NATIONAL PETROLEUM RESERVE IN ALASKA

DESIGN & CONSTRUCTION OF THE AWUNA WELLSITE

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For the

U. S. GEOLOGICAL SURVEY
Office of the National Petroleum Reserve in Alaska
Department of the Interior
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INTRODUCTION

Naval Petroleum Reserve No. 4 was established by Executive order of President Harding in 1923 in order to protect a potential source of petroleum for strategic purposes. The Reserve covers 23,000,000 acres in northern Alaska. It spans south from the Beaufort and Chukchi Seas to the Continental Divide in the Brooks Range and west from the Colville River to Icy Cape (Figure No. 1). In 1977 the name was changed to National Petroleum Reserve in Alaska (NPRA).

In 1944, the Navy began a large scale exploration program to assess the oil resource potential of the Reserve. The program began as a Naval Construction Battalion (Seabee) operation, but was changed to a civilian contract operation in 1946. During the first 2 years, in addition to performing some initial reconnaissance, the Seabees began construction of a camp and transportation facility infrastructure to support future activities. The gathering and interpretation of geological, geophysical and drilling data began in 1945. Drilling, geophysical and operations support activities were continued through 1953, at which time the program was closed out. During the 9 year program, nine small oil and/or gas fields were identified.

In 1974, the U. S. Congress authorized and funded a new program to perform geophysical work and to drill exploratory wells in the Reserve. This program was originally under the jurisdiction of the Navy but was transferred to the Department of the Interior in June 1977. The responsibility for the program was assigned to the U. S. Geological Survey (USGS). The Navy contracted the operation to Husky Oil NPR Operations, Inc. who acted as prime management contractor for the exploration program from late 1975 until 1983. Under this contract, Husky and its subcontractors drilled 27 exploratory oil wells in the NPRA.

WELL LOCATION AND DRILLING REQUIREMENTS

In the spring of 1979, the USGS directed Husky to develop plans to drill five exploratory wells, at specified locations, the following winter. One of these, a 15,000-foot deep well named Awuna Test Well No. 1, was located at latitude 69°09'12"N and longitude 158°01'21"W (Figure No. 1). This site is located about 220 miles from the nearest portion of the Alaskan road system and 72 air miles from the nearest heavy aircraft airstrip at Ivotuk.

Preliminary estimates indicated that about 6 months of actual drilling would be necessary to reach the required 15,000-foot depth. Other operations, such as site construction, rig mobilization, rig-up, rig-down and demobilization would require additional time. Site contruction would require the building of a 280,000 square foot drilling pad, installation of approximately 200 timber piling, a 5,000-foot long airstrip, fuel storage facilities, the location of a winter water source, and the construction of a a road system connecting the pad, the airstrip and the water source. Finally, the drilling would require considerable support activities such as supplying the site with food, fuel, materials and personnel.

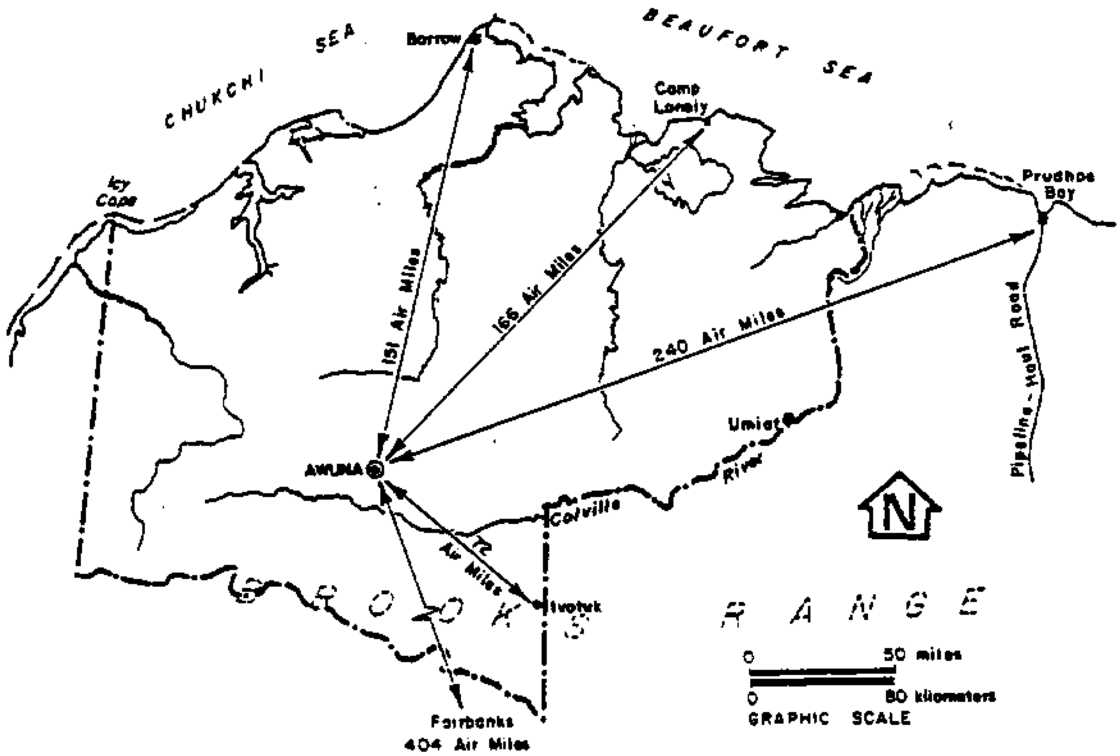

FIGURE NO. 1. LOCATION OF AWUNA

SITE CONDITIONS

Awuna is located in the northern foothills of the Brooks Range on rolling terrain. The site elevation is approximately 1,100 feet above sea level. The site is on a 1% southeasterly facing slope and is underlain by continuous permafrost. The local vegetation is predominantly tussock tundra. A series of small swampy lakes lie 1 to 3 miles south of the location. Lookout Ridge, a locally prominent outcropping, is just 4 miles to the south.

Weather at Awuna is typical of Alaska's North Slope. Winter presents temperatures as low as -60° F and periods of drifting, blowing snow. The tundra is frozen and protected by snow cover from November to May, and all major construction and drilling efforts occured during this period. Summers are short and mild, with the highest temperatures about +80° F. The average thawing index at the site is approximately 1,400 degree days Fahrenheit.

Survey and soils sampling were performed with helicopter support in July/August 1979. The soils were found to be highly ice-rich silts beneath a 10-inch organic mat. Moisture contents averaged about 225% by weight with individual readings as high as 1,200%. The site subsurface temperature was measured at 18° F by setting a permanent thermocouple at a depth of 50 feet. These soil conditions were confirmed during construction. A soils summary is included in Appendix I.

Thaw-stable borrow materials were located in several nearby areas. Even prior to site reconnaissance, it was known that large quantities of thaw-stable gravel would be found along the Colville River which was located 10 to 15 miles south of the well. On-site investigation identified other potential borrow sites. One, a sandstone outcrop 2 miles north of the well was judged capable of producing competent material with a quarry/crushing operation. A similar site was identified on the crest of a locally prominent feature named Lookout Ridge located about 4 miles south of the wellsite. Finally several small gravel deposits were located along the Awuna River, about 3 miles north of the wellsite .

SELECTION OF OVERALL DESIGN

Three primary factors affect the design of facilities constructed at a well location. These are the depth of the well, environmental considerations and economics. The projected depth of the well is the primary factor in determining the length of time which will be required on location. Completion of a well includes: mobilization of construction equipment and support camp to the location and construction of the wellsite facilities; mobilization of the rig and support equipment and camp; drilling; testing and suspending or abandoning the well; and finally demobilization of the rig and support equipment. If all this can be accomplished in approximately 170 days, or less, both environmental consideration and economics indicate that the well should be drilled in a single winter season. By electing this course of action, both the airstrip and roads can be constructed of ice. This is preferred to gravel construction environmentally because facilities made of ice disappear during break up. Ice construction is also less costly than gravel construction. Finally, for single winter use, the drilling pad can be constructed from material excavated during reserve pit construction without concern about its thaw-stability characteristics. By eliminating the need to develop a borrow source for thaw-stable material environmental disturbance is minimized and costs reduced.

If a well cannot be completed in a single winter season, two options exist. It can either be drilled on a year-round basis or drilled during two or more winter seasons, with all activities being suspended during the intervening summers. In the case of the Awuna well, more than a single winter would be required to reach the 15,000-foot target depth. Each of the two options were therefore investigated.

Drilling during the summer requires construction of a thaw-stable drilling pad, road system and airstrip, requiring about 400,000 cubic yards of thaw-stable fill. The cost of these thaw-stable summer facilities was estimated to be very high, ranging from $10 to $20 million. The alternative of drilling for two winter seasons (1979-80 and 1980-81) was studied and selected over construction of thaw-stable summer facilities. The comparable winter season costs were estimated as:

FY80 Civil Work	$3,000,000
Suspension of Drilling	500,000
Summer Rig Standby	600,000
FY81 Civil Work	1,000,000
Reenter	600,000
Total	$5,700,000

This was at least $4 million less expensive than the estimated minimum construction cost of a year-round, thaw-stable facility.

Even if such a rough cost analysis had indicated that all-season drilling would have been less expensive, environmental considerations would have taken precedence and dictated a winters-only drilling schedule. Awuna is located within the boundaries of the Utukok River Upland Special Area. Large numbers of caribou visit the area each spring to calve. Environmental stipulations restrict air activities from May 15 through July 15. This effectively shuts down the drilling activity for this period, eliminating a substantial portion of the cost benefits of construction all-season facilities.

Winter drilling also offered additional environmental advantages. Substantial reductions in earthwork quantities were realized by using ice roads and ice airstrips. Winter facilities would only require about 40,000 cubic yards of earthwork, a 10-fold reduction in quantity from the summer site requirements. Obtaining borrow material from the locally identified sources would have been difficult. The Colville River, and a corridor 2 miles wide on each side of the river, had been closed to disturbing activities such as borrow site development by nomination of the Colville for possible designation as a Wild and Scenic River. Development of a 400,000-cubic-yard borrow site on the crest of Lookout Ridge would have permanently degraded the visual qualities of the area. Extraction of sufficient material from either or both of the areas identified north of the well would have disturbed objectionably large areas.

As a result of these environmental concerns primarily and, to a lesser degree, the cost analysis, it was decided to drill the Awuna well on a winter-only basis.

After the two-winter-season drilling program was selected, the planned schedule shown in Table 1 was developed. It shows that the required drilling days would be available in the two winter seasons. It also fit conveniently with the availability of the rig and the construction equipment. A wellsite layout was then developed and is shown in Figure No. 2. The roads and airstrip were to be constructed of ice and disappear annually. The second season airstrip was to be constructed by flooding over the tundra, to produce a serviceable strip about 45 days earlier than possible on nearby lake locations.

TABLE 1.

SCHEDULE OF AWUNA WELL

Federal Fiscal Year	Dates	Approximate Total Days	Operation
FY79	7/1/79 - 8/31/79	62	Summer surveying
FY80	12/1/79 - 2/15/80	75	Construction of site
FY80	1/25/80 - 2/15/80	21	Fly rig in
FY80	2/15/80 - 2/29/80	14	Rig-up
FY80	3/1/80 - 5/1/80	61*	Drill
FY80	5/1/80 - 5/10/80	10	Suspend well
FY80	5/10/80 - 10/15/80	157	Stack out for summer
FY81	10/15/80 - 12/1/80	46	Reconstruct site
FY81	12/1/80 - 12/12/80	12	Rig-up/reenter
FY81	12/13/80 - 4/12/81	120*	Drill
FY81	4/13/81 - 4/25/81	12	Rig-down
FY81	4/15/81 - 5/1/8l	15	Fly rig out

* Total drilling = 61 + 120 = 181 days

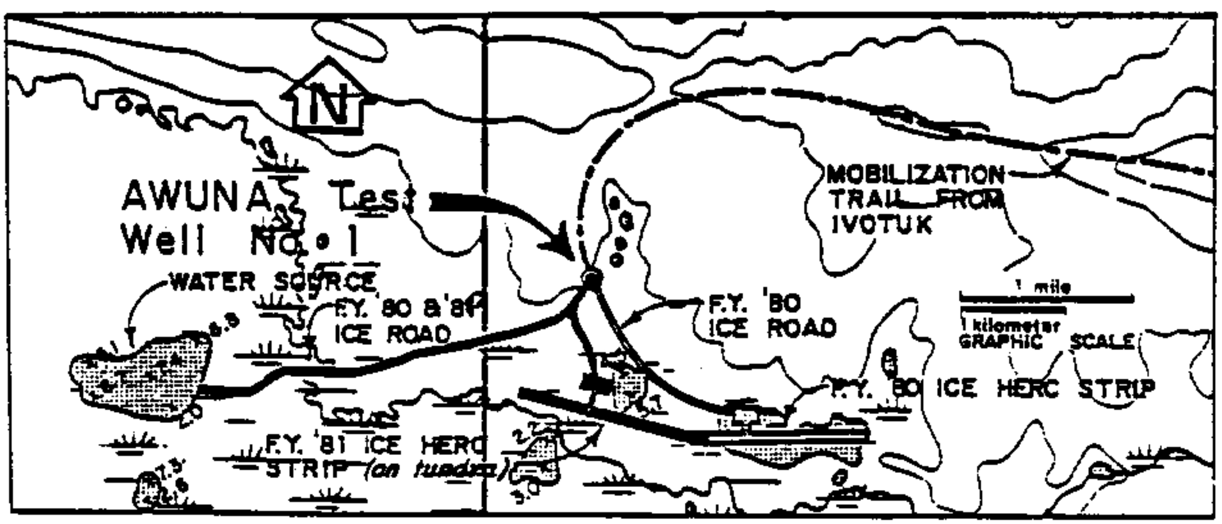

FIGURE NO. 2. LAYOUT OF AWUNA WELLSITE

The initial pad design contained two lifts of fill material. The lower lift was to be the ice-rich material from the reserve pit excavation. This was to be covered by a lift of competent borrow material to provide thaw stability for possible late spring operations and summer stackout of equipment and drilling materials. The rig would summer over on piling. The camp would either be supported on piling or on an insulated portion of the pad.

The USGS required that the necessity for borrow operations be closely reviewed. Husky's previous experience in the NPRA had shown that a 2-inch thickness of polystyrene insulation was sufficient to prevent significant summer thaw in the underlying soil. If bearing loads remain within the allowable compressive strengths of the insulation, a stable frozen subgrade foundation can be maintained below the insulation. Thus, it was determined to be technically feasible to stabilize portions of the ice-rich reserve pit excavation material through the summer season with insulation. If these insulation-stabilized areas were located properly, the pad could provide its required summer function without any thaw-stable borrow material. During summer stack-out (storage), the drilling rig, camp equipment and material must remain on a stable surface to avoid damaging settlements.

Elimination of borrow operations would save about $500,000. However, the darker, thaw-unstable material would become very muddy in late spring. An unserviceable pad could jeopardize rig operations. This risk was compared with the environmental and cost benefits of eliminating borrow operations. The decision was made to accept the risk and use only reserve pit excavation material plus insulation for the pad.

DESIGN OF THE DRILLING PAD

The final pad design is shown in Figure No. 3. Note the sloping terrain and the configuration of the pad and reserve pit. The reserve pit excavation furnished all material for pad construction.

The rig was positioned adjacent to the reserve pit so it could readily expel unwanted drilling fluids. Three 23,000 gallon double wall steel fuel tanks were set on piling adjacent to the rig. Drilling materials storage was at the back (north end) of the pad. The camp was set on short wooden piling in the designated camp area beyond the minimum distance requirement for rig fire safety. The area between the camp and rig provided a working area. The flare pit was constructed for testing the well, but unfortunately was never used.

The major concern in the pad design was insuring the stability of the drilling rig through the summer. Support piling were set to 23 feet below original grade. Experience had demonstrated this was adequate for rig operations and summer stack out on more stable pads.

Two events which could affect the adequacy of the piling design were considered. First, that runoff from the thawing silt, uphill from the rig, would flow beneath the rig, undermine the piling and fill the reserve pit.

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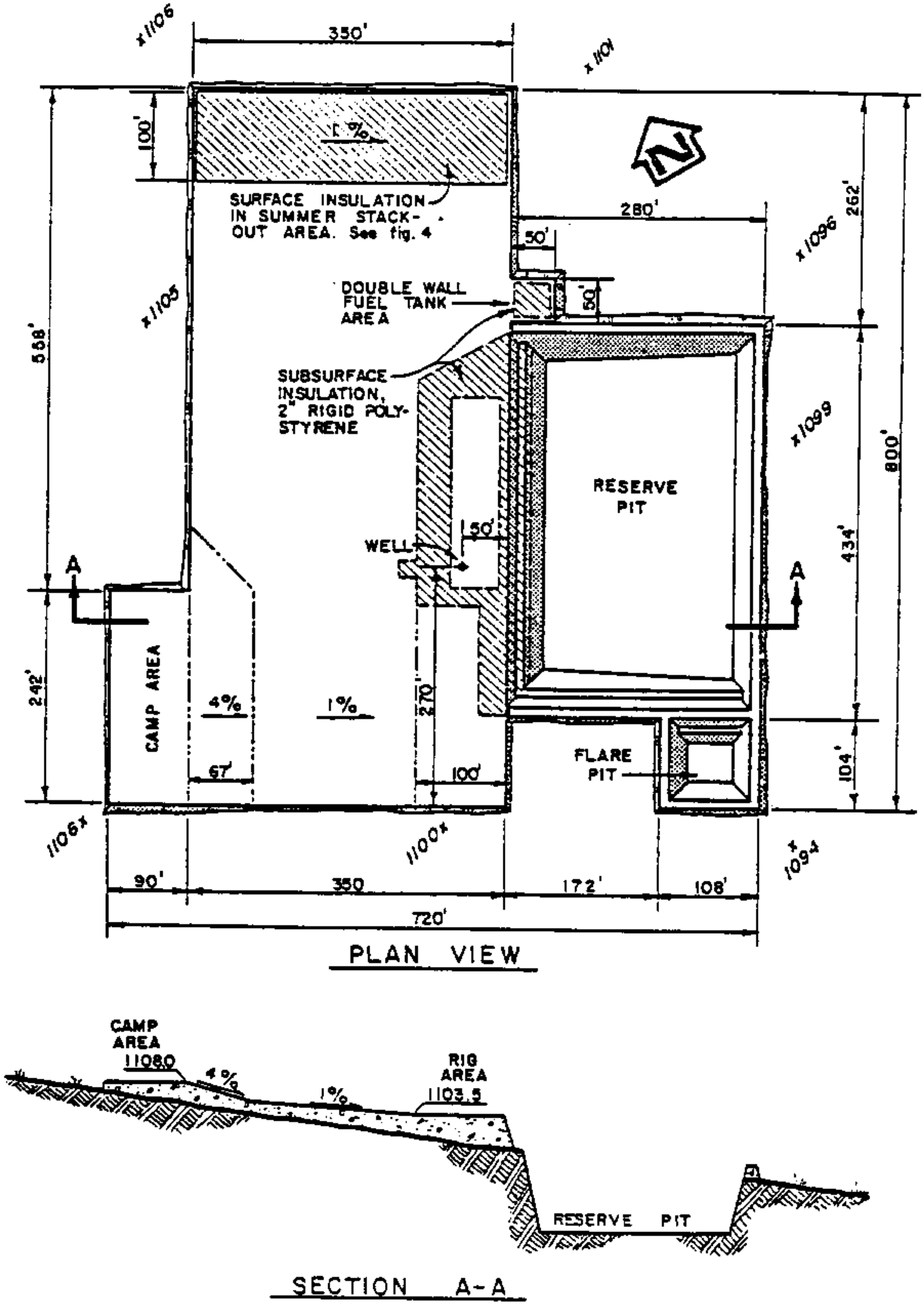

FIGURE NO. 3. AWUNA PAD DESIGN

Second, that the thawing silt would liquify, flow down the pad and induce excessive lateral loads on the timber piles. The possible occurrence of either event was eliminated by placing a sufficient area of insulation around the rig and 18-inches below the pad surface. This maintained a frozen belt on the up-slope perimeter of the rig area. Structural grade polystyrene insulation was specified so normal rig operational loading would not crush it (Reference No. 6). Insulation was not placed beneath the rig because the surrounding insulation was judged as adequate protection. The pad insulation was extended beyond the rig along the entire upper edge of the reserve pit to minimize flow of pad material into the pit.

The summer stack-out area was designed to remain uninsulated through the winter. During spring shut down, insulation was laid on the pad surface of the materials stack out area and covered with plywood. Heavy planking was used, as required, to spread concentrated loads over a greater area. This avoided crushing the insulation. After the summer, the planking, plywood and surviving insulation were salvaged. This design is shown in Figure No. 4

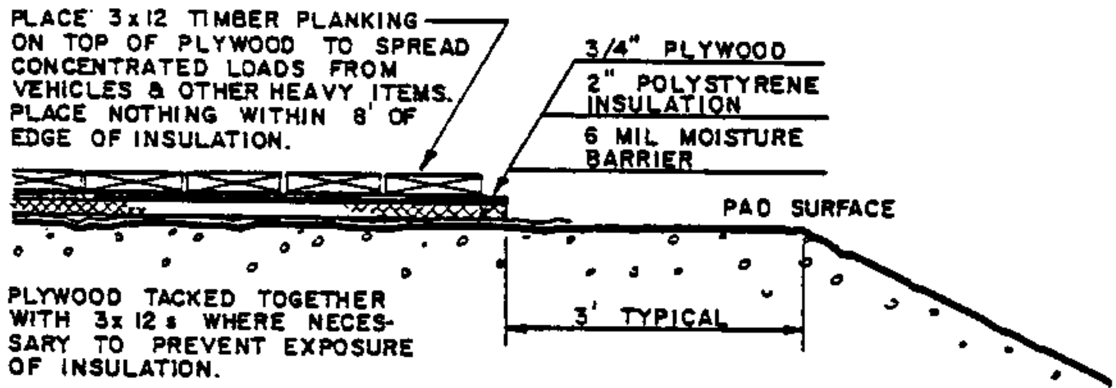

FIGURE NO. 4. STACK-OUT AREA INSULATION

Fourteen-foot-long piles were placed to support the fuel tanks which were to remain full all summer. Insulation was laid beneath the tanks to minimize thaw water from channeling down along the piling and jeopardizing their capacity to bear the heavy loads from the fuel and tanks. The fuel was utilized for start up the second winter, eliminating costly transportation of fuel by light aircraft.

The camp was supported by 8-foot-long piling. These piling were shallower than the fuel tank or rig piling for three reasons. First, the camp induced much lighter loading on the piling than the fuel tanks. Second, it was placed up slope from the pad, reducing the possibility that thaw water could reduce the bearing capacity of the piles. Third, drilling camps can normally tolerate as much as 6 inch differential settlements without great distress.

Another major design problem was the reserve pit. The environmental stipulations called for projected spent fluids containment entirely below the lowest original ground elevation in the reserve pit. Dikes provided only winter contingency storage and their integrity was not required during the summer. Thus, the only real concern was the slope from the rig to the reserve pit floor. This slope could melt back and jeopardize the rig support piling. This melting could come from the large heat/erosion potential of the fluids in the reserve pit, or from the sun's rays on the exposed southeasterly slope.

Figure No. 5 shows the final design for the reserve pit slope. The 8-foot-wide bench in mid-slope provides additional separation between the pit fluids and the rig piling. It was placed at original grade to utilize the cohesive and insulating value of the vegetative mat. Slope insulating matting was fabricated in 8-foot sections because it is typical board-stock lengths for both plywood and insulation. The joints were connected with strapped hinges to allow the matting to move as the subsurface soil thawed and settled. The attached piling served as anchors and weights for the matting.

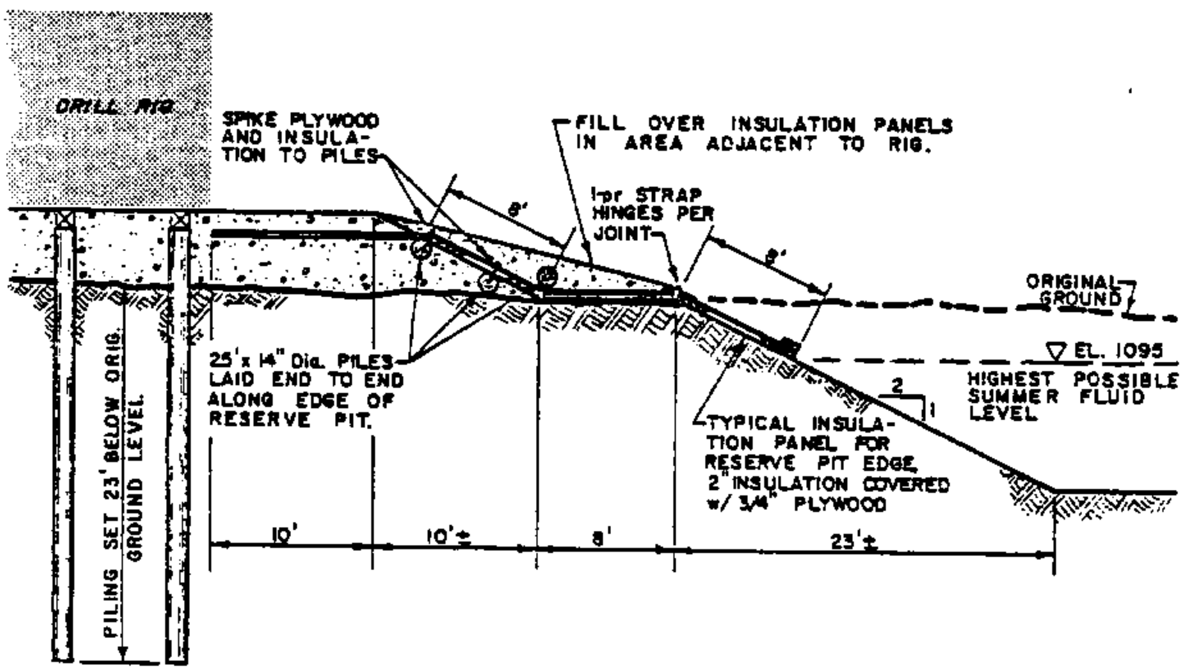

FIGURE NO. 5. AWUNA RESERVE PIT SLOPE

Two options were considered for preparing the reserve pit for the second winter of drilling. First, the pit could be pumped dry in late summer if the fluids, when tested, proved environmentally harmless. The pit could then be deepened the second winter to the required capacity, and the excavated material used to replace the massive thaw settlement expected on the pad. Second, another reserve pit could be constructed downslope of and surrounding the first year's pit. The first option was preferable because it was more economical, reduced the area of disturbance, and would require less excavation.

FIRST WINTER CONSTRUCTION

On December 12, 1979, the advance construction crew set out for Awuna from the Husky maintained airstrip at Ivotuk. A list of the equipment mobilized is contained in Appendix II. The advance train arrived at Awuna on December 23, 1979, traversing the 110-mile-long winter trail in 11 days. The 5,000-foot ice strip was operational on January 16, 1980. Additional construction equipment was flown in. This airlift was completed on January 25 and the rig move began immediately. All construction work was completed by February 15, 1980. No significant problems were encountered. The work closely followed the schedule shown in Table I.

THE SUMMER PERFORMANCE

The facility performed well during the summer thaw season. All major components survived the summer intact. The rig, left with the derrick up, had no difficulties whatsoever. A few items were placed too close to the edge of the insulated materials stack out area, where thawing caused local tipping of boxes or vehicles. No construction related problems were encountered with the camp.

As anticipated, the pad itself was in very poor condition. It was difficult to walk in the muck, and hip boots were a definite requirement when visiting the Awuna wellsite.

The pad developed a distinct drainage pattern during summer thaw. A small channel originated about 250 feet from the southwestern pad edge and cut southwesterly between the rig and camp. A larger drainage channel developed and received thaw water from the pad area between the rig, camp and materials storage area. Sheet flow from the tundra up slope from the pad also appeared to enter this drainage system. It flowed southeasterly between the fuel tanks and rig into the reserve pit. A smaller channel actually drained under the fuel tanks. This entire drainage system caused some concern about thaw around the fuel tank piling and additions to reserve pit volume, but neither problem developed and the flow essentially stopped by mid-July.

Fluid samples from the reserve pit were taken in August, analyzed, and deemed environmentally acceptable for discharge onto the tundra. The fluids were pumped from the pit in early September. The fluid was filtered through several oil-absorbent filled barrels before discharge in case hydrocarbons were encountered . The operation caused no apparent damage and eliminated the requirement for a second reserve pit.

The reserve pit slope adjacent to the pad suffered great subsidence. The insulation panels were greatly flexed and distorted, but they did provide some thermal protection through the summer. At no time did the thaw jeopardize the rig.

SECOND WINTER CONSTRUCTION

On September 21, a small crew placed the airstrip water pumping system on site with helicopters. All other equipment for second year construction had been left on the pad from the previous winter (Appendix II).

The drill camp was opened October 15 and ice road construction was begun with a low pressure, rubber tired all terrain vehicle. The pumping system for on-tundra ice airstrip construction was set up and pumping from the nearby lake began about November 5.

The reserve pit re-excavation and deepening was begun on November 14, after freeze back had occurred. The material ripped easily. It was dozed and hauled onto the pad, restoring the area around the rig to original grade. Excavation quantity was governed by projected fluid discharge from the rig for the second winter season. This required more excavation than the first winter due to the greater number of drilling days anticipated.

The ice airstrip pumping system performed well (Reference 3). A 6-inch submersible electric pump was set beneath the ice of a nearby lake. It pumped water into a 6-inch aluminum irrigation pipe system. The piping was insulated with standard strap-on urethane pipe insulation. The system distributed water over the rough, polygonal tundra on the eastern end of the strip and delivered the required 6,250,000 gallons of water by the fourth week of November. All terrain vehicles and conventional arctic water trucks hauled and sprayed water on the smoother western half. Runway lighting was installed and light aircraft operations were moved onto the final alignment from a temporary 2,000-foot ice airstrip which had been constructed nearby. A layer of unfrozen soil beneath the airstrip alignment delayed heavy aircraft operations until December 4, 1980.

The drillers had completed most preparations for drilling before the airstrip opened. The well was reentered on December 2, 1980, and drilling resumed December 5, 1980. Drilling continued until April 12, 1981. The well was plugged and abandoned, and the rig, equipment, camp and materials were flown off location by May 1, 1981. At the end, the location was quite muddy and the ice airstrip almost unserviceable to heavy aircraft.

The abandoned wellsite was environmentally restored. The area was cleaned up in June, 1981. Piling was trimmed off at grade and all exposed wood and insulation was removed. The pad was then aerially fertilized, and reseeded with tundra grasses. All areas other than the pad were constructed with ice, which would melt and disappear.

COMMENTS ON OVERALL PERFORMANCE

The wellsite achieved its major objectives. A workable drilling location was provided for the specified number of days over two winter seasons. During summer, the rig, camp, equipment and materials were left unattended on site without harm. Drilling was resumed the second winter on schedule. However, a few areas could have been improved. The insulation along the reserve pit slope should have been extended

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northward to meet the insulation under the fuel tanks. This would have provided a cintinuous frozen barrier and perhaps prevented the summer drainage into the reserve pit and around the tank piling.

The reserve pit slope insulation was untidy and expensive to install. Many other methods of insulating the slope are possible. Perhaps a soil filter fabric envelope around the insulation might be easier to install and more protective. Jute matting might also work.

The stack out area insulation was removed in November, 1980. The timbers and plywood were removed in acceptable condition. However, the insulation was frozen to the subgrade and was broken up during removal. Not only was it beyond salvage, but the scattered pieces constituted a clean up problem. This would be solved if retrieval occurred during late summer when a little thaw is probable beneath the insulation. However, this space was required for winter storage and the repeated traffic would have crushed it. The installation of another plywood layer beneath the insulation might alleviate this problem. Plywood would at least be less costly to clean-up after breakup.

SUMMARY

The design performed to expectations. The wellsite provided suitable drilling facilities which were more economical than the alternatives which had been considered. The unique construction techniques employed were stabilization of ice rich soil with insulation rather than using thaw stable fill and the construction of the second winter ice airstrip on tundra. These two techniques were primarily responsible for the cost savings and lessened environmental impact, which would not have been realized if an all-season facility had been constructed.

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APPENDIX I

HUSKY OIL

N P R Operations, Inc.
ANCHORAGE, ALASKA
SHALLOW EXPLORATION LOG

PROJECT	AWUNA TEST WELL #1
SHEET 1 OF 1	
LOCATION (Coordinates or Station)	N. 5540552.67 E. 497249.75
DRILLING AGENCY	☒ OTHER EXPLORATION SUPPLY & EQUIPMENT CO.
HOLE NO.	FIELD 1 PERMANENT 5-0-001
NAME OF DRILLER	LUCKY IVEY
WEATHER	33° TO 45° F SNOW / LIGHT SHOWERS
TYPE OF HOLE	ROTARY ☐ TEST PIT ☐ AUGER HOLE ☐ CHURN DRILL
DEPTH TO	
DEPTH DRILLED INTO	
TOTAL DEPTH OF HOLE	21'
SIZE AND TYPE OF BIT	3 7/8" STEP TAPER
DATUM FOR ELEVATION SHOWN	☐ TBM. ☒ MSL.
TYPE OF EQUIPMENT	MAYHEW 200 & 25 psi AIR COMP.
TYPE OF SAMPLES	
TOTAL NO. OF SAMPLES	Ø
DEPTH TO GROUND WATER	N/A
STARTED	7/7/79
DATE HOLE COMPLETED	7/7/79
EL TOP OF HOLE	1110.21
LOGGED BY:	J.C. IRETON
APPROVED BY:	
Approved by: HUSKY OIL N P R Ops. Inc.	Date

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0				PT		SPHAGNUM MOSS & TUSSOCKS
10"				ML		BROWN, FROZEN SILT
16"				ICE		ICE (WHITE CHIPS- NO SILT)
21'						

HUSKY OIL

N P R Operations, Inc.
ANCHORAGE, ALASKA

SHALLOW EXPLORATION LOG

PROJECT: AWUNA TEST WELL #1 — SHEET 1 OF 1

LOCATION (Coordinates or Station): N. 5540080.73 E. 496557.55

DRILLING AGENCY: ☐ ☒ OTHER EXPLORATION SUPPLY & EQUIP. CO.

HOLE NO.: FIELD 2 PERMANENT 5-0-002

NAME OF DRILLER: LUCKY IVEY

WEATHER: 33° TO 45°F. SNOW/LIGHT SHOWERS

TYPE OF HOLE: ROTARY — TEST PIT ☐ AUGER HOLE ☐ CHURN DRILL ☐

DEPTH TO:

DEPTH DRILLED INTO:

TOTAL DEPTH OF HOLE: 30'

SIZE AND TYPE OF BIT: 3 7/8" STEP TAPER

DATUM FOR ELEVATION SHOWN: ☐ TBM. ☒ MSL.

TYPE OF EQUIPMENT: MAYHEW 200 & 25 psi AIR COMP.

TYPE OF SAMPLES: GRAB

TOTAL NO. OF SAMPLES: 1

DEPTH TO GROUND WATER: N/A

STARTED: 7/7/79 — DATE HOLE COMPLETED: 7/7/79

EL TOP OF HOLE: 1106.23

LOGGED BY: J.C. IRETON

APPROVED BY:

Approved by: HUSKY OIL N P R Ops. Inc. Date

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0 – 10"				PT		SPHAGNUM MOSS & TUSSOCKS
10" – 16"				ML		BROWN SILT
16" – 10'	52.6	TS-1		ML		DARK BROWN ICE RICH SILT W/SOME ORGANICS. DILATENCY: SLOW PLASTIC THREAD: MED-STIFF DRY STRENGTH: MEDIUM PLASTICITY: SLIGHT-MEDIUM
10' – 30'				ICE		ICE, WHITE CHIPS - NO SILT

HUSKY OIL

N P R Operations, Inc.
ANCHORAGE, ALASKA

SHALLOW EXPLORATION LOG

PROJECT	AWUNA TEST WELL #1
SHEET OF	1 1
LOCATION (Coordinates or Station)	N. 5539609.16 E. 496629.38
DRILLING AGENCY	☒ OTHER EXPLORATION SUPPLY & EQUIPMENT CO.
HOLE NO. FIELD	13
PERMANENT	5-0-013
NAME OF DRILLER	LUCKY IVEY
WEATHER	40°F, INTERMITTENT SNOW SQUALLS, RAIN SHOWERS, 15 mph WEST WIND
TYPE OF HOLE	ROTARY — TEST PIT ☐ AUGER HOLE ☐ CHURN DRILL ☐
DEPTH TO ROCK	20'?
DEPTH DRILLED INTO ROCK	8'?
TOTAL DEPTH OF HOLE	28'
SIZE AND TYPE OF BIT	3⅞" STEP TAPER
DATUM FOR ELEVATION SHOWN	☐ TBM. ☒ MSL.
TYPE OF EQUIPMENT	MAYHEW 200 & 25 psi AIR COMP.
TYPE OF SAMPLES	
TOTAL NO. OF SAMPLES	Ø
DEPTH TO GROUND WATER	N/A
STARTED	7/8/79
DATE HOLE COMPLETED	7/8/79
EL. TOP OF HOLE	1105.35
LOGGED BY:	J.C. IRETON
APPROVED BY:	
Approved by: HUSKY OIL N P R Ops. Inc. Date	

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0 – 10"				PT		SPHAGNUM MOSS & TUSSOCKS
10" – 1'-8"				ML		FROZEN BROWN SILT
1'-8" – 16'				ICE		CLEAR ICE, NO SILT.
16' – 20'				ML	1/32"	ICE RICH GRAY SILT, SOME FINE GRIT.
20' – 28'				ML		ICE RICH GRAY SILT, VISIBLE ICE. MAY BE SILTSTONE BEDROCK, BUT IS QUITE SOFT.

HUSKY OIL

N P R Operations, Inc.
ANCHORAGE, ALASKA

SHALLOW EXPLORATION LOG

PROJECT: AWUNA TEST WELL #1			SHEET 1 OF 1
LOCATION (Coordinates or Station): N. 5539261.84 E. 496431.59			
DRILLING AGENCY: ☒ OTHER EXPLORATION SUPPLY & EQUIPMENT CO.			
HOLE NO. FIELD 14 PERMANENT 5-0-014	NAME OF DRILLER: LUCKY IVEY	WEATHER: 40°F, INTERMITTENT SNOW SQUALLS, RAIN SHOWERS, 15 mph WEST WIND	
TYPE OF HOLE: ROTARY — TEST PIT ☐ AUGER HOLE ☐ CHURN DRILL ☐	DEPTH TO	DEPTH DRILLED INTO	TOTAL DEPTH OF HOLE: 20'
SIZE AND TYPE OF BIT: 3⅞" STEP TAPER	DATUM FOR ELEVATION SHOWN: ☐ TBM. ☒ MSL.	TYPE OF EQUIPMENT: MAYHEW 200 & 25 psi AIR COMP.	
TYPE OF SAMPLES	TOTAL NO. OF SAMPLES: ∅	DEPTH TO GROUND WATER: N/A	STARTED 7/8/79 DATE HOLE COMPLETED 7/8/79
EL TOP OF HOLE: 1101.59	LOGGED BY: J.C. IRETON	APPROVED BY:	Approved by: HUSKY OIL N P R Ops. Inc. Date

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0				PT		SPHAGNUM MOSS & TUSSOCKS
10"				ML		BROWN SILT, BARELY FROZEN, SOMEWHAT ORGANIC.
15"				ML		ICE RICH GRAY SILT. VISIBLE ICE TO 6'. VERY ICE RICH TO 9'. MUCH VISIBLE ICE TO 20', BUT LENSES ARE NONEXISTANT OR VERY THIN.
20'						

AWUNA TEST WELL NO. 1

Construction Soils Testing

East Slope of Reserve Pit (Sample grabbed as representative on February 3, 1980)

a. Physical Characteristics

Soil Name - Organic Silt or Organic Clay (Borderline)
Soil Symbol - ML or OL - Plasticity thread - med stiff
Moisture Content - 234% by weight of dry soil
Moisture State - Supersaturated as ice with soil inclusions
Organic Content - 5.1% by weight of dry soil
Type of Organics - Fiberous peaty but relatively undecomposed
Plasticity Index - 6.5
Plastic Limit - 25.6% water content by weight of dry soil
Liquid Limit - 32.1% water content by weight of dry soil

b. Comment and Discussion

These characteristics indicate the soil will have a considerable loss of volume when thawed and dried, perhaps 50% or more, and that it will sluff and flow to low angles as it thaws. If the dikes of the reserve pit are composed of this soil, you may expect the dikes to practically disappear over summer; furthermore, the thawed dikes will not be dependable for liquid containment.

The organic content is so high by volume that the medium strength of the thawed-dried clayey soil may not hold its grains together and much wind erosion is a probability if the wind blows in the summer time at this location.

c. Conclusions and Recommendations

(1) If the reserve pit dikes are composed of this soil material, expect the dikes to be weak and undependable for liquid containment next summer, and to practically disappear by summer's-end, owing to sluffing and running out to low angles, and wind erosion.

(2) The reserve pit slopes will thaw and sluff to low angles throughout next summer, and the net containment volume will be greatly lowered thereby. Also, any slope insulation should be protected against these conditions.

(3) If the drilling pad is composed of these materials, expect very low strengths at all areas and especially adjacent to the edges of the pad embankment. Storage of heavy drilling supplies should be arranged to anticipate these conditions.

AWUNA TEST WELL NO. 1

Construction Soils Testing

West Slope of Reserve Pit (Sample grabbed as representative of February 3, 1980)

a. Physical Characteristics

Soil Name - Organic Silt or Organic Clay (Borderline)
Soil Symbol - ML or OL, Plasticity thread - med stiff
Moisture Content - 210.1% by weight of dry soil
Moisture State - Supersaturated as ice with soil inclusions
Organic Content - 6.2% by weight of dry soil
Type of Organics - Fiberous peaty but relatively undecomposed
Plasticity Index - 9.2
Plastic Limit - 27.6% water content by weight of dry soil
Liquid Limit - 36.8% water content by weight of dry soil

Comment: These characteristics are practically the same as for the sample from the east slope.

b. Conclusions and Recommendations

(1) If the reserve pit dikes are composed of this soil material, expect the dikes to be weak and undependable for liquid containment next summer, and to practically disappear by summer's-end, owing to sluffing and running out to low angles, and wind erosion.

(2) The reserve pit slopes will thaw and sluff to low angles throughout next summer, and the net containment volume will be greatly lowered thereby. Also, any slope insulation should be protected against these conditions.

(3) If the drilling pad is composed of these materials, expect very low strengths at all areas and especially adjacent to the edges of the pad embankment. Storage of heavy drilling supplies should be arranged to anticipate these conditions.

AWUNA TEST WELL NO. 1

Construction Soils Testing

Bottom of Reserve Pit (Sample grabbed as representative on February 3, 1980)

a. Physical Characteristics

Soil Name - Organic Silt or Organic Clay (Borderline)
Soil Symbol - ML or OL - Plasticity thread - med stiff
Moisture Content - 221% by weight of dry soil
Moisture State - Supersaturated as ice with soil inclusions
Type of Organics - Fiberous, peaty but relatively undecomposed
Plasticity Index - 5.8
Plastic Limit - 26.7% water content by weight of dry soil
Liquid Limit - 32.5% water content by weight of dry soil

Comment: These characteristics are practically the same as for the sample from the east slope.

b. Conclusions

To a small extent thawing of soil materials in the bottom of the reserve pit will ameliorate the loss of capacity owing to side slope sluffing. However, the thaw rate of bottom soils will decrease instead of increase as the summer advances, because the sluffed soils from the slopes will protect the bottom around the edges to a great extent; i.e., prevent water circulation from carrying heat down to the liquid-icy soil interface.

AWUNA TEST WELL NO. 1

Construction Soils Testing

Backfill Material for Drillsite Piling (Sample grabbed as representative on February 3, 1980)

a. Physical Characteristics

Soil Name - Silty Peat
Soil Symbol - Pt, Plasticity thread of silt portion, weak soft
Moisture Content - 1200% by weight of dry soil
Moisture State - Saturated to supersaturated with ice inclusion
Organic Content - 31.2% by weight of dry soil
Type of Organics - Fiberous peat but relatively undecomposed
Plasticity None

b. Comment and Discussion

These characteristics indicate the soil will have lower range adfreeze strengths at warm permafrost temperatures. However, thawing from the surface will be slowed by the high moisture and organic contents. This was not a good choice of material for use in backfilling the annulus around rig support pilings.

c. Conclusions and Recommendations

This soil may be extra susceptible to intrusion of freeze-depressant chemicals such as calcium chloride. Therefore, extra care should be taken by the drillers to avoid having any such solution accumulate around the pilings.

APPENDIX II

AWUNA ADVANCE TRAIN

OVERLAND FROM IVOTUK

Quantity	Description
2	D-8 Dozers with Ripper
2	D-7 Dozers with Winch
2	966 Loaders
1	12G Grader
1	Delta All Terrain Vehicle (30 ton)
4	Delta All Terrain Vehicle (15 ton)
3	26 ft. Arctic Water Vans
3	Tucker Tracked Personnel Carriers
3	Nodwell Tracked Service Vehicles
3	3,500 gal. Fuel Transfer Tanks
1	5,700 gal. Fuel Transfer Tank
4	40 ton Sleds
4	Light Plants
1	Generator Car on Skis
1	Kitchen/Diner on Skis
1	Wash Car on Skis
5	6-person Sleeper Cars on Skis

AWUNA EQUIPMENT LIST

PEAK CONSTRUCTION

Quantity	Description
2	D-8 Dozers with Rippers
2	D-7 Dozers with Winches
3	966 Loaders
4	Delta All Terrain Vehicles (15 ton)
1	Delta All Terrain Vehicle (30 ton)
3	Water Vans
1	12G Grader
2	End Dumps
1	Watson 2000 Auger for Piling
3	Tucker Tracked Personnel Carriers
3	3,500 gal. Fuel Transfer Tanks
3	23,000 gal. Double Wall Fuel Tanks
1	9,200 gal. Fuel Transfer on Wheels
1	5,700 gal. Fuel Transfer Tank
3	Nodwell Tracked Service Vehicles
5	Light Plants
5	Pickups
3	Suburbans
2	Office Cars on Skis
2	Generator Cars on Skis
1	Water Car on Skis
1	Wash Car on Skis
1	Diner Car on Skis
1	Kitchen Car on Skis
1	Dry Storage Car on Skis
11	Sleepers 6-man on Skis
1	Incinerator
2	Dry Shacks
1	Freight Sled

AWUNA SUMMER STACK OUT
EQUIPMENT FOR RECONSTRUCTION

Quantity	Description
2	D-8 Dozers with Rippers
1	D-7 Dozer with Winch
2	966 Loaders
1	12G Grader
4	Oil Field Bed Tandems (Heavy Winch Flatbeds)
4	Arctic Water Vans
2	Delta All Terrain Vehicles (15 ton)
3	Pickups
4	Light Plants
3	23,000 gal. Double Wall Fuel Tanks
2	Tucker Tracked Personnel Carriers
1	130 KW Generator
1	Weather Shack
1	50 KW Generator
2	6" Submersible Pumps
5000'	6" Aluminum Irrigation Pipe with Insulation