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BADAMI DEVELOPMENT PROJECT

Project Description and Environmental Assessment Supplement

July 1996

BP EXPLORATION

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BP EXPLORATION (ALASKA) INC.
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1. INTRODUCTION

BP Exploration (Alaska) Inc. (BPXA) is proposing to begin construction of the Badami Development Project, starting in the winter of 1996-1997. The proposed project, located about 25 miles east of existing Prudhoe Bay infrastructure, is based on a plan for economical development of 115 million barrels of oil, and involves a pad supporting the Central Processing Unit (CPU) and wells, a satellite well pad, a gravel mine site, an airstrip, a dock, an infield road system, a 26 mile 12-inch diameter sales oil pipeline from Badami to a tie-in with the Endicott pipeline, and a 35 mile 4 or 6-inch diameter utility pipeline extending from the Endicott Main Production Island (MPI) to the Badami CPU.

1.1 PROJECT PERMITTING HISTORY

Since 1994, BPXA has been working with the regulatory and resource agencies to secure required approvals and permits for development of the Badami oil field, which is located at Mikkelsen Bay approximately 25 miles east of the Prudhoe Bay Unit (Figure 1). Because development of the Badami field poses significant engineering, environmental and regulatory challenges, BPXA adopted a philosophy of open and frequent communication with Federal and State agencies and the North Slope Borough early in project planning.

In July 1994, following intensive pre-application meetings and workshops, BPXA submitted permit applications for appraisal well drilling and field development. That development proposal was based on very conceptual engineering and involved drilling, partial processing on site, and transport of multi-phase flow to Endicott for full processing. In reviewing this application package, some agencies expressed concern regarding the level of detail for decision-making. As a result, BPXA withdrew these applications in August 1994.

Through the fall of 1994, BPXA continued working on a conceptual development scheme, with emphasis on achieving an economical pipeline design. Based on the results of a feasibility analysis, BPXA decided to initiate preliminary engineering on a chilled, buried oil pipeline. In January 1995, a permit application package was submitted for a refined development scheme, involving full processing onsite, a combined well/facilities pad, and a chilled buried pipeline extending from Badami to a tie-in with the Endicott pipeline. At about the same time these permit applications were filed, BPXA formed the

Badami Alliance — a design/build organization charged with finding innovative solutions for economical field development. Also, in the winter of 1994-1995, the Badami #4 and #5 appraisal wells were drilled.

At the same time that agencies were reviewing the January 1995 applications, the Badami Alliance was completing preliminary engineering. Based on agency requests for additional information and on more complete engineering information, a set of revised permit applications was submitted in July 1995. These amendments were submitted for a project construction schedule beginning in the winter of 1995-1996, with facility start-up in October 1997. In October 1995, the project was found consistent with Alaska Coastal Management Program standards, subject to certain conditions, and several permits were issued (see Table 1).

In late summer 1995, the initial results of the Badami #4 and #5 wells showed recoverable reserves of about 100 million barrels. In contrast, the Badami Alliance had developed a preliminary engineering scheme for a project with 150 million barrels of recoverable reserves. As a result, the Alliance undertook the task of revising its preliminary development scheme for a project with a smaller scope. At this same time, BPXA formed a Drilling Alliance, which was charged with identifying the most innovative and cost-effective means of producing project reserves. By December 1995, the Drilling Alliance had determined that use of innovative multi-lateral drilling from two drillsites, along with other design changes, could significantly reduce project costs. Due to the scope of pending changes, BPXA withdrew its application for a Section 404/10 permit from the U.S. Army Corps of Engineers in December 1995.

In December 1995 and January 1996, BPXA explored several new design options, and also assessed the feasibility of retaining a 1997 startup. However, due to continued uncertainty over recoverable reserves, a 1998 startup was instead targeted. Since early 1996, both Alliances have been working intensively to design an economical project for development of the target reserves. The scope of the current project proposal is based on the results of continued reservoir, drilling, and facilities engineering, and is designed to develop recoverable reserves of 115 million barrels.

1.2 PROJECT SCOPE AND MILESTONES

The major components of the planned Badami project include:

- A development project with stand-alone production and process facilities;
- An elevated sales oil pipeline with three buried river crossings carrying crude oil to the Endicott sales oil pipeline;
- A utility line transporting gas and miscible injectant from Endicott to Badami (co-located with the sales oil pipeline for part of the route);

- Project construction without a permanent gravel access road from existing oil fields;
- A dock in Mikkelsen Bay for marine access for sealift, supplies, and emergency response;
- An airstrip and an in-field road system;
- The East Badami Creek gravel mine site;
- Project operation in a minimally manned mode; and
- Use of multi-lateral drilling.

The major milestones of the Badami Development Project are described in Table 2.

1.3 PERMITS AND APPROVALS

At this time, BPXA is concurrently applying for all the major construction and land use approvals required for the Badami Development, as listed in Table 1. This permit application package addresses information needs identified by agencies in consultations and meetings during the pre-application process. Badami permitting is in various stages of review. Several new applications are required, either based on new information or due to having withdrawn earlier applications. Some permits were previously issued, and now require modification. Finally, some permits are in various stages of ongoing review. The project was previously found consistent under state and local coastal management standards. An additional Alaska Coastal Management Program (ACMP) review will be conducted to determine the consistency of the current set of new or modified permit applications.

BPXA will apply for the major operational permits when more detailed design and operational information is developed (Table 1). There is currently insufficient information to support the detailed permit applications required for these permits. At this time, BPXA estimates that there will probably be four additional permit package submittals subject to ACMP review:

- an application for an Prevention of Significant Deterioration Air Quality Permit for drilling and permanent camp operations — estimated time for submittal is September 1996;
- applications for: a Solid Waste Disposal permit for drill cuttings washing and reuse; request for temporary storage of drilling waste; and an Oil Discharge Prevention and Contingency Plan (ODPCP) addressing drilling and fuel storage — estimated time for submittal is in the first quarter of 1997;

- application for an Prevention of Significant Deterioration Air Quality Permit for facility operations — to be submitted in the fourth quarter of 1997; and
- application for an amended ODPCP addressing facility and pipeline operations — estimated time for submittal is in the first quarter of 1998.

1.4 SCOPE OF SUPPLEMENTAL PROJECT DESCRIPTION AND ENVIRONMENTAL ASSESSMENT

This Supplemental Project Description and Environmental Assessment is intended to supplement and be used in conjunction with the January 1995 Project Description and Environmental Assessment. It provides an update of all the necessary information to support permit decision-making for the major construction and land use permit applications listed in Section 1.3.

Section 2 includes a supplemental alternatives analysis. The January 1995 document included an analysis of alternatives to the proposed action that were considered in early project planning. The major project components and activities that constitute BPXA's revised proposed action are described in Section 3. Supplemental environmental information is provided in Section 4; this section includes updated information on the affected environment, a revised impact analysis to reflect changes in the proposed project, and a tabulation of additional project mitigation measures. The remainder of the background information and impact assessment provided in January 1995 Project Description and Environmental Assessment is still valid for the proposed project revisions.

TABLE 1

PERMITS/APPROVALS — BADAMI DEVELOPMENT PROJECT

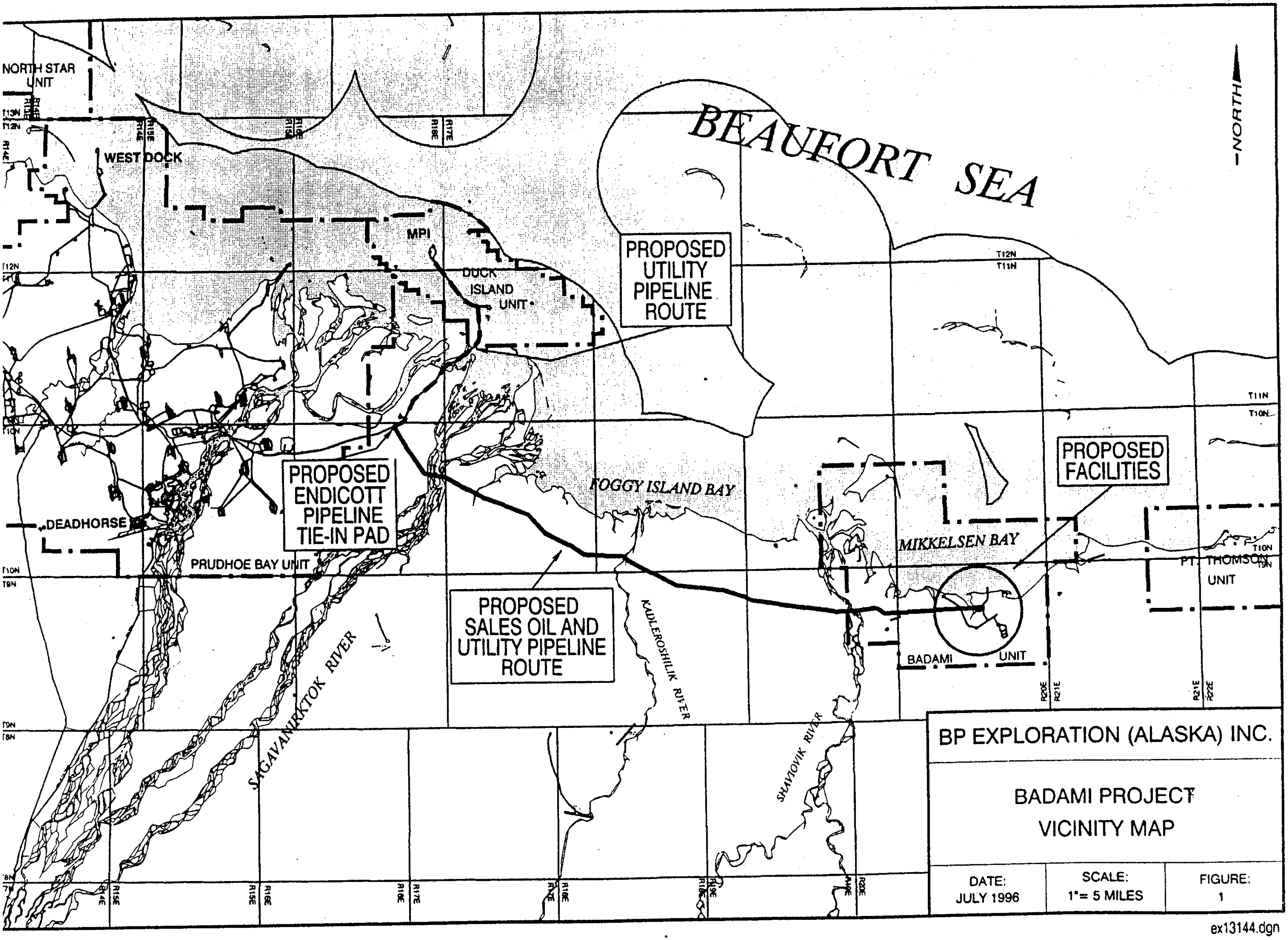
PERMIT	AGENCY	STATUS
Rezoning Approval - Resource Development District	NSB	approved 10/6/94
Underground Injection Control - Class I Well	USEPA	submitted 4/96
NPDES Stormwater - Construction and Operation - General Permit	USEPA	existing General Permit
Section 404/10	USACE	new application submitted 7/96
Coastal Consistency Determination	DGC	project previously found consistent - amendments to be reviewed
Unit Operations Approval	DNR/DOG	current permit to be modified
Temporary Water Use Permit - Pipeline Corridor	DNR/JPO	ongoing review of earlier application
Pipeline Right-of-Way Lease	DNR/JPO	new application submitted 7/96
Material Sale - Pipeline Corridor	DNR/JPO	withdraw Kadleroshilik and Shaviovik mine sites
E. Badami Gravel Mine Site Material Sale	DNR/DOL	minor modifcation; ongoing review of earlier application
Temporary Water Use Permit - Unit	DNR/DMWM	existing permit, no modification required
Section 401 Certificate of Reasonable Assurance	ADEC	new Section 404 application submitted 7/96
Wastewater Disposal Permit (Class I Well)	ADEC	submitted 7/96
Title 16 Fish Habitat Permits	ADF&G	existing permits require modification, new permit application submitted 7/96
Development Permit	NSB	submitted 7/96
Letter of Authorization for Incidental Take of Polar Bears	USFWS	to be submitted by 9/96
National Pollution Discharge Elimination System (NPDES) - General Permit	USEPA	new North Slope General Permit to be reviewed and expected to be issued by 12/96
Air Quality Control Permit to Operate (PSD - Drilling and Permanent Camp)	ADEC	to be submitted in the third quarter of 1996

TABLE 1
PERMITS/APPROVALS — BADAMI DEVELOPMENT PROJECT
(CONTINUED)

PERMIT	AGENCY	STATUS
Notification for Temporary Storage of Drilling Waste	ADEC	to be submitted in the first quarter of 1997
Oil Discharge Prevention and Contingency Plan (ODPCP) - Drilling	ADEC	to be submitted in the first quarter of 1997
Approval for Cuttings Washing and Reuse	ADEC	to be submitted in the first quarter of 1997
Air Quality Control Permit to Operate (PSD - Operations)	ADEC	to be submitted in the fourth quarter of 1997
Amended ODPCP - Operations	ADEC	to be submitted in the first quarter of 1998
Annular Injection/Permit to Drill	AOGCC	to be submitted later
Certificate of Public Convenience and Necessity	APUC	to be submitted later

TABLE 2
MAJOR MILESTONES
BADAMI DEVELOPMENT PROJECT

MILESTONE	TIME FRAME	DESCRIPTION
Permit Applications	July 1996	Applications for construction of field facilities and the pipeline system. Applications for operational permits will be submitted subsequently.
Detailed Engineering	3Q and 4Q 1996	Detailed pipeline engineering and project planning will commence in mid-1996. This will provide the necessary information for the major operational permits.
Project Sanction	December 1996	In December 1996 the Badami project will be presented to the BP Board of Directors for funding. By that time, BPXA desires to have the major land use/construction permits in hand and the right-of-way lease process sufficiently advanced to provide assurance of successful completion.
Gravel Construction	Winter 1996-97	Gravel construction will commence in late 1996 or early 1997 using equipment mobilized over ice roads. Most gravel works at the Badami field development will be done in a single winter season, including opening of the East Badami mine site.
Development Well Drilling	September 1997	Development drilling will begin using a single rig mobilized to the site via barge in August 1997. Most wells will be directionally drilled into the reservoir beneath Mikkelsen Bay.
Pipeline Construction	Winter 1997-98	Pipeline construction will commence in winter 1997-98 and is expected to take approximately 4 months to complete.
Sealift	Summer 1998	Process modules will be brought into Badami by sealift in the summer of 1998 and offloaded at the dock.
Production	Late 1998	Production from Badami will commence in the fourth quarter of 1998 and reach peak rates of about 30,000 barrels per day.



BP EXPLORATION (ALASKA) INC.

BADAMI PROJECT
VICINITY MAP

DATE:	SCALE:	FIGURE:
JULY 1996	1"= 5 MILES	1

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2. ALTERNATIVES ANALYSIS AND PROJECT RATIONALE

From the inception of planning for Badami, BPXA has evaluated a series of alternatives for design, construction, and operation of the project. The 1995 Project Description and Environmental Assessment contains a comprehensive discussion of alternatives evaluated during conceptual engineering. This section describes the additional alternatives analysis and basis for decisions reached during subsequent preliminary engineering, and is a supplement to Section 2 of the 1995 document. Alternatives for the following project components are discussed:

- drilling and pad locations
- pipeline mode
- gravel mine site

2.1 DRILLING AND PAD LOCATIONS

The Badami Well Alliance evaluated all aspects of drilling to determine the most economical and effective approach for development of the Badami reservoir. Based on conceptual engineering, use of directional extended reach drilling from a single onshore pad had been planned to access the offshore reservoir. Early in the process of evaluating drilling alternatives, the Well Alliance identified the use of multi-lateral wells as the best means of reducing both drilling cost and drilling risk. Multi-lateral technology allows several bottomhole locations to be accessed by each wellbore, thus reducing the number of tophole locations.

However, use of multi-lateral drilling from the onshore location proposed in 1995 would have required several of the multi-lateral wells to be extended reach. Because the combination of multi-lateral drilling with extended reach was determined to be high-risk, alternative pad location options were considered, including:

- two onshore pads
- one offshore pad and one onshore pad
- one offshore pad and two onshore pads

These alternatives were evaluated on the basis of recoverable reserves, cost, and environmental impact. Initially, in December 1995, the one offshore and one onshore pad scenario was selected based on assessment of these factors. However, several regulatory and resource agencies expressed strong concern regarding the potential impacts of the location of a longer gravel fill causeway and offshore drilling island. In addition, a reinterpretation of 3-D seismic data indicated that nearly all recoverable reserves could be accessed from two onshore locations (see Section 3.1). Based on the ability to target most of the reservoir from onshore, and on uncertainties associated with attempting to secure permits for an offshore drilling island and causeway, BPXA selected the proposed two-pad onshore development scheme. The one offshore and two onshore pads scenario was rejected based on permitting uncertainties.

Siting of the two onshore drill pads was based on reservoir engineering, drilling considerations, avoidance of higher value habitats, and cost. Due to agency concerns about a solid fill dock or causeway west of West Badami Creek, the dock design and general location proposed in July 1995 has been retained. With the dock in this location, it was most economical and practical to locate the gravel mine site and the CPU pad closer to the dock, rather than associated with the drill pad to the west. Likewise, maintaining an airstrip close to the CPU pad and minesite was more practical and cost-effective than using a location closer to the western satellite drill pad.

2.2 PIPELINE MODE

Early in project evaluation, it became apparent that the costs of constructing a new pipeline from this remote field to existing infrastructure would be a major factor in achieving an economically viable project. As described in the 1995 Project Description and Environmental Assessment, BPXA selected a chilled, buried pipeline design as the most economical mode based on the results of a 1994 feasibility analysis. Subsequently, more information about the Badami reservoir fluids and production facilities was developed and costs were identified. By the summer of 1995, cost estimates for chilling Badami crude were substantially higher than originally estimated because the Badami #4 and #5 wells revealed that the Badami oil is significantly more viscous than previously thought. At the same time, a re-evaluation of the costs of an elevated pipeline was conducted, and opportunities to reduce historical costs were identified. In fall 1995, an elevated pipeline with buried river crossings was selected based on comparison of construction and operations costs and risks.

During this process of re-evaluating pipeline options, two other design modes were considered and rejected. The option of a buried pipeline with cool oil (air-cooled rather than chilled) was evaluated, and found on a conceptual basis to be feasible. This option would have involved insulating the pipe and greater use of select backfill than the chilled buried mode. Based on uncertainties regarding the regulatory approval process for this design, and uncertainties over some cost factors, this option was rejected from further detailed consideration.

The option of a cool elevated pipeline was also evaluated. This option had the advantage of reducing several geotechnical concerns associated with warm buried river crossings. However, this design was rejected based on cooling costs and on operational risks associated with shutdowns when the oil cools in the pipeline.

2.3 MATERIAL SITES

In late 1995, the possibility of excavating gravel from the bottom of the large lake south of the proposed satellite pad and west of West Badami Creek ("Turkey Lake") was evaluated. The conceptual mining plan was to promote early freezing of the lake by removing snow or partially dewatering the lake, then cutting ice out of the lake to expose the bottom. Organics would have been stripped from the bottom, and stockpiled. The exposed gravel would then be excavated. Shallow areas were to have been retained along the lake edges to provide shallow water habitat. After mining, the organic material would have been returned to the lake, which would regain its normal surface water elevation in one to two years following construction.

This option offered several environmental benefits, including minimal alteration of existing habitats, and minimal visual disturbance. However, geotechnical investigations showed that there was a significantly larger quantity of organic and silty material than originally estimated, thus increasing costs of this mining plan. These increased costs, combined with the decision to locate most gravel pads and infrastructure to the east of West Badami Creek, resulted in dropping this option from further consideration.

The possibility of locating a gravel mine site in the Shaviovik River floodplain, and potential reuse of gravel from the abandoned Shaviovik airstrip were also considered and rejected. Given the proposed dock location, any gravel mine site to the west would result in substantially increased construction costs. Potential reconstruction of or reuse of gravel from the abandoned Shaviovik airstrip is not practical due to increased distance to facilities and liability concerns associated with reuse of that gravel.

3. DESCRIPTION OF THE PROPOSED PROJECT

The Badami reservoir is located primarily offshore beneath Mikkelsen Bay, about 25 miles east of existing North Slope oil field facilities (Figure 1 and Exhibit A). Conoco drilled the Badami #1 discovery well in 1990 and the Badami #2 exploration well in 1991. In 1993, BPXA acquired Conoco's interest in the Badami field and initiated planning for continued field appraisal and development. Extensive three-dimensional seismic analysis of the reservoir structure has already been completed. The Badami Unit was authorized by the Alaska Department of Natural Resources in 1995.

The proposed Badami development plan, including the field facilities and the pipeline system, has been formulated on the basis of alternatives analysis (see Section 2), preliminary engineering, and extensive interaction with the regulatory and resource agencies.

3.1 DEVELOPMENT PLAN

In early 1995, BPXA drilled two appraisal wells (Badami #4 and Badami #5) to further delineate the Badami reservoir. These wells were located offshore and drilled from ice pads. Based on results of these and other wells, in addition to seismic geophysical data, it is estimated that the Badami reservoir contains about 115 million barrels of recoverable reserves. Nearly the entire extent of the known reservoir can be developed from the proposed onshore drilling locations. BPXA eventually plans to drill wells into those areas of the reservoir which have not yet been delineated, and determine if any additional recoverable reserves can be developed in the future.

BPXA plans to start producing the field in October or November 1998. The first construction activity will be opening a gravel source at East Badami Creek in late 1996 or early 1997, followed by construction of gravel field facilities, including the Central Processing Unit (CPU) and well pad, a satellite well pad, a dock, an airstrip, and an in-field road system connecting these facilities. Some infrastructure will be installed on the pads in 1997. Development drilling will begin in September 1997, and the Badami pipelines will be constructed starting in January 1998, with completion by late April or early May 1998. Modules will be transported to the site and installed in the summer of 1998. Figure 2 shows the project schedule.

3.2 DRILLING

Directional drilling and multi-lateral well technology will be used to reach all target zones of the Badami reservoir. The current plan calls for drilling 30 production wells (11 at the CPU pad, 19 at the satellite pad). Through use of multi-lateral drilling, these 30 tophole locations will reach 39 bottomhole locations. At facility start-up, it is expected that as many as 10 wells will be brought into production. The remaining development drilling should be completed by 1999. The average surface spacing between wells will be 10 feet in order to minimize the size of the gravel pad.

In addition to production wells, waterflood source wells and a Class I injection well will be drilled. Waterflooding and miscible injection are planned to enhance oil recovery. No plans currently exist to use seawater as a waterflood source. Production wells would be selectively adapted for use as injection wells at various stages of drilling and project development.

3.3 PROJECT ACCESS

No gravel access road from North Slope facilities is planned for the Badami Development Project. During construction, ice roads will provide winter access to the Badami field. Throughout the drilling and construction period, the ice road will be built each winter just offshore on the sea ice, from the base of the Endicott Causeway to the field. During the winter of 1997-98, an onshore ice pad will parallel the pipeline route to support pipeline construction. During pipeline construction, ice access roads will also be constructed from the pipeline corridor to water sources. Ice roads may be used in subsequent years as necessary for maintenance or repairs.

Without a year-round gravel road, barge access to the site is required. Barges will support drilling and production operations during the open-water season and allow delivery of sea-lifted production modules. To allow barge access to the field, a gravel dock will be built in Mikkelsen Bay. The dock will also be an important facility needed for spill response. In the event of a spill or blowout on the pad, the dock would provide a staging area for the response. It could also be used for staging any spill response required in open-water or broken-ice conditions. The dock and the infield road system would be designed to be compatible with any reasonably foreseeable transportation needs associated with future development in the area.

The dock will be 1,000 to 1,100 feet long (Figures 3 to 5) to reach 6.4 feet of water below mean sea level. The side slopes on the dock will be 7:1. The 140-foot by 92-foot dockhead will be constructed with a sheet-piling face and sand bag slope protection along the side and back slopes. The road connecting the dock head to shore will be 50 feet wide along the traveled surface to allow module movement. About 106,600 cubic yards of gravel will be required to construct the dock, which will have a freeboard varying from 4.5 to 12 feet and will require fill of about 5.7 acres of seabed.

A gravel airstrip capable of supporting fully loaded Hercules aircraft will be constructed south of the facilities pad (Figures 6 to 7). Approximate maximum dimensions of this airstrip will be 4,500 feet long, 75 feet wide, and a minimum of 5 feet thick. In addition, the airstrip will have turnaround at each end with typical dimensions of 450 feet by 150 feet, and a minimum of 5 feet thick.

An in-field gravel road system will be constructed to connect the various facilities (Figure 3). The road connecting the dock to the CPU pad will be 50 feet wide on the crown to allow module movement from the dock to the CPU pad, while other infield roads will have crown widths of 30 feet. All roads will have a minimum thickness of 5 feet. The total length of the infield road system is about four and a half miles. A temporary storage/gravel stockpile pad will be constructed northwest of the East Badami Creek Mine Site (Figures 8 to 9). This pad will be 500 feet square and 8 feet thick, and will be used for storage during construction. After construction, the top 5 feet of the pad will provide a source of maintenance gravel.

A series of culverts will be installed for the infield road crossing of West Badami Creek and Middle Badami Creek (Figure 10). These culverts will be designed for the 200-year flood event, and to ensure fish passage. Culverts will also be installed at other locations in roads, pads, or the airstrip as necessary to maintain natural surface drainage patterns.

After completion of construction, activities on the site will be supported by barge in the summer, ice roads as needed in the winter, air access year round, and tundra travel (subject to seasonal closure). During fall freeze-up and spring breakup, activities will be supported by air access. The airstrip will allow transport of emergency equipment, including a relief rig, to the site if necessary.

Access may also be needed to the pipeline for any maintenance and repair work. Planned pipeline repairs will be performed in the winter using ice road access. Access for routine inspections will be via tundra travel and overflights. In the event of an unplanned need for maintenance or repairs, the method of access would be determined by the time of year. Section 3.12 provides additional information about operations and maintenance activities.

3.4 BADAMI FIELD FACILITIES

3.4.1 Well Pads

A two wellsite arrangement has been selected for the Badami project, as described in Section 2.1. The CPU pad, supporting both processing facilities and the east wellsite, will be constructed south of the Mikkelsen Bay coastline and east of West Badami Creek

(Figures 11 to 12). A satellite well pad with the west wellsite (Figures 13 to 14) will be constructed near the coastline between West Badami Creek and an unnamed inlet. The pad locations were selected based on: (1) optimizing the ability to directionally drill to reach an offshore reservoir; (2) avoiding wetter tundra; and (3) facilities layout requirements. The proposed layout and orientation of the pads provides a suitable configuration for using multi-lateral wells to drain that portion of the Badami reservoir which currently is thought to be commercially viable.

The proposed CPU pad will have approximate maximum working surface dimensions of 1,460 feet by 800 feet, plus a 470-foot by 382-foot flare pad. The gravel pad will extend a minimum of 5 feet above the existing tundra surface. The pad, including the flare pad, will cover approximately 32.6 acres of tundra, and will require about 480,000 cubic yards of gravel.

The satellite pad will have approximate maximum working surface dimensions of 510 feet by 348 feet, and will extend a minimum of 5 feet above the existing tundra surface. The pad will cover approximately 4.6 acres of tundra, requiring about 54,600 cubic yards of gravel.

Gravel cuttings from the top interval of each well will be recycled after washing and spread on the pads. Other drilling wastes will be either disposed of through on-site annular injection, on-site grinding and injection, or hauled off-site for treatment by a cuttings grinder and disposal in an approved injection well at Prudhoe Bay (see Section 10); space will also be provided for temporary storage of drilling wastes.

3.4.2 Badami Process Facilities

Field facilities will be located on the CPU pad and on the satellite pad. Each of these pads will include a wellsite, which consists of a group of multi-lateral wells, a manifold skid, and a test separator. The wells will all start operations as producers; a number of them will subsequently be converted to injectors, either gas (miscible injection) or water. The east wellsite on the CPU pad also contains disposal (Class I injection) and waterflood source wells. The manifold skids will contain the valves and associated piping necessary to place the producers on test and to select between water and miscible injection for the injectors. The test separator for the east wells is located in the CPU area.

A group of VSM supported in-field flowlines will connect the west wellsite to the CPU. The flowlines and pipelines will share a common set of VSMs between the west side of West Badami Creek and the CPU. Although the flowlines will not be regulated by the U.S. Department of Transportation, they will be designed to the same standard as regulated pipelines. The flowlines include:

FLOWLINE	SIZE	DESIGN PRESSURE
production flowline	12" insulated	350 psi
gas lift line	4" insulated	2,122 psi
water injection line	6" insulated	3,815 psi
miscible injection line	4" insulated	5,625 psi

The design pressures of the injection lines are subject to change as reservoir studies progress.

The CPU contains oil processing, gas injection and water treating and injection units, plus export oil metering and pumping equipment. The basic process is a three stage separation. Well fluids (oil, water and gas) will enter the process train through the inlet separator where a gas - liquid separation will be made at approximately 200 psi. The inlet separator will also serve as a surge vessel to help insulate the process unit from fluctuating inlet flow rates. The liquid stream from the inlet separator will be heated to approximately 180°F in fired heaters, then delivered to the second stage separator. The second stage separator will provide the main water - oil separation. It will operate at slightly below the pressure of the inlet separator. Whatever gas evolves from the oil as a result of the heating will be removed from the second stage separator. Oil from the second stage separator will be delivered to the oil dehydrator, a low pressure third stage separator which produces export quality oil. Limited volumes of water and gas will be removed from the oil in the oil dehydrator. Oil from the dehydrator will be transferred to the export oil meters and shipping pumps, then delivered to the pipeline.

Produced water from the process train will be stripped of entrained oil and reinjected into the reservoir along with make-up water from the water source wells. Centrifugal pumps will be used to boost the pressure of the water to the injection pressure. Solution gas which evolves from the oil, and lift gas which essentially is recycled, will be compressed and dehydrated. Lift gas will be removed from the combined gas stream; the remaining gas will be compressed further, blended with natural gas liquids imported from Endicott through the utility line, and reinjected as miscible injectant. Consideration is being given to importing gas as well as natural gas liquids from Endicott in order to optimize the enhanced oil recovery scheme. The fluids imported from Endicott will travel together as a multi-phase mixture in the utility line. Importing gas will affect equipment sizing and pressure rating, but will not change the process.

Utilities such as power generation, waste handling, and fuel gas conditioning will be located within the CPU. Storage, warehousing, maintenance facilities and a camp will also be located on the same pad as the CPU.

3.5 PIPELINE SYSTEM

This section describes basic information about the Badami Pipeline system. More detailed information about design, construction, operation, and maintenance of the pipeline system is contained in the Application for Pipeline Right-of-Way Lease (Amendment 2).

The pipeline system consists of a 12-inch diameter sales oil pipeline from the Badami CPU to a new Endicott facilities tie-in pad (Figure 1 and Exhibit A), and a 4 or 6-inch diameter utility pipeline from the Endicott Main Production Island (MPI) to the Badami CPU. The primary use for the utility line is to import natural gas liquids and natural gas from Endicott for enhanced oil recovery at Badami.

3.5.1 Pipeline System Alignment and Mode

In the segment of the pipeline system from the Badami CPU to the Endicott tie-in, the sales oil and utility pipelines will be elevated on new VSMs, except at three buried river crossings. From the Endicott tie-in to the Endicott MPI, the utility line will be elevated on existing VSMs, buried in the existing gravel road or causeway, or supported on sleepers between the MPI and the "Y" (where the Endicott causeway branches between the MPI and the SDI). Selection of a buried versus elevated mode for the utility line from the Endicott tie-in to the Endicott MPI will be determined based on negotiations with the Endicott Pipeline Company. The segment of the utility line from the Endicott tie-in to the "Y" will probably be located on existing VSMs. Burial in the existing gravel between the traveled road surface and the existing VSMs is the preferred mode for the utility pipeline between the Endicott MPI and the Y. These options are shown on Figure 15. The pipeline will be installed on existing brackets across the causeway breaches (Figure 16). No expansion of the causeway will be required for construction or operation of this buried line.

Exhibit A shows the proposed centerline alignment of the pipeline system route, proposed valve and riser pads, the proposed Endicott tie-in pad, and potential water sources. The pipeline system route was selected based on a set of planning criteria, including:

- Minimizing overall length
- Minimizing number of bends
- Selecting stable river crossing locations
- Selecting perpendicular river crossings
- Avoiding known cultural resource sites
- Avoiding or minimizing impacts to high value habitats
- Avoiding large, deep lakes

3.5.2 Elevated Pipelines

A typical pipeline installation on a VSM is shown on Figure 17. Depending on local topography, the pipeline system will be elevated at least 5 feet above the tundra surface to allow caribou and other wildlife to pass freely underneath the pipe.

The VSM spacing will be 55 feet, with 100-foot offsets installed a maximum of 6,000 feet apart to accommodate thermal expansion. The majority of VSMs will be on lightly loaded piles, which will be installed either with sand slurry in an oversized air-drilled hole or by driving in a hot water filled, undersized air drilled hole (Figure 17). Anchor piles will be installed at the mid-points of each segment, between offsets, and near each side of each river. Heavily loaded piles, such as the anchor piles, will be set in conventional sand slurry.

Normal VSMs will use 8-inch piles. Larger piles will be used as required, including for pipeline river and stream crossings. For the West Badami Creek crossing (including the two common carrier system pipelines and four infield flow lines), significant ice load design criteria have been identified, and the soils are generally saline and essentially unfrozen. Based on these conditions, cross-braced double 24-inch pile bents with 40-feet of embedment will be installed.

Pipeline isolation valves for the sales oil pipeline will be located as follows:

- Automated valves at the pipeline inlet and outlet, and on the east sides of the No Name and Sagavanirktok rivers.
- Check and manual block valves on the west side of the four main rivers and West Badami Creek.
- Manual block valves on the east side of the Shaviovik and Kadleroshilik rivers.

The automated valves can be remotely actuated through the Supervisory Control and Data Acquisition (SCADA) system. Manual pipeline isolation valves for the utility line will be installed near the shoreline at the landfall end of the Endicott Causeway, on both sides of the four major rivers, and on the west side of West Badami Creek. Automated isolation valves will be installed on the utility line at the inlet and outlet.

Existing turbine flow meters at Endicott and Pump Station #1 and the proposed Badami sales oil turbine flowmeter will measure flow into and out of the Endicott-Badami sales oil pipeline system. The Badami SCADA system will provide real time material balancing to monitor for pipeline leaks within the measurement accuracy of the metering system. In the event of an indicated loss of oil from the system, an operator alarm will be generated. Shut down of the pipelines will be remotely controlled by operators at Endicott or Badami, using the SCADA system.

Nine intermediate valves located on small gravel pads will be constructed along the pipeline route (see Exhibit A); the inlet and outlet valves will be co-located with other facilities. Figures 18 to 19 show typical layouts and sections for automated, manual, and manual plus check isolation valves. Pads will measure approximately 100 by 40 feet, and will be a minimum of 5 feet thick. All pads will be entirely contained within the right-of-way, as shown on Exhibit A. The purpose of the pads is to provide access points for valve operation and maintenance and staging areas for maintenance and operations activities or spill response, including helicopter landing sites. The valve pads will be located to avoid inundation from coastal storm surges and floods. Material for pad construction will be obtained from the East Badami mine site, from the DIU mine site, or from river crossing trench excavations.

The Badami Pipeline system will require construction of a pad at the tie-in with the Endicott Pipeline (Figures 20 to 21). The Endicott tie-in pad will be approximately 220 feet by 80 feet. The pad will contain a pig receiver, valving, and associated controls.

3.5.3 River Crossings

The Sagavanirktok, Kadleroshilik, and Shaviovik main channel river crossings will be buried, and the Shaviovik River floodplain, the No Name River, West Badami Creek, and other minor streams will have elevated crossings (Figures 22 to 23). The VSM designs for these elevated crossings will vary significantly, depending on scour and ice loading potential. The design philosophy for elevated stream crossings is to design VSMs that will withstand the greatest anticipated flood scour or ice impact event without compromising the mechanical integrity of the pipeline.

The burial depth for each of the buried crossings is below a calculated design scour depth; this design factor was established by substantial study and modeling of the existing and potential changes in river characteristics at each crossing location. A design flood based on data obtained from a 1992 flood was used for the Badami pipeline system. Regional and potential local scour have been computed based on sound river engineering principles, and a top of pipe depth beneath the forecast potential scour depth has been selected. Whenever a major flood event occurs during the operating life of the pipeline, a survey will be undertaken to confirm the integrity of the line.

Of greater concern with respect to pipe integrity at the buried river crossings than burial depth is the sagbend setback. Sagbend setback is the distance into the existing banks that the full burial depth is maintained, before making the transition between buried and elevated modes. In essence, it represents a safety factor on bank erosion associated with local scour, and maintains protection of the pipe in the event of a channel change that could erode one of the existing banks.

At the sagbend locations, 90° bends will be installed in the line, and vertical risers will provide the transitions from buried to above grade construction. The risers are subject to a limited thermal expansion. In order to mitigate against associated pipe stress, the risers will be encased in low strength, waterproof foam. In order to mitigate against potential local erosion around the riser and potential hydrodynamic loads during floods, small gravel pads will surround each riser (Figures 18 to 19).

At buried river crossings, both pipelines will have a coating of fusion-bonded epoxy, plus a concrete coating. Sacrificial anode cathodic protection systems will be provided for each buried section.

The frozen sections of the Sagavanirktok River crossing have been found to be somewhat susceptible to thaw settlement. In order to ensure conformance with the strain limits established for the line, the trench will be over-excavated by 10 feet, and a thaw-stable material will be used as for bedding. The type and source of this material will be based on material specifications developed during final design.

It is not necessary to over-excavate under the talik zones in the Sagavanirktok River. Given that those soils are already thawed, there should be little if any thaw settlement associated with the operation of a warm pipeline. For the Kadleroshilik and Shaviovik rivers, a limited potential thaw settlement beneath the design pipe burial depth has been identified, with an associated requirement for over-excavation of about two feet and replacement with thaw stable bedding material.

3.6 CONSTRUCTION

3.6.1 Drilling and Field Facilities

Construction activity for field development will begin as soon as possible in the winter of 1996-1997. An ice road will be constructed to mobilize equipment and materials to the Badami area, and a camp will be installed (see Section 3.11).

During the winter months, the East Badami Gravel Mine Site will be developed, and gravel from the mine used to construct the field facilities (pads, dock, airstrip, in-field road system). Snow and ice will be removed from the tundra surface and piled in areas near the construction sites. Gravel will then be laid, graded, and compacted. The dock will be constructed by flooding as necessary to ground the sea ice, then removing ice in the construction area. Gravel will then be laid on the exposed sea bed to construct the dock. Typical construction equipment to be used will include dozers, front-end loaders, rollers, and trucks.

After the spring of 1997, some thawing and subsequent settlement of the gravel structures are expected to occur. BPXA plans to regrade and recompact these gravel structures as necessary while they are thawed in the summer of 1997. Infrastructure and truckable materials will be mobilized to the site, and installation will begin once the gravel pads have been constructed.

A drill rig will be mobilized to the site in summer 1997 by barge. Development drilling is scheduled to begin in September 1997, and continue until all planned wells have been drilled, probably by 1999. The Badami camp will be used for drilling personnel (see Section 3.11).

Larger process modules will be sealifted to the Badami field in July 1998. Facilities will then be installed and commissioned. Field start-up is scheduled for late 1998 (see Figure 2).

3.6.2 Pipeline System

The pipeline system will be constructed during the winter of 1997-1998, and all work will be conducted from an ice pad to protect the tundra. The ice pad will be built to support numerous passes of heavy construction equipment. Construction will proceed from west to east along the right-of-way. VSMs will be installed and the pipeline will be placed on the VSMs (Figure 24). If the preferred option of burying portions of the utility line in the existing Endicott roadway and causeway system is selected, BPXA would like to install these portions in summer 1997.

The general river crossing construction methodology is to weld together a concrete coated, heavy walled river crossing section on the east side of each river as the mainline welding proceeds along the right-of-way from west to east (Figure 25). The excavation will then be done by means of drilling and blasting to break the ice and frozen soils. Ice will be bulldozed aside, and then the frozen soils will be removed from the trench by a combination of bulldozing, loading and hauling and backhoeing.

Although taliks of limited extent were located at the Kadleroshilik and Shaviovik Rivers in the winter, 1995 geotechnical field program, there was no indication of flow through those taliks. Frost penetration at those crossing locations will be promoted by means of removing or packing the snow to achieve "dry" frozen construction conditions. By comparison, the Sagavanirktok River exhibited significant groundwater flow in the taliks identified under both the main channels at the selected crossing location. It is expected that a combination of "dry" and "wet" construction conditions will exist at the Sagavanirktok River crossing. In that event, the dry portions of the river will be constructed before excavation of the wet sections begins. It may be necessary to pump water from the wet sections of the trench to avoid troublesome artesian flow at the construction site. It may also be advantageous to divert groundwater from the talik on one side to the other, either by driving the frost into the ground or by diversionary pumping. These techniques would result in the benefits of dry versus wet construction, including lower costs and improved ditch bottom smoothness.

Once the excavations are completed, the river crossing sections will be pulled into place and tied in. It is expected that the utility line will be strapped to the sales oil line before the pull, and that the two lines will be installed in one pull. Backfilling will be done by a combination of backhoe for the initial lift as required to pad and stabilize the line and bulldozer for the bulk spoil replacement. Excess spoil associated with the bulking from blasting and excavating and the imported backfill material will be graded out within the gravel floodplain areas, or used for nearby gravel construction. Voidage associated with thaw settlement occurring in the backfill after construction will be filled by means of normal transport of river bed granular material.

Disturbed river banks and the deep trenches between the river banks and the riser pads will be filled with relatively thaw stable backfill and bermed up as appropriate to avoid creating a depression in the land surface after settlement has occurred (Figure 26). As appropriate, diversion berms and berm breaks will be incorporated in the berms over the trenches in the buried segments. It is expected that the backfill will be topped with a veneer of fine grained soils and organics, and seeded with *Puccinelia arctica* to promote revegetation. At the river banks, where there is potential for erosion, coarser granular material from the gravel mine or the river excavation will be used as a veneer in order to achieve erosion resistance similar to the adjacent native material.

To ensure that only high-quality materials go into the Badami Pipeline, strict quality control will be required of all suppliers. All welds on the pipeline will be fully inspected using non-destructive testing during construction. Throughout construction, inspectors will be used to ensure that the approved welding procedures are followed. River crossing segments of the utility and sales oil pipelines will be pressure-tested using a non-freezing fluid prior to lowering-in. Because non-freezing hydrotest fluids will be rented from an appropriate supplier on the North Slope, no test fluid disposal will be required. The utility pipeline will be similarly pressure-tested with a rented, non-freezing test fluid once construction is completed in April 1998. The sales oil pipeline will be pressure tested with water in the summer of 1998. This hydrotest water will be disposed of in the Class I injection well at the Badami CPU.

Once the pipeline is in service, it will be regularly inspected by electronic internal inspection devices, commonly termed "smart pigs," which are hydraulically pumped through the line. Two types of pigs will be used. A magnetic flux device or ultrasonic device will be used to monitor wall thickness. Any changes in wall thickness will be quantified and located. If the indicated metal loss is severe enough to compromise the integrity of the pipeline, a verification and repair program will be undertaken.

The other internal inspection device is the Geo-Pig (or an equivalent), which uses an inertial guidance system to precisely monitor the position of line. Its output quantifies any bending and thus strains in the pipe which could occur from thaw subsidence or frost jacking. This information is used to calculate bending-induced strain in the pipe and to ensure that the combined strain levels in the line do not exceed acceptable strain limits under operating conditions.

3.7 GRAVEL SOURCES

Estimated quantities of gravel required for construction of each facility are listed in Table 3. Gravel for the CPU pad, satellite pad, dock, in-field road system, and airstrip will be obtained from the new East Badami Gravel Mine Site, located south of the facilities pad (Figure 27).

The mining plan and reclamation plan for the East Badami Gravel Mine Site have been developed in close coordination with the Alaska Department of Fish and Game (ADF&G), the Alaska Department of Natural Resources (ADNR), and other interested agencies. The construction mine site will be about 40.8 acres in size. Overburden will be stored along the western boundary of the site, and will be placed in a manner that provides interim habitat. The site has been slightly altered since July 1995 to avoid higher value tundra wetlands. In order to excavate the nearly 1.1 million cubic yards needed to construct field facilities, the mine will be excavated to an average depth of 20 feet. After construction is complete, the mine site will be allowed to flood. The planned excavation is designed to create fish overwintering habitat when flooded.

More information about development of the gravel mine site is contained in the July 1995 gravel mining and reclamation plans submitted to ADNR with the Competitive Material Sales applications.

3.8 SPILL PREVENTION AND RESPONSE

An Oil Discharge Prevention and Contingency Plan (ODPCP) was approved by the Alaska Department of Environmental Conservation (ADEC) on November 4, 1993 for BPXA's Badami area exploratory drilling operations. This plan was amended and approved to cover the Badami #4 and #5 appraisal wells. A new ODPCP will be prepared to incorporate Badami operations and spill response considerations. The Plan will include: drilling and facility and pipeline operations; identification of spill response equipment to be staged and/or deployed at sensitive areas along the pipeline route (primarily river crossings); equipment to be staged at the facility; and spill prevention and response considerations specific to a facility with limited access.

3.9 WASTE MANAGEMENT

All waste disposal procedures will conform with ADEC and U.S. Environmental Protection Agency (EPA) requirements. Figure 28 is a schematic plan for waste management during the project.

The majority of wastes generated during project construction will consist of drill cuttings and spent muds. Some drilling waste will also be generated during operations from well workover rigs. No reserve pit will be constructed. Drilling fluids will be disposed of through annular injection on-site, injection into an on-site permitted disposal well, or transported off-site to permitted disposal wells. Cuttings will either be washed, recycled, and used as a gravel construction material; disposed of on-site; or transported off-site for disposal. If cuttings are used for on-site construction materials, a testing program will be implemented to ensure that these gravels meet all regulatory requirements before being used. For on-site disposal, cuttings will be treated by a portable grinding unit and disposed of through annular injection or into a permitted on-site disposal well along with spent muds. Alternatively, cuttings will be transported off-site to the grinding facility and disposal well at Prudhoe Bay. Space for temporary storage of drilling wastes will be provided on the site.

In addition to drilling wastes, domestic wastewater and solid waste will be generated during the project. Solid wastes, including scrap metal and incinerator ash, will be hauled off-site for disposal at the North Slope Borough landfill. Combustible wastes will be taken to the North Slope Borough incinerator or incinerated on-site. Waste lubricating oil will be packaged in drums for shipment to an approved recycling facility.

An approved treatment unit will treat sanitary wastes. Effluent from the unit will be chlorinated, and the treated effluent will either be discharged to the tundra in accordance with an NPDES permit, be hauled to BPXA's Base Operations Center waste disposal facility, or used to support drilling operations. Alternately, wastewater can be disposed of through injection.

The estimated peak quantity of domestic wastewater generated during construction is approximately 27,000 gallons per day; the expected average effluent flow during operations is 4,000 gallons per day. Sewage sludge will be incinerated at the on-site facility, and incinerator ash and all other innocuous waste will be hauled to the North Slope Borough waste disposal facility.

Wastes shipped off-site will be transported via winter ice roads or summer barges. Any wastes generated during spring and fall (when both ice road and barge travel are interrupted by breakup and freeze-up) which must be transported off-site for disposal will be stored on-site in appropriate containers until they can be transported to existing off site facilities for disposal.

3.10 ENDICOTT FACILITIES

The Badami sales oil pipeline will terminate at the tie-in with the Endicott Pipeline, while the utility pipeline will be co-located within the Endicott right-of-way from the tie-in to the MPI. Since Badami oil will be added to the Endicott Pipeline at a time when Endicott production is declining, adequate capacity will be available to transport production from both fields.

The utility line will primarily be used to carry high pressure gas and natural gas liquids from Endicott to Badami for use as miscible injectant for enhanced oil recovery.

A tie-in will be made to Endicott's natural gas liquids unit. Custody transfer metering, and a high pressure transfer pump will be provided. Separately, a tie-in will be made to Endicott's high pressure gas system, and custody transfer metering will be provided before mixing the gas and natural gas liquids for delivery to the utility line.

3.11 SUPPORT FACILITIES

3.11.1 Camp

A camp to support construction of gravel facilities will be established in the Badami area in the winter of 1996-1997. The camp will remain operational through drilling and installation of facility modules and pipeline tie-in, and will also serve, at reduced occupancy, to meet facility operational needs. At peak occupancy, this camp will house approximately 360 workers.

3.11.2 Water Sources

Fresh water will be needed for ice pad and ice road construction, hydrotesting the pipeline, drilling operations, and domestic use. During field operations, up to 4,000 gallons of water per day will be needed for domestic use. Higher domestic water consumption and wastewater generation will occur during field construction and development drilling. A maximum estimated of 27,000 gallons of water per day could be required for domestic use during construction.

Domestic water will be obtained from a local permitted source (see Exhibit A). Possible sources include water from the East Badami Mine Site or from nearby deep lakes. Wastewater will either be treated on-site and discharged or hauled back to the Prudhoe Bay Unit for treatment and disposal (see Section 3.10).

Drilling of each Badami well will require about 1.8 million gallons, at a rate of 20,000 gallons per day, for a total maximum water consumption of about 67 million gallons. Annual construction of a sea ice road construction would require up to 20 million gallons of water, and ice road construction along the pipeline corridor would also require up to 20 million gallons. Drilling make-up water will be obtained from a nearby lake or the East Badami Mine Site. Hydrotesting of the sales oil pipeline will require approximately one million gallons at a rate of about 250,000 gallons per day. Water for ice road construction and hydrotesting will come from existing or new permitted sources in the pipeline corridor (Exhibit A).

3.11.3 Power and Fuel Storage

During early construction and drilling, electrical power will be obtained from diesel generators. Diesel fuel will be stored in one permanent and four temporary 5,000 barrel tanks. Secondary containment will be provided for this tank storage. Once the utility pipeline is ready for service, electrical power for drilling and construction support will be generated on-site using natural gas imported from Endicott. For field operations, power will be generated on-site from either locally produced gas or from gas imported from Endicott via the utility line.

3.11.4 Communications

Voice communications will be established between Badami and existing commercial facilities at Deadhorse. Data links will be established among Badami, Endicott, Pump Station 1, and possibly existing commercial systems at Deadhorse, as part of the SCADA system for operations of the Badami Pipelines system and CPU.

3.12 OPERATIONS AND MAINTENANCE

The Badami field will be a minimally staffed facility. Use of simple-to-operate facilities has been a basic design concept in planning this development. Much of the operation will be automated, reducing the need for extensive personnel on-site. At this point in facilities design, it is estimated that up to 50 full-time personnel will be required to operate the field and the pipeline.

A health, safety, and environment (HSE) program will be implemented for this project, including such measures as safety briefings, a safety officer, identification and correction of potential work hazards, environmental awareness, polar bear training, contingency plans for medical evacuations, first-aid training, and screening of workers for remote construction. All employees and contractors on the project will be required to attend regularly scheduled safety meetings. Any condition that could cause a hazard to the safety of workers at the Badami facility or on the pipeline will be reported to the responsible supervisor so that immediate action can be taken.

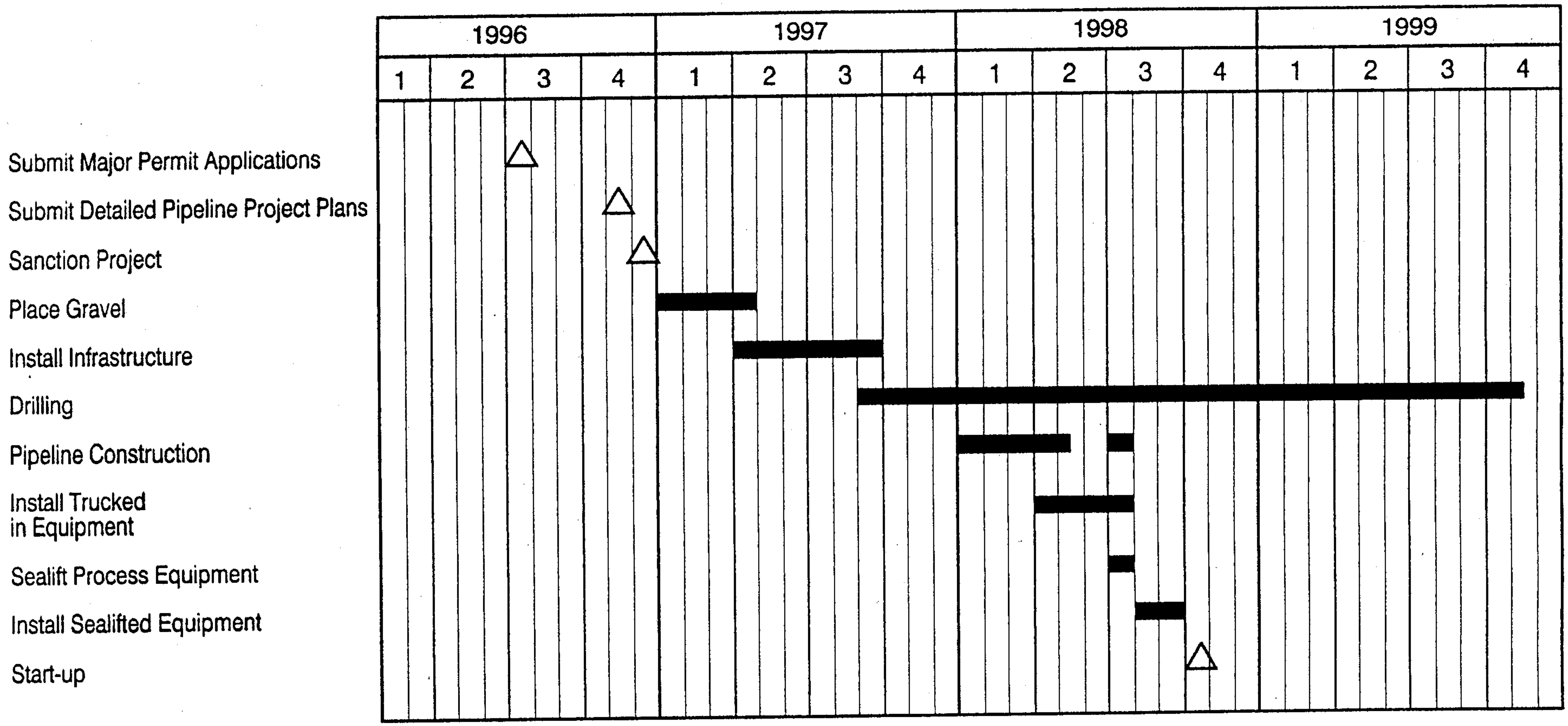
BPXA will also implement a program to ensure that construction, operation, and maintenance of project facilities are conducted in full compliance with relevant federal, state, and local regulations and permit conditions. One key objective of this program will be to ensure pipeline integrity, prevent spills or leaks, and establish procedures for performance monitoring to ensure continued integrity and for response planning.

After construction, a pipeline inspection and maintenance program will be implemented. The goals of this program will be to not only ensure pipeline operating integrity and safety, but also to prevent, identify, and respond to any situations that could cause significant damage to the environment. The pipeline will be regularly inspected by electronic internal inspection devices (pigs) to monitor any pipeline movement, corrosion, or mechanical damage. Regular aerial surveillance will also be conducted. The ongoing pipeline inspection and maintenance program will address potential adverse habitat or water quality impacts resulting from unplanned problems with pipeline performance.

No harm to vegetation is anticipated due to routine operation and maintenance of the pipeline. Access for minor repairs will be via either rollagons or helicopters. All pipeline isolation valves will have an adjacent gravel pad to allow for valve maintenance without harm to tundra. Any heavy equipment that might be needed for valve repairs could be transported using rollagons or be slung to the site with a heavy-lift helicopter.

Any planned pipeline repairs will be completed in winter from ice pads, if possible. Two options exist for repairs that are required at other times of year. During times when travel over the tundra is permitted, repairs would be supported by rollagons. Typical equipment for pipeline repairs include a small backhoe, a welding unit, short pipe sections, joint coating equipment, tools, and consumables. Wooden mats (40 feet by 8 feet) would be pinned together and laid on the tundra to minimize environmental disturbance. At times when tundra travel is prohibited, heavy-lift helicopters would be used to support repair work.

Minimal maintenance of river crossings is expected. Routine maintenance will be accomplished using small backhoes either mounted on or transported by rollagons. During breakup, equipment could be mobilized to the work area using heavy-lift helicopters. In a worst-case scenario, a temporary pipeline shutdown might be required until repairs could be performed.



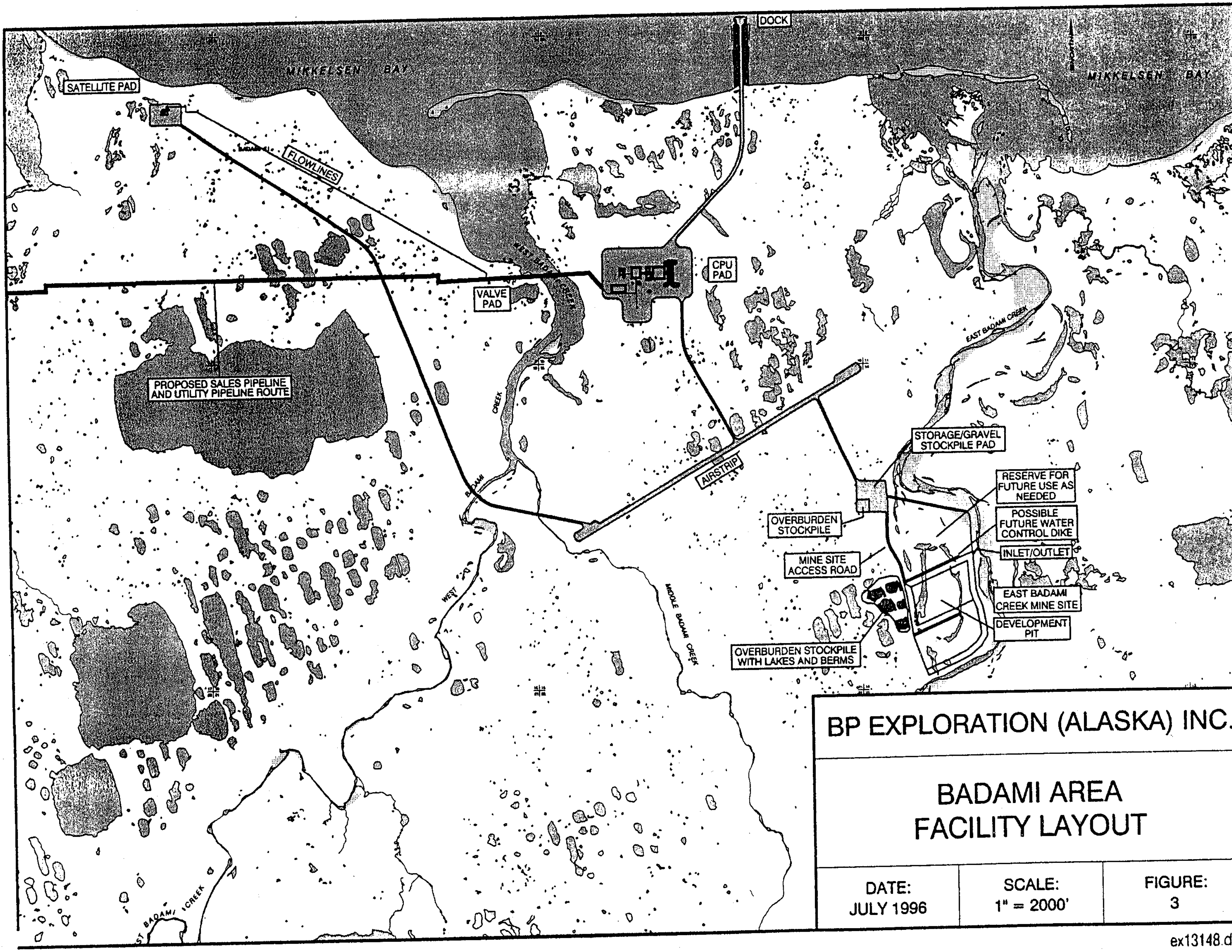
BP EXPLORATION (ALASKA) INC.

BADAMI DEVELOPMENT
PROJECT SCHEDULE

DATE:
JULY 1996

FIGURE:
2

ex13147.dgn

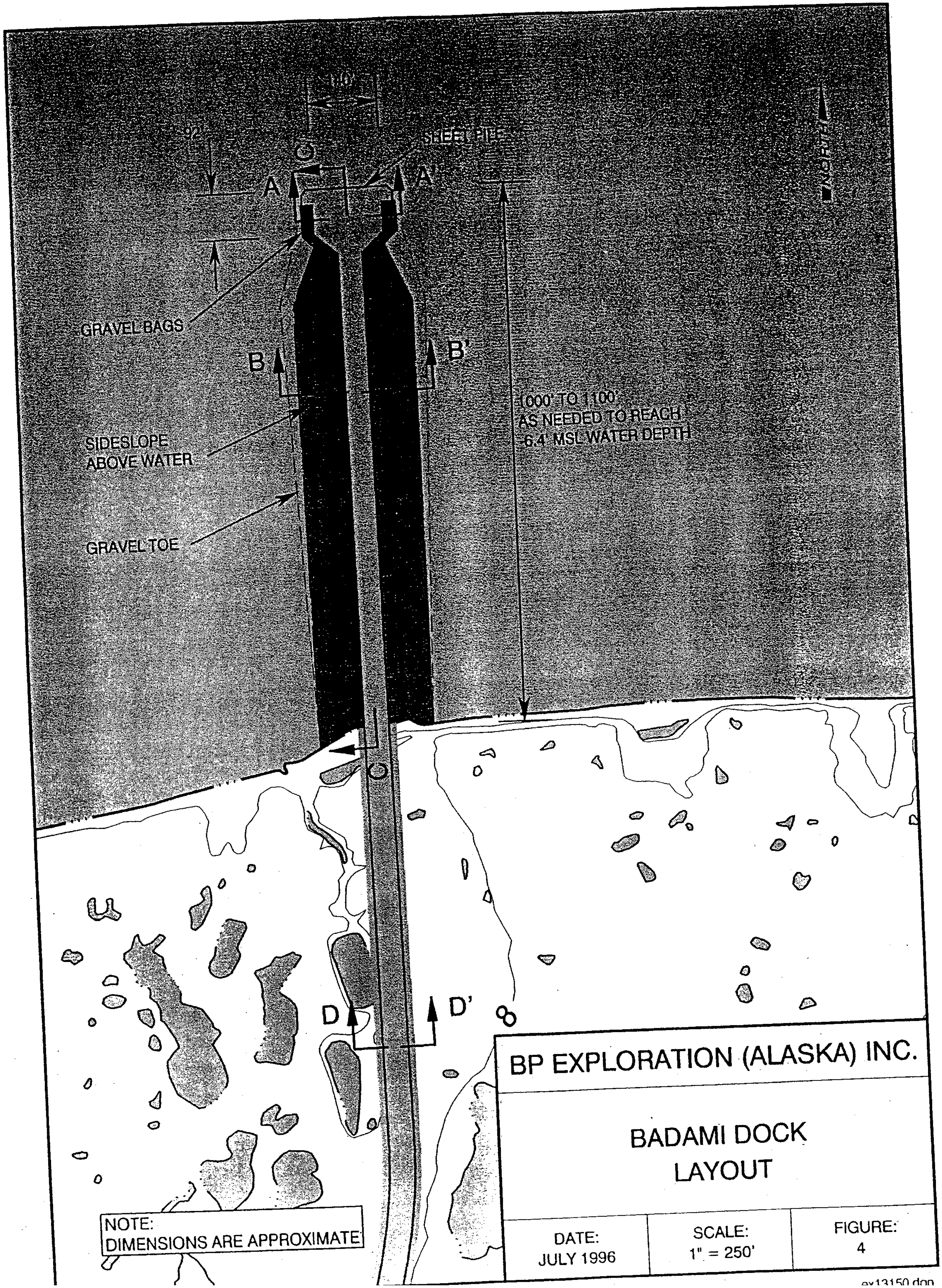


BP EXPLORATION (ALASKA) INC.

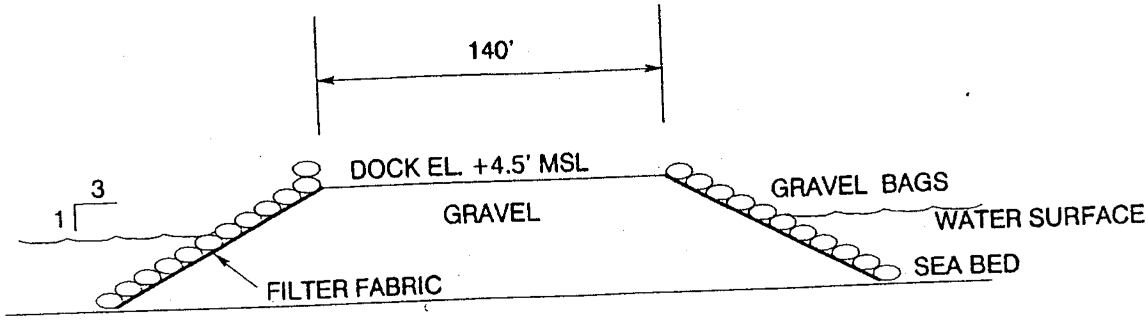
BADAMI AREA FACILITY LAYOUT

DATE: JULY 1996	SCALE: 1" = 2000'	FIGURE: 3

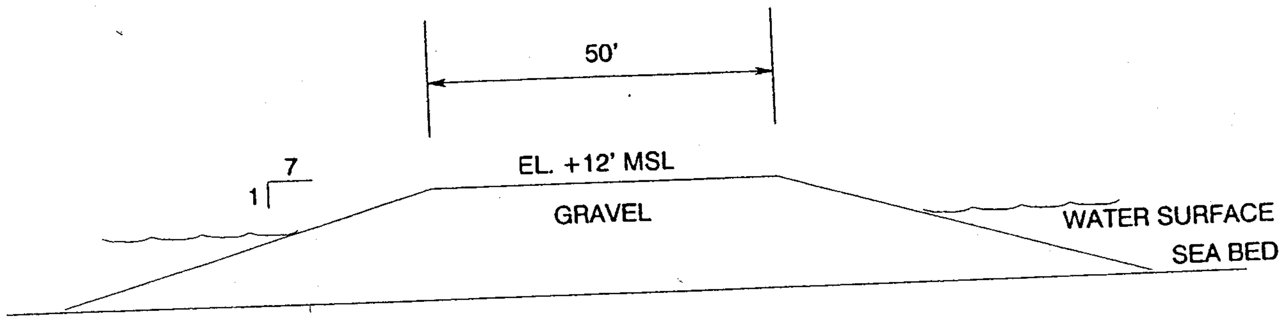
ex13148.dgn


110'
92'
SHEET PILE
NORTH
A
A'
C
GRAVEL BAGS
B
B'
1000' TO 1100'
AS NEEDED TO REACH
-6.4' MSL WATER DEPTH
SIDESLOPE
ABOVE WATER
GRAVEL TOE
C
D
D'
NOTE:
DIMENSIONS ARE APPROXIMATE
BP EXPLORATION (ALASKA) INC.
BADAMI DOCK
LAYOUT
DATE:
JULY 1996
SCALE:
1" = 250'
FIGURE:
4

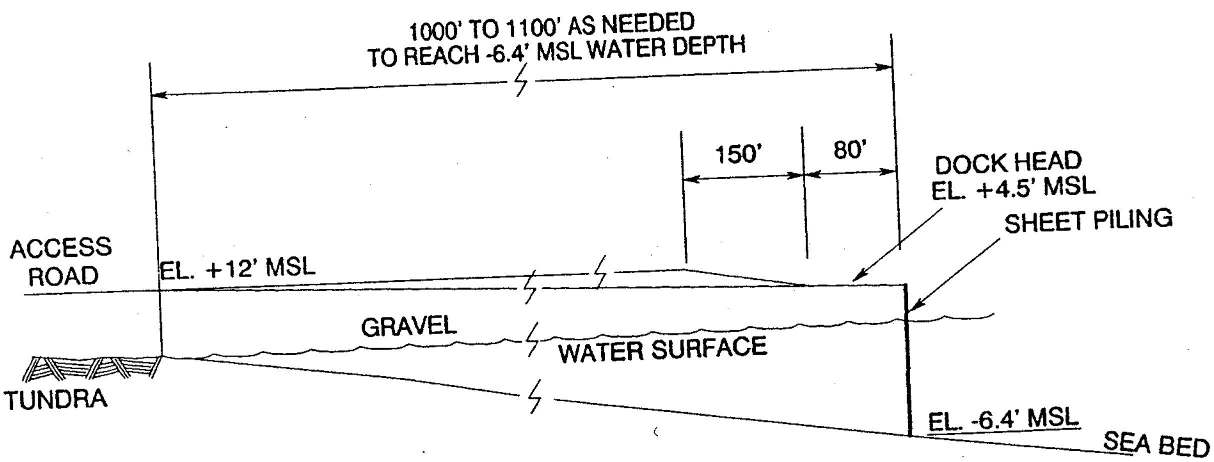
ex13150.dgn



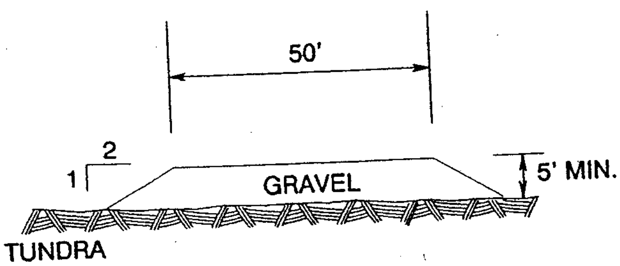
SECTION A - A'



SECTION B - B'



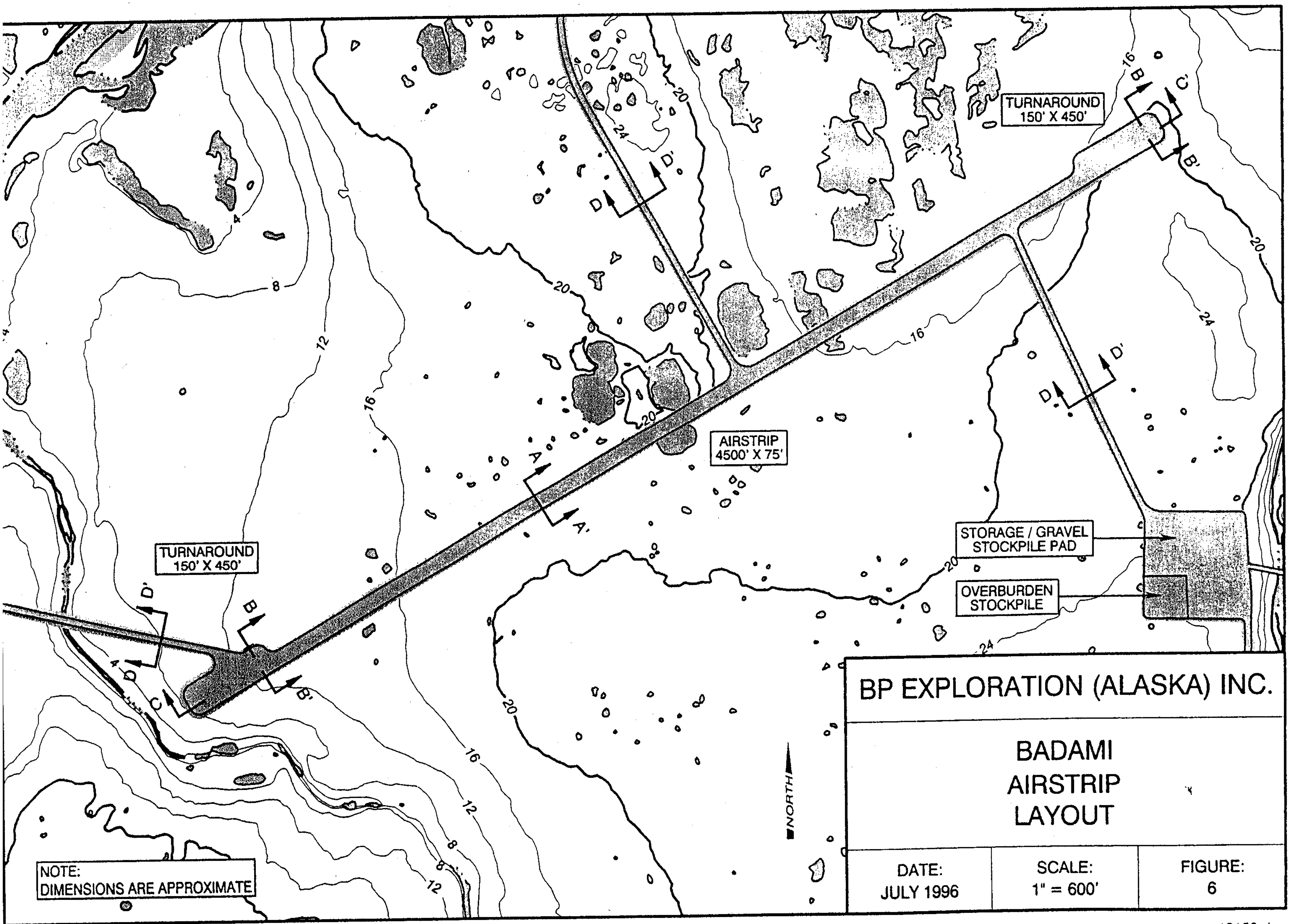
SECTION C - C'



SECTION D - D'

NOTE:
DIMENSIONS ARE APPROXIMATE

BP EXPLORATION (ALASKA) INC.		
BADAMI DOCK CROSS SECTIONS		
DATE: JULY 1996	SCALE: NOT TO SCALE	FIGURE: 5

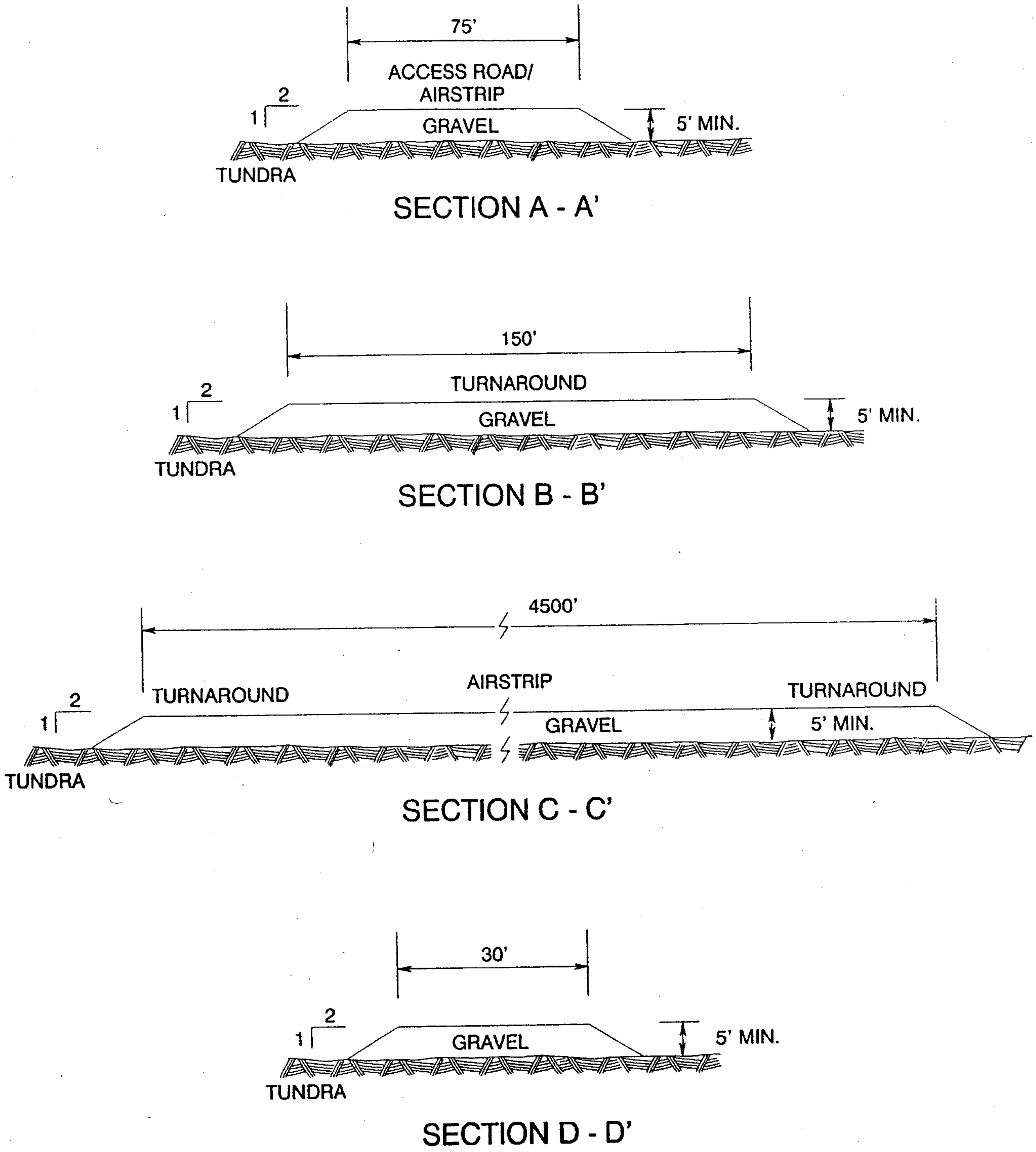


BP EXPLORATION (ALASKA) INC.

BADAMI
AIRSTRIP
LAYOUT

DATE:	SCALE:	FIGURE:
JULY 1996	1" = 600'	6

ex13150.dgn

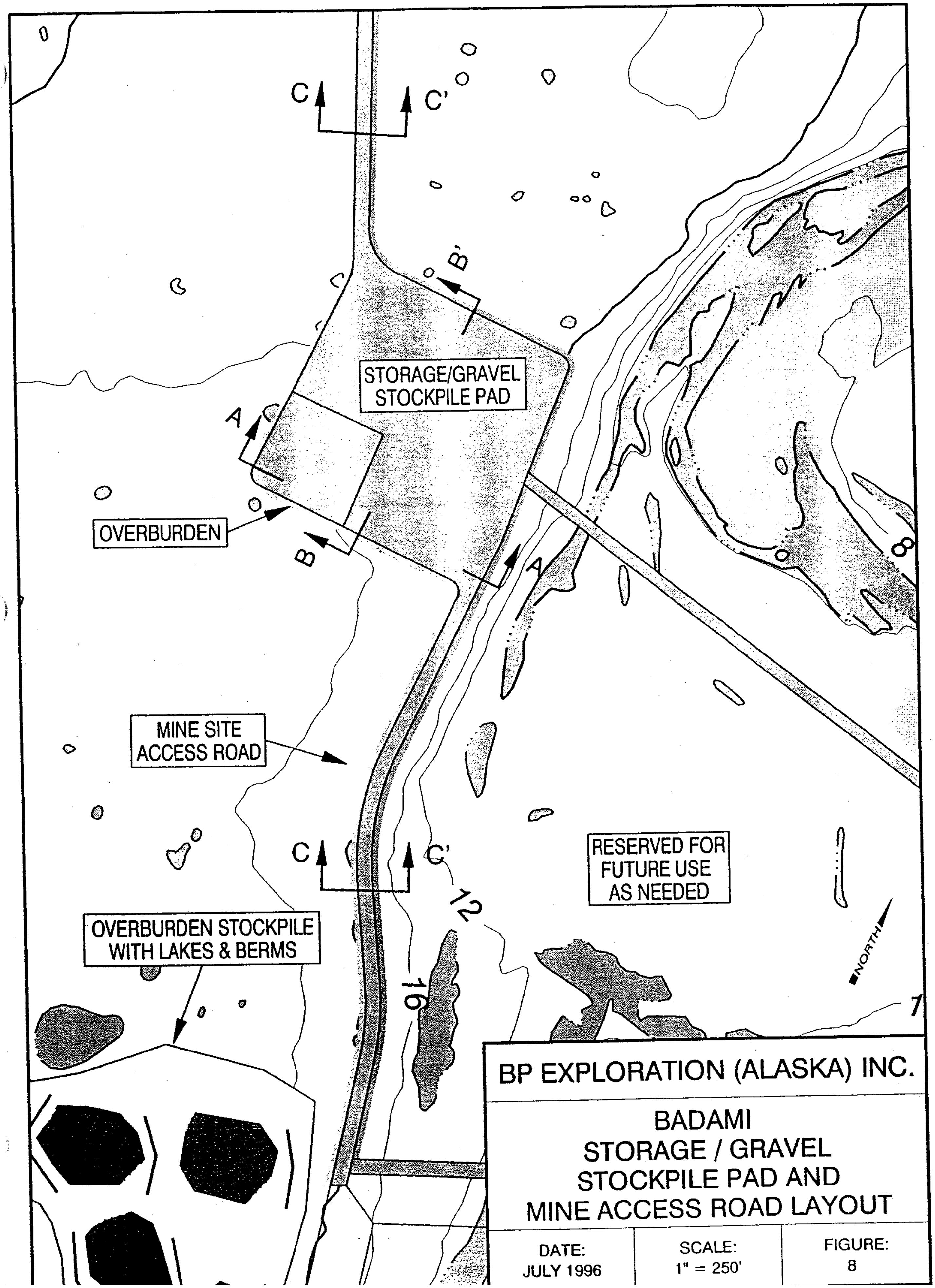


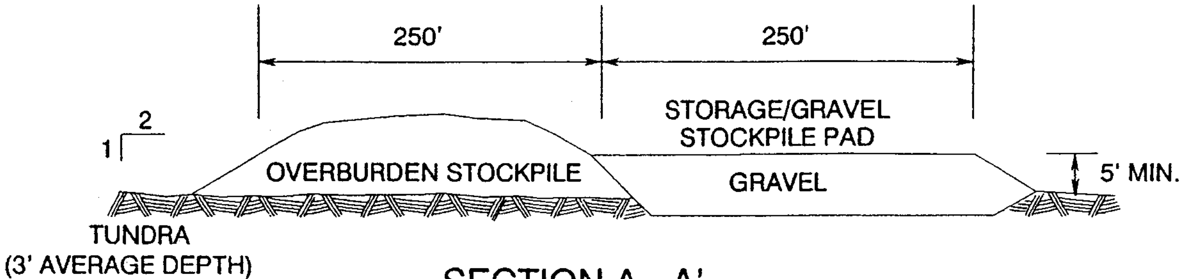
NOTE:
DIMENSIONS ARE APPROXIMATE

BP EXPLORATION (ALASKA) INC.

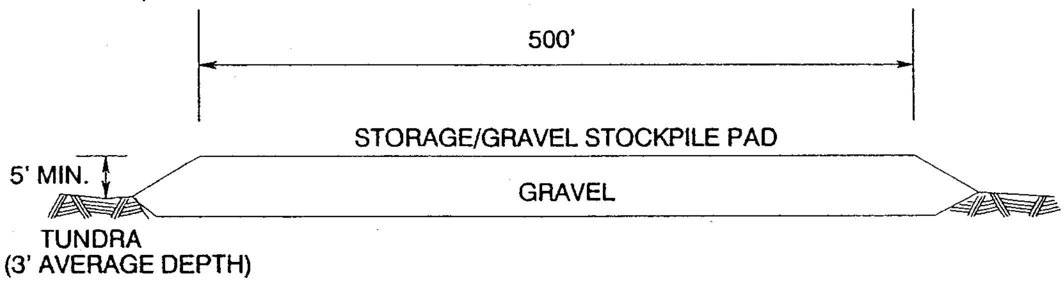
BADAMI AIRSTRIP
CROSS SECTIONS

DATE:	SCALE:	FIGURE:
JULY 1996	NOT TO SCALE	7

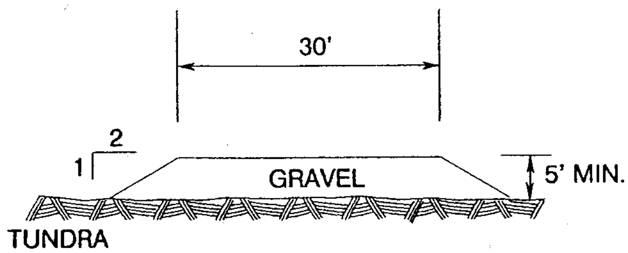

C
C'
B'
STORAGE/GRAVEL STOCKPILE PAD
A
OVERBURDEN
B
A
8
MINE SITE ACCESS ROAD
C
C'
12
RESERVED FOR FUTURE USE AS NEEDED
NORTH
OVERBURDEN STOCKPILE WITH LAKES & BERMS
16
BP EXPLORATION (ALASKA) INC.
BADAMI
STORAGE / GRAVEL
STOCKPILE PAD AND
MINE ACCESS ROAD LAYOUT
DATE: JULY 1996
SCALE: 1" = 250'
FIGURE: 8



SECTION A - A'



SECTION B - B'



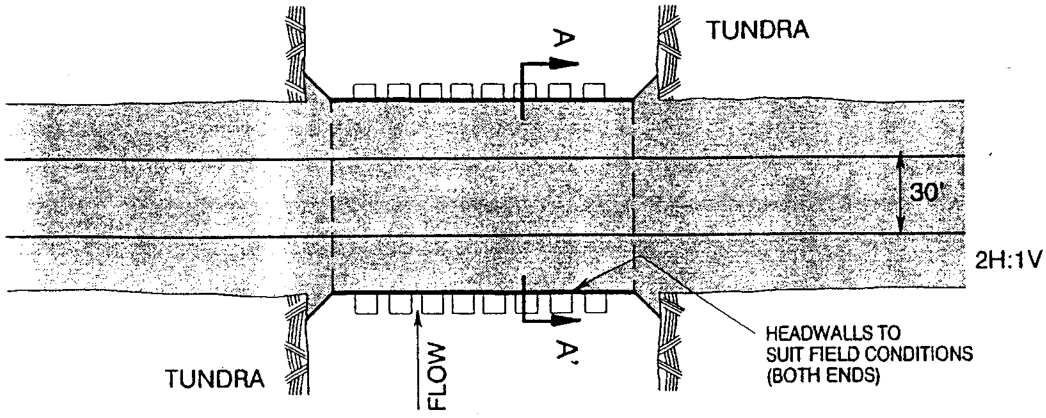
SECTION C - C'

NOTE:
DIMENSIONS ARE APPROXIMATE

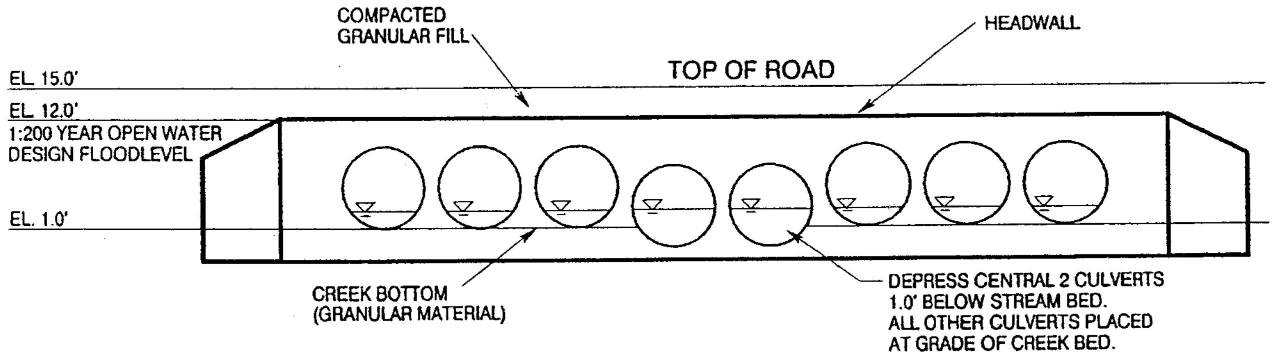
BP EXPLORATION (ALASKA) INC.

**BADAMI
STORAGE/GRAVEL STOCKPILE PAD
AND MINE ACCESS ROAD
CROSS SECTIONS**

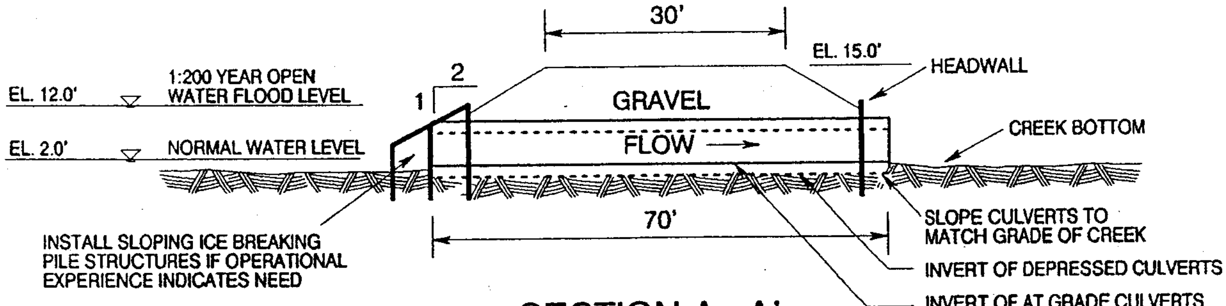
DATE:	SCALE:	FIGURE:
JULY 1996	NOT TO SCALE	9



PLAN



ELEVATION



SECTION A - A'

DATA SUMMARY

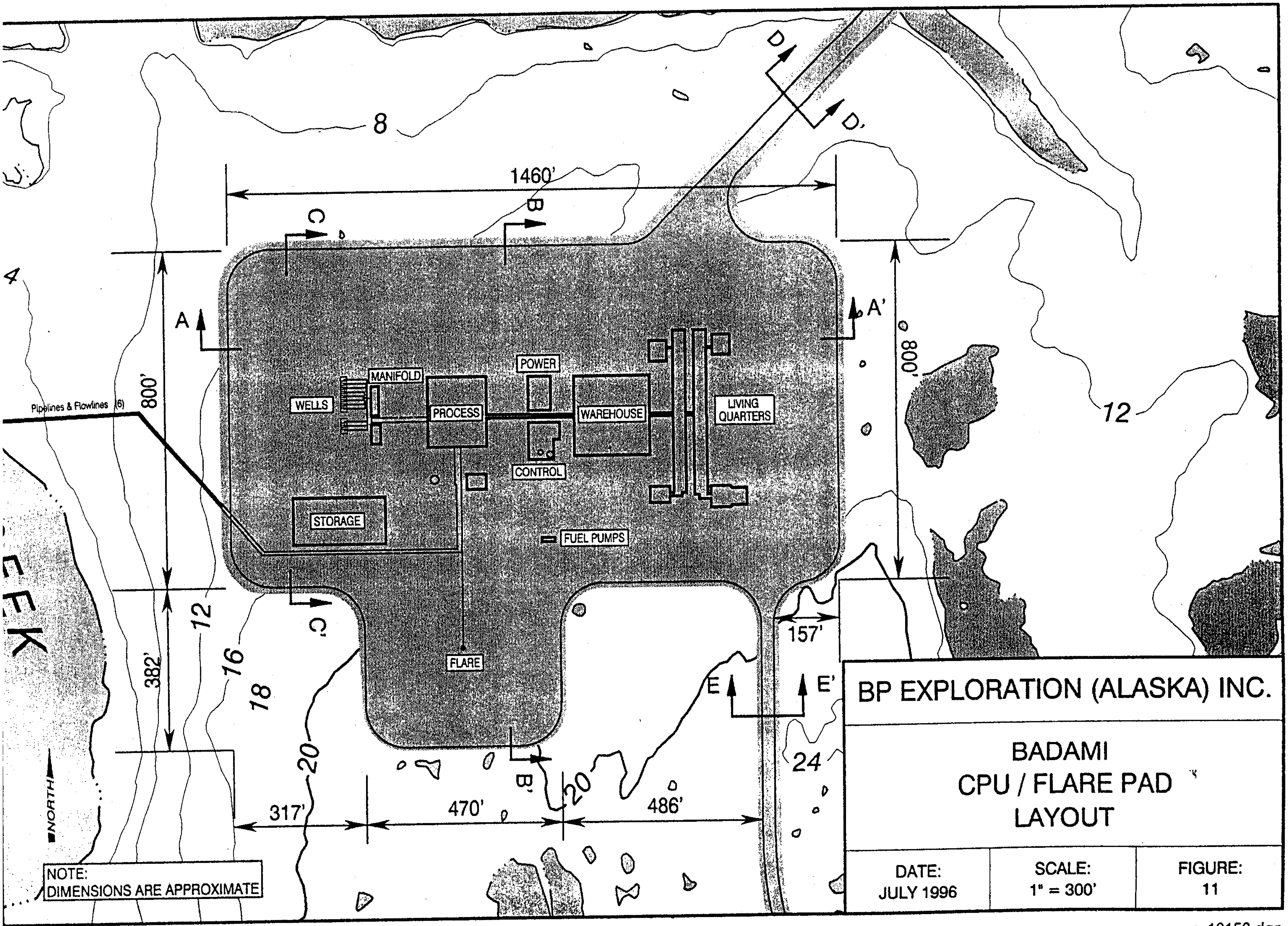
	WEST BADAMI CREEK	MIDDLE BADAMI CREEK
DESIGN FLOW	6,000 CFS	4,000 CFS
CULVERTS	8 - 8' DIAMETER	5 - 8' DIAMETER

NOTE:
DIMENSIONS ARE APPROXIMATE

BP EXPLORATION (ALASKA) INC.

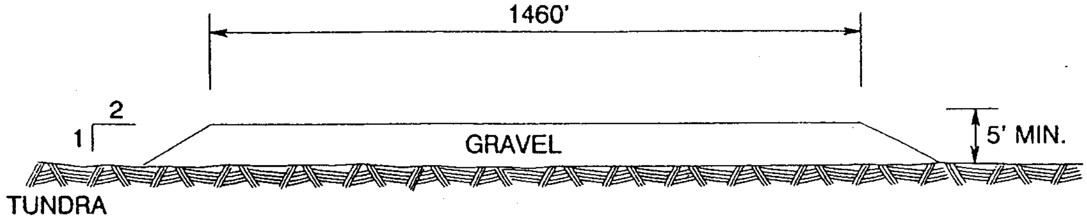
ROAD CULVERTS FOR WEST AND MIDDLE BADAMI CREEKS

DATE:	SCALE:	FIGURE:
JULY 1996	NOT TO SCALE	10

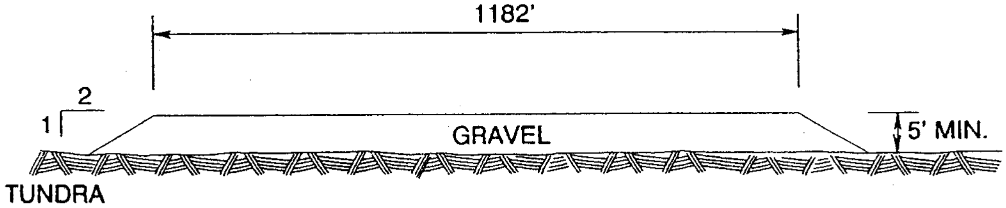


8
12
4
12
16
18
20
20
24
1460'
800'
800'
382'
317'
470'
486'
157'
A
A'
B
B'
C
C'
D
D'
E
E'
Pipelines & Flowlines (6)
WELLS
MANIFOLD
PROCESS
POWER
CONTROL
WAREHOUSE
LIVING QUARTERS
STORAGE
FUEL PUMPS
FLARE
NORTH
NOTE:
DIMENSIONS ARE APPROXIMATE
BP EXPLORATION (ALASKA) INC.
BADAMI
CPU / FLARE PAD
LAYOUT
DATE:
JULY 1996
SCALE:
1" = 300'
FIGURE:
11

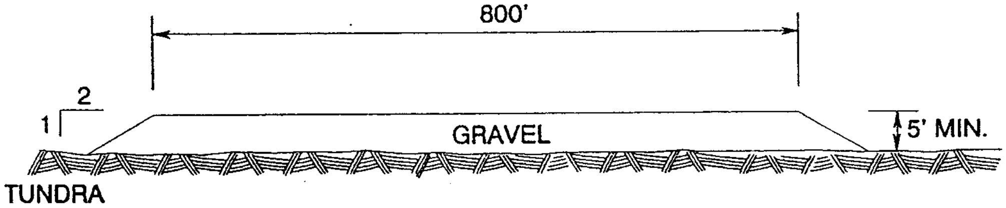
ex13150.dgn



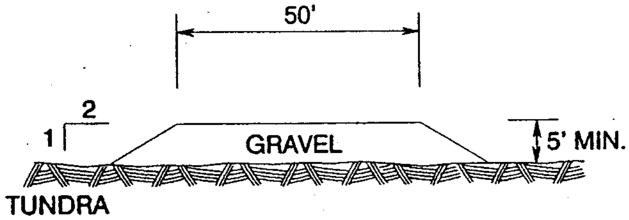
SECTION A - A'



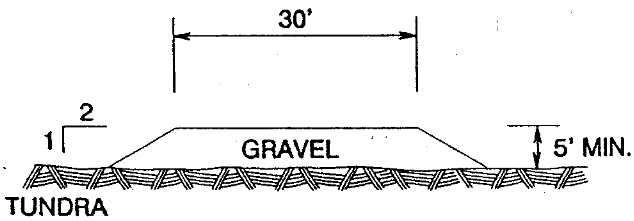
SECTION B - B'



SECTION C - C'



SECTION D - D'



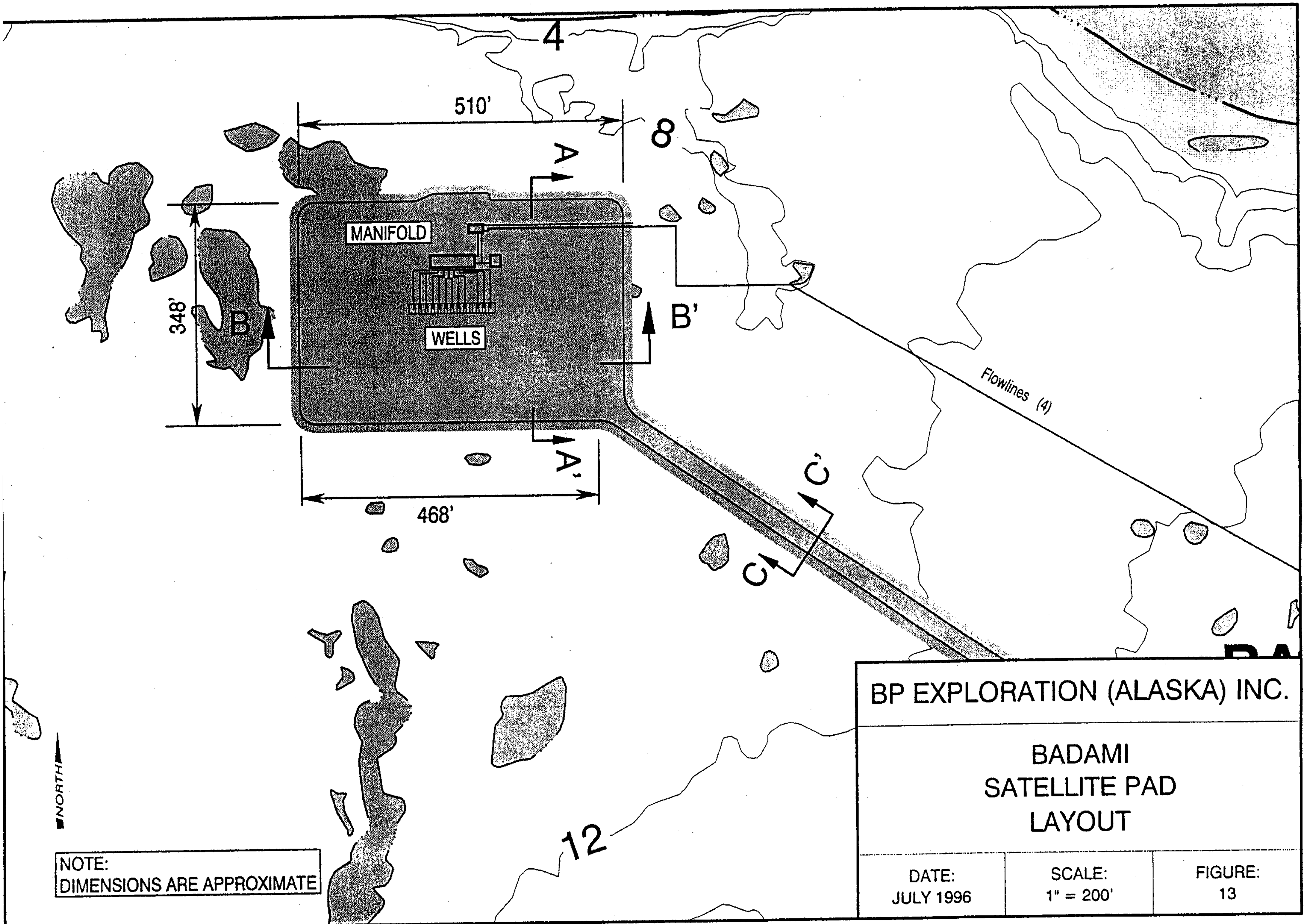
SECTION E - E'

NOTE:
DIMENSIONS ARE APPROXIMATE

BP EXPLORATION (ALASKA) INC.

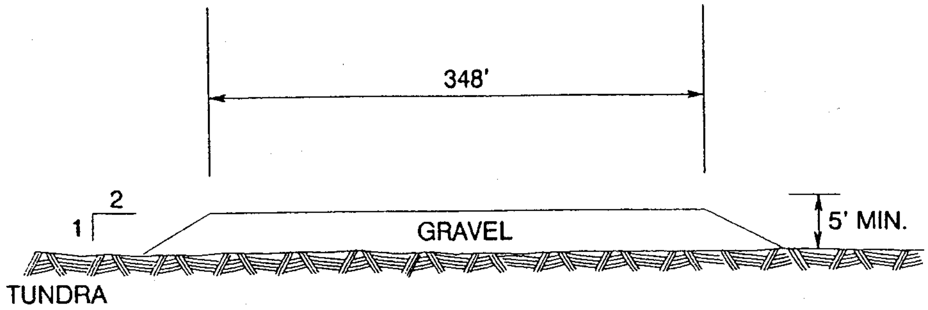
BADAMI
CPU / FLARE PAD
CROSS SECTIONS

DATE:	SCALE:	FIGURE:
JULY 1996	NOT TO SCALE	12

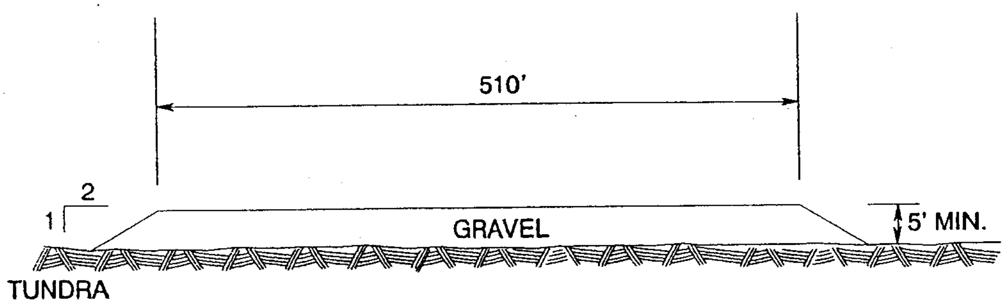


BP EXPLORATION (ALASKA) INC.		
BADAMI SATELLITE PAD LAYOUT		
DATE: JULY 1996	SCALE: 1" = 200'	FIGURE: 13

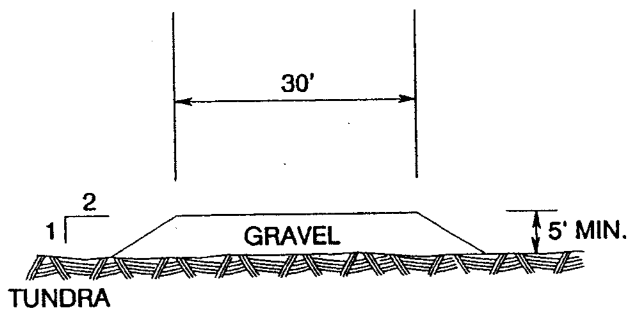
ex13150.dgn



SECTION A - A'



SECTION B - B'



SECTION C - C'

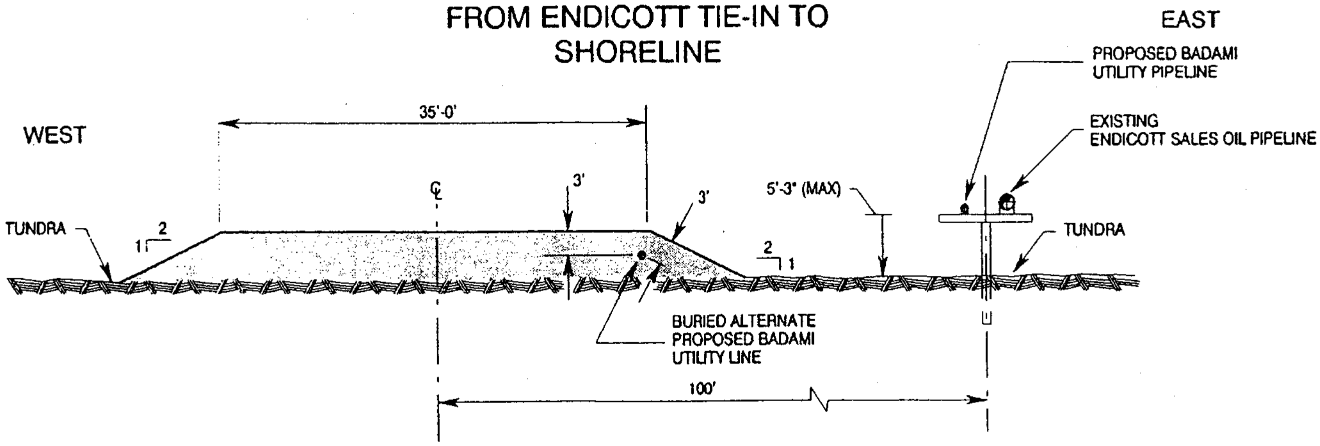
NOTE:
DIMENSIONS ARE APPROXIMATE

BP EXPLORATION (ALASKA) INC.

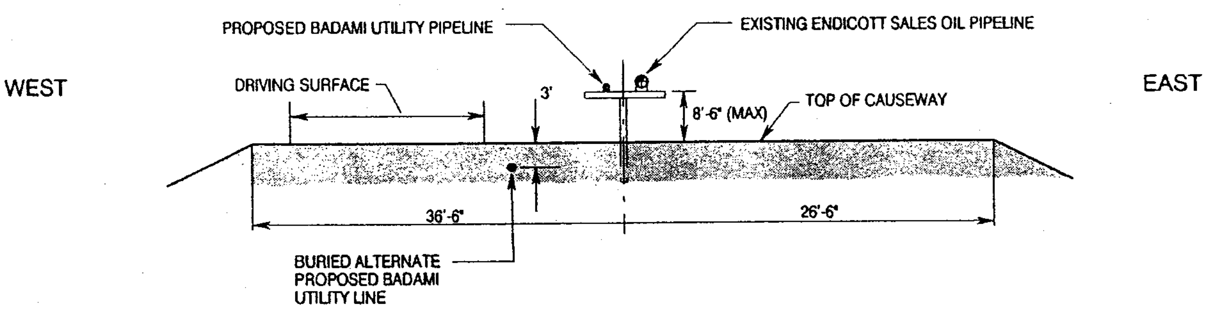
BADAMI
SATELLITE PAD
CROSS SECTIONS

DATE:	SCALE:	FIGURE:
JULY 1996	NOT TO SCALE	14

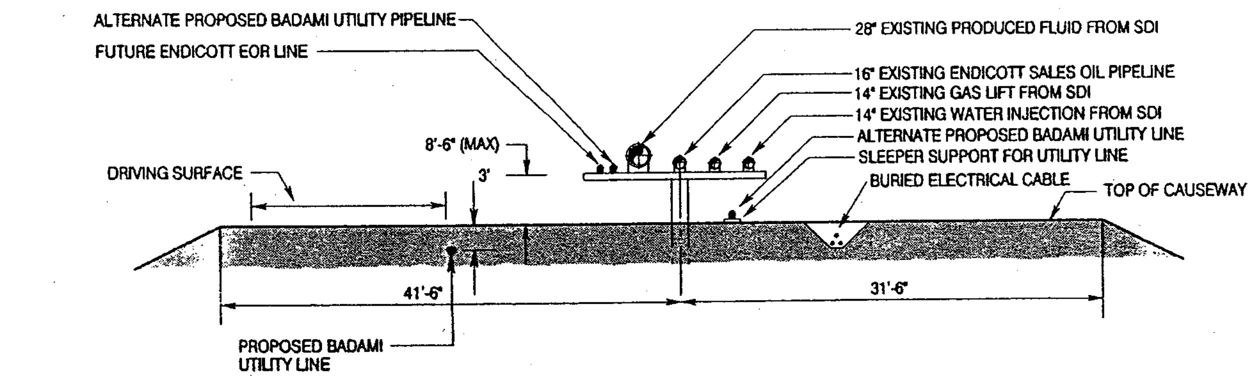
VSM CONFIGURATION FROM ENDICOTT TIE-IN TO SHORELINE



VSM CONFIGURATION SHORELINE TO "Y" INTERSECTION



VSM CONFIGURATION FROM "Y" INTERSECTION TO MPI

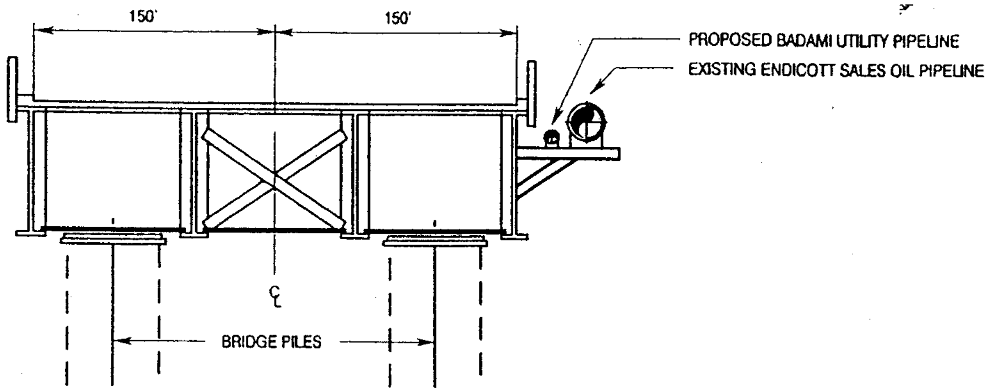


NOTE:
DIMENSIONS ARE APPROXIMATE

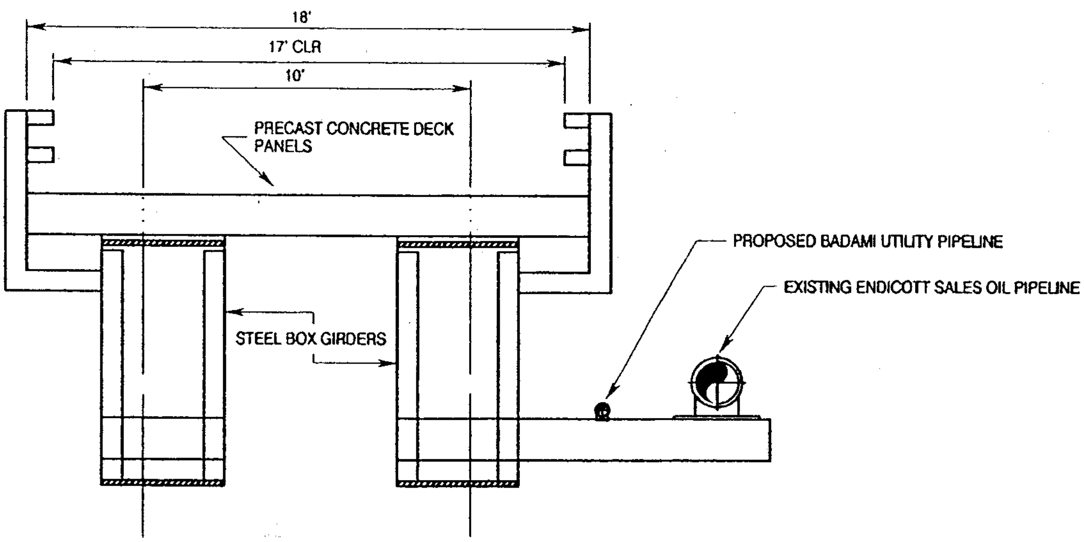
BP EXPLORATION (ALASKA) INC.

BADAMI
TYPICAL UTILITY PIPELINE CONFIGURATIONS
FROM ENDICOTT TIE-IN TO MPI
CROSS SECTIONS

DATE:	SCALE:	FIGURE:
JULY 1996	NOT TO SCALE	15

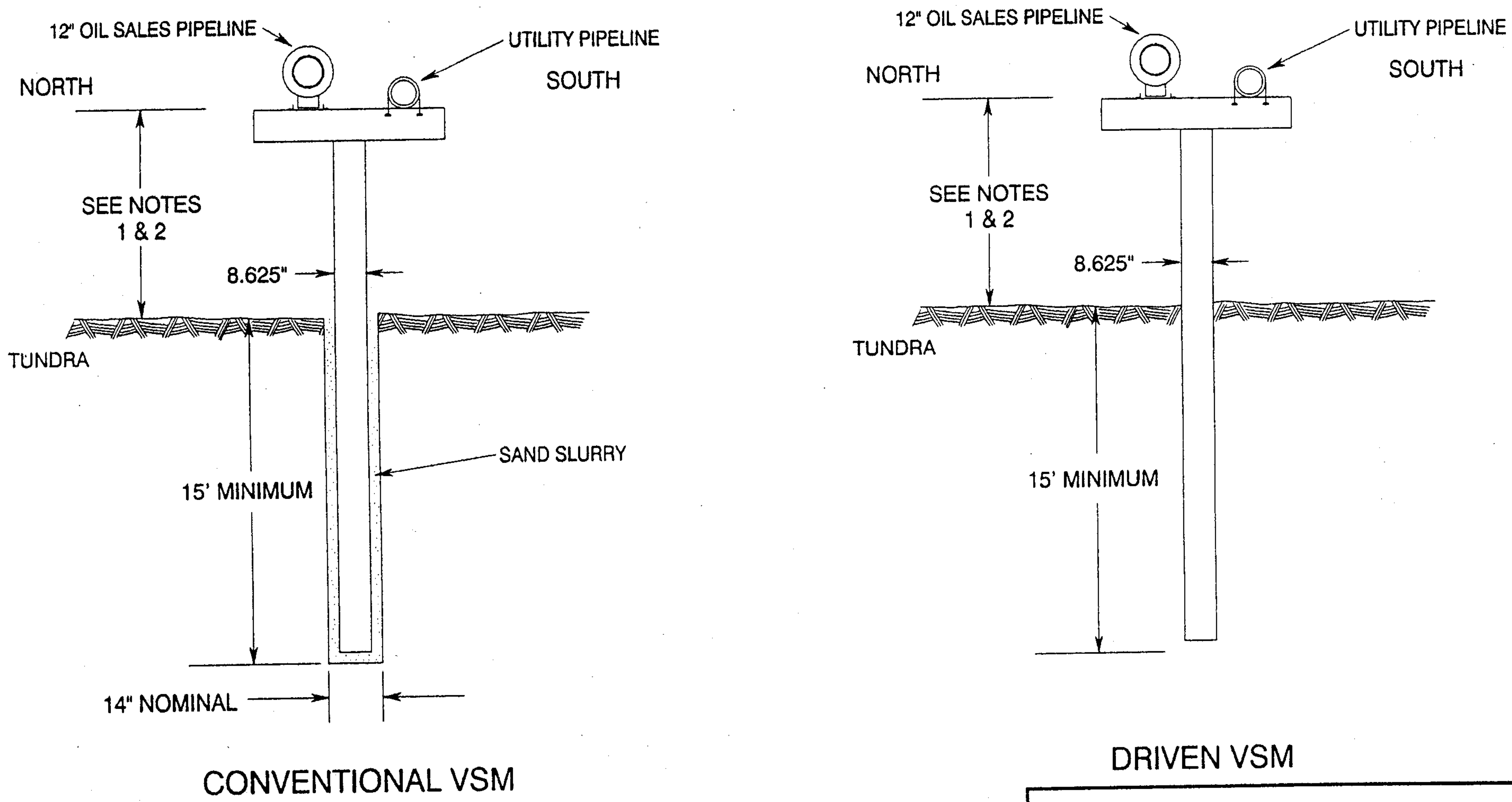


VSM CONFIGURATION
500' AND 200' BRIDGES



VSM CONFIGURATION
700' BRIDGE

BP EXPLORATION (ALASKA) INC.		
BADAMI TYPICAL UTILITY PIPELINE CONFIGURATIONS ENDICOTT CAUSEWAY BREACH CROSSING CROSS SECTIONS		
DATE: JULY 1996	SCALE: NOT TO SCALE	FIGURE: 16

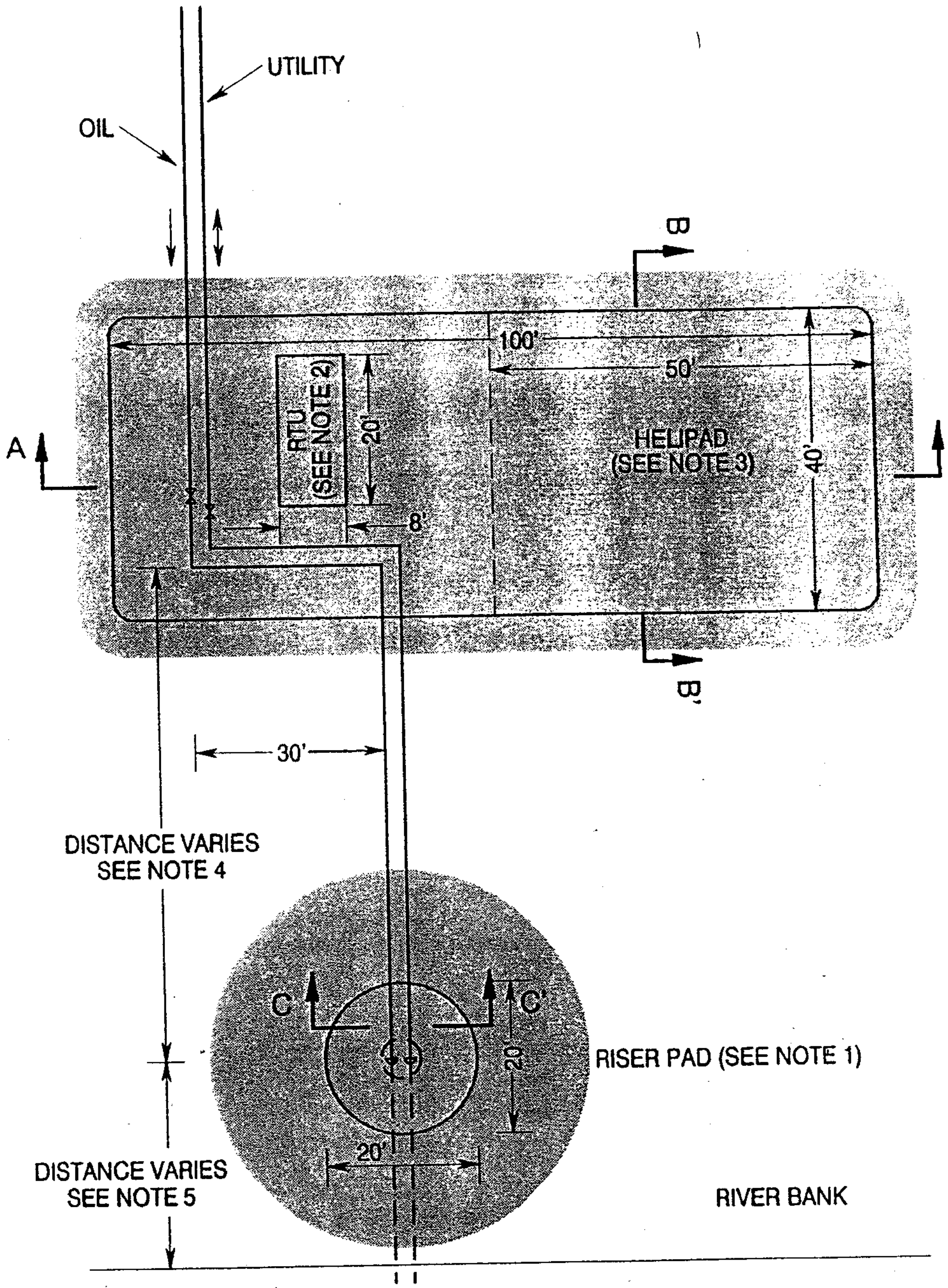


NOTES:

1. HEIGHT FROM GROUND TO BOTTOM OF PIPE WILL BE 5' MINIMUM TO 10' MAXIMUM FOR TYPICAL CROSS COUNTRY PIPELINE.
2. HEIGHT FROM DESIGN WATER LEVEL TO BOTTOM OF PIPE WILL BE 3' MINIMUM FOR WATER CROSSING.
3. DIMENSIONS ARE APPROXIMATE.

BP EXPLORATION (ALASKA) INC.		
NORMAL VSM INSTALLATION BADAMI CPU TO ENDICOTT TIE-IN		
DATE: JULY 1996	SCALE: N/A	FIGURE: 17

ex13151.dgn



NOTES:

1. RISER PADS LOCATED AT BURIED RIVER CROSSINGS: SAGAVANIRKTOK, KADLEROSHILIK & SHAVIOVIK RIVERS.

2. REMOTE TERMINAL UNIT BUILDING IS PRESENT ONLY WITH AUTOMATED VALVES ON EAST BANKS OF SAGAVANIRKTOK & NO NAME RIVERS.

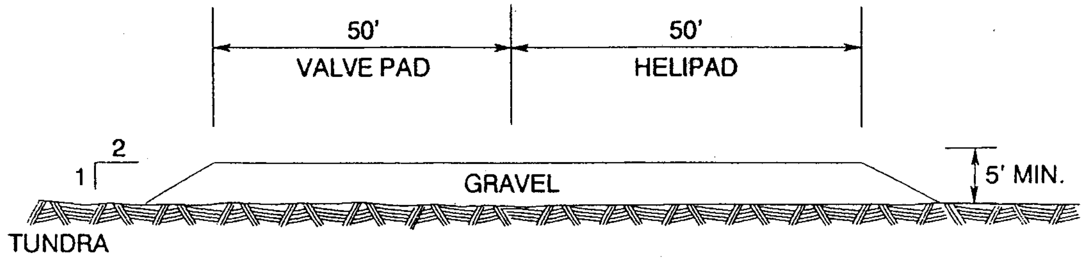
3. HELIPAD IS ON SOUTH AT SAGAVANIRKTOK, NO NAME RIVER & WEST BADAMI CREEK.
HELIPAD IS ON NORTH AT SHAVIOVIK AND KADLEROSHILIK RIVERS.

4. 170' ON BOTH SIDES OF SAGAVANIRKTOK AND KADLEROSHILIK RIVERS. 2,400 ON WEST SIDE, 96' ON EAST SIDE OF SHAVIOVIK RIVER.

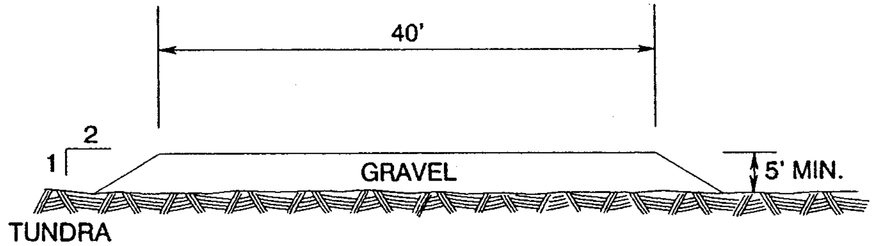
5. 200' EAST & WEST BANKS OF KADLEROSHILIK RIVER, WEST BANK OF SHAVIOVIK RIVER. 150' EAST BANK OF SHAVIOVIK RIVER, AND EAST BANK OF SAGAVANIRKTOK RIVER. 170' WEST BANK OF SAGAVANIRKTOK RIVER.

6. DIMENSIONS ARE APPROXIMATE.

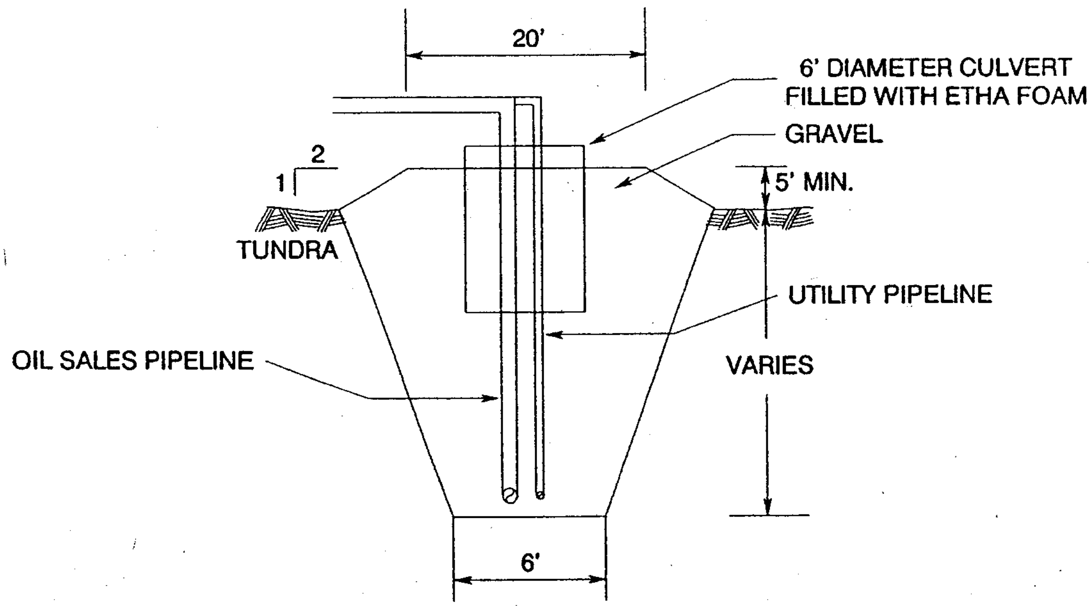
BP EXPLORATION (ALASKA) INC.		
BADAMI PIPELINE SYSTEM TYPICAL ISOLATION VALVE PAD LAYOUT		
DATE: JULY 1996	SCALE: NOT TO SCALE	FIGURE: 18



SECTION A - A'



SECTION B - B'



SECTION C - C'

NOTES:

1. RISER PADS LOCATED AT BURIED RIVER CROSSINGS: SAGAVANIRKTOK, KADLEROSHILIK & SHAVIOVIK RIVERS.

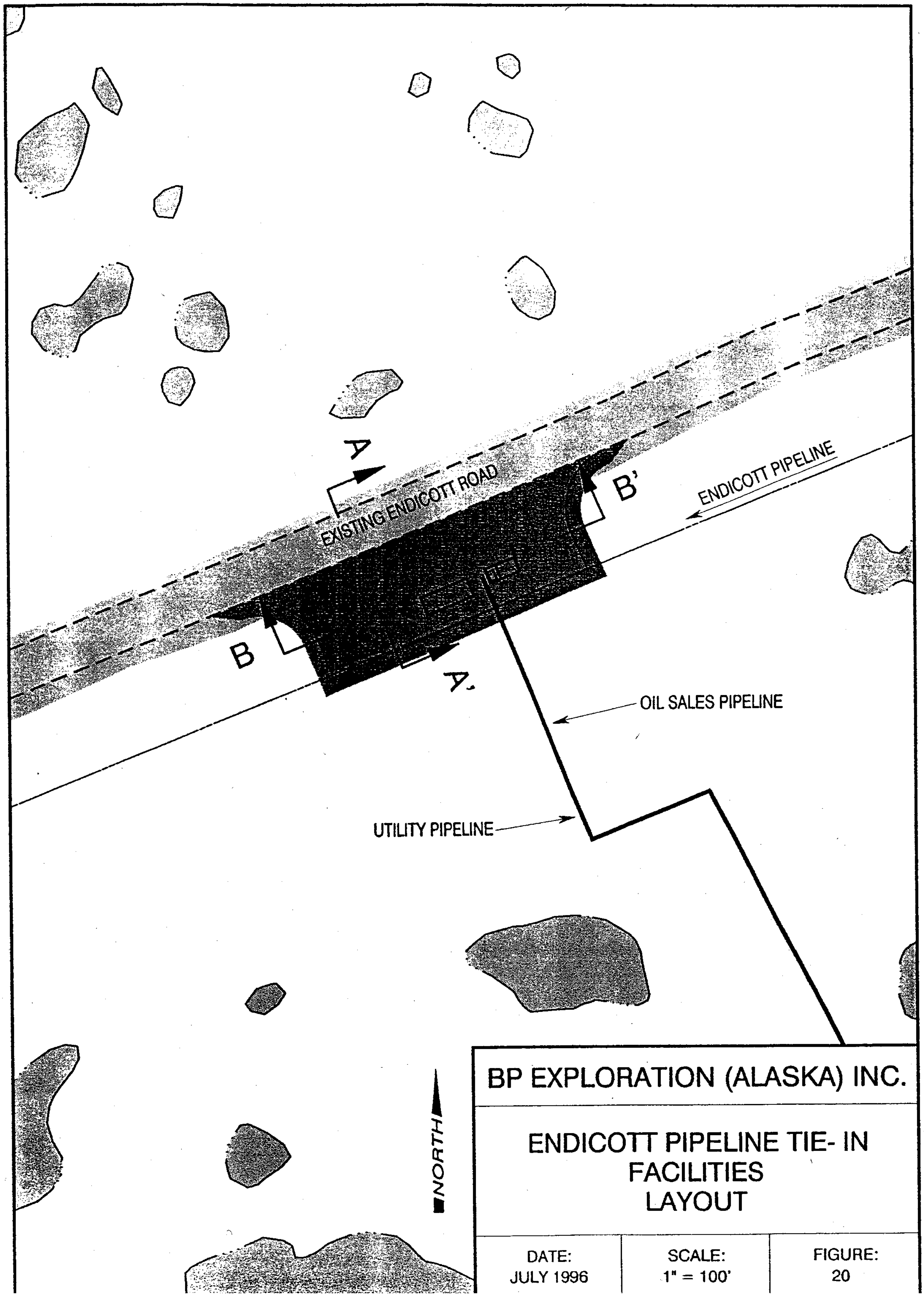
2. HELIPAD IS ON SOUTH AT SAGAVANIRKTOK, NO NAME RIVER & WEST BADAMI CREEK. HELIPAD IS ON NORTH AT SHAVIOVIK AND KADLEROSHILIK RIVERS.

3. DIMENSIONS ARE APPROXIMATE.

BP EXPLORATION (ALASKA) INC.

BADAMI PIPELINE SYSTEM
TYPICAL ISOLATION VALVE PAD
CROSS SECTIONS

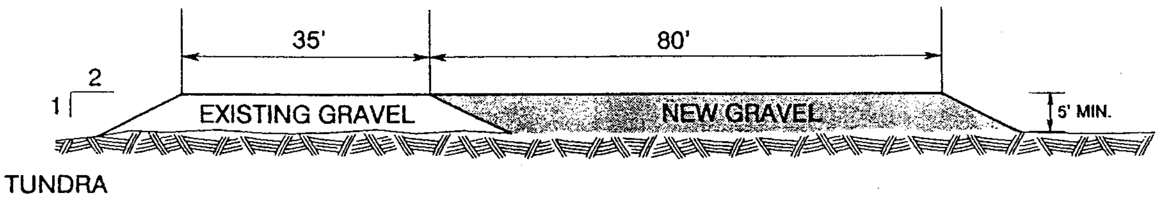
DATE:	SCALE:	FIGURE:
JULY 1996	NOT TO SCALE	19



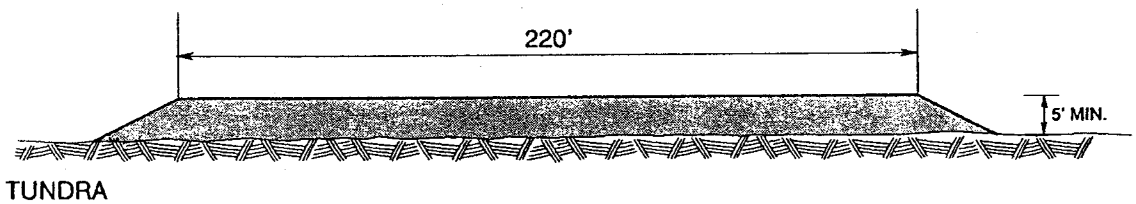
BP EXPLORATION (ALASKA) INC.

ENDICOTT PIPELINE TIE- IN FACILITIES LAYOUT

DATE:	SCALE:	FIGURE:
JULY 1996	1" = 100'	20



SECTION A - A'



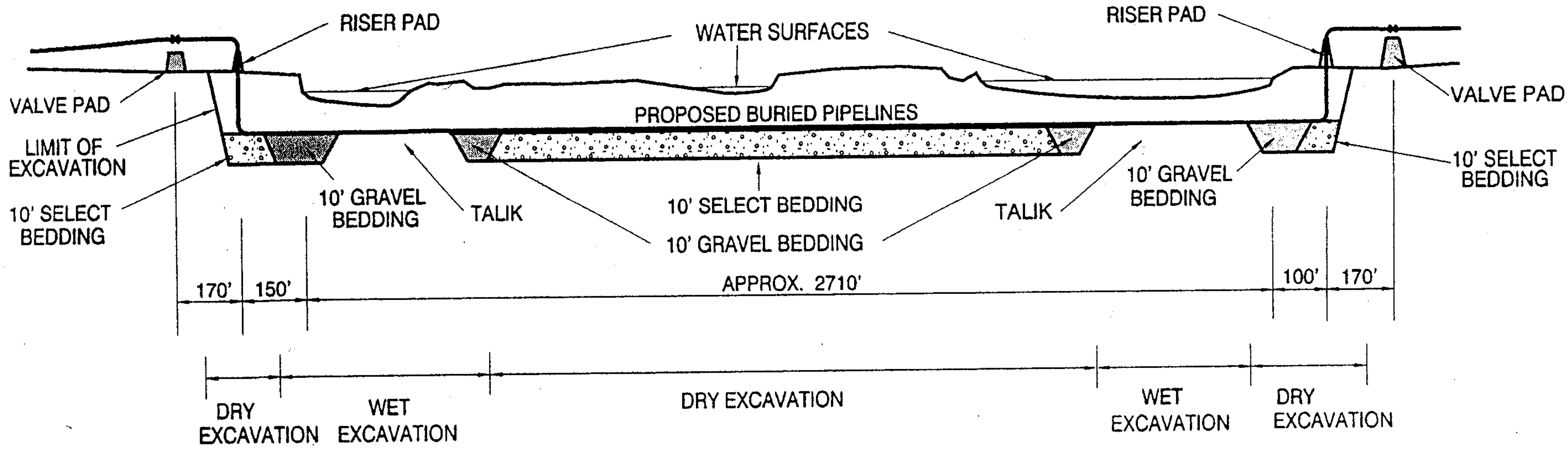
SECTION B - B'

NOTE:
DIMENSIONS ARE APPROXIMATE

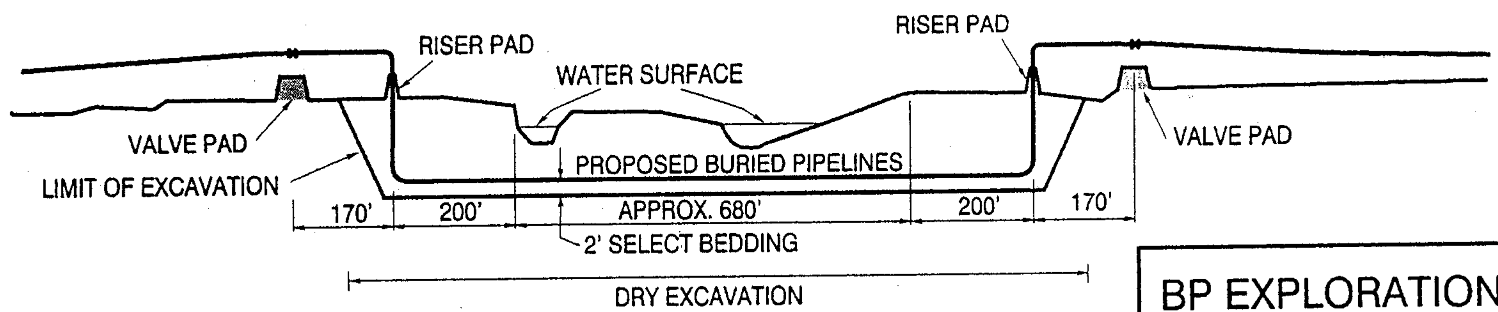
BP EXPLORATION (ALASKA) INC.

**ENDICOTT PIPELINE
TIE-IN FACILITIES
CROSS SECTIONS**

DATE:	SCALE:	FIGURE:
JULY 1996	NOT TO SCALE	21



SAGAVANIRKTOK RIVER



KADLEROSHILIK RIVER

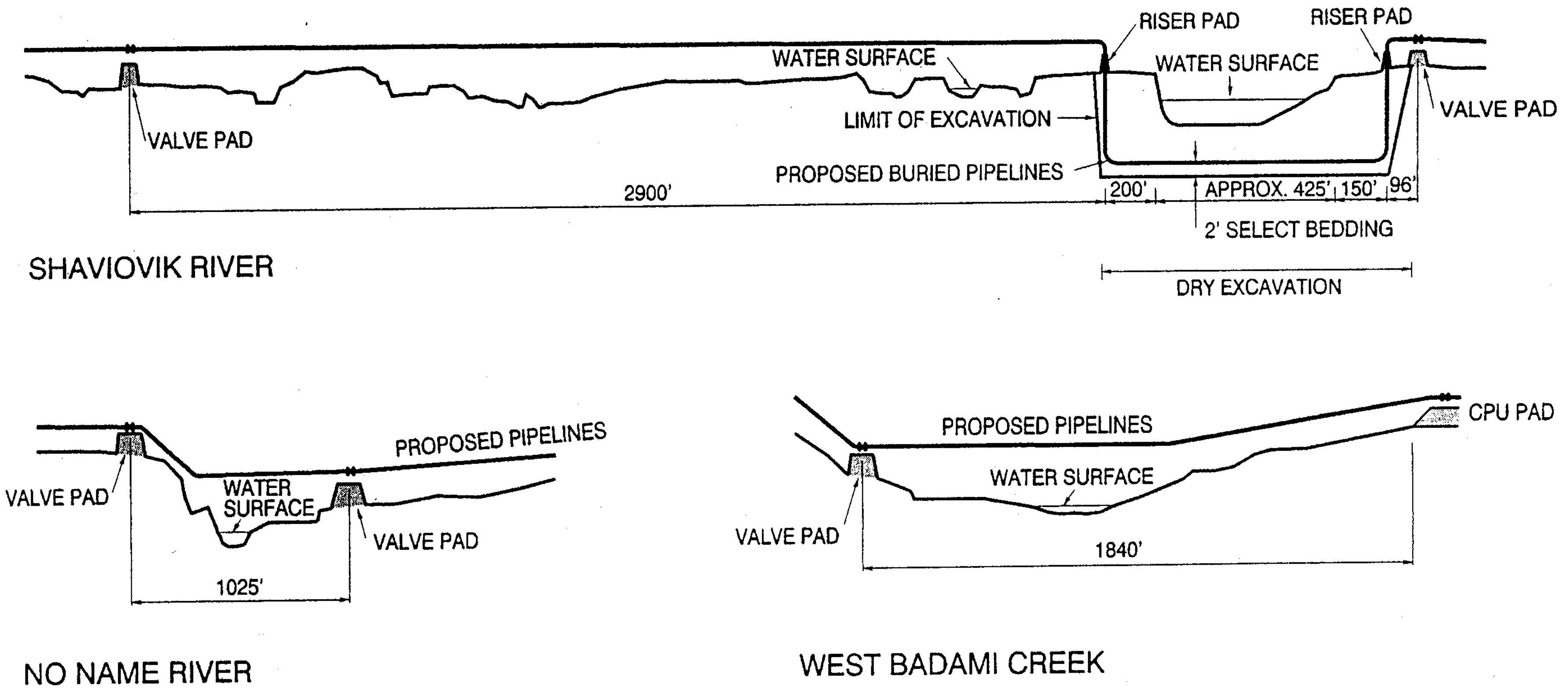
NOTE:
DIMENSIONS ARE APPROXIMATE

BP EXPLORATION (ALASKA) INC.

BADAMI PIPELINE SYSTEM
SAGAVANIRKTOK AND
KADLEROSHILIK RIVER
CONCEPTUAL CROSSINGS

DATE:	SCALE:	FIGURE:
JULY 1996	N/A	22

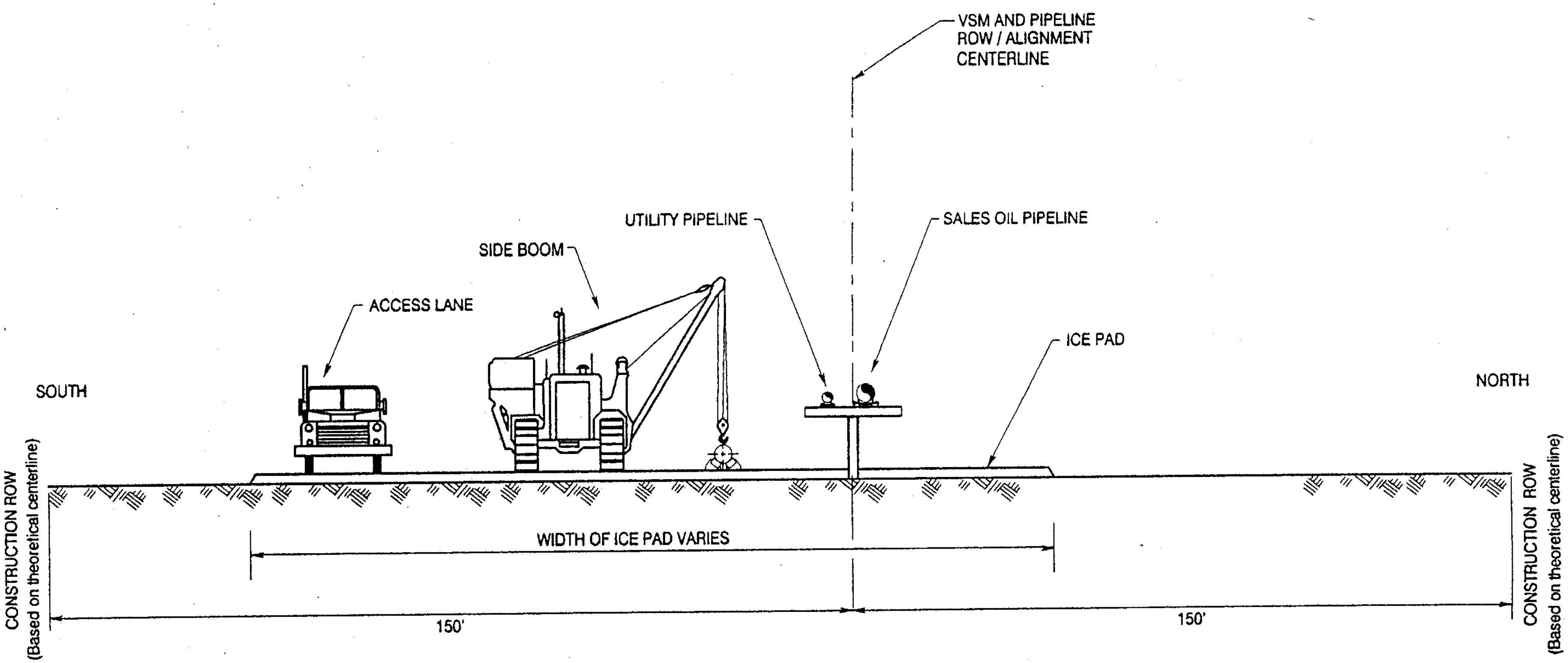
ex13151.dgn



NOTE:
DIMENSIONS ARE APPROXIMATE

BP EXPLORATION (ALASKA) INC.		
BADAMI PIPELINE SYSTEM SHAVIOVIK, NO NAME AND WEST BADAMI CREEK CONCEPTUAL CROSSINGS		
DATE: JULY 1996	SCALE: N/A	FIGURE: 23

ex13151.dgn

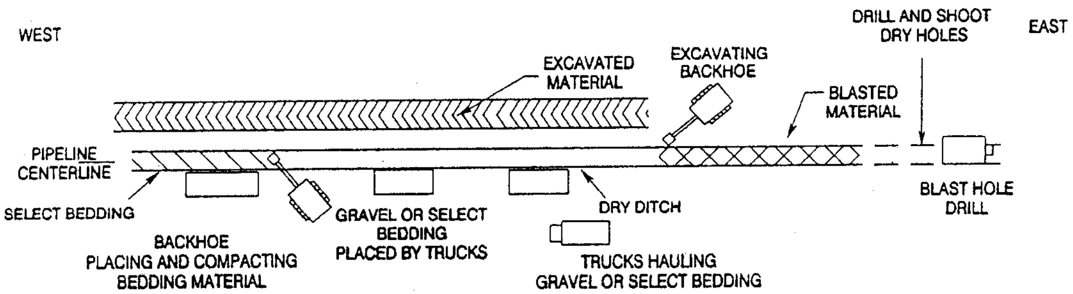


NOTES:

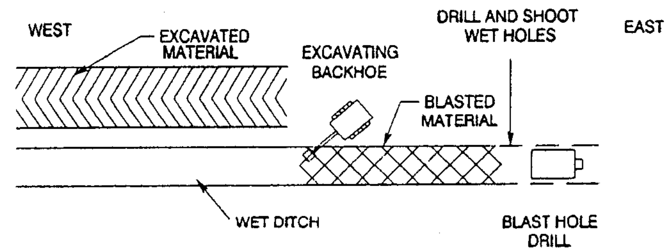
1. HEIGHT FROM GROUND TO BOTTOM OF PIPE WILL BE 5' MINIMUM TO 10' MAXIMUM FOR TYPICAL CROSS COUNTRY PIPELINE.
2. HEIGHT FROM DESIGN WATER LEVEL TO BOTTOM OF PIPE WILL BE 3' MINIMUM TO 17' MAXIMUM FOR VSM'S IN RIVERS AND STREAMS.

BP EXPLORATION (ALASKA) INC.		
BADAMI PIPELINE SYSTEM TYPICAL CONSTRUCTION PLAN FOR ABOVE-GRADE SEGMENTS		
DATE: JULY 1996	SCALE: N/A	FIGURE: 24

ex13151.dgn

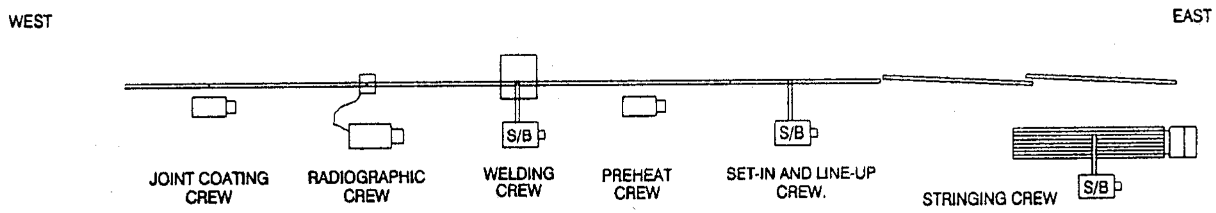


TRENCH EXCAVATION & BEDDING PLACEMENT FOR DRY SECTIONS



TRENCH EXCAVATION (NO BEDDING) FOR WET SECTIONS

(TALIK PORTIONS OF SAGAVANIRKTOK RIVER)



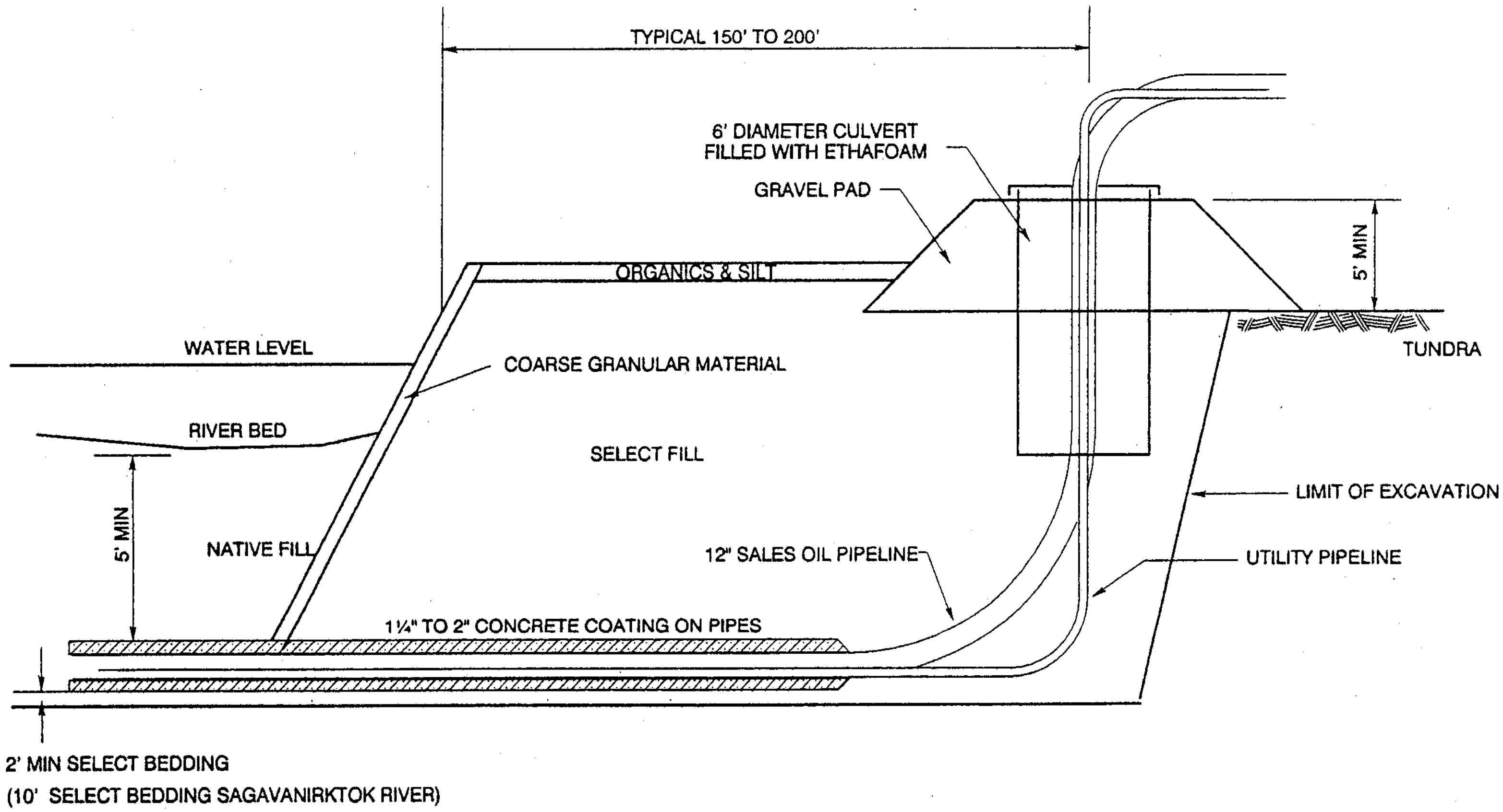
PIPELINE FABRICATION

NOTE:

1. FABRICATED RIVER CROSSING SECTION IS PULLED INTO TRENCH AND BACKFILLED.
2. S/B = SIDE BOOM.
3. DIRECTION OF TRAVEL IS WEST TO EAST.

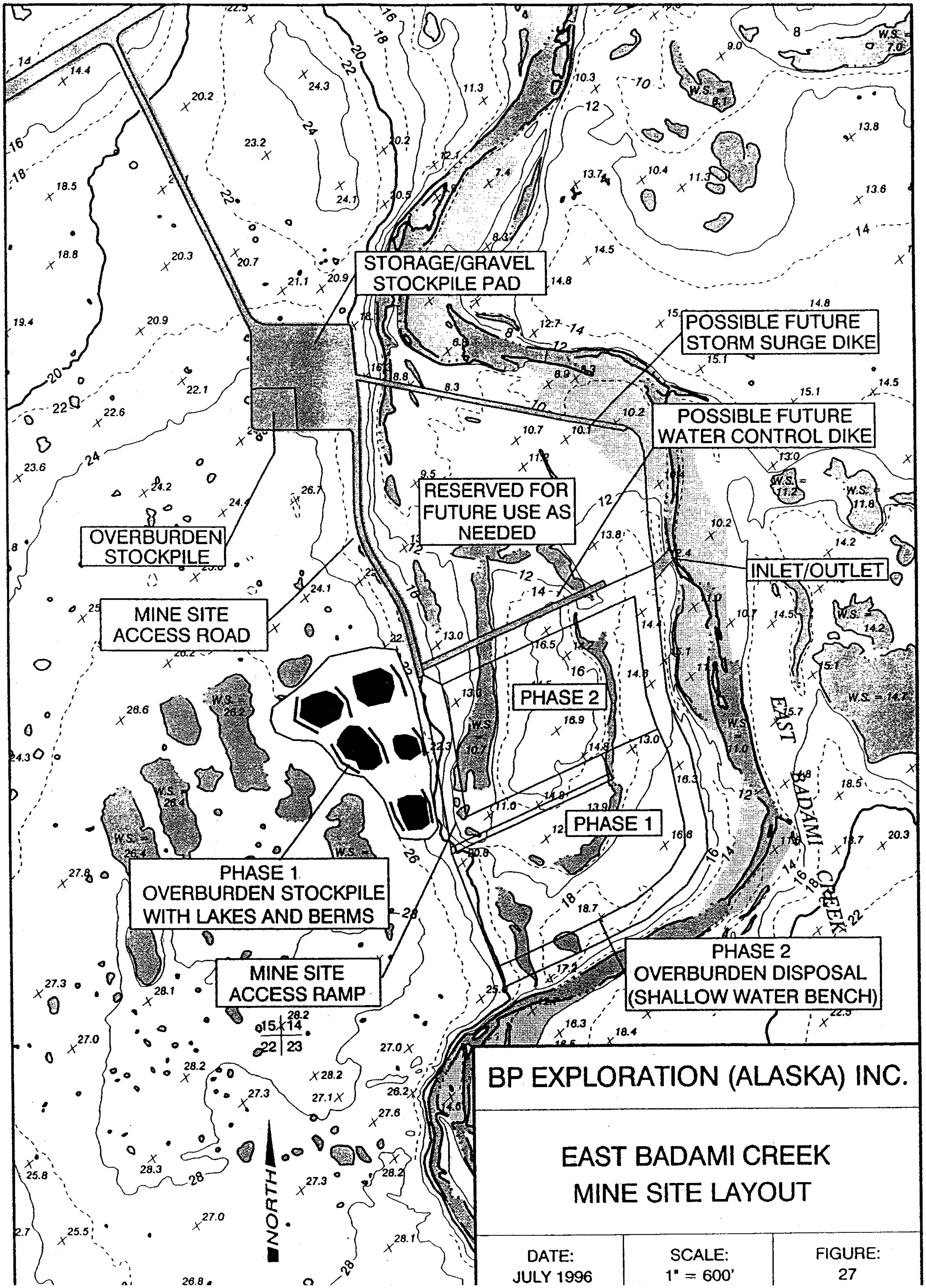
BP EXPLORATION (ALASKA) INC.		
BADAMI PIPELINE SYSTEM PIPELINE CONSTRUCTION PLAN FOR BURIED RIVER CROSSINGS		
DATE: JULY 1996	SCALE: N/A	FIGURE: 25

ex13151.dgn



BP EXPLORATION (ALASKA) INC.		
BADAMI PIPELINE SYSTEM TYPICAL RIVER BANK RESTORATION		
DATE: JULY 1996	SCALE: N/A	FIGURE: 26

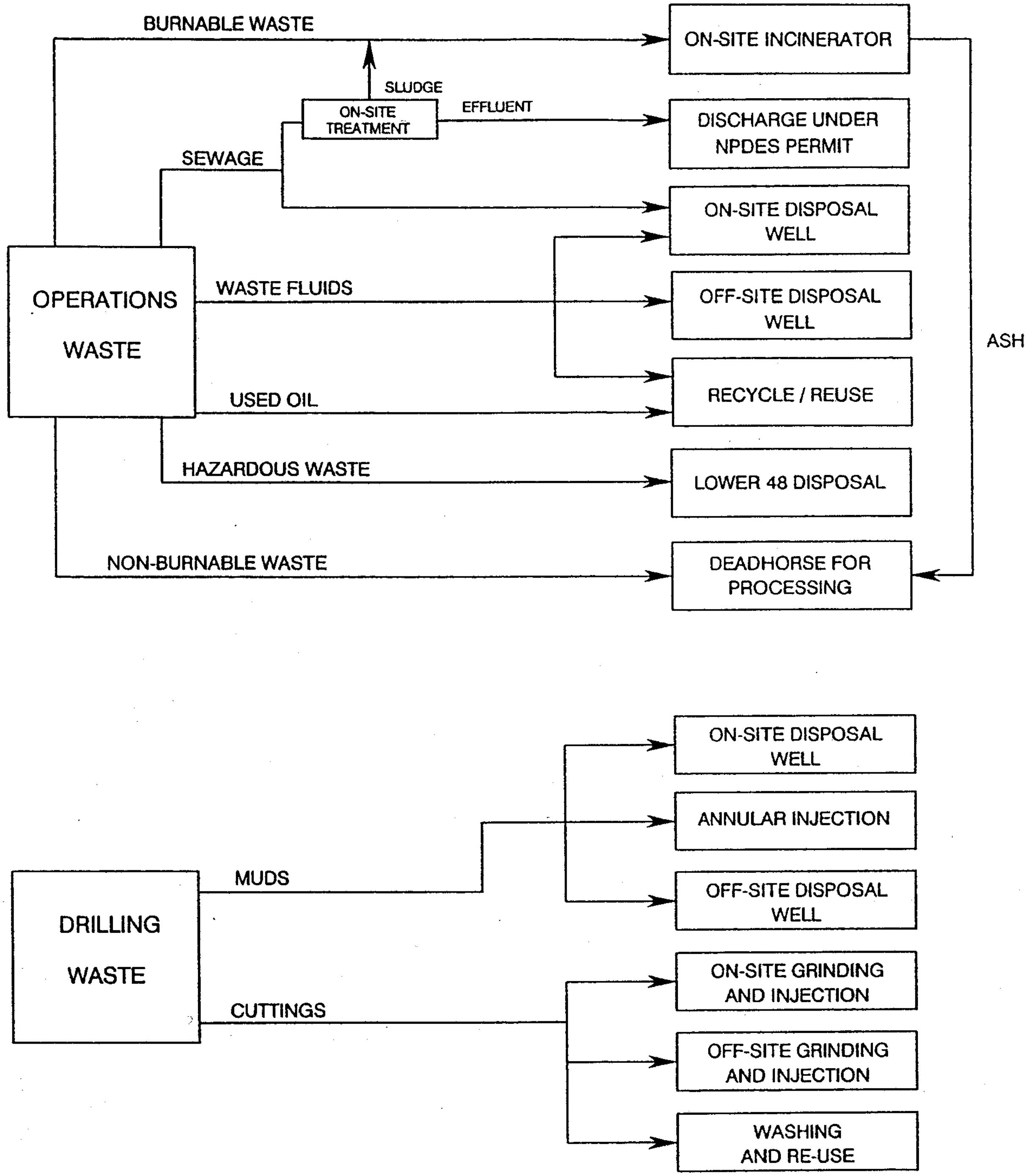
ex13151.dgn



BP EXPLORATION (ALASKA) INC.

EAST BADAMI CREEK MINE SITE LAYOUT

DATE:	SCALE:	FIGURE:
JULY 1996	1" = 600'	27



BP EXPLORATION (ALASKA) INC.

BADAMI DEVELOPMENT PROJECT

WASTE MANAGEMENT PLAN

DATE: JULY 1996		FIGURE: 28

4. SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT

This section contains updated information on the affected environment, a revised impact analysis to reflect changes in the proposed project, and a tabulation of additional project mitigation measures. Most of the information provided in Sections 4, 5, and 6 (Affected Environment, Project Impacts, Mitigation Measures) of the January 1995 Project Description and Environmental Assessment is still valid for the proposed project revisions.

4.1 AFFECTED ENVIRONMENT

4.1.1 Geomorphology and Hydrology

To determine geotechnical conditions at the buried portions of the pipeline system, water content and the presence of silts were determined by drilling boreholes at the proposed crossings of the Shaviovik, Kadleroshilik, and Sagavanirktok rivers in 1994 and 1995 (Duane Miller and Associates 1994, 1995). These data indicate that, at the typical depth at which the top of the buried pipeline would be located, water content of the soils was generally less than 12 percent by dry weight. However, soils with a water content approaching 18 percent by dry weight were encountered in some boreholes. In 1996, deeper boreholes were drilled to determine thaw settlement potential associated with a warm buried pipeline. In this program, silty sand layers containing some organic material were encountered in the Sagavanirktok River, and the water content of these soils approached 40 percent by dry weight. The amount of fines in the 1996 samples was generally less than 10 percent, but the silty organic sands contain up to 45 percent fines at depths of 18 to 28 feet (or about 0 to 10 feet below the anticipated base of the buried pipeline).

4.1.2 Oceanography and Fisheries of Mikkelsen Bay

A fish and oceanography study was conducted between July 7 and August 25, 1995 to obtain specific data with which to evaluate predictions regarding fish use and hydrographic conditions in Mikkelsen Bay (LGL Alaska Research Associates and Woodward-Clyde Consultants 1996).

Oceanographic data confirmed that Mikkelsen Bay, a marine embayment, is dominated by the regional wind-driven hydrographic processes of upwelling and downwelling. After breakup, salinity generally increases throughout the summer. The bay intermittently receives fresh water from one distributary of the Shaviovik River and from the No Name River, both of which are located on its west side, during west wind events and from elevated stream discharges during summer rain storms. During open-water seasons with pronounced periods of steady west winds, downwelling would be expected to interrupt the seasonal salinity increase of Mikkelsen Bay. In 1995, two downwelling events associated with periods of steady west winds reduced salinity in the bay. In addition, infrequent periods of heavy rainfall freshened the top half meter of the bay for brief periods (generally one day).

Fish species were present at expected abundance levels. The 1995 data supported most pre-field season predictions, which were based on the extensive fisheries studies that have been conducted in coastal areas between the Colville and Canning rivers, as follows:

- Catches of Arctic cisco ≥age-4 at Mikkelsen Bay were similar to catches in the Prudhoe Bay area, but catches of age-1, -2, and -3 Arctic cisco were lower. The larger fish migrate extensively along the coast during summer.
- Age-0 Arctic cisco were caught in Mikkelsen Bay because the fish were transported from Canada by fairly strong and persistent easterly winds.
- Catches of small (<180 mm) least cisco were lower in Mikkelsen Bay than in the Prudhoe Bay area, as Mikkelsen Bay is further from the Colville River than Prudhoe Bay, and 1995 was not a strong west-wind year.
- Catches of age-0, -1, and -2 broad whitefish were lower in Mikkelsen Bay than in the Prudhoe Bay area. These fish normally remain in the brackish waters of the Sagavanirktok River delta.
- Catches of Dolly Varden ≤350 mm or >350 mm were similar to those in the Prudhoe Bay area. Very few Dolly Varden <150 mm were caught in Mikkelsen Bay, as small fish do not generally enter the coastal waters during summer. The catch-per-unit-effort for all sizes decreased through August as fish returned to overwintering areas, including the Sagavanirktok River.
- Catches of Arctic grayling were lower in Mikkelsen Bay than in the Prudhoe Bay area. Grayling move into coastal waters when salinity is low, and occasionally they move from one river drainage to another (Hemming 1996). Only one grayling was caught in Mikkelsen Bay.

The 1995 data did not support two pre-field season predictions. There were more large (≥age-3) broad whitefish and large (≥ 180 mm) least cisco caught in Mikkelsen Bay than predicted. Lower than expected salinities in the bay, which occurred in conjunction with a notable rainfall in the third week of July, may have facilitated movement of large broad whitefish into the area. In 1995, numerous large least cisco moved into and east of Mikkelsen Bay, and historical data indicate that they occasionally disperse as far east as Camden Bay. By August, the majority of both species were caught on the east side of fyke nets, indicating that the broad whitefish were returning to the Sagavanirktok River, and the least cisco to the Colville River, for overwintering.

4.1.3 Fish Use of Freshwater Habitats

In 1995, the Alaska Department of Fish and Game (Hemming 1996) investigated fish use of six coastal streams between the Sagavanirktok River and Bullen Point that are within the proposed Badami development area. The species captured were: freshwater - Arctic grayling and round whitefish; anadromous - Dolly Varden and ninespine stickleback; and marine - fourhorn sculpin. Results for each stream, from east to west, are as follows:

- East Badami Creek - Ninespine stickleback and Arctic grayling were previously reported. In 1995, ninespine stickleback, Dolly Varden, and fourhorn sculpin were captured.
- No Name Creek - Ninespine stickleback, Dolly Varden, Arctic grayling, and round whitefish were captured.
- Shaviovik River - Dolly Varden, Arctic grayling, and ninespine stickleback were previously reported, and all three species were captured in 1995.
- West Shaviovik Creek - Ninespine stickleback, Dolly Varden, and Arctic grayling were captured.
- Kadleroshilik River - Arctic grayling, ninespine stickleback, and slimy sculpin were previously reported, and the first two species and Dolly Varden were captured in 1995.
- East Sag Creek - Ninespine stickleback, Dolly Varden, and Arctic grayling were captured.

Ninespine stickleback, the most abundant species, and Dolly Varden were present in all six streams, and Arctic grayling were present in five streams. As discussed in Section 4.1.2, coregonid fish (Arctic and least cisco and broad whitefish) were found in Mikkelsen Bay, but none was observed in the sample catch in the study area coastal streams. A review of coastal plain fish surveys and the results of this study indicate that coregonid fish are not present in the study area coastal streams east of the Sagavanirktok River, whereas they are present in coastal streams west of the Sagavanirktok River.

4.2 ENVIRONMENTAL CONSEQUENCES

The potential impacts of the proposed development are essentially the same as those described in the January 1995 Project Description and Environmental Assessment, except for the elevated pipeline and the 1,200-foot dock, which were addressed as alternatives. The following sections provide updates on the dock, the gravel and excavation requirements for onshore facilities, and the elevated pipeline. New information is provided on the effects of a warm oil pipeline buried at river crossings.

4.2.1 Nearshore Structure

The solid-fill gravel dock has been shortened from approximately 2,400 feet to between 1,000 and 1,100 feet and relocated to a site about 3,000 feet east of the site proposed in the January 1995 Project Description and Environmental Assessment. Seabed coverage has been reduced from about 23.8 acres to about six acres. Shallow-draft barges will be used to transport the modules to the dock, and dredging will not be required. Oceanographic effects, which were considered to be minimal with the 2,400-foot structure, will be reduced further. In 1995, large broad whitefish and large least cisco were caught in Mikkelsen Bay, indicating that the bay is within the dispersal ranges of these species. Large Arctic cisco migrate extensively along the coast during summer, and they were present in Mikkelsen Bay in 1995. Age-0 Arctic cisco were caught in Mikkelsen Bay because 1995 was generally characterized by strong and persistent easterly winds, and the fish were transported from Canada to the west. Use of the project area marine environment by small Dolly Varden and grayling is limited. The potential effect of the development on all these species is still anticipated to be minimal.

4.2.2 Onshore Facilities Requiring Gravel Placement

The proposed onshore gravel structures include three pads (CPU pad, satellite drilling pad, and storage/gravel stockpile pad), an airstrip, and an in-field road system. Total acreages of tundra wetlands covered by these facilities and the East Badami Creek material site are shown in Table 4. The vegetation types were described in the January 1995 Project Description and Environmental Assessment. The primary wetlands types affected by placement of approximately 83 acres of gravel for these facilities and development of approximately 49 acres for the minesite are the moist/wet tundra complex (Type IVa) and moist sedge/dwarf shrub tundra (Va). These two types represent over 80 percent of the area covered. Total acreage covered is approximately two acres less than was proposed in July 1995.

4.2.3 Elevated Pipeline

As described in Chapter 3, the pipeline system includes two separate pipelines: the Badami sales oil pipeline and a smaller utility pipeline. The pipelines will be elevated on VSMs, except at river crossings and possibly along a portion of the Endicott causeway.

The pipelines will be elevated at least 5 feet above the tundra surface. As discussed in the January 1995 Project Description and Environmental Assessment, natural drainage patterns would not be altered by the elevated line. At cross-country segments, caribou and other wildlife would be able to pass freely underneath the pipelines. At buried river crossings, the primary travel routes for muskoxen and moose would not be restricted.

4.2.4 Buried River Crossings

The assessment of buried river crossings in the January 1995 Project Description and Environmental Assessment was based on a buried chilled oil line, which would have crossed under the Sagavanirktok, Kadleroshilik, Shaviovik and No Name rivers, West Badami Creek, and 25 beaded streams. The entire line would have been buried in permafrost, except for some thawed sections at river crossings. Select backfill would have been used to reduce the amount of potential thaw settlement in the trench backfill on top of the pipeline, and to avoid the formation of a surface depression over the pipeline trench.

The elevated hot oil pipeline and the utility pipeline will be buried under three rivers, the Sagavanirktok, Kadleroshilik, and Shaviovik. The primary concerns at these crossings are thaw settlement and potential bank erosion associated with local scour. Because the pipe will be laid in granular riverbed materials, select backfill is no longer needed, and gravel mines will not be required adjacent to major river crossings.

A thaw bulb will form around the pipeline at each of the buried river crossings. The amount of potential thaw subsidence under the pipe depends on the quantity of excess ice in the underlying soils. Section 4.1.1 described the recent studies that were conducted to determine soil properties at the river crossings, thus establishing a basis for predicting thaw settlement. The thaw stability of the pipeline system will be maintained by overexcavating areas of frozen, fine-grained soils and providing a thaw stable bedding material to limit differential settlement. Segments of the Sagavanirktok River crossing location will be overexcavated by 10 feet, and portions of the Kadleroshilik and Shaviovik river crossing locations will be overexcavated by two feet, to mitigate against potential differential settlement. An estimated 5,000 cubic yards of thaw stable material will be used as bedding.

As described in Section 3.5.2, 90-degree bends will be installed in the line at the sagbend locations, and vertical risers will provide the transition from buried to above grade construction. The risers between the buried and elevated segments could be vunerable to exposure through scouring and erosion, especially during summer flood events. Therefore, sagbend setback distances have been established for riser locations at each crossing. For buried segments, the top of the pipe will be below the design scour depth. Disturbed river banks and the deep trenches between the river banks and the riser pads will be filled with relatively thaw stable material and bermed up as appropriate to avoid creating a depression in the land surface after settlement occurs. At the river banks, where there is potential for erosion, coarser granular material from the gravel mine or the river excavation will be used as a veneer to achieve erosion resistance similar to the adjacent frozen native material. Section 3.6.2 contains a detailed description of river crossing construction and rehabilitation methods, including streambank revegetation.

The pipeline will be placed in the river crossings during winter. All rivers are expected to be frozen to bottom at the time of construction. Alaska Department of Fish and Game blasting criteria will be followed for the trench excavation. There will be a potential for temporary disturbances to fish overwintering habitat in the Sagavanirktok River. Taliks containing flowing groundwater were found to exist at roughly the pipe burial depth during the 1995 geotechnical field program (Duane Miller and Associates 1995). Construction of the buried crossing may involve diverting water between the taliks or partial dewatering of the taliks. Temporary reduction of groundwater flow to downstream areas may occur.

4.3 MITIGATION

The 1995 Project Description and Environmental Assessment contained an extensive list of mitigation measures that had been incorporated into project design, construction, and operation. The majority of these remain valid for this revised project design. In addition, several new mitigation measures for the current design have been identified, as outlined below:

- selection of an onshore development alternative (See Section 2.1 of this document)
- use of 10-foot well spacing to reduce gravel drill pad size requirements
- reduction of the cuttings volume due to use of multi-lateral wells
- use of an elevated pipeline to minimize surface disturbances
- elevation of the pipeline to a minimum of five feet above ground level to facilitate wildlife passage

- separation of the infield road and pipeline system to facilitate wildlife passage
- selection of a West Badami Creek road crossing alternative with small culverts and minimal fill that avoids more valuable fish habitat downstream
- incorporation of a maximum flood design based on data obtained from a 1992 flood
- reduction of air emissions and diesel storage requirements by using gas from Endicott for fuel for the drill rig and the camp in the early phase of project development
- use of a shorter dock covering six, rather than 23.8, acres of seabed
- elimination of the requirement for offshore dredging by using shallow draft barges to transport equipment modules
- elimination of the requirement for gravel mines for select backfill at two major river crossings
- relocation of the East Badami Creek minesite overburden area to avoid higher value tundra wetlands
- elimination of the requirement for new VSMs for the utility line by using the Endicott VSMs onshore

TABLE 4
SUMMARY OF VEGETATION COVERAGE BY GRAVEL FILL
BADAMI DEVELOPMENT PROJECT*
(Acres)

FACILITY	VEGETATION TYPE (WALKER ET AL. 1983)											
	Ia	IIIa	IIIb	IIId	IVa	Va	Vd	Ve	IXb	BS	TOTAL	% OF TOTAL
AIRSTRIP[1]	0.44	0	0	1.10	0.75	10.46	.94	0.80	0	0	14.49	10.9
CPU PAD[2]	0	0	0	0	0	32.37	0.27	0	0	0	32.64	24.7
SATELLITE PAD	0.06	0	0	1.94	0	2.64	0	0	0	0	4.64	3.5
STORAGE / GRAVEL STOCKPILE PAD	0	0	0	0	0.70	5.04	0	0	0	0	5.74	4.3
MINE SITE												
Development[3]	3.91	0	0	0	27.79	0.02	2.21	0	6.51	0	40.44	30.6
Overburden[4]	0.09	0	0	0	3.06	3.71	0.35	1.42	0	0	8.63	6.5
TOTAL MINE SITE	4.00	0	0	0	30.85	3.73	2.56	1.42	6.51	0	49.07	37.1
ROADS												
Dock to CPU Pad	0.21	0	0	3.07	0	2.56	0	0	0	0.07	5.91	4.5
CPU Pad to Airstrip	0	0	0	0	0.53	1.69	1.03	0	0	0	3.25	2.5
Airstrip to Storage/Gravel Stockpile Pad	0	0	0	0	0.26	1.51	0	0.24	0	0	2.01	1.5
Airstrip to Satellite Pad	0.10	0.49	0.05	0.19	2.47	9.49	0.19	0	0	0	12.98	9.8
Storage/Gravel Stockpile Pad to Mine Site	0	0	0	0	0.002	1.59	0	0	0	0	1.59	1.2
TOTAL ROADS	0.31	0.49	0.05	3.26	3.26	16.84	1.22	0.24	0	0.07	25.74	19.5
TOTAL	4.81	0.49	0.05	6.30	35.56	71.08	4.99	2.46	6.51	0.07	132.32	
% of TOTAL	3.6	0.4	0.04	4.8	26.9	53.7	3.8	1.8	4.9	0.06		100

1. Includes apron, helipad, and turnarounds.
2. Includes flare pit.
3. Includes water control dike.
4. Overburden stockpile with lakes and berms.

*Exclusive of valve pads, VSM placement, and Endicott tie-in pad

5. SUPPLEMENTAL REFERENCES

Duane Miller and Associates. 1994. 1994 geotechnical investigation on Badami soils. Report for BP Exploration (Alaska) Inc.

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