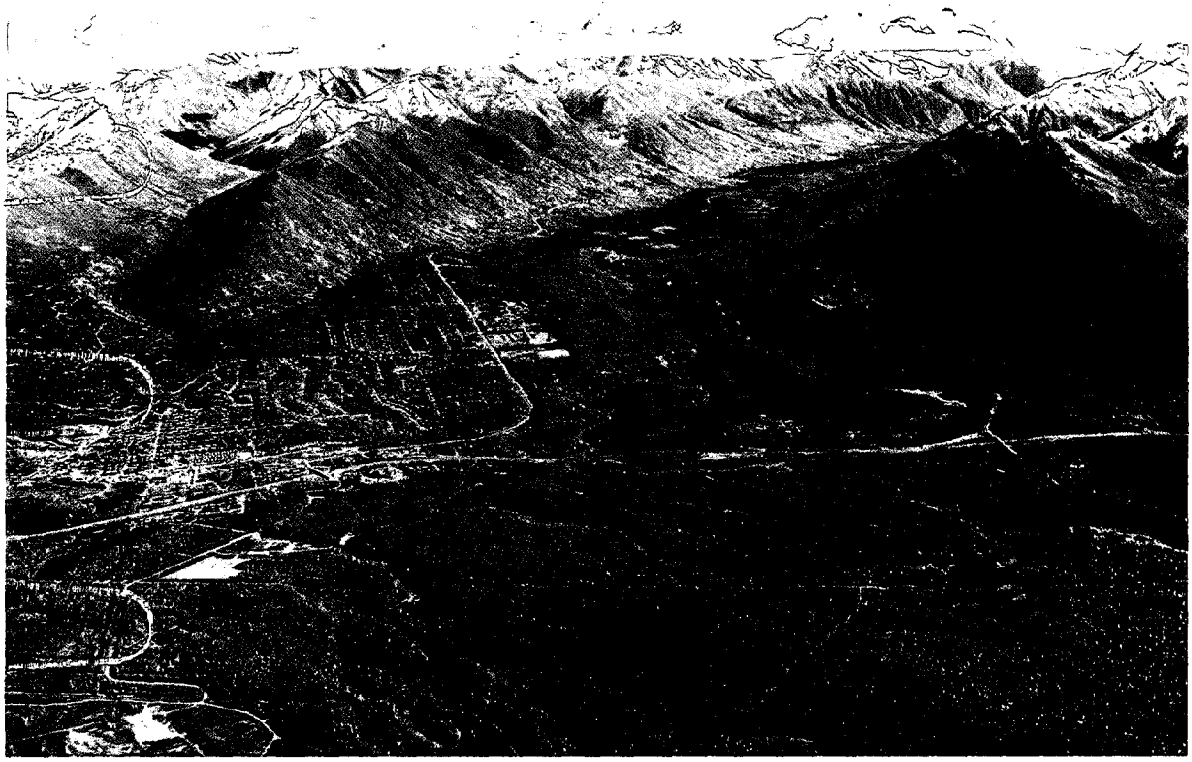
TASK 4
TRANSMISSION MAIN DESIGN

Appendix

IV

Eagle River Water Resource Study



Municipality of Anchorage
Water and Sewer Utilities

CH2M HILL

December 1981

TASK 4
TRANSMISSION MAIN DESIGN

Appendix

IV

Eagle River Water Resource Study

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Water and Sewer Utilities

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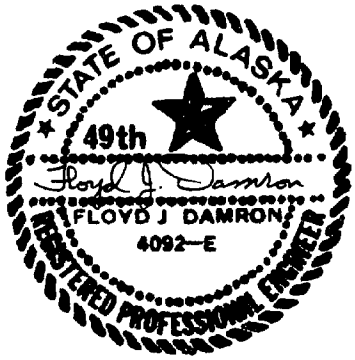

This report was prepared under the supervision of a registered professional engineer.

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PREFACE

To pursue the recommendations for further study that were prescribed in the Metropolitan Anchorage Urban Study, completed by the U.S. Corps of Engineers in 1979, the Municipality of Anchorage engaged CH2M HILL to conduct the Eagle River Water Resource Study. The purpose of the study is to investigate the potential sources of water supply from the Eagle River Valley. The original scope of the work comprised four tasks:

Task 1	Well Drilling Program
Task 2	Preliminary Damsite Investigation
Task 3	Flour Water Treatment Study
Task 4	Transmission Main Design

Task 5, Eklutna Lake Alternative Water Source Evaluation, was added to the scope after the completion of the first four tasks.

The report for each task is bound separately as an appendix to the Executive Summary of the entire study. This Appendix IV is the report for Task 4, Transmission Main Design.

ACKNOWLEDGMENTS

CH2M HILL would like to express its appreciation to the Anchorage Water and Sewer Utilities staff for their assistance throughout this project. They provided input at weekly meetings, updated the scopes of tasks, and provided general administrative assistance.

The following provided invaluable assistance throughout the project:

- Alaska Department of Environmental Conservation
- Alaska Department of Transportation and Public Facilities
- Chugach Electric Association
- Habitat Protection, Alaska Department of Fish and Game
- Anchorage Municipal Light and Power
- Alaska Gas and Service Company
- U.S. Bureau of Land Management, Anchorage District Office
- Facilities Engineering, Fort Richardson, Alaska, HQ 172nd Infantry Brigade
- Harding-Lawson Associates
- Air Photo Tech, Inc.
- Lounsbury & Associates
- Eklutna, Inc., for providing ready access to its property and pertinent input at weekly meetings

SUMMARY AND CONCLUSIONS

The objective of Task 4 of the Eagle River Water Resource Study was to prepare the preliminary design for the proposed water transmission main from the Eagle River to the Municipal Water Treatment Plant. During the preliminary design of the Task 4 transmission main, it was not known if the final source of water would be groundwater or surface water.

The standards used in the preliminary design are in accordance with commonly accepted standards for the design of large-diameter pipelines located in cold climates. These standards served as a basis for the formulation of alternative pipeline alignments and for the preparation of cost estimates. The accompanying table lists the representative criteria.

DESIGN CRITERIA

Design Capacity	57.8 mgd[a]
Pipe Size	48-inch-diameter
External Loads	
Depth of Cover	7 feet for most areas
Backfill	Determined by "Marston Load Theory"
Live Loads	Standard H-20 wheel load except where greater loads are anticipated
Thrust Restraint	Thrust blocks or restraining joints
Rights-of-Way	
Construction (temporary)	Approximately 100 feet
Operation and Maintenance (permanent)	Approximately 20 to 25 feet

[a] A total of 70 mgd would be diverted from the Eagle River, 12.2 mgd for the pipeline that will divert flows north to the Eagle River-Chugiak-Eklutna area and 57.8 mgd to the Anchorage Bowl. The transmission main for the communities north of Eagle River was not designed as a part of Task 4.

Three separate pipeline alignments were formulated and evaluated:

Alternative 1 Glenn Highway Alignment

Alternative 2 Eklutna Powerline-Glenn Highway Alignment

Alternative 3 Alaska Railroad Alignment

Alternative 3, Alaska Railroad alignment, was eliminated during initial screening because of high construction costs, environmental constraints, and the potential difficulties associated with its implementation. Following a more detailed review of Alternatives 1 and 2, Alternative 1 was selected as being the most cost-effective and the easier to implement.

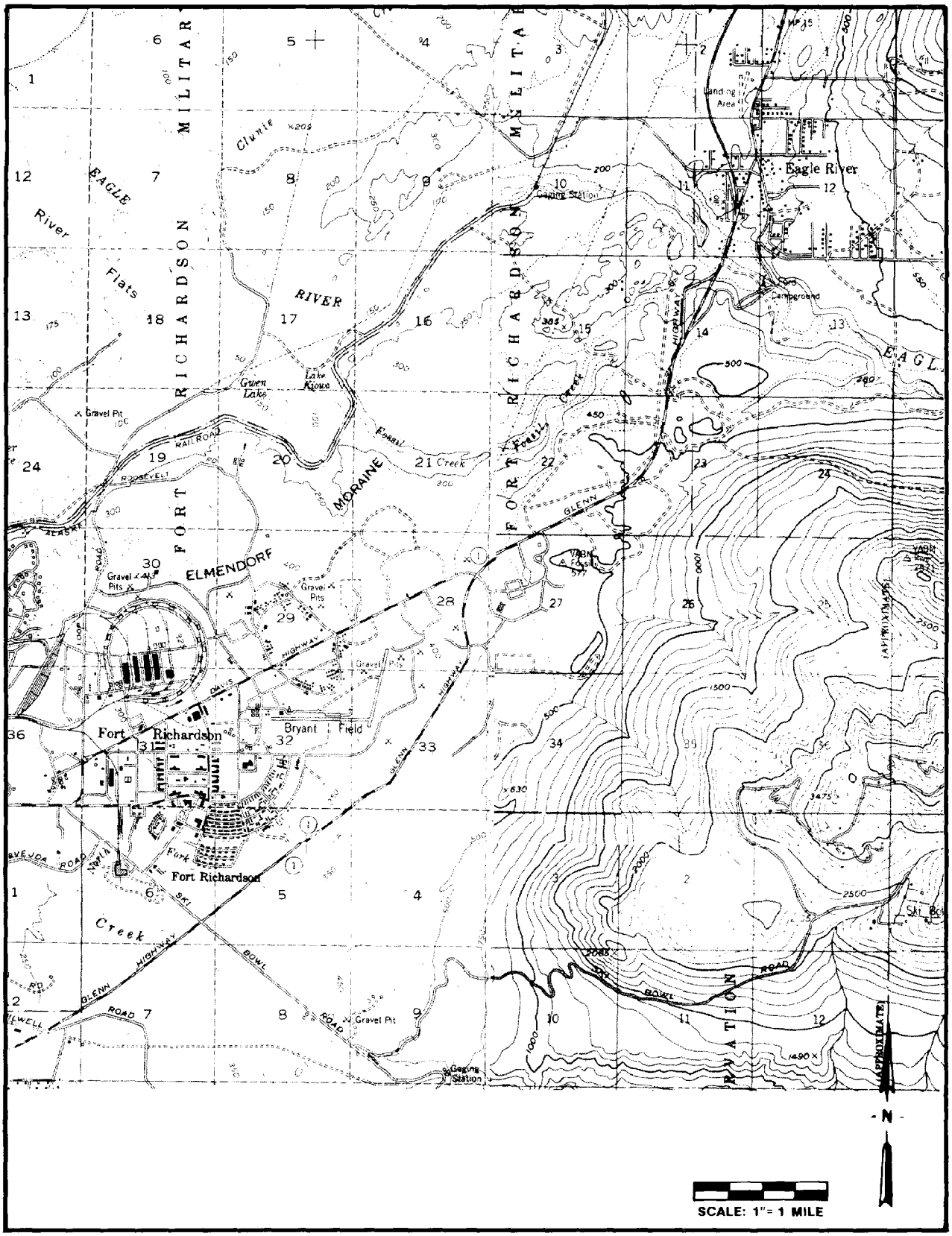
The soils along the selected Alternative 1 alignment were tested at the depths at which pipe would be laid. These tests measured the soils' corrosion-causing potential on the three types of pipe material that appear most practical for the project: ductile iron, concrete cylinder, and welded steel. The soils were found to be relatively noncorrosive to metallic pipe materials. Cathodic protection is probably unnecessary for pipe coated with material such as coal tar epoxy, coal tar enamel, or cement mortar or concrete.

Fifteen test pits along the selected pipeline alignment were excavated with a backhoe during field tests. The soils were visually classified, and pocket penetrometer tests were made on selected strata in the test pit side walls. In addition to field testing, the geotechnical study included an analysis of seismic-induced loading and displacement effects on the pipeline, dewatering requirements, and sloping and/or temporary shoring requirements of the excavated trench wall.

During the preliminary design process, the Municipality of Anchorage; Eklutna, Inc.; the U.S. Army; and the State of Alaska Department of Transportation reviewed the selected pipeline alignment. Based on this review and additional engineering data from the corrosion and geotechnical studies, the alignment was partially modified.

The selected alignment, incorporating the modifications, is depicted in the accompanying figure. The alignment parallels Glenn Highway for the majority of the route and will require about 41,000 linear feet of 48-inch-diameter pipe and 1,200 linear feet of 30-inch-diameter pipe to convey the water from the Eagle River to the Municipality's existing water treatment plant.

The selected project will require one stream crossing as well as encroachments into existing easements and rights-of-way. Agencies that will require permits prior to construction are documented in this report.



Modified Alternative 1 Alignment

The preliminary cost estimate for the construction of the project is $19,959,000, including engineering, legal, and administrative costs and allowances for contingencies. The cost estimate is based on November 1981 dollars and is intended only as an order-of-magnitude estimate, with an expected accuracy of +50 to -30 percent.

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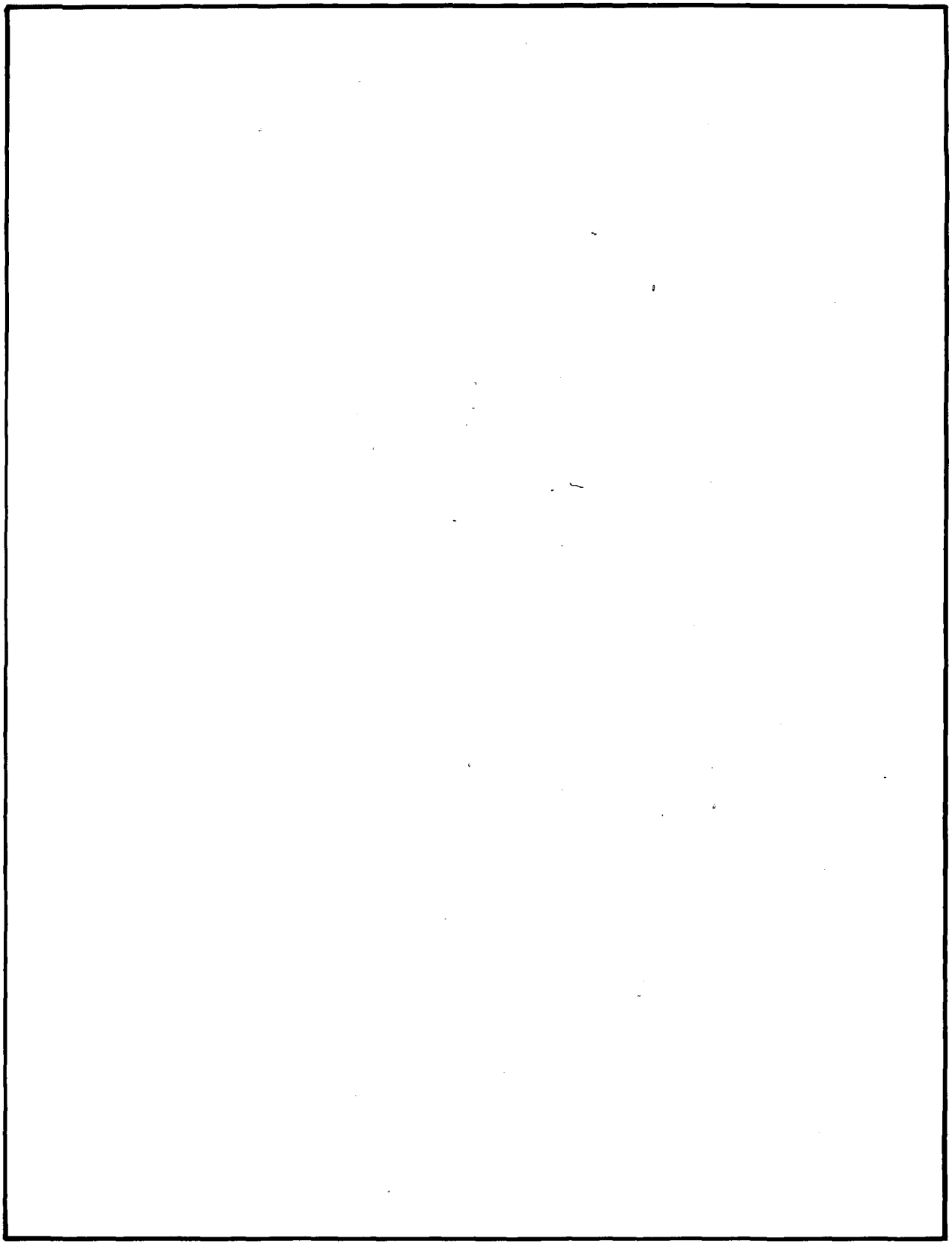


Part I
Alternative Pipeline Alignments

Chapter 1
INTRODUCTION

BACKGROUND

The population and, thus, the water supply needs of the metropolitan Anchorage area are rapidly growing. Presently, water to Anchorage is principally supplied by surface water from Ship Creek and by groundwater wells in the Anchorage Bowl. However, if present growth trends continue, these sources will not meet future needs.

In 1974 the United States Congress authorized the U.S. Army Corps of Engineers to perform the Metropolitan Anchorage Urban Study (MAUS), which was completed in 1979. The purpose of the MAUS was "to evaluate the adequacy of the developed water supply in the metropolitan Anchorage area, to determine future water demands, to assess sources for water supply development, and to formulate water supply plans to meet the increased future demand" (U.S. Army Corps of Engineers, 1979). The MAUS study area comprised the Anchorage Bowl and the area northeast to the town of Eklutna (Figure 1-1).

The projected future water demand increases, determined in the MAUS, are shown in Figure 1-2. It is expected that by the year 2025 an additional 81.5 million gallons per day (mgd) of water will be needed to meet the increased demands in the area.

The MAUS report identified many potential sources of supply: Eagle River Valley groundwater; Anchorage Bowl groundwater; and surface water from Campbell Creek, Ship Creek, Eagle River, and Eklutna Lake. Two plans were recommended by MAUS for future study. Plan IV, which ranked first environmentally and socially, included a combination of supply from Ship Creek, Anchorage Bowl groundwater, and Eklutna Lake. Plan VI, which ranked first on an economic basis, included an increased supply from Ship Creek, winter diversion from Eagle River, further development of Anchorage Bowl groundwater, and exploration for Eagle River Valley groundwater.

To increase the existing water supply sources within the Anchorage Bowl, the Municipality recently constructed a 36-inch supply main to its water treatment plant from the military diversion facility on Ship Creek. Other developments are expected to include new wells to increase groundwater supply and the expansion of the Municipal Water Treatment Plant facilities. However, rapidly growing demands in Anchorage require development of a new source outside the Anchorage Bowl within the next 10 years. The Eagle River-Chugiak-Eklutna area, northeast of Anchorage, needs a new source now.

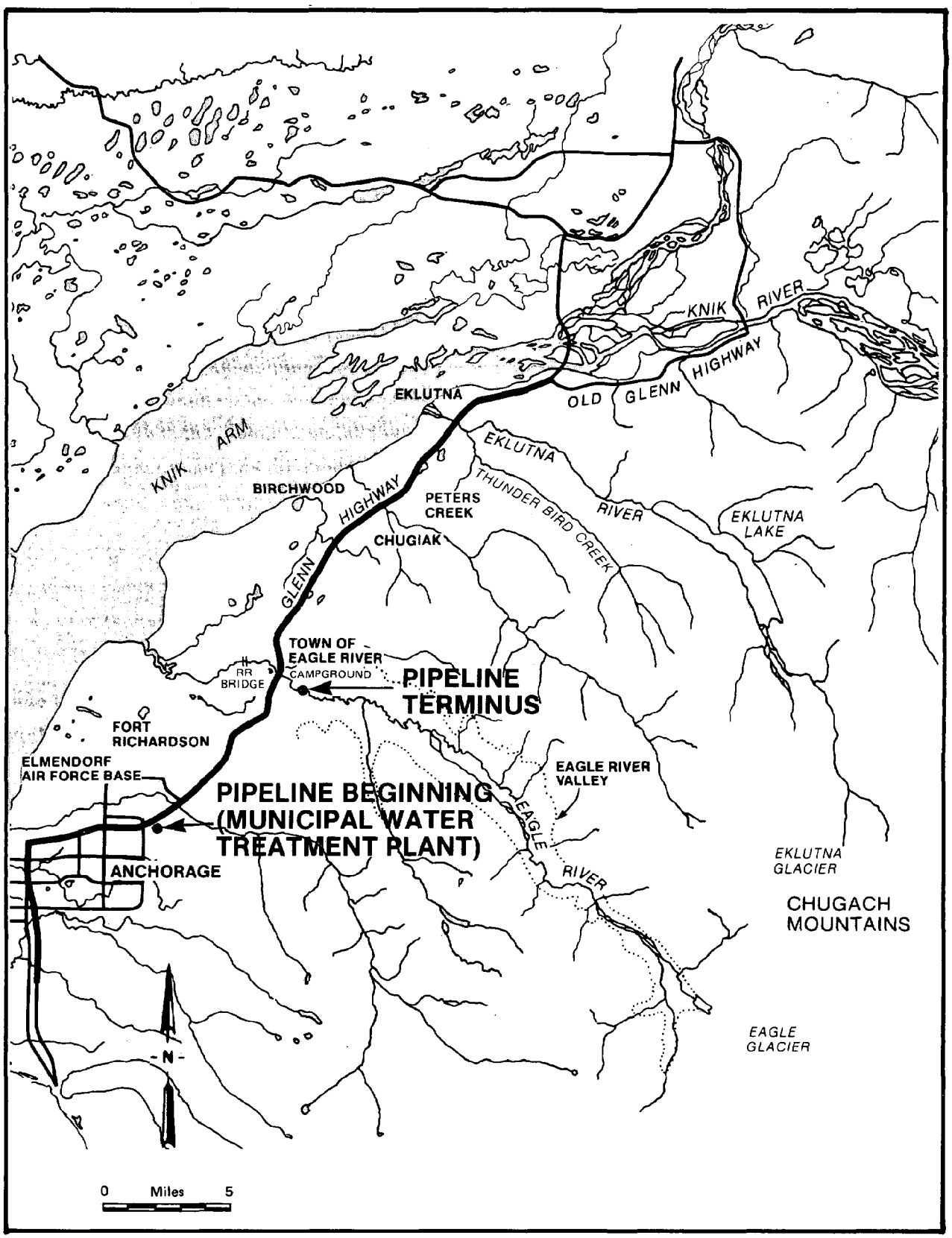
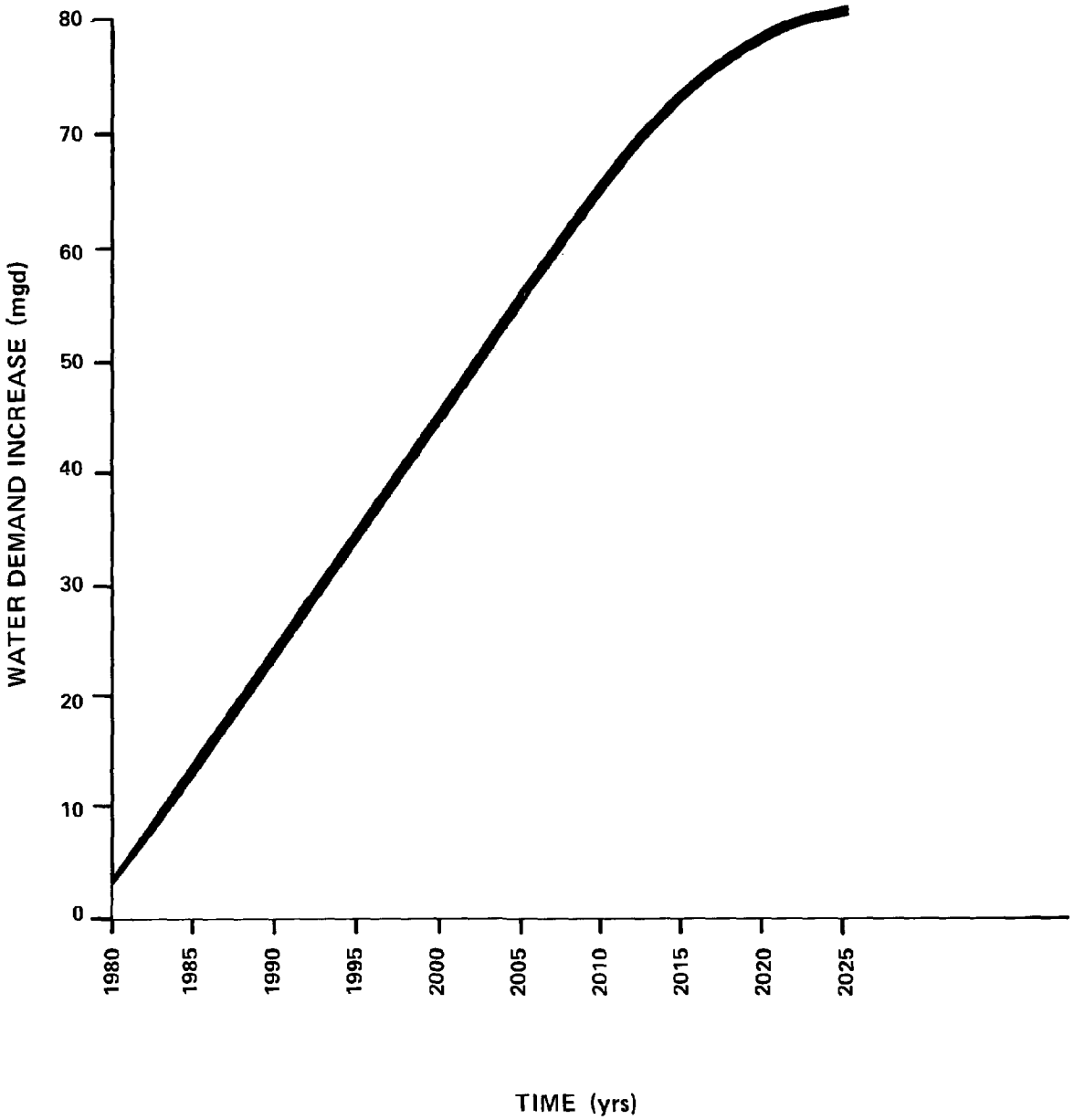


Figure 1-1
Vicinity Map



NOTE: Increase Based on 1977 Total Demand.

SOURCE: U.S. Corps of Engineers. 1979.

Figure 1-2
Projected Water Demand Increase 1980-2025

As a result of the MAUS findings, the Municipality decided to investigate potential sources outside the Anchorage Bowl that could supply 70 mgd of water. On the basis of the MAUS population projection, this diversion would satisfy the demands of the entire study area through the year 2012. The increases in water supply capacity that are expected to be developed within the Anchorage Bowl will delay the need for the full 70-mgd capacity of the new water source outside the Bowl until approximately the year 2020 or longer.

To investigate possible sources of water supply outside the Anchorage Bowl, the Municipality engaged CH2M HILL to conduct the Eagle River Water Resource Study. This original scope of the study comprised four separate tasks to investigate the Eagle River Valley as a potential source of municipal and industrial water supply:

- Task 1, a well drilling program to study the feasibility of developing the Eagle River Valley as a groundwater source
- Task 2, a preliminary damsite investigation to determine the feasibility of developing the Eagle River as a surface water source
- Task 3 was a study to determine if glacial rock flour in the Eagle River water could be easily removed
- Task 4, a preliminary design of a pipeline to transport groundwater or surface water from the Eagle River Valley to Anchorage

Each task was conducted independently.

The results of the first four tasks clearly indicate that a substantial dam and reservoir are required to develop Eagle River as a water source. Before committing itself to this dam and reservoir project, the Municipality of Anchorage increased the study scope to include Task 5, Eklutna Lake Alternative Water Source Evaluation. Task 5 analyzed the capability of Eklutna Lake to supply the 70 mgd of water to the area. The lake is 30 miles northeast of downtown Anchorage and 16 miles northeast of the Eagle River (Figure 1-1).

The report of each task appears as an appendix to the Executive Summary of the entire study. This Appendix IV is the report for Task 4, Transmission Main Design.

PURPOSE AND SCOPE

The objective of Task 4 was to prepare the preliminary design for the proposed water transmission main from the Eagle River to the Municipal Water Treatment Plant.

The total scope of work for Task 4, in accordance with the Municipality of Anchorage's contract for professional services with CH2M HILL, is to prepare the following:

- o Predesign plans showing alternative pipeline alignments
- o Design criteria
- o Soils analyses
- o Corrosion analyses
- o Environmental assessments
- o Alternative materials evaluation
- o Preliminary technical specifications
- o Preliminary design drawings
- o Cost estimate
- o Additional information that may be requested by the Municipality
- o Conclusions and recommendations

The purpose of the preliminary design report, the preliminary plans, and the technical specifications is to establish design criteria and resolve major questions pertaining to design concepts. This effort represents approximately 30 to 40 percent of the design effort required to prepare construction contract documents. The remaining 60 to 70 percent of the design should be accomplished during the final design phase.

The scope does not include the design of a transmission main to the communities north of the Eagle River.

Appendix II, the report for Task 2, Preliminary Damsite Investigation, contains an assessment of the area's environment. This report for Task 4 addresses all the other items in the scope of work, concluding with a discussion of the permit acquisition process and recommendations for final design work. The contents of the report will provide the basis for the preparation of final contract documents, which is not a part of this scope of work.

SITE DESCRIPTION

The pipeline was designed to receive water at a proposed pump station (Appendix II, Preliminary Damsite Investigation) approximately 1 mile upstream of the Eagle River Campground (Figure 1-1). The 8 miles between this point and the Municipal Water

Treatment Plant is occupied by Fort Richardson (6.5 miles) and land owned by Eklutna, Inc., (1.5 miles).

That section of the pipeline located on Fort Richardson would follow existing roads and utility rights-of-way, where possible, to minimize the impacts to the environment. Although the area is heavily wooded with spruce and aspen and is spotted with marshy areas, most of the alignment avoids excessive clearing and disturbance to the marshes. North of Fort Richardson to the Eagle River the pipeline alignment follows a jeep trail immediately east of the old Eagle River dump. In order to provide sufficient work area, some clearing of this heavily wooded area would be required.

The selected route avoids railroad, stream, and major road crossings, except it does cross Ship Creek. Special construction methods would be used to minimize the impacts to the creek.

Typically, the selected alignment crosses deep unconsolidated deposits of glacial and alluvial surficial soils. In a few isolated areas, bedrock may exist at or near the ground surface. Near Hiland Drive, the pipeline crosses the Knik Fault Zone. The Knik Fault Zone was probably the site of major crustal activity in the past; it is not known to have exhibited movement recently (within the past ±10,000 years).

LIMITATIONS

This report has been prepared for the use of the Anchorage Water and Sewer Utility for specific application to the Eagle River Water Resource Study, Transmission Main Design, in accordance with generally accepted engineering practices. No other warranty, expressed or implied, is made. In the event of any changes to the conditions considered under this study, the conclusions and recommendations contained in this report will not be considered valid unless the changes are reviewed and the conclusions or recommendations are modified or verified in writing by CH2M HILL.

Numerous supply options are possible, each of which may affect the alignment of sections of the proposed pipeline. The preliminary design was limited by the following assumptions:

- The transmission main design will begin at the existing Municipal Water Treatment Plant, near Oilwell Road
- The transmission main design will terminate at the south side of the Eagle River, approximately 1.4 miles upstream of Glenn Highway
- Horizontal alignments between the water treatment plant and the Eagle River will generally follow the highway and existing utility rights-of-way to reduce environmental impacts

Chapter 2
DESIGN CRITERIA AND CONSIDERATIONS

The preliminary design of the water transmission pipeline was prepared using commonly accepted standards for the design of large-diameter pressure pipelines located in cold climates. The purpose of this chapter is to identify those standards and to discuss their application to specific project conditions.

Many variables were unknown during the preparation of the design criteria, such as the source of supply, the location of the treatment and storage facilities, the requirements for connecting to the Municipality's distribution system, and the method of and location of facilities for pumping. For the purpose of preparing the design criteria, certain assumptions were made. These assumptions are mentioned in the sections pertaining to specific criteria.

HYDRAULICS

Projected Study Area Water Demands

The MAUS study concluded that the Anchorage Bowl and Eagle River area would need 81.5 million gallons per day (mgd) more water in the year 2025 than in 1977. Potential sources of this additional supply have been identified as groundwater from either the Anchorage Bowl or the Eagle River Valley and surface water from Campbell Creek, Ship Creek, Eagle River, and Eklutna Lake. These sources would be transported to the Anchorage Bowl and the Eagle River-Chugiak-Eklutna area. Table 2-1 summarizes the increased demands and shows the effect of these variables on the demands.

Table 2-1
PROJECTED STUDY AREA
WATER DEMAND INCREASE

Area	Demand Increase Over 1977 (mgd)				
	1990	2000	2010	2020	2025
Entire Water Study Area[a]	23.4	45.4	66.5	79.4	81.5
Anchorage Bowl Only	20.9	38.6	55.2	65.3	66.9
Eagle River-Chugiak-Eklutna	2.5	6.8	11.3	14.1	14.6

[a]MAUS, Volume 2, Water Supply. 1979.

Design Flows

The scope of work developed by the Municipality of Anchorage for Task 2, Preliminary Damsite Investigation, requires a water diversion from Eagle River of 70 mgd. At a meeting in October 1980, representatives from the U.S. Army Corps of Engineers, CH2M HILL, and the Municipality of Anchorage decided that a portion of this flow would be diverted north to the Eagle River-Chugiak-Eklutna area and the remainder of the flow south to the Anchorage Bowl area. This Task 4 considers only the pipeline to the Anchorage Bowl.

The conservative assumption was made that no additional groundwater would be developed in the Anchorage Bowl and that the increased water demand would be proportioned between the Anchorage Bowl and the Eagle River-Chugiak-Eklutna area based on population projects. With these assumptions and the water demand projections in Table 2-1, a diversion of 70 mgd would satisfy the entire study area water demand through the year 2012, approximately. The Eagle River-Chugiak-Eklutna area would represent approximately 12.2 mgd, 17.5 percent of the total study area demand. Thus, approximately 57.8 mgd would be diverted south to Anchorage and 12.2 mgd north. If additional supplies are developed from either groundwater or surface sources, a 57.8-mgd-capacity pipeline may have the capacity to serve the Anchorage Bowl area to the year 2025.

According to the MAUS report, water would be delivered from the Eagle River only during the winter months until 1992. It is assumed that this winter flow would be treated at the existing Municipal Water Treatment Plant. After 1992, water from the Eagle River would be needed by the Municipality of Anchorage on a year-round basis. Also, it is assumed that this supply, which would include Eagle River "flour" water during the summer months, would be treated in the Eagle River area and would then be transported south to Anchorage and north to the Eagle River-Chugiak-Eklutna area.

Therefore, the preliminary design capacity of the pipeline would be 57.8 mgd from the Eagle River to the vicinity of the Municipal Water Treatment Plant. A lower-capacity pipeline would connect this line to the Municipal Water Treatment Plant to carry the pre-1992 flows. After 1992, this reach of pipe may not be necessary except for emergency use, and, possibly, a new reach of pipe would lead directly to the Anchorage distribution system. Summertime diversions from Eagle River would require extensive treatment for sediment and flour removal before being piped to the distribution system (Appendix III, Flour Water Treatment Study).

Based on the design flow of 57.8 mgd, pipe diameters in the range of 48 to 54 inches were considered when discussing other design criteria.

Design Velocities

Raw water from Eagle River, transported to the existing water treatment plant until 1992, would contain settleable solids. To avoid sediment buildup in the pipeline, a minimum self-cleaning velocity of 2 feet per second is desirable. To obtain this velocity, a flow of 16 mgd in a 48-inch-diameter pipe is necessary, and a flow of 20.5 mgd in a 54-inch-diameter pipe. For sediment control, we recommend a 48-inch-diameter pipe. Frequent cleaning of the pipeline may be required until the area reaches a 16-mgd demand.

High velocities can cause excessive head loss, damaged pipe linings, and severe water hammer problems. Therefore, the maximum velocities through the pipeline should be limited to 7 to 10 feet per second.

Depending on the selected pipeline alignment, water either will be pumped the entire distance from Eagle River to Anchorage or be pumped part of the way, with flow by gravity the remainder of the distance.

Commonly, design velocities ranging from 5 to 7 feet per second are considered to be economical for force-main-type pipelines. The economical pipeline size for pumped water must be determined by comparing the present worth of future power cost savings to the cost of installing a larger pipe. A larger pipe will reduce friction losses and consume less power to pump the water.

Based on the above criteria, a 48- or 54-inch-diameter pipe appears to be the most cost-effective for a pumped flow of 57.8 mgd. Once the final alignment and pipe material have been selected, the analysis of pipe size or combinations of pipe size can be refined.

Design Pressures

Design pressures will vary depending on the pipeline route selected, the location of the water source, and the hydraulic characteristics of the system. Unless a high dam is constructed or the dam is located considerably farther upstream than discussed in MAUS, the water will have to be pumped to the Municipality of Anchorage. The selected alignment and point of delivery will determine if the water must be pumped its entire length or whether it may be pumped to a midpoint, with sufficient head to flow the remaining distance by gravity.

The pipeline will be subjected primarily to static pressure, pressure necessary to overcome friction losses, and surge pressures. The static pressure is related to the differences in elevation between a point on the pipeline and the hydraulic gradeline at no-flow conditions. The pressure necessary to overcome friction is

the head that must be added to the water to make it flow through the pipeline. Surge pressures are caused by rapid changes in flow such as quick opening or closing of valves or by pump startup or shutdown without special control devices.

Friction Loss

The Hazen-Williams formula was used for the design of the transmission main:

$$Q = 1.318\ CR^{0.63}S^{0.54}A$$

where

Q = flow, in cfs (cubic feet per second)
C = roughness coefficient
R = hydraulic radius, feet
S = energy loss per foot of pipe
A = cross-sectional area, square feet

The roughness coefficient varies with the type and size of pipe material, the water velocity, and, particularly, the age of the pipe. Assuming a pipeline life of 40 to 50 years and that sediment removal within the pipeline will be provided, a roughness coefficient "C" of 120 should be used to size the pipeline. Initially, the "C" factor for the pipeline may be approximately 140 because the pipe will be clean and smooth.

Surge Analysis

Valve closure, pump shutdown, and pump startup cause transient pressure waves (water hammer or surges) in pipe systems. If not properly considered in the design by including a surge allowance, such operations can cause major damage to the system.

To select the required pipe strength or class for preliminary design purposes, a surge allowance of 50 psi is assumed. This surge allowance is selected on the basis of the assumption that surges will be controlled to 50 psi by the installation of surge tanks or other methods of surge control.

When the preliminary design is completed, including the pump station, surge tanks, and regulating reservoir, a computer analysis of surge conditions will be conducted to solve hydraulic transient problems.

STAGED CONSTRUCTION

The possibility of constructing two 36-inch-diameter, 29-mgd pipelines in two stages was considered. If additional groundwater is developed in the Anchorage Bowl, a 36-inch pipeline would meet the additional water supply needs of Anchorage until approximately the year 2000. At that time, a second pipeline could be

installed. The two pipelines would offer greater reliability and operational flexibility than a single pipeline. In addition, the useful life of half of the pipeline capacity could be extended by 20 years because of its later construction.

The advantages and disadvantages of staged construction were reviewed with the staff of the Municipality of Anchorage. Staged construction was eliminated from further study because of higher annual and capital costs and the potential difficulty in obtaining encroachment permits and rights-of-way for the construction of the second pipeline.

EXTERNAL LOADS AND RESTRAINTS

Depth of Cover

The depth at which the pipeline is installed will affect the amount of backfill load that will cover the pipeline. A deep pipeline is subjected to more backfill load than a shallow pipeline and, as a result, must be either stronger, installed in a higher class of bedding, or both.

The cover provides the pipe with its prime source of protection against freezing, unforeseen surface point loads, future construction activities, and unauthorized excavations. A standard practice in the Anchorage area is to install small-diameter water pipes at a depth of approximately 10 feet, providing a range of 7 to 10 feet of cover. This depth generally provides adequate protection against freezing. However, because the proposed pipeline will be in the range of 48 inches to 54 inches in diameter, 7 feet of cover would be adequate for normal conditions. This is consistent with the depth of the recent 36-inch pipeline installed near the existing water treatment plant. Special conditions, such as creek crossings and natural gas line crossings, may require insulation, extra cover, or both.

Backfill Loads

The Marston theory is the most commonly used method for calculating soil loads on pipelines. This theory and the formulas based on this theory were used to calculate the backfill loads for this pipeline. This includes formulas for calculating the loads on rigid pipes, flexible pipes, conduits in tunnels, and positive projecting conduits. ASCE Manuals and Reports on Engineering Practice No. 37 (WPCF Manual of Practice No. 9) is one of many sources for information on the Marston theory.

In the absence of more specific data on the properties of the local soils, it is recommended that a minimum of 125 pounds per cubic foot be used as the unit weight of soil and that a K_μ value of 0.110 be used in determining the cohesion coefficient (C_d) of overburden soil. Further geotechnical explorations may indicate

that less conservative values may be used, which will result in a more economical design. The cohesion coefficient can vary from zero for loose dry sand to 1,000 for hard clay. A determination of the soil type and its coefficient of cohesion must be made at each proposed tunnel location.

Live Loads

Unless it is known that live loads will not be allowed to pass over the pipeline, a live load allowance should be added to the backfill load prior to determining the required pipe strength. The usual live load that is considered in pipeline design is that imposed by H-20 truck wheel loadings. However, the proposed pipeline may be subjected to live loads from trains, military tanks, and other off-highway vehicles. At locations where loads greater than the standard H-20 truck wheel load may be imposed on the pipeline, the greater loads must be considered in the design.

It is recommended that the H-20 truck wheel load be used to determine pipe strength and necessary backfill at all other locations along the pipeline. It appears from discussions with the military that H-20 loading criteria will be adequate. During final design, the military should again be contacted to verify that loading conditions have not changed.

The value that is usually used for the concentrated load in the H-20 wheel loading is 16,000 pounds, which also meets local regulations. An effective length, L, of 3 feet should be used for all pipe sections longer than 3 feet.

Values for load coefficients and impact factors used to calculate live loads on the pipeline vary depending on certain parameters. These values are listed in various textbooks and handbooks, including ASCE Manuals-Report on Engineering Practice No. 37.

Allowable Loads

The ability of a pipe to perform satisfactorily under the load conditions to which it will be subjected depends on the pipe itself and on conditions surrounding the pipe.

The pipe materials considered for this project are ductile iron, concrete cylinder, and welded steel. These are flexible and semi-flexible pipes that derive at least part of their load-carrying ability from passive soil pressure (lateral support). Passive pressure is generated as the top of the pipe deflects downward, forcing the sides to move outward against the backfill material.

Two very important factors must be considered in this type of design: the amount of deflection at the top of the pipe that is tolerable or acceptable and the modulus of soil reaction, E', of the backfill material that surrounds the pipe.

The amount of deflection that is acceptable depends upon the type of pipe and the type of pipe lining. For cement mortar-lined ductile iron and welded steel pipe, a maximum deflection of 2-1/2 percent is recommended. The recommended maximum deflection for concrete cylinder pipe is 0.00025 times the square of the diameter.

Published values of E' vary from zero to 3,000. This factor is dependent upon properties of the initial backfill material, degree of compaction, trench conditions, and the native soil. Because these factors are difficult to determine accurately through laboratory testing, recommended values of E' for various bedding materials and compaction requirements must be determined by field studies or by experience and judgment. In addition, the design specifications must be compatible with the E' values selected. A more complete discussion of this subject can be found in an article by A. K. Howard titled "Modulus of Soil Reaction Values for Buried Flexible Pipe," published in the Journal of the Geotechnical Engineering Division, ASCE, Volume 103, No. GT1, January 1977, pp. 33-43. Usually, an E' value in the range of about 700 to 1,000 is selected.

Different methods for determining allowable pipe loads have been developed for each type of pipe. The methods to be used for this project can be found in the following design references.

Type of Pipe	Design Reference
Ductile Iron	AWWA Standard C-150, published by the American Water Works Association
Concrete Cylinder	A Method of Determining Permissible Earth Cover Loads on Concrete Cylinder Pipe, Ameron Engineering Library No. 1-1, published by Ameron Pipe Products Group
Welded Steel	Welded Steel Pipe, Steel Plate Engineering Data - Volume 3, published by American Iron and Steel Institute

Thrust Requirements

All pipe bends, deadends, junctions, size changes, closed valves, and other appurtenances will develop unbalanced thrust forces caused by static and dynamic pressures.

Unbalanced thrust forces can occur in either the horizontal plane, the vertical plane, or a combination of both.

Calculation of Thrust Forces

The horizontal thrust force on a bend caused by static pressures can be calculated from the formula:

$$T = 2\ PA \sin \frac{\theta}{2}$$

where:

T = resultant thrust force in pounds

P = operating pressure plus surge pressure or test pressure, whichever is greater in psi

A = pipe cross-sectional area in square inches

θ = angle of deflection at bend in degrees

The thrust force on a bend caused by dynamic pressures would be the result of the change in pressure as water travels around the bend. Normally, this force is small in comparison to that caused by static pressure.

The dynamic thrust forces generated at bends, size changes, partially closed valves, and other appurtenances can be determined by using the formulas for minor losses contained in such references as King and Braters' Handbook of Hydraulics. The static thrust forces can be determined through the laws of statics.

Thrust Restraint

To protect the system, unbalanced thrust forces must be counteracted through thrust restraint, which is achieved by using either thrust blocks or restraining joints.

Thrust blocks used for forces in the horizontal plane or for downward forces in the vertical plane are bearing blocks that depend upon the load bearing capacity of the surrounding soil. (Refer to Chapter 6, Geotechnical Exploration, for a discussion of allowable soil-bearing pressures.) Thrust blocks for upward forces in the vertical plane must be gravity-type blocks that resist the force strictly through the weight of the block itself.

The restrained-joint method involves tying joints together back to a point so that the unbalanced force is totally transmitted to the surrounding soil through friction and passive soil resistance.

Various references are available for the details on the methods of designing thrust restraint for either method. Pamphlets and data distributed by the Cast Iron Pipe Research Association deal quite thoroughly with this type of project.

Obstacles and severe changes in the right-of-way alignments will require fittings and proper thrust restraint. In such cases, the change in alignment should be made so that standard fittings can be used.

RIGHTS-OF-WAY

Construction Requirements

A sufficient working area must be provided to allow the contractor to install the pipeline in the most efficient manner possible. Enough space must be provided for the trench; storage for the excavated spoil, bedding material, pipe, and fittings; and room to efficiently move men and equipment during the excavation, pipe placing, and backfilling processes.

Figure 2-1 illustrates that the working area required to install a 48- to 54-inch-diameter pipe in a 12-foot-deep trench could easily amount to 90 to 100 feet in width. In the event that the pipe is to be installed at a greater depth, even more working area would be required.

It is recommended that a minimum of 100 feet be made available to the contractor for the installation of the pipeline. Special considerations should be given to areas such as creek crossings, utility crossings, bore pits, and areas where the trench depth will be greater than 10 to 12 feet.

The working space can be obtained as a permanent right-of-way or as a combination of permanent right-of-way and temporary easement.

Operation and Maintenance Requirements

After the pipeline is installed, access must be available for operation and maintenance purposes. In addition, it is desirable to have control of a strip of ground on each side of the pipeline to prevent encroachment of other facilities that might hinder future operation and maintenance work or that might otherwise endanger the pipeline.

A permanent right-of-way 25 feet wide would meet the needs of a single pipeline.

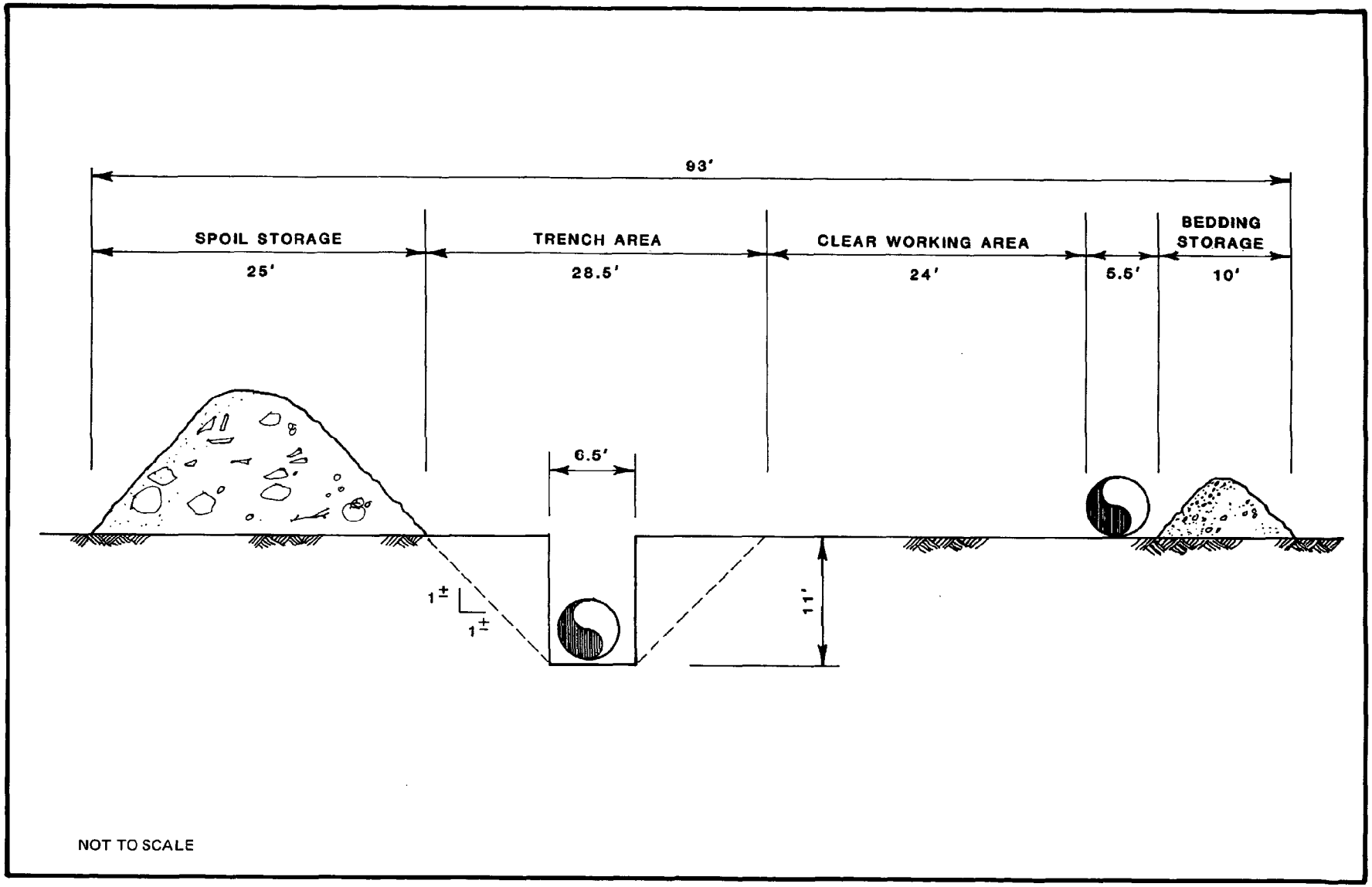


Figure 2-1
Construction Right-of-Way Requirements

ADDITIONAL DESIGN CONSIDERATIONS

Pipe Access

Manholes should be provided at convenient intervals to allow access during construction and during subsequent maintenance operations. Recommended minimum spacing is 2,500 feet. Also, at least one access manhole should be installed between any two adjacent isolation valves.

Isolation Valves

Isolation valves should be installed at intervals of approximately 1 mile to aid in the operation and maintenance of the pipeline. Isolation valves will allow partial draining of the pipe for maintenance purposes.

Air/Vacuum Valves

Air release and vacuum release valves must be installed at all summits, at all abrupt downward changes in grade, and at the downstream side of all isolation valves. These valves must be installed so they will operate at any time, even during the coldest winter. Thus, they must be protected and located in a controlled environment with ready access to large volumes of air.

Blowoff/Drain Valves

A blowoff/drain valve should be installed at all sag points and at other locations between isolation valves so that they can effectively drain the pipeline. Because sections of the main pipeline located in flat terrain will not be under pressure during draining operations, it may be necessary to design the blowoff assembly as the suction header for a portable pump. Gravity-type drains would be used in areas where the discharge or drain pipeline can be installed on a descending grade and daylighted into an existing drainage area.

A 1-mile section of 48-inch-diameter pipe has a volume of approximately 500,000 gallons. Because of the quantity of water that these valves can handle, they must be properly sized and located. A rough rule of thumb is to provide 2 inches of blowoff size for every foot of pipe diameter. The valves also must be located so that flooding or ponding problems will not be created when the pipeline is drained.

Hydrostatic Testing

The pipeline should be hydrostatically tested at the line pressure and at a fixed pressure for surge. Generally, this fixed pressure would vary from 50 to 100 psi. Normally, a water line would

be tested in short sections, 1,000 to 3,000 feet. Because mechanisms for testing a large-diameter pipeline with bulkhead can be extremely expensive and difficult to install, it is suggested that the pipeline be tested between the isolation valves, which are recommended to be at intervals of 1 mile.

Providing water for testing may be a problem, depending on the contractor's sequence of operation. An efficient construction procedure, from a standpoint of testing, would be to start construction at the existing water treatment plant and then to proceed north. Water is available with sufficient head to supply the entire length of the proposed alignment. The highest point on the preliminary designed pipeline is 20 feet below the surface of the Ship Creek reservoir.

Chapter 3
EVALUATION OF PIPELINE MATERIALS

This chapter discusses the various pipeline materials that might be available for this project, evaluates their applicability, and recommends one or more that are suitable.

EVALUATION PARAMETERS

A number of parameters usually are considered in the evaluation of various pipe materials. Although these parameters are associated primarily with conditions of service, they also include other considerations, such as availability. In this section, these parameters are discussed in relation to specific project requirements.

Flow Conditions

Under peak flow conditions, the majority of the pipeline will operate under a pressure of zero to 120 psi, not including surge pressures. It is assumed that a section of the pipeline normally will act as a gravity system, except when surge occurs. Therefore, including a controlled surge allowance of 50 psi, the design pressures will vary from 50 to 170 psi. Flow velocities at design conditions will be in the range of 5 to 7 feet per second.

Strength Requirements

The pipe must be able to provide reliable service under subarctic conditions and will be installed with a minimum of 7 feet of cover. However, depth of cover will vary and may be as great as 20 feet at isolated locations. In addition to carrying the backfill dead load, the pipeline must also be able to withstand the superimposed live load from at least an H-20 truck load. The internal pressure to which the pipeline will be subjected should not be used to reduce the strength requirements caused by external loads.

The pipe also must be able to withstand stresses induced by minor earth movements such as small to moderate earthquakes or frost heaving. The seismicity of the area dictates the following considerations:

- Short joint spacing, 10 to 20 feet in fault zone areas
- Joint type: bell and spigot
- Special provisions for connections to appurtenant structures

Handling Characteristics

The pipe material for this project might be manufactured a long distance from the construction site, be handled several times, and be stored in between handlings. The pipe material must be able to withstand this handling, shipping, and exposure to the elements.

Installation Requirements

The pipeline will be installed in a cold climate with a relatively short construction season. Therefore, it must be easy to assemble and install. Jointing procedures should not require highly specialized equipment or skills.

Estimated Cost

The cost of pipe material in any pipeline project can be a significant factor, but it is not the only factor that should be considered for material selection. Total installation cost plus operation and maintenance cost should be considered in evaluating alternative pipe materials.

AVAILABILITY

Several kinds of pipe materials are available for small-diameter pipelines. However, many, such as PVC and fiberglass reinforced pipe, are not available in the sizes required for this project. Other materials are very costly and do not provide any advantage in installation, operation and maintenance, or reliability.

After reviewing the kinds of pipe materials that are available, it was concluded that only four types of pipe should be given further consideration. They are ductile iron pipe, concrete cylinder pipe, welded steel pipe, and reinforced concrete pressure pipe.

Ductile iron pipe will conform to AWWA Standard C 151, with a cement mortar lining conforming to AWWA Standard C 104. The standard outside coating on ductile iron pipe is a bituminous coating approximately 1 mil thick. Ductile iron pipe is available in a number of thickness classes, and several types of restrained and unrestrained joints are available. The pipe is available in nominal lengths of 18 and 20 feet.

Concrete cylinder pipe will conform to AWWA Standard C 303. The pipe is available in various pressure classes. Joints are usually bell and spigot, with O-ring rubber gaskets. The pipe is available in 32-foot lengths.

Welded steel pipe will conform to AWWA Standard C 200, with a cement mortar lining conforming to AWWA Standard C 205 and a coal tar enamel coating conforming to AWWA Standard C 203. Welded steel pipe has the greatest variety of joint types, including welded joints, bell and spigot with O-ring rubber gasket joints, and mechanically coupled joints. The pipe is usually furnished in 40-foot lengths, but can be furnished in 48-foot lengths.

Reinforced concrete pressure pipe (RCP), conforming to ASTM C 361, minimum Class 125 (rated 125 feet), is an acceptable pipe material in those areas where the design pressure is less than 54 psi. Assuming a surge allowance of 50 psi, RCP would be an acceptable alternative only in those areas where the static pressure could not exceed 125 feet if the downstream isolation valves were closed near the treatment plant. If this event should occur, RCP would be unacceptable for approximately 65 percent of the pipeline length. Because of the limited area where RCP can be used and because using a low-pressure pipe limits the possibility of increasing the design flow and head of the system in the future, RCP is not considered further in this initial evaluation. Following completion of a surge analysis of the complete system, the use of reinforced concrete pressure pipe may merit consideration in sections of the system.

COMPARISON

Ductile iron, concrete cylinder, and welded steel pipe can be designed to satisfactorily meet the flow and installation conditions of this pipeline. Concrete cylinder and welded steel pipe are manufactured in the Oregon-Washington area and ductile iron pipe is manufactured in Alabama. Because the pipe for a project of this type is not a standard item, all three types are equally available.

Chapter 5, Corrosion Study, includes a discussion of the recommended linings and coatings for each type of pipe material. In general, standard coatings and linings are acceptable for ductile iron pipe and concrete cylinder pipe. For welded steel pipe, a coal-tar epoxy coating and either a coal-tar epoxy or concrete lining are recommended.

Ductile iron pipe is fairly rigid and gets most of its load-supporting strength from the pipe itself. Pipe bedding and the backfill around the pipe are not as critical to a successful installation as they are for the other two types of pipeline material.

Concrete cylinder pipe is considered a semirigid pipe. Part of its load-supporting strength comes from the pipe and part comes from the support provided by the bedding and backfill around the pipe. Proper pipe bedding and initial backfill are critical to a successful installation of this type of pipe.

Welded steel pipe is a flexible pipe. Very little of its load supporting strength comes from the pipe itself. Its strength is developed by the lateral support of the soil as its horizontal diameter increases under load and by the soil arch formed over the pipe as its vertical diameter decreases. There are limits to the vertical deflection, beyond which the pipe will collapse. Proper bedding and initial backfill are even more important to a proper flexible pipe installation than to a semirigid pipe installation.

Table 3-1 contains prices for several different sizes and classes of these pipe materials. The material costs in the table include shipping charges to Anchorage. For future reference, the September 1980 national average ENR CCI was 3336. As can be seen from the table, costs for welded steel pipe are considerably lower than those for ductile iron and concrete cylinder pipe. However, the more stringent backfill requirements that are required for welded steel pipe will drastically reduce the difference when the installed cost is considered.

Table 3-1
PIPELINE MATERIAL COST ESTIMATES[a]
(Dollars Per Foot)

	Ductile Iron Pipe[b]		Concrete Cylinder Pipe[c]			Welded Steel Pipe[d]			
Pipe Size	Class 50	Class 52	Class 100	Class 125	Class 150	3/16" Wall	1/4" Wall	5/16" Wall	3/8" Wall
42"	74.50	91.52	82.00	87.00	93.00	52.49	62.38	72.23	--
48"	92.75	115.59	120.00	123.00	130.00	--	65.71	77.13	88.38
54"	121.85	154.03	130.00	136.00	145.00	--	90.04	103.00	115.64

[a] September 1980 prices, f.o.b. Anchorage, Alaska.

[b] AWWA C-151, cement mortar lined, tyton joints.

[c] AWWA C-303, bell and spigot joints.

[d] AWWA C-200, cement mortar lined, coal-tar enamel coating, welded joints.

RECOMMENDATION

Ductile iron pipe, concrete cylinder pipe, and welded steel pipe can meet the project's design requirements. Ductile iron pipe has been used extensively in the Anchorage Water and Sewer Utilities system and has proven itself to be a reliable pipe material for the area. Ductile iron is, in fact, one of two types of water pipe materials allowed in the Municipality's standard specifications.

The other type of water pipe material allowed in the standard specifications is concrete cylinder pipe. Concrete cylinder pipe is usually not competitive with ductile iron pipe in this area, particularly in the smaller sizes and the lower classes. Therefore, there has not been extensive use of this material in the local area.

Welded steel pipe has had little or no recent use in local water works; however, it does offer a potential for reduced initial costs.

We recommend that the above three types of pipeline materials be considered as alternatives for this project.

Chapter 4
EVALUATION OF ALTERNATIVE PIPELINE ALIGNMENTS

In determining the horizontal and vertical alignments, certain assumptions were made on the basis of information presented in the MAUS report, the Request for Proposal from the Municipality of Anchorage, and discussions with the management staff of the Municipality of Anchorage. The assumptions critical to the alignment study are:

- A total flow of 70 mgd would be diverted from the Eagle River at a point about 1.4 miles upstream of the intersection of the Eagle River and the Glenn Highway. Approximately 17.5 percent of this flow would be diverted north to the Eagle River-Chugiak-Eklutna area. The remainder of the flow would be pumped south to the Anchorage Bowl.

- The annual flow, 70 mgd, would remain constant throughout the year.

- The new water treatment plant would be located in the Eagle River Valley.

- A regulating reservoir, if required, would be designed in conjunction with the pump station supplying the pipeline.

- The beginning point of the transmission main would be the existing municipal water treatment plant, near Oilwell Road.

Initially, three horizontal alignments were reviewed:

1. From Eagle River to Hiland Drive and parallel to and east of the Glenn Highway to the existing water treatment plant.

2. Along the Eagle River to the Eklutna powerline right-of-way, along this powerline right-of-way to the Glenn Highway, and southwest along the east side of the Glenn Highway to the existing water treatment plant.

3. Along the Eagle River to the Alaska Railroad, through Fort Richardson, and south to the existing water treatment plant.

The basis for the formulation of Alternatives 2 and 3 was to reduce the energy requirements associated with Alternative 1. Alternative 1, although shorter, results in the highest pumping lift. The three alternative alignments are shown on Figures 4-1, 4-2, and 4-3.

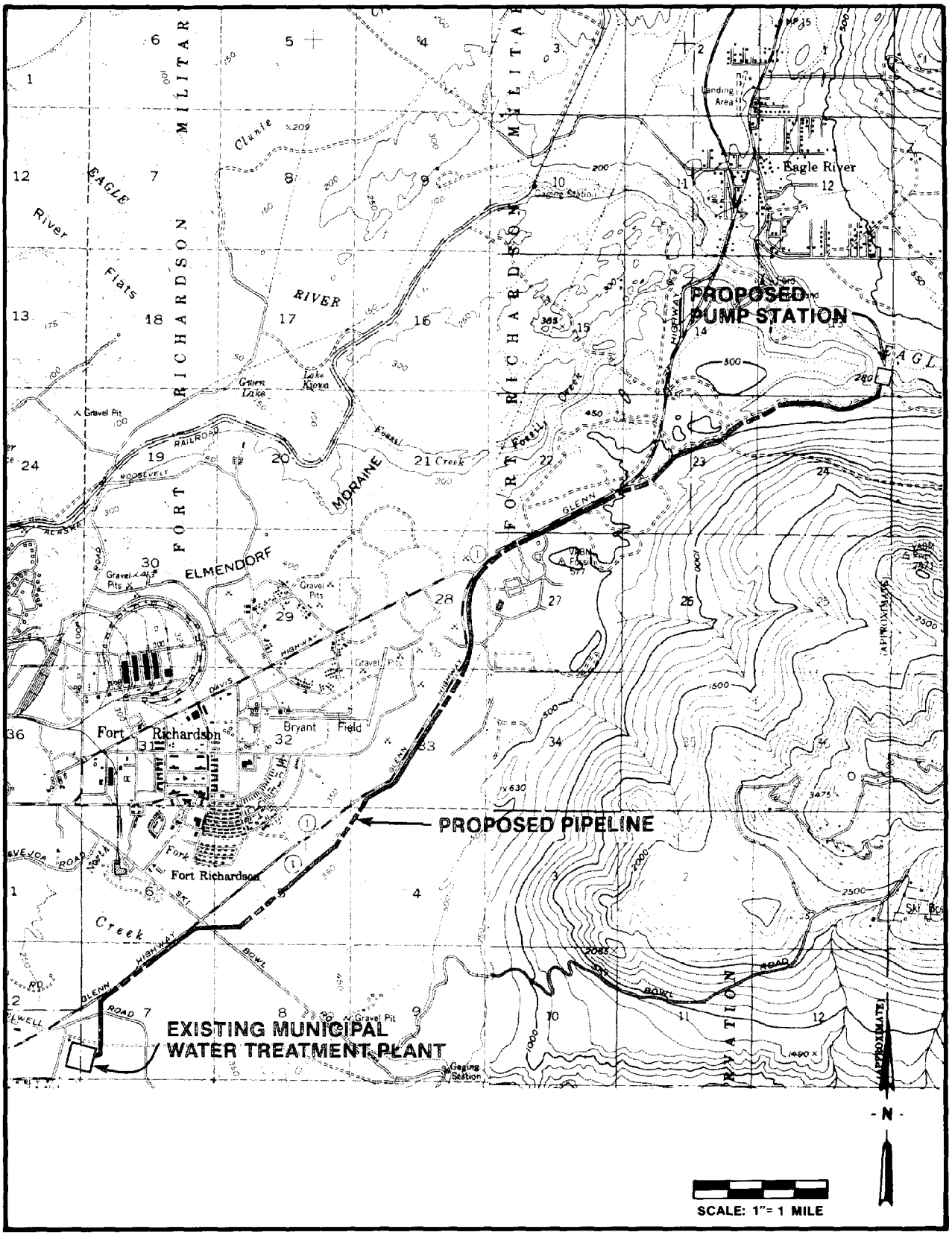


Figure 4-1
Alternative 1
Glenn Highway Alignment

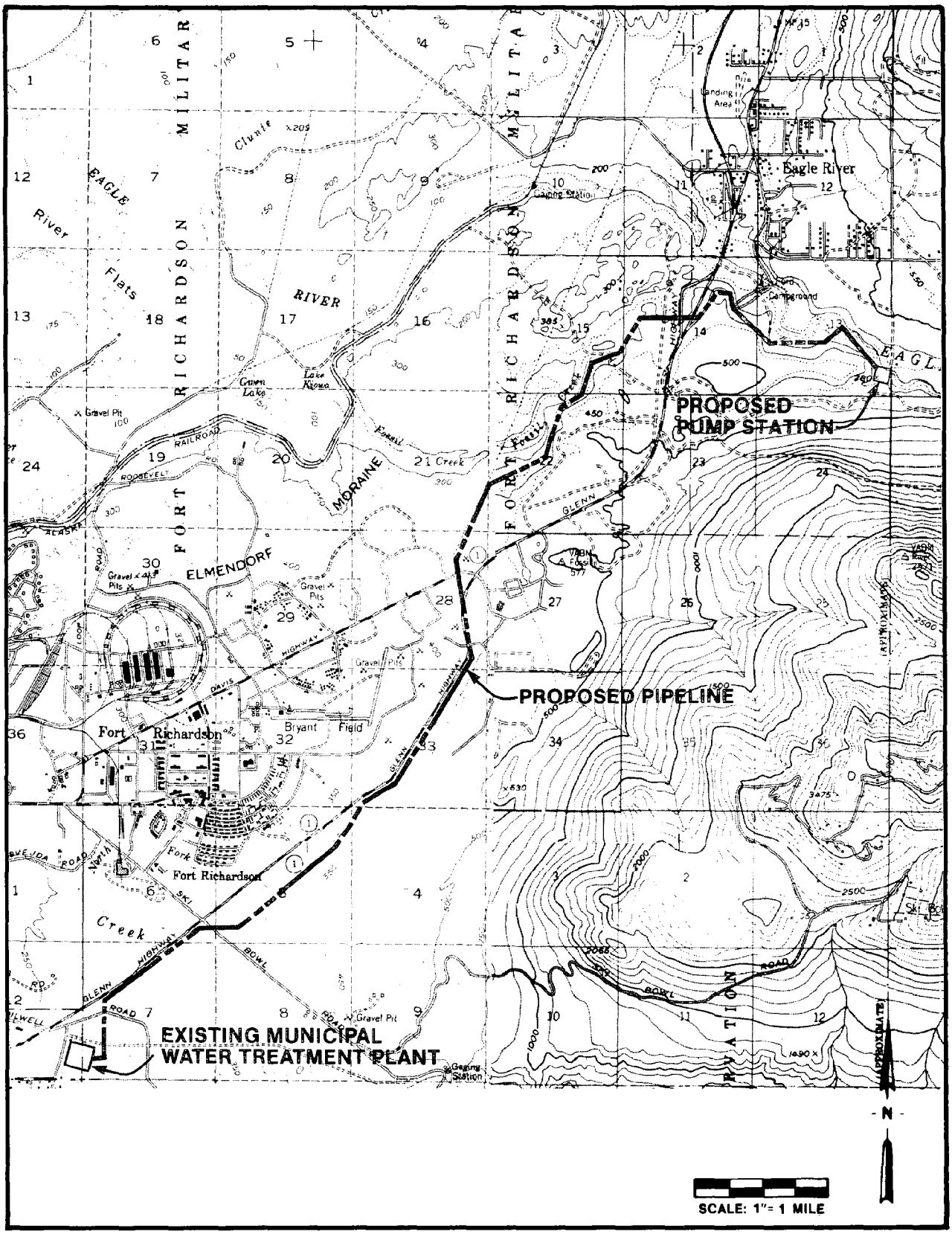


Figure 4-2
Alternative 2
Eklutna Powerline-
Glenn Highway Alignment

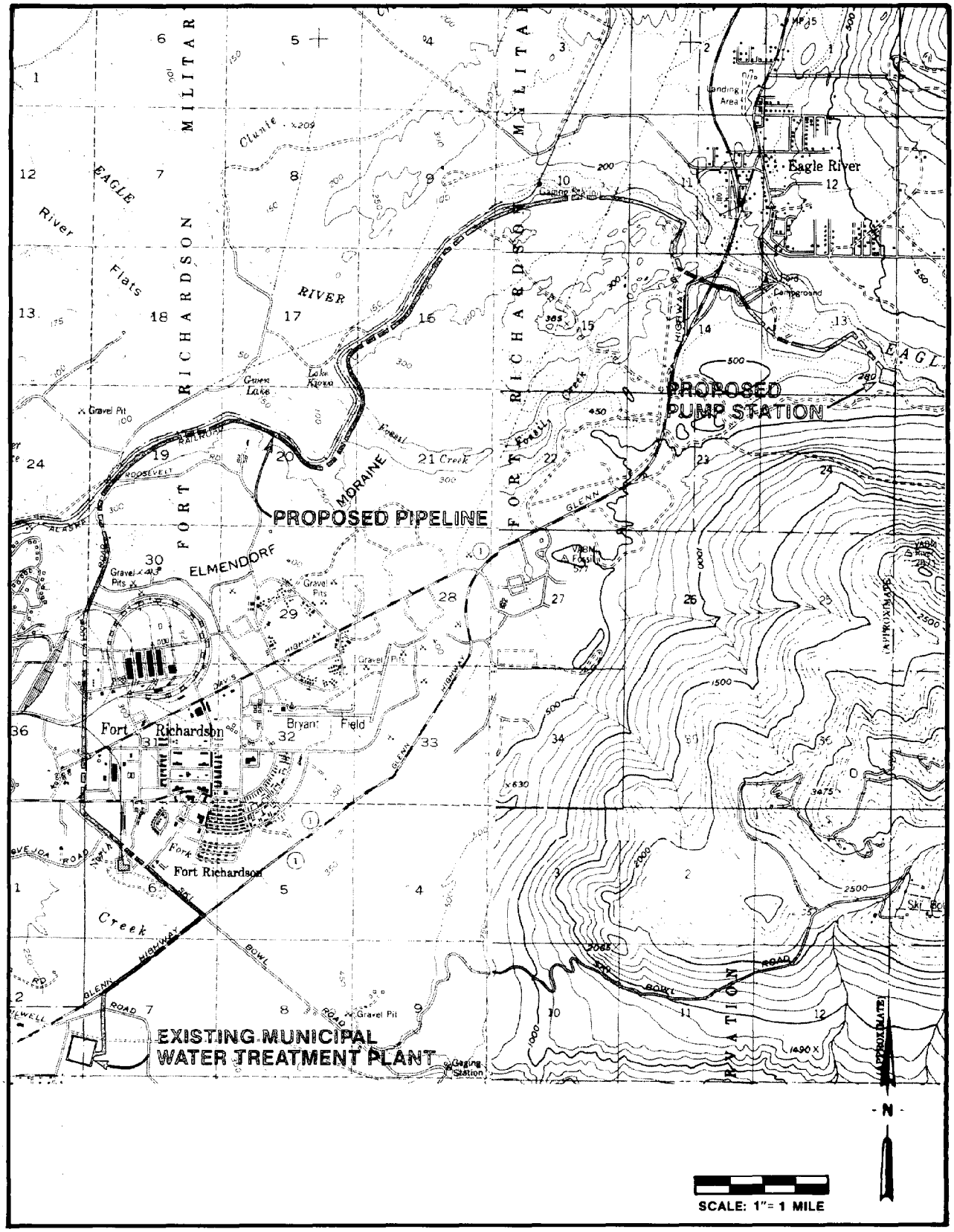


Figure 4-3
Alternative 3
Alaska Railroad Alignment

To screen the alignments to the most viable, each alternative was evaluated for capital costs and environmental and institutional constraints. Subsequently, the two remaining alternatives were then evaluated in more detail based on the following criteria:

- o Capital costs
- o Annual costs, including annualized capital costs and O&M and energy costs
- o Environmental constraints
- o Flexibility and reliability
- o Ability to implement, permits required
- o Ease of construction
- o Utility conflicts and relocation
- o Other (traffic control, future service)

INITIAL EVALUATION OF ALTERNATIVES

Alignment Comparison

Alternative 1

Alternative 1, the Glenn Highway Route, generally follows the route shown in the MAUS report for Alternative 5, Eagle River diversion. From the Municipal Water Treatment Plant, Alternative 1 alignment proceeds north and then northeast along a route in the Glenn Highway right-of-way to Arctic Valley Road. From Arctic Valley Road, the pipeline follows a frontage road to the Fort Richardson Rifle Range and parallels the eastern right-of-way of the Glenn Highway. Leaving the Glenn Highway, the pipeline traverses an area that is forested by birch and spruce and is accessible from a jeep trail to a high point located 3,000 feet south of the intersection of the Glenn Highway and Hiland Drive. The pipeline descends along the jeep trail to the pipeline's terminus at Eagle River, approximately 1.4 miles upstream from the Glenn Highway. The distance between the high point and the terminus of the pipeline is 10,000 feet.

This pipeline route measures approximately 43,000 feet (8.14 miles) in length. No Glenn Highway crossing is necessary; however, a water crossing at Ship Creek is required, as with all alternatives.

Alternative 2

An alternative route that reduces the static head associated with Alternative 1 by 100 feet was formulated. Alternative 2 follows the same route as Alternative 1 from the water treatment plant to a point about 3,000 feet south of the Fort Richardson Special Weapons Shop. Alternative 2 then travels north across the Glenn Highway along the Eklutna powerline right-of-way and northeast through a heavily forested area along Fossil Creek. The pipeline crosses the Glenn Highway just north of the State Correctional Institute and follows Eagle River east through heavily wooded areas to the same point of diversion described for Alternative 1.

The Alternative 2 route is approximately 50,500 feet (9.56 miles) long. Roughly 50 percent of this pipeline is located in timbered land that requires clearing. This route involves two Glenn Highway crossings and one crossing at Ship Creek.

Alternative 3

A route following Alaska Railroad rights-of-way was selected for study to provide a route that results in a minimum static lift of 58 feet from the Eagle River (elevation 320) to the Municipal Water Treatment Plant (elevation 378). This route is approximately 68,000 linear feet (12.88 miles) in length. Beginning at the water treatment plant, the pipeline parallels the Glenn Highway to Arctic Valley Road, turns northwest along Arctic Valley Road to Loop Road, then west to the Alaska Railroad. The pipeline then turns northeast and parallels the Alaska Railroad. It then follows along the south side of Eagle River to the west side of Glenn Highway. From the intersection of the Eagle River and Glenn Highway, the Alternative 3 alignment follows the same route described for Alternative 2 to the same terminus as described for Alternatives 1 and 2.

The Alternative 3 route would require a substantial amount of clearing, pavement replacement, two Glenn Highway crossings, and two railroad crossings. The pipeline for this alignment would be approximately 6 inches greater in diameter than the other alternatives to accommodate its length and to produce a smaller pumping head requirement than for Alternatives 1 and 2.

Cost Comparison

Capital Cost Estimates

The capital cost estimates for each alignment are presented in Table 4-1.

Table 4-1
ESTIMATED CAPITAL COSTS
FOR ALTERNATIVE PIPELINE ALIGNMENTS[a]

Item	Alt. 1 (43,000 lf)	Alt. 2 (50,500 lf)	Alt. 3 (68,000 lf)
Pipeline	$ 9,700,000	$11,900,000	$18,360,000
River or Creek Crossings	50,000	275,000	225,000
Clearing	70,000	170,000	230,000
Pavement Replacement	1,000,000	900,000	500,000
Pump Station	5,750,000	5,000,000	4,000,000
Highway & Railroad Crossings	-0-	205,000	300,000
Pipeline Appurtenances	970,000	1,190,000	1,840,000
40% Contingencies[b]	7,016,000	7,855,000	10,182,000
Total	$24,556,000	$27,495,000	$35,637,000

Notes: Rights-of-way purchase costs were not considered. Mobilization costs and costs for a possible flow-regulating reservoir are not included because they would be essentially equal for all alternatives.

[a] In September 1980 dollars for the Anchorage area.

[b] Includes construction contingencies and engineering, administrative, and technical services.

Capital Cost Estimating Curves

Capital cost estimating curves were developed for pipelines and pump stations using bid summaries for recently bid projects in Anchorage, past project experience, and U.S. Bureau of Reclamation (USBR) estimating guides.

Pipeline Cost Estimating Curve. The pipeline cost estimating curve, Figure 4-4, includes the cost for all work necessary to install the pipe in place. Costs for clearing and grubbing, pavement replacement, highway undercrossings, and miscellaneous items such as air valves and blowoff valves were calculated separately. Items of work included in the pipeline costs and the assumptions that were used to prepare the costs are as follows:

- Trench excavation will require a minimum of blasting (1 percent of trench or less) and a minimum of dewatering for an assumed trench depth of 12 feet.
- Imported backfill, 90 percent compacted, will be used as bedding and pipe zone material to 1 foot above the pipe's outside diameter. The remainder will be native

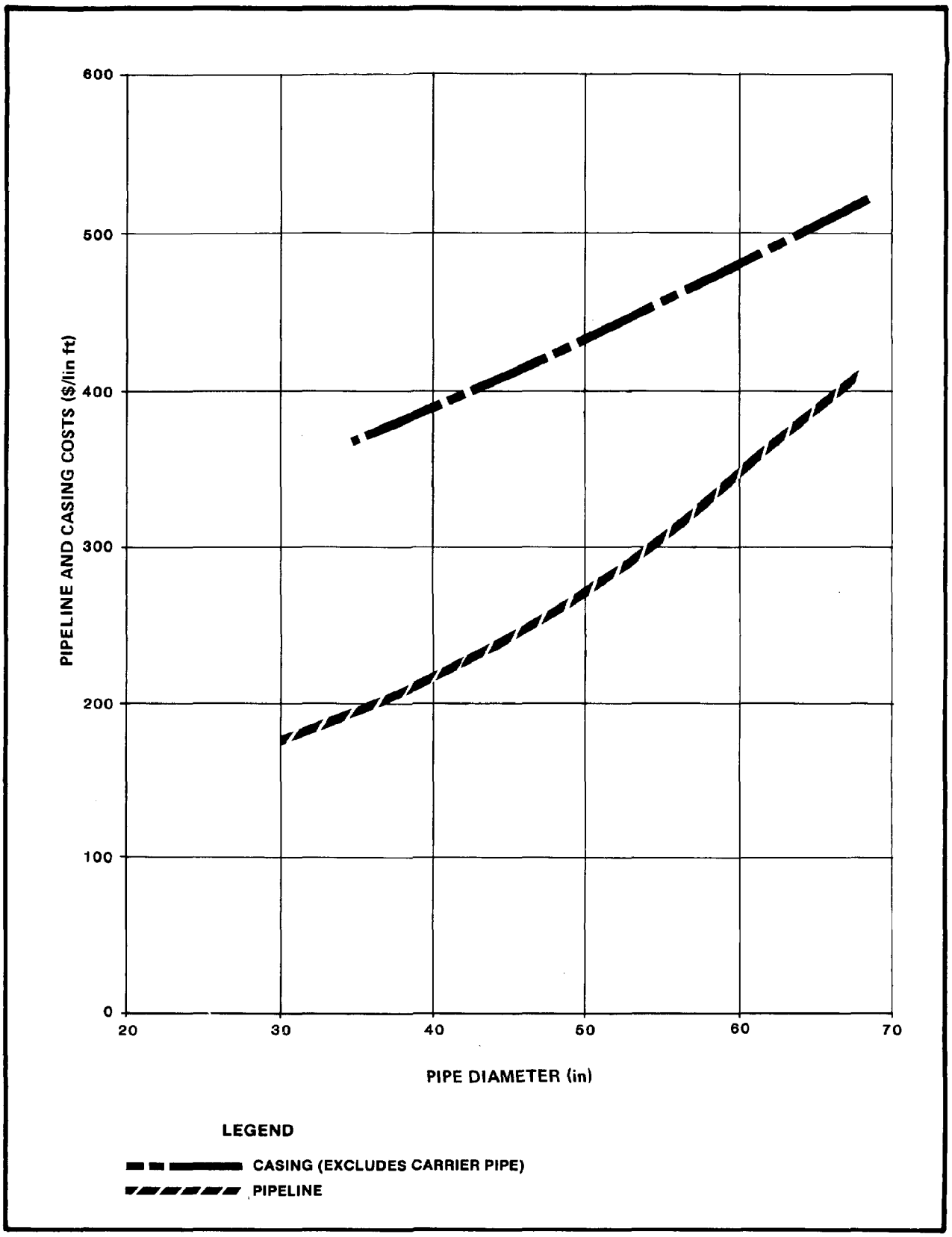


Figure 4-4
Pipeline and Casing Costs

material compacted from 90 to 95 percent in roadways and 80 percent in easements.

- Pipe is assumed to be concrete cylinder pipe, welded steel pipe, or ductile iron pipe with an average minimum working class of 150 psi.

- Miscellaneous costs included in the pipe prices are for pioneering access roads, mobilization, pipe testing, cleanup and grading, and landscape restoration.

Other pipeline-related costs are as follows:

- Pipeline crossing of the Glenn Highway will require boring and jacking or tunneling. It was assumed that the diameter of the casing or tunnel liner would be 12 inches greater than the carrier pipe. This cost was estimated on the basis of the cost estimating curve shown on Figure 4-4 and includes pits for jacking equipment, casing, and material removal.

- Pavement replacement costs were based on a structural section of 12 inches of aggregate base and 3 inches of asphalt. It was assumed that an average 12-foot width of pavement would be replaced at an estimated cost of $2 per square foot. Wherever possible, the pipeline would be located at the edge of the roadway rather than in the center to avoid pavement destruction and replacement.

- Clearing and grubbing costs were estimated at $2,000 per acre along existing roads and $3,000 per acre for other areas, based on a clearing width of 90 feet.

- Ten percent of the pipeline cost was added to the estimated construction costs to cover miscellaneous items such as thrust blocks, air valves, and blowoff valves.

- River crossings were estimated based on each individual site. The costs included excavation, pipe placement, and concrete encasement of the pipe.

Pump Station Estimated Costs. Pump station costs are order-of-magnitude costs based on the assumption that the pump station will be designed in accordance with Hydraulic Institute standards and that it will include the following:

- Rotating drum screens to protect the Eagle River fishery

- o Trashrack
- o Vertical-type pumping units
- o Standby pumps and power
- o In-line flow measuring devices
- o Housed pumping units

Conclusion

Alternative 3, the Alaska Railroad route, was eliminated from further study because of the high construction costs, the environmental constraints, and the potential difficulties in implementing this proposed project. It would be difficult to obtain rights-of-way for the portion of the route that traverses Fort Richardson along Loop Road. Also, based on past experience, permits required for longitudinal access to railroad rights-of-way are extremely costly to obtain, and, therefore, it would probably be necessary to locate the pipeline on military property adjacent to the railroad.

DETAILED ANALYSIS OF ALTERNATIVES 1 AND 2

Aerial photographs were made on August 4, 1980, of Alternative 1 and 2 routes for the purpose of preparing 1"=400' photoplans.

These preliminary general plans, shown in Exhibit A, depict the proposed routes, rights-of-way, property boundaries, ownerships, and existing utilities. The station designations in this chapter refer to the stations in the photoplans. It should be emphasized that the routes shown are general corridors and do not represent final alignments.

Horizontal Alignments

Interferences

Alternative 1. The centerline of the transmission main would pass along the uphill edge of a sanitary landfill between Stations 472+00 and 480+00. This area may have deposits of toxic materials that could be hazardous to the construction crew, the public, and the operation and maintenance staff of the pipeline. The underground conditions will be investigated during the geotechnical and corrosion studies, and the alignment will be adjusted to avoid potential problems.

At Stations 402+00 and 397+00, the pipeline would pass within 50 feet and 30 feet, respectively, of the State of Alaska, Department of Transportation Weigh Station and a structure known as

the Fort Richardson Rifle Range. Construction activities should not result in any damage, provided that the contractor is restricted to the working easement.

Alternative 2. The centerline of the transmission main would pass through the Chugach State Park and near the State Correctional Institution. Although we anticipate no damage to any existing structures during construction, the contractor's working hours may be restricted by the permitting agencies because of construction noise.

Utilities

Conflict with existing gas, water, sewer, and electrical utilities would not be significant with either alternative. The Alternative 1 alignment would cross several existing utilities in the vicinity of the Fort Richardson Special Weapons Shop, Station 370+00, which are largely avoided by the Alternative 2 alignment. In general, the Alternative 2 alignment would result in less utility conflict than the Alternative 1 alignment. Utilities are addressed in more detail in Chapter 10, Recommendations for Final Design Work.

Soils

Based on existing geologic maps and a field review of the alternative routes, the soils encountered in the Alternative 1 route would present fewer construction problems than those associated with the Alternative 2 route. Problems with groundwater will be greater with the Alternative 2 route, particularly along Eagle River and Fossil Creek, than with the Alternative 1 route.

Easements and Permits

Both alternatives would require permits from the same number of agencies. However, because Alternative 2 is longer and follows an alignment through a more environmentally sensitive area, permits would be more difficult to obtain. These sensitive areas are the section of the route near the Chugach State Park campground immediately adjacent to Eagle River and the section adjacent to the Eklutna powerline. A list of the agencies that potentially will require permits is included in Chapter 9, Permit Acquisition Process.

One crossing of Ship Creek is required for both the Alternative 1 and 2 alignments. Stream crossings of Eagle River may be required if Alternative 2 is constructed, depending on the final alignment near the dam.

Public Interface

Problems caused during construction by noise, dust, traffic control, and interruption of public and governmental access would be

minimal for each route. Public inconvenience, particularly caused by noise and access difficulties, may be a problem for Alternative 2 construction in the vicinities of the Chugach State Park campground and the State Correctional Institute, Stations 500+00 to 532+00.

Traffic control along the Glenn Highway frontage road would be required during construction of both Alternatives 1 and 2. Along this frontage road, which is paralleled by an electrical transmission main, alternating one-way traffic in one lane, with traffic control, probably would be necessary during daytime construction. Normal two-way traffic flow would be restored after working hours.

Each alternative would require close coordination with Fort Richardson, the State of Alaska, and Eklutna, Inc., to minimize disruption of their services. Although neither route will cause major disruptions to the public, Alternative 1 appears to provide the least public inconvenience.

Operation, Maintenance, and Accessibility

To permit either routine maintenance or special maintenance, the pipeline must be accessible. Of the two alternative alignments, Alternative 1 would offer better accessibility. It follows Glenn Highway and frontage roads. The northern terminus of the pipeline is relatively accessible from Hiland Drive and a jeep trail. Construction of a maintenance road along the jeep trail route, Station 462+00 to 530+00, should be considered during final design.

Vertical Alignments

To compare the annual costs of each alternative route it was necessary to develop a vertical profile of each route. The vertical profile and the design criteria generated in Chapter 2 were used to size future pumping facilities and to determine energy costs.

Alternative 1

As shown on Figure 4-5, a pump station located at the Eagle River would require a static lift of approximately 240 feet. This is based on a peak flow of 57.8 mgd and a total dynamic head (TDH), less surge, of 273 feet. Based on this TDH, the expected power requirement of the pump station is approximately 4,300 horsepower.

The required pipeline diameter is estimated to be 48 inches, based on maximum allowable velocities of 5 to 7 feet per second and a

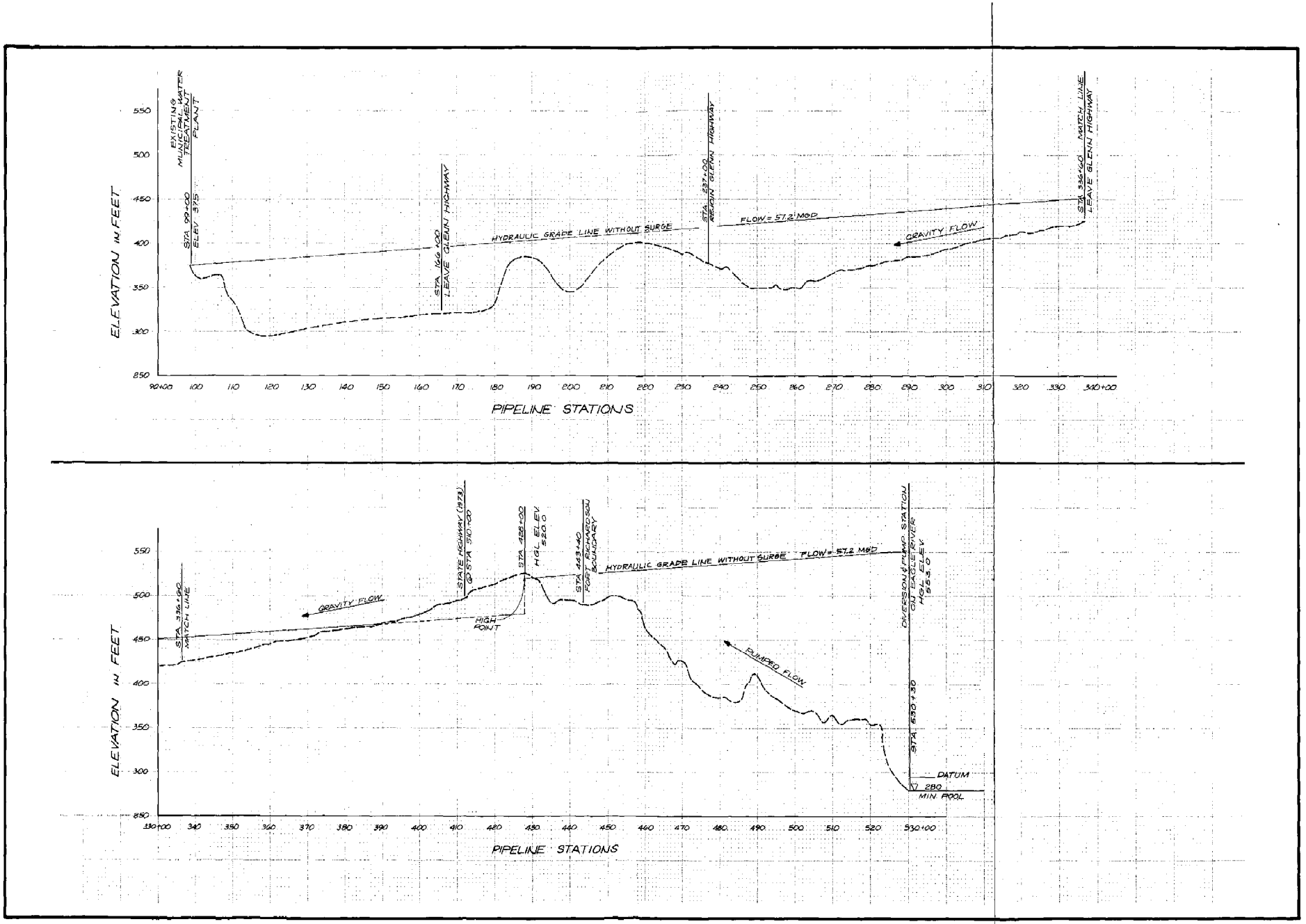


Figure 4-5
Alternative 1
Vertical Profile

flow of 57.8 mgd. For preliminary estimating purposes, the pipeline is assumed to require, on the average, Class 150 pipe. Following a surge analysis in the final design, the class of pipe will be determined on a station-to-station basis. Depending on the head conditions in the various reaches, the pipeline will probably vary from Class 100 to Class 200.

Alternative 2

The profile of Alternative 2 is shown on Figure 4-6. This alignment has a static head of approximately 140 feet and a TDH of 223 feet, assuming a peak flow rate of 57.8 mgd and neglecting surge. Based on the TDH of 223 feet, the pump station requires 3,500 horsepower. Thus, the Alternative 2 alignment, although greater in length than Alternative 1, has a TDH that is 50 feet less and requires 800 fewer horsepower to operate at peak flow.

The pipeline varies in size from 54 inches from Station 100+00 to 378+00 to 48 inches from Station 378+00 to 605+00. Accounting for surge in the same manner as for Alternative 1, the average class of the pipe is assumed to be Class 150.

Comparison of Annual Costs

An annualized cost comparison of the two alternatives was made on the basis of the capital costs shown in Table 4-1 and the following assumptions:

- Economic life of 40 years
- Interest rate of 7 percent
- Mechanical and electrical components of the pump station initially sized for year 2005 flows, with replacement or addition to these components in year 2005 to accommodate year 2025 flows
- 20-year life for machinery; costs include one replacement
- Present power costs

The electrical costs are based on the average daily water flows projected in the MAUS report. The present power rates furnished by the Matanuska Electric Association are:

Demand Charge (September 1980)	
0-50 kW per month	$0.00
Over 50 kW per month	$4.19/kW

Energy Charges	
0-500 kWh	14.2¢/kWh
500-2,000 kWh	5.2¢/kWh
2,000-10,000 kWh	3.9¢/kWh
10,000-200,000 kWh	2.9¢/kWh
Over 200,000 kWh	2.3¢/kWh

Maintenance costs were calculated at .25 percent of the associated construction costs. This percentage cost represents the average cost of maintenance over a long period. The annual costs for each alternative were calculated to be approximately $2,400,000 per year.*

RECOMMENDATION

The information presented in this chapter was reviewed with the Municipality of Anchorage on October 1, 1980. At that time, the Alternative 1 alignment was selected as the recommended alignment because it had fewer environmental constraints and appeared to be easiest to implement from a standpoint of obtaining permits and rights-of-way.

The selection of the Alternative 1 alignment represented a recommended alignment corridor and not a specific route selection. Subsequent to further studies by CH2M HILL along the selected alignment and to review of the alignment by various agencies, a more specific alignment was formulated. A discussion of these studies and of the specific alignment is in the following chapters.

*Chapter 6 of Appendix V, Eklutna Lake Alternative Water Source Evaluation, has a more detailed discussion of project energy requirements and costs, including an annual cost summary for the Eagle River dam and reservoir project. Future increases in power supply may be supplied from coal-fired thermal plants with generation costs of about 8.66 cents per kWh (1981 prices).

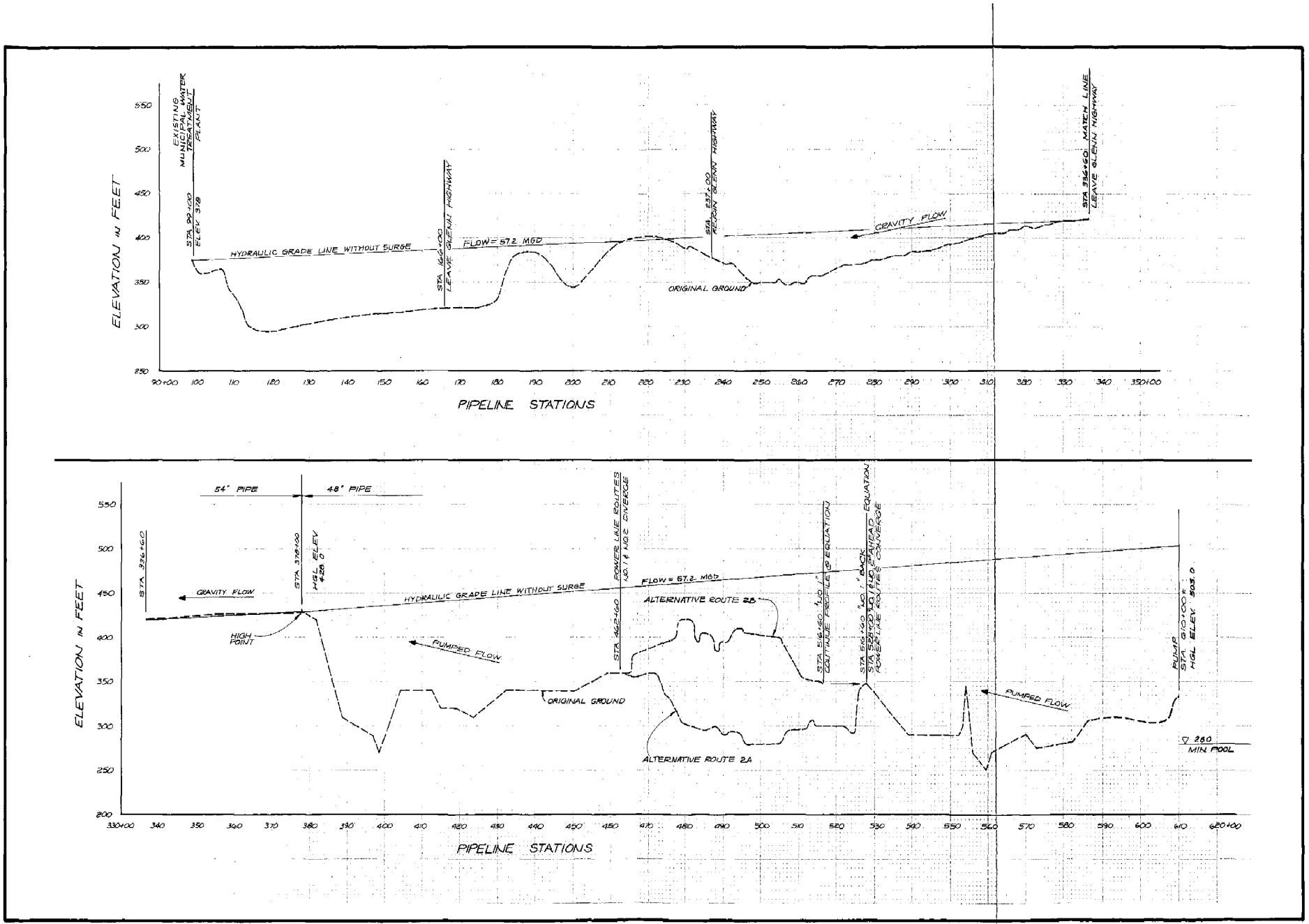
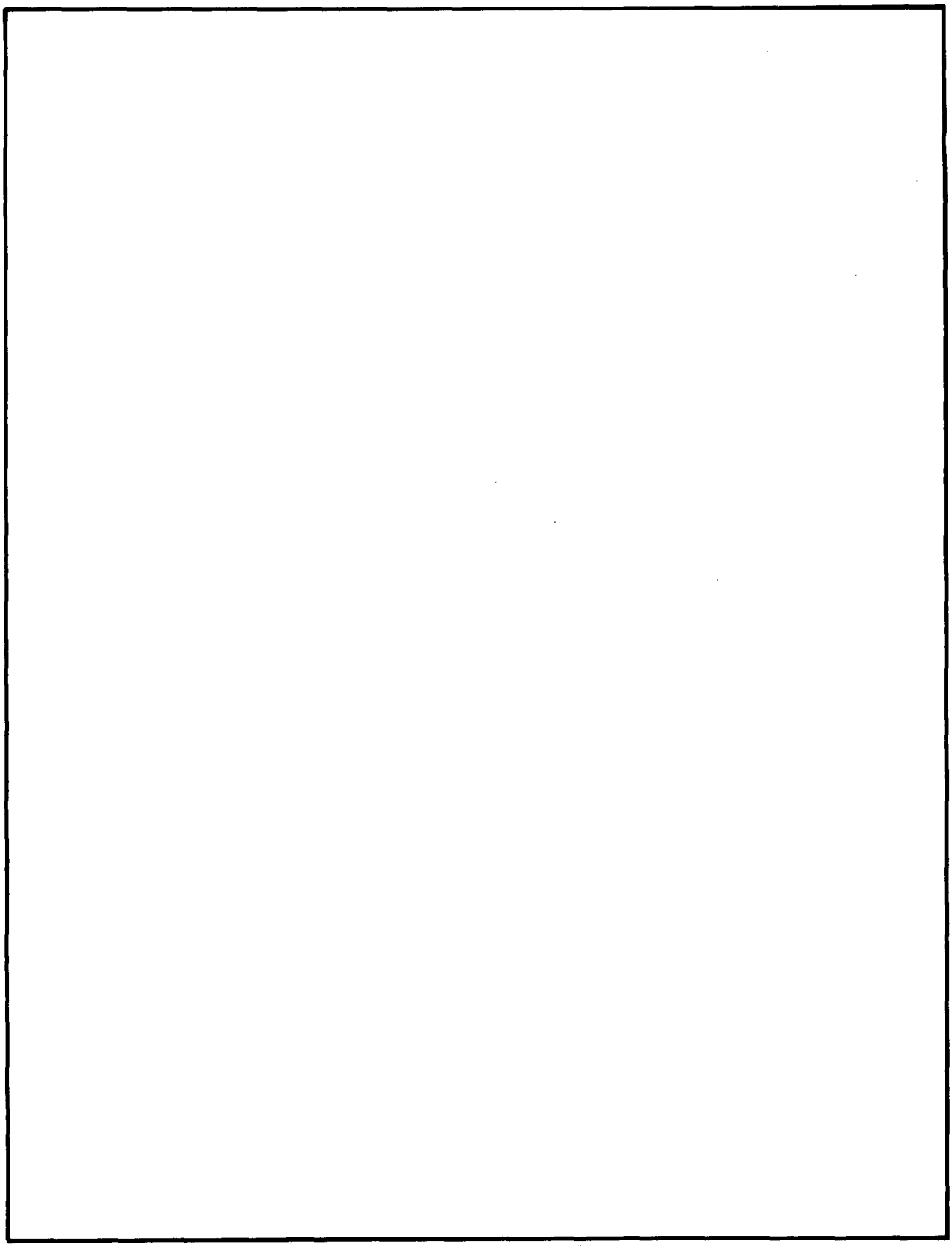


Figure 4-6
Alternative 2
Vertical Profile



Part II
Selected Pipeline Alignment

Chapter 5
CORROSION STUDY

This chapter presents the procedures for and the results of field tests for the corrosion study along the selected (Alternative 1) pipeline alignment from Eagle River to the Municipal Water Treatment Plant. Certain areas along the approximately 8.2-mile-long pipeline route were surveyed to determine the corrosivity of the soil toward the pipe material alternatives. In addition, existing water quality data were reviewed to estimate the corrosivity of Eagle River water.

Recommendations based on this study are included at the end of this chapter. However, this was a preliminary corrosion study; further investigation should be undertaken during the final design.

FIELD TEST PROCEDURES AND RESULTS

The field portion of this study consisted of several tasks:

- Measurement of the soil resistivity along the selected alignment
- Inspection, sampling, and chemical analysis of the soils at test pits along the route
- Measurement of stray electrical current in the earth at selected locations

Soil Resistivity

The process of corrosion is electrochemical in nature because it includes a transfer of electrical energy and one or more chemical changes. On buried metal structures, electrochemical cells can be formed in which metallic ions leave the structure and flow into the soil. This chemical change of the metal results in the formation of iron oxide (i.e., the familiar red rust).

A soil's ability to conduct electricity is one of the most important factors controlling the rate of corrosion. The lower the soil resistivity, the better the electricity is conducted and the faster metal corrodes; the higher the resistivity, the slower it corrodes.

The relationship of the corrosivity of a soil to its resistivity is as follows:

Less than 30 ohmmeters	Very corrosive
Thirty ohmmeters to 100 ohmmeters	Moderately corrosive
Over 100 ohmmeters	Mildly corrosive

During this survey, the electrical resistivity of the soil along the pipeline route was measured by the Wenner Four-Pin Method at selected depths of 2.5, 5, 7.5, 10, and 15 feet. The average soil resistivity from the ground surface to each selected depth was calculated, along with the resistivity of the soil layers between test depths. These data are listed on Table 5-1. The lowest soil resistivity measured (147 ohmmeters) was the 5.0- to 7.5-foot-depth layer at Station 490+00. All other measurements were higher, indicating that the soil is only mildly corrosive.

Table 5-1
SOIL RESISTIVITY

	Average Resistivity (ohmmeter) From Grade to Depth					Layer Resistivity (ohmmeter) at Depth			
Station	2.5 ft	5.0 ft	7.5 ft	10 ft	15 ft	2.5-5.0 ft	5.0-7.5 ft	7.5-10 ft	10-15 ft
102+00	2,885	4,060	3,840	3,480	2,628	6,850	3,464	2,716	1,705
113+00	875	942	1,044	1,206	1,242	1,020	1,197	2,792	1,321
139+00	535	749	877	1,066	1,215	1,248	1,336	2,998	1,686
150+00	565	764	999	1,084	1,254	1,179	2,596	1,455	1,827
164+00	5,050	1,620	1,605	1,218	1,071	965	1,576	707	863
170+00	1,575	2,220	2,340	1,992	1,527	3,760	2,624	1,377	1,041
118+00[a]	2,725	2,390	1,935	1,480	1,548	2,128	1,401	868	--
142+00[a]	1,005	1,460	1,770	1,730	1,971	2,668	3,076	1,620	2,732
153+00	238	404	552	580	699	1,320	2,065	684	1,185
180+00	263	376	547	686	888	656	6,238	2,845	2,160
202+00	885	814	613	622	438	753	411	649	275
215+00	1,030	843	--	876	870	713	912	912	854
230+00	670	657	693	580	585	644	778	389	298
250+00	2,130	1,350	1,905	1,242	2,814	988	1,072	608	--
265+00	1,150	1,800	2,460	2,580	2,391	4,140	9,225	3,022	2,085
281+00	640	822	--	1,112	2,667	1,149	1,718	1,718	--
295+00	427	698	879	1,008	1,257	1,910	1,826	1,801	2,844
310+00	6,450	1,000	6,750	6,840	6,030	22,241	4,091	7,125	4,875
327+00	1,030	1,240	1,285	1,470	1,548	1,557	1,387	2,582	1,732
347+00	5,800	5,420	5,760	4,600	5,340	5,087	6,586	2,867	7,873
356+00	10,250	10,700	8,445	7,060	5,640	11,191	5,941	4,732	4,022
372+00	5,360	8,210	7,395	7,580	6,600	17,532	6,170	8,195	5,244
384+00	10,010	9,840	8,430	6,180	6,300	9,676	6,522	3,432	6,554
402+00	8,800	8,430	7,530	8,000	5,940	8,090	6,205	9,843	3,921
425+00	5,650	7,610	7,485	7,740	7,200	11,652	7,247	8,621	6,318
435+00	1,435	1,480	1,545	1,820	2,367	1,528	1,694	3,905	5,934
455+00	17,950	19,900	13,470	11,980	24,720	22,325	8,182	8,995	--
465+00	920	703	967	880	1,428	569	3,909	692	--
475+00	4,995	4,320	2,910	2,780	1,860	3,806	1,761	2,451	1,119
478+00	2,135	1,580	1,161	784	816	1,254	759	397	888
490+00	1,560	433	261	356	558	251	147	326	326
496+00	8,500	11,500	7,710	7,240	9,120	1,777	4,647	6,121	1,897
510+00	670	561	553	488	1,368	482	539	360	--
520+00	337	320	472	436	558	327	3,076	354	1,267
529+00	8,200	8,430	7,560	7,100	6,090	8,673	6,266	6,004	4,741

[a]Alternative route parallel to Glenn Highway.

Chemical Analysis of Soil

Water-soluble chemicals that release chloride and sulfate ions are especially detrimental to steel and concrete, respectively. The pH value of a soil indicates whether it is acidic (pH less than 7) or alkaline (pH greater than 7). Soils that are highly acidic can be detrimental to metallic and concrete pipe.

Soil samples were taken at 10 locations. The results of the soil analyses are shown in Table 5-2. The quantitative analyses indicate that the pH of the soil ranges from slightly alkaline to slightly acidic, and the amounts of soluble chloride and sulfate are very small. On the basis of these tests, little corrosion of proposed pipe materials is expected from the chemical composition of the soil.

Table 5-2
CHEMICAL ANALYSIS OF SOIL SAMPLES

Station	pH[a]	Chloride[b]	Sulfate[b]
113+00	6.03	3	5
118+00[c]	6.46	3	4
164+00	7.84	3	3
170+00	7.41	3	5
425+00	6.57	3	3
490+00	6.82	3	3
496+00	6.88	3	5
510+00	6.90	3	7
520+00	7.06	3	29
529+00	7.10	15	3

[a] 100-gram soil sample mixed with 300 milliliters of distilled water.

[b] Milligrams per kilogram of dry soil.

[c] Alternative route parallel to Glenn Highway.

Stray Electrical Current

Stray electrical current can accelerate pipeline corrosion. Stray current measurements were made at selected locations by placing two copper/copper sulfate ($Cu/CuSO_4$) electrodes 50 feet apart and in contact with the earth. Earth current between the electrodes causes a potential or voltage difference directly proportional to the magnitude of the current between them. The polarity and magnitude of the potential between the electrodes were

measured with a high impedance voltmeter. These "earth potential measurements" are listed in Table 5-3. The measurements are very low values, indicating negligible amounts of stray current. There will be no effect on metal pipe materials under present and anticipated future conditions.

Table 5-3
EARTH POTENTIAL MEASUREMENTS

Station[a]	Direction	Potential (millivolts)
118+00	North-South	0.1 (south electrode +)
	East-West	0.0
170+00	North-South	0.1 (north electrode +)
	East-West	0.0
360+00	North-South	0.0
	East-West	0.1 (west electrode +)

[a]Station references are taken from Exhibit A, Preliminary General Plans (Alternative 1).

REVIEW OF WATER QUALITY DATA

Water quality data from CH2M HILL studies and from the MAUS report were reviewed to estimate the corrosivity of Eagle River water toward metallic pipe materials. The MAUS report stated that water from Eagle River "should be fairly stable (neither aggressive nor corrosive)." Our analysis of the data indicates that the alkalinity and hardness of the water vary significantly on a seasonal basis and that the water could be somewhat corrosive during times of low alkalinity and hardness. The water may also tend to leach cement and cement mortar under these conditions. When the water has higher alkalinity and hardness, our analysis indicates that it is stable.

SUMMARY AND RECOMMENDATIONS

Ductile Iron and Steel Pipe

The soil at the depth at which the pipe will be laid is of high electrical resistivity and is composed mainly of sands and gravels. Therefore, it is noncorrosive to ductile iron and mildly corrosive to steel.

Because of the relatively noncorrosive nature of the soil to ductile iron, cathodic protection of a ductile iron pipeline is unnecessary.

Also, no supplemental external coating or polyethylene encasement of the ductile iron pipe should be required, except possibly in the area of the old Eagle River dump.

All metallic pipe materials should be lined to minimize the potential for internal corrosion. Linings that provide acceptable corrosion resistance are coal-tar enamel and coal-tar epoxy. Cement mortar or concrete linings may undergo some seasonal leaching when the water is soft but should provide adequate protection for pipe metal.

Although all the soils along the route are of high resistivity, the various soil groups tested differ in resistivity by one or two orders of magnitude. This difference could cause corrosion on a continuous pipeline installed through several soil horizons or boundaries. For this reason, the joints of the ductile iron pipeline should be rubber-gasketed rather than bonded to stop the flow of corrosion currents caused by differences in soil resistivity in large areas along the pipeline.

Welded steel pipe and fittings require an external coating of coal-tar enamel (AWWA C203) or coal-tar epoxy (AWWA C210) to reduce the amount of corrosion caused by the variation in soil resistivity. The pipeline should also be equipped with test wires for future corrosion monitoring. Steel pipe with unbonded mechanical joints is not recommended because electrical continuity of the pipeline would be required if cathodic protection is ever needed.

Electrical measurements indicate that no significant stray direct current is present in the earth at the locations tested. The present operation of Alaska Gas and Service Company's cathodic protection systems for its gas lines is, therefore, not expected to cause corrosion in the proposed pipeline. However, measures should be included in the design to mitigate interference on the pipeline by the operation of possible, future, rectifier-operated cathodic protection systems constructed closer to the pipeline.

Concrete Cylinder Pipe

Chemical tests of soil samples from the pipe route indicate mild corrosivity toward concrete cylinder pipe. The tests indicate that the soil is mildly acidic and would react with some of the alkaline hydrated cement in concrete. However, the acidity of the soil is sufficiently low that no significant deterioration of concrete cylinder pipe is expected.

Chapter 6
GEOTECHNICAL EXPLORATION

A geotechnical exploration was performed to aid in the preliminary design and construction of the selected Alternative 1 alignment of the Eagle River Pipeline.

The scope of work included:

- Collection and synthesis of available information on subsurface conditions along and near the selected alignment
- Subsurface exploration using backhoe-excavated test pits
- Geotechnical engineering analysis

The geotechnical exploration was conducted with the understanding that additional geotechnical work will be performed for final design. Recommendations for additional work appear in Chapter 10. Should differing subsurface conditions be encountered during subsequent geotechnical work or during construction, CH2M HILL should be notified, so it can be determined whether the recommendations of this report need to be reevaluated.

INFORMATION COLLECTION AND SYNTHESIS

Some of the subsurface information used in the geotechnical exploration was originally prepared for other purposes and without the specific knowledge of this project (generalized geologic maps, planning reports, state highway reports). This information therefore has limited application and must be complemented during final design by additional exploration (borings, test pits, laboratory tests).

Regional Geology

The selected alignment lies in the Cook Inlet-Susitna Lowland section of the Pacific Troughs Physiographic Province (Roberts, 1976). This section was part of a deep oceanic trench that was filled with sediments during Mesozoic and early Tertiary times (30 to 225 million years ago) and then folded and faulted downward. Subsequently, the area was partially filled with Tertiary and Quaternary (less than 65 million years old) sediments (Hunt, 1974) and is now a structural trough between uplifts of the Alaska Range to the north and the Chugach Mountains immediately to the southeast.

Local Geology

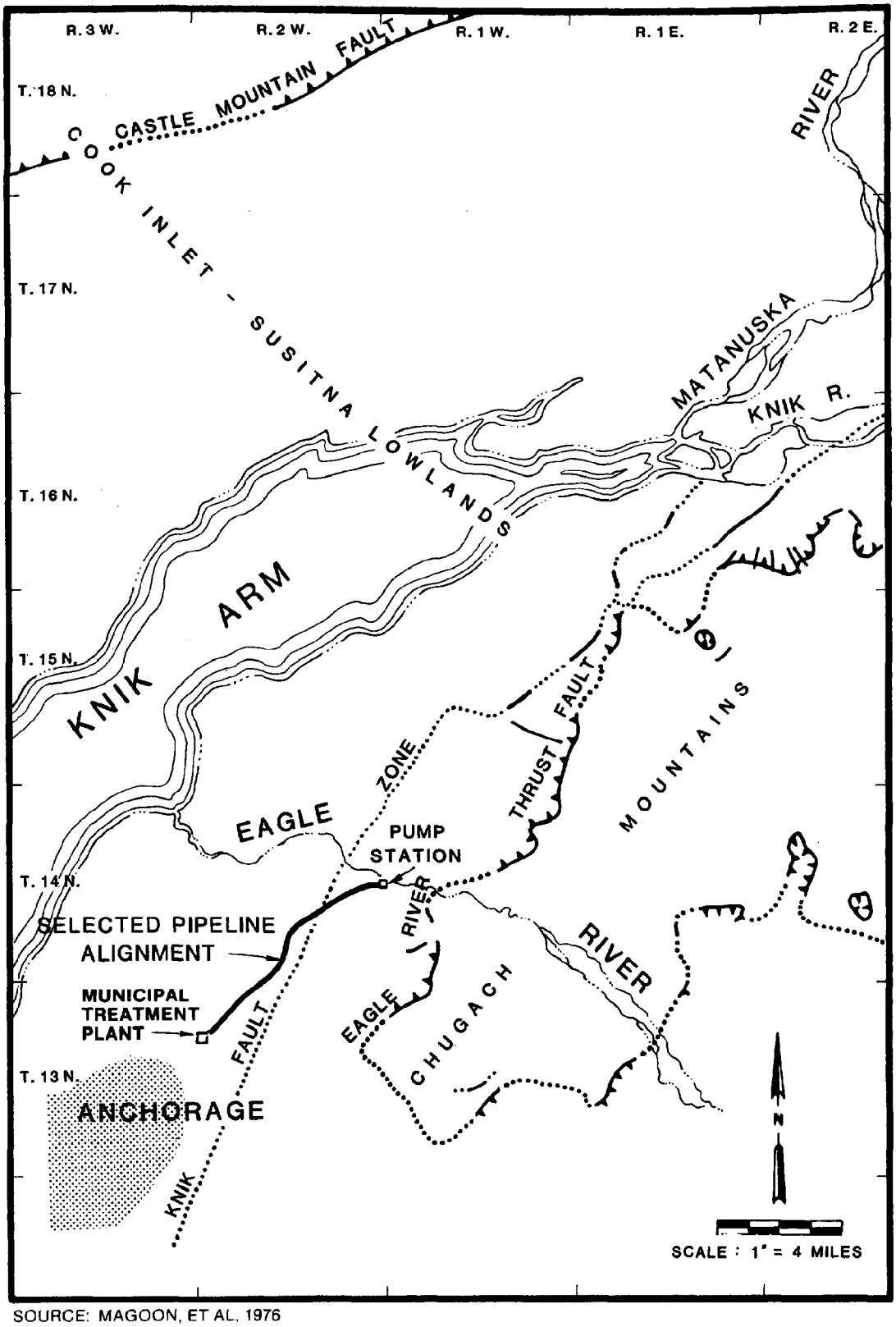
Interpretation of the local geology is based on generalized geologic maps (Schmoll, et al., 1980; Schmoll and Dobrovolny, 1972; Magoon, et al., 1976) except as cited by specific reference. Five distinct periods of glaciation have been identified in the area.

Typically, the selected alignment crosses glacial and alluvial surficial soil. The unconsolidated surficial deposits vary in thickness along the alignment. Variations in thickness occur, at times, over short distances.

In general, bedrock outcrops of the Chugach Mountains are within 2 miles of the route. The existing geologic information indicates bedrock may exist at or near the ground surface in two isolated locations. Most of the selected alignment, however, crosses deep unconsolidated deposits.

Bedrock underlying the surficial deposits consists of two distinct groups separated by the Knik Fault Zone (see Figure 6-1). The Knik Fault Zone trends northeast and crosses the selected alignment at approximately Station 425+00. (For locations of stations mentioned in this chapter, refer to the Alternative 1 alignment stationing shown in Exhibit A, Preliminary General Plans.) From the water treatment plant to approximately Station 425+00, the pipeline is on the southwest side of the Knik Fault, and bedrock consists of soft sedimentary rocks of the Kenai Group of late Tertiary age (2 to 38 million years old). Rocks of the Kenai Group are exposed near the town of Eagle River. Soil depth to bedrock of the Kenai Group along the selected alignment was not determined during the geotechnical exploration; however, generalized geologic mapping indicates depth to bedrock may be over 100 feet (Zenone, et al., 1974).

From approximately Station 425+00 to Eagle River (northeast side of the Knik Fault), bedrock consists of rocks of the McHugh complex. The McHugh complex contains weakly metamorphosed sedimentary and related igneous rocks of Jurassic and Cretaceous age (85 to 185 million years old). Large outcrops of the McHugh complex are typically 1 to 1.5 miles from the selected alignment. Generalized mapping (Schmoll, et al., 1980) shows an outcrop for the McHugh Formation at approximately Station 520+00. The outcrop, however, could not be located during the field exploration. Approximately 0.1 mile south of Station 500+00, an outcrop of gabbro was tentatively mapped (Schmoll, et al., 1980). This outcrop also could not be located during the field exploration. Approximately 0.1 mile north of Station 500+00, the USGS has conducted deep resistivity measurements that indicate bedrock is over 300 feet deep (the USGS report is preliminary, and the reference cannot be cited). Well exploration drilling by CH2M HILL indicates bedrock in the upper reaches of Eagle River Valley is at least 700 feet deep (see Appendix I, Well Drilling Program).



SOURCE: MAGOON, ET AL, 1976

LEGEND

THRUST FAULT, SAWTEETH ON UPPER PLATE

FAULT, SOLID WHERE EXPOSED, DOTTED WHERE CONCEALED

Figure 6-1
Known Faults

Historic Seismicity

Anchorage and its vicinity are in an area of historically high seismicity. Most earthquakes occur at considerable depth (30 to 50 kilometers) and do not produce surface rupture. Records of historic earthquakes have been compiled by the National Oceanic and Atmospheric Administration (NOAA 1975; NOAA, 1976a and 1976b) and are available for search on CH2M HILL's DECsystem-10 computer. Two searches were performed for this report:

- o 100-kilometer search radius for earthquakes with magnitude 3 or greater
- o 300-kilometer search radius for earthquakes with magnitude 6 or greater

The searches were performed for a radius from a given point. The point selected was the approximate midpoint stationing of the selected alignment.

The search records are shown in Exhibit B. A summary of the records is shown in Table 6-1. Table 6-1 clearly depicts the high seismicity of the area and indicates the need for a detailed analysis to select the design earthquake(s).

The historic earthquake producing the most damage along the selected alignment was the Prince William Sound earthquake of March 27, 1964 (largest earthquake shown in Table 6-1). This earthquake and its resulting damage in the vicinity of the selected alignment are well documented. The Prince William Sound earthquake should be considered the minimum design level earthquake for the pipeline. Additional studies during final design may indicate a larger design earthquake is warranted.

Known Faults

Known faults in the vicinity of the selected alignment are shown on Figure 6-1.

The closest known active fault is the Castle Mountain Fault (Brogan et al., 1975), approximately 25 miles (40 kilometers) north of the pipeline at its closest point.

The pipeline route crosses the Knik Fault Zone at approximately Station 425+00. (The fault zone location is inferred at this location.) The Knik Fault Zone is believed to consist of steeply dipping to vertical parallel faults.

The Eagle River Thrust Fault passes approximately 1.5 miles (2.4 kilometers) east of the proposed pump station location, its closest point to the pipeline. The upper plate of the fault is to the northwest and the lower plate to the southeast.

Table 6-1
HISTORIC SEISMICITY

Richter Magnitude	Search Radius (kilometers)	Number of Occurrences	Years[a] Recorded	Calculated Number[b] of Occurrences Per 100 years	Closest Recorded Epicenter (kilometers)
3-3.99	100	145	1964-1979	910	20±
4-4.99	100	70	1963-1979	410	25±
5-5.99	100	14	1963-1979	82	15±
6-6.49	100	7	±1930-1979	14	30±
	300	31	±1930-1979	62	F100
6.5-6.99	100	1	±1910-1979	1.4	95±
	300	11	±1910-1979	16	F100
7-7.49	100	3	±1910-1979	4.3	60±
	300	8	±1910-1979	11	F100
7.5-7.99	300	0	±1910-1979		
8.0-8.24	300	1	±1910-1979	1.4	105±

[a]First year of record taken as that year appropriate for return period analysis.

[b]Calculated number of occurrences per 100 years = number of occurrences divided by number of years of record times 100 (see "a" above).

The Knik Fault Zone and the Eagle River Thrust Fault were probably the sites of major crustal activity in the past but are not known to have exhibited recent movement (within the past ±10,000 years). There is a small possibility that renewed activity may occur along the Knik Fault Zone (Zenone et al., 1974). While references indicate the Knik Fault Zone should be considered inactive, the significance of renewed activity on pipeline performance warrants further exploration during final design.

The pipeline may cross or pass close to other unidentified faults that are concealed by the thick glacial and alluvial deposits. Additional information concerning the seismicity of the area can be found in Appendix II, Preliminary Damsite Investigation.

Glenn Highway

Subsurface explorations were performed by the Alaska Department of Highways for upgrading Glenn Highway immediately adjacent to the selected alignment approximately between Stations 120+00 and 420+00. These explorations were performed from 1967 through 1972 and are summarized in reports dated 1970 and 1974 (see references).

The Department performed 115 test borings using truck-mounted, continuous-flight auger rigs. The borings, which typically were terminated before a 10-foot depth, were situated between the vicinity of the Municipal Water Treatment Plant and Station 420+00. Some of the findings were:

- Variable soils above the 5-foot depth, ranging from peat to sandy gravel with cobbles and boulders
- Mixtures of sand and gravel with varying amounts of cobbles and boulders (NSF or F-1 frost susceptibility classification) were typical of soils below 5 feet
- No groundwater in some borings; near the ground surface in others
- One glacial erratic, 20+ feet in maximum dimension was found (the summary reports mention the possibility of other glacial erratics)
- Approximately one-third of the borings indicated refusal at maximum depth

SUBSURFACE EXPLORATION

Test Pit Procedures

The subsurface exploration performed for this report consisted of 15 test pits, excavated and backfilled October 22 and 23, 1980. A rubber-tired Case 580B backhoe equipped with a 2-foot-wide bucket was used for the work. Test pits were located in relation to noticeable topographic features; the approximate locations are shown in Exhibit A.

It is important to note that the subsurface exploration typically did not penetrate to the depth required to lay the pipe (approximately 12 feet). Important observations of subsurface conditions (especially groundwater) at invert depth and pipeline foundation conditions were not directly made.

Soils encountered in the test pits were visually classified by a geotechnical engineer from CH2M HILL in approximate accordance with American Society for Testing and Materials (ASTM) Standard D 2488, "Description of Soils (Visual-Manual Procedure)." Soil classification using this standard helps establish a uniformity in nomenclature, but does not ensure an exact classification. Judgment is still the primary factor, especially in field classification.

In addition, the natural variability in soil deposits creates a complex picture of the subsurface if precise descriptions are employed for each stratum encountered. Soil descriptions for this

exploration have, therefore, been simplified for purposes of interpretation.

Pocket penetrometer tests were performed on selected strata in the test pit side walls. No sampling or laboratory tests were performed. Test pit logs and pocket penetrometer results are shown in Exhibit C.

Summary of Test Pit Observations

The soils encountered in the test pits primarily consist of zero to 2.5 feet of organic surficial soil underlain by predominantly granular soils. The organic material usually is peat or roots, grasses, and leaves in various stages of decomposition. The granular soils typically are silty sand, sand, and mixtures of sand and gravel containing varying amounts of cobbles and boulders. The granular soils vary from loose to dense in consistency and typically are medium-loose to medium-dense.

Some fine-grained strata (sandy silt and clayey sandy silt) were encountered within 3 feet of the ground surface. Test Pit No. 9 was excavated in a landfill, and partially decomposed refuse was encountered.

The major difficulty in excavating the test pits was the removal of boulders and large cobbles. In two test pits, the backhoe could not excavate them. The largest boulder observed in the test pits was approximately 3 feet in maximum dimension. Occasional boulders also were observed on the ground surface adjacent to the pipeline route; the largest was approximately 5 feet in maximum dimension. Bedrock was not encountered in any of the test pits.

Groundwater was encountered in 4 of the 15 test pits at depths of approximately 3 to 9 feet. Where encountered, the inflow into the test pit was very rapid, decreasing the stability of the sidewalls and preventing excavation more than about 1.5 feet below the groundwater table. Soils above the groundwater table were generally moist to slightly wet.

Frost-susceptible materials were encountered at various locations. These materials typically consist of mixtures of silt and sand with various amounts of clay and gravel. Where groundwater is also present, these soils may present frost problems.

Nonfrost-susceptible material was encountered at many locations along the selected alignment, consisting typically of clean mixtures of sand and gravel. This material is prevalent along most of the alignment from the Municipal Water Treatment Plant to Hiland Drive, but from Hiland Drive to the proposed pump station limited amounts were encountered.

Sloughing of the test pit sidewalls was observed in all but four test pits and consisted generally of material gradually falling from the sidewalls as the test pit was excavated. No massive blocks of material sloughed into the test pits.

RECOMMENDED DESIGN CONSIDERATIONS

The following design considerations are based on limited information. Changes and additional refinement should be anticipated during final design.

Alignment

The pipeline alignment should bypass marsh and landfill deposits. The selected alignment does this.

Crossings of active faults should be made at an alignment that will elongate the pipeline based on expected fault displacement. Thrust blocks and other pipeline "anchors" should be remote from the location of potential rupture. Potential areas of earthquake-induced liquefaction and slope instability were not explored and may affect the pipeline alignment.

Dewatering

Positive measures should be implemented along portions of the alignment to control groundwater during excavation, pipe laying, and backfilling. These measures should primarily consist of well points because of the large amounts of groundwater anticipated. Pumping from sumps located outside the pipeline area may be an appropriate measure if the stability of the pipe foundation or excavation is not endangered by this method. Soils containing appreciable amounts of silt and sand or those loose in consistency should not be dewatered by sump pumping.

Design of the dewatering system should account for potential settlement of adjacent areas and removal of fines by piping.

Excavation

Conventional equipment, such as a large track-mounted backhoe, should be suitable for pipeline excavation. Isolated areas may require blasting to aid in excavating large boulders or bedrock.

Sloped excavations and/or temporary shoring will be necessary for safe excavation. Proper dewatering will aid in the safety of excavations. Applicable governmental regulations, such as OSHA regulations, may dictate the sloping and/or temporary shoring requirements.

Pipe Zone Material and Backfill

Large amounts of foundation stabilization material should not be necessary for installation of the pipe. Additional deep exploration is necessary to verify this, however.

Pipe zone material (from approximately 6 inches below the pipe to approximately 6 inches above the pipe) should conform to Class C bedding as specified in the Standard Specifications for the Municipality of Anchorage. In addition to the requirements in the Standard Specifications, pipe zone material should be reasonably well graded from coarse to fine, should have a minimum sand equivalent of 30 and a maximum liquid limit of 25, and should be rounded, not angular. Rounded particles will aid in compaction below the spring line and reduce pipe corrosion at individual contact points with the soil. Limited quantities of suitable pipe zone material were encountered during the subsurface exploration. If excavated material is to be used for pipe zone material, it should be processed, especially to remove oversize particles.

Pipe zone material should be placed in horizontal lifts less than 8 inches in loose thickness and compacted to at least 90 percent relative compaction. Relative compaction is defined as the ratio, in percent, of the as-compacted dry density to the maximum dry density as determined by ASTM D 1557. Special attention should be given to placement of pipe zone material below the spring line to help ensure uniform pipe support and to prevent pipe damage and displacement. Care should be taken when depositing and compacting backfill above the pipe zone to avoid damaging or displacing the pipe.

Backfill above the pipe zone should consist of excavated material that is reasonably well graded from coarse to fine, contains sufficient fines to aid in compaction, and is free from organic and deleterious material. Material suitable for backfill above the pipe zone was encountered in many of the test pits. Some material processing should be anticipated to remove oversize particles.

Backfill above the pipe zone should be divided into two classes depending on the allowable settlement (settlement refers to settlement above the pipe zone only).

Where settlement should be kept to a minimum (road crossings, for example), compaction requirements should be specified for maximum particle size, maximum loose lift thickness, and minimum relative compaction. All these requirements should be verified through field inspection and testing during construction.

Where settlement is not important, consideration should be given to developing a method of specification for placement and compaction of backfill. The areas where settlement is not important should be crowned to account for future settlement, and when

these areas are delineated, plans for the area should be studied so that possible future construction over the pipeline (a future roadway for example) is taken into account.

For both pipe zone material and backfill above the pipe zone, compaction moisture content should be as close as practical to optimum to aid compaction. Also, compaction should be accomplished by mechanical means; flooding and jetting should not be allowed.

Ship Creek Crossing

It appears that the only feasible method of constructing the crossing is under water (versus jacking or dewatering). The top of the pipe zone should be 1 to 2 feet below the depth of scour to resist uplift and exposure of the pipe. Additional study is necessary to determine the depth of scour.

Partial lowering of the groundwater table during construction of the crossing should not be allowed because this would tend to loosen or uplift the foundation material. Also to resist uplift, the pipe should be concrete encased with a suitable tremie concrete. It is recommended that reinforcement be provided perpendicular to the axis of the pipe and that riprap and riprap bedding be placed along the streambanks at the crossing to minimize erosion of backfill.

Thrust Blocks

The allowable soil-bearing pressure is dependent upon many factors that must be addressed during final design. For preliminary sizing of thrust blocks, the allowable bearing pressure has been calculated using the following assumptions:

- Ground surface is horizontal
- Moist soil unit weight = 125 pcf
- Saturated unit weight = 135 pcf
- Effective soil friction angle = 35 degrees
- Effective soil cohesion = 0
- Cover = 4 feet (ground surface to top of block)
- Height of block = 6 feet
- Design groundwater table = 6 feet
- Steady-state pipeline flow conditions (no surge or cyclic loads)

- Factor of safety = 1.25
- Thrust block poured neat against an undisturbed vertical soil face

The Rankine passive earth pressure theory was used to calculate the ultimate passive pressure; the resulting allowable bearing pressure is shown on Figure 6-2. Allowable passive pressures are used for preliminary design only and should not be used for final design.

The ground surface configuration influences the amount of soil within the passive zone. Thrust blocks on sloping hillsides where the pipeline thrust is directed out from the slope face deserve special consideration. These blocks should be placed well into the slope, a minimum of 3 feet, so that a full passive zone is mobilized or the allowable passive pressure should account for the reduced passive zone. In addition, the pipeline thrust should act between the midpoint and the lower-third-point of the thrust block (see Figure 6-2). This will aid in making the thrust force and soil resistance colinear.

Some thrust blocks cannot be poured neat against undisturbed vertical soil-bearing surfaces. In such cases, it is anticipated that the thrust block will be poured neat on a sloping soil face, or the thrust block will be formed and subsequently backfilled against. Selection of allowable bearing pressures should account for these and other probable methods of construction.

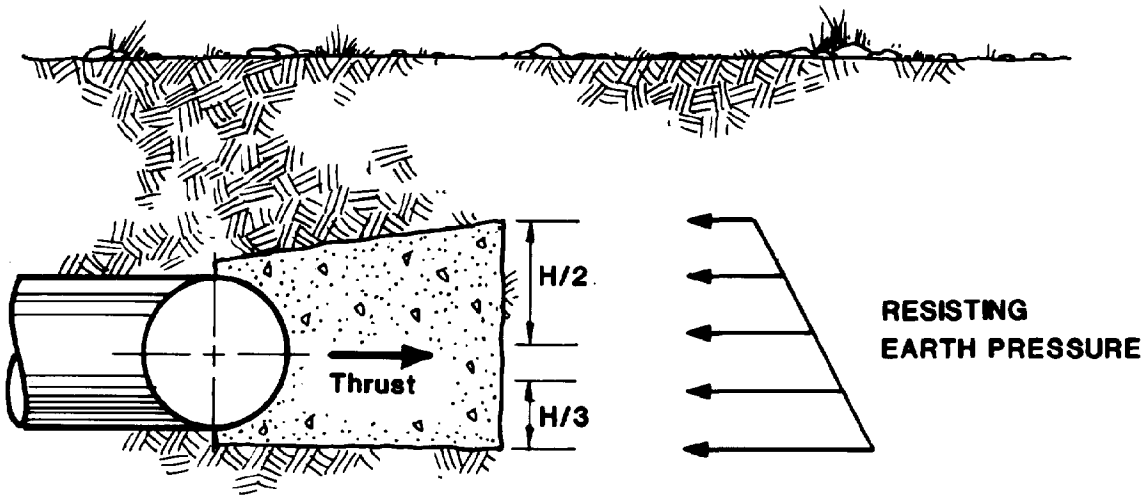
Frost Susceptibility and Frost Penetration

With a minimum cover of 7 feet over the pipe, frost effects should be minimal on the pipe itself and no special design considerations are necessary. Specifically, no significant lateral or heave loads are anticipated for the pipe.

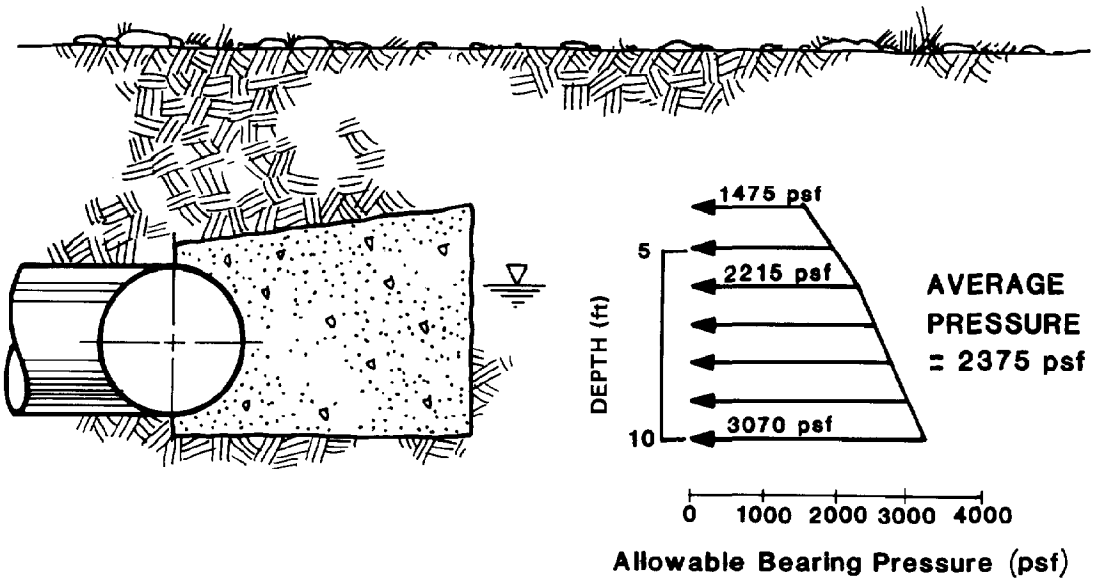
Appurtenant structures such as blowoffs, access manholes, or air valves will require special consideration during final design. From a geotechnical standpoint, backfill around and underneath these appurtenant structures should consist of nonfrost-susceptible material.

In addition, road crossings and other areas where surface heave cannot be tolerated will require special consideration during final design. Nonfrost-susceptible backfill will be necessary in these locations, also.

Further exploration and laboratory testing are necessary to define the location and amount of nonfrost-susceptible material along the alignment. Refer to Chapter 10 for recommendations for exploration during final design.



LINE OF THRUST



ALLOWABLE BEARING PRESSURE

Figure 6-2
Thrust Block

Chapter 7
SUMMARY OF PRELIMINARY DESIGN AND SPECIFICATIONS

During the preliminary design process, the selected Alternative 1 pipeline alignment was reviewed by the Municipality of Anchorage, Eklutna, Inc., the U.S. Army, and the Alaska State Department of Transportation. Based on this review process, as well as additional engineering data, the alignment was modified in some reaches of the pipeline.

This chapter summarizes the preliminary pipeline design and discusses the modifications to the selected Alternative 1 alignment. It also contains special conditions and general survey information that are associated with the preliminary design and a summary of the preliminary technical specifications.

Final preparation of plans and specifications associated with final design will cover the legal conditions, permit and rights-of-way stipulations, electrical requirements, telemetry and controls, subsurface soil information, funding agency requirements, and modifications of the draft specifications.

PRELIMINARY PLANS

General Alignment

Figure 7-1 depicts the selected Alternative 1 general alignment with modifications. The pipeline begins just east-northeast of the existing Municipal Water Treatment Plant. From that point, it continues north to the right-of-way of the Glenn Highway. At that point, it turns northeast and parallels the Glenn Highway to a point about 1,200 feet east of Arctic Valley Road. The pipeline then leaves the Glenn Highway right-of-way and is routed to the east approximately 600 feet, where it turns back to the northeast and parallels the Eklutna powerline right-of-way. Once the pipeline route passes the road into the main gate to Fort Richardson, it continues along a parallel route with the frontage road, the Eklutna powerline, and the Glenn Highway in a northeasterly direction to the Department of Transportation Weigh Station on the Glenn Highway. Approximately 1,200 feet to the northeast of the weigh station, the pipeline route leaves the Glenn Highway and follows an access road to Hiland Drive, crosses Hiland Drive, and then follows a jeep trail down to Eagle River. The end of the pipeline is in the immediate vicinity of Eagle River where the proposed pump station would be built.

Specific Alignment Comments

The preliminary plans, which appear in a reduced-size version in Exhibit E, show the pipeline alignment and its appurtenances in

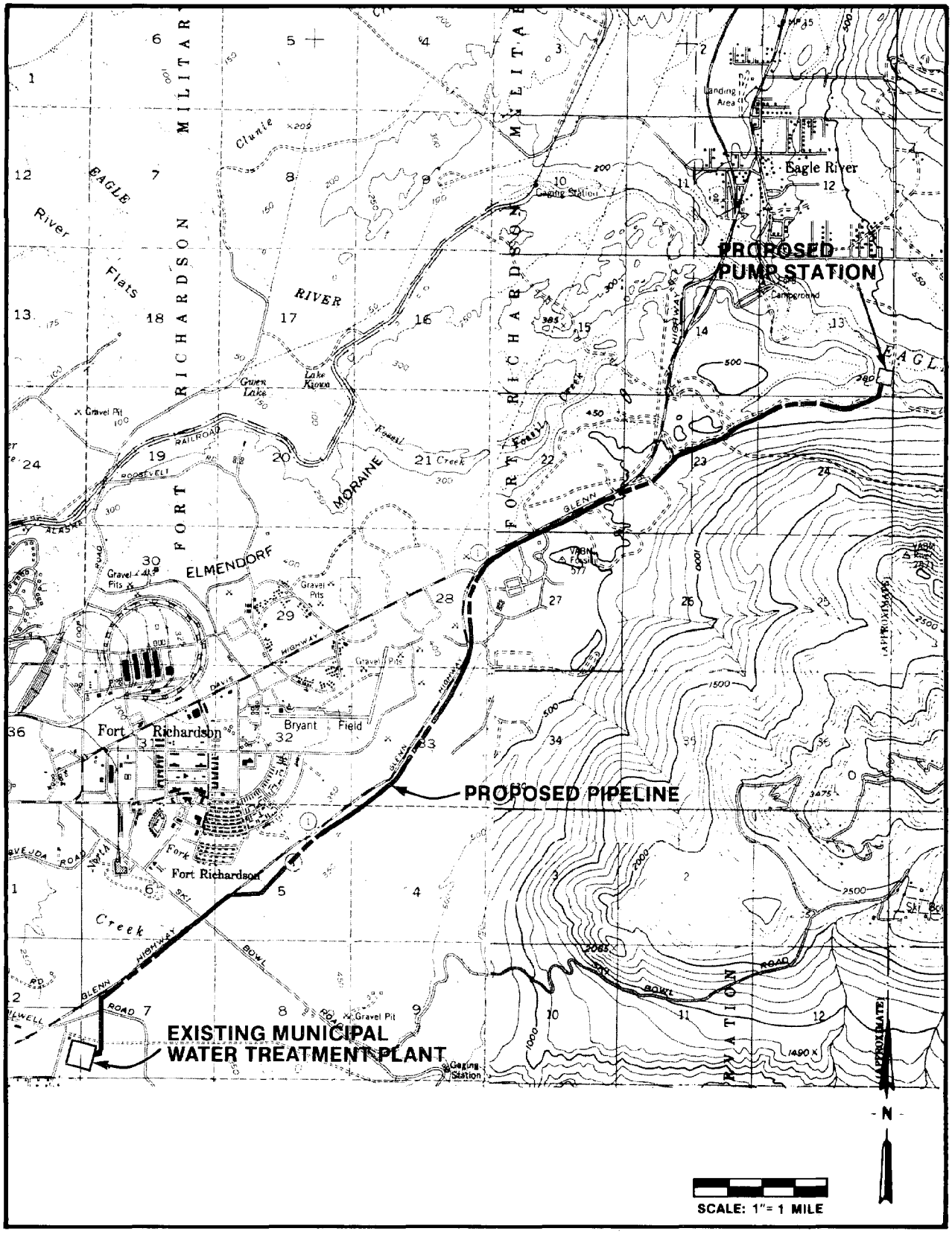


Figure 7-1
Modified Alternative 1
Alignment

detail. All the stations referred to in this chapter can be found in the preliminary plans.

The stationing for the Eagle River water transmission pipeline begins at a point (Station 180+80) near the Municipal Water Treatment Plant. Details showing the pipeline connection to the treatment plant are not included because of the uncertainty associated with the future plant expansion.

At Station 192+40, a special fitting provides for a change in the direction of the pipeline to parallel the Glenn Highway. Along the Glenn Highway axis of the fitting, a blind flange has been incorporated to allow for future connection of a continuing pipeline that would parallel the Glenn Highway and proceed toward Anchorage. Also at this special fitting, the pipeline size is increased from a nominal diameter of 30 inches to 48 inches. The balance of the pipeline from the special fitting to Station 600+00 is a 48-inch nominal diameter.

At approximately Station 193+00, the pipeline crosses an 8-inch military multiproducts pipeline and at Station 193+20, crosses a 12-inch existing gas line. These utilities, as with other utilities along the pipeline route, will need to be further identified and located during the final design stage of the project. Crossing over or under natural gas lines will require that the water main be protected from freezing.

Between the special fitting and beyond Ship Creek to Arctic Valley Road, the pipeline is shown in a location which parallels the Glenn Highway controlled access and right-of-way boundary line. It is located 10 feet outside of the boundary to minimize the degree of clearing necessary for the construction of the pipeline.

Between Station 230+10 and Station 231+60, the pipeline crosses Ship Creek. On each side of the creek crossing, pipe cutoff walls should be installed to prevent water seeping along the pipeline from Ship Creek. For the crossing itself, reinforced concrete should cover the top one-half of the pipe to offset any buoyancy forces. The lower half of the pipeline will be located on satisfactory pipe bedding material. These measures are necessary to protect the pipeline from channel erosion. Also, the stream banks should be riprapped to avoid erosion of the trench backfill material. These special measures will need to be taken during final design and construction. Refer to the additional discussion presented in Chapter 9, Permit Acquisition Process.

Approximately at Station 241+50, the pipeline crosses Arctic Valley Road. Open-cut methods will be used to cross the road.

Beyond Arctic Valley Road, the pipeline continues to parallel the Glenn Highway right-of-way until it reaches approximately

Station 253+70. The pipeline then heads east to approximately Station 258+38. As the pipeline leaves the Glenn Highway, it proceeds up a steep hill toward the Eklutna powerline. It will probably be necessary, following construction, to revegetate or provide slope protection for this portion of the alignment. The pipeline alignment then turns toward the north and parallels the Eklutna powerline right-of-way to approximately Station 315+10. Along the Eklutna right-of-way, the pipeline is initially on the west side of the right-of-way and then crosses to the eastern side of the right-of-way to achieve better access and fit the topography.

Between Arctic Valley Road and the main gate to Fort Richardson, the pipeline alignment originally followed the Frontage Road. Preliminary plans were developed and reviewed by Fort Richardson personnel and, at their request, the alignment was modified to follow the Eklutna powerline right-of-way instead. For this reason, new plan and profile sheets were prepared using existing aerial photography. Because the targeting for horizontal control of the photography was based on the Frontage Road alignment, the horizontal scale for portions of Preliminary Plan Sheets 6 through 8 is approximate.

Approximately at Station 313+00, the pipeline crosses the Frontage Road, which connects to the main entrance to Fort Richardson. Since the pipeline is located outside the controlled access and right-of-way area, an open-cut trench across the road is planned. This is significantly cheaper than boring and jacking the pipeline under the road.

Between Station 315+00 and the Alaska Department of Transportation Weigh Station located approximately at Station 475+00, the pipeline alignment parallels the Frontage Road or the Eklutna powerline right-of-way where necessary. Review of the possible alignment by the Fort Richardson personnel showed a preference for locating the pipeline on the Glenn Highway side of the Frontage Road. This alignment was preferred because the clearing of trees for the pipeline between the frontage road and Glenn Highway would increase traffic sight distance, thus reducing automobile collisions with moose.

Between the main gate entrance to Fort Richardson and the Department of Transportation Weigh Station, the pipeline occasionally encroaches on the controlled access right-of-way for the Glenn Highway. This encroachment is minimized to the extent possible, except where the Frontage Road or Eklutna powerline forces the alignment up to 30 feet into the controlled access area. Because of a need to locate on the Glenn Highway side of the Frontage Road, these encroachments should be acceptable to the Federal Highway Commission. (Refer to Chapter 9, Permit Acquisition Process.) Also, the encroachment is necessary to keep the

pipeline outside of the Eklutna powerline right-of-way to increase workers' safety during pipeline construction.

Approximately at Station 489+00, the pipeline alignment leaves the Glenn Highway and parallels an access road in a northeasterly course toward Eagle River.

At Station 511+30, the pipeline crosses the high point of the system. At this point, the pipeline is open to the atmosphere in an air and access vault. The high point of this system was left open to the atmosphere to avoid the need for an air and vacuum valve. Also, the preliminary design of the pipeline does allow gravity pressure flow between the high point of the system and the water treatment plant.

From Station 511+30, the pipeline parallels the access road/jeep trail to Eagle River in a northeasterly direction. Cleared areas are crossed whenever possible to avoid additional clearing of trees during construction of the pipeline.

At Station 534+00, the pipeline crosses Hiland Drive in, what is expected to be, an open-cut trench.

Approximately between Station 543+00 and Station 552+00, the pipeline will parallel the old Eagle River dump. The alignment has been shifted to allow the pipeline to pass to the southeast of the old dump to avoid possible contamination.

At Station 600+00, the pipeline ends in the vicinity of Eagle River. As with the water treatment plant end of the pipeline, no connection details were shown because of the uncertainty associated with the location of the proposed pump station.

SPECIAL CONDITIONS

Old Eagle River Dump

Between Stations 543+00 and 552+00, the pipeline is located adjacent to the old Eagle River dump. The soil at the site is mildly corrosive. The old dump is potentially a source of contaminants to a potable water system. In this area, the pipeline will be located a minimum of 100 feet uphill from the edge of the site. To verify the outer limits of the site during final design, borings should be made and cased. Piezometers should be installed to monitor the quality and movement of the groundwater.

Future Connections

At this stage in design, the point of supply and the location of treatment have not been determined. Presently, it is assumed that the supply will come from Eagle River and the treatment

plant will be in the area of the diversion. Following this assumption, treated water will be pumped north to the Eagle River-Chugiak-Eklutna area and south through the proposed pipeline to the existing Municipal Water Treatment Plant. No future connections are anticipated between Eagle River and the Municipal Water Treatment Plant.

During the design of the pump station, the advantages of constructing a regulating reservoir in the vicinity of Station 510+00 should be investigated. This regulating reservoir may serve to average the minimum and maximum daily flows and thus minimize the size of the pump station and complexity of pump selection and controls.

Eagle River Access Road

Assuming water will be diverted, treated, and pumped from Eagle River, consideration should be given during final design to construction of the pipeline within the roadway prism of the access road from Hiland Drive to Eagle River. This would minimize the amount of project clearing, provide better accessibility to the pipeline, and reduce overall project costs.

SURVEY INFORMATION

Aerial photography and preparation of the general plan sheets and the photoplan/profile sheets were completed by Air Photo Tech, Inc. Hewitt V. Lounsbury and Associates performed much of the surveying work for this task.

Aerial Photography

Aerial photography for the 1"=400'± general plan sheets was taken August 4, 1980. A set of the contact prints was provided to the Municipality of Anchorage with the preliminary plans. The general plans are only approximate in scale because the horizontal control was developed from existing USGS quad sheets and other available mapping. These plans were developed solely for the purpose of identifying alternative routes.

The 1"=100' preliminary photoplan/profile sheets were developed from aerial photography of the selected alignment, dated October 25, 1980. This work was scheduled for early October, immediately following leaf drop, but, due to adverse weather, was delayed to late October. This delay reduced the overall quality of the photo image, particularly in the Eagle River area where the hillside area is shaded due to the low sun angle.

Horizontal Control

Photo control points were established using monuments along the selected route at intervals of approximately 1,300 feet. The

monuments were traversed by a second-order survey, adjusted and fixed to the United States Coast and Geodetic Survey (USC&GS) datum.

The monuments consist of rebar or rebar with an aluminum cap driven in the ground. Should the Municipality of Anchorage or the U.S. Army anticipate that this monumentation will be beneficial for future work, we recommend that the rebar be replaced with standard brass or aluminum tablets set in concrete. The tablets may require witness posts and should be stamped with an appropriate identification number.

Vertical Control

Elevations of the photo control points used in profiling the selected route are based on USGS datum.

PRELIMINARY TECHNICAL SPECIFICATIONS

Draft technical specifications have been prepared for the Eagle River transmission main and are included in Exhibit F. The specifications follow the format used by the Municipality of Anchorage. Special provisions are prepared to modify the Municipality's Standard Specifications, dated June 1980.

These draft technical specifications are based on the preliminary plans and will be modified and expanded following final design. Divisions of the Standard Specifications, which are referred to or modified in the preliminary technical specifications, are as follows:

1. Division 10 - General Provisions
2. Division 20 - Earthwork
3. Division 30 - Concrete
4. Division 60 - Water Systems
5. Division 70 - Miscellaneous Items
6. Division 80 - Standard Details

Chapter 8
PRELIMINARY COST ESTIMATE

The purpose of this preliminary cost estimate is to present a range of probable costs for the construction of a 48-inch-diameter pipeline from a site at Eagle River to the existing Municipal Water Treatment Plant near the Glenn Highway and Muldoon Road.

COST ESTIMATE

The cost estimate is presented in Table 8-1 and is based on November 1981 dollars. No attempt is made to predict a construction schedule or cost of construction.

Costs outlined in the body of the estimate are the only ones considered. Operations, maintenance, and permit costs are not included. Mobilization and demobilization are shown as a separate cost item instead of being incorporated into unit costs. Bonds and insurance costs (truck and auto, liability, builder's risk, performance, and payment bond) are also shown as a separate cost and amount to 2.5 percent of construction. The legal, administrative, and engineering costs are estimated to be 20 percent of the construction costs. Depending on the amount of geotechnical work required and the difficulty in obtaining permits, this cost normally will range from 15 to 20 percent. The project contingency allowance was estimated to be 30 percent. Under the assumption that water will be obtained from the Eagle River, this allowance may vary from 20 to 30 percent.

BASES FOR COST ESTIMATES

The following information sources and assumptions were used in the preparation of the preliminary cost estimate:

- Material price quotes on major items were obtained from vendors, and freight and profit allowances were added by CH2M HILL staff.

- Machinery rates were based on current rental rates plus fuel, oil, and lubricant allowance, plus the cost of the appropriate operator.

- Labor rates were based on raw rates as published by the Alaska Chapter of the Associated General Contractors of America plus 55 percent of raw costs for contractor's general conditions. Included in this category are Social Security contribution, workman's compensation insurance, timekeeping functions, general superintendent and vehicle, other personnel not included in crew rates, and miscellaneous nonqualified expenses. On top

Table 8-1
EAGLE RIVER WATER SUPPLY TRANSMISSION MAIN
PRELIMINARY COST ESTIMATE

Component	Quantity	Unit Price ($)	Total ($)
Mobilization and Demobilization	Lump sum	706,000	706,000
Clearing and Grubbing	Lump sum	327,000	327,000
48-Inch Pipe Installed	40,700 lin ft	260	10,582,000
30-Inch Pipe Installed	1,160 lin ft	175	203,000
Trench Stabilization Material	1,400 tons	18	25,200
Air-Vacuum Valve Assemblies	8 ea	10,000	80,000
Type 1 Blowoff Valve Assembly	4 ea	2,900	11,600
Type 2 Blowoff Valve Assembly	3 ea	3,800	11,400
36-Inch Isolation Valve and Thrust Restraint	7 ea	33,000	231,000
Valve & Fitting Station 192+40	Lump sum	20,000	20,000
Air and Access Vault Station 511+30	Lump sum	20,000	20,000
Ship Creek Crossing	150 lin ft	400	60,000
Access Manholes	11 ea	12,000	132,000
Telemetry & Controls	Lump sum	50,000	50,000
Compacted Embankment	1,200 cu yd	6.55	7,860
18-Inch CMP Cross Drains	38 lin ft	50.00	1,900
Pipe Location Monuments	89 ea	150.00	13,350
	Subtotal		12,482,310
	Bonds & Insurance (2.5%)		312,000
	Legal, Admin, Engineering (20%)		2,559,000
	Subtotal		15,353,000
	Contingency (30%)		4,606,000
	PROJECT TOTAL		19,959,000

Note: All costs are in November 1981 dollars.

of the labor-plus-55-percent figure, an additional 15 percent was allowed for contractor overhead and profit. It was assumed that the work will be conducted in six 10-hour shifts per week, amounting to 20 hours of overtime. This additional cost is included in the developed hourly rates.

- Production rates were obtained from various published sources such as the Richardson Rapid Cost Estimating System (Richardson Engineering Services, Inc., 1981) and vendor literature.

- Costs reflect a contractor profit for each item and do not include allowances for high initial costs at the beginning of a particular job. Contractor bids will sometimes be structured in this way to stimulate an early high cash flow for the contractor. For example, a higher-than-usual figure was not used for clearing and grubbing, and an unusually low figure was used for trench backfill or asphalt pavement replacement.

- Backfill for nontrafficked areas will be compacted to 80 percent.

- No blasting is anticipated.

- Dewatering of the area is not expected.

- A temporary diversion of Ship Creek will be required.

- Minimum depth of cover on top of pipe will be 7 feet.

- For the purpose of this estimate, the pipe was assumed to be cement-mortar-lined, Class 52 ductile iron with push-on joints and mechanical joint fittings.

- The pipe will be flushed, tested, and disinfected by section. No special provisions will be required for chlorinated water disposal.

- Pavement replacement costs are based on the section shown in Detail 114 of the Municipality of Anchorage Standard Specifications, dated June 1980. These costs are included in the in-place costs of the 48-inch-diameter pipe.

- Clearing and grubbing costs include an allowance for constructing temporary, nonspecification roads. Clearing width was assumed to be 75 feet.

- Monuments for pipeline locations were considered to be not more than 500 feet apart.

- This estimate does not include a treatment plant or pumping station. It also does not include costs for connection to those facilities.

Indirect Costs

Indirect costs are included in the 55 percent markup on labor and are set forth here. They could be carried in a separate overhead account, but quantification would be burdensome and would not increase the accuracy of the estimate.

Jobsite Overhead

Jobsite overhead includes trucks and autos not with crews (general superintendent, expediter); personnel not on crews (project manager, manager, superintendent, safety engineer, timekeepers, clerical assistants); temporary facilities (contractor's office and attendant expenses, temporary toilets, signs and barricades, tool sheds and storage facilities); supplies and expendables (stationery, copy machine, postage, drinking water, first aid equipment, hand tools, fuel, oil, and lubricants for vehicles and equipment); temporary protection and OSHA requirements (fencing, protection against vandalism and theft, and dust control); telephone and radios; survey; progress reports and scheduling (CPM or scheduling engineer, progress reports, certified payrolls); testing (concrete, hydrostatic testing); and job cleanup.

Home Office Overhead

Home office overhead includes office staff salaries, physical plant, sales promotion and education, yard expenses, loss of interest on retainage, and interest.

The indirect costs shown here are basically complete (Richardson Engineering Services, Inc., 1981). Other items could be added, but insignificant gains in accuracy would be realized. These items are covered in contingencies.

Rights-of-Way Cost

The alignment of the pipeline would generally follow Glenn Highway and cross land owned by the United States Army, the State of Alaska, and Eklutna, Inc. Rights-of-way acquisition is based on the following assumptions:

- No charge will be levied for granting easements across State of Alaska or U.S. Army parcels.

- Right-of-way across Eklutna, Inc., property would be covered in acquisition costs for a dam and reservoir if a significant supply of groundwater is not found during the performance of Task 1, Well Drilling Program.

Chapter 9
PERMIT ACQUISITION PROCESS

Various local, state, and Federal agencies will require that they be notifed and that permits be acquired before the start of construction of the water transmission pipeline. Described below are those agencies that must be contacted and the information they require. The U.S. Bureau of Land Management and the Department of Environmental Conservation are the agencies from which most of the permits are required.

UNITED STATES BUREAU OF LAND MANAGEMENT

A rights-of-way grant to cross Federal lands must be acquired from the Bureau of Land Management (BLM). To apply for a grant, an application letter must be addressed to the State Office of the Bureau of Land Management. This letter must contain a detailed description of the planned project, including all technical information and a construction schedule. In addition, it must include three complete sets of drawings (original reproducibles of certain drawings may be required). The application letter also must provide general information relating to the applicants' civil rights assurances, disclosure of plans, and other related items. This general information may be substituted by a reference to another municipal grant application (for example, the Municipality of Anchorage's 36-inch water transmission pipeline). BLM may require some reimbursement for this grant if their costs of monitoring construction work exceed $5,000.

Approval of a rights-of-way grant will be subject to comments from the military and the various utility companies whose easements are crossed on Federal land. Letters of nonobjection will be required from each utility company involved. The Corps of Engineers and the Fort Richardson Facilities Engineers will need to approve the rights-of-way locations within military land before the BLM can approve the grant. These groups should be contacted as early as possible to speed the grant approval process. The Fort Richardson Facility Engineers contact should be made through the Director of Facilities Engineering, AFTZ-FE of HQ 172nd Infantry Brigade at Fort Richardson.

The BLM will also require detailed information about the Ship Creek crossing before rights-of-way can be approved. A detailed environmental analysis by either the Municipality or the BLM will be needed to satisfy this requirement.

It will take the BLM approximately 3.5 months to process the rights-of-way grant application once the application letter is delivered. More time might be required if there are objections from the military or the utility companies. The Ship Creek crossing could also increase the process time if an environmental

impact statment or public hearings are required. The time required could be minimized by making early contact with all involved groups.

Preliminary investigations, including surveying, geotechnical, and archeological work, may proceed during the rights-of-way grant application process if a temporary use permit is obtained from the BLM. This permit takes approximately 1 week to process. A copy of this permit application, which must be completed in duplicate, is shown in Exhibit E.

CHUGACH ELECTRIC ASSOCIATION

To obtain permission to cross or occupy the Chugach Electric Association's easements, a letter describing the proposed crossing must be written to its general manager. This letter must contain drawings and other information related to the rights-of-way infringement. On the basis of this information and, if there are no significant problems, Chugach Electric Association will issue a letter of nonobjection to the BLM. Normally, easement crossings are not disapproved; however, occupation of a substantial length of its rights-of-way might not be acceptable.

ALASKA GAS AND SERVICE COMPANY

The Alaska Gas and Service Company must submit to the BLM a letter of nonobjection for all crossings of Alaska Gas and Service Company easements. To prepare this letter, they require detailed information about the crossings, including drawings and plans showing exactly how the gas line will be crossed and safeguarded. The gas company will not normally object to crossings if its lines are safeguarded, and they will recommend alternatives if they disapprove of the crossings. All information submitted by the Municipality should be directed to the chief engineer.

ANCHORAGE MUNICIPAL LIGHT AND POWER

Anchorage Municipal Light and Power (ML&P) normally grants permission for crossings of its easements as long as no power poles need to be relocated. To obtain permission, a letter and completed set of final drawings should be submitted to its chief engineer. ML&P will review the crossings and make any comments it deems necessary as soon as possible.

BUREAU OF INDIAN AFFAIRS

A rights-of-way authorization or land use permit may be required from the Bureau of Indian Affairs (BIA) wherever Indian land is crossed. The BIA asks that the owners of the Indian land, Eklutna, Inc., be contacted directly with permit application information. Requirements for obtaining rights-of-way permits include

a preliminary survey (with BIA permission), landowners' written consent, accurate mapping, an agreement to stipulations for construction and maintenance of the rights-of-way, and a deposit for payment of the rights-of-way cost and severance damages, if necessary.

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

To determine which state permits are required for a proposed project, a master application process has been enacted through the Department of Environmental Conservation (DEC) Permit Center. Details of this process and a sample application form can be found in Exhibit D, under "General Information," "Laws of Alaska," and "Master Application."

The master application process identifies all state permits that are required for a project. To identify the specific state permits required, the DEC Permit Center recommends that a master application form be submitted as early as possible. The individual state permit applications need not be completed at the same time as the master application submittal. However, they must be completed and returned to the permit center within 30 days or a new master application will be required. Under the terms of the master application process, the permit applications must be processed by the permit center within 6 months from the date of the master application submittal.

In conjunction with filing a master application form, it is important that the individual permit applications be filed directly with the permit center. Direct application to the individual state agencies would probably delay the permit approval process.

The following paragraphs present permit application information from several of the state departments that will be involved in the permit procedure for the water transmission pipeline.

ALASKA DEPARTMENT OF TRANSPORTATION

The DEC master application process will ensure that the Alaska Department of Transportation (DOT) is contacted regarding permit requirements. The DOT will then request that a utility permit on highway rights-of-way be obtained for the Glenn Highway rights-of-way encroachment and for the Hiland Drive Crossing. A copy of this permit application form is included in Exhibit D. Along with the permit applications, a project description, drawings, and records of all correspondence already made with the DOT should be submitted.

According to the DOT, whenever limited access rights-of-way are encroached upon, detailed information discussing alternative routes that were considered must be submitted. Strong justification for locating the utility within the highway rights-of-way must

be shown. Justification could be: (1) that there is no other choice for the location, (2) that other alternatives are of considerably higher expense, or (3) as in this case, that the U.S. Army states in writing that this location is the only acceptable one.

ALASKA DEPARTMENT OF FISH AND GAME

The Department of Fish and Game will be contacted through the DEC master permit application process. This department will request that a Habitat Protection Permit be obtained for the Ship Creek crossing. To obtain this permit, detailed information concerning the construction dates, the method of crossing, and type of construction equipment will be needed. This information must be returned to the Department of Fish and Game through the DEC process. Ordinarily, the Department of Fish and Game will allow in-water work in Ship Creek only between May 15 and July 15.

Chapter 10
RECOMMENDATIONS FOR FINAL DESIGN WORK

The purpose of the preliminary design report, the preliminary plans, and the technical specifications is to establish design criteria and to resolve major questions pertaining to design concepts. This effort represents approximately 30 to 40 percent of the design work required for preparation of construction contract documents. The remaining 60 to 70 percent of the design would be accomplished during the final design phase.

FINAL DESIGN

Items of work that will be required during final design are:

- Geotechnical investigation
- Corrosion investigation
- Surveys and rights-of-way acquisition
- Utilities concerns
- Hydraulics analysis
- Engineering cost estimate
- Permit acquisition

Geotechnical Investigation

The following recommendations for future exploration are based on the need for additional information that was identified during preliminary design. These recommendations cannot, however, be considered complete because the final design will identify additional and more detailed geotechnical considerations.

Seismicity

Additional analysis is necessary to establish the design earthquake(s). This analysis should involve statistical analysis of historic earthquake records. If significant time elapses between preliminary and final design, the historic records provided in Exhibit B may need updating.

Upon selection of the design earthquake(s), the following concerns need to be addressed:

- Response of the buried pipeline to shaking, including special attention to the pipeline's interaction with appurtenant structures

- o Liquefaction
- o Seismic-induced slope instability
- o Seismic-induced settlement

The Knik Fault Zone crossing should be studied further to evaluate its potential for activity and the direction and magnitude of relative ground displacement (if any) at the depth of pipe burial. This will require an evaluation of the relative displacement of the bedrock and the depth of unconsolidated deposits overlying the bedrock.

Subsurface Exploration and Laboratory Tests

Borings and large-scale test pits are necessary to describe more accurately the subsurface conditions, especially the pipeline foundation conditions. Appropriate laboratory tests are necessary to characterize the subsurface materials, to aid in the selection of design soil parameters, and to identify the frost susceptibility of these materials. Special attention should be given to subsurface conditions at thrust block locations and at the Ship Creek crossing.

Design groundwater levels need to be established at thrust block locations. Also, the groundwater regime in the vicinity of the old dump should be studied. Special attention should be directed toward ensuring that pipeline backfill will not act as a "conduit" for leachate movement. Consideration should be given to the use of cutoff collars to minimize leachate movement.

It is recommended that groundwater information available for other locations along the pipeline be studied and that additional information be gathered to aid in defining the need for, and in designing, construction dewatering systems.

Excavated materials (borrow materials) should be processed or materials should be imported for use over much of the pipeline, especially for pipe zone material. Identification of potential borrow sources and evaluation of the economics of imported material will influence the selection of appropriate backfill materials and the subsequent material specification.

Corrosion Investigation

During final design, alignment changes should be reviewed to verify that the soils along the revised route are not substantially more corrosive than those of the preliminary route studied. The review should also include the location of nearby natural gas pipelines and associated cathodic protection systems to ensure that the Eagle River pipeline is not affected by interference from

newly constructed gas company facilities. This review would be accomplished by field work (testing and sampling) and by contacting the Alaska Gas and Service Company.

Updated water quality data from Eagle River should be reviewed if cement mortar is considered for lining metallic pipe. The purpose of the review will be to verify that the water contains sufficient hardness and alkalinity during the year to avoid excessive leaching of the cement from the cement mortar.

Survey and Rights-of-Way

The field surveys were performed during the preliminary design phase to provide horizontal control for the aerial photography necessary for the preparation of plan and profile sheets. This control may serve as ground control for subsequent surveys required during final design.

A rights-of-way survey will be necessary during final design to determine the location of the centerline of the pipeline in relationship to existing property lines and rights-of-way boundaries. The final pipeline alignment will then be field tied to the rights-of-way survey so that the easements may be prepared.

The final pipeline centerline alignment should be monumented and reprofiled so that the profile reflects the exact location of the pipeline. During this task, it may be advantageous to monument all angle points and the beginning and ending of horizontal curves for use during construction staking.

Rights-of-way work required during construction should include the preparation of legal descriptions of easements, rights-of-way plats, and formal permit applications. Easement descriptions will be needed for both permanent and temporary (construction) easements. Rights-of-way plats would include the data necessary for the appraiser to evaluate the subject easement. These data would include:

- Parcel number
- Existing easement
- Size and shape of the parcel for appraisal
- Size and shape of the easement
- Physical monuments or other pertinent features
- Title identity

Utilities Concerns

Prior to construction of the pipeline, the following types of utilities problems will require solutions by the contractor:

- Protecting existing utility poles and towers from overturning
- Protecting workmen from high voltage lines and gas mains
- Maintaining the operation of existing utilities

Hydraulics Analysis

Many variables are still unknown that can affect the hydraulics of the system. These unknowns include the method and location of facilities for pumping water from the source, as well as the treatment, storage, and distribution of the water.

Once the source of supply, the location of the treatment and storage facilities, and the requirements for connecting to the Municipality's distribution system are known, a total system hydraulic analysis will be required. Although it is not anticipated that the pipe diameter will change, the class of pipe and the size of air valves could vary from those specified in the preliminary design once the surge analysis is completed. For this reason, the class of pipe and size of air valves are not shown on the attached preliminary plans.

Engineering Cost Estimate

At the beginning and conclusion of the final design, the engineering cost estimate should be updated to reflect current costs and design. At this time, the administrative, legal, and engineering allowance and the contingency allowance should be reviewed in detail. Rights-of-way and permit acquisition costs should be included in the final project estimate.

Permits

Requests for encroachment permits have been initiated during the preliminary design phase. The preliminary alignment has been reviewed by personnel from Fort Richardson and the State Department of Transportation, and their comments have been incorporated into the preliminary plans.

Prior to and during final design, continuing effort will be required to satisfy each agency's requirements for issuance of encroachment permits. Chapter 9, Permit Acquisition Process, discusses the general requirements of each permitter in more detail.

PREPARATION OF THE FINAL CONTRACT DOCUMENTS

The reduced half-scale preliminary plans shown in Exhibit E were developed to serve as a basis for final design drawings. Following detailed review by the Municipality of Anchorage's staff and by the permitting agencies, the pipeline alignment and detail sheets will require modification.

For contract documents, it is recommended that 1"=50' scale photoplans be used. This scale would be compatible with the recently completed plans for the 36-inch supply main to its water treatment plant from the military diversion facility on Ship Creek. Fifty-scale drawings are advantageous for depicting, in greater detail, such items as existing utilities and pavement replacement and clearing requirements. The photo control established during preliminary design, supplemented with some intermediate points, would be sufficient for the preparation of new plans.

Work that would be included in the final preparation of the plans is:

- Determination of the class of pipe required for various reaches of the pipeline
- Determination of the classes of backfill required for various sections of the route
- Determination and detailed specification of the methods for protecting the pipeline appurtenances from freezing
- Determination of thrust block size at each bend
- Determination of the size of air valves after completion of the surge analysis
- Detail cathodic test stations if required
- Preparation of casing details if these are required by the permitter (presently, open-cut crossings are anticipated)
- Preparation of electrical drawings (including telemetry)
- Complete erosion control and stream crossing details
- Preparation of sump pump details for draining vaults
- Review of dewatering requirements for the pipeline route and detailed specifications of dewatering methods

- Determination of the depth of existing underground utilities at proposed crossings

- Preparation of trench details as required by the permitter; preparation of special details where necessary to meet these requirements

- Determination of the methods for protecting the proposed pipeline from existing cathodic protection systems

- Determination of the methods for separating the proposed water transmission main from existing sewers in accordance with State Health Department standards

- Miscellaneous details

As was previously stated, draft technical specifications were prepared from the preliminary plans. During final design, these specifications will be expanded to include the legal specifications, invitation to bid, bonds, general conditions, and special provisions. They will be modified to reflect the final plans, the latest Municipality of Anchorage standard specifications, and all permits and soils information.

Chapter 11
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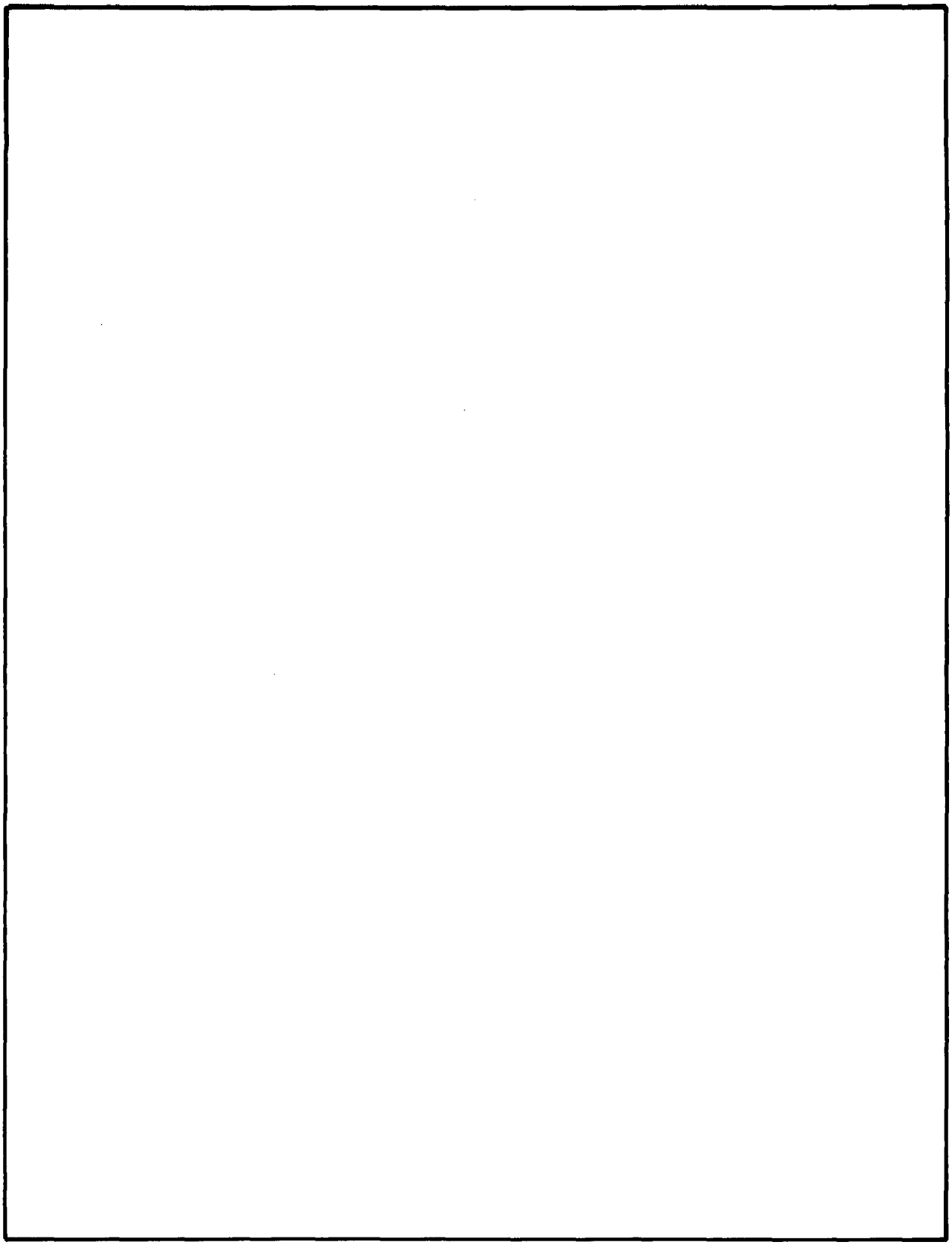
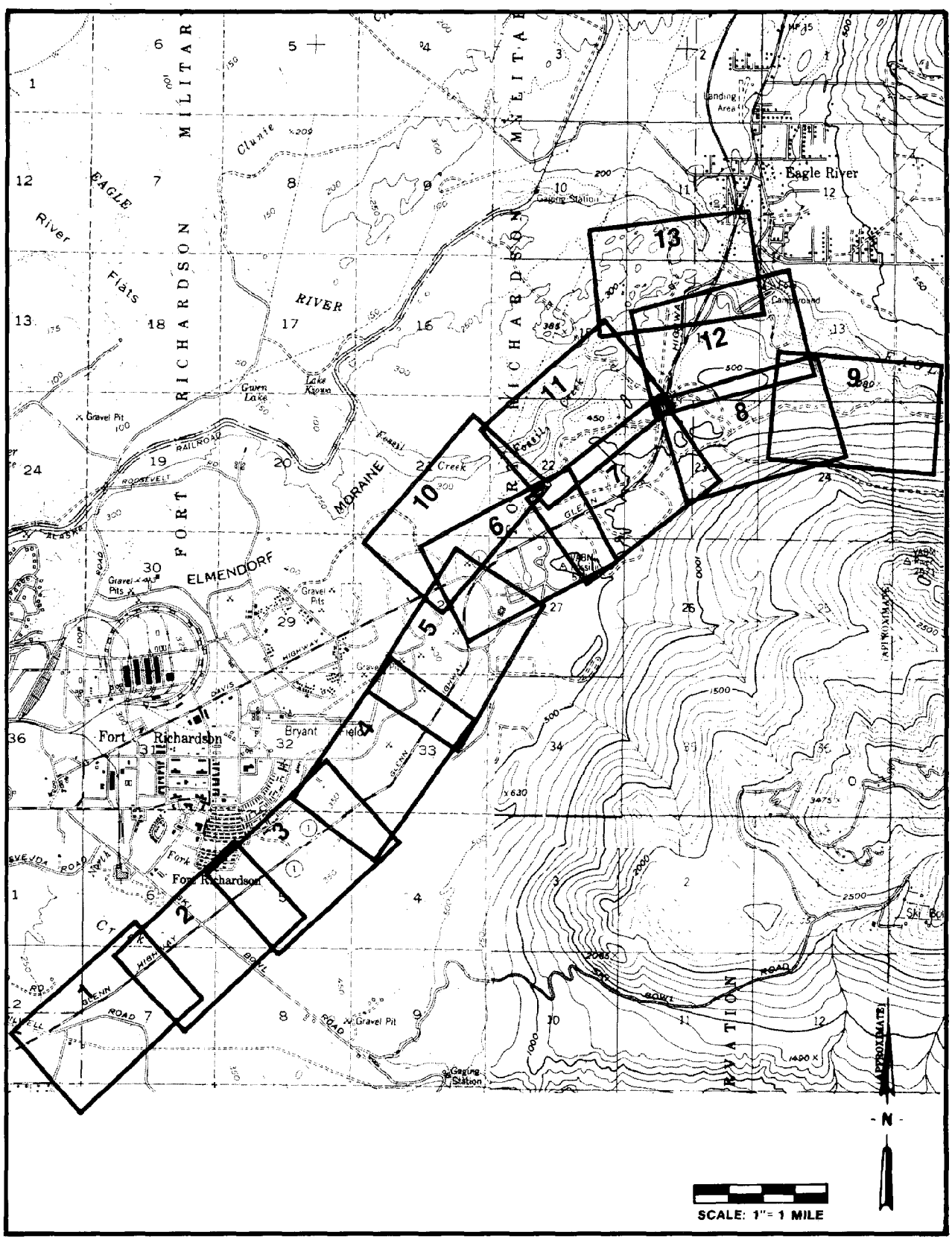


Exhibit A
Preliminary General Plans



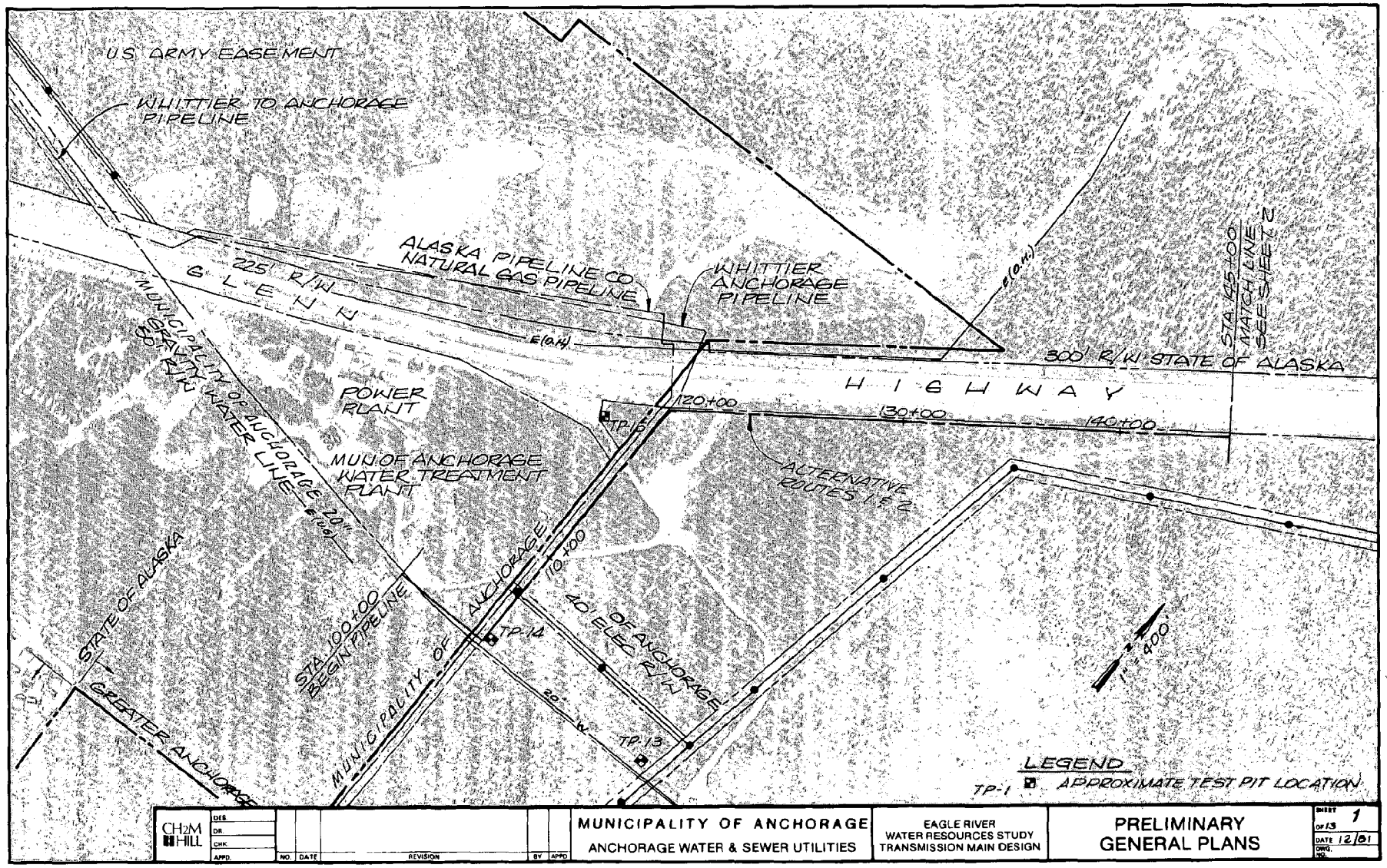
Preliminary General Plans Index

ABBREVIATIONS

ABND	ABANDON
AH	AHEAD
BK	BACK
COMM	COMMUNICATION
CONC	CONCRETE
ELEC	ELECTRIC
INC	INCORPORATED
MUN	MUNICIPALITY
RD	ROAD
R/W	RIGHT-OF-WAY
S	SEWER
STA	STATION
W	WATER
U.S.D.O.I.	UNITED STATES DEPARTMENT OF THE INTERIOR

LEGEND

E(UG)	EXISTING UNDERGROUND ELECTRICAL
E(OH)	EXISTING OVERHEAD ELECTRICAL
T(UG)	EXISTING UNDERGROUND TELEPHONE
T(OH)	EXISTING OVERHEAD TELEPHONE
—E—	ELECTRICAL
—S—	SEWER
—W—	WATER
—▷◁—	VALVE
—G—	GAS
—●—	POWER LINE
— - - -	EXISTING RIGHT-OF-WAY
410+00	PROPOSED WATER TRANSMISSION MAIN WITH STATION
■	SOIL TEST PIT
▫--▫--▫	STORM DRAIN W/CATCH BASINS
⟩—⟨	CULVERT



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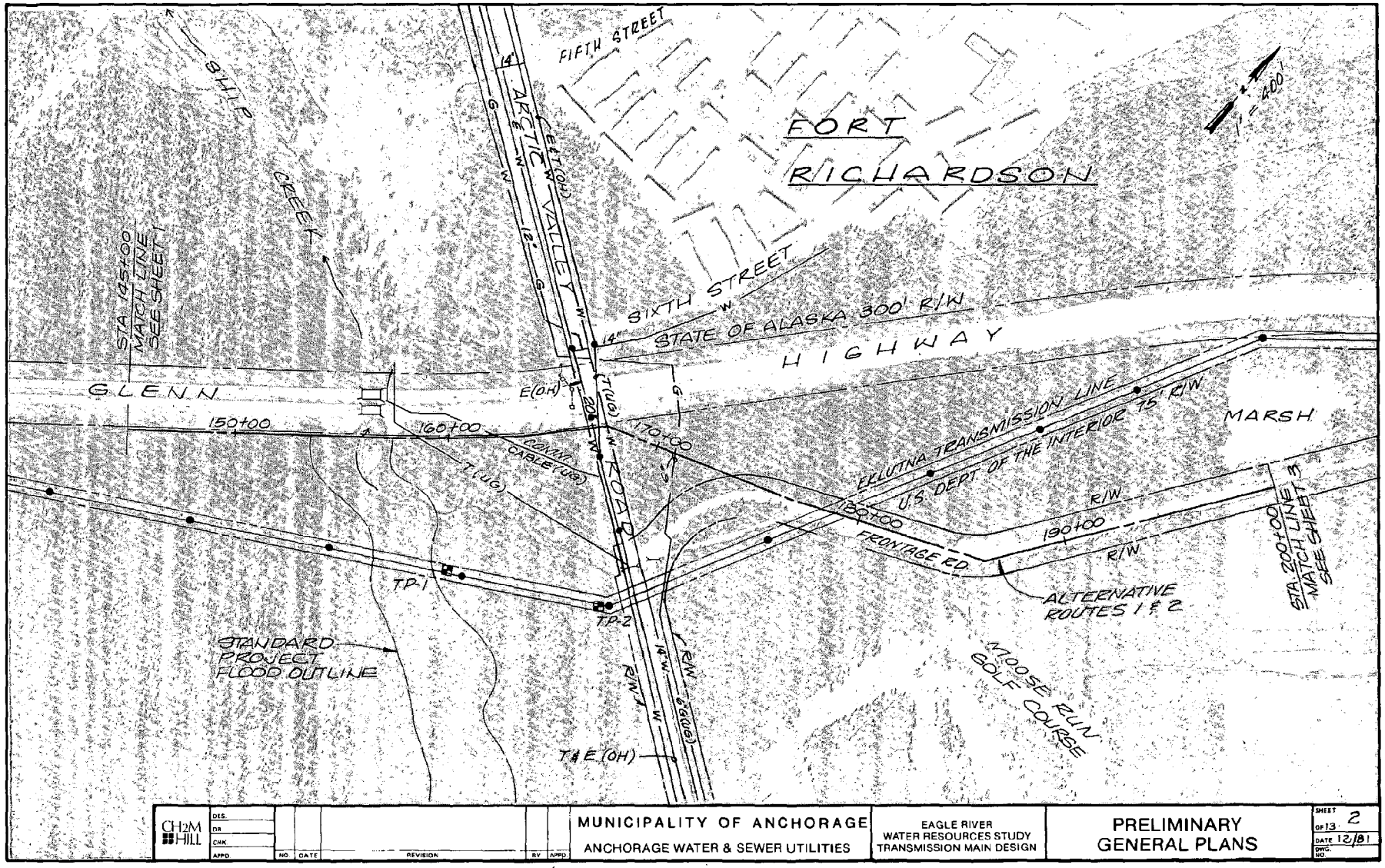

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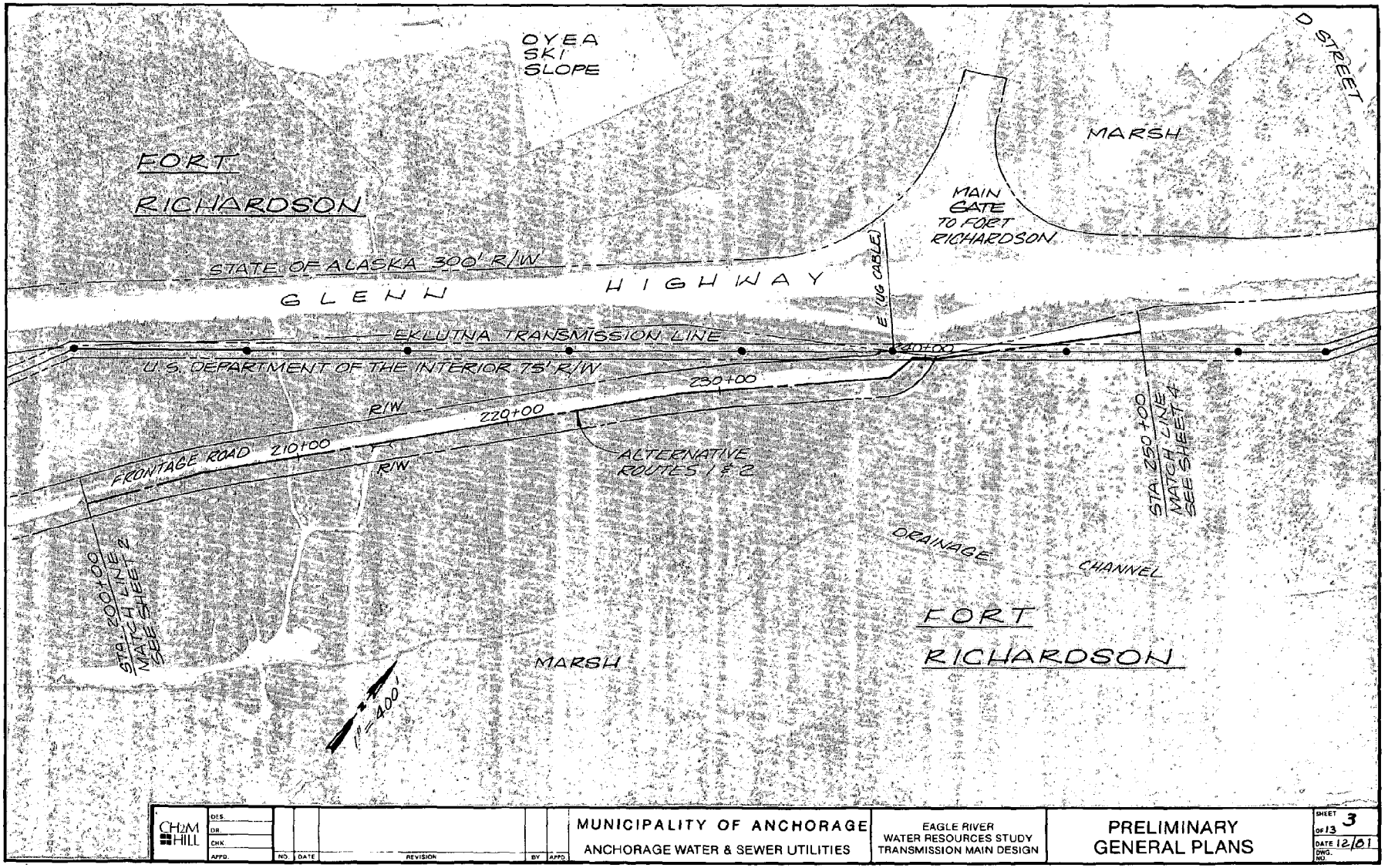

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EAGLE RIVER
WATER RESOURCES STUDY
TRANSMISSION MAIN DESIGN

PRELIMINARY GENERAL PLANS

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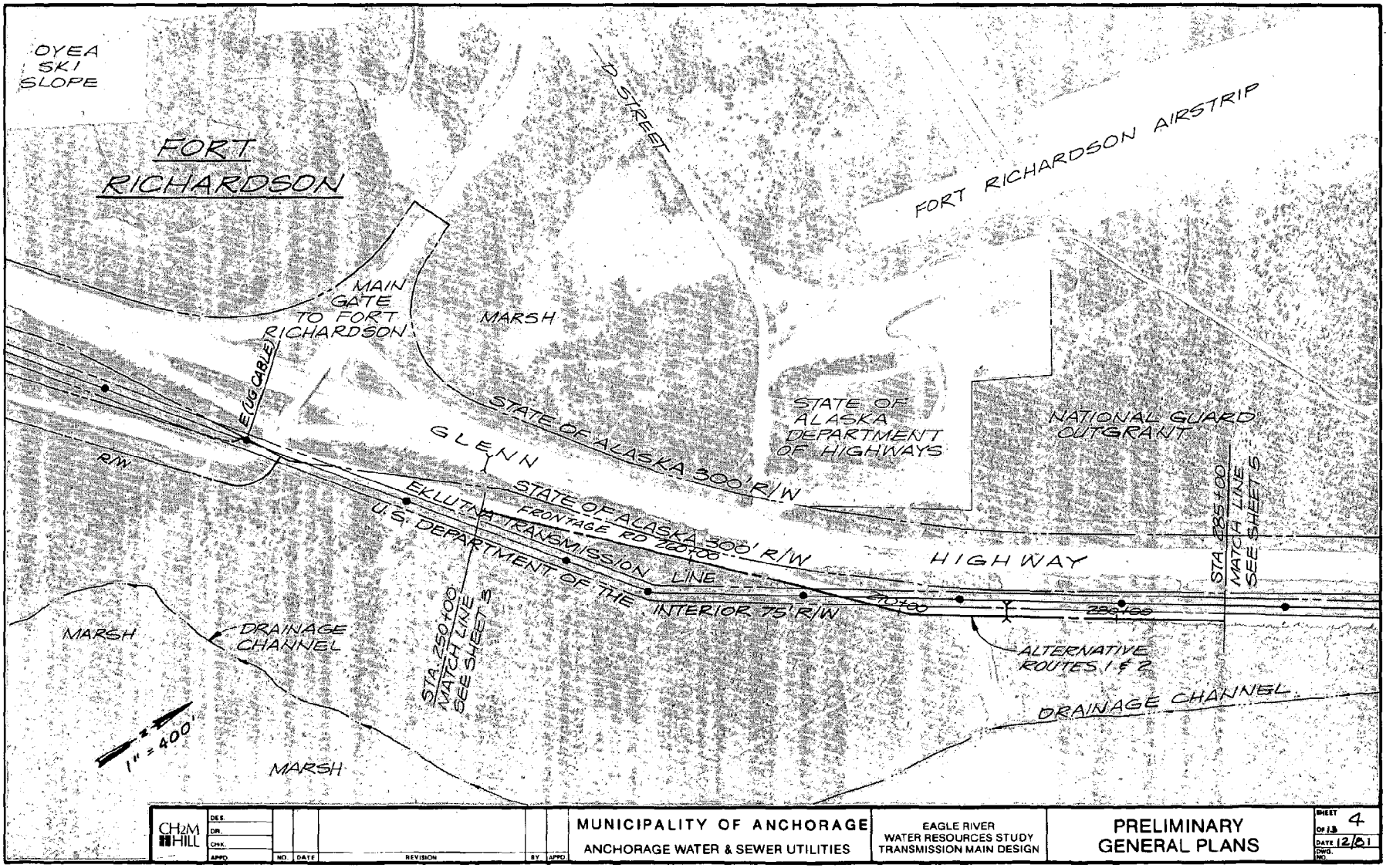

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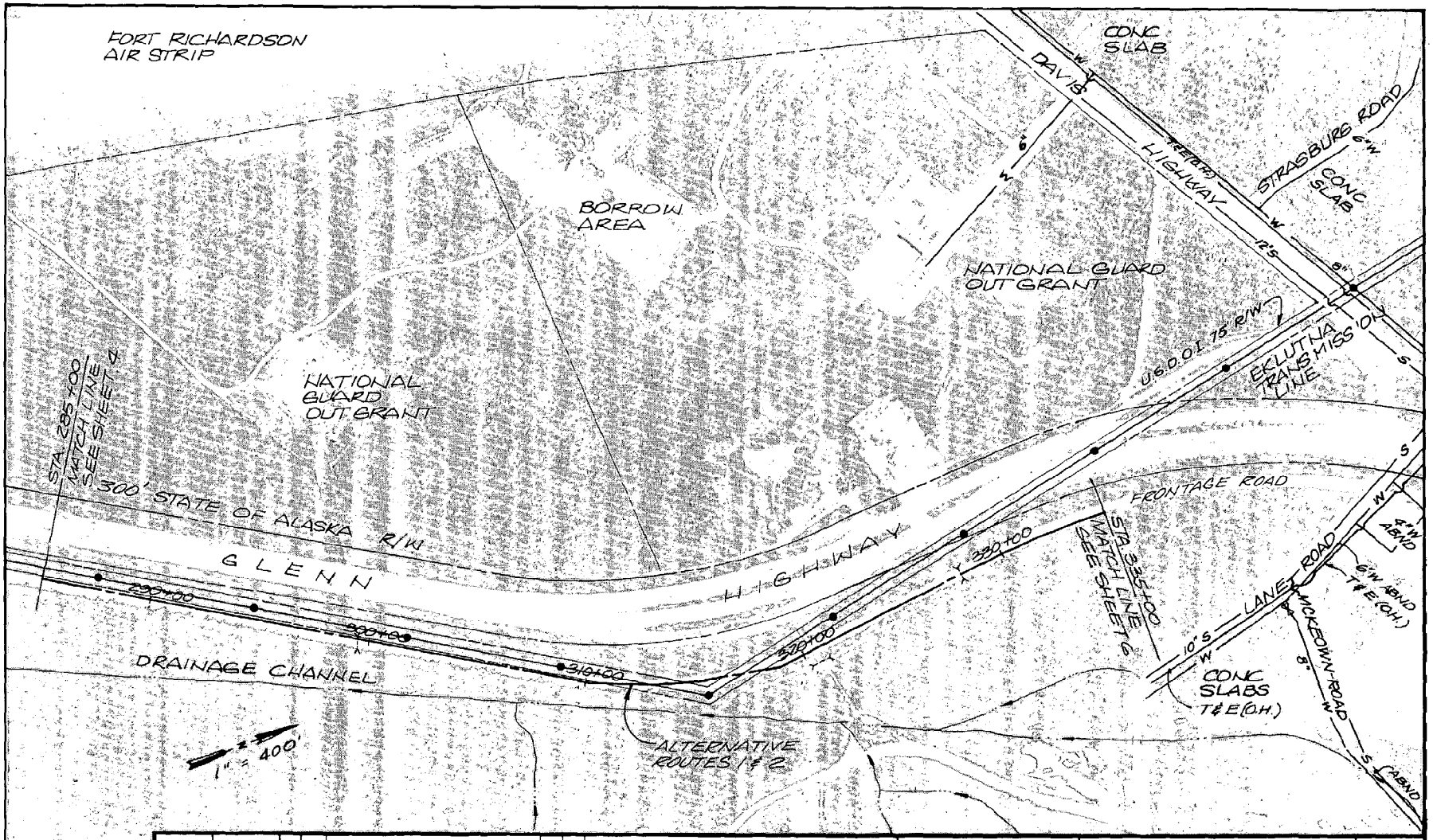

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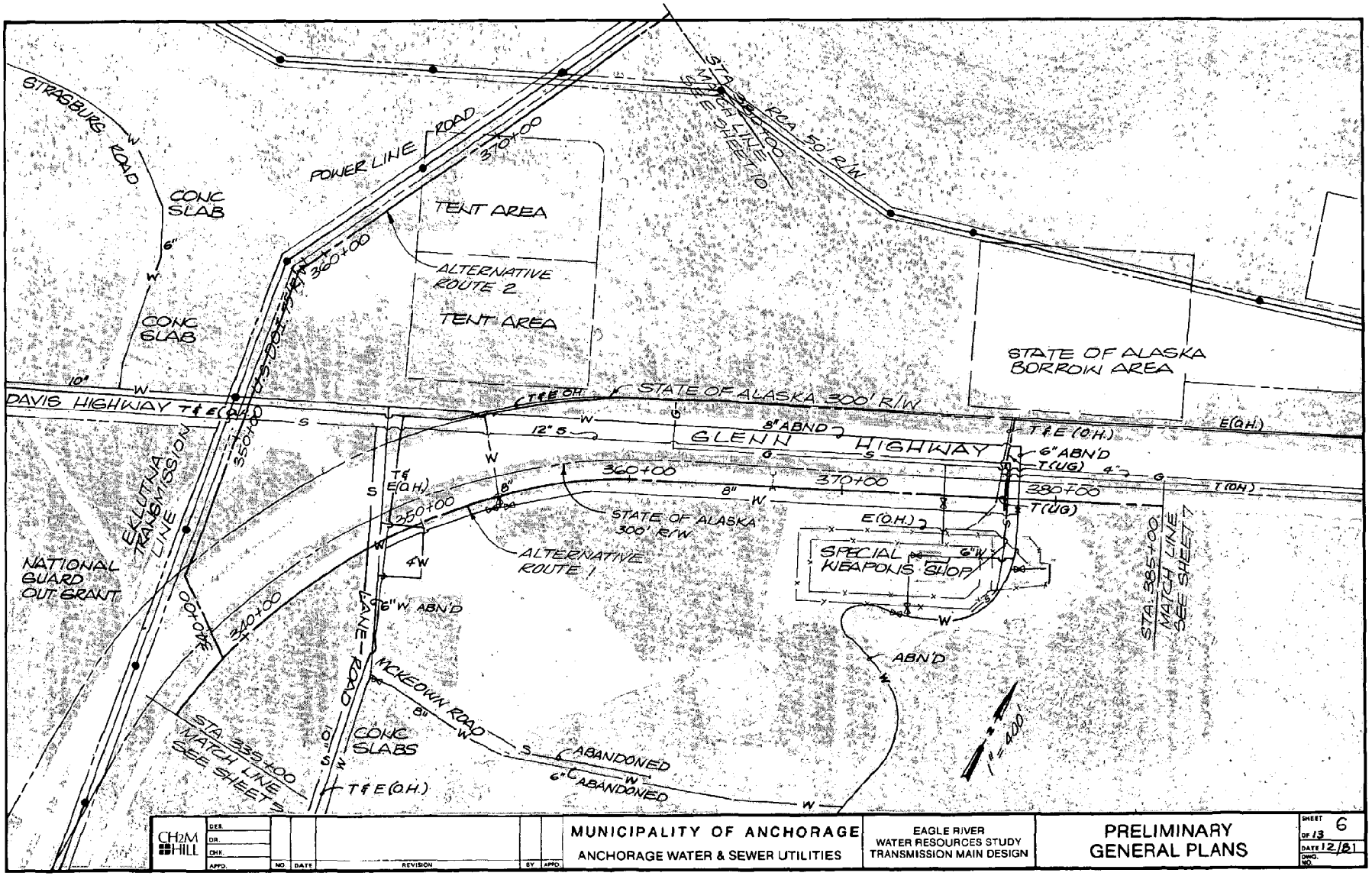

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MUNICIPALITY OF ANCHORAGE
ANCHORAGE WATER & SEWER UTILITIES

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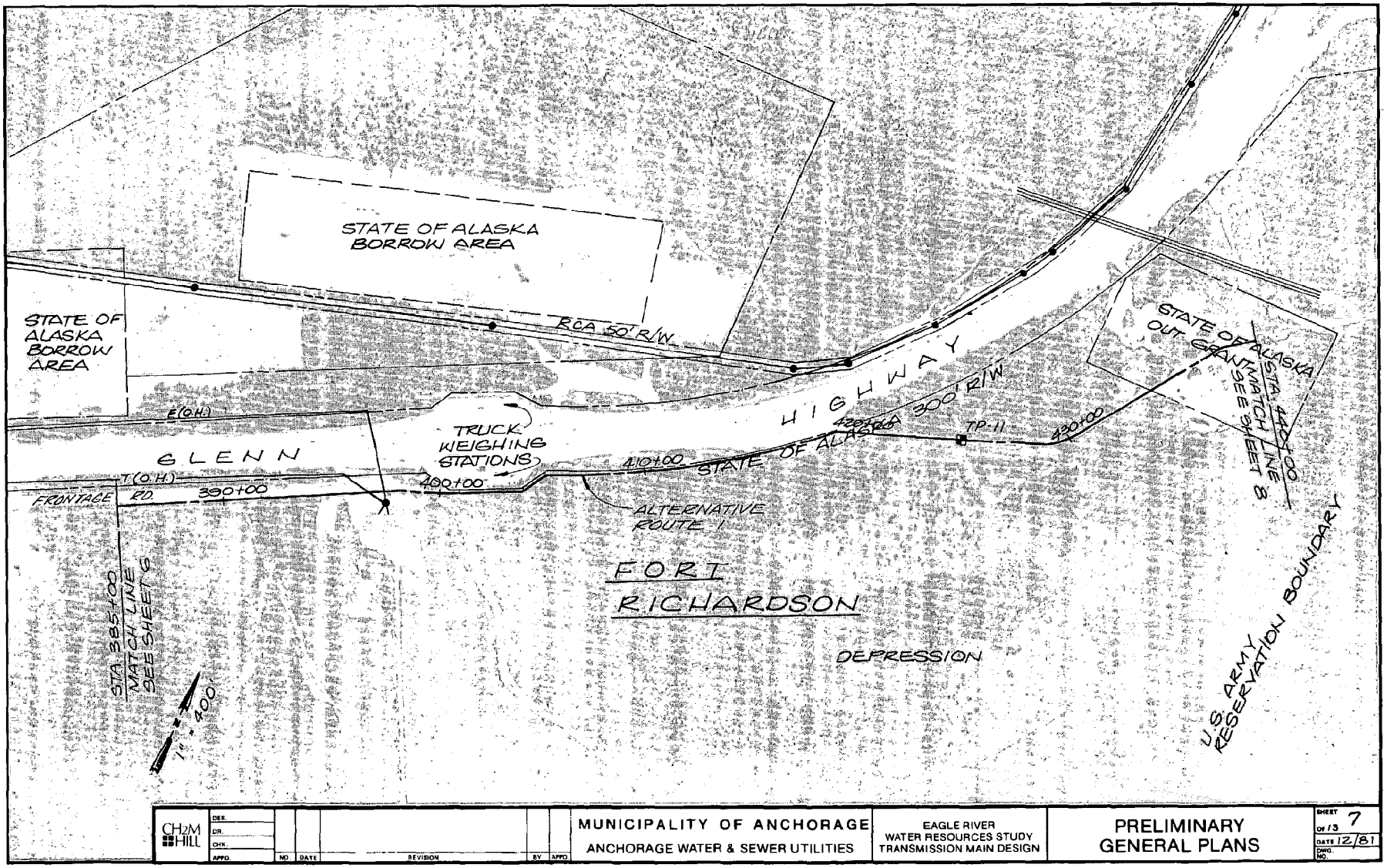

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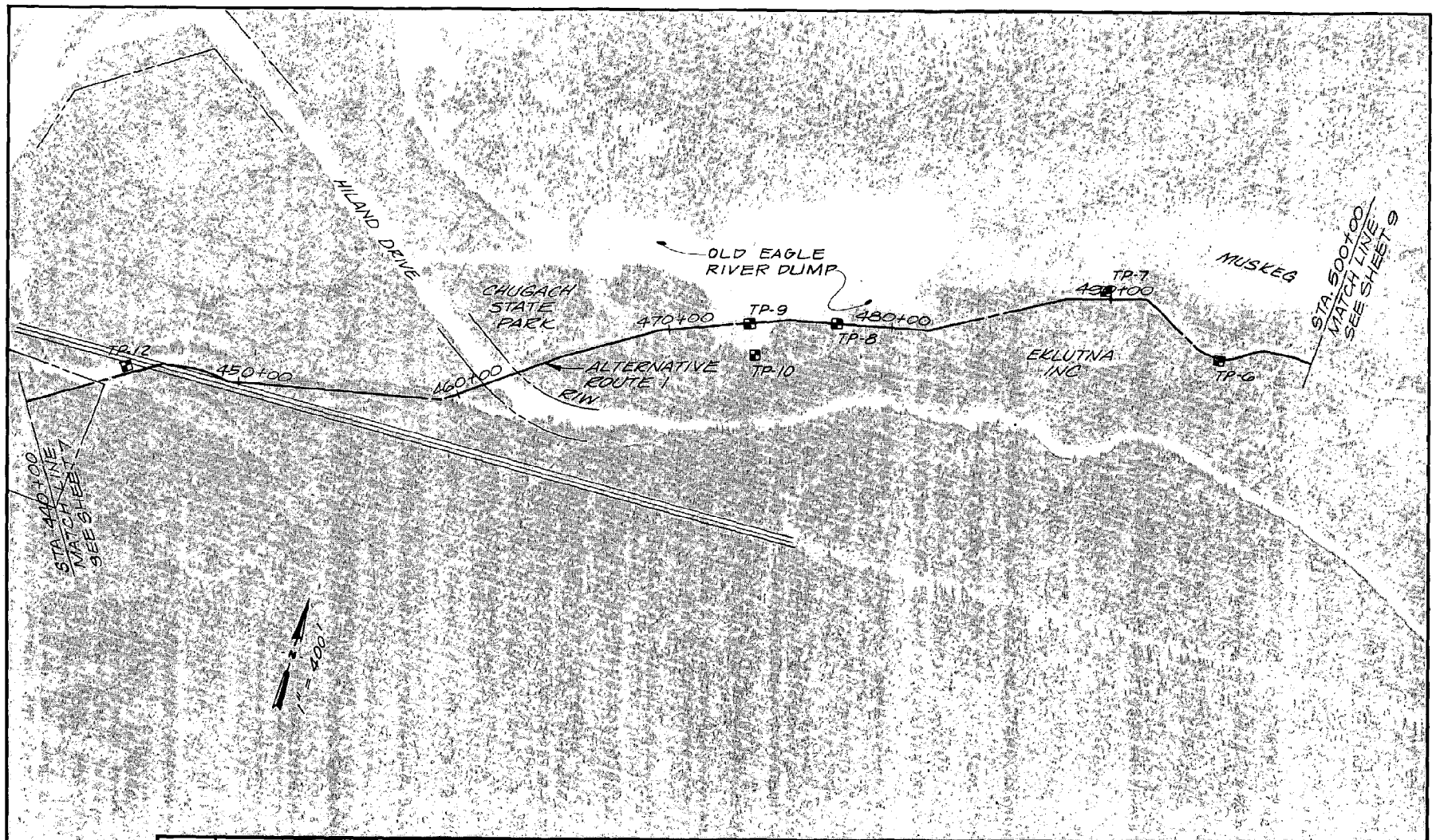

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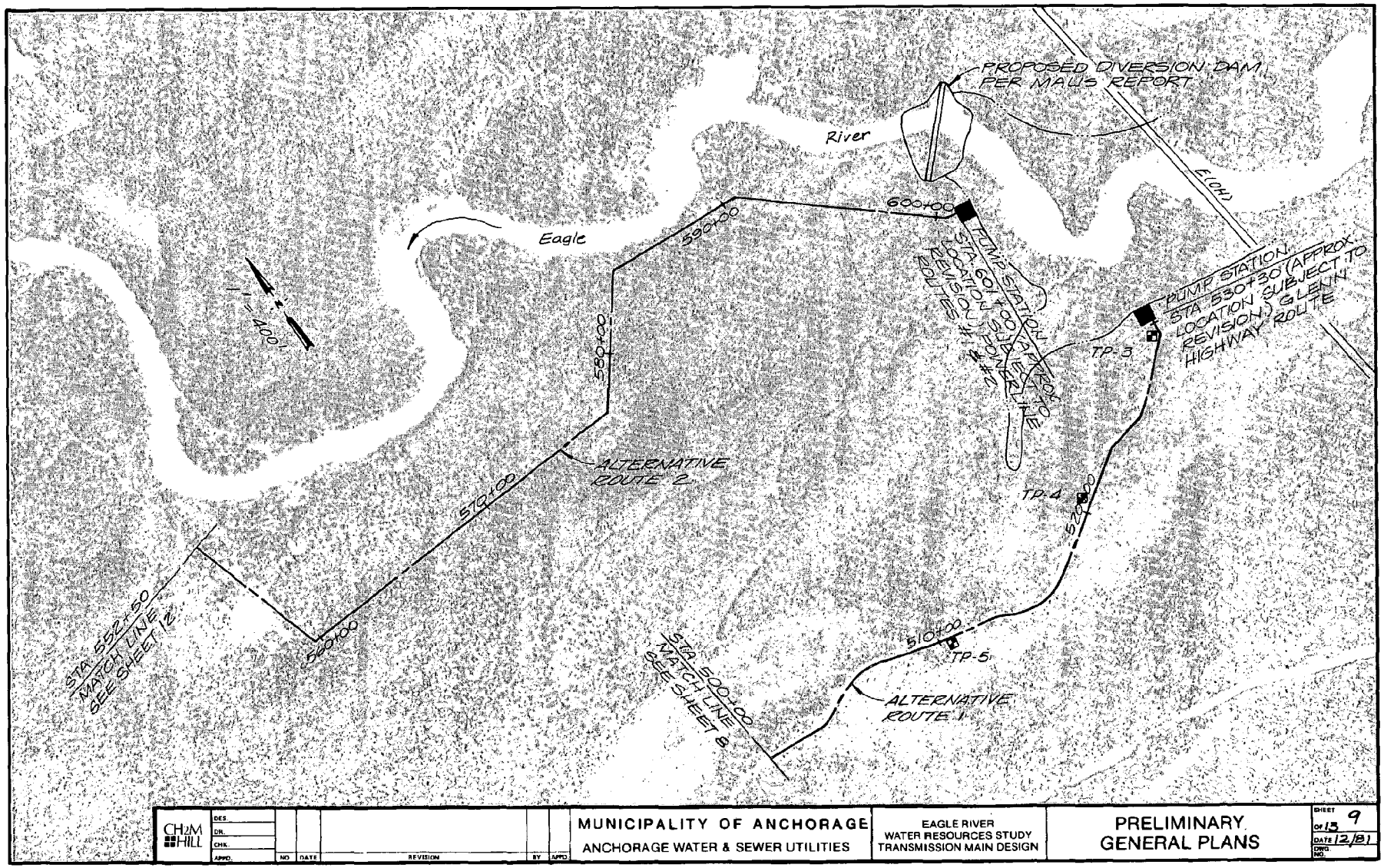

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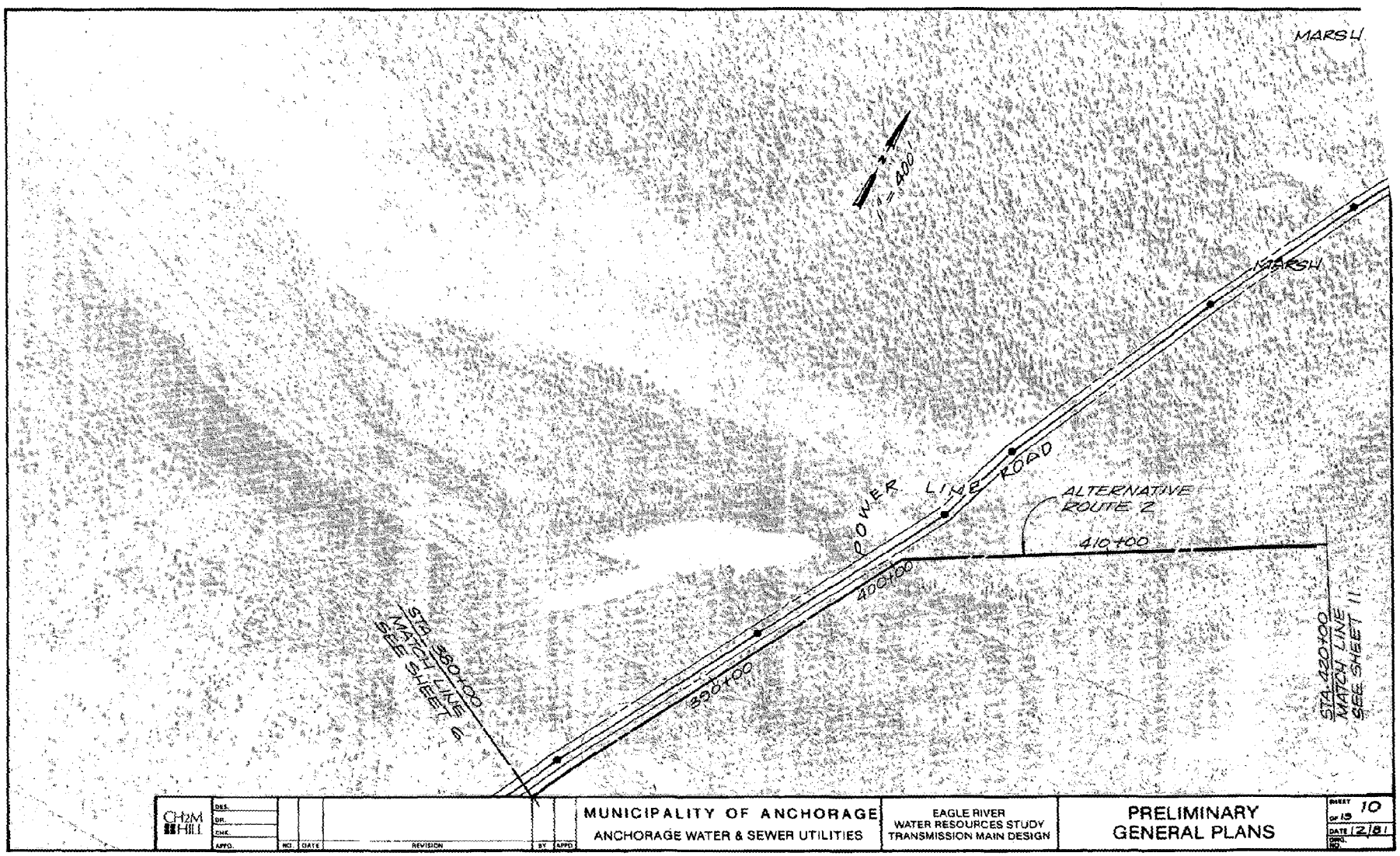

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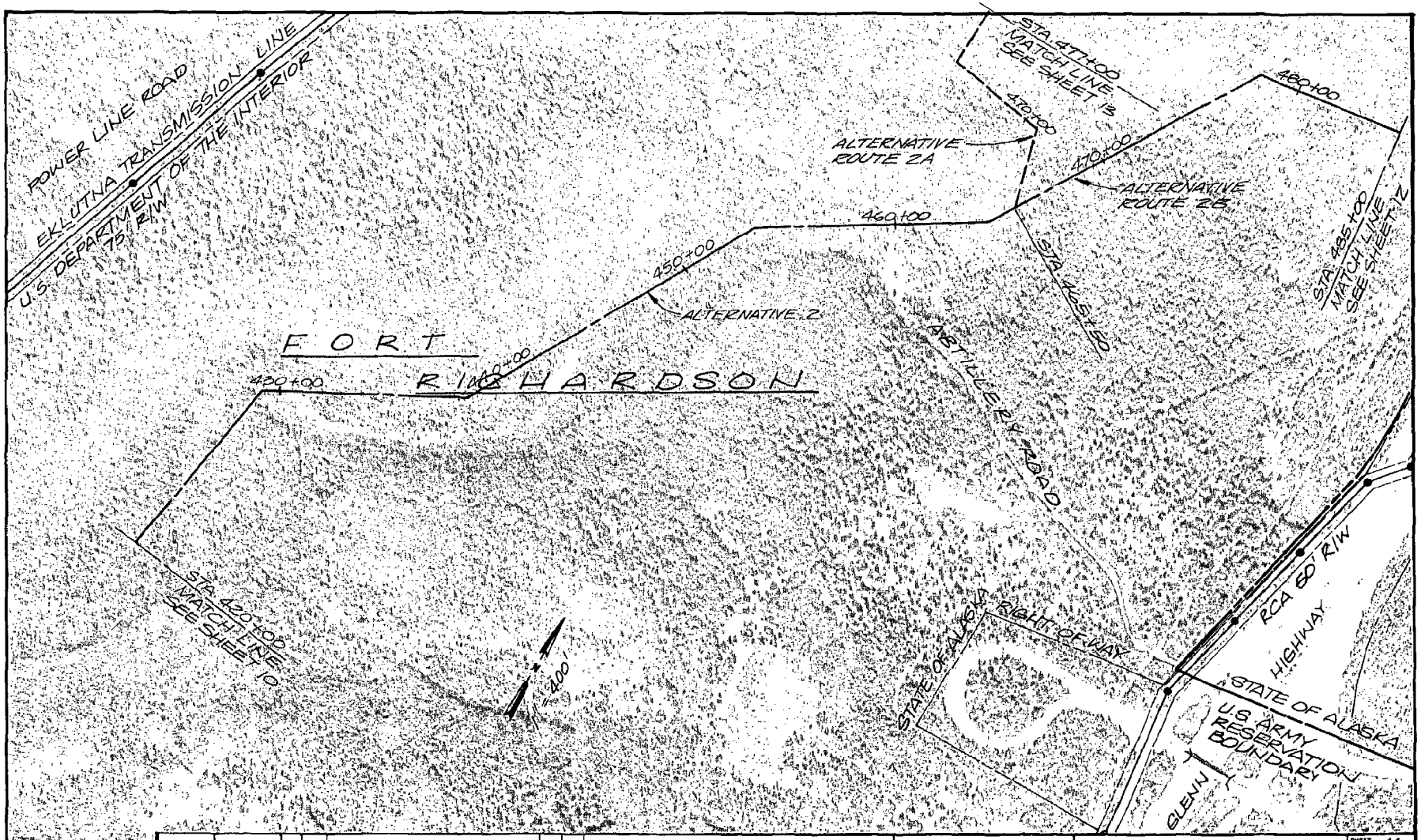

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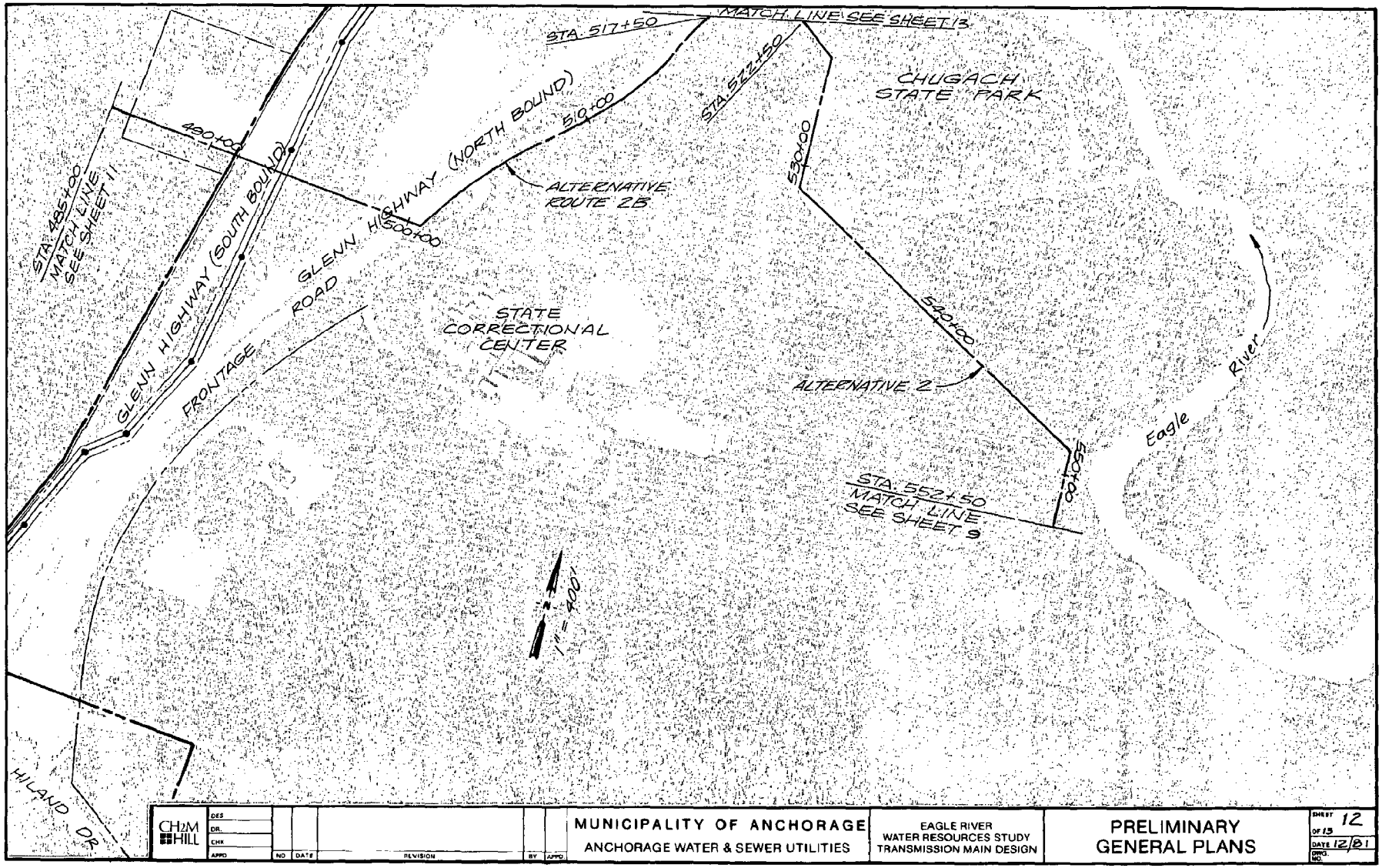

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EAGLE RIVER WATER RESOURCES STUDY TRANSMISSION MAIN DESIGN

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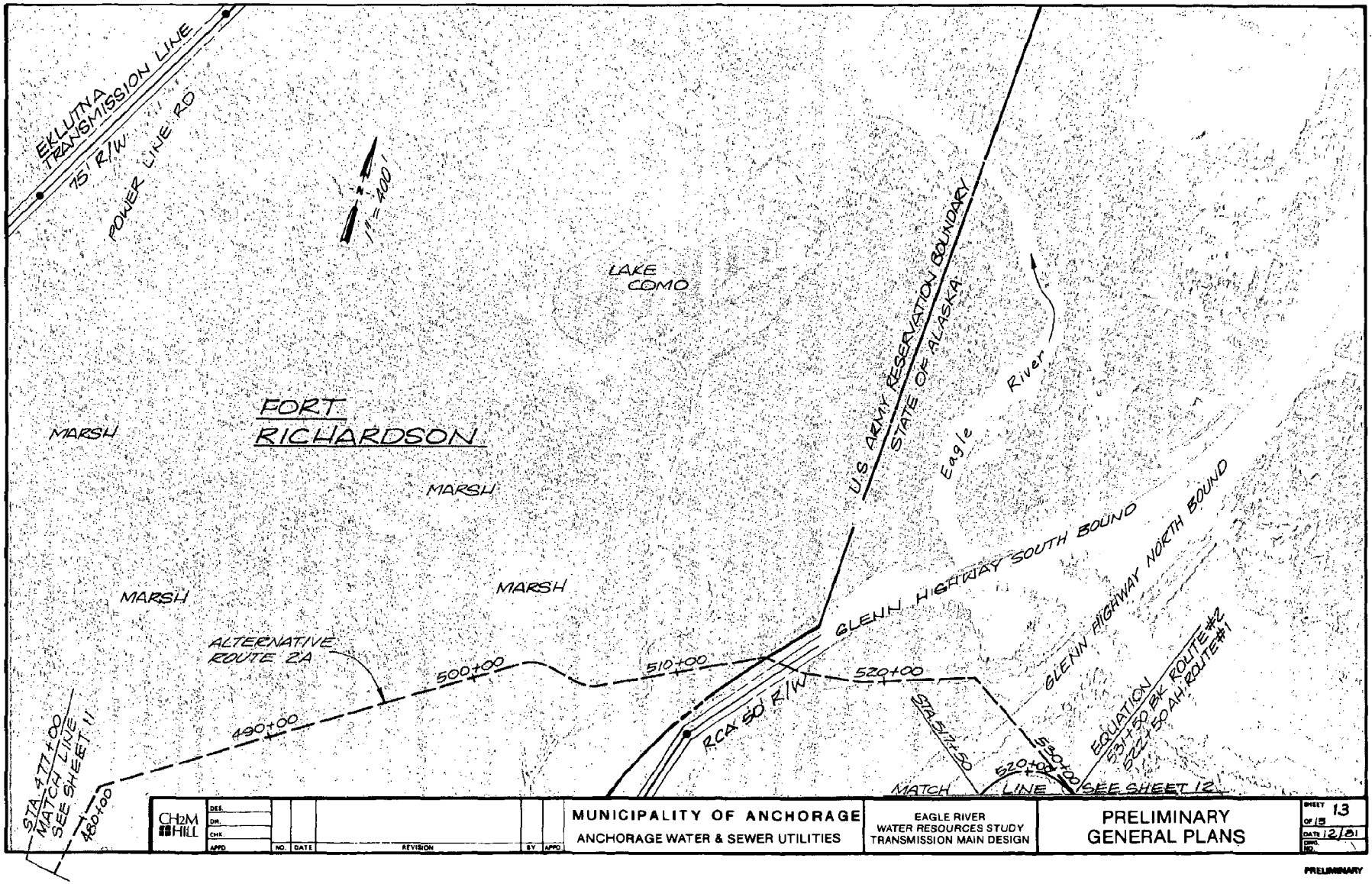

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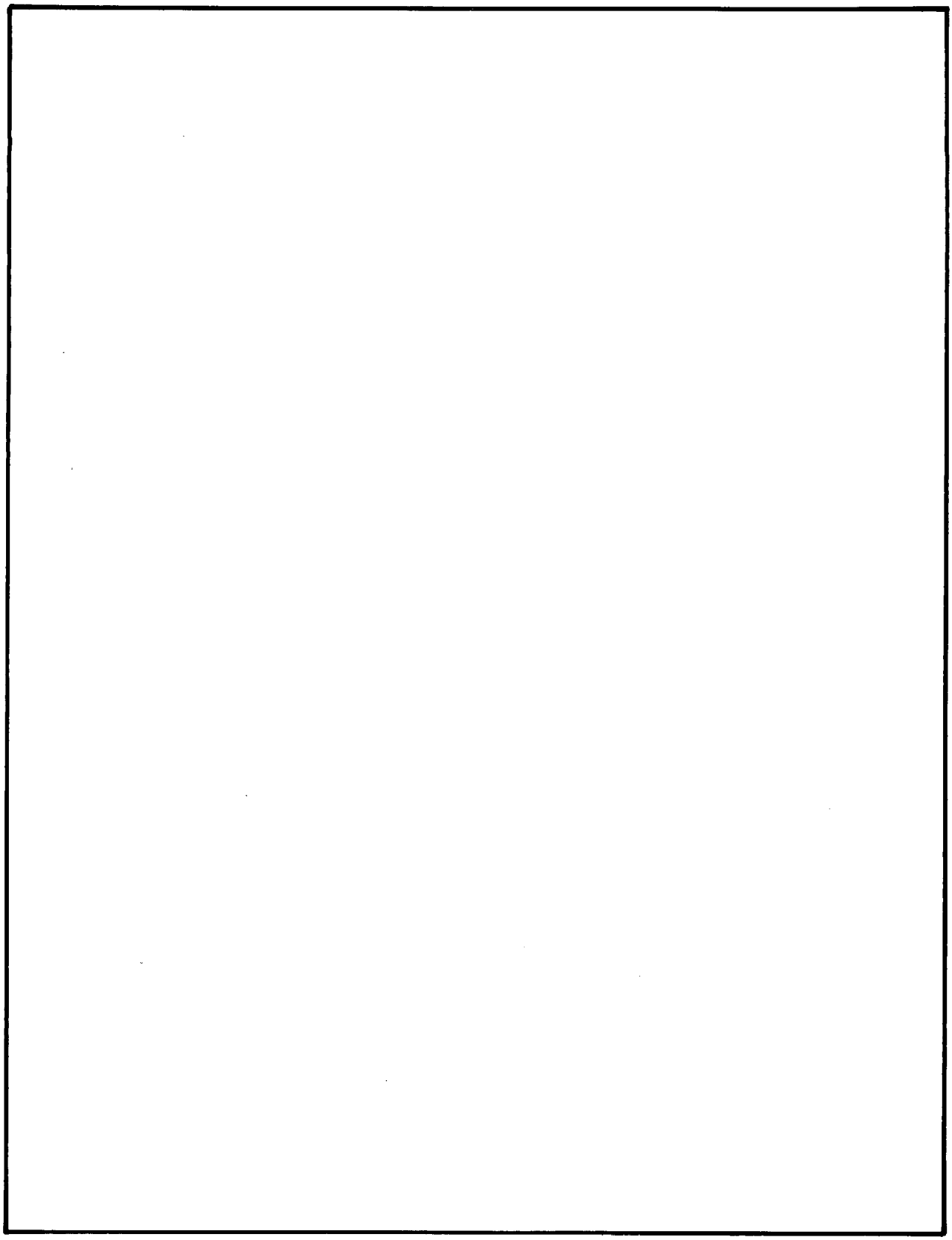

Exhibit B
Earthquake Data

EARTHQUAKE DATA FILE

EAGLE RIVER PIPELINE K13765.E1 100KM RADIUS SEARCH ABOUT 61.27 DEG. N., 149.6 MAGNITUDE ≥ 3 80/12/01 PAGE 1

SOURCE	YEAR	MO	DA	HR	MN	SEC	LAT	LONG	DEPTH (KM)	MAGNITUDES BODY	SURF.	OTHER	LOCAL	INT MAP	INT MAX	PHENOM DTSVNO	RN	CE	Q/S	MAR	DG	DIST (KM)
EQH	1909	09	19	20	00	00.0Z	60.600N	149.270W				7.40PAS			V		014	F		231	09	77
G-R	1911	09	22	05	01	24.0	60.500N	149.000W	060			6.90PAS			VIII	QS	014	D		231	09	92
G-R	1931	01	27	14	29	03.0	60.750N	149.000W				5.60PAS					014	F		231	09	67
G-R	1932	09	14	08	43	23.0	61.000N	148.000W	050			6.25PAS			V		002	F		231	18	92
G-R	1933	01	04	03	59	28.0	61.000N	148.000W	025A			6.25PAS			VI		002	D		231	18	92
G-R	1933	04	27	02	36	04.0	61.250N	150.750W	025A			7.00PAS			VII		002	D		232	10	60
CHG	1933	06	12	15	23	38.0	61.500N	150.500W				5.60PAS					002	F		232	10	53
G-R	1933	06	13	22	19	47.0	61.000N	151.000W	025A			6.25PAS			V		002	F		232	11	79
G-R	1933	06	19	18	47	43.0	61.250N	150.500W	025A			6.00PAS			V		002	F		232	10	46
G-R	1941	07	30	01	51	21.0	61.000N	151.000W				6.25PAS			VI		002	D		232	11	79
G-R	1943	11	03	14	32	17.0	61.750N	151.000W	025A			7.30PAS			V		002	F		232	11	90
ISS	1951	06	25	16	12	37.0	61.100N	150.100W	128			6.25PAS			V		002	F		232	10	31
CGS	1962	05	10	00	03	40.2	62.000N	150.100W	072			6.00BRK			V		001	F	020	232	20	85
CGS	1963	04	03	15	54	51.7	61.200N	147.800W	071	5.70MB							002		028	231	17	98
CGS	1963	05	13	17	50	19.3	61.100N	151.000W	096	5.40MB							002		011	232	11	76
CGS	1963	09	03	12	59	52.3	61.900N	150.400W	116	4.00MB							002		007	232	10	81
CGS	1963	11	24	17	48	47.0	61.800N	149.500W	036	4.30MB							002		009	231	19	59
CGS	1964	01	05	01	31	27.0	61.900N	149.500W	072	4.60MB							002		011	231	19	70
CGS	1964	01	28	18	30	43.9	61.200N	147.800W	172	4.00MB							002		007	231	17	98
CGS	1964	02	02	01	48	16.0	61.600N	149.700W	033	3.80MB							002		004	231	19	37
CGS	1964	02	09	02	29	17.0	60.600N	150.800W	099	3.80MB							014		005	232	00	98
CGS	1964	03	22	06	22	15.1	61.300N	147.800W	062	4.50MB							002		014	231	17	98
CGS	1964	03	28	09	26	16.5	61.300N	148.800W	033	4.40MB							002		013	231	18	44
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CGS	1964	03	29	03	38	38.1	60.700N	149.100W	040	5.10MB							014		038	231	09	69
CGS	1964	03	29	11	31	56.8	60.600N	148.700W	020	4.00MB							014		009	231	08	90
CGS	1964	03	29	23	40	54.8	61.100N	151.000W	025	4.70MB							002		020	232	11	76
CGS	1964	03	30	03	35	12.0	61.200N	151.100W	030	4.40MB							002		007	232	11	79
CGS	1964	03	30	10	31	22.0	60.500N	149.600W	030	4.40MB							014		012	231	09	85
CGS	1964	03	30	11	35	18.8	61.500N	147.900W	025	4.40MB							002		015	231	17	96
CGS	1964	03	30	17	41	13.4	61.500N	150.000W	040	4.30MB							002		017	232	10	32
CGS	1964	04	01	01	21	05.4	60.600N	149.200W	025	4.60MB							014		014	231	09	78
CGS	1964	04	02	00	16	44.7	60.900N	148.000W	033	4.10MB							014		005	231	08	97
CGS	1964	04	02	12	20	25.2	60.900N	148.100W	010	4.10MB							014		005	231	08	92
CGS	1964	04	02	14	22	03.4	60.500N	149.000W	033	4.30MB							014		005	231	09	92
CGS	1964	04	03	06	56	09.7	60.700N	149.400W	033	3.90MB							014		005	231	09	64
CGS	1964	04	05	15	21	47.0	60.700N	149.100W	033	3.80MB							014		010	231	09	69
CGS	1964	04	07	03	53	57.2	61.100N	148.700W	033	4.20MB							002		011	231	18	53
CGS	1964	04	12	02	06	19.8	60.900N	149.500W	020	4.20MB							014		011	231	09	41
CGS	1964	04	12	14	35	39.2	61.200N	151.100W	028	5.00MB					IV		002	F	041	232	11	79
CGS	1964	04	13	23	48	52.7	61.000N	149.300W	033	4.10MB							002		009	231	19	35
CGS	1964	04	14	16	59	30.1	61.400N	150.800W	035	5.10MB							002		036	232	10	64
CGS	1964	04	16	14	31	16.3	61.400N	149.200W	033	4.60MB							002		015	231	19	27
CGS	1964	04	17	07	26	39.0	61.100N	149.400W	033	4.40MB							002		007	231	19	22
CGS	1964	05	10	12	01	23.8	60.700N	148.400W	033	3.70MB							014		005	231	08	92
CGS	1964	05	15	05	11	17.3	61.400N	147.900W	033	3.70MB							002	F	005	231	17	93
CGS	1964	05	20	01	55	23.8	61.300N	148.300W	033	4.00MB							002		006	231	18	71
CGS	1964	06	03	11	25	45.5	61.100N	151.200W	033	3.80MB							002		006	232	11	86
CGS	1964	06	10	07	35	56.7	61.300N	148.800W	033	3.90MB							002		005	231	18	44

SOURCE	YEAR	MO	DA	HR	MN	SEC	LAT	LONG	DEPTH (KM)	MAGNITUDES BODY	SURF.	OTHER	LOCAL	INT MAP	INT MAX	PHENOM	DTSYNO	RN	CE	Q/S	MAR	DG	DIST (KM)
CGS	1964	06	26	05	28	49.0	61.700N	148.300W	033	4.30MB								002		011	231	18	85
CGS	1964	07	27	23	20	56.2	60.900N	148.000W	033	4.20MB								014	F	006	231	08	97
CGS	1964	08	16	02	57	05.6	61.600N	150.200W	063	4.10MB								002		008	232	10	47
CGS	1964	09	13	17	44	10.2	61.400N	149.800W	033	3.90MB								002	F	005	231	19	17
CGS	1964	09	23	16	37	19.1	61.600N	150.000W	033	4.10MB								002	F	005	232	10	41
CGS	1965	01	01	20	02	38.0	61.700N	148.900W	033	4.30MB								002		008	231	18	61
CGS	1965	01	11	16	57	27.0	61.100N	151.000W	059	5.40MB								002		022	232	11	76
CGS	1965	04	19	07	15	54.4	62.100N	150.200W	083	4.10MB								001		014	232	20	97
CGS	1965	05	11	17	37	38.3	61.400N	149.600W	058	5.50MB		5.75PAS			IV			002	F	015	231	19	14
CGS	1965	05	20	12	01	49.2	61.000N	150.200W	166	3.90MB								002		005	232	10	43
CGS	1965	07	15	05	45	03.5	61.800N	148.800W	064	3.80MB								002	F	006	231	18	73
CGS	1965	08	08	11	28	21.9	61.200N	149.300W	086	4.10MB								002		007	231	19	19
CGS	1965	08	13	15	19	17.2	61.200N	151.400W	092	4.20MB								002		019	232	11	95
CGS	1965	08	26	05	00	46.2	60.900N	149.500W	033	3.80MB								014		005	231	09	41
CGS	1966	01	18	21	46	01.5	61.500N	150.700W	069	4.10MB								002	F	011	232	10	62
CGS	1966	03	03	17	37	03.7	61.400N	150.600W	053	4.00MB								002	F	010	232	10	54
CGS	1966	04	05	14	10	53.7	61.700N	148.000W	112	3.70MB								002		009	231	18	99
CGS	1966	05	26	10	44	11.6	60.800N	151.200W	087	4.50MB								014		019	232	01	99
CGS	1966	09	01	23	19	08.1	61.700N	149.700W	063	5.10MB								002	F	079	231	19	48
CGS	1966	09	09	15	36	57.3	61.400N	147.800W	058	4.40MB								002		015	231	17	99
CGS	1966	10	07	20	55	56.4	61.700N	150.100W	057	5.60MB					IV			002	F	115	232	10	54
CGS	1966	10	08	10	03	47.0	61.300N	150.500W	033	3.70MB								002	F	007	232	10	46
CGS	1966	12	16	21	59	46.2	61.400N	149.500W	053	4.10MB								002	F	012	231	19	16
CGS	1967	03	20	08	23	00.8	60.436N	149.576W	060	4.20MB								014	F	015	231	09	93
CGS	1967	04	03	17	33	12.5	61.870N	148.547W	032	3.80MB								002	F	012	231	18	88
CGS	1967	05	08	06	40	29.3	62.146N	149.838W	065	3.80MB								001	F	009	231	29	97
USE	1967	08	18	05	50	29.0	61.500N	151.000W	019	4.50MB								002	F	043	232	11	77
CGS	1967	11	08	14	41	02.5	61.500N	150.000W	038	3.90MB								002		011	232	10	32
CGS	1968	03	08	09	52	42.0	60.800N	150.800W	057	3.20MB								014		009	232	00	82
CGS	1968	03	08	16	26	54.7	61.400N	150.000W	041	3.90MB								002		011	232	10	24
CGS	1968	05	02	11	46	17.0*	61.398N	151.121W	058	3.70MB								002		005	232	11	81
CGS	1968	08	31	17	47	06.9	61.734N	150.911W	066	4.10MB								002		013	232	10	85
CGS	1968	09	22	06	13	56.6	61.184N	150.729W	051	4.00MB								002		009	232	10	59
CGS	1968	09	24	06	44	16.9	61.442N	149.870W	050	3.70MB					IV			002	F	010	231	19	22
CGS	1968	10	07	11	31	49.6	60.936N	149.814W	036	3.80MB								014		010	231	09	39
USE	1968	10	07	18	54	53.6	61.400N	150.300W	055	4.20MB					IV			002	F	016	232	10	38
CGS	1968	11	12	10	20	50.1	61.491N	150.368W	060	3.60MB								002		013	232	10	46
CGS	1969	01	19	08	42	22.3	61.759N	150.966W	057	3.90MB								002		012	232	10	88
USE	1969	05	14	10	26	51.3	61.200N	149.800W	040	3.90MB								002	F	016	231	19	12
CGS	1969	05	25	04	20	43.6	61.583N	150.119W	050	3.60MB								002		012	232	10	43
USE	1969	08	06	00	38	42.8	61.400N	150.700W	053	4.80MB					IV			002	F	022	232	10	59
USE	1969	10	10	18	56	30.5	60.500N	148.700W	006	3.80MB								014	F	011	231	08	99
CGS	1969	10	30	11	26	57.2	61.695N	151.297W	067	3.90MB								002		013	232	11	100
USE	1969	11	07	01	52	35.7	62.000N	150.300W	061	3.80MB					IV			001	F	017	232	20	88
CGS	1969	11	24	05	09	10.6	60.844N	149.626W	079	4.20MB								014		012	231	09	47
CGS	1969	12	03	18	50	41.2	62.124N	149.601W	033N				3.30MLCGS					001		012	231	29	94
CGS	1969	12	07	18	49	35.5	61.259N	150.210W	052	3.60MB								002		015	232	10	31
CGS	1970	03	29	11	18	09.3	61.236N	150.950W	068	3.80MB			3.70MLCGS					002		010	232	10	71
CGS	1970	04	03	17	05	14.1	61.401N	150.119W	052	3.40MB								002		014	232	10	29

SOURCE	YEAR	MO	DA	HR	MN	SEC	LAT	LONG	DEPTH (KM)	MAGNITUDES BODY	MAGNITUDES SURF.	MAGNITUDES OTHER	MAGNITUDES LOCAL	INT MAP	INT MAX	PHENOM	DISVNO	RN	CE	Q/S	MAR	DG	DIST (KM)
CGS	1970	04	06	22	56	04.3*	60.673N	150.562W	033N				3.10MLCGS					014		014	232	00	83
USE	1970	05	10	21	32	53.2	61.700N	150.000W	055	3.70MB					IV			002	F	011	232	10	51
CGS	1970	06	10	04	15	16.8	61.311N	151.086W	064	4.00MB								002		025	232	11	77
CGS	1970	07	01	12	46	31.9	60.618N	150.891W	048	3.90MB								014		018	232	00	100
USE	1970	07	04	08	47	45.3	61.500N	149.400W	040	3.80MB					III			002	F	027	231	19	28
USE	1970	07	30	02	16	08.8	60.600N	148.600W	024	4.70MB			4.70MLCGS		III			014	F	030	231	08	93
NOS	1970	11	02	02	05	19.0*	61.250N	148.673W	032				3.40MLNOS					002		011	231	18	51
NOS	1970	11	05	06	52	57.9*	60.691N	148.694W	016				3.50MLNOS					014		011	231	08	82
NOS	1970	11	23	01	13	57.8	61.492N	149.854W	049	3.90MB								002		011	231	19	27
USE	1970	12	28	02	56	57.5	61.600N	149.600W	047	3.80MB								002	F	012	231	19	36
NOS	1971	06	02	19	06	32.9	61.030N	151.256W	029	5.00MB			5.50MLNOS		IV			002	F	048	232	11	91
NOS	1971	07	05	02	50	50.3	61.380N	147.838W	048	3.60MB								002		013	231	17	97
ERL	1971	07	21	11	36	12.7	60.486N	149.675W	038	3.30MB			3.20MLERL					014		008	231	09	88
ERL	1971	08	10	23	08	56.9	61.808N	150.046W	034	3.30MB			3.00MLERL					002		010	232	10	63
ERL	1971	10	19	18	51	09.1	61.555N	150.176W	050	3.90MB								002		013	232	10	42
ERL	1971	11	09	16	49	36.0*	61.006N	150.831W	033N				3.20MLERL					002		010	232	10	71
ERL	1971	12	01	08	03	57.7	61.650N	149.281W	024	3.70MB			3.10MLERL		IV			002	F	010	231	19	46
ERL	1971	12	30	17	56	03.5	61.145N	150.360W	041	4.10MB			3.70MLERL		IV			002	F	014	232	10	41
ERL	1972	01	31	22	31	44.3	62.070N	150.480W	074	3.70MB					II			001	F	020	232	20	100
ERL	1972	02	25	09	26	59.0	61.160N	149.411W	045	3.50MB			3.50MLERL					002	F	014	231	19	17
ERL	1972	04	11	18	21	35.5	62.023N	150.418W	018	4.50MB			4.20MLERL					001		025	232	20	93
ERL	1972	04	25	13	35	54.1	61.984N	148.823W	058	4.60MB								002	F	044	231	18	90
ERL	1972	05	14	09	39	55.0	61.855N	150.297W	057	3.80MB								002		020	232	10	73
ERL	1972	08	03	00	09	54.3	61.789N	150.806W	062	3.40MB								002		014	232	10	84
ERL	1972	08	12	02	00	37.6*	61.509N	149.872W	046	3.60MB								002		016	231	19	28
ERL	1972	08	13	11	10	49.1	62.049N	150.485W	066	3.30MB								001		018	232	20	97
ERL	1972	09	16	09	39	13.8*	60.676N	150.369W	023				3.20MLERL					014		017	232	00	77
ERL	1972	10	25	15	03	33.1	61.301N	150.499W	030				3.20MLPMR		III			002	F	009	232	10	46
ERL	1972	10	27	18	18	14.7	61.520N	150.351W	054	3.70MB								002	F	013	232	10	47
ERL	1972	11	11	09	46	51.3	60.471N	150.387W	050	3.20MB			3.30MLERL					014		017	232	00	98
ERL	1972	11	30	17	30	33.3	61.734N	149.992W	054	3.30MB								002		013	231	19	54
ERL	1972	12	29	18	46	31.7*	61.532N	151.164W	074	3.40MB								002		010	232	11	86
ERL	1973	01	07	04	45	06.4	60.835N	150.057W	031				3.50MLERL					014		011	232	00	54
ERL	1973	01	22	13	39	54.6	61.996N	149.477W	057	3.60MB								002		017	231	19	80
ERL	1973	02	07	18	52	23.1	61.263N	150.478W	045	3.60MB			3.40MLERL		II			002	F	017	232	10	45
ERL	1973	02	08	15	00	48.9	61.759N	150.177W	054	3.80MB								002	F	022	232	10	60
ERL	1973	02	23	08	10	39.9	61.460N	150.785W	064	3.10MB								002		010	232	10	65
ERL	1973	04	06	05	22	57.3	61.233N	149.472W	039	3.80MB			3.60MLERL		II			002	F	021	231	19	9
ERL	1973	04	14	14	09	57.4*	60.584N	150.561W	057	3.50MB								014		016	232	00	92
ERL	1973	04	16	20	47	41.1*	60.800N	150.739W	033N				3.20MLERL					014		014	232	00	79
ERL	1973	04	30	11	55	29.2	60.951N	151.131W	033	3.40MB								014	F	018	232	01	88
ERL	1973	05	12	14	47	09.6	62.075N	149.707W	059	3.30MB								001		018	231	29	89
ERL	1973	06	25	04	36	59.8	61.670N	150.055W	015	3.40MB			3.10MLERL					002	F	017	232	10	49
ERL	1973	07	15	05	53	27.7	61.572N	150.298W	049				3.10MLPMR		I			002	F	011	232	10	48
GS	1973	09	28	00	34	46.7	61.394N	151.480W	082	3.60MB								002		022	232	11	100
GS	1973	10	10	15	12	55.6	62.082N	149.656W	057	3.60MB								001		023	231	29	90
GS	1973	11	01	16	50	22.0	61.999N	150.616W	069	3.90MB					IV			002	F	024	232	10	95
GS	1974	01	22	04	09	45.2	60.851N	150.019W	050	3.40MB								014		14	232	00	51
GS	1974	03	01	08	00	34.8	61.186N	148.512W	051	3.30MB								002		18	231	18	61

SOURCE	YEAR	MO	DA	HR	MN	SEC	LAT	LONG	DEPTH (KM)	MAGNITUDES BODY	SURF,	OTHER	LOCAL	INT MAP	INT MAX	PHENOM	DTSVNO	RN	CE	Q/S	MAR	DG	DIST (KM)
GS	1974	03	02	20	10	04.6	61.079N	148.182W	054	3.30MB								002		19	231	18	81
GS	1974	03	03	17	58	55.8	62.037N	149.445W	067	3.80MB								001		20	231	29	85
GS	1974	03	05	23	58	31.7	62.125N	149.806W	063	3.80MB								001		12	231	29	95
GS	1974	03	14	18	46	09.5*	60.775N	151.166W	039	4.10MB			4.00MLPMR					014		18	232	01	99
GS	1974	03	21	23	01	30.9	61.696N	150.926W	071	3.70MB								002		17	232	10	83
GS	1974	03	30	06	46	39.2	61.698N	150.996W	083	3.50MB								002		13	232	10	86
GS	1974	04	26	14	23	14.6	61.847N	150.668W	078	3.30MB								002		16	232	10	83
GS	1974	05	11	04	17	34.7	61.663N	150.587W	067	3.80MB					II			002	F	23	232	10	66
GS	1974	05	26	18	13	58.6	61.573N	150.240W	003				3.10MLPMR		II			002	F	15	232	10	46
GS	1974	05	28	08	21	59.4	60.614N	149.777W	027	3.40MB			3.80MLPMR		II			014	F	18	231	09	74
GS	1974	07	31	09	20	51.6	60.525N	150.048W	044	4.30MB					IV			014		29	232	00	86
GS	1974	09	23	11	57	10.1*	61.843N	150.137W	061	3.40MB								002		17	232	10	68
GS	1974	09	27	03	36	25.7	61.578N	149.949W	072	3.70MB					II			002	F	15	231	19	37
GS	1974	12	29	18	25	00.7	61.597N	150.511W	067D	5.60MB					V			002	F	81	232	10	59
GS	1974	12	30	03	33	16.6	61.982N	149.686W	062D	5.10MB					V			002	F	88	231	19	79
GS	1975	01	01	03	55	12.0	61.909N	149.738W	066	5.90MB					V			002	D	118	231	19	70
GS	1975	01	01	21	15	54.8	61.411N	150.059W	063	3.80MB					III			002	F	16	232	10	27
GS	1975	01	13	00	31	55.6	61.434N	150.494W	066	4.80MB					IV			002	F	45	232	10	49
GS	1975	01	17	01	33	52.0	61.658N	150.897W	070	3.80MB								002		11	232	10	79
GS	1975	01	27	00	23	09.7	61.277N	149.808W	046	3.90MB					III			002	F	15	231	19	9
GS	1975	01	28	07	25	01.2	61.353N	149.970W	042	3.70MB								002	F	19	231	19	20
GS	1975	03	12	14	05	31.5	61.915N	150.307W	010	3.90MB			4.00MLPMR					002	F	22	232	10	79
GS	1975	04	07	22	13	46.1	61.557N	150.570W	011	3.60MB			3.00MLPMR					002	F	16	232	10	59
GS	1975	04	18	08	52	32.6	61.813N	150.557W	041	3.50MB			3.00MLPMR					002	F	16	232	10	77
GS	1975	05	18	17	39	07.9*	60.869N	149.835W	050	3.7 MB								014		14	231	09	47
GS	1975	06	11	05	14	08.2	62.165N	149.635W	059	4.3 MB								001	F	41	231	29	99
GS	1975	08	01	07	04	33.0	61.919N	150.763W	079	4.6 MB								002		22	232	10	93
GS	1975	10	23	23	11	31.6	61.731N	150.118W	033N				3.20MLPMR					002		16	232	10	57
GS	1975	12	01	22	15	21.2	61.471N	149.136W	042	3.7 MB					IV			002	F	17	231	19	34
GS	1976	05	09	15	39	12.6	61.522N	151.286W	033N				3.10MLPMR					002		10	232	11	92
GS	1976	06	30	01	44	21.6*	60.659N	149.731W	021				3.10MLPMR					014		10	231	09	69
GS	1976	08	30	10	01	12.9	61.301N	151.431W	082	4.1 MB								002		16	232	11	96
GS	1976	09	09	15	28	14.9	61.380N	150.180W	032				3.20MLPMR					002		10	232	10	31
GS	1976	11	11	18	18	30.5*	61.314N	149.793W	033N				3.20MLPMR					002	F	8	231	19	9
GS	1976	12	13	17	27	53.6	61.873N	150.703W	074	4.3 MB								002		15	232	10	87
GS	1976	12	15	09	51	32.3	61.347N	150.249W	051	3.7 MB					III			002	F	13	232	10	33
GS	1977	01	19	07	36	36.9	62.146N	149.331W	081	3.8 MB								001		13	231	29	98
GS	1977	01	25	17	12	19.1*	60.983N	149.988W	037				3.50MLPMR					002	F	11	231	09	37
GIA	1977	01	25	17	12	19.8	61.065N	149.952W	037				3.16MLGIA					002		19	231	19	29
GS	1977	03	02	00	17	24.5	61.912N	150.630W	025	3.7 MB			3.40MLPMR					002		12	232	10	89
GS	1977	03	25	13	39	45.2	60.843N	148.137W	055	4.6 MB					IV			014	F	41	231	08	94
GS	1977	04	28	18	58	52.7	61.405N	150.964W	073	3. MB								002		23	232	10	72
GS	1977	05	11	17	33	30.7	61.704N	150.465W	076	3.9 MB					IV			002	F	23	232	10	65
GS	1977	06	02	16	29	46.3	61.314N	150.329W	067	3.6 MB					V			002	F	19	232	10	37
GS	1977	06	06	10	08	11.5	62.163N	149.548W	060	4.1 MB					III			001	F	17	231	29	99
GS	1977	06	17	08	26	28.9	61.492N	150.319W	074	4.3 MB					IV			002	F	30	232	10	43
GIA	1977	06	17	08	26	29.5	61.474N	150.300W	066				3.93MLGIA					002		17	232	10	42
GS	1977	06	18	05	59	53.7	61.554N	150.665W	052				3.10MLPMR					002		10	232	10	63
GS	1977	07	08	19	59	39.9	61.168N	150.855W	072	4.7 MB					IV			002	F	73	232	10	66

SOURCE	YEAR	MO	DA	HR	MN	SEC	LAT	LONG	DEPTH (KM)	MAGNITUDES BODY	MAGNITUDES SURF, OTHER	MAGNITUDES LOCAL	INT MAP	INT MAX	PHENOM DTSVNU	RN	CE	Q/S	MAR	DG	DIST (KM)
GIA	1977	07	08	19	59	40.4	61.105N	150.704W	69			4.50MLGIA				002		13	232	10	60
GIA	1977	07	15	02	06	14.9	61.630N	150.857W	59			3.46MLGIA				002		29	232	10	76
GS	1977	07	22	05	57	00.5	61.027N	150.401W	051	3.8 MB		4.00MLPMR				002	F	22	232	10	50
GIA	1977	07	22	05	57	01.8	61.128N	150.184W	22			4.00MLGIA				002		22	232	10	34
GS	1977	08	07	04	28	52.5	61.111N	151.209W	033N			3.20MLPMR				002		12	232	11	86
GIA	1977	08	12	19	28	15.3	61.551N	151.234W	71			3.62MLGIA				002		22	232	11	91
GIA	1977	08	19	04	28	58.2	61.936N	150.089W	36			3.05MLGIA				002		19	232	10	77
GS	1977	08	19	09	08	05.0*	61.962N	150.108W	033N			3.10MLPMR				001		15	232	10	80
GIA	1977	09	05	20	24	32.8	61.346N	150.717W	25			3.07MLGIA				002		11	232	10	58
GS	1977	09	17	15	42	42.2*	60.864N	150.840W	033N			3.70MLPMR				014		20	232	00	79
GIA	1977	09	23	22	37	44.4	60.757N	150.668W	35			3.56MLGIA				014		22	232	00	80
GS	1977	10	18	10	48	37.3*	60.704N	150.790W	033N	3.7 MB		3.40MLPMR		II		014	F	24	232	00	89
GS	1977	10	28	08	53	34.5*	60.910N	149.723W	026			3.40MLPMR		I		014	F	22	231	09	40
GS	1977	11	06	09	23	28.2	61.994N	150.734W	078	4.1 MB						001		15	232	10	99
GS	1978	01	06	21	59	01.1	60.909N	149.382W	045	4.6 MB				IV		014	F	36	231	09	43
GS	1978	01	09	07	06	05.8	62.000N	148.824W	009			3.50MLPMR		III		001	F	10	231	28	92
GS	1978	05	27	14	50	09.1	60.545N	150.702W	038			3.50MLPMR				014		20	232	00	100
GS	1978	06	14	11	27	03.8	61.626N	149.510W	033N			3.60MLPMR				002		20	231	19	39
GS	1978	07	13	15	27	33.5	62.113N	149.947W	040			3.50MLPMR		II		001	F	9	231	29	95
GS	1978	10	06	05	54	05.2	61.932N	150.665W	006			4.60MLPMR		III		002	F	17	232	10	91
GS	1978	10	30	11	11	38.4	60.963N	150.315W	048	3.3 MB						002	F	34	232	00	50
GS	1978	10	31	12	28	30.1	61.914N	149.571W	033N	3.5 MB		3.40MLPMR				002	F	28	231	19	71
GS	1978	11	03	12	17	26.7	60.829N	149.895W	033N			3.20MLPMR				014		20	231	09	52
GS	1978	11	24		28	12.8	62.027N	150.519W	074	4.5 MB						001	F	37	232	20	95
GS	1978	11	24	08	50	45.4*	61.992N	150.515W	077	3.2 MB						001	F	29	232	10	92
GS	1978	12	09	17	10	38.8*	61.397N	150.647W	073	3.9 MB						002		33	232	10	55
GS	1979	01	04	15	35	04.0	61.732N	150.037W	34			3.40MLPMR				002	F	17	232	10	55
GS	1979	01	12	12	06	31.9	61.832N	150.804W	48	3.5 MB						002		19	232	10	88
GS	1979	01	12	23	14	16.5	60.999N	149.424W	34	3.5 MB		3.30MLPMR				002		24	231	09	33
GS	1979	01	27	16	48	11.5	60.957N	149.378W	49	3.6 MB						002	F	15	231	09	38
GS	1979	02	04	22	05	46.0	62.066N	150.161W	33N	3.7 MB		3.80MLPMR				001		13	232	20	92
GS	1979	02	20	11	39	38.1*	61.727N	150.823W	33N	3.3 MB		3.00MLPMR				002		22	232	10	80
GS	1979	03	14	13	31	34.5	60.984N	149.385W	41	4.0 MB				IV		002	F	23	231	09	35
GS	1979	03	20	21	20	22.8*	61.173N	150.606W	92	3.7 MB						002		26	232	10	53
GS	1979	05	31	4	22	54.3	61.735N	149.881W	55	3.4 MB						002	F	12	231	19	53
GS	1979	06	23	10	46	58.6*	61.869N	150.280W	33N	3.1 MB		3.10MLPMR		IV		002	F	14	232	10	74
GS	1979	06	28	2	09	47.1*	61.828N	150.517W	33N			3.20MLPMR				002		8	232	10	77
GS	1979	08	28	17	06	09.6*	60.854N	150.914W	33N			3.30MLPMR				014		8	232	00	83
GS	1979	10	07	5	59	21.8	61.217N	150.432W	9			3.10MLPMR				002	F	10	232	10	43
GS	1979	10	18	11	51	58.6*	62.133N	150.215W	33N			3.80MLPMR				001		10	232	20	100
GS	1979	10	27	14	37	00.4	62.028N	150.551W	33N			3.20MLPMR				001		16	232	20	96
GS	1979	11	14	23	00	42.8	61.381N	150.094W	57	5.1 MB				IV		002	F	117	232	10	27
GS	1979	12	28	14	47	51.6	61.958N	150.521W	63	3.2 MB						001		10	232	10	89

THIS RUN CONTAINS 240 HITS

PREPARED BY CH2M HILL FROM DATA SUPPLIED BY THE NATIONAL GEOPHYSICAL AND SOLAR-TERRESTRIAL DATA CENTER
ENVIRONMENTAL DATA SERVICE----------NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

EARTHQUAKE DATA FILE

EAGLE RIVER PIPELINE K13765.E1 300KM RADIUS SEARCH ABOUT 61.27 DEG. N., 149.6 MAGNITUDE ≥ 6 80/12/01 PAGE 1

SOURCE	YEAR	MO	DA	HR	MN	SEC	LAT	LONG	DEPTH (KM)	MAGNITUDES BODY	MAGNITUDES SURF.	MAGNITUDES OTHER	MAGNITUDES LOCAL	INT MAP	INT MAX	PHENOM	RN	CE	Q/S	MAR	DG	DIST (KM)
EQH	1909	09	19	20	00	00.0Z	60.600N	149.270W				7.40PAS			V		014	F		231	09	
G-R	1911	09	22	05	01	24.0	60.500N	149.000W	060			6.90PAS			VIII	QS	014	D		231	09	
G-R	1912	01	31	20	11	48.0	61.000N	147.500W	080			7.25PAS			V		002	F		231	17	118
G-R	1928	06	21	16	27	13.0	60.000N	146.500W	025A			7.00PAS			VI		002	D		231	06	222
G-R	1929	07	03	00	53	00.0	62.500N	149.000W	025A			6.25PAS					001	F		231	29	141
G-R	1931	12	24	03	40	40.0	60.000N	152.000W	100			6.25PAS			IV		002	F	BBA	232	02	192
G-R	1932	03	25	23	54	51.0	62.500N	153.000W	025A			6.00PAS					001			232	23	224
G-R	1932	03	25	23	58	31.0	62.500N	152.500W	025A			6.90PAS			VII		001	D		232	22	204
G-R	1932	06	08	07	52	39.0	62.500N	153.000W	025A			6.00PAS					001			232	23	224
G-R	1932	09	14	08	43	23.0	61.000N	148.000W	050			6.25PAS			V		002	F		231	18	
G-R	1933	01	04	03	59	28.0	61.000N	148.000W	025A			6.25PAS			VI		002	D		231	18	
G-R	1933	04	27	02	36	04.0	61.250N	150.750W	025A			7.00PAS			VII		002	D		232	10	
G-R	1933	06	13	22	19	47.0	61.000N	151.000W	025A			6.25PAS			V		002	F		232	11	
G-R	1933	06	19	18	47	43.0	61.250N	150.500W	025A			6.00PAS			V		002	F		232	10	
G-R	1934	05	04	04	36	07.0	61.250N	147.500W	080			7.20PAS			VI		002	D		231	17	114
G-R	1934	06	02	16	45	29.0	61.250N	147.000W	025A			6.25PAS					002	F		231	17	141
G-R	1934	06	18	09	13	50.0	60.500N	151.000W	080			6.75PAS			V		014	D	AAA	232	01	113
G-R	1934	08	02	07	13	08.0	61.500N	147.500W	025A			6.00PAS			V		002	F		231	17	116
G-R	1940	10	11	07	53	10.0	59.500N	152.000W	025A			6.00PAS					002			196	92	236
G-R	1941	07	30	01	51	21.0	61.000N	151.000W				6.25PAS			VI		002	D		232	11	
G-R	1942	12	05	14	28	40.0	59.500N	152.000W	100			6.50PAS					002		BBB	196	92	236
G-R	1943	11	03	14	32	17.0	61.750N	151.000W	025A			7.30PAS			V		002	F		232	11	
G-R	1946	01	12	20	25	37.0	59.250N	147.250W	050			7.20PAS			IV		015	F		195	97	261
G-R	1948	08	19	13	50	46.0	63.000N	150.500W	100			6.25PAS					001		BBB	232	30	198
G-R	1949	09	27	15	30	45.0	59.750N	149.000W	050			7.00PAS			V	Q	014	F		195	99	173
JSS	1951	06	25	16	12	37.0	61.100N	150.100W	128			6.25PAS			V		002	F		232	10	
USE	1954	10	03	11	18	46.0	60.500N	151.000W	100			6.75PAS			VIII		014	D		232	01	113
USE	1958	01	24	23	17	29.0	60.000N	152.000W	060			6.50PAS			IV		002	F		232	02	192
ISS	1959	12	26	18	19	08.0	59.740N	151.380W				6.25PAS					014	F		196	91	195
CGS	1961	09	05	11	34	37.3	60.000N	150.600W	043			6.13PAS			VI		014	D		232	00	151
CGS	1962	05	10	00	03	40.2	62.000N	150.100W	072			6.00BRK			V		001	F	020	232	20	
CGS	1962	07	16	12	54	40.6	62.300N	153.100W	039			6.00PAL			V		001	D		232	23	216
CGS	1962	08	18	16	43	54.3	62.300N	152.500W	032			6.13PAS			V		001	F	050	232	22	190
CGS	1962	08	18	17	46	14.9	62.300N	152.500W	032			6.38PAS			V		001	F	038	232	22	190
CGS	1963	05	02	23	13	09.4	63.100N	149.900W	079	6.10MB							001		019	231	39	204
CGS	1963	06	24	04	26	37.9	59.500N	151.700W	052	5.70MB		6.75PAS			VII		014	D	014	196	91	228
USE	1964	03	28	03	36	14.0S	61.040N	147.730W	033G		8.3SH	8.00PAS		USE	X	UTS	002	C	181	231	17	105
CGS	1964	03	28	04	54	07.9	59.800N	149.400W	025	6.10MB							014		025	195	99	164
CGS	1964	03	28	07	10	21.4	58.800N	149.500W	020	6.10MB		6.20PAS					015	F	053	195	89	275
CGS	1964	03	28	09	52	55.7	59.700N	146.600W	030	5.50MB		6.20PAS					015	F	056	195	96	241
CGS	1964	03	28	14	47	37.1	60.400N	146.500W	010	5.70MB		6.30PAS					002	F	061	231	06	196
CGS	1964	03	28	14	49	13.7	60.400N	147.100W	010	5.80MB		6.50PAS					002	F	028	231	07	168
CGS	1964	03	28	20	29	08.6	59.800N	148.700W	040	5.80MB		6.60PAS					014	F	081	195	98	171
CGS	1964	03	30	07	09	34.0	59.900N	145.700W	015	5.60MB		6.20PAS					015	F	080	195	95	264
CGS	1964	04	03	22	33	42.2	61.600N	147.600W	040	5.70MB		6.00PAS			V		002	D	080	231	17	114
CGS	1964	04	20	11	56	41.6	61.400N	147.300W	030	5.70MB		6.50PAS					002	F	087	231	17	125
CGS	1964	04	21	05	01	35.7	61.500N	147.400W	040	5.40MB		6.00PAS					002	F	066	231	17	122
USE	1968	04	23	20	29	14.5	58.700N	150.000W	023	6.30MB		6.13PAS					015	F	058	196	80	287
USE	1968	12	17	12	02	15.0P	60.200N	152.800W	086	5.90MB		6.50PAS			VI		002	F	101	232	02	210
USE	1970	01	16	08	05	39.6	60.300N	152.700W	091D	5.60MB		6.00PAS			V		002	F	078	232	02	199

SOURCE	YEAR	MO	DA	HR	MN	SEC	LAT	LONG	DEPTH (KM)	MAGNITUDES BODY	MAGNITUDES SURF.	MAGNITUDES OTHER	MAGNITUDES LOCAL	INT MAP	INT MAX	PHENOM DTSVNO	RN	CE	Q/S	MAR	DG	DIST (KM)
CGS	1970	08	18	17	52	06.3	60.700N	145.384W	016	5.60MB	5.98H	6.00PAS	5.90MLCGS		IV		002	F	082	231	05	238

THIS RUN CONTAINS 51 HITS

PREPARED BY CH2M HILL FROM DATA SUPPLIED BY THE NATIONAL GEOPHYSICAL AND SOLAR-TERRESTRIAL DATA CENTER
ENVIRONMENTAL DATA SERVICE----------NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

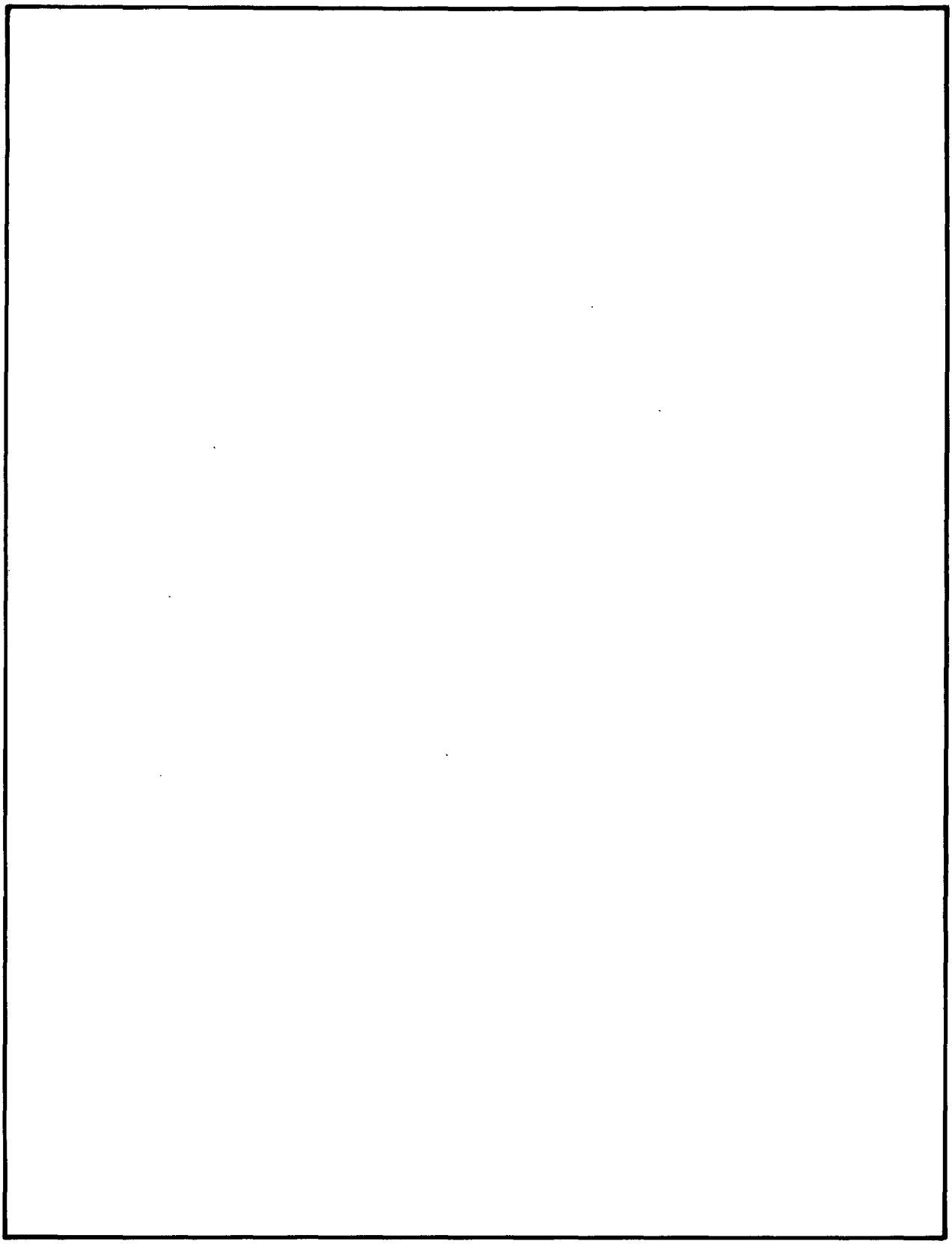
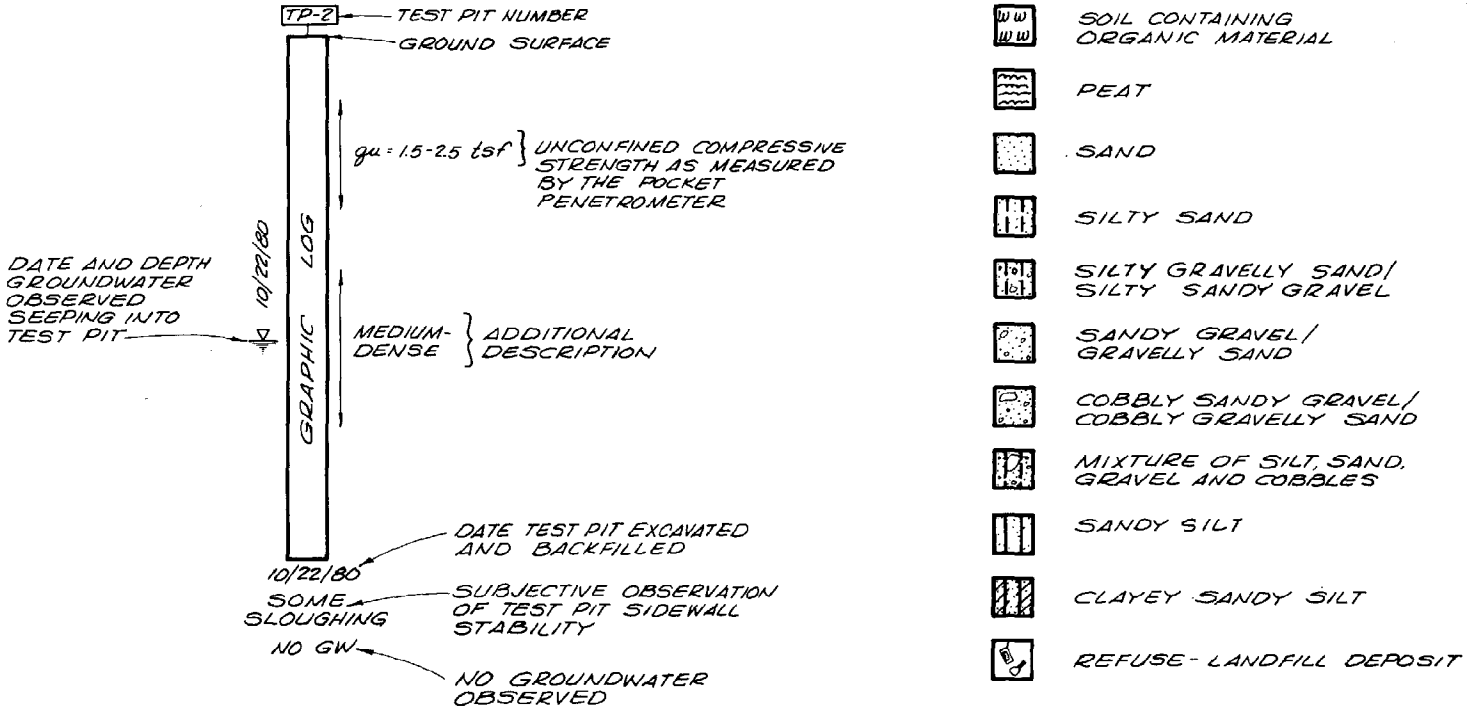
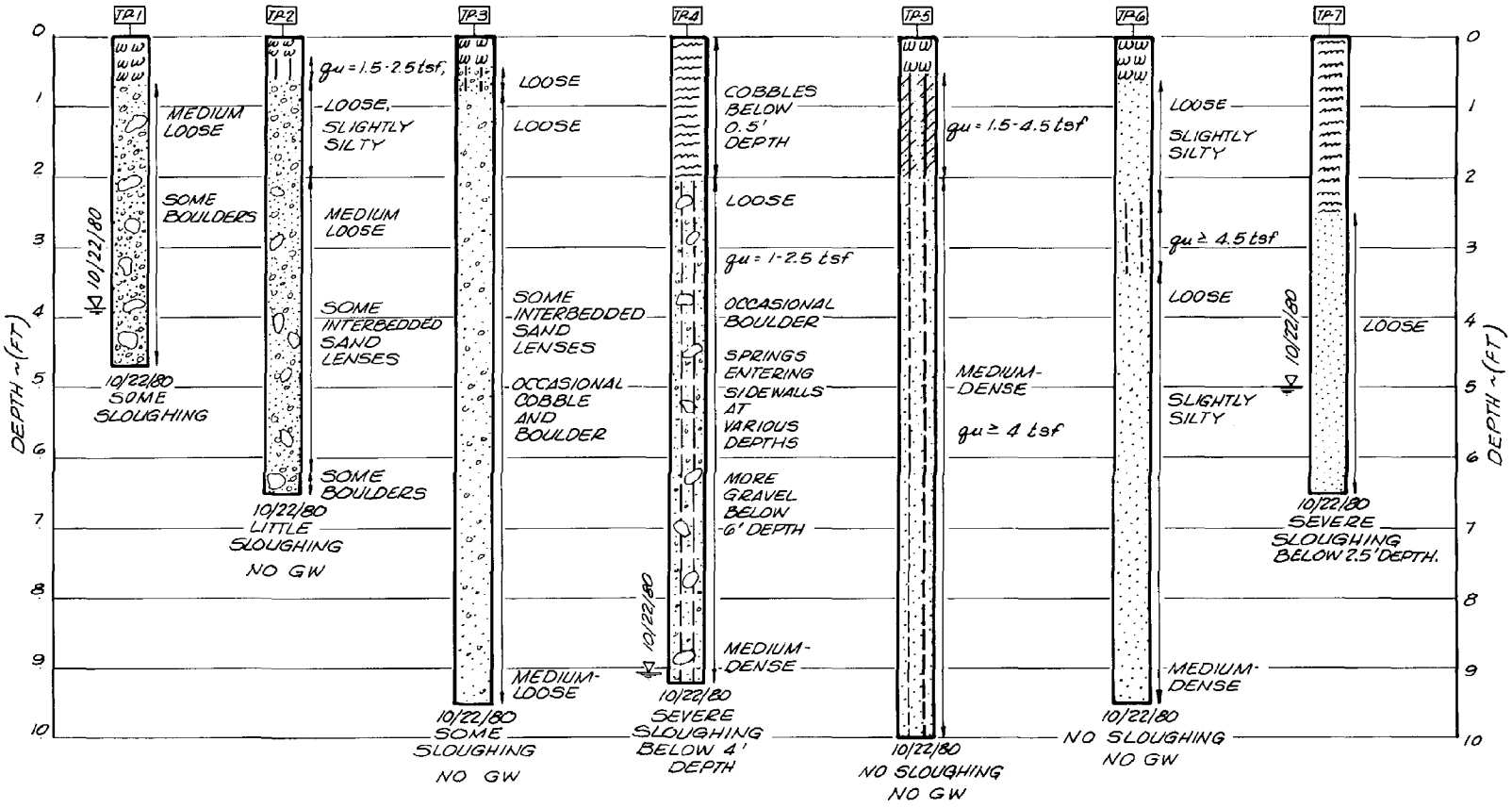


Exhibit C
Test Pit Logs



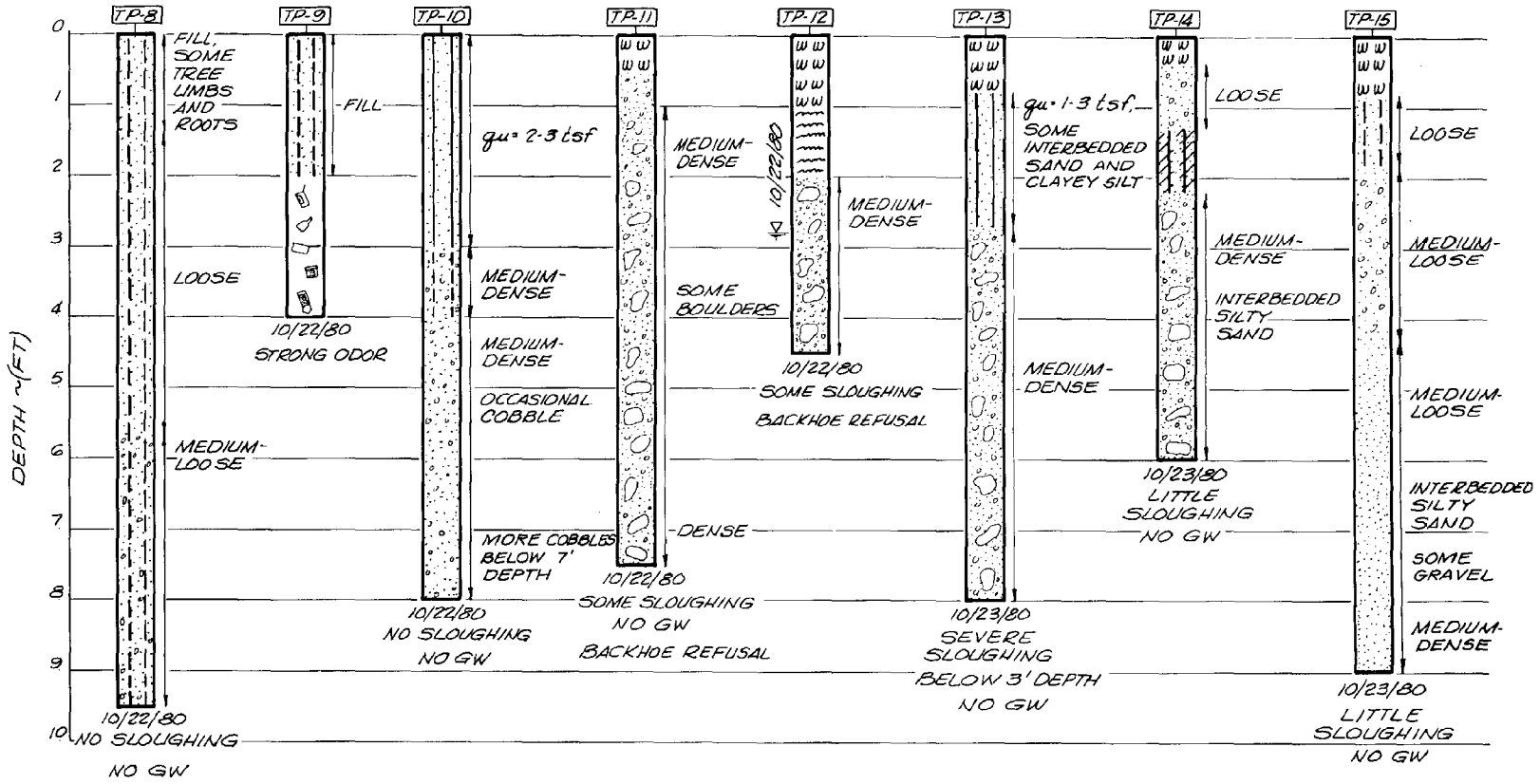
NOTE:
THE TEST PIT LOGS NECESSARILY REFLECT SUBSURFACE CONDITIONS ONLY AT SPECIFIC LOCATIONS AND MAY NOT REFLECT VARIATIONS BETWEEN LOCATIONS. IN ADDITION, THE PASSAGE OF TIME MAY ALTER THE CONDITIONS OBSERVED IN THE TEST PITS, ESPECIALLY WITH RESPECT TO GROUNDWATER.

Legend for Figures C-1 and C-2



NOTE:
SEE EXHIBIT A FOR TEST PIT LOCATIONS.

Figure C-1
Logs for Test Pits 1-7



NOTE:
SEE EXHIBIT A FOR TEST PIT LOCATIONS.

Figure C-2
Logs for Test Pits 8-15

Exhibit D
Sample Permits

Form 2920–1
(November 1977)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FORM APPROVED
OMB NO. 42–R0996

TEMPORARY USE APPLICATION AND PERMIT

Title 1, Sec. 28(e) of the Mineral Leasing Act of 1920, 30 U.S.C. 185, as amended; Secs. 302(b) and 504(a) of P.L. 94–579, October 21, 1976, 43 U.S.C. 1732, 1764.

Serial Number

INSTRUCTIONS ON REVERSE

APPLICATION

1. Name *(first, middle initial, and last)* | Address *(include zip code)*

2. Give legal description of public lands for which you are applying

TOWNSHIP	RANGE	SECTION	SUBDIVISION

Meridian	State	County	Acres *(number)*

3. Proposed date(s) of use: From to

4a. Are you 21 years of age or over? ☐ Yes ☐ No

b. Are you a citizen of the United States or have you declared your intention? ☐ Yes ☐ No

c. As applicant, are you a ☐ Partnership ☐ Association ☐ Corporation; ☐ Individual(s); or an agency of ☐ Federal Government ☐ State Government ☐ Political subdivision of any state?

d. Are the statements required by Instruction Number 2 attached? ☐ Yes ☐ No ☐ Not applicable

5. Are you making this application for your own use and benefit? ☐ Yes ☐ No *(If "no," explain)*

6. Are the lands now improved, occupied, or used? ☐ Yes ☐ No *(If "yes," describe improvements and purposes, identify users and occupants)*

7a. What do you propose to use the lands for?

b. What improvements, including sanitation facilities, do you intend to make? *(Describe improvements and attach drawings, if convenient)*

c. What is the estimated cost of proposed improvement? $

d. What is the proposed source of water for domestic or other uses?

8. Have you enclosed filing fee of $10? ☐ Yes ☐ No *(See Instruction Number 3)*

I CERTIFY That the information given by me in this application is true, complete, and correct to the best of my knowledge and belief and is given in good faith.

(Date) (Signature of Applicant)

Title 18 U.S.C. Section 1001, makes it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, ficitious, or fraudulent statements or representations as to any matter within its jurisdiction.

NOTICE

The Privacy Act of 1974 and the regulation in 43 CFR 2.48(d) provide that you be furnished the following information in connection with information required by this application for a Temporary Use Application and Permit.

AUTHORITY: 43 U.S.C. 1201; 43 CFR Part 2920 and 30 U.S.C. 185; Part 2880.

PRINCIPAL PURPOSE: The information is to be used to process your application.

ROUTINE USES: (1) The adjudication of the applicant's request for a Land Use Permit. (2) Documentation for public information. (3) Transfer to appropriate Federal agencies when concurrence is required prior to granting a right in public lands or resources. (4)(5) Information from the record and/or the record will be transferred to appropriate Federal, State, local or foreign agencies, when relevant to civil, criminal or regulatory investigations or prosecutions.

EFFECT OF NOT PROVIDING INFORMATION: Disclosure of the information is voluntary. If all the information is not provided, the application may be rejected.

PERMIT

Permission is hereby granted to

of

to use the following-described lands:

TOWNSHIP	RANGE	SECTION	SUBDIVISION

Meridian	State	County	Acres *(number)*

for the purpose of

and subject to the following conditions:

1. This permit is issued for the period specified below. It is revocable at the discretion of the authorized officer of the Bureau of Land Management, at any time upon notice. This permit is subject to valid adverse claims heretofore or hereafter acquired.

2. Permittee shall pay annually, in advance, to the authorized officer the sum of dollars as rental or such other sum as may be required if a rental adjustment is made.

3. Permittee shall observe all Federal, State, and local laws and regulations applicable to the premises and to erection or maintenance of signs or advertising displays including the regulations for the protection of game birds and game animals, and shall keep the premises in a neat, orderly, and sanitary condition.

4. Use or occupancy of land under this permit shall commence within months from date hereof and shall be exercised at least days each year.

5. Permittee shall take all reasonable precautions to prevent and suppress forest, brush, and grass fire and prevent pollution of waters on or in the vicinity of the lands.

6. Authorized representatives of the Department of the Interior, other Federal agencies, and game wardens shall at all times have the right to enter the premises on official business.

7. Permittee shall not enclose roads or trails commonly in public use.

8. Permittee shall pay the United States for any damage to its property resulting from this use.

9. Permittee shall notify the authorized officer of address change immediately.

10. This permit is subject to all applicable provisions of the regulations (43 CFR 2920) which are made a part hereof.

11. Permittee agrees to have the serial number of this permit marked or painted on each advertising display erected or maintained under the authority of such permit.

12. Permittee shall not cut any timber on the lands without prior permission from the authorized officer.

13. This permit is subject to the provisions of Executive Order No. 11246 of September 24, 1965, as amended, which sets forth the Equal Opportunity clauses. A copy of this order may be obtained from the signing officer.

14. This permit may not be assigned without prior approval of the authorized officer of the Bureau of Land Management.

15. Special Conditions:

Permit issued for period

From _____ _____ _____ _____
(Authorized Officer)

To _____ _____ _____
(Title) (Date)

INSTRUCTIONS

1. Submit, in *duplicate*, to any local office of the Bureau of Land Management having jurisdiction of the lands.

2. An application by a partnership or association must be accompanied by a statement by each member that he is a citizen of the United States or has filed a declaration to become a citizen. An application by a corporation must be accompanied by a statement showing that the corporation is authorized to hold land in the State in which the land is located and that the person making the application is authorized to act for the corporation.

3. If applicant is other than a Federal, State, or local governmental agency, this application must be accompanied by a nonreturnable filing fee of $10 made payable to the Bureau of Land Management.

4. If this application is for permission to erect an advertising display or sign, the applicant must: (a) attach an accurate and fully descriptive diagram, sketch, or photograph (at least 3" × 5") of the sign or display to be erected showing the dimensions, type of construction, estimated cost, the advertising material to be included thereon, the plan of illumination, if any, and the manner of attachment to the land; and, (b) a photograph (at least 3" × 5") showing the site on which the sign or display is to be erected.

GPO 843-060

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
MASTER APPLICATION - INFORMATION SHEET
Environmental Procedures Act, AS 46.35

GENERAL INFORMATION

The master application serves as a notice of intent to the State of a proposed project by an applicant. This form was designed to include a broad range of State and local government interests, therefore, many of the questions may not apply to your proposed project. Please read this application before completing it. Answer all questions pertaining to your proposed project. Any missing or misleading answers may delay the processing of your application. Complete a site diagram of the project and submit it with your signed application to one of the Permit Information Centers listed below.

Alaska Permit Information Center
Department of Environmental Conservation
437 "E" Street, Second Floor
Anchorage, Alaska 99501
Telephone: (907) 279-0254

Alaska Permit Information Center
Department of Environmental Conservation
675 7th Avenue, P.O. Box 1601
Fairbanks, Alaska 99707
Telephone: (907) 452-2340

Alaska Permit Information Center
Department of Environmental Conservation
Pouch O, 3220 Hospital Drive
Juneau, Alaska 99811
Telephone: (907) 465-2615

GENERAL PROCEDURES FOR PROCESSING APPLICATIONS UNDER AS 46.35

Upon receipt of the master application in a permit center, the following steps are taken:

Master Application

1. Copies of the master application and the site diagram are sent for review to all State departments and any municipality where the project is located. A statement is requested regarding agency jurisdiction and any permits that may be required for the proposed project.

2. These agencies must respond to the permit center within 15 days. If the agencies have any jurisdiction over the project and require a permit, they will submit their individual applications to the permit center with a statement of whether a hearing is required.

Individual State & Local Permit Applications

1. The permit center will send the individual applications to the applicant for completion. Completed applications and required fees should be returned to the permit center.

2. The returned applications and fees will be sent to the proper agencies. The permit center will make the arrangements for a public hearing on the project, if a hearing is required. Within 30 days receipt of the last applications, the permit center will have a notice published once a week for three consecutive weeks. The applicant will be required to pay for the publication of these notices.

3. The public hearing will be held in or near the municipality where the major part of the proposed project is located. This hearing will be held within 20 to 30 days of the last publication of the notice. Members of the public and the applicant may be present. Any State agency that requires a permit for the project shall be represented at the hearing.

4. At the close of the hearing, the chairman will establish a date (within 90 days from the hearing date) for the final decisions on all applications on the project. The final decisions will be submitted to the Department of Environmental Conservation. They will be incorporated into one document and submitted to the applicant personally or by certified mail.

LAWS OF ALASKA

1977

Source

HCS CSSB 227

Chapter No.

60

AN ACT

Regulating the procedure on applications for permits for the use of the state's air, land, or water resources; and providing for an effective date.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

* Section 1. AS 46 is amended by adding a new chapter to read:

CHAPTER 35. ENVIRONMENTAL PROCEDURES COORDINATION.

Sec. 46.35.010. LEGISLATIVE DETERMINATION. The legislature determines that the substantial burdens placed upon persons who are proposing to undertake certain types of projects in this state through requirements to obtain numerous permits and related documents from various federal, state and local agencies are undesirable and should be alleviated. The legislature further finds that present methods for obtaining public views relating to applications to state and local agencies pertaining to these projects are cumbersome and place undue hardships on members of the public with the result that the public ability to express its views is hindered and not facilitated.

Sec. 46.35.020. PURPOSE. It is the purpose of this chapter to

(1) establish a simplified procedure to assist those who, to satisfy the requirements of federal, state, and local law must obtain a permit from one or more federal, state or local government agencies by establishing a procedure to coordinate the administrative decision-making process;

(2) provide to the members of the public a better opportunity to present their views on proposed uses of the state's natural resources and related environmental

concerns before federal, state and local agencies decide on applications for permits;

(3) provide to applicants for the use of the air, land or water resources of the state a greater degree of certainty on permit requirements of federal, state, and local governments;

(4) increase the coordination between federal, state, and local agencies in their administration of programs affecting the state's air, land, and water resources;

(5) establish an opportunity for members of the public to obtain information pertaining to requirements of federal, state, and local law which must be satisfied before undertaking a project in this state.

Sec. 46.35.030. MASTER APPLICATION. (a) A person proposing a project which requires the issuance of one or more permits may submit a master application to the department requesting the issuance of all permits and documents necessary before the construction and operation of the project in the state. The master application shall be on a form established by the department and shall contain sufficient information as to the location and the nature of the project, including discharge of wastes and use of or interference with natural resources of the state.

(b) Upon receipt of a properly completed master application, the department shall immediately forward a copy of the application to all heads of executive departments of the state and the chief elected official of all municipalities in which a portion of the project is proposed to be constructed, together with the date by which the agency shall respond to the master application.

(c) Each agency notified shall respond in writing to the department by the specified date, not exceeding 15 days from receipt, as determined by the department, advising

(1) whether the agency has an interest in the master application;

(2) if the response to (1) of this subsection is affirmative, the permit program under the agency's jurisdiction to which the project described in the master application is pertinent; and

(3) whether, in relation to the master application, a public hearing as provided in secs. 50 and 60 of this chapter would be in the public interest.

(d) Each notified agency which (1) responds within the specified date that it does not have an interest in the master application; or (2) does not respond as required within the specified date, may not subsequently require a permit of the applicant for the project described in the master application unless the master application contained false, misleading, or deceptive information, or other information or lack of information which would reasonably lead an agency to misjudge its interest in the

master application.

(e) The department shall submit application forms relating to permit programs identified in affirmative responses under (c) of this section to the applicant with a direction to complete and return them to the department within a reasonable time as specified by the department.

(f) When the applications, properly completed, have been returned to the department, each of the applications shall be transmitted to the appropriate state agency for the performance of its responsibilities of decision making in accordance with the procedures of this chapter.

Sec. 46.35.040. WITHHOLDING FINAL PERMIT. When it appears that the applicant does not own or control the land or water necessary for the siting of the project in the master application, the department shall continue the proceedings under this chapter but may withhold the final permit until the applicant has obtained ownership or control of the land or water necessary for the site of the project. If the applicant has applied for land or water necessary for the siting of the project from the state or a municipality of the state, the state agency or municipality shall promptly adjudicate the application for the land or water filed by applicant.

Sec. 46.35.050. NOTICE OF PROPOSED PROJECT. (a) The department, within 30 days after transmittal under sec. 30(f) of this chapter, shall cause a notice to be published at the applicant's expense once each week for three consecutive weeks in a newspaper of general circulation within each municipality in which the project is proposed to be constructed or operated. The notice shall describe the nature of the master application, including, with reasonable specificity, the project proposed, its location, the various permits or documents applied for, and the state agency having jurisdiction over each permit or document. Except as provided in (b) of this section, the notice shall also state the time and place of the public hearing which shall be scheduled not less than 20 or more than 30 days after the date of last publication of the notice. It shall further state that a copy of the master application and a copy of all applications for the project are available for public inspection in the regional office of the department nearest to where the project is proposed to be constructed or operated, as well as at the department office in the capital and any other locations the department may designate in the notice.

(b) If no part of the project is to be constructed or operated in a municipality, or if there is no regularly published newspaper of frequency at least weekly, the public notice shall be published in a newspaper in the judicial district in which the project is proposed.

(c) If the responses received by the department from state agencies under sec. 30(f) of this chapter unanimously state the position that a public hearing concerning a master application is not necessary in the public interest, and the department, after a careful evaluation, taking into consideration all interests involved, including the

opportunity for members of the public to present views, agrees, the provisions of (a) of this section pertaining to the time and place of a public hearing shall not be included in the notice. In that case the notice shall state that members of the public may present their views and supporting materials in writing to the department regarding any of the permits applied for within 30 days after the last date of publication of the notice in a newspaper.

Sec. 46.35.060. PUBLIC HEARING. (a) Except as provided in sec. 50(b) of this chapter, before a final decision is made on a permit application relating to a project subject to the procedures of this chapter, a public hearing shall be held in or near the municipality in which all or a major part of the proposed project is to be constructed or operated, or, if the project is not to be constructed or operated in a municipality, the hearing shall be held at a location reasonably convenient to the site of the proposed project. The hearing shall be held in accordance with the notice given under sec. 50(a) of this chapter. At the hearing the applicant may submit any relevant information and material in support of his applications, and members of the public may present relevant views and supporting materials relating to any or all of the applications being considered.

(b) Each state agency having an application for a permit before it under sec. 50(a) of this chapter shall be represented at the public hearing by its commissioner or his designee. The commissioner of the department, his designee, or a hearing officer appointed by the governor, shall chair the hearing; however, the representative of any state agency other than the department within whose jurisdiction a specific application lies shall conduct the portion of the hearing pertaining to submission of information, views, and supporting materials which concern that application. The chairman may continue a hearing from time to time and place to place.

(c) No provisions of AS 44.62 apply to the hearing conducted under this section, and the hearing shall be conducted for the purpose of obtaining information for the assistance of state agencies and not as a trial or adversary proceeding.

(d) Federal and local government agencies may be represented at the hearings, at their option, by their chief executive officer or his designee.

(e) The hearing shall be electronically recorded, and copies of the recording shall be made available to state, federal and local agencies upon request.

Sec. 46.35.070. FINAL DECISION. (a) Upon completion of the public hearing the chairman, after consultation with the state agency representatives, shall establish the date by which all state agencies shall forward their final decisions on applications before them to the department. The date established shall be within the following 90-day period after the public hearing.

(b) In a situation where a notice is provided under sec. 50(b) of this chapter, the department shall, 30 days after the last notice publication in the newspaper, submit a copy of all views and supporting material received by it to each agency as described in the notice as having an application before it. At the same time, the department shall notify each state agency, in writing, of the date by which final decisions on applications shall be forwarded to the department. That date shall be no later than 90 days after the date of last publication of the notice, but may be extended by the department for reasonable cause.

(c) Each final decision shall state the basis for the conclusion together with a final order denying the application for a permit or granting it, subject to a condition of approval as the deciding agency may have the power to impose. An agency which denies an application shall, with its final decision denying the application, provide a written summary suggesting alternate means of completing the project, or, if no alternative is feasible, the agency shall provide a written summary of its reasons for that conclusion.

(d) As soon as all final decisions are received by the department under (b) and (c) of this section, the department shall incorporate them, without modification, into one document and transmit it to the applicant either personally or by registered mail.

(e) Each state agency having jurisdiction to approve or deny an application for a permit shall have the power vested in it before the effective date of this Act to make such determinations. Nothing in secs. 30 - 70 of this chapter lessens or reduces these powers, and secs. 30 -70 of this chapter modify only the procedures to be followed in the carrying out of the powers.

(f) A state agency, in the performance of its responsibilities of decision making under this chapter, may request or receive additional information from an applicant and others before or after the public hearing.

Sec. 46.35.080. WITHDRAWAL OF AGENCY FROM PARTICIPATION. (a) A state agency responding affirmatively under sec. 30(b) of this chapter may withdraw from participation in the processing provided in secs. 30 - 70 of this chapter at any time, by written notification to the department, if it subsequently appears to the state agency that it has no permit programs under its jurisdiction applicable to the project.

(b) A decision by a state agency to withdraw from the proceeding is irreversible, and the state agency may not subsequently require a permit of the applicant for the project described in the master application unless the master application contained false, misleading, or deceptive information, or other information or lack of information which would reasonably lead an agency to misjudge its interest in the master application.

Sec. 46.35.090. ADMINISTRATIVE AND JUDICIAL REVIEW. (a) A person aggrieved by a final decision issued under

sec. 70(d) of this chapter may file a notice of appeal with the commissioner requesting an adjudicatory hearing within 30 days of transmittal of the final decision to the person. A failure to file a timely notice of appeal constitutes a waiver of the person's right to review the final decision, unless the failure was due to circumstances beyond the applicant's control.

(b) The commissioner shall grant a request for an adjudicatory hearing within 20 days of filing of the notice of appeal if he determines that the notice raises a reasonable issue of fact or law material to the final decision.

(c) A hearing officer appointed under AS 44.62.350 shall preside at hearings under this section, rule on the admission and exclusion of evidence, advise the deciding officers on matters of law, and participate in posthearing deliberations.

(d) Appeals shall be heard jointly by the commissioner, or his designee, of each agency which rendered a final decision under sec. 70 of this chapter for which the person requesting the hearing is aggrieved. The commissioner, or his designee, of each agency shall decide only that portion of the appeal which involves his agency.

(e) The commissioner, after consultation with other state agencies and local governments, shall adopt regulations governing the conduct of adjudicatory hearings under this section. The commissioner may enter into cooperative agreements with local governments and federal agencies for the joint holding of adjudicatory hearings. To the extent feasible, regulations adopted under this section shall conform to adjudicatory hearing procedures for the review of permit decisions under AS 30.25 and AS 46.03. Notwithstanding AS 44.62.330(a)(44), adjudicatory hearing procedures to review permit decisions under this chapter, or under AS 30.25 or AS 46.03, need not conform to the Administrative Procedure Act (AS 44.62.330 et seq).

(f) A person aggrieved by a final decision of the commissioner under this section may appeal the decision to the superior court in the manner provided by AS 44.62.560 - 44.62.570.

Sec. 46.35.100. TIME. It is the sense of the legislature that time is of the essence in the processing of applications under this chapter. Whenever a section in this chapter states a time within which an act or a review is to be completed, the legislature has determined that the time allotted is adequate for a responsive state agency or municipality to complete the act or review. If unusual conditions prevent this from happening, it is the sense of the legislature that minimum extensions of the period established in this chapter may be granted upon a determination that the delay occurred beyond the control of the reviewing agency or municipality.

Sec. 46.35.110. APPLICATION. Notwithstanding any other provisions of regulation or statute relating to the processing of application for permits, the procedures set

out in this chapter are exclusive for applications filed under sec. 30 of this chapter. The procedures of this chapter are in lieu of any procedures otherwise provided by law or regulation, and are to be followed by a state agency in ruling upon those applications.

Sec. 46.35.120. FEE SCHEDULES. Fee schedules previously established or authorized by law for an application for a permit continue to apply. The department shall collect the fees and forward them to the appropriate state agency.

Sec. 46.35.130. COMPLIANCE WITH LOCAL ZONING ORDINANCES AND PLANS. (a) No permit for a project filed under sec. 30 of this chapter may be issued unless the application has provided a certification from the appropriate local government that the project is in compliance with the zoning ordinances and associated comprehensive plans administered by the local government regarding the project. If the local government has no such ordinances or plans, the local government shall certify that fact. A local government may accept applications for certification under this section and shall rule upon them within 30 days. A local government may impose stipulations of performance in its approval, but, upon certification, the local government may not change the zoning ordinances as to the proposed project until the procedures of this chapter, including an appeal, are completed.

(b) Approval of an application for certification as provided in this section shall not eliminate any requirements of ordinances administered by a local government. A ruling by local government denying an application for certification is not appealable under this chapter, except that the denial of an application for certification under (a) of this section does not preclude the applicant from filing an application under a different statute or procedure.

Sec. 46.35.140. APPLICABILITY OF OTHER LAWS. Nothing in this chapter modifies in any manner the applicability of a land use law or regulation or local zoning ordinances to land of a state agency.

Sec. 46.35.150. REGULATIONS AND AUTHORITIES. The department may adopt regulations to implement the provisions of this chapter.

Sec. 46.35.160. PERMIT REQUIREMENTS INFORMATION CENTERS. (a) The department shall establish permit requirement information centers at the commissioner's office and in all of its regional offices and may enter into an agreement with the governing body of any municipality having a population of more than 1,000 persons to establish and maintain local information centers to provide information to the public, in readily understandable form, regarding the requirements of federal, state, and local governments for permits which must be acquired before initiating projects in this state and to provide assistance in the completion of permit applications.

(b) Each regional office of the department and other

offices as the department may establish shall provide a master application to any person requesting it. The department shall provide information, forms, instructions, and assistance in the completion of a master application under this chapter to a person requesting assistance.

Sec. 46.35.170. CONFLICTS AND COMPLIANCE WITH FEDERAL REQUIREMENTS. (a) If any part of this chapter is found in conflict with federal requirements regarding the allocation of federal funds to the state, that part of this chapter is inoperative to the extent of the conflict regarding the agencies affected, and the determination shall not affect the operation of the remainder of this chapter.

(b) The department, to the extent necessary to comply with procedural requirements of federal law relating to permit systems operated by the state, may modify the notice, timing, hearing and related procedural matters provided in this chapter.

Sec. 46.35.200. DEFINITIONS. In this chapter

(1) "commissioner" means the commissioner of environmental conservation;

(2) "department" means the Department of Environmental Conservation;

(3) "local government" means a city or borough including a municipality unified under AS 29.68.240 - 29.68.440;

(4) "permit" means each of the following licenses, permits or authorizations required to be obtained from a state agency before constructing or operating a project in the state, or any other license, permit or authorization which may be designated by the commissioner:

(A) waste water disposal permit -- AS 46.03.100, 18 AAC 72;

(B) solid waste disposal permit -- AS 46.03.100, 18 AAC 60;

(C) air emissions permit -- AS 46.03.150, 18 AAC 50.120;

(D) pesticides permit -- AS 46.03.320, 18 AAC 90;

(E) surface oiling permit -- AS 46.03.740, 18 AAC 75;

(F) open burning permit -- AS 46.03.020, 18 AAC 50.120;

(G) anadromous fish protection permit -- AS 16.05.870, 5 AAC 95.100;

(H) critical habitat area permit -- AS 16.20.250 - 16.20.260;

(I) state game refuge land permit -- AS 16.20.050 - 16.20.060;

(J) encroachment permit -- AS 19.25.200;

(K) utility permit -- AS 19.25.010;

(L) driveway permit -- AS 19.05.020, 17 AAC 10.020;

(M) state park incompatible use permit -- AS 41.20.020, 11 AAC 18.010;

(N) access roads permit -- AS 41.20.020, 11 AAC 18.020;

(O) water well permit -- AS 31.05.030, 11 AAC 22.140;

(P) brine or other salt water waste disposal permit -- AS 31.05.070, 11 AAC 22.250;

(Q) coal development permit -- AS 27.20.-010, 11 AAC 46.010;

(R) right-of-way and easement permits -- AS 38.05.330, 11 AAC 58.200;

(S) special land use permit -- AS 38.05-.035, 11 AAC 58.210;

(T) tidelands permit -- AS 38.05.320, 11 AAC 62.710;

(U) tidelands right-of-way or easement permit -- AS 38.05.320, 11 AAC 62.810;

(V) limited personal use permit -- AS 38.05.320, 11 AAC 62.820;

(W) permit to appropriate water -- AS 46.15.040, 11 AAC 72.050;

(X) dam construction permit -- AS 46.15.-040, 11 AAC 72.060;

(Y) preferred use permit -- AS 46.15.040, 11 AAC 72.160;

(Z) permit for use of timber or materials -- AS 38.05.110, 11 AAC 76.185;

(AA) authorization for tidelands transportation -- AS 38.05.110, 11 AAC 76.205;

(BB) special material use permit -- AS 38.05.115, 11 AAC 76.540;

(CC) mineral and geothermal prospecting permits -- AS 38.05.145;

(DD) tide and submerged lands prospecting

permit -- AS 38.05.250;

(EE) surface use permit -- AS 38.05.255, 11 AAC 86.600;

(FF) burning permit during fire season -- AS 41.15.050, 11 AAC 92.010;

(GG) miscellaneous state land use permit -- AS 38.05.035, 11 AAC 96.010;

(HH) right-of-way permit -- AS 38.05.330;

(5) "person" means an individual, municipal, public, or private corporation, or other entity, and includes a state agency and a local government;

(6) "processing" and "processing of applications" means the entire process followed in relation to the making of decisions on an application for a permit and review of it as provided in secs. 30 - 80 of this chapter;

(7) "project" means any new activity or expansion of or addition to an existing activity, fixed in location, for which permits are required before construction or operation;

(8) "state agency" means a state department, commission, board or other agency of the state; for the purposes of this chapter "state agency" also means a local or regional air pollution control authority established under AS 46.03.210.

Sec. 46.35.210. SHORT TITLE. This Act may be cited as the Environmental Procedures Coordination Act.

* Sec. 2. AS 46.03.020 is amended by adding a new paragraph to read:

(11) after consultation with other state agencies and local government officials, identify and propose for addition or deletion, by regulation, other licenses, permits or authorizations for which the provisions of ch. 30 of this title are applicable, and report annually to the legislature the permits which have been included or deleted.

* Sec. 3. The department, after consultation with other state agencies and local governments, shall submit to the legislature by January 1, 1979, a report setting out the results of the experience under this chapter together with any recommendations and views pertaining to ways and means of improving the procedures and otherwise satisfying the purposes of this chapter.

* Sec. 4. This Act takes effect October 1, 1977.

Approved by the Governor: May 27, 1977
Actual Effective Date: October 1, 1977

INTERIM MASTER APPLICATION

Permit Information Center
Alaska Department of Environmental Conservation

MASTER APPLICATION

NO. _____

CERTIFICATION

(to be completed by local government)

I hereby certify the project described herein is in compliance with all zoning ordinances and associated comprehensive plans administered by

_____

_____
(Local Government Official's Signature)

_____
(Title)

_____
(Date)

I hereby certify the property described in Section II is not under the jurisdiction of any zoning ordinance or associated comprehensive plan administered by _____

_____
(Local Government Official's Signature)

_____
(Title)

_____
(Date)

A. Name of Applicant: _____

Address: _____
(Street Number or R.F.D.) (City) (State) (Zip Code)

Phone Number: _____

B. Consultant or Contact Person: _____

Address: _____
(Street Number or R.F.D.) (City) (State) (Zip Code)

Phone Number: _____

II. Activity Location

A. Location of Work (smallest legal subdivision): _____

_____

_____

_____

Within Section _____, Township _____, Range _____

B. Distance and direction from nearest incorporated town or city:

_____ _____

_____

_____

III. General Activity Description

A. Beginning Construction Date: _____ Completion Date: _____

B. Description of Project (describe the project objectives, purpose and need): _____

_____

_____

C. Description of Work (describe the project construction and operation): _____

_____

_____

_____

IV. SPECIFIC ACTIVITY DESCRIPTION

A. The construction or operation of this project involves: (check all appropriate boxes).

- ☐ Commercial development
- ☐ Industrial development
- ☐ Institution
- ☐ Residential development

Above checked development includes:

- ☐ Electrical
- ☐ Plumbing
- ☐ Elevator
- ☐ Mechanical equipment in structures
- ☐ Boiler
- ☐ Pressure vessels
- ☐ Pressure piping
- ☐ Prefabricated structures

Sewage disposal:

- ☐ Septic tank and drainfield installation or alternative disposal system
- ☐ Connection to municipal sewer system
- ☐ Develop or connection to nonmunicipal sewer system

- ☐ Connection to municipal water system
- ☐ Develop or connection to nonmunicipal water system
- ☐ School water supply
- ☐ Surface mining (including rock quarry, material borrow site, sand and gravel, etc.)
- ☐ Underground mining
- ☐ Dredging
- ☐ Oil and gas drilling and exploration
- ☐ Geothermal drilling and exploration
- ☐ Well injection
- ☐ Well construction
- ☐ Fireworks
- ☐ Marine facility (access, dock, float, etc.)
- ☐ Explosives
- ☐ Disposal of surplus mineral resources

Food service facilities:

- ☐ Restaurant
- ☐ Temporary
- ☐ Limited service restaurant
- ☐ Commissary
- ☐ Food vending warehouse
- ☐ Vending machine
- ☐ Mobile unit(s)
- ☐ Shellfish distributors
- ☐ Shucker-packers
- ☐ Harvesters
- ☐ Swimming pool
- ☐ Health facility (hospital, inpatient care, nursing home, etc.)
- ☐ Home for aged
- ☐ Group care home
- ☐ Child care agency
- ☐ Day care facility
- ☐ Post-secondary education facility at a new location
- ☐ Junkyard
- ☐ Alcohol or alcoholic beverages (industrial, manufacture, wholesale, retail)
- ☐ Hydraulic structure
- ☐ Irrigation, drainage
- ☐ Hydroelectric facilities
- ☐ Mobile home park
- ☐ Airfield construction or modification
- ☐ Advertising signs
- ☐ Cultural site development
- ☐ Pneumatic conveyance facilities
- ☐ Liquid petroleum gas
- ☐ Flammable and/or combustible liquids
- ☐ Shore-based handling devices
- ☐ Excavation
- ☐ Land leveling
- ☐ Stream bed alteration, movement of material within banks
- ☐ Flood control project (stream channelization)
- ☐ Agriculture
- ☐ Aquaculture
- ☐ Bulkhead
- ☐ Burning
- ☐ Dam construction
- ☐ Forest management
- ☐ Tree cutting
- ☐ Right-of-way clearing
- ☐ Gravel operation
- ☐ Road construction
- ☐ Solid waste disposal
- ☐ Utilities
- ☐ Port Development
- ☐ Propagation of fish or wildlife
- ☐ Landfill
- ☐ Tourist facilities (hotel, motel, recreational park, organization camp, picnic park, mass gathering)
- ☐ Other _____

	Yes	No	
B.	☐	☐	All or a portion of the activity will be located within 200 feet of the ordinary high water mark or within the floodplain of _____, a tributary (name of stream or body of water) of _____; (name of stream or body of water)
C.			Work will be conducted (include anticipated dates work will take place)
	☐	☐	Over Water _____ (dates)
	☐	☐	In or under water _____ (dates)
D.	☐	☐	The proposed work will be vented or will release materials into the air. (explain) _____ _____ _____
E.	☐	☐	Will the construction or use of the final facility result in the discharge of a pollutant? Into: ☐ Ground water ☐ Surface water ☐ Sewer system Explain (pollutant): _____
F.	☐	☐	Will your proposal include facilities for the disposal of sewage? ☐ Septic Tank and Drainfield Installation ☐ Connection to Municipal sewer system ☐ Develop a Nonmunicipal (individual) treatment facility
G.	☐	☐	Will construction or operations of the final facility involve the use of ground or surface water?

SOURCE	USE
☐ Ground water	☐ Domestic Use
☐ Surface water	☐ Commercial/Industrial Use
	☐ Other _____

Quantity of water use: _____ cfs, or _____ gpm.

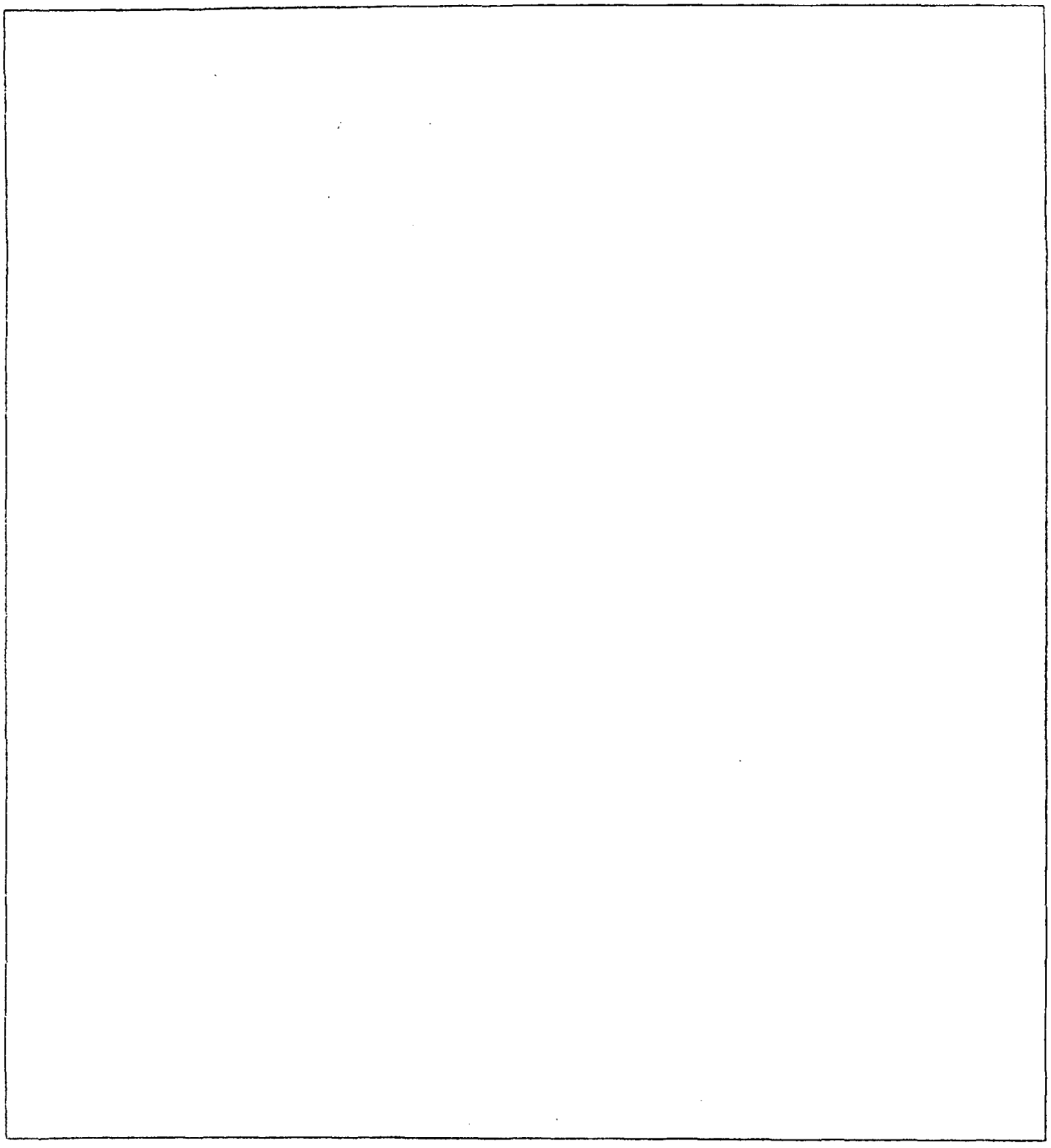
if surface water, name of source: _____, (stream or body of water)

a tributary of _____ (name of stream or body of water)

	Yes	No	
H.	☐	☐	Will your proposal include facilities for public water supply? ☐ Connection to Municipal supply system ☐ Develop a Nonmunicipal (individual) supply system
I.	☐	☐	Will your proposal require the construction or modification of a dam for the storage of water? Height of dam: _____ feet. Quantity of water to be stored: _____ acre feet.
J.	☐	☐	Do you plan to dispose of material by burning? ☐ Natural material (organic) ☐ Man-made material (processed)
K.	☐	☐	Do you plan to dump any mill waste or forest debris?
L.	☐	☐	Do you plan to conduct a commercial operation with power driven machinery in dead or down timber?
M.	☐	☐	Do you propose to remove more than 10,000 tons or disturb more than two acres of land in order to remove gravel, clay, coal, stone, sand, metallic ore, or any other similar solid material or substance to be excavated from natural deposits on or in the earth for commercial, industrial, or construction uses?
N.	☐	☐	Do you plan to conduct any activity on or directly pertaining to forest land and related to growing, harvesting or processing timber including: road and travel construction; timber harvest; precommercial thinning; reforestation; fertilization; prevention and suppression of diseases and insects; salvage of trees; right-of-way clearing; or brush control?
O.	☐	☐	Do you plan to recover stray logs, other than logs owned by you, from waters of the State?
P.	☐	☐	Does your proposal involve work within, adjacent to, or near a state park?
Q.	☐	☐	Do you have control of the land on which the project is located? Who does? ☐ I own/control the land. ☐ I control the land through a license from a private individual/company. ☐ The State owns the land. ☐ Federal land. ☐ Locally owned land.

V. PROJECT DIAGRAM

Show the general area involved by the project. Include the proposed project improvements, existing topography, streams or bodies of water, landmarks, property lines, north arrow, scale, etc. (include additional pages if necessary)



VI. ENVIRONMENTAL IMPACT

	Yes	No	
A.	☐	☐	Have you been asked to complete an "Assessment of Environmental Impact"? (If completed, please attach a copy.)
B.	☐	☐	Has an "Environmental Impact Statement" been requested before you begin your project? (If completed, please attach a copy.)

C. Comments: _____

_____

_____

_____

The information given on this application is complete and accurate to the best of my knowledge and belief.

_____

(Applicant's Signature)

_____

(date)

25D-261
3/80

Page_____ of _____
Permit No. _____

APPLICATION FOR UTILITY PERMIT ON HIGHWAY RIGHTS-OF-WAY

****

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

Application is hereby made for permission to place, construct and thereafter maintain a _____ facility in, on, along or across the Rights of Way of the Department of Transportation.

I. The facility is to be located: _____

_____

II. Location and extent of required clearing: _____

_____

_____

III. Joint use with: _____

in accordance with _____ attached as Exhibit _____

_____

IV. Facility to be constructured in accordance with the following:

a. Plans dated _____, consisting of _____

b. Specifications dated _____, consisting of _____ pages.

c. In conformance with (Code) _____

V. Work to commence on or about _____ and to be completed on or about _____

The applicant in carrying out any or all of the work herein above mentioned or referred to in this application, and in the authorized Utility Permit issued therefore, shall strictly conform to the terms of such Utility Permit; Alaska Statutes 19.25.010 and 19.25.020; regulations as set forth in the Alaska Administrative Code, Title 17-Highways, Chapter 15, Engineering-Utility Permits, and any revisions thereto, and such policy directive as issued by the Commissioner of the Department of Transportation.

The applicant shall comply with regulations of all other governmental agencies and the work shall be accomplished in a manner that will not be detrimental to the highway and appurtenances nor in any manner endanger the traveling public.

APPLICANT: _____ DATE: _____

ADDRESS: _____ PHONE: _____

BY: _____ TITLE: _____

Permit No. _____

PIPE CARRIERS

TRANSMITTANT: _____

WORKING PRESSURE: _____

NUMBER OF CONDUITS: _____

DIAMETER OF CONDUITS: _____

TYPE AND CLASS OF PIPE: _____

ENCASEMENT DIAMETER & TYPE: _____

CROSSING ANGLE: _____

LONGITUDINAL FACILITY LENGTH: _____

OFFSET FROM HIGHWAY CENTERLINE: _____

DEPTH BELOW DITCH ELEVATION: _____

REQUESTED METHOD OF INSTALLATION ON LONGITUDINAL FACILITY:

TRENCHING: _____ PLOWING: _____

REQUESTED METHOD INSTALLATION ON ROAD CROSSINGS:

BORING: _____ JACKING: _____ OPEN CUT: _____

CONSTRUCTION CODE(S) APPLICABLE: _____

_____

ADDITIONAL INFORMATION: _____

_____

_____

_____

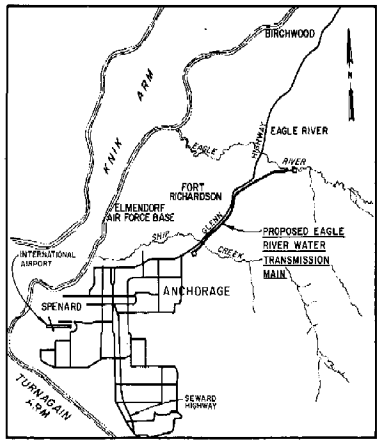
_____

_____

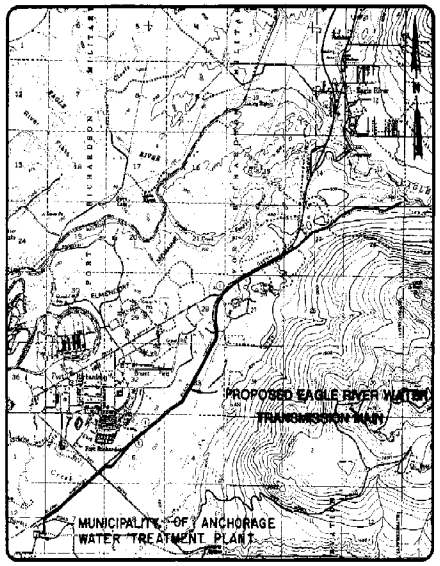
Exhibit E
Preliminary Plans

MUNICIPALITY OF ANCHORAGE

ANCHORAGE WATER & SEWER UTILITIES



VICINITY MAP



LOCATION MAP

INDEX TO PLAN

"The preparation of this study was financed in part by funds from the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, administered by the Division of Community Planning, Alaska Department of Community and Regional Affairs."

1981

EAGLE RIVER WATER RESOURCES STUDY

TRANSMISSION MAIN

PRELIMINARY PLANS

ANCHORAGE WATER & SEWER UTILITIES · MUNICIPALITY OF ANCHORAGE · AWSU

ABBREVIATIONS

ABN'D	ABANDONED
ADDT'L	ADDITIONAL
APPD	APPROVED
AWU	ANCHORAGE WATER UTILITY
BC	BEGIN CURVE
BVC	BEGIN VERTICAL CURVE
CHK	CHECKED
CI	CAST IRON
℄	CENTERLINE
CLR	CLEAR
CMP	CORRUGATED METAL PIPE
CONST	CONSTRUCT
COR	CORNER
CU YD	CUBIC YARD
DES	DESIGNED
DIA	DIAMETER
DIAG	DIAGONAL
DIM	DIMENSION
DIP	DUCTILE IRON PIPE
DR	DRAWN
DWG	DRAWING
E	ELECTRIC
EA	EACH
EC	END OF CURVE
EL	ELEVATION
EVC	END OF VERTICAL CURVE
EW	EACH WAY
EXIST	EXISTING
FA	FACE
FCA	FLANGE COUPLING ADAPTOR
FT	FEET
G	GAS
GIP	GALVANIZED IRON PIPE
GV	GATE VALVE
H	HEIGHT
HORIZ	HORIZONTAL
HP	HIGH PRESSURE
INC	INCORPORATED
INVT	INVERT
L	LENGTH
LF	LINEAR FEET
MAX	MAXIMUM
MH	MANHOLE
MIN	MINIMUM
MUN	MUNICIPALITY
NO	NUMBER
NTS	NOT TO SCALE
OC	ON CENTER
OH	OVERHEAD
OPG	OPENING
O/S	OFFSET
PCF	POUNDS PER CUBIC FOOT
PSI	POUNDS PER SQUARE INCH
PT	POINT
R	RADIUS
RCCP	REINFORCED CONCRETE CYLINDER PIPE
RCP	REINFORCED CONCRETE PIPE
RD	ROAD
REINF	REINFORCED
REQ'D	REQUIRED
R/W	RIGHT-OF-WAY
S	SLOPE
SEC	SECTION
SF	SQUARE FEET
STA	STATION
SYMM	SYMMETRICAL
T	TANGENT
TP	TRANSMISSION PRESSURE
TYP	TYPICAL
UG	UNDERGROUND
VB	VAULT BOX
VC	VERTICAL CURVE
VERT	VERTICAL
VPI	VERTICAL POINT OF INCIDENCE
W	WIRE
W/	WITH
WS	WELDED STEEL

LEGEND

E (UG)	EXISTING UNDERGROUND ELECTRICAL
E (OH)	EXISTING OVERHEAD ELECTRICAL
T (UG)	EXISTING UNDERGROUND TELEPHONE
T(OH)	EXISTING OVERHEAD TELEPHONE
—S—	SEWER
—W—	WATER
—G—	GAS
	POWER (TELEPHONE) POLE
	EXISTING FENCE
	EXISTING MANHOLE
	EXISTING VALVE
	PHOTO CONTROL POINT
	PROPERTY LINE OR RIGHT-OF-WAY
	WELL
	OVERHEAD LIGHTING
	ELECTRICAL TOWER
	UNDERGROUND UTILITY LINE
	TEST PIT – NUMBER
	BACKFILL CLASSIFICATION
	GUY WIRE
	PROPOSED MANHOLE
	EASEMENT LINE
	PROPOSED VALVE
Δ	DELTA
	ANGLE POINT
ø	DIAMETER
@	AT
	PLAN VIEW – AREA OF THRUST BLOCK IN SQUARE FEET
	PROFILE VIEW – AREA OF THRUST BLOCK IN SQUARE FEET FOR VERTICAL UPBENDS
	BLOWOFF VALVE
	CULVERT
	CENTERLINE OF EAGLE RIVER PIPELINE & STATION
	MOUND BACKFILL OVER TOP OF PIPE
	COMBINATION AIR VALVES INCLUDE AIR RELIEF VALVE AND AIR AND VACUUM VALVES

CH2M HILL

DES. HOW
DR. JDC
CHK. CAF
APPD. JPO

NO.	DATE	REVISION	BY	APPD.

MUNICIPALITY OF ANCHORAGE
ANCHORAGE WATER & SEWER UTILITIES

EAGLE RIVER WATER RESOURCES STUDY
TRANSMISSION MAIN

ABBREVIATIONS AND LEGEND

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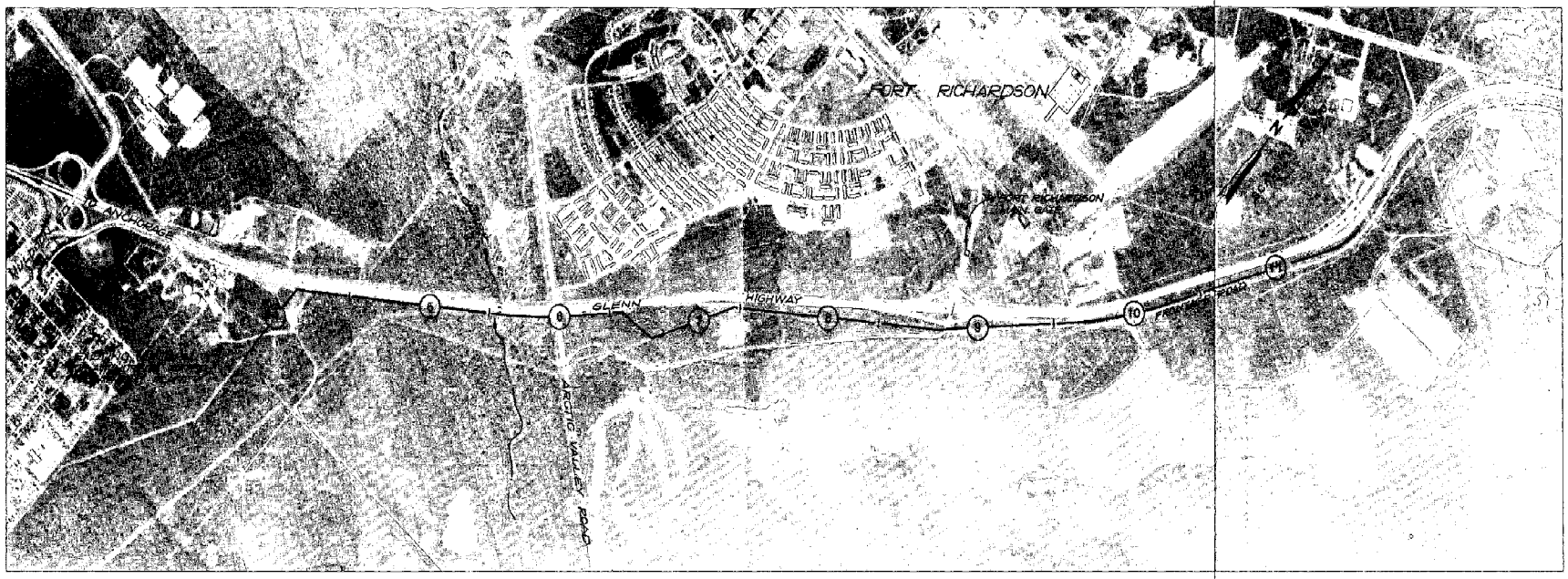

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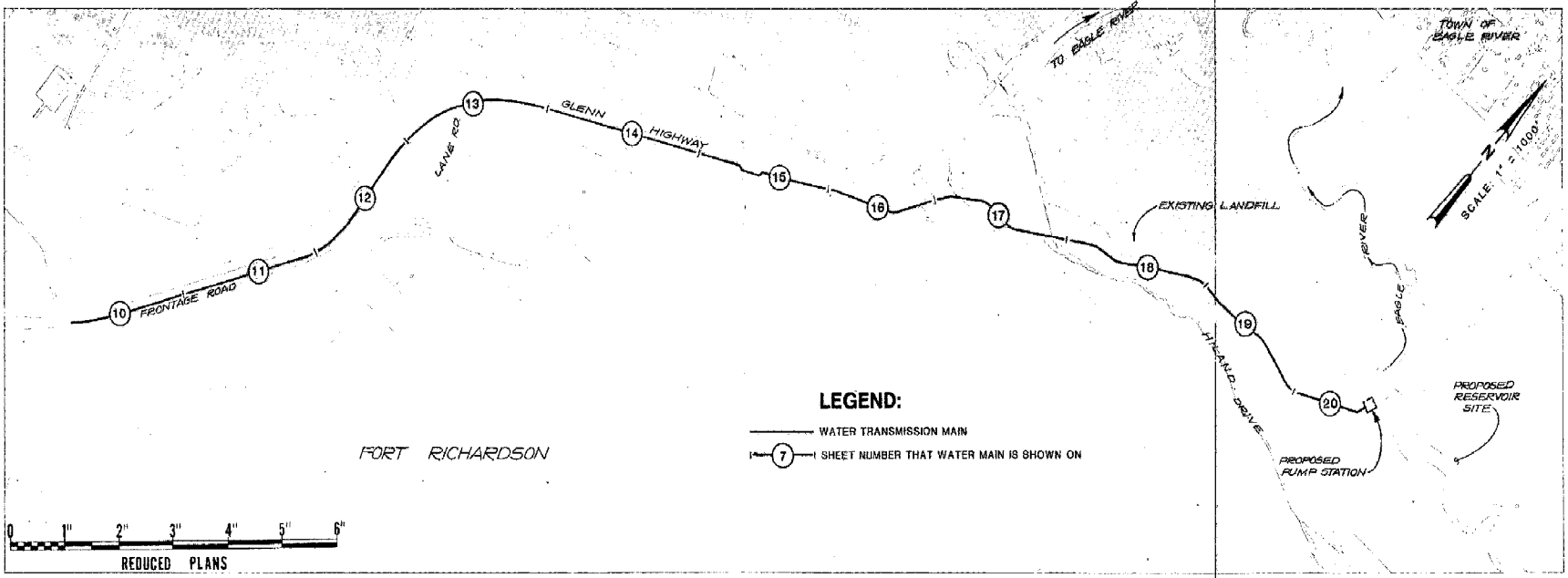

CH2M HILL	DES. HOW DR. vnd CHK. CAF APPD.	NO.	DATE	REVISION	BY	APPD.	MUNICIPALITY OF ANCHORAGE ANCHORAGE WATER & SEWER UTILITIES	EAGLE RIVER WATER RESOURCES STUDY TRANSMISSION MAIN	**GENERAL PLAN**

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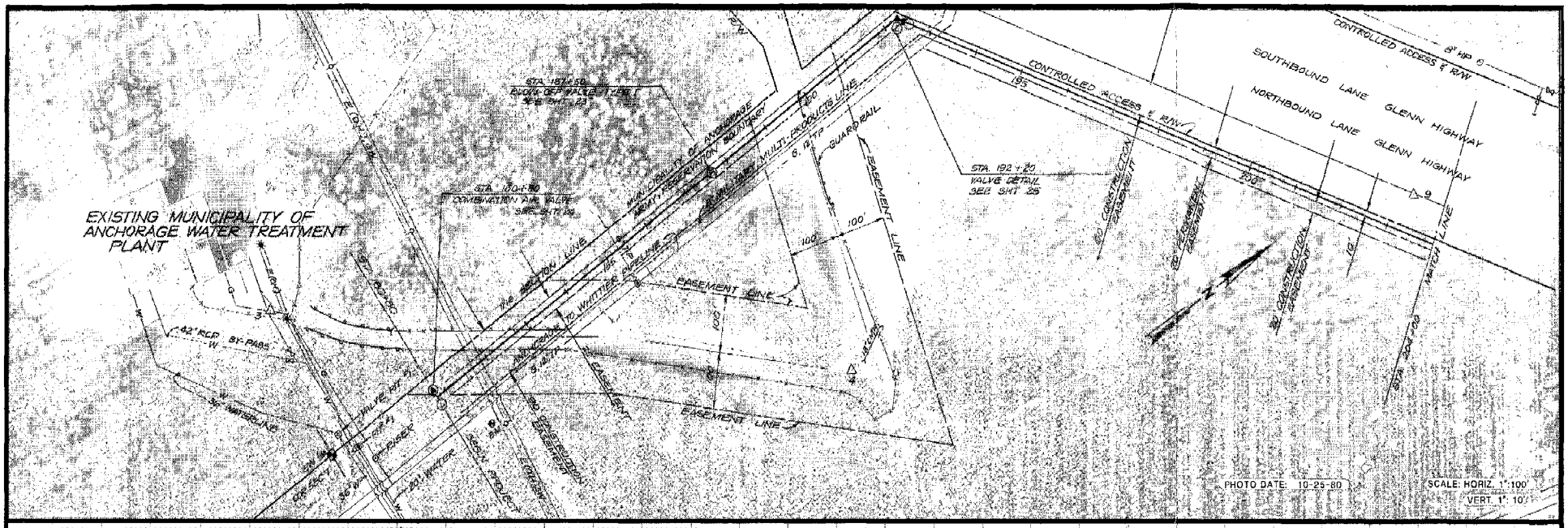

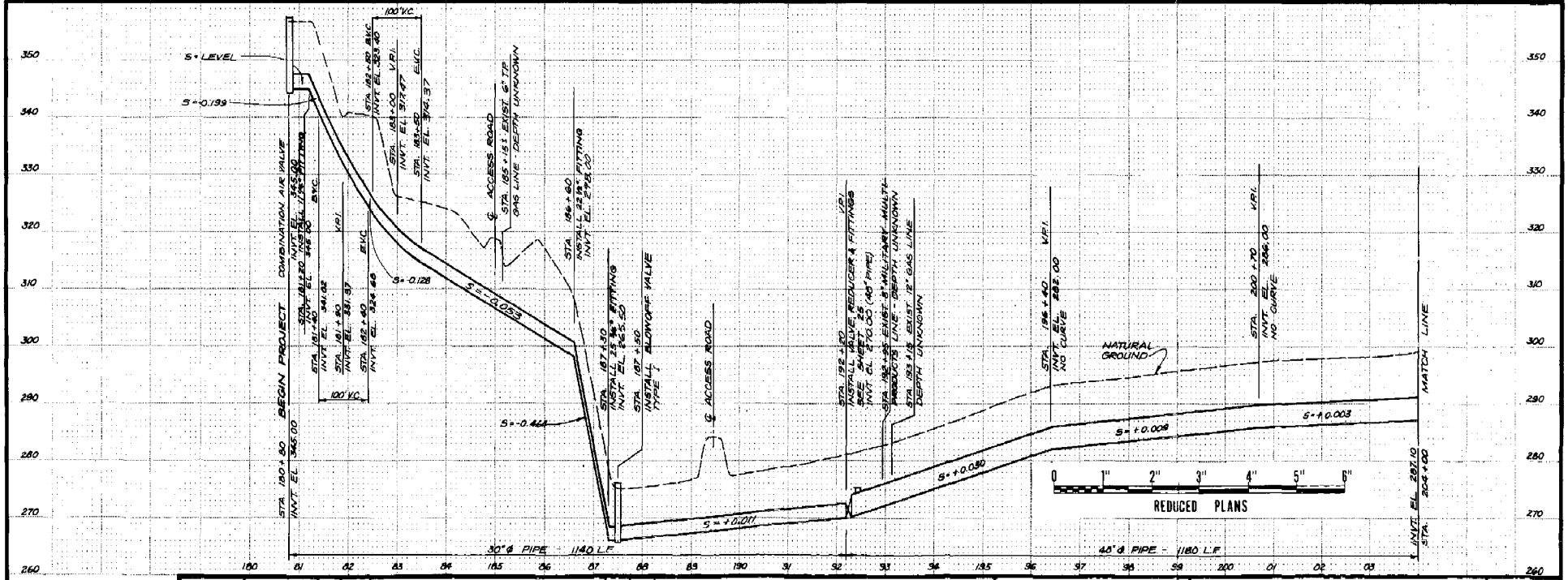

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EAGLE RIVER WATER RESOURCES STUDY TRANSMISSION MAIN

PRELIMINARY

PLAN AND PROFILE

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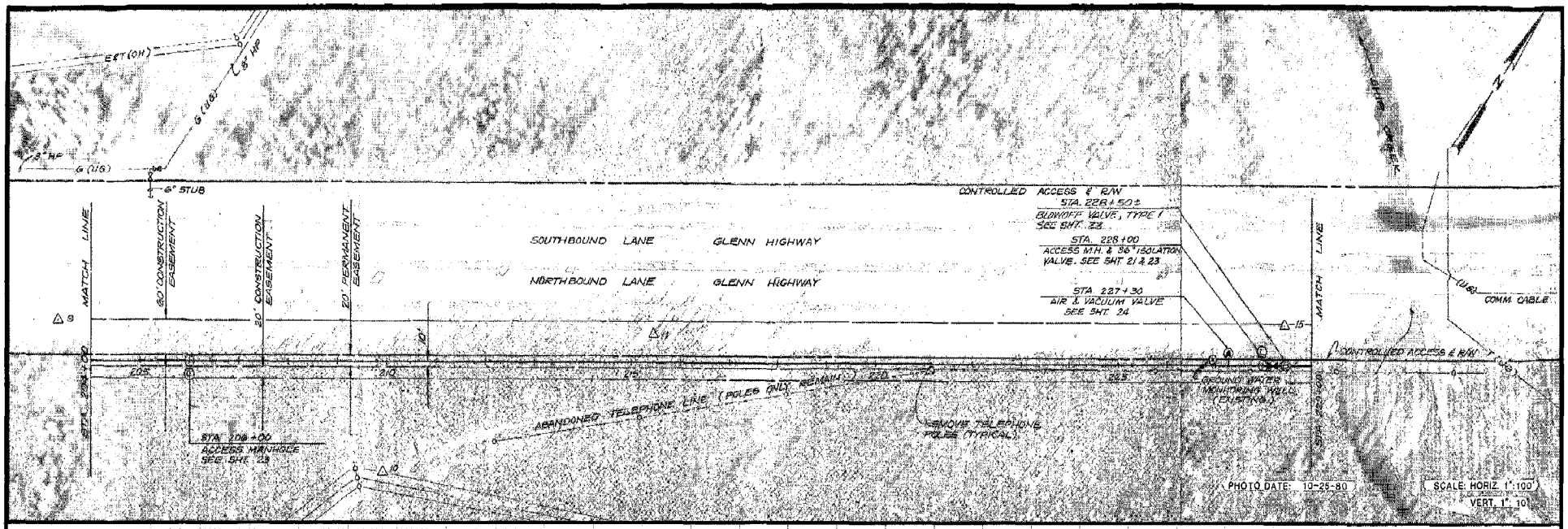

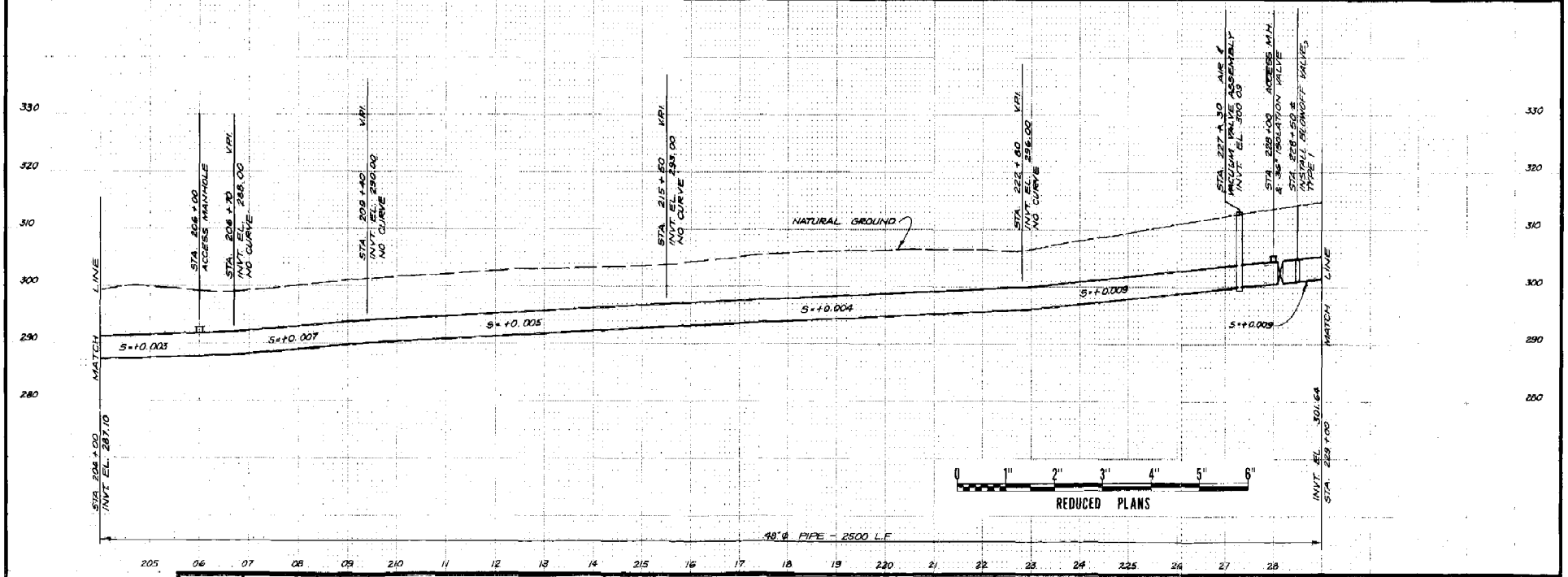

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EAGLE RIVER WATER RESOURCES STUDY
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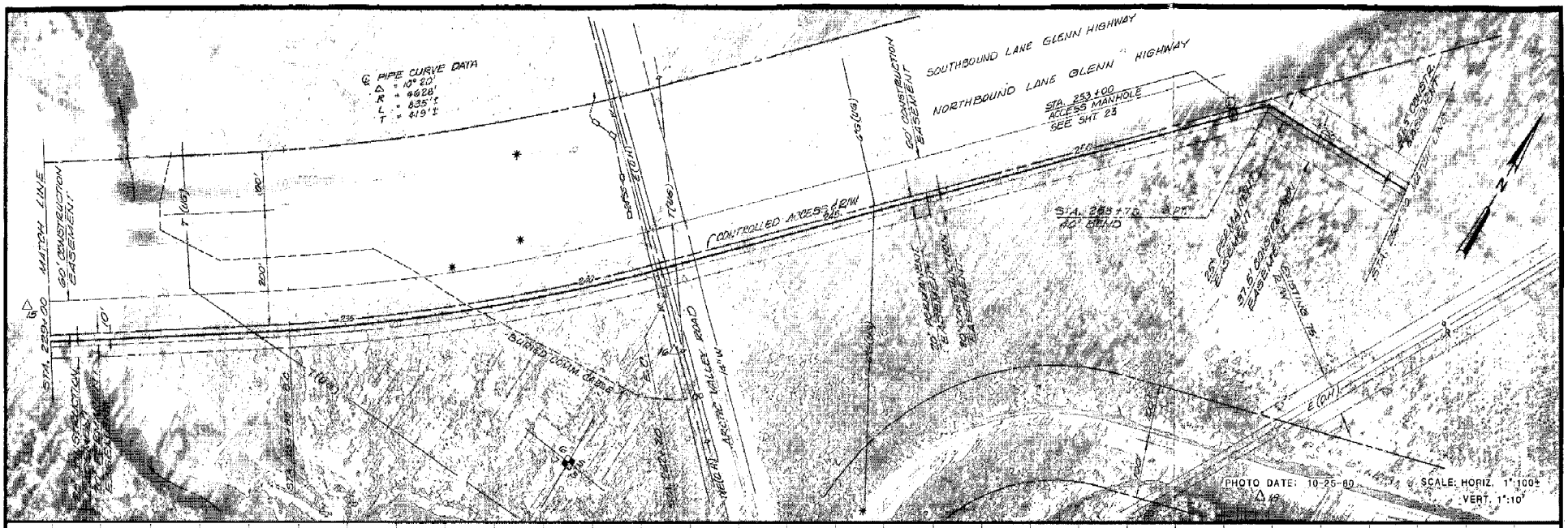

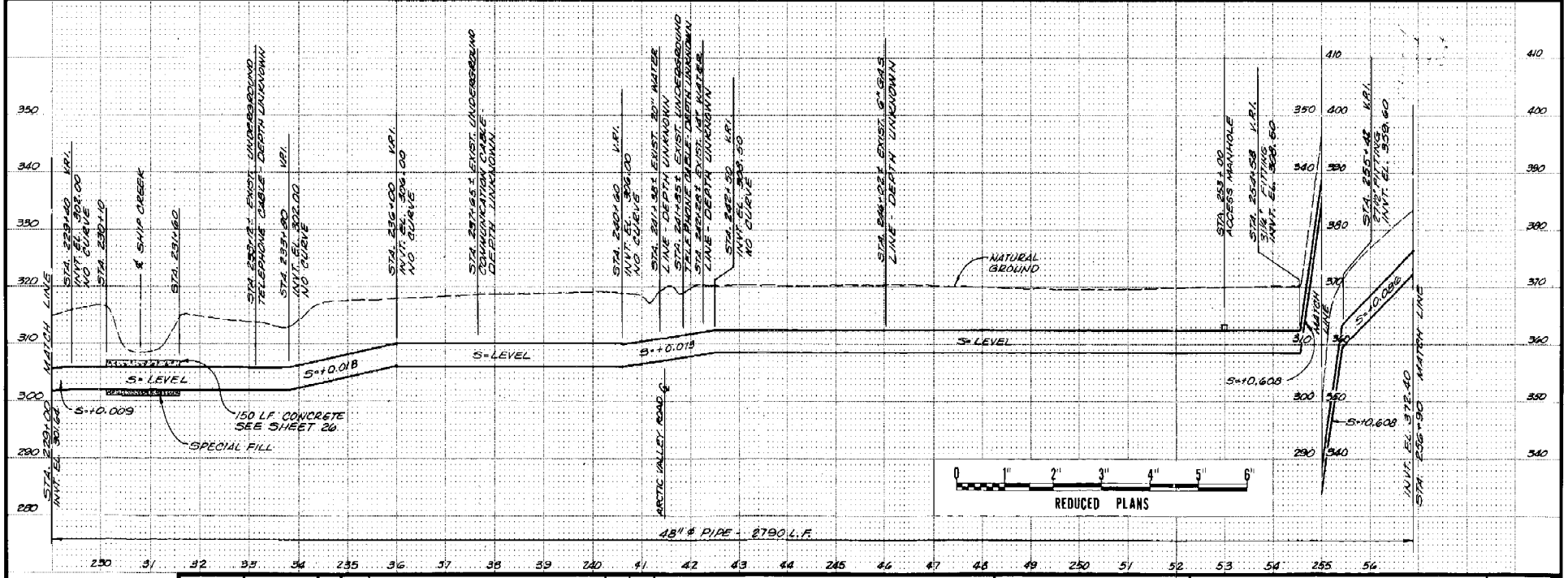

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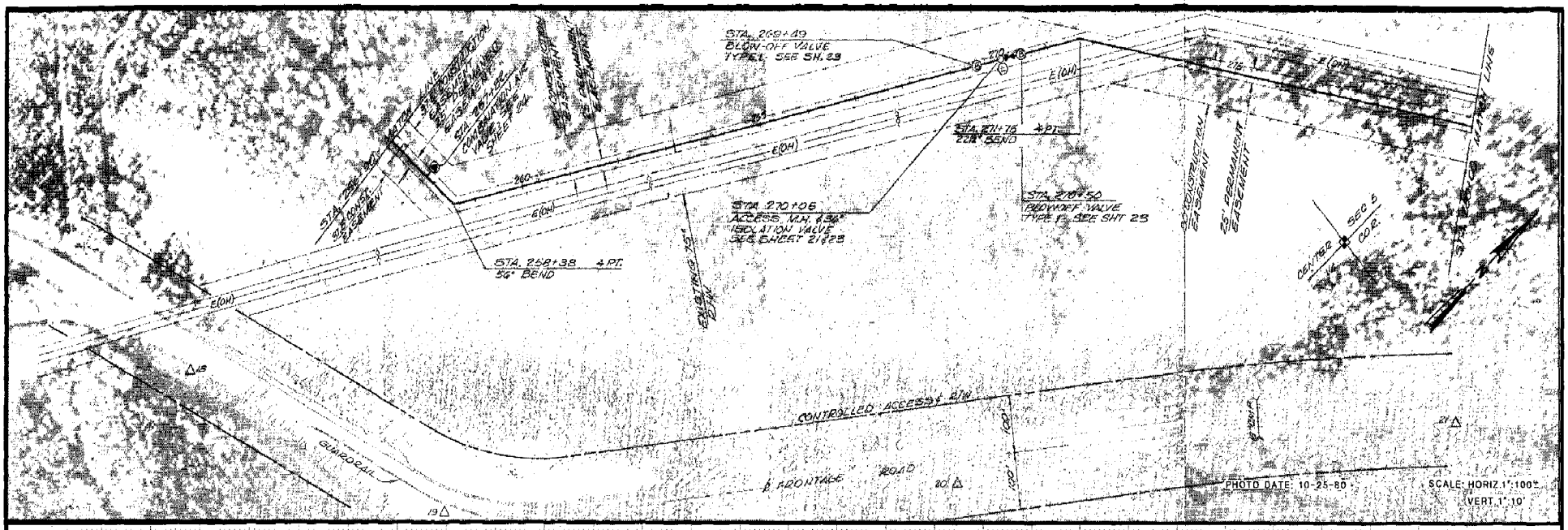

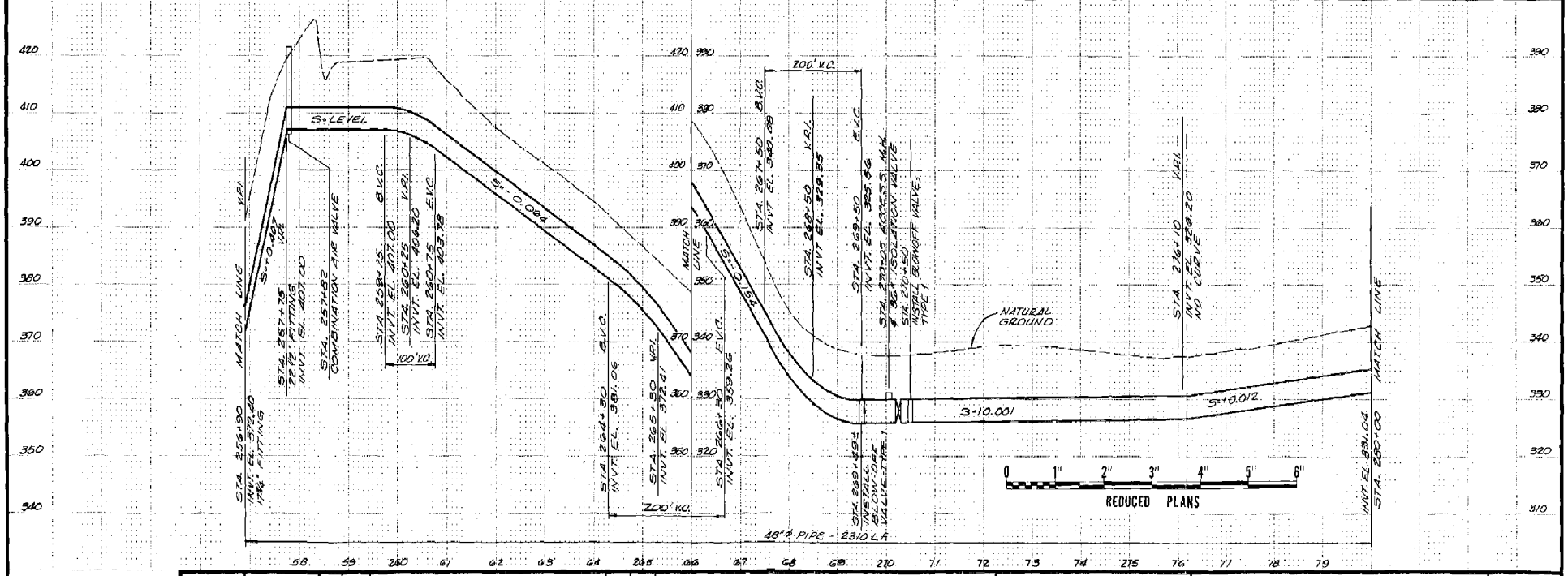

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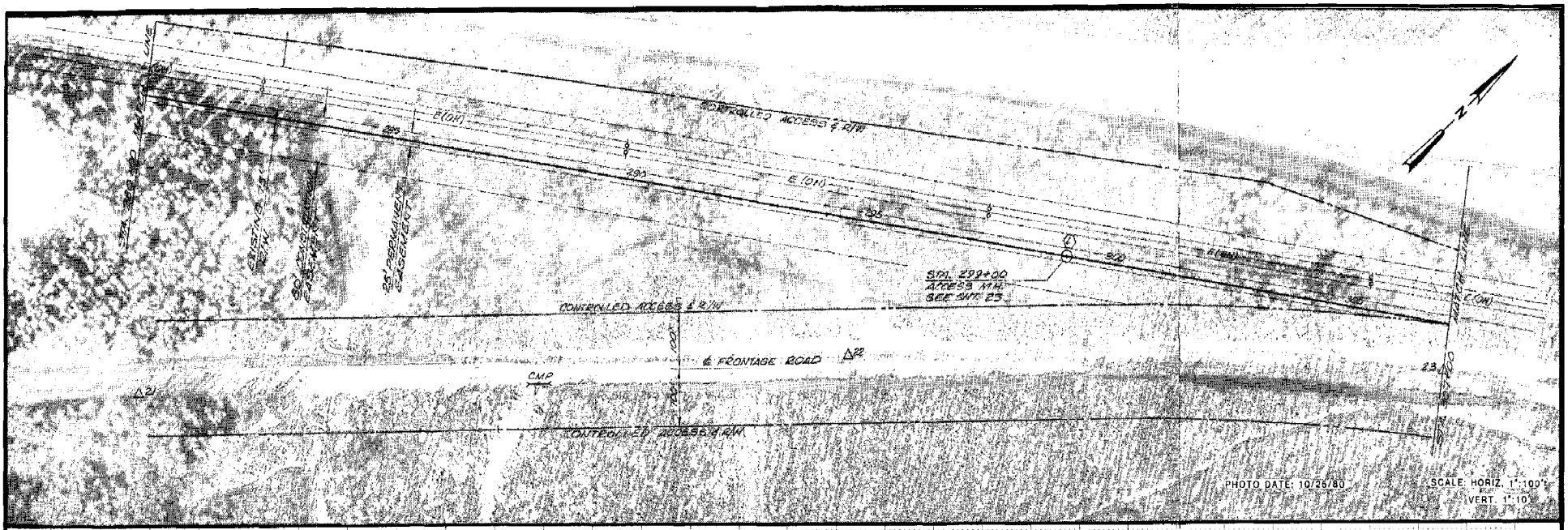

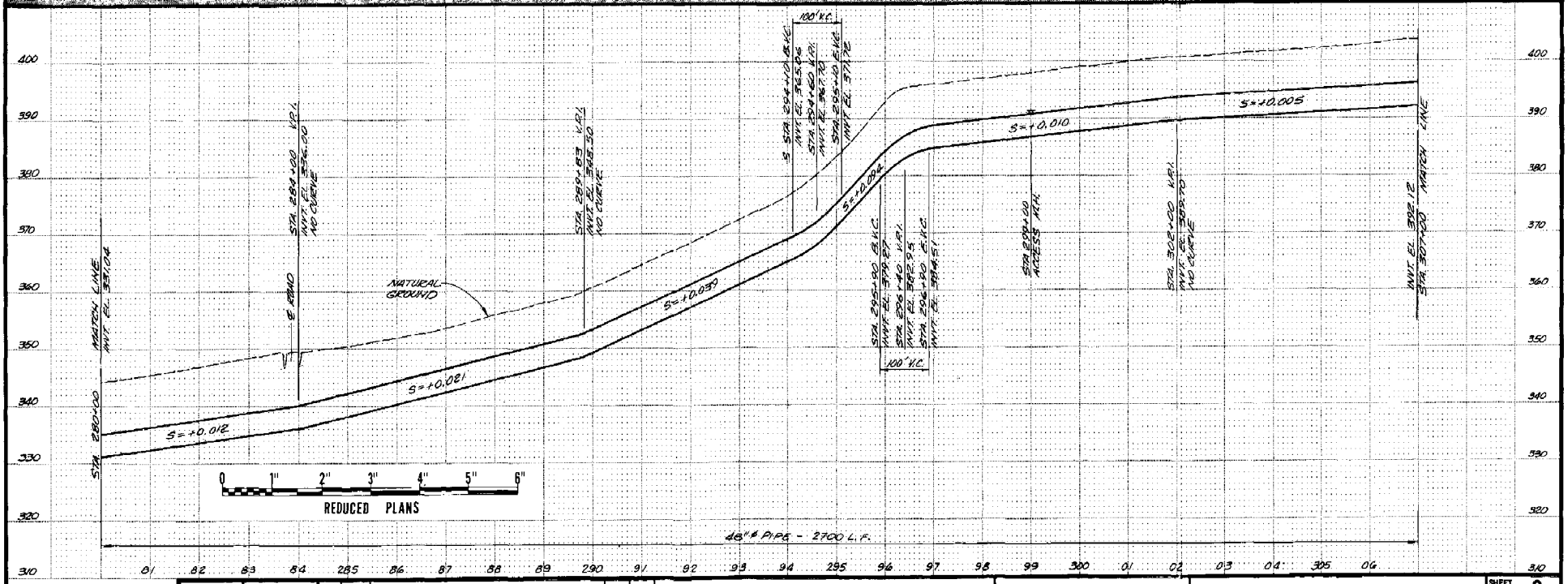

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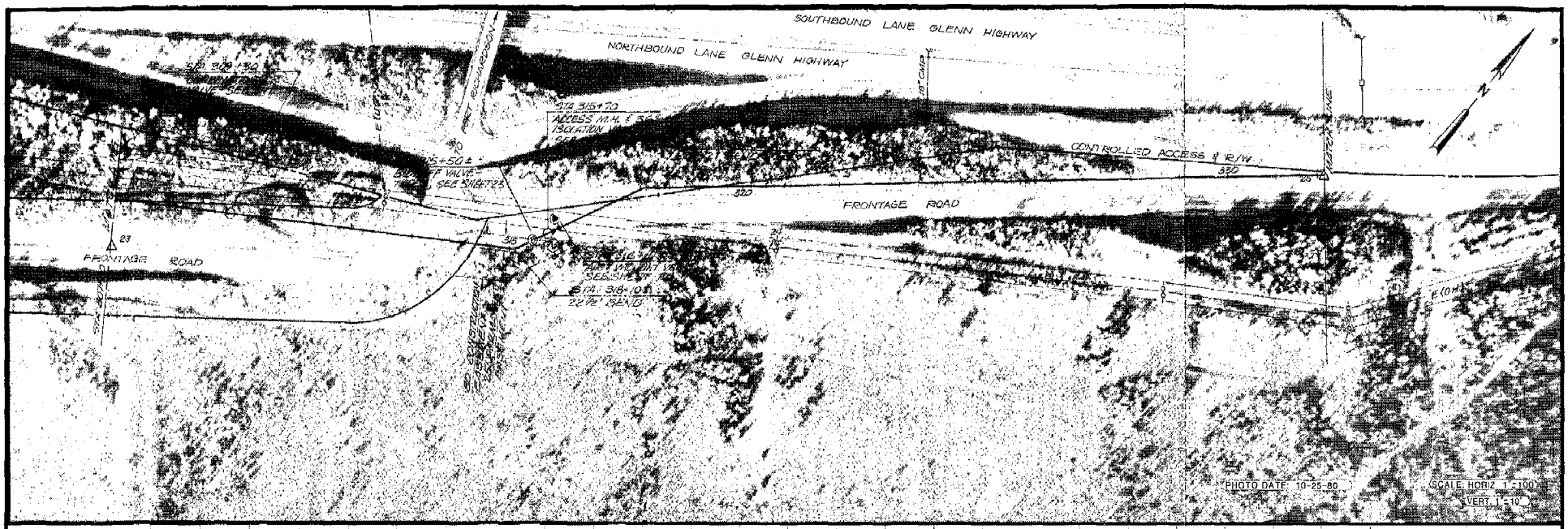

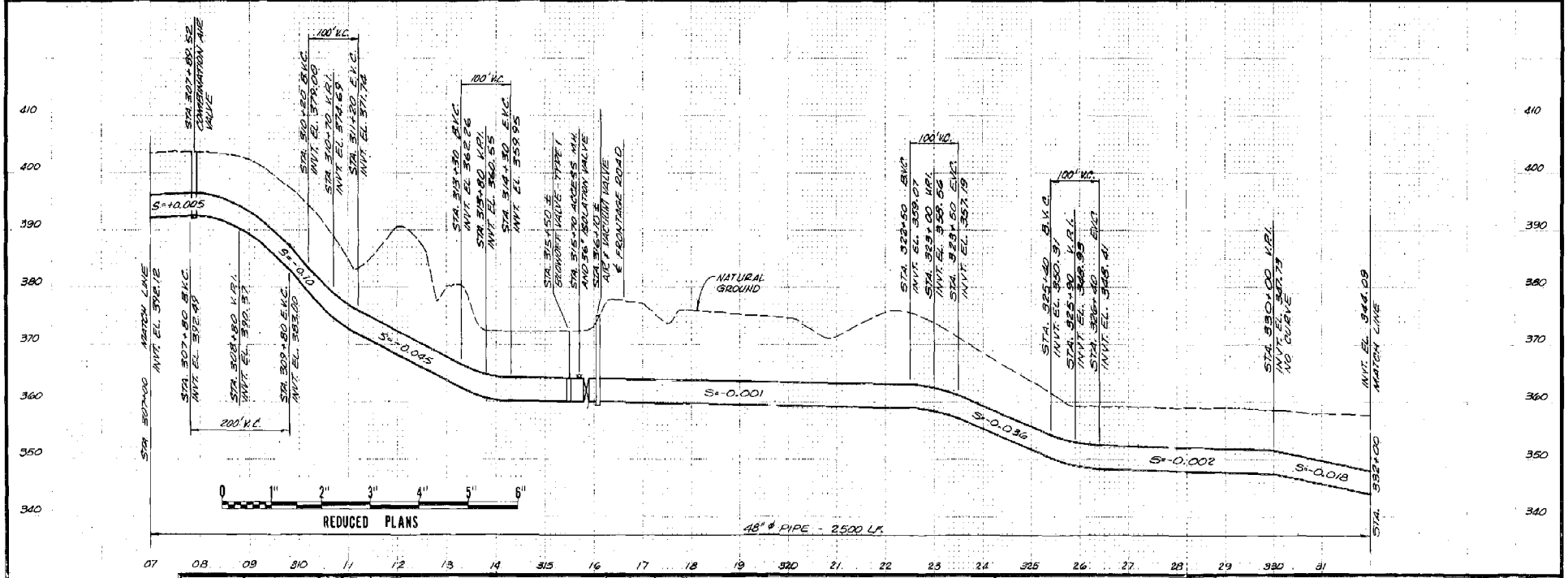

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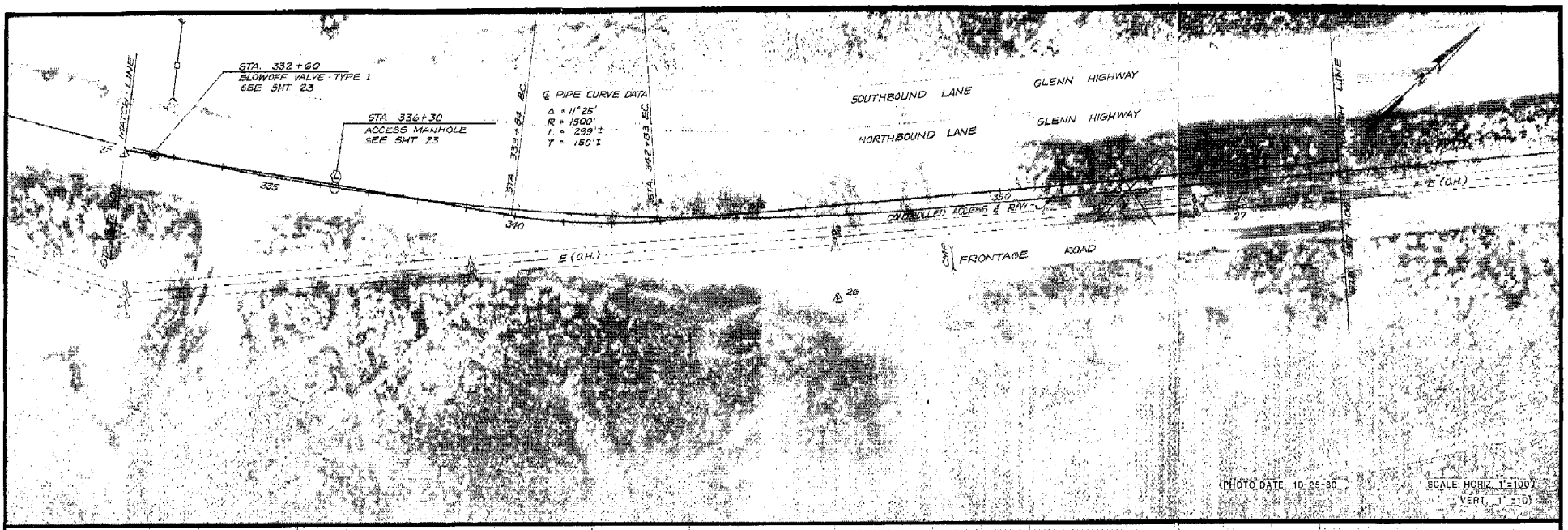

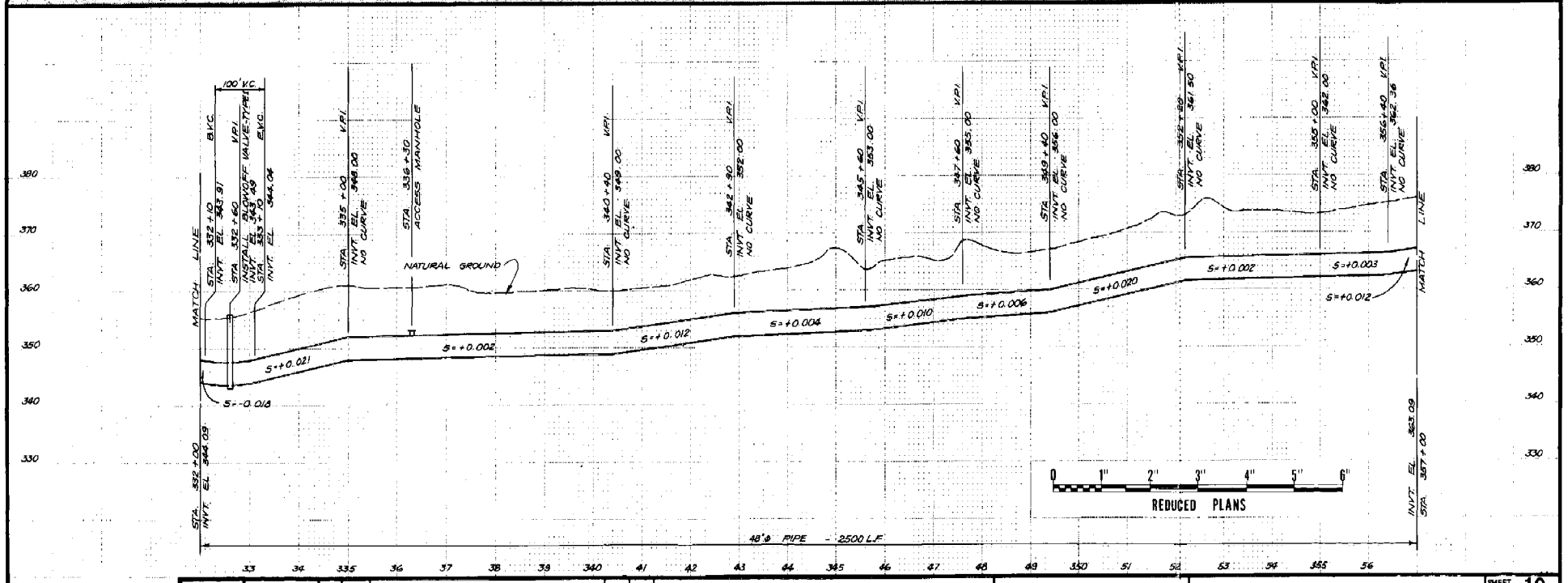

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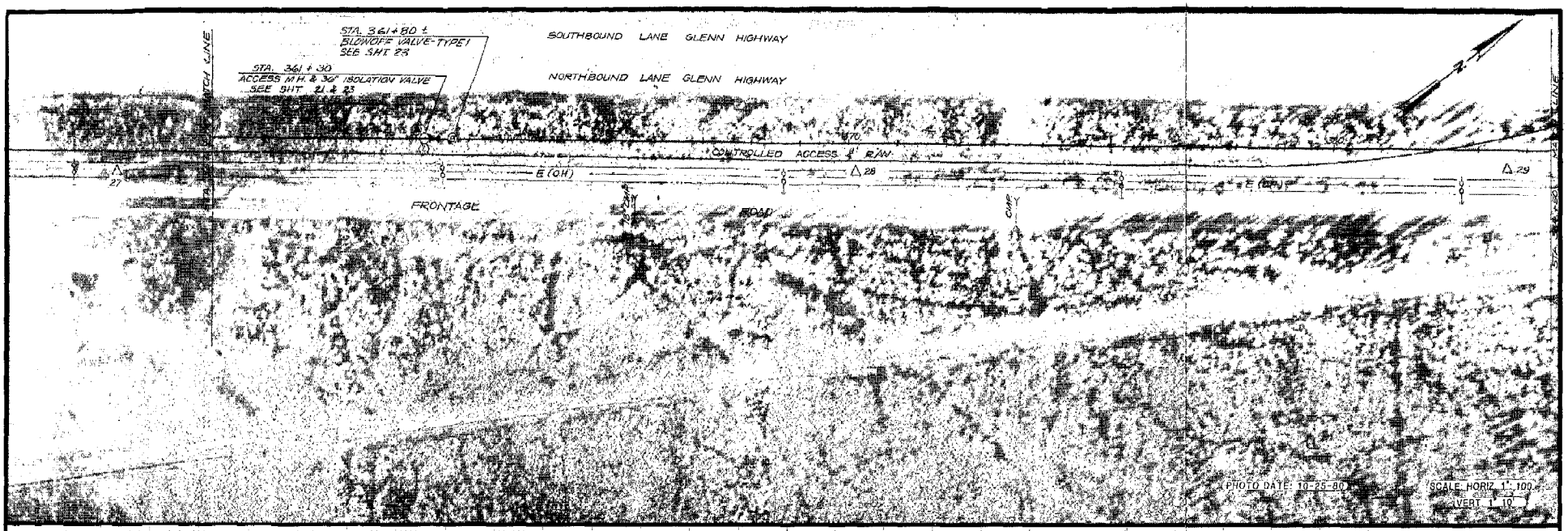

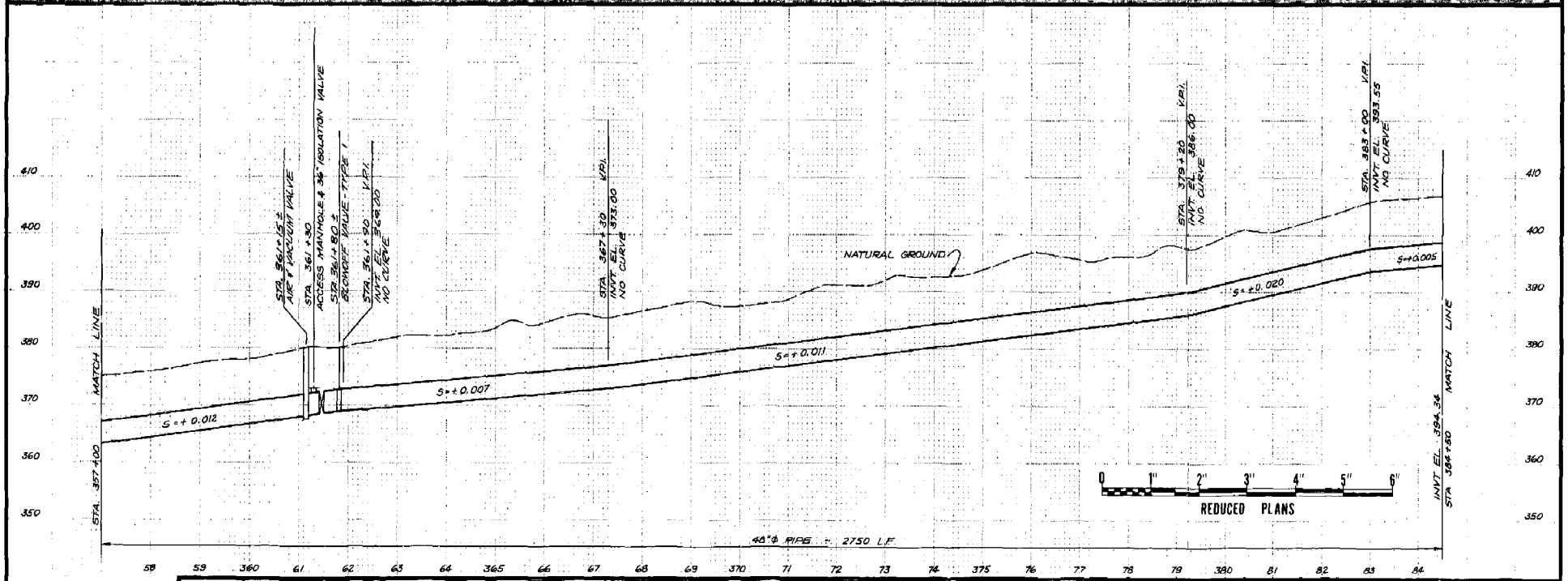

CH2M HILL

DES. HOW
DR. vnd
CHK. CAF
APPD. JPO

NO.	DATE	REVISION	BY	APPD.

MUNICIPALITY OF ANCHORAGE
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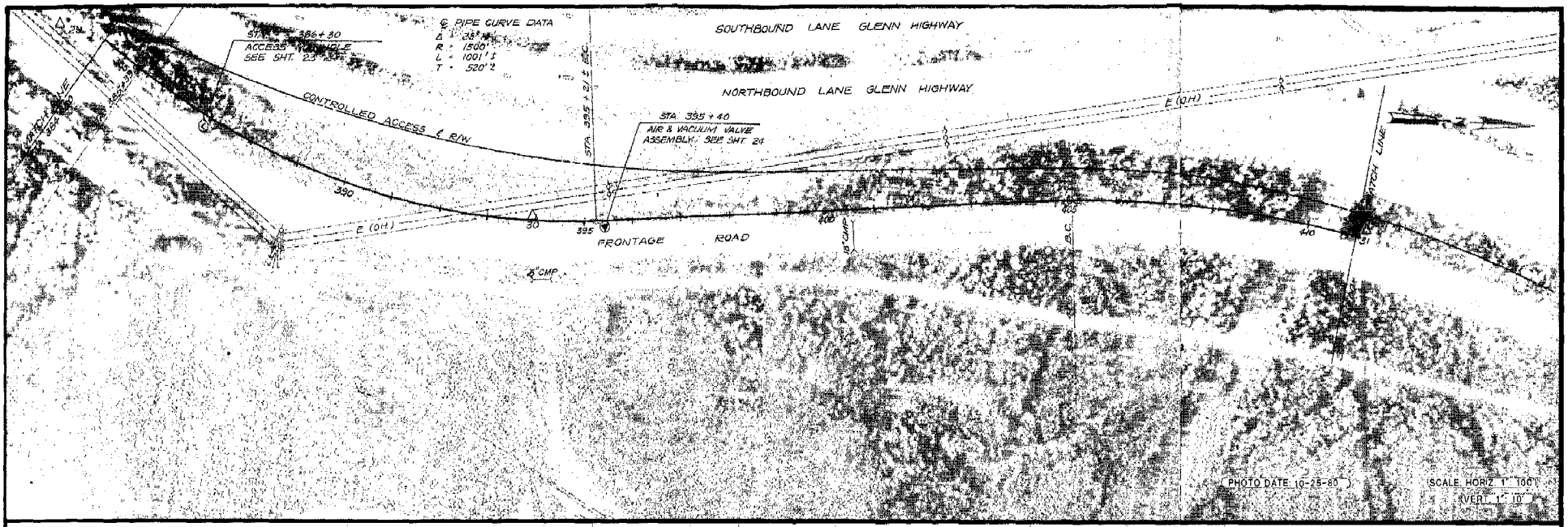

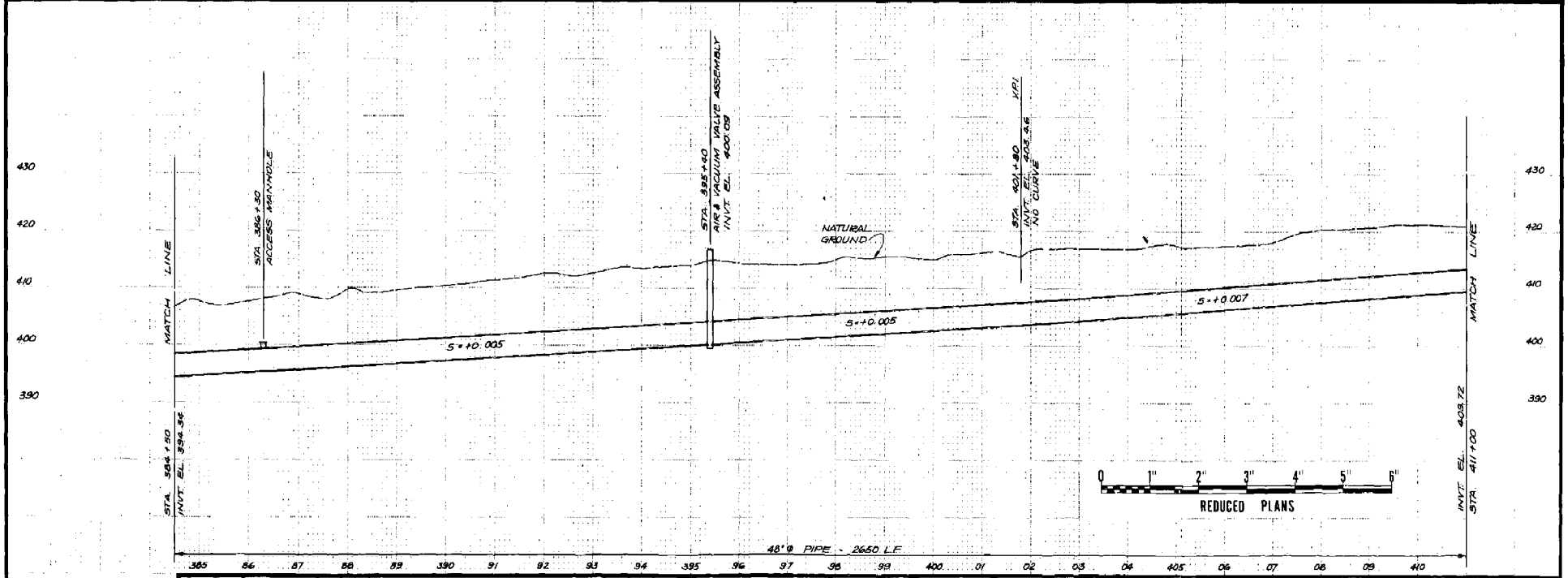

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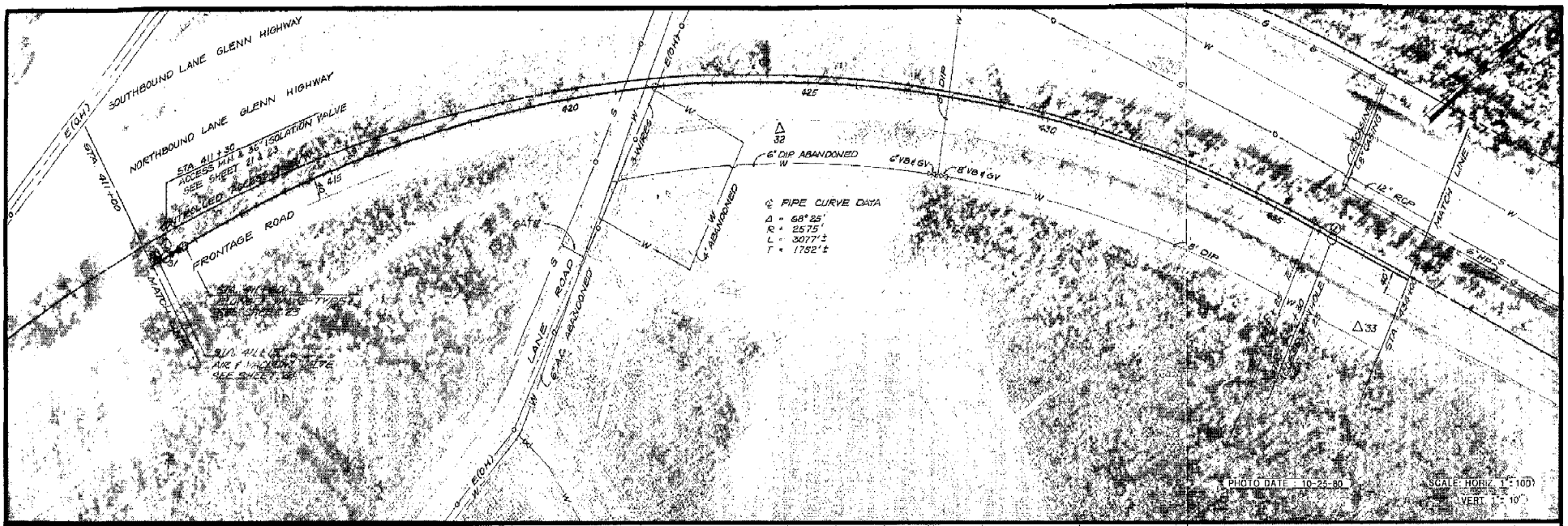

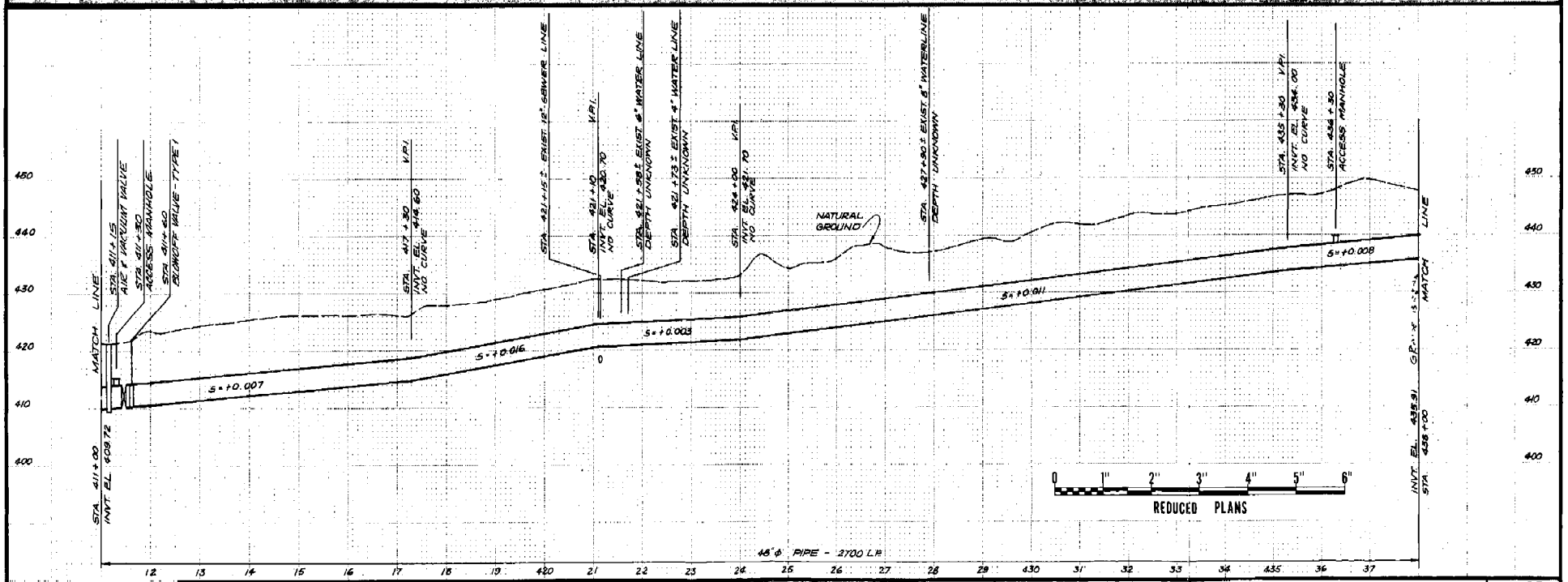

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EAGLE RIVER WATER RESOURCES STUDY TRANSMISSION MAIN

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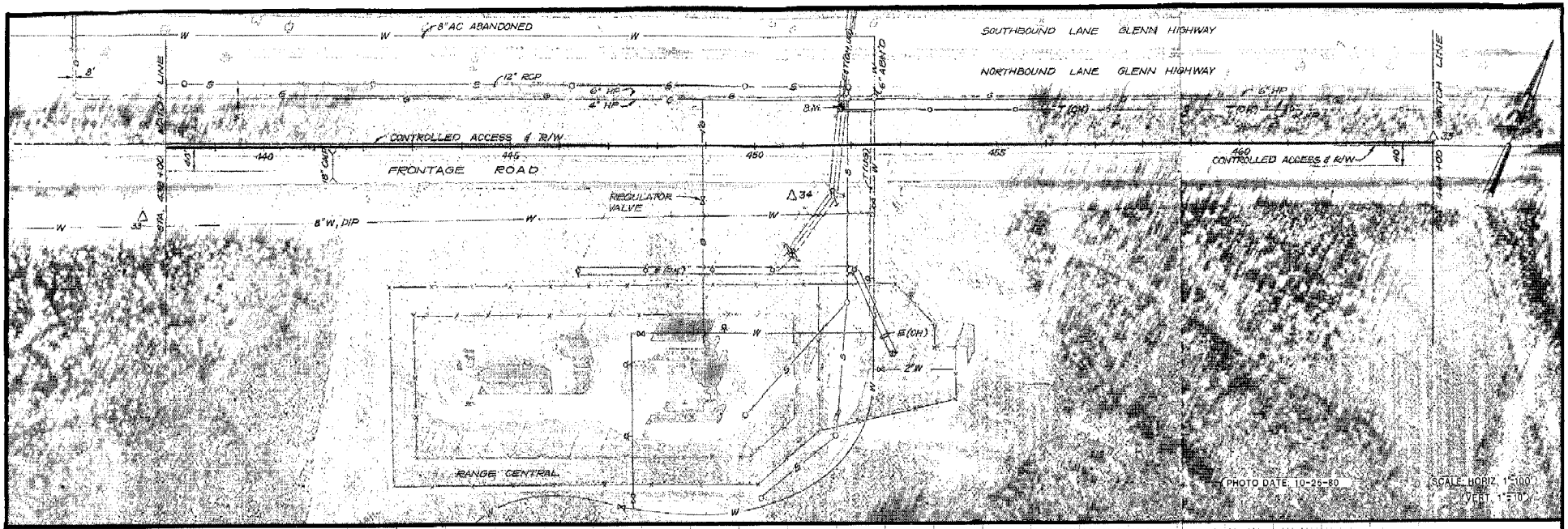

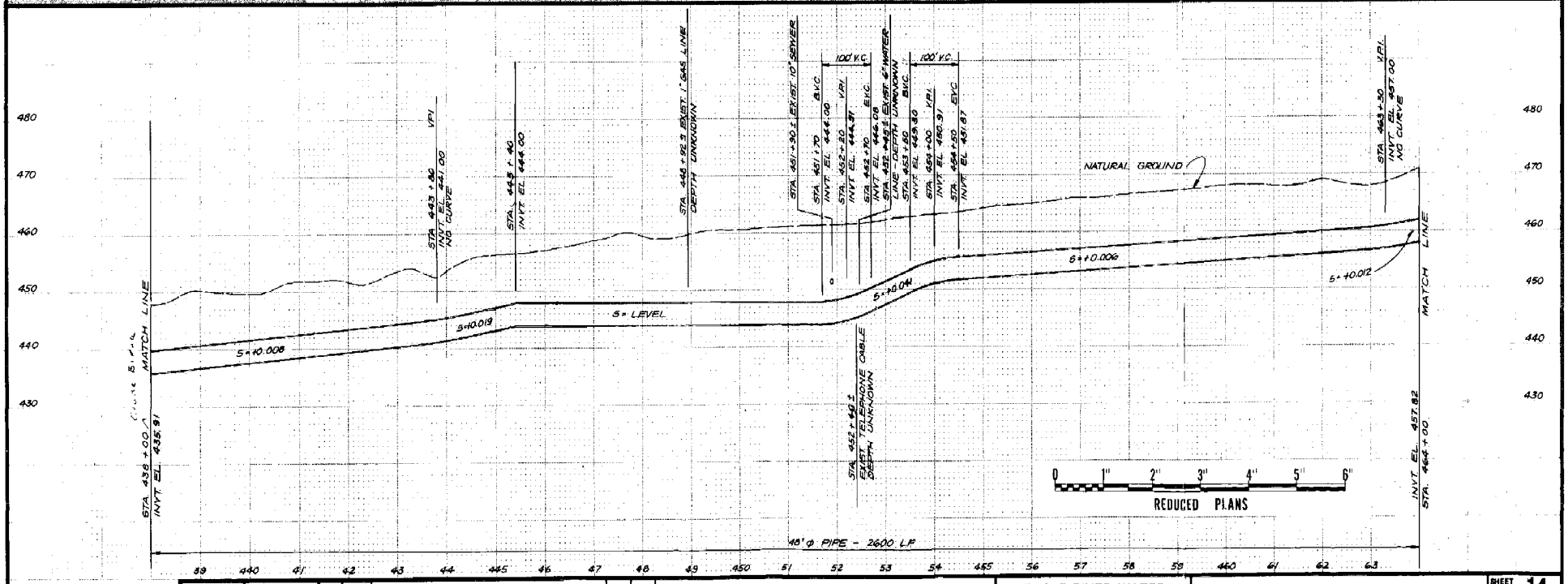

CH2M HILL	DES. HOW DR. vnd CHK. CAF APPD.	NO.	DATE	REVISION	BY	APPD.	MUNICIPALITY OF ANCHORAGE ANCHORAGE WATER & SEWER UTILITIES

EAGLE RIVER WATER RESOURCES STUDY
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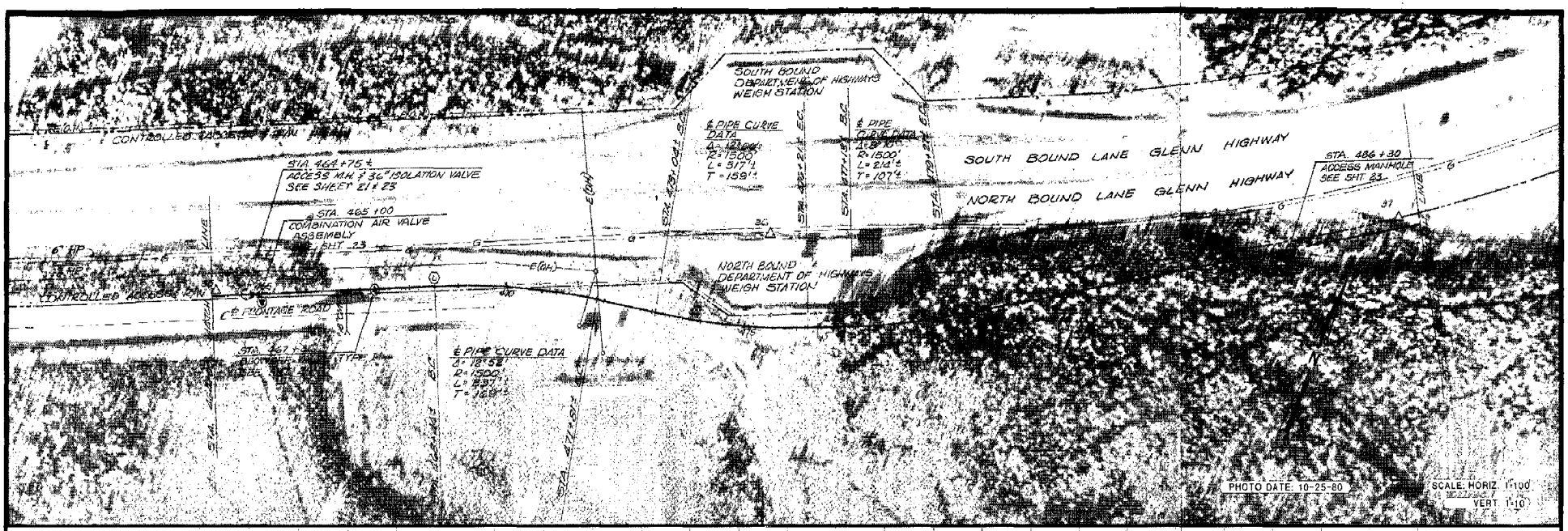
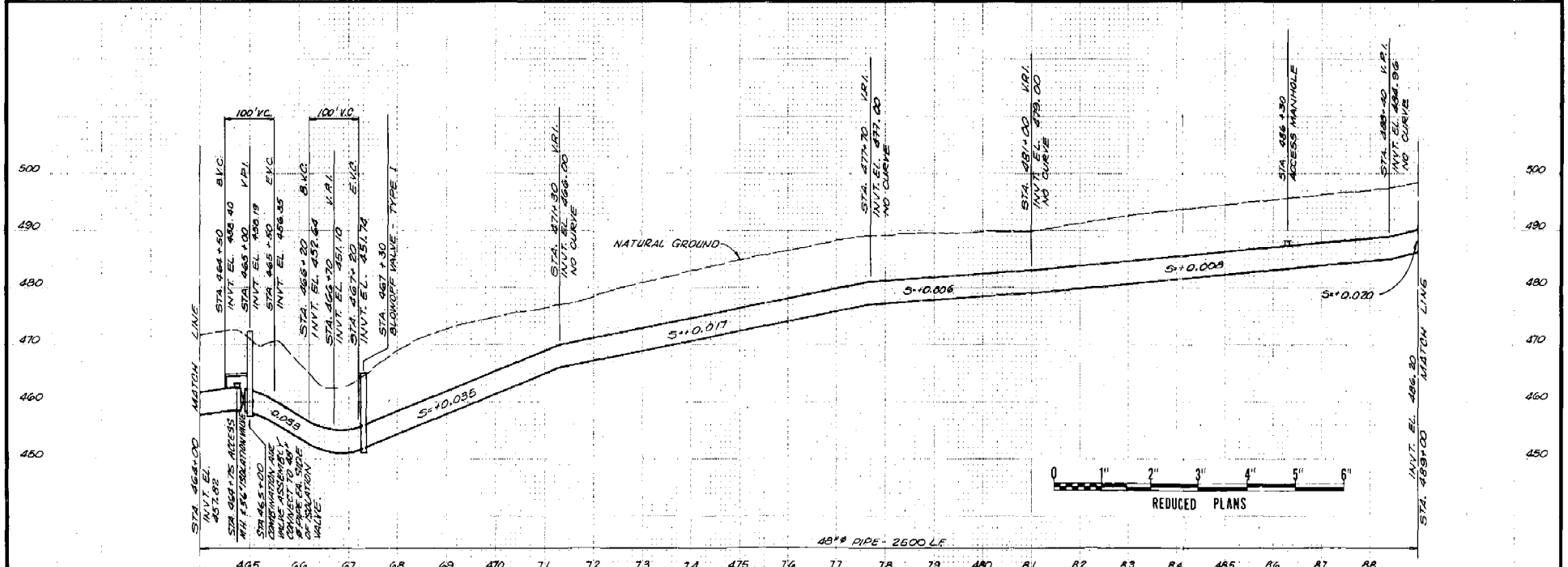
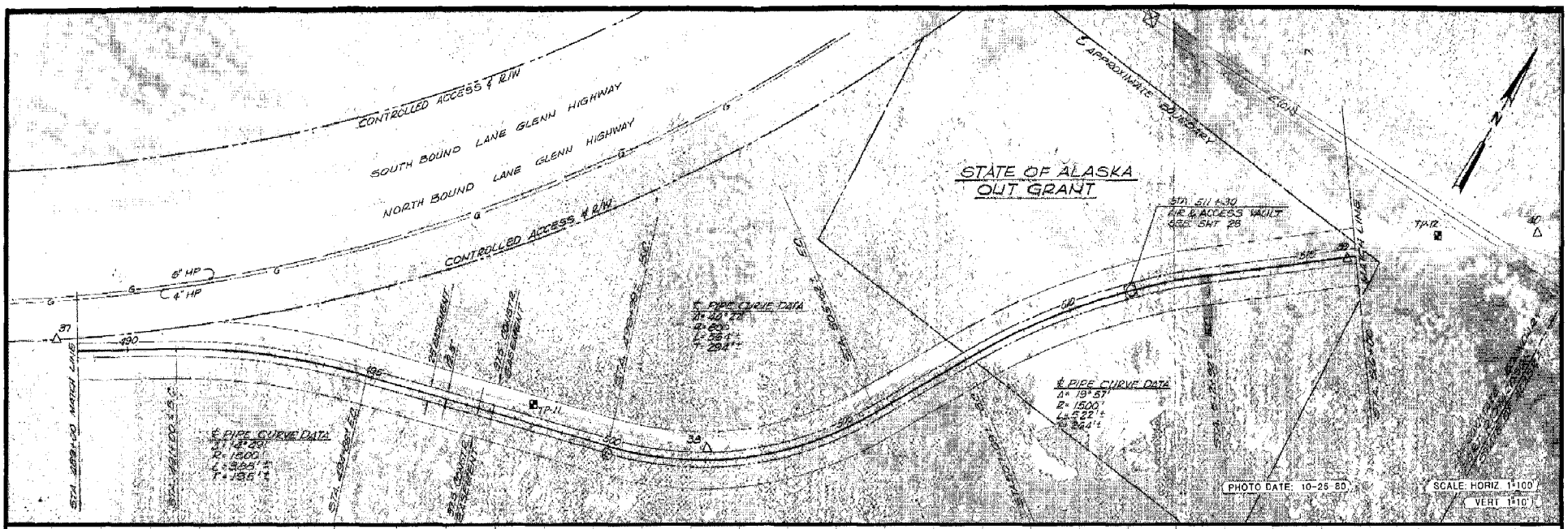
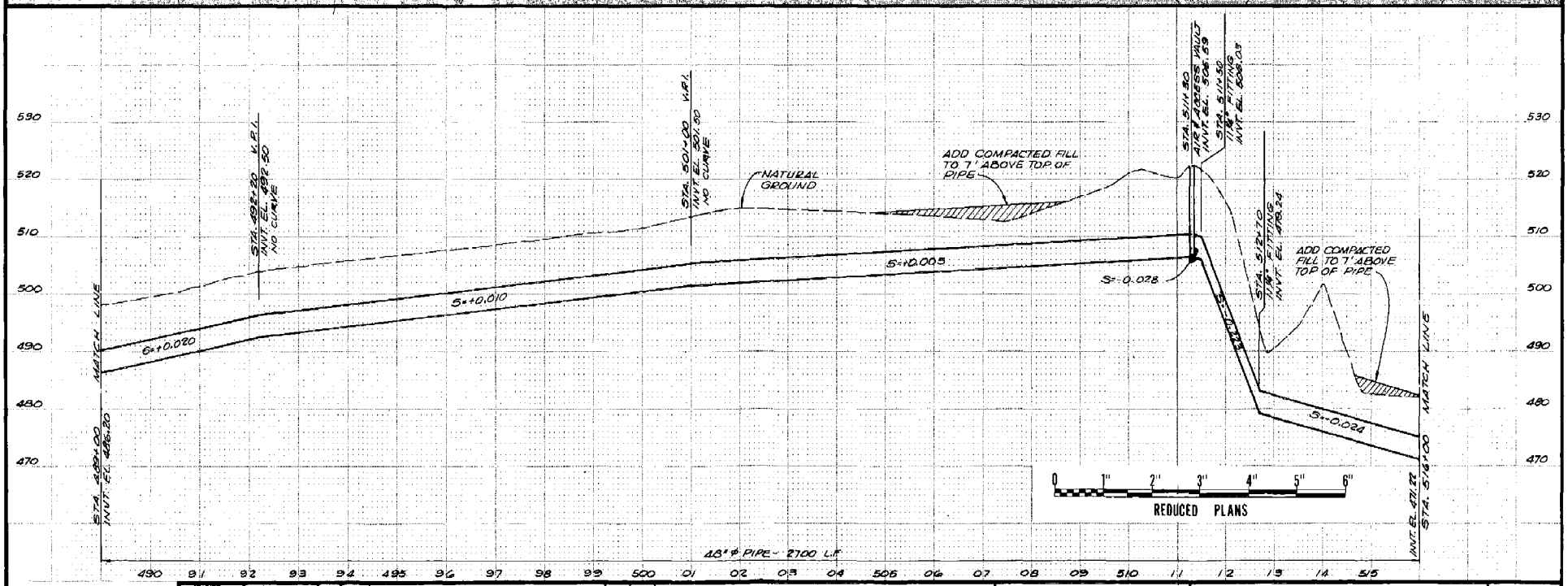


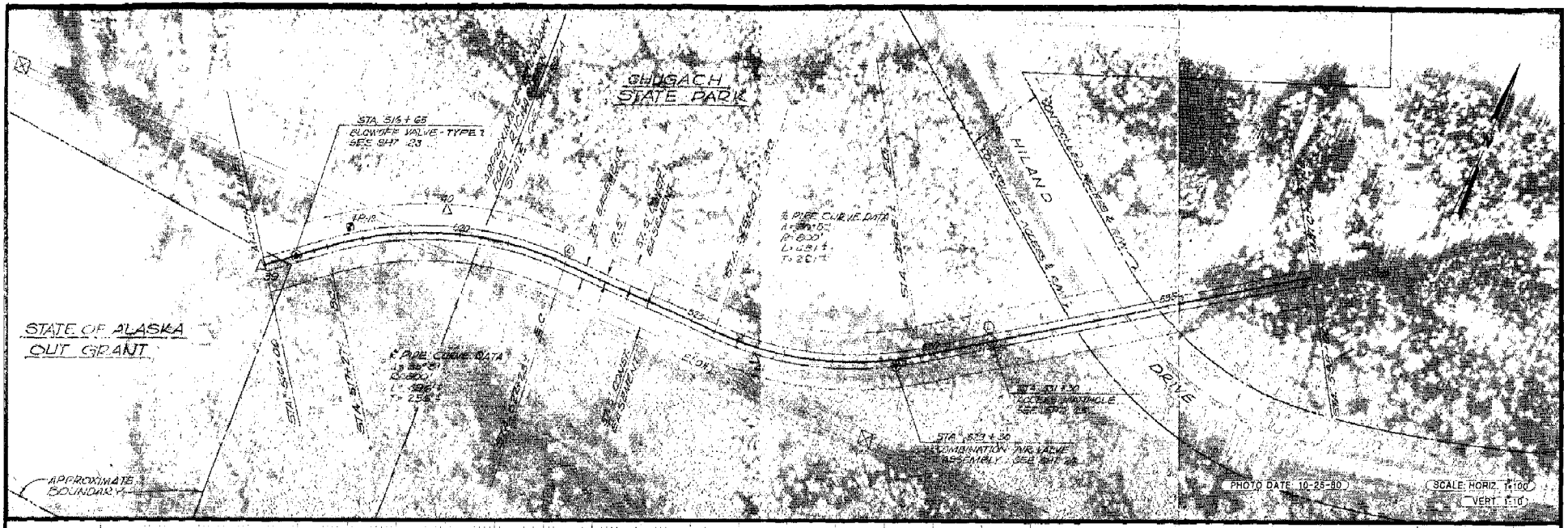


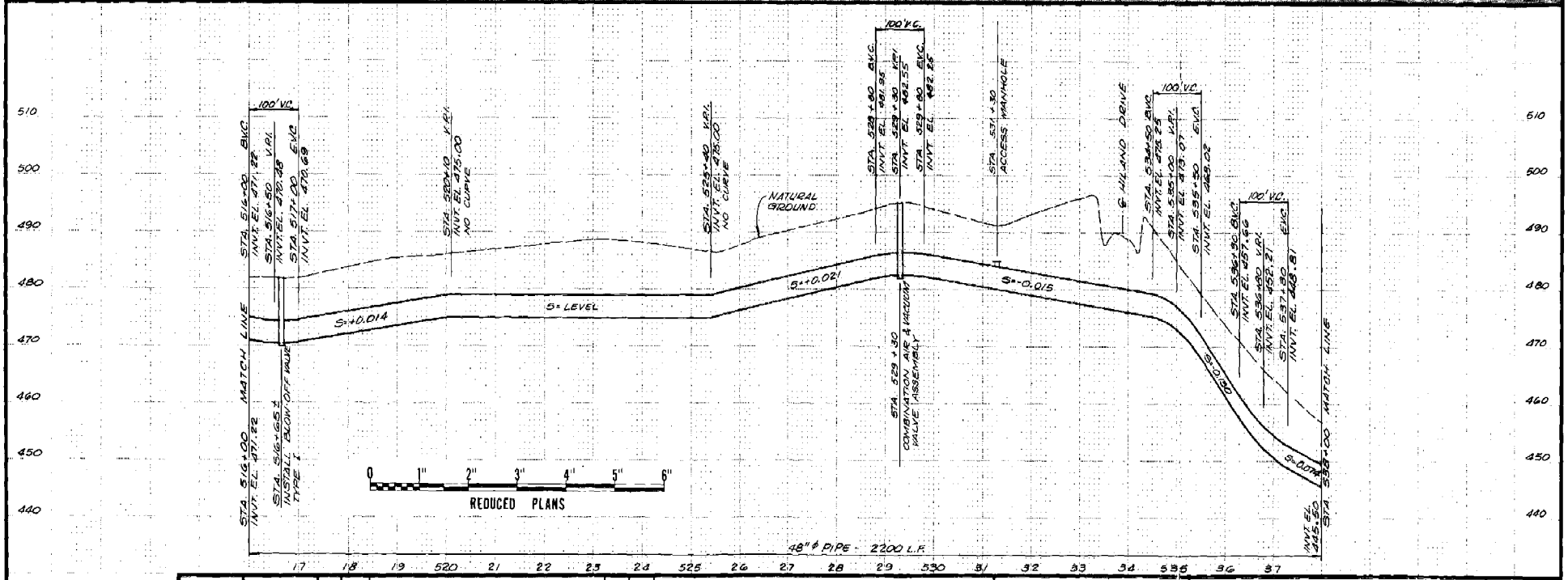
CH2M HILL	DES. HOW DR. H.E.H. CHK. CAF APPD.	NO.	DATE	REVISION	BY	APPD.	MUNICIPALITY OF ANCHORAGE ANCHORAGE WATER & SEWER UTILITIES	EAGLE RIVER WATER RESOURCES STUDY TRANSMISSION MAIN	PRELIMINARY **PLAN AND PROFILE**	SHEET 15 OF 26 DATE JUNE 1981 DWG NO. K13785.E1



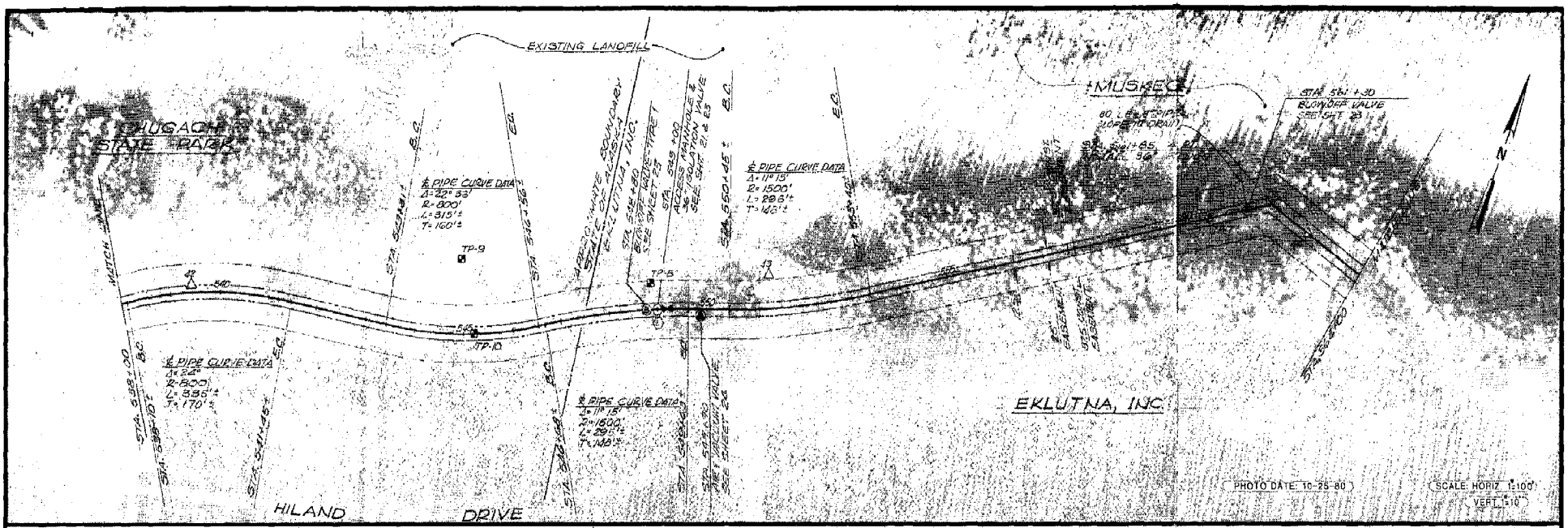


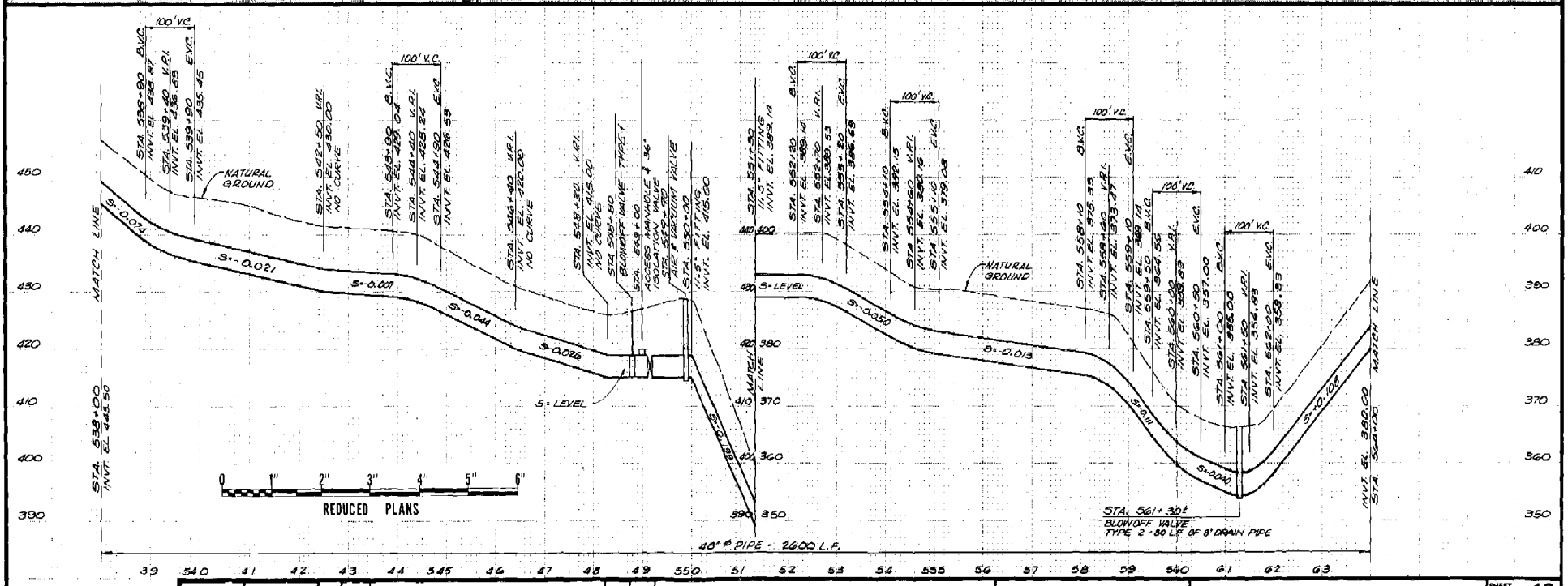
CH2M HILL	DES. HOW DR. H.E.H. CHK. CAF APPD. JHO	NO.	DATE	REVISION	BY	APPD.	MUNICIPALITY OF ANCHORAGE ANCHORAGE WATER & SEWER UTILITIES	EAGLE RIVER WATER RESOURCES STUDY TRANSMISSION MAIN	PRELIMINARY **PLAN AND PROFILE**	SHEET 16 OF 26 DATE JUNE 1981 DWG. NO. K13765.E1





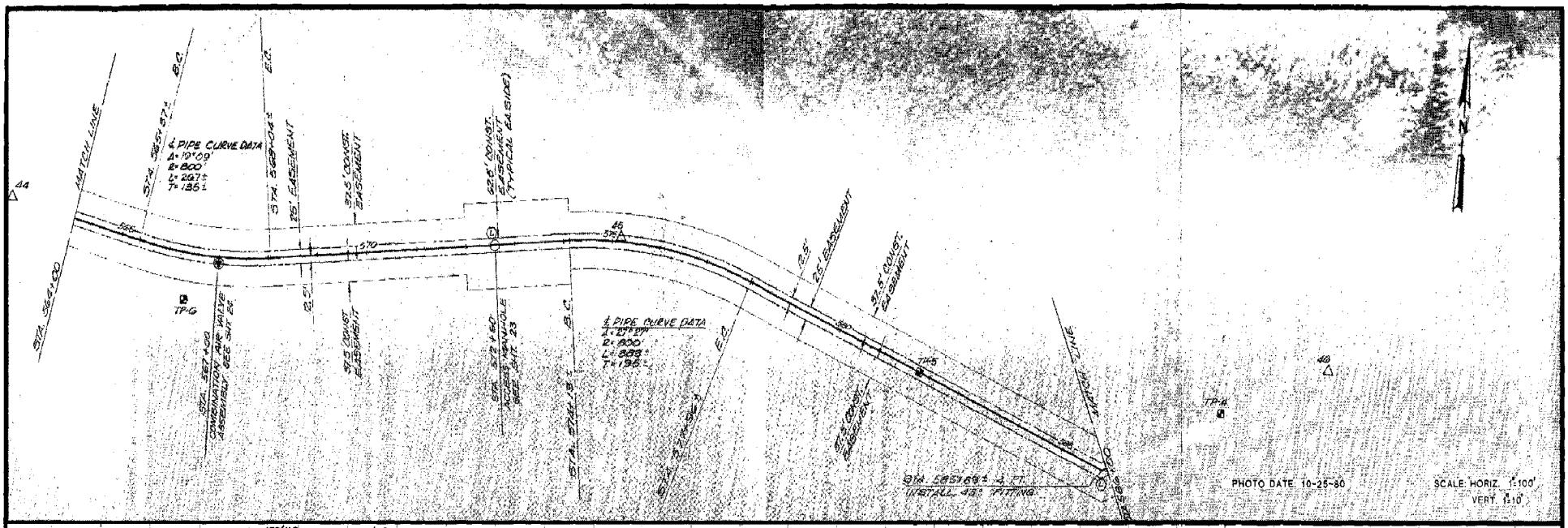
CH2M HILL	DES. HOW DR. H.E.H. CHK. CAF APPD.	NO.	DATE	REVISION	BY	APPD.	MUNICIPALITY OF ANCHORAGE ANCHORAGE WATER & SEWER UTILITIES	EAGLE RIVER WATER RESOURCES STUDY TRANSMISSION MAIN	PRELIMINARY **PLAN AND PROFILE**	SHEET 17 OF 26 DATE JUNE 1981 DWG. NO. K13785.E1

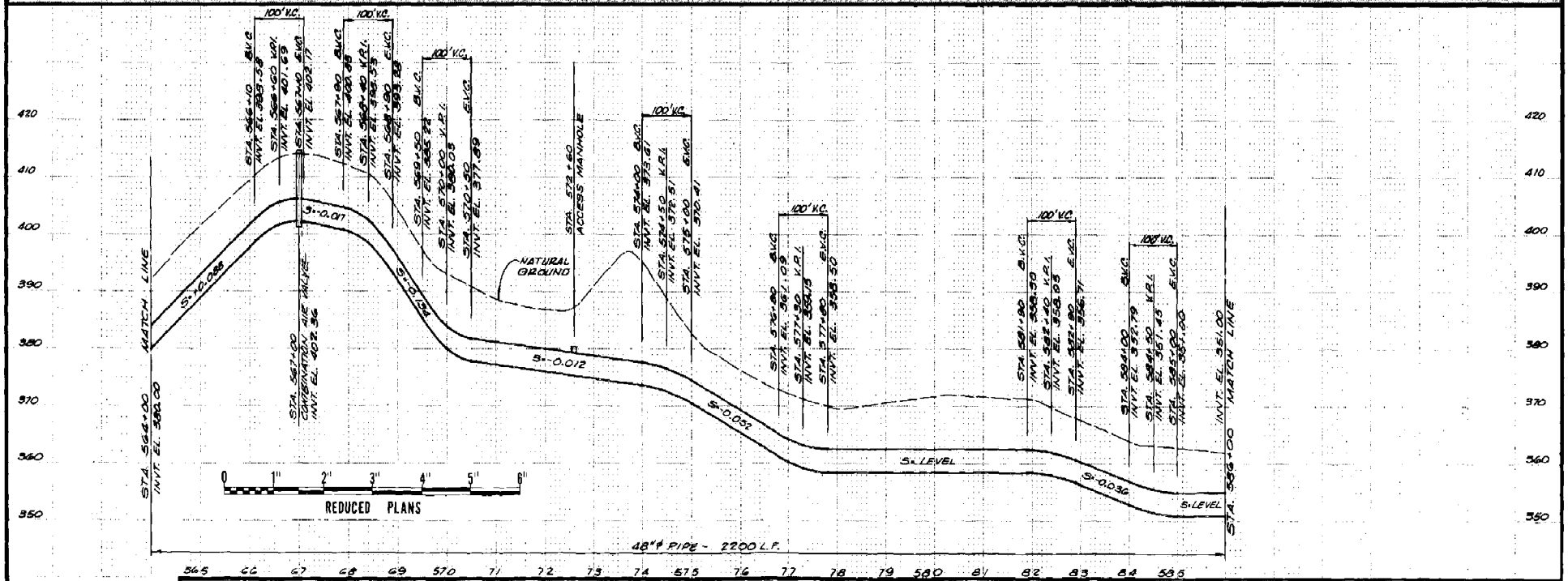




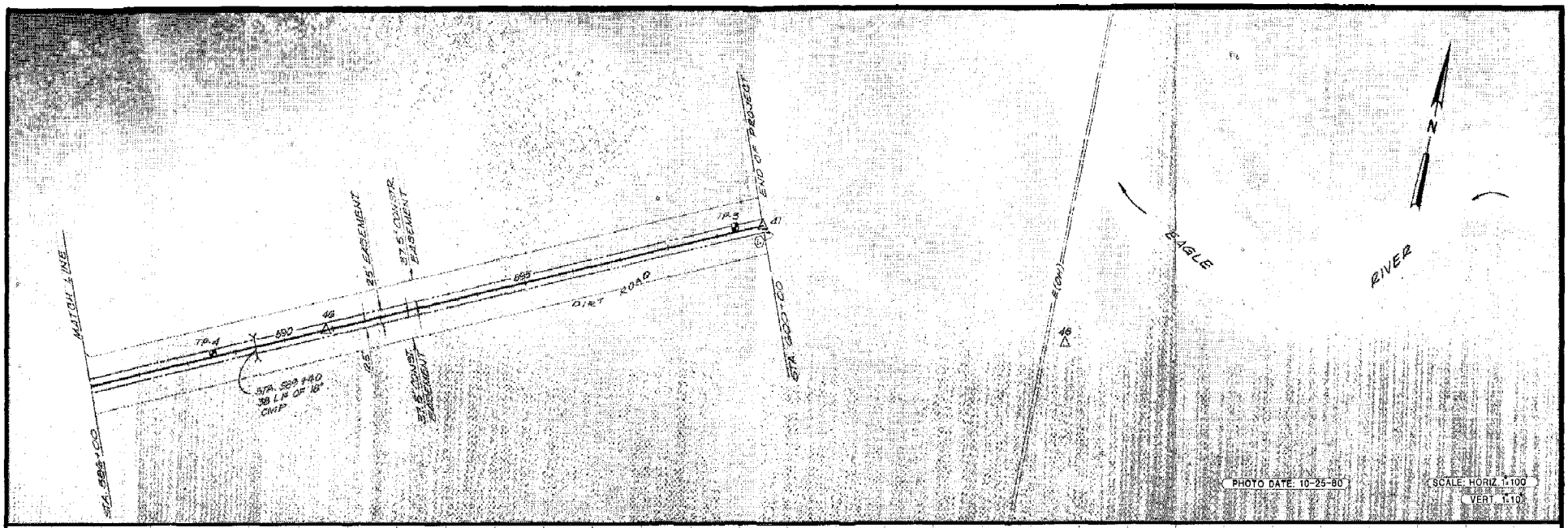
CH2M HILL	DES. HOW DR. H.E.H. CHK. CAF APPD.	NO.	DATE	REVISION	BY	APPD.	MUNICIPALITY OF ANCHORAGE ANCHORAGE WATER & SEWER UTILITIES	EAGLE RIVER WATER RESOURCES STUDY TRANSMISSION MAIN	PRELIMINARY PLAN AND PROFILE

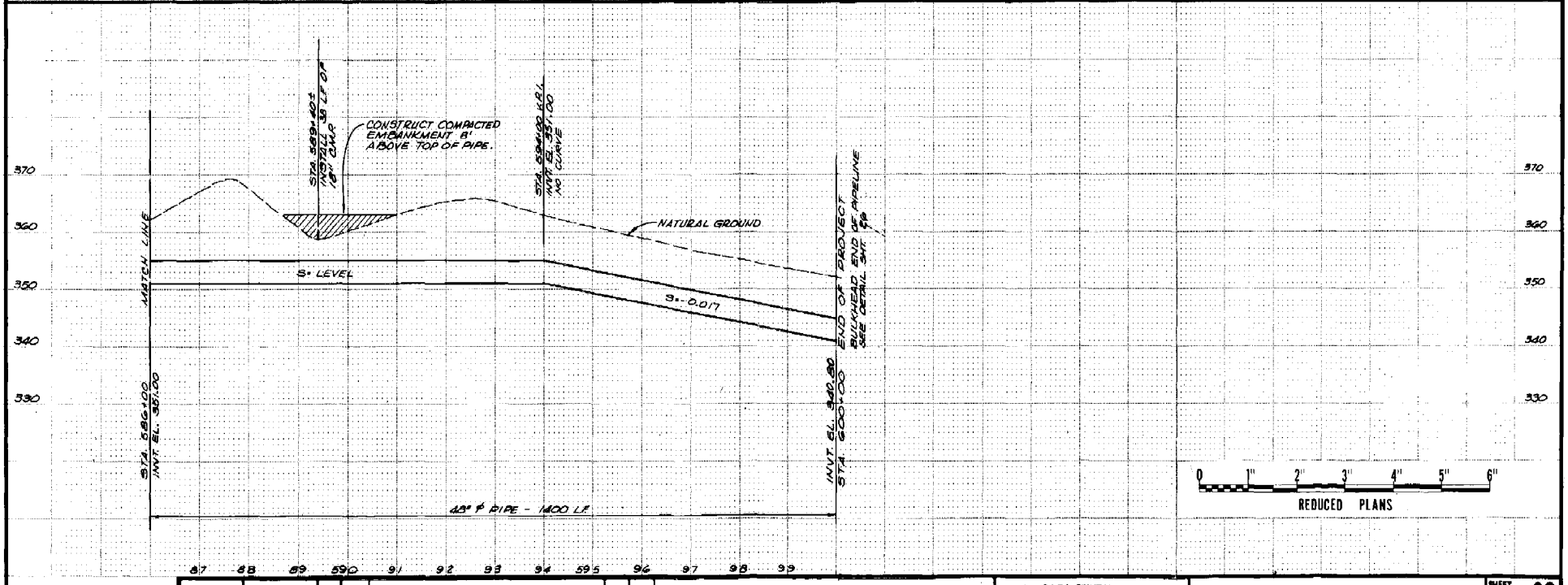
SHEET 18 OF 26
DATE JUNE 1981
DWG. NO. K13765.E1



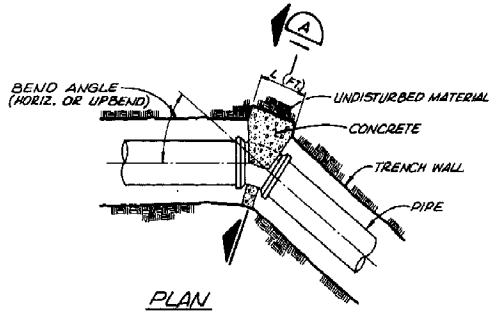


CH2M HILL	DES. HOW DR. H.E.H. CHK. CAF APPD.	NO.	DATE	REVISION	BY	APPD.	MUNICIPALITY OF ANCHORAGE ANCHORAGE WATER & SEWER UTILITIES	EAGLE RIVER WATER RESOURCES STUDY TRANSMISSION MAIN	PRELIMINARY **PLAN AND PROFILE**	SHEET 19 OF 26 DATE JUNE 1981 DWG. NO. K13765.E1

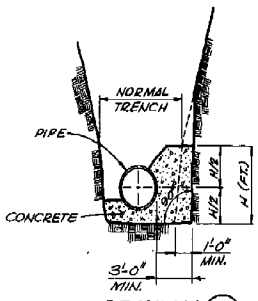




CH2M HILL	DES. HOW DR. H.E.H. CHK. CAF APPD.	NO.	DATE	REVISION	BY	APPD.	MUNICIPALITY OF ANCHORAGE ANCHORAGE WATER & SEWER UTILITIES	EAGLE RIVER WATER RESOURCES STUDY TRANSMISSION MAIN	PRELIMINARY **PLAN AND PROFILE**	SHEET 20 OF 26 DATE JUNE 1981 DWG NO. K13785.E1



PLAN



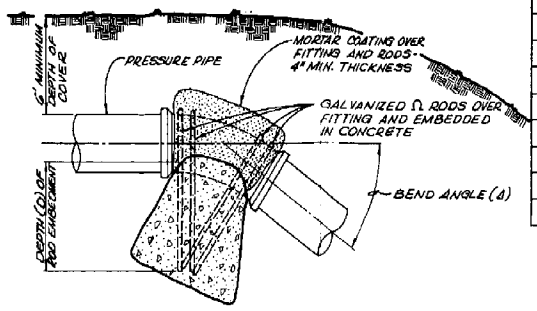
SECTION (A)

NOTES:

1. THE AREA OF THE THRUST BLOCKS WILL BE DETERMINED FOLLOWING A SURGE ANALYSIS AND A COMPLETE GEOTECHNICAL INVESTIGATION. THIS WORK WILL BE COMPLETED DURING FINAL DESIGN.
2. BEARING SURFACE OF THRUST BLOCKS MUST BE NORMAL TO RESULTANT THRUST OF BEND AND BEAR ON SUITABLE UNDISTURBED MATERIAL.
3. KEEP CONCRETE CLEAR OF JOINT AND JOINT ACCESSORIES.
4. DIMENSIONS "L" AND "H" SHALL BE DETERMINED BY THE ENGINEER.

HORIZONTAL THRUST BLOCKS

N.T.S.



VERTICAL ANCHOR BLOCKS

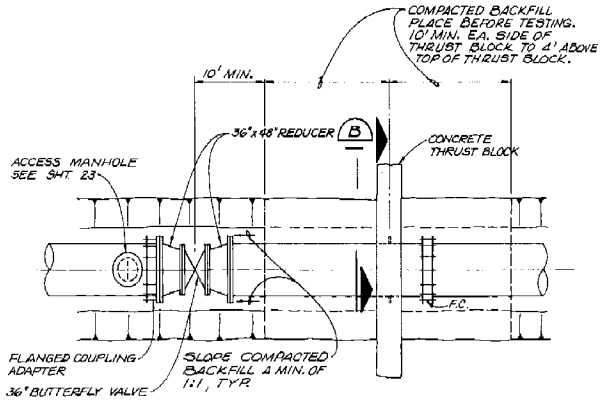
N.T.S.

NOTES:

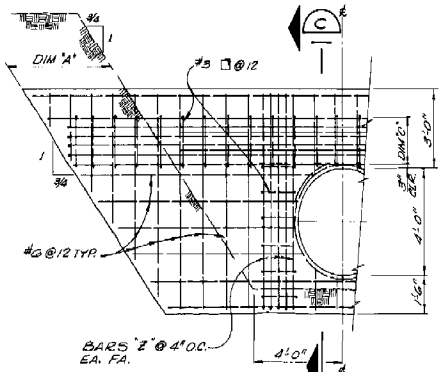
1. KEEP CONCRETE CLEAR OF JOINT & JOINT ACCESSORIES.
2. ANCHOR BLOCKS FOR VERTICAL UPBENDS SHALL BE THE SAME AS FOR HORIZONTAL BENDS. REFER TO HORIZONTAL THRUST BLOCK DETAIL FOR SIZE OF BLOCK REQUIRED AT EACH STATION.
3. SIZE OF ANCHOR BLOCKS ARE BASED ON A SOIL UNIT WEIGHT = 110 PCF AND THE TEST PRESSURE OF THE PIPELINE.
4. VOLUME OF ANCHOR BLOCKS FOR DOWNBENDS IS SHOWN IN TABLE I. (TABLE I TO BE COMPLETED DURING FINAL DESIGN.)

TABLE 1

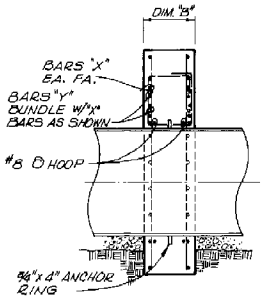
STATION	TEST PRESSURE (PSI.)	Δ (DEGREES)	VOLUME OF CONCRETE (CU. YD.)
181+20			
186+60			
511+50			
549+00			



PLAN



SECTION (B)



SECTION (C)

ALTERNATIVE I, THRUST BLOCKS							ALTERNATIVE II
TEST PRESSURE	DIMENSIONS			REINFORCING			*LENGTH OF RESTAINED JOINTS
	DIM. "A"	DIM. "B"	DIM. "C"	BARS "X"	BARS "Y"	BARS "Z"	
50 PSI		1'-9"	1'-6"	6-#8 □	2-#8x11'-0"	5-#8 L	50 FT.
100 PSI		2'-3"	1'-9"	6-#10 □	2-#8x14'-6"	4-#8 L	70 FT.
150 PSI		2'-10"	2'-0"	6-#11 □	2-#10x16'-0"	6-#8 L	100 FT.
200 PSI	—	—	—	—	—	—	130 FT.

* LENGTH OF BACKFILLED RESTAINED JOINT PIPE EA. SIDE OF VALVE TO BE USED IN LIEU OF THRUST BLOCKS.

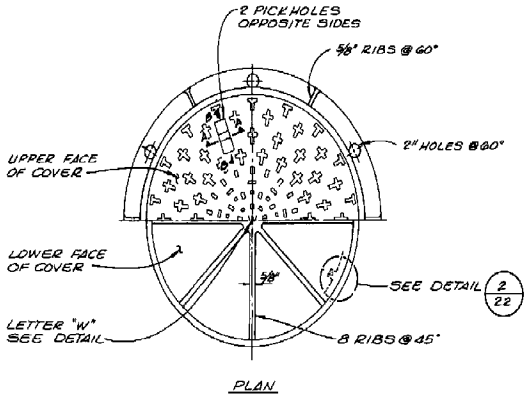
ISOLATION VALVE DETAILS

N.T.S.

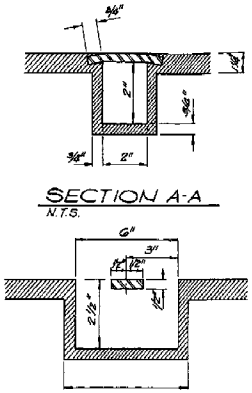
0 1" 2" 3" 4" 5" 6"

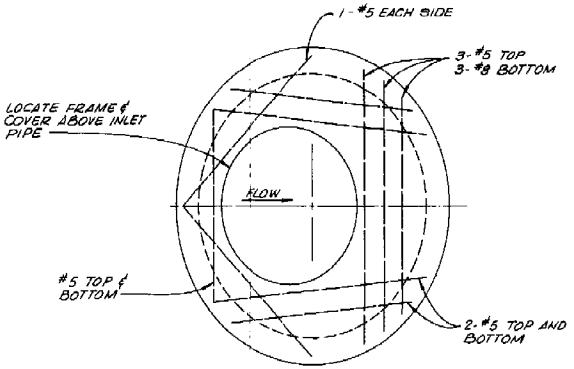
REDUCED PLANS

CH2M HILL	DES. HOW DR. H.E.H. CHK. CAF APPD. JAS	NO. DATE REVISION BY APPD.	MUNICIPALITY OF ANCHORAGE ANCHORAGE WATER & SEWER UTILITIES	EAGLE RIVER WATER RESOURCES STUDY TRANSMISSION MAIN	PRELIMINARY THRUST BLOCK DETAILS	SHEET 21 OF 26 DATE JUNE 1981 DWG. NO. K 19766.E1

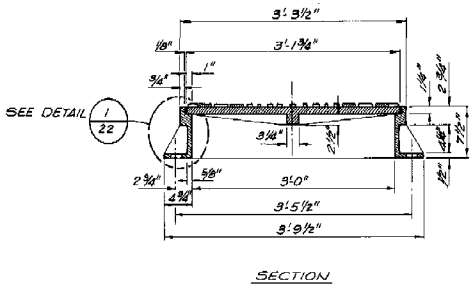


PLAN



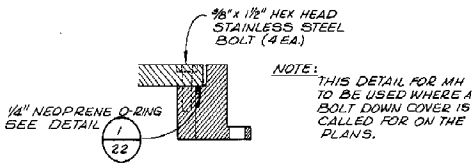


PLAN
3/4"=1'-0"

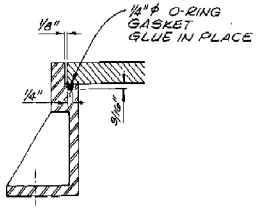


SECTION

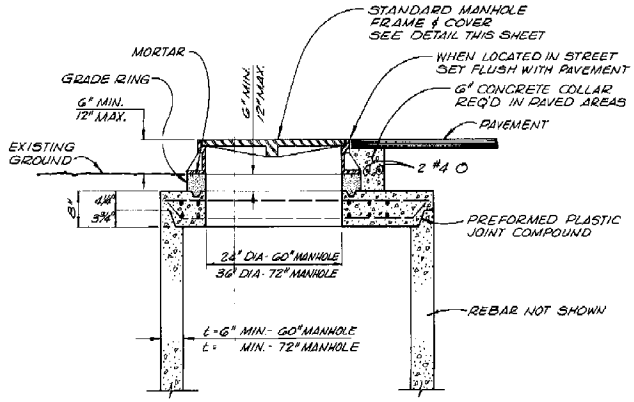
STANDARD 36" MANHOLE FRAME & COVER
N.T.S.



DETAIL 2/22
N.T.S.



DETAIL 1/22
N.T.S.



SECTION
3/4"=1'-0"

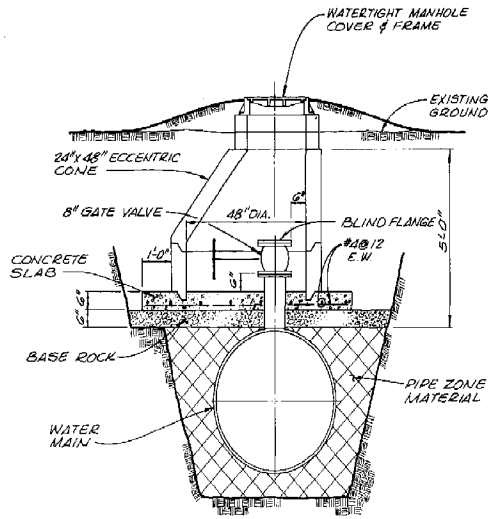
FLAT TOP SLAB DETAILS

NOTE:

REFER TO MUNICIPALITY OF ANCHORAGE'S STANDARD SPECIFICATIONS & DETAILS FOR STANDARD MANHOLE SECTIONS AND COVER DETAILS.

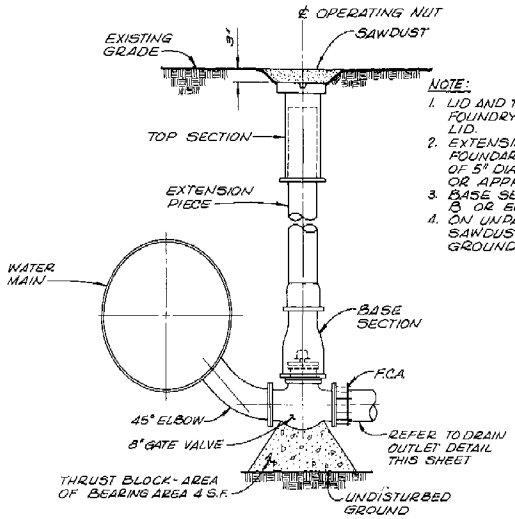
0 1" 2" 3" 4" 5" 6"
REDUCED PLANS

CH2M HILL	DES. HOW DR. H.E.H. CHK. CAP APPD. JHD	NO.	DATE	REVISION	BY	APPD.	MUNICIPALITY OF ANCHORAGE ANCHORAGE WATER & SEWER UTILITIES	EAGLE RIVER WATER RESOURCES STUDY TRANSMISSION MAIN	PRELIMINARY TYPICAL MANHOLE DETAILS	SHEET 22 OF 26 DATE JUNE 1981 DWG. NO. K 13766.E1



TYPE 1 BLOWOFF ASSEMBLY

N.T.S.

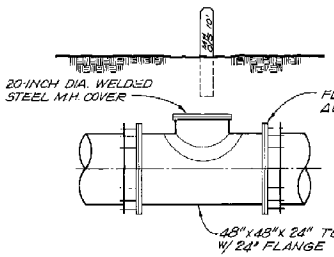


NOTE:

1. LID AND TOP SECTION TO BE OLYMPIC FOUNDRY TYPE C, OR EQUAL LOCKDOWN LID.
2. EXTENSION PIECE TO BE OLYMPIC FOUNDARY TYPE A 10 FOOT SECTION OF 5" DIA. SINGLE HUB SOIL PIPE OR APPROVED EQUAL.
3. BASE SECTION TO BE OLYMPIC TYPE B OR EQUAL.
4. ON UNPAVED INSTALLATIONS, PLACE SAWDUST FROM LID TO EXISTING GROUND LEVEL.

TYPE 2 BLOWOFF ASSEMBLY

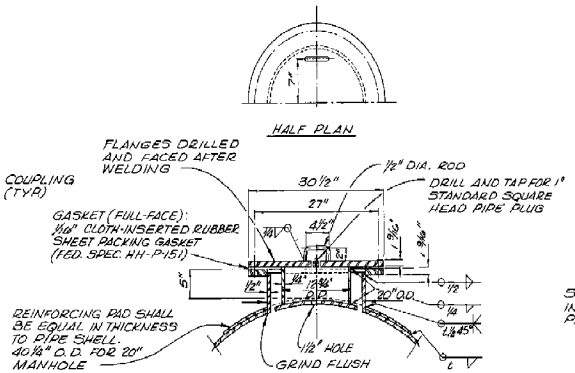
N.T.S.



ACCESS MANHOLES SHALL BE LOCATED AS SHOWN ON PLAN AND PROFILE SHEETS. WHERE ACCESS MANHOLE IS LOCATED ADJACENT TO AN ISOLATION VALVE, SEE SHT. 21 FOR DETAILS.

ACCESS MANHOLE

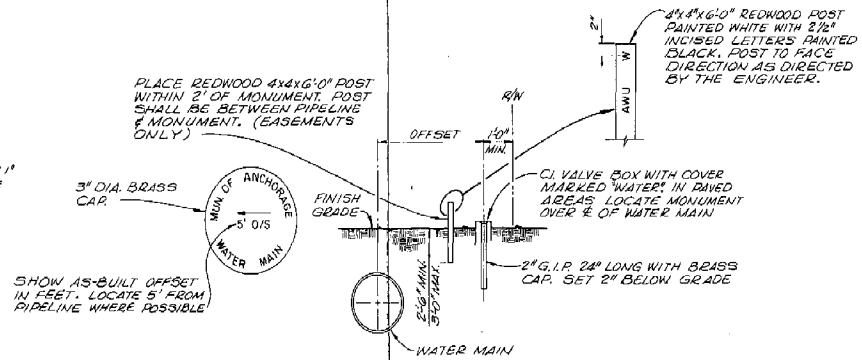
N.T.S.



SECTION

20" DIA. WELDED STEEL MANHOLE DETAIL

N.T.S.



NOTE:

MONUMENTS TO BE SET AT ALL LOCATIONS SHOWN ON THE PLAN & PROFILE SHEETS OR AS DIRECTED BY THE ENGINEER.

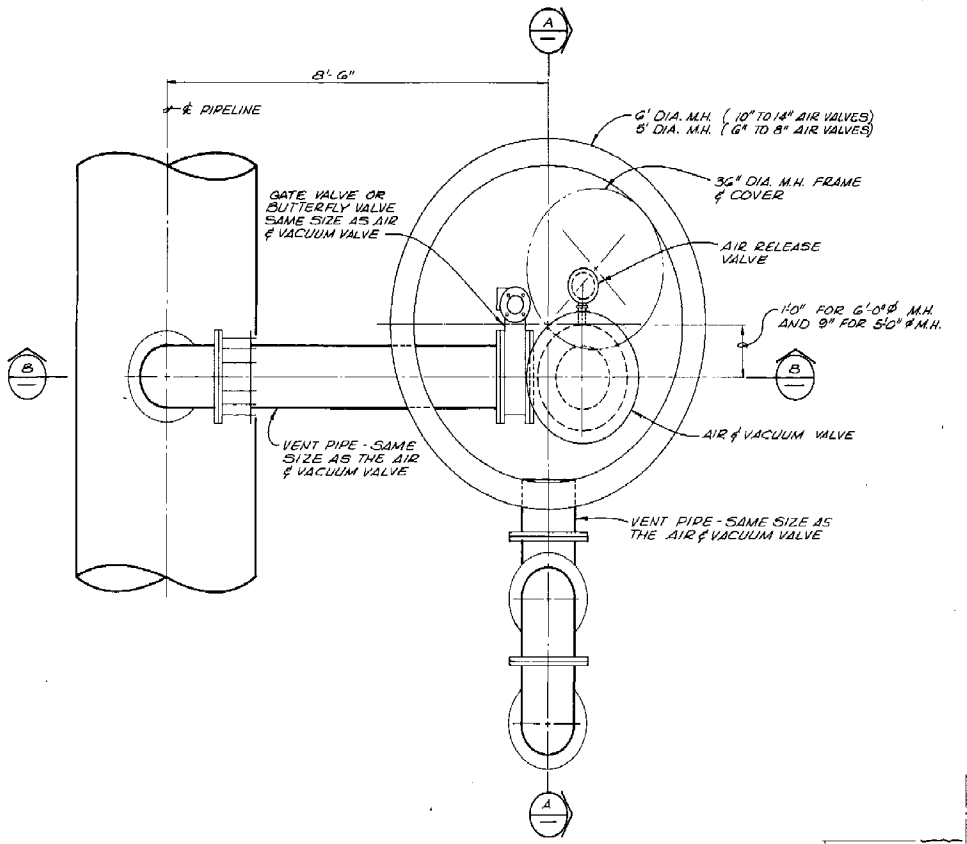
PIPELINE LOCATION MONUMENT

N.T.S.

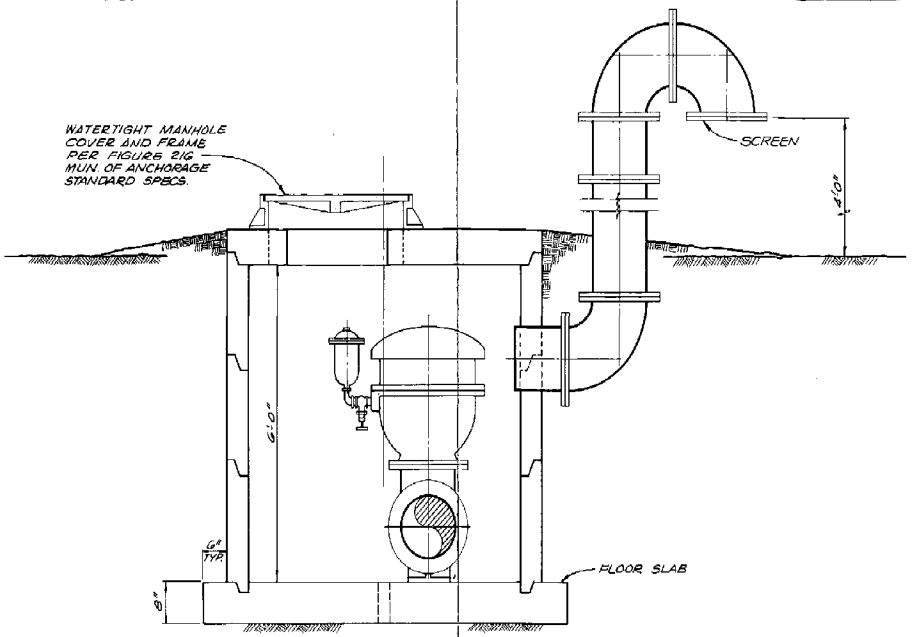
0 1" 2" 3" 4" 5" 6"

REDUCED PLANS

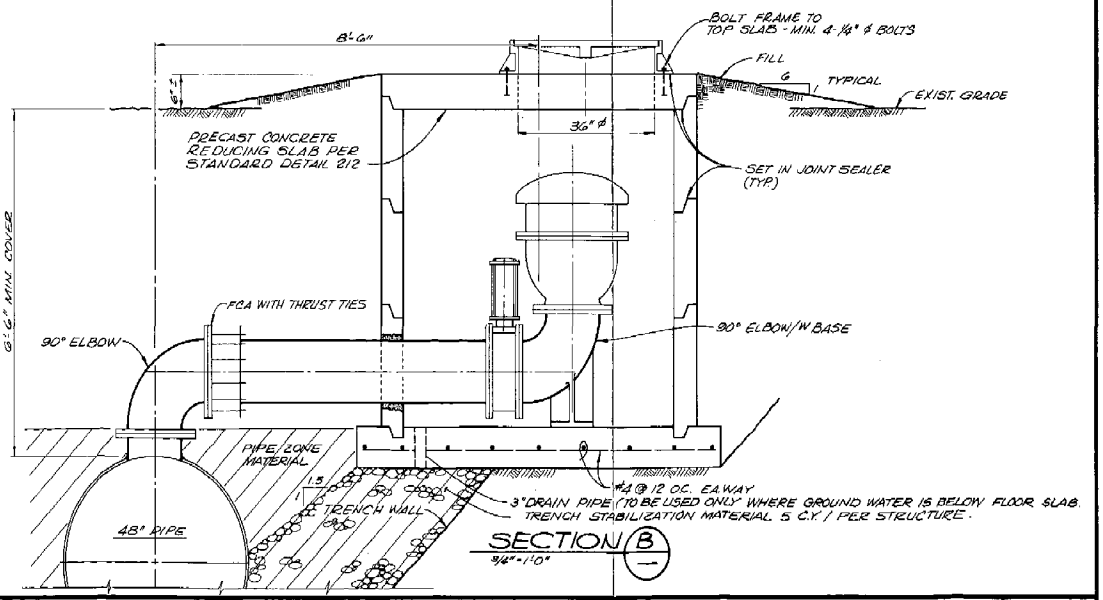
CH2M HILL	DES. HOW DR. H.E.H. CHK. DAF APPD.	NO.	DATE	REVISION	BY	APPD.	MUNICIPALITY OF ANCHORAGE ANCHORAGE WATER & SEWER UTILIES	EAGLE RIVER WATER RESOURCES STUDY TRANSMISSION MAIN	PRELIMINARY BLOWOFF ASSEMBLY DETAILS	SHEET 23 OF 26 DATE JUNE 1981 DWG. NO. K 13765.E1



PLAN
3/4" = 1'-0"



SECTION A
3/4" = 1'-0"



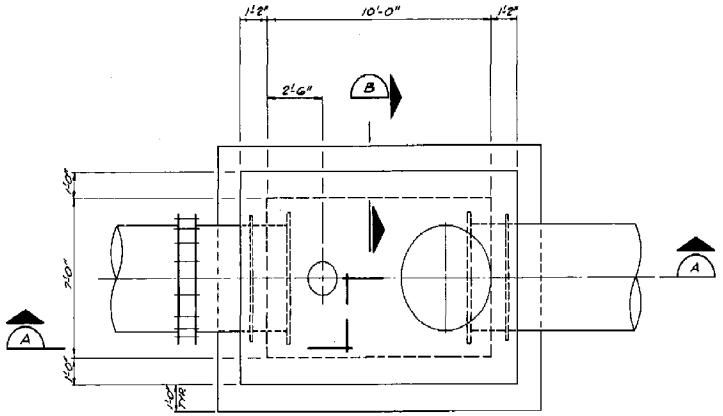
SECTION B
3/4" = 1'-0"

NOTES :

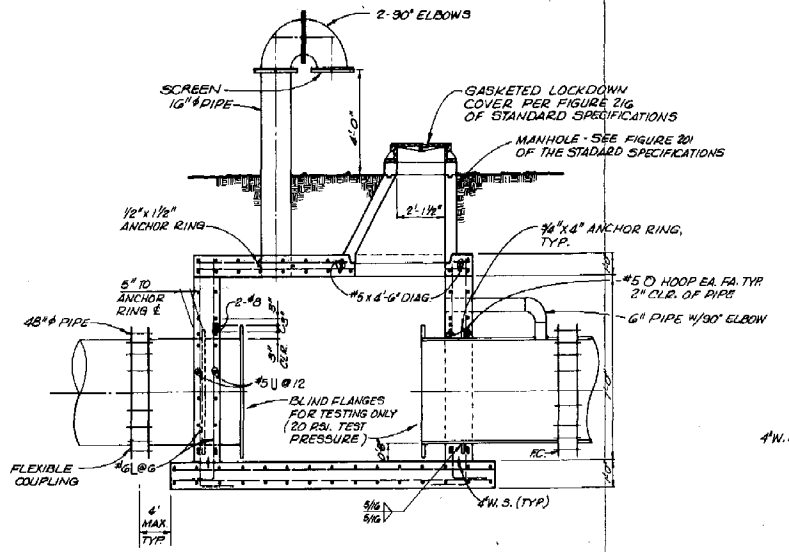
1. COMBINATION AIR VALVES INCLUDE AIR RELIEF VALVE AND AIR & VACUUM VALVES.
2. SIZE OF AIR & VACUUM VALVES TO BE DETERMINED DURING FINAL DESIGN FOLLOWING SURGE ANALYSIS. TENTATIVE LOCATION OF AIR VALVES ARE SHOWN ON PLAN AND PROFILE SHEETS.
3. PROTECTION OF VALVES AND PIPING AGAINST FREEZING IS NOT SHOWN AND WILL BE DETERMINED DURING FINAL DESIGN.

0 1" 2" 3" 4" 5" 6"
REDUCED PLANS

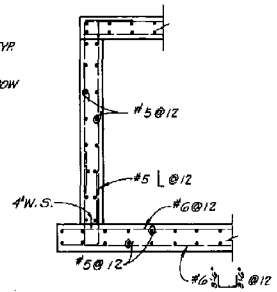
CH2M HILL	DES. HOW DR. H.E.H. CHK. CAF APPD. JHO	NO.	DATE	REVISION	BY	APPD.	MUNICIPALITY OF ANCHORAGE ANCHORAGE WATER & SEWER UTILITIES
EAGLE RIVER WATER RESOURCES STUDY TRANSMISSION MAIN	PRELIMINARY AIR VALVE ASSEMBLY DETAILS	SHEET 24 OF 26 DATE JUNE 1981 DWG. NO. K 18765.E1					



PLAN
3/8" = 1'-0"

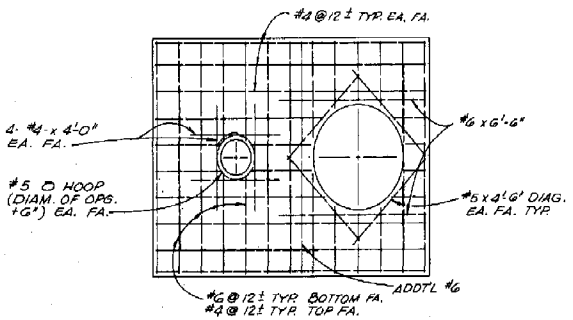


SECTION (A)
3/8" = 1'-0"

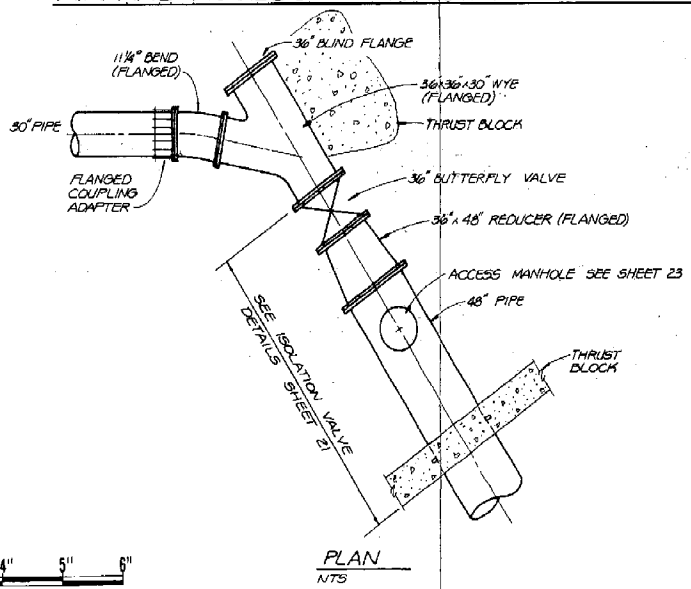


SECTION (B)
3/8" = 1'-0"

AIR AND ACCESS VAULT - STATION 511 + 30



ROOF SLAB REINF.
3/8" = 1'-0"



PLAN
NTS

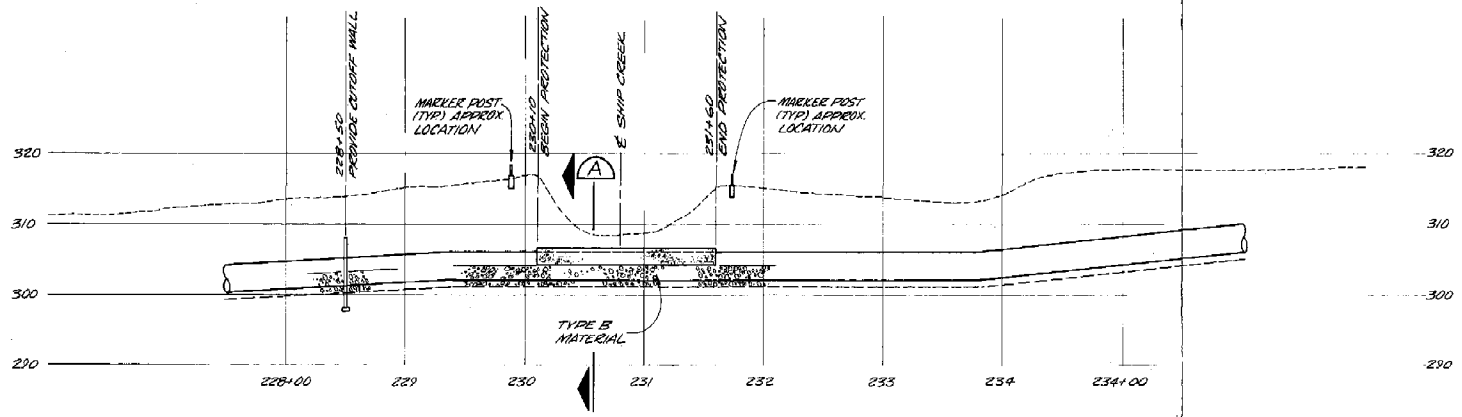
NOTES:

1. DESIGN OF THE HIGH WATER ALARM SYSTEM AND PROTECTION OF THE STRUCTURE AND PIPING AGAINST FREEZING WILL BE COMPLETED DURING FINAL DESIGN.

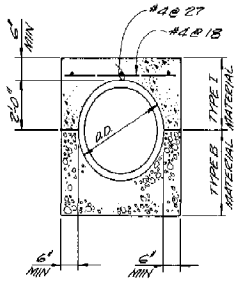
0 1" 2" 3" 4" 5" 6"
REDUCED PLANS

VALVE DETAIL - STATION 192+20

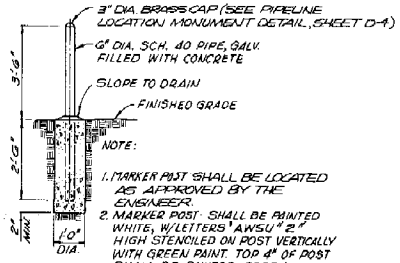
CH2M HILL	DES. HOW DR. H.E.H. CHK. CAF APPD. JHS	NO.	DATE	REVISION	BY	APPD.	MUNICIPALITY OF ANCHORAGE ANCHORAGE WATER & SEWER UTILITIES	EAGLE RIVER WATER RESOURCES STUDY TRANSMISSION MAIN	PRELIMINARY ACCESS VAULT DETAILS STA. 511 + 30	SHEET 25 OF 26 DATE JUNE 1981 DWG. NO. K 18766.61



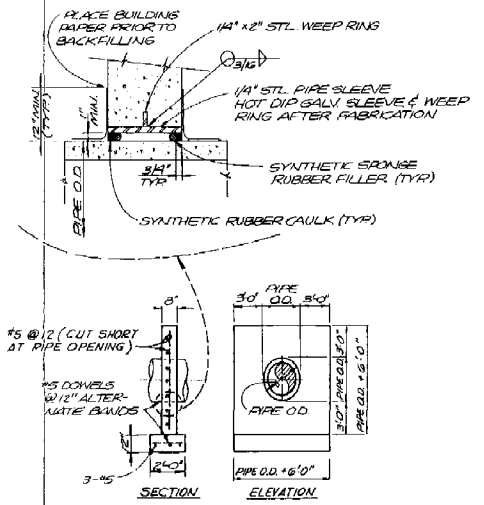
SHIP CREEK CROSSING
@ STA. 231+00 ±
NTS



SECTION A
NTS



MARKER POST DETAIL
N.T.S.



CUTOFF WALL DETAIL
N.T.S.

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REDUCED PLANS

CH2M HILL	DES. HOW DR. RAM CHK. CAP APPD. JAS	NO.	DATE	REVISION	BY	APPD.	MUNICIPALITY OF ANCHORAGE ANCHORAGE WATER & SEWER UTILITIES
EAGLE RIVER WATER RESOURCES STUDY TRANSMISSION MAIN	SHIP CREEK CROSSING	SHEET 26 OF 26 DATE JUNE 1981 DWG. NO. K13765.E1					

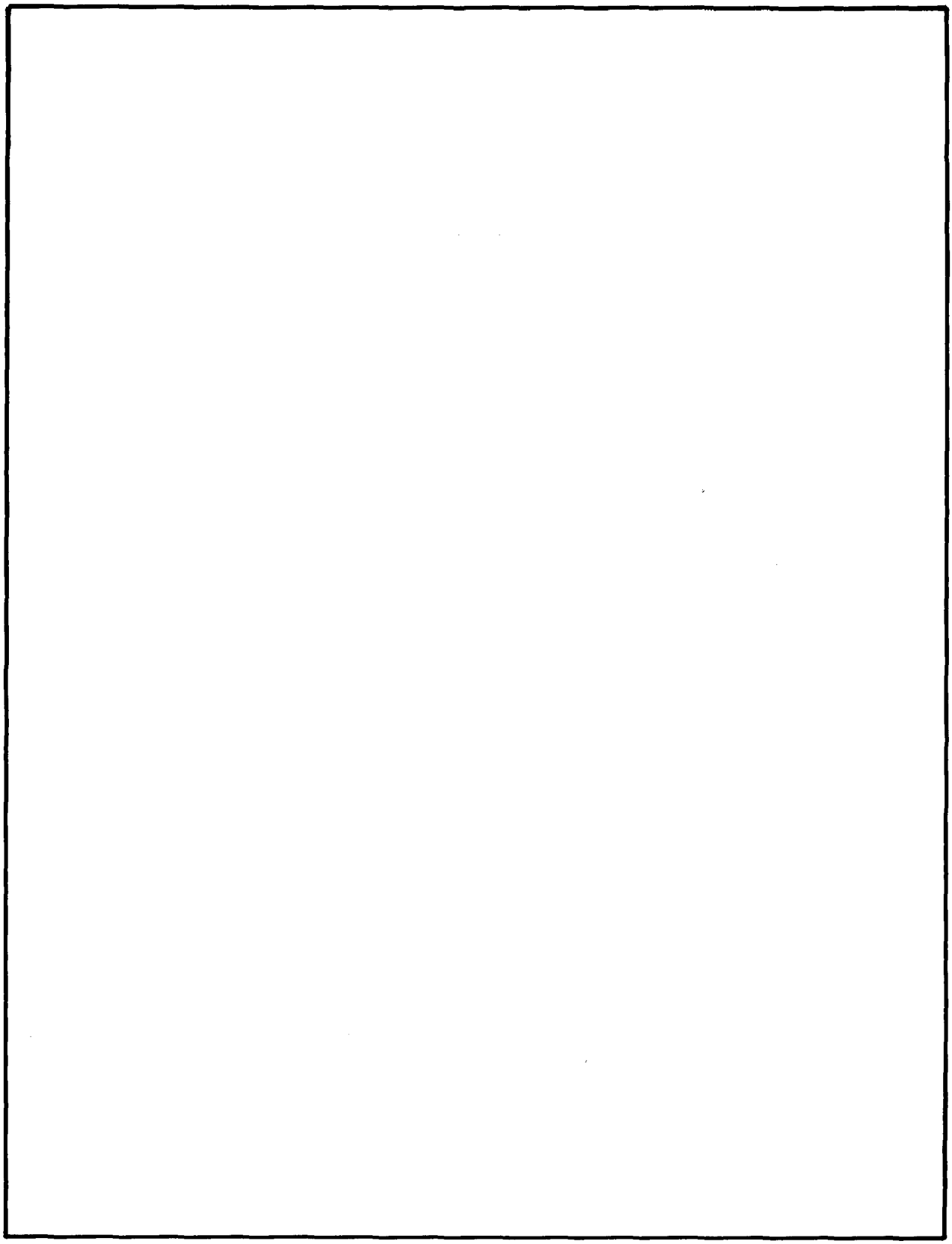

Exhibit F
Preliminary Technical Specifications

EAGLE RIVER WATER RESOURCE STUDY

TRANSMISSION MAIN

PRELIMINARY TECHNICAL SPECIFICATIONS PIPING AND APPURTENANCES

DECEMBER 1981

DIVISION 90
MUNICIPALITY OF ANCHORAGE

EAGLE RIVER WATER RESOURCE STUDY
TRANSMISSION MAIN STUDY

SPECIAL PROVISIONS

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EAGLE RIVER WATER RESOURCE STUDY
TRANSMISSION MAIN

SECTION 90.03

PIPING AND APPURTENANCES

SECTION 90.03 PIPING AND APPURTENANCES

Information contained in this section is modifications, deletions, and additions to the requirements of the Municipality of Anchorage Standard Specifications (M.A.S.S.)

DIVISION 20.00 STANDARD CONSTRUCTION SPECIFICATIONS FOR EARTHWORK

SECTION 20.01 GENERAL

Revisions to Article 1.6, M.A.S.S., Subsurface Investigations

Article 3.1 Subsurface Investigation

Refer to M.A.S.S. Section 20.01, GENERAL, Article 1.6 Subsurface Investigation; add the following:

A preliminary subsurface investigation was performed for the 30- and 48-inch transmission main. The report, giving the results of subsurface investigation, may be examined at the Municipality of Anchorage's office located at 3000 Arctic Boulevard, Anchorage, Alaska.

SECTION 20.07 TRENCH EXCAVATION AND BACKFILL

Revisions to Article 7.2, M.A.S.S., Trench Excavation and Backfill - Description.

Article 3.2 Trench Width

The maximum allowable width of the trench measured at the top of the pipe is shown on the Plans and is related to the strength of the pipe materials. Where the trench exceeds the allowable width shown on the Plans, the Contractor shall provide, at his expense, a higher strength pipe or a superior class of bedding. The revised pipe design shall be submitted to and approved by the Engineer prior to the installation of the pipe. In lieu of this requirement, the Contractor may substitute concrete for pipe zone material between the flowline and the centerline of the pipe.

Article 3.3 Riprap

Rock riprap shall be hard, durable, angular quarry rock having a specific gravity of not less than 2.65. All material shall be clean and free of deleterious impurities including earth, clay, refuse, and adherent coating. The least dimension of any one piece shall not

be less than one-third the greatest dimension. Submit samples of the rock proposed for approval prior to delivery to the jobsite.

Rock riprap shall be reasonably well graded and shall conform to the following gradation requirements:

Weight of Rock (lb.)	Percent Larger Than by Weight
200	0 - 5
75	40 - 80
5	80 - 100

Place rock riprap carefully so that the surface of the rock is flush with the surface of the original ground. Average depth of riprap shall be not less than 24 inches. Intermix the sizes of riprap material to provide uniform gradation between small and large material.

SECTION 20.19 REMOVE EXISTING PAVEMENT

Revisions to Article 19.1, General

Article 3.4 Pavement Removal

Removal of existing pavement shall be in conformance with the permitting agencies.

DIVISION 60.00 STANDARD CONSTRUCTION SPECIFICATIONS FOR WATER SYSTEMS

SECTION 60.01 GENERAL

Article 3.5 Scope of Work

In general, this project comprises the construction of approximately 41,000 linear feet of 48-inch pressure pipe, 1,200 linear feet of 30-inch pressure pipe, undercrossing of Ship Creek, and numerous valve installations.

Article 3.6 Applicable Standards

The applicable standards referenced in Municipality of Anchorage Standard Specifications (M.A.S.S.), Section 60.01, Article 1.2, shall apply. In addition, the most recent revision of the following AWWA Standards shall apply for straight-seam welded steel pipe only:

C200 Steel Water Pipe 6 Inches and Larger

C203 Coal-Tar Protective Coatings and Linings for Steel Water Pipelines

C205 Cement-Mortar Protective Lining and Coating for Steel Water Pipe

C206 Field Welding of Steel Water Pipe

C207 Steel Pipe Flanges for Waterworks Service

C208 Dimensions for Steel Water Pipe Fittings

The following Steel Structures Painting Council (SSPC) Specifications are used:

SP3 Power Tool Cleaning
SP5 White Metal Blast Cleaning

Article 3.7 Alternative Types of Pipe

With the exception of those areas where a particular type of pipe is required, the Contractor may furnish any one of the following types of pipe specified for the pressure pipe:

1. Ductile Iron Pipe

2. Welded Steel Pipe

3. Concrete Cylinder Pipe

Contractor may bid on any of the alternatives and shall so indicate his choice in the bid. Prices bid will include full payment of all specials or modifications of details necessary or required to utilize the pipeline material chosen.

The same pipe material shall be used for all individual pipe diameters. In specific locations shown on the plans, or as specified herein, a particular type or types of pipe will be required. This note does not imply that the remainder of the pipe should be that particular type or types of pipe.

Article 3.8 Bid Proposal Submittals[1]

"The bidders shall submit, with his bid proposal, the following information for the pipe he proposes to furnish for this project.

[1] Municipality of Anchorage - 1980 Water Utility Improvements, 36-Inch Transmission Main, Diversion Dam to Water Treatment Plant, Specifications.

a. Type of pipe.

b. Class(es) and minimum metal wall thickness(es) of pipe to be furnished.

c. Type(s) of joints to be furnished.

d. Nominal laying lengths of pipe to be furnished.

e. Type(s) of interior lining and exterior coatings proposed.

f. Method proposed for joint and thrust restraint.

If the bidder fails to submit the above information with the proposal the bid shall be considered non-responsive and shall be disqualified."

SECTION 60.02 FURNISH AND INSTALL PIPE

Revisions to Article 2.2, M.A.S.S., Materials.

Article 3.9 Ductile Iron Pipe and Fittings

a. Pipe

Ductile iron pipe shall conform to AWWA Standards C-150 and C-151, with cement mortar lining conforming to AWWA Standard C-104. Class 52 pipe shall be used for all pipe between three (3) inches and twenty-four (24) inches in diameter. Class 50 shall be used for all pipe larger than twenty-four (24) inches. Inspection and certification statements shall be furnished.

b. Joints and Connections

General: Ductile iron fittings shall have push-on, mechanical, or flanged joints, unless otherwise indicated on the drawings or called for in the Specifications, conforming to AWWA Standards C-110 and C-111.

The following submittals are required:

1. Affidavit of compliance.

2. Design calculations, including thrust restraints.

3. Tabulated layout schedule.

4. Details of specials and fittings.

Push-on-Joints: Ductile iron pipe joints shall be push-on rubber gasket type, unless otherwise indicated on the drawings, conforming to AWWA C-151. Furnish joint lubricant in the amount and as recommended by the pipe manufacturer. Furnish sufficient feeler gauges of the proper size, type, and shape to check the rubber gaskets during installation of the pipe.

Mechanical Joint Fittings: Mechanical joint ductile iron fittings shall conform to AWWA C-110 and shall be of a class at least equal to that of the adjacent pipe. Cement mortar lining for fittings shall be the same thickness specified for the pipe.

Flanged Joint Fittings: Flanged fittings shall conform to AWWA Standard C-110 125 pound rated at 250 psi working pressure and, in all cases, be compatible with the specified equipment to be installed. Flanged fittings shall be cement mortar lined to the same thickness specified for the pipe.

Gasket material for flanged joints shall be cloth-inserted sheet rubber gaskets conforming to AWWA Standard C-207, 1/8-inch thick. Gasket material shall be free from corrosive alkali or acid ingredients.

Bolts shall have rough square heads and hexagonal nuts made to American Standard dimensions and shall be chamfered and trimmed. Short lengths of flanged pipe, where shown, shall be the screw-on flange type, factory assembled only.

Coatings for Mechanical Couplings and Flanges: Flexible couplings, flanged coupling adapters, and flanges shall be lined with two (2) coats of coal tar epoxy to a minimum dry film thickness of 16 mils. Exterior surfaces shall be coated with coal tar primer. Coatings shall

be applied to surfaces which have been sand-blasted to white metal in accordance with SSPC-SP5. Minimum sleeve length shall be 7 inches.

c. Polyethylene Encasement

Where shown on the Plans, buried ductile iron pipe shall be encased with one sheet of 8-mil-minimum-thick polyethylene to form a continuous and all-encompassing layer of polyethylene between ductile iron and the surrounding earth or backfill material. All polyethylene shall be secured in place with 10-mil polyethylene tape. The polyethylene encasement shall be held back a distance of 2 feet on each side of buried couplings.

d. Joint Tie Rods

Tie rods shall be threaded black iron or mild steel and shall be located symmetrically around the perimeter of the pipe, using anchoring lugs of standard manufacture for attachment where required. Tie rods shall be 3/4-inch diameter on pipes twenty-four (24) inches and less and one (1) inch diameter on pipes thirty (30) inches and over.

There shall be two (2) rods on pipes twelve (12) inches and less in diameter. There shall be four (4) rods on pipes fourteen (14) to sixteen (16) inches in diameter. There shall be six (6) rods on pipe eighteen (18) to twenty (20) inches in diameter and on pipe thirty (30) inches in diameter. There shall be eight (8) rods on pipes twenty-two to thirty-six (36) inches in diameter. There shall be twelve (12) rods on pipes forty-two (42) inches in diameter, and fourteen (14) rods on pipes forty-eight (48) inches in diameter.

The tie rod coating shall be Koppers Bitumastic 505, manufactured by Koppers Company, Inc. The coating shall be applied to a total thickness of 18 mils in two coats and shall be applied in conformance with the manufacturer's recommendations.

e. Concrete for Thrust Blocking

Concrete for thrust blocking shall be 2,500 psi and shall be in accordance with M.A.S.S. Division 30, Concrete.

Article 3.10 Welded Steel Pipe and Fittings

a. Pipe

General: An affidavit by the pipe manufacturer shall be furnished to the Engineer showing compliance to the required Specifications. Data on all tests performed by the manufacturer or his materials suppliers shall be provided upon request of the Engineer.

Before starting pipe fabrication, the Contractor shall furnish shop drawings in quadruplicate which shall show details of standard pipe sections, fittings, and special pieces. Dimensions, plate size, coating and lining, quantities of pipe by size and lengths, and other pertinent information shall be shown. The drawings shall include a laying schedule to indicate the locations where standard lengths and short lengths of pipe, fittings, and special pieces are to be placed. It is expected that positioning of fittings and making transitions to other types of pipe will require field cutting of closure pieces to be furnished for this purpose. Each pipe and fitting shall be marked on the outside to indicate the class of pipe and location. All marking shall be coded to the laying schedule.

Pipe shall be the size and class shown on the Plans and shall be fabricated to meet the requirements of Section 3 of AWWA C200. Minimum wall thickness shall be 10 gauge. The design stress in the pipe wall shall not exceed 50 percent of the minimum yield point of the steel, or 16,500 psi, whichever is less.

At the Contractor's option, steel pipe shall be coal tar enamel lined and coated or cement mortar lined and coal tar enamel coated. Only one type of lining and coating shall be used for each pipe diameter. Cement mortar linings shall conform to AWWA C205, and coal tar enamel linings and coatings shall conform to AWWA C203, and these Specifications.

In addition to the inspection and test procedures provided for in AWWA C200, the Engineer may elect to perform radiographic inspection of welds during fabrication of the pipe. The pipe manufacturer shall cooperate and provide reasonable assistance to facilitate such inspection.

Tests for compliance with the Specification will be made and paid for by the Owner. The Contractor shall pay for retests performed by the Owner and shall repair all faulty welds at no cost to the Owner.

Nominal lengths of pipe sections shall be 40 feet maximum where the pipelines are on straight alignments. Short lengths shall be provided as necessary to meet the alignment and grade requirements on curves or other conditions shown on the Plans. It shall be the Contractor's responsibility to determine the length and number of short lengths to satisfy alignment and grade requirements.

Coal Tar Coating and Lining: The exterior coating shall be coal tar enamel applied in accordance with AWWA Standard C203, Section A1.5, latest revision except as specified herein. The exterior coating shall consist of the following:

a. Primer
b. Coal tar enamel (3/32 in. + 1/32 in.)
c. Fibrous glass mat
d. Coal tar enamel (1/32 in. min.)
e. Bonded asbestos felt
f. Whitewash

The coal tar lining shall conform to the requirements of AWWA C203 and shall consist of primer and coal tar enamel applied to a minimum thickness of 3/32 inch; the allowable variations in thickness shall not exceed plus or minus 1/32 inch.

Coal tar primer shall conform to the requirements of AWWA C203, Section 2.4.2, and shall be a product of the manufacturer which produces the enamel.

Coal tar enamel shall conform to the requirements of AWWA Standard C203, Section 2.5, Type 1.

Fibrous glass mat shall conform to the requirements of AWWA C203, Section A2.1.

Asbestos felt shall conform to the requirements of AWWA C203, Section 2.10.

Whitewash shall conform to the requirements of AWWA C203, Section 2.11.

All coating materials used in the work shall be furnished in the original sealed containers and clearly marked with contents, Specification number, date of manufacture, and manufacturer's trade name. Materials shall be new and shall be used within 12 months of the date of manufacture.

At the request of the Engineer, the Contractor shall furnish samples of materials and a certified copy of test results made by the coating manufacturer in accordance with Section 2.6 of AWWA C203. Test procedures shall be in accordance with AWWA C203, Section 2.8, except that penetration tests shall be made on an area of the prepared sample from which approximately 1/32 inch of the exposed surface has been removed by cutting or scraping.

b. Joints and Connections

Pipe Ends: Except where shop-welded, field-welded, or mechanically coupled joints are required, pipe ends shall be bell and spigot with rubber gasket. Rubber gaskets shall be furnished with the pipe and stored in a cool, dry, and shaded place in sealed containers. Furnish joint lubricant in the amount recommended by the pipe manufacturer for making the bell and spigot joints.

Pipe ends for 200 psi and greater pipe shall be preformed Carnegie spigots and bells except where shop-welded, field-welded, or mechanical coupled joints are required.

Where field-welded joints are required, the pipe shall have lap joints for field welding or plain ends for jointing with field-welded butt straps. Butt strap thickness shall not be less than that of the pipe wall.

Where a "Carnegie" type joint is used, field welding of the bell and spigot joints is allowed provided that the gasket is left out for the inside welds or a 1/4-inch-diameter steel filler rod is placed in the outside joint space between the bell and spigot rings for outside welds.

Pipe with plain ends shall be furnished where jointing is with mechanical couplings or flanged coupling adapters. The hold-back on plain end pipe shall be at least 8 inches long and be protected with a shop-applied two-coat, 16-mil dry film total thickness of coal tar epoxy, Porter Tarset C200, Amercoat No. 78, or equal.

All exposed steel surfaces at pipe ends shall be cleaned to white metal in accordance with Steel Structures Painting Council Specifications SP 5. Coal tar epoxy shall then be applied to clean and dry surfaces in strict accordance with manufacturer's instructions. Coal tar epoxy shall be Porter Tarset C200, Amercoat No. 78, or equal. The coating shall be applied in two uniform coats to a minimum dry film thickness of 16 mils. Necessary precautions of cleaning and curing time between coats shall be followed to assure bonding between subsequent coats. Delamination will not be permitted. The coal tar epoxy shall overlap the shop-applied coal tar coating on interior and exterior surfaces. The epoxy shall not overlap the cement mortar lining at ends of bell and spigot joints.

Fittings: Fittings shall be fabricated in accordance with AWWA C200 and of the same type of steel as the adjacent pipe and have ends compatible with the adjacent pipe. Lining and coating of fittings shall conform to that for the pipe.

Dimensions of fittings shall conform to Table 2 of the AWWA C208, except that elbow radius may be 2-1/2 nominal pipe inside diameter in lieu of radii developed by fixed tangents. Minimum steel thickness shall be 3/16 inch.

Flanged Joints: Flanges for pipe shall be steel hub flanges, Class D, conforming to AWWA C207. AWWA C207, Table 1, Class D flanges may be used provided a 6-inch-long minimum 7-gauge cylinder is welded to the flange prior to flange face machining.

Nuts and bolts shall be of the sizes and quantities recommended in AWWA C207. Gaskets for flanged joints shall be cloth-inserted sheet rubber gaskets in one piece conforming to AWWA C207 and ANSI B16.21, 1/16-inch thick. The gasket shall be full cut, with holes to pass bolts. Gasket material shall be free from corrosive alkali or acid ingredients. Segmented straight-joint or interlocking gaskets will not be accepted.

Mechanical Couplings: Flexible couplings and flanged coupling adapters shall be as manufactured by Smith-Blair, Christy Metal Products, Dresser Industries, or equal, and of the proper size to joint the pipes or fittings being coupled. Insulating couplings shall be Dresser Style 39, Smith-Blair Style 416, or equal.

Coatings for Mechanical Couplings and Flanges: Coatings for mechanical couplings and flanges shall be in accordance with Article 3.9.b.

Diapers: Diaper material shall be at least 12-ounce duck and shall be as approved by the Engineer.

Bond Straps: Bond straps shall be 10-gauge mild steel strips, 3/4-inch wide as shown. Straps shall be shop-welded to the ends of the pipe in a manner which will not obstruct jointing the pipe. The other end of the straps shall be field-welded after the joint is made. Bond straps shall be furnished for similar installation on closure sections, special fittings, and flexible couplings.

Bond Bar and Bond Lug Protection: The bond bar and bond lug coating shall be Koppers Bitumastic 505, manufactured by Koppers Company, Inc. The coating shall be applied to a total thickness of 18 mils in two coats and shall be applied in conformance with the manufacturer's recommendations.

Concrete for Thrust Blocking: Concrete for thrust blocking shall be 2,500 psi and shall be in accordance with M.A.S.S., Division 30, Concrete.

Article 3.11 Concrete Cylinder Pipe and Fittings

a. Pipe

An affidavit by the pipe manufacturer shall be furnished to the Engineer showing compliance to the required Specifications. Data on all tests performed by the manufacturer or his materials suppliers shall be provided upon request of the Engineer.

Before starting pipe fabrication, the Contractor shall furnish shop drawings in quadruplicate which shall show details of standard pipe sections, fittings, and special pieces. Dimensions, plate size, coating and lining, quantities of pipe by size and lengths, and other pertinent information shall be shown. The drawings shall include a laying schedule to indicate the locations where standard lengths and short lengths of pipe, fittings, and special pieces are to be placed. It is expected that positioning of fittings and making transitions to other types of pipe will require field cutting of closure pieces to be furnished for this purpose. Each pipe and fitting shall be marked on the outside to indicate the class of pipe and location. All marking shall be coded to the laying schedule.

Concrete cylinder pipe shall conform to AWWA C303, except that Section 3.3 shall be modified to require that the total cross sectional steel area of the bell ring plus the rod reinforcement over the bell ring exceed the circumferential steel area in a like length of the barrel area by one-third. Pipe shall be designed for

internal pressure in accordance with Appendix A of AWWA C303, but the minimum steel cylinder thickness shall be 12 gauge.

Concrete cylinder pipe shall be the class and size as shown on the Plans. Cement shall be Type V.

In addition to the inspection and test procedures provided for in AWWA C303, the Engineer may elect to perform radiographic inspection of welds during fabrication of the pipe. The pipe manufacturer shall cooperate and provide reasonable assistance to facilitate such inspection.

Nominal lengths of pipe sections shall be 40 feet maximum where the pipelines are on straight alignments. Short lengths shall be provided as necessary to meet the alignment and grade requirements on curves or other conditions shown on the Plans. It shall be the Contractor's responsibility to determine the length and number of short lengths to satisfy alignment and grade requirements.

b. Joints and Connections

Joints, fittings, mechanical couplings, coatings for coupling and flanges, and diapers shall be in accordance with article, WELDED STEEL PIPE AND FITTINGS.

c. Concrete for Thrust Blocking

Concrete for thrust blocking shall be 2,500 psi and shall be in accordance with M.A.S.S., Division 30, CONCRETE.

Revisions to Article 2.3, M.A.S.S., CONSTRUCTION

Article 3.12 Material Delivery

a. Distribution: Distribute material on the job no faster than it can be used to good advantage. In general, no more than 1 week's supply of material shall be distributed in advance of laying, unless otherwise approved.

During transportation, storage, and placing, pipe and materials shall be protected, supported, and handled in a manner to prevent damage to the materials, especially linings and coatings. Only implements and equipment suitable for proper and safe handling of the materials shall be used. Fabric slings shall be used to lift pipe and fittings, not chains or cables.

The Contractor shall, upon delivery and prior to unloading, inspect each pipe shipment and check total quantities against the delivery slip, recording any damaged or missing items. If an item is damaged during shipment or unloading, it shall be set aside and clearly marked so that repair may be effected prior to incorporating those items into the work. If an item delivered does not meet the minimum requirements established for the project, or if repairs cannot be effected so as to meet those standards, that item shall be removed from the jobsite and replaced with a like kind.

Precautions shall be taken to avoid damage to the delivered items regardless of the methods used in loading or unloading. All work shall be performed in a safe manner from the delivery to the construction site. Handle the pipe so as to prevent injury to the coating and lining. Place no pipe or other material inside any other pipe at any time after it has been coated.

Store all rubber gaskets in a cool, well-ventilated place, and do not expose to the direct rays of the sun. Do not allow contact with oils, fuels, or petroleum solvents.

b. Pipe Handling and Storage: Pipe handling shall be controlled so as to guard against damage due to improper cushioning, pipe collision, and dragging or rolling over rough, rocky ground. Stockpiling shall be accomplished so that the bottom layer of pipe shall be placed on a flat base and adequately blocked to prevent shifting. Bell and spigot ends shall alternate between adjacent pipe sections and not be stockpiled in more than two layers. All pipe shall be supported by the pipe barrel so that the joint ends are free from load concentrations.

c. Markings: Each length of straight pipe and each special shall be clearly marked as follows:

Straight Pipe: Pressure class and location of pipe with reference to layout drawings.

Specials: Location in alignment, special identification marks with reference to layout drawings, top and bottom of pipe.

d. Internal Bracing for Welded Steel and Concrete Cylinder Pipe: Bracing consisting of crossed struts shall be installed at the point of pipe manufacture to support the pipe wall at the four quadrant points. The maximum spacing along the pipe shall be 1 foot inside each end and at the one-third points for each 40-foot section of pipe, with a minimum of four struts per pipe length. The struts shall be installed with pads and wedges in such a manner that the pipe lining will not be damaged. The struts shall remain in place until the pipe has been backfilled to the top of pipe zone.

Article 3.13 Installation

a. Cleaning Pipe and Fittings: Remove all lumps and blisters, and excess coal tar coating from the bell and spigot ends of each pipe. Wire brush the outside of the spigot and the inside of the bell and wipe clean and free from foreign materials before the pipe is laid.

Wipe the ends of mechanical joint pipe and fittings and of rubber gasket joint pipe and fittings clean of all dirt, grease, and foreign matter.

Do not allow foreign material to enter the pipe while it is being placed in the trench.

b. Coal Tar Coating and Lining for Welded Steel Pipe: All surfaces to be coated shall be cleaned of all oil, grease, and wax by wiping and scrubbing the surface with clean cloths or brushes saturated with solvent. A second cleaning shall be performed with clean solvent and clean cloths or brushes to avoid leaving a

thin film of oil, wax, or grease on the surface. Solvents used for cleaning shall be compatible with coal tar coating materials and shall comply with state and local requirements for air pollution. All weld spatter shall be removed and rough welds shall be ground to remove surface irregularities. All surfaces to be coated shall then be blast cleaned to white metal using hard sharp sand or steel grit to produce a surface with a gray-white uniform metallic color. The blasting material shall pass a No. 16 U.S. standard screen, and at least 85 percent shall be retained on a No. 50 U.S. standard screen. Adequate air separators shall be used to effectively remove all oil and free moisture from sandblast air. After cleaning, surfaces shall be protected from any contamination, including oil, grease, dirt, and rust, until the final coating has been applied. Surface upon which rust forms or becomes contaminated in the interval between cleaning and coating or between coats shall be recleaned and sandblasted as directed by the Engineer.

Coal tar primer shall be applied to properly cleaned surfaces immediately following blasting and cleaning operations. Application of primer shall be in accordance with AWWA C203, Section 2.13.2. Primer shall be applied to a uniform thickness without visible thin spots. Application of coal tar enamel shall conform to the requirements of AWWA C203, Sections 2.13.3, 2.13.4, 2.13.5, 2.13.7, and 2.13.8 except Section 2.13.8.7 shall not apply. Heating kettles shall be thermostatically controlled or equipped with recording thermometers furnished by the Contractor. Hold-back of the coating at pipe ends shall be in accordance with AWWA C203, Section 2.13.10. Enamel when applied to the pipe shall have a penetration of not less than seven (7) at 77 degrees F when tested as specified in ASTM D 5-65. Bond of the coating after application to steel pipe shall be equivalent to that required for the coating of laboratory test plates as specified in AWWA C203, Section 2.8.

Electrical inspection of all coated pipe and specials shall be conducted by the Contractor in accordance with AWWA C203, Section 2.13.12,

immediately prior to lowering the pipe into the trench. Inspection and electrical equipment shall be furnished at the Contractor's expense.

c. Standard Joint Protection for Concrete Cylinder Pipe: After the pipe section has been laid, thoroughly clean the space between bell and spigot and fill the annular space with a Portland cement grout, composed of one part cement to one part fine aggregate with sufficient water to form a mixture the consistency of thick cream. Wrap the joint with a strip of woven fabric and band around the pipe at each side of the joint. The fabric shall be of such a weave as to allow the escape of air and excess water but prevent escape of mortar. Pour the joint full of grout through a space in the woven fabric slightly to one side of the top. Rod the grout with a beaded wire or chain as it is poured into the joint. Immediately after completing the exterior joint, place damp earth over and around the joint to prevent rapid drying. Styrofoam "diapers" with integral banding may be used subject to prior approval by the Engineer of the design and method of use.

After the backfill has been placed at least to the top of the pipe, dampen the inside joint space with water or a neat cement slurry and fill by compacting into the joint a Portland cement mortar composed of one part cement to not more than two parts fine aggregate with only sufficient water to form a stiff mix. The finished surface shall be a dense troweled surface, free of projections or depressions.

d. Laying Pipe: Carefully inspect pipe and materials before laying and discard all damaged or defective materials. After the pipe has been lowered into the trench, assemble couplings in accordance with printed instructions of the manufacturer for the type of coupling used. Special attention shall be given to proper lubrication of the joint and installation of the gasket. Gaskets in completed joints shall be checked with a feeler gauge, furnished by the pipe manufacturer, to verify proper seating. When the coupling used is not self-positioning and does not establish the

separation of the ends of the pipe automatically, separate the ends of the pipe as recommended by the pipe manufacturer.

Protect the pipe to prevent entrance of foreign material before the pipe is placed in the new line. At all times when laying is not in progress, close open ends of the pipe with a watertight plug or other approved means so no trench water or foreign material can enter the pipe. Take all precautions necessary to prevent the pipe from floating.

e. Thrust Blocking: Provide thrust blocking as shown on the Drawings. Place thrust blocking between undisturbed ground and the fitting to be anchored. Place the blocking so that the pipe and fitting joints will be accessible for repairs, unless otherwise directed.

In lieu of thrust blocking horizontal deflections, restraint of the joints may be used. Calculations of the lengths of required restrained sections of pipe shall be as recommended by the pipe supplier and approved by the Engineer.

f. Trench Excavation and Backfill: Trench excavation and backfill, preparation of trench, and backfill within the pipe zone shall be in accordance with Division 20.00, EARTHWORK, M.A.S.S.

Article 3.14 Alignment and Grade

Angular deflections at each joint shall be kept to a maximum of 75 percent of the manufacturer's recommendation. Shorter lengths of pipe shall be used in areas where greater flexibility is required to maintain line and grade.

Article 3.15 Jointing of Metal Pipe

a. Cutting Pipe: Cut pipe for inserting valves, fittings, or closure pieces in a neat and workmanlike manner without damaging the pipe or lining and so as to leave a smooth end at right angles to the axis of the pipe.

Cut pipe with a milling-type cutter or saw. Do not flame cut. Dress cut ends of pipe to remove sharp edges or projections. Dress cut ends of push-on joint pipe by beveling, as recommended by the manufacturer.

b. Flanged Joints: Make up flanged joints using the specified bolts, nuts, and gaskets. Before tightening the nuts, the two faces of the flanges shall be parallel and firmly against the gasket. Tighten all nuts progressively a little at a time. Do not overstress bolts to compensate for poor alignment of the flanges.

c. Bell and Spigot with Rubber Gasket Joints: Assemble joint in accordance with manufacturer's instructions. Check joint with a feeler gauge to assure proper seating of the gasket. All joints shall be bonded and coated. Joints in the pipe with cement mortar lining shall be protected on the inside as specified in section, CONCRETE CYLINDER PIPE.

d. Field-welded Joints: Pipe with field-welded joints shall be installed in accordance with AWWA C206.

Interior surfaces of field-welded joints shall be cleaned by power wire brushing in accordance with SSPC-SP3 and scrubbed with solvents in accordance with SSPC-SP1. Cleaned surfaces shall then be lined with two coats of coal tar epoxy, Porter Tarset C200, Amercoat No. 78, or equal. Field joints of concrete-lined pipe shall be lined and coated in accordance with AWWA C205, Appendix A.

Exterior surfaces of field-welded joints shall be cleaned by sandblasting to white metal in accordance with SSPC-SP5 and coated with coal tar tape and primer.

e. Installation of Bond Bars: Bond bars for welded steel pipe shall be installed as indicated after the joint is made and the joint protection has been applied. The weld shall be made as shown. Be careful to avoid heat damage to the pipe coating and wrapping during welding. Damage to coating shall be repaired. Do not weld directly to pipe unless pipe interior coating can be repaired.

Bond bar welds to mechanical coupling middle rings shall made before the coupling is installed. Repair the corrosion protection of the interior of the middle ring after welding.

After welding, the bond bar shall be wire brushed to remove dirt, rust, and weld splatter. Apply hot coal-tar enamel coating as specified for mechanical couplings.

Revisions to Article 2.4, M.A.S.S., Testing

Article 3.16 Flushing

Before sterilizing, flush all foreign matter from the pipeline. Provide hoses, temporary pipes, ditches, etc., as required to dispose of flushing water without damage to adjacent properties. Flushing velocities shall be at least 2.5 fps. For large-diameter pipe where it is impractical or impossible to flush the pipe at 2.5-fps velocity, clean the pipeline in place from the inside by brushing and sweeping, then flush the line at a lower velocity.

The requirement that all flushing of newly constructed mains will be done between the hours of 1:00 a.m. and 6:00 a.m. is hereby waived.

Water used for flushing and disinfection shall be disposed of in an approved manner. Disposal of water into stream channels shall meet the requirements of the U.S. Army, State Department of Fish and Game, and Eklutna, Inc.

Article 3.17 Hydrostatic Testing

Make pressure and leakage tests on all pipe. Tests shall be made on sections not to exceed 5,500 feet long or the distance between isolation valves, whichever is less. Furnish all necessary equipment and material, make all taps, and furnish all closure pieces in the pipe as required. The Engineer shall monitor and approve a satisfactory test.

Conduct tests after the pipe and trench, excluding valves and fittings, have been completely backfilled. Where any section of pipe is provided with concrete thrust blocking, do not conduct pressure test until at least 5 days have elapsed after the concrete thrust blocking was installed. The test pressure

shall be as shown on the Plans, and the duration of each pressure test shall be 2 hours unless otherwise directed.

Article 3.18 Disinfection

Inject the chlorine mixture into the pipeline to be treated at the beginning of the line through a corporation stop or suitable tap in the top of the pipeline. Water from the existing system or other approved source shall be controlled so as to flow slowly into the newly laid pipeline during the application of chlorine. The rate of chlorine mixture flow shall be in such proportion to the rate of water entering the pipe that the combined mixture shall contain 40 to 50 ppm of free available chlorine. Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Use check valves if necessary.

Treated water shall be retained in the pipeline long enough to destroy all nonspore-forming bacteria. With proper flushing and the specified solution strength, 24 hours is adequate. At the end of the 24-hour period, the sterilizing mixture shall have a strength of at least 10 ppm of chlorine.

Operate all valves and other appurtenances during sterilization to assure that the sterilizing mixture is dispersed into all parts of the line, including dead ends and similar areas that otherwise may not receive the treated water.

Do not place concentrated quantities of commercial sterilizers in the line before it is filled with water.

After chlorination, flush the water from the line until the water through the line is equal chemically and bacteriologically to the permanent source of supply.

Dispose of sterilizing water in an approved manner. Do not allow sterilizing water to flow into a waterway without adequate dilution or other satisfactory method of reducing chlorine concentrations to a safe level.

Article 3.19 Radiographic Inspection

During installation of pipe with welded joints, the Engineer may elect to perform radiographic inspection of field welds. The Contractor shall fully cooperate to facilitate such inspection. If this type of inspection is used, time for setting up, operating, and removing the X-ray equipment may, at times, cause inconvenience or minor delays to the Contractor's operation. No claims for delay of the work due to radiographic inspection will be considered.

Tests for compliance with the Specifications will be made and paid for by the Owner. The Contractor shall pay for all retests performed by the Owner and shall repair all faulty welds at no cost to the Owner.

Section 60.03 Furnish and Install Valves

Revisions to Article 3.2, M.A.S.S. Materials

Article 3.20 Gate Valves

a. Gate Valves 14-Inch and Smaller: Valves shall be iron body, bronze-mounted, double-disc, parallel seat, NRS valves with O-ring seals, and shall open when the stem is rotated counterclockwise. Unless otherwise shown, valves shall have 2-inch square wrench nut. Valve ends and valve sizes shall be as shown. Valves shall conform to AWWA C500.

   Joint materials for mechanical joint or push-on joint for cast iron pipe shall conform to AWWA C111. Joint materials for joining valves to asbestos-cement pipe shall conform to AWWA C603. Joint materials for flanged joints shall consist of 1/8-inch thick, full-face, one-piece, cloth-inserted rubber gaskets conforming to Section 2 of AWWA C207. Bolts and nuts shall conform to Section 2 of AWWA C207.

b. Gate Valves Larger Than 14-Inch: Valves shall conform to AWWA C500 and shall have double-disc gates with parallel seats. The valve manufacturer shall supply an affidavit of compliance and certified drawings for the valves.

Gate discs shall be bronze. Stem seal shall be O-ring. The valves shall have 2-inch square wrench nuts or handwheel operators as shown with valve opening by a clockwise rotation.

Gears shall conform to AWWA C500. Bypass shall be as shown.

Article 3.21 Butterfly Valves

Butterfly valves shall have a minimum working pressure equal to that of the pipeline or 150 psi, whichever is greater. Valve components shall withstand the environmental conditions in contact, and provide continuous trouble-free service.

Gate valves may be substituted for butterfly valves.

Article 3.22 Valve Wrenches

Provide tee-handle wrenches, lengths as required, to extend 36 to 48 inches above ground level when operating any valve installed.

Article 3.23 Air and Vacuum Valves

Air and vacuum valves shall have cast iron bodies with stainless steel float. The cover and baffle, float stem, and guide shall be bronze, and the seat shall be Buna-N. Valves shall be suitable for use at the minimum pressures hereinbefore specified and shall be the size shown on the Plans. The valves shall be complete with backflushing and blowoff accessories. Valves shall be APCO as manufactured by American Valve and Primer Corporation; Crispin as manufactured by Multiplex Manufacturing Company; or equal.

Article 3.24 Air Release Valves

Air release valves shall have cast iron bodies with stainless steel floats. Other components shall be stainless steel or bronze. Valves shall be suitable for use at the minimum pressures hereinbefore specified and shall be the size shown on the Plans. The valves shall be complete with backflushing and blowoff accessories. Valves shall be APCO as manufactured by American Valve and Primer Corporation; Crispin as manufactured by Multiplex Manufacturing Company; or equal.

Article 3.25 Combination Air Release Valves

Combination air release valves shall have cast iron bodies and covers and stainless steel floats. Float guides, bushings, and lever pins shall be stainless steel or bronze. Valves shall be designed for use at the minimum pressure hereinbefore specified and shall be the size shown on the Plans.

Article 3.26 Bolts, Gaskets, Glands, Nuts

Bolts, gaskets, glands, nuts, and miscellaneous accessories required to install all special valves are to be furnished. Bolts for flanged connections shall be galvanized steel with American Standard regular unfinished square or hex heads. Nuts shall be galvanized steel with American Standard regular hexagonal dimensions. Full face gaskets for flanged connections shall be 1/8-inch thick rubber. Jointing materials for mechanical joints shall conform to AWWA C111.

Article 3.27 Extension Stems

Where the depth of the operating nut is more than 3 feet, operating extensions shall be provided to bring the operating nut to a point 18 inches below the surface of the ground or pavement. The extension stem shall be constructed of steel.

Extension stems shall be Mueller or equal. Stem diameters shall be 1-1/4-inch unless otherwise shown. Stem guides shall be Mueller A-26448 or equal. Guides shall be spaced such that the slenderness ratio of the stem body does not exceed 200.

Revisions to Article 3.3, M.A.S.S., Construction

Article 3.28 Construction of Valves

Before installation, carefully clean valves of all foreign material, adjust stuffing boxes, and inspect valves in open and closed positions. Install valves in accordance with the applicable portions of these Specifications. Unless otherwise indicated, install valves with the stem vertical. Mount horizontal valves in such a manner that adequate clearance is provided for operation. Installation practices shall conform to manufacturer's recommendations.

Prior to installing flanged valves, the flange faces shall be thoroughly cleaned. After cleaning, insert the gasket and tighten the nuts progressively and uniformly. If flanges leak under pressure, loosen the nuts, reseat or replace the gasket, retighten the nuts, and retest the joint. Joints must be watertight at test pressures before acceptance.

Thoroughly clean threads of screwed joints by wire brushing, swabbing, or other approved methods. Apply approved joint compound to threads prior to making joint. Joints shall be watertight at test pressures before acceptance.

For floor stands, stem guides, etc., cast-in-place during concrete placement. Threads shall be protected and shall be cleaned before the nuts are attached and tightened.

Valves will be tested at the same time that the adjacent pipeline is tested. Joints shall show no visible leakage under test. Repair joints that show signs of leakage prior to final acceptance. If there are any special parts of control systems or operators that might be damaged by the pipeline test, they shall be properly protected. The Contractor will be held responsible for any damage caused by the testing.

Sterilize valves at the same time the pipelines to which they are attached are sterilized.