ACRES

# SUSITNA HYDROELECTRIC PROJECT

January 8, 1982
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Mr. Carl Yanagawa
Regional Supervisor for Habitat Division
Alaska Department of Fish & Game
333 Raspberry Road
Anchorage, Alaska 99502

Dear Mr. Yanagawa:

I am enclosing for your review the following reports prepared by the Alaska Department of Fish and Game for the Susitna Hydroelectric Project:

1. Final Draft Report, Adult Anadramous Fisheries Project

2. Resident and Juvenile Anadramous Fish Investigations on the Lower Susitna River

3. Aquatic Habitat Investigations

These reports are provided for your information only, they are not part of our formal Agency Coordination Program. Comments are not requested but will certainly be accepted.

Sincerely,

James D. Gill
Resident Manager

JDG/ja

Encl: as



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ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

TASK 2 - SURVEYS AND SITE FACILITIES

SUBTASK 2.10
ACCESS PLANNING STUDY

PRELIMINARY
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ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
ACCESS PLANNING STUDY

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# INTRODUCTION

SUSITNA HYDROELECTRIC PROJECT
ACCESS PLANNING
REPORT

# 1 - INTRODUCTION

The Susitna Hydroelectric Project has, for many years, been considered a viable source of "clean" energy for Central Alaska. The project has been viewed as including one or more dams on the upper Susitna River. Extensive preliminary work has been done on the project by various government agencies. In an effort to expedite the project, the State of Alaska through the Alaska Power Authority, in late 1979, initiated the necessary feasibility studies and preparation of the necessary FERC (Federal Energy Regulatory Commission) license application. Access to the project is a part of those studies.

## 1.1 - The Study Area

The location of the project is approximately 120 air miles north of Anchorage (see Figure 1.1). The dams, as proposed, would be up stream from Talkeetna laying between the Parks Highway and the Denali Highway. This area is remote, with no existing access. The quantities of materials and supplies required for construction of the project and for the maintenance of the construction camps are of such a magnitude as to require major transportation facilities to serve the project site.

## 1.2 - Study Description

The Access Planning Study involved the selection of potential highway and railroad alignments that would serve the dam sites selected for detailed study. The process involved aerial reconnaissance of the potential corridors, definition of the parameters which control the horizontal and vertical alignment and the selection and analysis of alternative alignments which serve the needs of the entire project.

## 1.3 - Objectives And Scope of Study

The objectives of the Access Planning Study are as follows:

(a) To define an access route location or combination of route locations that will serve the supply needs of the hydroelectric project with a minimum of environmental impact.

(b) To determine a reasonable combination of transportation modes which will provide a cost effective system of supply.

(c) To define an access plan that will meet the overall scheduling requirements of the hydroelectric project.

The Scope of the Study includes the definition and analysis of routes within three general corridors. Corridor 1 is located on the north side of the Susitna River from the Parks Highway to the Watana site. Corridor 2 is on the south side of the Susitna River between the same general termini. Both corridors were required to serve both Devil Canyon and Watana Dam site. The third corridor connects the Watana Dam site with the Denali Highway to the north. Both road and railroad access are to be considered.

The study must examine the corridors and generate preliminary route locations and cost estimates. The costs estimates will include the costs of constructing the access, maintaining the facility and moving material over the route. The environmental impacts of the various alignments are to be addressed under Task 7, however a continuous flow of input from the environmental studies will be provided to aid in studying the alignments.

Engineering, Soils, Cost and Environmental information will be combined to develop alternate access plans that satisfy the stated objectives. This report will present those alternate plans.

## 1.4 - PLAN FORMULATION AND SELECTION PROCESS

There are a number of important factors to be considered in developing and analysing transportation facility plans. The locations of the dams, of course, dictate terminal points common to all access plans. The number and size of loads of material and supplies together with the volume of traffic to be generated by the construction camp population dictate the design parameters appropriate to the facility. The terrain, soils and environmental concerns control and limit the possible location for the facility. All of these factors will be considered.

### (a) Planning Methodology

The planning process for transportation facilities of this magnitude is one of a series of iterations in which proposals are developed, tested, revised and tested again until a plan emerges that serves the desired function in a cost effective and environmentally sound manner. Following this pattern design parameters were developed then potential alignments were selected that appeared to serve the project needs. A number of alternative alignments were identified for further consideration. During the process of evaluating the engineering considerations of the alternatives some were eliminated and some sections of others were revised so that all remaining sections conformed to the required design parameters. The information on the remaining sections was then given to the geological team and the environmental team for additional input. Consideration of this input has resulted in elimination of additional sections and changes in some of those remaining. The various available port facilities and transportation modal options were identified and then combined with the remaining possible alignments to form possible access plans. Each plan was then analyzed to determine how well the project objectives were satisfied. Any advantages or disadvantages were identified and the estimated costs for construction, maintenance and logistics were developed.

(b) Economic Analysis

Each access plan has four major cost factors associated with it. Each of the cost factors were considered and used in comparing the alternate access plans and determining the cost-effectiveness of the various plans.

- Construction cost estimates were prepared for each alternative. These estimates were very preliminary and valid only for comparison and determining the order of cost magnitude. More refined cost estimates are not possible or necessary at this stage of the work. Detailed cost estimates are not possible due to the lack of micro-scale data. The estimates prepared are, however, correct with regard to order of magnitude and, because of the assumptions, for comparison purposes.

- Maintenance cost estimates were developed for the various plans. These costs covered only maintenance on the facility constructed. Maintenance costs on existing facilities that may be atributable to the project would be difficult to identify and the difference between plans would be insignificant.

- Logistics costs as used herein are the costs associated with moving material, supplies and equipment to the site. Port costs, freight rates for various modes, and the transportation modal split combine to generate signficant cost variations when comparing access plans. Each plan was evaluated by estimating the transportation costs for major material items to be moved to the site.

- Schedule costs were discussed in terms of time delays that would result from selecting any of the alternate plans. Dollar costs were not estimated for any such delays because the complexities of such estimates go far beyond the scope of this work. It is intuitively obvious, however, that with a project of the magnitude of the Susitna Hydroelectric Project any delays from the planned schedule will have major construction cost ramifications due to inflation and social cost ramifications resulting from the inability to meet the demand for power.

## 1.5 - Organization of Report

The objective of the report is to present a series of alternative access plans which serve the needs of the Susitna Hydroelectric project. The report does not include a single recommended plan.

The body of the report contains a discussion of the pertinent features. Detailed technical information is contained in a series of appendices. The report is organized as follows.

Section 1. Introduction

Section 2. Summary

The section contains a complete Summary of the report.

Section 3. Scope of Work

This section outlines the Scope of Work associated with the results presented with this document.

Section 4. Previous Studies

This section briefly summarizes the access information available in previous Susitna Basin Studies done by others.

Section 5. Project Design

This Section briefly describes the Susitna Hydroelectric Project in a way that sets the stage for the remainder of the access analysis.

Section 6. Project Schedule

This section discusses the overall planned schedule for the Susitna Hydroelectric Project and identifies the scheduling requirements for construction of the access facilities.

Section 7. Logistics Requirements

This section presents the estimated quantities of the major items of equipment, materials and supplies that must be transported to the site during the course of construction, including the supplies necessary for the construction camp. Any particular constraints affecting the mobilization and/or movement of material for access construction are also discussed.

Section 8. Access Design Parameters

This section discusses the specifics of the basic design parameters for both road and railroad construction. The parameters discussed include curvature, maximum grades, horizontal and vertical clearance requirements, load requirements and surfacing requirements.

Section 9. Corridor Selection

This section discusses the process by which the suggested corridors were selected for study and includes a discussion of each of the alignment segments originally investigated.

Section 10. Access Plans

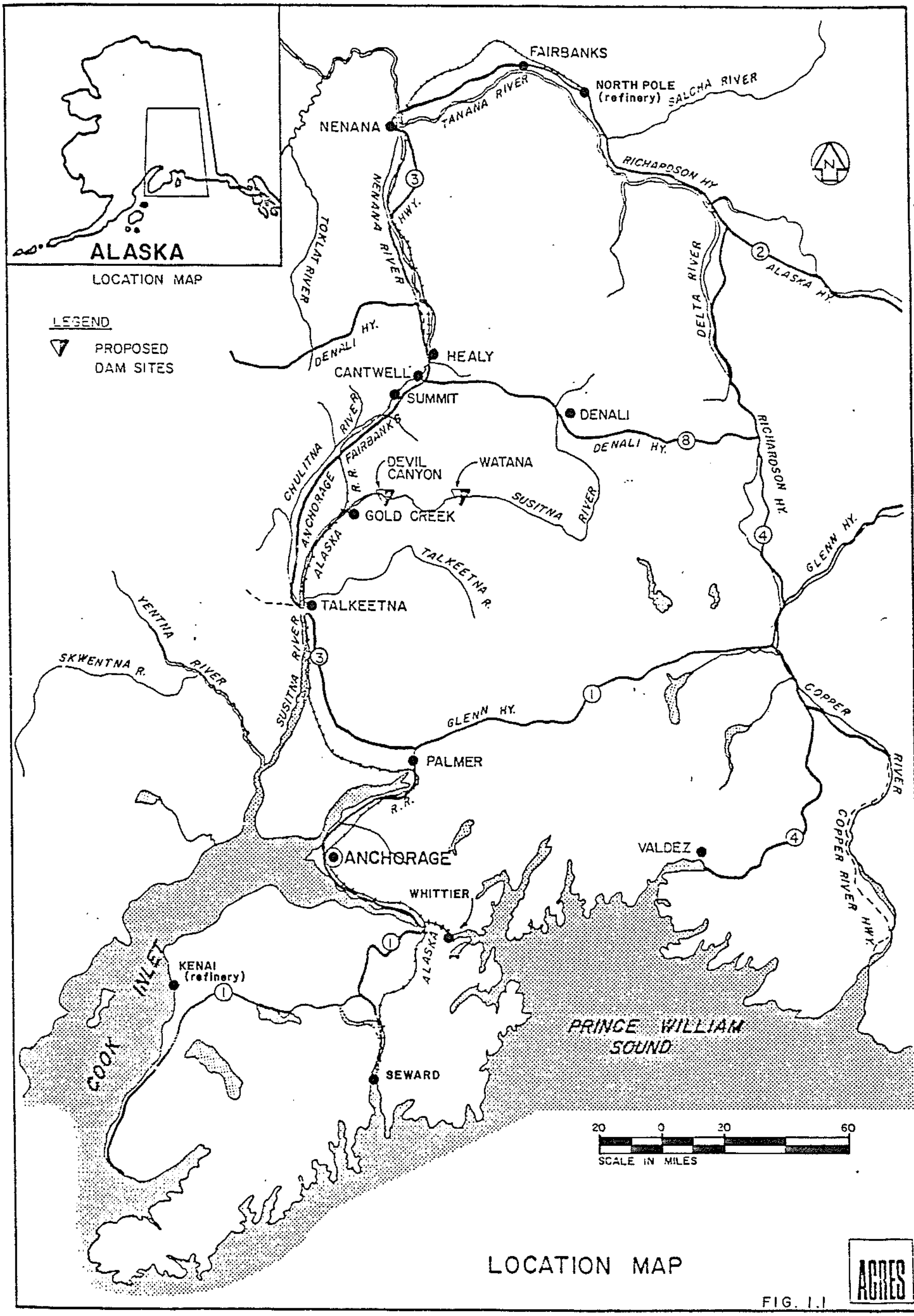
This section presents a series of alternate access plans including a discussion of the pros and cons of the various available ports, shipping options, and land transportation modes. Cost estimates for each plan are developed which include construction, maintenance and logistics costs.

Section 11. Conclusions and Recommendations

Conclusions and recommendations are not a part of this report because additional environmental data is to be considered along with the data presented here. A final recommendation is expected to result from that analysis combined with the results of this study.

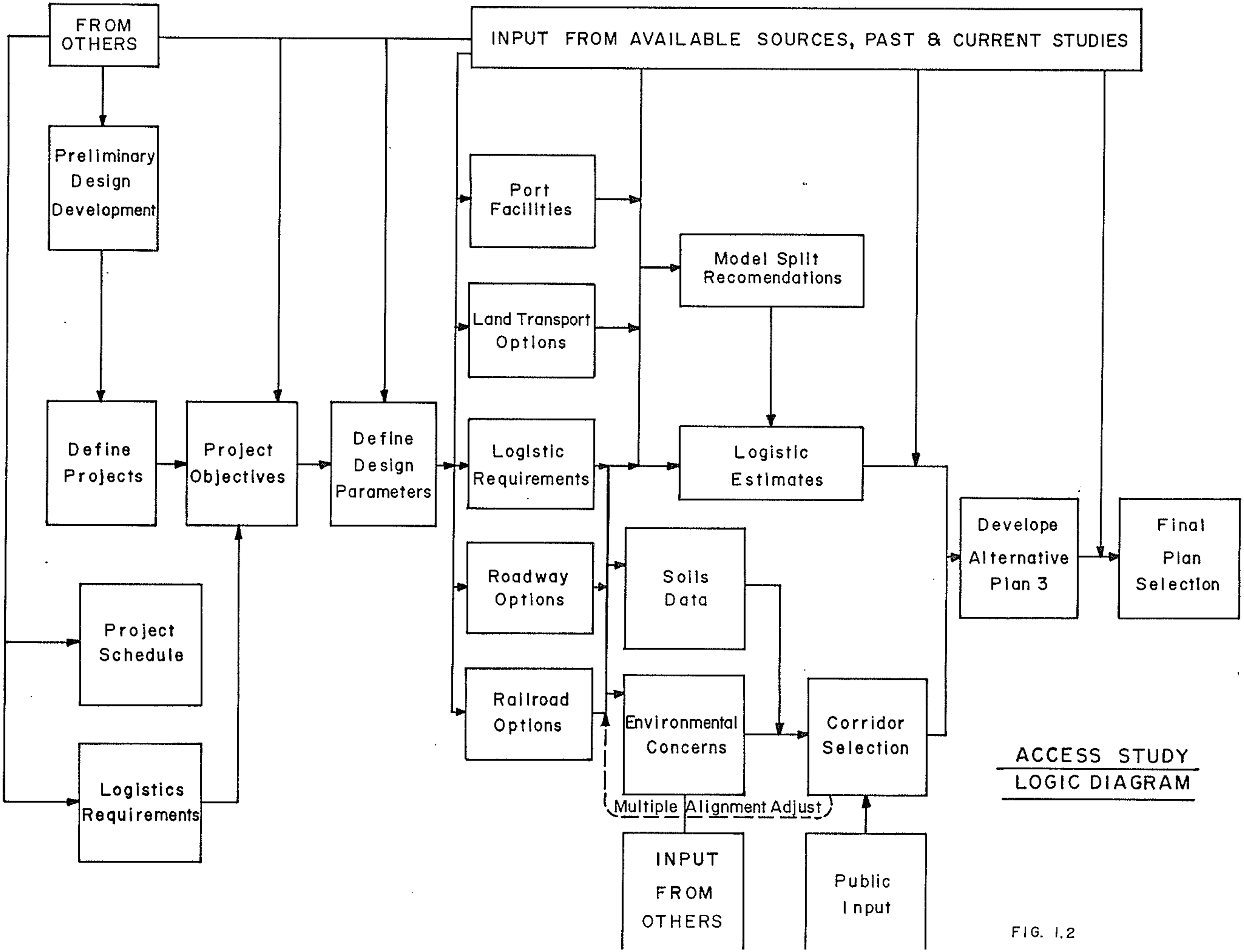
APPENDICIES

| | |
|---|---|
| Appendix A | Preliminary Design Development |
| Appendix B | Proposed Alternative Segments |
| Appendix C | Alternative Comparison - Grade, Curvature and Distance |
| Appendix D | Terrain Unit Maps |
| Appendix E | Environmental Concerns |
| Appendix F | Alternative Plans |




LOCATION MAP

FIG. 1.1




ACCESS STUDY
LOGIC DIAGRAM

FIG. 1.2

# SUMMARY

## 2 - Summary

This summary is intended to provide a brief overview of the access study, its methods and results.

### 2.1 - Scope of Work

The scope of work for the Susitna Access Study was defined in general terms in the original Plan of Study (POS) for the Susitna Hydroelectric Project. The POS required that three corridors be examined and the both road and rail options be included. The access plan was required to serve both Watana and Devil Canyon Dams and be able to satisfy the desired project schedule.

### 2.2 - Prevous Studies

Previous studies of the Susitna Hydroelectric project were reviewed to determine the extent of work that had been done relative to access. Very little had been done. The Corps of Engineers had carried the access question the furthest and their 1975 reports included a roadway that followed closely the alignment described as Plan 1 from Parks Highway to Watana on the south side of the river via Gold Creek.

### 2.3 - Project Design

Preliminary design of the hydroelectric project provided input to the access study. The quantities of materials to be imported to the project site and the size of the work crews were considered in estimating the costs of transportion and in selecting the ports and land transportation modal splits suggested in the various plans.

Watana 1993
Devil Canyon 2000

## 2.4 - Project Schedule

The overall schedule for the Susitna Hydroelectric project has been set based on projected power requirements in the region. These studies show that power from Watana Dam is needed first with power on line required in 1993. A period of eight years is projected to build the facility. This requires initial construction in 1985. The Federal Energy Regulatory Commissions license is anticipated in late 1984 on early 1985. Construction of access facilities cannot predate the FERC license therefore an access plan was desired that would allow mobilization and resupply activities to occur in 1985. This meant a plan providing access to Watana that could be made passable in one construction season. The estimated construction time for Devil Canyon is seven years with construction projected to begin in 1993.

## 2.5 - Logistics Requirements

The primary requirements for imported material and supplies were provided by other tasks. The volumes of materials were combined with planned construction schedules to project required average rates of flow for supplies.

TABLE 2.1

Major Quantities in the Dams

| | Watana | Devil Canyon |
|---|---|---|
| Excavation (Rock & Earth) | 22,000,000 c.y. | 5,000,000 c.y. |
| Fill | 76,000,000 c.y. | 1,335,000 c.y. |
| Construction Equipment | 16,000 ton | 5,000 ton |
| Explosives | 20,000 ton | 3,000 ton |
| Cement | 350,000 ton | 650,000 ton |
| Reinforcing Steel | 33,000 ton | 22,000 ton |
| Rock Bolts | 12,500 ton | 3,000 ton |
| Steel Support & Liners | 3,600 ton | 2,200 ton |
| Mechanical, Structural & Electrical Equipment | 15,000 ton | 13,500 ton |
| Fuel | 75,000,000 gal. | 17,000,000 gal. |

Camp populations were estimated at 4,500 persons for Watana and 3,100 persons for Devil Canyon. Past experience shows that camps of this size require 13 pounds of food and supplies per occupant and 1.1 gallons of fuel oil per occupant on a daily basis.* These quantities where combined with the construction schedules to develop the following average material flow requirements for the project.

* Data provided by Arctic Hosts, Inc., Anchorage Alaska.

TABLE 2.2

SUMMARY OF REQUIRED AVERAGE MATERIAL FLOW RATES

| | Watana Dam | Devil Canyon Dam |
|---|---|---|
| Trucks | 90 | 110 |
| Contingency & Misc. | 18 | 22 |
| Total | 108 Truck Loads/week | 132 Truck Loads/week |
| Rail Cars | 39 | 44 |
| Contingency & Misc. | 8 | 9 |
| Total | 47 Rail Car Loads/week | 53 Rail Car Loads/week |

2.6 - Project Parameters

The required freight movements and the size and weight of transformers and other major components were used to establish parameters for line, grade and load requirements for both railway and roadway options. These parameters were then used to identify potential access routes and are based on standards published by The American Association of State Highway and Transportation Officials (AASHTO) and the American Railway Engineering Association (AREA).

TABLE 2.3

APPROVED ROADWAY DESIGN PARAMETERS

| | |
|---|---|
| Design Speed | 60 mph |
| Maximum Grade | 6% |
| Maximum Curvature | 5% |
| Design Loading (Construction Period) | 80 Kip Axle & 200 Kip total |
| Design Loading (After Construction) | HS-20 |

APSC grade 10-12%

TABLE 2.4

APPROVED RAILROAD DESIGN PARAMETERS

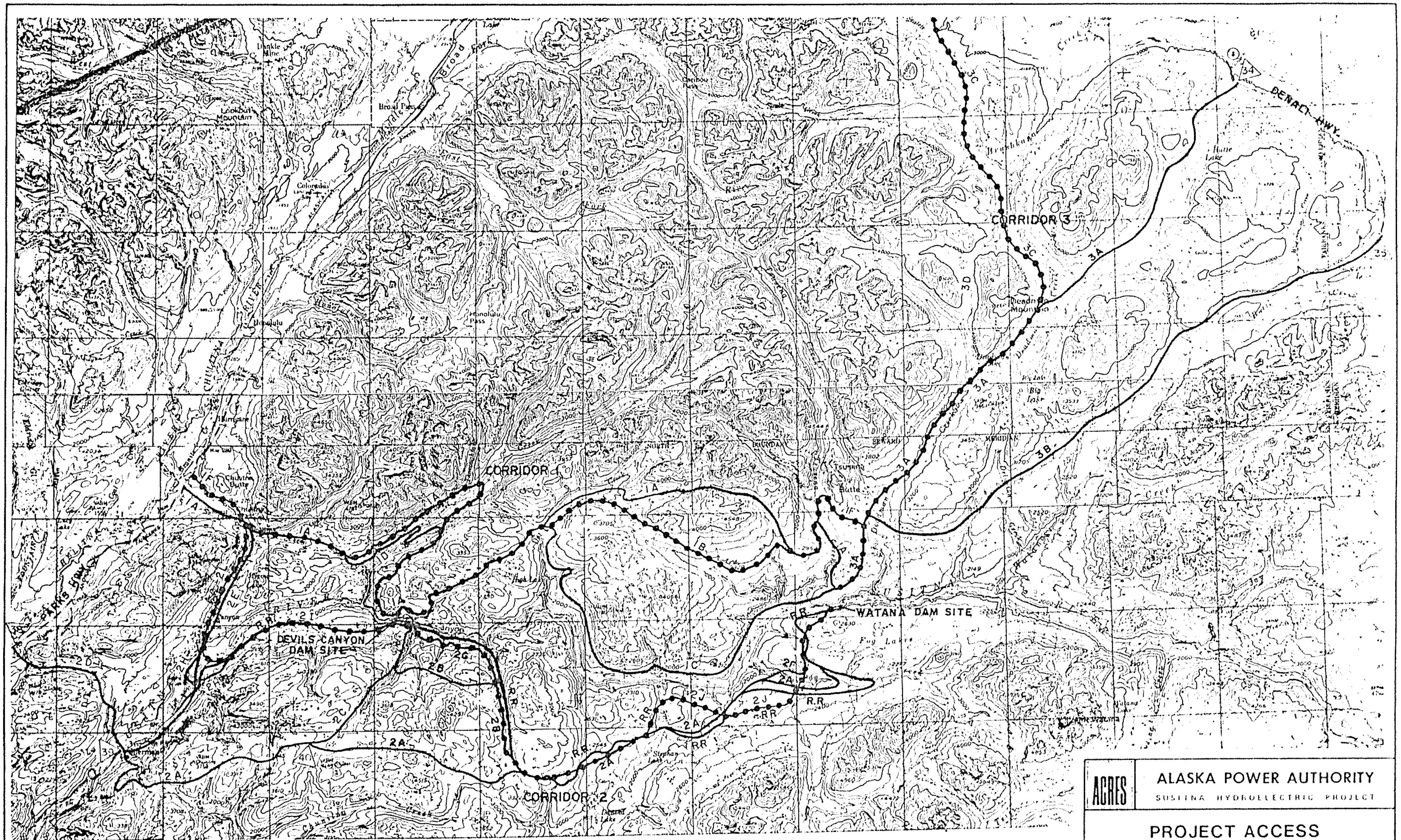
| | |
|---|---|
| Maximum Grade | 2.5% |
| Maximum Curvature | 10° |
| Loading | E-72. |

2.7 - Alternatives Segments

The design parameters were used to define a series of alternative alignment segments that could be mixed and matched to define alternate access routes meeting project requirements. The segments as originally defined were given to the soils and environmental teams for their input. That input, along with engineering considerations was used to eliminate some segments and modify others. The remaining segments were combined to establish preferred routes in each corridor. These corridor alignments are shown on Figure 2.1.

2.8 - Alternative Access Plans

Alternative access plans were developed. Each plan included recommended Alaskan ports, line haul mode, location of transfer points and delivery mode.




PREFERED ROUTE IN EACH CORRIDOR

OTHER ALTERNATES INVESTIGATED

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SUSITNA HYDROELECTRIC PROJECT

PROJECT ACCESS

LOCATION ALTERNATIVES

SCALE:

FIG 2.1

The sea ports checked include the following:

Anchorage
Seward
Whittier
Valdez

Anchorage is the preferred port for those items suitable for shipment in conventional containers and trucks. The port has the apparent adequate capacity and the best facilities of the four. The drawback in Anchorage is a lack of capabilities for roll-on roll-off rail shipment. Anchorage does, at times, have an ice problem.

Seward is unable to compete directly with Anchorage in facilities or capacity. Seward is suitable for an overflow port as there is equipment available to handle container cargo and there is direct rail and highway access. Seward is an ice free port.

Whittier is unique in that there is roll-on roll-off rail capability. Because of freight rates and handling charges Whitter is the obvious choice for arrival of all materials that can be shipped by rail car.

Valdez has a considerable capacity and is expanding its port facilities. Valdez has been eliminated from major consideration for a number of reasons that would contribute to increases in project cost.

- Lack of Rail Service
- Highest Wharfage and Handling Costs of Any of the Four
- Longest Truck Haul to the Project

Anchorage and Whittier are the ports selected and are common to all plans.

Line haul rates were collected from the Alaska Railroad and several trucking firms. A comparison of line haul rates is shown below.

TABLE 2.5

LINE HAUL RATES IN DOLLARS/TON-MILE

| Item | Rail | Truck |
|---|---|---|
| Equipment | 0.1878 | 0.2069 |
| Steel | 0.2577 | 0.2069 |
| Cement | 0.1565 | 0.2069 |
| Fuel | 0.1450 | 0.2069 |
| General Cargo | 0.1262 | 0.2069 |
| Explosives | 0.6267 | 0.2069 |

While certain items may move by truck with lower costs, the mix of items and quantities make it clear that the overall most cost effective line haul mode is rail. For this reason all plans contemplate rail haul to the maximum extent practicable.

A total of seven access plans have been outlined. There are no plans including the segments around Portage Creek as the engineering, soils and environmental problems have combined to make the Portage Creek drainage very undesirable.

Plan 1 serves both Devil Canyon and Watana Dam by road south of the Susitna River. This plan includes a rail head at Gold Creek and road access to the Parks Highway. This plan encounters significant amounts of critical wildlife habitat around Stephan and Fog Lakes. There are some extensive areas of deep organic soils and soils containing massive ice near Stephan Lake. There are major schedule constraints involving two major bridges and extensive rock construction. The schedule constraints are such that the construction of Watana could be delayed by as much as three years.

Plan 2 is the railroad alternative to Plan 1. Plan 2 also does not satisfy the requirement of being able to allow resupply of construction activities at Watana in one construction season.

Plan 3 serves Watana by road from the Denali Highway east of Cantwell. A railhead is called for at Cantwell. Access to the Devil Canyon Dam is by road with a railhead at Gold Creek. This plan meets all primary objectives of the study but does not include a direct connection between Watana and Devil Canyon. The roadway from Denali Highway can be made usable for construction equipment and resupply in one construction season allowing access to Devil Canyon to be constructed as required.

Plan 4 is similar to Plan 3 except that access to Devil Canyon is to be by rail rather than road.

Plan 5 uses all roadway connecting with the Parks Highway and a railhead at Gold Creek. The south side of the river is followed to Devil Canyon. At this point the plan calls for a high bridge over the Susitna River and utilization of the north side alignment between Devil Canyon and Watana. This plan avoids the majority of the identified environmentally critical areas of all three corridors. There is a major time constraint however. The high bridge at Devil Canyon would have to be a suspension bridge approximately 2600 feet long. Such a bridge would require a three year construction period thus delaying construction of Watana by at least that much.

Plan 6 is the same as Plan 4 except that a road is included between Watana and Devil Canyon for the exclusive use of the maintanance and oeprations personnel. This plan satisfies all major objectives of the study.

Plan 7 is the same as Plan 3 except that a road is included between Watana and Devil Canyon for the exclusive use of the maintenance and operations personnel. This plan satisifies all major objectives of the study.

The final choice of access plan will be made after additional input from the remainder of the study team can be evaluated.

SCOPE OF WORK

# 3 - SCOPE OF WORK

The Scope of Work discussed in this Section includes the development and selection of corridor alignments, an analysis of modal split options and selection of alternative access plans designed to provide a cost effective access system that will satisfy the project requirments while meeting the project schedule.

Further details of the Scope of Work may be found in Acres' Plan of Study (POS).

## 3.1 - Corridor Selection

The initial step in selecting the corridors was definition of the parameters that control line and grade. Preliminary estimates of the size and weight of the critical components were made and the width, grade and curvature parameters were selected to allow movement of those components

After the controlling parameters were defined, possible alignments were identified using 1:63,360 scale contour maps. A number of alternate segments were identified for further analysis. Potential corridors were to be identified on both sides of the Susitna River from the Parks Highway to Watana and, from Watana north to the Denali Highway. At least one corridor was to include a potential for rail service to both Dam sites.

The alternative segments were grouped into possible total routes. The possible routes were compared with regard to alignment, gradient, soil conditions, environmental constraints and other considerations to determine the most favorable alignment within each corridor.

### 3.2 Modal Split Analysis

The modal split analysis was necessary to suggest the optimum mix of transportation modes and the most advantagous transfer point between modes.

Potential seaports and the cargo handling capability of the respective ports are of prime importance. It was necessary to determine if roll-on roll-off rail barge service was possible or if material must come by barge and be transfered to rail and/or truck.

Freight rates for the railroad and for truck haul were checked to determine the most economical way to ship various items within the State of Alaska.

The estimated quantities of the major items were supplied from other tasks. Using these quantities and the rate information a variety of modal mix options were examined to determine the cost effectiveness of the apparent options.

### 3.3 Access Plan Development

This effort is a mix and match exercise in which the various combinations of potential corridor segments and modal split options are tested to compare cost effectiveness of the over all plan and the degree to which overall project time schedules are served. The cost effectiveness of the various plans are based on combined costs of construction, maintenance and logistics over the construction life of the project. The degree to which the overall time schedule can be satisfied is based on two factors, estimated construction time for the access facility and whether the plan will allow inital work on the dams to begin as planned.

# PREVIOUS STUDIES

## 4 - PREVIOUS STUDIES

The studies done by the various agencies that have looked at the Susitna Hydroelectric project have presented much information on the many alternative power developement plans. These same studies have included very little data on access to the project. Generally, construction of a road is presumed and little else is mentioned.

### 4.1. U.S. Corps of Engineers

The 1975 report prepared by the Corps of Engineers incorporated a road access that corresponds very closely with one of the corridors defined in the study. That access proposal began at the Parks Highway near Chulitna Station, parallels the Alaska railroad south and east to a crossing of the Susitna river then proceeds up the south side of the river to Devil Canyon and on the the Watana site via the north end of Stephan Lake and the west end of Fog Lakes. The facility contemplated was a 24-foot wide roadway designed for 30 miles per hour. A rail head was planned at Gold Creek also.

### 4.2 Others

Other studies done on the Susitna Hydroelectric project over the years mentioned access only in passing and and did not develop access plans.

# PROJECT DESIGN

# 5 - PROJECT DESIGN

The Susitna Hydroelectric Project is developing as a two dam system. The total system will include, in addition to the dams themselves, all associated on-site power generating facilities, and transmission facilities. A large construction camp with all of the required support facilities will be needed during construction, at each dam, and a permanent village for the operating and maintenance staff will be necessary after construction is complete. An airstrip and other access facilities over which all of the equipment, personnel and supplies will reach the project site must be provided as early in the project as possible.

## 5.1 - The Dams and Related Facilities

(a) The Watana Dam is projected to be a large earth and rockfill structure involving placement of approximately 76 million cubic yards of zone type embankment that will come largely from borrow areas near the site. The dam is to be located on the main stream of the Susitna River a short distance above the mouth of Tsusena Creek. During construction, the river is to be diverted through tunnels which will be gated and used for other purposes after completion of the work. The Power house is planned to be underground while the spillways are to be surface structures configured to prevent nitrogen saturation of downstream waters. Staging areas for construction activities are available on both sides of the river at the Watana Site.

(b) The Devil Canyon Dam is projected to be a concrete arch structure set in the section of the Susitna River known as Devil Canyon. To achieve planned pool elevation, a low saddle dam will be required south of the main dam. River diversion will again be through tunnels during the construction period and the power house for this structure will also be underground. Construction activities will probably be staged from the south side at Devil Canyon because of the terrain.

(c) The Transmission Lines are proposed for the north side of the river from Watana west to a connection with the Anchorage-Fairbanks intertie near Chulitna Pass. The final location of the transmission corridor has not been selected as of this time.

## 5.2 - Construction Camps

A Construction Camp is expected to be located near the Watana site and probably on the north side of the river. Manpower requirements based on quantities of materials and projected construction schedule show a need for up to 4,500 persons during the peak of construction activities at Watana. Current plans call for a construction camp at each of the dams. There is a shortage of land suitable for a camp near the Devil Canyon site, however, there is one site near the south end. Manpower projections for Devil Canyon construction indicates a peak population of 3,100 persons.

## 5.3 - Permanent Village

The size and complexity of the overall system will require a full time maintenance and operations staff. Projections show that this staff including their dependents will require a permanent village of approximately 45 dwelling units plus support buildings.

5.4 - Airstrip

Over-all project development, the size of the work force involved and the remote nature of the site indicate that an airstrip will be desirable for a wide variety of reasons including the movement of personnel and a need of rapid emergency evacuation capability. To that end, a runway site has been located on the north side of the Susitna River near the proposed site for the Watana construction camp. It is expected that the airstrip will be constructed very early in the project. The proposed facility would be adequate for aircraft up to and including a C-130. The location study for the airstrip has been done as a part of another task.

5.5 - Project Access

Providing access into a remote area such as the upper Susitna, while small in comparison to the total project, is a major undertaking in itself. Massive quantities of material, supplies, equipment and fuel must be moved to the project site in an uninterupted flow. Estimates of the amounts of the principal materials to be imported to the site and used in construction of the dams and related facilities are included in Appendix A. The movement of materials in such quantities requires a railroad or a high type of highway comparable to rural highways throughout the country. The access to the project is the topic of this study.

# PROJECT SCHEDULE

# 6 - PROJECT SCHEDULE

The Susitna Hydroelectric project is intended to provide electrical power to the Alaska Railbelt region. The time frame for providing the required generating capacity has been determined as a result of Task 6 "Design Development".

## 6.1 - Power Demand Growth

The load and demand growth projections presented in the Task 6 "Design Development" report indicate that more electrical power will be required by the year 2000 than can be generated by the Susitna Hydroelectric Project alone. The demand over and above that which Susitna can satisfy will have to be provided from other sources, quite probably fossil fuel fired steam generators. The demand growth curves indicate that power from the Watana Dam is needed in 1993 and power from Devil Canyon Dam in needed by 2000. The Wabana generating capacity can be installed in stages with the initial 400 megawatts available in 1993 and the second 400 megawatts on line in 1996.

## 6.2 - Generating Facility Schedule

Construction periods for Watana Dam and Devil Canyon Dam are projected as eight years and seven years respectively. If power from Watana is needed in 1993 and an eight-year period is required to construct the dam then construction must begin in 1985. Power from Devil Canyon is needed in 2000. Backing up seven years indicates that construction must begin in 1993. The construction schedules currently show access construction beginning January 1985 with work on the diversion tunnels beginning during the second quarter of 1985 and on the cofferdams and main abutments of Watana in the third quarter of 1985.

## 6.3 - Access Facility Schedule Constraints

Access is an integral part of the total project and as such is subject to FERC approval for construction. Current project schedules are based on FERC licensing in late 1984. Access construction is currently planned to begin in very early 1985, as soon as possible following FERC licensing. If access construction is to begin in 1985 and construction activities on the dam are to begin in mid to late 1985 then it is necessary that an access facility be provided that can be passable for heavy equipment, explosives and fuel supplies sometime during the 1985 construction season. Any access plan that cannot be brought to rough grade and kept passable in a single construction season will require one of two schedule adjustments, access construction prior to FERC licensing or delay in work on the Watana Dam.

# LOGISTICS REQUIREMENTS

# 7 - LOGISTICS REQUIREMENTS

The dams and associated facilities are of a size that require vast quantities of equipment, materials, supplies and personnel for construction. Because of the remote location, a base camp must be provided that will resemble a small town complete with all essential services near each dam site. A permanent village must also be provided for the operations and maintenance personnel who will be stationed at the project when construction is completed.

The principle logistics requirements include the equipment, materials and supplies necessary for the dams and related facilities including the camp and permanent village, the food and other items necessary to provide for the crew during construction and the logistics requirements for construction of the access facilities. The requirements for the dams and related facilities and the camp supply needs will be discussed here. Logistic requirements for the alternate access plans will not be discussed in detail. Logistic requirements at access construction will vary with location, length, and bridge requirements. Significant constraints of access construction will be identified however, the cost of this element of logistics will be included in the estimated construction costs.

## 7.1 - Construction Equipment, Materials and Supplies

The following estimates of equipment, materials and supplies are presented as a basis for the cost estimates to be generated as a part of analyzing and comparing the various access plans to be presented.

The major quantities to be incorporated into the project are shown in Table 7.1.

Table 7.1 Major Quantities in the Dams

| | Watana | Devil Canyon |
|---|---|---|
| Excavation (Rock & Earth | 22,000,000 c.y. | 5,000,000 c.y. |
| Fill | 76,000,000 c.y. | 1,335,000 c.y. |
| Construction Equipment | 16,000 ton | 5,000 ton |
| Explosives | 20,000 ton | 3,000 ton |
| Cement | 350,000 ton | 650,000 ton |
| Reinforcing Steel | 33,000 ton | 22,000 ton |
| Rock Bolts | 12,500 ton | 3,000 ton |
| Steel Support & Liners | 3,600 ton | 2,200 ton |
| Mechanical, Structural Electrical Equipment | 15,000 ton | 13,500 ton |
| Fuel | 75,000,000 gal. | 17,000,000 gal. |

Additional items that will be required for each dam include: Tires, Equipment Parts, and miscellaneous lumber and building material. Actual estimated quantities are not available and are largely a function of the contractor's operation.

For a comparison of transportation costs only the easily identified major items will be listed individually. These items will allow comparisons of the relative differences in transportation costs when reviewing alternative plans.

In order to estimate quantities of fuel, tires and parts required at each site, estimates of equipment fleets with average unit fuel consumption figures were made. See Table 7.2.

The fuel consumption rates shown in Table 7.2 are estimates based on Alaskan General Contractors experience with similar equipment.

Table 7.2 Construction Fleet

| Equipment | Fuel Per Unit (1 gallon/hr.) | # Units * | |
|---|---|---|---|
| | | Watana | Devil Canyon |
| 40 C.Y. End Dumps | 21 | 40 | 6 |
| 8 C.Y. Loaders | 15.5 | 10 | 5 |
| Motor Patrols (Cat 14) | 6.5 | 8 | 4 |
| D-9 | 17 | 30 | 5 |
| D-7 | 8 | 10 | 3 |
| Cranes | 10 | 2 | 4 |
| Rock Crusher | 20 | 1 | 2 |
| Screening Plant | 10 | 1 | 2 |
| Concrete Plant | 10 | 1 | 2 |
| Mixer Trucks | 10 | 3 | 3 |
| Fork Lifts | 5 | 6 | 6 |
| Dump Trucks | 10 | 10 | 2 |
| Compactors | 8 | 6 | 2 |
| Power Generator | 20 | 2 | 2 |
| Miscellaneous | 7 | 20 | 15 |
| Pickups and other Gasoline Vehicles | 2 | 60 | 30 |

| | Watana | Devil Canyon |
|---|---|---|
| By Rail: Flat car loads | 133 | 66 |
| By Road: Truck loads | 67 | 31 |
| self driven units | 143 | 62 |
| Total Units | 210 | 93 |

* The number of units represents the anticipated number of pieces necessary based on the materials needed to be moved, amount of time per machine to move them and the total time frame provided to complete the task. When this input was not available it is a result of estimates from previous project experience.

Table 7.3

WEEKLY DIESEL FUEL REQUIREMENTS FOR CONSTRUCTION

| Equipment Type | Watana gallons/week | Devil Canyon gallons/week |
|---|---|---|
| End Dumps | 94,080 | 14,100 |
| Loaders | 17,360 | 8,680 |
| Motor Patrols | 5,820 | 2,900 |
| D-9 | 57,120 | 9,520 |
| D-7 | 8,960 | 2,700 |
| Cranes | 2,240 | 4,480 |
| Crushers | 2,240 | 4,480 |
| Screening Plant | 1,120 | 2,240 |
| Concrete Plant | 1,120 | 2,240 |
| Mixer Trucks | 3,360 | 3,360 |
| Fork Lifts | 3,360 | 3,360 |
| Dump Trucks | 11,200 | 2,240 |
| Compactors | 5,380 | 1,790 |
| Power Generator | 4,480 | 4,480 |
| Miscellaneous Vehicles | 15,680 | 11,760 |
| ** Total Gallons per week | 227,700 | 78,330 |

* Assume 24 hours per day and severn days per week. An assumption has been made that 1/3 of the equipment will be down for service and maintenance at all times this provides for 112 hours/week base.

** This is an estimated average fuel flowage during the major portion of the activity. Actual flowage may vary significantly.

Table 7.4

REQUIRED DIESEL FUEL

| | Watana | Devil Canyon |
|---|---|---|
| Diesel Fuel | 227,700 Gal./wk. | 78,330 Gal./wk. |
| Truck Loads @ 7,500 Gal./load *** | 30 Loads/wk. | 10.4 Loads/wk. |
| Rail Car Loads @ 20,000 Gal/load *** | 11 Loads/wk. | 4 Loads/wk. |

*** Sizes of loads are typical of what is currently available.

## TABLE 7.5

## REQUIRED MATERIAL FLOW RATES

| | Watana | Devil Canyon |
|---|---|---|
| Gasoline | 20,160 Gal./wk. | 10,000 Gal./wk. |
| Truck Loads @ 7,500 Gal./load | 3 Loads/wk. | 1.3 Loads/wk. |
| Rail Car Loads @ 20,000 Gal./load | 1 Load/wk. | 0.5 Load/wk. |
| | | |
| Time Requirement*** | 7 yrs. | 6 yrs. |
| Cement | 350,000 ton | 650,000 ton |
| Quantity per week | 1154 ton/wk. | 2,500 ton/wk. |
| Truck Loads @ 30 ton/Load* | 38.5 Loads/wk. | 83.3 Loads/wk. |
| Rail Car Loads @ 75 ton/Load* | 15.4 Load/wk. | 33.3 Load/wk. |
| | | |
| Steel (all) | 49,100 ton | 27,200 ton |
| Quantity per week | 162 ton/wk. | 105 ton/wk. |
| Truck @ 30 ton | 5.4 Loads/wk. | 3.5 Loads/wk. |
| Rail Car Loads @ 75 ton | 2.2 Loads/wk. | 1.4 Load/wk. |
| | | |
| Explosives | 20,000 ton | 3,000 ton |
| Quantity per week | 66 ton/wk | 11.5 ton/wk |
| Truck loads @ 30 ton | 2.2 load/wk | 0.4 load/wk |
| Rail Carloads @ 75 ton | 0.9 load /wk | 0.15 load/wk |
| | | |
| Mechanical, Structural Electrical | 15,000 ton | 13,500 ton |
| Quantity per week | 49.5 ton/wk | 52 ton/wk |
| Truck loads @ 30 ton | 1.6 load/wk | 1.7 load/wk |
| Railcars loads @ 75 ton | 0.7 load/wk | 0.7 load/wk |
| | | |
| Tires and Parts ** Truck loads | 2 Loads/wk. | 2 Loads/wk. |
| | | |
| Subtotal Trucks Loads/wk. | 52.7 | 92.2 |
| Subtotal Rail Cars Loads/wk. | 22.2 | 38.1 |

* Sizes of loads are typical of what is currently available.

** This Figure represents a rough estimate of truck/rail car loads of materials that will be needed for maintenance of construction equipment.

*** Assumed deliveries over 10 months per year activity and 1 year less than total construction time. The schedules show startup period of about one year before the peak activity levels are approached.

## 7.2 - Support Requirements

Supplies and fuel for the base camps must flow steadily and smoothly. It has been estimated the construction camp population will be approximately 4,500 for Watana and 3,100 for Devil Canyon. A camp operation report together with information from experienced arctic work camp contractors indicates a camp of 3,000-5,000 people would require approximately thirteen (13) pounds of food and supplies per person per day and fuel for power and heat at 1.1 gallons per person per day. These figures convert to the following delivery rates:

### Camp Supplies

$$\frac{\text{4500 persons}}{\text{2000 lb./ton}} \times \frac{\text{13 lb.}}{\text{man-day}} \times \frac{\text{7 days}}{\text{week}} = \text{204.8 tons/week (Watana)}$$

$$\frac{\text{3100 persons}}{\text{2000 lb./ton}} \times \frac{\text{13 lb.}}{\text{man-day}} \times \frac{\text{7 days}}{\text{week}} = \text{141.1 tons/week (Devil Canyon)}$$

| | Watana | Devil Canyon |
|---|---|---|
| Truck Loads @ 30 tons each = | 6.8 load/wk | 4.7 load/wk |
| Rail Cars @ 75 tons each = | 2.7 load/wk | 1.9 load/wk |

### Camp Fuel

$$\text{4500 persons} \times \frac{\text{1.1 gal.}}{\text{day}} \times \frac{\text{7 days}}{\text{week}} = \text{35,000 gal./week (Watana)}$$

$$\text{3100 persons} \times \frac{\text{1.1 gal.}}{\text{day}} \times \frac{\text{7 days}}{\text{week}} = \text{24,000 gal./week (Devil Canyon)}$$

Truck Loads @ 7,500 gallons = 5 loads per week for Watana; 3½ per week for Devil Canyon.

Rail Car Loads @ 20,000 gallons = 2 loads per week for Watana; 1¼ per week for Devil Canyon.

## 7.3. - Permanent Village

The permanent Village is estimated as 45 dwelling units. It is expected that construction of the village will occur over a period of two years at an average of two truck loads of materials per dwelling unit.

## 7.4 - Summary of Freight Movements

The following summary of freight movements is intended to show the order of magnitude for transport requirements on the access facility.

Table 7.6
SUMMARY OF REQUIRED AVERAGE MATERIAL FLOW RATES

| | Watana Dam | Devils Canyon Dam |
|---|---|---|
| Trucks | 95 | 111 |
| Contingency & Misc. | 19 | 22 |
| Total | 114 Trucks Loads/week | 133 Truck Loads/week |
| Rail Cars | 38 | 45 |
| Contingency & Misc. | 8 | 9 |
| Total | 46 Rail Cars Loads/week | 54 Rail Cars Loads/week |

Note: Total includes Tables 7.4, 7.5, camp supplies and camp fuel. Total does not include initial mobilization of construction equipment or materials for permanent village.

## 7.5 - Personnel Movements

In addition to the requirements for moving freight the workers themselves must be moved to the site. There are at least four options for accomplishing the movement of personnel depending on the nature of the access facility provided and the types of controls put on the construction personnel. Construction crews and support personnel will be working 7 days per week and three shifts per day. Even with this kind of schedule large numbers of people will be off shift at any one time. It would seem appropriate that these people have some way of leaving the area. Options include the following:

1. An aircraft shuttle
2. A rail shuttle if rail only is provided
3. A bus shuttle
4. Private vehicles

An aircraft shuttle could be used for the movement of personnel to the construction camp. Transportation costs would be high and the mode is extremely vulnerable to weather limitations.

Several of the access plans outlined herein include options for access to all or part of the project by rail only. The camp populations are such that a steady flow of personnel to and from camp may be expected. If only ten percent of the population travels on a given day, the total person trips will be in the range of 300 to 500 daily.

Rail coaches normally seat 50 to 80 persons. If access to either dam is limited to rail only, then a regularly scheduled shuttle train of an engine and two to four passenger cars will be needed to provide the required service. This service combined with the freight haul requirements will necessitate additional rail sidings and a much more complex communication system on the rails.

If roads are provided as primary access to the job site, a bus shuttle could be provided for personnel movements. This would best be handled by commerical carrier. The cost could be borne either by the individual or the project.

The use of private vehicle would be the simplest method to administer. It would also allow the workers the greatest flexibility. If only 10% of the population travels on a given day, traffic volumes on the access road could exceed 500 vehicles per day. Traffic volumes at this level normally warrant a paved surface rather than a gravel surface.

For the purpose of comparison, in this report, logistics costs will not include passenger transportation.

# ACCESS ROUTE
# DESIGN PARAMETERS

# 8. - ACCESS ROUTE DESIGN PARAMETERS

The plan of study for the Susitna Project calls for the analysis of three general routes and two transportation modes to provide access to the proposed dam sites from port facilities or instate sources of supply. Consideration must be given to using road, railroad or a combination of both to serve the project.

The alternate routes to be studied were required to accomodate the following:

- Serve all dam sites that might be proven feasible by other portions of the overall study.

- Corridors had to be included on the North and South sides of the Susitna River with connections to the Alaska Railroad near Gold Creek, to the Parks Highway and to the Denali Highway.

In order to be able to make a valid comparison between alternatives a basis for that comparison must be established, with this thought in mind, proposed design ciriteria were developed.

## 8.1 - Roadway Parameters

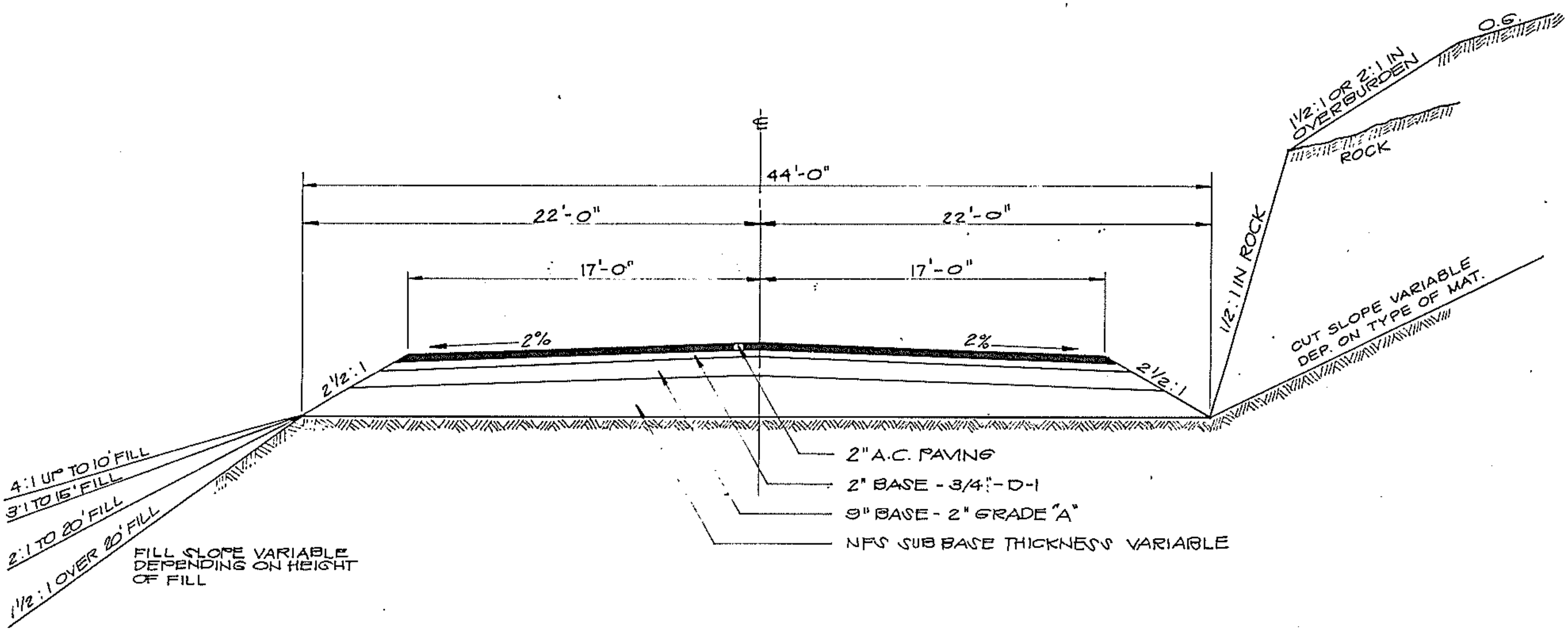
Originally the access road was envisioned as a low volume service road. The road was to be adequate for moving the necessary amounts of material and personnel but not necessarily in conformance will all requirement for a major public highway. As a result the original proposed design parameters were for a 30 mile per hour design with a 30 foot top width.

TABLE 8.1
ORIGINAL PROPOSED DESIGN CRITERIA

| | Road |
|---|---|
| Design Speed | 30 mph |
| Maximum Grade | 10% |
| Maximum Curvature | 19° |
| Design Loading | HS-20 |

Design criteria such as these are used to establish guidelines for design. The designer normally attempts to provide horizontal and vertical alignment that is better than the minimum alignment such limits would provide. In order to maintain schedule, work began on a number of possible alignments prior to approval of the proposed criteria. While the corridor definition work was in progress information on certain primary dam components was developed that required flatter grades and curves. Satisfying these criteria would provide a roadway that would essentially conform to a 50-60 mile per hour design speed. Subsequent work confirmed the need for roadway design criteria for 60 mile per hour design speed. The relatively high roadway design parameters are required because of the size and weight of certain components of the dams that must be manufactured and imported to the site. The approved roadway design parameters are given in Table 8.2. With acceptance of the design parameters, a typical cross section was developed and is depicted in Figure 8.1.

Projected traffic volumes suggest that asphalt pavement should be provided if personnel access to the construction camps is by private auto.




## TYPICAL ROAD CROSS SECTION

0 5 10
SCALE IN FEET

| REV. | |
|---|---|
| DATE | INT'L |
| | |
| | |
| | |

FIG. 8.1

ACRES

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS ROAD**

**TYPICAL CROSS SECTION**

DWN RE
CKD VG

TABLE 8.2

APPROVED ROADWAY DESIGN PARAMETERS

| | |
|---|---|
| Design Speed | 60 mph |
| Maximum Grade | 6% |
| Maximum Curvature | 5° |
| Design Loading (Construction Period) | 80 Kip Axle & 200 Kip total |
| Design Loading (After Construction) | HS-20 |

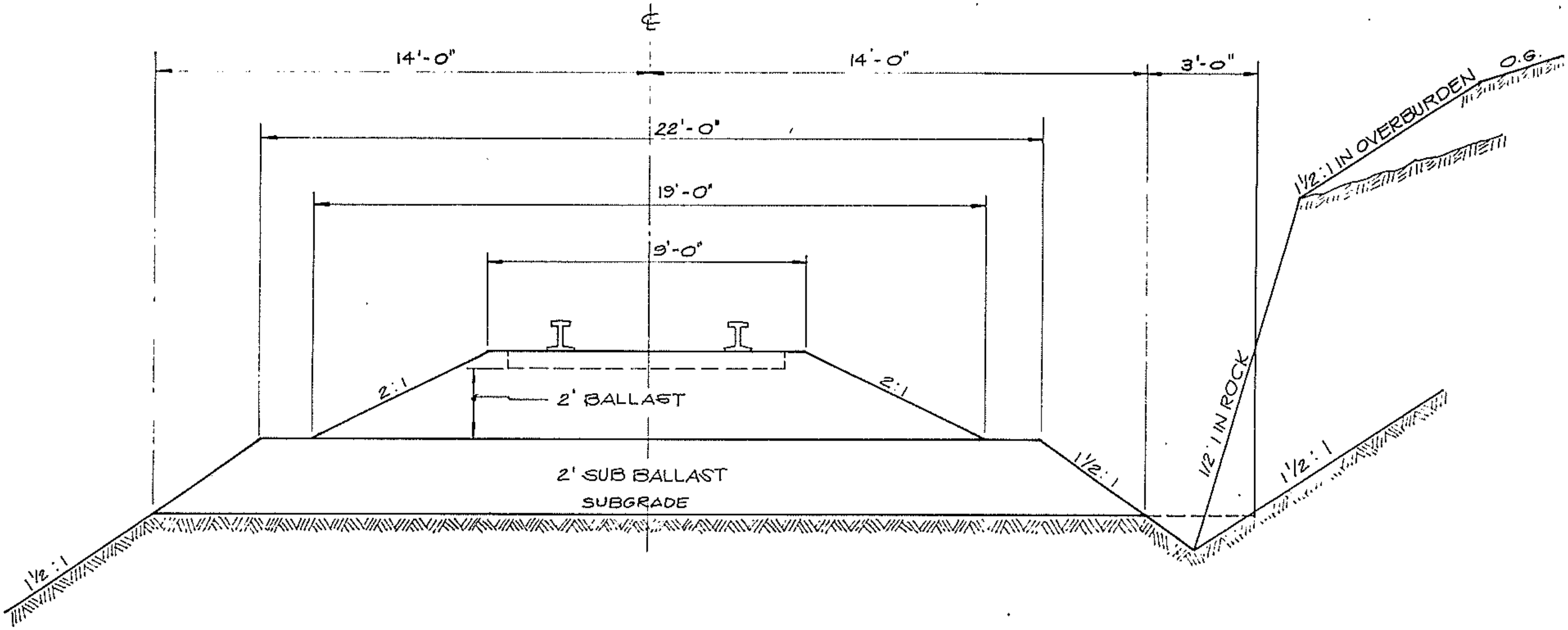
## 8.2 - Rail Road Parameters

The volume of bulk materials to be moved to the Susitna project during the fifteen year period of construction make consideration of rail service mandatory. The principle concern with using the Alaska railroad was the load capacity of existing trackage and bridges. Horizontal and verticle clearences governing the overall size of loads that can be moved by rail are controlled by existing facilities. The exisiting facilities conform to the American Railway Engineering Association (AREA) standards. The Engineering office for the Alaska Railroad states that the ARR is currently rated as an E-50 railroad. They are in the process of up grading to E-80 facilities. The Chief Engineer for the ARR recommended using an E-72 loading for railway planning. Input from the railroad engineering staff and AREA standards suggest the following design parameters would be appropriate.

TABLE 8.3

APPROVED RAILROAD DESIGN PARAMETERS

| | |
|---|---|
| Maximum Grade | 2.5% |
| Maximum Curvature | 10° |
| Loading | E-72.* |




## TYPICAL RAILROAD CROSS SECTION

0 1 2 3 6
SCALE IN FEET

| REV. DATE | INT'L |
|---|---|
| | |
| | |

ACRES

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS RAILROAD**

**TYPICAL CROSS SECTION**

DWN REL

FIG. 8

# CORRIDOR SELECTION

## 9.0 - CORRIDOR SELECTION

The general locations for the potential access corridors were defined in the POS. The next step in the process was the determination of where within these general corridors facilities could be built that would conform to the required design parameters. To that end, a series of alternate segments were identified and then evaluated. This section documents the process by which this segment selection was done and the results of the evaluation.

### 9.1 - Methodology

The Susitna Hydroelectric Project is located on a section of the Susitna River that is remote wilderness. Earlier studies by government agencies had generated some contour mapping in the vicinity of the proposed dam sites. The only other available contour information was USGS mapping on a one-inch (1") equals one (1) mile scale with one-hunderd foot (100') contour intervals. To aid the project team in selecting possible routes, a low level helicopter flight was made in late March, 1980. A mosaic was then made of the USGS mapping from Gold Creek and the Parks Highway through the Watana site and out to the Denali Highway north of Watana. Using the preliminary design parameters and information gained from the overflight of the project area, a number of possible alignments were laid out on the map mosaic.

The various alternatives were split into convenient segments. Some of these segments were unique while others could be common to two (2) or more alternatives. Each segment was analyzed for grades on a section by section basis. Each curve was checked for degree of curve and deflection angle. Each curve and each identifiable gradient section were then tabulated. The various segments considered were combined to provide a total of thirty-six (36) possible alignment alternatives that could conceivably be constructed to provide access to one or both of the principle dam sites. The various combinations of segments making up potential access route alignments were compared. The alignments identified as being the most attractive within each of the three (3) general corridors required by the plan of study was selected for further work. A low level reconnaissance flight with part of the environmental team was made April 30, 1980 to review the proposed corridor alignments prior to the photographic flights. Valuable input for future analysis was gained, and there was nothing identified that would force a major line change at this early stage of the work.

On May 5, 1980 the proposed corridor alignments were approved for photographic flights.

For the purpose of analysis the proposed general corridors are identified as follows:

Corridor 1 On the north side of the Susitna River between the Parks Highway and the Watana Camp.

Corridor 2 On the south side of the Susitna River between the Parks Highway and Watana Dam site. This corridor is being studied for railroad possibilities as well as road.

Corridor 3 Connecting Watana Camp with the Denali Highway to the north.

## 9.2 - Discussion of Alternative

A number of alternative segments were considered within each of these three (3) general corridors. The alternative segments within the respective corridors are discussed below and shown in Appendix B.

(a) Segment 1-A

(i) Description

This segment begins near MP 156 on the Parks Highway in the vicinity of Chulitna Pass. The line runs south east through Chulitna Pass crossing the rail road near summit lake, then proceeds easterly across Indian River and on to the Portage Creek Canyon. The line travels northeasterly for several miles while desending into a crossing of Portage Creek then south westerly while climbing out of Portage Creek to the north side of the Devil Canyon Dam Site. From Devil Canyon the line proceeds north easterly crossing into the upper reaches of Devil Creek then easterly through a 4,000-foot high pass and follows a drainage to a crossing of Tsusena Creek then south to the north side of the Watana Dam Site. Over-all length of the line is sixty four and seven tenths miles. The segment is shown on Figure 9.1.

(ii) Line and Grade

Segment 1-A is well within the desired limits with regard to alinement and grade with the exception of the portion through Portage Creek and near Devil Canyon. The terrain in Portage Creek Canyon is very difficult. Providing an alignment through Portage Creek Canyon that conforms with the design parameters will require very heavy earthwork and several small to medium length bridges across the side drainages.

(iii) Drainage Features

Most of the drainages along 1-A carry flows which can be passed through standard culverts quite satisfactorily. Bridges or multiplate pipe will be required for Indian River, Portage Creek, Devil Creek and Tsusena Creek.

(iv) Bridges

As stated, at least four bridges are expected. The Indian River bridge is a 440-foot long three span structure whose configuration is dictated more by the shape of the crossing than by the quantity of water in the river. The Portage Creek bridge will be a two or three span structure approximately 200 feet long. The Devil Creek bridge will be a simple one span structure less than 100 feet long. The Tsusena Creek bridge is expected to be a 260-foot three span structure similar to the Portage Creek bridge. Any construction within the Portage Creek Canyon will require additional structures in the under 200-foot class at several side drainages.

(v) Soils

Much of the alignment for segment 1-A from the Parks Highway to Devil Canyon traverses frozen soils, generally basal till with moderate side slopes. Drill holes indicate permanent ice beginning at depths of around fifteen feet. The material consists of gravels, sands and silts. Properly handled the material can be used to construct road bed, however the silts and sands will erode readily unless protected. The material is generally frost susceptible due to the silt content which will require a substantial non-frost susceptible subbase layer in the road bed. The soil is very susceptible to thaw settlement making it necessary to severly limit the depth of excavation and then requiring extensive borrow areas to provide roadway embankment.

There are extensive organics in the section of line from the Parks Highway through Chulitna Pass. This material is ten to twenty feet deep and will be difficult to build on. The remainder of the segment encounters occasional small areas of organic soils. With the exception of the crossings of Portage and Tsusena Creeks these areas of organics can be avioided.

The Portage Creek Canyon section traverses very steep cross slopes. Because of the frozen soils any road-way construction in the area could result in major erosion and thaw settlement problems at deep cuts will be unavoidable.

The section of 1-A from Devil Canyon to Watana traverses soils with shallow to exposed bedrock. Most of this section traverse relatively gentle cross-slopes. These conditions will allow road bed construction without undue problems with erosion and thaw settlement. Borrow sources are available close by the alignment.

(vi) Environmental Concerns

Portions of Segment 1-A have significant potential environmental problems. The section between the Parks Highway and Chulitna Pass traverses an obvious wetland area and encroaches on the Denali State park. Both Indian River and Portage Creek are anadromous fish streams. Indian River could be crossed without a serious conflict with the fish, however the potential for erosion that would result from construction in the Portage Creek Canyon may well pose a threat to the Portage Creek fish runs. The lower Portage Creek area has been identified as a potential raptor area and most of Portage Creek is known furbearer habitat. The alignment between Devil Canyon and Watana does not encroach on any environmentally sensitive areas.

(vii) Segment Suitability

Segment 1-A is actually a full length alternate alignment. The section from the Parks Highway to Devil Canyon is not considered suitable for access construction. This section has numerous construction, soils and environmental problems. The section from Devil Canyon to Watana remains viable.

(b) Segment 1-B

(i) Description

Segment 1-B is an alternate to a portion of 1-A between Devil Creek and Tsusena Creek. The segment begins just west of Devil Creek and drops into the Devil Creek drainage, crossing the creek, and swings north and east past Mama Bear Lake, then south easterly through a wide pass at 3,400-foot elevation, then proceeds easterly to rejoin segment 1-A before reaching Tsusena Creek. See Figure 9.1.

This alignment lies south of 1-A and utilizes a broader, lower pass which should be easier to keep open during and after snow storms. The cross slopes are gentle to moderate with the steepest being as the line climbs out of Devil Creek.

This segment is 16.2 miles in length

(ii) Line and Grade

Alignment and grade on this segment are well within the required parameters.

(iii) Draninage Features

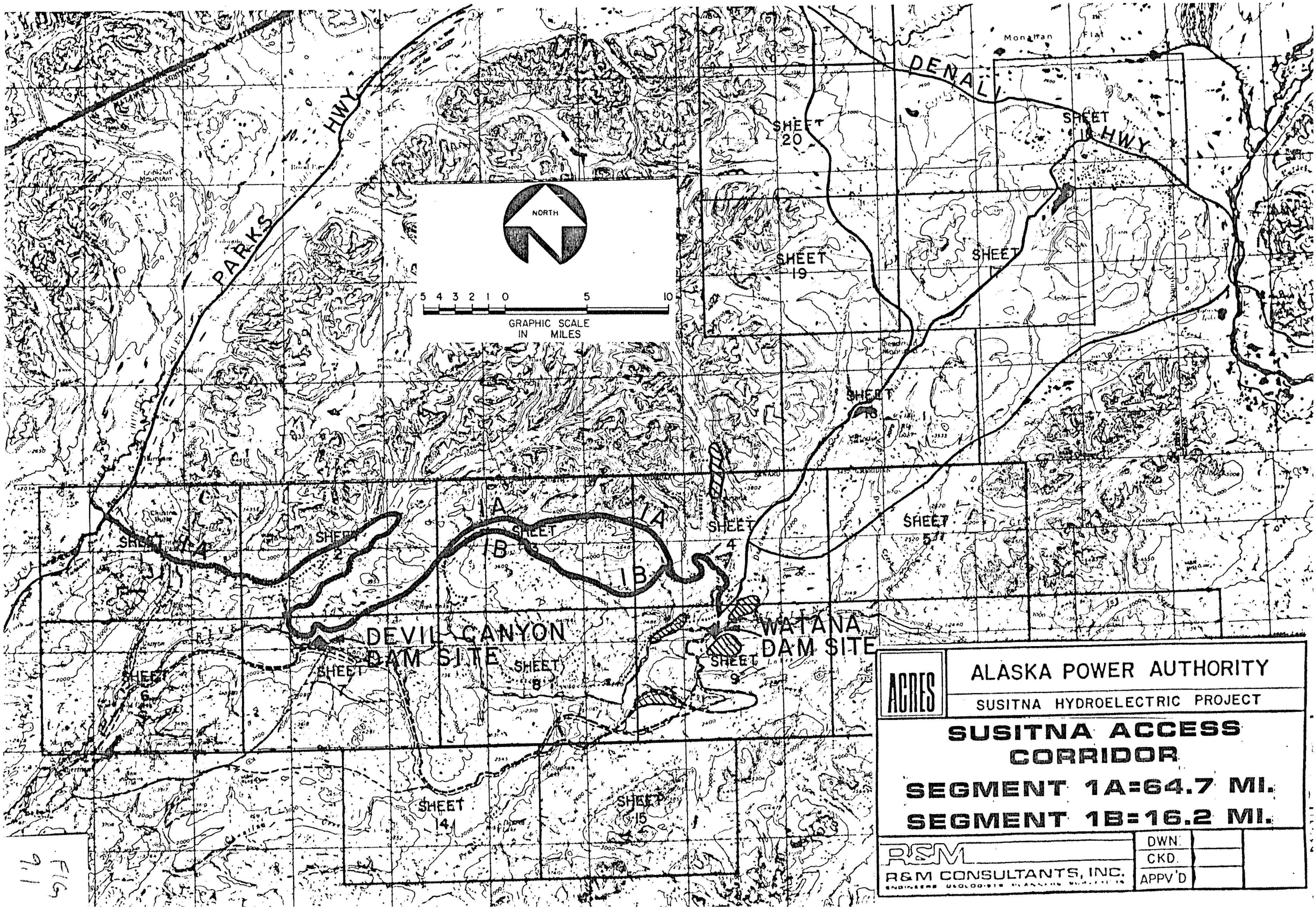
Segment 1-B encounters no major or complicated drainage features. Cross culverts will be required at intervals. The only major stream crossing is Devil Creek.

(iv) Bridges

The only Bridge on this segment is expected to be the Devil Creek crossing. This bridge will be a simple two hundred foot structure, probably with three spans.

(v) Soils

Some frozen Basal till with shallow bedrock occurs as the line drops into Devil Creek. Cross slopes are such that heavy cuts should not be required. Erosion and thaw settlement problems should be kept to a minimum. The crossing of Devil Creek is on thawed soils generally Ablation tills and flood plain deposits which are good soils for road bed construction. Climbing out of Devil Creek, the line crosses good soils with bedrock at or near the surface. Frozen soils are not encountered untill the east end of Mama Bear Lake. The remainder of the alignment is sporadically frozen soils however the terrain has gentle to moderate slopes which will allow road bed construction without heavy cuts.



DENALI HWY
PARKS HWY
NORTH
5 4 3 2 1 0 5 10
GRAPHIC SCALE IN MILES
SHEET 20
SHEET 19
SHEET 17
SHEET 16
SHEET 18
SHEET 1A
SHEET 2
SHEET 3
SHEET 4
SHEET 5
SHEET 6
SHEET 7
SHEET 8
SHEET 9
SHEET 14
SHEET 15
1A
1B
DEVIL CANYON DAM SITE
WATANA DAM SITE
ACRES
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
SUSITNA ACCESS CORRIDOR
SEGMENT 1A=64.7 MI.
SEGMENT 1B=16.2 MI.
R&M
R&M CONSULTANTS, INC.
DWN.
CKD.
APPV'D

FIG 2.1

(vi) Environmental Concerns

This segment does not appear to cross any environmentally sensitive areas. The alignment is generally at or above the tree line and conflicts with wildlife appear to be minimal. Where erodable soils are encountered, slopes are flat enough that a minimum of soil will be exposed thereby keeping the potential for erosion down.

(vii) Segment Suitability

Segment 1-B is a viable alternate. It does exhibit some advantage over 1-A in that the pass is lower and such that snow control should be easier.

(c) Segment 1-C

(i) Description

This segment leaves 1-B at Devil Creek and descends Devil Creek to the Susitna River then up the Susitna River crossing Tsusena Creek near its mouth and climbing to the north end of the Watana Dam. This alignment was intended to provide a water level access along the Devil Canyon reservoir. See Figure 9.2.

The segment is 27.5 miles in length.

(ii) Line and Grade

This segment can be constructed to meet 30 mph design speed but cannot meet the desired parameters. There are two sections where grades approaching eight percent cannot be avoided.

(iii) Drainage Features

This segment is generally side hill construction with numerous stream crossings. With the exception of Devil Creek and Tsusena Creek, culverts should handle the drainage concerns with no more than normal considerations.

(iv) Bridges

Two bridges are positively identified at Devil Creek and at Tsusena Creek. Both bridges would be in the one hundred fifty to two hundred foot catagory with two or three spans.

(v) Soils

This alignment crosses generally good soils with some scattered frozen materials near Watana Camp. The portion of Alternate 1-C along the Susitna River is mostly in frozen materials composed of solifluction deposits which are composed of saturated soil material and rock debris especially subject to frost creep or down slope movement. In addition there are large slide scar areas crossed and one apparently active landslide area (see Appendix D). The unfrozen and organic soils at the surface are covering sections of permafrost and these soils are prone to frost heave and thaw settlement. Since the majority of the slopes face the south, thawing is more likely giving lower bearing strengths and very low slope stability as evidence by the existing slide scars.

(vi) Environmental Concerns

There are a number of potential environmental concerns with this alignment. Erosion from cut and fill slopes in frozen soils and existing slides would be a major problem. The timbered side hills are important moose and black bear habitat. The most important habitat area is near the mouth of Tsusena Creek.

(vii) Segment Suitability

This segment is not very suitable; poor soils conditions, the inability to meet grade requirements, and the encroachments on wildlife habitat make this segment unattractive. In addition, the alignment encroaches on a borrow area needed for construction of Watana Dam (Borrow Area C) and crosses a portion of the construction area.

(d) Segment 1-D

This alignment is a shorter steeper crossing of Portage Creek. The alignment uses switch backs, steep grades and sharp curves to minimize the amount of damage in the Portage Creek Canyon. See Figure 9.2.

The segment is 9.0 miles in length.

(ii) Line and Grade

Vertical and horizontal alignment violate the desired parameters. There is no possibility of constructing an acceptable alignment on this segment.

(iii) Drainage Features

There are no significant drainage features on this alignment. Ditches and cross culverts would be standard type construction.

(iv) Bridge

A bridge would be required at Portage Creek very similar to the segment 1-A Portage Creek Bridge; a three span structure approximately 200 feet long.

(v) Soils

This segment traverses some very steep ground completely characterized by frozen soils which are highly subject to erosion, thaw settlement and frost heave.

(vi) Environmental Concerns

Portage Creek is an anadromous fish stream and there is concern that erosion of cut and fill slopes would be detrimental. In addition the alignment traverses known furbearer habitat and potential raptor nesting areas.

(vii) Segments Suitability

This segment is not suitable for further consideration.

(e) Segment 1-E

(i) Description

This segment is an alternate crossing of Tsusena Creek upstream from the 1-A crossing and connects with 3-A near Deadman Creek. See Figure 9.2.

This segment is 7.5 miles long.

(ii) Line and Grade

While longer than the 1-A crossing, this segment crosses Tsusena Creek with easier grades and good horizontal alignment.

(iii) Drainage Features

There are no significant drainage features on this segment. Normal ditch and culvert construction will serve.

(iv) Bridges

A bridge will be required over Tsusena Creek. The bridge will be a simple two span structure of about 150 feet in length.

(v) Soils

This segment crosses generally thawed soils exhibiting good road building characteristics.

(vi) Environmental Concerns

The crossing is far enough up Tsusena Creek to avoid the most critical moose habitat. The soils are such that the erosion possibilities are low, making this an attractive option.

(vii) Segment Suitability

This is a good segment much more suitable than 1-A in the Tsusena Creek drainage. The bridge crossing is good and cross slopes are moderate.

(f) Segment 1-F

(i) Descreption

This segment is an alternate to the section of 1-A from Parks Highway through Chulitna Pass. This segment crosses the railroad track closer to the highway and traverses the base of Chulitna Butte against the railroad tracks connecting with 1-A east of Summit Lake. See Figure 9.2.

This segment is 4.1 miles long.

(ii) Line and Grade

This segment conforms with the preferred design parameters although is not as straight and flat as the comparible sections of 1-A.

(iii) Drainage Features

No major drainages features are encountered. There are a few small streams crossed which can be handled with culverts. The line does avoid the wetland area traversed by 1-A.

(iv) Bridges

This segment does not include any bridges.

(v) Soils

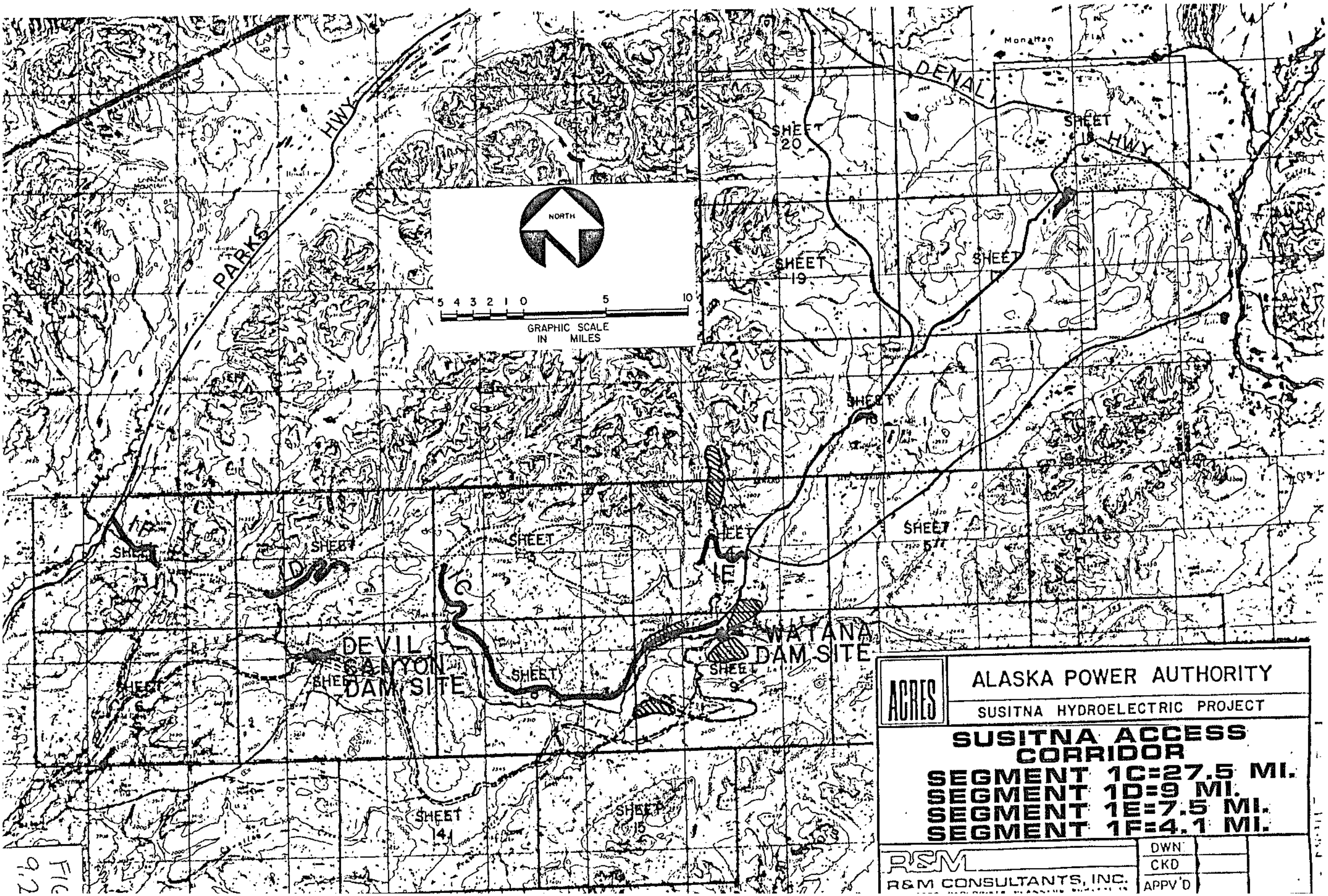
This section crosses frozen basal till and organic soils just as 1-A does, however, the extent of organics is much smaller. 1-F is further up slope and on moderate cross-slopes. The terrain is generally suitable for fill type construction often used to bridge organics and insulate frozen soils. As with other areas of the project there is some 10-15 feet of unfrozen soil over the permafrost; at least a portion of which can be worked in normal fashion provided due care is used with regard to erosion, thaw settlement and frost heave.

(vi) Environmental Concerns

The first two miles of the line encroach on a corner of Denali state park essentialy parrallel to the rail road. This alignment may require the taking of some dwelling units in the Chulitna Pass area. No critical habitats area appear to be impacted.

(vii) Segment Suitability

This segment essentially parallels the railroad and in so doing should have minimal added environmental impact. The wetland area in the pass is avoided and, while frozen and organic soils are a factor, they can be dealt with. This segment is preferable to the corresponding section of 1-A.


PARKS HWY
DENALI HWY
NORTH
5 4 3 2 1 0 5 10
GRAPHIC SCALE IN MILES
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SHEET 14
SHEET 15
SHEET 9
DEVIL CANYON DAM SITE
WATANA DAM SITE
1C
1D
1E
1F
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
SUSITNA ACCESS CORRIDOR
SEGMENT 1C=27.5 MI.
SEGMENT 1D=9 MI.
SEGMENT 1E=7.5 MI.
SEGMENT 1F=4.1 MI.
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DWN
CKD
APPV'D

(g) Segment 2-A

(i) Description

This segment begins at Sherman on the Alaska railroad south of Gold Creek. The alignment climbs the river bluffs via switchbacks to the higher ground near the head of Gold Creek. From there the line runs generally east on the high ground to the divide above Prairie Creek. The line then desends along a ridge and passes just north of Stephan Lake then proceeds easterly to a crossing of Fog Creek and north to the Watana Dam site past the west end of Fog Lakes. See Figure 9.3.

This alignment is 56.7 miles long.

(ii) Line and Grade

This alignment conforms quite well with the design parameters except for the climb from Sherman to the head of Gold Creek. This section is switchbacks using grades to ten percent and very sharp curves.

(iii) Drainage Features

Drainage features along this route are routine. The only problem areas being the west area near Stephan Lake and near Fog Lake where flat, boggy and frozen ground will be difficult to drain.

(iv) Bridges

The only Bridge involved with this alignment is the crossing of Fog Creek. This is a major bridge. The canyon is fairly deep with near vertical rock walls. The length of the crossing is approximately 600 feet. The probable structure type is a continuous deck truss that can utilize cantilever type construction techniques. This bridge will take eighteen to twenty four months to construct and will require a passable road over which to transport materials. This bridge could be a major schedule constraint.

(v) Soils

This alignment traverses a variety of soils. The climb through the switchbacks from Sherman is in an area of frozen Basal till over bedrock. The steep terrain will require heavy cuts and fills which will not be suitable. The Basal till is erodable and subject to frost heave and thaw settlements all of which would be major problem in the switch back area.

The section from the head of Gold Creek to the Prairie Creek divide crosses sporadically frozen soils and colluvial deposits mixed will bedrock. The material is generally acceptable for roadbed construction provided proper care is exercised with regard to frost susceptibility and erosion control. Scattered pockets of shallow organics exist that could be largely avoided.

From Prairie Creek divide to Watana the soils are Lusterines over frozen tills with pockets of organics and some bedrock near Fog Creek. The soils are acceptable for roadbed construction provided that consideration is given to frost susceptability, and thaw settlement and erosion. The soils near the end of Stephan Lake show evidence of massive ice. This area should be avoided if possible.

(vi) Environmental Concerns

The environmental concerns along this alignment are in the Stephan Lake - Fog Lakes area. These areas are prime habitats for varity of big game animals, waterfowl, and fur bearers. There is a potential for raptor use in the Fog Creek area. These same areas have been identified as having archeological sites of potential significance. There is a concern that public access to these area will have detrimental effects on big game populations and on the archeaological sites.

(vii) Segment Suitability

The portion from Sherman to the Prairie Creek divide is not considered as suitable because of difficult line and grade restrictions above Sherman and the fact that this line does not directly serve Devil Canyon.

The portion from the Prairie Creek divide to Watana is suitable for construction although there are some unavoidable environmental concerns. A portion of the line passes through borrow area H designated for use in construction Watana Dam. Some re-routing would be required to avoid the massive ice near Stephan Lake.

(h) Segment 2-B

(i) Description

This segment begins in at the south side of the Devil Canyon Dam site and travels south, up Cheechako Creek, about two miles before turning east and crossing the creek. The line then continues south easterly for about five miles while climbing to the top of a deep gorge. At this point the segment turns southerly following the top edge of the gorge to its head and join 2-A at the Prairie Creek divide. See Figure 9.3.

This segment is 13.6 miles in length.

(ii) Line and Grade

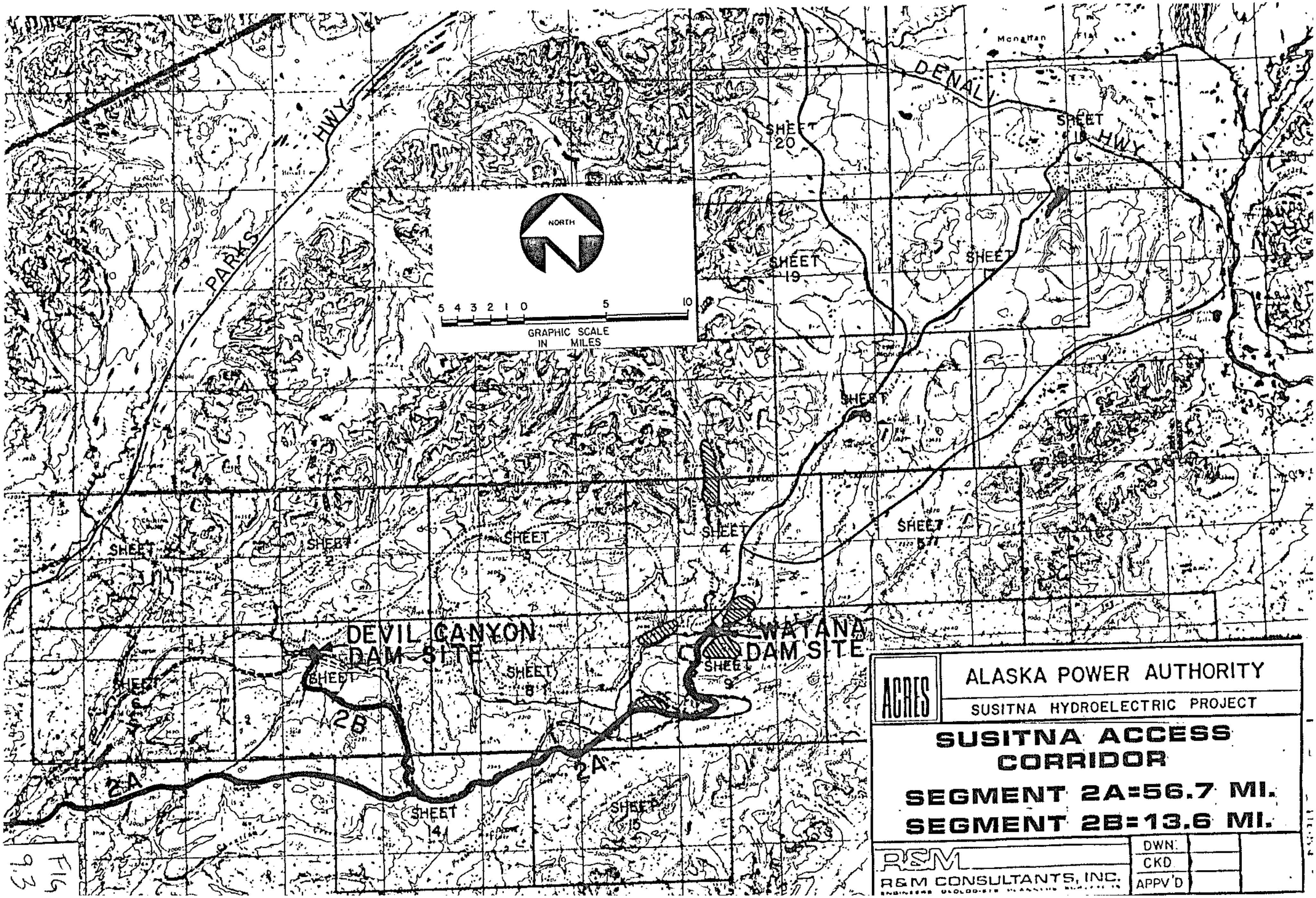
The horizontal alignment on this segment is acceptable. It is not possible to bring the portion south of Devil Canyon into conformance with the required gradient criteria. 7% to 10% grades would be required for about two miles.

(iii) Drainage Features

This alignment is located on high ground with little or no drainages involved. The one exception is a three mile reach that follows a small stream. The line appears to be above the stream far enough to avoid direct conflicts and should be no problem.

(iv) Bridges

One Bridge will be required crossing Cheechako Creek. This will be over a deep rock gorge. It will be curved and will require long spans and some tall towers for the intermediate supports. Because the bridge will be on a curve it will likely be a steel box girder structure. A second, more conventional bridge may also be required across a tributary of Cheechako Creek.




ACRES

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS CORRIDOR**

**SEGMENT 2A=56.7 MI.**

**SEGMENT 2B=13.6 MI.**

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CKD
APPV'D

FIG 9.3

(v) Soils

The soils are Basal till over bedrock - generally frozen along the first part of the line and bedrock or colluvium over bedrock along the remainder. The frozen till is on variable cross slopes much of it steep enough to require large fills to avoid cuts in frozen soils. Extensive borrow may be required to provide material for the fills.

(vi) Environmental Concerns

Portions of this segment traverse areas used by caribou as winter range because the wind keeps the ridge tops blown of snow. No other environmental conflicts have been identified.

(vii) Segment Suitability

The westerly section of 2-B near Devil Canyon is not suitable in that excessive grades cannot be avoided. The easterly end along the deep gorge approaching the Prairie Creek divide is highly suitable in that soils are rock, grades and alignment satisfactory.

(i) Segment 2-C

(i) Description

This segment runs south from 2-B near Devil Canyon up the Cheechako Creek drainage to join 2-A. This was intended to be the side connection to serve Devil Canyon from 2-A. See Figure 9.4.

This segment is 7.5 miles long.

(ii) Line and Grade

The horizontal alignment on this segment is satisfactory however grades exceed the desired maximum with no way of improving it. Over four miles of the line would be in the 7% to 9% range.

(iii) Drainage Features

There are no special drainage features along the segment. Several cross drainages exist; however standard ditchs and culverts will serve.

(iv) Bridge

There are no bridges on this segment.

(v) Soils

This segment crosses unfrozen colluvial deposits and bedrock generally acceptable for normal roadway construction with proper attention to erosion control and frost classification of materials.

(vi) Environmental Concerns

There have been no significant environmental conflicts identified along this alignment.

(vii) Segment Suitability

This segment is not considered suitable because of excessive grades.

(j) Segment 2-D

(i) Description

This section begins at Sherman, crosses the Susitna River and cuts through a pass inside Denali State Park to connect with the Parks Highway. See Figure 9.4.

This segment is 10.7 miles long.

(ii) Line and Grade

All of this segment conforms to the requirements for horizontal and verticale alignment. The grades do approach 6% however.

(iii) Drainage Features

This segment is located nearly in the bottom of drainages and may generate some conflicts with the streams. In addition there is a wet area in the pass west of the river which may result in surface drainage problems.

(iv) Bridges

A major bridge over the Susitna River will be required. The bridge will be a mulitspan structure, probably welded plate girders, and approximately 1,000 feet long.

(vi) Soils

The soils along this corridor have not been mapped. The material immediately north has been mapped and is frozen basil till over bedrock with some pockets of organics interspersed.

(vi) Environmental Concerns

This segment cuts directly through Denali State Park. Some wetlands are involved and while not verified the vegitation is typical of other areas that have been identified as Moose habitat.

(vii) Segment Suitability

This segment is not considered viable because it passes through Denali State Park and would disrupt the Park without demonstrating an off setting distinct advantage.

(k) Segment 2-E

(i) Descriptions

This segment connects 2A and 2D at Sherman with 1-A at Chulitna Pass. The lines generally parallels the railroad and was looked at as an alternative to 2-D in connecting with the Parks Highway. From Sherman to Gold Creek the alignment runs between the railroad and the base of the mountain. In two locations it is squeezed into some difficult side hill construction. After crossing the Susitna River the line stays back from the bluff above Indian River to avoid some side hill construction. See Figure 9.4.

The length of the line is 15.6 miles.

(ii) Line and Grade

Horizonal and verticle alignment conform with the desired parameters.

(iii) Drainage Features

There are no special drainage considerations on this segment normal ditches and culverts will serve.

(iv) Bridges

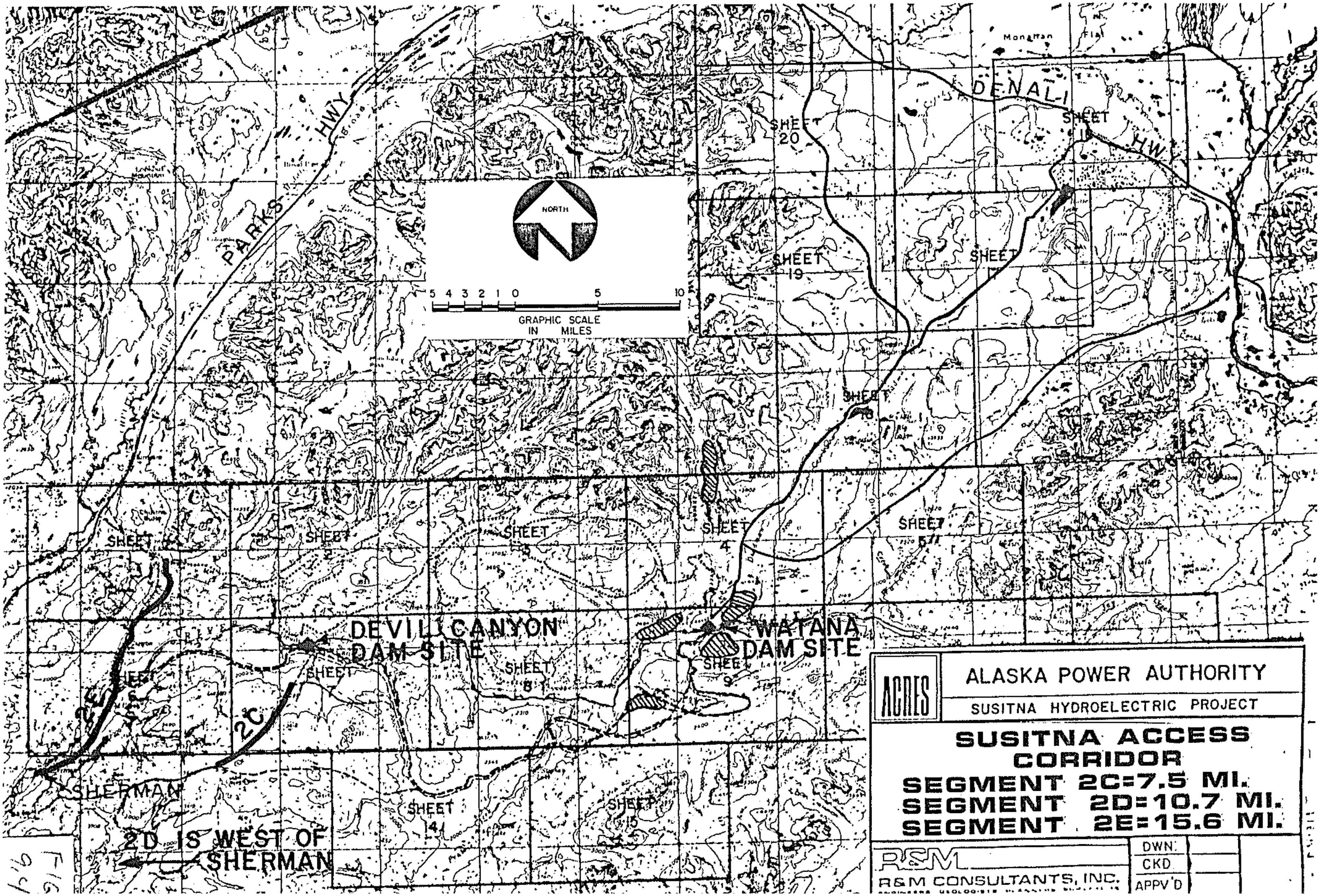
There are a total of three bridges identified on this segment. The main stream Susitna River Bridge is located immediately upstream of the Railroad Bridge. The first of two bridges over Indian River is just upstream from the Susitna River and will be an approximately 400-foot, three span structure. The second bridge over Indian River is near Chulitna Pass this will also be an approximately 400-foot, three span struction.

(v) Soils

This segment has a variety of soil types. The portion south of the Susitna River crossing is largely alluvial and flood plain deposits exhibiting good road building characteristics. This material is unfrozen and normal care with erosion contol and frost heave will result in a quality facility. The section north of the Susitna River crosses frozen Basal till and, some floodplain deposits near the stream crossings.

(vi) Environmental Concerns

The principle environmental concerns for the segment result from potential impacts on the Susitna and Indian Rivers. In each case there is a potential for equipment working in the streams. The impacts should be temporary in nature and not adversely effect the fish populations.


DENALI HWY
PARKS HWY
NORTH
5 4 3 2 1 0 5 10
GRAPHIC SCALE IN MILES
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SHEET 7
SHEET 8
SHEET 9
SHEET 14
SHEET 15
DEVIL CANYON DAM SITE
WATANA DAM SITE
SHERMAN
2C
2E
2D IS WEST OF SHERMAN
ACRES
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
SUSITNA ACCESS CORRIDOR
SEGMENT 2C=7.5 MI.
SEGMENT 2D=10.7 MI.
SEGMENT 2E=15.6 MI.
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APPV'D

The segment does border a State land disposal area known as the "Indian River Remote" disposal.

(vii) Segment Suitability

The entire segment is suitable for construction. Only portions of it may be used depending on the final access plan accepted.

(l) Segment 2-F

(i) Description

Segment 2F is a road alignment developed to shorten the distance traveled by 2A in crossing Fog Creek. The segment uses a bridge and somewhat steeper grade to effect a nearly straight crossing rather than a long switch back. See Figure 9.5.

This segment is 3.9 miles long.

(ii) Line and Grade

This segment does conform to the desired parameters for horizontal and vertical alignment. Grades do approach the 6% maximum. The horizontal alignment can allow safe truck operations on the alignment and need not be designed at the maximum curvature.

(iii) Drainage Features

The segment does not encounter major drainage features other than Fog Creek. A bridge will be required for Fog Creek while other drainage considerations can be treated satisfactorily with normal ditches and culverts.

(iv) Bridges

A major bridge is required on this segment at Fog Creek the structure crosses a deep rocky gorge. The structure type suggested is a deck truss because of the propable span arrangement and height of intermediate support towers. Structures of this type require considerable length of time to assemble. One and one half to two years is probable.

(v) Soils

The soils are Lusterines over frozen Basal tills south of Fog Creek and frozen Basal tills over bedrock north of Fog Creek. There is bedrock at or near the surface at Fog Creek. The south side of Fog Creek is a designated borrow source for Watana Dam.

(vi) Environmental Concerns

The entire area traversed by the segment has been identified as Moose and Caribou habitat. Fog Creek has been identified as potential raptor habitat.

(vii) Segment Suitability

The segment is considered suitable for construction with one exception. The alignment does pass through one of the borrow sources for Watana Dam. For this reason segment 2-J was selected and 2-F dropped from further consideration.

(m) Segment 2-G

(i) Description

Segment 2-G begins at Devil Canyon Dam on the south side and follows the side hill upstream while climbing to join segment 2B as both lines turn south away from the Susitna along the top of a deep gorge. This segment is an alternate to 2-B that can conform with design parameters. See Figure 9.5.

Over all length of the segment is 7.7 miles.

(ii) Line and Grade

This segment has acceptable line and grade. The segment was designed to bypass the grade problems of segment 2-B.

(iii) Drainage Features

Standard culverts and ditches will serve all known drainage considerations for this segment.

(iv) Bridges

This segment includes a major structure over Cheechako Creek just after leaving Devil Canyon. This structure would be a three span deck truss over a deep narrow gorge. This type of structure will require one and one half to two years to construct.

(v) Soils

Soils on the segment are varied. Portions of the line cross frozen Basil till with bedrock near the surface, exposed bedrock, and bedrock under Colluvium. Cross slopes are generally steep. This segment will require extensive rock excavation resulting in slow construction.

(vi) Environmental Concerns

The segment passes along the Susitna River banks which have been identified as potential raptor habitat. Extensive side hill construction on fairly steep terrain increases the potential for erosion and slides.

(vii) Segment Suitibility

This segment is suitable for construction should south side road access be selected. There are some scheduling constraints however because of the bridges and the extent of construction in rock.

(n) Segment 2-H

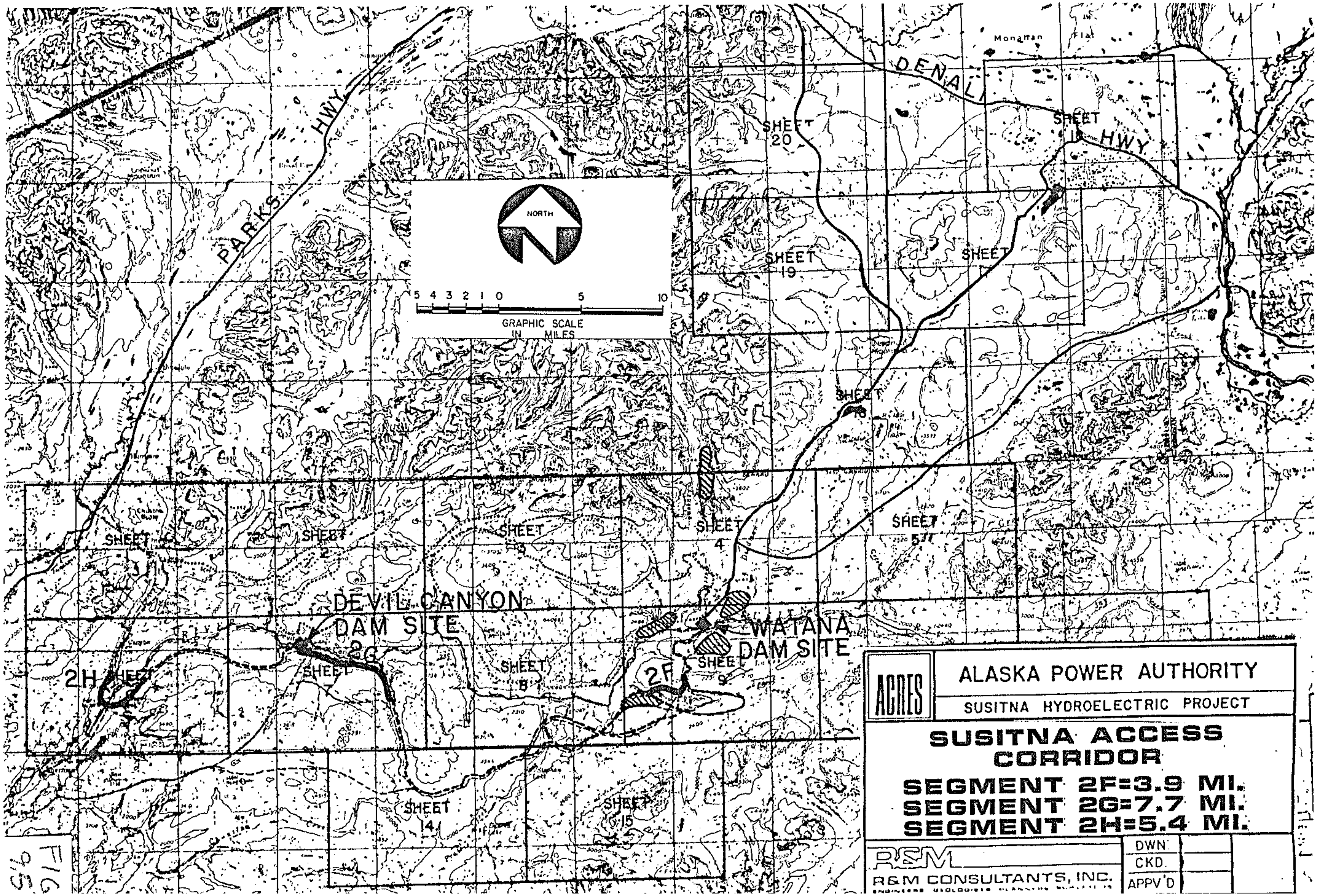
(i) Description

This segment leaves 2-E at Indian River and closely parallels the railroad south across the Susitna River then turns north easterly to connect with 2-I about two miles upstream from Gold Creek. This segment would be one logical route if road access were provided from the Park Highway while providing a rail head at Gold Creek. See Figure 9.5.

This segment is 5.4 miles long.

(ii) Line and Grade

The horizontal and vertical alignments for this segment will meet desired parameters.



PARKS HWY
DENALI HWY
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GRAPHIC SCALE IN MILES
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SHEET 8
SHEET 9
SHEET 14
SHEET 15
DEVIL CANYON DAM SITE
WATANA DAM SITE
2F
2G
2H
ACRES
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
SUSITNA ACCESS CORRIDOR
SEGMENT 2F=3.9 MI.
SEGMENT 2G=7.7 MI.
SEGMENT 2H=5.4 MI.
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(iii) Drainage Features

The only drainage features of note on this segment are Indian River and the Susitna River.

(iv) Bridges

Bridges required on this segment would be similar in configuration to those required at the Susitna River and the first Indian River crossing of Segment 2E. The location will vary from the 2-E location, however the general design would be similar.

(v) Soils

The soils encountered along 2-H are largely floodplain and terrace deposits with portions located on frozen Basil till.

(vi) Environmental Concerns

Both the Susitna River and Indian River are anodromous streams at the proposed crossing. Bridge construction would have to be done in a manner approved by the responsible agencies. No other significant environmental concerns have been identified.

(vii) Segment Suitability

This segment is suitable for construction. All or part may be used depending on the final access plan adopted.

(o) Segment 2-I

(i) Description

This segment is located on the south side of the Susitna River slowly assending in elevation to reach the south end of Devil Canyon Dam. The segment begins about 2 miles above Gold Creek. See Figure 9.6.

The segment is 11.4 miles long.

(ii) Line and Grade

This segment has very good horizontal and vertical alignment generally providing an alignment that will be better than the required minimums would provide.

(iii) Drainage Features

Several drainages cross this segment. Some of these may require large culverts such as multiplate or pipe arches of a type common to highway construction. A portion of the alignment follows a small drainage, care must be taken to protect this stream.

(iv) Bridges

It does not appear that any bridges will be required on this segment. There are two drainages where final design may dictate a small bridge however nothing that would be a significant schedule constraint.

(v) Soils

Nearly all of this segment traverses frozen Basal till on side slopes varying from flat to moderately steep. Care must be taken not to cut so deep as to disturb the thermal regime without insulation or other special features to protect the underlying conditions. Large quantities of borrow will be required for this section because of the frozen soils.

(vi) Environmental Concern

No major environmental concerns have been identified along this segment. There are small wetland areas that must be considered in final design.

(viii) Segment Suitability

This segment is suitable for construction of roadway. Access to Devil Canyon from Gold Creek could be provided fairly rapidly via this segment.

(p) Segment 2-J

(i) Description

This segment provides an alternative to 2A around Stephan Lake and the borrow area near Fog Creek. The alignment moves north of 2A as is passes Stephan Lake to avoid some wetland and bad soil areas then crosses 2A and runs south and east of 2A joining 2F north of Fog Creek. See Figure 9.6.

The segment is 12.2 miles long.

(ii) Line area Grade

This segment has good line and grade its entire length. There are some maximum (6%) grades at Fog Creek.

(iii) Drainage Features

This alignment crosses several small drainages of the type normally handled with culverts. There appears to be no significant drainage problems.

(iv) Bridges

There is a major bridge over Fog Creek. This bridge would be similar to the structure required on 2-F, multispan, and approximately 500 feet in length. It may be possible to use a welded plate girder structure rather than a truss. If so, some six to twelve months could be saved on the construction schedule when compared to the bridges on 2-F. This bridge will still require a year to build.

(v) Soils

The soils along this segment are largely Lusterines over frozen Basal tills. These soils are sensitive and require care in designing slopes, ditches and other features to avoid erosion, frost heave and thaw settlement. Cross slopes are generally gentle to moderate thus allowing cuts to be kept to a minimum.

(vi) Environmental Concerns

The entire segment traverses quality wildlife habitat. Moose, Bear, Caribou, Raptors, and Furbearers use this area. The segment does stay further from Stephan Lake, other than that the impacts would be comparible to 2A.

(vii) Segment Suitability

The segment is suitable for construction. It has two advantages over 2A in that it is further from Stephen Lake and the associated environmental concerns and it skirts the edge of borrow area H for Watana Dam.

(q) Segment 2-K

(i) Description

This segment was proposed as a shorter alternative to a portion of 2-H. The segment leaves 2E as the south side of the Susitna River and turns sharply east climbing to join 2H on top of a bluff. See Figure 9.6.

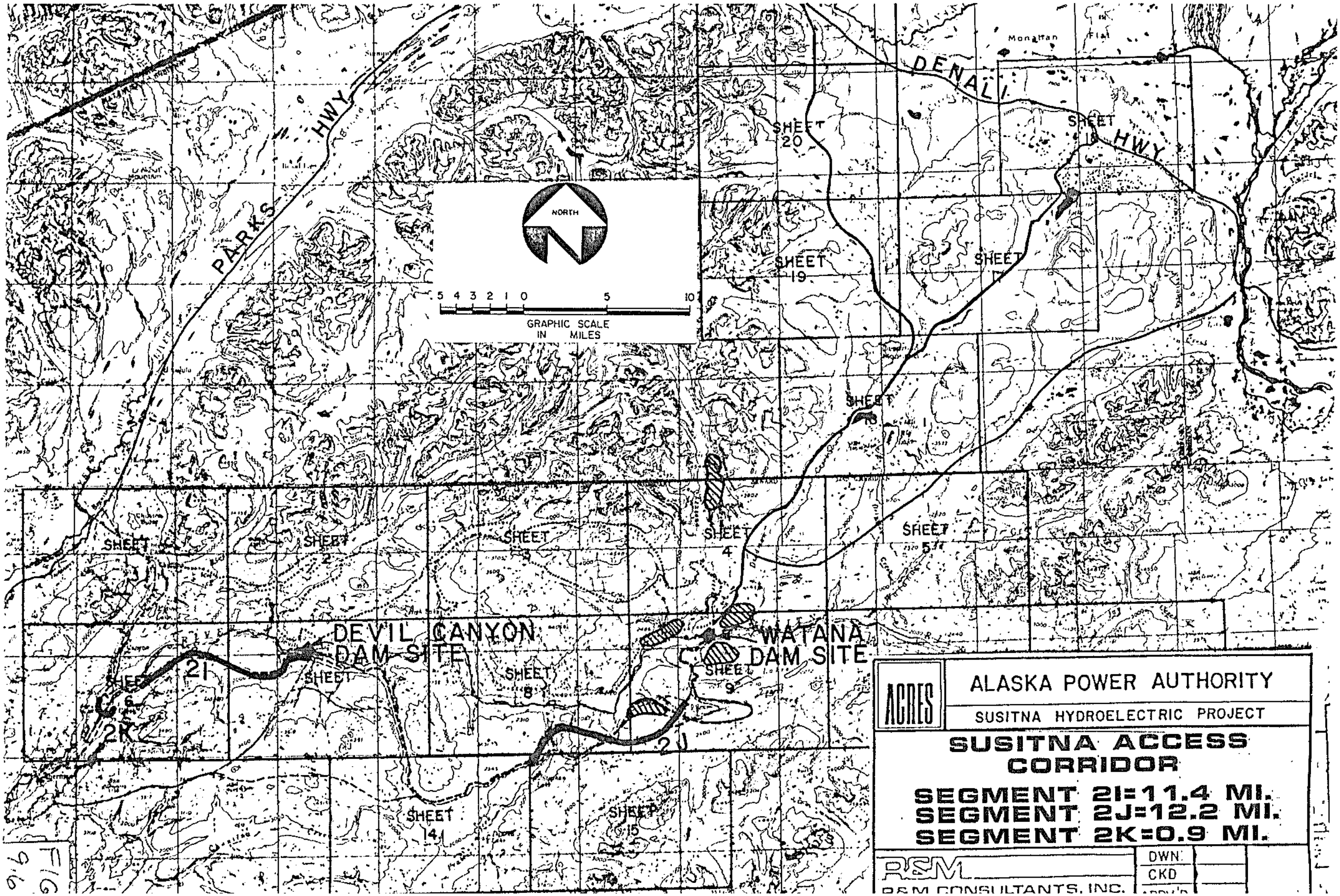
This segment is only 0.9 miles long.

(ii) Line and Grade

This segment conforms to the required parameters however maximum curvature and gradients are involved.

(iii) Drainage Features

No significant drainage features are encountered by this segment.



PARKS HWY
DENALI HWY
NORTH
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GRAPHIC SCALE IN MILES
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SHEET 14
SHEET 15
DEVIL CANYON DAM SITE
WATANA DAM SITE
2I
2J
2K
ACRES
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
SUSITNA ACCESS CORRIDOR
SEGMENT 2I=11.4 MI.
SEGMENT 2J=12.2 MI.
SEGMENT 2K=0.9 MI.
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CKD

FIG 9.6

(iv) Bridges

No bridges are involved on this segment.

(v) Soils

The soils crossed are flood plain deposits and frozen Basal tills. Much of the alignment would require high fills constructed of borrow. Some cuts in frozen material are also likely as the line joins 2-H on top of the bluff.

(vi) Environmental Concerns

No major environmental conflicts appear along this segment.

(vii) Segment Suitability

The segment is suitable but not desirable due to the use of maximum curves and grades and the requirment for high fills.

(r) Segment 2-L

(i) Description

This segment is parallel to 2E connecting 1-A at Chulitna Pass with 2-I east of Gold Creek. Portions are coincident with 2E. The primary purpose of this alternate is to provide a line that has less potential for conflict with a State of Alaska Land disposal tract. Another potential Susitna River crossing is identified that allows the alignment to avoid going over or around a short, high bluff. See Figure 9.7.

This line is 8.7 miles long.

(ii) Line and Grade

The horizontal and verticle alignments for segement 2-L satisfy all requirements.

(iii) Drainage Features

No abnormal drainage features are encountered. There are several small cross drainages suitable for conventional culverts.

(iv) Bridges

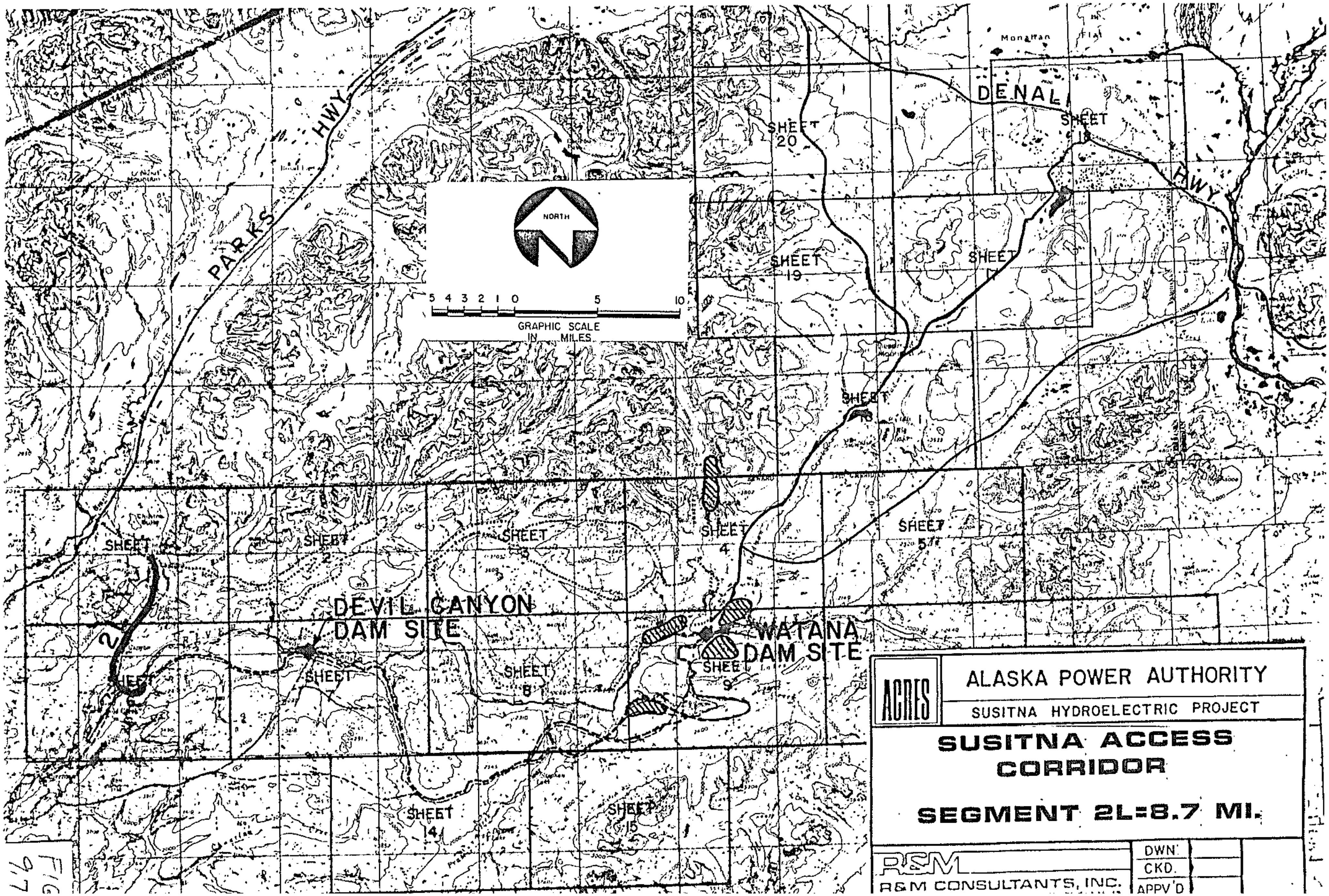
The Susitna River must be crossed. This structure can be a mulitspan continuous welded plate girder structure. The over all length is such that approximately two years will be needed to construct this structure. This segment also requires one bridge over Indian River. This would be a three span continuous welded plate girder structure about 400-foot in length.

(v) Soils

The soils traversed by the segment are predominately frozen Basal till. Care must be taken to avoid disturbing the thermal balance. The side slopes are moderate. The line is intended to stay along the break just on the top of a bluff along Indian River.

(vi) Environmental Concerns

There are salmon using Indian River, therefore care should be taken to minimize erosion. There is private property close to the line. Property owners have expressed a negative feeling about having any access facility near them.




ACRES

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS CORRIDOR**

**SEGMENT 2L=8.7 MI.**

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(vii) Segment Suitability

The segment is suitable for construction and would be preferable to the corresponding section of 2E. It reduces the possibility of any potential encroachment on private property. The line requires one less crossing of Indian River than does 2-E, and provides a good crossing of the Susitna while eliminating the need to build over or around a bluff on the south side of the Susitna River.

(s) Segment 2-R

(i) Description

This segment is the principle rail alternative identified for the project. The alignment is within corridor 2 on the south side of the Susitna. The line would begin at the railroad at Gold Creek traversing a short section of steep terrain at water level then becoming coincident with Segement 2-I all the way to Devil Canyon. From Devil Canyon 2-R traverses the side hill above the Susitna River parallel to and below segment 2-G turning south and requiring a full bench cut up the side of a steep gorge to the Prairie Creek divide above Stephan Lake. From this point the segment is essentially coincident with Segment 2-A all the way to Watana Dam except for a few sections that require wider swings to maintain the acceptable grades. See Figure 9.8.

The line is 57.7 miles long.

(ii) Line and Grade

The line conforms with the desired parameters for railroad construction. The ruling grade is approximately 2.5% which we are advised is comparable to some mainline sections on the Alaska Railroad.

(iii) Drainage Features

Drainage features along the route include the same small streams and wet areas encountered by the roadway segments. Culverts will handle most cross drainages although a few will be large enough to require multiplate or pipe arch type structures. There are some wetland areas that must be considered also, particularly near Stephan Lake.

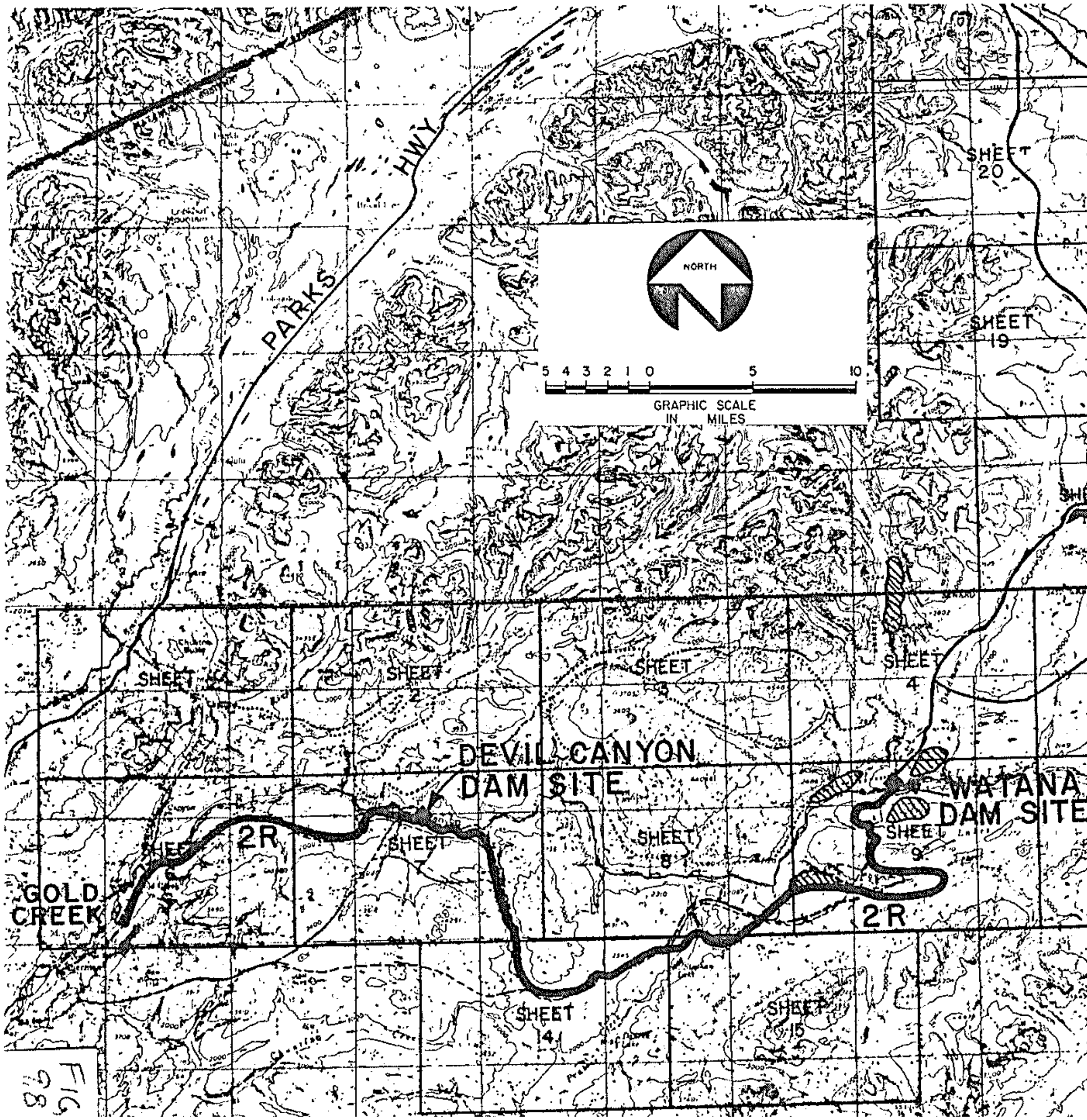
(iv) Bridge

The railroad alignment required only one major bridge. That is across Cheechako Creek just upstream from Devil Canyon. This will probably be a Deck Truss requiring three spans. This type of structure will require about two years to build and no rail service could be provided with any sort of bypass.

(v) Soils

This alignment crosses the same general soil type as other segments described. Much of the alignment is on frozen soils that tend to be subject to erosion, frost heave, and thaw settlement with a few sections of deep organic soils and one section between Devil Canyon and Stephan Lake having very heavy rock work.

This line also crosses the massive ice area near Stephan Lake.




ACRES

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

# SUSITNA ACCESS CORRIDOR

## SEGMENT 2R=57.7 MI.

R&M

R&M CONSULTANTS, INC.

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FIG 98

(vi) Envrionment Concerns

The Environmental concerns for the railroad are the same as for the roadway. The primary area of environmental concern is near Stephan and Fog Lakes 2-R does encroach on the borrow area H for Watana Dam.

(vii) Segment Suitability

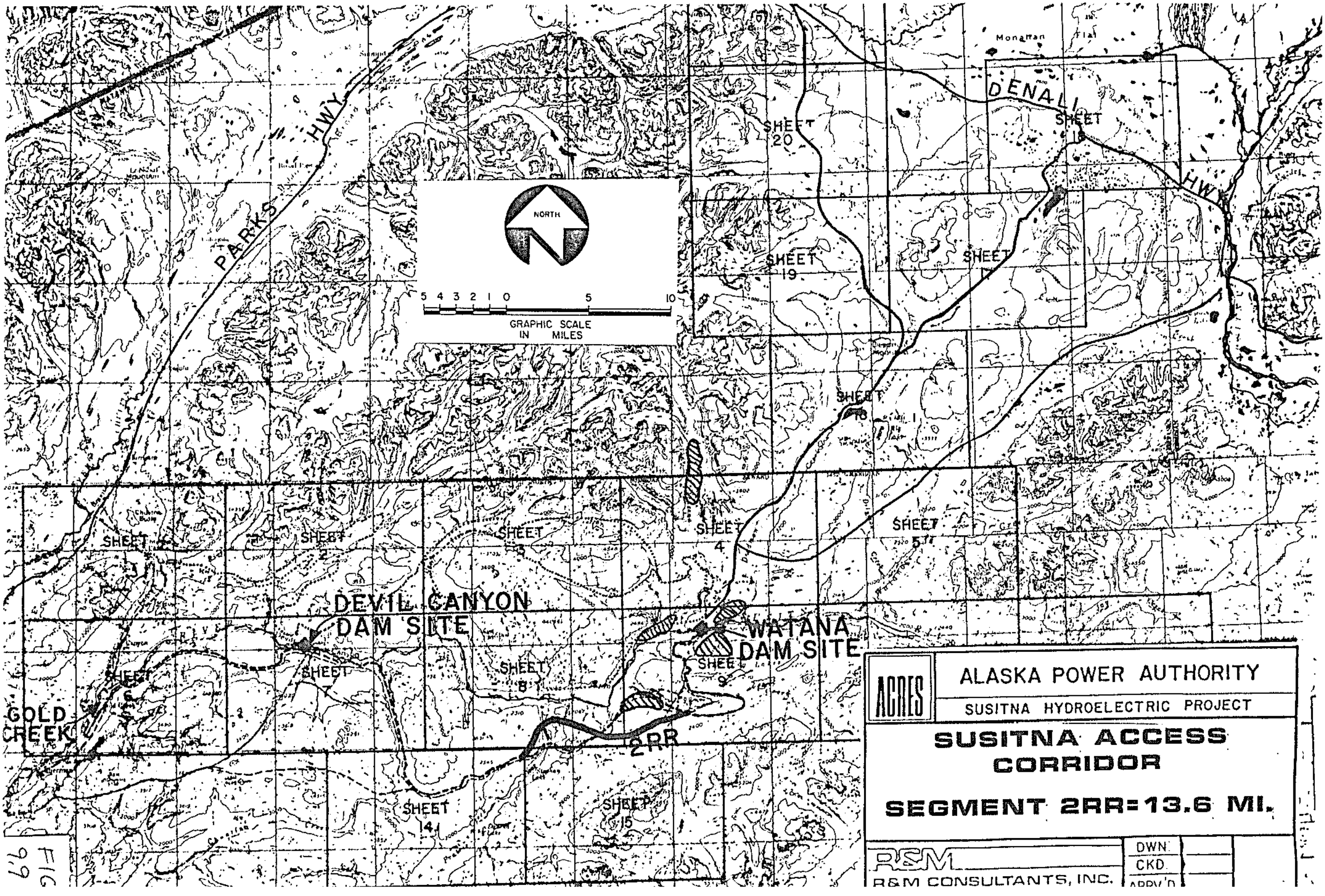
If Railroad is chosen for access this segment is quite suitable. There are however certain schedule constraints to be considered. The Cheehako Creek bridge is a two year construction project. The portion of road bed from Devil Canyon to the Prairie Creek divide is, to a large extent, a rock excavation project requiring extensive blasting. This section alone will take a construction season. The terrain south of the Susitna makes winter mobilization very difficult if not impossible. Summer supply would require extensive roads and resulting environmental damage. It appears that construction of rail access to Watana would require three to four years.

(t) Segment 2-RR

(i) Description

This segment is an alternate railroad alignment in the Stephan Lake area which avoids the worst soils conditions of Segment 2-R in this vicinity. See Figure 9.9.

Length of the segment is 13.6 miles.




ACRES

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS CORRIDOR**

**SEGMENT 2RR=13.6 MI.**

R&M

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DWN. CKD. APPV'D.

FIG 9.9

(ii) Line and Grades

The alignment conforms to the required parameters for line and grade with no distinct advantage over 2-R.

(iii) Drainage Features

There are no unique or special drainage features on this segment. Standard drainage practice will serve adequately.

(iv) Bridges

No Bridges are required on this segment.

(v) Soils

The soils are predominately frozen Basal till or Lusterines over frozen Basal till. These materials require care in design and construction. They are common to all segments however.

(vi) Environmental Concerns

All environmental conflicts have been identified. They are essentially the same as for 2-R.

(vii) Segment Suitability

This segment does have some advantage over 2-R in that it avoids the worst of the organic soils near Stephan Lake and avoids borrow area H as designated for construction of Watana Dam.

(u) Segment 3-A

(i) Description

Segment 3-A begins at Watana Dam on the north side of the river. The alignment proceeds north easterly to Deadman Creek then ascends Deadman Creek on an easy grade past Deadman Lake, continuing onto Butte Lake and connecting with the Denali Highway some 40 miles east of Cantwell. See Figure 9.10.

The line is 38.5 miles long.

(ii) Line and Grade

The horizontal and vertical alignment of this segment are excellent.

(iii) Drainage Feature

All streams and intermitent drainages on this alignment could be served by culverts of varying sizes.

(iv) Bridges

There are no bridges on this alignment

(v) Soils

The soils traversed along this alignment are unfrozen till, frozen Solifluction deposits, flood plain deposits, alluvial fans and Lusterines. The cross slope, with few exceptions are gentle enough so that major cuts and fills can be avoided. This will keep the disturbance of erodible and/or frozen soils to a minimum. The needed borrow areas to provide embankment over frozen soils will be much less than for other segments discussed so far.

(vi) Enviornment Concerns

The environmental concerns identified to include archaeological finds near Deadman and Butte Lakes. A known Bald Eagle nest tree, and the fact that much of the line traverses areas sometimes used by the Nelchina Caribou herd as calving grounds and summer range.

(vi) Segment Suitability

This segment is suitable for roadway construction. The terrain is gentle enough that by using mulitple contracts and winter mobilization this entire alignment could be made possible in a single construction season, thereby minimizing any potential schedule impact on construction of Watana Dam.

(v) Segment 3-B

(i) Description

This segment leaves 3-A at Deadman Creek and proceeds east into the Watana Creek drainage. The line proceeds up Watana Creek to its head then follows Butte Creek northeasterly to an intersection with the Denali Highway at the Susitna River. See Figure 9.10.

This line is 36.6 miles long.

(ii) Line and Grade

All desired parameters for line and grade are satisfied.

(iii) Drainage Features

No abnormal drainage feature are encountered although crossings of Deadman Creek and Butte Creek are required. These will necessitate small bridges or large pipe structures.

(iv) Bridges

At this time no bridges are planned. The crossing of Deadman and Butte Creek could be accomplished using Pipe arch structures that are much faster and more economical than bridges.

(v) Soils

The soils along this alignment are similar to thoses encountered along 3-A except that more wet ground is encountered as the Denali Highway is approached. The soils along this line were not mapped in detail.

(vi) Environmental Concern

This alignment also serves known Caribou calving grounds.

(vii) Segment Suitability

This segment has been detemined to be less suitable that 3A or 3C for the following reasons.

- The crossings of Deadman and Butte Creeks

- Intersects Denali Highway furtherst from the potentail railhead at Cantwell, thereby increasing haul distance and the length of Denali Highway to be maintained.

(u) Segment 3-C

(i) Description

This segment leaves 3-A north of Deadman Lake and travels northerly to intersect the Denali Highway west of Seattle Creek some 25 miles east of Cantwell. See Figure 9.10.

This segment is 23.4 miles long.

(ii) Line and Grade

The line and grade for this line are excellent comparing favorably with 3-A.

(iii) Drainage Features

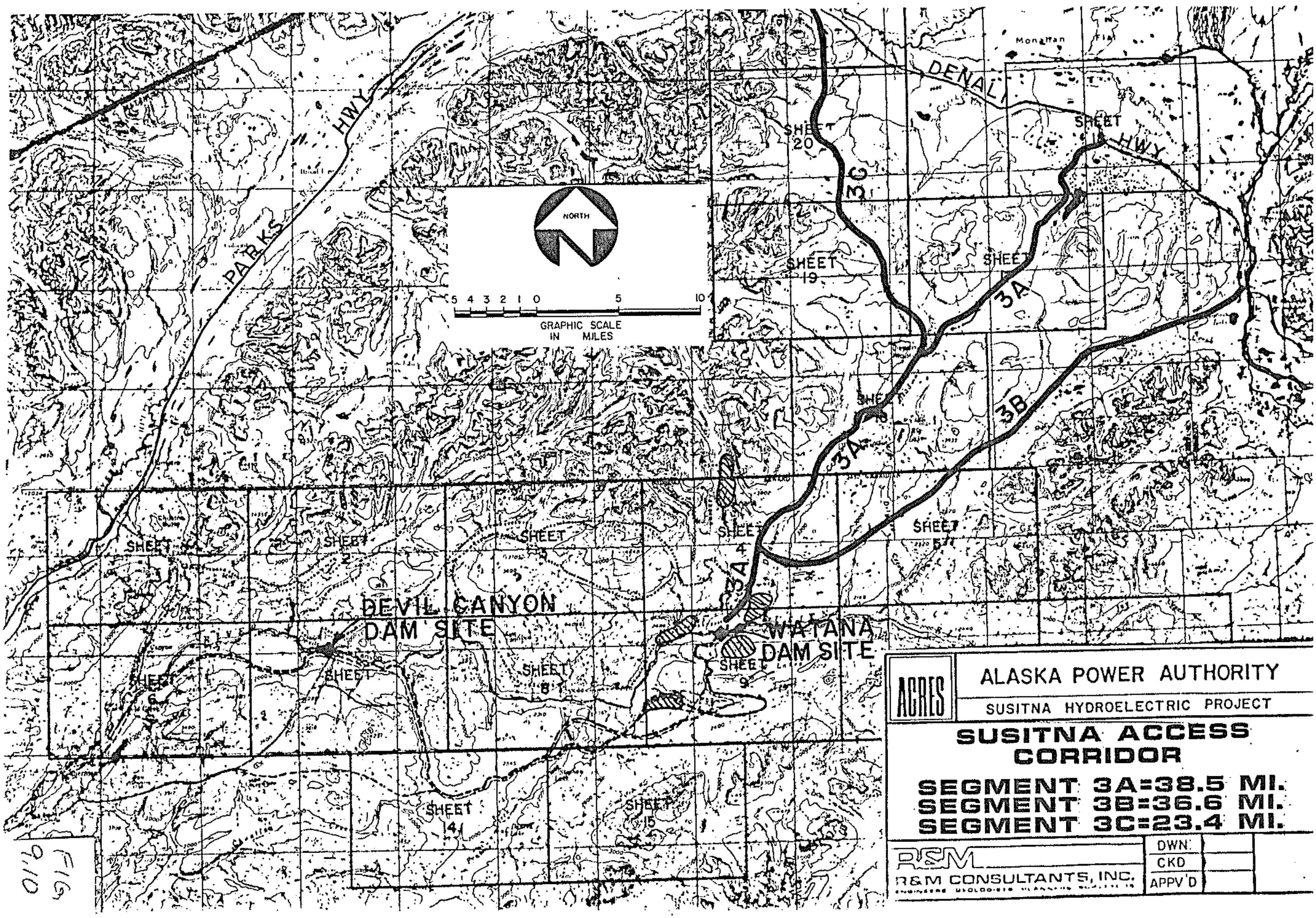
Drainage for the alignment will be by roadside ditches and standard culverts.

(iv) Bridges

No Bridges are required on the alignment.

(v) Soils

This segment shows the largest amounts of unfrozen materials of any line investigated. Because of terrain and soil types nearly all of this alignment can be constructed with side borrow techniques requiring a minimum of disturbance away from the alignment.




ACRES

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS CORRIDOR**

**SEGMENT 3A=38.5 MI.**
**SEGMENT 3B=36.6 MI.**
**SEGMENT 3C=23.4 MI.**

R&M CONSULTANTS, INC.

| DWN. | |
|---|---|
| CKD | |
| APPV'D | |

FIG 9.10

(vi) Environmental Considerations

This line avoids most of the area identified as caribou calving area. Summer caribou range is traversed, however little other environemental impact is identifiable from construction activities.

(vii) Segment Suitabiltiy

This segment appears to be quite suitable for implementation. It largely avoids the principle environmental concern pertaining to caribou calving. It can be made passable in a single construction season and it requires the least maintenance on the Denali Highway.

## 9.3 - Corridor Summary

With the various segments identified and estimates made of grades and curvature a series of probable combinations were developed and compared. The criteria used to compare the alternative combinations are as follows:

- Overall length to be constructed;
- Average grade;
- Average deflection per mile.

The tabulation of the comparison in included in Appendix A.

The alternatives identified as being most favorable based on length, alignment and grade are as follows:

For Corridor 1. Parks Highway to Watana Dam site - North side Segments 1-A and 1-B.

| | |
|---|---|
| Overall | 72.50 Miles |
| Average Grade | 2.4% |
| Deflection Per Mile | 7°06'+ |

This Corridor will be identified as Alternate A in further studies.

For Corridor 2. Parks Highway to Watana Dam Site - South Side Segments 1-E, 2-L, 2-I, 2-G, 2-B, 2-A, 2-F

| | |
|---|---|
| Overall | 62.03 Miles |
| Average Grade | 2.2% |
| Deflection Per Mile | 7.°50°± |

This Corridor will be identified as Alternate B in further studies.

For Corridor 3. Watana Dam to Denali Highway Segment 3-A and 3-C

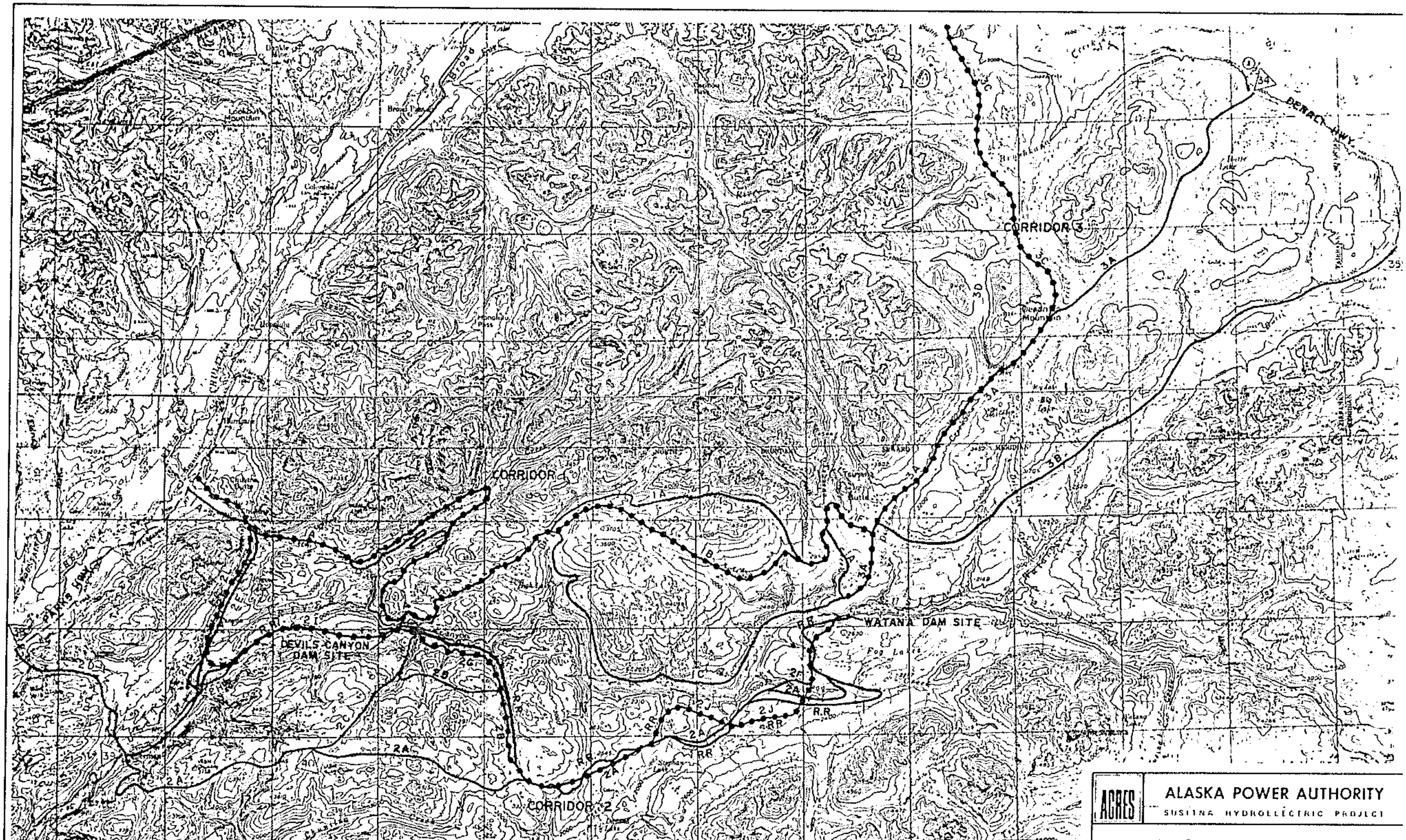
| | |
|---|---|
| Overall | 44.32 Miles |
| Average Grade | 1.3% |
| Deflection Per Mile | 1°30'± |

This Corridor will be identified as Alternate C in further studies.

For Railroad. Use 2-R and 2-RR on the south side of the river from Gold Creek to Watana Dam site. This closely follows the preferred road alignment for Corridor 2.

| | |
|---|---|
| Overall | 57.86 Miles |
| Average Grade | 1.5% |
| Deflection Per Mile | 5°11'± |

This line will be identified as Alternate R in further studies.




PREFERED ROUTE IN EACH CORRIDOR

OTHER ALTERNATES INVESTIGATED

REV

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ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

## PROJECT ACCESS LOCATION ALTERNATIVES

SCALE:

FIG 9.11

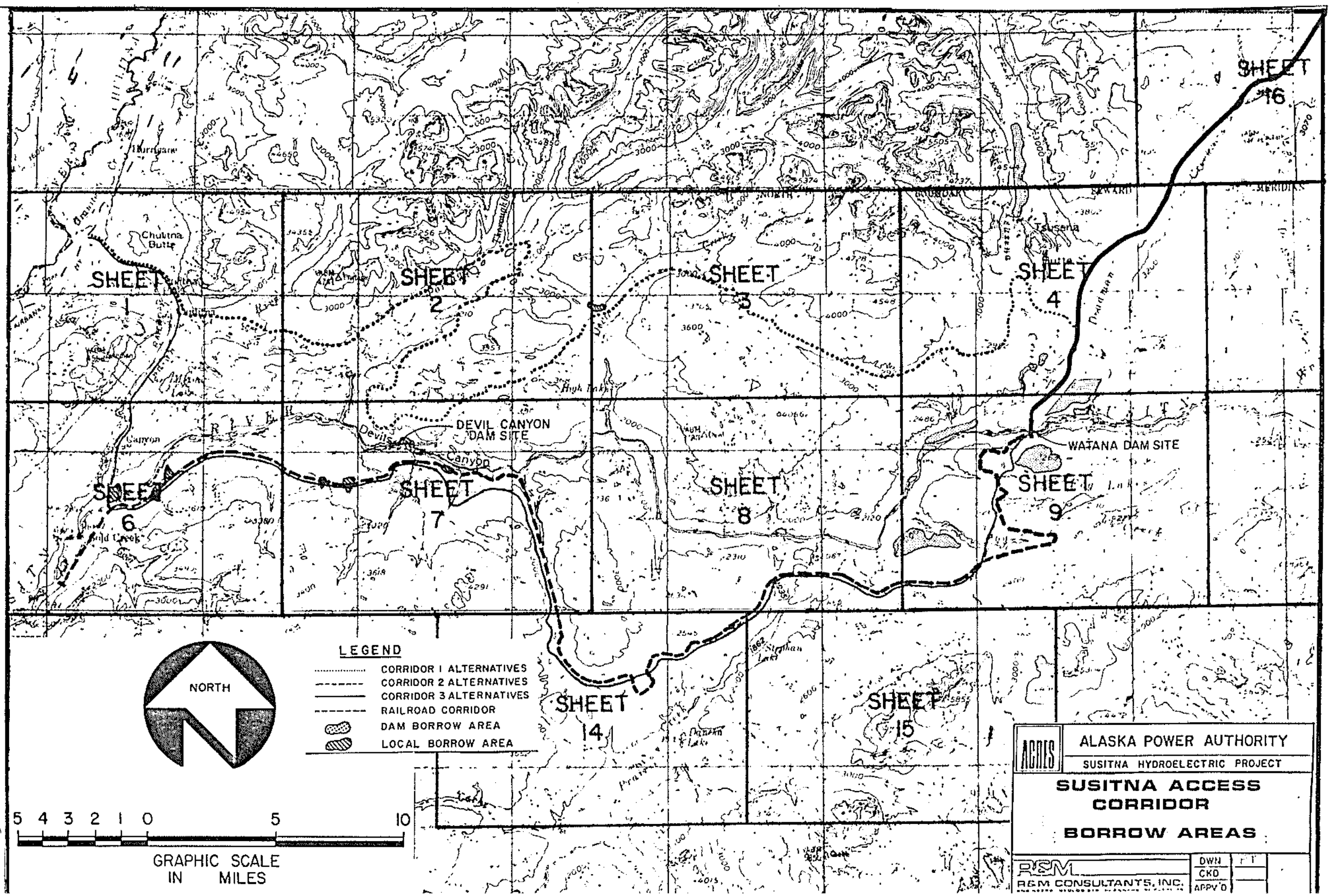

SHEET 1
SHEET 2
SHEET 3
SHEET 4
SHEET 6
SHEET 7
SHEET 8
SHEET 9
SHEET 14
SHEET 15
SHEET 16
DEVIL CANYON DAM SITE
WATANA DAM SITE
Chulitna Butte
Devils Canyon
High Lake
Tsusena Butte
Gold Creek
NORTH
LEGEND
CORRIDOR 1 ALTERNATIVES
CORRIDOR 2 ALTERNATIVES
CORRIDOR 3 ALTERNATIVES
RAILROAD CORRIDOR
DAM BORROW AREA
LOCAL BORROW AREA
5 4 3 2 1 0 5 10
GRAPHIC SCALE IN MILES
ACRES
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
SUSITNA ACCESS CORRIDOR
BORROW AREAS
R&M CONSULTANTS, INC.
DWN
CKD
APPV'D

Fig 9

# ACCESS PLANS

## 10 - ACCESS PLANS

The Access plan selected should provide a cost effective method of serving the total requirements of the project, including construction schedule, provide a facility that can serve the ultimate recreational uses following construction, provide for maintance of the facilities, and control or minimize the impact on the environment.

### 10.1 - Supply Sources and Shipping Options

Nearly all material supplies and equipment that will be required for construction of the Susitna project will have to be brought in from outside Alaska. The major exception to this is fuel which is available from two separate in state sources.

For this reason an assumption has been made that all such items other than explosives will be shipped from Seattle, Washington. Explosive will be shipped through Prince Rupert B.C. It is felt that this is reasonable in that sources of supply and transportation within the Continental United States will be identical for all alternatives and that differences in shipping costs will result from Port of Entry in to Alaska and differences in modal split and route traveled within the state.

Sources of fuel within the state are the refineries at Kenai and at North Pole, Alaska. Transport from Kenai would be via product pipe line to Anchorage and rail or truck from Anchorage. Transport from North Pole would be via rail or truck.

Shipping options include a variety of transportation modes. There is no direct rail connection to Alaska therefore all items brought in from elsewhere must come by sea or air. Air Transport will not be adressed because of the costs involved and the limitation on quantities. Ships and barges will be most likely be used to bring most items to Alaska. Trucks could be used, however the rate disparity between sea and trucking makes trucking very unattractive. The barges offer some options with regard to connecting land transportation modes.

- Roll-on Roll-off Rail Cars
- Roll-on Roll-off Trucks
- Containers
- Pallatized Cargo
- Bulk Cargo

The type and quantities of materials and supplies required by the project are such that the roll-on roll-off modes and containers are the obvious choice because of the reduced need for storage and handling.

Once the materials are in Alaska the shipping options are reduced to rail or truck. Rail can offer bulk car load transport or piggy back from the dock to the project rail head. Trucks are capable of moving everything from either the dock or the project railhead.

## 10.2 - Alaska Ports

The sea ports within Alaska that could serve the project are:

- Anchorage
- Seward
- Whitter
- Valdez

### (a) Anchorage

(i) Facilities

- Petroleum Terminal - 612 feet long with multiple manifolds and electric hose handling hoists.
- General Cargo Terminal #1 - 600 feet long - 47 feet wide. Live load 600 pounds per square inch, Containers.
- General Cargo Terminal #2 - 610 feet long - 69 feet wide containers and Bulk Cement.
- General Cargo Terminals #3 - 898 feet long - Roll-on Roll-off trucks and containers.
- 35 feet of water MLLW as the dock face.
- Cranes

  - 2 - 40 Ton Level Luffing Gantry
  - 1 - 7½ Ton Level Luffing Gantry
  - 2 - 27½ Ton Container Cranes

- Transit Shed - 52,950 square feet - 22-foot ceiling - heated - Rail and truck access.

- Staging and Storage Areas

  A - 4.6 acres
  B - 6.4 acres
  C - 6.7 acres

(ii) <u>Limitations</u>

- Cook Inlet does form heavy ice floes during the winter months. Tidal fluctuations keep the ice broken up, however there are periodic problems for shipping due to winter ice.

- There is no provision for roll-on roll-off rail.

(b) Seward

(i) Facilities

- One general cargo dock capable of handling a single ship.
- A single 40 ton level luffing gantry.
- Truck and rail service to the dock.
- 20 acres open storage.

(ii) Limitations

- No covered storage
- Limited capacity
- No movement of explosive allowed

(c) Whittier

(i) Facilities

- Single dock with roll-on roll-off rail capacity
- Rail switchyard for storing cars from barge and making up train.

(ii) Limitation

- No truck access

(d) Valdez

(i) Facilities

- 600' x 60' wooden dock

- 33-foot of water MLLW at the dock face
- 1 - 150 ton crawler crane
- 1 - 100 ton fork lift
- 2 - 30 ton fork lifts
- 3 - 9 ton fork lifts
- 5 - 3 ton fork lifts
- 200 acre open storage area four miles from dock
- 12,000 square foot warehouse at dock
- Two private barge docks having 0- to 1-foot of water at MLLW. Both were used during the Trans-Alaska pipe line construction.
- New dock under construction is a floating dock 700' x 100' with live load capacity of 1,000 lb./sq.ft. and served by two 150 ton crawler cranes. Work should be completed in 1982.

(ii) Limitations

- No railroad access

(e) Comparisons

Anchorage is closest to the project and has the greatest flexbility. Winter ice and the lack of roll-on roll-off rail capability not withstanding Anchorage is a viable sea port for the project.

Seward is a longer haul than Anchorage and does not have the capacity of Anchorage however it is an ice free port and could be used nicely as an alternate should ice conditions or volume of traffic become such that there would be delays in reaching Anchorage. For this reason Sewared is not considered further except as an alternate if needed. It must be noted that explosives cannot flow through Seward.

Whitter is a viable port for all items that can be shipped via rail car load lots. The roll-on roll-off rail barge capability is very attractive for bulk items and heavy equipment. Whitter is an ice free port so that material can flow year round.

Valdez apparently will have the capacity to handle the material flow however this is the longest truck haul and there is no rail access to Valdez. The lack of rail acess and the length of truck haul combine to effectively eleminate Valdez from consideration as a viable sea port to serve the Susitna Project.

TABLE 10.1
Mileage from Ports to Rail Head or Project

| | Anchorage | Seward | Whitter | Valdez* |
|---|---|---|---|---|
| Rail Haul to | | | | |
| Gold Creek | 149 mi | 262 | 211 | NA |
| Devil Canyon | 165 mi | 278 | 227 | - |
| Cantwell | 205 mi | 318 | 267 | NA |
| Watana via Devil Canyon | 207 mi | 320 | 269 | - |
| Truck Haul to | | | | |
| Gold Creek, via B-1 | 180 | 307 | NA | |
| Devil Canyon | 193 | 320 | NA | 393 mi |
| Cantwell | 212 | 339 | NA | |
| Watana via Devil Canyon, B-3 | 229 | 356 | NA | |
| Watana via Denali Highway | 277 | 404 | NA | 349 mi |
| Watana via Devil Canyon, A-2 | 234 | 361 | NA | |

* The road milage from Valdez is shown via Denali Highway and Richardson Highway and Corridor 3.

The access plans must include the ports through which materials should flow. For comparison purposes shipping rates through the possible ports were requested. Table 10.2 below includes "across the dock" costs including handling as derived from the data supplied by port offices and shippers.

TABLE 10.2
ACROSS THE DOCK HANDLING COSTS

| Material From Seattle (6) | Cost in $/Ton (1) To Anchorage | (2) To Seward | (4) To Whittier | (1) To Valdez |
|---|---|---|---|---|
| Reinforcing Steel | 72.00 | 72.00 | 55.00 | 86.00 |
| Structural Steel | 85.40 | 85.40 | 55.00 | 125.00 |
| Cement | 66.00 | 66.00 | (3) 55.00 | 80.00 |
| General Cargo | 80.00 | 80.00 | 55.00 | 110.00 |
| Equipment | 160.00 | 160.00 | 120.00 | 191.00 |
| Explosives | 89.00 | Not Allowed | 55.00 | 115.00 |

1 Quoted by Pacific Western.

2 Information not received - Estimated equal to Anchorge.

3 Rate for 140,000 lb Hopper Cars - Rates for Bags 100.00/ton as per ARR.

4 Rates derived from quotion by ARR.

5 Includes Stevedoring at all ports.

6 Explosives must flow through Prince Rupert, B.C.

## 10.3 - Surface Transportation Modal Options

There are two obvious modes of transportation available to serve the project, Truck and Rail. The project may be served by either one or a combination of both. In order to compare the two modes the respective rates are presented in ton-mile figures. In this way length of haul may be considered in the analysis.

TABLE 10.3
LINE HAUL RATES IN $/TON-MILE

| Item | Rail* | Truck** |
|---|---|---|
| Equipment | 0.1878 | 0.2069 |
| Steel | 0.2577 | 0.2069 |
| Cement | 0.1565 | 0.2069 |
| Fuel | 0.1450 | 0.2069 |
| General Cargo | 0.1262 | 0.2069 |
| Explosives | 0.6267 | 0.2069 |

* From price per 100 Lb. rates quoted by ARR.
** One rate for all quoted by three separate truck lines. The cost shown is an average of three rates.

The modal alternates that seem most probable include the following:

- Truck from port to the site.
- Rail from port to the site.
- Rail to Gold Creek or Cantwell and truck from the rail head to the site.

## 10.4 - Access Plans

To this point three alternative Corridors have been defined. Estimates have been made of the amounts of materials required at each site and freight handling costs have been identified for the available transportation modes and ports. The three major costs pertaining to access are logistics, construction and maintenance. Estimated construction costs are outlined. Maintenance costs will not be estimated in detail. Instead, an estimate of the relative difference in difficulty of maintenance will be applied to an average maintenance figure of $10,000 per mile per year. Alaska Department of Transportation and Public Facilities records show an average annual maintenance cost of $10,000 per mile for primary highways.

TABLE 10.4

MAINTENANCE FACTORS

| | Section | Maintenance Factor* |
|---|---|---|
| A-1 | Parks Highway to Portage Creek | 1.0 |
| | Portage Creek - Devil Canyon | 1.4 |
| A-2 | Devil Canyon - Watana | 1.0 |
| B-1 | Parks Highway to Gold Creek | 1.0 |
| B-2 | Gold Creek to Devil Canyon | 1.2 |
| B-3 | Gold Creek to Stephan Lake | 1.3 |
| | Stephan Lake to Watana | 1.0 |
| C | Denali Highway to Watana | 0.8 |
| R-1 | Gold Creek to Devil Canyon | 0.5 |
| R-2 | Devil Canyon to Stephan Lake | 0.7 |
| | Stephan Lake to Fog Creek | 0.6 |

* Based an author's past experience.

The alternate corridors identified herein are split into sections for further analysis. Those sections are as follows:

TABLE 10.5
BASIC CORRIDOR SEGMENTS

| Section | Description |
|---|---|
| A-1 | Parks Highway to Devil Canyon (north side) |
| A-2 | Devil Canyon to Watana (north side) |
| B-1 | Parks Highway to Gold Creek |
| B-2 | Gold Creek to Devil Canyon (south side) |
| B-3 | Devil Canyon to Watana (south side) |
| C | Denali Highway to Watana |
| R-1 | Gold Creek to Devil Canyon |
| R-2 | Devil Canyon to Watana |

The access plans outlined below are made of combinations of the above listed corridor segments.

(a) Plan I

(i) Description

Access Plan I is a basic roadway plan beginning at the Parks Highway and serving both Devil Cayon and Watana dams from the south side of the river. See Figure 10.1.

(ii) Sea Ports

There are two sea ports that appear logical for serving the project. Anchorage and Whittier. These are common to all access plans. Seward is available as an emergency backup to Anchorage. All items that can be shipped in carload lots should enter the State through Whittier because of the rail barge facility. Information provided by railroad officials indicates that this facility can handle any rail load that can be shipped on main line trackage in the continental United

States and fit on the barge. Other cargo should be containerized for shipment through Anchorage because of port capacity and available area for short term storage.

(iii) Modal Split

The split in transportation modes is consistant through all plans. Based on ton mile freight costs, the railroad should be used to as near the project as practical for all items except explosives. Therefore the rail mode should be used for all items to a rail head at Gold Creek. For Plan I, a rail head should be provided at Gold Creek with truck haul from Gold Creek to the work site.

(iv) Sections Included

The corridor sections included in Plan I include B-1, B-2, and B-3.

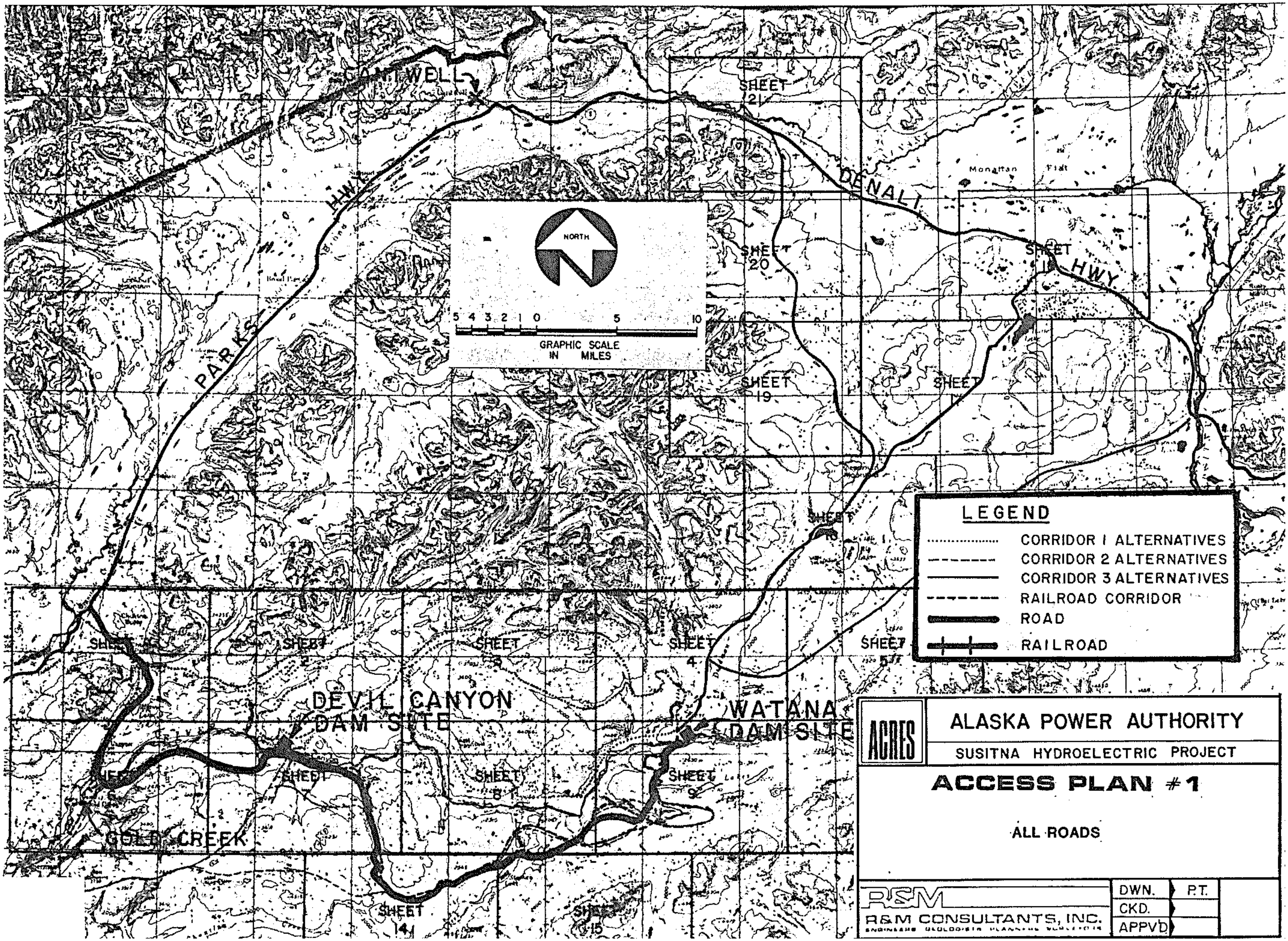
(v) Cost Estimates

The estimated cost of Plan I in 1982 dollars is outlined below:

| | |
|---|---|
| Construction (D&C) | $158,140,152 |
| Maintanance | 7,996,640 |
| Logistics | 214,438,346 |
| TOTAL | 380,575,138 |

(vi) Advantages/Disadvantages

This plan has the advantages of being the shortest haul to serve the project and a further advantage of requiring just a single rail head at Gold Creek while utilizing the same section from Gold Creek to Devil Canyon throughout the construction of both dams.


CANTWELL
PARKS HWY.
DENALI HWY.
NORTH
5 4 3 2 1 0 5 10
GRAPHIC SCALE IN MILES
SHEET 21
SHEET 20
SHEET 19
SHEET 18
SHEET 17
SHEET 11
SHEET 2
SHEET 3
SHEET 4
SHEET 5
SHEET 7
SHEET 8
SHEET 9
SHEET 14
SHEET 15
DEVIL CANYON DAM SITE
WATANA DAM SITE
GOLD CREEK
LEGEND
CORRIDOR 1 ALTERNATIVES
CORRIDOR 2 ALTERNATIVES
CORRIDOR 3 ALTERNATIVES
RAILROAD CORRIDOR
ROAD
RAILROAD
ACRES
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
ACCESS PLAN #1
ALL ROADS
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Disadvantages deal primarily with schedule constraints and potential environmental impacts. The plan includes a major bridge above Cheechako Creek that will take 18-24 months to construct with about twelve miles of heavy rock construction immediately beyond. The rock work will be slow work and there is no easy access around Cheechako Creek to allow the rock work to proceed coincident with the bridge. In addition, a similar but shorter bridge is required at Fog Creek. The Fog Creek bridge will require approximately 18 months to construct. These time constraints combined with the length of facility to be constructed will require an overall construction period of nearly four years. The terrain is such that construction of multiple sections simultaneously would not be practical. Recent soils investigations have revealed massive ice at or near the surface with up to 20 feet of organic soils in the area north of Stephan Lake.

(b) Plan 2

(i) Description

This plan is the railroad alternative to serve both dams. A spur track would be constructed beginning at Gold Creek and following the south side of the river to Watana Dam. There would be no roadway involved with this plan. See Figure 10.2.

(ii) Sea Ports

Anchorage and Whittier would be the obvious sea ports for this plan. The rail barge capabilities of Whittier would be vital to this plan.

(iii) Modal Split

Transportation would be essentially single mode with all material being transported from the dock to the job site by rail. The movement of personnel would be by rail or by air. The volumes of personnel would probably dictate passenger train service. This service has not been included in the cost estimates.

(iv) Section Included

This plan includes Sections R-1 and R-2.

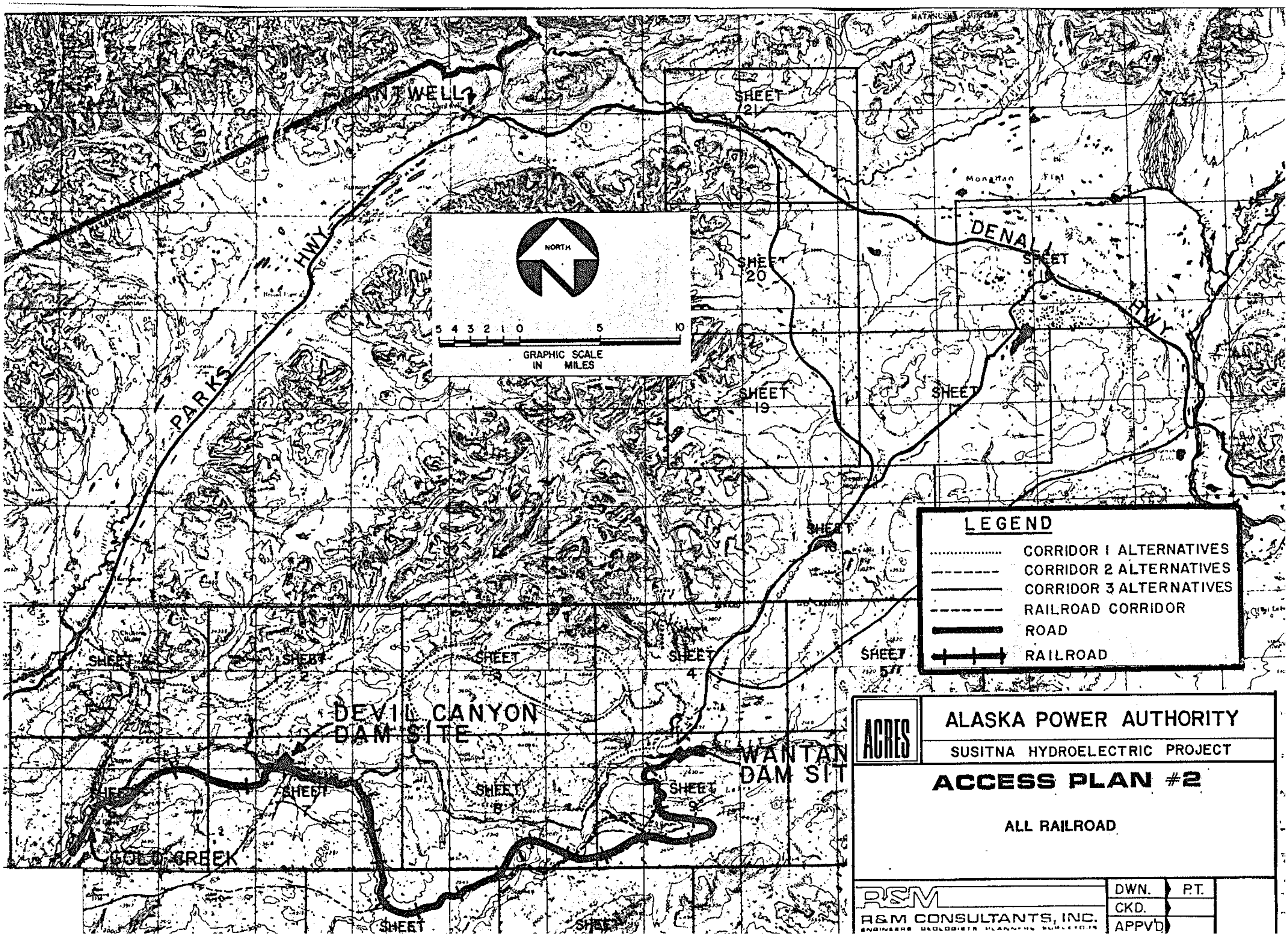
(v) Cost Estimates

The estimated cost of Plan 2 in 1982 dollars is outlined below:

| | |
|---|---|
| Construction (D&C) | 139,786,755 |
| Maintanance | 3,549,670 |
| Logistics | 213,620,014 |
| TOTAL | 356,956,439 |

(vi) Advantages/Disadvantages

- This plan appears to be the least total cost alternate for serving the project.
- This plan essentially eliminates concern about the impact of public access to the project area.
- The rail line could be used as a transportation facility to aid in potential mineral resources along part of the route.
- Least cost to maintain
- Least Logistics cost



CANTWELL
PARKS HWY
DENALI HWY
SHEET 21
SHEET 20
SHEET 19
SHEET
SHEET 18
SHEET 1
SHEET 2
SHEET 3
SHEET 4
SHEET 5
SHEET 8
SHEET 9
DEVIL CANYON DAM SITE
WATANA DAM SITE
GOLD CREEK
NORTH
5 4 3 2 1 0 5 10
GRAPHIC SCALE IN MILES
LEGEND
CORRIDOR 1 ALTERNATIVES
CORRIDOR 2 ALTERNATIVES
CORRIDOR 3 ALTERNATIVES
RAILROAD CORRIDOR
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ACCESS PLAN #2
ALL RAILROAD
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CKD.
APPV'D.

- A significant disadvantage is that the line must be built lineally rather than in simultaneous sections.
- Another disadvantage is the major bridge at Cheechako Creek. This also is an 18-24 month construction project.
- The section of heavy rock construction is even more severe than for Plan I because grades hold the line down further on the slope in the critical section.
- The ice and organic soils problems near Stephan Lake would have more impact on the railroad than on a roadway.
- As with Plan I, construction time would be three to four years.

(c) Plan 3

(i) Description

This plan uses a combination of rail and truck. Construction of Watana Dam would be served from a rail head at Cantwell by truck across the Denali highway and along Alternate C. Construction of Devil Canyon dam would be served by truck from a rail head at Gold Creek with road access to Parks Highway. This plan does not include a connection between the two dams. See Figure 10.3.

(ii) Sea Ports

Common to all plans are Anchorage and Whittier.

(iii) Modal Split

This plan requires rail heads at Gold Creek and at Cantwell. Materials would move from port to rail head via rail road, be transfered to trucks at the rail head and be hauled to the work site by truck. The movements of construction workers would be via private auto direct to the construction camp.

(iv) Section Included

This plan includes Sections B-1, B-2 and C

(v) Cost Estimates

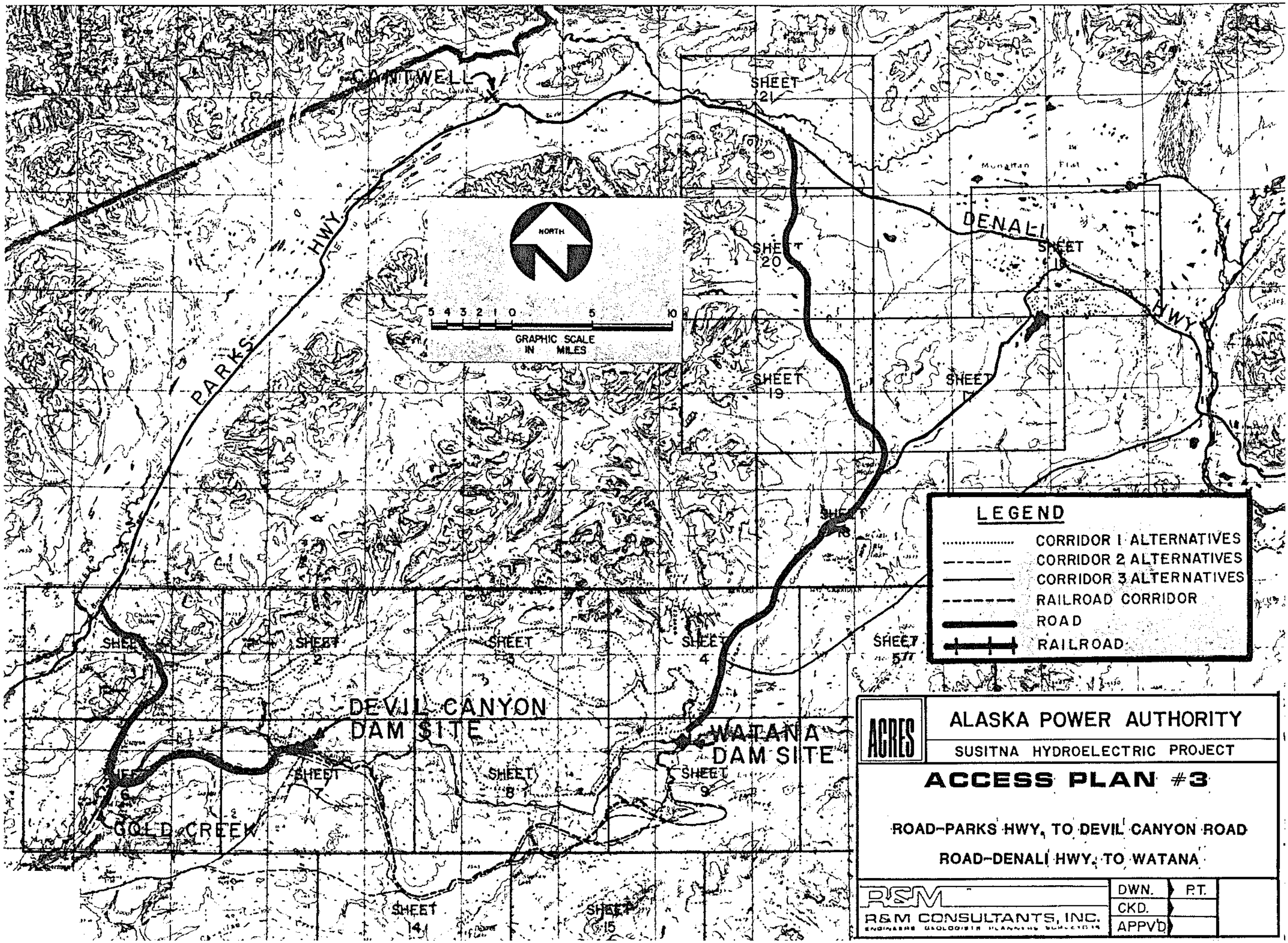
This plan is estimated to cost as follows:

| | |
|---|---|
| Construction (D&C) | 156,509,746 |
| Maintanance | 6,142,720 |
| Logistics | 228,050,607 |
| TOTAL | 390,703,073 |

(vi) Advantages/Disadvantages

The advantages of the plan are:

- It utilizes Section C which is the only approach to Watana that could be completed sufficiently in one season to allow resupply of construction activities at Watana.
- Personnel access via private auto.
- No major bridges necessary for movement of construction materials.
- Segments B-1 and B-2 including the Susitna River Bridge could be built during the period of construction for Watana thereby eliminating the time constraints.



CANTWELL
SHEET 21
SHEET 20
SHEET 19
SHEET 18
SHEET 17
SHEET 16
SHEET 1
SHEET 2
SHEET 3
SHEET 4
SHEET 5
SHEET 6
SHEET 7
SHEET 8
SHEET 9
SHEET 14
SHEET 15
PARKS HWY
DENALI HWY
NORTH
5 4 3 2 1 0 5 10
GRAPHIC SCALE IN MILES
DEVIL CANYON DAM SITE
WATANA DAM SITE
GOLD CREEK
LEGEND
CORRIDOR 1 ALTERNATIVES
CORRIDOR 2 ALTERNATIVES
CORRIDOR 3 ALTERNATIVES
RAILROAD CORRIDOR
ROAD
RAILROAD
ACRES
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
ACCESS PLAN #3
ROAD-PARKS HWY. TO DEVIL CANYON ROAD
ROAD-DENALI HWY. TO WATANA
R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS
DWN. P.T.
CKD.
APPV'D

The disadvantages of the plan are:

- Potential environmental impacts resulting from public access to additional portions of the Nelchina Caribou Range.
- Lack of direct access between dams for maintenance and operations staff.

(d) Plan 4

(i) Description

This plan serves Watana by truck from a rail head at Cantwell and Devils Canyon by rail from Gold Creek. In the plan there is no connection between dams.

(ii) Sea Ports

The same sea ports are common to all plans. They are Anchorage and Whittier.

(iii) Modal Split

This plan would require rail service to Cantwell via existing trackage with construction of a rail head at Cantwell and truck service from Cantwell to Watana.

Devil Canyon would be served by rail only from Gold Creek with the second rail head at the Devil Canyon dam site.

All material would flow by rail to the rail head. Personnel access for Watana would be via private vehicle while rail shuttle service, probably from Hurricane, would be required for Devil Canyon.

(iv) Section Included

This plan would require construction of Sections C and R-1

(v) Cost Estimates

The estimated cost of Plan 4 in 1982 dollars is outlined below:

| | |
|---|---|
| Construction (D&C) | 124,129,310 |
| Maintanance | 4,750,630 |
| Logistics | 228,004,342 |
| TOTAL | 356,884,282 |

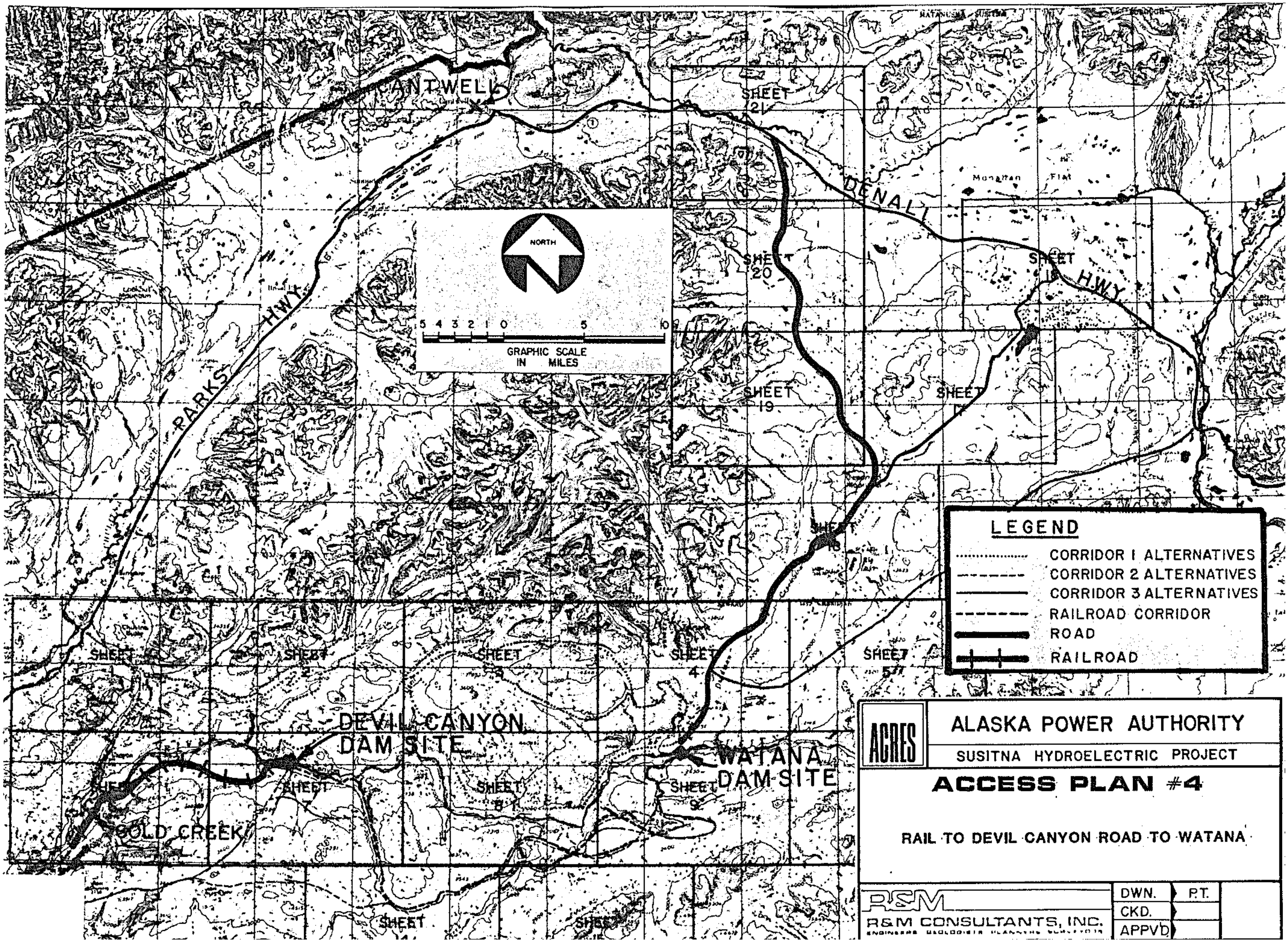
(vi) Advantages/Disadvantages

The advantages of this plan include:

- Good compliance with required project schedule.
- Sections C to serve Watana can be constructed sufficiently to allow resupply in one season using multiple simultaneous contracts for shortened sections with primary mobilization via winter snow road.
- No major bridges.

The disadvantages include:

- Potential impact from public access.
- Need for rail shuttle to move personnel into Devil Canyon.
- No direct connection between dams for maintenance and operations staff.


CANTWELL
DENALI HWY
PARKS HWY
Monahan Flat
NORTH
5 4 3 2 1 0 5 10
GRAPHIC SCALE IN MILES
SHEET 21
SHEET 20
SHEET 19
SHEET 16
SHEET 17
SHEET 18
SHEET 1
SHEET 2
SHEET 3
SHEET 4
SHEET 5
SHEET 7
SHEET 8
SHEET 9
DEVIL CANYON DAM SITE
WATANA DAM SITE
GOLD CREEK
LEGEND
CORRIDOR 1 ALTERNATIVES
CORRIDOR 2 ALTERNATIVES
CORRIDOR 3 ALTERNATIVES
RAILROAD CORRIDOR
ROAD
RAILROAD
ACRES
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
ACCESS PLAN #4
RAIL TO DEVIL CANYON ROAD TO WATANA
R&M
R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS
DWN. P.T.
CKD.
APPV'D

(e) Plan 5

(i) Description

This plan serves both dams by truck from a rail head at Gold Creek. The south side of the river is used to Devil Canyon with a major bridge downstream from the damsite, then the north side is used to Watana. A road way connection to the Parks Highway is included.

(ii) Sea Ports

This plan utilized Anchorage and Whittier as do the other plans presented.

(iii) Modal Split

Rail haul to Gold Creek with a subsequent truck haul to the work site. Personnel would access the camps via private auto.

(iv) Sections Included

The Sections that would be included in this plan are B-1, B-2, and A-2 with bridges over the Susitna River.

(v) Cost Estimates

The estimated costs of this plan are outlined below:

| | |
|---|---|
| High Susitna Bridge (D&C) | 13,260,000 |
| Construction (D&C) | 128,420,452 |
| Maintanance | 7,504,800 |
| Logistics | 215,571,641 |
| TOTAL | 364,756,893 |

* High Bridge Cost: 2,600 ft. x 34 ft. x $150/sq. ft.

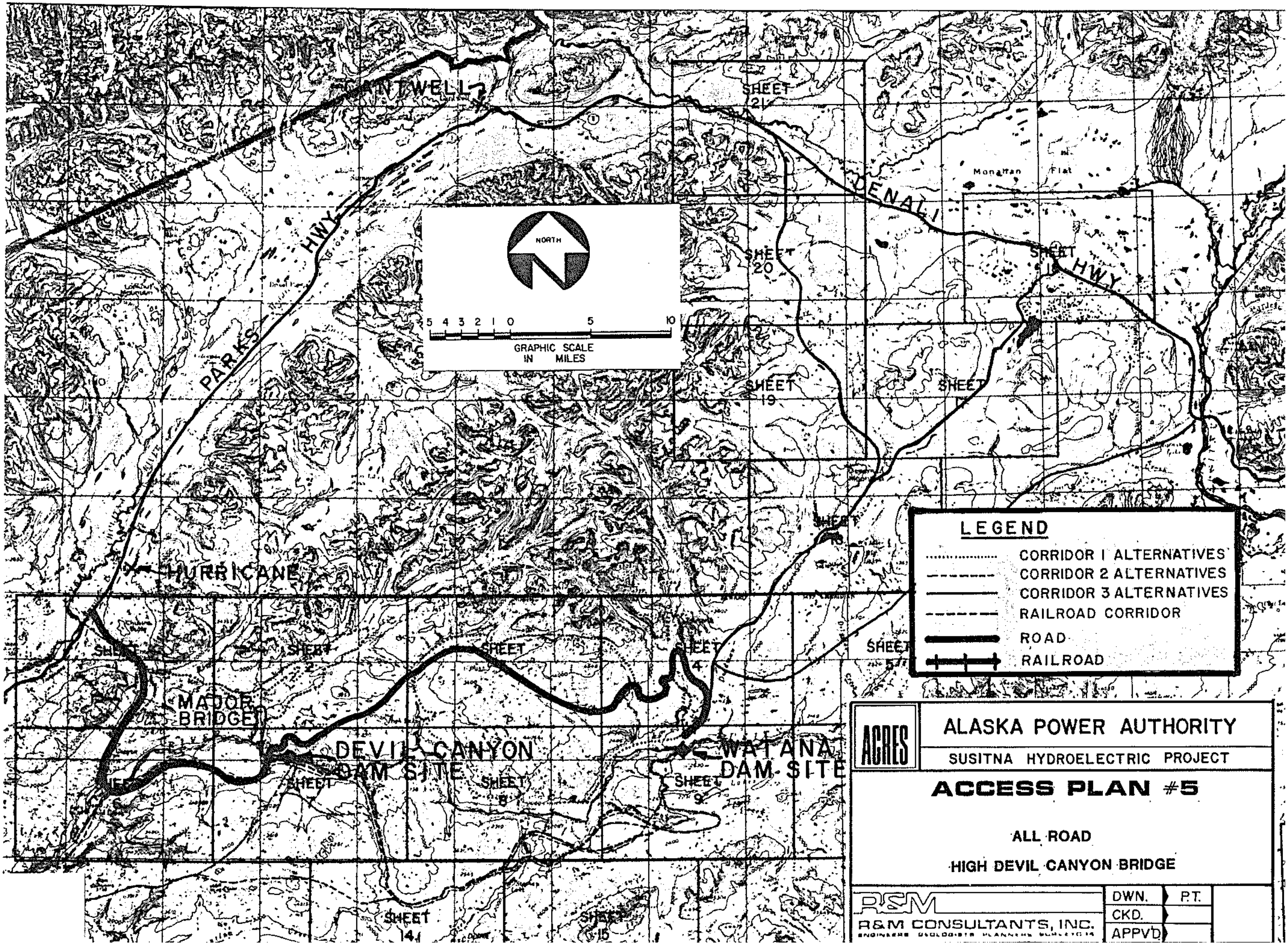
(vi) Advantages/Disadvantages

The advantages of this plan are:

- The segments involved encounter the apparent minimum of environmental conflicts.
- Personnel access is via private auto.

The disadvantages include:

- A requirement for total construction of the access prior to being able to resupply construction at Watana.
- The requirement to construct a high bridge over the Susitna below Devil Canyon. This would be a suspension bridge and would require two to three years to construct thus preventing work beyond until the bridge could be crossed.
- The time from the construction of this plan would be three to four years with the associated negative impacts on total project schedule.


CANTWELL
DENALI HWY
PARKS HWY
Monahan Flat
SHEET 21
SHEET 20
SHEET 19
SHEET 18
SHEET 17
SHEET 16
NORTH
5 4 3 2 1 0 5 10
GRAPHIC SCALE IN MILES
HURRICANE
MADDOR BRIDGE
DEVIL CANYON DAM SITE
WATANA DAM SITE
SHEET 2
SHEET 4
SHEET 5
SHEET 8
SHEET 9
SHEET 14
SHEET 15
LEGEND
CORRIDOR 1 ALTERNATIVES
CORRIDOR 2 ALTERNATIVES
CORRIDOR 3 ALTERNATIVES
RAILROAD CORRIDOR
ROAD
RAILROAD
ACRES
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
ACCESS PLAN #5
ALL ROAD
HIGH DEVIL CANYON BRIDGE
R&M CONSULTANTS, INC.
DWN. P.T.
CKD.
APPV'D

(f) Plan 6

(i) Description

This plan is essentially the same as Plan 4 except that a secondary road is provided along the north side between the dams for use by the maintenance and operations staff. This plan would use the top of Devil Canyon Dam for a crossing rather than constructing a bridge.

(ii) Sea Port

As with all plans, the sea ports will be Anchorage and Whittier.

(iii) Modal Split

This plan contemplates rail haul to Cantwell with truck haul from Cantwell to Watana and direct rail haul to Devil Canyon via Gold Creek. Personnel access to Watana by private auto and Devil Canyon by rail shuttle.

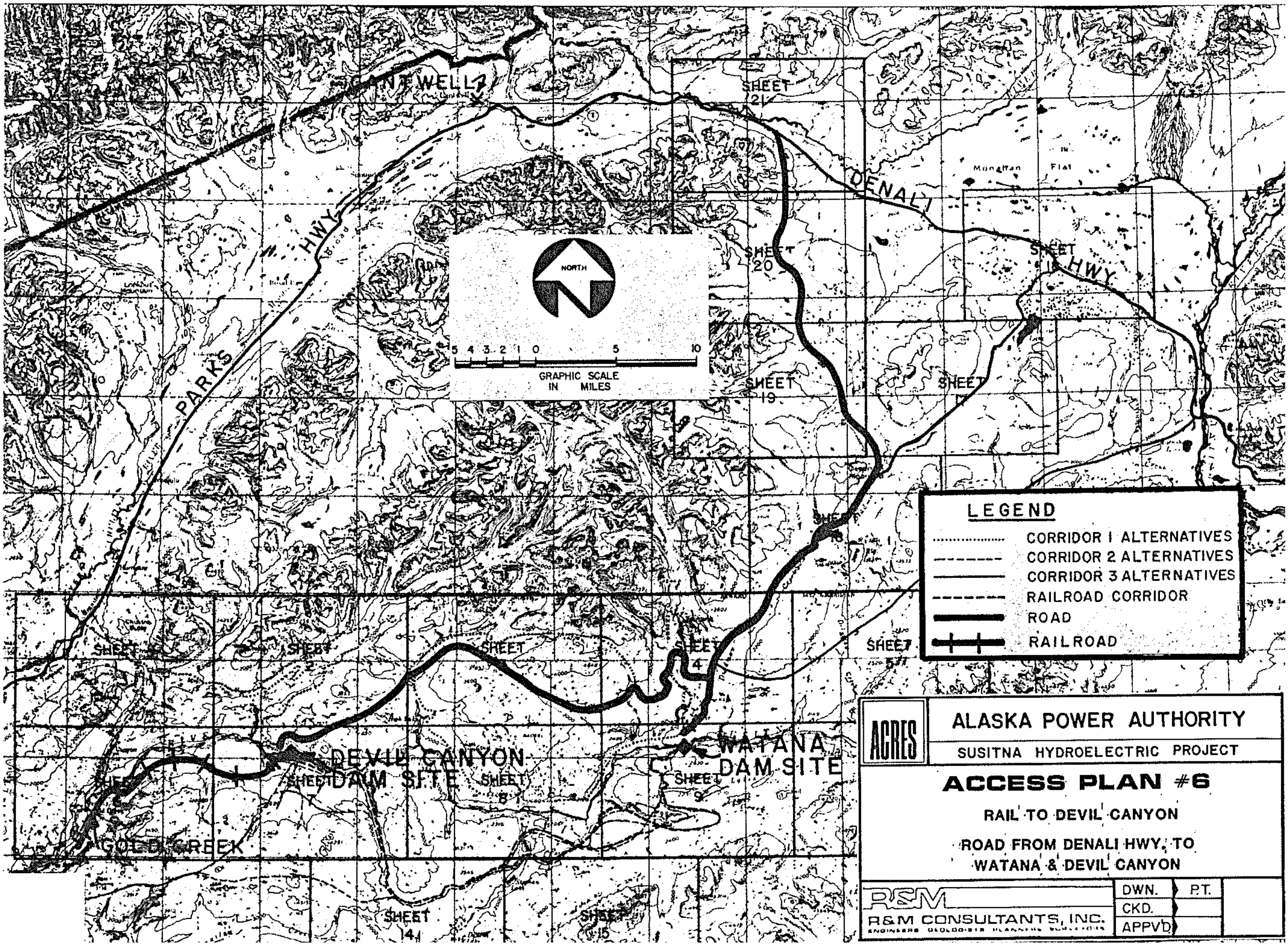
(iv) Section Included

The Sections included are A-2, R-1 and C

(v) Cost Estimates

The estimated cost of the plan is outlined below:

| | |
|---|---|
| Construction (D&C) | 183,240,606 |
| Maintanance | 7,638,130 |
| Logistics | 228,004,342 |
| TOTAL | 418,883,078 |


CANTWELL
DENALI
HWY
PARKS
HWY
SHEET 21
SHEET 20
SHEET 19
SHEET
SHEET 18
SHEET 4
SHEET 8
SHEET 9
SHEET 14
SHEET 15
NORTH
5 4 3 2 1 0 5 10
GRAPHIC SCALE IN MILES
DEVIL CANYON DAM SITE
WATANA DAM SITE
GOLD CREEK
LEGEND
CORRIDOR 1 ALTERNATIVES
CORRIDOR 2 ALTERNATIVES
CORRIDOR 3 ALTERNATIVES
RAILROAD CORRIDOR
ROAD
RAILROAD
ACRES
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
ACCESS PLAN #6
RAIL TO DEVIL CANYON
ROAD FROM DENALI HWY. TO WATANA & DEVIL CANYON
R&M CONSULTANTS, INC.
DWN. P.T.
CKD.
APPVD

(vi) Advantages/Disadvantages

The advantages of the plan include:

- Good compliance with the required project schedule.
- Section C to serve Watana can be constructed to a point that would allow resupply in one construction season using multiple simultaneous contracts over short sections with primary mobilization over winter snow roads.
- No major bridges involved.
- Direct access between dams for maintenance and operations staff.

The disadvantages of the plan include:

- The potential impact from increased public access.
- The need for a rail shuttle to bring personnel to the Devil Canyon site.

(g) Plan 7

(i) Description

This plan serves Watana by truck from a rail head at Cantwell, Devil Canyon by truck from a rail head at Gold Creek with a road connection to the Parks Highway and a road connection between dams north of the river. This plan would use the crest of Devil Canyon for a crossing rather than constructing a bridge.

(ii) Sea Ports

Anchorage and Whittier are the logical sea ports for this plan.

(iii) Modal Split

All freight would travel by rail to the appropriate rail head then by truck to the work sites. Personnel travel would be by private vehicle.

(iv) Section Included

The Sections include B-1, B-2, A-2, C with rail head construction at Gold Creek and Cantwell.

(v) Cost Estimates

The estimated cost of this plan is outlined below:

| | |
|---|---|
| Construction (D&C) | 215,621,042 |
| Maintanance | 9,030,220 |
| Logistics | 228,050,607 |
| TOTAL | 452,701,869 |

(vi) Advantages/Disadvantages

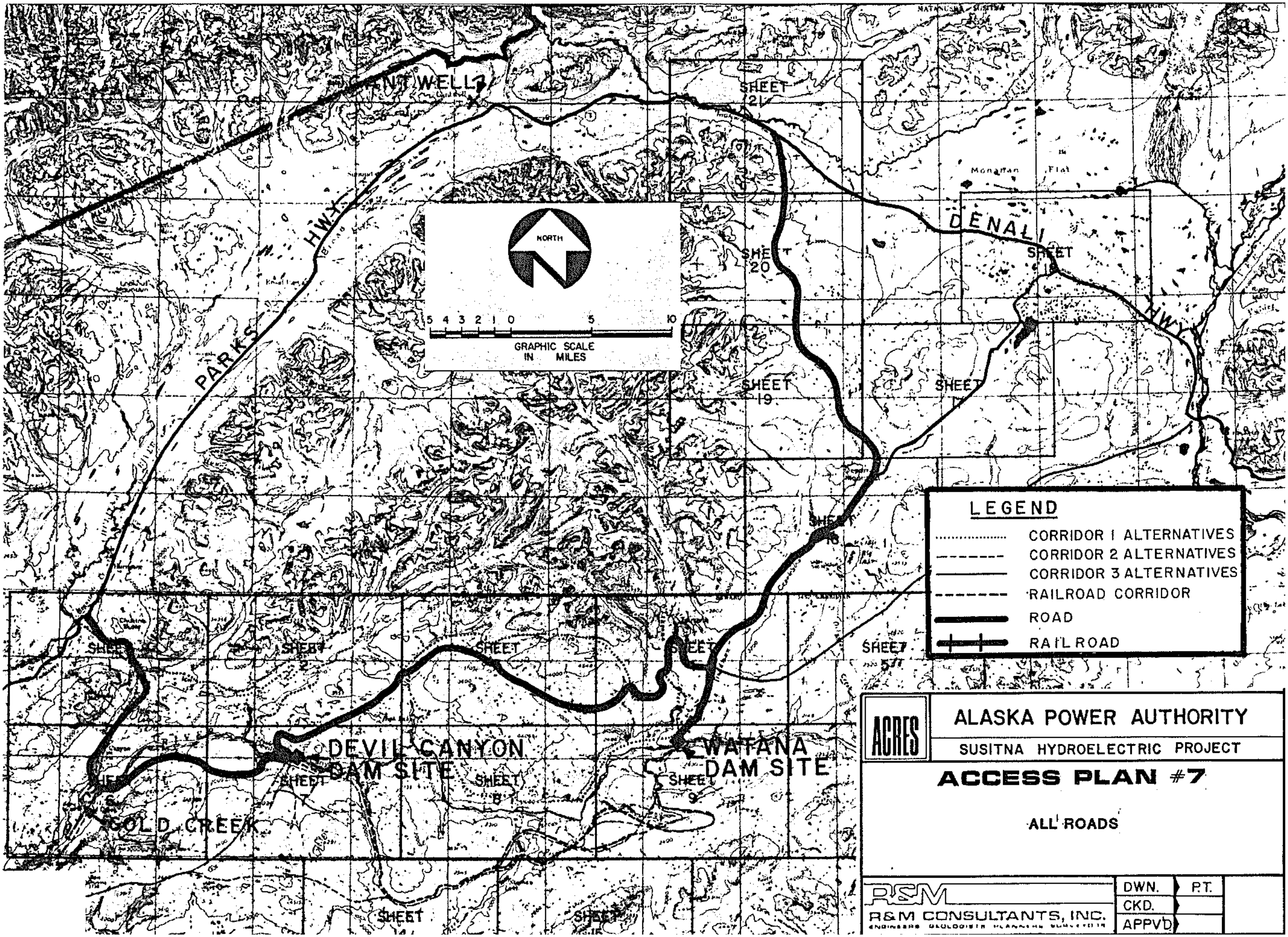
The advantages of this plan include:

- Good compliance with the required project schedule.
- Section C to serve Watana can be constructed in one season sufficient to allow resupply.

- The only major bridge is over the Susitna River at Gold Creek and is not on the project critical path.
- Direct access between dams for the maintenance and operations staff.
- All personnel access via private auto.

The disadvantages of this plan include:

- The potential impacts from public access.




ACRES

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

**ACCESS PLAN #7**

ALL ROADS

R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

| | |
|---|---|
| DWN. | P.T. |
| CKD. | |
| APPV'D | |

(h) Plan 8

(i) Description

This plan is esssentially the same as Plan 5, except that there is no road connection between the Parks Highway and Gold Creek. The plan serves both dams by truck from a rail head at Gold Creek. The south side of the river is used to Devil Canyon with a major bridge downstream from the damsite, then the north side is used to Watana. All truck tractors will initially have to be ferried to Gold Creek by train, than they will be able to shuttle between Gold Creek and the damsites.

(ii) Sea Ports

This plan utilized Anchorage and Whittier as do the other plans presented.

(iii) Modal Split

Rail haul to Gold Creek with a subsequent truck haul to the work site. Personnel would access the camps via train to Gold Creek, than bus shuttle on the road, or by air.

(iv) Sections Included

The Sections that would be included in this plan are B-2 and A-2 with one bridge over the Susitna River.

(v) Cost Estimates

The estimated costs of this plan are outlined below:

| | |
|---|---|
| High Susitna Bridge | 13,260,000 |
| Construction | 78,327,742 |
| Maintanance | 5,103,300 |
| Logistics | 215,571,641 |
| TOTAL | 312,262,683 |

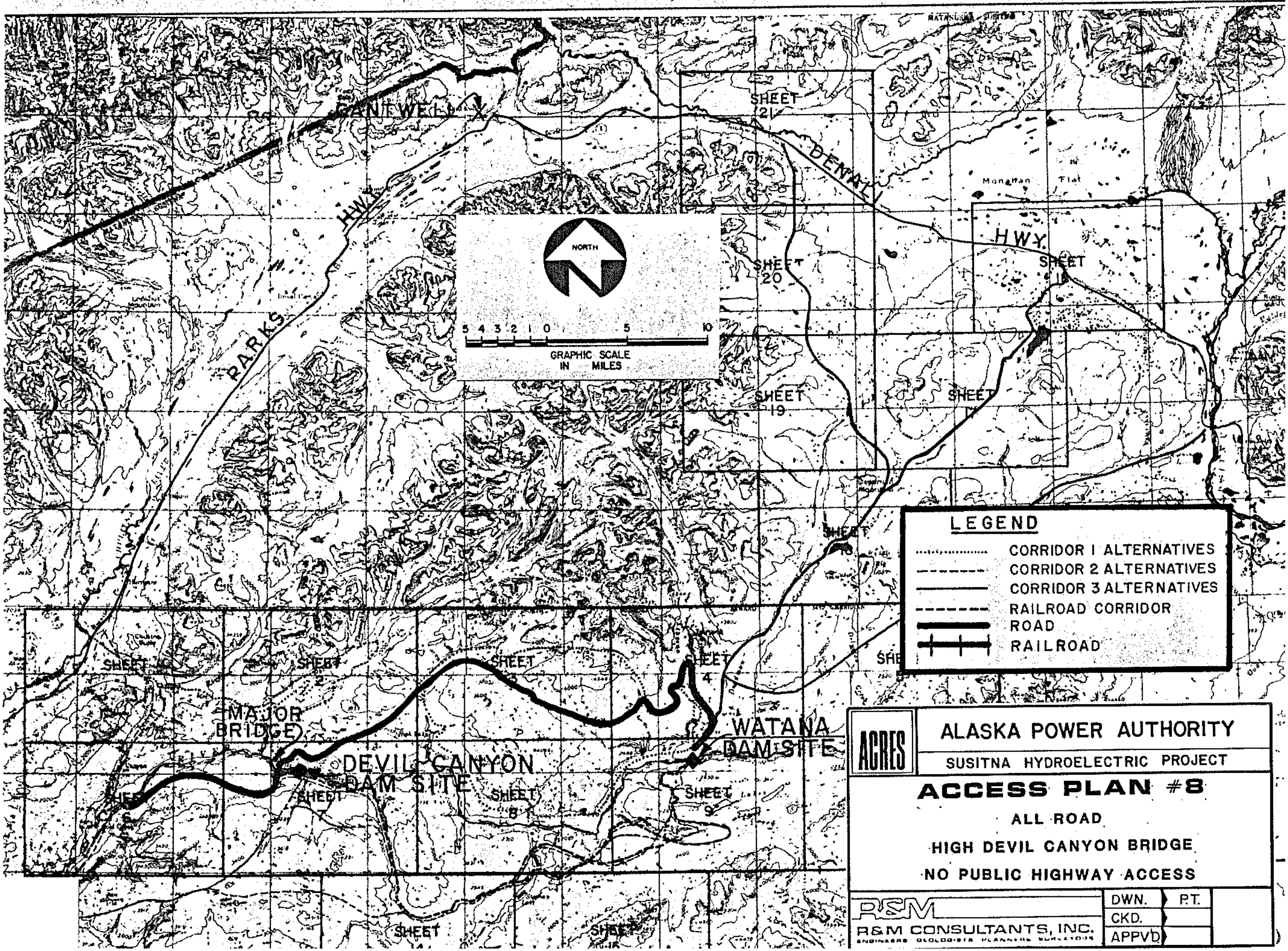
(vi) Advantages/Disadvantages

The advantages of this plan are:

- The segments involved encounter the apparent minimum of environmental conflicts.
- Public access is restricted.
- Lowest design and construction cost
- Lowest overall costs.

The disadvantages include:

- A requirement for total construction of the access prior to being able to resupply construction at Watana.
- The requirement to construct a high bridge over the Susitna below Devil Canyon. This would be a suspension bridge and would require two to three years to construct thus preventing work beyond until the bridge could be crossed.
- The time from the construction of this plan would be three to four years with the associated negative impacts on total project schedule.
- Need to provide transportation for personnel access.



CANTWELL
PARKS HWY
DENALI HWY
NORTH
5 4 3 2 1 0 5 10
GRAPHIC SCALE IN MILES
SHEET 21
SHEET 20
SHEET 19
SHEET
SHEET 1
SHEET 2
SHEET
SHEET 4
SHEET 8
SHEET 9
MAJOR BRIDGE
DEVIL CANYON DAM SITE
WATANA DAM SITE
LEGEND
CORRIDOR 1 ALTERNATIVES
CORRIDOR 2 ALTERNATIVES
CORRIDOR 3 ALTERNATIVES
RAILROAD CORRIDOR
ROAD
RAILROAD
ACRES
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
ACCESS PLAN #8
ALL ROAD
HIGH DEVIL CANYON BRIDGE
NO PUBLIC HIGHWAY ACCESS
R&M CONSULTANTS, INC.
DWN. P.T.
CKD.
APPVD

# CONCLUSIONS
# AND
# RECOMMENDATIONS

## 11 - Conclusions and Recommendations

No final conclusions or recommendations are made at this time. Additional input is required from other project team members before a final plan selection can be made.

# APPENDIX A

# PRELIMINARY DESIGN DEVELOPMENT

## Appendix A - Preliminary Design Development

The Susitna Hydrolelectric project includes two large dams. These structures are located in remote wilderness however the size of the structures are such that major transportation facilities are required to serve the project and small communities are needed to house the construction crews.

In order to demonstrate the magnitude of the planned development plan views of the dams are included as are the projected construction schedules. Correspondence is included that identifies the major quantity requirements and crew requirements. This data has been used in the development and analysis of the various access plans.

August 20, 1981
P5700.11.10
T.1078

R&M Consultants Inc.
P.O. Box 6087
5024 Cordova Street
Anchorage, Alaska 99503

Attention: Mr. N. Gutcher

Dear Mr. Gutcher:

Susitna Hydroelectric Project
Estimate of Total Weights

As discussed with you on August 10, we have made an initial estimate of the total weights of various major items needed for construction of the Susitna development. These quantities should be used in completing the logistics portion of your access road report and are as follows:

| | Watana | Devil Canyon |
|---|---|---|
| Installed Mechanical, Structural & Electrical Equipment | 15,000 ton | 13,500 ton |
| Construction Equipment | 16,000 ton | 5,000 ton |
| Explosives | 20,000 ton | 3,000 ton |
| Cement | 350,000 ton | 650,000 ton |
| Reinforcing Steel | 33,000 ton | 22,000 ton |
| Rock Bolts | 12,500 ton | 3,000 ton |
| Steel Support & Liners | 3,600 ton | 2,200 ton |
| Fuel | 75 million gallons | 17 million gallons |

...URES AMERICAN INCORPORATED

Please forward your completed report to us by September 15. If you have any questions or need further information please contact either Tom Gwozdek or myself at this office.

Sincerely,

Dennis Meilhede

D. Meilhede

DM/ljr

cc: J. Lawrence
J. Hayden
J. Gill
F. Toth

EXHIBIT A-2

September 4, 1981
P5700.11.10
T.1132

R&M Consultants
P.O. Box 6037
5024 Cordova Street
Anchorage, AK 99503

Attention: Mr. N. Gutcher

Dear Mr. Gutcher:

Susitna Hydroelectric Project
Project Schedule

As you requested, enclosed please find the following:

1. Preliminary Schedule Watana - July 1981
2. Preliminary Schedule Devil Canyon - July 1981
3. Most Recent Layout-Watana (reduced Dylar)
4. Most Recent Layout-Devil Canyon (reduced Dylar)

As we discussed, these items reflect the present level of development of the Susitna Project and can be used in completion of your access road logistics study. Finalized layouts and schedules are, of course, impossible to provide at this time. Similarly, our present estimate for peak camp size is 4,500 units at Watana and 3,100 units at Devil Canyon.

If you have any further questions, please call.

Sincerely,

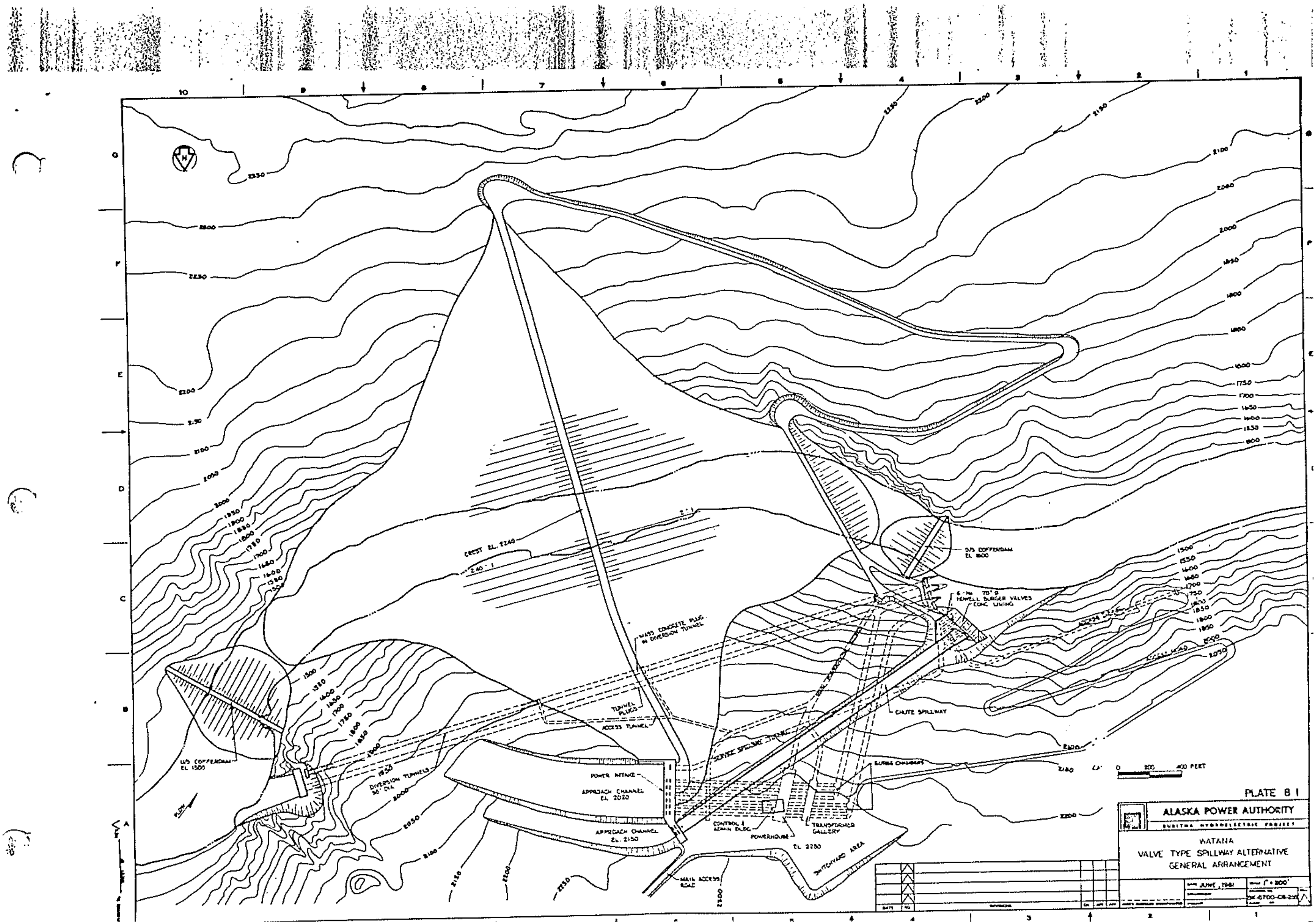
Dennis Meilhede

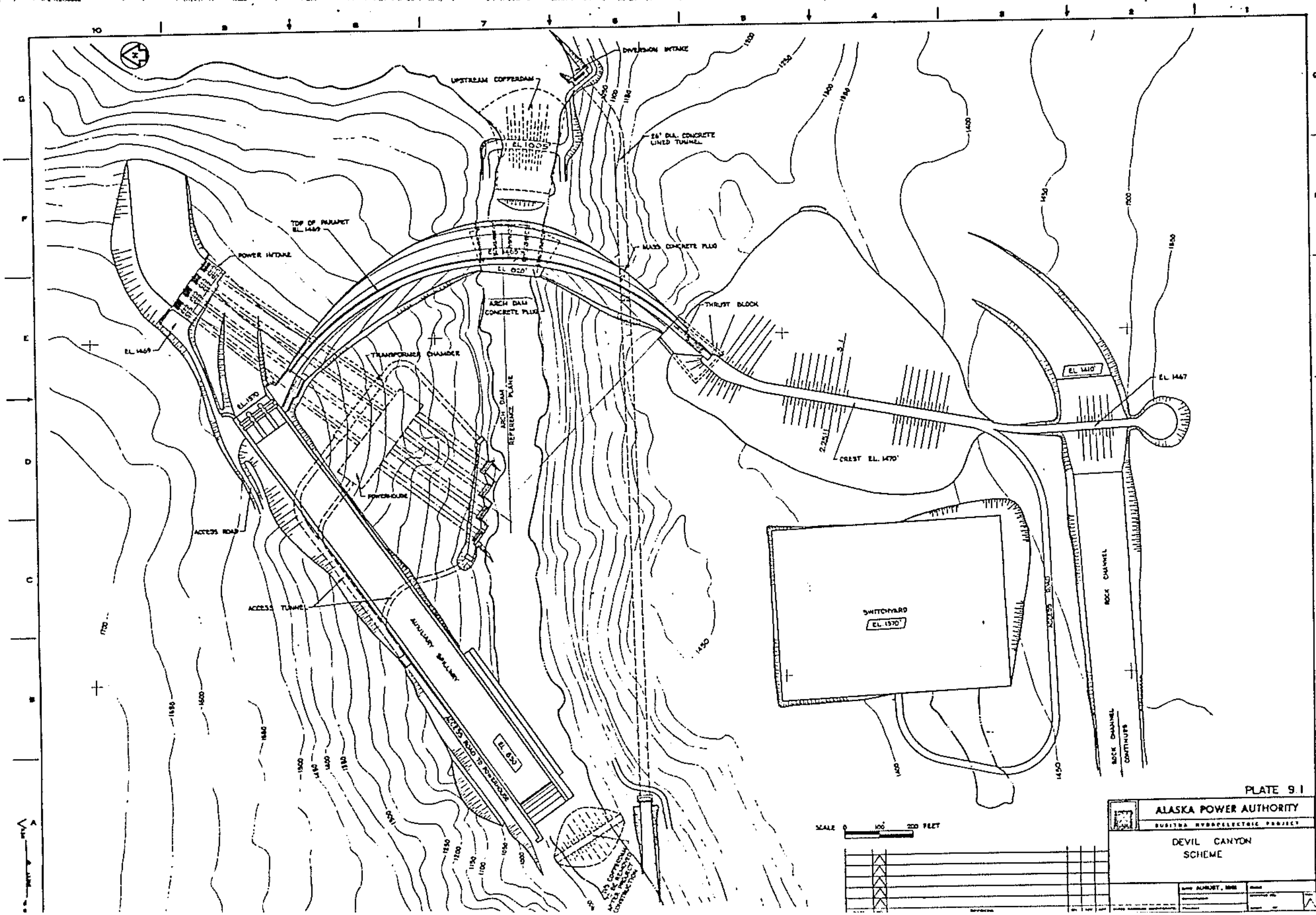
Dennis Meilhede

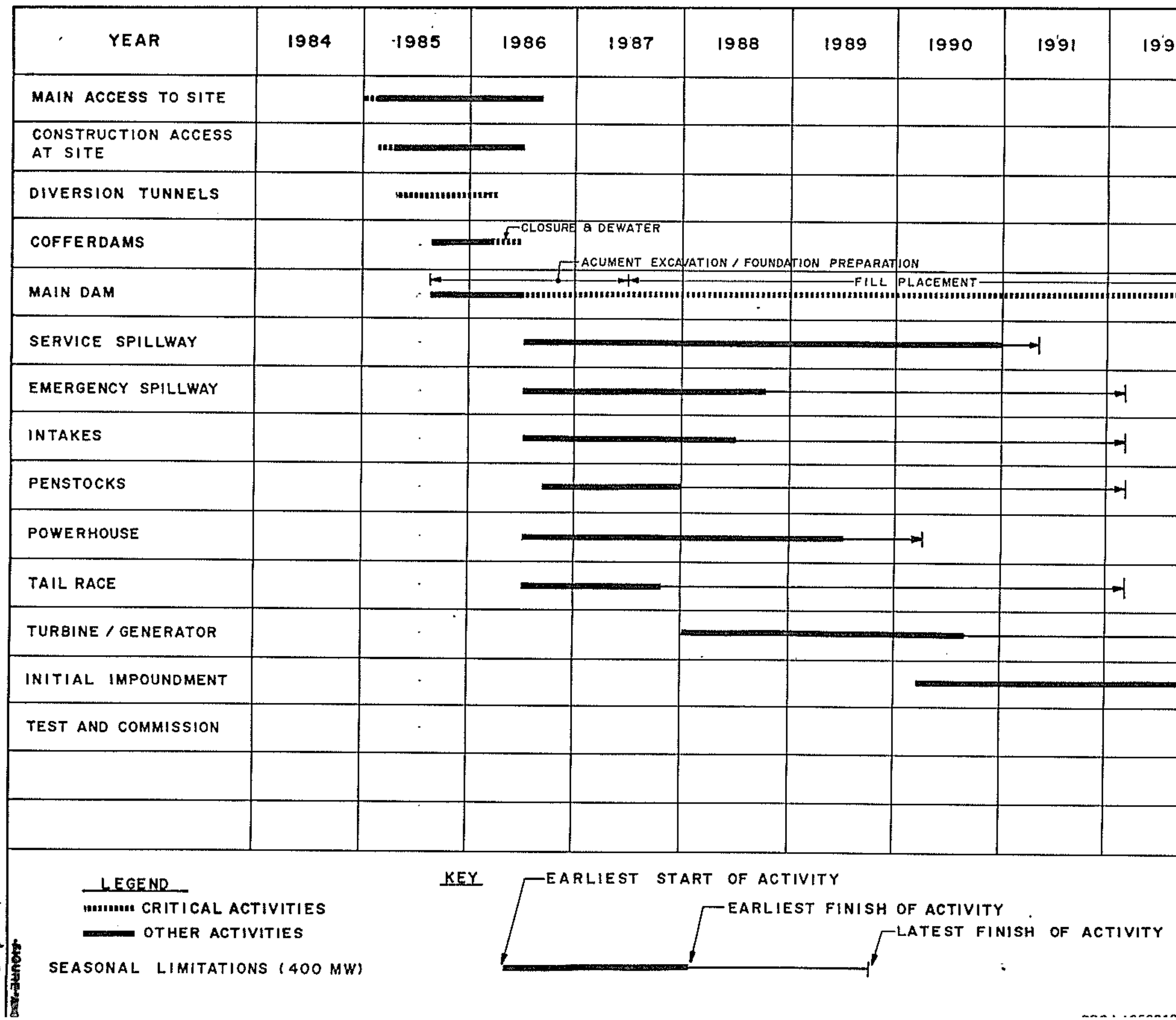
DM:db

Enclosures

cc: J. Lawrence
J. Hayden
T. Gwozdek


CREST EL. 2240
D/S COFFERDAM
EL 1500
6 - No 78" Ø
HOWELL BUNGER VALVES
CONC LINING
MASS CONCRETE PLUG
IN DIVERSION TUNNEL
CHUTE SPILLWAY
TUNNEL PLUGS
ACCESS TUNNEL
U/S COFFERDAM
EL 1500
DIVERSION TUNNELS
FLOW
POWER INTAKE
APPROACH CHANNEL
EL 2020
APPROACH CHANNEL
EL 2150
SURGE CHAMBERS
CONTROL & ADMIN BLDG
POWERHOUSE
TRANSFORMER GALLERY
EL 2250
SWITCHYARD AREA
MAIN ACCESS ROAD
0 200 400 FEET
PLATE B 1
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA
VALVE TYPE SPILLWAY ALTERNATIVE
GENERAL ARRANGEMENT
JUNE, 1981
1" = 200'


DIVERSION INTAKE
UPSTREAM COFFERDAM
26' DIA. CONCRETE LINED TUNNEL
TOP OF PARAPET EL. 1469
POWER INTAKE
MASS CONCRETE PLUG
THRUST BLOCK
ARCH DAM CONCRETE PLUG
ARCH DAM REFERENCE PLANE
TRANSFORMER CHAMBER
POWERHOUSE
ACCESS ROAD
ACCESS TUNNEL
AUXILIARY SPILLWAY
ACCESS ROAD TO POWERHOUSE
CREST EL. 1470'
SWITCHYARD
EL. 1370'
ROCK CHANNEL
ROCK CHANNEL CONTINUES
EL. 1410'
EL. 1467
SCALE 0 100 200 FEET
PLATE 9.1
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
DEVIL CANYON SCHEME



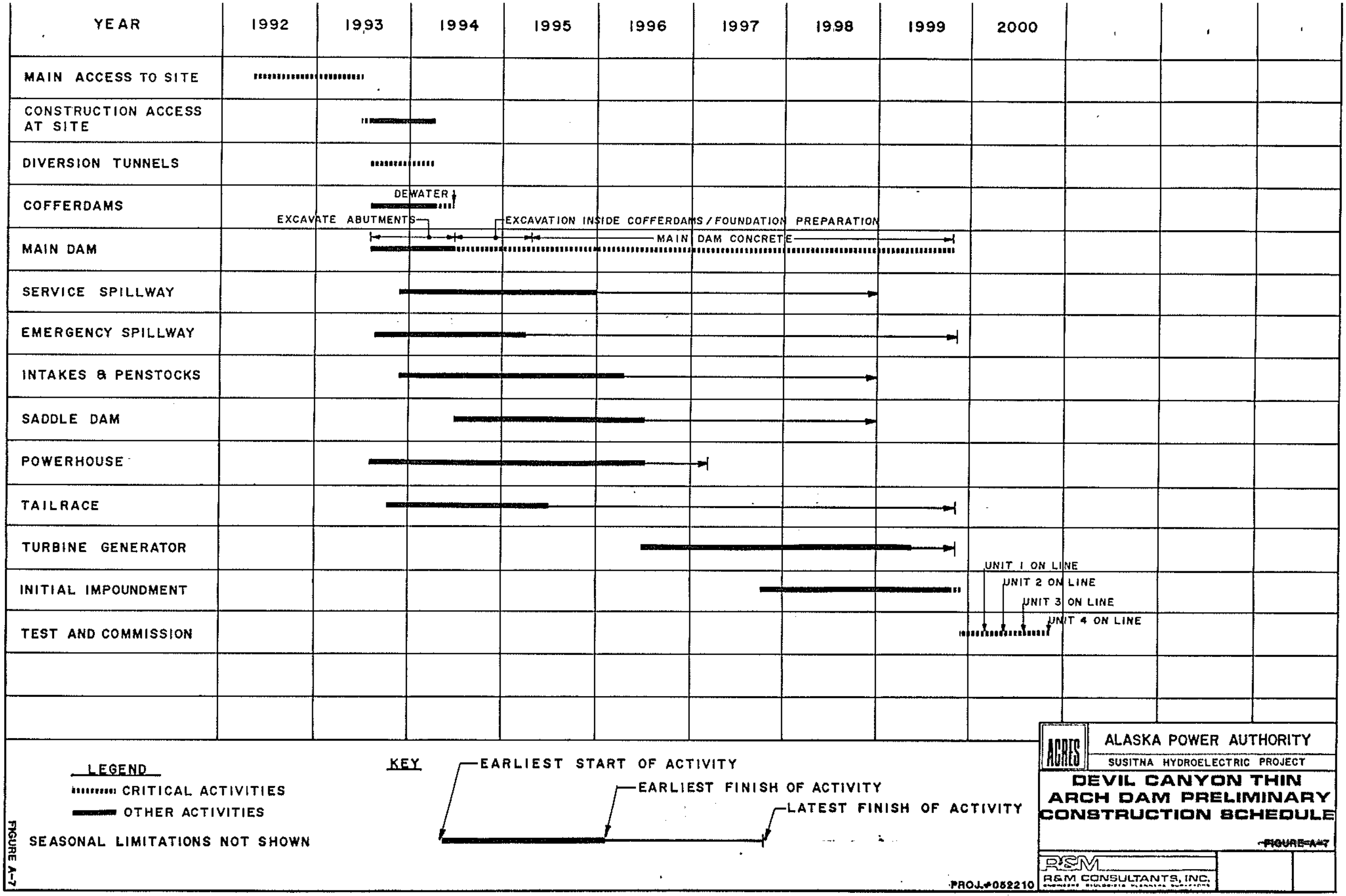

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

**WATANA FILL DAM PRELIMINARY SCHEDULE**

FIGURE A-8

R&M CONSULTANTS, INC.

FIG A.8




ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

**DEVIL CANYON THIN ARCH DAM PRELIMINARY CONSTRUCTION SCHEDULE**

FIGURE A-7

R&M CONSULTANTS, INC.

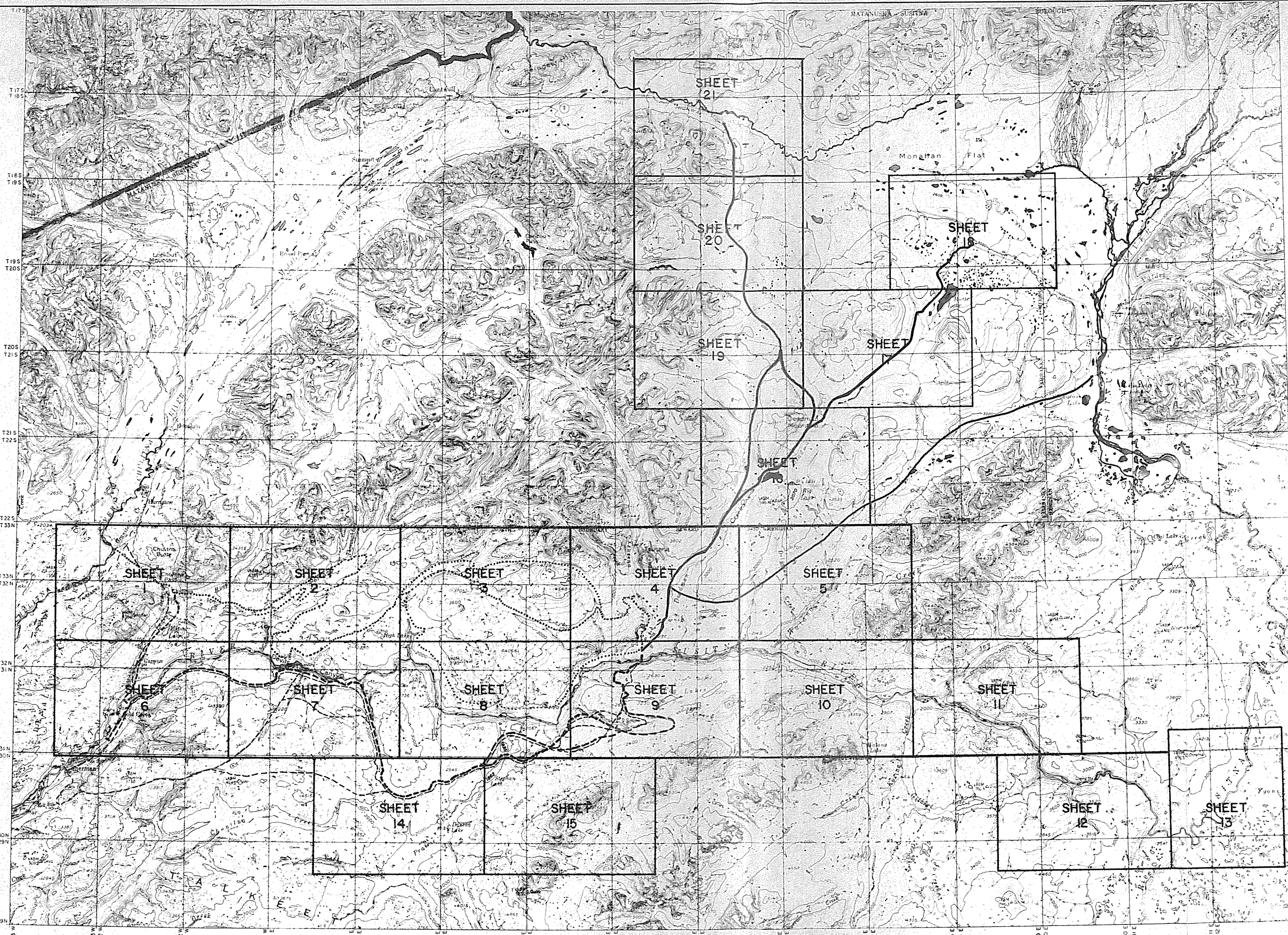
PROJ. #052210

# APPENDIX B

## PROPOSED ALTERNATIVES SEGMENTS

## Appendix B Proposed Alternative Segements

Appendix B consist of a set of map showing each of the alternatives alignment segments studied during the course of the work.




**LEGEND**

- ............ CORRIDOR 1 ALTERNATIVES
- - - - - - - CORRIDOR 2 ALTERNATIVES
- ———— CORRIDOR 3 ALTERNATIVES
- ‒ ‒ ‒ ‒ ‒ RAILROAD CORRIDOR

NOTE

SHEETS NO. 5, 10, 11, 12, & 13 ARE OMITTED. NO ACCESS CORRIDORS ARE CONTAINED THEREIN.

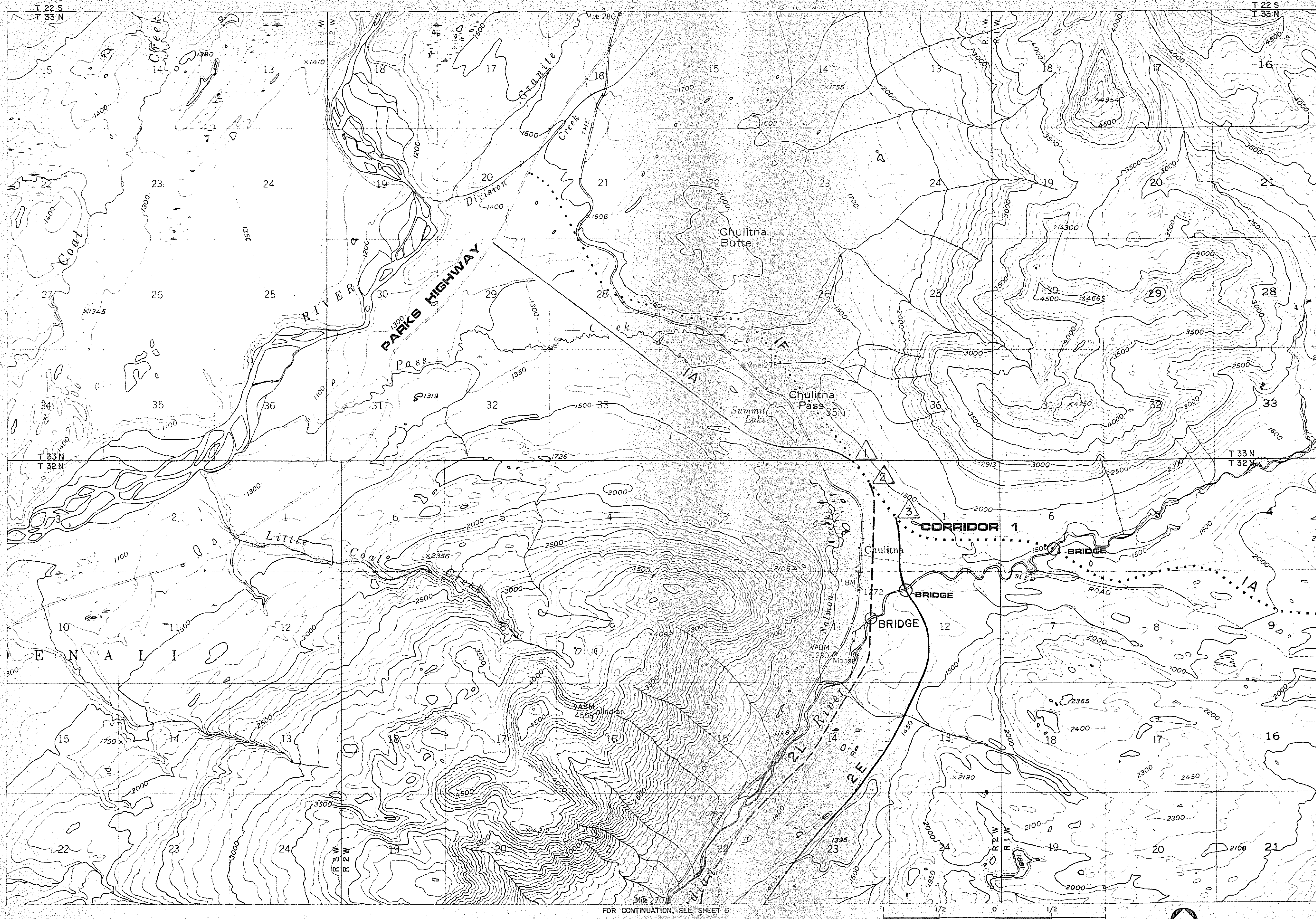
R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

PREPARED FOR: ACRES AMERICAN, INC.

# INDEX MAP

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

| | |
|---|---|
| 1980 DATE | 052210 PROJ. NO. |
| NKG DESIGN | 0 |
| JJS DRAWN | OF |
| NKG CHECKED | |
| APPROVED | |




R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

PREPARED FOR:
ACRES AMERICAN, INC.

# ACCESS CORRIDORS

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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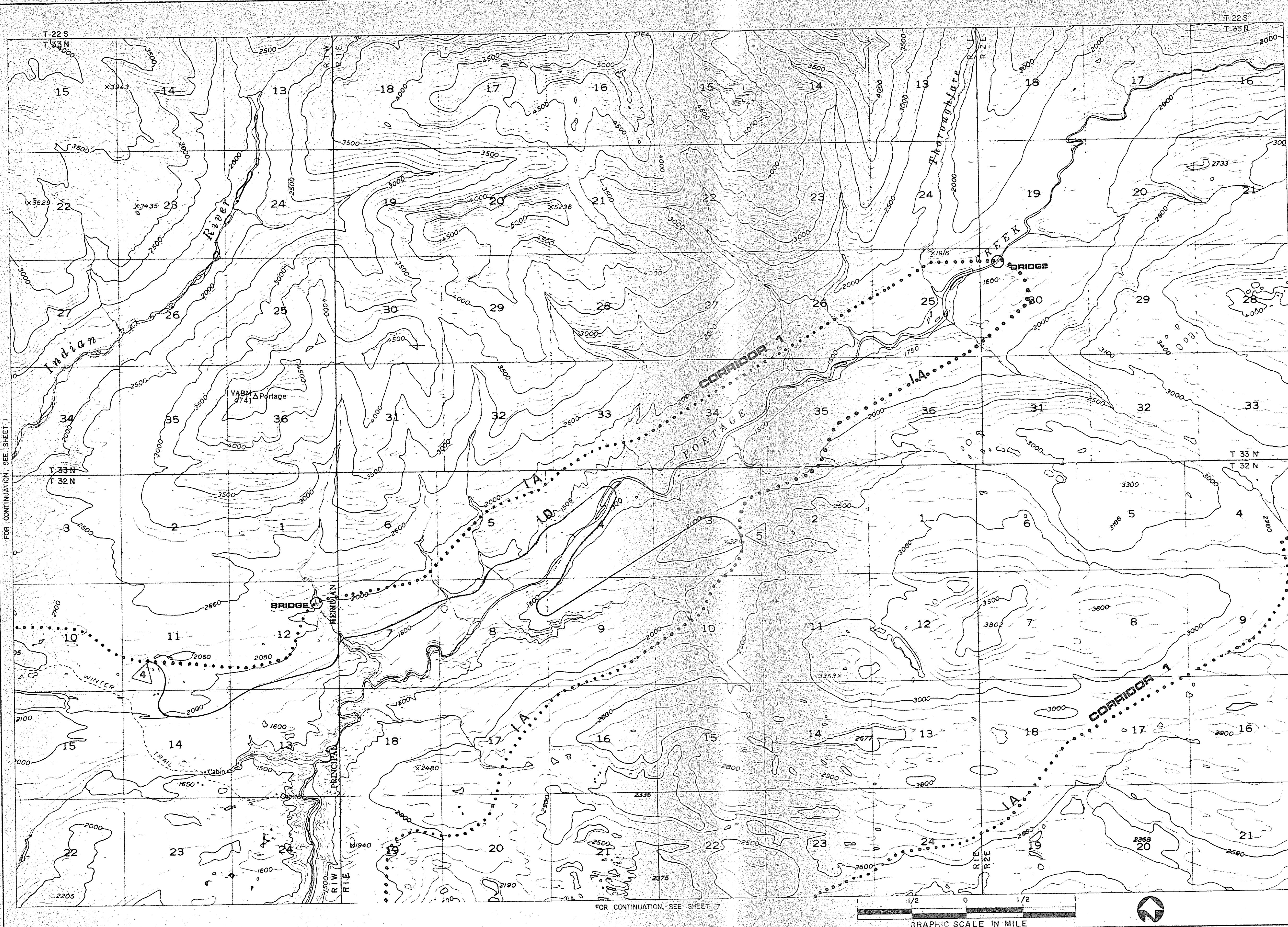
| APPROVED | |

PROJ NO 052210

1 OF




FOR CONTINUATION, SEE SHEET 1

FOR CONTINUATION, SEE SHEET 3

FOR CONTINUATION, SEE SHEET 7

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ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

# ACCESS CORRIDORS

PREPARED FOR:
ACRES AMERICAN, INC.

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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|---|---|
| 1980 | DATE |
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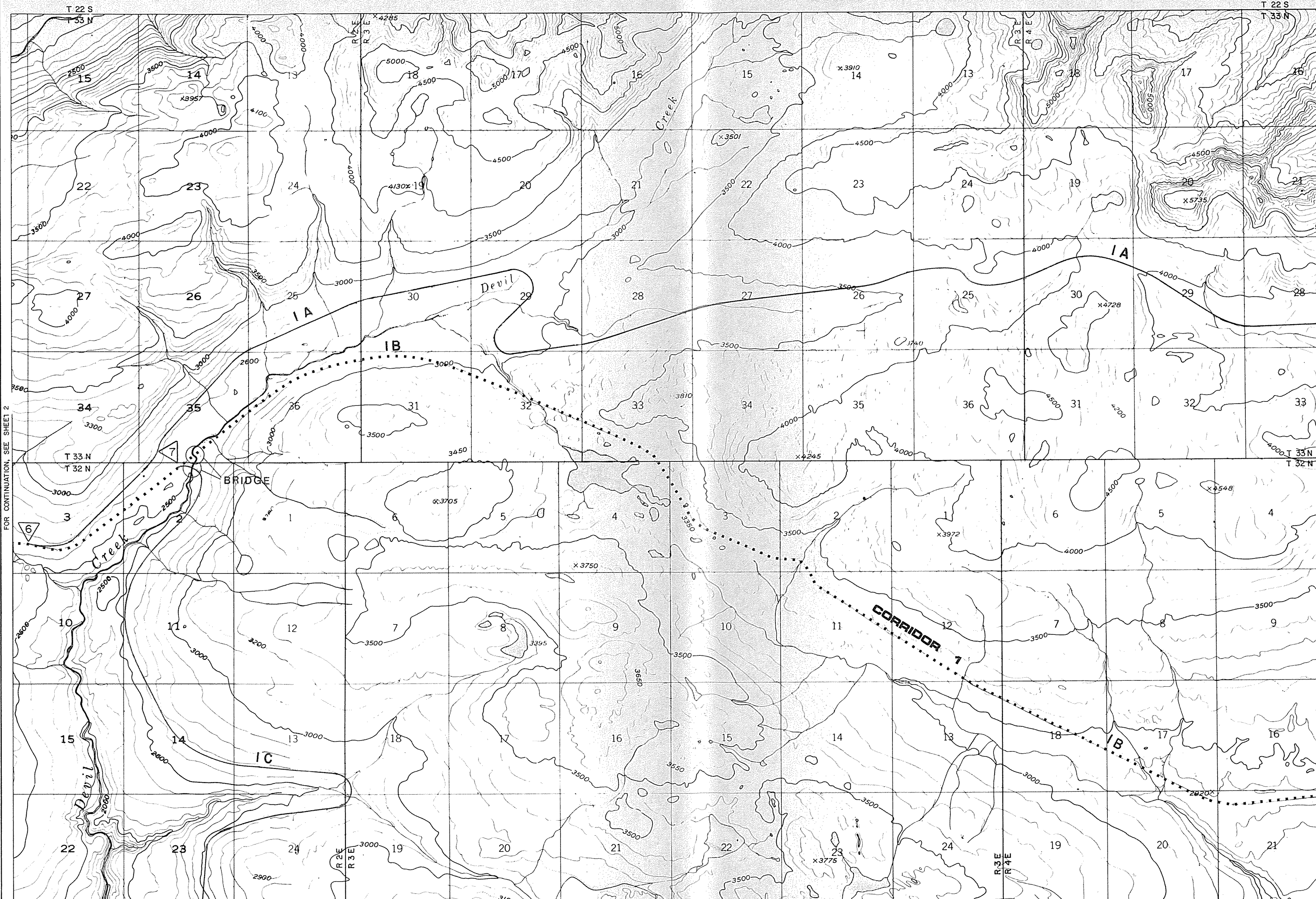
| JIS | DRAWN |
| NKG | CHECKED |
| | APPROVED |

052 PROJ NO

2 OF




FOR CONTINUATION, SEE SHEET 2

FOR CONTINUATION, SEE SHEET 4

FOR CONTINUATION, SEE SHEET 8

1 1/2 0 1/2 1

GRAPHIC SCALE IN MILE

PREPARED FOR:
ACRES AMERICAN, INC.

R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

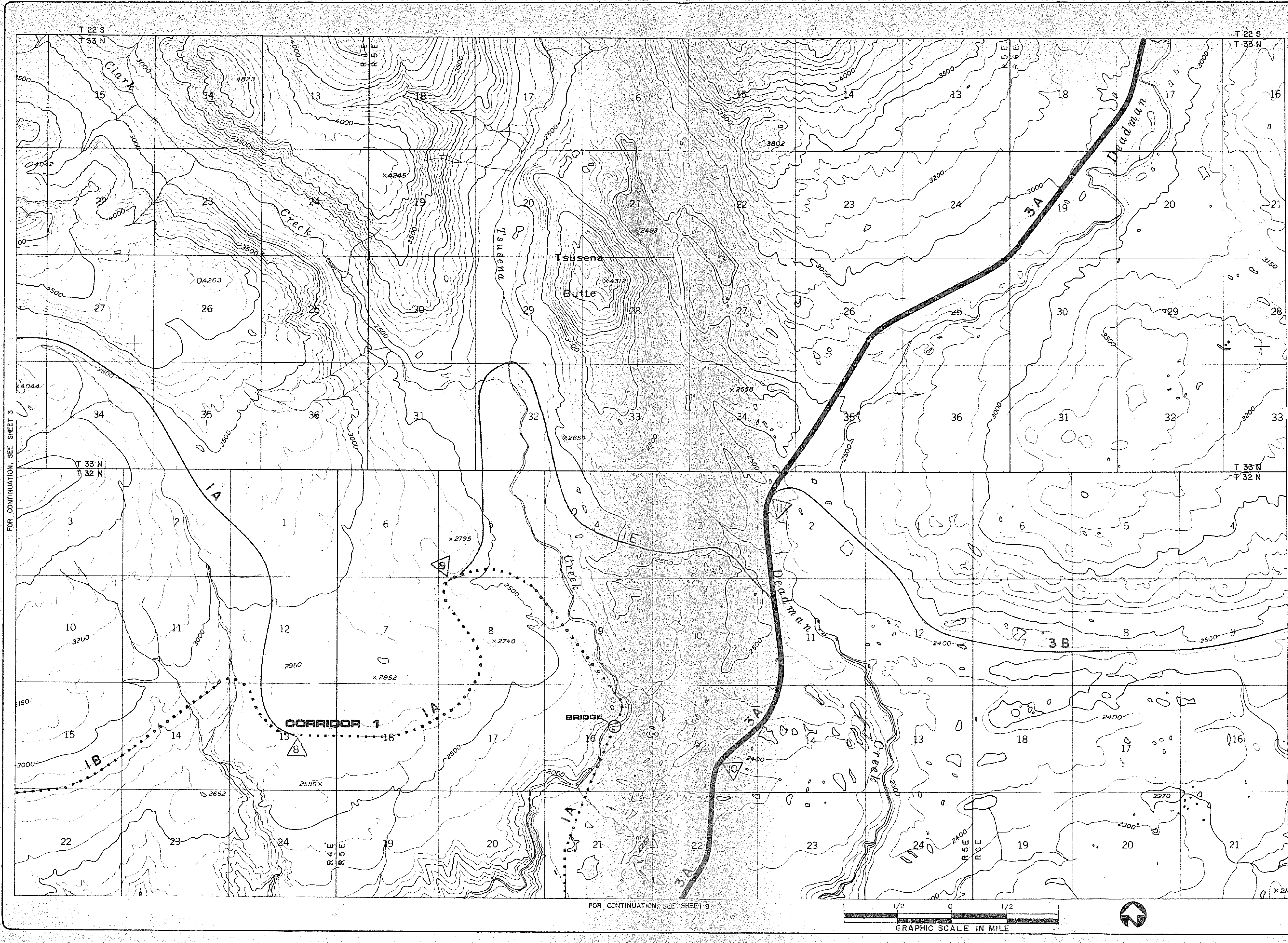
# ACCESS CORRIDORS

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

| | |
|---|---|
| 1980 | DATE |
| NKG | DESIGN |
| JIS | DRAWN |
| NKG | CHECKED |
| | APPROVED |

052210
PROJ. NO.

3
OF




# ACCESS CORRIDORS

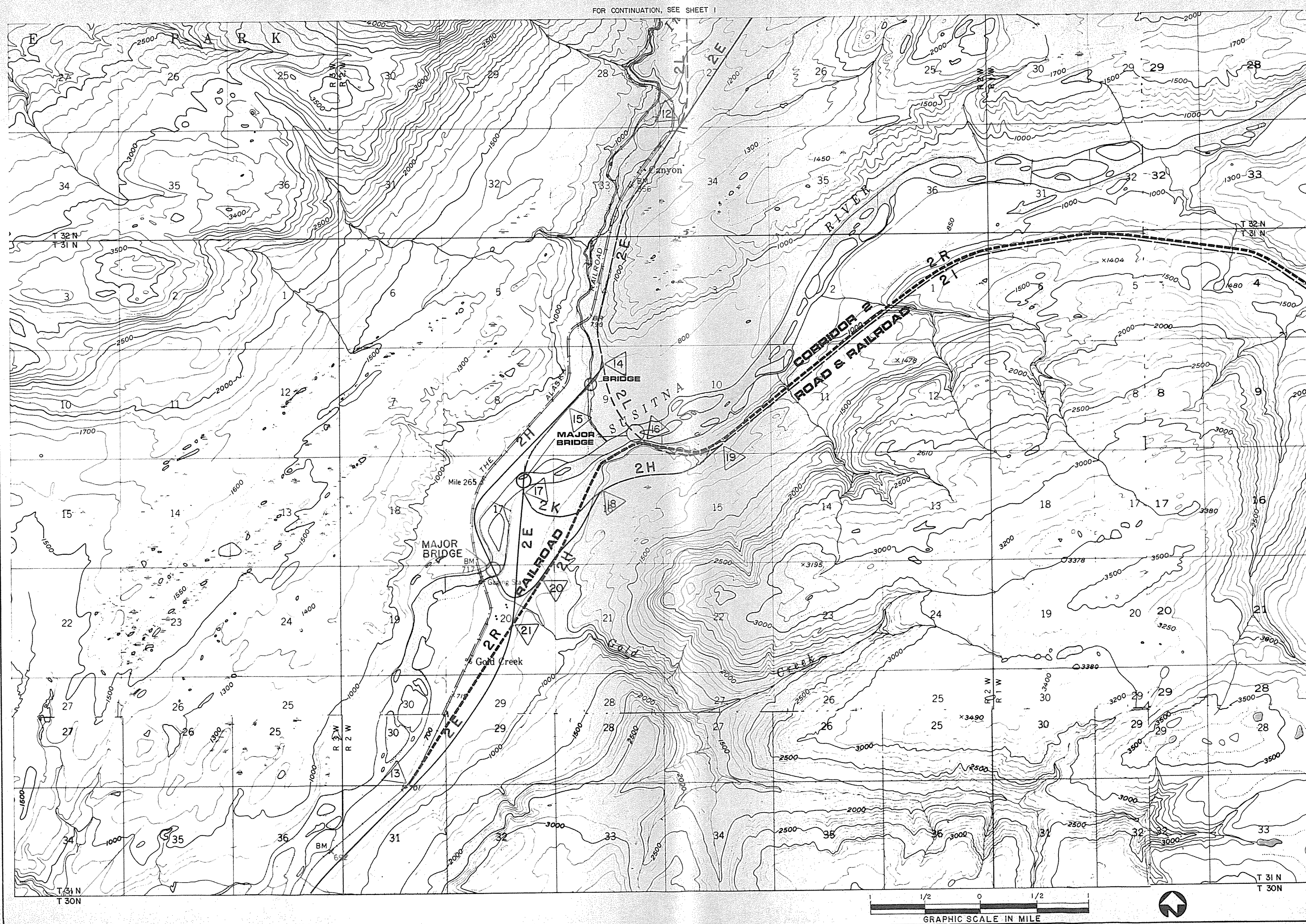
R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

PREPARED FOR:
ACRES AMERICAN, INC.

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

| | |
|---|---|
| 1980 | DATE |
| NKG | DESIGN |
| JJS | DRAWN |
| NKG | CHECKED |
| | APPROVED |

052210
PROJ NO
4
OF




**R&M CONSULTANTS, INC.**
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

# ACCESS CORRIDORS

PREPARED FOR:
ACRES AMERICAN, INC.

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

| | |
|---|---|
| DATE | 1980 |
| DESIGN | NKG |
| DRAWN | JIS |
| CHECKED | NKG |
| APPROVED | |
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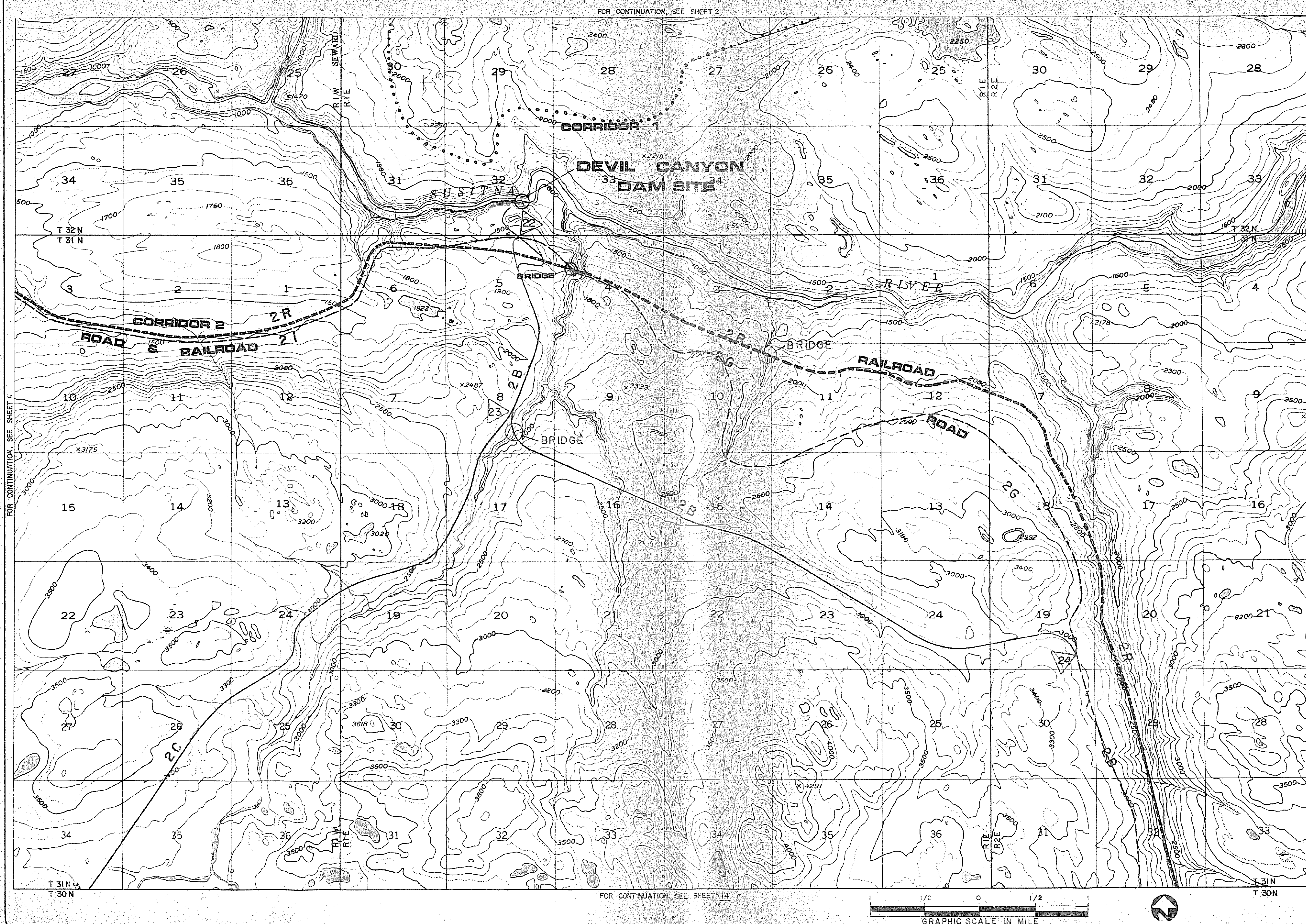


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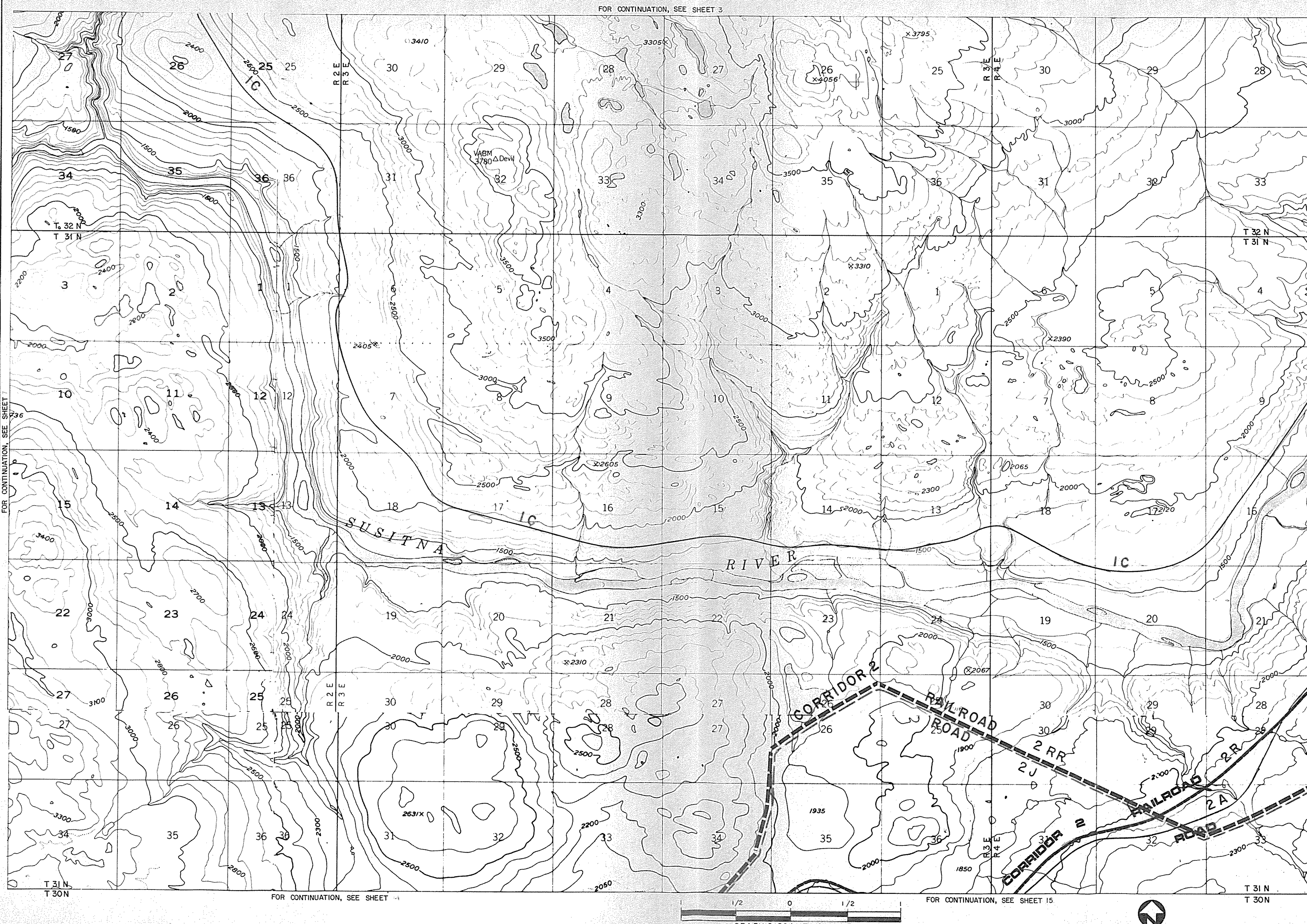


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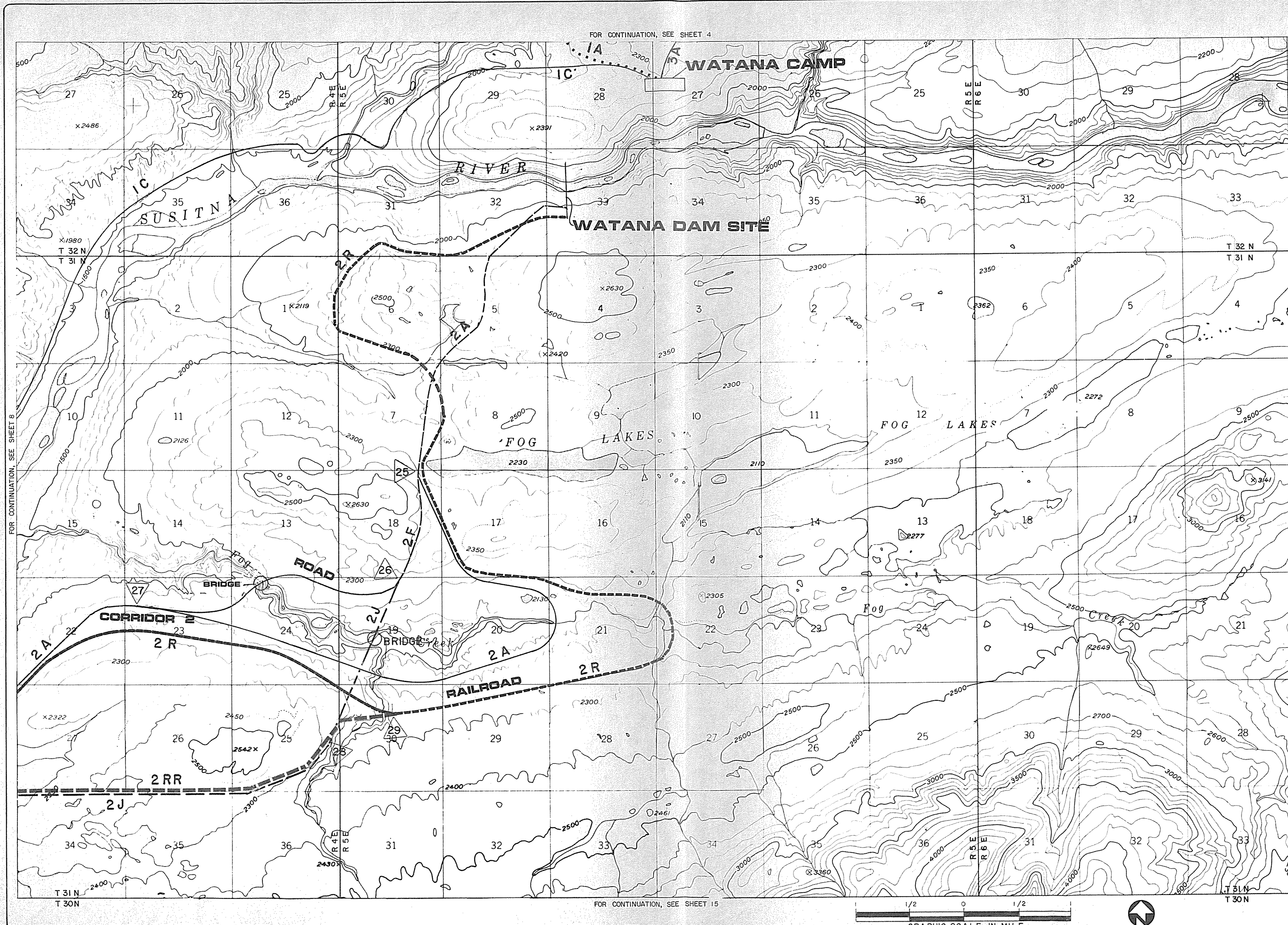


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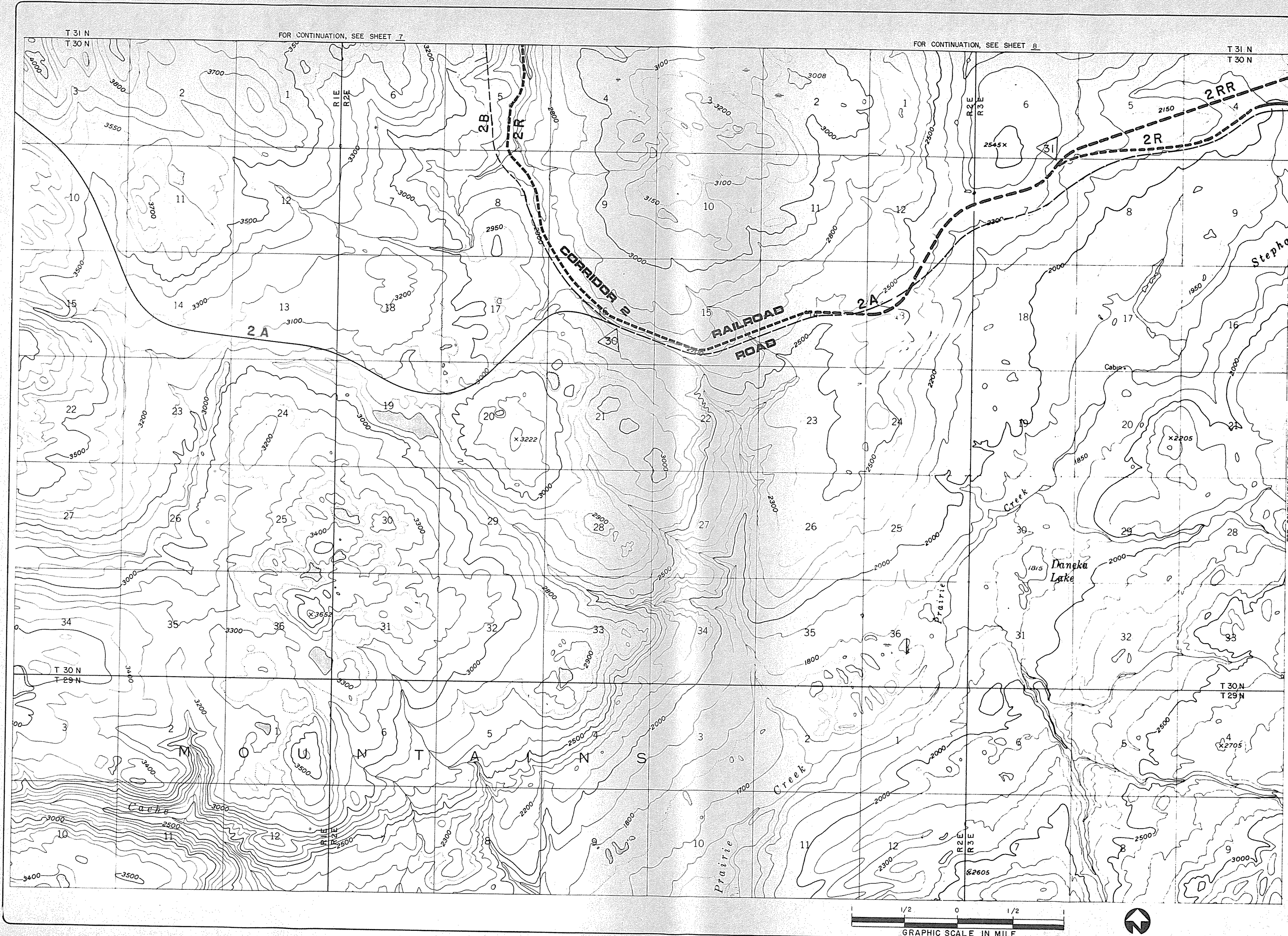


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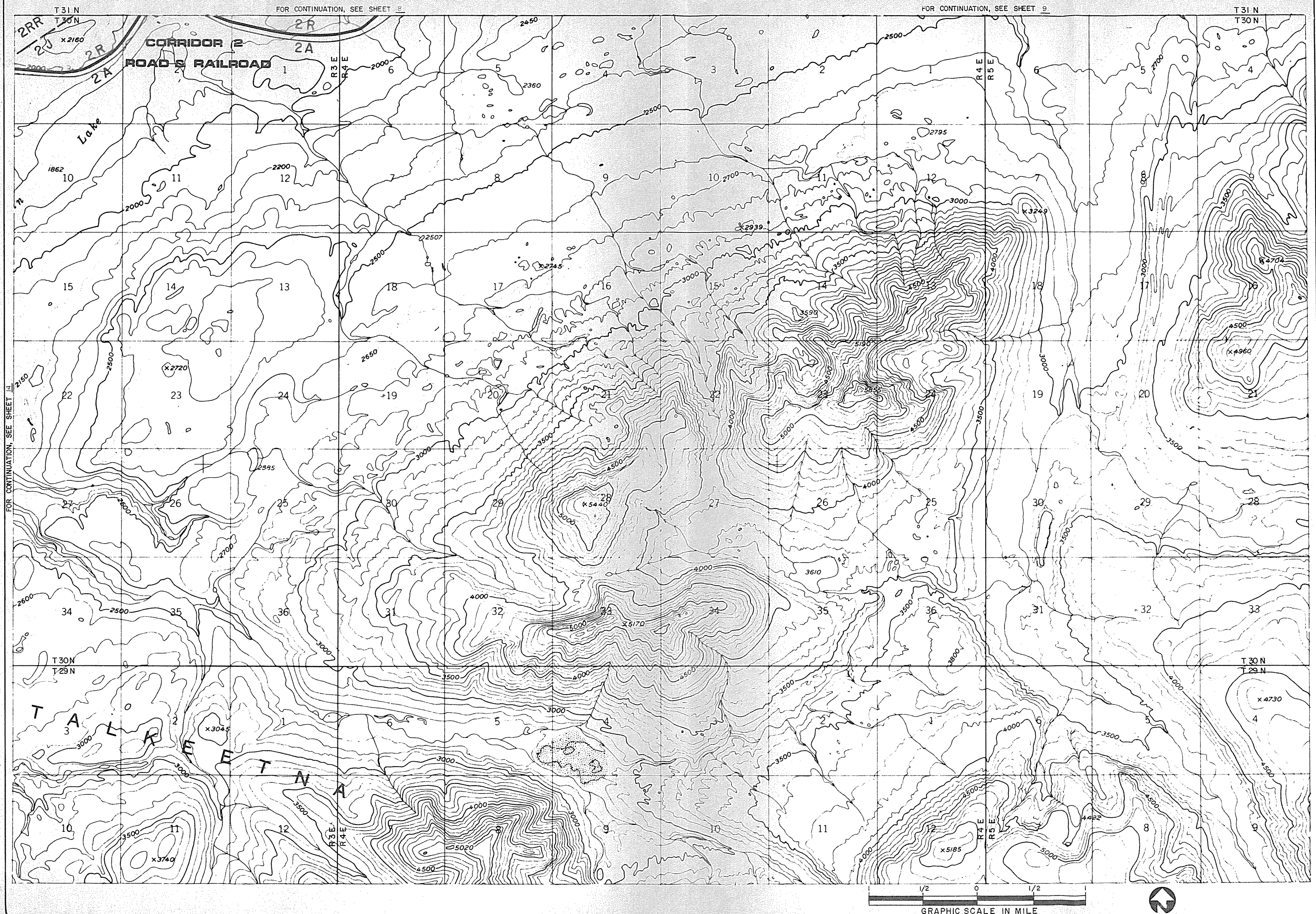


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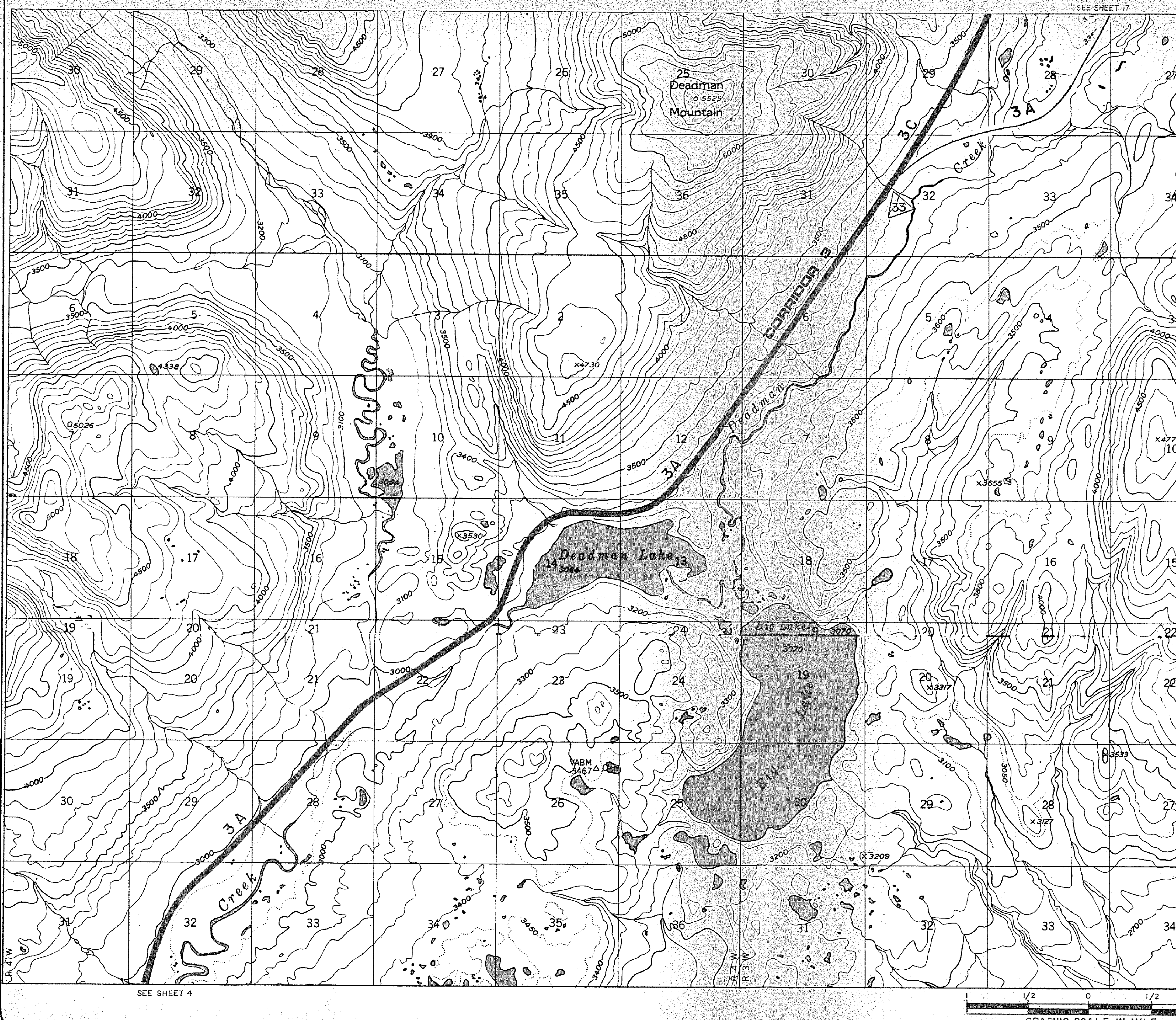


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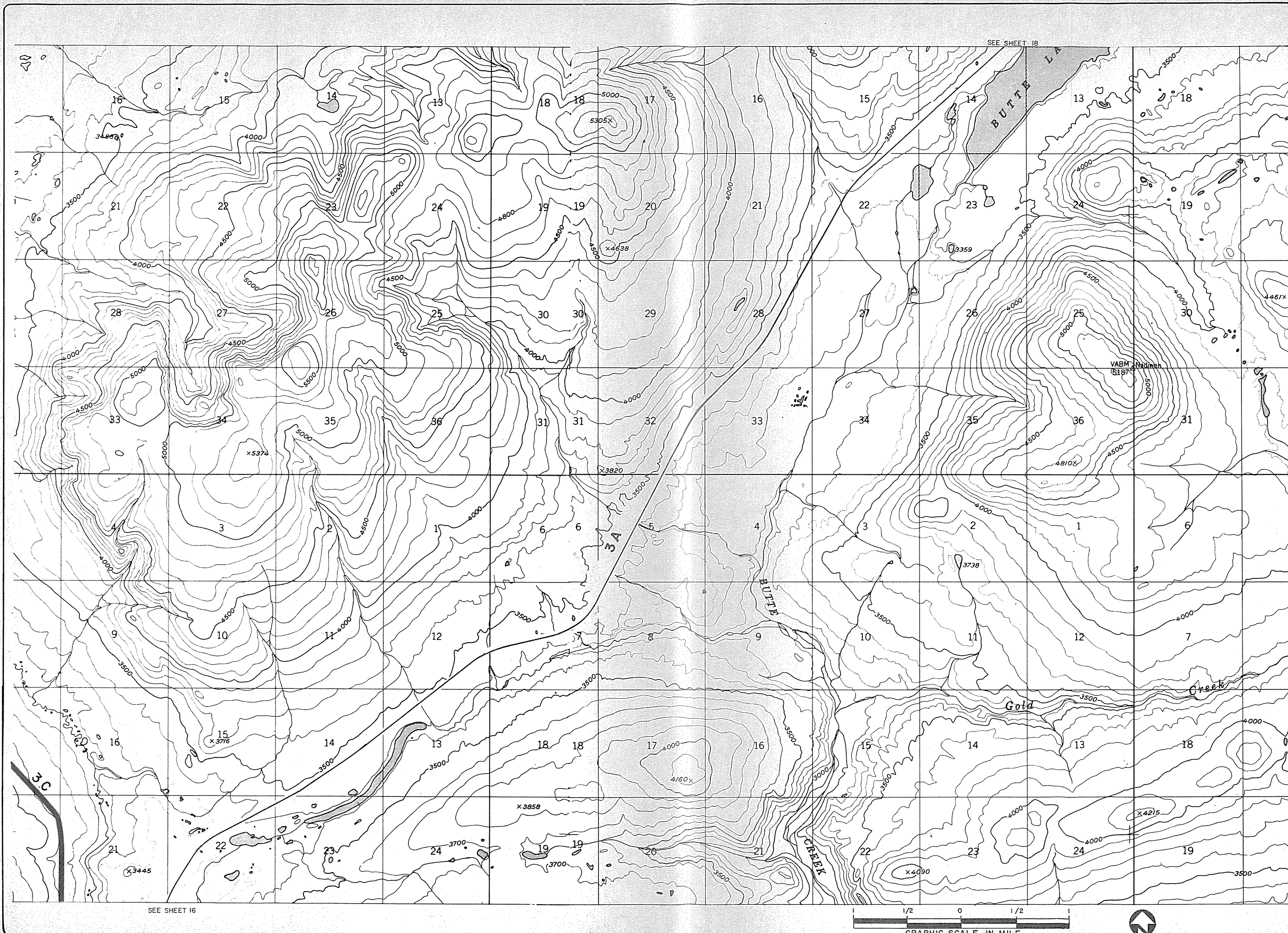


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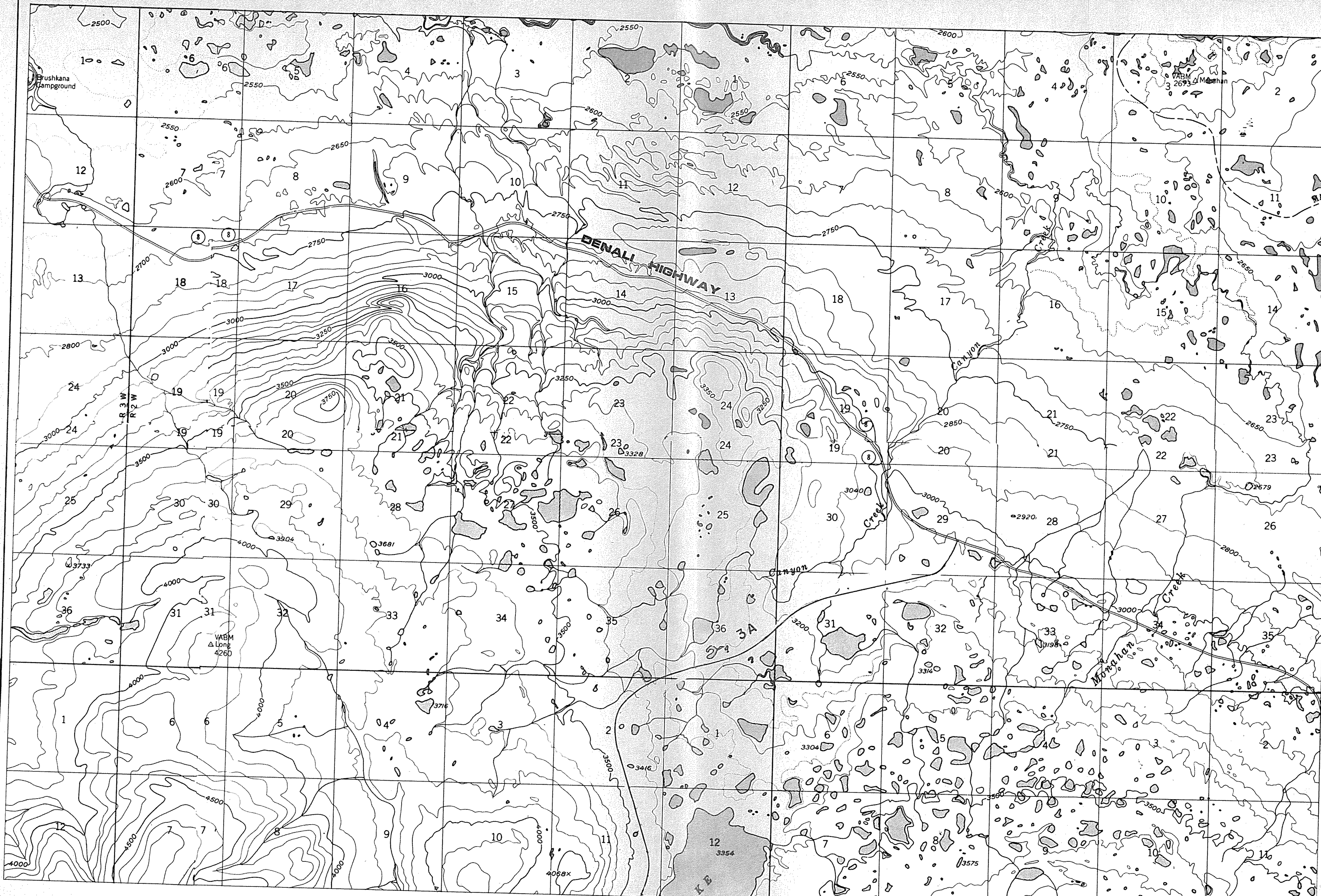


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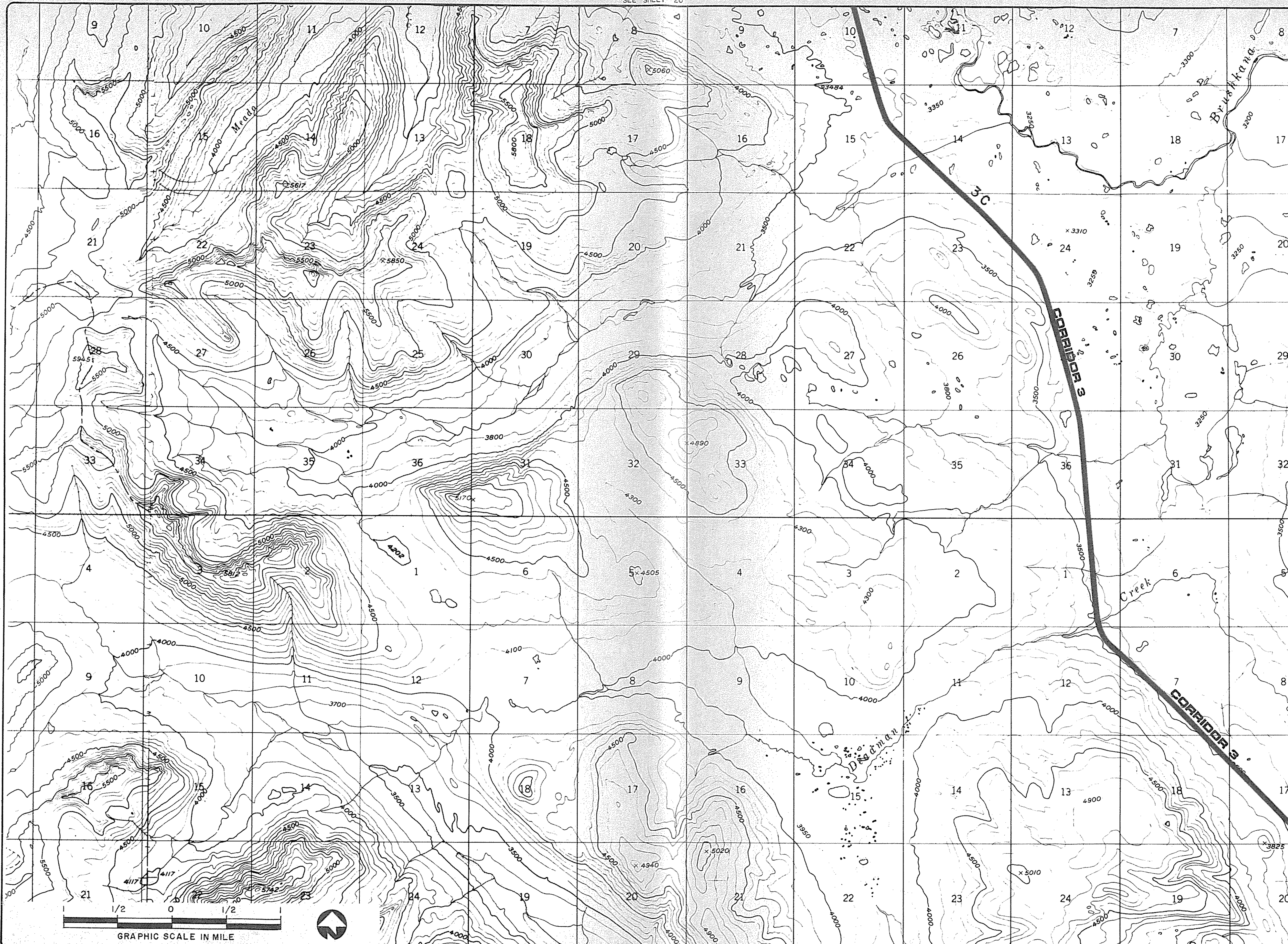


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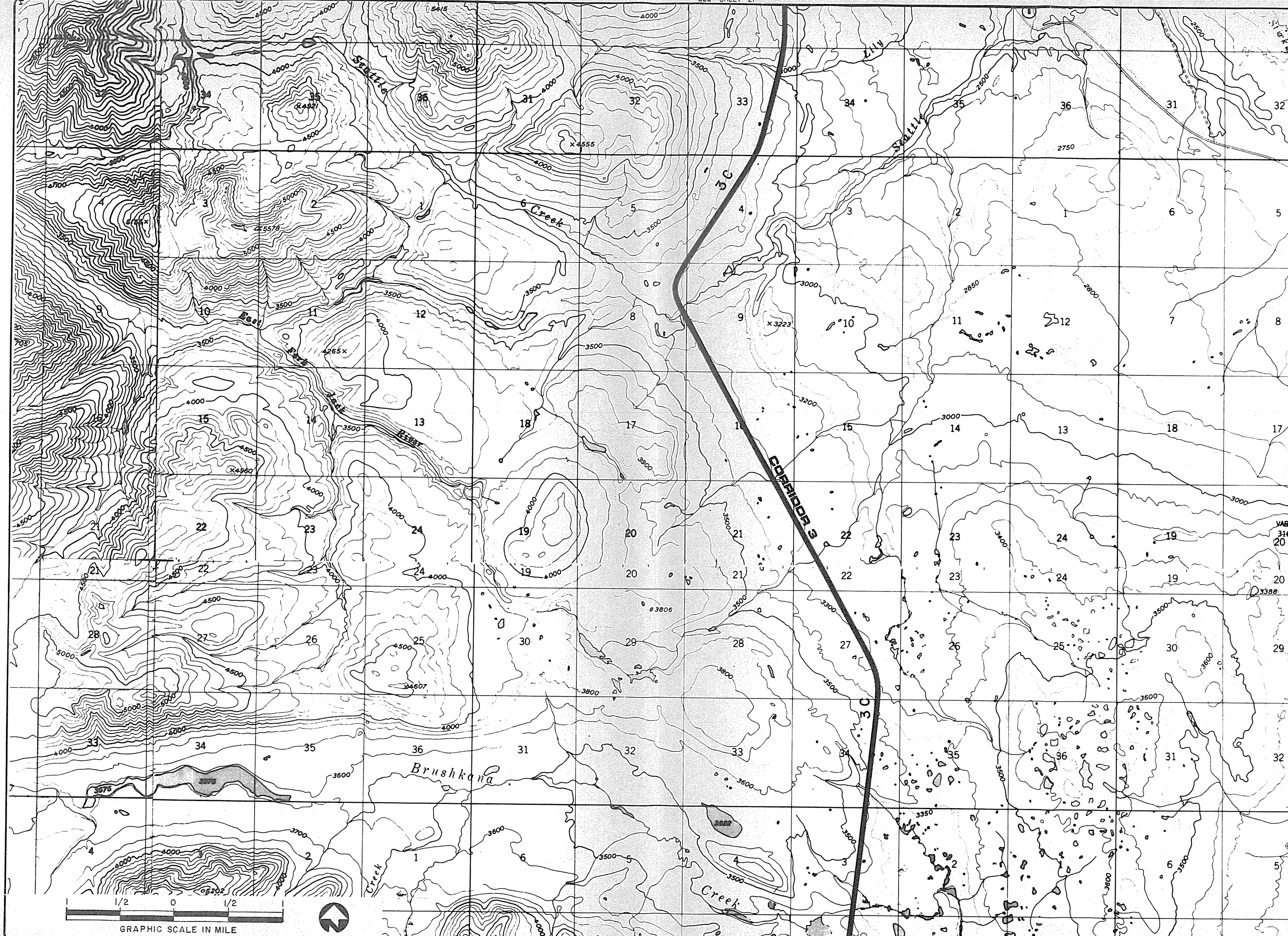


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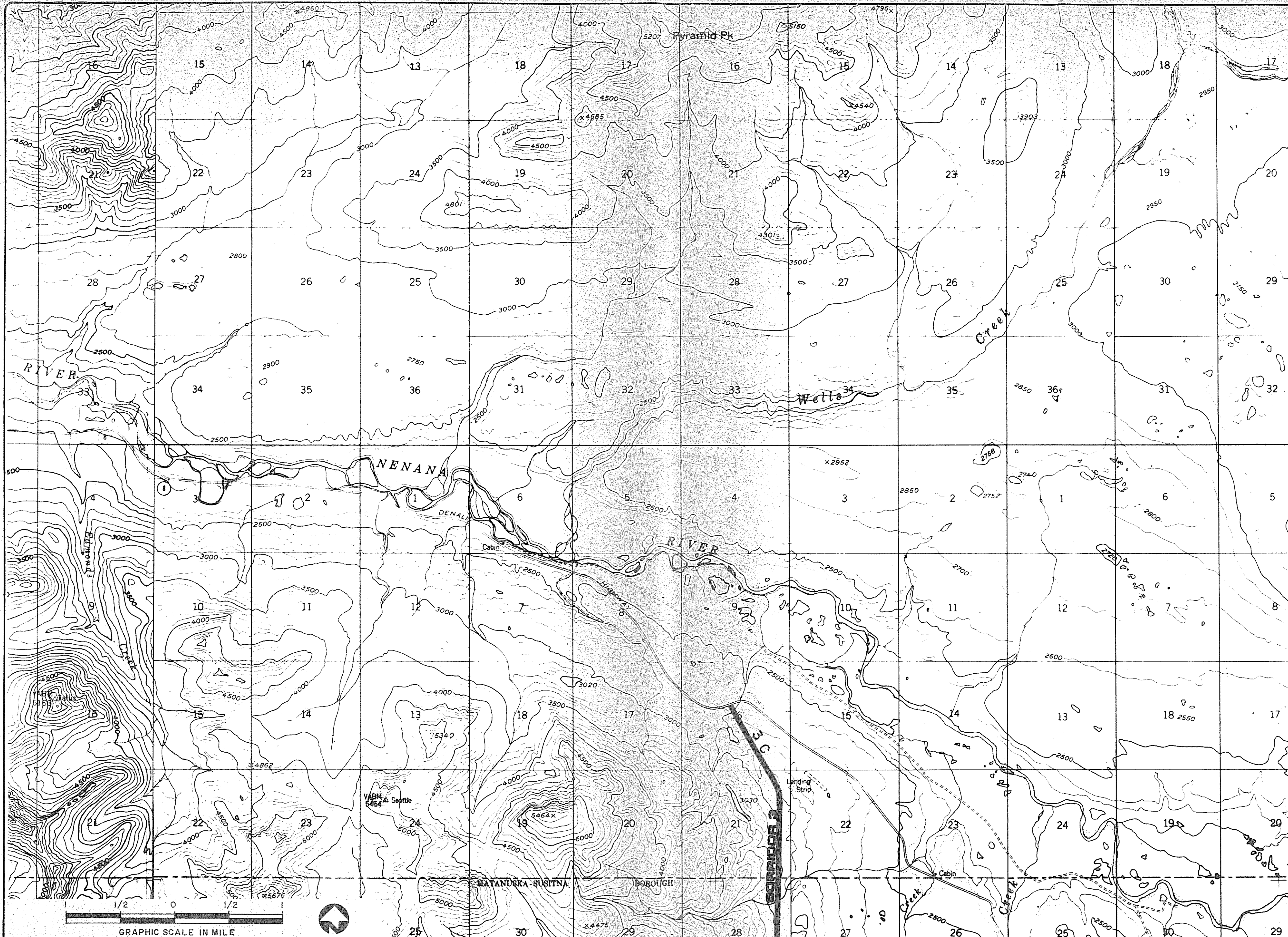


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FOR CONTINUATION, SEE SHEET 20

# APPENDIX C

## ALTERNATIVE COMPARISON

APPENDIX C

COMPARISON OF ALTERNATIVE SEGMENTS

GRADE, CURVATURE AND DISTANCE

Appendix C lists the length, average grade and sum of defection angles for each segment studied and each potential combination of segments. This tabulation was used to select the combination that make up the prefered alignment within each corridor.

TABLE C.1, Summary of Alignment parameters

| | Distance (Miles) | Average Grade % | Sum of Deflections |
|---|---|---|---|
| Segment 1-A | 64.7 Miles | 2.51% | 492° 34' |
| Segment 1-B | 16.2 Miles | 1.91% | 57° 10' |
| Segment 1-C | 27.5 Miles | 2.10% | 163° 37' |
| Segment 1-D | 9.0 Miles | 4.19% | 125° 57' |
| Segment 1-E | 7.5 Miles | 3.82% | 282° 38' |
| Segment 1-F | 4.1 Miles | 2.24% | 138° 51' |
| Segment 2-A | 56.7 Miles | 2.72% | 154° 29' |
| Segment 2-B | 13.6 Miles | 3.32% | 79° 08' |
| Segment 2-C | 7.5 Miles | 5.08% | 26° 16' |
| Segment 2-D | 10.7 Miles | 3.32% | 16° 48' |
| Segment 2-E | 15.6 Miles | 2.09% | 35° 16' |
| Segment 2-F | 3.9 Miles | 2.09% | 22° 16' |
| Segment 2-G | 7.7 Miles | 4.49% | 152° 30' |
| Segment 2-H | 5.4 Miles | 1.91% | 24° 00' |
| Segment 2-I | 11.4 Miles | 1.13% | 18° 30' |
| Segment 2-J | 12.2 Miles | 3.78% | 268° 48' |
| Segment 2-K | 0.9 Miles | 5.9% | 120° 00' |
| Segment 2-L | 8.7 Miles | 2.1% | 34° 28' |
| Segment 3-A | 38.5 Miles | 1.26% | 59° 16' |
| Segment 3-B | 38.5 Miles | | |
| Segment 3-C | 23.4 Miles | 1.18% | 84° 12' |

| | Distance (Miles) | Average Grade % | Sum of Deflections |
|---|---|---|---|
| Railroad (2-R) | 57.7 Miles | 1.48% | 299° 59' |
| Railroad 2-RR | 13.6 Miles | | |

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## C.2 - Combinations of Aligment Parameters

North of Susitna River Access Roads (Corridors 1 and 3)

| | | Distance (Miles) | Average Grade | Defl. Mile | Sum of Deflections |
|---|---|---|---|---|---|
| 1. | Segment 1-A - Watana Camp to Parks Hwy. N. Jct. | 68.6 Mi. | 2.51% | 7° 10.82' | 492° 34.15 |
| 2. | Segment 1-A, 1-B - Watana Camp to Parks Hwy. | 64.8 Mi. | 2.37% | 7° 05.66' | 460° 17.07 |
| 3. | Segment 1-A, 1-C - Watana Camp to Parks Hwy. | 68.08 Mi. | 2.35% | 7° 59.86' | 544° 29.10 |
| 4. | Segment 1-A, 1-D - Watana Camp to Parks Hwy. | 64.27 Mi. | 2.70% | 8° 29.59' | 545° 51.13 |
| 5. | Segment 1-A, 1-B, 1-D - Watana Camp to Parks Hwy. | 60.55 Mi. | 2.58% | 8° 28.90' | 513° 34.04 |
| 6. | Segment 1-A, 1-C, 1-D - Watana Camp to Parks Hwy. | 63.75 Mi. | 2.54% | 9° 22.61' | 597° 46.07 |
| 7. | Segment 1-A, 3-A - Devil Canyon to Denali Hwy. | 77.50 Mi. | 1.83% | 5° 07.09' | 396° 39.52 |
| 8. | Segment 1-A, 1-B, 3-A - Devil Canyon to Denali Hwy. | 73.16 Mi. | 1.67% | 4° 56.29' | 364° 22.94 |
| 9. | Segment 1-A, 1-C, 3-A - Devil Canyon to Denali Hwy. | 76.73 Mi. | 2.22% | 5° 49.63' | 448° 34.47 |
| 10. | Segment 3-A - Watana Camp to Denali Hwy. | 39.09 Mi. | 1.26% | 1° 30.96' | 59° 15.72 |
| 11. | Segment 3-B - Watana Camp to Denali Hwy. | 41.98 Mi. | 1.15% | 2° 13.15' | 93° 09.49 |
| 12. | Segment 1-A, 3-B - Devil Canyon to Denali Hwy. | 80.39 Mi. | 1.73% | 5° 21.36' | 430° 33.79 |
| 13. | Segment 1-A, 1-B, 3-B - Devil Canyon to Denali Hwy. | 76.68 Mi. | 1.58% | 5° 11.64' | 398° 16.71 |
| 14. | Segment 1-A, 1-C, 3-B - Devil Canyon to Denali Hwy. | 79.86 Mi. | 1.59% | 6° 02.49' | 482° 28.74 |
| 34. | Segment 1-A, 1-B, 1-E, 1-F Watana to Park Highway | 69.98 Mi. | 2.21% | 7°09' | 538° 24' |
| 36. | Segment 3A, 3C | 51. Mi | 1.48% | 1°24' | 49° 18' |

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South of Susitna River (Corridor 2)

| | | Distance (Miles) | Average Grade | Defl. Mile | Sum of Deflections |
|---|---|---|---|---|---|
| 15. | Segment 2-A - Watana to Sherman | 56.6 Mi. | 2.72% | 2° 43.77' | 154° 29.53 |
| 16. | Segment 2-A, 2-D - Watana to Parks Hwy. | 67.15 Mi. | 2.81% | 2° 33.05' | 171° 17.37 |
| 17. | Segment 2-A, 2-E, 1-A - Watana to Parks Hwy. | 76.51 Mi. | 2.52% | 2° 33.11' | 195° 14.77 |
| 18. | Segment 2-A, 2-F - Watana to Sherman | 54.79 Mi. | 2.81% | 3° 00.09' | 164° 26.93 |
| 19. | Segment 2-A, 2-F, 2-D - Watana to Parks Hwy. | 65.34 Mi. | 2.89% | 2° 46.43' | 181° 14.77 |
| 20. | Segment 2-A, 2-F, 2-E - Watana To Gold Creek | 74.69 Mi. | 2.58% | 2° 44.84' | 205° 12.17 |
| 21. | Segment 2-A, 2-B, 2-C - Watana to Sherman | 59.47 Mi. | 3.26% | 4° 02.91' | 240° 45.96 |
| 22. | Segment 2-A, 2-F, 2-B, 2-C - Watana to Sherman | 57.66 Mi. | 3.36% | 3° 57.73' | 228° 27.48 |
| 23. | Segment 2-A, 2-B, 2-C, 2-D - Watana to Parks Hwy. | 70.02 Mi. | 3.85% | 3° 40.71' | 257° 33.80 |
| 24. | Segment 2-A, 2-F, 2-B, 2-C, 2-E, 1-A - Watana to Parks Hwy. | 77.56 Mi. | 3.00% | 3° 28.26' | 269° 12.72 |
| 25. | Segment 2-A, 2-B, 2-G, 2-I, 2-H - Watana to Gold Creek | 51.66 Mi. | 2.38% | 5° 32.25' | 286° 04.2' |
| 26. | Segment 2-A, 2-B, 2-G, 2-I, 2-H, 2-E, 2-D - Watana to Parks Hwy. | 68.50 Mi. | 2.09% | 4° 04.18' | 278° 46.48 |
| 27. | Segment 2-A, 2-B, 2-G, 2-I, 2-H, 2-E, 1-A - Watana to Parks Hwy. N. Jct. | 68.25 Mi. | 2.17% | 4° 36.27' | 314° 15.28 |

South of Susitna River (Corridor 2)
(Continued)

| | | Distance (Miles) | Average Grade | Defl. Mile | Sum of Deflections |
|---|---|---|---|---|---|
| 28. | Railroad 2-R, Watana to Gold Creek | 58.01 Mi. | 1.48% | 5° 10.27' | 299° 58.86' |
| 29. | Segment 2-A, 2-B, 2-C, 2-E, Watana to Parks Hwy. | 79.37 Mi. | 2.93% | 3° 32.82' | 281° 31.2' |
| 30. | Segment 2-A, 2-F, 2-B, 2-G, 2-D - Watana to Parks Hwy. S. Jct. | 68.21 Mi. | 3.35% | 3° 35.74' | 245° 15.32' |
| 31. | Segment 2-A, 2-F, 2-B, 2-G, 2-I, 2-H - Watana to Gold Creek | 49.23 Mi. | 2.33% | 5° 56.30' | 296° 1.6' |
| 32. | Segment 2-A, 2-F, 2-B, 2-G, 2-I, 2-H, 2-E, 2-D - Watana to Parks Hwy. S. Jct. | 66.69 Mi. | 2.41% | 4° 54.59' | 327° 26.39' |
| 33. | Segment 2-A, 2-F, 2-B, 2-G, 2-I, 2-H, 2-E, 2-I Watana to Parks Hwy. | 66.44 Mi. | 2.22% | 4° 50.79' | 324° 12.18' |
| 35. | Segment 1-F, 2-L, 2-I 2-G, 2-B, 2-A, 2-J | 68.5 Mi. | 2.10% | 4° 06' | 284° 58' |

Combinations beyond these include a varity of segments that are minor adjustments and do not significantly impact length grade or curvature.

The Combinations selected for each corridor are:

| | |
|---|---|
| Corridor 1 | Combination 34 |
| Corridor 2 | Combination 35 |
| Corridor 3 | Combination 36 |

# APPENDIX D

# TERRAIN UNIT MAPPING

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## Appendix D - Terrain Unit Maps

This appendix includes the terrain unit analysis for the access alternatives.

This data identifies the surface geology and tabulates the engineering characteristics of the various soils. The alternative segments studied are plotted on the Terrain Unit Maps. The soil types and characteristics have been taken into account in developing the construction cost estimates for the alternate plans.

# TERRAIN UNIT PROPERTIES AND ENGINEERING INTERPRETATION

| TERRAIN UNIT SYMBOL | TERRAIN UNIT NAME | TOPOGRAPHY AND AREAL INTERPRETATION | SOIL STRATIGRAPHY | SLOPE CLASSI-FICATION | PROBABLE UNIFIED SOIL TYPES | DRAINAGE AND PERMEABILITY IN UNFROZEN SOILS | EROSION POTENTIAL | GROUND WATER TABLE | PROBABLE PERMAFROST DISTRIBUTION | FROST HEAVE POTENTIAL | THAW SETTLEMENT POTENTIAL | BEARING STRENGTH | SLOPE STABILITY | SUITABILITY AS SOURCE OF BORROW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bxu | Unweathered, consolidated bedrock | Cliffs in river canyon, rounded knobs on broad valley floor and mountain peaks. | | Moderate to Near-Vertical | - | - | Low | Deep | | Nil | Nil | Very High | Moderate to High | Fine - Poor<br>Coarse - Good |
| C | Colluvial deposits | Predominatly found at the base of steeper bedrock slopes as coalescing cones and fans and rock glaciers. | Angular frost cracked, blocks of rock, some silt and sand. | Moderate to Steep | GP, GW, GM, SW, SM | Good/High | Moderate to High | Deep | Sporadic at Low Elevation. Discontinuous at High Elevations | Low to High | Low to Moderate | Low to Moderate | Low to Moderate | Fine - Poor<br>Coarse - Variable |
| Cl | Landslide deposits | Hummocky unconsolidated deposits most common along the Susitna River and its major tributaries | Silty gravels, silty sands and sandy silts; possible crude contorted layers. | Moderate to Steep | GM, SM, ML | Poor/Low | High | Shallow (perched) | Active - Unfrozen<br>Inactive - Frozen | High | High where Frozen | Low | Low | Poor |
| Cs–f | Solifluction deposits | Relatively smooth to labate topography created by the flow of materials subjected to frequent freeze/thaw cycles. | Silty sand and sandy silt showing contorted layering. | Gently to Steeping Sloping | SW, SM, ML | Frozen | High | Shallow (perched) | Continuous | High | High | High | Low | Poor |
| Ffg | Granular alluvial fan | Low cone shaped deposits formed where high gradient streams flow onto flat surfaces. | Rounded cobbles and gravel with sand and some silt, some sorting and layering of materials. | Moderate | GW, SW | Good/High | Moderate | Shallow | Unfrozen | Low | Low | High | High | Fine - Poor<br>Coarse - Good |
| Fp | Floodplain deposits | Flat plains, slightly above and adjacent to the present Susitna River and its major tributaries. | Rounded cobbles, gravel and sand sorted and layered. With or without silt cover. | Flat to Gentle | GW, GP, SW, SP, SM | Good/High | High | Very Shallow | Unfrozen | Generally Low, High for Surface Cover | Low | Surficial Silts Low. Sands and Gravels High | High | Fine - Poor<br>Coarse - Good. |
| Fpt | Terrace | Flat surface remnants of former floodplain deposits isolated above present floodplain. | Rounded cobbles, gravel and sand with some silt covered by a thin silt layers. Sorted and layered. | Flat to Gentle | GW, GP, SW, SP, SM, ML | Good/High | Low | Deep | Unfrozen | Generally Low, High for Surface Cover | Low | High | Low to Moderate | Fine - Poor<br>Coarse - Good |
| GFo | Outwash deposits | Bottoms of U-shaped tributary valleys and adjacent to Susitna area. | Rounded & striated cobbles, gravel, and sand, crudely sorted and layered. | Gentle | GW, SW | Good/High | Moderate | Shallow to Deep | Unfrozen | Low | Low | High | Low to High | Fine - Poor<br>Coarse - Excellent |
| GFe | Esker deposits | Rounded to sharp crested sinuous ridges in upper Susitna area. | Rounded & striated cobbles, gravel, and sand. Crudely to well sorted and layered. | Steep Local Slopes | GW, SW | Good/High | Moderate | Deep | Unfrozen | Low | Low | High | Moderate | Fine - Poor<br>Coarse - Excellent |
| GFk | Kame deposits | Rounded to sharp-crested, Hummocky hills. | Rounded & striated cobbles, gravel, and sand. Crudely sorted and layered. | Steep Local Slopes | GW, SW | Good/High | Moderate | Deep | Unfrozen | Low | Low | High | Moderate | Fine - Poor<br>Coarse - Excellent |
| Gta | Ablation till | Tributary valley side walls and valley bottoms in general, between Tsusena and Deadman Creek Hummocky rolling surface, numerous channels. | Rounded and striated cobbles, gravel and sand, no sorting or layering. Boulder-cobble lag covering surface. | Gentle to Steep | GW, GM, SW, SM | Moderate/Moderate | Moderate | Shallow to Moderately deep | Unfrozen to Sporadic | Low to Moderate | Low to Moderate | Moderate to High | Moderate | Fine - Poor<br>Coarse - Fair |
| Gtb–f | Basal till (frozen) | Bottoms of larger U-shaped valleys and adjacent gentle slopes. | Gravely silty sand and gravely sandy silt; no layering or sorting; cobbles and boulders poorly rounded and striated. | Gentle to Steep | GM, SM, ML | Frozen | Moderate | Shallow (perched | Continuous | High | High | Low if Thawed. High when Frozen | Low | Fine - Poor<br>Coarse - Poor |
| O | Organic deposits | In swales between small rises on lowlands and in high elevation bedrock areas. Flat surface to steplike terraces. | Decomposed and undecomposed organic material with some silt. | Flat | Pt, OL | Poor/Moderate to High | Low | At Surface | Discontinuous Overlies Continuous | High | High | Very low | Low | Nil |
| L–f | Lacustrines (frozen) | Lowlands (below 3000') flat surface in the Tyone - Oshetna River area. | Sandy silt and silty sand with occasional pebbles, sorted and layered. | Gentle | SP, SW, ML | Frozen | High | Shallow (perched) | Continuous | High | High | Low if Thawed. High when Frozen | Low | Poor |
| L / Gta –f | Lacustrine sediments over ablation till | Gently rolling to hummocky surface surrounding Butte Lake | Stratified sandy silt and silty sand over unsorted silty sandy gravel. | Gentle to Moderate | SP, SW, ML / GW, GM, SW, SM | Frozen | Moderate | Shallow (perched | Continuous | Moderate to High | Moderate to High | Low if Thawed. High when Frozen | Low | Fine - Poor<br>Coarse - Fair |
| L / Gtb–f | Lacustrine deposits over basal till | Lowlands, (below 3000') between Stephan Lake and Watana Creek, and extending upstream past the Tyone River. | Well sorted silty sand and sandy silt overlying basal till. | Gentle to Moderate | SP, SW, ML, / GM, SM ML | Lacustrine-Good/Good Basal Till-Frozen | Lacustrine-High Basal Till-Moderate | Moderately deep | L - Discontinuous<br>Gtb-f - Continuous | High | High | Low when Thawed. High when Frozen | Low | Poor |
| Cs–f / Gtb–f | Solifluction deposits (frozen) over basal till (frozen) | Smooth to lobate steplike topography on gentle slopes above the proglacial lake level, west of Tsusena Creek. | Unsorted gravels, sands, & silts with thin ice layers, contorted soil layering. | Moderate to Steep | GM, SM, ML | Frozen | Moderate | Shallow (perched) | Continuous | High | High | Low when Thawed. High when Frozen | Low | Poor |
| Cs–f / Gta | Solifluction deposits (frozen) over ablation till | Smooth to lobate and hummocky topography along Deadman Creek. | Silty, sandy, gravel and silty gravely sand showing contorted layering. | Moderate to Steep | GW, GM, SW, SM | Frozen | Moderate | Shallow (perched) | Continuous | High | High | Low if Thawed. High when Frozen | Low | Poor |
| Cs–f / Fpt | Solifluction deposits (frozen) over terrace sediments | Smooth to lobate flows of frozen fine grained materials, found on terrace of the Susitna, frequent between the Tyone and Oshetna Rivers. | Silty, sand and sandy silt showing contorted layering over gentle sorted and layered rounded cobbles, gravel and sand. | Gentle | SW, SM, ML / GW, GP, SW, SP, SM, ML | Frozen | Moderate | Shallow (perched) | Continuous | High | High | High when Frozen. Low when Thawed. | Low | Fine - Poor<br>Coarse - Fair |
| Cs–f / Bxu | Solifluction deposits (frozen) over bedrock | Smooth to lobate steplike topography on the flanks of some mountains, north and south of the Devil Canyon area. | Mixed gravels sands and silts with thin ice layers and faint contorted soil layering over bedrock | Moderate to Steep | GW, GM, SW, SM, ML / bedrock | Frozen | High | Shallow (perched) | Continuous | High | High | High | Low | Poor |
| Gtb–f / Bxu | Frozen basal till over bedrock | Rolling lowland areas and moderate to steeply sloping river canyon walls. Transitional to high mountains areas. | Gravels, silty sand and sandy silt with no layering or sorting, overlying bedrock. | Moderate to Steep | SP, SM, ML, / Bedrock | Frozen | Moderate | Shallow (perched) | Continuous | High | High | Low if Thawed. High when Frozen | Low | Poor |
| Gta / Bxu | Ablation till over unweathered bedrock | Hummocky rolling surface transitional to higher mountains adjacent to Deadman Creek. | Rounded and striated cobbles, gravel and sand, no sorting or layering, over bedrock. | Gentle to Steep | GW, GM, SW, SM / bedrock | Good/High | Moderate | Shallow to Moderately deep | Discontinuous | Low to Moderate | Low to Moderate | Low if Thawed. High when Frozen | Moderate | Fine - Poor<br>Coarse - Fair |
| C / Bxu+Bxu | Colluvium over bedrock and bedrock exposures | Higher elevation mountain areas and steep slopes along the Susitna River and its major tribuatries. | Angular blocks of rock with some sand and silt overlying bedrock. | Steep to Near-Vertical | GP, GW, GM, SW, SM / Bedrock | Good/Low to High | Moderate to High | Deep | Sporadic | Low to High | Low to Moderate | Low to Very High | Moderate to High | Fine - Poor<br>Coarse - Fair |
| C / Bxw +Bxw | Colluvium over Weathered, poorly consolidated bedrock | Small cliffs cut into tertiary non-marine sediments along Watana Creek, and tertiary volcanics in Fog Creek. | Angular rubble with silt and sand over poorly consolidated or highly weathered bedrock. | Steep to Near-Vertical | GW, GM, SW, SM, ML | Good/Low to Moderate | Moderate | Deep | Continuous | Low to High | Low to Moderate | Low to Moderate | Moderate | Fine - Poor<br>Coarse - Poor |

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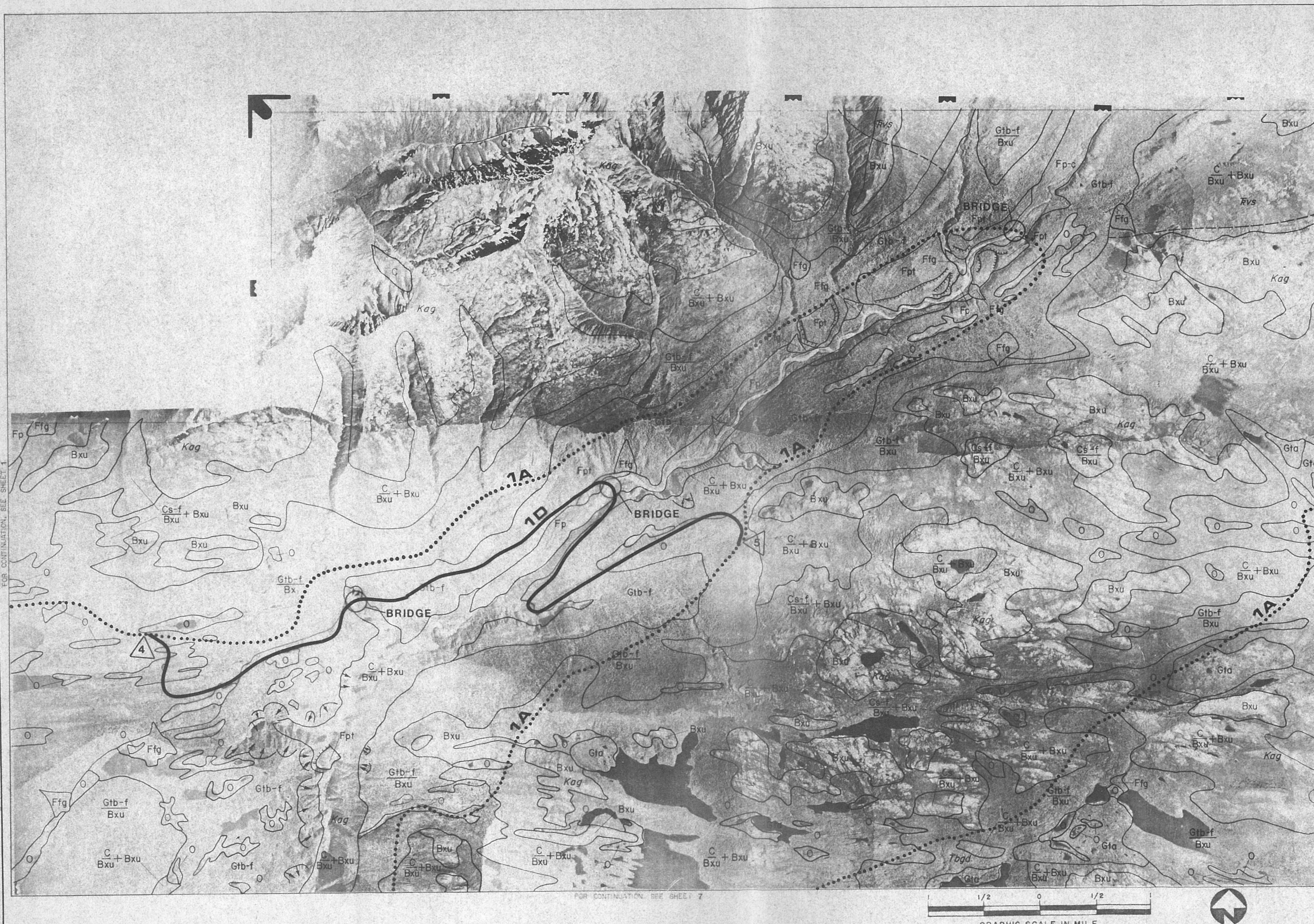


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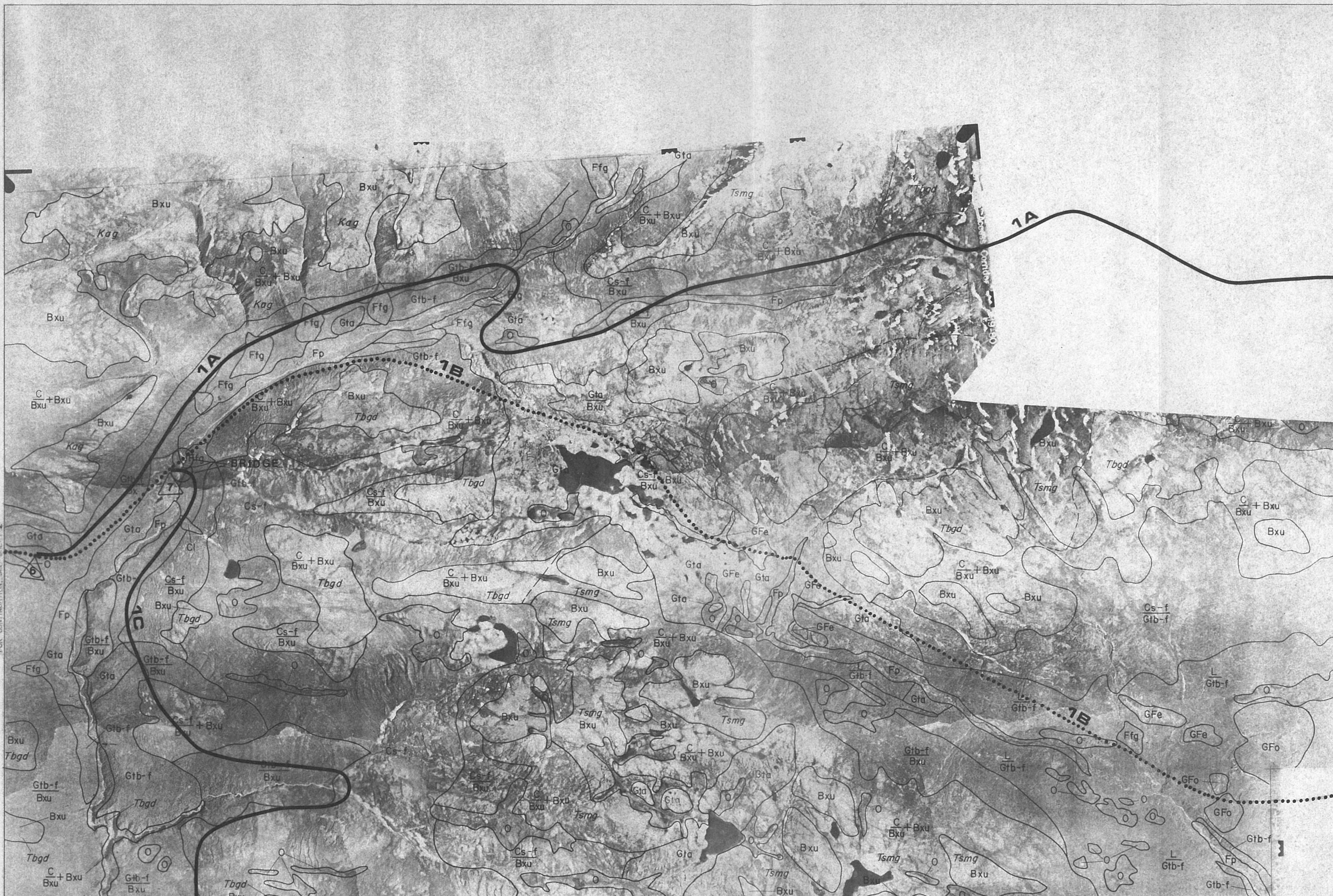


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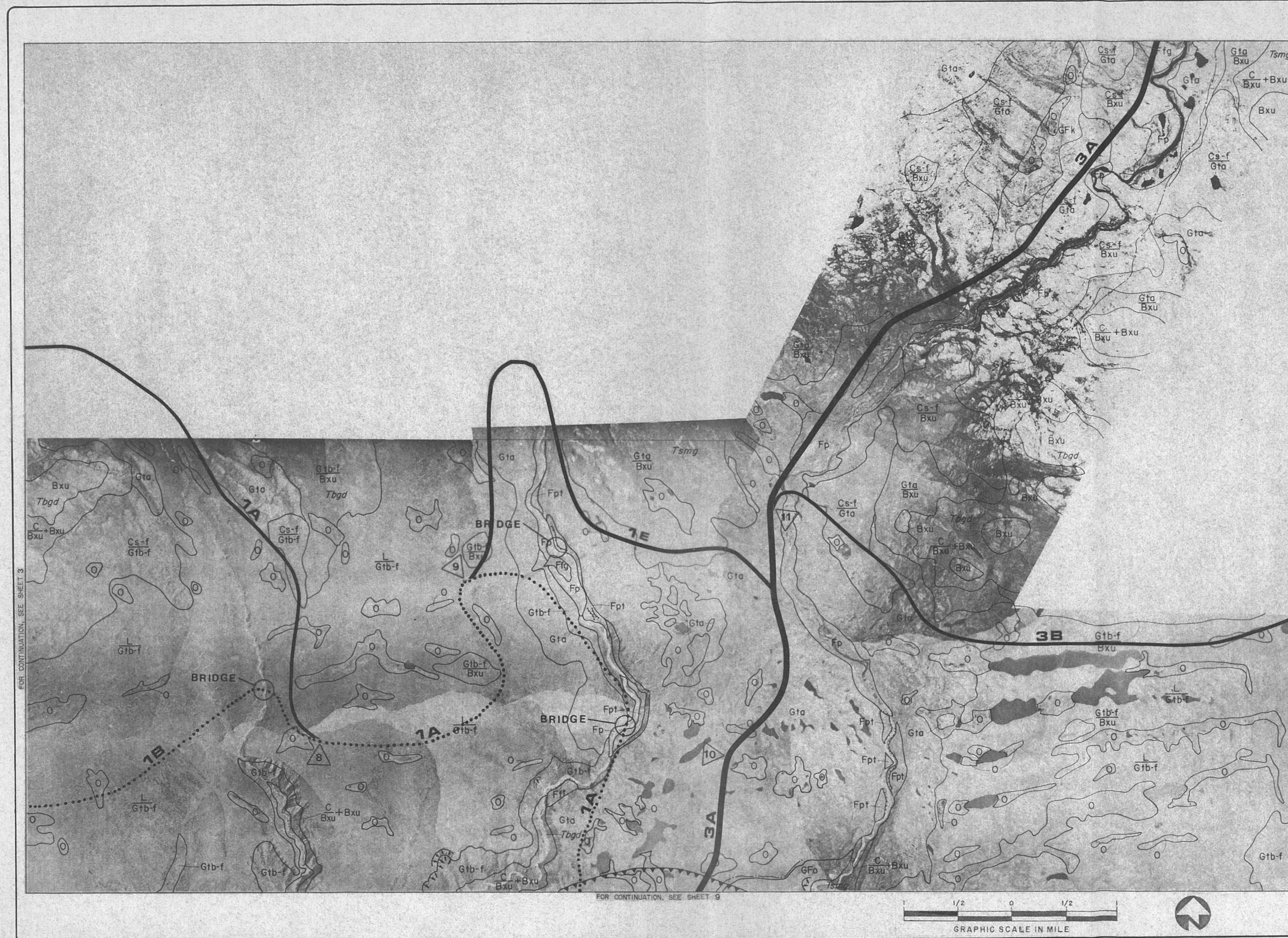


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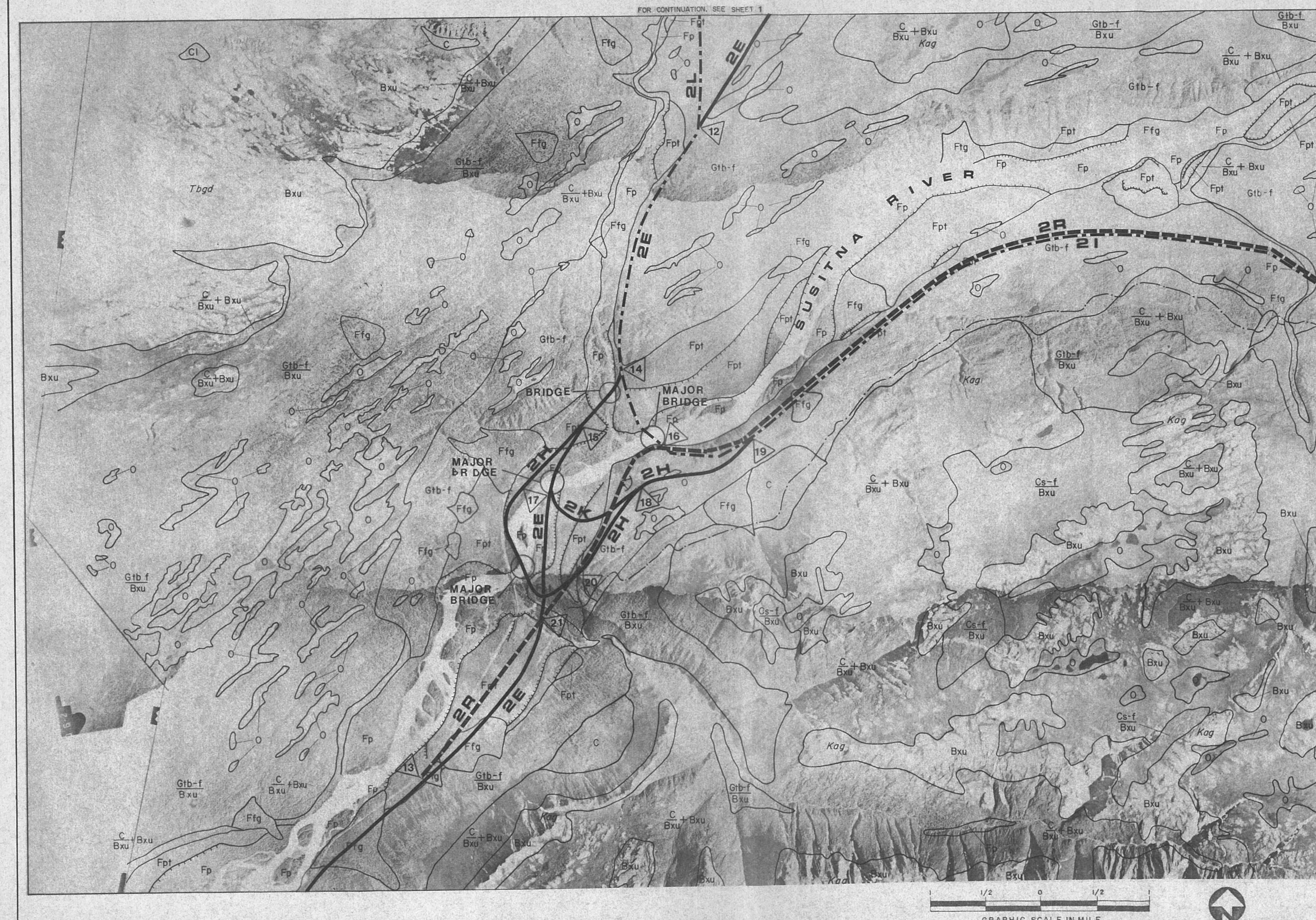


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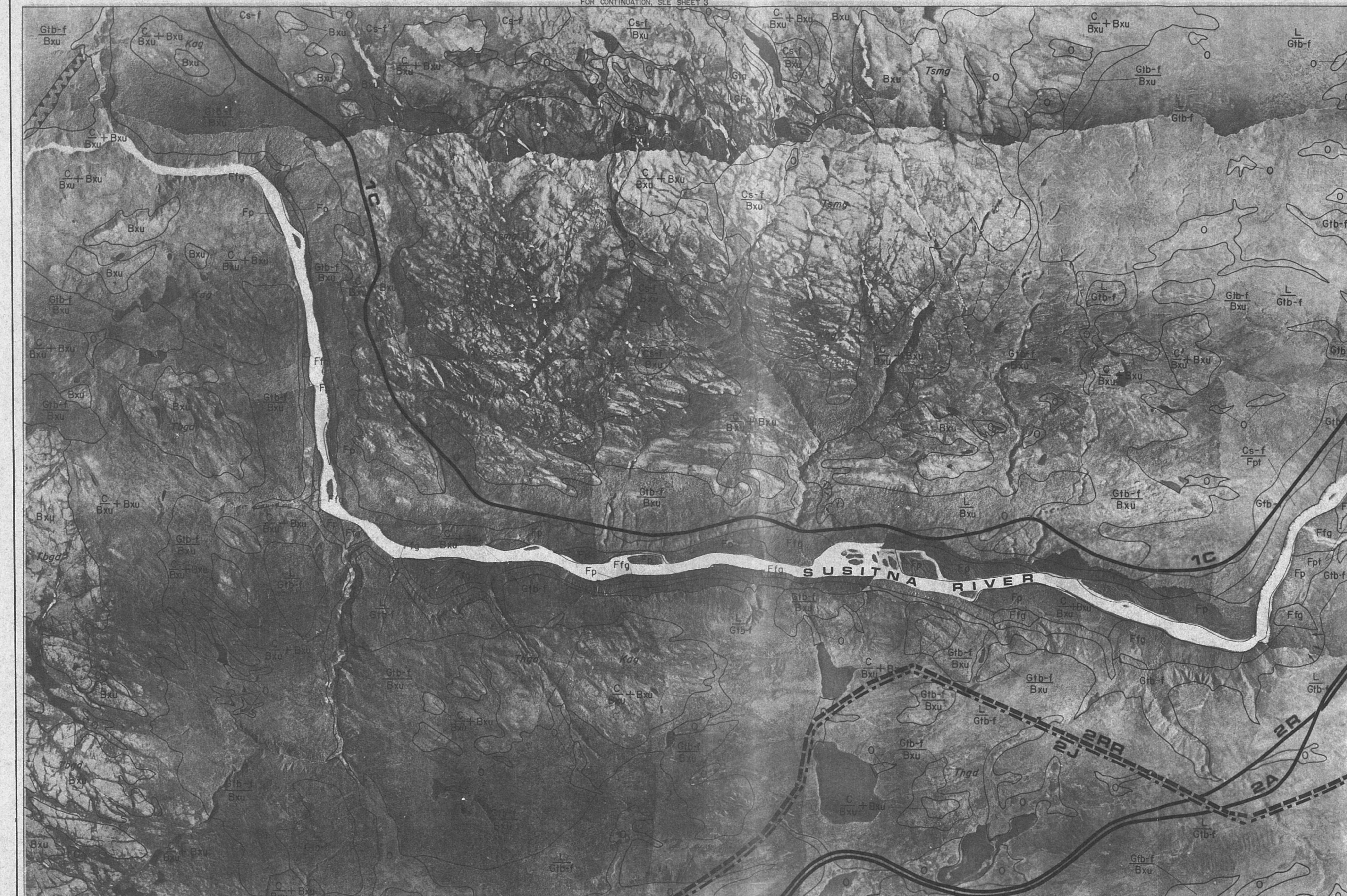


FOR CONTINUATION, SEE SHEET 9

FOR CONTINUATION, SEE SHEET 14

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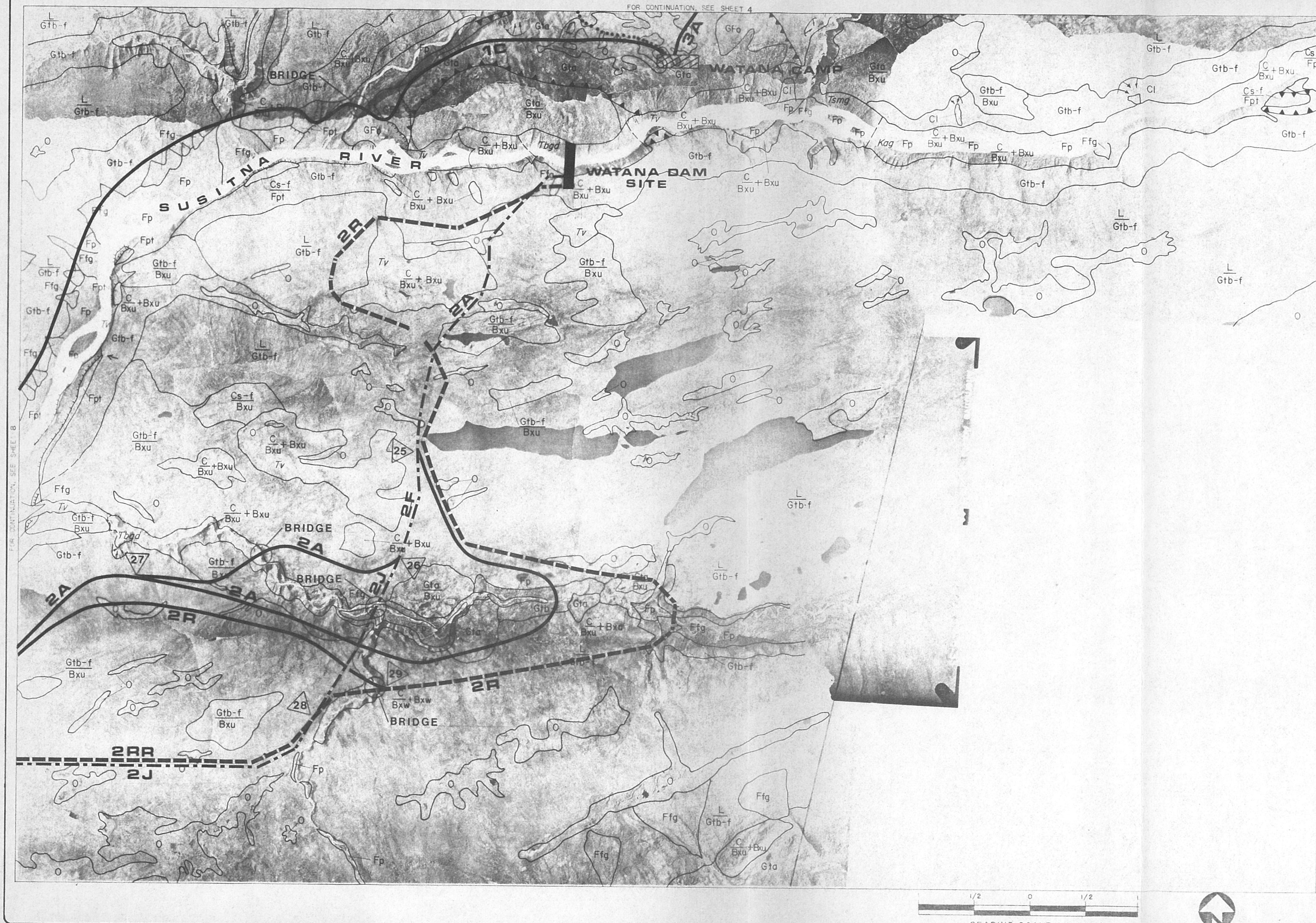


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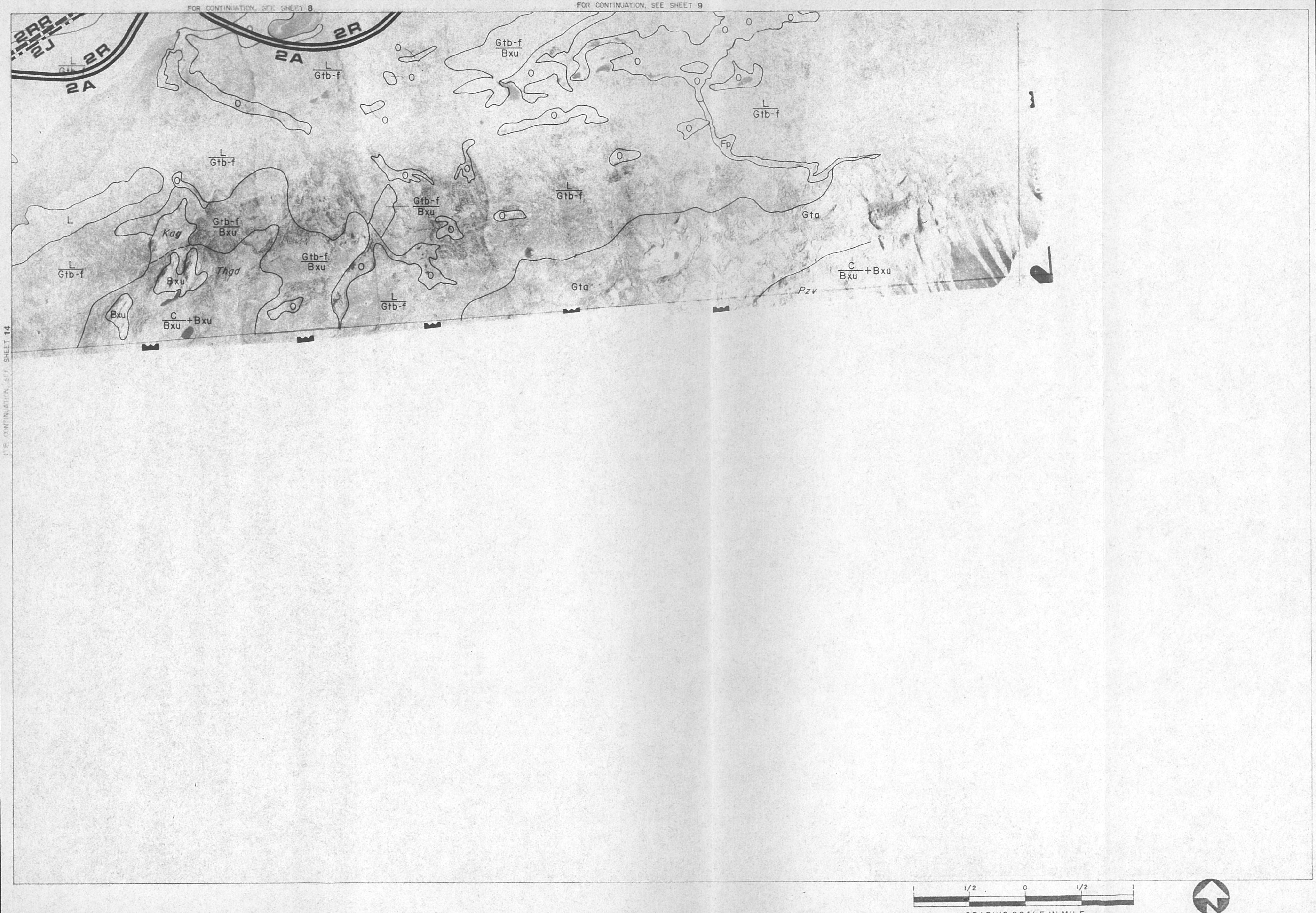


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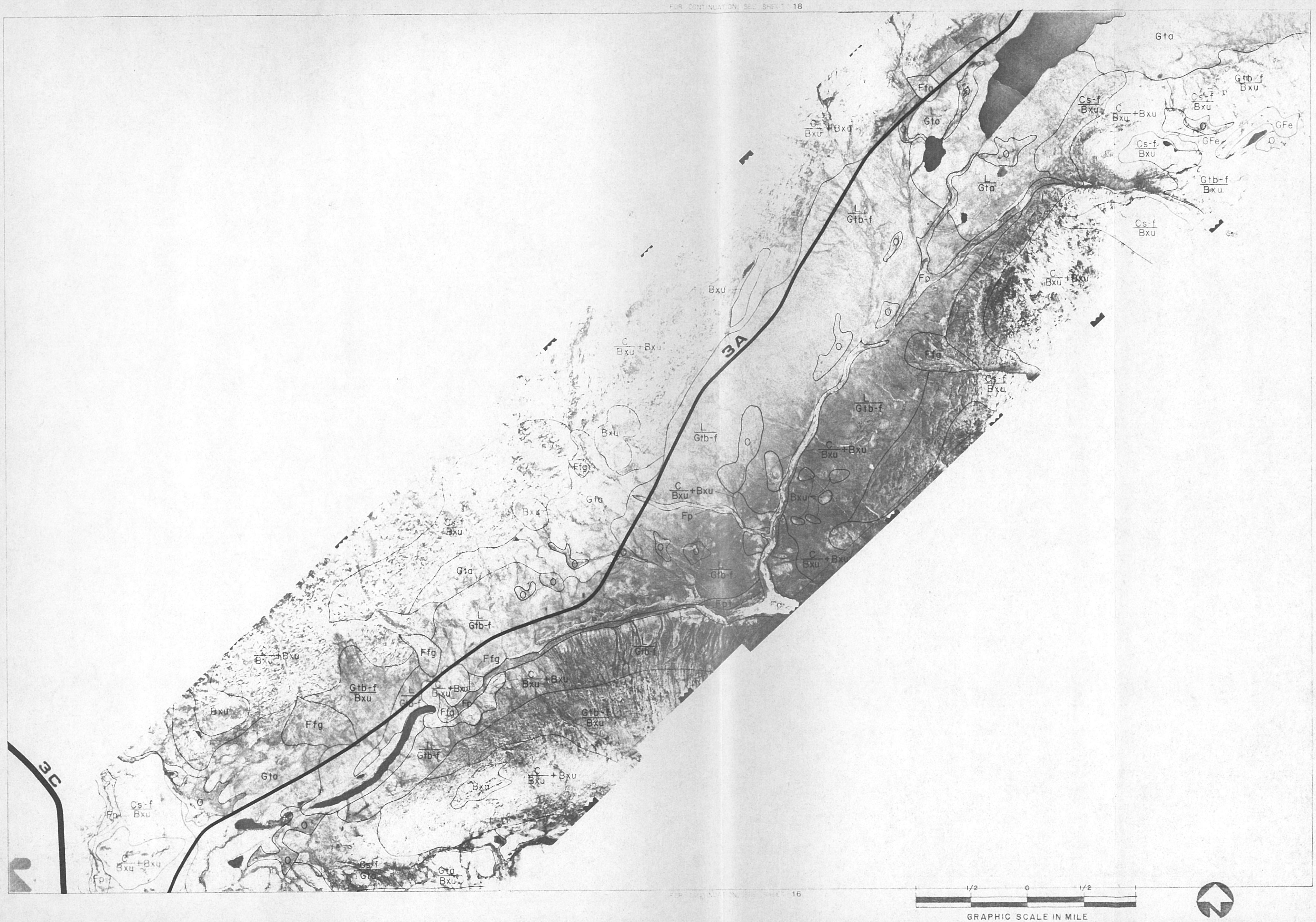


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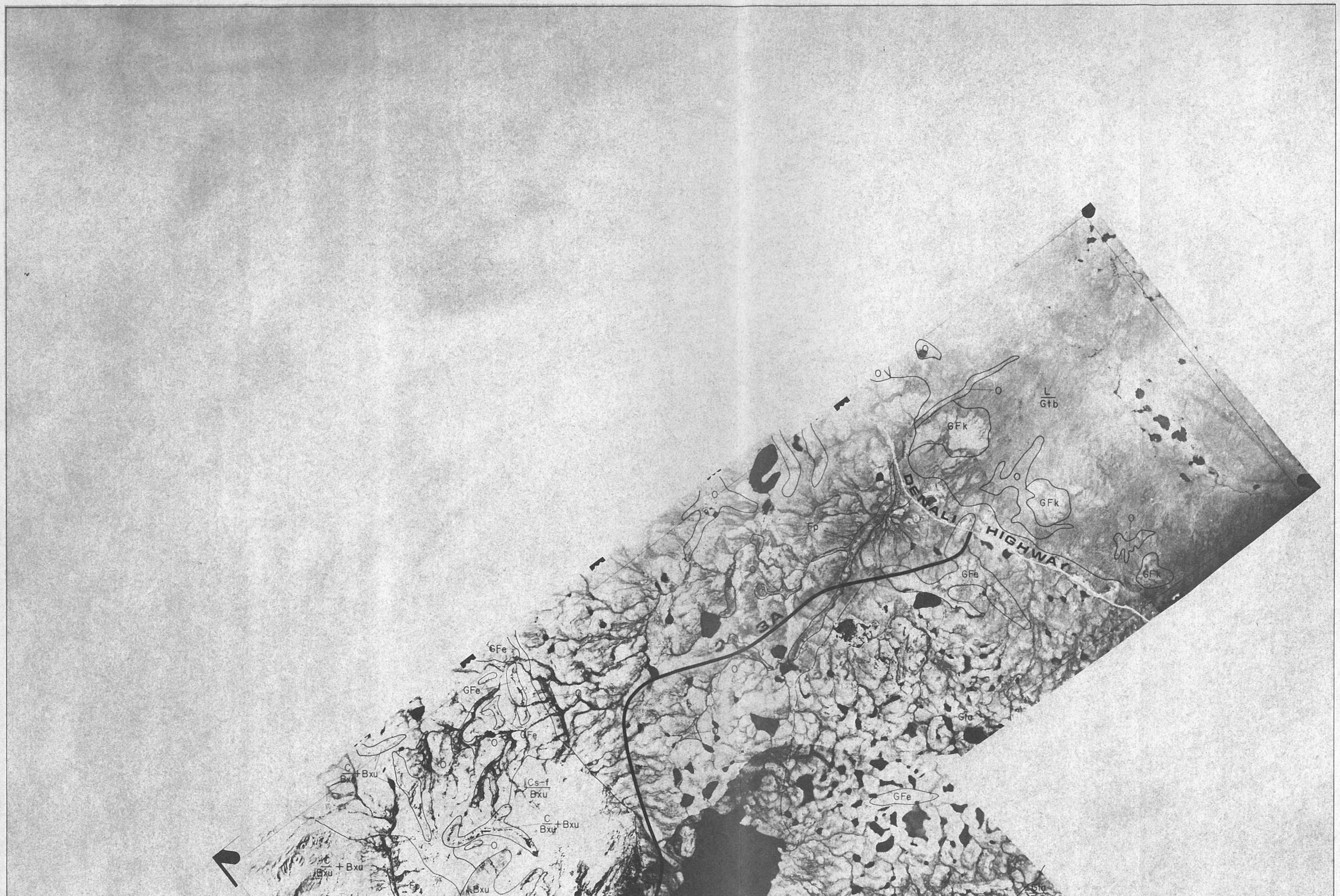


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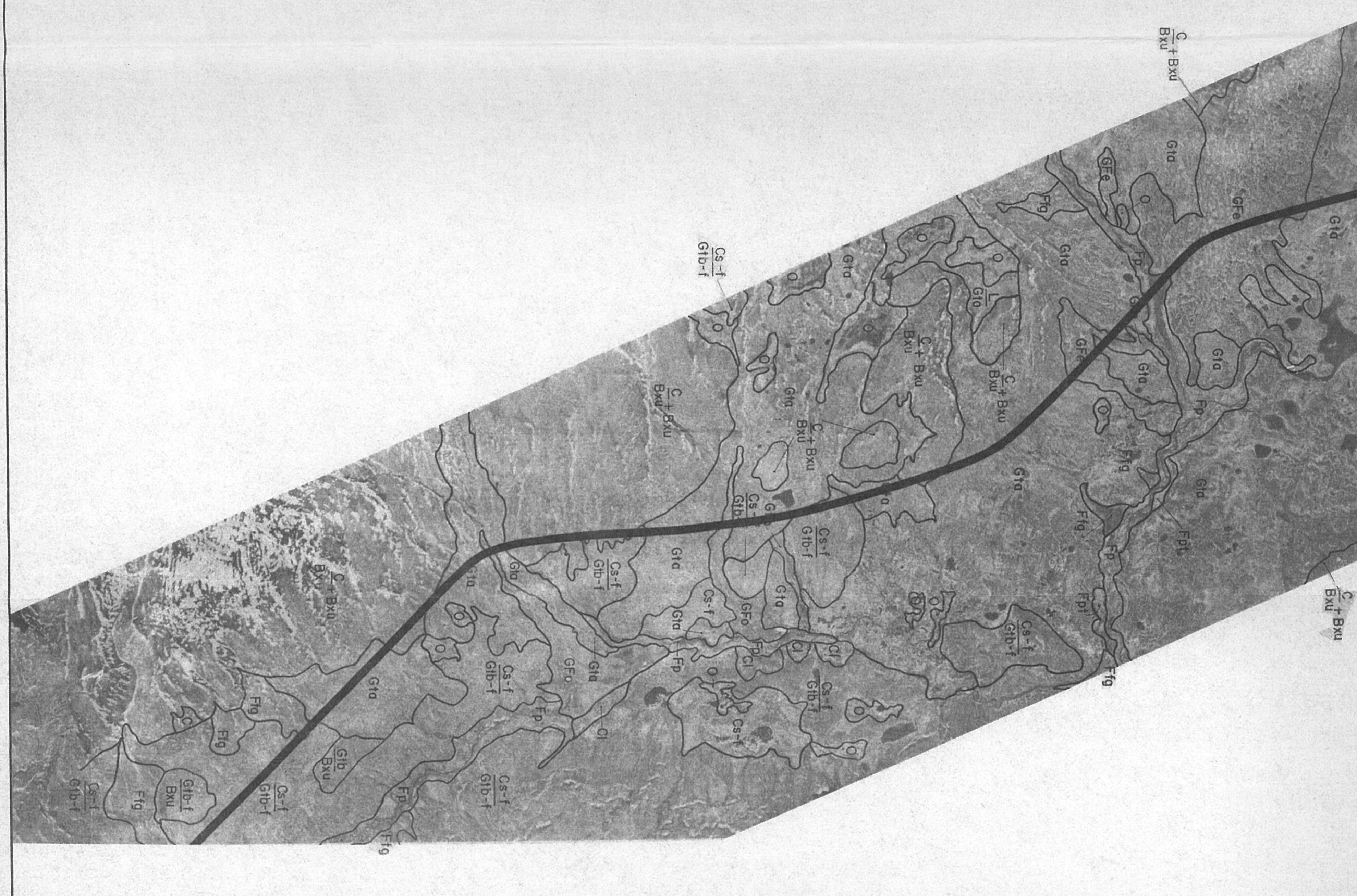


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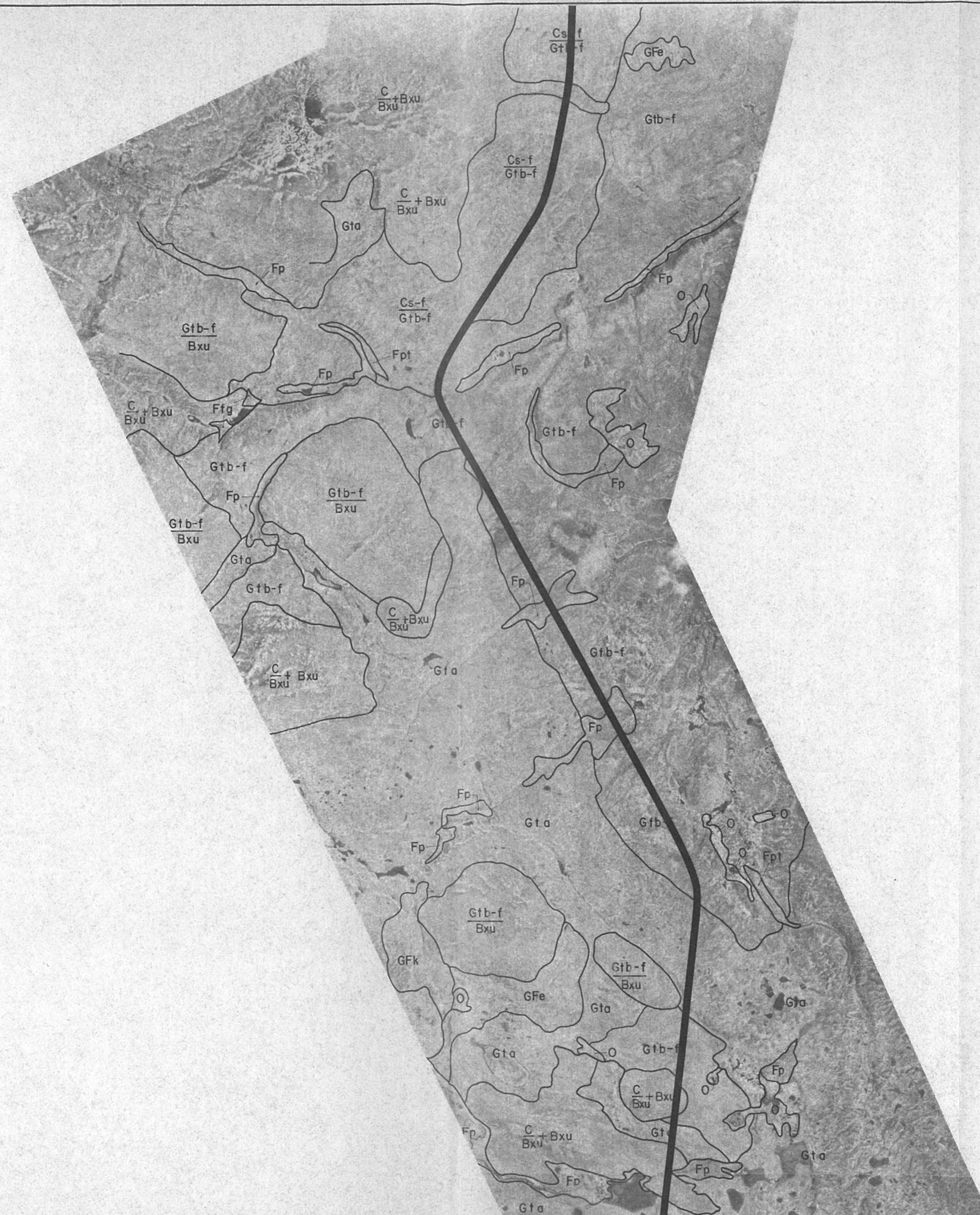


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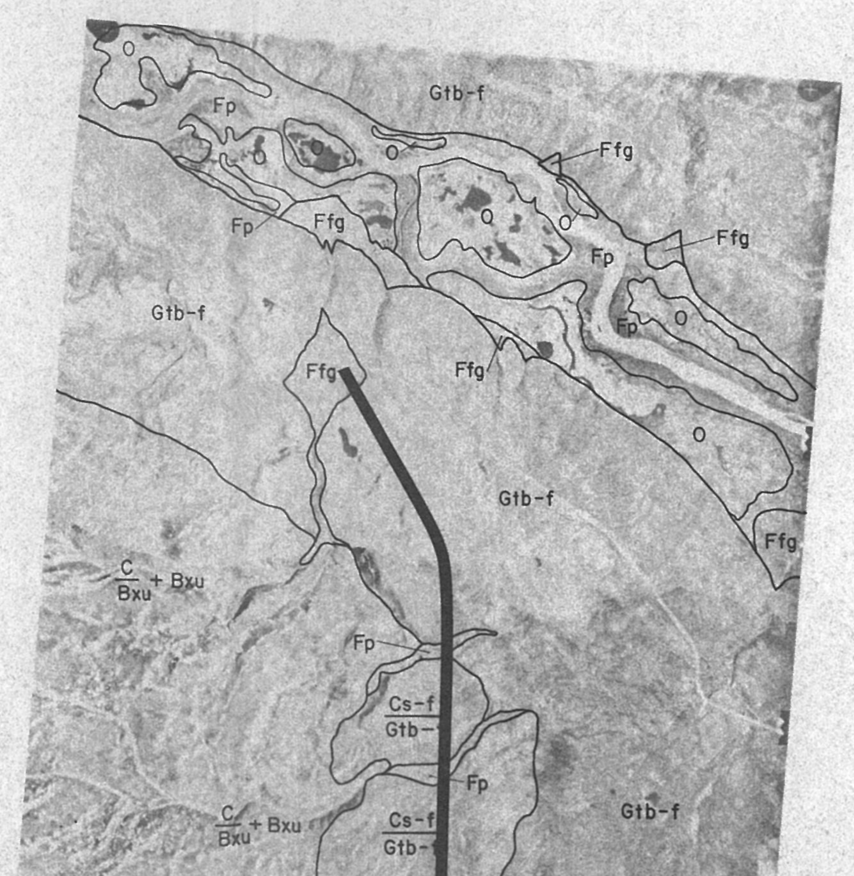


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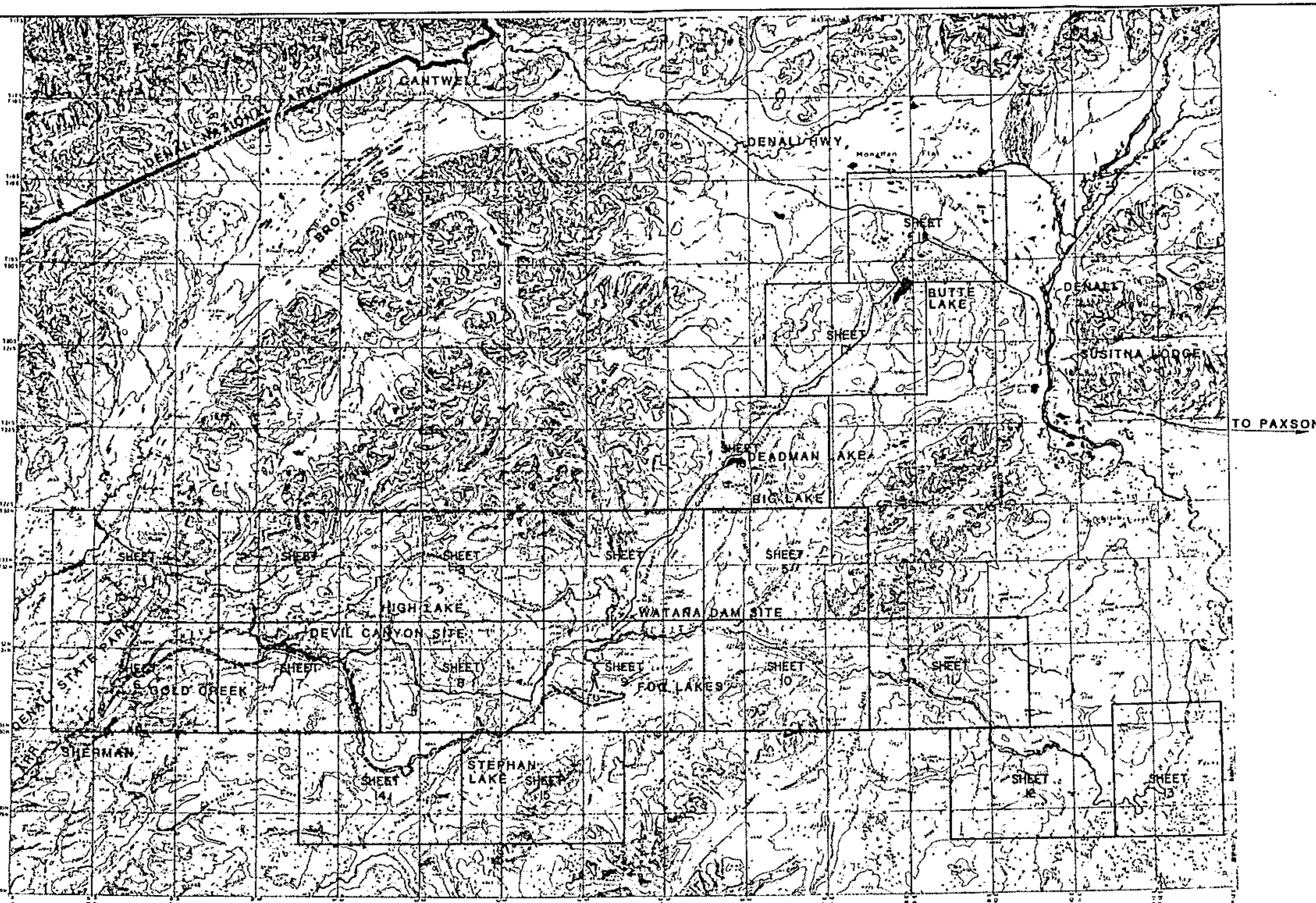
# APPENDIX E

# ENVIRONMENTAL CONCERNS

## Appendix E - Environmental Conflicts

Appendix E is a series of maps on which the more obvious and/or critical potential environmental conflicts are indicated. This data has been provided by the Environmental team and is fully considered in analyzing the access plans.

The following exhibits do not cover the currently perferred alignment from Deadman Lake to the Denali Highway. This segment was selected to avoid the caribou calving area around Butte Lake. The new line does infringe on summer Caribou range.




## LEGEND

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| ........... | CORRIDOR 1 |
| - - - - - - | CORRIDOR 2 |
| ———— | CORRIDOR 3 |
| ▬ ▬ ▬ | RAILROAD |

## NOTE

SHEETS NO ; 5, 10 11, 12, & 13 ARE OMITTED NO ACCESS CORRIDORS ARE CONTAINED THEREIN

NORTH

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# INDEX MAP

ALASKA POWER AUTHORITY
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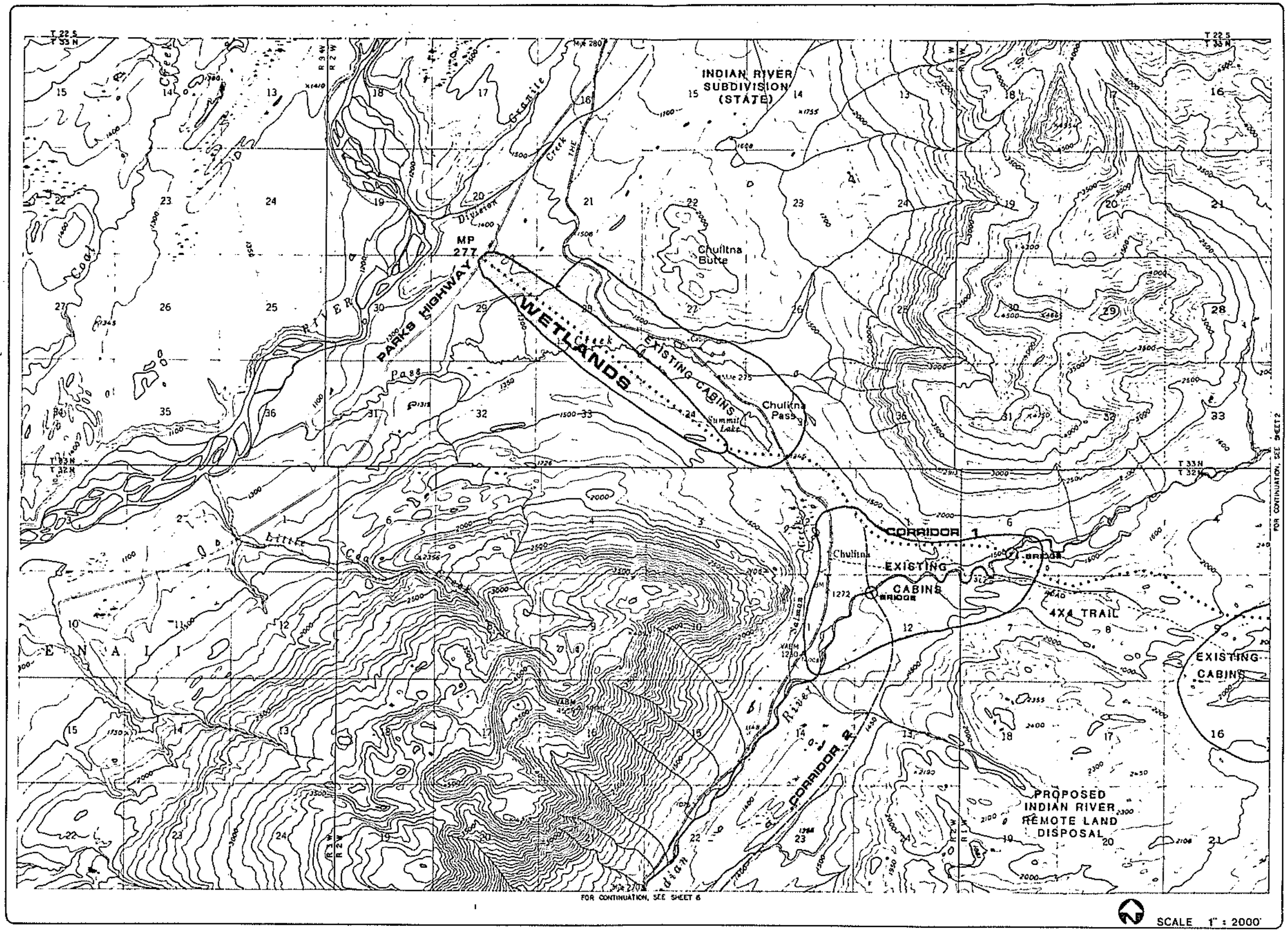


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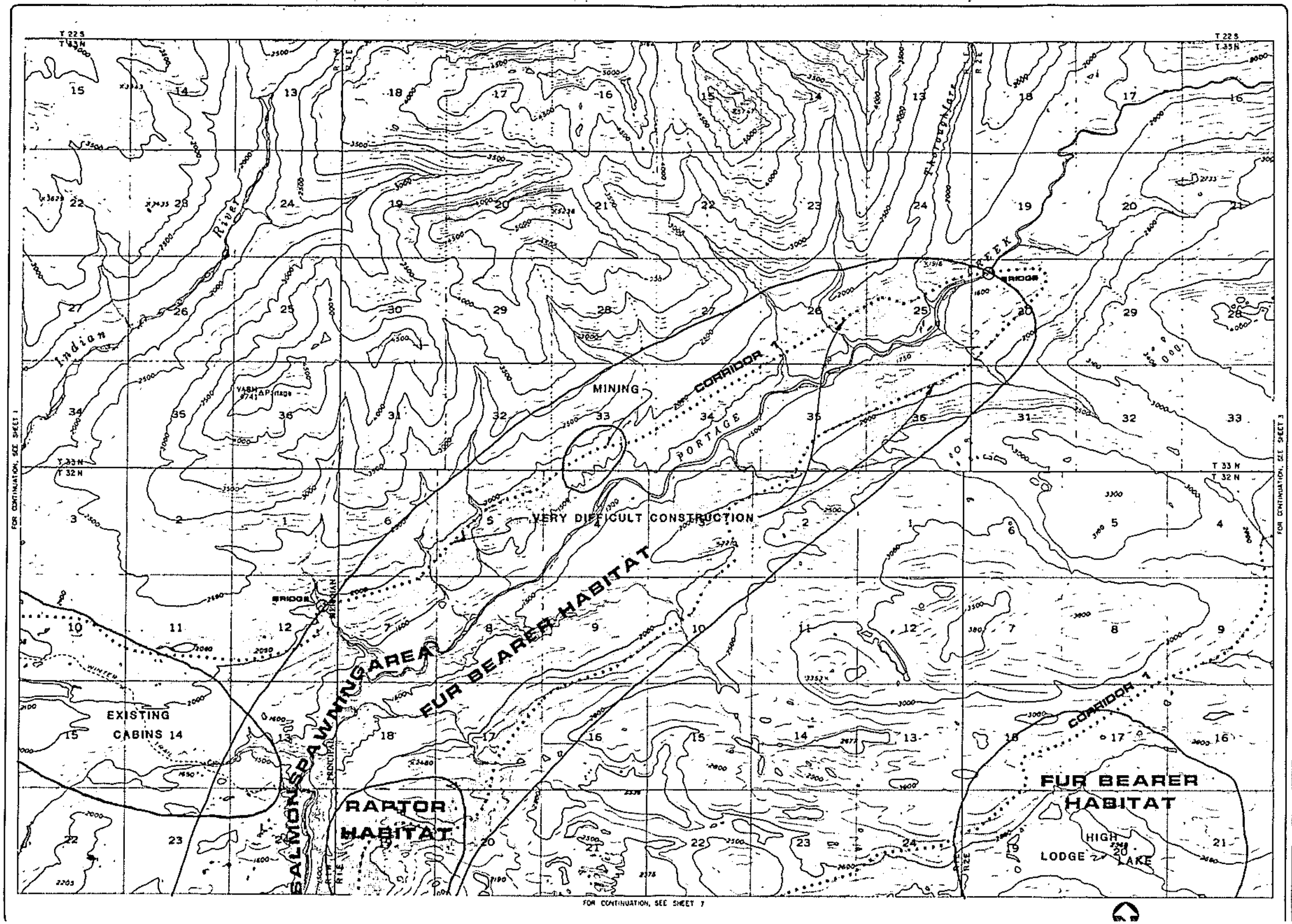


FOR CONTINUATION, SEE SHEET 1

FOR CONTINUATION, SEE SHEET 3

FOR CONTINUATION, SEE SHEET 7

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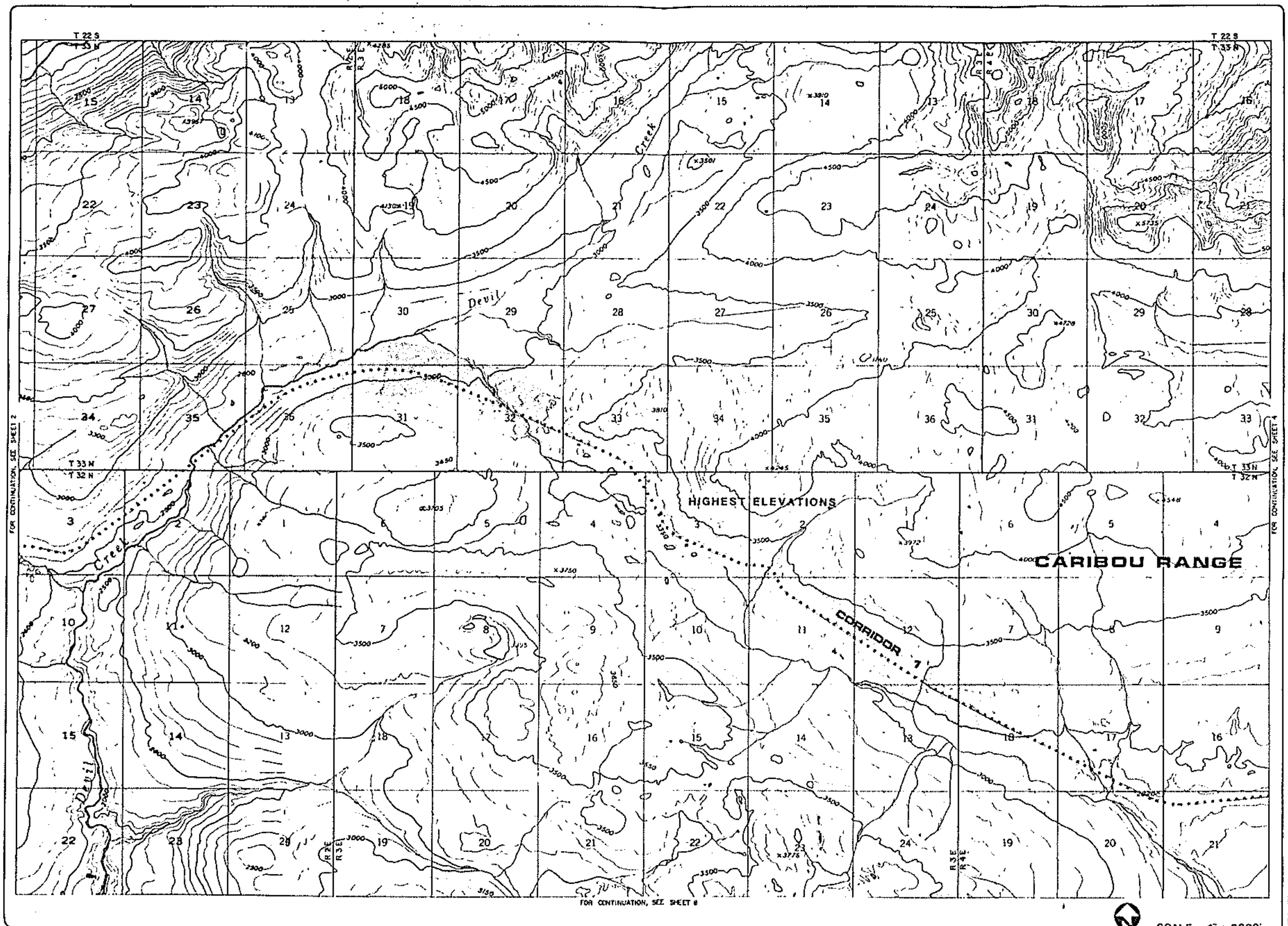


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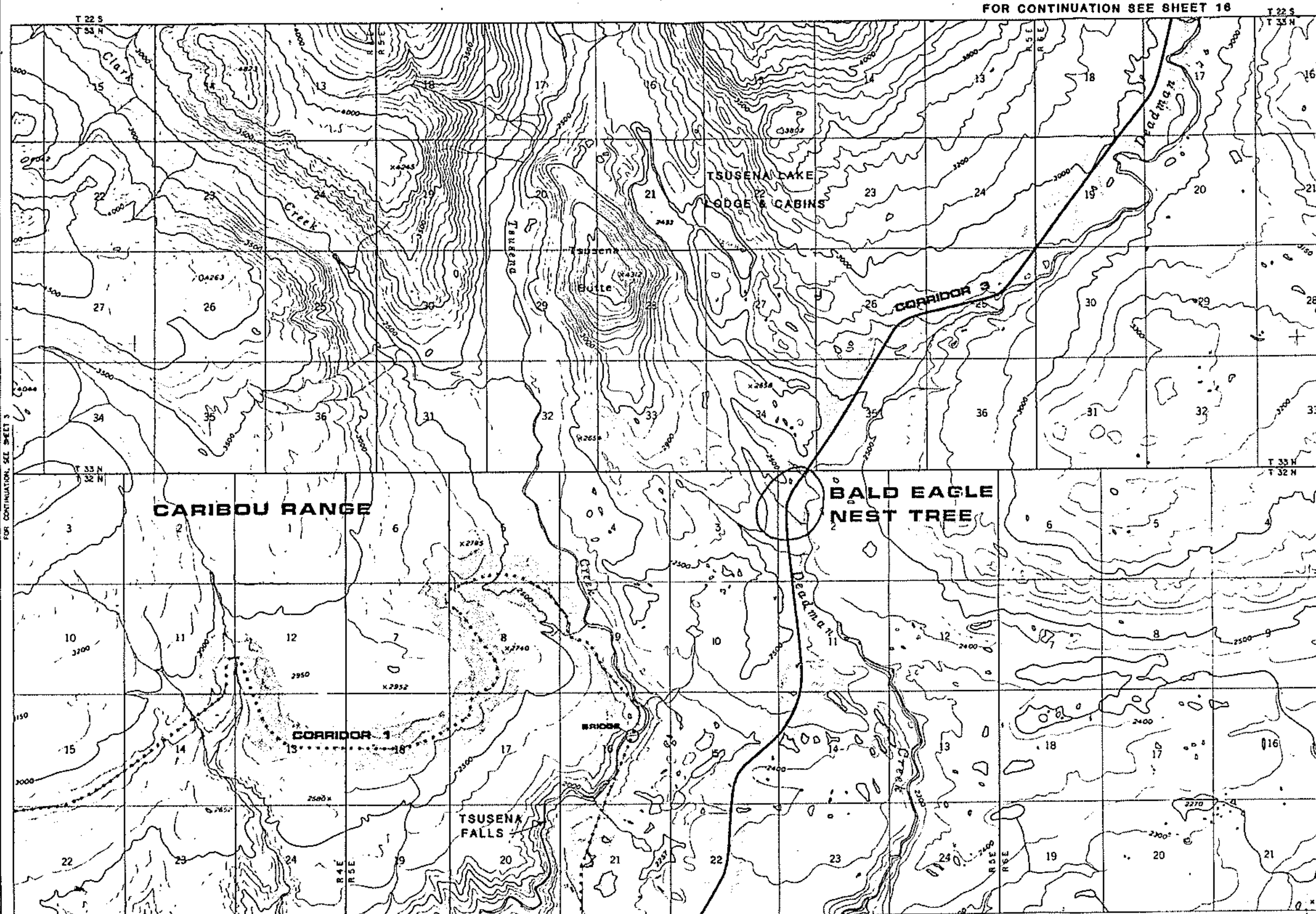


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SCALE 1" : 2000'

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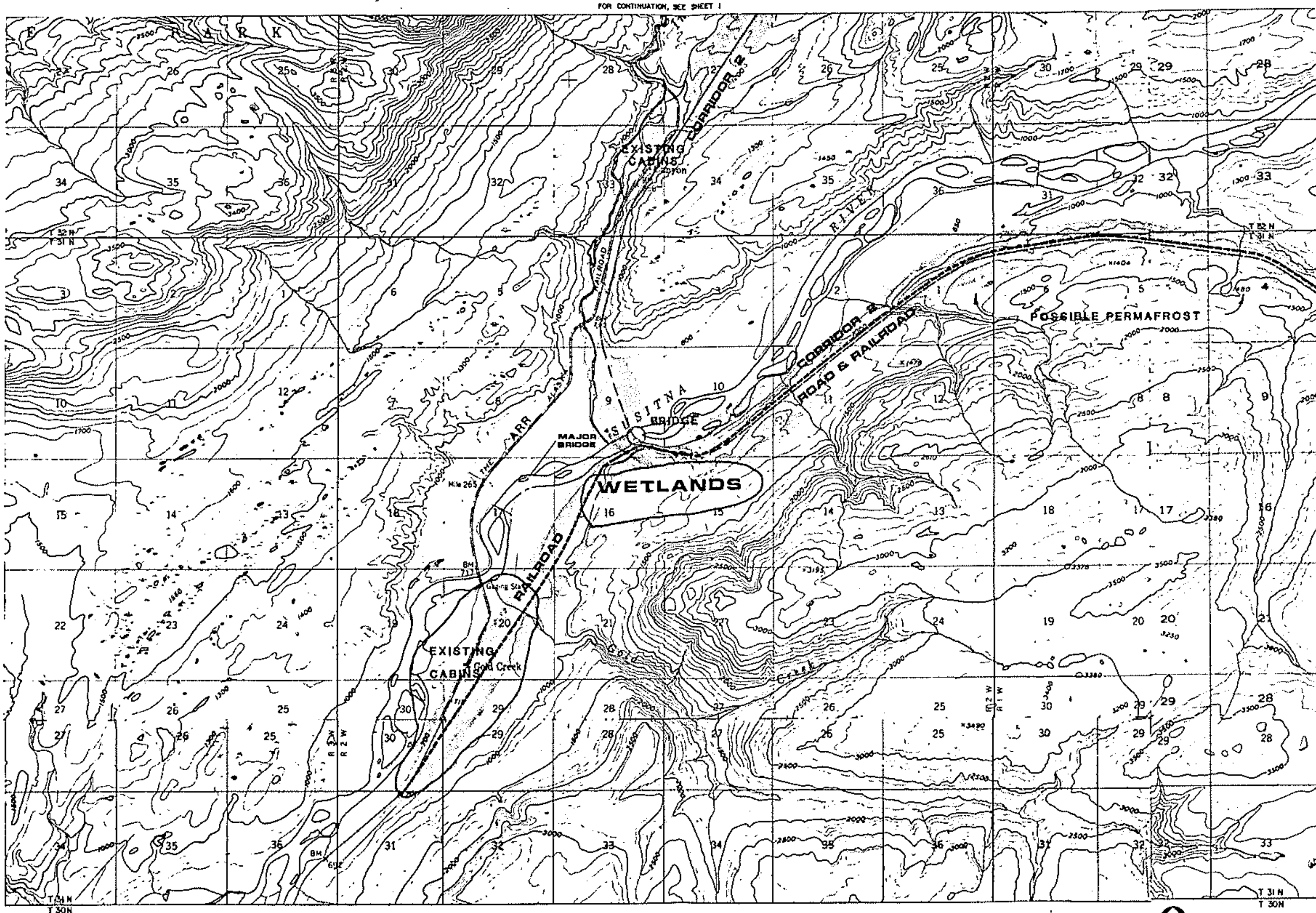


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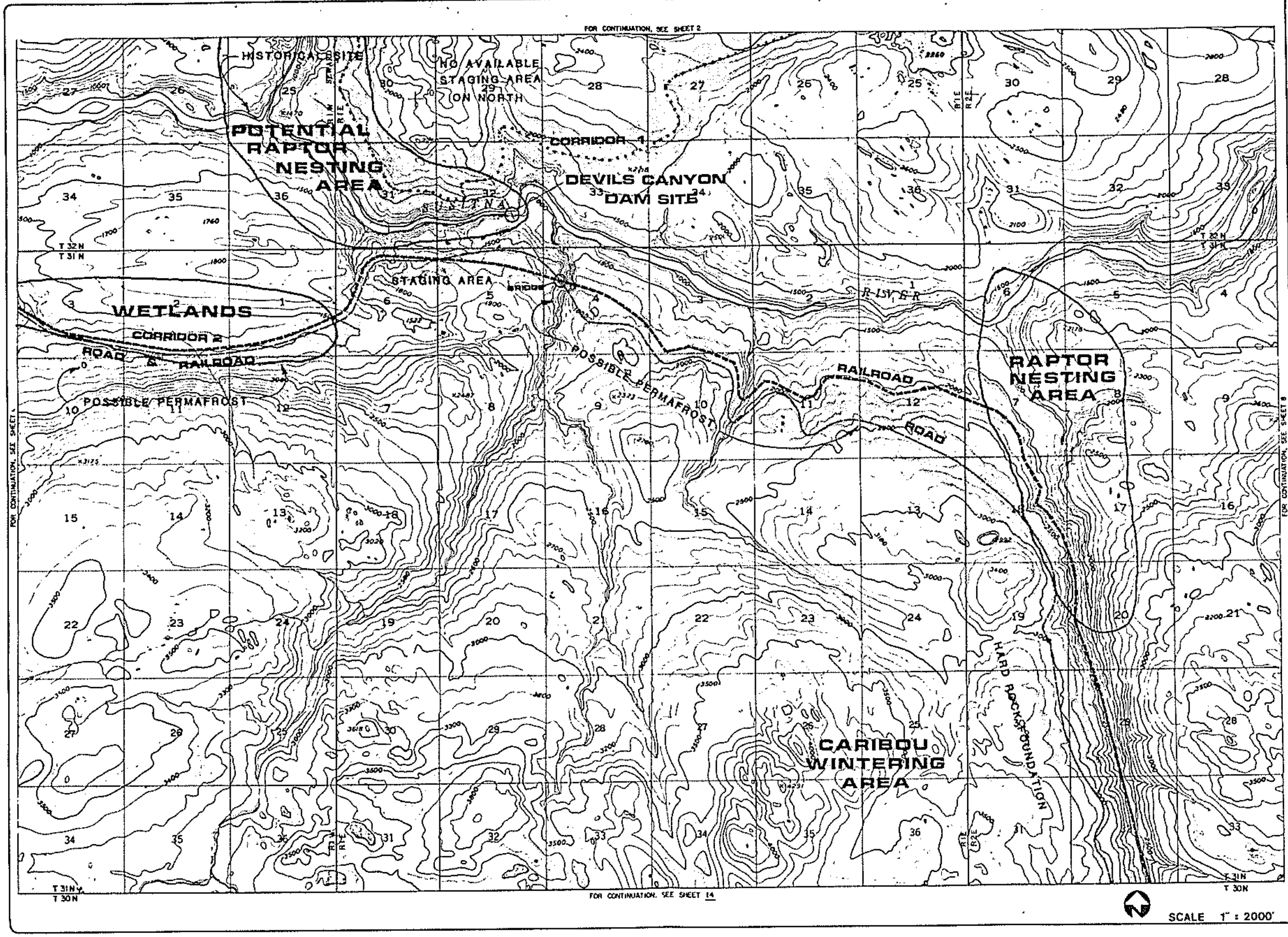


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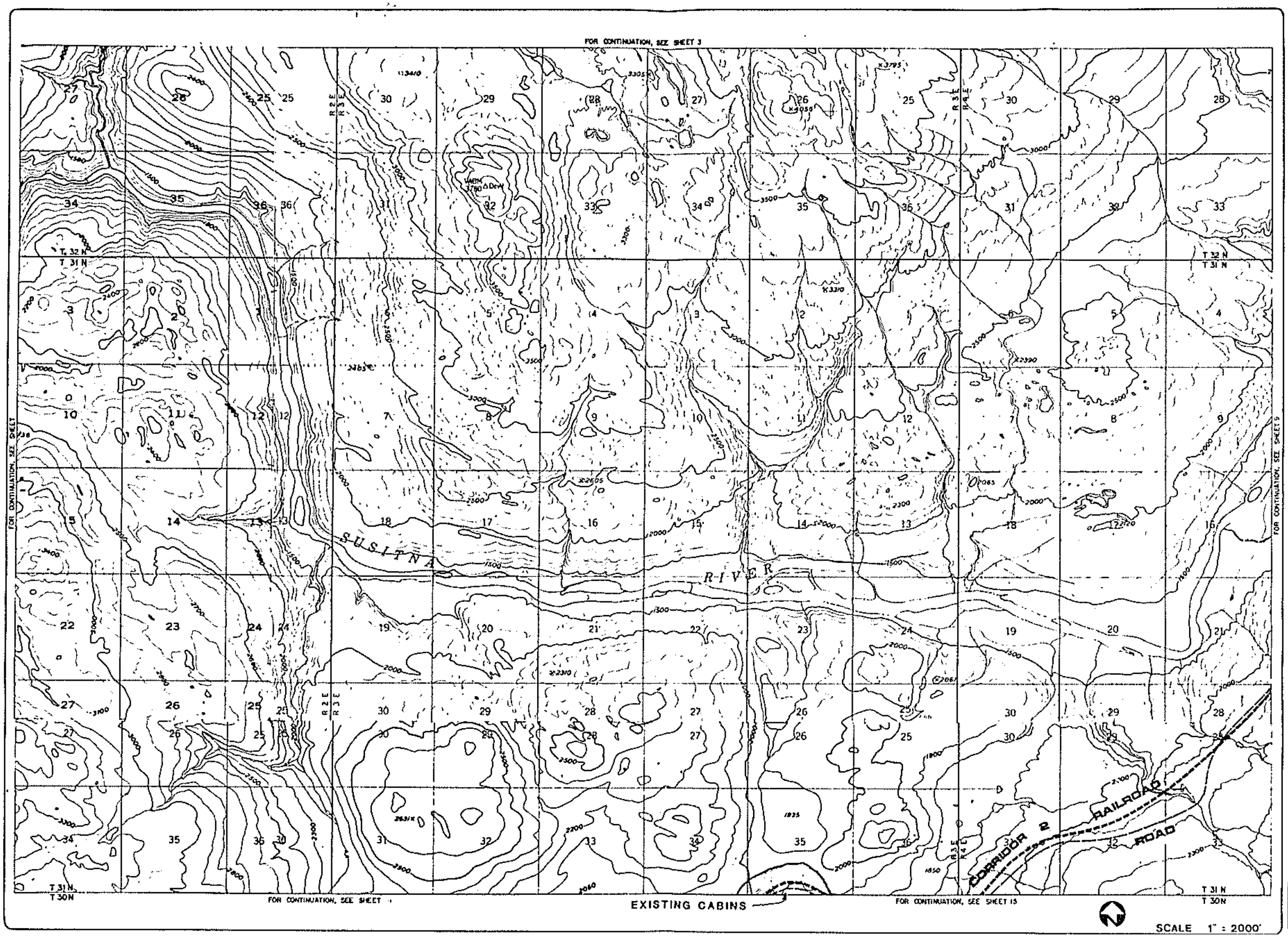


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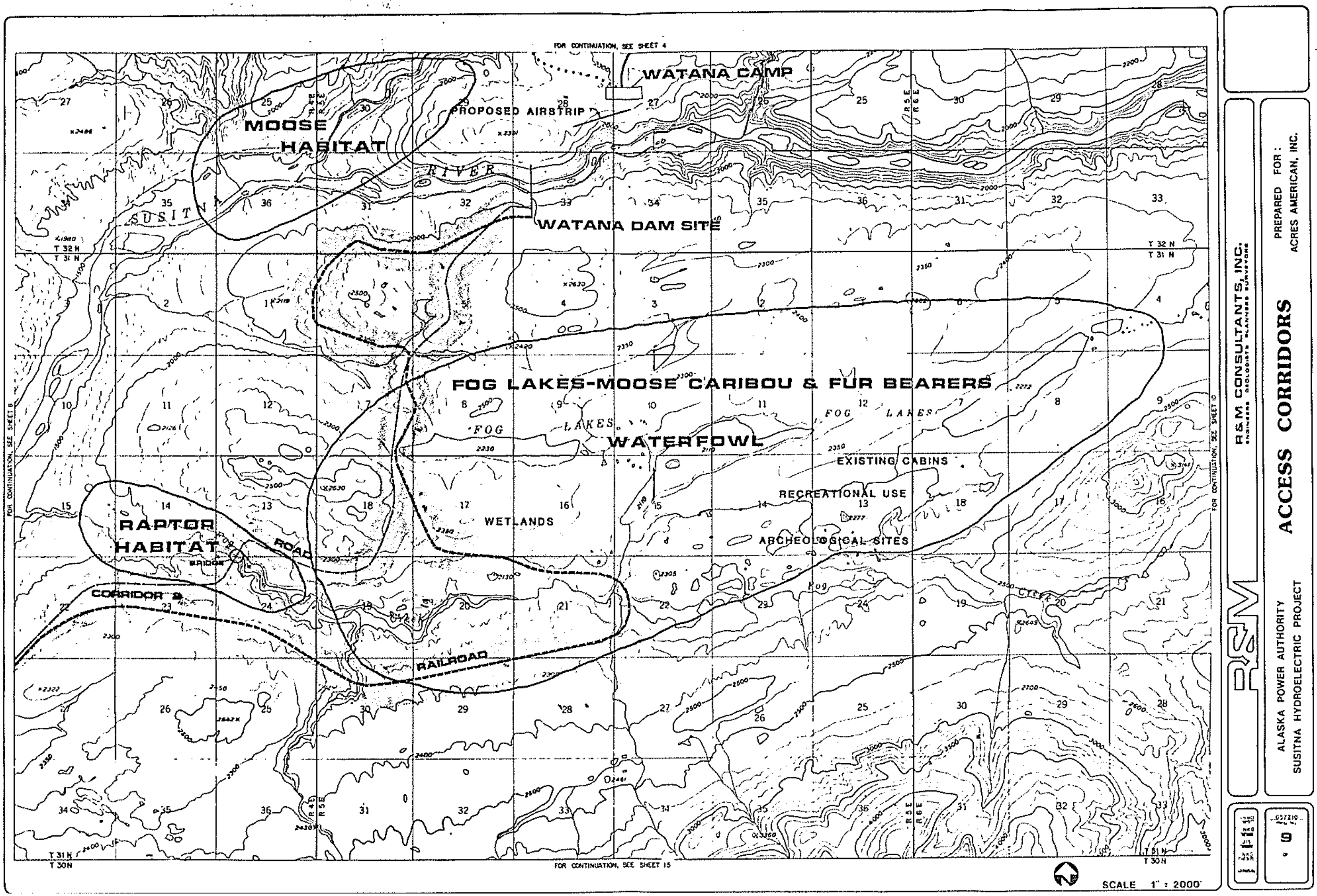
FOR CONTINUATION, SEE SHEET 4
WATANA CAMP
PROPOSED AIRSTRIP
MOOSE HABITAT
SUSITNA RIVER
WATANA DAM SITE
FOG LAKES-MOOSE CARIBOU & FUR BEARERS
FOG LAKES
WATERFOWL
EXISTING CABINS
RECREATIONAL USE
WETLANDS
ARCHEOLOGICAL SITES
RAPTOR HABITAT
BRIDGE
ROAD
CORRIDOR 2
RAILROAD
FOR CONTINUATION, SEE SHEET 15
SCALE 1" = 2000'
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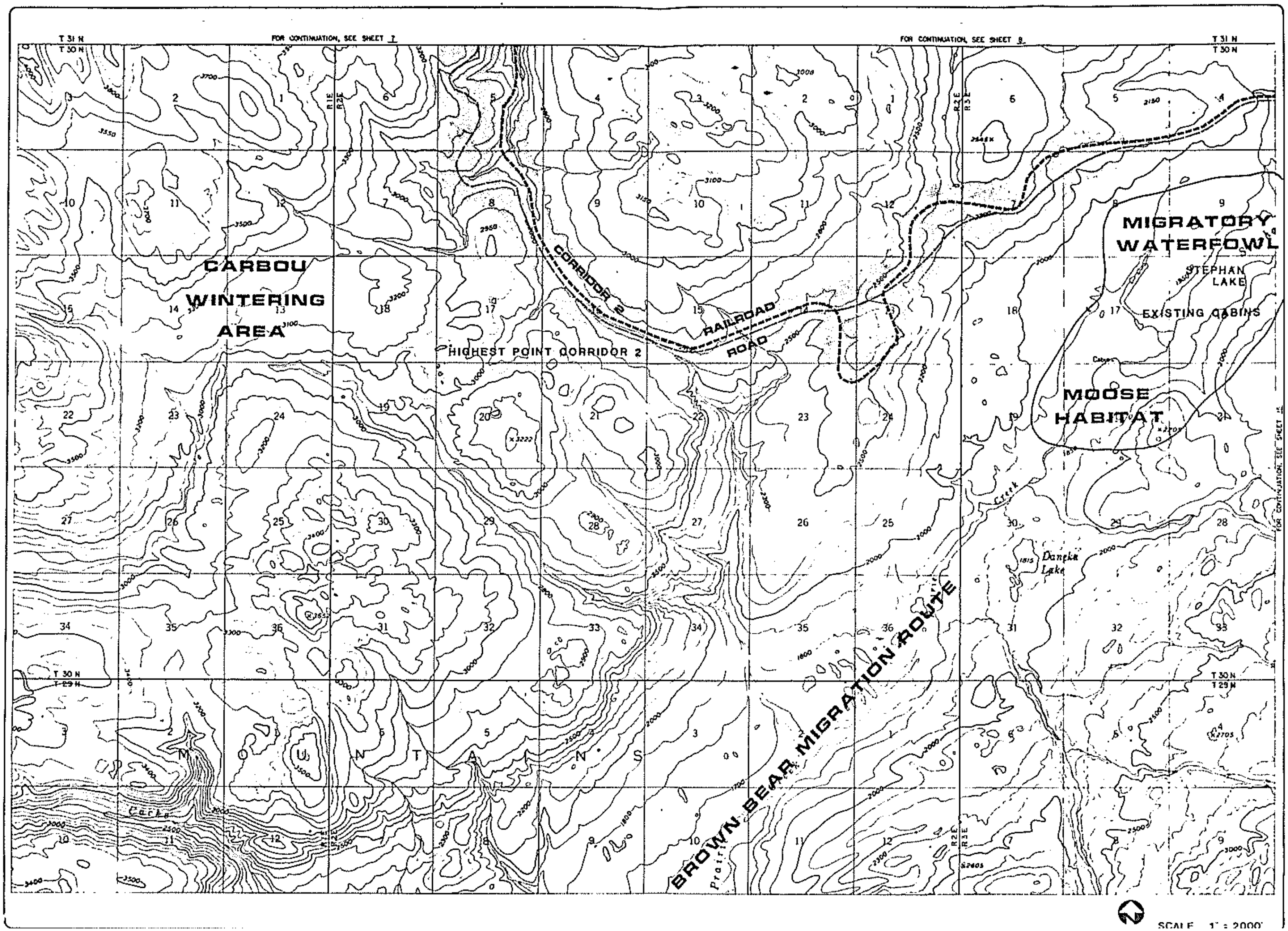


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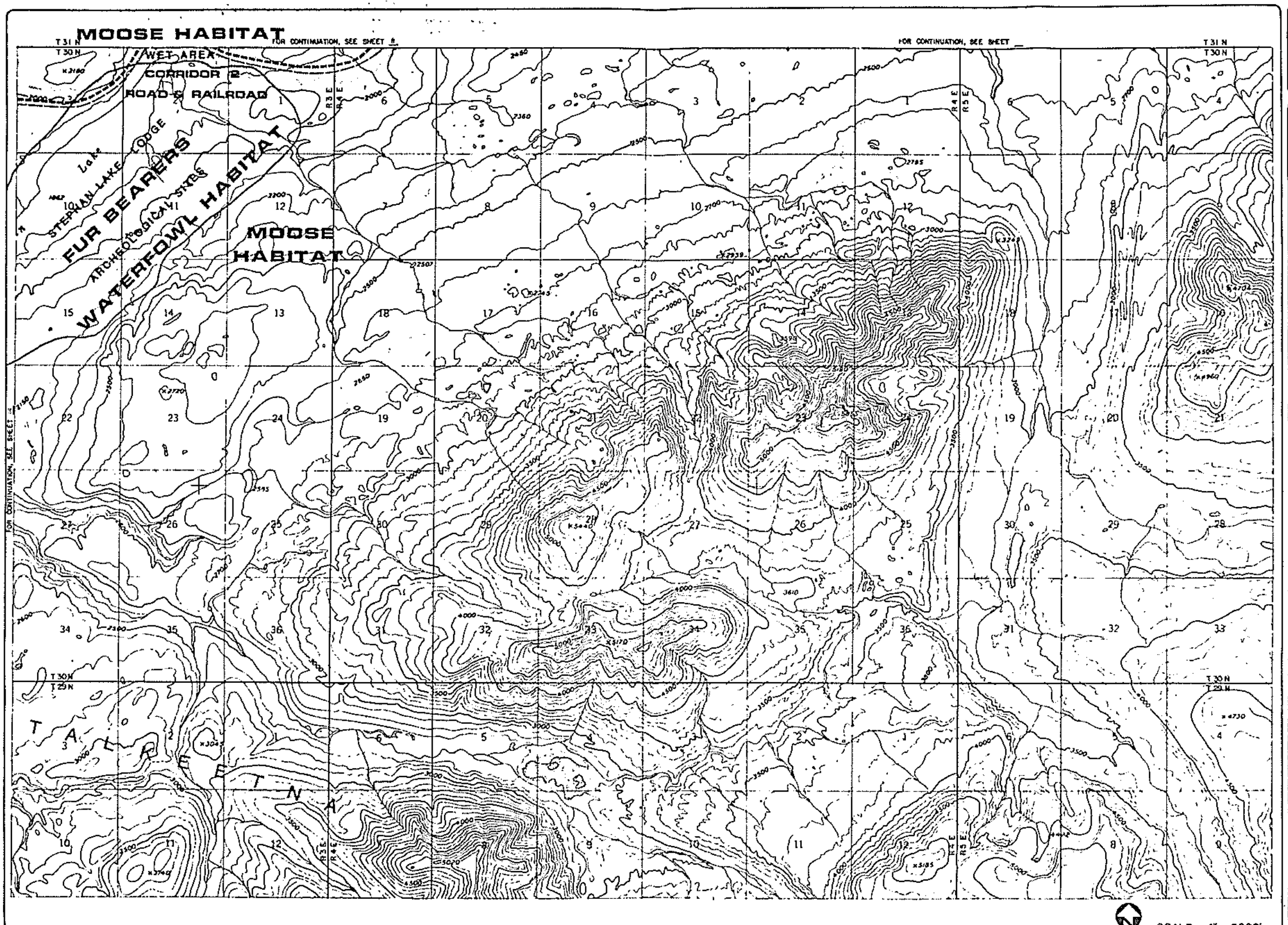


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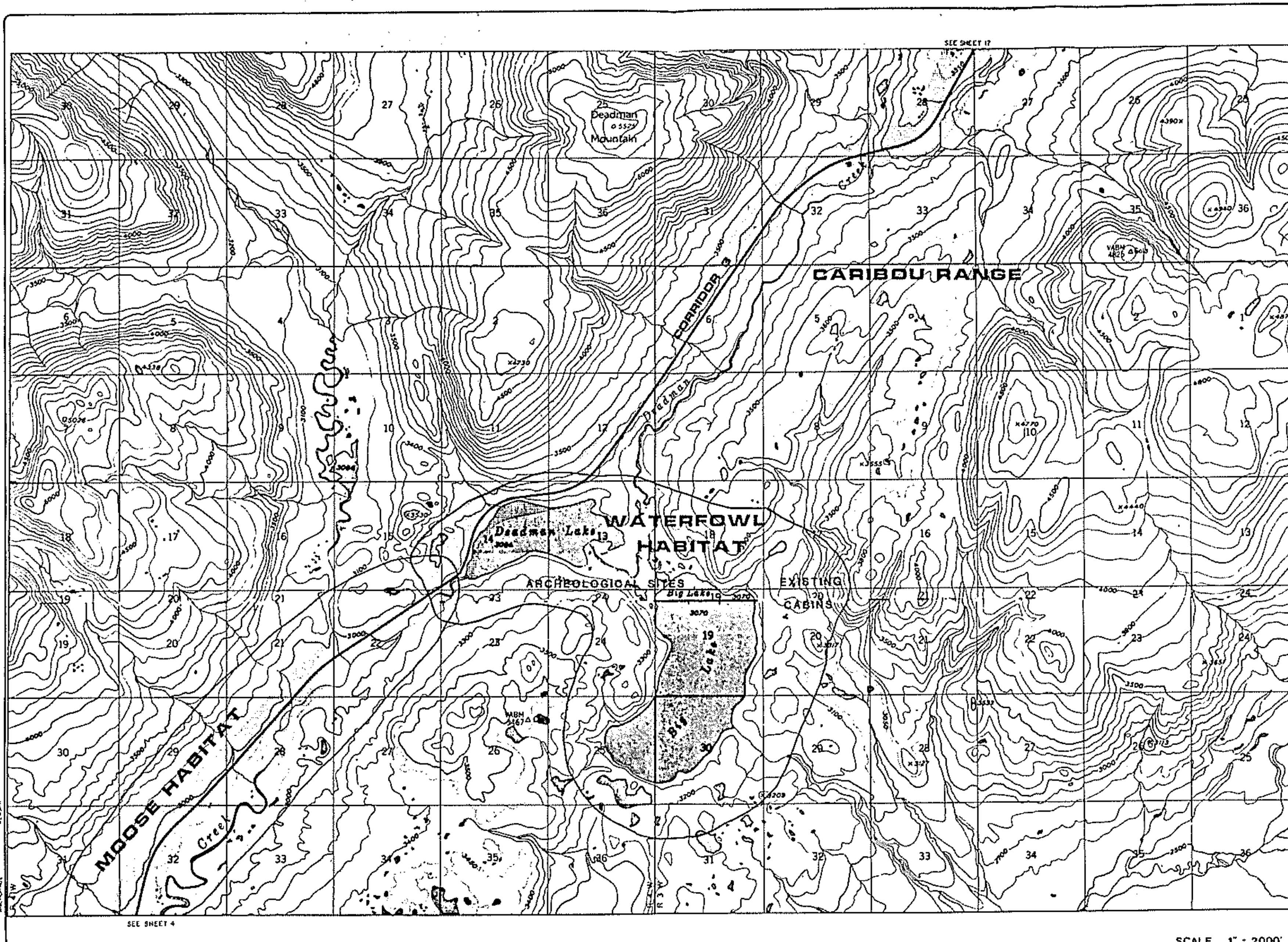


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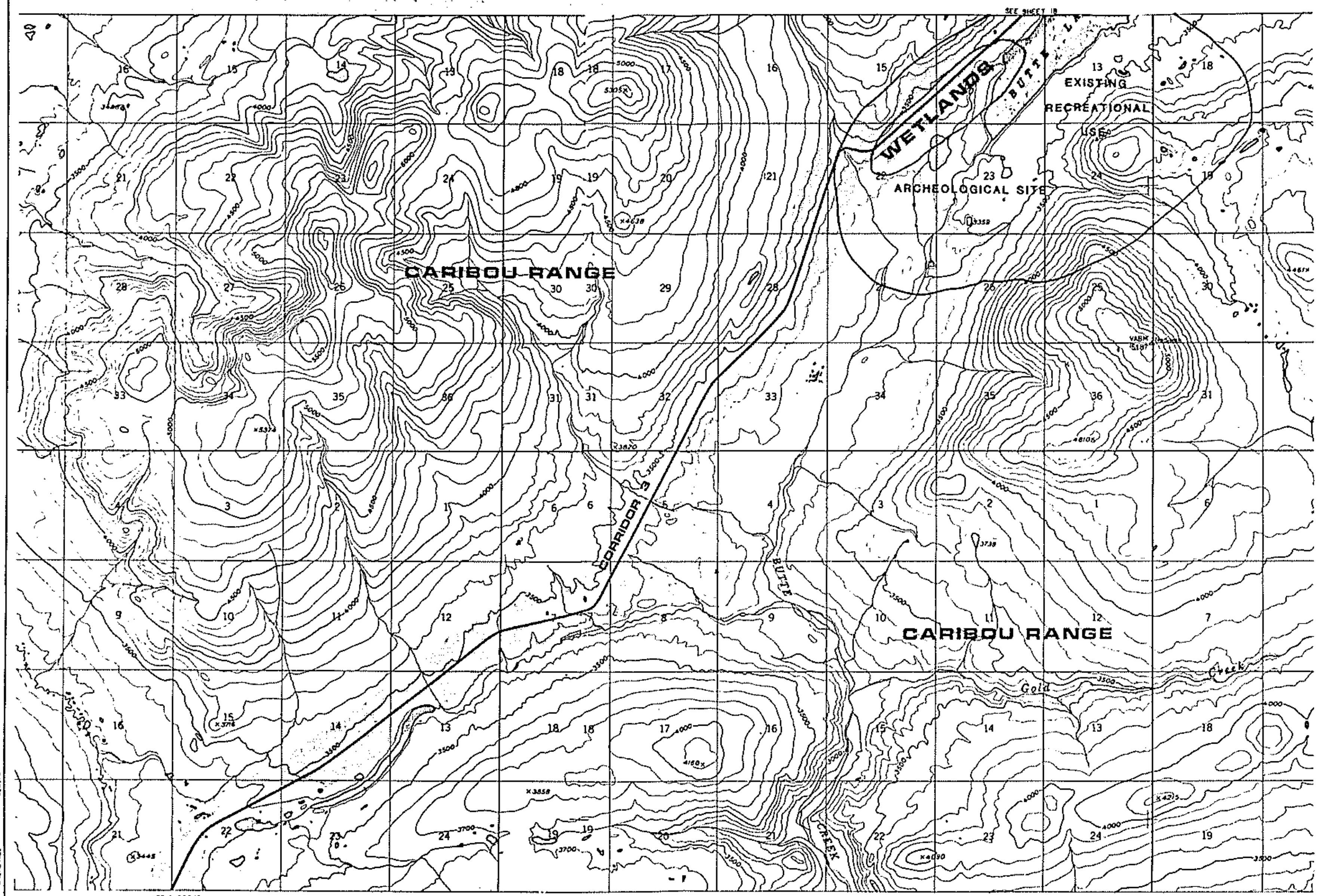


SCALE 1" : 2000'

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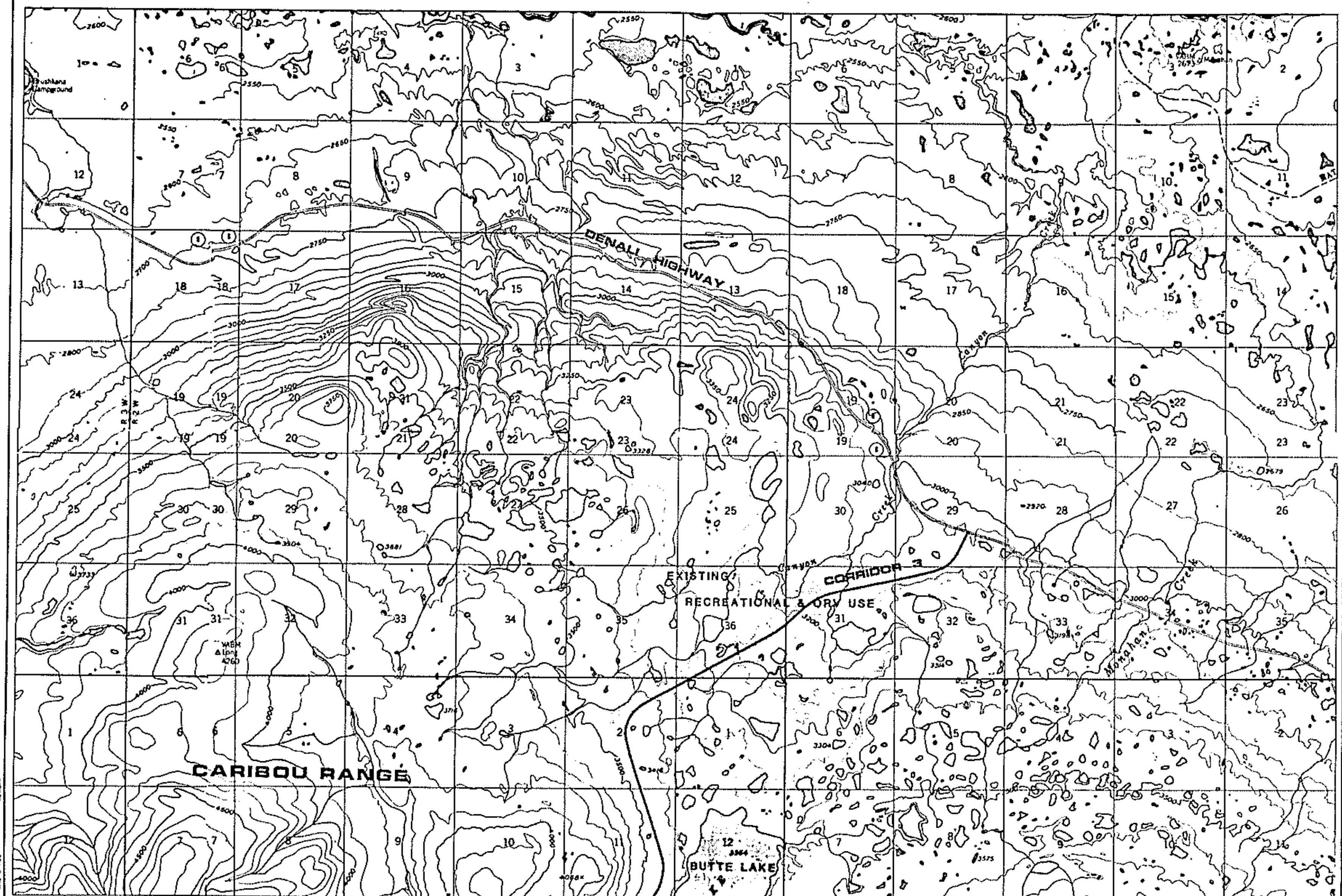


SCALE 1" = 2000'

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# APPENDIX F

# COST ESTIMATES

## APPENDIX F - COST ESTIMATES

The overall costs of the various access plans must be a considered in the selection process. The access plans and their estimated costs are outlined herein. The process by which the estimates were generated is documentaed and the primary components of each plan are set forth.

### F.1 - Introduction

Common elements to all plans include quantities to be moved, the ports through which all commodites are assumed to flow and the ton-mile costs of haul for rail and truck. The costs differences developed here in will result from differences in length, difficulty of construction and maintinance, bridges, rail heads, and the length of haul on each mode.

### F.2 - Sea Ports

The Alaska sea ports identified for use in supplying the Susitna Hydroelectric Project are Anchorage and Whitter.

Anchorage is the perferred port for those items suitable for shipments in conventional containers and trucks. The port apparently has adequate capacity and the best facilities of any Alaska ports. The draw back in Anchorage is the lack of capabilities for roll-on roll-off rail shipments.

Whittier is unique in that there is roll-on roll-off rail capability. Because of freight rates and handling charges Whitter is the obvious choice for arrival of all materials that can be shipped by rail car.

Seward and Valdez were investigated and eleminated as primary parts for reasons of distance, port facilities and/or port costs.

TABLE F-2.1
ACROSS THE DOCK HANDLING COSTS

| Material From Seattle (6) | Cost in $/Ton (1) To Anchorage | (2) To Seward | (4) To Whittier | (1) To Valdez |
|---|---|---|---|---|
| Reinforcing Steel | 72.00 | 72.00 | 55.00 | 86.00 |
| Structural Steel | 85.40 | 85.40 | 55.00 | 125.00 |
| Cement | 66.00 | 66.00 | 55.00(3) | 80.00 |
| General Cargo | 80.00 | 80.00 | 55.00 | 110.00 |
| Equipment | 160.00 | 160.00 | 120.00 | 191.00 |
| Explosives | 89.00 | Not Allowed | 55.00 | 115.00 |

1 Quoted by Pacific Western.

2 Information not received - Estimated equal to Anchorge. Rates for fuel included in modal alternate section.

3 Rate for 140,000 lb Hopper Cars - Rates for Bags 100.00/ton as per ARR.

4 Rates derived from quotion by ARR.

5 Includes Stevedoring at all ports.

6 Explosives must flow through Prince Rupert, B.C.

Line Haul rates were collected from the Alaska Railroad and several trucking firms. Comparison of line haul rates is shown below.

TABLE F-2.2
LINE HAUL RATES IN DOLLARS/TON-MILE

| Item | Rail | Truck |
|---|---|---|
| Equipment | 0.1878 | 0.2069 |
| Steel | 0.2577 | 0.2069 |
| Cement | 0.1565 | 0.2069 |
| Fuel | 0.1450 | 0.2069 |
| General Cargo | 0.1262 | 0.2069 |
| Explosives | 0.6267 | 0.2069 |

While certain items may move by truck with lower costs, the mix of items and quantities make it clear that the overall most cost effective line haul mode is rail. For this reason all plans contemplate rail haul to the maximum extent practicable.

F.4 - Railhead

Railhead facilities will be required at one or more locations depending on the final plan adopted. The logistics estimates indicate a need to be able to handle a flow of 40 to 60 rail car loads per week. The detailed requirements for the railhead will vary with location however for the purposes of the study a typical facility has been developed and will be considered as applicable at all locations.

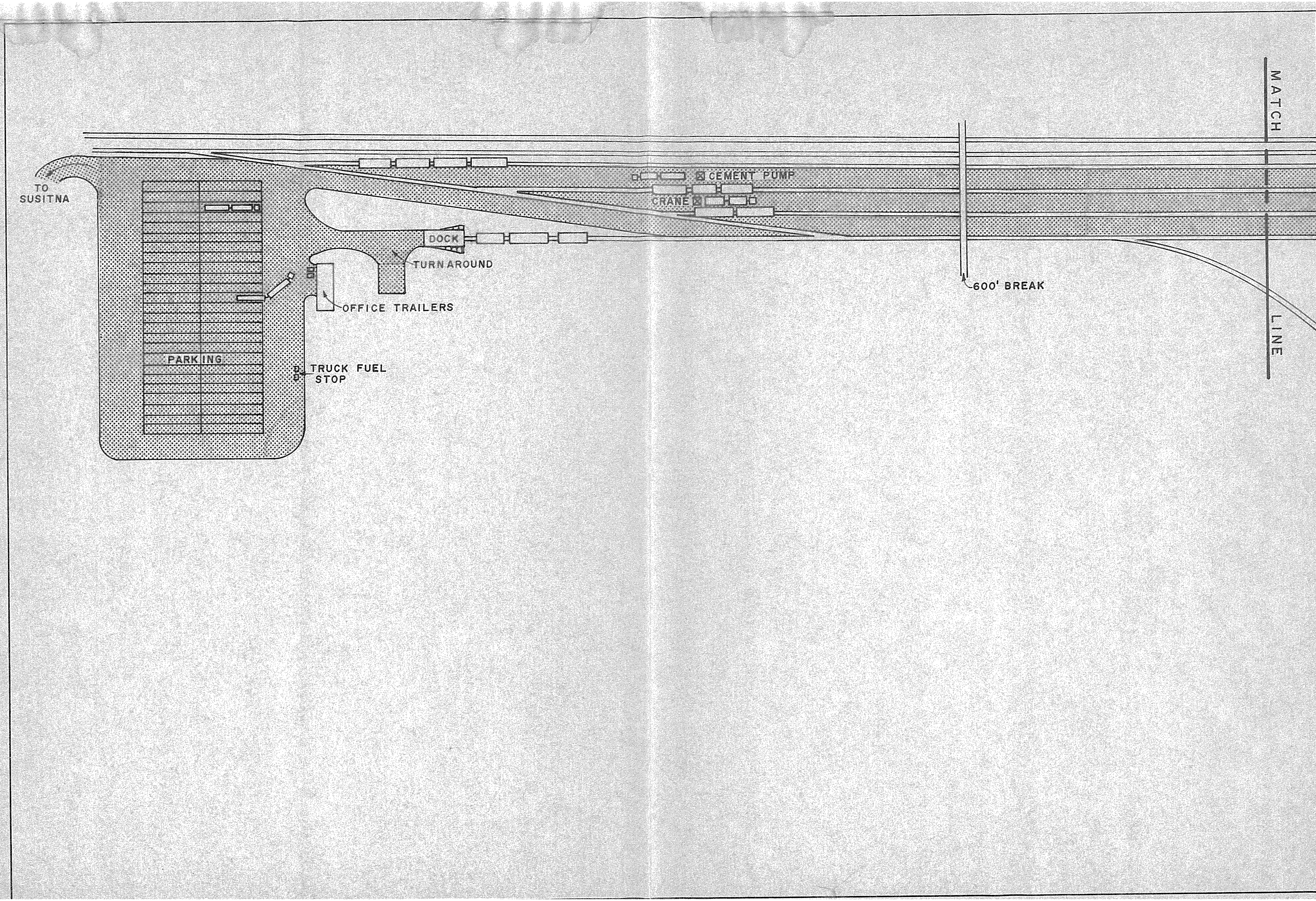
The typical railhead layout is based on the following requirements. The proposed layout is shown in Figure F-4.1. The estimated construction cost of the typical rail head is $5,160,000 as shown in Table F-4.1.

Scope: The rail head must be capable of handling about 50 cars at a time.

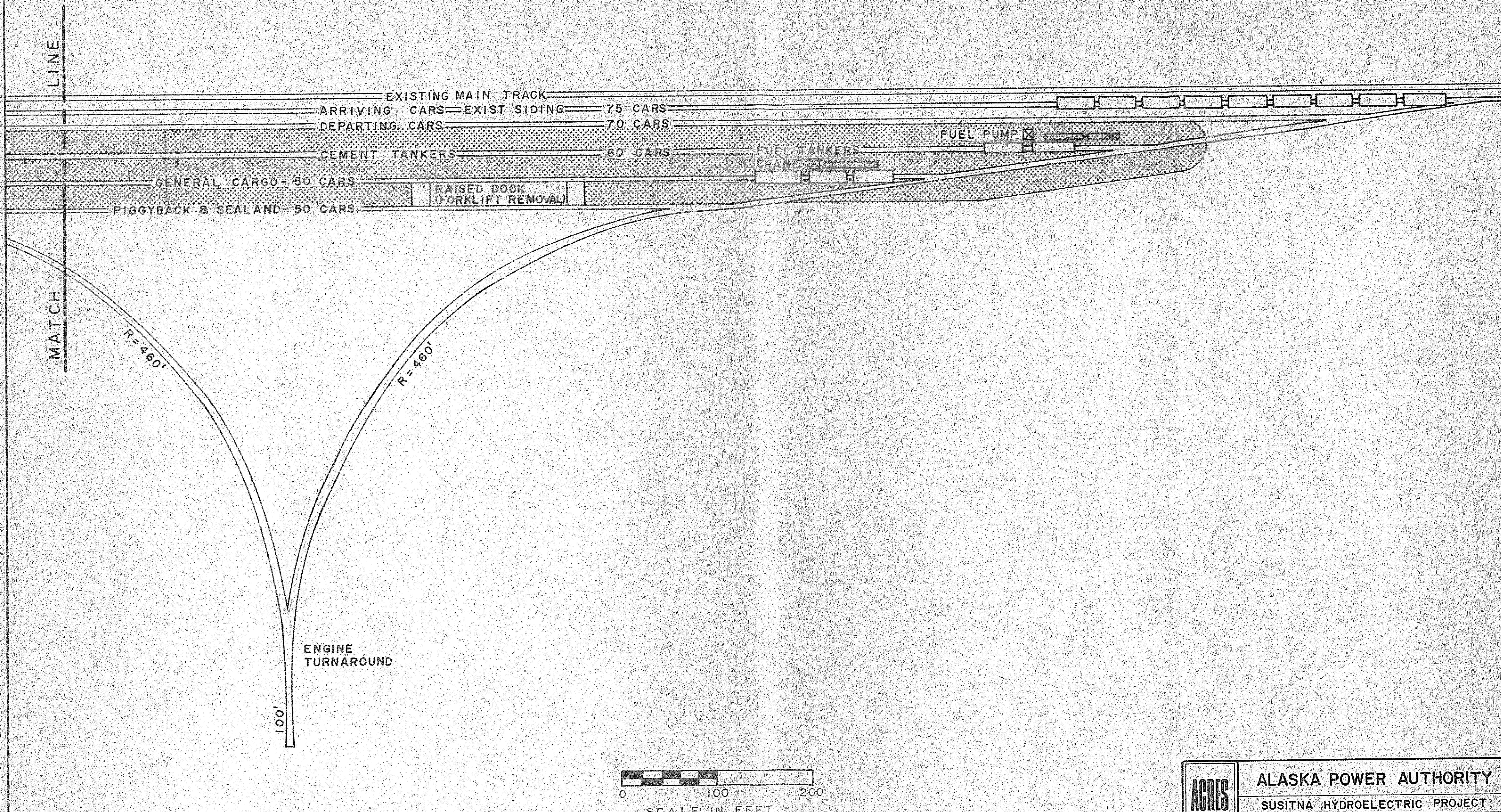
1) Piggybacks
2) Containerized (Sealand type)
3) Tank Cars
4) Hopper Cars

Elements:

1) Sidings to store rail cars arriving and departing
2) Siding (s) to store rail tankers for on-demand pumping into truck tankers
3) Cement pumping areas



TO SUSITNA
PARKING
DOCK
TURNAROUND
OFFICE TRAILERS
TRUCK FUEL STOP
CEMENT PUMP
CRANE
600' BREAK
MATCH LINE

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ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

TYPICAL PLAN

RAIL TO TRUCK TRANSFER FACILITY

PROJ. No. 052210

R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

| | |
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| DWN. | P.T. |
| CKD. | |
| APPV'D | |

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4) Piggyback off loading area (ramp)
5) Containerized off loading area (w/crane or forklift) (contractors to supply equipment)
6) Truck storage and maneuvering area
7) Office space and employee facilities (contractor supplies)
8) Truck fueling/servicing (contractor supplies)

Details

- Degree of curvature should not exceed 12° 30'

- Require 45' length of track per car. Minimum main line or ladder to ladder spacing 18' center to center. Minimum body to body track spacing 14 feet.

- Maximum angle of ladder to sideing, for a slow moving freight yard, #8 frog, is 7°9'10".

- Arrival and departure tracks should each be long enough to hold the longest train anticipated. Optimum yard capacity = 110% of arrival rate.

Parameters:

- Volume: 50 cars/wk. Use a maximum of 50 cars arriving in 1 day. These could all be of one type.

- Length: need 45' per car = 2,250'

- Between Sidings: Need 2 lane road (24' plus track width), minimum 14' from No. 1 to 2, 14' from No. 2 to 3, 29' from No. 3 to 4, and 29' from No. 4 to 5.

- Ladder Lengths: When spacing = 14', difference in length = 111½', when spacing = 29', difference in length = 231'

- Actual Lengths: No. 5 Minimum = 2,250', leg could be longer if terrain dictates.

  No. 4 = 2,250' (min.)
  No. 3 = 2,250' + 2 (231) = 2,712
  No. 2 = 2,712 + 2 (231) = 3,174
  No. 1 = 3,174 + 111½ = 3,397

  Note, No. 1 siding already exists at Gold Creek and is 4000' long.

- Turnaround:
  R = 460'
  A = 100' (2 cars) (Tangent length beyond switch)

- Trucks: WB-60, WB-50, maximum turning radius = 45', minimum turning radius = 19.8, maximum length = 65', max width = 8.5' or for wide load parking slots: use 12' x 70' aisle: 55' wide to allow for turn into stalls, # of slots = 50 ea.

<u>Sources:</u>


- Hennes, Robert G. and Ekse, Martin I., <u>Fundamentals of Transportation Engineering</u>. McGraw Hill Book Company, 1955 New York.

° Merritt, Frederick S., Standard Handbook for Civil Engineers 2nd Ed. McGraw - Hill Book Company 1976 New York.

TABLE F-4.1
RAIL HEAD COST ESTIMATE

| | | AMOUNT | UNIT PRICE | 1981 ANCHORAGE PRICE |
|---|---|---|---|---|
| 1. | Clearing | 25 ac. | $4,000/ac. | $ 100,000 |
| 2. | Waste Excavation | 78,000 cy | $3.50/cy | 273,000 |
| 3. | Common Excavation | 505,000 cy | $3.00/cy | 1,515,000 |
| 4. | Rock Excavation | -0- | -0- | -0- |
| 5. | Borrow | -0- | -0- | -0- |
| 6. | Grade A Base | 4,900 cy | $12.00/cy | 58,800 |
| 7. | D-1 Base | 2,400 cy | $15.00/ton | 36,000 |
| 8. | AC Surfacing | 2,200 tons | $55.00/ton | 121,000 |
| 9. | Fabric | -0- | -0- | -0- |
| 10. | Topsoil and Seed | 15 ac. | $2,500/ac | 37,500 |
| 11. | Traffic Control Devices | L.S. | | 500 |
| 12. | Subballast | 25,800 cy | $6.00/yd | 154,800 |
| 13. | Trackage | 19,700 l.f. | $100/l.f. | 1,970,000 |
| 14. | Dock Lumber (6"x6") | 16 mbf | $400/mbf | 6,400 |
| | | | 1981 TOTAL | $4,273,000 |
| | | | Round to | $4,300,000 |
| | | Converting to 1982 Dollars (20% index increase) | | $5,160,000 |

## F.5 - Bridges

Bridges are major cost items and for some plans, major schedule constraints. Layout plans for the major bridges are included. Bridge cost estimates are based on Alaska Department of Transporation and Public Facilities average bid information. This information was provided by a Department of Transporation and Public Facilities estimator. Bridge prices up-dated to 1982 dollars are approaching $150.00/square foot of deck for complete installations.

The railroad bridges normally include heavier members and foundation elements however they are narrower. Information received form the Alaska Railroad Engineering department indicates that square foot costs for railroad bridges are approximately double that for highway bridge. Therefore a cost of $300.00/square foot will be used for estimating railroad bridge costs.

Figure F 5.1 shows a 440-foot continuous welded plate girder structure over Indian River. This structure, with slight variations in height and/or length is typical of all possible crossings of Indian River.

Figure F 5.2 shows the Susitna River structure proposed for segment 2-L. Other segments crossing the Susitna near Gold Creek would have a bridge that would have different alignment characteristics, however over-all demensions would be similar in most cases. Cost estimates are based on the structure shown.

Figure F5.3 shows the road and railroad bridges over Cheechako Creek immediately above Devil Canyon. This structure is in a location that makes it a major time constraint.

Figure F5.4 shows the roadway structure over Fog Creek.

Figure F5.5 a roadway structure over an unnamed creek about two miles east of Cheechako Creek in Corridor 2.

Figure F5.6 shows the type and approximate size of structure that would be required to serve as a high bridge at Devil Canyon. This bridge will take approximately three years to construct. The $150/square foot cost is probably low for this type of structure however there is no eqivalent Alaska bridge, so that estimate is used.

F.6 Quantity Estimating Cross Sections

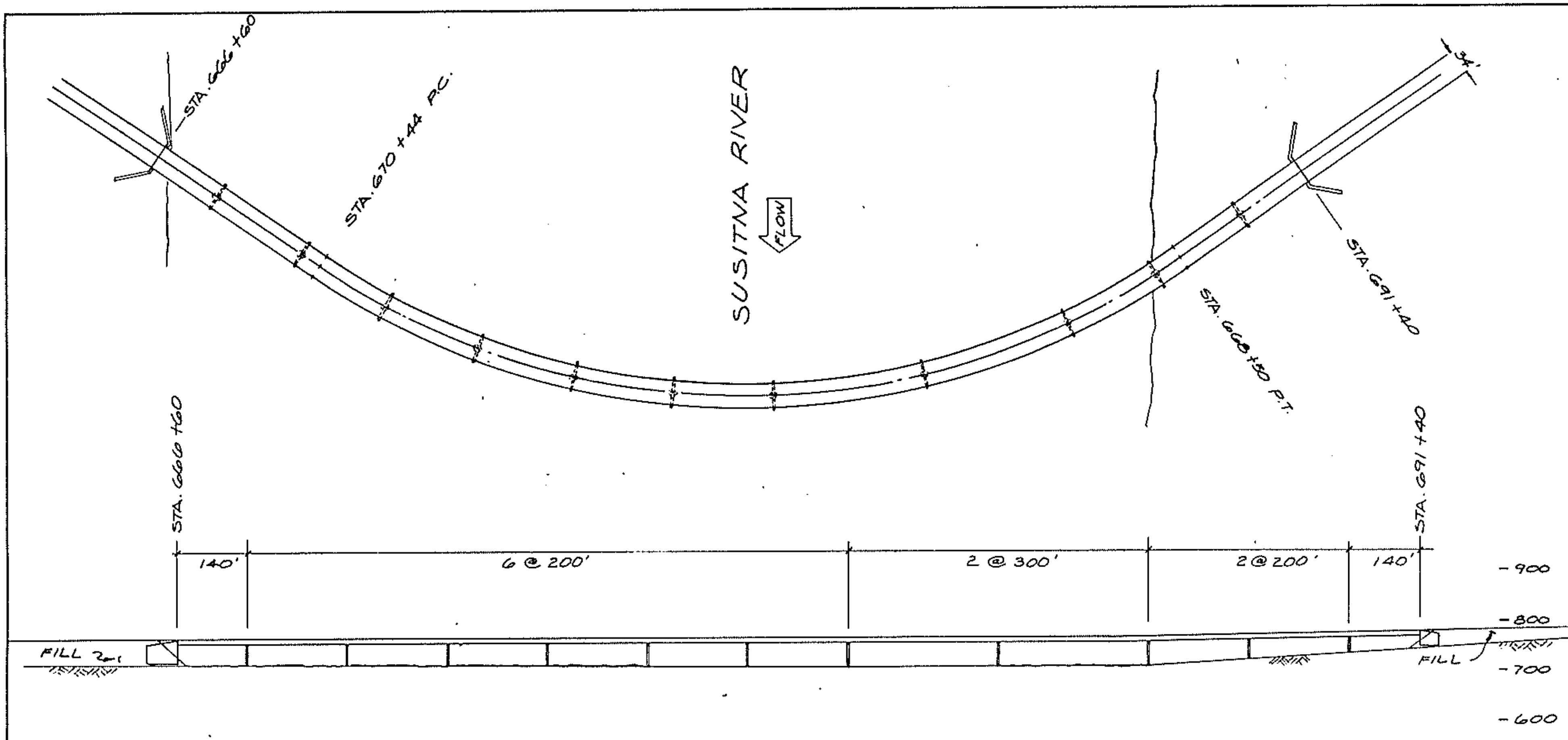
For purposes of estimating excavation quantities along the preferred routes within each of the 3 corridors and the railroad corridor, cross slopes were taken from available contour maps along with lengths of alignments.

Cross sections were prepared for cross slopes of 0-10%, 15%, 25%, 30%, 35%, 40%, 45%, and 50%. The upper 2 feet of material was considered as waste excavation on all alignments.

It was considered that average variations of subgrade from the ideal cut equal fill section would be 10 feet.

Frozen materials were considered to have a maximum cut of 10 feet to protect the 15 feet depth of frozen indicated in the soils information. This maximum cut depth requires a higher grade line than would be most economical for a balanced cut = fill section. Local borrow would be necessary to make up the difference.

On cross slopes up to 10%, particulary along corridor #3 a borrow pit type of cross section is proposed to provide material for




## ORTHOTROPIC STEEL STRUCTURE 2480 FT. BRIDGE

200 100 0 200
GRAPHIC SCALE IN FT

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SUSITNA HYDROELECTRIC PROJECT

SUSITNA ACCESS CORRIDOR

**SUSITNA RIVER BRIDGE CORRIDOR # 2**

R&M CONSULTANTS, INC.

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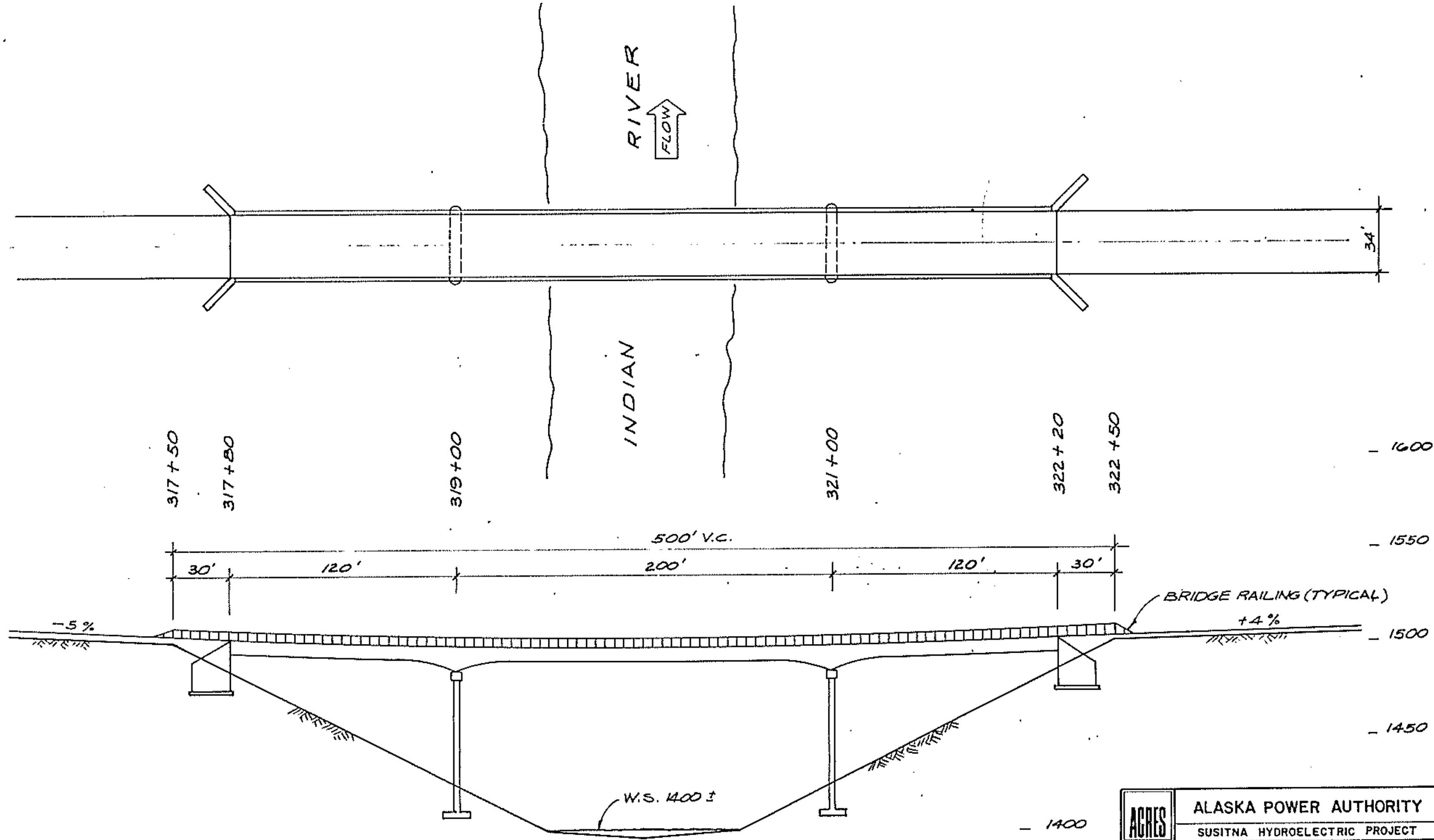
| APPV'D | N.K.G. |

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# 440 FT. CONTINUOUS WELDED PLATE GIRDER 3 SPAN BRIDGE

50 25 0 50

GRAPHIC SCALE IN FT.

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SUSITNA ACCESS CORRIDOR

**INDIAN RIVER BRIDGE CORRIDOR # 1**

R&M CONSULTANTS, INC.

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| DWN | O.E.P. |
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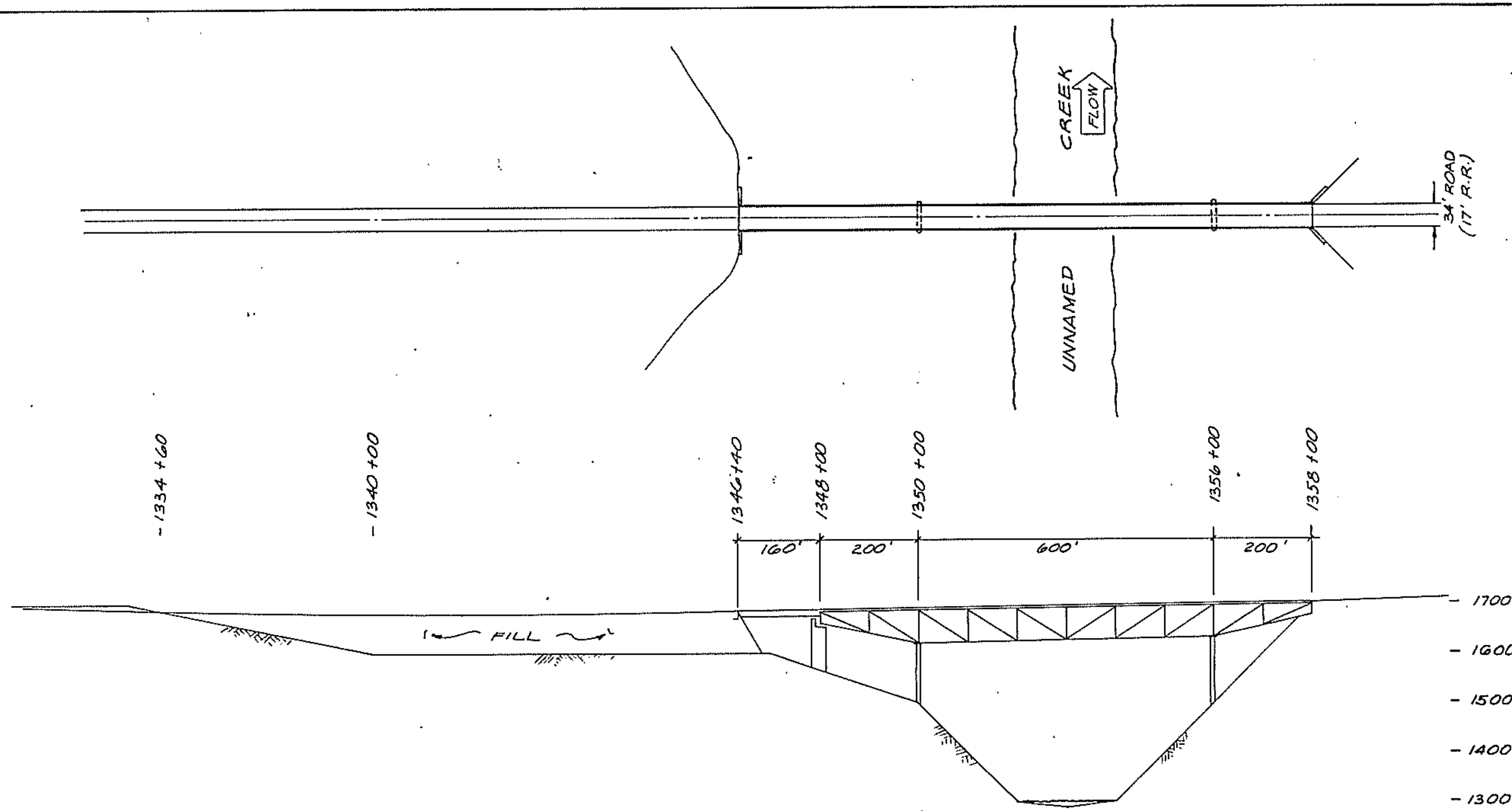
| APPV'D | N.K.G. |




## 1160 FT. STEEL DECK TRUSS BRIDGE

200 100 0 200
GRAPHIC SCALE IN FT.

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SUSITNA HYDROELECTRIC PROJECT

SUSITNA ACCESS CORRIDOR

**ROAD OR RAILROAD BRIDGE SOUTH OF DEVIL CANYON**

R&M CONSULTANTS, INC.

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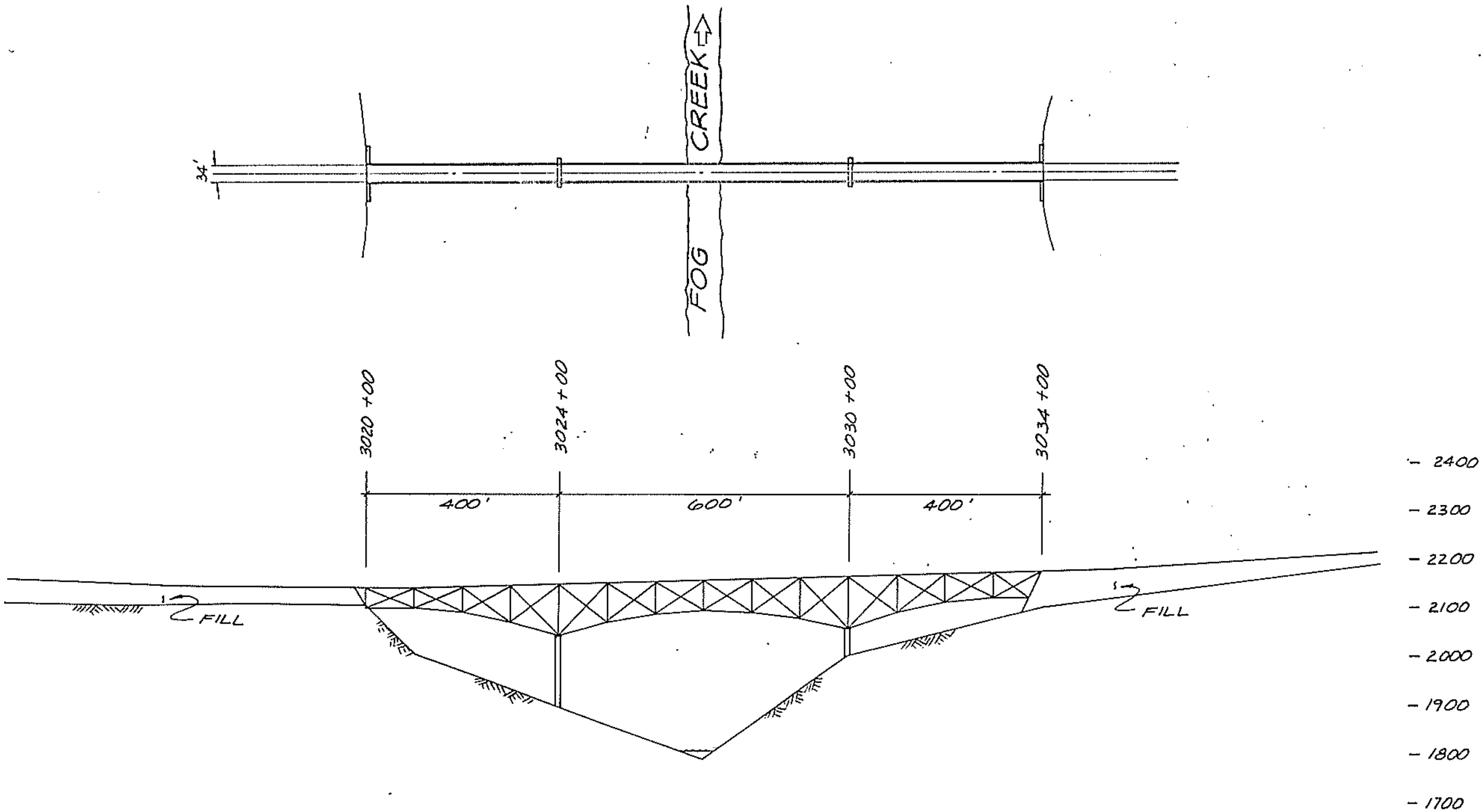
| APPV'D | NKG |




## 1400 FT. STEEL DECK TRUSS BRIDGE

200 100 0 200
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SUSITNA HYDROELECTRIC PROJECT

SUSITNA ACCESS CORRIDOR

# FOG CREEK BRIDGE

R&M CONSULTANTS, INC.

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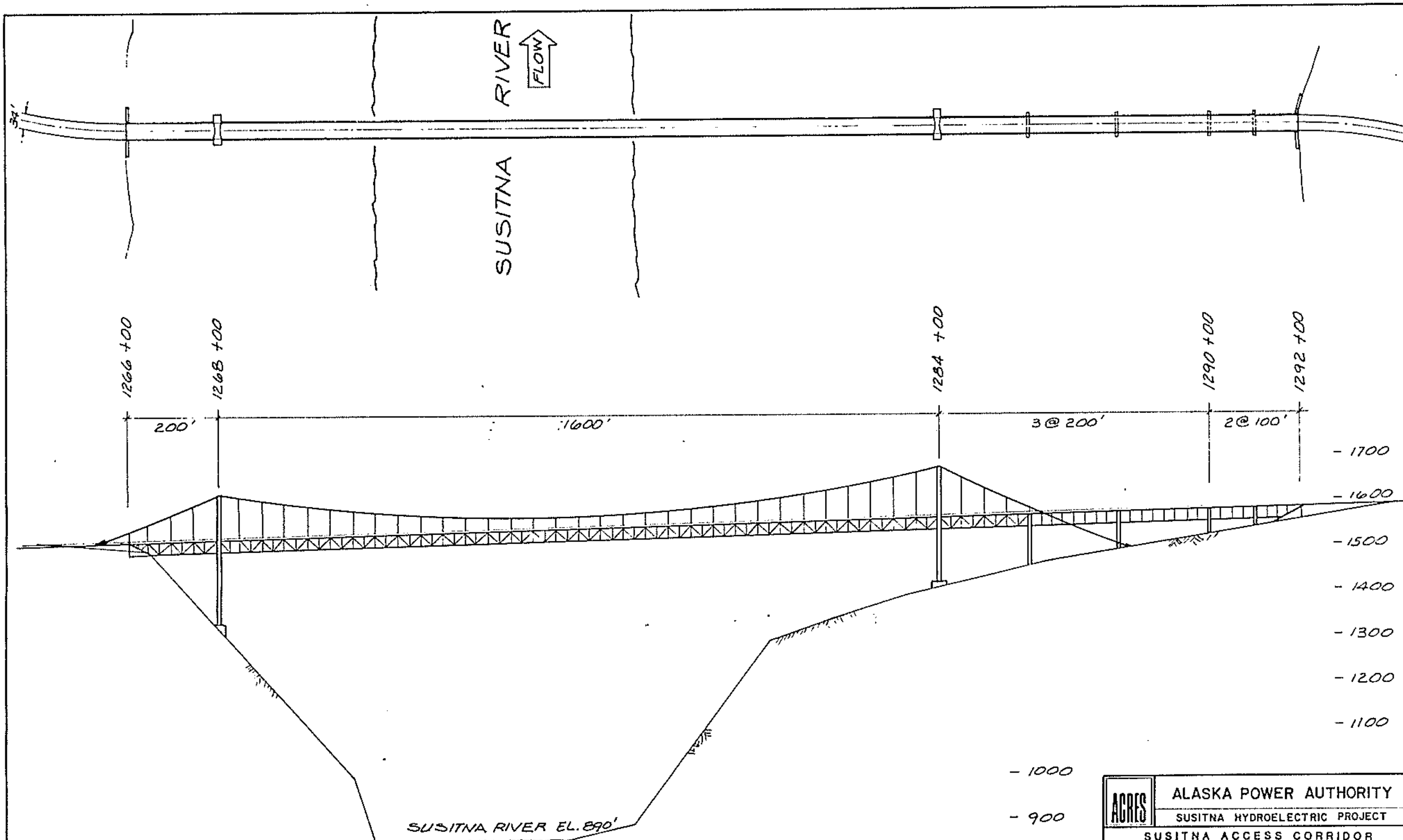
| CKD | V.G. |
| APPVD | N K G |

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## 2600 FT. STEEL SUSPENSION BRIDGE

200 100 0 200
GRAPHIC SCALE IN FT

PROJ. # 052210

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SUSITNA HYDROELECTRIC PROJECT

SUSITNA ACCESS CORRIDOR

**SUSITNA RIVER BRIDGE AT DEVIL CANYON**

R&M CONSULTANTS, INC.

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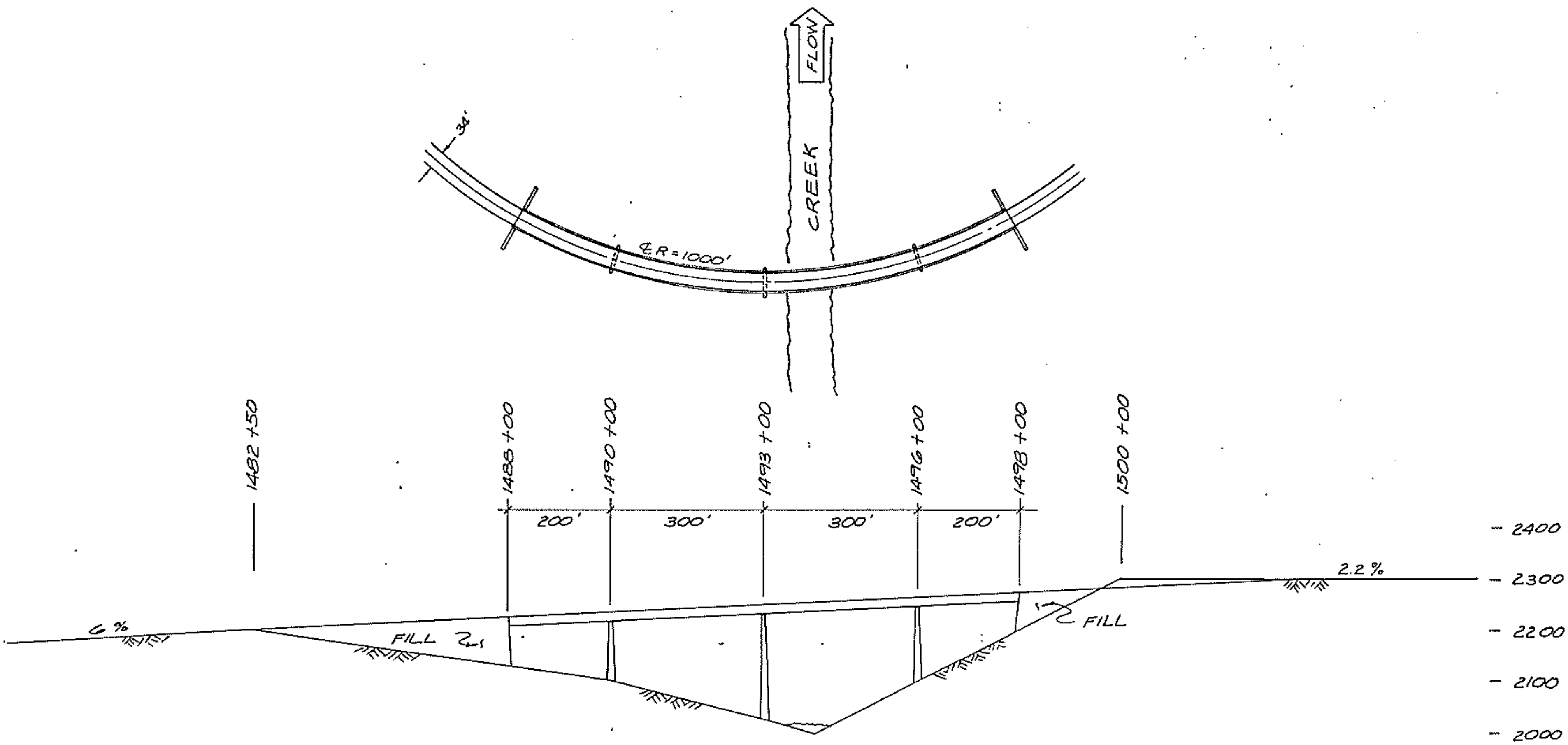
| DWN | O.E.P. |
| CKD | V.G. |
| APPV'D | N.K.G. |




**1000 FT. STEEL BOX GIRDER BRIDGE**

200 100 0 200

GRAPHIC SCALE IN FT.

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SUSITNA HYDROELECTRIC PROJECT

SUSITNA ACCESS CORRIDOR

**CORRIDOR # 2 BRIDGE**

**SE OF DEVIL CANYON**

| | |
|---|---|
| DWN | OEP |
| CKD | VG |

raising the subgrade elevation above the existing ground. Stripped or waste material can go back into the borrow pits.

Up to 15% cross slope, cuts will probably not exceed 10 feet. so no quantity variations would be anticiapted between frozen and unfrozen materials.

The 25%, 30%, and 35% cross slope sections indicate for unfrozen ground a + unfrozen and - unfrozen section 10 feet apart vertically with the excavation quantity balancing the fill quantities. The Frozen subgrade upper and lower limits with a maximum of 10 feet cut require borrow to balance.

On cross slopes of 40% and over, it was considered that after the 2 feet of waste excavation on the surface there would be another 3 feet of usuable excavation before encountering rock excavation. In rock excavation, the frozen condition does not require the maximum 10 feet cut requirement.

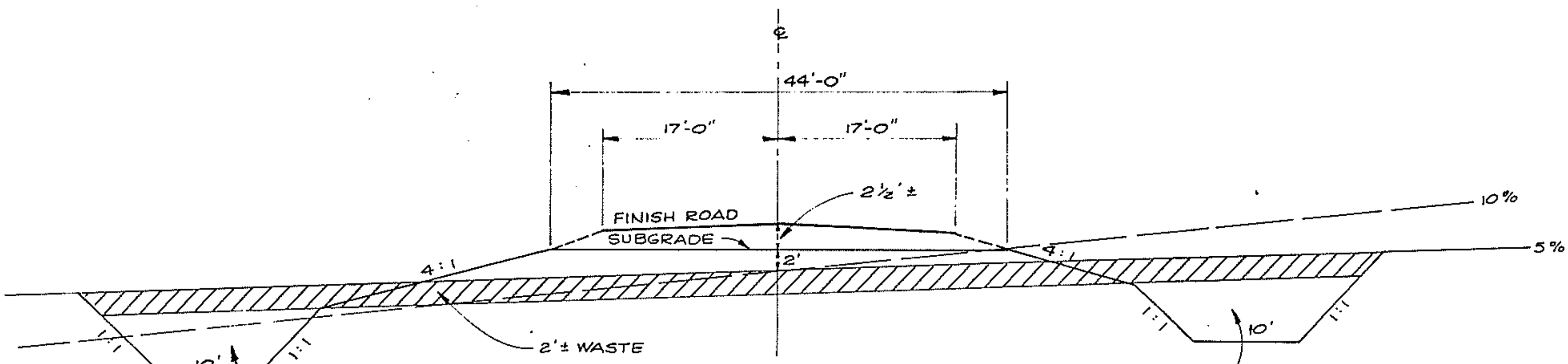
Fill slopes on the roadway sections vary depending on fill height. Cut slopes are used as ½:1 in rock and 1½:1 or flatter in normal materials.

Examination of the terrain unit maps provided additional information as to where rock and organics were to be encountered. Adjustments were made in rock and waste excavation from this information.

The sections used for estimating are shown in Figures F6.1-F6.16

F.7 - <u>Drainage</u>

The cross drainage requirements for the preferred alignment within each corridor were estimated. The design flows were determined




BORROW PIT SECTION
0-10% CROSS SLOPE
QUANTITY ESTIMATING
CROSS SECTION

0 5 10 20
SCALE IN FEET

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ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

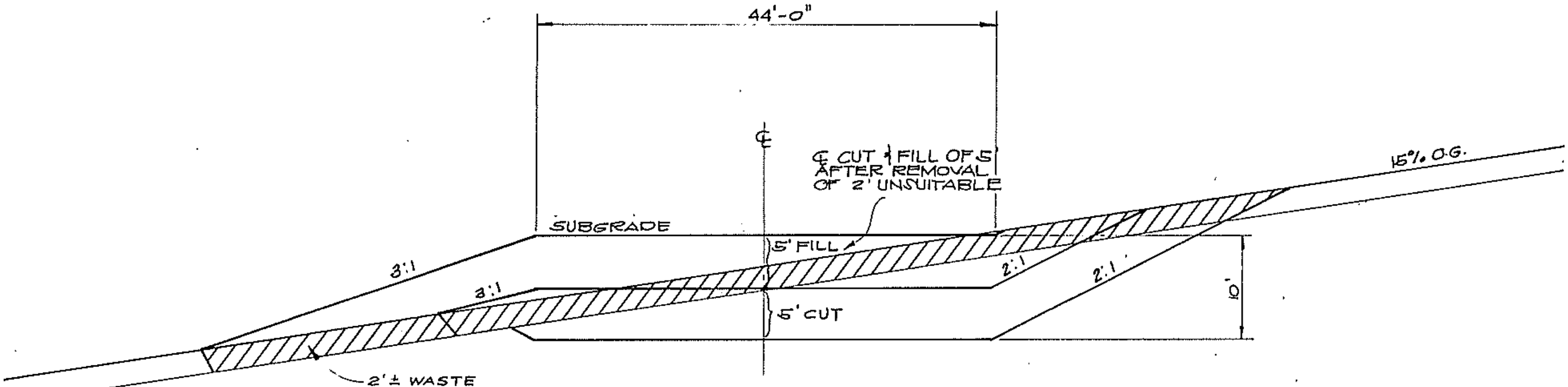
**SUSITNA ACCESS ROAD**

**TYPICAL BORROW PIT CROSS SECTION 0-10% CROSS SLOPE**

R&M CONSULTANTS INC.

DWN PA
CKD VG

PROJECT #




15% CROSS SLOPE
QUANTITY ESTIMATING
CROSS SECTION

0 5 10 20
SCALE IN FEET

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ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS ROAD**

**ESTIMATING CROSS SECTION**

R&M CONSULTANTS, INC.

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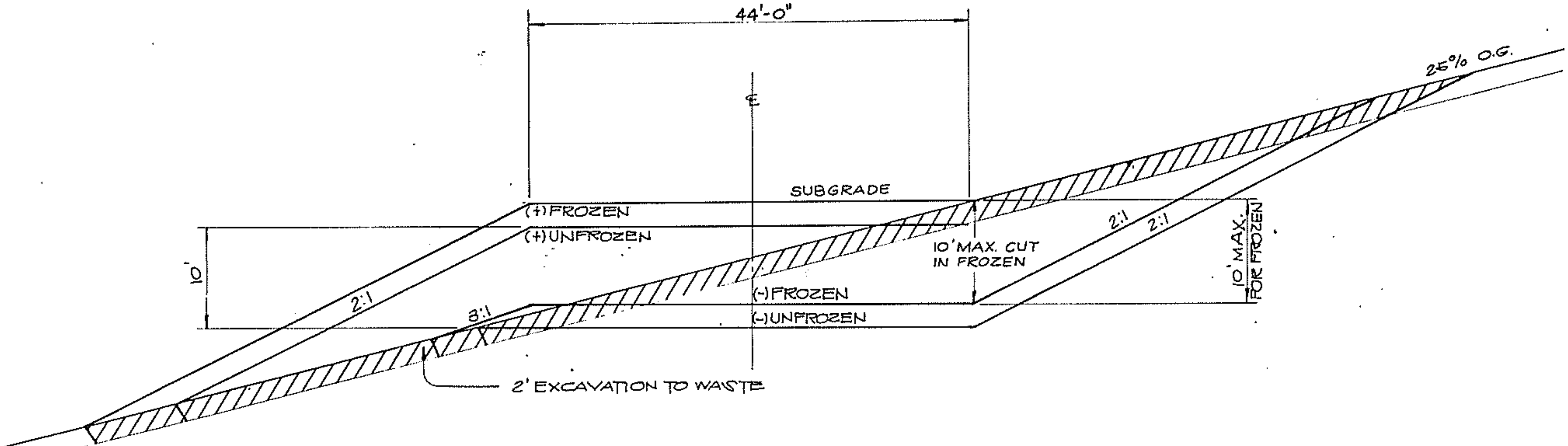
| APPV'D | |




25% CROSS SLOPE QUANTITY ESTIMATING CROSS SECTION

0 5 10 20
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ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS ROAD**

**ESTIMATING CROSS SECTION**

R&M CONSULTANTS, INC.

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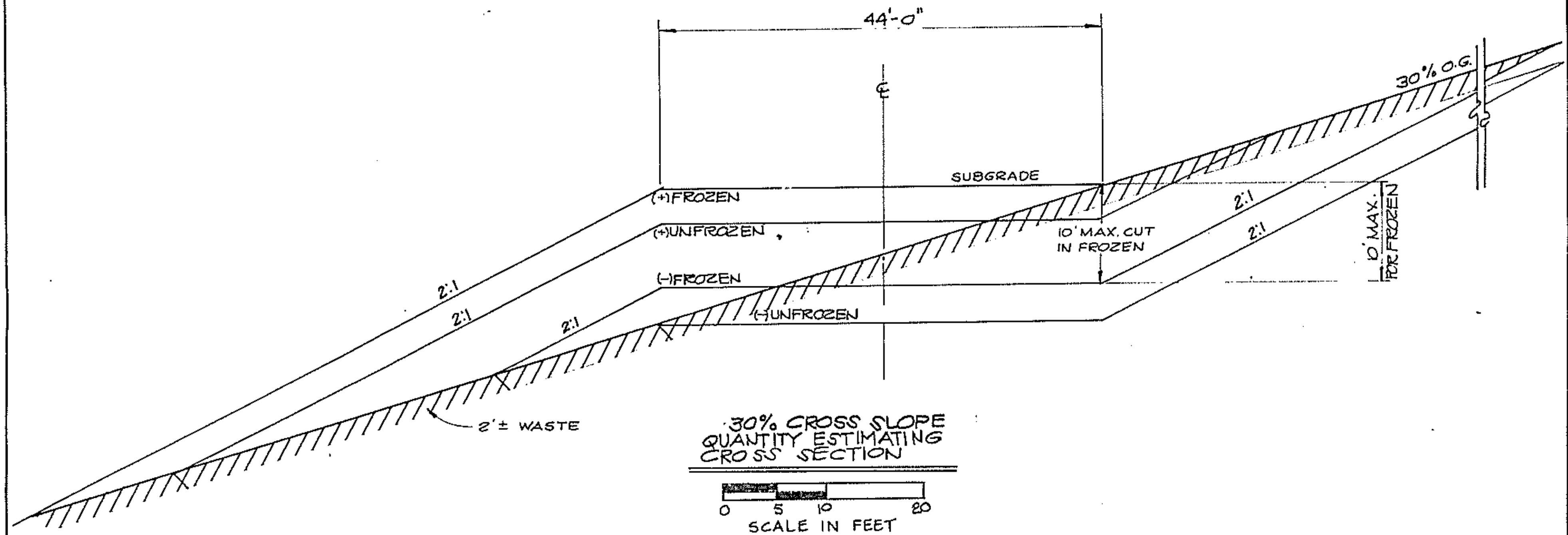


30% CROSS SLOPE QUANTITY ESTIMATING CROSS SECTION

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SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS ROAD**

**ESTIMATING CROSS SECTION**

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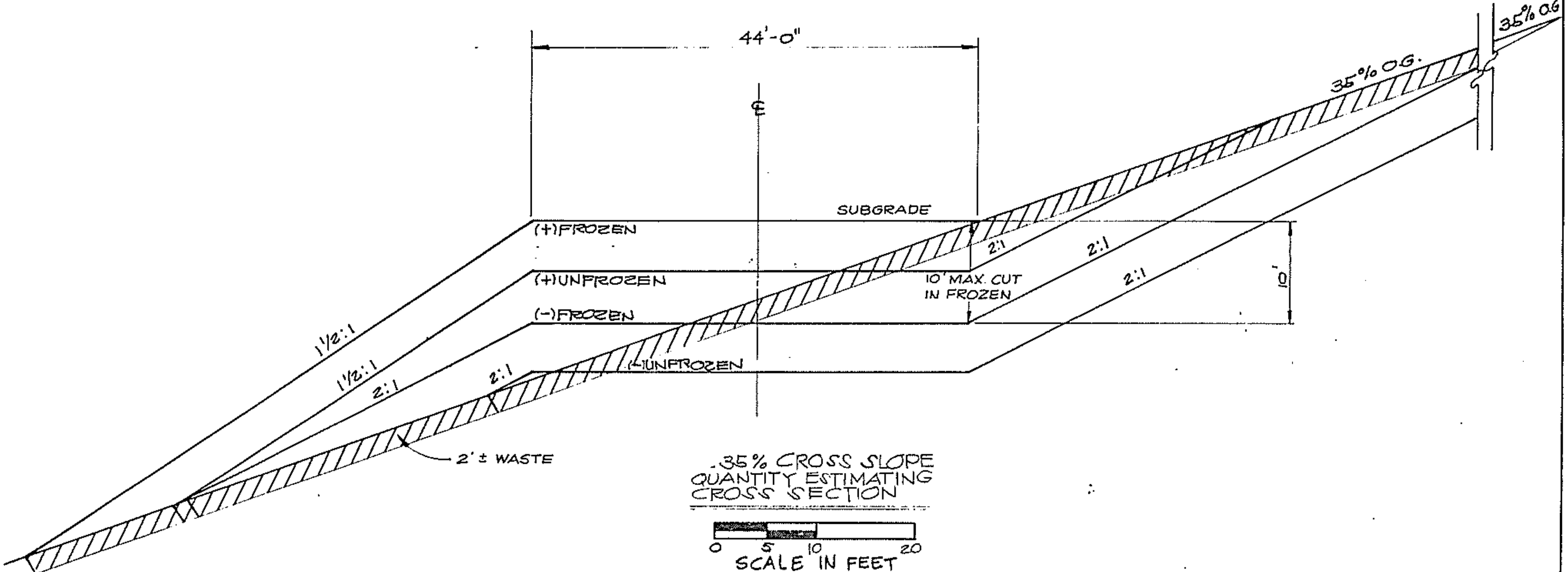


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SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS ROAD**

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R&M CONSULTANTS, INC.

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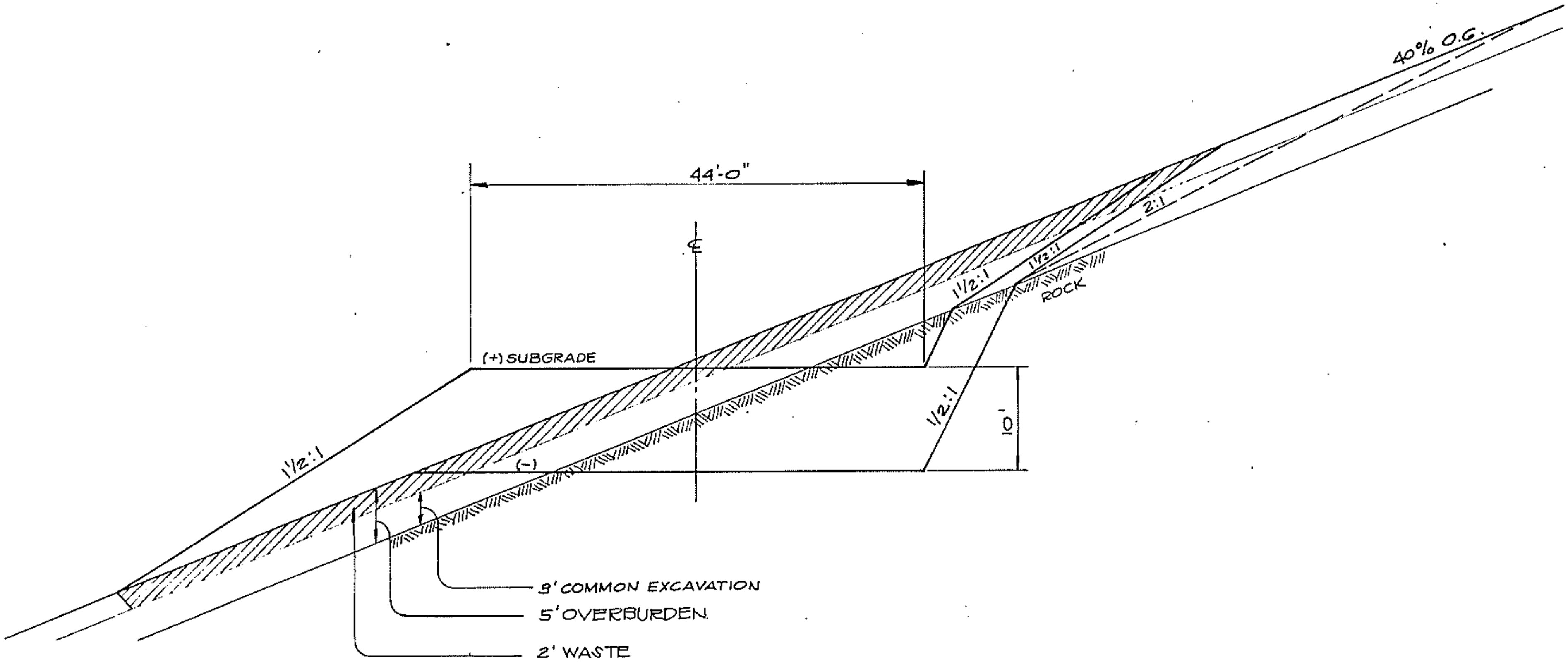


40% CROSS SLOPE
QUANTITY ESTIMATING
CROSS SECTION

0 5 10 20
SCALE IN FEET

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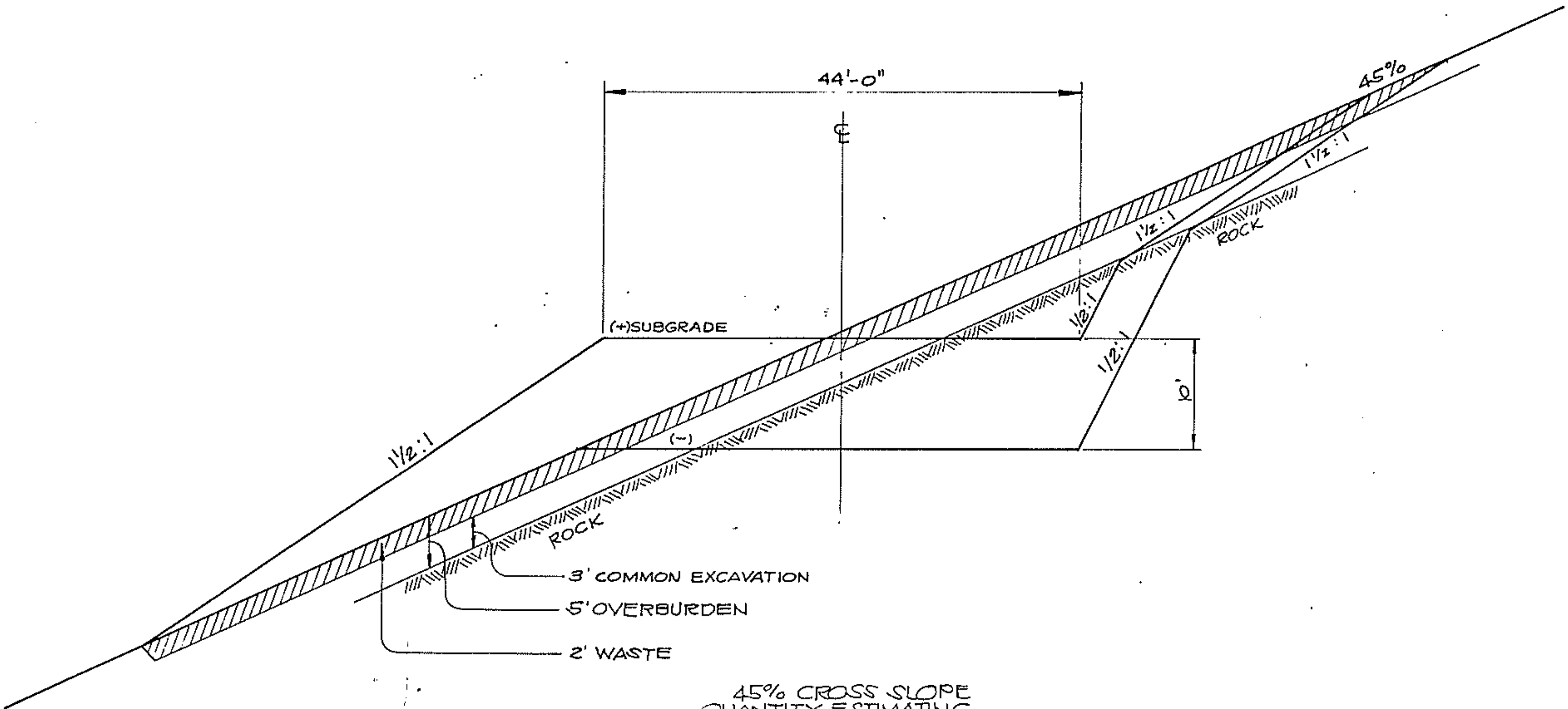
SUSITNA HYDROELECTRIC PROJECT

SUSITNA ACCESS ROAD

ESTIMATING CROSS SECTION

R&M CONSULTANTS, INC. DWN REL CKD VG




45% CROSS SLOPE
QUANTITY ESTIMATING
CROSS SECTION

0 5 10 20
SCALE IN FEET

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ESTIMATING
CROSS SECTION

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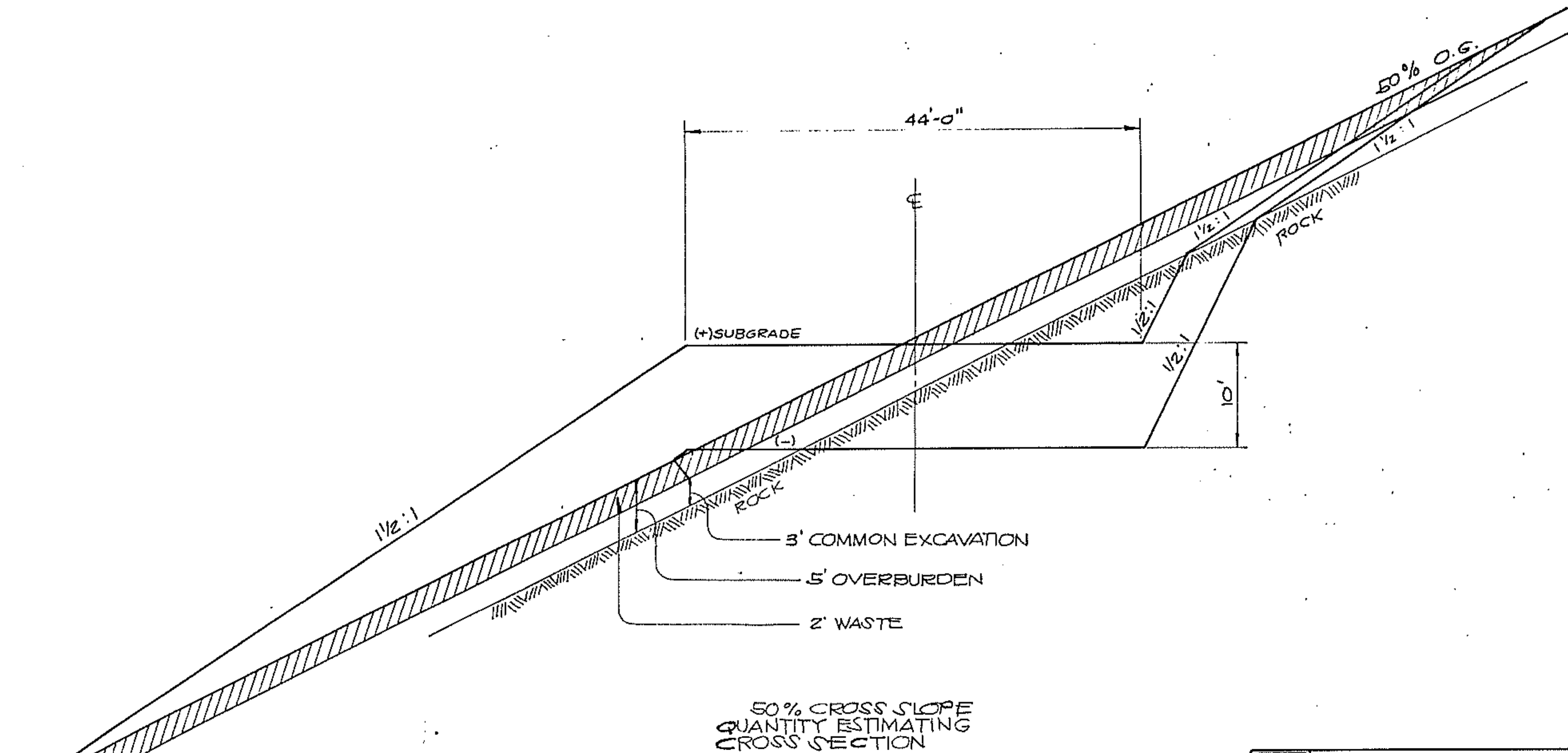


50% CROSS SLOPE QUANTITY ESTIMATING CROSS SECTION

0 5 10 20

SCALE IN FEET

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SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS ROAD**

**ESTIMATING CROSS SECTION**

R&M CONSULTANTS, INC.

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CKD VG

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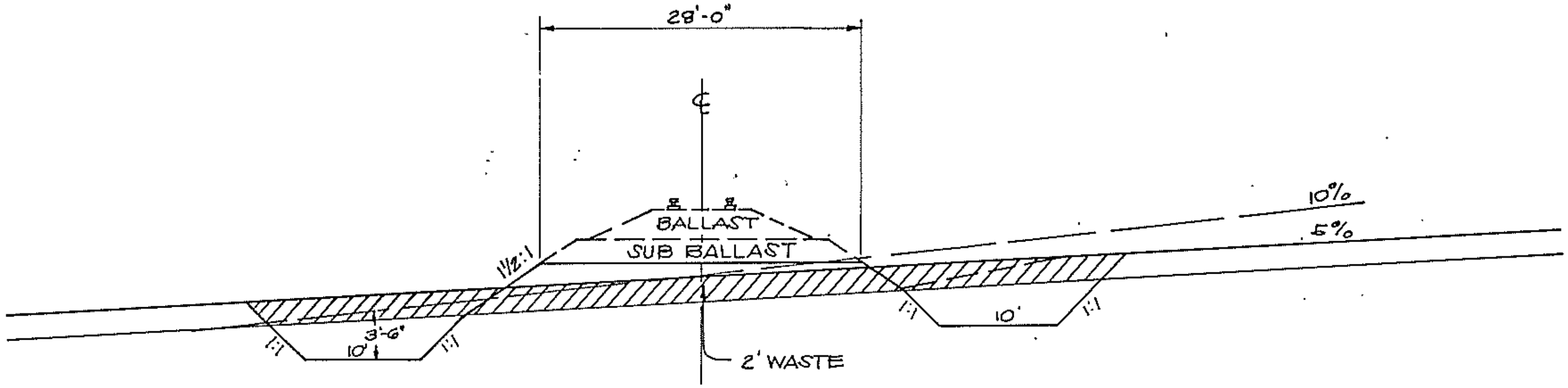


BORROW PIT SECTION
0-10% CROSS SLOPE
QUANTITY ESTIMATING
CROSS SECTION

0 5 10 20
SCALE IN FEET

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PROJ.# 052210

ACRES

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS RAILROAD**

**TYPICAL BORROW PIT CROSS SECTION 0-10% CROSS SLOPE**

R&M CONSULTANTS, INC.

| DWN. | REL |
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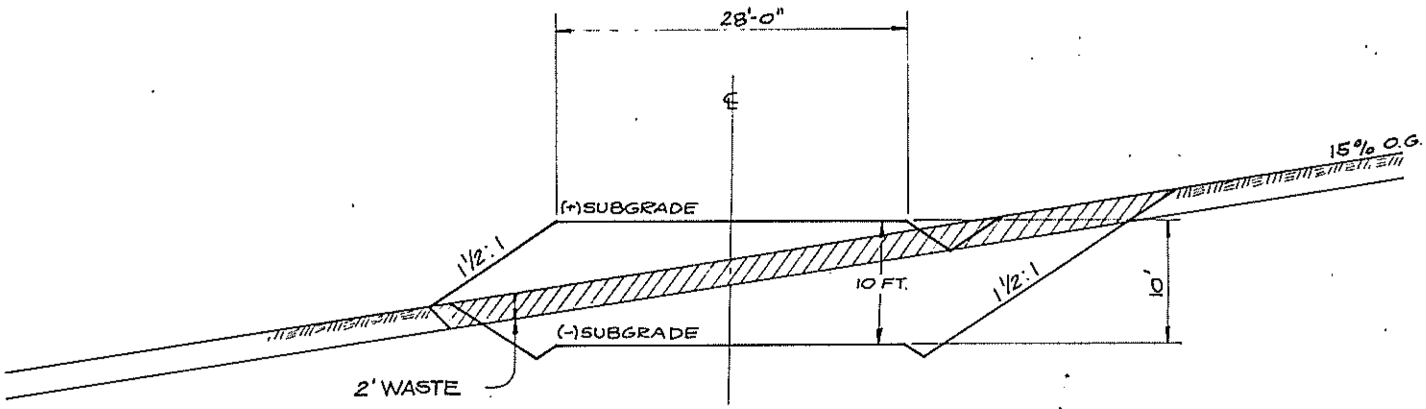
| APPV'D | |




15% CROSS SLOPE
QUANTITY ESTIMATING
CROSS SECTION

0 5 10 20
SCALE IN FEET

REV.

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PROJ.# 052210

ACRES

ALASKA POWER AUTHORITY

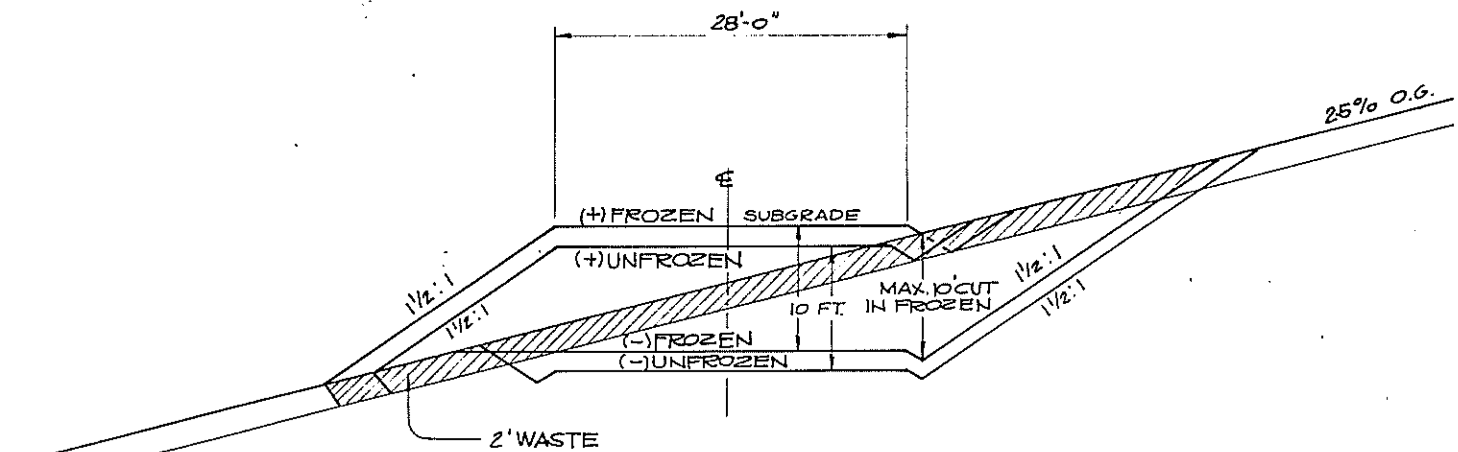
SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS RAILROAD**

**ESTIMATING CROSS SECTION**

R&M CONSULTANTS, INC.

DWN | REL
CKC | 7G
APP |




25% CROSS SLOPE
QUANTITY ESTIMATING
CROSS SECTION

0 5 10 20
SCALE IN FEET

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SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS RAILROAD**
**ESTIMATING CROSS SECTION**

R&M CONSULTANTS, INC.

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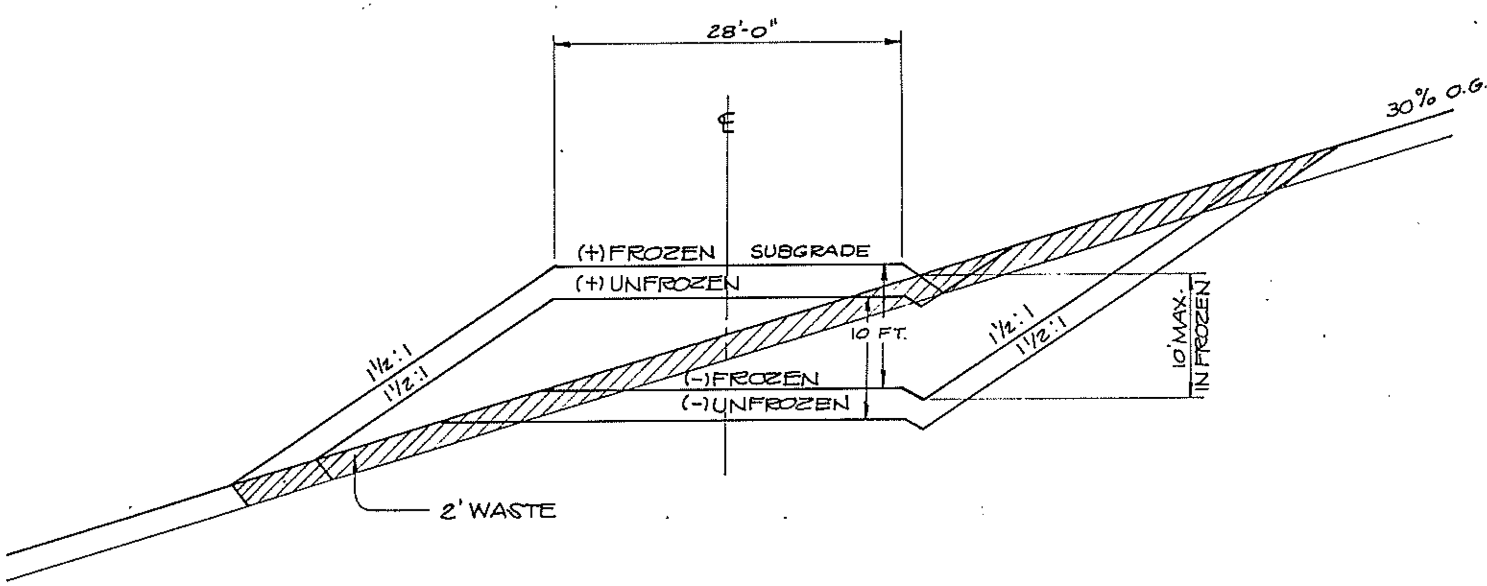



30% CROSS SLOPE
QUANTITY ESTIMATING
CROSS SECTION

0 5 10 20
SCALE IN FEET

REV

| DATE | INTL. |
| --- | --- |
| | |
| | |
| | |

PROJ # OF221J

ACRES

ALASKA POWER AUTHORITY

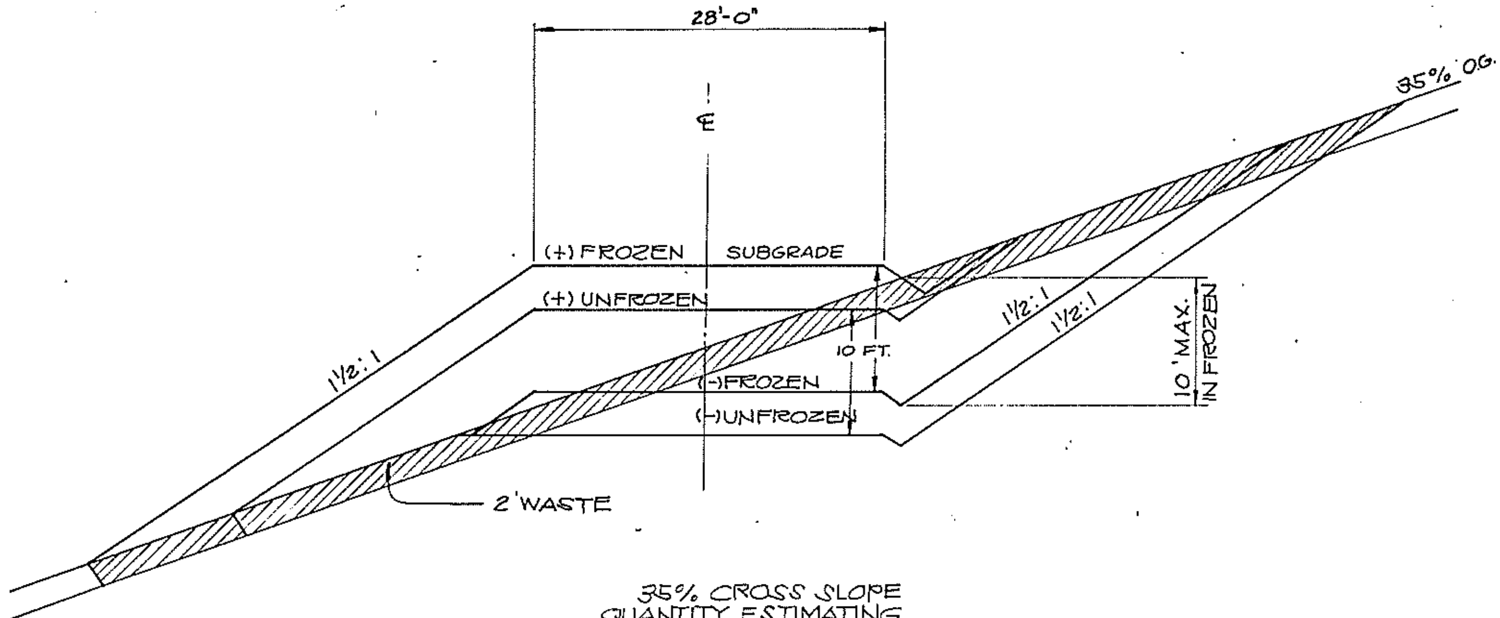
SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS RAILROAD**

**ESTIMATING CROSS SECTION**

R&M CONSULTANTS, INC.

| DWN | REL |
| --- | --- |
| CKD | VG |
| APPVD | |




35% CROSS SLOPE
QUANTITY ESTIMATING
CROSS SECTION

0 5 10 20
SCALE IN FEET

| REV. DATE | INT'L |
|---|---|
| | |
| | |
| | |
| | |

PROJ. # 052210

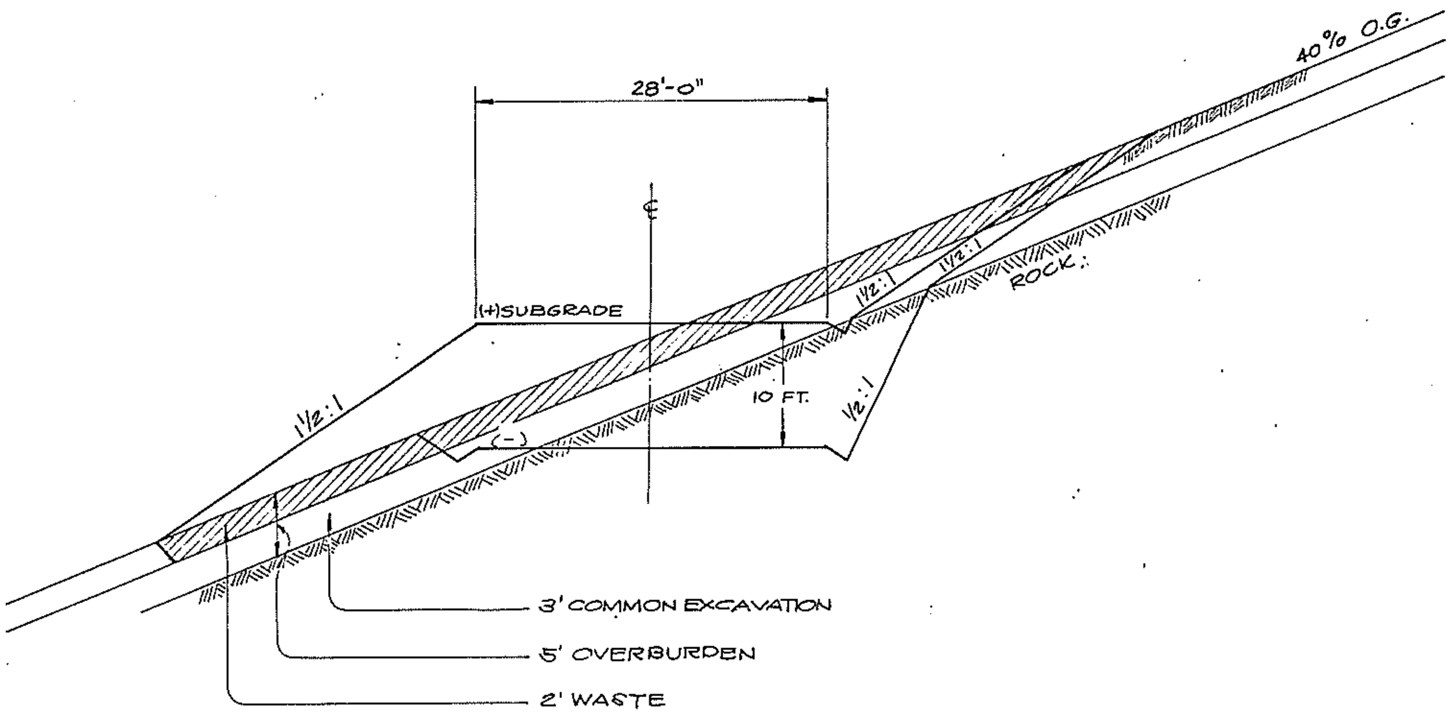
ACRES
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS RAILROAD**

**ESTIMATING CROSS SECTION**

R&M CONSULTANTS, INC.

| DWN | REL |
|---|---|
| CKD | VG |
| APP'D | |




40% CROSS SLOPE
QUANTITY ESTIMATING
CROSS SECTION

0 10 20
SCALE IN FEET

| REV. DATE | INTL. |
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| | |
| | |

PROJ. # 052210

ACRES

ALASKA POWER AUTHORITY

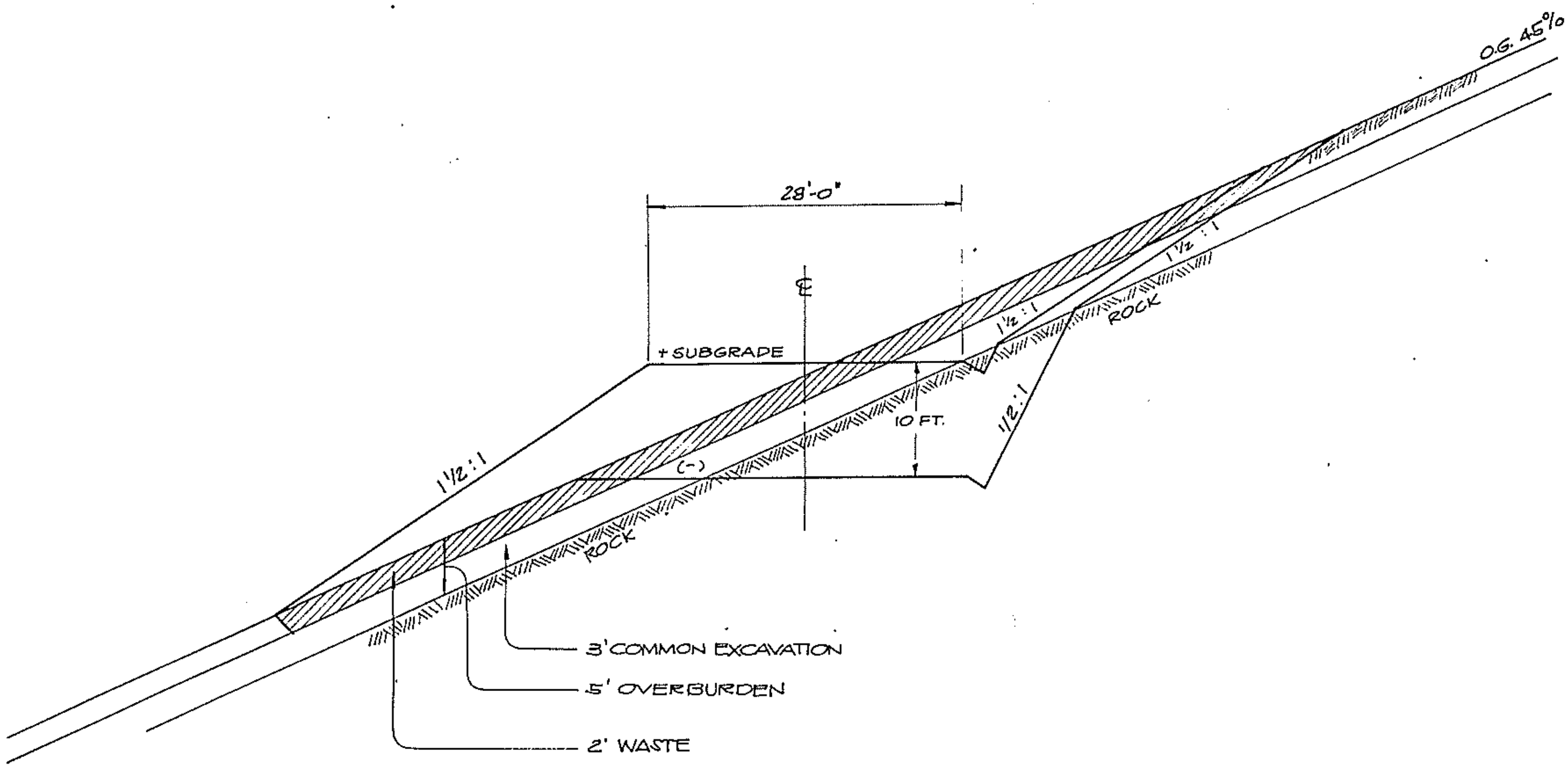
SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS RAILROAD**

**ESTIMATING CROSS SECTION**

R&M CONSULTANTS, INC.

| | |
| --- | --- |
| DWN | REL |
| CKD | VG |
| APP'V'D | |




45% CROSS SLOPE
QUANTITY ESTIMATING
CROSS SECTION


| REV. DATE | INTL. |
|---|---|
| | |
| | |
| | |
| | |

ACRES

ALASKA POWER AUTHORITY

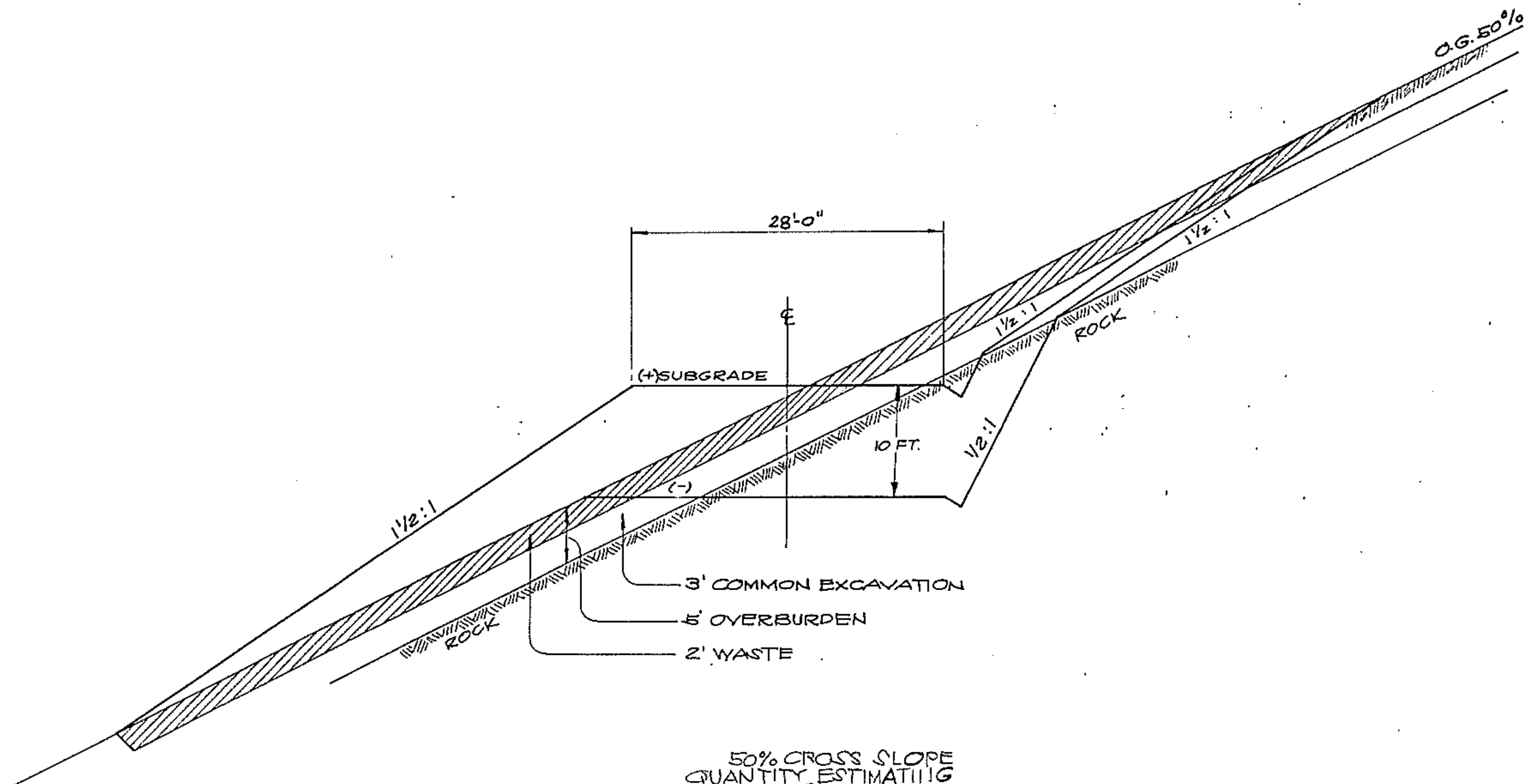
SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS RAILROAD**

**ESTIMATING CROSS SECTION**

R&M CONSULTANTS, INC.

DWN | REL
CKD | VG




50% CROSS SLOPE QUANTITY ESTIMATING CROSS SECTION

0 5 10 20

SCALE IN FEET

| REV. DATE | INT'L. |
| --- | --- |
| | |
| | |
| | |
| | |

PROJ # 052210

ACRES

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

**SUSITNA ACCESS RAILROAD**

**ESTIMATING CROSS SECTION**

R&M CONSULTANTS, INC.

| DWN | REL |
| --- | --- |
| CKD | VG |
| APPV'D | |

by defining the respective drainage areas on USGS quadrangle maps and applying regression equations developed by the U.S. Geologic Survey. "Flood characteristic of Alaskan Streams". Water Resources Investigation 78-129 R.D. Lamke 1979.

Culvert sizes and lengths developed by this process are shown in Table F 7.1.

TABLE F-7.1
CULVERTS (in lineal feet)

| Size DIA. | A-1 L.F. | A-2 L.F. | B-1 L.F. | B-2 L.F. | B-3 L.F. | C L.F. | R-1 L.F. | R-2 L.F. |
|---|---|---|---|---|---|---|---|---|
| 18" | 18,530 | 23,035 | 7,055 | 8,245 | 27,115 | 26,350 | 9,000 | 15,950 |
| 36" | 300 | 0 | 100 | 200 | 200 | 100 | 200 | 200 |
| 42" | 300 | 200 | 200 | 100 | 0 | 400 | 100 | 0 |
| 48" | 100 | 0 | 0 | 0 | 100 | 600 | 0 | 100 |
| 54" | 100 | 200 | 0 | 100 | 200 | 200 | 100 | 200 |
| 60" | 400 | 400 | 100 | 100 | 100 | 300 | 100 | 100 |
| 72" | 100 | 100 | 100 | 100 | 100 | 0 | 100 | 100 |
| 84" | 0 | 100 | 0 | 0 | 100 | 200 | 0 | 100 |
| 96" | 100 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| 108" | 0 | 200 | 0 | 0 | 0 | 200 | 0 | 0 |
| 120" | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| (1) 144" | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) 168" | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

(1) Pipes larger than 120" will be either multiplate culvert or pipe arch similar to "Armco Super Span".

(2) 18" diameter pipes average 85' long under highway, 50' under railroad, larger pipes average 100 feet long.

## F.8 - Consturction Cost Estimates

The construction costs estimates outlined below include mobilization, construction camps, construction survey and engineering service.

## Disscussion of Bid Items

Clearing. Included is clearing and grubbing of vegetation to ten feet outside of excavation limits, and disposal of the material.

Waste Excavation. Removal and disposal of existing topsoil, muck, organics and other deliterious material.

Rock Excavation. Removal of material too hard to economically rip. Price includes placing in the fill or stock piling for later use in the structural section.

Common Excavation. All other excavation including removal and disposal or placement in fill.

Borrow. Where insufficient material is acquired for fill from common and rock excavation separate payment will be made to develope, excavate, and place material from borrow pits.

NFS Subbase. Non-frost susceptible granular material meeting standard specifications.

Grade "A" Base and D-1 Base. Granular, crushed material meeting standard specifications.

A.C. Sufacing. Bituminous concrete, including aggregate, asphalt binder, prime coat and tack coat.

Guardrail. Standard single rail guardrail.

Culverts. 18" cross culverts are figured per linear foot. Larger culverts (36" & over), for individual stream crossings are each multiplied by appropriate costs per foot, depending on diameter, and lumped into one sum. Costs includes placement, any special bedding requirements on materials, and head walls.

Fabric. Standard Mirafi or Typar filter fabric, to be placed over organics too deep to economically remove and replace.

Thaw Pipe. One thaw pipe per culvert. Price includes hangers, caps, standpipes, etc.

Topsoil and Seed. Topsoil will be manufactured from appropriate materials removed under waste excavation. Seed includes a hydroseed mixture of seed, fertilizer and lime.

Traffic Control Devices. Includes all standard signs and pavement markings, plus reflective paddle boards as delineators along the entire length of road.

Bridges. All highway bridges, regardless of type, are at present figured on the same per square foot basis. Rail bridges are also figured on a single price per square foot bases.

Rail Head. The lump sum price includes all clearing, excavation, subballast, ballast, track, switches, Grade "A" base, D-1 base, A.C. surfacing, topsoil and seeding, traffic control devices and timber crib docks as needed to complete a rail head facility on an existing track or at either damsite. The rail head includes five sidings for train make up and off loading of various types of equipment and material, two docks, a parking area for trucks, and an engine turn around. Contractor will provide his own warehouse, office, cranes, fuel facilities, cement pumps, fuel pumps and any other equipment deemed necessary.

Subballast. Granular material meeting standard specifications.

Trackage. Includes rail, ties, and ballast. Switches are considered as equivalent to 200 feet of track for the purpose of this estimate.

TABLE F-8.1

SUSITNA ACCESS CONSTRUCTION ESTIMATES

SEGMENT A-1

PARKS HIGHWAY TO DEVIL CANYON
STA 0+00 to 1,650+00 165,000 ft. = 31.25 Mi.

| | Quantity | Unit Price | Total |
|---|---|---|---|
| Clearing | 477 AC. | 4,800.00 | 2,289,600 |
| Waste Excavtion | 1,294,200 C.Y. | 4.00 | 5,176,800 |
| Common Excavation | 1,189,072 C.Y. | 3.50 | 4,161,752 |
| Rock Excavation | 49,728 C.Y. | 12.00 | 596,736 |
| Borrow | 515,600 C.Y. | 5.00 | 2,578,000 |
| NFS Subbase Material | 321,750 C.Y. | 7.00 | 2,252,250 |
| Grade "A" Base Material | 175,560 C.Y. | 14.00 | 2,457,840 |
| D-1 Base Material | 73,260 Tons | 18.00 | 1,318,680 |
| A.C. Surfacing | 67,089 Tons | 66.00 | 4,427,874 |
| Guardrail | 17,650 L.F. | 36.00 | 635,400 |
| 18" Culverts | 18,530 L.F. | 24.00 | 444,720 |
| 36" + Culverts | L.S. | - | 254,400 |
| Fabric | 69,180 S.Y. | 2.50 | 172,950 |
| Thaw Pipes | 20,030 L.F. | 36.00 | 721,080 |
| Top Soil & Seed | 288 A.C. | 3,000.00 | 864,000 |
| Traffic Control Devices | 31.25 mi. | 15,000.00 | 468,750 |
| Bridges | 33,660 S.F. | 150.00 | 5,049,000 |
| Rail Head | 1 ea. | 5,160,000.00 | 5,160,000 |
| TOTAL | | | $39,029,832 |

TABLE F-8.2

SUSITNA ACCESS CONSTRUCTION ESTIMATES

SEGMENT A-2

DEVIL CAYON TO WATANA (Incl. along corr. 3)
STA 1,650+00 to 3,828+00 217,800 ft. = 41.25 mi.

| | Quantity | Unit Price | Total |
|---|---|---|---|
| Clearing | 576 AC. | 4,800.00 | 2,764,800 |
| Waste Excavtion | 1,536,500 C.Y. | 4.00 | 6,146,000 |
| Common Excavation | 1,603,973 C.Y. | 3.50 | 5,613,906 |
| Rock Excavation | 146,527 C.Y. | 12.00 | 1,758,324 |
| Borrow | 156,700 C.Y. | 5.00 | 783,500 |
| NFS Subbase Material | 424,710 C.Y. | 7.00 | 2,972,970 |
| Grade "A" Base Material | 231,739 C.Y. | 14.00 | 3,244,346 |
| D-1 Base Material | 96,704 Tons | 18.00 | 1,740,672 |
| A.C. Surfacing | 88,557 Tons | 66.00 | 5,844,762 |
| Guardrail | 6,050 L.F. | 36.00 | 217,800 |
| 18" Culverts | 23,035 L.F. | 24.00 | 552,840 |
| 36" + Culverts | L.S. | - | 245,000 |
| Fabric | 49,820 S.Y. | 2.50 | 124,550 |
| Thaw Pipes | 24,335 L.F. | 36.00 | 876,060 |
| Top Soil & Seed | 326 A.C. | 3,000.00 | 978,000 |
| Traffic Control Devices | 41.25 mi. | 15,000.00 | 618,750 |
| Bridges | 6,800 S.F. | 150.00 | 1,020,000 |
| TOTAL | | | $35,502,280 |

TABLE F-8.3

SUSITNA ACCESS CONSTRUCTION ESTIMATES

SEGMENT CORRIDOR #1 Alone - (295 STA of Cor #3 Included)

PARKS HIGHWAY TO WATANA DAMSITE
STA 0+00 to 3,828+00 382,800 ft. = 72.50 mi.

| | Quantity | Unit Price | Total |
|---|---|---|---|
| Clearing | 1053 AC. | 4,800.00 | 5,054,400 |
| Waste Excavtion | 2,830,700 C.Y. | 4.00 | 11,322,800 |
| Common Excavation | 2,793,045 C.Y. | 3.50 | 9,775,658 |
| Rock Excavation | 196,255 C.Y. | 12.00 | 2,355,060 |
| Borrow | 672,300 C.Y. | 5.00 | 3,361,500 |
| NFS Subbase Material | 746,460 C.Y. | 7.00 | 5,225,220 |
| Grade "A" Base Material | 407,299 C.Y. | 14.00 | 5,702,186 |
| D-1 Base Material | 169,964 Tons | 18.00 | 3,059,352 |
| A.C. Surfacing | 155,646 Tons | 66.00 | 10,272,636 |
| Guardrail | 23,700 L.F. | 36.00 | 853,200 |
| 18" Culverts | 41,565 L.F. | 24.00 | 997,560 |
| 36" + Culverts | L.S. | - | 499,400 |
| Fabric | 119,000 S.Y. | 2.50 | 297,500 |
| Thaw Pipes | 44,365 L.F. | 36.00 | 1,597,140 |
| Top Soil & Seed | 614 A.C. | 3,000.00 | 1,842,000 |
| Traffic Control Devices | 72.50 mi. | 15,000.00 | 1,087,500 |
| Bridges | 40,460 S.F. | 150.00 | 6,069,000 |
| Rail Head | 1 ea. | 5,160,000.00 | 5,160,000 |
| TOTAL | | | $74,532,112 |

r26/b29

TABLE F-8.4

SUSITNA ACCESS CONSTRUCTION ESTIMATES

SEGMENT B-1

PARKS HIGHWAY TO GOLD CREEK
STA 0+00 to 700+00    70,000 ft. = 13.26 Mi.

| | Quantity | Unit Price | Total |
|---|---|---|---|
| Clearing | 210 AC. | 4,800.00 | 1,008,000 |
| Waste Excavtion | 575,480 C.Y. | 4.00 | 2,301,920 |
| Common Excavation | 570,180 C.Y. | 3.50 | 1,995,630 |
| Rock Excavation | 35,850 C.Y. | 12.00 | 430,200 |
| Borrow | 126,600 C.Y. | 5.00 | 633,000 |
| NFS Subbase Material | 136,500 C.Y. | 7.00 | 955,500 |
| Grade "A" Base Material | 74,480 C.Y. | 14.00 | 1,042,720 |
| D-1 Base Material | 31,080 Tons | 18.00 | 559,440 |
| A.C. Surfacing | 28,462 Tons | 66.00 | 1,878,492 |
| Guardrail | 9,800 L.F. | 36.00 | 352,800 |
| 18" Culverts | 7,055 L.F. | 24.00 | 169,320 |
| 36" + Culverts | L.S. | - | 42,700 |
| Fabric | 18,844 S.Y. | 2.50 | 47,110 |
| Thaw Pipes | 7,555 L.F. | 36.00 | 271,980 |
| Top Soil & Seed | 130 A.C. | 3,000.00 | 390,000 |
| Traffic Control Devices | 13.26 mi. | 15,000.00 | 198,900 |
| Bridges | 84,320 S.F. | 150.00 | 12,648,000 |
| Rail Head (Gold Creek) | 1 ea. | 5,160,000.00 | 5,160,000 |
| TOTAL | | | $30,085,712 |

r26/b30

TABLE F-8.5

SUSITNA ACCESS CONSTRUCTION ESTIMATES

SEGMENT B-2

GOLD CREEK TO DEVIL CANYON

STA 700+00 to 1,350+00 65,000 ft. = 12.31 Mi.

| | Quantity | Unit Price | Total |
|---|---|---|---|
| Clearing | 161 AC. | 4,800.00 | 772,800 |
| Waste Excavtion | 422,890 C.Y. | 4.00 | 1,691,560 |
| Common Excavation | 335,935 C.Y. | 3.50 | 1,175,773 |
| Rock Excavation | 23,625 C.Y. | 12.00 | 283,500 |
| Borrow | 445,200 C.Y. | 5.00 | 2,226,000 |
| NFS Subbase Material | 126,750 C.Y. | 7.00 | 887,250 |
| Grade "A" Base Material | 69,160 C.Y. | 14.00 | 968,240 |
| D-1 Base Material | 28,860 Tons | 18.00 | 519,480 |
| A.C. Surfacing | 26,429 Tons | 66.00 | 1,744,314 |
| Guardrail | 6,700 L.F. | 36.00 | 241,200 |
| 18" Culverts | 8,245 L.F. | 24.00 | 197,880 |
| 36" + Culverts | L.S. | - | 50,400 |
| Fabric | 8,777 S.Y. | 2.50 | 21,942 |
| Thaw Pipes | 8,845 L.F. | 36.00 | 318,420 |
| Top Soil & Seed | 86 A.C. | 3,000.00 | 258,000 |
| Traffic Control Devices | 12.31 mi. | 15,000.00 | 184,650 |
| Bridges | 0 | 150.00 | 0 |
| TOTAL | | | $11,541,409 |

TABLE F-8.6

SUSITNA ACCESS CONSTRUCTION ESTIMATES

SEGMENT B-3

DEVIL CANYON TO WATANA

STA 1,350+00 to 3,275+00   192,500 ft. = 36.46 Mi.

| | Quantity | Unit Price | Total |
|---|---|---|---|
| Clearing | 631 AC. | 4,800.00 | 3,028,800 |
| Waste Excavtion | 1,750,160 C.Y. | 4.00 | 7,000,640 |
| Common Excavation | 1,564,430 C.Y. | 3.50 | 5,475,505 |
| Rock Excavation | 246,750 C.Y. | 12.00 | 2,961,000 |
| Borrow | 101,100 C.Y. | 5.00 | 505,500 |
| NFS Subbase Material | 375,375 C.Y. | 7.00 | 2,627,625 |
| Grade "A" Base Material | 204,820 C.Y. | 14.00 | 2,867,480 |
| D-1 Base Material | 85,470 Tons | 18.00 | 1,538,460 |
| A.C. Surfacing | 78,271 Tons | 66.00 | 5,165,886 |
| Guardrail | 8,300 L.F. | 36.00 | 298,800 |
| 18" Culverts | 27,115 L.F. | 24.00 | 650,760 |
| 36" + Culverts | L.S. | - | 63,100 |
| Fabric | 96,541 S.Y. | 2.50 | 241,353 |
| Thaw Pipes | 27,615 L.F. | 36.00 | 994,140 |
| Top Soil & Seed | 410 A.C. | 3,000.00 | 1,230,000 |
| Traffic Control Devices | 36.46 mi. | 15,000.00 | 546,900 |
| Bridges | 121,040 S.F. | 150.00 | 18,156,000 |
| TOTAL | | | $53,351,949 |

TABLE F-8.7

SUSITNA ACCESS CONSTRUCTION ESTIMATES

SEGMENT CORRIDOR #2 - entire length

PARKS HIGHWAY TO WATANA DAMSITE
STA 0+00 to 3,275+00 3,275,00 lf. = 62.03 Mi.

| | Quantity | Unit Price | Total |
|---|---|---|---|
| Clearing | 1002 AC. | 4,800.00 | 4,809,600 |
| Waste Excavtion | 2,748,530 C.Y. | 4.00 | 10,994,120 |
| Common Excavation | 2,470,545 C.Y. | 3.50 | 8,646,908 |
| Rock Excavation | 306,225 C.Y. | 12.00 | 3,674,700 |
| Borrow | 672,900 C.Y. | 5.00 | 3,364,500 |
| NFS Subbase Material | 638,625 C.Y. | 7.00 | 4,470,375 |
| Grade "A" Base Material | 348,460 C.Y. | 14.00 | 4,878,440 |
| D-1 Base Material | 145,410 Tons | 18.00 | 2,617,380 |
| A.C. Surfacing | 133,162 Tons | 66.00 | 8,788,692 |
| Guardrail | 24,800 L.F. | 36.00 | 892,800 |
| 18" Culverts | 42,415 L.F. | 24.00 | 1,017,960 |
| 36 + Culverts | L.S. | - | 156,200 |
| Fabric | 124,162 S.Y. | 2.50 | 310,405 |
| Thaw Pipes | 44,015 L.F. | 36.00 | 1,584,540 |
| Top Soil & Seed | 626 A.C. | 3,000.00 | 1,878,000 |
| Traffic Control Devices | 62.03 mi. | 15,000.00 | 930,450 |
| Bridges | 205,360 S.F. | 150.00 | 30,804,000 |
| Rail Head (Gold Creek) | 1 ea. | 5,160,000.00 | 5,160,000 |
| TOTAL | | | $94,979,070 |

TABLE F-8.8

SUSITNA ACCESS CONSTRUCTION ESTIMATES

SEGMENT C = CORRIDOR 3

DENALI HIGHWAY TO WATANA

STA 0+00 to 2,340+00 234,000 Lf. = 44.32 Mi.

This estimate includes upgrading and paving of ± 25 miles of Denali Highway.

| | Quantity | Unit Price | Total |
|---|---|---|---|
| Clearing | 800 AC. | 4,800.00 | 3,840,000 |
| Waste Excavtion | 2,245,400 C.Y. | 4.00 | 8,981,600 |
| Common Excavation | 2,450,800 C.Y. | 3.50 | 8,577,800 |
| Rock Excavation | 41,800 C.Y. | 12.00 | 501,600 |
| Borrow | 20,000 C.Y. | 5.00 | 100,000 |
| NFS Subbase Material | 470,000 C.Y. | 7.00 | 3,290,000 |
| Grade "A" Base Material | 300,000 C.Y. | 14.00 | 4,200,000 |
| D-1 Base Material | 162,500 Tons | 18.00 | 2,925,000 |
| A.C. Surfacing | 148,813 Tons | 66.00 | 9,821,658 |
| Guardrail | 4,200 L.F. | 36.00 | 151,200 |
| 18" Culverts | 30,350 L.F. | 24.00 | 728,400 |
| 36" + Culverts | L.S. | - | 450,000 |
| Fabric | 12,907 S.Y. | 2.50 | 32,268 |
| Thaw Pipes | 28,650 L.F. | 36.00 | 1,031,400 |
| Top Soil & Seed | 514 A.C. | 3,000.00 | 1,542,000 |
| Traffic Control Devices | 69.32 mi. | 15,000.00 | 1,039,800 |
| Bridges | 0 | 150.00 | 0 |
| Rail Head (Cantwell) | 1 ea. | 5,160,000.00 | 5,160,000 |
| TOTAL | | | $52,372,726 |

Note: This estimate includes quantities for upgrading and paving Denali Highway from Cantwell to STA. 0+00 on Segment C. The subtotal for just the Denali Highway is $7,307,762.

r26/b34

TABLE F-8.9

SUSITNA ACCESS CONSTRUCTION ESTIMATES

SEGMENT R-1

RAILROAD - GOLD CREEK TO DEVIL CANYON
STA 490+00 to 1,350+00 86,000 Lf = 16.29 Mi.

| | Quantity | Unit Price | Total |
|---|---|---|---|
| Clearing | 156 AC. | 4,800.00 | 748,800 |
| Waste Excavtion | 376,480 C.Y. | 4.00 | 1,505,920 |
| Common Excavation | 335,320 C.Y. | 3.50 | 1,173,620 |
| Rock Excavation | 2,200 C.Y. | 12.00 | 26,400 |
| Borrow | 108,500 C.Y. | 5.00 | 542,500 |
| 18" Culverts | 9,000 L.F. | 24.00 | 216,000 |
| 36" + Culverts | L.S. | - | 93,100 |
| Fabric | 3,121 S.Y. | 2.50 | 7,803 |
| Thaw Pipes | 10,100 L.F. | 36.00 | 363,600 |
| Top Soil & Seed | 101 A.C. | 3,000.00 | 303,000 |
| Bridges | 0 S.F. | 300.00 | 0 |
| Subballast | 166,667 yds. | 7.00 | 1,166,669 |
| Trackage (Inchl. siding and 3 switches | 90,600 L.F. | 120.00 | 10,872,000 |
| Railhead (Devil Canyon) | 1 ea. | 5,160,000.00 | 5,160,000 |
| TOTAL | | | $22,179,412 |

TABLE F-8.10

SUSITNA ACCESS CONSTRUCTION ESTIMATES

SEGMENT R-2

DEVIL CANYON TO WATANA

STA 1,350 to 3,545+00 219,500 L.F. = 41.57 Mi.

| | Quantity | Unit Price | Total |
|---|---|---|---|
| Clearing | 461 AC. | 4,800.00 | 2,212,800 |
| Waste Excavtion | 1,162,740 C.Y. | 4.00 | 4,650,960 |
| Common Excavation | 722,200 C.Y. | 3.50 | 2,527,700 |
| Rock Excavation | 168,960 C.Y. | 12.00 | 2,027,520 |
| Borrow | 29,000 C.Y. | 5.00 | 145,000 |
| 18" Culverts | 15,950 L.F. | 24.00 | 382,800 |
| 36" + Culverts | L.S. | - | 63,100 |
| Fabric | 65,378 S.Y. | 2.50 | 163,445 |
| Thaw Pipes | 16,450 L.F. | 36.00 | 592,200 |
| Top Soil & Seed | 320 A.C. | 3,000.00 | 960,000 |
| Bridges | 41,820 S.F. | 300.00 | 12,546,000 |
| Subballast | 421,296 C.Y. | 7.00 | 2,949,072 |
| Trackage (Inchl. 2 sidings and 4 switches | 228,300 L.F. | 120.00 | 27,396,000 |
| Railhead (Watana) | 1 ea. | 5,160,000.00 | 5,160,000 |
| TOTAL | | | $61,776,597 |

r26/b36

TABLE F-8.11

SUSITNA ACCESS CONSTRUCTION ESTIMATES

SEGMENT Railroad (entire corridor)

GOLD CREEK TO DEVIL CANYON

STA 490+00 to 3,545+00 305,500 L.F. = 57.86 Mi.

| | Quantity | Unit Price | Total |
|---|---|---|---|
| Clearing | 618 AC. | 4,800.00 | 2,961,600 |
| Waste Excavtion | 1,539,220 C.Y. | 4.00 | 6,156,880 |
| Common Excavation | 1,057,520 C.Y. | 3.50 | 3,701,320 |
| Rock Excavation | 171,160 C.Y. | 12.00 | 2,053,920 |
| Borrow | 137,500 C.Y. | 5.00 | 687,500 |
| 18" Culverts | 24,950 L.F. | 24.00 | 598,800 |
| 36" + Culverts | L.S. | - | 156,200 |
| Fabric | 68,499 S.Y. | 2.50 | 171,248 |
| Thaw Pipes | 26,550 L.F. | 36.00 | 955,800 |
| Top Soil & Seed | 421 A.C. | 3,000.00 | 1,263,000 |
| Bridges | 41,820 S.F. | 300.00 | 12,546,000 |
| Subballast | 587,963 C.Y. | 7.00 | 4,115,741 |
| Trackage (Inchl. 2 sidings and 4 switches | 318,900 L.F. | 120.00 | 38,268,000 |
| Railhead (at each dam) | 2 ea. | 5,160,000.00 | 10,320,000 |
| TOTAL | | | $83,956,009 |

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TABLE F-8.12
SUSITNA D&C COSTS

| | A-1 | A-2 | A(#1) |
|---|---|---|---|
| SUBTOTAL - ITEMIZED CONSTR. COST = X | $39,029,832 | $35,502,280 | $74,532,112 |
| Mobilization = .1X | 3,902,983 | 3,550,228 | 7,453,211 |
| Surveys = .1X | 3,902,983 | 3,550,228 | 7,453,211 |
| Camp = .1X | 3,902,983 | 3,550,228 | 7,453,211 |
| Contingency = .2X | 7,805,966 | 7,100,456 | 14,906,422 |
| TOTAL CONSTRUCTION COST = 1.5X | 48,544,747 | 53,253,420 | 111,798,167 |
| Design Fee = F = 5% Constr. Cost = .075X | 2,927,237 | 2,662,671 | 5,558,908 |
| Design Survey = .10F = .0075X | 292,723 | 266,267 | 558,991 |
| Design Soils = .15F = .01125X | 439,086 | 399,400 | 838,486 |
| Construction Inspection = .80F = .06X | 2,341,790 | 2,130,137 | 4,471,927 |
| Quality Control = .15F = .01125X | 439,086 | 399,400 | 838,486 |
| TOTAL DESIGN COSTS = .165X | $ 6,439,922 | $ 5,856,876 | $ 12,297,798 |
| TOTAL D&C COSTS = 1.665X | $64,984,669 | $59,111,296 | $124,095,965 |

susi9/e1

TABLE F-8.13
SUSITNA D&C COSTS

| | B-1 | B-2 | B-3 | B(#2) |
|---|---|---|---|---|
| SUBTOTAL - ITEMIZED CONSTR. COST = X | $30,085,712 | $11,541,409 | $53,351,949 | $ 94,979,070 |
| Mobilization = .IX | 3,008,571 | 1,154,141 | 5,335,195 | 9,497,907 |
| Surveys = .IX | 3,008,571 | 1,154,141 | 5,335,195 | 9,497,907 |
| Camp = .IX | 3,008,571 | 1,154,141 | 5,335,195 | 9,497,907 |
| Contingency = .2X | 6,017,142 | 2,308,282 | 10,670,390 | 18,995,814 |
| TOTAL CONSTRUCTION COST = 1.5x | 45,128,568 | 17,312,114 | 80,027,924 | 142,468,605 |
| Design Fee = F = 5% Total Constr. Cost = .075x | 2,256,428 | 865,606 | 4,001,396 | 7,123,430 |
| Design Survey = .10F = .0075x | 225,643 | 86,561 | 400,140 | 712,343 |
| Design Soils = .15F = .01125x | 338,464 | 129,841 | 600,209 | 1068,515 |
| Construction Inspection = .80F = .06x | 1,805,143 | 692,484 | 3,201,117 | 5,698,744 |
| Quality Control = .15F = .01125x | 338,464 | 129,841 | 600,209 | 1,068,514 |
| TOTAL DESIGN COSTS = .165x | $ 4,964,142 | $ 1,904,332 | $ 8,803,071 | $ 15,671,547 |
| TOTAL D&C COSTS = 1.665x | $50,092,710 | $19,216,446 | $88,830,995 | $158,140,152 |

susi9/e2

TABLE F-8.14
SUSITNA D&C COSTS

| | C |
|---|---|
| SUBTOTAL - ITEMIZED CONSTR. COST = X | $52,372,726 |
| Mobilization = .1X | 5,237,273 |
| Surveys = .1X | 5,237,273 |
| Camp = .1X | 5,237,273 |
| Contingency = .2X | 10,474,545 |
| TOTAL CONSTRUCTION COST = 1.5X | 78,559,090 |
| Design Fee = F = 5% Constr. Cost = .075X | 3,927,955 |
| Design Survey = .10F = .0075X | 392,795 |
| Design Soils = .15F = .01125X | 589,193 |
| Construction Inspection = .80F = .06X | 3,142,364 |
| Qual. Control = .15F = .01125X | 589,193 |
| TOTAL DESIGN COSTS = .165X | $ 8,641,500 |
| TOTAL D&C COSTS = 1.665X | $87,200,590 |

TABLE F-8.15

SUSITNA D&C COSTS

| | R-1 | R-2 | R(RR) |
|---|---|---|---|
| SUBTOTAL - ITEMIZED CONSTR. COST = X | $22,179,412 | $ 61,776,597 | $ 83,956,009 |
| Mobilization = .1X | 2,217,941 | 6,177,660 | 8,395,601 |
| Surveys = .1X | 2,217,941 | 6,177,660 | 8,395,601 |
| Camp = .1X | 2,217,941 | 6,177,660 | 8,395,601 |
| Contingency = .2X | 4,435,882 | 12,355,319 | 16,791,202 |
| TOTAL CONSTRUCTION COST = 1.5x | 33,269,117 | 92,664,896 | 125,934,014 |
| Design Fee = F = 5% Constr. Cost = .075x | 1,663,456 | 4,633,245 | 6,296,701 |
| Design Survey = .10F = .0075x | 166,346 | 463,324 | 629,670 |
| Design Soils = .15F = .01125x | 249,518 | 694,987 | 944,505 |
| Construction Inspection = .80F = .06x | 1,330,765 | 3,706,596 | 5,037,361 |
| Quality Control = .15F = .01125x | 249,518 | 694,987 | 944,505 |
| TOTAL DESIGN COSTS | $ 3,659,603 | $10,193,139 | $ 13,852,742 |
| TOTAL D&C COSTS | $36,928,720 | $102,858,034 | $139,786,755 |

F.9 - Maintenance Costs

The cost of maintaining the transportation facilities can be signficant over a period of years. These costs are tabulated below based on Department of Transportation and Public Facilities average annual costs of $10,000 per month.

TABLE F-9.1
MAINTENANCE COSTS

| Plan | Section | Factor | Length | Annual Cost | Years Used | Total Cost |
|---|---|---|---|---|---|---|
| 1 | B-1 | 1.0 | 13.26 | $132,600 | 15 | $1,989,000 |
| | B-2 | 1.2 | 12.31 | 147,720 | 15 | 2,215,800 |
| | B-3 | 1.3 | 36.46 | 473,980 | 8 | 3,791,840 |
| | | | | | | $7,996,640 |
| 2 | R-1 | 0.5 | 16.29 | 81,450 | 15 | $1,221,750 |
| | R-2 | 0.7 | 41.57 | 290,990 | 8 | 2,327,920 |
| | | | | | | $3,549,670 |
| 3 | B-1 | 1.0 | 13.26 | 132,600 | 7 | $ 928,200 |
| | B-2 | 1.2 | 12.31 | 147,720 | 7 | 1,034,040 |
| | C | 0.8 | 44.32 | 354,560 | 8 | 2,836,480 |
| | Denali Hwy. | 0.8 | 21.00 | 168,000 | 8 | 1,344,000 |
| | | | | | | $6,142,720 |
| 4 | C | 0.8 | 44.32 | 354,560 | 8 | $2,836,480 |
| | Denali Hwy. | 0.8 | 21.00 | 168,000 | 8 | 1,344,000 |
| | R-1 | 0.5 | 16.29 | 81,450 | 7 | 570,150 |
| | | | | | | $4,750,630 |
| 5 | B-1 | 1.0 | 13.26 | 132,600 | 15 | $1,989,000 |
| | B-2 | 1.2 | 12.31 | 147,720 | 15 | 2,215,800 |
| | A-2 | 1.0 | 41.25 | 412,500 | 8 | 3,300,000 |
| | | | | | | $7,504,800 |
| 6 | C | 0.8 | 44.32 | 354,560 | 8 | $2,836,480 |
| | Denali Hwy. | 0.8 | 21.00 | 168,000 | 8 | 1,344,000 |
| | R-1 | 0.5 | 16.29 | 81,450 | 7 | 570,150 |
| | A-2 | 1.0 | 41.25 | 412,500 | 7 | 2,887,500 |
| | | | | | | $7,638,130 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7 | C | 0.8 | 44.32 | 354,560 | 8 | $2,836,480 |
| | Denali Hwy. | 0.8 | 21.00 | 168,000 | 8 | 1,334,000 |
| | B-1 | 1.0 | 13.26 | 132,600 | 7 | 928,200 |
| | B-2 | 1.2 | 12.31 | 147,720 | 7 | 1,034,040 |
| | A-2 | 1.0 | 41.25 | 412,500 | 7 | 2,887,500 |
| | | | | | | $9,030,220 |
| 8 | B-2 | 1.2 | 12.31 | 147,720 | 15 | $2,215,800 |
| | A-2 | 1.0 | 41.25 | 412,500 | 7 | 2,887,500 |
| | | | | | | $5,103,300 |

F.10 - Logistics Costs

The logistic costs are the costs directly associated with movement of freight. Table F.10-1 tabulates the railroad costs associated with Watana. Table F.10-2 tabulates the railroad costs associates with Devil Canyon. Table F.10-3 tabulates the truck haul costs for both dams. Table F.10-4 shows the combined logistic costs for all plans.

# WATANA LOGISTIC BREAKDOWN

Table F-10.1

| | | Rail Barge Whittier | | Container Barge (Anchorage) | | Rail Road | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tons | Cost $/ton | Cost | Cost $/ton | Cost | Cost $/ton Mi. | 62 Mi. Whittier to Anchorage | 149 Mi. Anchorage to Gold Creek | 16 Mi. Gold Creek to Devil Canyon | 42 Mi. Devil Canyon to Watana | 56 Mi. Gold Creek to Cantwell |
| Const. Equimpment | 16,000 | 120.00 | $ 1,920,000 | - | - | 0.1878 | 186,298 | 447,715 | 48,077 | 126,202 | 168,269 |
| Explosives | 20,000 | 55.00 | 1,100,000 | - | - | 0.6267 | 777,108 | 1,867,566 | 200,544 | 526,428 | 701,904 |
| Cement | 350,000 | 55.00 | 19,250,000 | - | - | 0.1565 | 3,396,050 | 8,161,475 | 876,400 | 2,300,550 | 3,067,400 |
| Rein. Steel | 33,000 | 55.00 | 1,815,000 | - | - | 0.2577 | 527,254 | 1,267,111 | 136,066 | 357,172 | 476,230 |
| Rock Bolts | 12,500 | 55.00 | 687,500 | - | - | 0.2577 | 199,718 | 479,966 | 51,540 | 135,293 | 180,390 |
| Steel Support | 3,600 | 55.00 | 198,000 | - | - | 0.2577 | 57,519 | 138,230 | 14,843 | 38,964 | 51,952 |
| Mics., str., elc. equip. | 15,000 | 55.00 | 825,000 | - | - | 0.1262 | 117,366 | 282,057 | 30,288 | 79,506 | 106,008 |
| Constr. Fuel | 300,000 | 55.00 | 16,500,000 | - | - | 0.1450 | 2,697,000 | 6,481,500 | 696,000 | 1,827,000 | 2,436,000 |
| Camp Fuel | 51,000 | 55.00 | 2,805,000 | - | - | 0.1450 | 458,490 | 1,101,855 | 118,320 | 310,590 | 414,120 |
| Tires & Parts | 21,800 | - | - | 80.00 | 1,744,000 | 0.1878 | | 610,002 | 65,505 | 171,950 | 229,266 |
| Camp Supplies | 74,600 | - | - | 80.00 | 5,968,000 | 0.1262 | | 1,402,763 | 150,632 | 395,410 | 527,213 |
| Village | 1,400 | - | - | 80.00 | 112,000 | 0.1262 | | 26,325 | 2,827 | 7,421 | 9,894 |
| Contingency & Misc. | 196,600 | - | - | 80.00 | 15,728,000 | 0.1262 | | 3,696,827 | 396,975 | 1,042,059 | 1,389,412 |
| | 1,095,500 | | 45,100,500 | | 23,552,000 | | 8,416,803 | 25,963,392 | 2,788,017 | 7,318,545 | 9,758,058 |
| | | | 1 | | 2 | | 3 | 4 | 5 | 6 | 7 |

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DEVIL CANYON LOGISTIC BREAKDOWN

Table F10.2

| | | Rail Barge Whittier | | Container Barge (Anchorage) | | Rail Road | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tons | Cost $/ton | Cost | Cost $/ton | Cost | Cost $/ton Mi. | 62 Mi. Whittier to Anchorage | 149 Mi. Anchorage to Gold Creek | 16 Mi. Gold Creek to Devil Canyon |
| Const. Equimpment | 5,000 | 120.00 | $600,000 | - | - | .1878 | 58,218 | 139,911 | 15,024 |
| Explosive | 3,000 | 55.00 | 165,000 | - | - | .6267 | 116,566 | 280,135 | 30,082 |
| Cement | 650,000 | 55.00 | 35,750,000 | - | - | .1565 | 6,306,950 | 15,157,025 | 1,627,600 |
| Rein. Steel | 22,000 | 55.00 | 1,210,000 | - | - | .2577 | 351,503 | 844,741 | 90,710 |
| Rock Bolts | 3,000 | 55.00 | 165,000 | - | - | .2577 | 47,932 | 115,192 | 12,370 |
| Steel Support | 2,200 | 55.00 | 121,000 | - | - | .2577 | 35,150 | 84,474 | 9,071 |
| Mics., str., elc. equip. | 13,500 | 55.00 | 742,500 | - | - | .1262 | 105,629 | 253,851 | 27,259 |
| Constr. Fuel | 68,000 | 55.00 | 3,740,000 | - | - | .1450 | 611,320 | 1,469,140 | 157,760 |
| Camp Fuel | 30,000 | 55.00 | 1,650,000 | - | - | .1450 | 269,700 | 648,150 | 69,600 |
| Tires & Parts | 18,700 | - | - | 80.00 | 1,496,000 | .1878 | 0 | 523,267 | 59,190 |
| Camp Supplies | 44,000 | - | - | 80.00 | 3,520,000 | .1262 | 0 | 827,367 | 88,845 |
| Village | 1,300 | - | - | 80.00 | 104,000 | .1262 | 0 | 24,445 | 2,625 |
| Contingency & Misc. | 205,900 | - | - | 80.00 | 16,472,000 | .1262 | 0 | 3,871,702 | 415,753 |
| | 1,066,600 | | $44,143,500 | | $21,592,000 | | 7,902,968 | 24,239,400 | 2,602,889 |
| | | | 8 | | 9 | | 10 | 11 | 12 |

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## ROAD HAUL SEGMENT COSTS

F.10-3

| Item | Tons | $/ton Mi. Rate | Gold Creek to Devil Canyon 12 Mi. (B-2) | Devil Canyon to Watana 36 Mi. (B-3) | Cantwell to Watana 65 Mi. | Devil Canyon to Watana 41 Mi. North |
|---|---|---|---|---|---|---|
| All Watana | 1,095,500 | .2069 | 2,719,907 | 8,159,722 | 14,732,832 | 9,293,017 |
| | | | 15 | 16 | 17 | 18 |
| All Devil | 1,066,600 | .2069 | 2,648,154 | | | |
| | | | 19 | | | |

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# LOGISTICS TOTALS

Table F.10-4

| | | |
|---|---|---|
| Plan 1: | Use: Water: 1, 2, 8, 9 | $134,388,000 |
| | Rail to Gold Creek : 3, 4, 10, 11 | 66,522,563 |
| | Truck to Dams: 15, 16, 19 | 13,527,783 |
| | TOTAL | $214,438,346 |
| Plan 2: | Use: Water: 1, 2, 8, 9 | $134,388,000 |
| | Rail to Gold Creek: 3, 4, 10, 11 | 66,522,563 |
| | Rail to Dams: 12, 5, 6 | 12,709,451 |
| | TOTAL | $213,620,014 |
| Plan 3 & 7: | Use: Water: 1, 2, 8, 9 | $134,388,000 |
| | Rail to Gold Creek: 3, 4, 10, 11 | 66,523,563 |
| | Rail to Cantwell: 7 | 9,758,058 |
| | Truck to Watana from Cantwell: 17 | 14,732,832 |
| | Truck to Devil Canyon via Gold Creek: | 2,648,154 |
| | TOTAL | $228,050,607 |
| Plan 4 & 6: | Use: Water: 1, 2, 8, 9 | $134,388,000 |
| | Rail to Gold Creek: 3, 4, 10, 11 | 66,522,563 |
| | Rail to Cantwell: 7 | 9,758,058 |
| | Rail to Devil 12 | 2,602,889 |
| | Truck to Watana from Cantwell 17 | 14,732,832 |
| | TOTAL | $228,004,342 |
| Plan 5 & 8: | Use: Water: 1, 2, 8, 9 | $134,388,000 |
| | Rail to Gold Creek: 3, 4, 10, 11 | 66,522,563 |
| | Truck to Devil Canyon: 15, 19 | 5,368,061 |
| | Northside Truck to Watana 18 | 9,293,017 |
| | TOTAL | $215,571,641 |