing for complete hydration and expansion to take place. Circulation should be restored at this point.
5. Advance back into the hole slowly, using low pump pressure, circulating as you progress and continue the drilling operation. If mud loss is still a problem, repeat the process.

At the first sign of mud loss, Plugz-It/Max can be added slowly at the suction to be carried by the fluid into the loss zone.

PLUGZ-IT/Max is conveniently packaged in 30 pound multi-walled bags.



WYO-BEN, INC. 550 S. 24th St. West P.O. Box 1979 Billings, MT 59103 USA
406~652-6351 Fax: 406~656-0748 Toll Free: 1-800-548-7055 www.wyoben.com email@wyoben.com

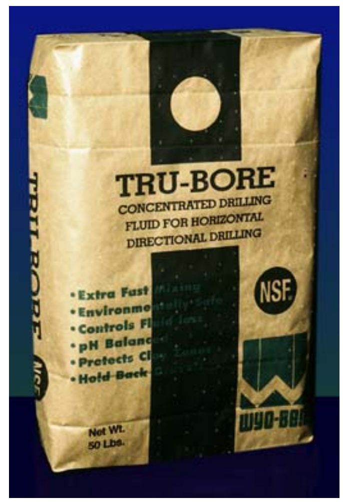
TRU-BORE

The Simplest Solution to Boring Problems

TRU-BORE is a highly concentrated bentonite based drilling fluid designed for difficult drilling operations in both vertical and horizontal borings. It is extremely effective in horizontal drilling applications to maintain hole integrity during pullback. It is non-toxic and environmentally safe. Its fast-hydrating formula allows contractors to mix fast and build viscosity quickly. TRU-BORE stabilizes formations ranging from moderate clay soils to high concentrations of sand. By forming a thin tough filter cake, fluid loss to areas around the bore hole is reduced. These factors, coupled with excellent gel strength values make TRU-BORE the best risk management tool available today.

TYPICAL CHARACTERISTICS:

- Barrel Yield: 240 - 260
- Fluid Loss: 12 – cc.
- Mesh: 80% ± 2 passing 200 mesh
- PH 8.1 ± .2
- Moisture: 8% ± 1.5



MIXING RATIOS:
For 500 Gallons of Make-Up Water

For every 100 gallons of make-up water, adding 15 to 25 pounds of TRU-BORE will yield a viscosity of approximately 45 seconds on a Marsh funnel. At a rate of 27 pounds per 100 gallons, viscosity can climb to 60 seconds.

Clay:	1½ bags for viscosity of 32-35 seconds, then add UNI-DRILL liquid polymer to reach a viscosity of 42-45 seconds. (The addition of UNI-DRILL keeps the clays from thickening the mud system even more.)
Sand:	2¼ - 3 bags for viscosity of 55 ± seconds
Unknown or Medium Soils:	1½ - 3 bags for viscosity of 45 seconds

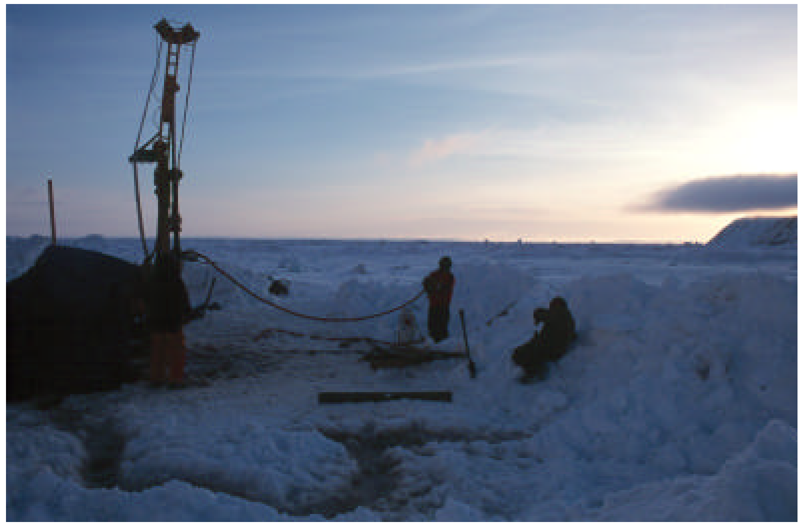
TRU-BORE is packaged in 50 pound multi-walled paper bags, palletized 60 bags per pallet and shrink-wrapped.

WYO-BEN, INC. 550 S. 24th St. West P.O. Box 1979 Billings, Montana 59103 USA
406~652-6351 Fax: 406~656-0748 Toll Free: 1~800-548-7055 www.wyoben.com email@wyoben.com

Appendix C

Geotechnical Report

Little Diomede Seawater Intake



Geotechnical Report
Little Diomede Island
Seawater Intake

May 2002

Prepared for:
VECO Polar Resources

Prepared by:
Peratrovich, Nottingham & Drage, Inc.
1506 West 36th Ave
Anchorage, Alaska, 99503

Peratrovich, Nottingham, & Drage, Inc.
engineering consultants

1. Introduction

This report presents the results of subsurface explorations, laboratory testing and geotechnical engineering studies conducted by Peratrovich, Nottingham & Drage, Inc (PN&D) for the Arctic Environmental Observatory's proposed installation of a seawater intake located at the City of Diomede on Little Diomede Island, Alaska.

Little Diomede Island is located 135 miles northwest of Nome in the middle of the Bering Straits. The village, located on the west side of the island (Fig. 1), has 133 residents who live a subsistence lifestyle. Access is by helicopter during the ice-free months and by fixed wing aircraft during the period when the sea ice is stable enough to construct a runway, usually from February into May.

The Arctic Environmental Observatory is located at the high school on the north end of the village. A temporary seawater intake line was installed in the summer of 2000 and 2001. The line was incased in a pipe through the surf zone and laid on the seafloor out to a distance of a 150 feet from the shore in 10 feet of water. This method of installation was not reliable, requiring maintenance after summer storms and was vulnerable to damage by sea ice. To reduce the risk of damage to the seawater intake lines and create a long term, low maintenance installation several options have been proposed, two of which involve running the line under the seafloor. The proposed permanent intake is to be located in 26± feet of water, 600± feet from shore to ensure that it is operable through the winter.

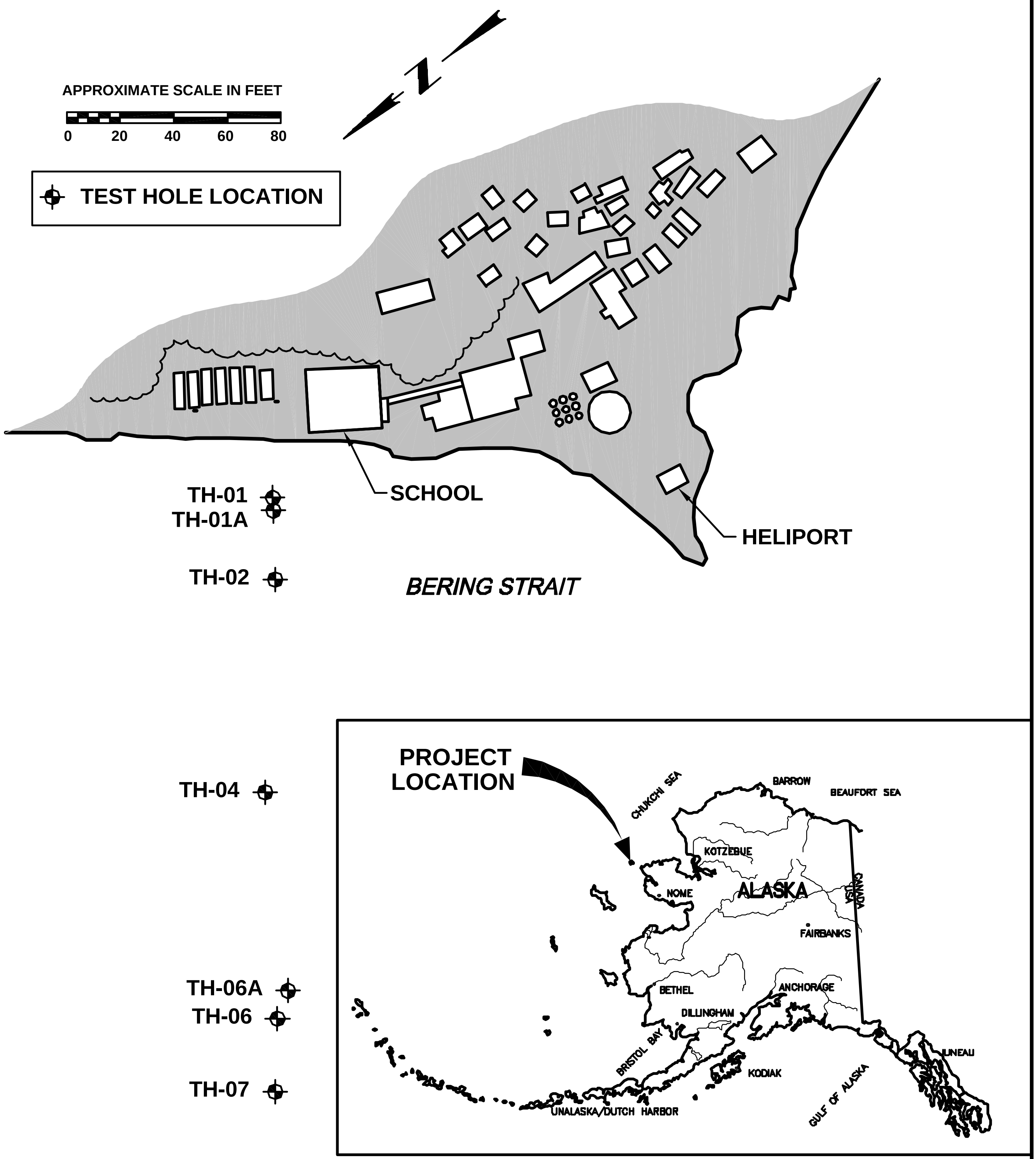
This geotechnical investigation was undertaken to determine subsurface conditions at the site and to evaluate various options for installation of the seawater intake line. A total of seven test holes were drilled as part of this study, at locations along the proposed route of seawater intake line.

2. Equipment and Methods

2.1 Field Investigation

PN&D conducted a subsurface investigation at the site from March 6 to April 5, 2002. The investigation consisted of seven testholes, identified as TH-1, TH-1A, TH-2, TH-04, TH-06, TH-06A and TH-07 to depths of 15 to 49 feet from the ice surface. Testhole logs are presented in Appendix A. Testhole locations and ground/seafloor elevations are shown on Figure 2. Testhole locations and elevations were surveyed with a theodolite and electronic distance-measuring device (EDM) to an arbitrary datum and are accurate to ± 1 foot.

Geotechnical drilling services were provided by Denali Drilling, Inc. as subcontractors to VECO Polar Resources. All drilling was supervised by a PN&D geologist who prepared a log of each testhole. A CME 45 sled mounted drill rig was used in conjunction with a



VILLAGE OF DIOMEDE
LITTLE DIOMEDE ISLAND

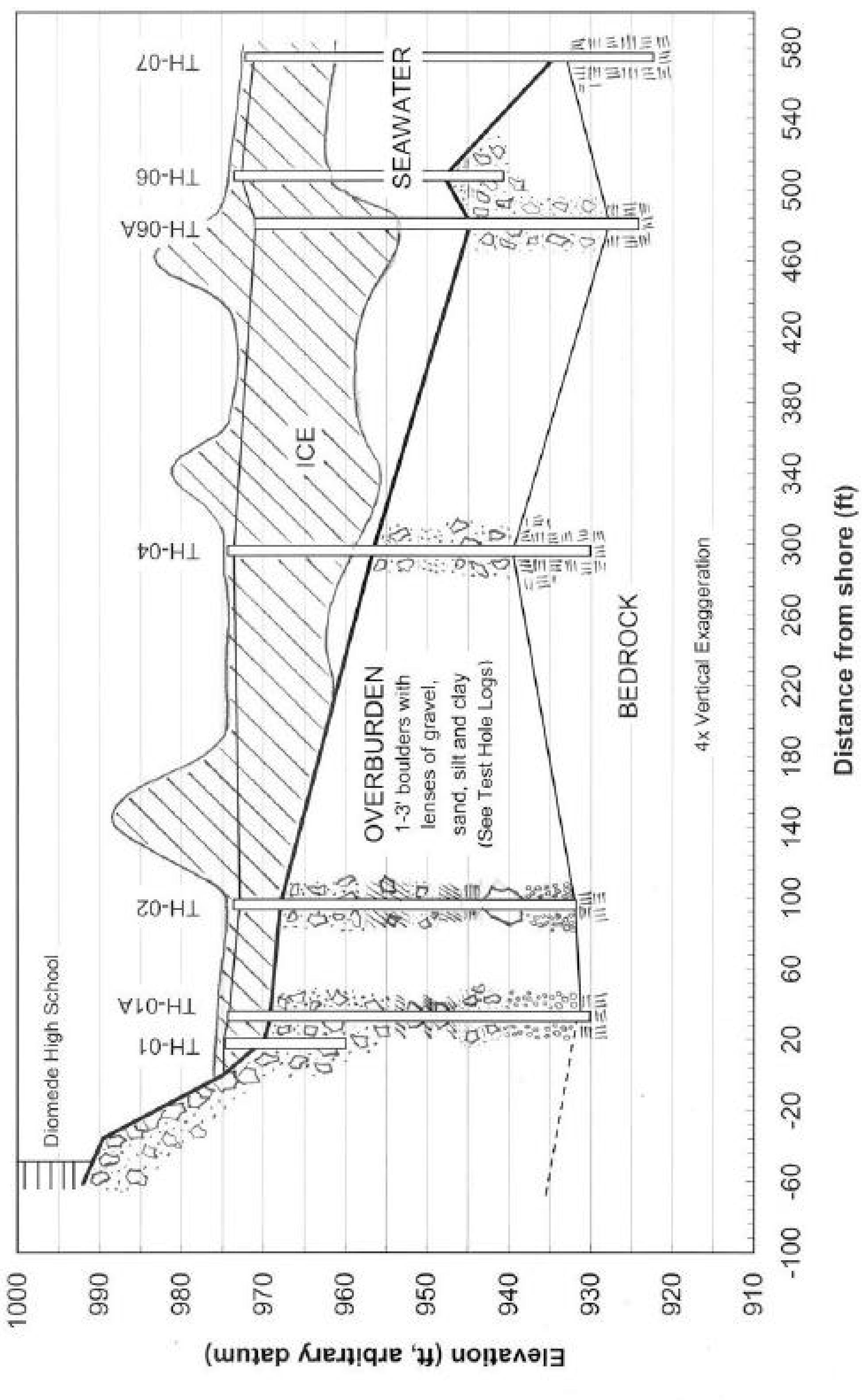


Figure 2. Cross section along proposed seawater intake line route showing test hole locations and elevations. Bottom of ice, seafloor and top of bedrock locations are approximate except at test hole locations.

variety of down hole drills/hammers and advancing 4”casing. After completion all casing was removed.

Samples were collected at 10-ft intervals, where conditions permitted. Sampling methods included split-spoon sampling of sediment, rock coring and collection of drill cuttings. Split-spoon sampling was conducted by methods described in ASTM D 1586 using a 2.5-inch inside diameter (I.D.) by 3-inch outside diameter (O.D.) sampler. The sampler was driven using a 300-pound safety hammer, falling 30 inches per blow. The safety hammer was raised using a cathead. This type of sampling is noted with the abbreviation “Sm” on the borehole logs and in this report. The split-spoon sampler was driven a minimum of 18 inches at each sample location, with blow counts being recorded for each 6-inch interval. Unadjusted, uncorrected blow counts required to penetrate the sampling interval from 6 to 18 inches are reported on the final borehole logs. These values give a measure of the relative density of cohesionless soils, or the relative consistency of cohesive soils. Rock core sampling was conducted by methods described in ASTM D 2113-99 using a 2-inch I.D. swivel type double tube core barrel.

2.2 Laboratory Testing

Selected representative sediment and rock samples were sent to a lab to confirm field classifications and to determine index properties of the typical materials encountered at the site. A total of 4 sediment samples were submitted for laboratory particle size analysis. Three rock cores were submitted for compressive strength analysis. Alaska Testlab in Anchorage, AK performed the laboratory testing. Laboratory results are included in Table 1 and, Appendices B and C.

Field and laboratory soil and rock classification and testing was conducted in accordance with the Unified Soil Classification System (USCS) and the following ASTM Standards:

D 422 Method for Particle-Size Analysis of Soils
D 1586 Method for Penetration Test and Split-Barrel Sampling of Soils
D 2487 Test Method for Classification of Soils for Engineering Purposes
D 2488 Practice for Description and Identifications of Soils (Visual-Manual Procedure)
D 6032 Test Method for Determining rock Quality Designation (RQD) of Rock Core

All sediment and rock samples were retained for possible further reference.

Sampling Methods   Sm - 2"ID spoon with 300lb hammer, G - cuttings, Cd - rock core

Sample #	Lab	Depth	Method	Description	Lab Results
TH-01 Sample 1		11	Sm	gravel with pebbles (up to 1.5") with sand/silt matrix BC (blow counts not reported, went through rock)	
TH-01A Sample 1	*	31	Sm	white and tan sand with black fine sand/silt matrix BC 11, 20, 11 (Blow Counts low, not undisturbed sample)	Well Graded Sand with Silt, SW-SM
TH-01A Sample 2		37	G	fine gravel with sand (up to 0.5")	
TH-01A Sample 3	*	42	G	gravel (up to 0.5") with sand	Well Graded Sand with Gravel, SW
TH-02 Sample 1		9	G	gravel (up to 0.25") with sand	
TH-02 Sample 2	*	18	G	silt with sand/clay	Poorly Graded Sand with Silt, SP-SM
TH-02 Sample 3		26	G	clay with silt	
TH-04 Sample 1		23	G	broken cobbles	
TH-04 Sample 2	*	40	Cd	4.5' of coring, 2.5' recovered, granitic, RQD 23%	19,290 psi compressive strength
TH-06A Sample 1	*	44	Sm	granitic pebbles up to 2" BC (blow counts not reported, pebble jammed in sampler)	Poorly Graded Gravel with Sand, GP
TH-06A Sample 2	*	45	Cd	4' rock core, granitic, RQD 70%	19,500 psi compressive strength
TH-07 Sample 1	*	44	Cd	2' core, granitic, RQD 62%	21,850 psi compressive strength
TH-07 Sample 2		46	Cd	3' core, granitic, RQD 62%	

Table 1. Description of samples taken and lab results where applicable.

3. Site Conditions

3.1 Surface Conditions

Little Diomede Island is approximately two square miles in area and rises 1300' above the Bering Strait. The island is composed of talus and bedrock of porphyritic granite. The shoreward end of the proposed seawater intake line is at the base of a talus slope that has been benched for construction of the Diomede High School, the school heat plant and water storage tanks. The bench is 15'-20' above and 35' back from the shore. The slope down to the shore consists of 2-4' sub-angular boulders that become smaller and more rounded toward the shore. Underwater video of the temporary intake line on the seafloor out to 150' off shore shows rounded cobbles covered in seaweed. At 300 ft boulders and sand was found at the surface. At 500 ft offshore three feet of sand and broken shells were found on the surface of the seafloor. The villagers indicated that sediment from slides on the north end of the island into the sea moves through the area. It is possible that discrete sediment waves form from the slide debris and move through the project area. At 600 ft offshore bedrock was at the surface.

3.2 Subsurface Conditions

No subsurface investigations have been done at the proposed entrance location of the seawater intake line. Villagers who worked on the high school just south of the site said that sand and boulders were encountered when excavating for the foundation. Larsen Engineering investigated the elementary school foundation soils, 150 ft south of the site, and dug three test holes to a maximum depth of 6 ft. The hole located nearest the shore had medium course sand to 3 ft boulders. The two holes inshore had fewer cobbles and boulders with sand and fines. Frozen soil was encountered 2.5 to 3 ft deep.

Bedrock was reached at testholes TH-01A, TH-02, TH-04, TH-06A, and TH-07. Bedrock was cored in testholes TH-04, TH-06A and TH-07. Bedrock is found at an average elevation of 933 ft (arbitrary datum of 1000 feet at the high school foundation), approximately 40 feet below the ice surface. The top of bedrock is relatively flat, with elevations in most testhole locations ranging from 928 ft to 933 ft with bedrock at 940 ft in TH-04.

Material overlaying the bedrock ranged in thickness from 38 ft to 0.5 ft decreasing farther offshore. At TH-01A and TH-02 the material overlaying the bedrock, 38 ft and 36 ft thick, respectively, consists of granite cobbles and boulders of up to 4 ft in a sand matrix, with 1-6 ft layers of silt and/or clay. Directly on top of the bedrock is a layer of black, sandy gravel with coarser gravel at the top of bedrock. This gravel layer is 13 ft thick at TH-01, and 7 ft thick at TH-02. In testholes TH-04, TH-06, TH-06A and TH-07 only the cobbles and boulders with a sandy matrix are present.

The bedrock is a porphyritic granite composed of approximately:

- 15% Quartz,
- 62% Potassium Feldspar,
- 5% Biotite,

- 3% Hornblende, and
- 15% Plagioclase.

The largest crystals (phenocrysts), up to 1.5 inches, are potassium feldspar. These are the largest in samples from TH-07, in the sample from TH-06 they are smaller, but more numerous. The sample from TH-04 shows the most variation in phenocryst size and mineral composition; there is a greater amount of biotite and hornblende in some portions of the sample, and in these areas phenocrysts may be absent.

The rock cores obtained from testholes TH-04, TH-06A and TH-07 have Rock Quality Designations (RQD's) of 23%, 70% and 62%, respectively, and compressive strength of 19,000 to 21,000 psi (see App. C). At the bottom of TH-04 drill cuttings were lost during the first coring run and an attempt at a second coring run was abandoned because five feet of sediment had filled the hole while resetting the core barrel.

4. References

Jumikis, A.R. 1983. *Rock Mechanics.* Gulf Publishing Company, Houston, TX.

Larsen Engineering, Inc. 1997. Diomede Elementary School Foundation Repairs. Prepared for Bering Strait School District. December 15, 1997.

R&M Consultants, Inc. 1979. Report on Proposed High School Foundation Site Selection and Inspection, Little Diomede Island, Alaska. Prepared for Bering Strait School District. August 27, 1979.

U.S. Geological Survey. 1980. Geologic Map of Alaska.

APPENDIX A:
SOIL TEST HOLE LOGS

SOILS CLASSIFICATION

CLASSIFICATION: Soils identification and classification is accomplished in accordance with the Unified Soil Classification System per ASTM D 2487 and D 2488.

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS More than half is larger than No. 200 sieve	GRAVELS More than half coarse fraction is larger than No. 4 sieve size	Clean gravels with little or no fines	GW	Well graded gravels, gravel–sand mixtures
			GP	Poorly graded gravels, gravel–sand mixtures
		Gravels with over 12% fines	GM	Silty Gravels, poorly graded gravel–sand–silt mixtures
			GC	Clayey gravels, poorly graded gravel–sand–clay mixtures
	SANDS More than half coarse fraction is smaller than No. 4 sieve size	Clean sands with little or no fines	SW	Well graded sands, gravelly sands
			SP	Poorly graded sands, gravelly sands
		Sands with over 12% fines	SM	Silty sand, poorly graded sand–silt mixtures
			SC	Clayey sands, poorly graded sand–clay mixtures
FINE GRAINED SOILS More than half is smaller than No. 200 sieve	SILTS AND CLAYS Liquid limit less than 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays lean clays
			OL	Organic clays and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid limit greater than 50		MH	Inorganic silts, micaceous or diatomacious fine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
HIGH ORGANIC SOILS			PT	Peat and other highly organic soils

LITTLE DIOMEDE ISLAND
GEOTECHNICAL REPORT

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SOIL CLASSIFICATION

FIGURE A1

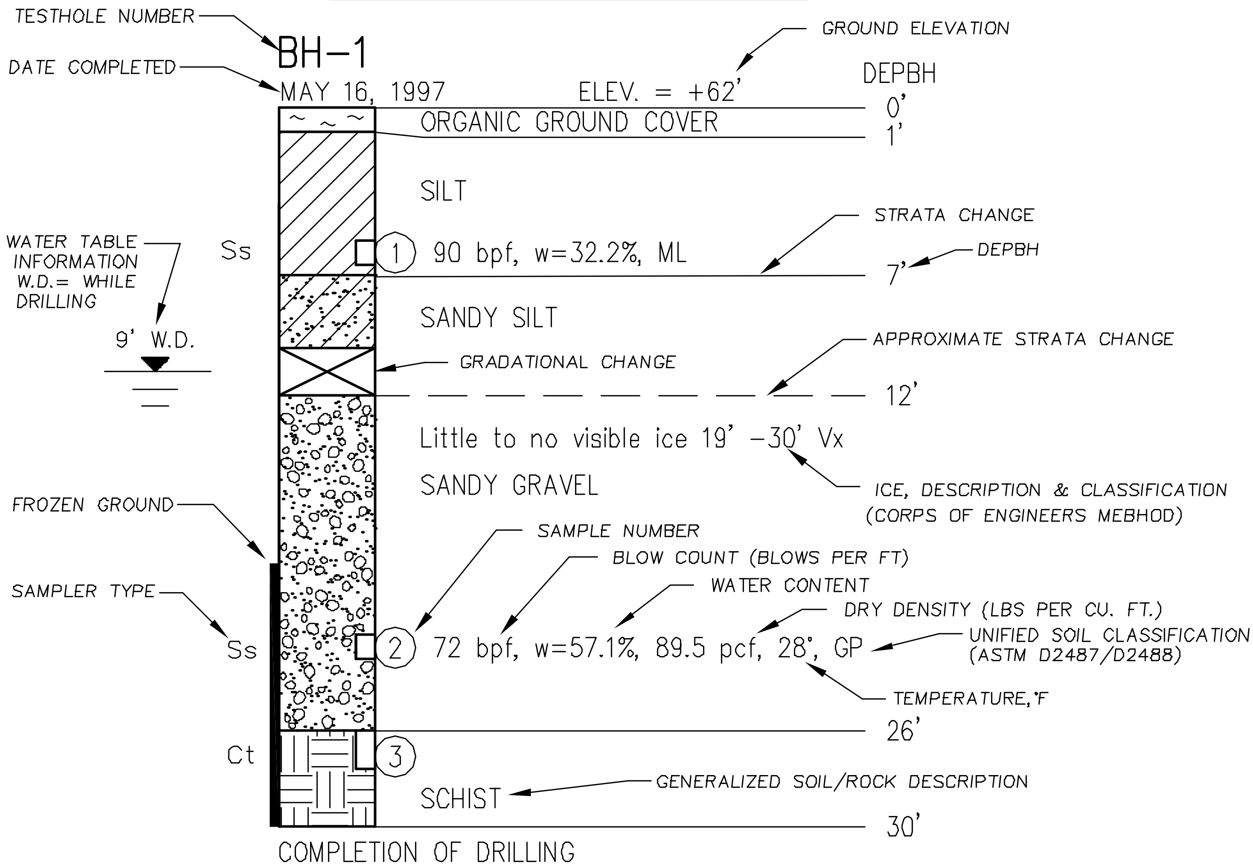
PN&D PROJECT #D1013

SAMPLER TYPE SYMBOLS

St . . . 1.4" I.D. SPLIT SPOON W/ 47# HAMMER
Ss . . . 1.4" I.D. SPLIT SPOON W/ 140# HAMMER
Sx . . . 2" I.D. SPLIT SPOON DRIVEN W/ 140# HAMMER
Sl . . . 2.5" I.D. SPLIT SPOON W/ 140# HAMMER
Sm . . . 2.5" I.D. SPLIT SPOON W/ 300# HAMMER
Sh . . . 2.5" I.D. SPLIT SPOON W/ 340# HAMMER
Sp . . . 2.5" I.D. SPLIT SPOON, PUSHED
Hs . . . 1.4" I.D. SPLIT SPOON DRIVEN W/ AIR HAMMER
Hl . . . 2.5" I.D. SPLIT SPOON DRIVEN W/ AIR HAMMER

Ts . . . SHELBY TUBE
Pb . . . PITCHER BARREL
Cs . . . CORE BARREL W/ SINGLE TUBE
Cd . . . CORE BARREL W/ DOUBLE TUBE
Ct . . . CORE BARREL W/ TRIPLE TUBE
Bs . . . BULK SAMPLE
A . . . AUGER SAMPLE
G . . . GRAB SAMPLE
Bl . . . BRASS LINER

TYPICAL TEST HOLE LOG



DRILLING SYMBOLS

WO: Wash Out
WL: Water Level
WCI: Wet Cave In
DCI: Dry Cave In
WS: While Sampling

WD: While Drilling
BCR: Before Casing Removal
ACR: After Casing Removal
AB: After Boring
TD: Total Depth

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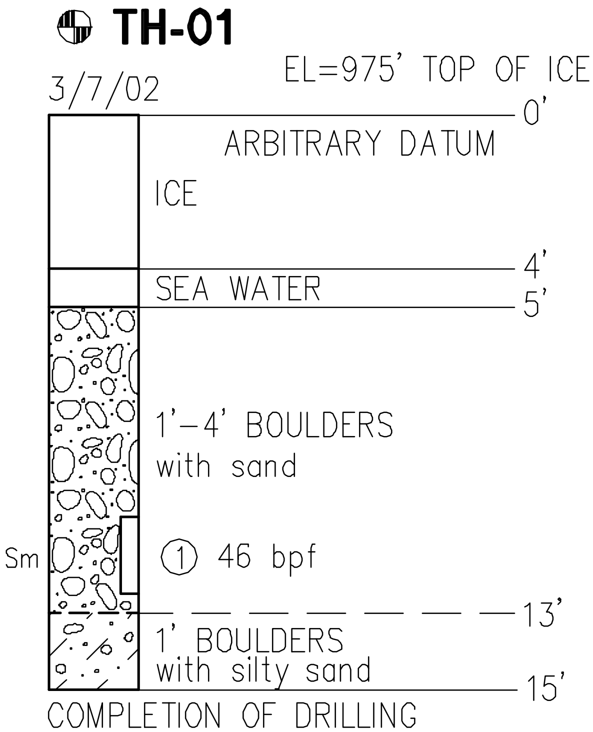
TYPICAL TEST HOLE LOG AND SYMBOLS

FIGURE A2

PN&D PROJECT #D1013



PN&D PROJECT #01013

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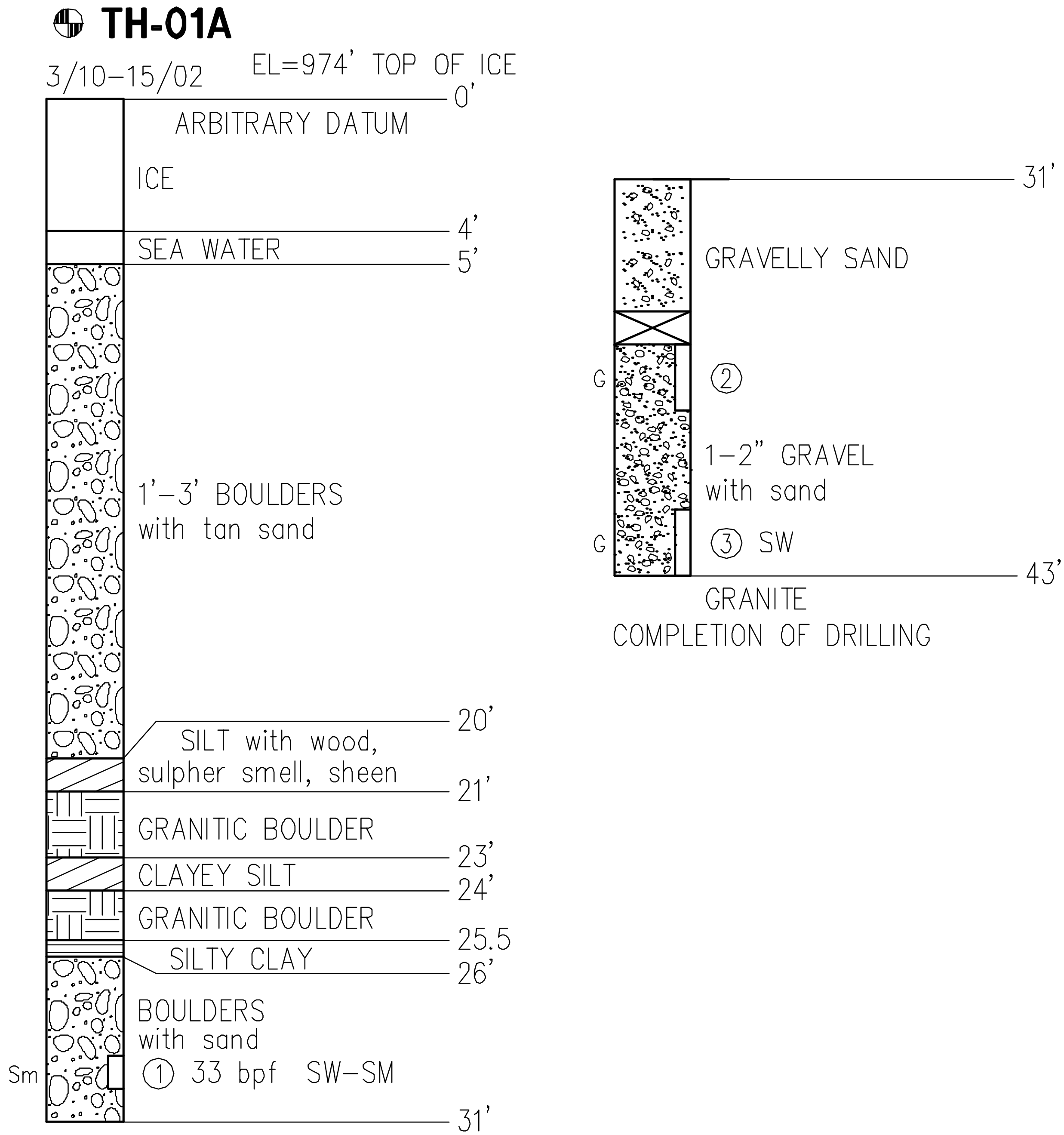
TEST HOLE LOG TH-01

FIGURE
A3



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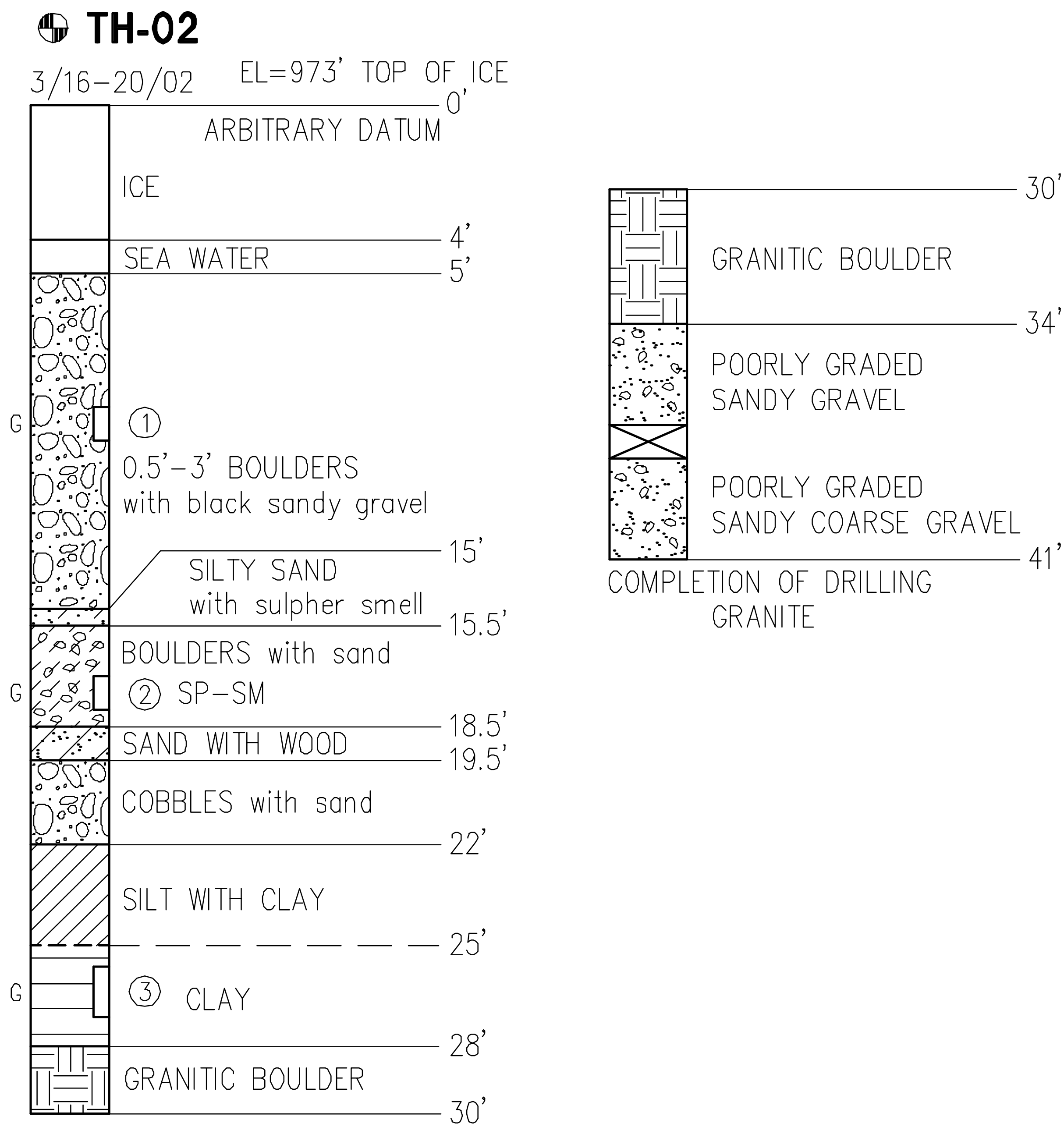
TEST HOLE LOG TH-01A

FIGURE A4

PN&D PROJECT #01013



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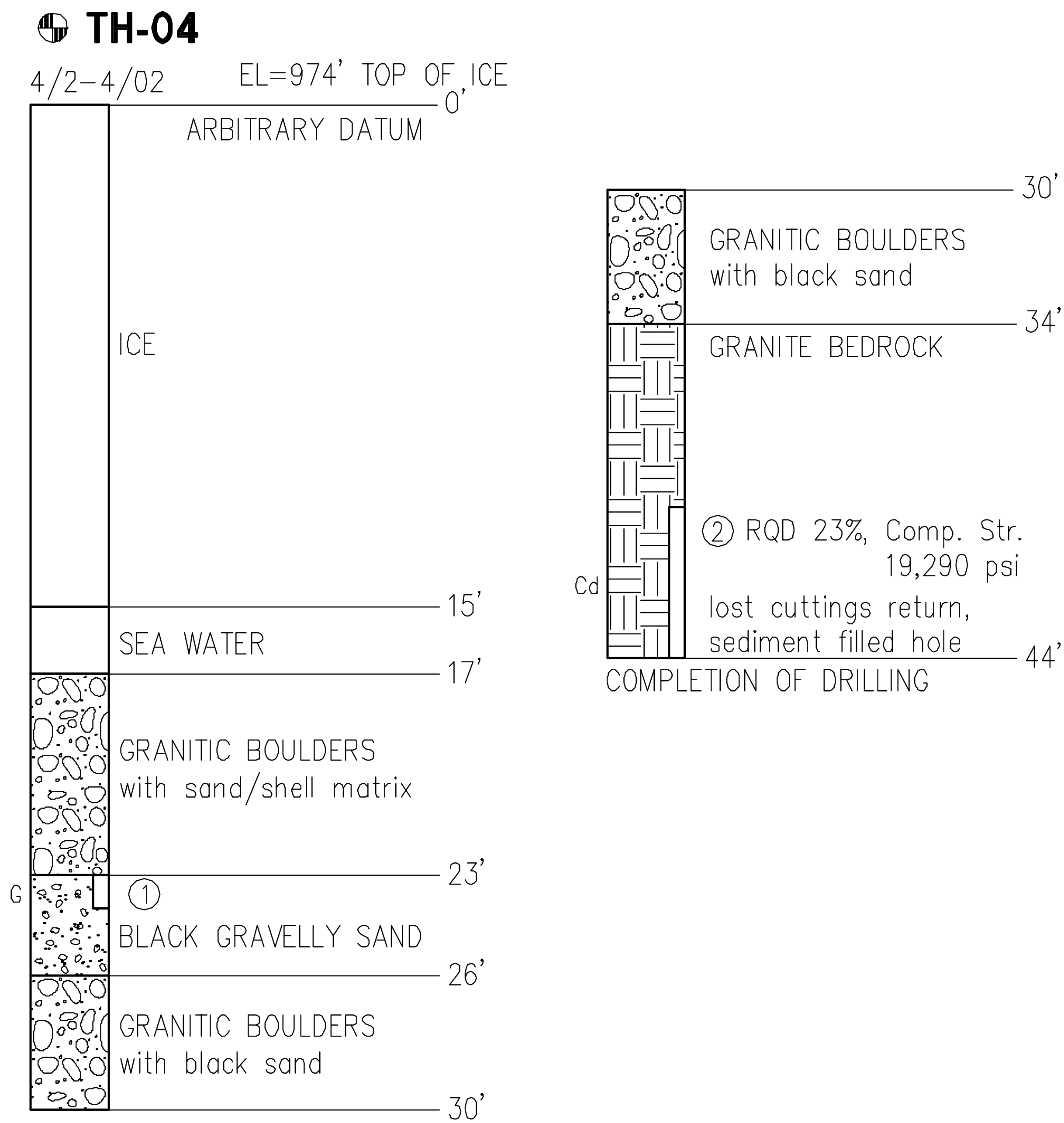
TEST HOLE LOG TH-02

FIGURE
A5

PN&D PROJECT #01013



PN&D PROJECT #01013

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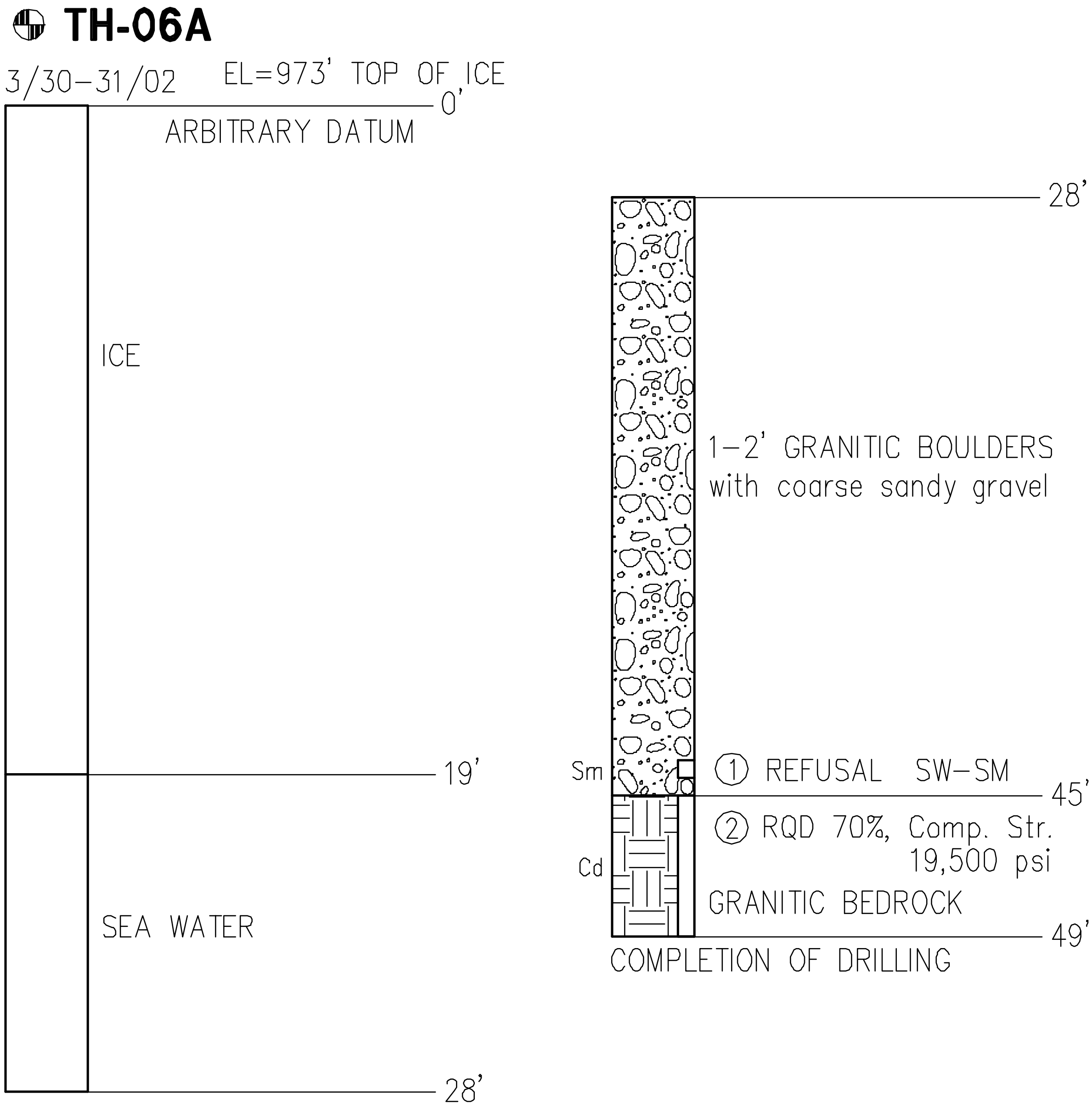
TEST HOLE LOG TH-04

FIGURE
A6



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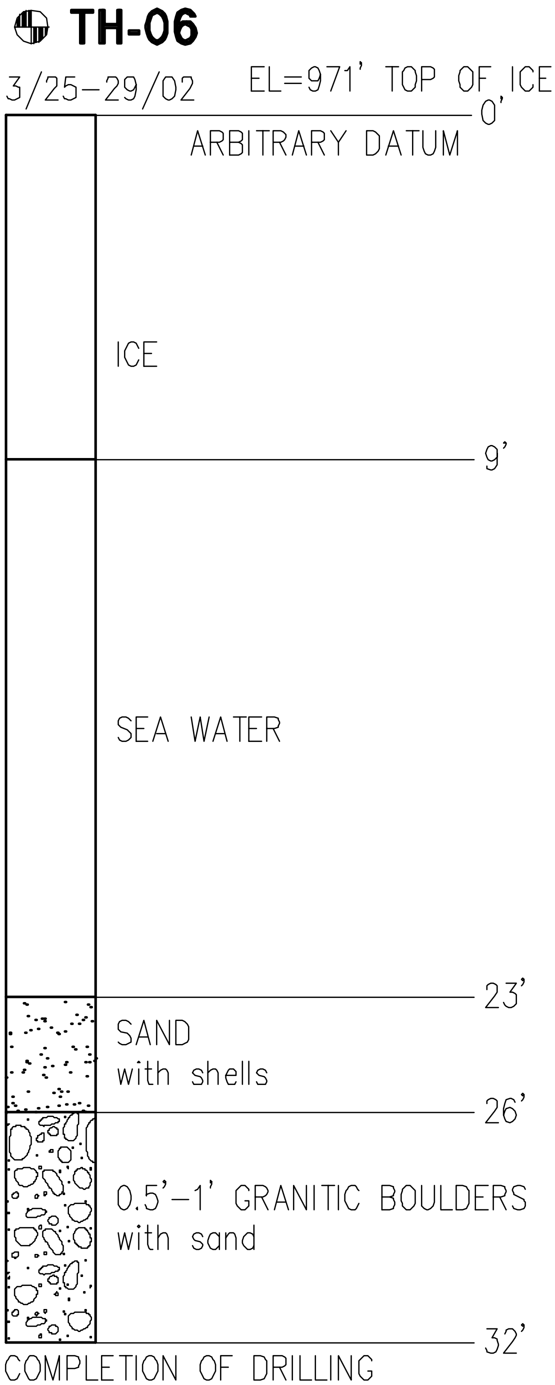
TEST HOLE LOG TH-06A

FIGURE A7

PN&D PROJECT #01013



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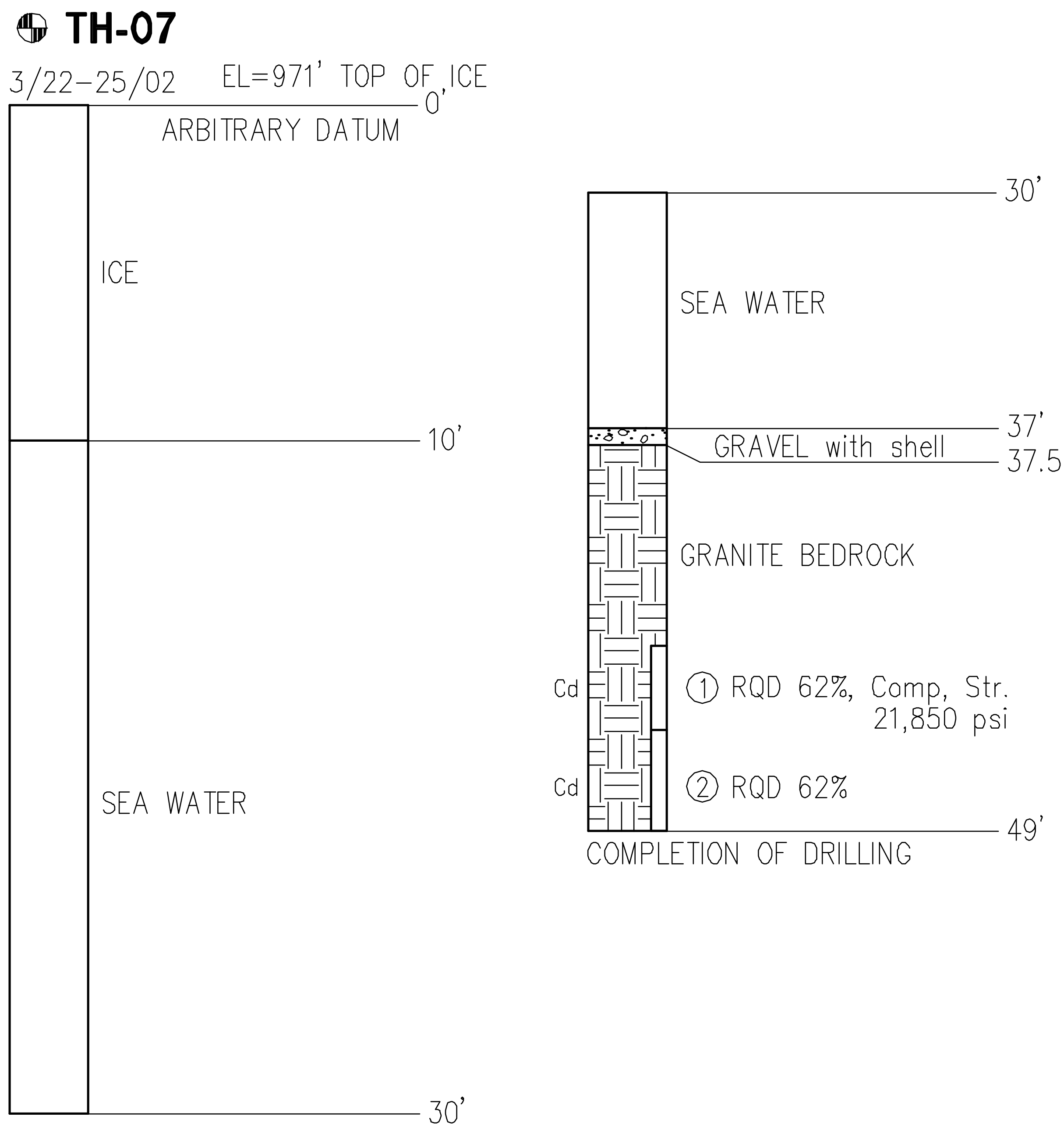
TEST HOLE LOG TH-06

FIGURE **A8**

PN&D PROJECT #01013



LITTLE DIOMEDE ISLAND
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Engineering Consultants

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TEST HOLE LOG TH-07

FIGURE
A9

PN&D PROJECT #01013

APPENDIX B:
SOIL SIEVE ANALYSIS RESULTS

ALASKA TESTLAB
A Division of DOWL LLC

Client: Peratrovich Nottingham & Drage

Project: Little Diomede 01013.03

Location: TH-01A, SA-1

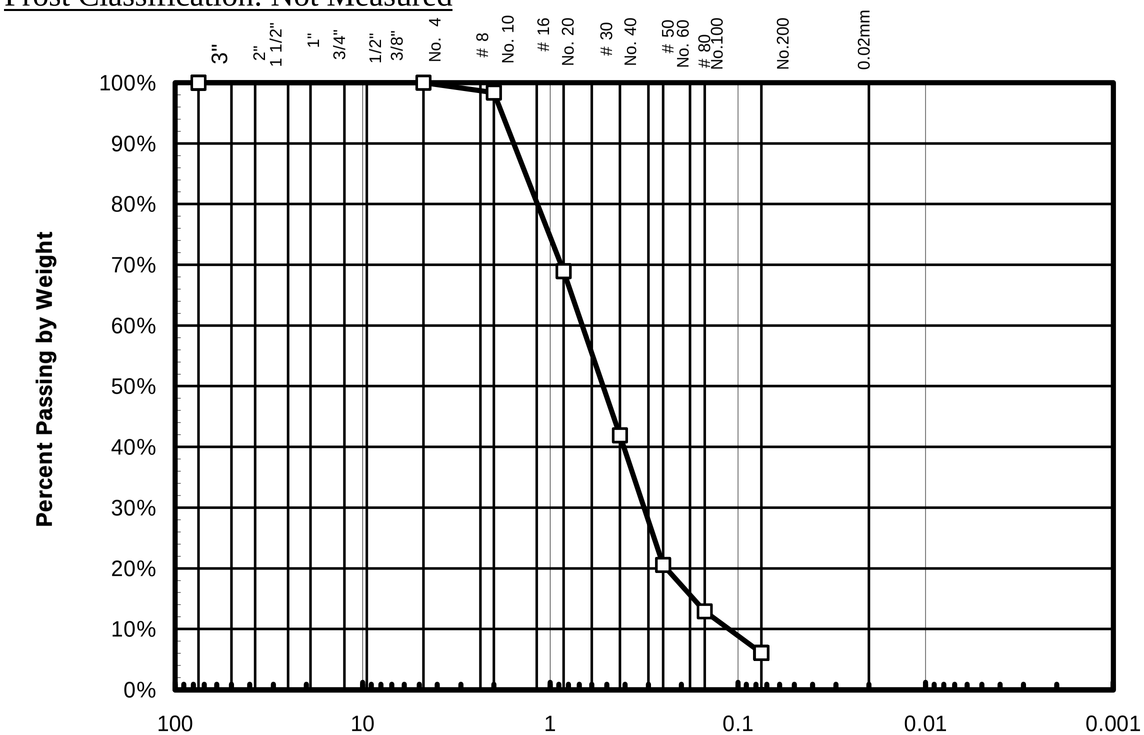
Submitted by Client

PARTICLE-SIZE
DIST. ASTM D422

W.O. A29727
Lab No. 552
Received: 4/22/02
Reported: 4/26/02

Engineering Classification: Well Graded SAND with Silt , SW-SM

Frost Classification: Not Measured



SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"		
1/2"		
3/8"		
No. 4	100%	
Total Wt. = 375.1g		
No. 8		
No. 10	98%	
No. 16		
No. 20	69%	
No. 30		
No. 40	42%	
No. 50		
No. 60	21%	
No. 80		
No. 100	13%	
No. 200	6.1%	
Total Wt. of Fine Fraction = 375.1g		
0.02 mm		

David L Andersen

David L. Andersen, P.E., General Manager

ALASKA TESTLAB
A Division of DOWL LLC

Client: Peratrovich Nottingham & Drage

Project: Little Diomede 01013.03

Location: TH-01A, SA-3

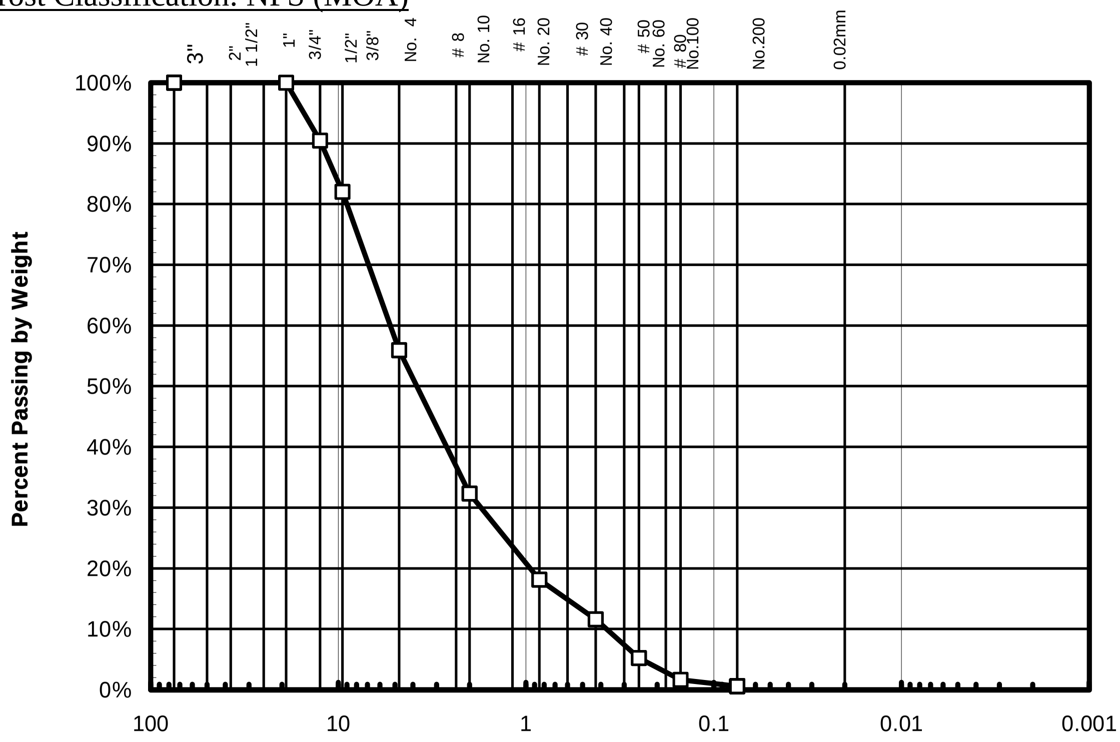
Submitted by Client

PARTICLE-SIZE
DIST. ASTM D422

W.O. A29727
Lab No. 551
Received: 4/22/02
Reported: 4/26/02

Engineering Classification: Well Graded SAND with Gravel, SW

Frost Classification: NFS (MOA)



SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"	100%	
1/2"	90%	
3/8"	82%	
No. 4	56%	
Total Wt. = 1395g		
No. 8		
No. 10	32%	
No. 16		
No. 20	18%	
No. 30		
No. 40	12%	
No. 50		
No. 60	5%	
No. 80		
No. 100	2%	
No. 200	0.6%	
Total Wt. of Fine Fraction = 378.3g		
0.02 mm		

David L Andersen
David L. Andersen, P.E., General Manager

4040 B Street Anchorage Alaska 99503 • 907/562-2000 • 907/563-3953

ALASKA TESTLAB
A Division of DOWL LLC

Client: Peratrovich Nottingham & Drage

Project: Little Diomede 01013.03

Location: TH-02, SA-2

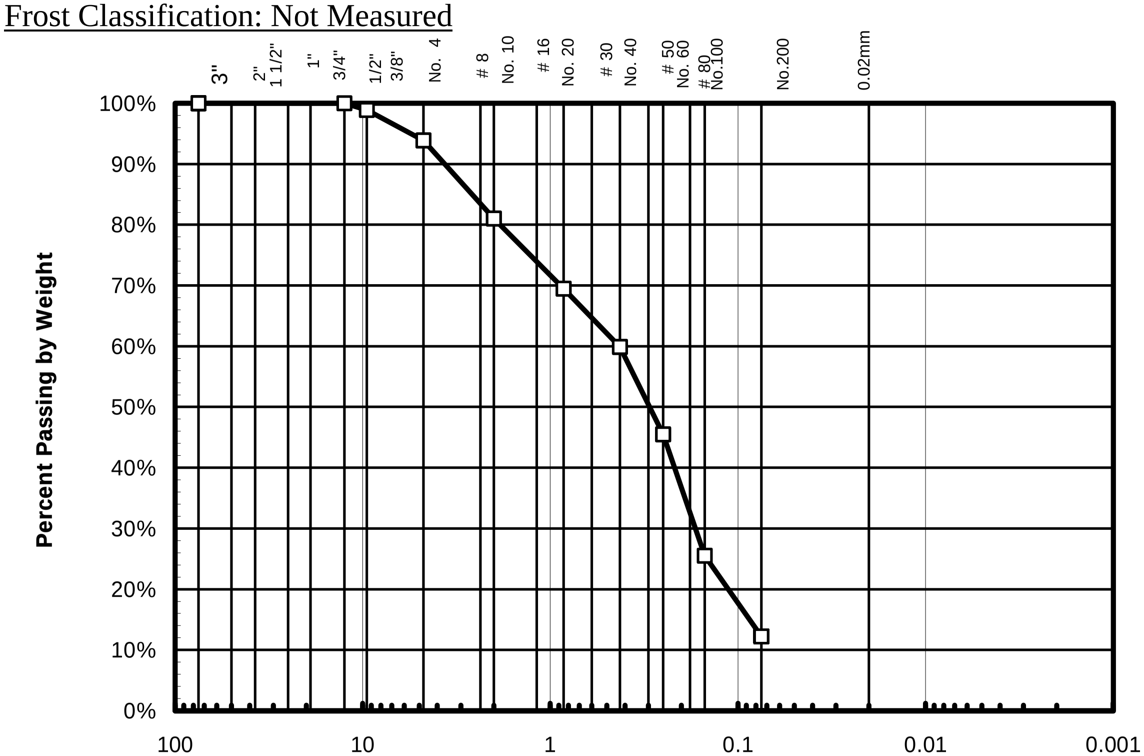
Submitted by Client

PARTICLE-SIZE DIST. ASTM D422

W.O. A29727
Lab No. 550
Received: 4/22/02
Reported: 4/26/02

Engineering Classification: Poorly Graded SAND with Silt , SP-SM

Frost Classification: Not Measured



SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"		
1/2"	100%	
3/8"	99%	
No. 4	94%	
Total Wt. = 292.3g		
No. 8		
No. 10	81%	
No. 16		
No. 20	69%	
No. 30		
No. 40	60%	
No. 50		
No. 60	45%	
No. 80		
No. 100	26%	
No. 200	12%	
Total Wt. of Fine Fraction = 274.4g		
0.02 mm		

David L Andersen

David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
A Division of DOWL LLC

Client: Peratrovich Nottingham & Drage

Project: Little Diomede 01013.03

Location: TH-06, SA-1

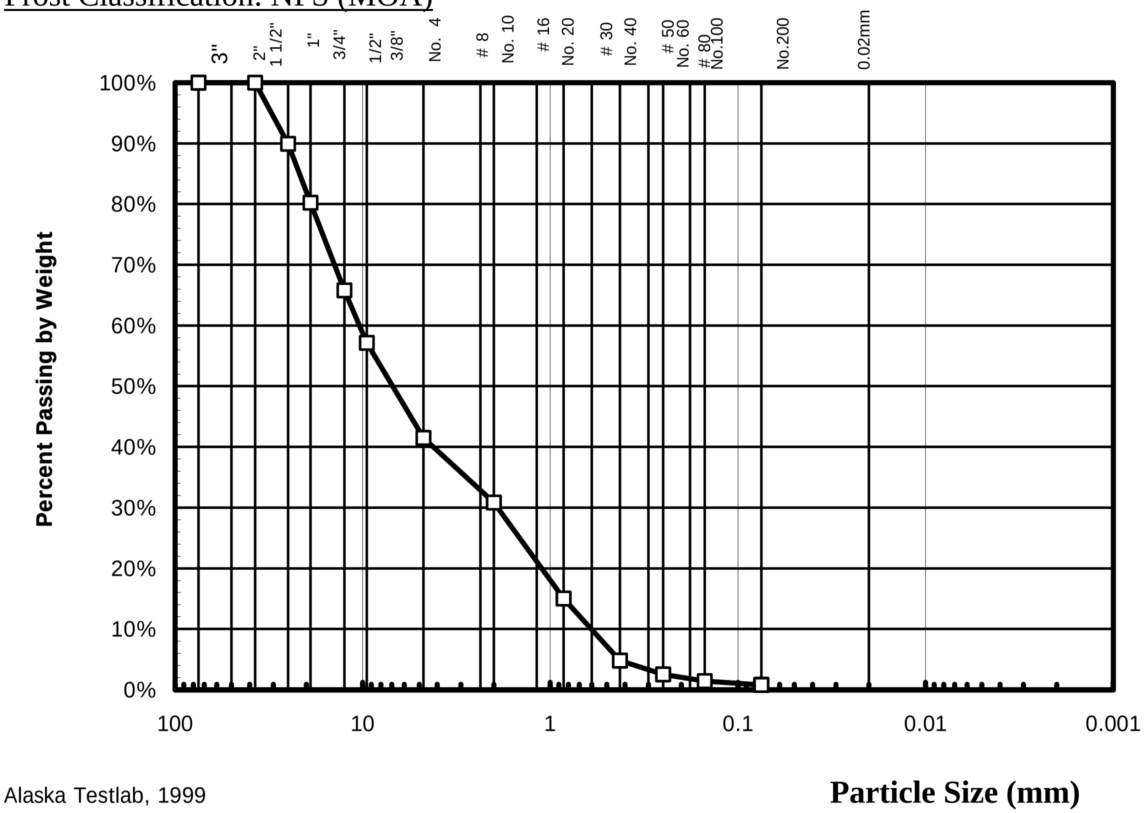
Submitted by Client

PARTICLE-SIZE
DIST. ASTM D422

W.O. A29727
Lab No. 549
Received: 4/22/02
Reported: 4/26/02

Engineering Classification: Poorly Graded GRAVEL with Sand, GP

Frost Classification: NFS (MOA)



SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"	100%	
1"	90%	
3/4"	80%	
1/2"	66%	
3/8"	57%	
No. 4	41%	
Total Wt. = 439.8g		
No. 8		
No. 10	31%	
No. 16		
No. 20	15%	
No. 30		
No. 40	5%	
No. 50		
No. 60	3%	
No. 80		
No. 100	1%	
No. 200	0.8%	
Total Wt. of Fine Fraction = 182.5g		
0.02 mm		

David L Andersen

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APPENDIX C:
ROCK CORE
COMPRESSIVE STRENGTH
TEST RESULTS

ALASKA TESTLAB
A Division of DOWL LLC

May 17, 2002
W.O. A29727

Peratrovich Nottingham & Drage
1506 W. 36th Ave. Suite 101
Anchorage, Alaska 99503

Attention: Mr. Jasper Hardison

Project: Little Diomede 01013.03
Rock Core Compressive Strength

Sample I.D.	Diameter (in)	Height (in)	Load (lbs)	Area (in)	Compressive Strength (psi)
TH-04, SA-02	1.853"	3.530"	51,496	2.67	19,290
TH-6A, SA-02	1.856"	3.655"	52,653	2.70	19,500
TH-07, SA-01	1.868"	3.502"	59,866	2.74	21,850

David L. Andersen, P.E., General Manager

A29727.29727 Rock Core psi.DLA.051702.jlb

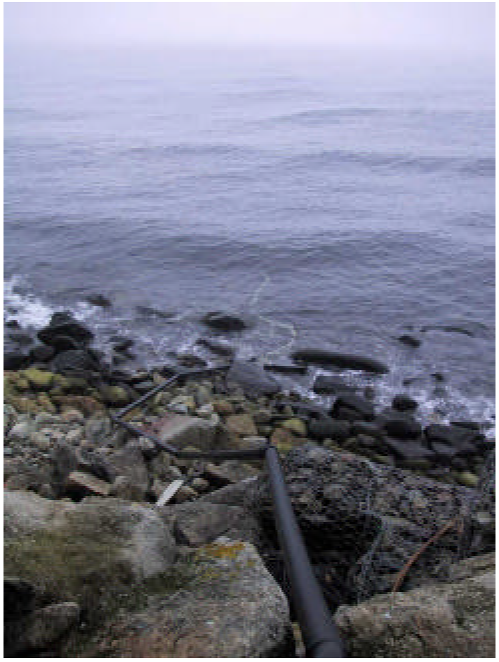
Appendix D:
SITE PHOTOGRAPHS

View from above the village looking west. Cleared area on right side of photo is for the drilling and goes out approximately 600 ft from shore. Drill rig can be seen above the four rectangular water tanks of the high school.

Drilling at hole TH-07. Little Diomede Island in background.

Drilling at hole TH-01A. Diomede High School in the background.

Drilling at hole TH-07. Big Diomede Island, Russia in the right background.



View of slope below Diomede High School showing the existing seawater intake line.

View to the north of Diomede High School and talus slope to the shore. The Science Shack is underneath the far end of the school.