TERA 40-4492

SUPPLEMENT TO

ENVIRONMENTAL REPORT SUBSURFACE TAILINGS DISPOSAL

FOR

FEDERAL-AMERICAN PARTNERS

GAS HILLS MINING DISTRICT

FREMONT COUNTY
WYOMING

FEDERAL AMERICAN PARTNERS

TO ACCOMPANY APPLICATION FOR THE RENEWAL OF
NRC SOURCE MATERIALS LICENSE SUA - 667

DOCKET NO. 40-4492
MARCH 1980

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FEDERAL-AMERICAN PARTNERS

Telephone 856-8283
Gas Hills Star Route
RIVERTON, WYOMING 82501

Dear Recipient:

This enclosed environmental report supplement, prepared by Kaiser Engineers, represents Federal-American Partners' proposal for its subsurface tailings disposal program.

This proposal represents a revision of the first submittal for subsurface disposal of millwaste in order to address the current status of operations at FAP and the more recent technology for uranium tailings disposal.

In view of the finite storage capacity in our existing tailings impoundment, we request that the review process proceed as expeditiously as possible. In this regard, we are prepared to cooperate fully toward the goal of license acquisition.

If you have any inquiries, do not hesitate to contact us.

Very truly yours,
Prepared by:

J. F. Spisak / D. Adams

John F. Spisak
Chief Metallurgist

Approved by:

K. H. Wright / D. Adams

Ken H. Wright
General Manager

JFS/ka

Enclosure

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PREPARED BY
KAISER ENGINEERS, INC.

TABLE OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

1.1 PURPOSE OF REPORT

This report presents a design for the proposed subsurface tailings disposal facilities at the Federal-American Partners (FAP) Uranium Project, Gas Hills Mining District, Fremont County, Wyoming. The report supplements the "Environmental Report for Federal-American Partners" issued in December 1979 and prepared by Kaiser Engineers, Inc. of Oakland, California.

1.2 REFERENCE REPORTS

The design is also based on the following reports by F. M. Fox and Associates, Inc. of Wheat Ridge, Colorado:

- "Baseline Geotechnical Investigation for the Subsurface Disposal of Millwaste," January 1979.
- "Request Response, August 24, 1979 U.S.N.R.C. Request."
- "Additional Geotechnical Investigation and Design for the Subsurface Disposal of Millwaste."

1.3 BACKGROUND SUMMARY

Mill tailings are presently being pumped to an existing disposal pond formed by a peripheral earth dam. This is designated as Tailings Pond No. 2 and is shown in figure 1.1. Free liquid from Tailings Pond No. 2 is collected in a decant sump and pumped to a solar evaporation pond shown in figure 1.1. Tailings Pond No. 2 is projected to be filled to its approximate maximum capacity by late 1981. This may necessitate the closure of the mill unless an alternative disposal site can be prepared.

Disposal of tailings in the Sagebrush-Tablestakes pit, shown in figure 1.1, was studied in 1979 by F. M. Fox and Associates. The study presented results of a subsurface investigation and included alternative designs for disposal of tailings. At the request of the United States Nuclear Regulatory Commission (U.S.N.R.C.), additional information was presented in a Request Response along with a subsequent report entitled "Additional Geotechnical Investigation and Design for the Subsurface Disposal of Millwaste."

Based on these documents, a pit design was developed in conformance with regulatory requirements of the U.S.N.R.C. This design is presented in the following sections. The design requires additional testing and investigation which is presently being undertaken by Dames & Moore, Inc. Salt Lake City, Utah. Their investigation consists of an evaluation of available groundwater data to provide an estimate of the groundwater surface which will occur after mining operations cease, and testing of clay soils at borrow areas in the vicinity of the FAP property to evaluate their suitability for use as a lining material in the disposal pit. The results of this study are included in the Appendix. An additional investigation will be done later to include an analysis of seepage from the pit bottom and pit wall. During this time, detailed drawings and construction specifications will be prepared and submitted for approval, along with the seepage analysis.

1.4 ALTERNATIVES STUDIED

Five alternative pit designs have been studied and are as follows.

1.4.1 Alternative No. 1 (Proposed Alternative)

The pit would be clay lined with the bottom lining located at the mined-out pit elevation and a clay lining on the sidewalls extending 10 feet above the estimated historical groundwater table. The sidewall lining would be supported by coarse tailings solids.

1.4.2 Alternative No. 2

This alternative is the same as alternative No. 1 except that the sidewall lining would be supported by an earth embankment (2 to 1 slope) instead of deposited tailings.

1.4.3 Alternative No. 3

Alternative No. 3 consists of a clay-lined pit in which the pit would be backfilled to 10 feet above the estimated historical groundwater table and then lined on the bottom only.

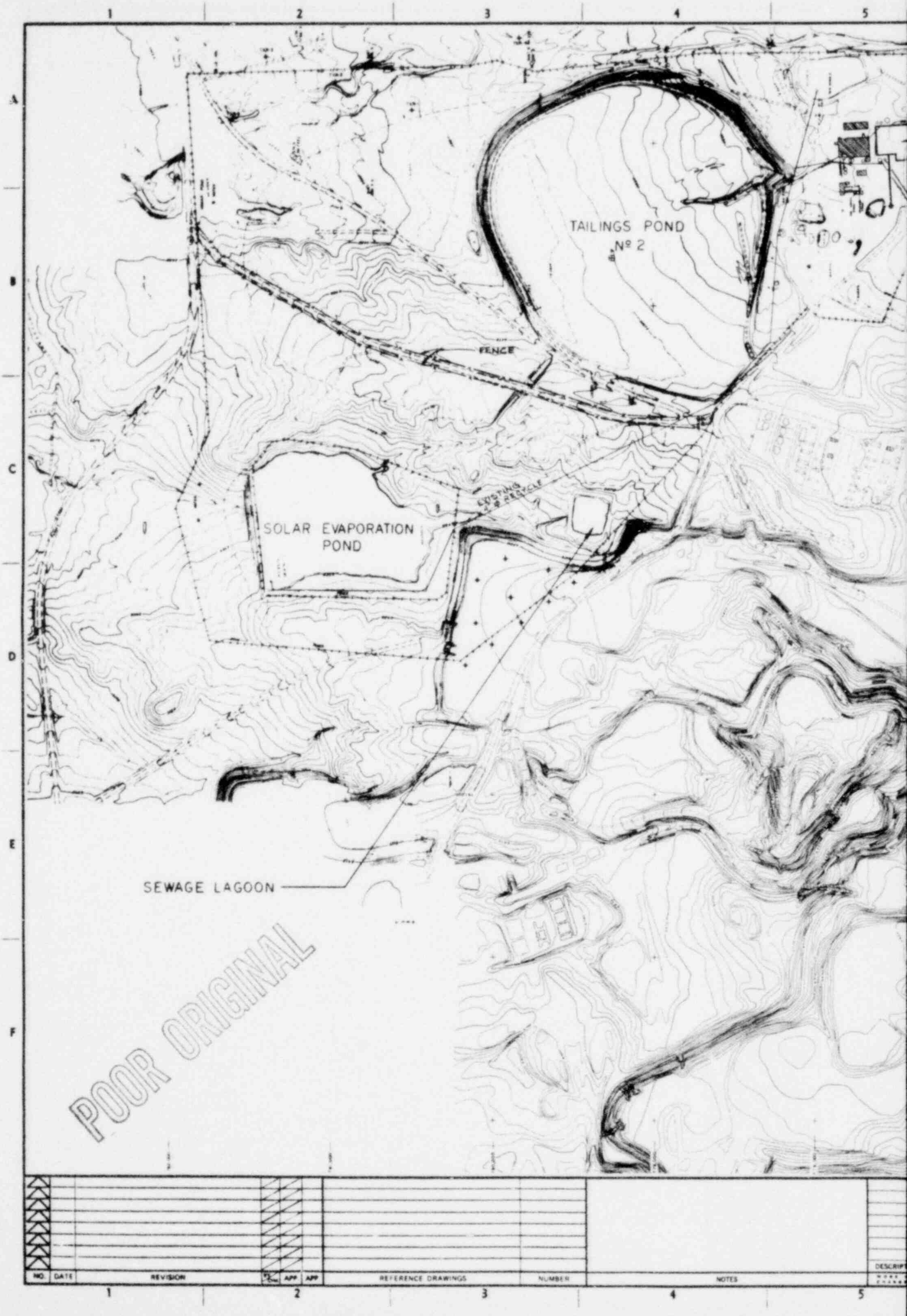
1.4.4 Alternative No. 4

Alternative No. 4 would consist of a disposal site in the vicinity of the Sagebrush-Tablestakes pit formed by excavation.

1.4.5 Alternative No. 5

Alternative No. 5 would consist of a disposal site in a mined-out pit in the Gas Hills Mining District other than the Sagebrush-Tablestakes pit.

These alternatives are described further in the following sections. A table of the comparative costs and volumes is presented in section 5.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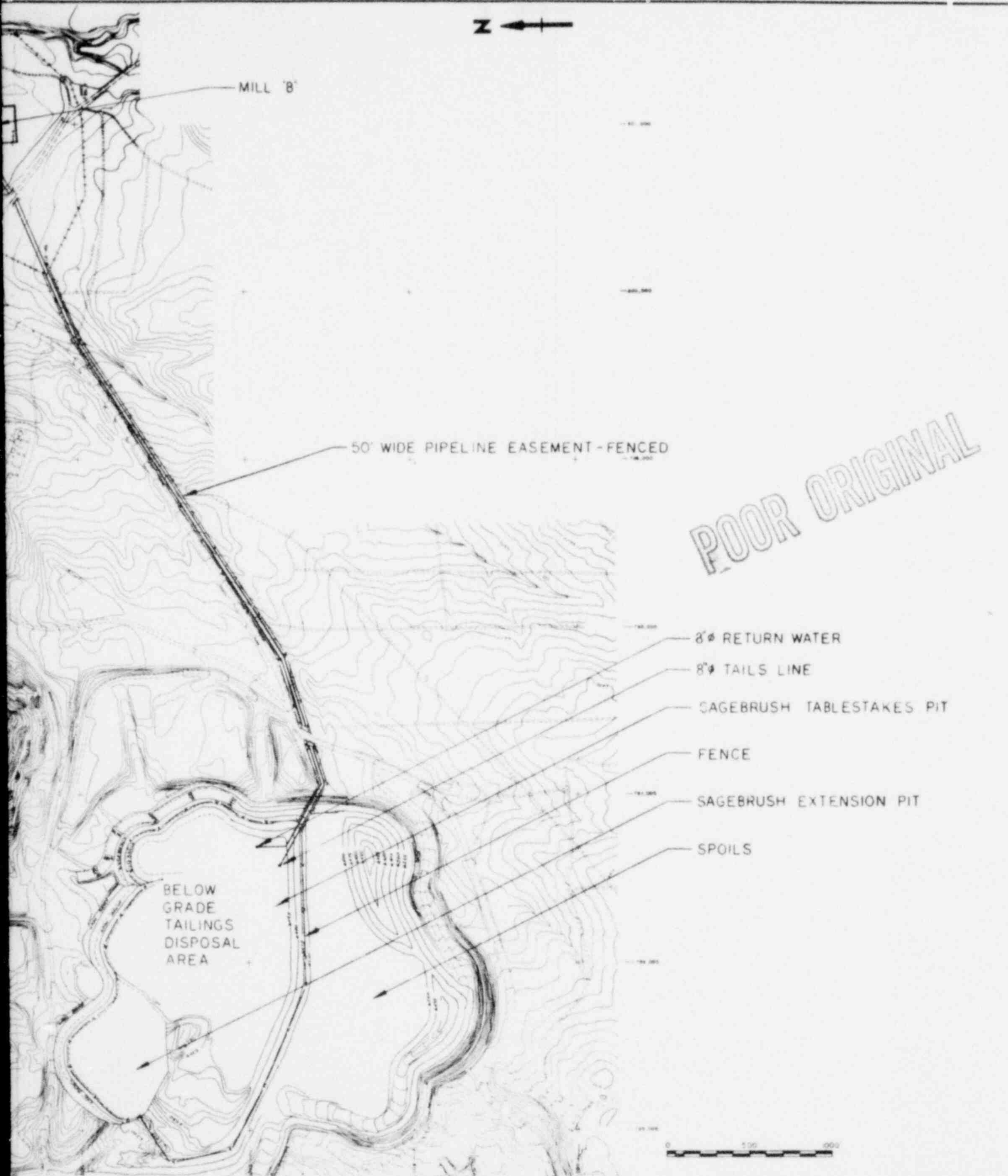

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COST ACCOUNT

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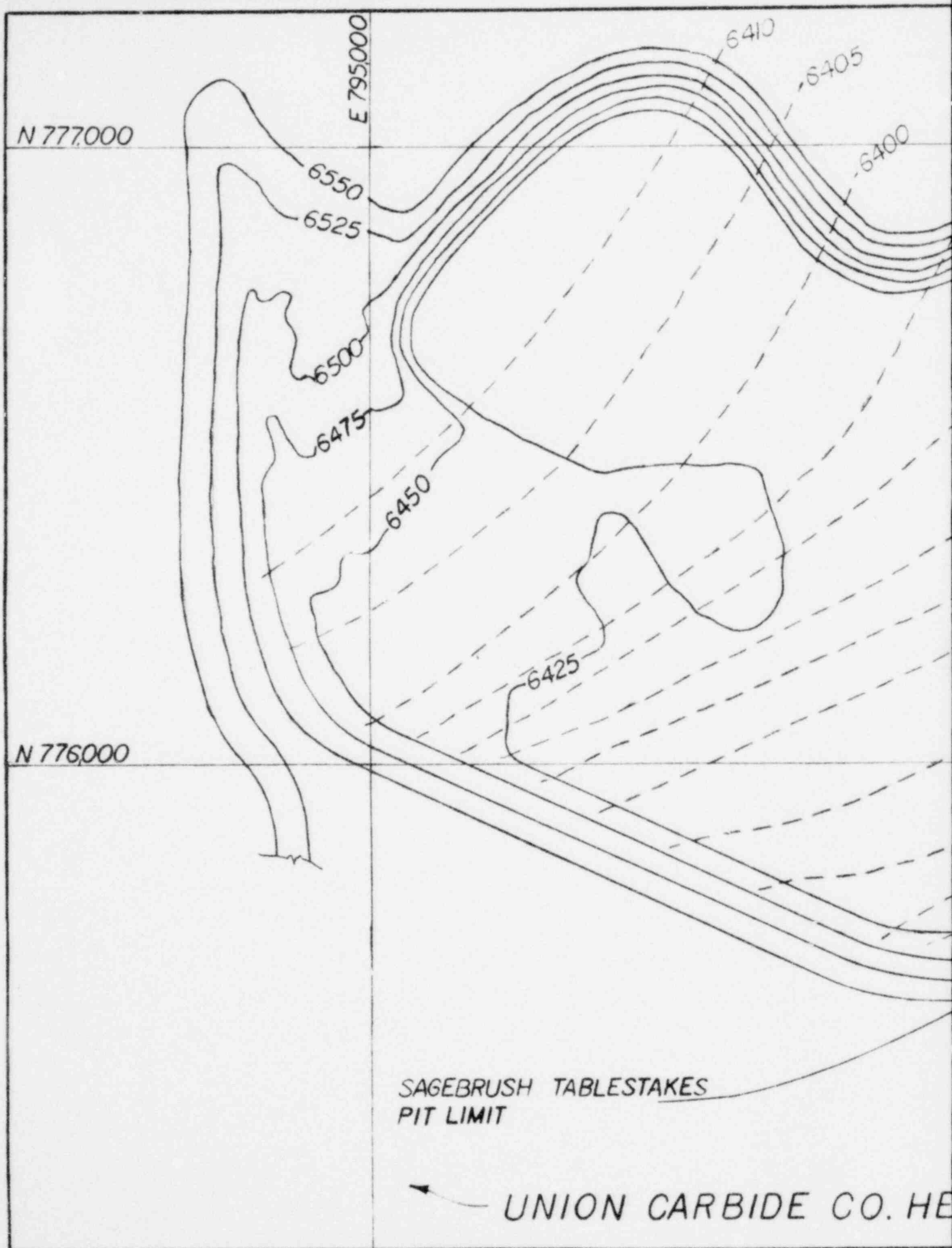
FAP URANIUM MILL-GAS HILLS, WYOMING

PLANT SITE
GENERAL ARRANGEMENT

JOB No. 79159 | FIG. 1-1 | REVISION R-0



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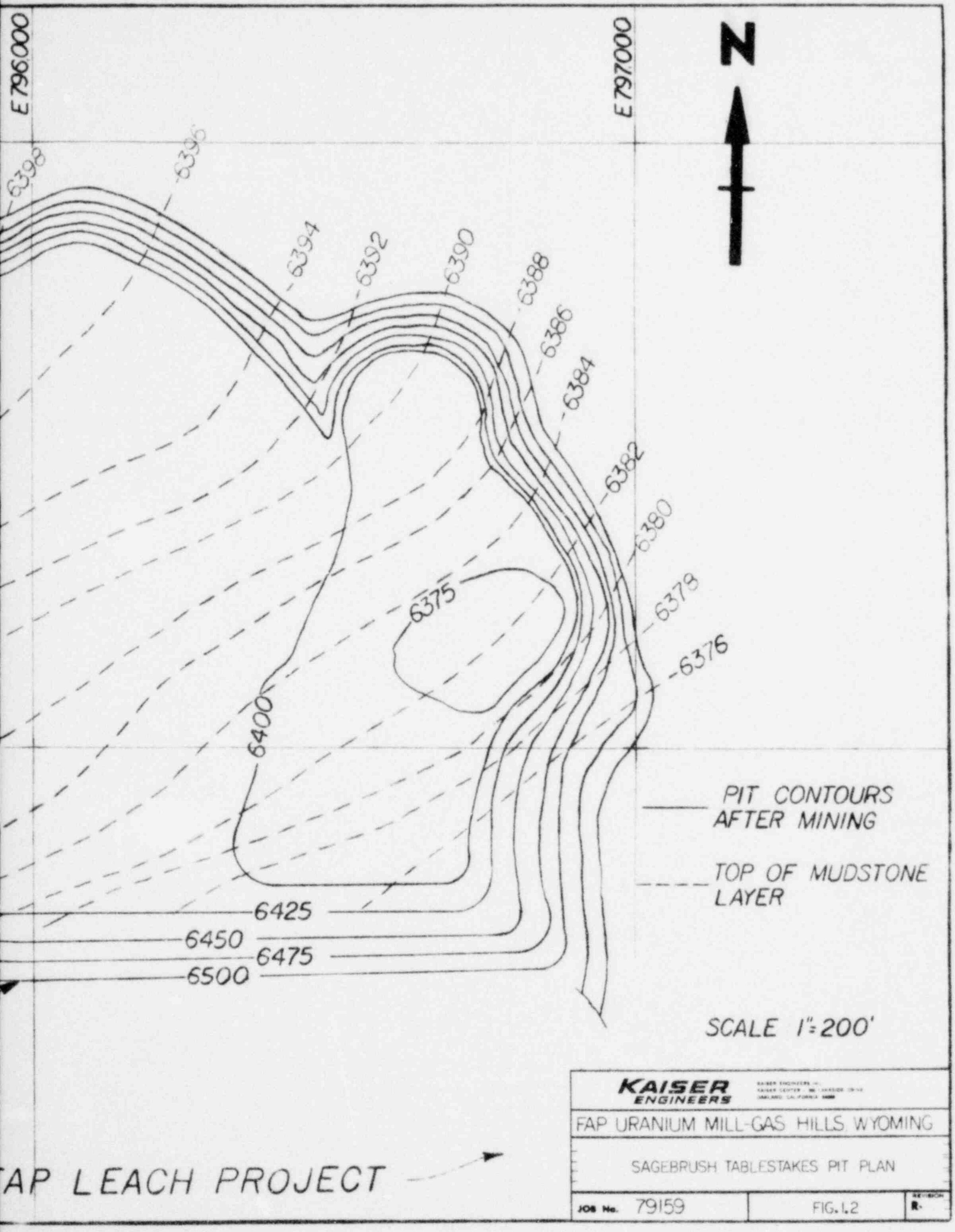


KAISER ENGINEERS

FAP URANIUM MILL-GAS HILLS, WYOMING

SAGEBRUSH TABLESTAKES PIT PLAN

JOB No. 79159 | FIG. 1.2

2. ALTERNATIVE NO. 1 (PRIMARY ALTERNATIVE)

2.1 PRESENT CONDITION OF PIT

The Sagebrush-Tablestakes pit is almost completely depleted of uranium ore. When mining operations are complete, in April 1980, the pit will have a volume of 6.5 million cubic yards and will be 175 feet deep at the eastern end. The bottom of the pit will slope to the east at a grade of approximately 3 percent. The north and east walls of the pit consist of benches cut into the sandstone bedrock with 1/2 to 1 side slopes. The horizontal benches are 20 feet wide and 80 feet apart measured vertically. The south and west walls of the pit, when finished, will consist of mine waste backfill placed to a maximum elevation of 6500 by the Union Carbide Company. The area geology, seismic conditions and hydrology are discussed in the reports referred to in section 1 and in the Appendix.

2.2 PROSPOSED CONSTRUCTION

2.2.1 Pit Bottom

The pit bottom would be graded and compacted to eliminate surface roughness and a 3-foot liner of compacted clay soil would be placed over it. The bottom liner would be extended up along the sidewalls in vertical increments. The clay liner would be watered at intervals as required to maintain a minimum moisture content to prevent shrinkage and cracking. The pit bottom limits are shown in figure 2.1 and a typical section of the pit is shown in figure 2.2.

2.2.2 Underdrain System

An underdrain system would be installed along the perimeter of the pit bottom as shown in figure 2.1. The system would include a perforated polyethylene pipe surrounded by concentric layers of crushed stone and coarse and fine sand. The underdrain pipe would extend eastward to a gravel collection sump. Vertical pipes would extend upward from the sump and through the tailings. Pumps would be set into the vertical pipes which would pump the underdrainage out of the pit. The purpose of the underdrain system would be to remove entrapped liquid from the tailings in order to prevent the liquid from seeping out of the pond and also to consolidate the tailings so that construction equipment would be able to travel over the surface for reclamation.

2.2.3 Sidewall Construction

The clay liner would extend upward along the side of the pit. Construction of the liner would consist of placing incremental lifts of clay and earth fill as shown in figure 2.3. The width of the clay liner would be 10 feet because the material would be deposited by scrapers with an 8-foot width. The earth fill placed alongside the liner would provide structural support for the clay, and would in turn be supported by coarse tailings. The coarse tailings would be deposited by settlement from the discharge of tailings into the pit through spigots in a pipeline running along the earth fill embankment parallel to the pit wall. The sidewall liner would be constructed in stages so that the surface of the liner remains within an upper and lower limit. The lower limit would be necessary in order to provide a minimum freeboard of 5 feet above the beach of coarse tailings. The upper limit would be necessary to provide a stable earth structure. The clay liner would terminate when the surface of the liner reaches an elevation of 10 feet above the estimated pre-mining groundwater elevation as shown in plate 5 in the Appendix.

2.3 SURFACE DECANT SYSTEM

Liquid collected of the surface of the pond would normally by allowed to evaporate. If a significant amount of water accumulates on the surface of the tailings, decant pumps mounted on floating platforms would be used to remove the water and pump it back to the mill for reuse.

2.4 COST OF DISPOSAL SYSTEM

The overall cost for the alternative No. 1 disposal system is shown in the following table:

Item	Cost
Clay bottom lining	$1,040,000
Clay sidewall lining	325,000
Earth fill on sidewall	87,000
Dewatering system	116,000
Underdrain system	809,000
Monitoring wells	72,000
Reclamation	1,286,000
Total	$3,898,000

2.5 EFFECTIVE STORAGE VOLUME

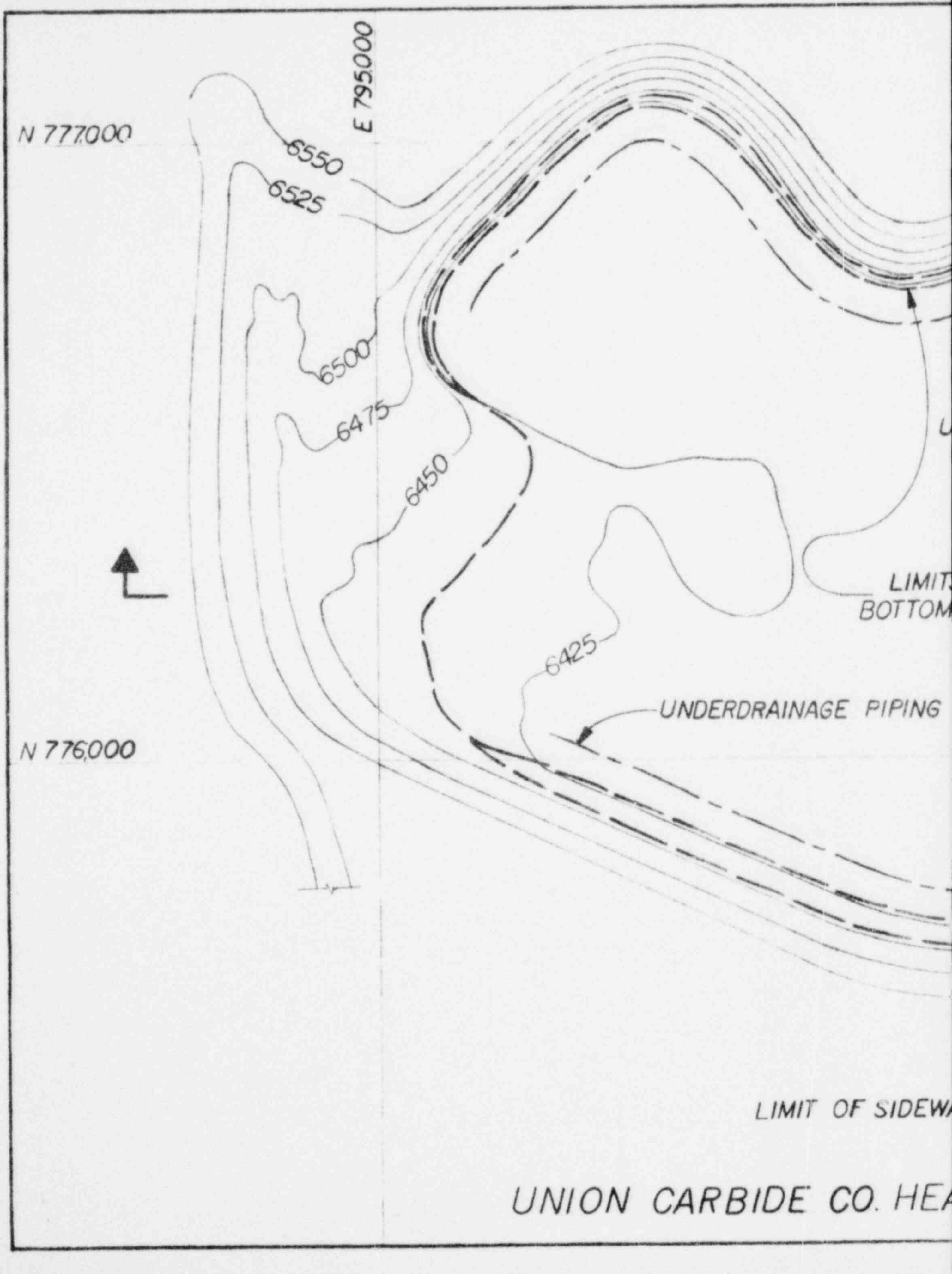
The storage capacity of the Sagebrush-Tablestakes pit would be somewhat reduced by the volume of the lining materials placed on the bottom and sides. The estimated volume of these materials is 276,000 cubic yards. This would reduce the storeage capacity of the pit from 6.5 million cubic yards to 6.2 million cubic yards. This would provide storage of tailings for 6.7 years of plant operation at 1 million short tons per year, assuming an in-place dry density of tailings of 80 pounds per cubic foot.

2.6 STORAGE OF TAILINGS POND NO. 2 MATERIAL

The Sagebrush-Tablestakes pit could be used for storage of a portion of the tailings presently stored in Tailings Pond No. 2. The total volume to be moved and the contaminated dams and soil, would be approximately 6 million cubic yards. Of this amount, 1.6 million cubic yards could be placed in the Sagebrush-Tablestakes pit. The remaining 4.6 million cubic yards of storage space in the Sagebrush-Tablestakes pit which would allow storage of tailings from mill operations for 5.0 years.

2.7 RECLAMATION

Reclamation of the Sagebrush-Tablestakes pit would be part of the overall reclamation plan described in section 9 of the Environmental Report referred to in paragraph 1.1 of this supplemental report.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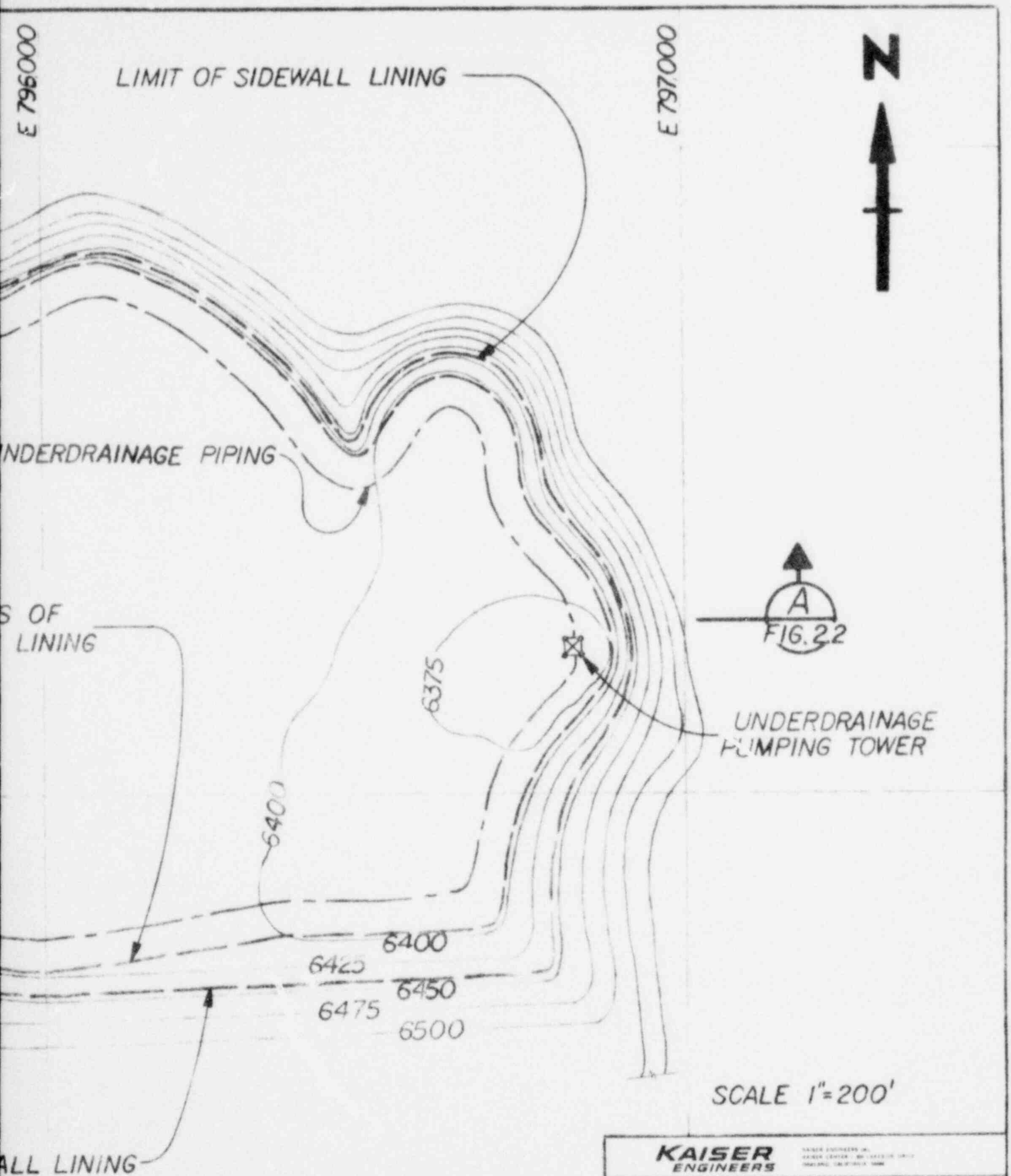

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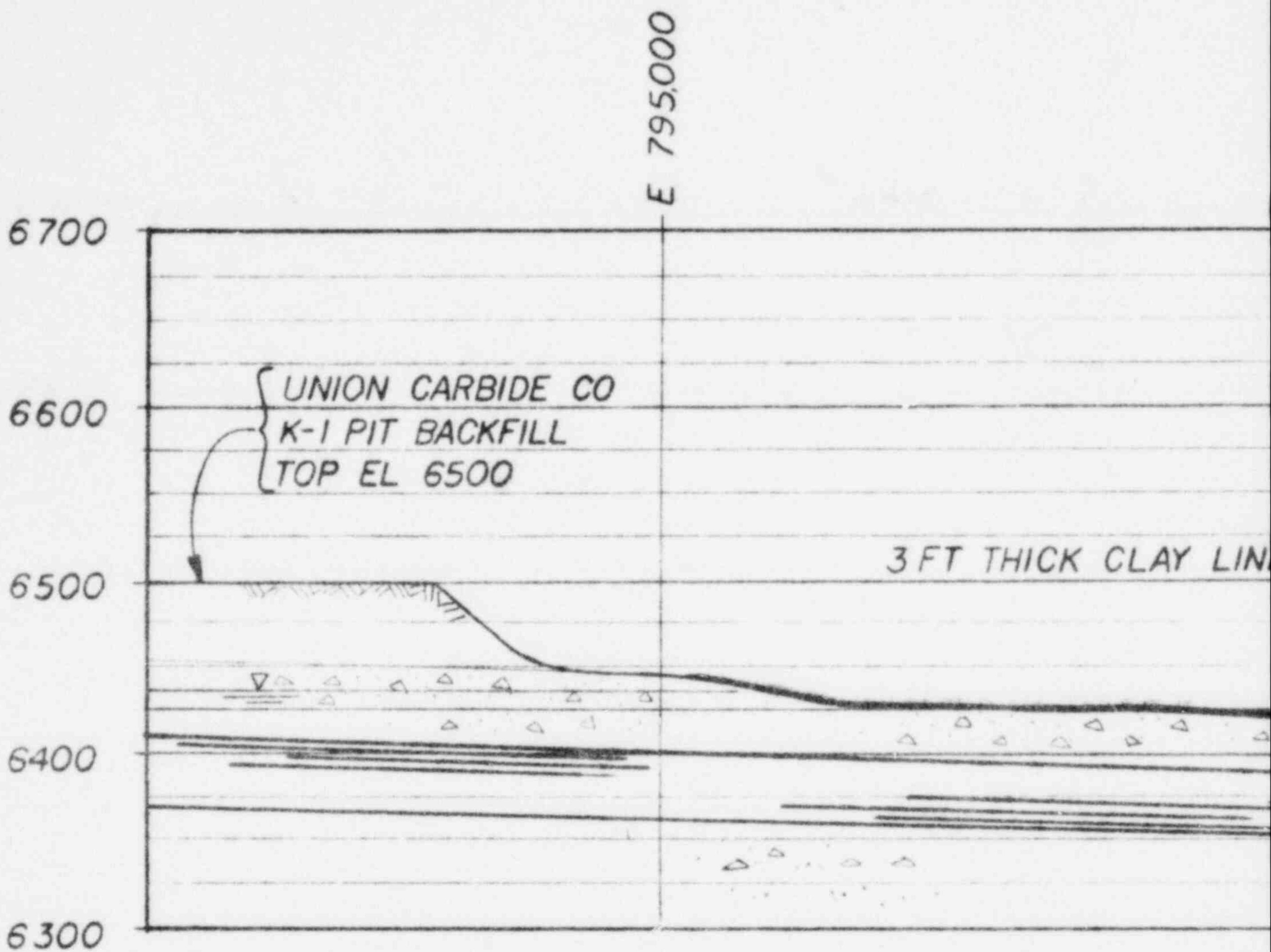
ALTERNATIVE Nº1
PIT BOTTOM PREPARATION-PLAN

JOB No. 79159	FIG. 2.1	R-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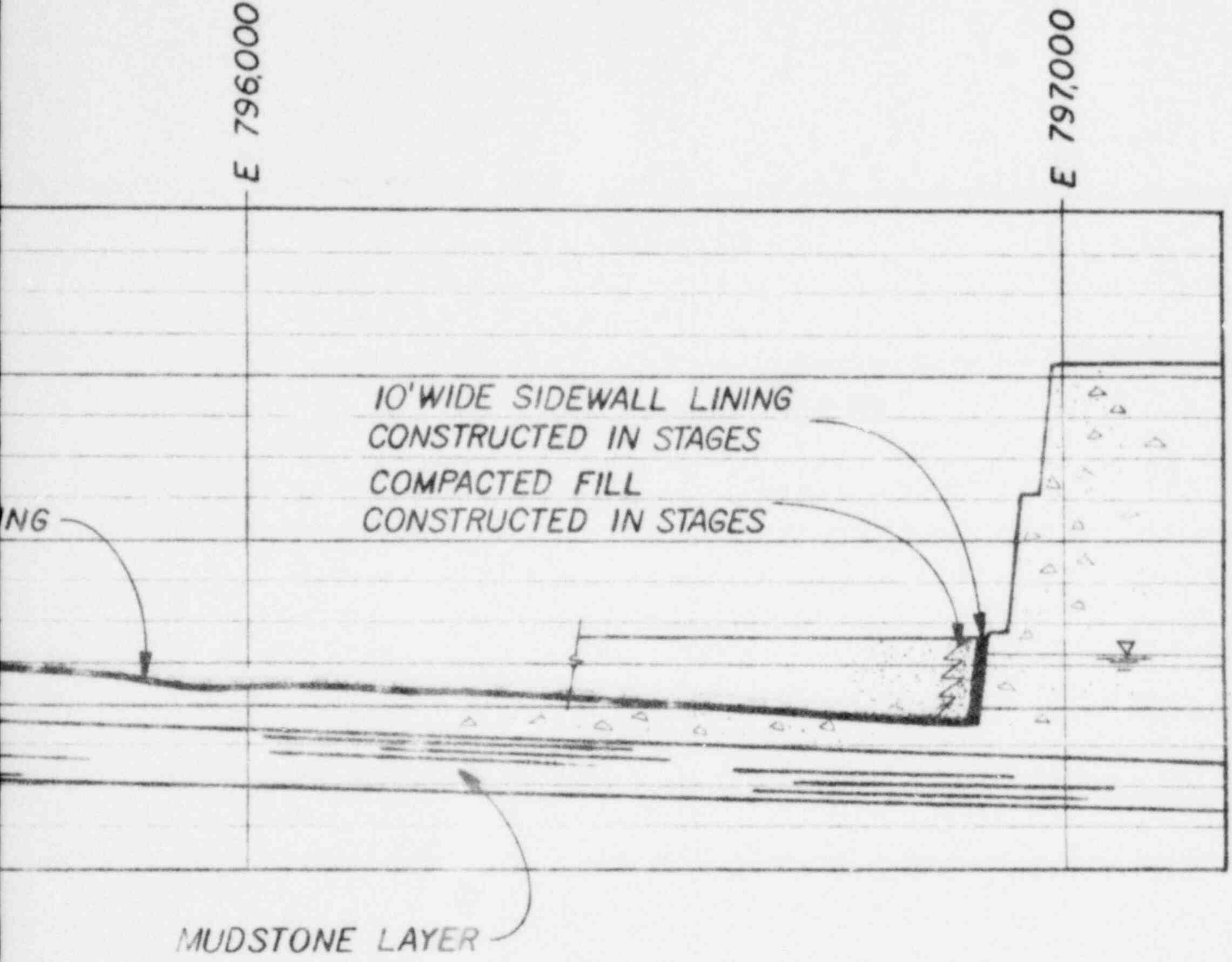

SCALE {1" = 200' HORIZ. / 1" = 100' VERT.}

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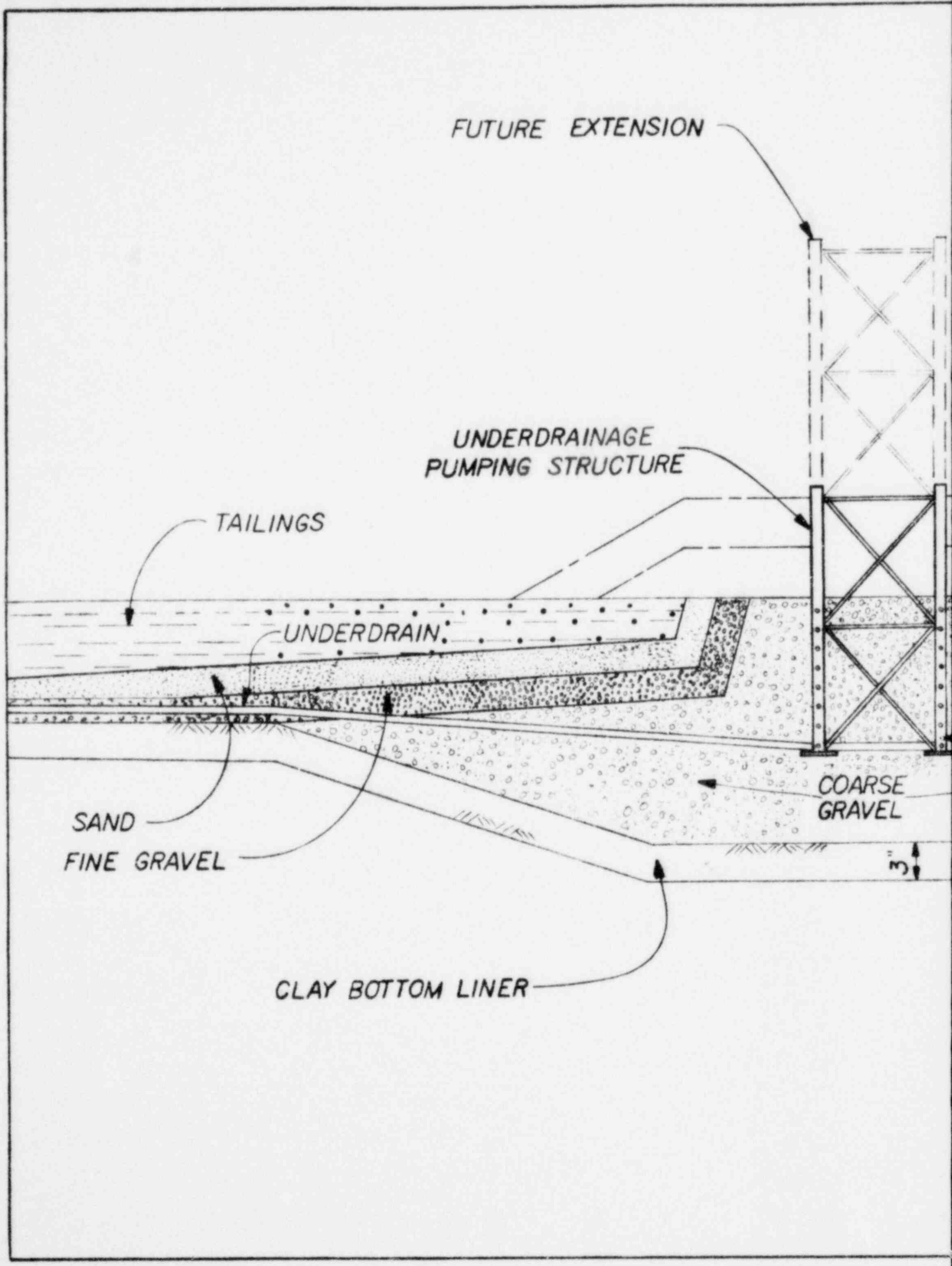
FAP URANIUM MILL-GAS HILLS WYOMING

ALTERNATIVE Nº1
PIT BOTTOM PREPARATION-SECTION

JOB No. 79159 | FIG. 2.2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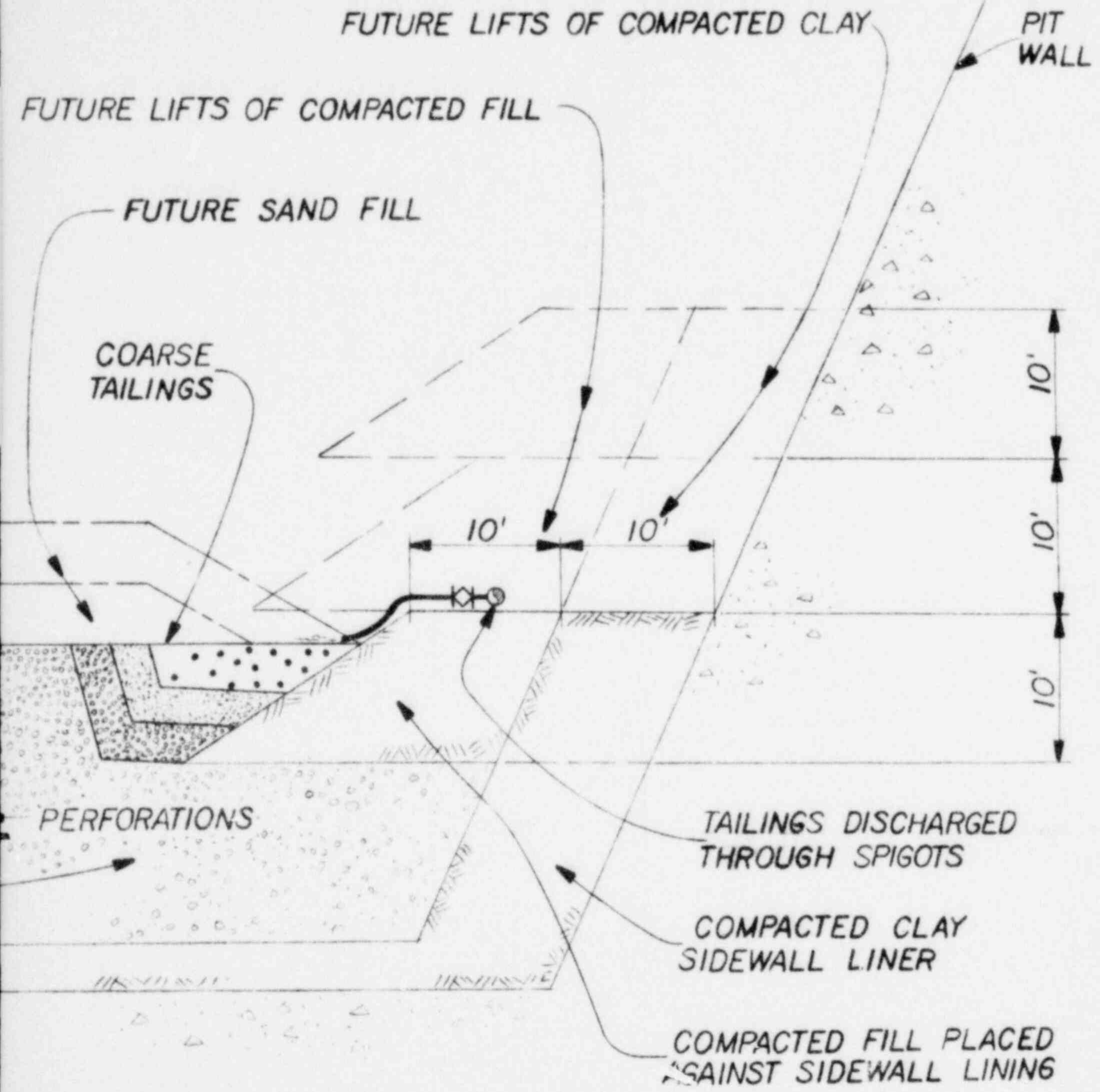

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KAISER ENGINEERS

FAP URANIUM MILL-GAS HILLS WYOMING

ALTERNATIVE Nº1
SIDEWALL LINING CONSTRUCTION

JOB No. 79159 | FIG. 2.3 | R-

3. ALTERNATIVE NO. 2

3.1 PREPARATION OF PIT BOTTOM

The pit would be prepared and lined on the bottom as described for alternative No. 1.

3.2 UNDERDRAIN SYSTEM

An underdrain system would be installed as described in alternative No. 1 except that the underdrains would be aligned in the center of the pit instead of the perimeter of the pit bottom. This can be done because the use of an earth embankment would make it unnecessary to provide a supporting layer of coarse tailings against the sidewall liner.

3.3 SIDEWALL CONSTRUCTION

A clay liner would be constructed along the side of the pit along with an earth embankment designed to support the liner without coarse tailings placed against it. This would permit the construction of the liner in a single stage at the beginning of the project. A typical section of the embankment is given in figure 3.2.

3.4 SURFACE DECANT SYSTEM

A surface decant system would be provided as described for alternative No. 1.

3.5 COST OF DISPOSAL SYSTEM

The cost of the alternative No. 2 disposal system is similar to that of the alternative No. 1 system except for the cost of placing 180,000 additional cubic yards of earth fill against the sidewall liner. The resulting cost would be as follows:

Alternative No. 1	$3,898,000
Additional earthwork	435,000
Total	$4,333,000

3.6 EFFECTIVE STORAGE VOLUME

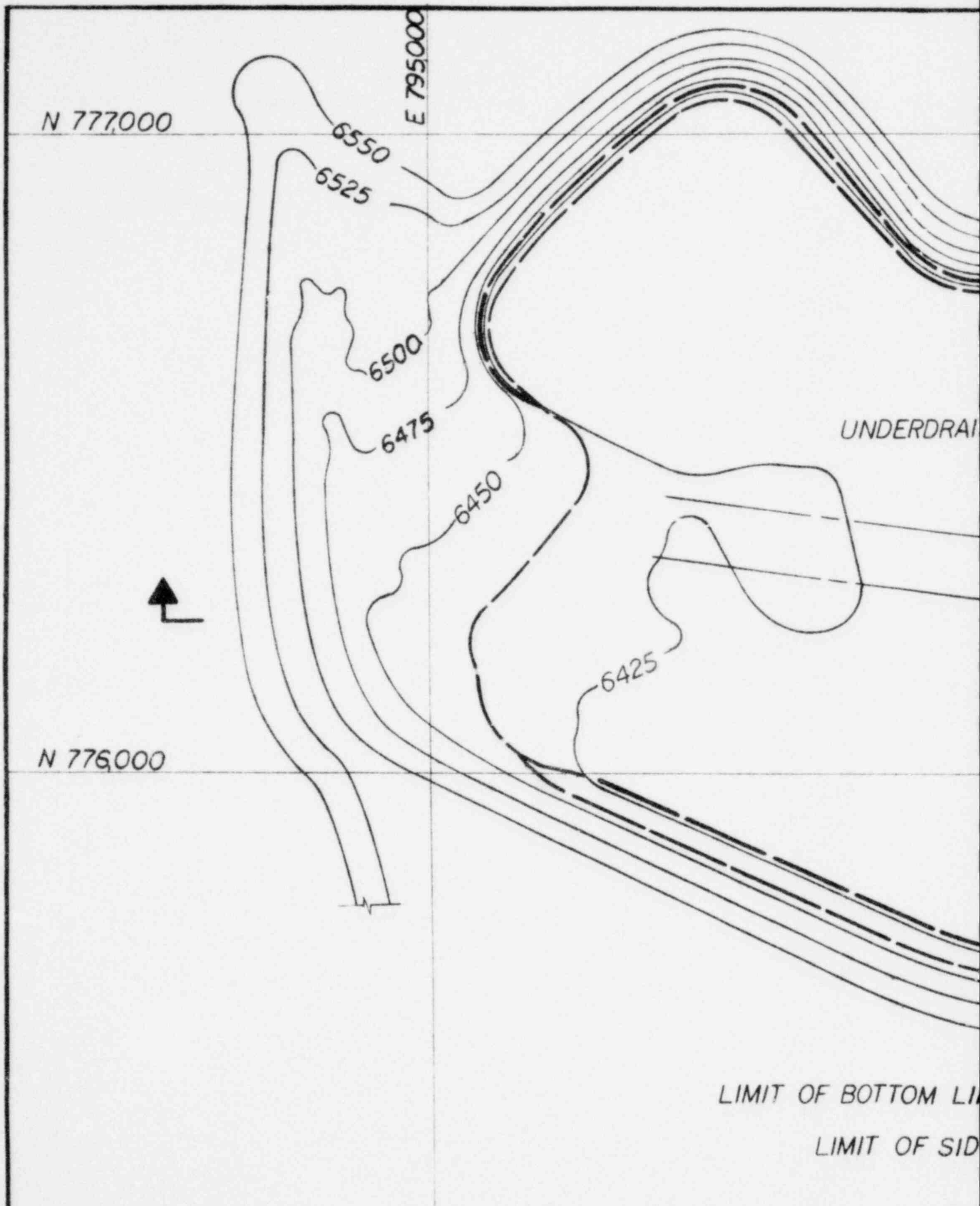
The storage capacity of the alternative No. 2 pit would be reduced from an initial volume of 6.5 million cubic yards to 6.1 million cubic yards by the embankment and lining materials placed in it. The volume of the pit would provide storage of tailings for 6.6 years of plant operation at 1 million short tons per year and an in-place dry density of tailings of 80 pounds per cubic foot.

3.7 STORAGE OF TAILINGS POND NO. 2 MATERIAL

The Sagebrush-Tablestakes pit could be used for storage of a portion of the tailings presently stored in Tailings Pond No. 2 as discussed in section 2, paragraph 2.6. For alternative No. 2 however, the volume available for the material is 1.5 million cubic yards. The remaining 4.6 million cubic yards of storage would provide for 5.0 years of mill operation.

3.8 RECLAMATION

Reclamation of the Sagebrush-Tablestakes pit would be done as part of the overall reclamation plan described in section 9 of the Environmental Report referred to in paragraph 1.1 of this supplemental report.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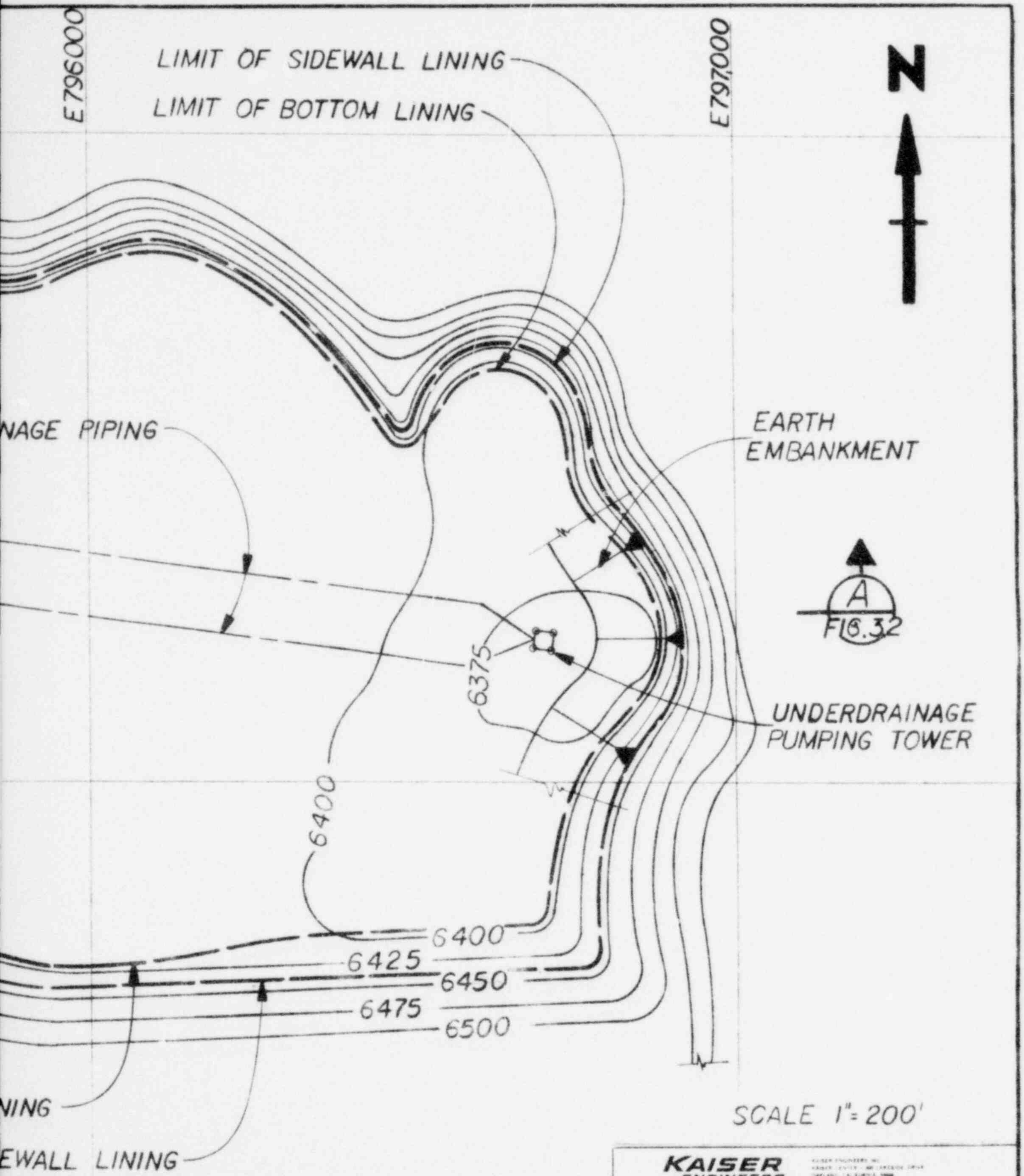

EAP LEACH PROJECT

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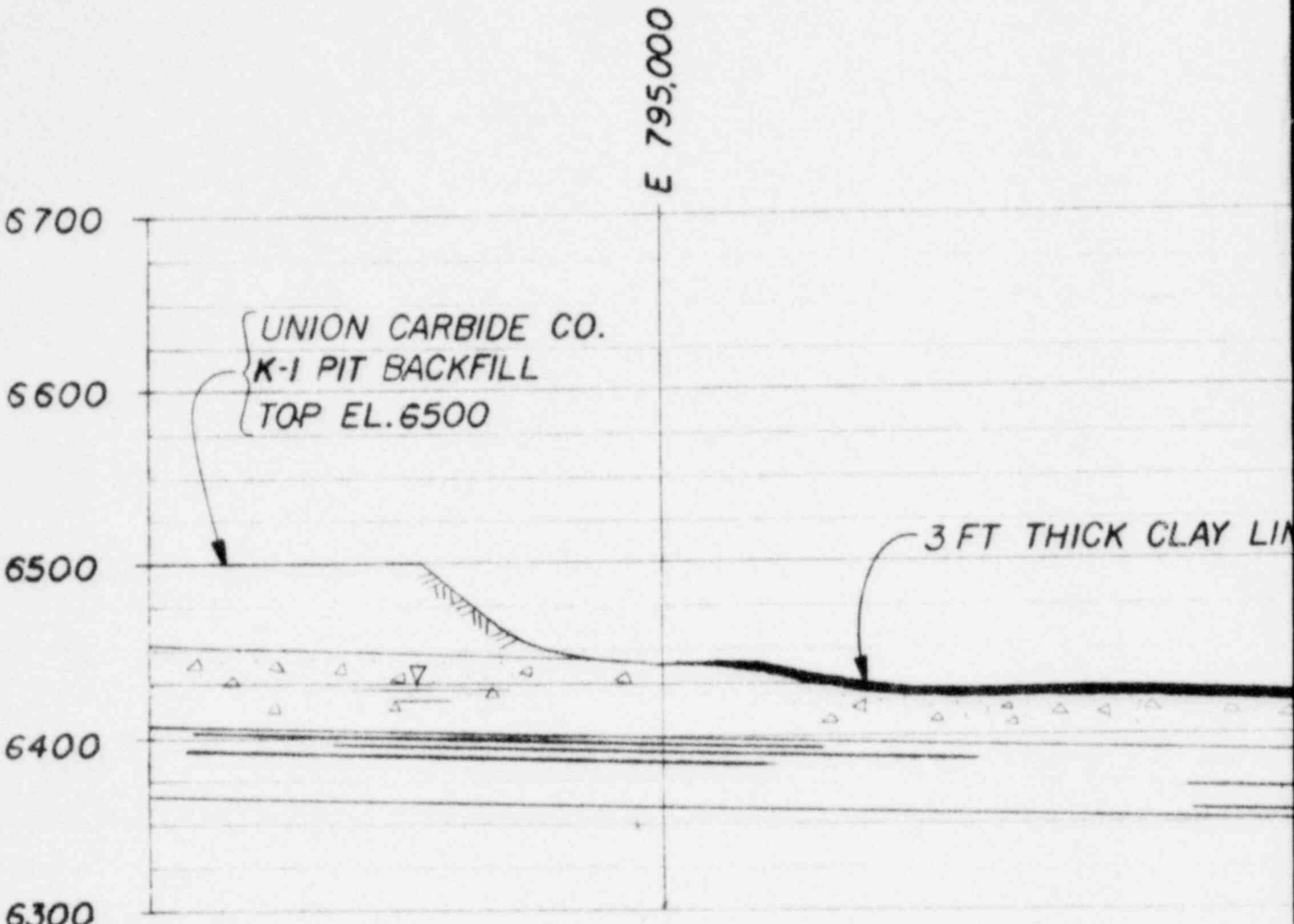
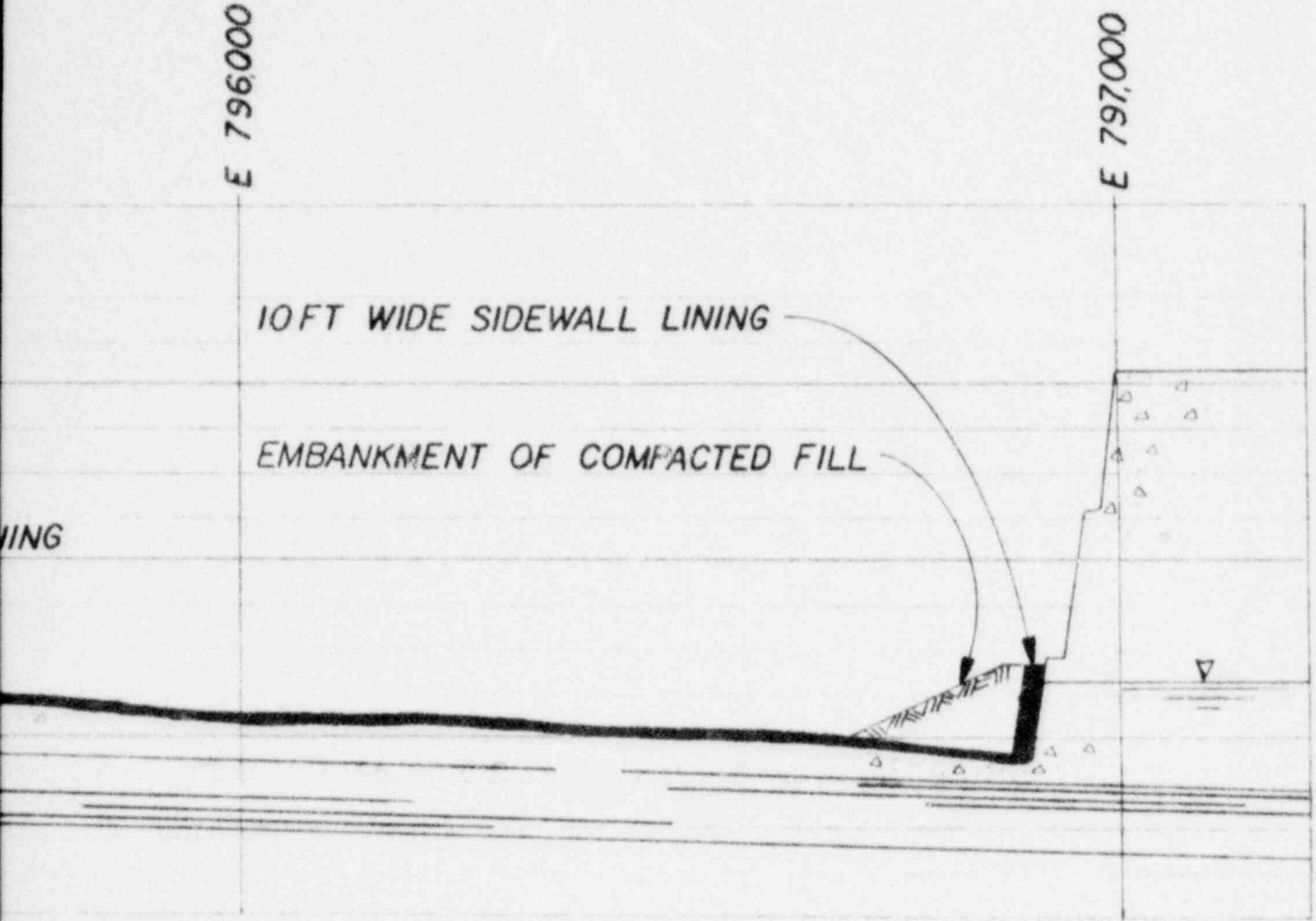
FAP URANIUM MILL-GAS HILLS WYOMING		
ALTERNATIVE Nº 2 PIT CROSS SECTION		
JOB No. 79159	FIG. 3.1	R-



SECTION A FIG. 3.1



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ALTERNATIVE Nº 2
TYPICAL EMBANKMENT SECTION

JOB No. 79159 | FIG. 3.2 | R-

4. ALTERNATIVE NO. 3

4.1 PREPARATION OF PIT BOTTOM

The pit bottom for alternative No. 3 would be backfilled to 10 feet above the estimated historical groundwater table using an estimated 2.2 million cubic yards of overburden soils which had been removed from the pit during mining operations. Backfill operations would be done with conventional earthmoving and compaction equipment. The pit bottom would then be covered with a 3-foot lining of compacted clay soil. The clay lining would be maintain at proper moisture content to prevent shrinkage and cracking. The pit bottom contours are shown in figure 4.1 and a typical section of the pit is shown in figure 4.2.

4.2 UNDERDRAIN SYSTEM

The underdrain system for alternative No. 3 would be similar to that of alternative No. 2. The coarse tailings would be deposited in the center of the pond because there is no need for coarse material to be placed against the sidewall.

4.3 SURFACE DECANT SYSTEM

A surface decant system would be provided as described for alternative Nos. 1 and 2.

4.4 COST OF DISPOSAL SYSTEM

The cost of the alternative No. 3 disposal system would be as follows:

Item	Cost
Backfill on pit bottom	$3,762,000
Clay bottom lining	1,142,000
Dewatering system	250,000
Underdrain system	630,000
Monitoring wells	72,000
Reclamation	1,286,000
Subtotal	$7,142,000
Additional pit storage to provide 6.2 years of tailings storage	6,912,000
Total Comparative Cost	$14,054,000

4.5 EFFECTIVE STORAGE VOLUME

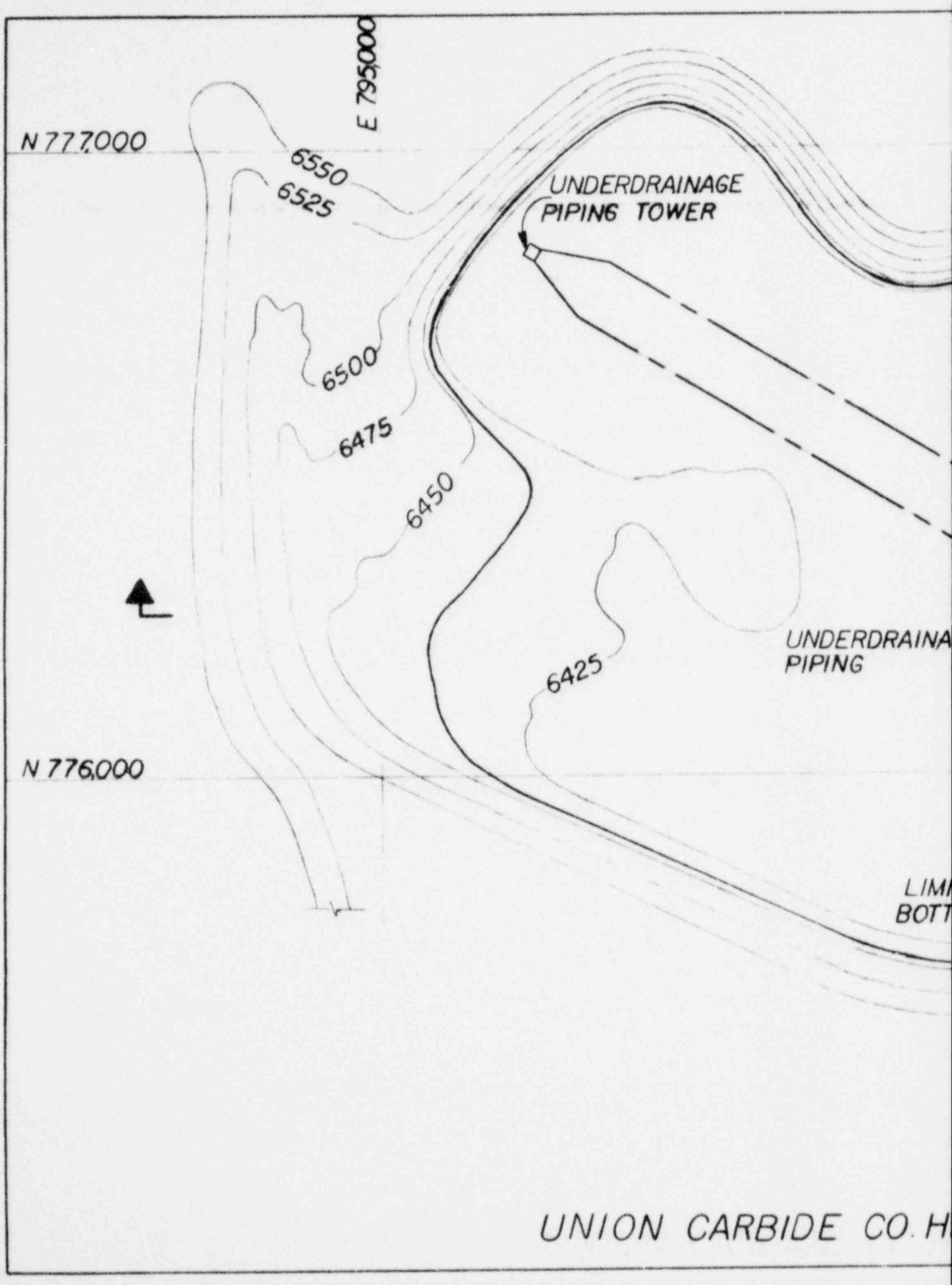
The storage capacity of the alternative No. 3 pit would be reduced from an initial volume of 6.5 million cubic yards to 4.1 million cubic yards by backfill and lining materials placed in it. The volume of the pit would provide storage of tailings for 4.4 years of plant operation at 1 million short tons per year and an in-place dry density of tailings of 80 pounds per cubic foot.

The loss of tailings storage volume could be made up by using an excavated pit with a similar clay lining. It is estimated that this additional pit would cost $6,912,000. This additional cost has been added to the estimate in paragraph 4.4 to provide a cost which may be compared with the cost of alternative Nos. 1 and 2 as follows:

Alternative	Years of Storage	Cost
1	6.2	$ 3,898,000
2	6.1	$ 4,333,000
3	6.2	$14,054,000

4.6 STORAGE OF TAILINGS POND NO. 2 MATERIAL

Because of the limited storage capacity available in the Sagebrush-Tablestakes pit under alternative No. 3, material from Tailings Pond No. 2 could not be stored in it without using the additional excavated pit discussed in paragraph 4.5. The amount of material from Tailings Pond No. 2 would be limited to 1.6 million cubic yards in order to leave space for 4.6 million cubic yards of tailings from future milling operations. The material from Tailings Pond No. 2 would be distributed to both the Sagebrush-Tablestakes pit and the additional excavated pit depending on the operations schedule and haul distances. The use of larger excavated pits for storage of all of the material from Tailings Pond No. 2 is discussed in the following section.



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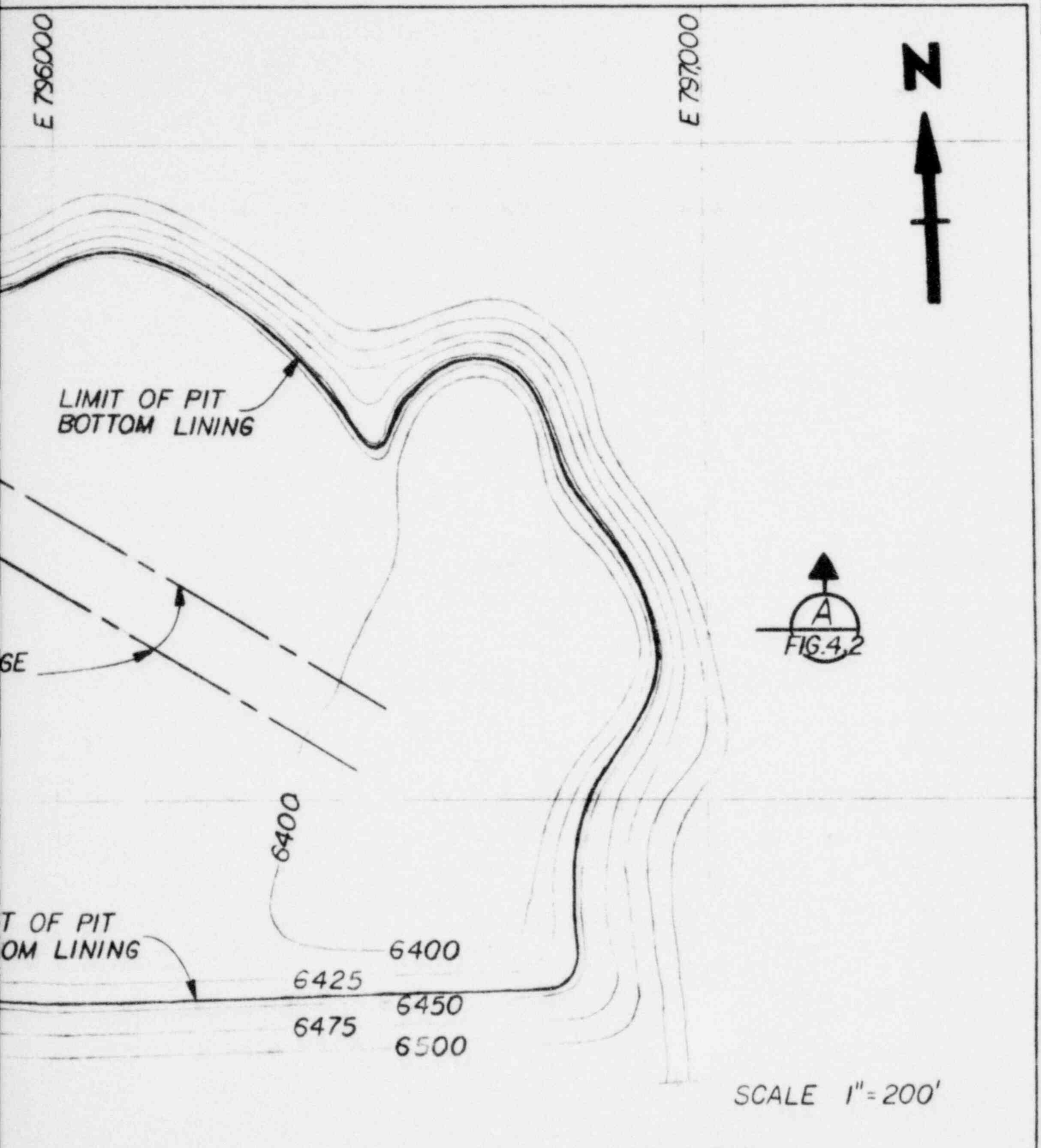

EAP LEACH PROJECT

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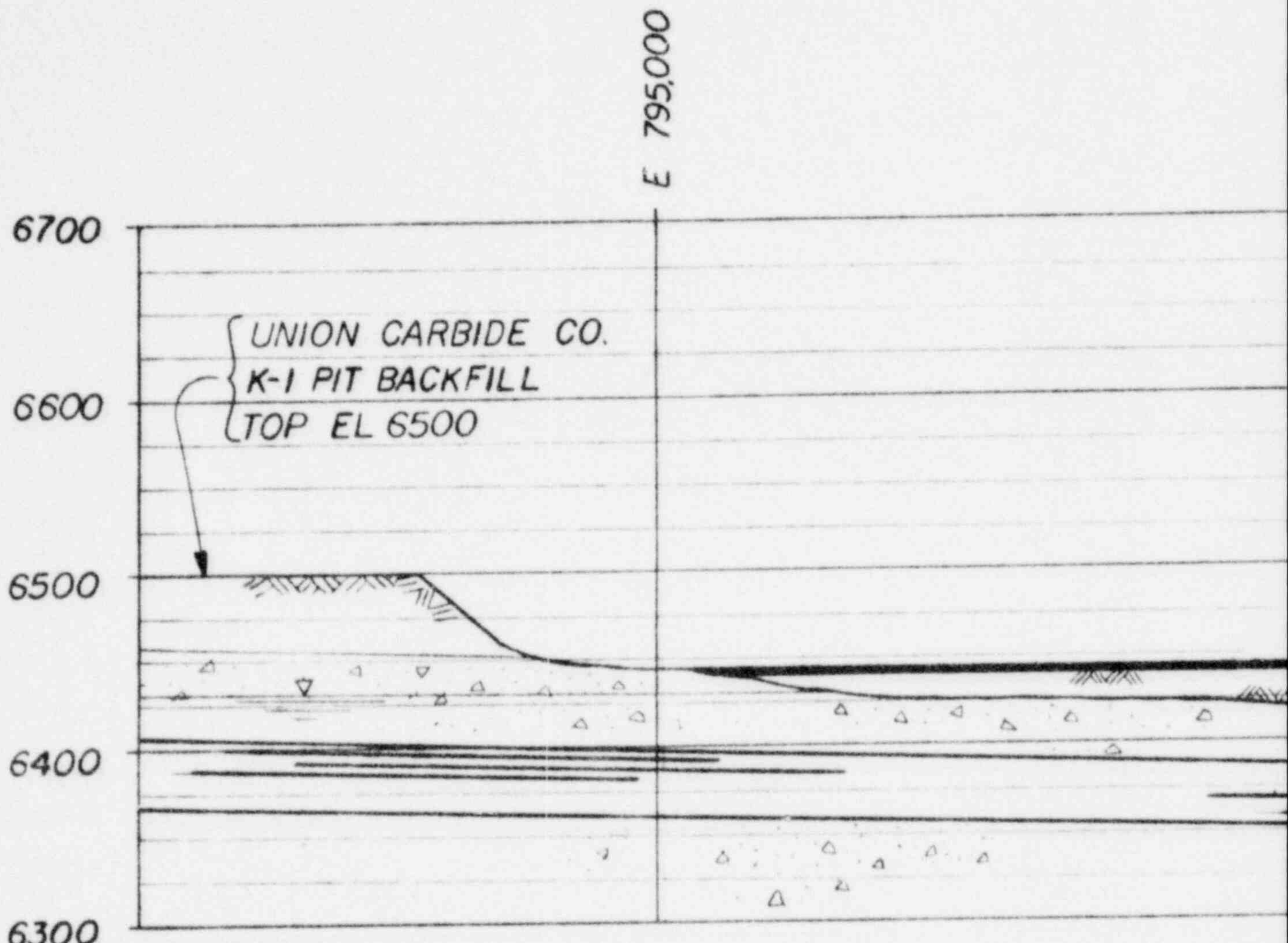
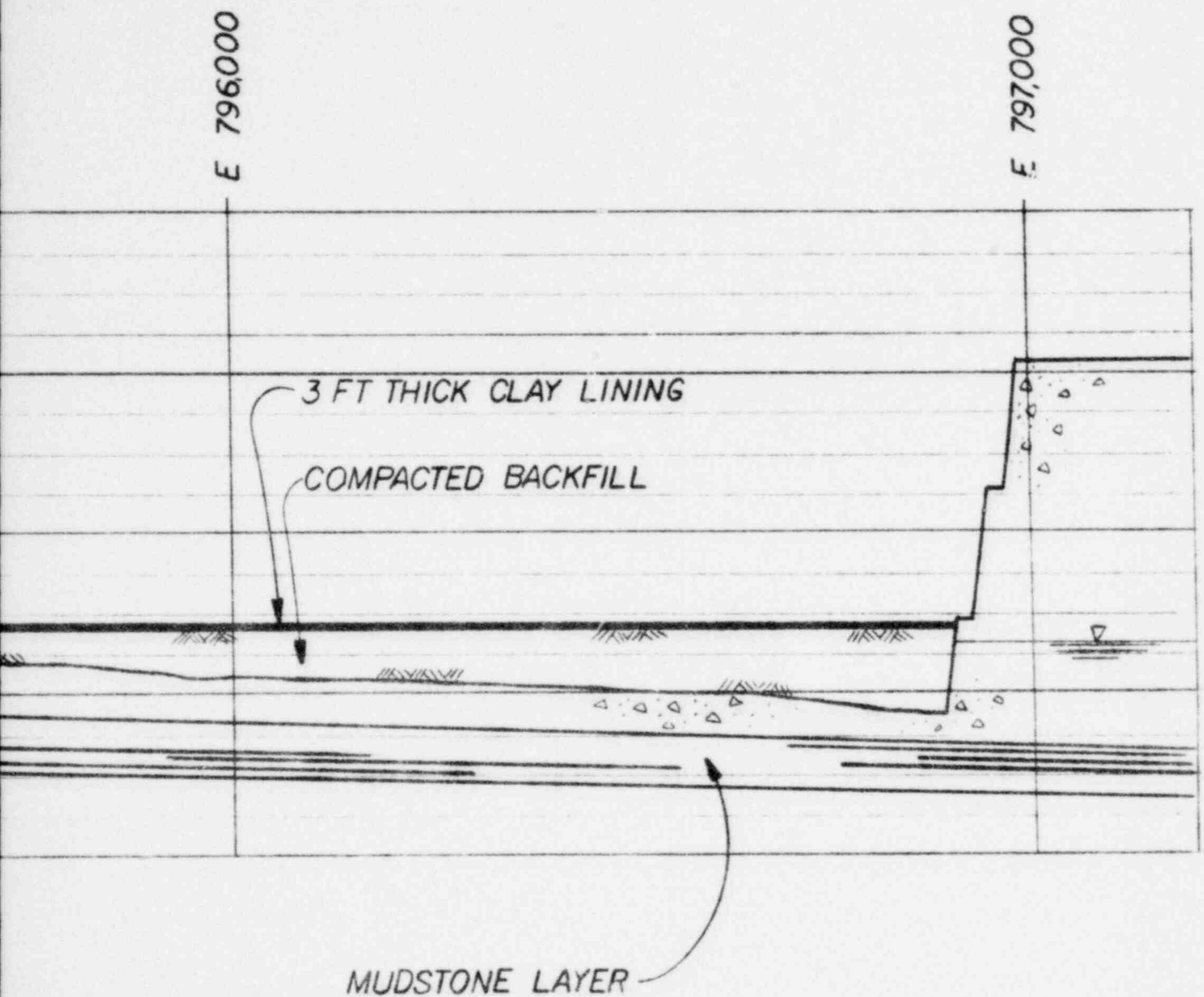
FAP URANIUM MILL-GAS HILLS WYOMING

ALTERNATIVE Nº 3
PIT PLAN

JOB No. 79159		FIG. 4.1	R-



SECTION A
FIG.4



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1" = 100' VERT.

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ALTERNATIVE Nº 3
PIT SECTION

JOB No. 79159	FIG. 4.2	REVISION R-

5. ALTERNATIVE SUBSURFACE DISPOSAL SITES

5.1 ALTERNATIVE NO. 4

5.1.1 Alternative Excavated Pit

Tailings could be disposed of in a pit formed completely by excavation at a site near the existing mill. This would require acquisition of new property and initiation of a new site investigation similar to the present investigation for the Sagebrush-Tablestakes pit.

5.1.2 Construction Requirements

A new site would require an enormous capital investment for pit preparation as well as cause damage to a presently undisturbed 150 acre area. Construction would require clearing and grubbing, stripping and stockpiling of topsoil, excavation of a pit, deposition of spoil, and a clay lining as described in previous sections of this report.

5.1.3 Estimated Cost

The following table gives the estimated cost for an excavated pit with a volume of 6.2 million cubic yards. A conceptual sketch of the pit is given in figure 5.1.

Item	Cost
Clearing and grubbing	$ 150,000
Stripping and stockpiling topsoil	368,000
Excavation of pit	13,500,000
Clay lining (5-mile haul)	3,570,000
Underdrain system	630,000
Monitoring wells	72,000
Reclamation	3,215,000
Total	$21,505,000

5.1.4 Schedule for Pit Preparation

The preparation of an excavated pit would conform to the following approximate schedule:

Task	Date
Submit supplemental environmental report to reviewing agencies and obtain permission to enter on the site	March 1980

Task	Date
Initiate new site investigation	May 1980
Prepare new report and submit to reviewing agencies	December 1980
Submit construction drawings and specifications and seepage analysis to reviewing agencies and obtain property	June 1981
Obtain permit	August 1981
Obtain property rights, begin construction and install monitoring wells	March 1982
Complete construction	March 1983
Begin tailings deposition	May 1983

5.2 ALTERNATIVE NO. 5

Tailings could be disposed of at other mined-out pits owned by Federal-American Partners. An example of this would be the Sunset pit which is projected to be completed in the summer of 1980. Use of any pit other than the Sagebrush-Tablestakes pit would require several additional pumping stations to transport the tailings slurry over long distances and return the underdrainage to the mill.

In addition, a new site investigation similar to the present investigation for the Sagebrush-Tablestakes pit would have to be initiated. This would cause a serious delay in the preparation of a disposal site for tailings.

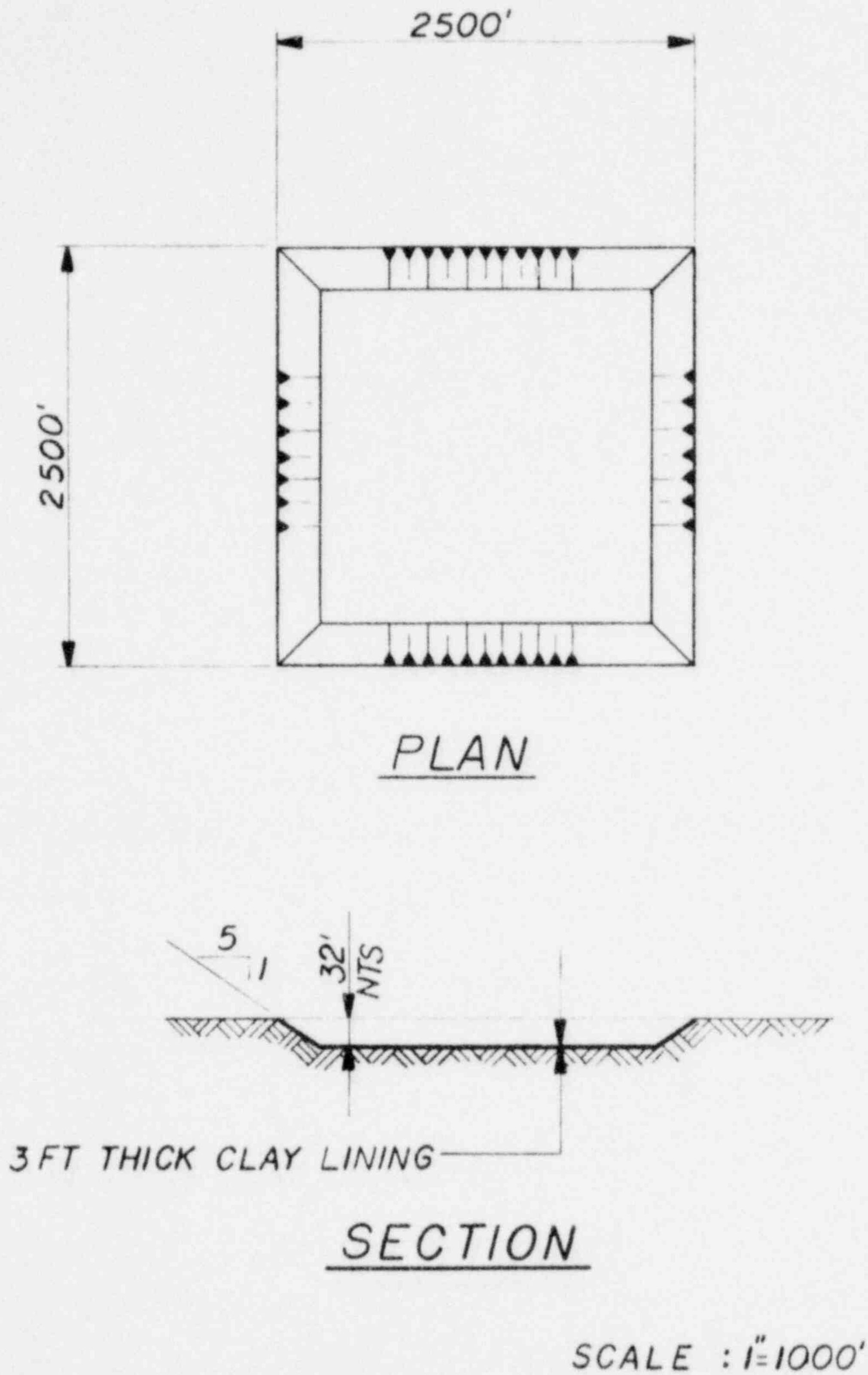
At present, an in-depth study of alternative mined-out pits has not been done due to the disadvantages outlined above.

5.3 COMPARISON OF ALTERNATIVES

The volume and costs for five alternative pit designs are listed in the following table:

	Alternative	Volume (Million Cubic Yards)	Cost ($)
1.	Sagebrush-Tablestakes pit with clay-lined sidewalls	6.2	3,898,000
2.	Same as above with earth embankment support for sidewalls	6.1	4,333,000

	Alternative	Volume (Million Cubic Yards)	Cost ($)
3.A	Sagebrush-Tablestakes pit with backfill to elevation 6445	4.3	7,142,000
3.B	Same as above with additional pit excavation included	6.2	14,054,000
4.	Completely excavated pit	6.2	21,505,000
5.	Other mined-out pit	(not available)	(not available)



KAISER ENGINEERS

FAP URANIUM MILL-GAS HILLS, WYOMING

EXCAVATED PIT

JOB No. 79159	FIG. 5.1	REVISION R-

6. TIME SCHEDULE FOR COMPLETION

6.1 SCHEDULE REQUIREMENTS

As discussed in paragraph 1.3, it is essential that the Sagebrush-Tablestakes pit be prepared to be available for tailings disposal by late 1981. The time schedule for final design of the pit, review by regulating and licensing agencies and construction is therefore extremely critical. In addition, the climatic conditions at the pit allow little flexibility in construction scheduling.

6.2 PROPOSED SCHEDULE

The proposed schedule is as follows:

Task	Date
Submit supplemental Environmental Report to reviewing agencies	March 1980
Prepare final submittal	August 1980
Obtain permits	November 1980
Install pumping/monitoring wells	December 1980
Begin construction of pit liner and underdrain system	February 1981
Complete construction	September 1981
Begin tailings deposition	August 1981

7. OPERATING PROCEDURES

7.1 BASIC OBJECTIVE

The primary objective of the proposed subsurface disposal system is to provide an acceptable method of disposing of tailings that conforms to all agency requirements. The main design objective has been to minimize operational requirements and maintenance, and mitigate adverse impacts over the short and long term.

7.2 SLURRY SYSTEM

The slurry transfer system would consist of slurry pumps located at the mill, an 8-inch slurry pipeline and a distribution system. Underdrainage and decant liquid from the pit would be returned through an 8-inch return line. Tailings would be pumped to the pit as a slurry with the following approximate composition by weight:

Sand	9%
Slimes	21%
Liquid	70%

The tailings slurry line and return line would be placed in a trench with moderate embankments to contain any leaks that may result from line failure or wear. A continuous tailings discharge monitor would be located at the discharge point on the tailings line to provide a warning in case of any interruption in tailings flow which would indicate a failure. The lines would be made of polyethylene with flanged joints at 120 foot intervals to allow periodic inspection and replacement of worn sections.

7.3 PROCEDURE FOR PIT DISPOSAL

Tailings slurry would be discharged initially at the end of the pit near the underdrain tower. Discharge would be directed over the underdrains to allow the coarse material to settle out over the filter material. The coarse material would be placed at the periphery of the pond for alternative No. 1 in order to support the clay liner. For alternative Nos. 2 and 3, the coarse material would be placed in the center of the pond. As adequate coarse tailings are provided for the center filter drainage blanket and the slimes begin to migrate away from the tower, the tailings slurry discharge point would also be moved away from the tower along the underdrain. Future shifts of the tailings slurry discharge point would vary as required to maintain a sufficient sand covering on the drainage blanket.

7.4 TAILINGS DEWATERING SYSTEM

The tailings dewatering system would consist of an underdrain system, a collection sump, four stainless steel stand pipes, pumps, and decant lines pumping into the return water pipeline. The collection sump and level control system for the pumps would be designed to keep to underdrains flowing partially full at all times.

7.5 DECANT SYSTEM

Pumps mounted on floating platforms would also be provided to remove any excessive quantities of liquid from the surface of the pit. The liquid removed would be pumped into the return water pipeline where it would return to the mill for re-use along with underdrainage.

7.6 SPECIAL ENVIRONMENTAL CONSIDERATIONS

Routine supervisory inspections would be made of the entire system and entries would be made in the shift log. Overall management responsibility would be assigned to an operations superintendent. In the event that dust is generated at the tailings disposal site, dust suppression measures, such as sprinkling and chemical agents, would be used.

8. MONITORING WELL SYSTEM

8.1 GENERAL REQUIREMENTS

Monitoring wells would be installed around the Sagebrush-Tablestakes pit as shown in figure 8.1. The wells would be installed prior to commencement of tailings deposition to obtain background information. They would then be used throughout the life of the system to obtain samples of groundwater and measure the groundwater elevation.

8.2 SCHEDULE OF SAMPLING

New monitor wells would be sampled monthly for a minimum of three months. After the first three months, the wells would be sampled quarterly for chemical analyses and annually for radiological analyses.

8.3 ANALYSIS OF SAMPLES

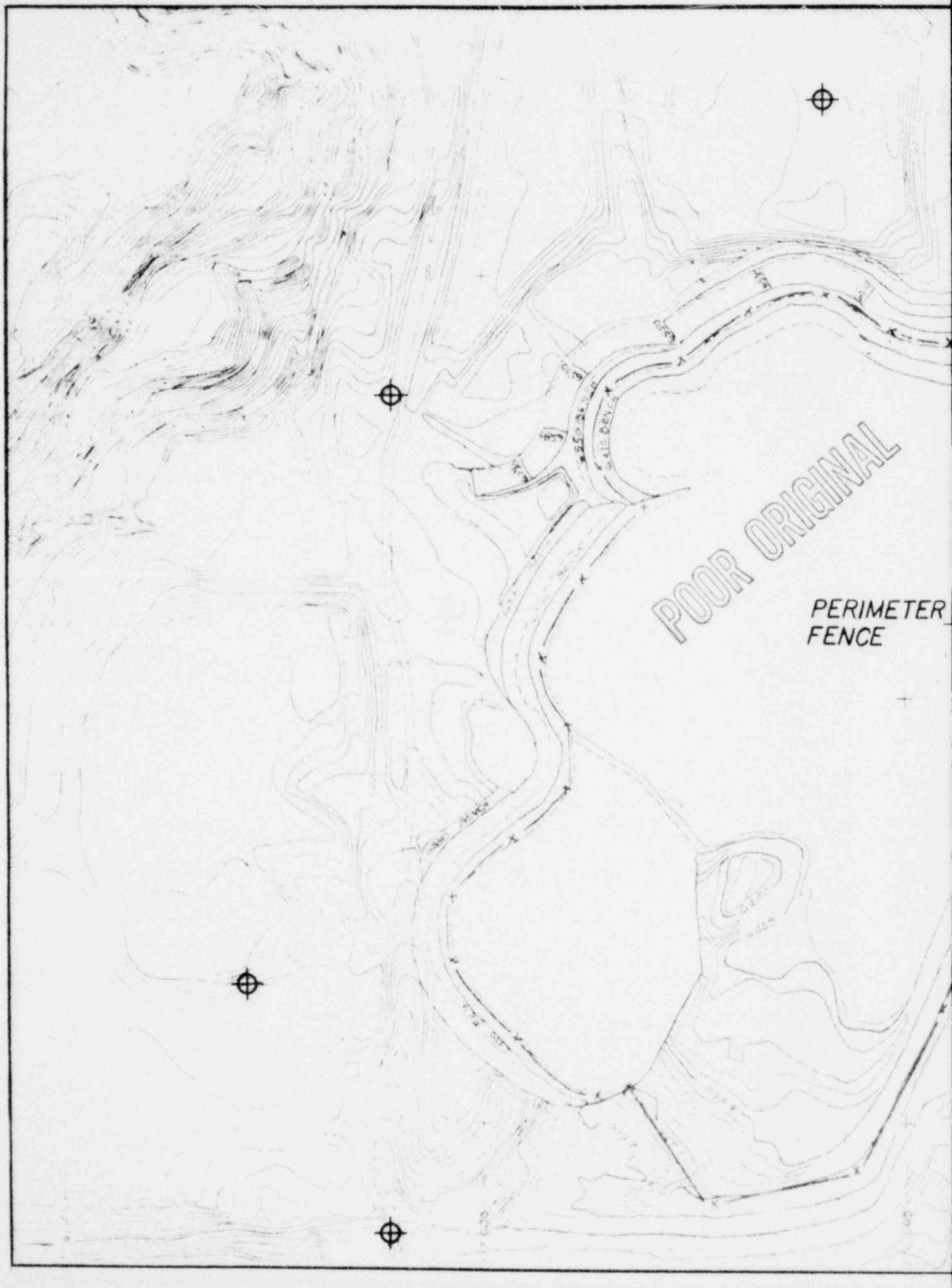
Samples taken from monitoring wells would be analyzed for the following constituents:

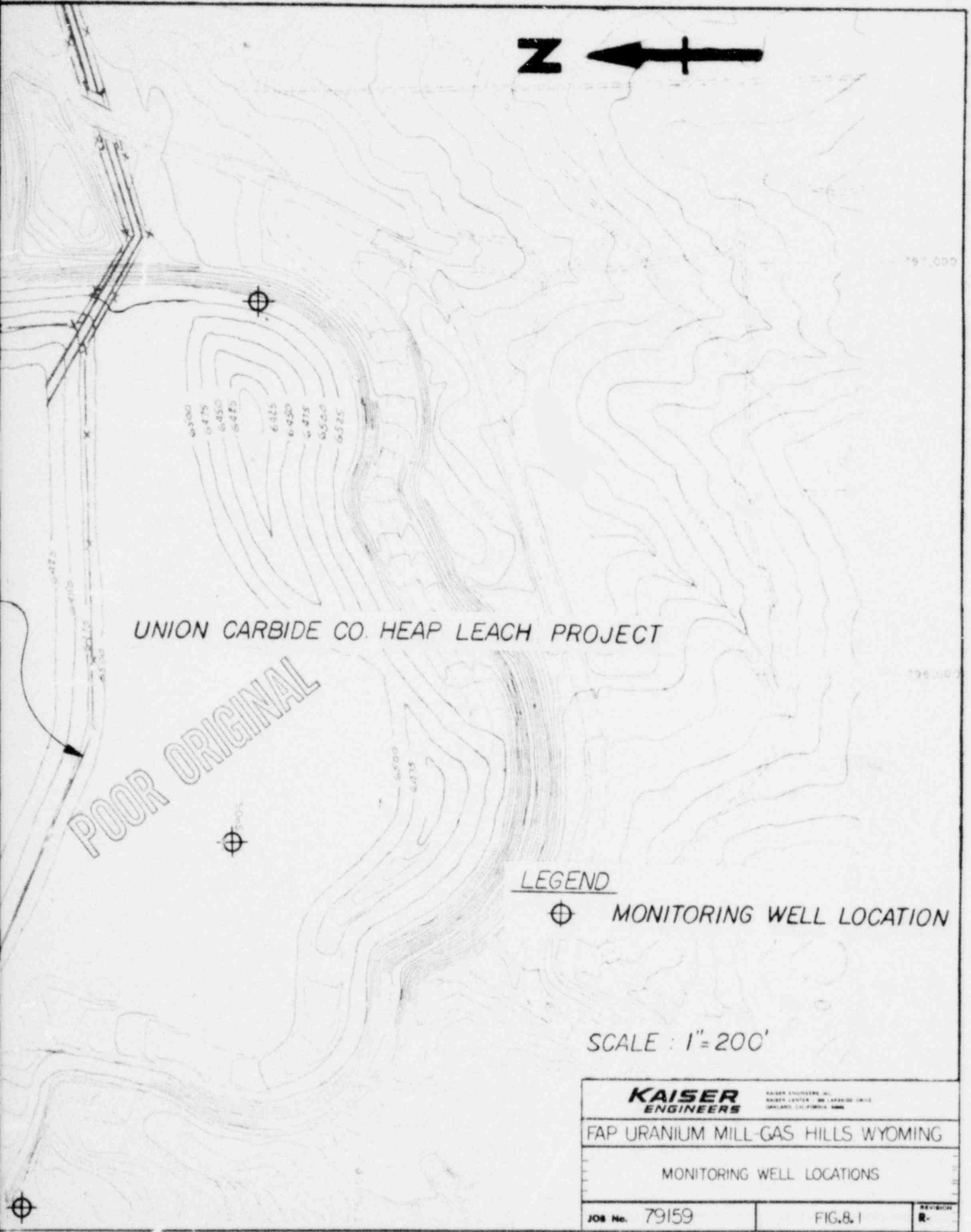
Quarterly

pH	Magnesium
Conductivity	Ammonia as N
Arsenic	Nitrate as N
Chloride	Lead
Cyanide	Selenium
Iron	Sulfate
Manganese	Total dissolved solids
	Elevation

Annually

Gross Alpha	Lead 210
Radium 226	Polonium 210
Thorium 230	Uranium - Natural


PERIMETER
FENCE



Z
UNION CARBIDE CO. HEAP LEACH PROJECT
POOR ORIGINAL
LEGEND
MONITORING WELL LOCATION
SCALE : 1" = 200'
KAISER ENGINEERS
FAP URANIUM MILL-GAS HILLS WYOMING
MONITORING WELL LOCATIONS
JOB No. 79159
FIG.8.1
REVISION R-

9. CONTINGENCY PLAN FOR GROUNDWATER CONTAMINATION

9.1 PURPOSE

The purpose of this section is to describe a plan of action in the event of groundwater contamination resulting from the use of the Sagebrush-Tablestakes pit for tailings disposal.

9.2 PROPOSED PLAN OF ACTION

In the event that the monitor wells detect contamination that exceeds the applicable water quality standards, the following action would be taken:

- o Regulating agencies would be notified.
- o Qualified consultants would be retained to define the extent of the contamination and prepare design recommendations for controlling the contamination to the maximum extent reasonably achievable.
- o If necessary, additional wells and pumps would be installed to recover contaminated liquid.

10. RECLAMATION OF THE PIT

10.1 PIT SURFACING MATERIAL

After completion of milling operations, the tailings pit would be used to deposit non-salvageable equipment, building material, and contaminated ground. Overburden soils would be placed on top of the pit to a depth sufficient to reduce the radon gas emanation to twice the natural background rate. The overburden soils used for this surfacing would have the following contents:

Clay	20%
Silt	18%
Sand	62%

10.2 GRADING

The surface of the pit cover would be graded to slope away from the center at a grade sufficient to cause water to drain freely without depressions where water would collect.

10.3 REVEGETATION

After placement of stockpiled overburden, the upper surface would be treated with soil amendments, fertilized and seeded. Tilling operations would be conducted in a direction perpendicular to the predominant south-southwest winds. The seed mixture given in table 9.3-2 of the Environmental Report would be drilled at a rate of 15 pounds per acre. Operational monitoring of vegetation, water and air quality would continue into the post-operational period until bond release.

POOR ORIGINAL

Appendix

REPORT
GROUND WATER AND CLAY SOURCE INVESTIVATION
PROPOSED SUBSURFACE DISPOSAL PROJECT
WEST GAS HILLS, WYOMING
FOR FEDERAL AMERICAN PARTNERS

DAMES & MOORE
Salt Lake City, Utah
Job No. 10500 003-06

February, 1980

INTRODUCTION

Federal-American Partners is currently evaluating the feasibility of disposing mill waste (tailing) below grade in the Sagebrush-Tablestakes open pit mine. The location of the proposed disposal area is shown on Plate 1, Vicinity Map. Feasibility of the subgrade disposal alternatives requires the evaluation of two related environmental concerns:

1) An estimate of the pre-mining regional ground water level in the vicinity of the proposed disposal areas. An estimate of the pre-mining ground water level will allow assessment of possible ground water impacts of the proposed subgrade disposal alternatives.

2) An evaluation of clay sources. All of the proposed subsurface disposal alternatives utilize low permeability materials as liners to restrict seepage. Source identification, as well as estimates of quantities and geotechnical parameters are required.

SCOPE

Ground Water Investigation

The purpose of the ground water investigation is to determine, as accurately as possible, the ground water levels that existed in the Sagebrush-Tablestakes area prior to commencement of mining operations. Data by which the pre-mining ground water elevation was estimated are as follows:

1. Review of ground water and well information in the area from the U.S. Geological Survey, U.S. Department of Energy (DOE), and the Wyoming Office of the State Engineer.

2. Review of on-site piezometer and monitoring well data, boring logs and mineral exploration drill hole data, where applicable.

3. Review of the history of mining operations.

4. A brief field study of the pit area

On the basis of our review of items 1, 2 and 3 above, it was concluded that a mathematical model to calculate pre-mining ground water levels requires more detailed data than is presentl available. Pre-mining ground water levels were, therefore, estimated on the basis of historical data.

Clay Source Investigation

A preliminary estimate of the low permeability lining material required to initiate one of the proposed disposal alternatives is on the order of 250,000 yds^3 (Personal Communication, Mike Jones, Kaiser Engineers). The purpose of the clay source investigation is, therefore, to identify whether a source area(s) capable of providing the required quantity exists and to estimate the quality of the material available. Data collection consisted of the following:

1. A field exploration program. The field survey consisted of identifying existing stockpiles, estimating quantities, and obtaining representative soil samples for laboratory testing. Frozen ground precluded backhoe exploration in some areas.

2. Soil samples obtained in the field were tested in the laboratory for compaction characteristics, hydraulic conductivity, gradation and chemical suitability.

3. Review of geophysical logs in areas to be stripped and mined in the near future.

GEOLOGIC SETTING

General

The rolling plain and badland topography of the area has resulted from the erosion of thick sequences of non-marine Tertiary sediments which once formed a broad mantle over the entire region. In some areas, the Tertiary strata have been entirely removed by erosion, exposing the underlying Mesozoic rock. At the site, where most of the Tertiary sediments have been removed, the Wind River Formation is the only Tertiary stratum exposed. It is from the Wind River Formation that all uranium deposits are mined in the Gas Hills District. Younger Tertiary formations outcrop in the Beaver Rim south of the site. Plate 2, Local Geology, presents the principal geologic features in the vicinity.

Stratigraphy

The lithologic and water bearing properties of rock strata in the vicinity are summarized on Plate 3, Stratigraphic Description. The site is underlain by the Wind River Formation which has been divided into two primary members: a lower fine-grained unit and an upper (Puddle Springs) arkose member. The thickness of the Wind River Formation varies with the irregularities of the erosion surface upon which it was deposited. The Puddle Springs arkose member, consisting of massive, yellowish-gray, fine-to-medium-grained arkosic sandstone with occasional beds of conglomerate, siltstone and claystone, underlies the site. The sandstones and conglomerates are uncemented or weakly cemented with iron oxide. The lower fine-grained member which is composed of variegated siltstone and claystone, very fine-grained sandstone and a few carbonaceous shale beds, lies at a depth of 50 to 100 feet at the site. The lower fine-grained member varies from 150 to over 200 feet thick. The Wind River Formation is poorly indurated and only slightly cemented. The contact between the formation and the thin residual soil developed upon its surface is gradual and indistinct.

Uranium deposits in the Wind River Formation occur in three north-trending belts about six miles in length and three miles apart. The site is in the vicinity of the westernmost belt. The uranium ore occurs in lenses of permeable sandstone often below the water table.

The Wind River Formation rests unconformably upon Mesozoic strata. Pre-Tertiary formations are shown on Plate 3, Stratigraphic Description.

Stratigraphically, above the Wind River Formation is a series of younger Tertiary formations composed primarily of non-marine siltstones, claystones mudstones, sandstones and conglomerates. Bentonite is also present in the Tertiary sequence. These strata are exposed south of the site in the Beaver Rim area. Unconsolidated sediments of Quaternary age in the vicinity are alluvium, colluvium, landslide debris and terrace deposits.

Structure

The Gas Hills area lies along the southern margin of the Wind River basin, an elongate east-trending structural basin, and along the northern margin of the east-trending Sweetwater uplift. The Sweetwater uplift is gently inclined southwestward along its northern flank.

The Wind River Formation unconformably overlies progressively older strata southward across the area. Subjacent rocks, ranging in age from Paleocene to Precambrian, were folded during the Cretaceous or early Tertiary and deeply eroded prior to deposition of the Wind River Formation. In the site vicinity, the Mesozoic sedimentary strata underlying the Wind River Formation dip in a northerly direction 10 to 20 degrees. The Wind River Formation dips one to three degrees in a southwesterly direction. A system of east-trending normal faults and fractures and a number of northwest-trending gentle folds were developed in the strata during late Tertiary time. Structural features in the site vicinity are shown on Plate 2, Local Geology.

Site Soil and Bedrock Conditions

The Sagebrush-Tablestakes open-pit mine is excavated entirely through the upper arkosic member of the Wind River Formation and partially through the lower member. Excavation generally ends at the top of a relatively thick claystone lense 200-250 feet below original grade at approximately elevation 6,390. Overburden and stripping wastes are stockpiled generally to the north of the Sagebrush-Tablestakes pit and, at present, overburden is being placed in the Bullrush open-pit mine (Plate 1).

The Wind River Formation at the site consists of light brown, soft, fine to medium sandstone and brown to greenish-brown, soft, sandy claystone. The sandstone, which represents the upper part of the Puddle Springs arkose member, is uncemented, friable, and unfractured. The upper surface of the lower member is irregular but generally slopes southwestward. The lower member is green silty clayey sandstone to sandy claystone.

Previous studies by F. M. Fox (1979) indicate that the hydraulic conductivity of the in-place materials is low. Results of pack tests predominantly displayed a range in values of 1 to 8 ft/yr and .6 to 10 ft/yr for the upper and lower facies of the Wind River Formation, respectively. These values agree qualitatively with values obtained by Dames & Moore for other studies in the Gas Hills vicinity.

The Sagebrush Fault is an important structural feature at the site. The fault is located on the north end of the Sagebrush-Tablestakes area, as shown on Plates 2 and 4. The downthrown side is to the north with an estimated 120-foot offset.

GROUND WATER INVESTIGATION

Sources of Data

Data available prior to the beginning of mining operations is scarce. A report entitled "Ground Water Conditions and the Relation to Uranium Deposits in the Gas Hills Area, Fremont and Natrona Counties, Wyoming" (Marks, 1958) presents ground water levels in the Gas Hills region prior to most of the current mining activity. Ground water data for the report were obtained from open drill holes. Elevation control consisted of field location by air photo and U.S.G.S. 7½-minute quadrangle maps (Personal Communication, L. Y. Marks). Contour intervals for the U.S.G.S. quadrangle maps in the vicinity are 20 feet and, therefore, accuracy of the estimated ground water elevations in the report is ±10 feet. A copy of an original work map prepared during Marks' field studies was obtained from Federal American Partners.

Locations of wells filed with the Wyoming Office of the State Engineer are displayed on Plate 1, Vicinity Map. Table 1 summarizes the well log data obtained.

U.S.G.S. publication entitled "Ground-Water Resources and Geology of the Wind River Basin Area, Central Wyoming" (Whitcomb & Lowry, 1969) contains

REVISIONS
BY ______ DATE ______
FILE ______
BY ______ DATE ______
CHECKED BY ______

TABLE 1

SUMMARY OF WELL LOG DATA
(WITHIN 5 MILES OF SITE)

Ref. No.	Well	Date Of Well Completion	Total Depth (Ft.)	Reported Yield (GPM)	Main Aquifer	Static Water Level Depth (Ft.)	Estimated Elevation Of Water in Well
1	Puddle Springs	17/3	175	5	Wind River Fm	35	6,180*
2	Puddle Springs	17/1	150	5	Wind River Fm	40	6,245*
3	Lucky Mc #8	6/58	1,500	80	Cloverly Fm	392	6,020*
4	Lucby Mc #4	7/56	112	300	Qal or Twd	28	6,412*
5	Lucky Mc #5	6/57	995	350	Cloverly Fm	100	6,390*
6	Lucky Mc #11	8/57	2,140	120	Cloverly Fm	186	6,340*
7	Lucky Mc #7	8/57	1,720	150	Cloverly Fm	28	6,350*
8	Lucky Mc #1	8/54	90	10	Alluvium?	30	6,410*
9	Lucky Mc #6		1,340	350	Cloverly Fm	53	6,380*
10	Lucky Mc #9		1,362	625	Phosphoria & Tensleep Fms	26	6,495*
11	Lucky Mc #2	10/55	110	350	Wind River Fm	20	6,455*
12	Jay #1	12/56	206	100	Sandstone	80	6,440*
13	George #1		130	450	Wind River Fm	Open Pit	
14	Mimar #2	6/61	110	30	Qal or Twd	40	6,370*
15	Mimar #3	7/61	110	30	Qal or Twd	40	6,370*
16	Mimar #1	6/61	110	30	Qal or Twd	40	6,405*
17	Federal #8	8/59	270	100	Wind River Fm	70	6,388
18	Federal #6	7/59	415	100	Wind River Fm	70	6,402
19	Federal #13	11/61	350	125	Wind River Fm	?	6,350*
20	Federal #5	6/59	289	?	Wind River Fm	85	6,342
21	Federal #11	11/61	200	100	Wind River Fm	130	6,385*
22	Federal #16		360	?	Wind River Fm	170	6,320*
23	Sagebrush #1	3/57	180	70	Wind River Fm	126	6,414*
24	Federal #1	2/58	371	?	Wind River Fm	125	6,392
25	Federal #3	2/58	260	?	Wind River Fm	140	6,361
26	Federal #2	2/58	289	?	Wind River Fm	90	6,451
27	Federal #7	7/59	215	35	Wind River Fm	85	6,405
33	U.C.C. Shop	12/74	355	25	Wind River Fm	120	6,414
34	GR-1	12/76	193		Wind River Fm	137	6,486
35	Lucky Mc. No. 14	4/79	1,482	502	Tensleep Fm	70	6,470
36	Lucky Mc. No. 12	9/75	1,451	400	Tensleep Fm	80	6,480
37	White Ridge No. 4	1973	165	20	Wind River Fm	65	6,458
38	Peach #2	7/77	240		Wind River Fm	136	6,650
39	Peach #3	8/77	400		Wind River Fm	204	6,556
40	Peach #4	7/77	290		Wind River Fm	137	6,642
41	Peach #5	7/77	420		Wind River Fm	159	6,618
42	Peach #6	8/77	460		Wind River Fm	149	6,651
43	Peach #7	7/77	310		Wind River Fm	125	6,671
44	Peach #8	8/77	420		Wind River Fm	133	6,781
45	Peach #9	8/77	400		Wind River Fm	150	6,577
46	Peach Piez. A	10/77	452		Wind River Fm	75	7,366
47	Peach Piez. C	1/79	470	44	Wind River Fm	42	6,758
48	Peach Piez. D	1/79	550	11	Wind River Fm	209	6,711
49	Peach Piez. E	11/78	420	6	Wind River Fm	32	6,768
50	Peach Piez. F	11/78	400		Wind River Fm	45	6,673
51	Peach Piez. G	1/79	750		Wind River Fm	127	6,888
APPLICATIONS:							
28	Sagebrush 1		250	225	Wind River Fm	Open Pit	
29	Tablestakes 1		200	225	Wind River Fm	Open Pit	

WELLS UNFILED UPON:

30 Near Willow Springs Draw - no data available

31 Near Coyote Cre[illegible] - no data available

32 At George Homest[illegible]d - no data available

*Elevations estimated by locating on USGS 7½' quadrangle maps.

DAMES & MOORE

a map displaying ground water elevations in the Wind River Formation regionally but contours are conspicuously missing in the Gas Hills vicinity. The ground water elevations agree relatively well with those obtained by Marks down gradient of the active mining area.

A network of piezometers was installed around the Sagebrush-Tablestakes and Bullrush open pit mines (F.M. Fox, Inc., 1979). This network was monitored for approximately two months after installation. Results of the monitoring are presented in Table A-1 in the Appendix. A network of piezometers was installed around the tailing ponds but was not reviewed as a part of this project.

No detailed records of ground water conditions encountered during mining are kept by Federal American Partners (FAP). However, the following information was obtained from discussions with FAP personnel:

1. Ground water was first encountered at the south side of the Sagebrush-Tablestakes pit between elevation 6,435-6,440 in April, 1967.

2. Ground water was first encountered in the Bullrush pit at approximately elevation 6,350 in April, 1969.

3. Approximately 130 gpm is being pumped from the Sagebrush pit at the present time.

The field review of the pit area consisted of visual observations and measurement of water levels in piezometers still in existence in the pit area. In addition, the following observations were made:

1. A visible seepage face was present along the southern face of the pit wall. The top of the saturated zone was approximately at elevation 6,390.

2. Mudstone lenses could be seen at various elevations on the pit wall. Small amounts of perched seepage were observed above these lenses.

Most of the piezometers installed by F. M. Fox have subsequently been destroyed by the mining operation. Ground water levels were recorded in piezometer ST-F10, ST-F14 and ST-F15. The data are presented with previous monitoring results in Appendix B.

History

Uranium mining has been active in the Gas Hills region for over 20 years. The chronological sequence of events related to mining activities near Federal American Partners' Sagebrush-Tablestakes open-pit mine aid in understanding the changes to the pre-mining ground water system.

Mr. L. Y. Marks concluded the field work for his ground water project in October, 1957. At that time ground water in the vicinity of the Sagebrush-Tablestakes area was relatively undisturbed. Ground water elevations, as interpreted by Marks in 1957, in the vicinity of the Sagebrush-Tablestakes area are shown in Plate 3.

Between late 1957 and 1962 at least 11 wells were installed for culinary and industrial use to supply the Federal American camp and mill. Pumping test results reported for individual wells indicate drawdowns of 10-40 feet for discharges of approximately 100 gpm during short duration tests (less than 12 hours). No reliable records of quantities pumped by the wells exist to our knowledge; however, it is reasonable to expect that drawdowns of 20-50 feet occur locally near the wells based on the reported pumping test data.

Open-pit mining and stripping in the Sagebrush-Tablestakes pit operated in essentially dry conditions until April, 1967 when ground water was encountered between elevations 6,435 and 6,440. Ditching along the south end of the pit has captured seepage and directed it to a sump where it is pumped out of the pit as shown on Plate 6.

Ground water was first encountered in the Bullrush pit (located north of the Sagebrush pit) in April, 1969 at approximately elevation 6,350. It should be noted that pumping from the nearby Federal wells may have resulted in a significant drawdown in the Bullrush area.

Federal American Partners used an underground mining operation between 1970 and 1974. Three portals for the mine entered sidewalls of the Sagebrush-Tablestakes pit, as it existed in 1970. Records maintained by Federal American Partners personnel indicate that ground water was encountered between elevations 6,422 and 6,430. Maximum pumping to dewater the underground operation was 17 gpm. These formerly active underground areas are currently being uncovered by open pit mining.

A network of 15 piezometers was installed by F. M. Fox, Inc. during 1978. The ground water map displayed (Plate 2) in their report entitled "Baseline Geotechnical Investigation" shows the effects of pit dewatering and pumping by the Federal American camp and mill wells. Ground water flow directions are locally reversed in the pit areas when compared with the regional gradient because of pumping for pit dewatering.

Four of the fifteen wells installed are screened below a mudstone layer, 20 feet or more in thickness. The top of the mudstone layer is at approximately elevation 6,400. F. M. Fox, Inc. concluded, in effect, that piezometric levels below the mudstone layer are not affected by pit dewatering, that pizometric levels above the mudstone layer would increase approximately 30 feet after the Sagebrush pit had been backfilled, and, therefore, ground water above the mudstone layer is perched.

Conclusions

Plate 5 displays our interpretation of pre-mining ground water levels. The estimated pre-mining ground water elevations range from approximately 6,440 at the south end of the Sagebrush pit to 6,430 at the north end, corresponding to a northerly gradient of .009.

The ground water elevations were determined by adjusting Marks' map to conform with the observations recorded by Federal American personnel and information from wells installed prior to 1959 or wells distant from the influence of mine pit dewatering. Comparison of water levels reported on well logs with data presented by Marks (1958) shows that in almost all cases Marks' data are higher by 10 feet or more. The water table surface as shown in Plate 5, although somewhat lower, falls within the range of accuracy used by Marks to prepare his water table surface map.

As was indicated in the report by Marks, and the report by F. M. Fox, the ground water gradient changes abruptly near the Sagebrush Fault with water levels approximately 40-50 feet lower on the downthrown (north) side of the fault.

The piezometric maps prepared by F. M. Fox display the effects of pit dewatering. The ground water contours, except where affected by the Sagebrush Fault, parallel the existing open pit topography.

A mudstone layer below approximately elevation 6,400 varies in thickness from 20 to over 40 feet in the Sagebrush-Tablestakes pit. This layer will tend to direct seepage horizontally because of its relatively high horizontal to vertical hydraulic conductivity ratio.

Monitoring of piezometers ST-F14 and ST-F15, which have screened intervals below the mudstone layer, have recorded levels at an elevation of approximately 6,400. The effect of dewatering on piezometric levels below the mudstone layer is unknown. Water levels recorded in ST-F14 and ST-F15 (screened below mudstone layer) during the field studies in January, 1980 indicated a gradient toward the existing sump in the southeast corner of the Sagebrush pit. Therefore, piezometric levels in the confined aquifer below the mudstone layer may be affected by pit dewatering. It is apparent from these data, however, that a continuous unsaturated zone below the base of the mudstone layer does not exist.

CLAY SOURCE INVESTIGATION

Source Areas

Possible source areas for lining materials were determined through discussions with Federal American Partners personnel, discussions with neighboring land owners, review of geological information available, and a field investigation. Potential source areas investigated are displayed on Plate 1 and are as follows:

1. Sagebrush-Tablestakes Pit.

   Three sources of low permeability materials are currently available in the Sagebrush-Tablestakes Pit. Fine grained lenses of the lower Wind River Formation encountered during stripping operations are currently being stockpiled at the location shown on Plate 6. In addition to the material stockpiled, additional fine grained lenses will be available for stockpiling as stripping and mining activities continue. The mudstone layer below approximately elevation 6,400 is also a potential source of low permeability material.

2. Bullrush Pit.

   A portion of the stripping wastes from the Sagebrush-Tablestakes Pit is being disposed in the Bullrush Pit at the present time. Materials were checked for suitability.

3. Sunset Pit.

   The Sunset Pit is being actively mined. A survey of the pit area was made to determine if suitable low permeability materials are available.

4. Clyde Bret Pit.

   Open-pit mining operations are presently inactive in this pit. A stockpile of material removed during stripping operations is present and was examined.

5. Neighboring Mining Operations.

   Representatives of Union Carbide Corporation were contacted regarding availability of low permeability materials from their stripping operations.

6. Development of New Clay Sources.

   The possibility of obtaining Cody Shale or other locally outcropping units containing low permeability materials was briefly investigated.

Source areas 2 and 3 listed above were eliminated after field inspection. Materials stockpiled in the area consist mostly of fine to medium sand with some silt. Small areas of finer materials exist but have not been segregated from the coarser materials. Segregation at this time would not be possible.

Source area 5 was eliminated after discussions with Union Carbide Corporation (UCC) personnel. All clay available to UCC is scheduled for use on their site.

Source area 6 is a possibility which would require investigations beyond the scope of this report to determine feasibility as clay sources. Discussions with American Nuclear Corporation personnel indicated two possible sources that could be made available to Federal American Partners. Bentonite was encountered in drilling performed south of the site in the Wagon Bed Formation (Beaver Rim area). No information was readily available regarding location of the bentonite seams, estimated quantities or land ownership.

Cody Shale outcrops northeast of the Federal American site at the northern edge of Sec. 21, T.33 N., R.90 W. near Sarcophagus Butte, as shown on Plate 2, Local Geology. The land owned by American Nuclear Corporation is south of the Cody Shale contact and has Wind River Formation at the surface. The thickness of Wind River Formation is estimated as 20 to 50 feet. It is recommended that this alternative not be pursued unless other alternatives prove completely unfeasible.

Field Explorations and Laboratory Testing

General

A field exploration and laboratory testing program was conducted for the proposed tailing disposal project. Data obtained during the course of a previous study (F.M. Fox, Inc., 1979) were reviewed. In addition, data from this study were compared with data obtained in our previous studies for similar projects in the area.

A geologic reconnaissance and a surface sampling program were conducted for this study. Soil samples obtained were classified by visual and textural examination in the field, and by supplemental inspection and testing in our laboratory.

Laboratory tests including moisture and density, grain-size distribution, Atterberg limits, compaction, permeability and consolidation tests, have been performed during this study and the previous study by F. M. Fox, Inc. (1979). In addition, clay mineralogy and exchange properties were determined at independent laboratories. Detailed discussions of procedures and testing results are presented in Appendix A.

In general, the materials tested exhibit physical characteristics similar to materials tested for other projects in the Gas Hills vicinity. The materials exhibit low permeability with 20% - 50% by weight passing the #200 mesh screen. The predominant mineral in the clay fraction is montmorillonite and the materials generally exhibit a low plasticity. Soils with physical characteristics closely approximated by the soils analyzed for this report have been successfully utilized in several similar projects in the area.

Estimated Quantities Available

Available sources of low permeability materials for the purposes of this report consist of existing stockpiles or areas to be strip mined in the near future. Stockpile quantities were determined by estimating heights and dimensions of the stockpile in the field. These estimates could be better defined by field surveys.

Estimates of clayey materials available from future mining areas were defined by interpretation of geophysical logs supplied by Federal American Partners. Gamma ray and resistivity logs were examined concurrently to determine clayey zones. Table B-2 in Appendix B lists logs supplied by Federal American Partners that were used to estimate quantities of clayey materials available from future mining areas.

A summary of the estimates is listed below:

Source	Location	Estimated Haul Distance (miles)	Estimated Quantity (cu yds)
Stockpile	Sagebrush-Tablestakes	Less than .2	35,000
Future Mining Areas	Sagebrush-Tablestakes, Sagebrush Extension	Less than .2	85,000
Basal Mudstone Layer	Sagebrush-Tablestakes	Less than .2	60,000
Stockpile	Clyde Bret	6	150,000
		Total Available -------	330,000

The quantities as estimated above are based on the following assumptions:

1) Only 30% of the clay available from future mining areas as determined by the interpretation of the geophysical logs will be recovered as lining material.

2) Only five feet of material is usable from the basal mudstone layer. In addition, material removed from the basal mudstone will only be obtained from areas that are at elevation 6,410 or lower at the present time.

Recommendations and Conclusions

It is our opinion that the required quantities of suitable lining material can be developed. However, because of the multiple sources that have to be developed to produce the required quantities and the variations in material properties, a high degree of quality control will be necessary during construction. We, therefore, recommend that an experienced soils engineer be present during construction of the liners to direct a quality control program from source to final product.

REFERENCES

F.M. Fox & Associates, Inc., Baseline Geotechnical Investigation for the Subsurface Disposal of Mill Waste, January, 1979.

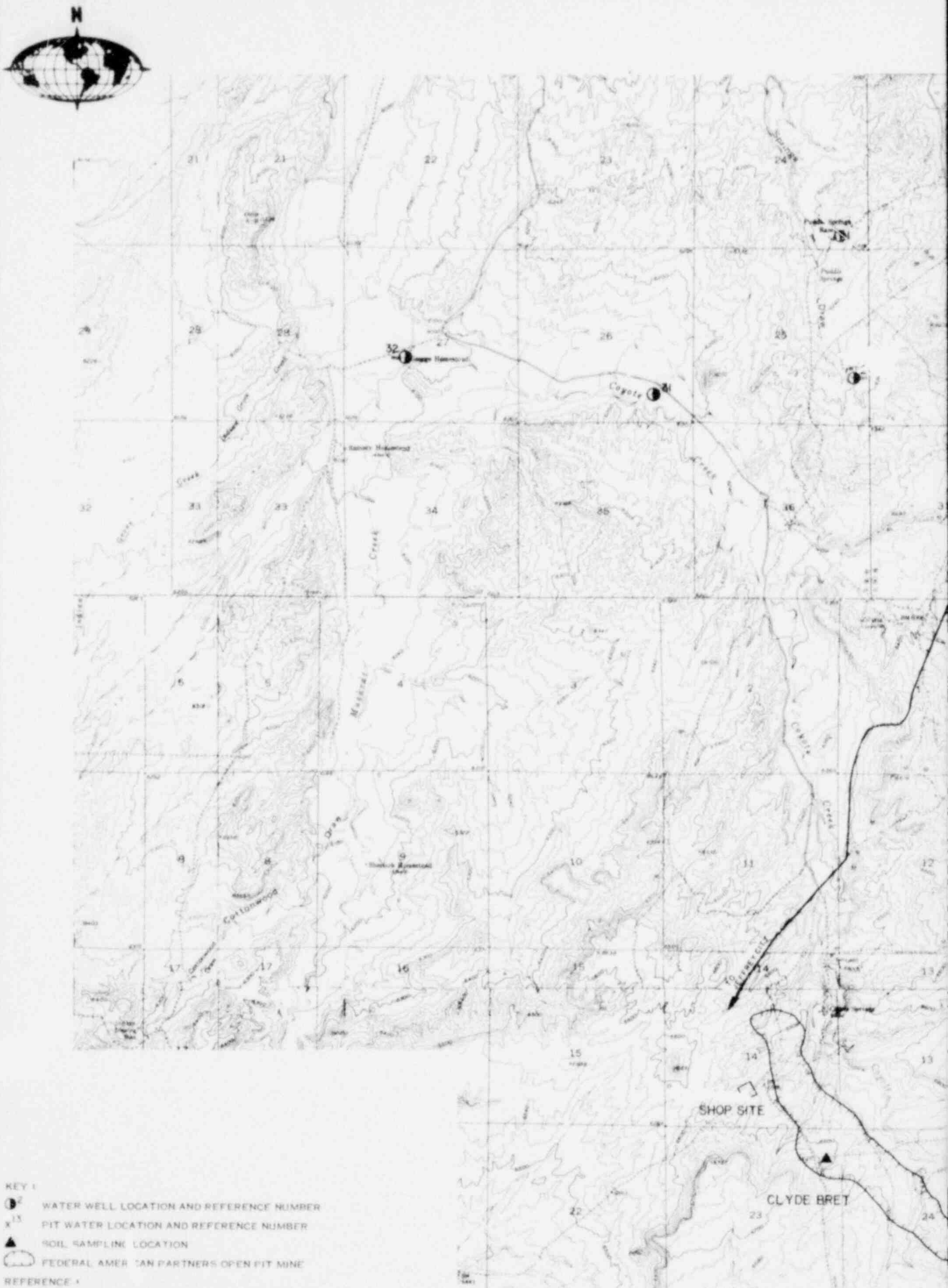
_______, Additional Geotechnical Investigation and Design For the Subsurface Disposal of Mill Waste.

Jones, M., Kaiser Engineers (verbal communication), 1980.

Marks, L. Y., Ground Water Conditions and the Relation to Uranium Deposits in the Gas Hills Area, Freemont and Natrona Counties, Wyoming: Technical Memorandum TM-197, U.S. Atomic Energy Commission. Presented at the Annual Meeting of the Geological Society of America in St. Louis on November 8, 1958.

_______, Bureau of Mines (verbal communication), 1980.

Whitcomb, H.A., and M.E. Lowry, Ground Water Resources and Geology of the Wind River Basin Area, Central Wyoming: Hydrologic Investigations Atlas HA-270, U.S. Geological Survey, Washington, D.C., 1969.



KEY :

WATER WELL LOCATION AND REFERENCE NUMBER

PIT WATER LOCATION AND REFERENCE NUMBER

SOIL SAMPLINK LOCATION

FEDERAL AMER CAN PARTNERS OPEN PIT MINE

REFERENCE :

U.S.G.S. QUADRANGLE MAPS ENTITLED, "RONGIS RESERVOIR" "PUDDLE SPRINGS", "McINTOSH MEADOWS", "GAS HILLS", "COYOTE SPRINGS", "AND MUSCRAT BASIN".

FEET

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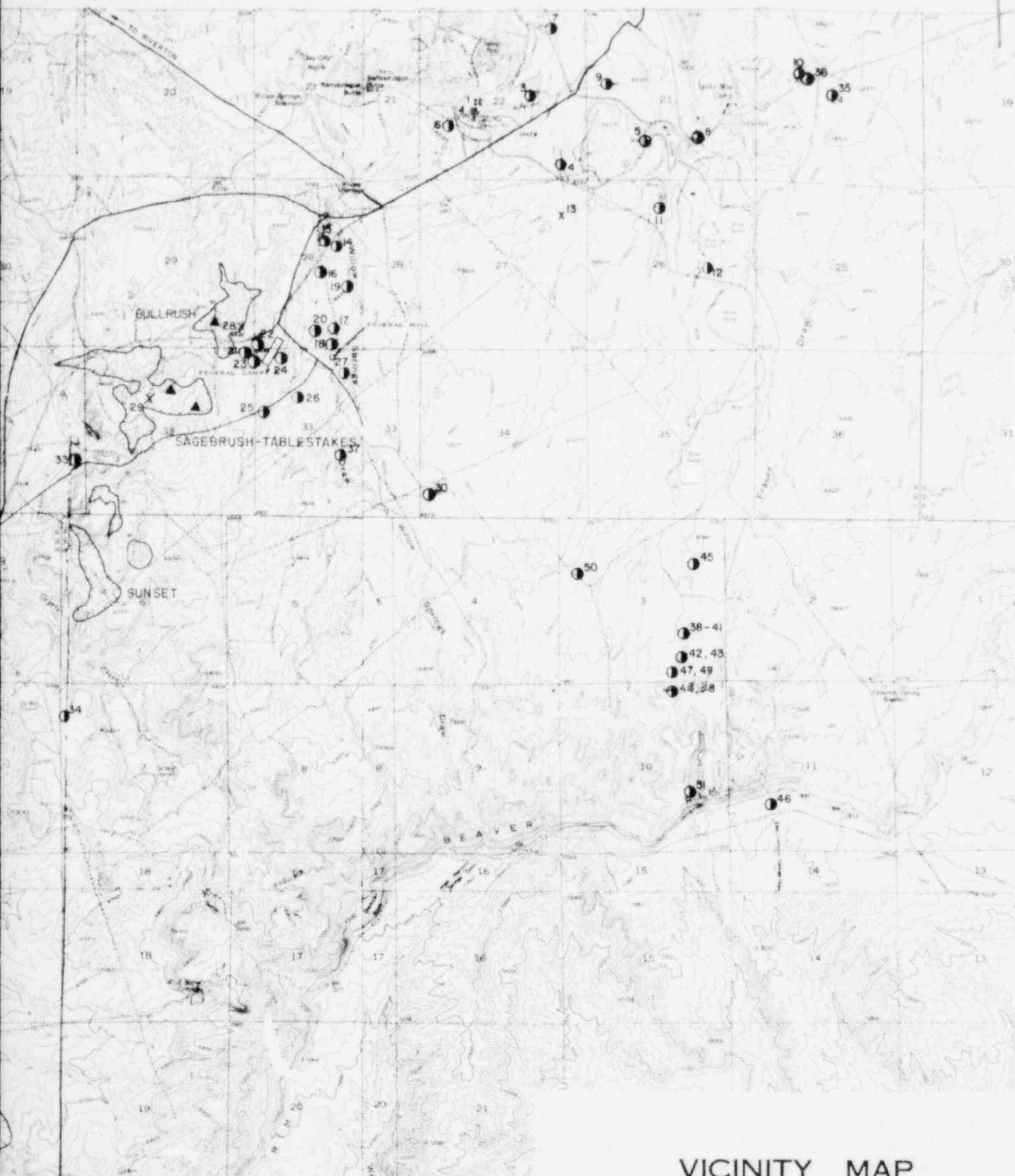
POOR ORIGINAL



VICINITY MAP

POOR ORIGINAL

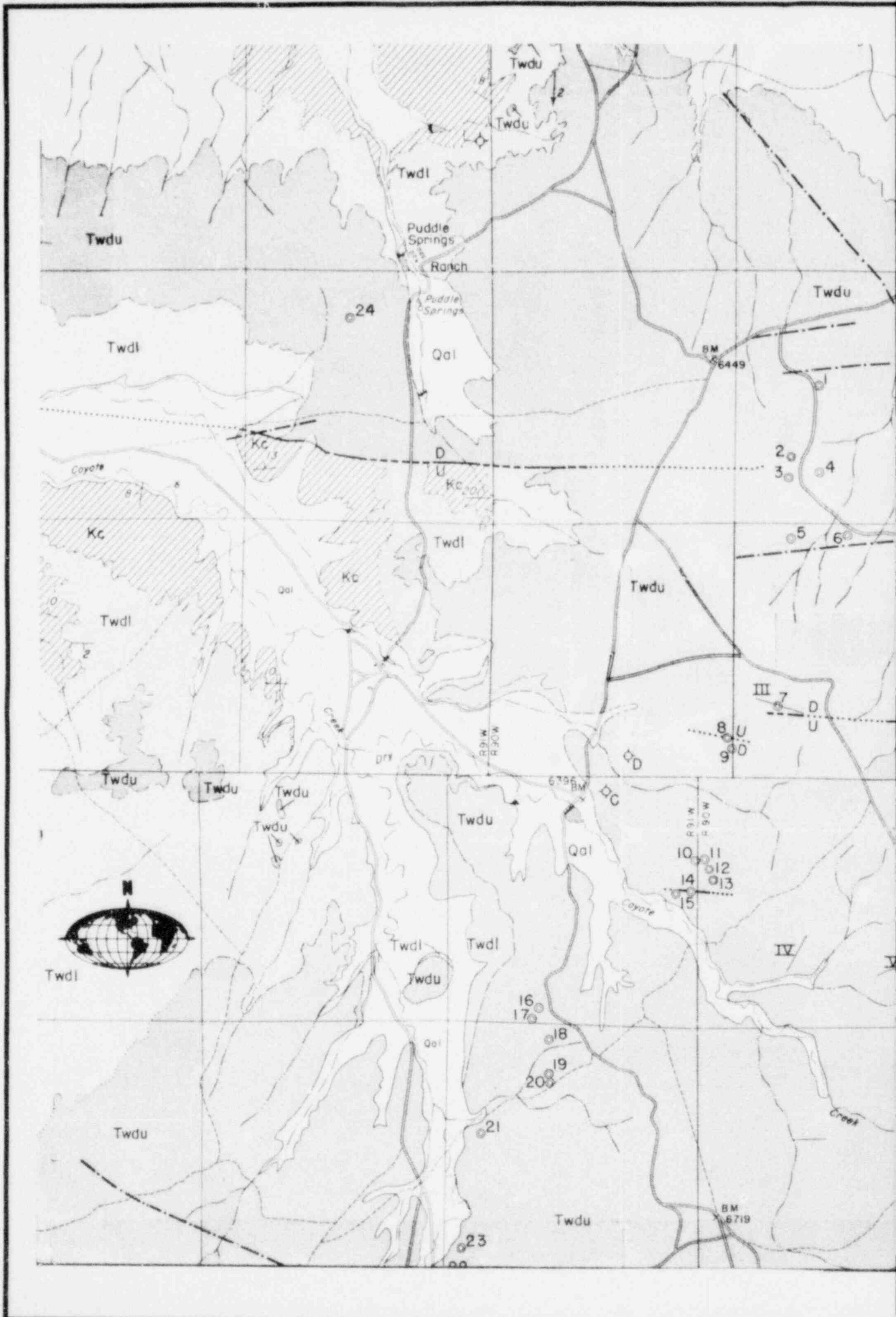
DAMES & MOORE

PLATE I

POOR ORIGINAL

FILE 0822-067
UNION CARBIDE
BY H.S.T. DATE 3-20-74
CHECKED BY DATE 3-26-74

REVISIONS
BY DATE 2-10-75
BY
PLATE OF



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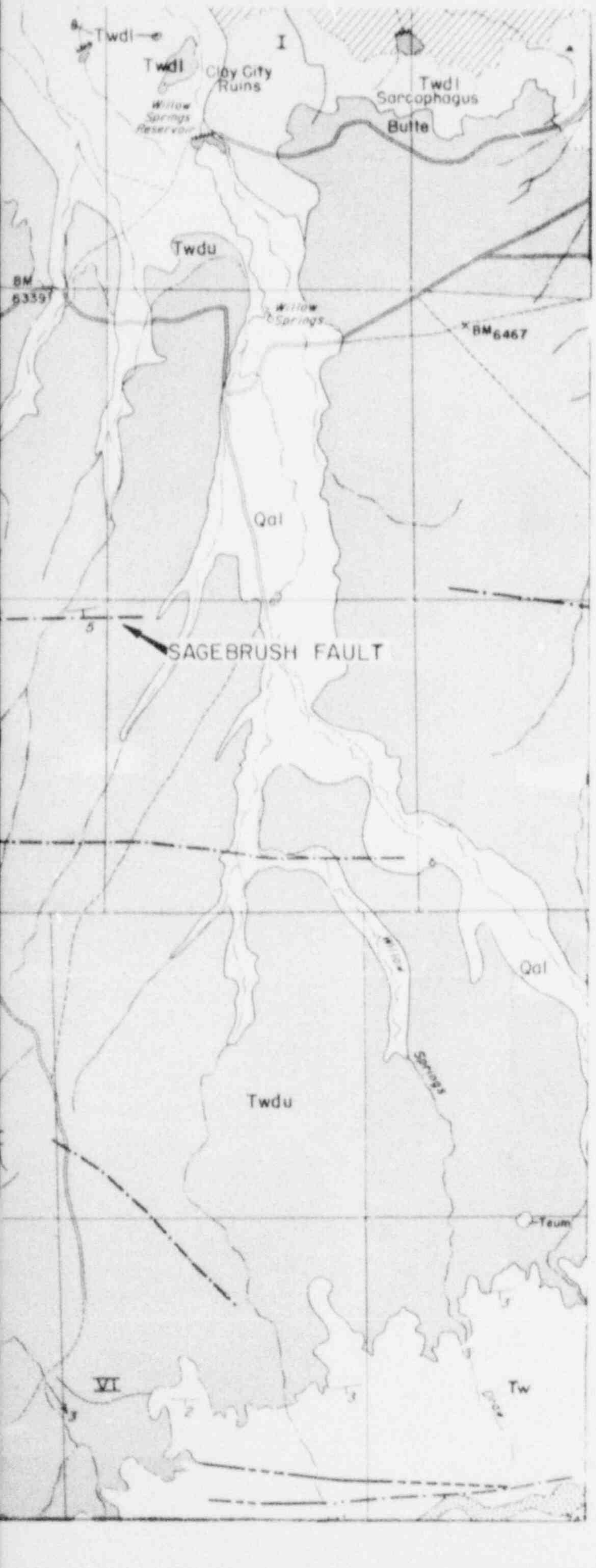

KEY

Qal	ALLUVIUM, SLOPEWASH, TERRACE DEPOSITS
Tw	WAGON BED FORMATION
Twdu	WIND RIVER FORMATION — UPPER FACIES
Twdl	— LOWER FACIES
Kc	CODY SHALE

SEE PLATE 3 FOR FULL STRATIGRAPHIC DESCRIPTION

CONTACT

FAULT

LINEAMENT ON AERIAL PHOTOGRAPH

STRIKE AND DIP OF BEDS

OIL WELL (DRY HOLE)

GEOLOGIC SECTION (PLATE 7)

REFERENCE ZELLER, SOISTER, HYDEN (1956) SHEET 1

SCALE ONE INCH EQUALS ONE-HALF MILE (.)

LOCAL GEOLOGY

DAMES & MOORE

AGE	SYMBOL	GENERAL DESCRIPTION	THICKNESS (FEET)	WATER BEARING PROPERTIES IN SITE REGION
QUATERNARY	Qal	ALLUVIUM, COLLUVIUM, SLOPE WASH AND TERRACE DEPOSITS		VARIABLE – MAY YIELD WATER TO SOME SHALLOW WELLS NEAR STREAMS
	Qls	LANDSLIDE DEBRIS		NOT PRESENT AT SITE
TERTIARY	Tsr	SPLIT ROCK FM – WELL SORTED VOLCANIC SANDSTONE WITH SOME CONGLOMERATE BEDS	120-150	NOT PRESENT AT SITE
		EROSIONAL UNCONFORMITY		
	Twr	WHITE RIVER FM – BENTONITIC MUDSTONE WITH LENSES OF ARKOSIC SANDSTONE AND CONGLOMERATE	100-650	NOT PRESENT AT SITE
		EROSIONAL UNCONFORMITY		
	Tw	WAGON BED FM – SANDSTONE, SILTSTONE AND MUDSTONE	150-700	NOT PRESENT AT SITE
	Twd (Twdu / Twdl)	WIND RIVER FM – UPPER FACIES SANDSTONE, CONGLOMERATE AND OCCASIONAL MUDSTONE – LOWER FACIES SILTSTONE, CLAYSTONE, SOME FINE SANDSTONES	0 - 900	UPPER FACIES YIELDS TO SHALLOW WELLS IN VICINITY, LOWER FACIES MAY YIELD SMALL AMOUNTS. TYPICALLY YIELDS 30-125 GPM, ONE REPORT OF 350 GPM
		ANGULAR UNCONFORMITY		
CRETACEOUS	Kc	CODY SHALE – SHALE AND SANDSTONE	5000-5500	AQUICLUDE
	Kf	FRONTIER FM – SANDSTONE AND SHALE	580-910	SOME WATER REPORTED BUT APPARENTLY NOT UTILIZED (WELLS 6, 7)
	Km	MOWRY SHALE – SILICEOUS SHALE WITH SILTSTONE AND BENTONITIC BEDS	400-540	AQUICLUDE
	Kt	THERMOPOLIS SHALE – SOFT SHALE WITH SOME SANDSTONE, SILTSTONE AND BENTONITIC BEDS	210-260	AQUICLUDE
	Kjm	CLOVERLY AND MORRISON FMS (UNDIFFERENTIATED) – SANDSTONE, CONGLOMERATE, SHALE AND CLAYSTONE	290-380	UPPER SANDSTONE AND CONGLOMERATE BED OF CLOVERLY FM IS THE PRINCIPAL AQUIFER FOR DEEP WELLS (WELLS 3, 5, 6, 7, 9) YIELDS OF 80 TO 350 GPM REPORTED
JURASSIC	Js	SUNDANCE FM – SANDSTONE, SHALE AND SOME LIMESTONE, UPPER PART IS GLAUCONITIC	220-260	UNKNOWN
		UNCONFORMITY		
	Jn	NUGGET SANDSTONE – SANDSTONE AND SHALY SANDSTONE	170-325	UNKNOWN
		UNCONFORMITY		
TRIASSIC	₮c	CHUGWATER FM – SANDSTONE WITH BEDS OF LIMESTONE AND SILTSTONE	1100-1270	SMALL AMOUNTS OF WATER REPORTED IN THIS FORMATION (WELL 10)
	₮d	DINWOODY FM – SANDSTONE AND SHALE, SOME DOLOMITE	60	NOT KNOWN TO YIELD WATER NEAR SITE
PERMIAN	Pp	PHOSPHORIA FM – DOLOMITIC SILTSTONE AND DOLOMITE WITH SOME CHERTY AND PHOSPHATIC ZONES	350	PHOSPHORIA FM YIELDS FROM FRACTURED DOLOMITE IN WELL 10. REPORTED YIELD OF WELL 10 IS 625 GPM FROM PHOSPHORIA AND TENSLEEP FORMATION
		UNCONFORMITY		
	P₱t	TENSLEEP SANDSTONE – SANDSTONE WITH SOME DOLOMITE AND CHERTY DOLOMITE BEDS	230-300	
PENNSYLVANIAN	₱a	AMSDEN FM – SANDSTONE AND SHALE WITH LIMESTONE AND DOLOMITE BEDS	190	UNKNOWN, PROBABLY POOR
		UNCONFORMITY		
MISSISSIPIAN	Mm	MADISON LIMESTONE – LIMESTONE AND DOLOMITE	320-420	UNKNOWN – CAVERNS AND SOLUTION CAVITIES YIELD LARGE QUANTITIES IN OTHER PARTS OF STATE
		UNCONFORMITY		
CAMBRIAN	Є	GALLATIN LIMESTONE, GROS VENTRE FM, AND FLATHEAD SANDSTONE (UNDIFFERENTIATED) GLAUCONITIC LIMESTONE, GLAUCONITIC SILTSTONE AND SANDSTONE, QUARTZITE	570-880	UNKNOWN
PRECAMBRIAN	PЄ	UNNAMED – GRANITE, GNEISS, SCHIST		UNKNOWN

STRATIGRAPHIC DESCRIPTION

DAMES & MOORE

PLATE 3

KEY :

GROUND WATER LEVEL MEASURED JANUARY, 1980

6458 ESTIMATED GROUND WATER ELEVATION IN WELL

6200 GROUND WATER ELEVATION CONTOURS (MARKS, 1958)

O CONTROL POINT FOR GROUND WATER ELEVATION CONTOURS (MARKS, 1958)

REFERENCE :

MARKS, L.Y. (1958) GROUND WATER CONDITIONS AND THE RELATION TO URANIUM DEPOSITS IN THE GAS HILLS AREA, FREEMONT AND NATRONA COUNTIES, WYOMING. U.S. ATOMIC ENERGY COMMISSION TECHNICAL MEMORANDUM TM-197.

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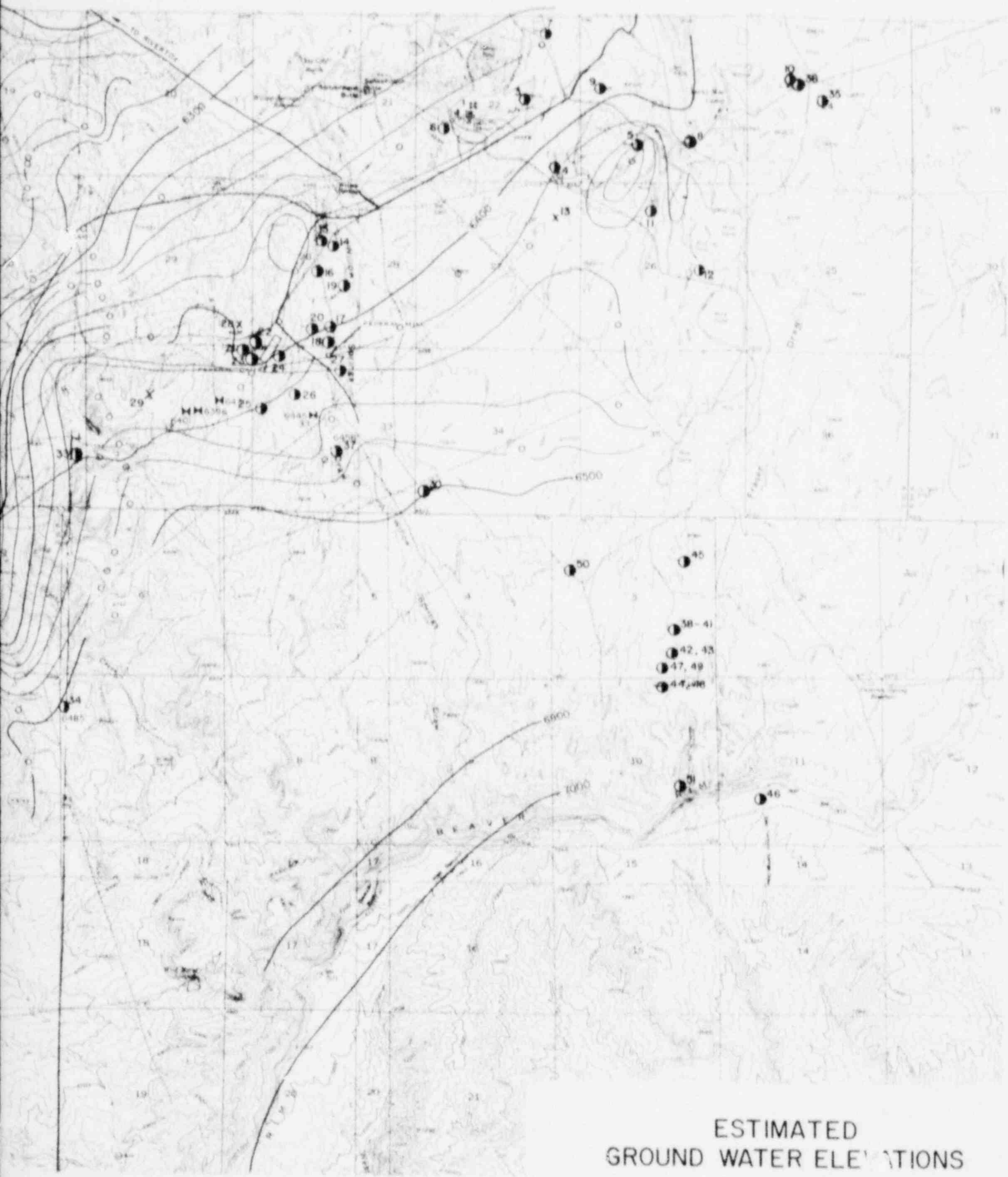


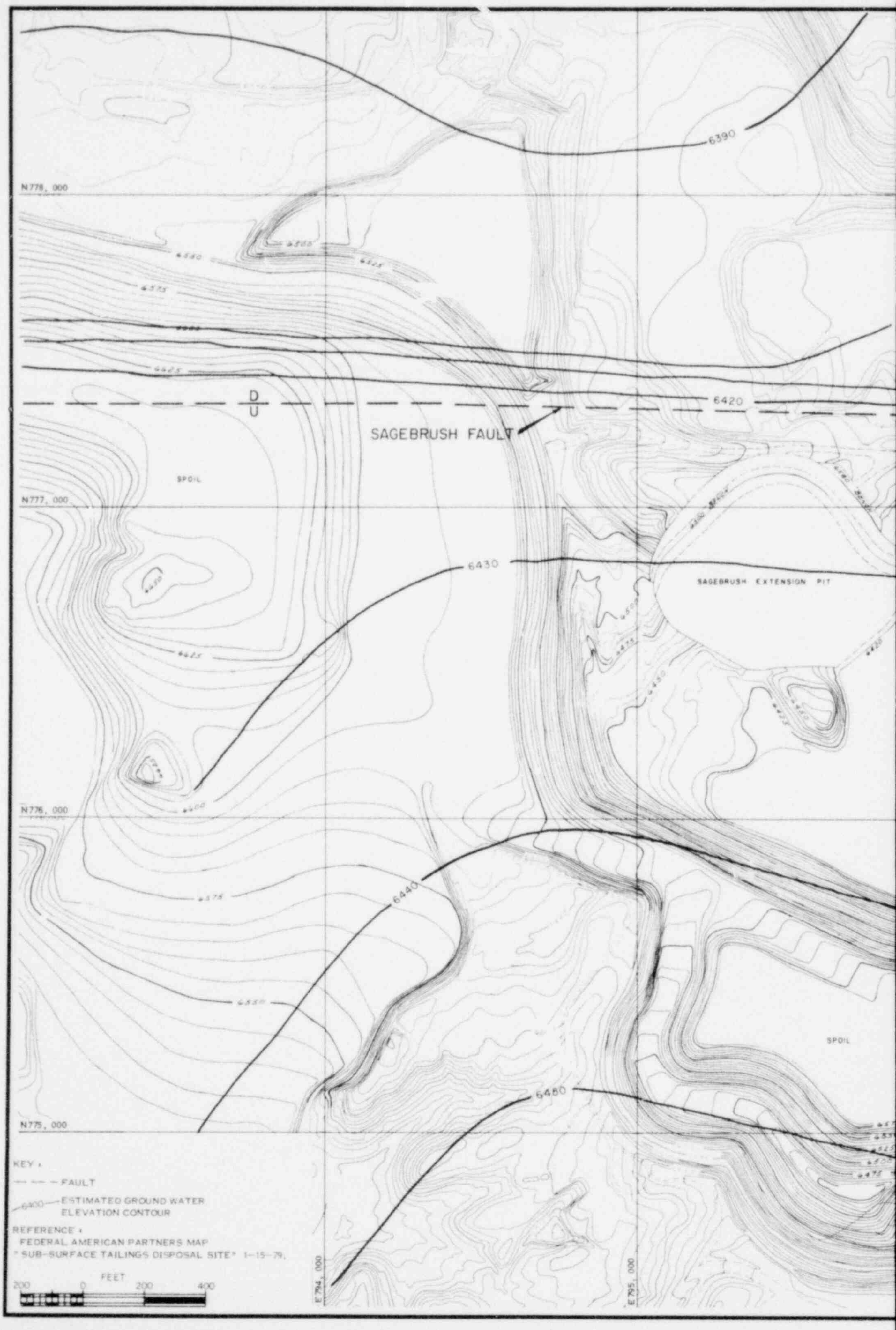
ESTIMATED
GROUND WATER ELE'ATIONS
(BY MARKS)

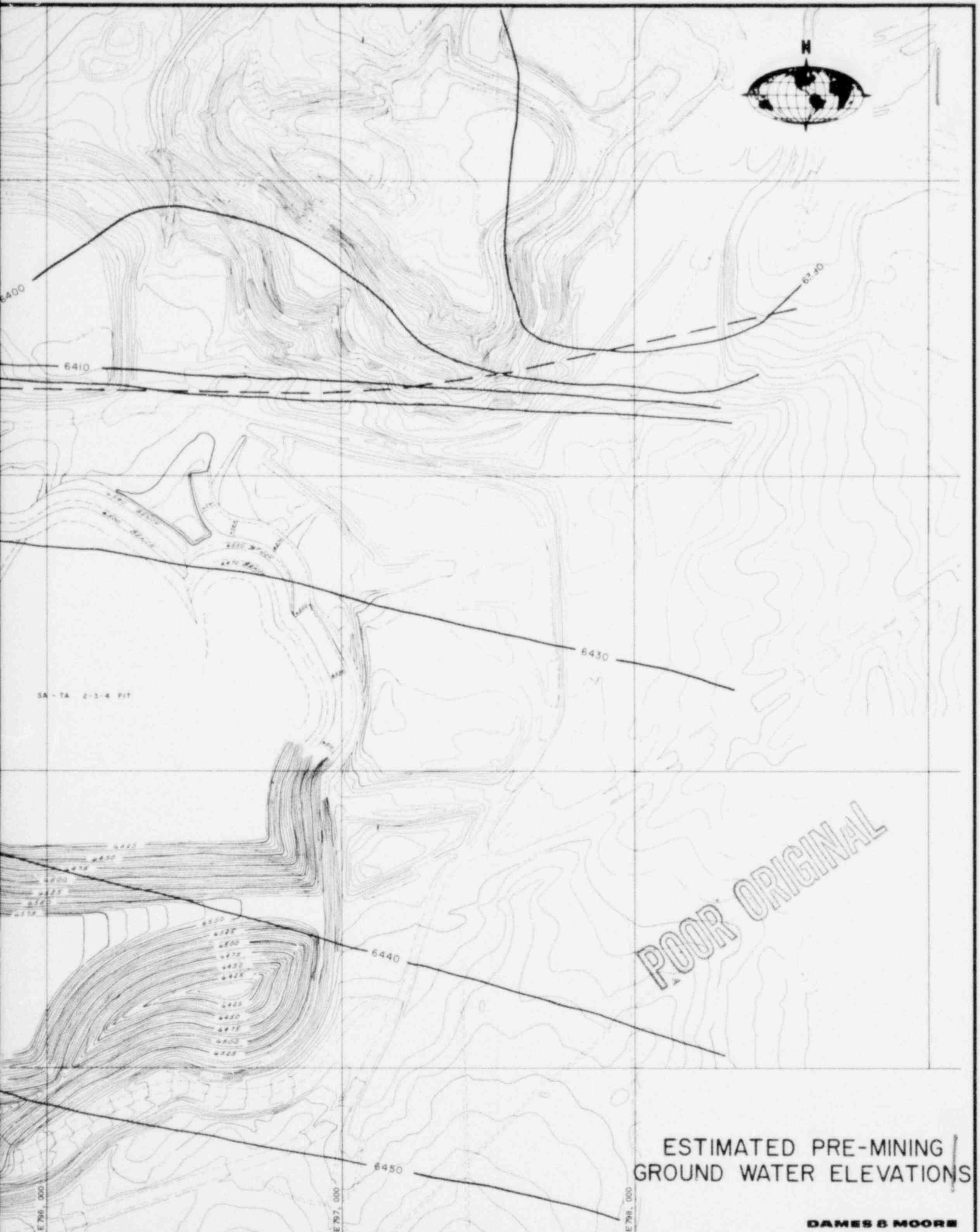
POOR ORIGINAL

DAMES & MOORE

PLATE 4

POOR ORIGINAL

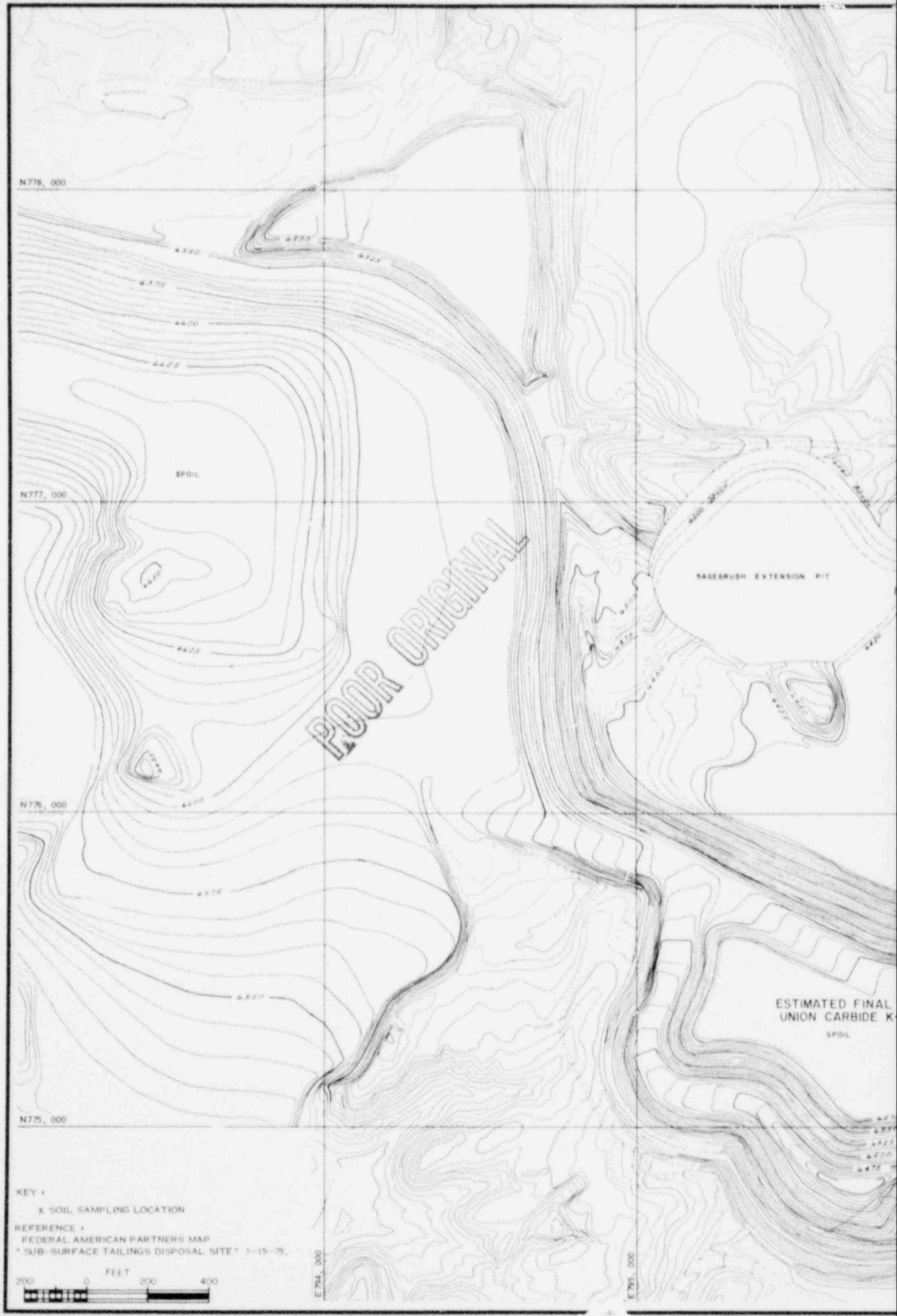




ESTIMATED PRE-MINING GROUND WATER ELEVATIONS

DAMES & MOORE

PLATE 5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E794, 000
E795, 000
SPOIL
POOR ORIGINAL
SAGEBRUSH EXTENSION PIT
ESTIMATED FINAL
UNION CARBIDE K
SPOIL
KEY :
X SOIL SAMPLING LOCATION
REFERENCE :
FEDERAL AMERICAN PARTNERS MAP
" SUB-SURFACE TAILINGS DISPOSAL SITE" 1-15-79.
FEET
200 0 200 400

SOIL SAMPLE LOCATIONS

DAMES & MOORE

PLATE 6

APPENDIX A

FIELD EXPLORATIONS AND LABORATORY TESTING

General

A field exploration and laboratory testing program was conducted for the proposed tailing disposal project. Data obtained during the course of a previous study (F.M. Fox, Inc., 1979) were reviewed. Applicable information from this previous study is summarized herein. In addition, data from this study were compared with data obtained in our previous studies for similar projects in the area.

Field Exploration

A geologic reconnaissance and a surface sampling program were conducted for this study. Soil samples obtained were classified by visual and textural examination in the field, and by supplemental inspection and testing in our laboratory.

A description of surface samples obtained during this study is presented below:

Sample Number*	Sample Type	Soil Type	Comment
STDM-1	Bag	Dark Green Silty Clayey Sand	Stockpile
STDM-2	Bulk	Dark Green Sandy Clay	Representative of mudstone layer
STDM-3	Thin Wall	Dark Green Sandy Clay	Representative of mudstone layer
STDM-4	Bag	Dark Green Silty Sand	Representative of coarse material present in mudstone layer
STDM-5	Bag	Dark Green Silty Clayey Sand	Stockpile
STDM-6	Thin Wall	Dark Green Silty Clayey Sand	Loose material in stockpile

Sample Number*	Sample Type	Soil Type	Comment
STDM-7	Bulk	Dark Green Silty Clayey Sand	Stockpile
STDM-8	Thin Wall	Dark Green Silty Clayey Sand	Dense material in stockpile
STDM-9	Bag	Dark Green Silty Clayey Sand	Stockpile
STDM-10	Bulk	Dark Green Clayey Sand	Mudstone lense from bench above and north of stockpile
BR-1	Bulk	Dark Green, Fine-Medium Silty Sand	
CB-1	Bag	Brown Fine to Medium Silty Sand	
CB-2	Bag	Green Clayey Silt	Finest material in stockpile
CB-3	Bulk	Olive-Brown Silty Sand	

* STDM - Sagebrush-Tablestakes Pit
BR - Bullrush Pit
CB - Clyde Bret

See Plate 6 for locations.

Laboratory Tests

Laboratory tests including moisture and density, grain-size distribution, Atterberg limits, compaction, permeability and consolidation tests, have been performed during this study and the previous study by F. M. Fox, Inc. (1979). In addition, clay mineralogy and exchange properties were determined at independent laboratories. Pertinent results are summarized in the following sections.

Grain-Size Distribution

Gradation tests were performed on selected samples to aid in soil classification. The results are presented on Plates A-1 through A-4. A range of approximately 20-50% by weight passing the #200 mesh screen was found for the samples tested. A similar range was present in the soils tested by F. M. Fox.

Atterberg Limits

To provide additional classification data, Atterberg limits tests were performed. The results are summarized below:

Sample No.	L.L.	P.I.	Class
STDM-2	36.3	13.1	ML-CL
STDM-7	34.1	14.8	CL
STDM-8	37.2	11.0	ML
STDM-10	31.6	11.4	CL
BR-1	26.6	3.5	ML
CB-3	32.4	6.7	ML

Compaction Tests

Compaction tests were performed upon three selected samples. The tests were performed in accordance with the American Association of State Highway Testing Officials (A.A.S.H.T.O.) T-180 Method of Compaction. Test results are presented on Plate A-5 through A-7.

Permeability Tests

To determine the permeability characteristics of possible liner materials, a series of permeability tests were performed upon recompacted samples. Plate A-8 describes the lab permeability. Samples, with the exception of STDM-3, were recompacted to approximately 90 percent of the maximum dry density as determined by the A.A.S.H.T.O. T-180 Method of Compaction. The permeability for STDM-3 was obtained from an undisturbed sample from the mudstone layer. Samples were tested with water and with a sulfuric acid solution with an initial pH of 2. Results are summarized below:

Sample No.	Confining Pressure (PSF)	Hydraulic Conductivity (Ft/Yr) Water	Acid
STDM-2	2,000	3.4	.18
STDM-3	2,000	11	1.8
STDM-7	2,000	.40	†
BR-1	2,000	22	12

† Flow not measurable

Experience has shown that the hydraulic conductivity values determined with acid are low initially but increase to values approximately the same as those obtained for water after several weeks. Because of the immediate need for data, percolation tests were run until stable values were obtained.

Consolidation Tests

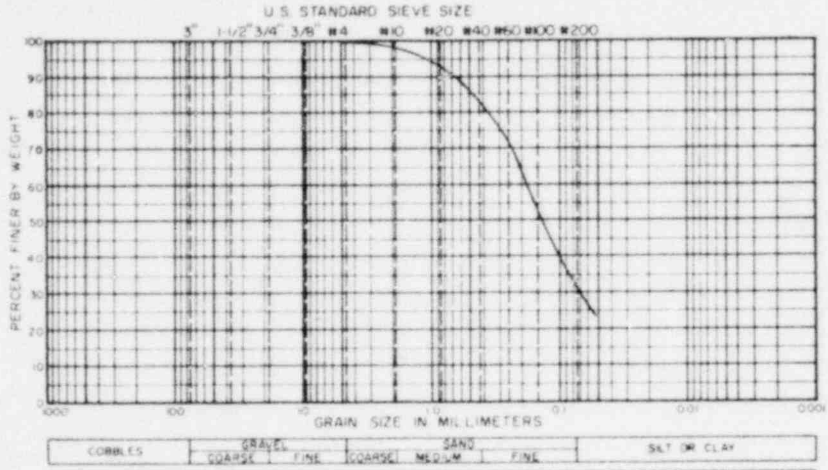
Consolidation tests were performed on samples STDM-2 and STDM-7. Primary consolidation appears to have been very rapid, possibly occurring in the first 10-15 seconds of the test. Because of the rapid consolidation, accurate values of the coefficient of consolidation and, therefore, permeability could not be determined. Based on the assumption that 90% of the consolidation had occurred after 10 seconds, hydraulic conductivity values on the order of .1 ft/yr were calculated for both samples.

Clay Mineralogy

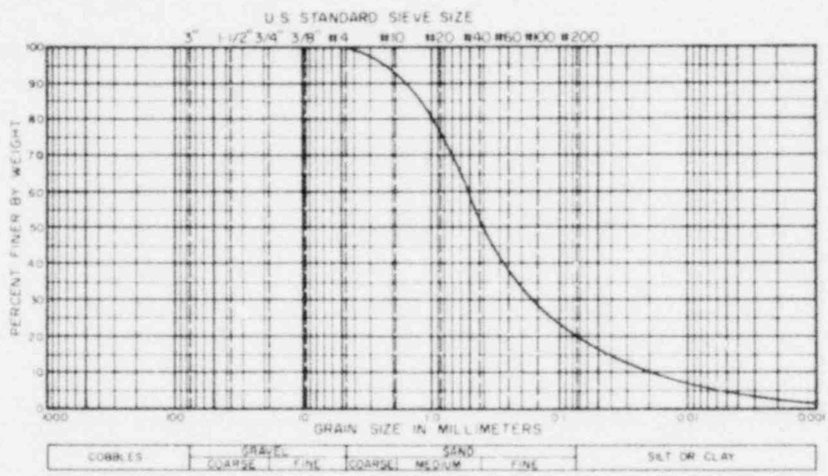
The clay mineralogy of three samples was determined by X-ray diffraction at the University of Utah laboratory. Diffraction patterns were obtained for each sample following air drying, vapor glycolation at 60°C, heating to 250°C for one hour, and heating to 550°C. Semi-quantitative estimates of the percentage of each mineral in the clay fraction were made from integrated peak intensity on the glycolated sample. The results are listed below:

Sample No.	Clay Mineralogy
STDM-7	Smectite 90% Kaolonite 10%
BR-1	Smectite 80% Kaolonite 20%
CB-3	Smectite 85% Kaolonite 15%

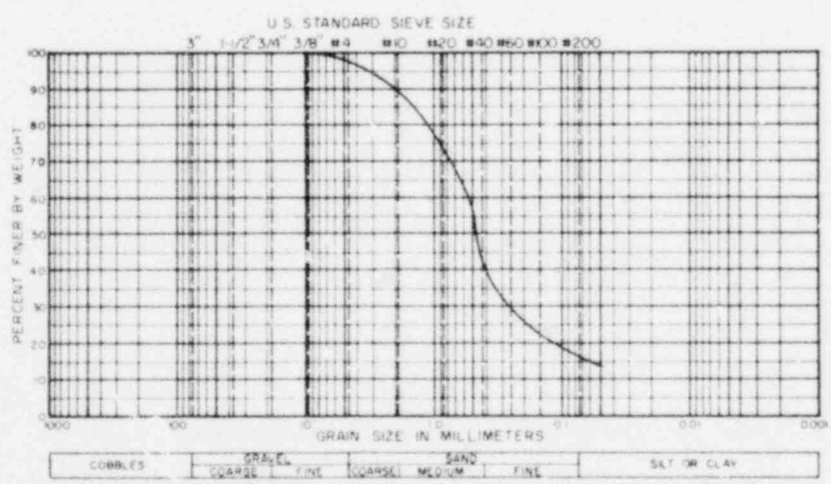
The above samples are in the process of having determinations of cation exchange capacity and exchangeable cations performed. The results will be completed by March 30, 1980. The physical characteristics and clay mineralogy of the soils tested for this project are similar to soils tested for other projects in the area, and, therefore, cation exchange capacities of 5-15 meq/100g are anticipated.



LOCATION	DEPTH	CLASSIFICATION
STDM-1	SURFACE	SILTY FINE TO MEDIUM SAND



LOCATION	DEPTH	CLASSIFICATION
STDM-2	SURFACE	SILTY FINE TO COARSE SAND



LOCATION	DEPTH	CLASSIFICATION
STDM-3	SURFACE	SILTY FINE TO COARSE SAND

GRADATION CURVES

POOR ORIGINAL

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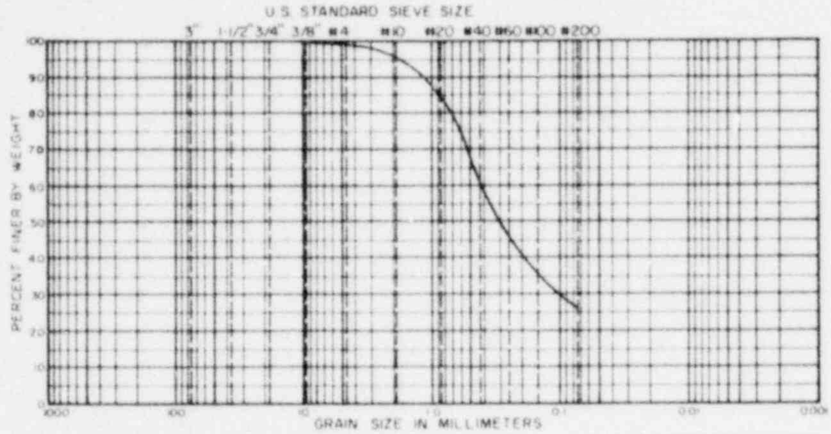
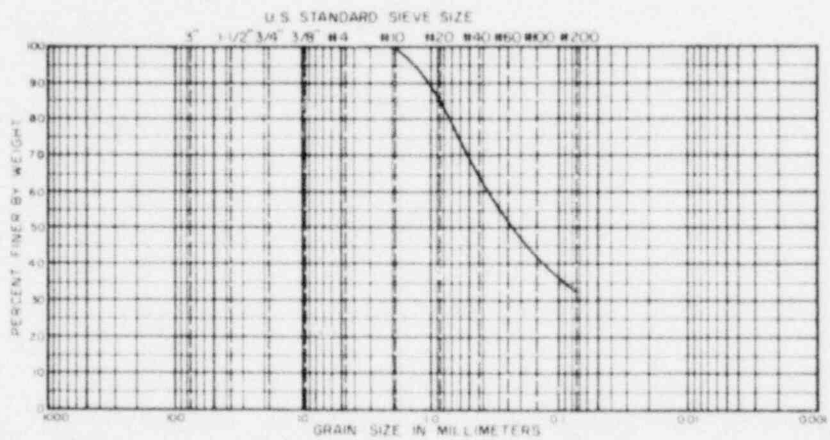


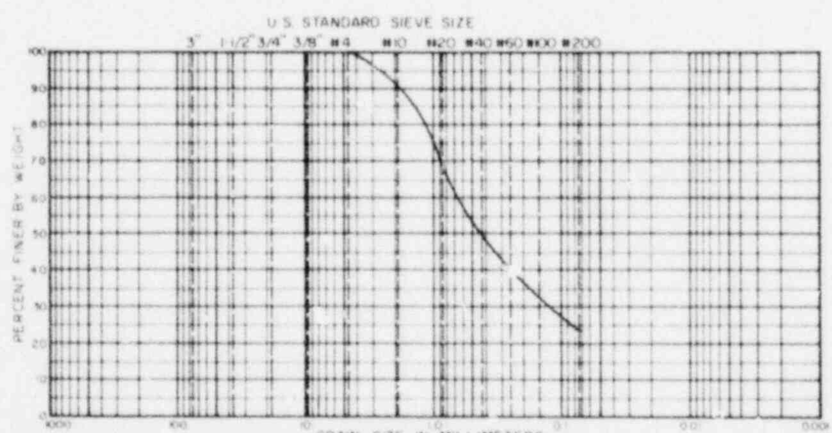
COBBLES	GRAVEL COARSE	GRAVEL FINE	SAND COARSE	SAND MEDIUM	SAND FINE	SILT OR CLAY

LOCATION	DEPTH	CLASSIFICATION
STDM-5	SURFACE	SILTY FINE TO COARSE SAND



COBBLES	GRAVEL COARSE	GRAVEL FINE	SAND COARSE	SAND MEDIUM	SAND FINE	SILT OR CLAY

LOCATION	DEPTH	CLASSIFICATION
STDM-7	3'	SILTY FINE TO MEDIUM SAND

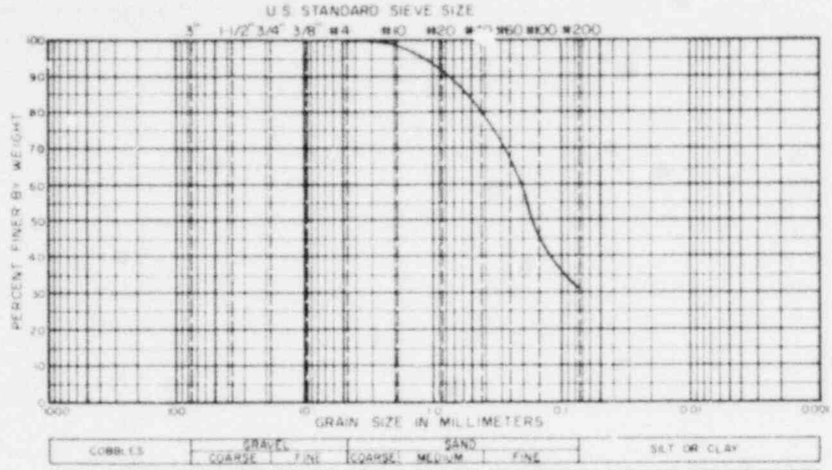


COBBLES	GRAVEL COARSE	GRAVEL FINE	SAND COARSE	SAND MEDIUM	SAND FINE	SILT OR CLAY

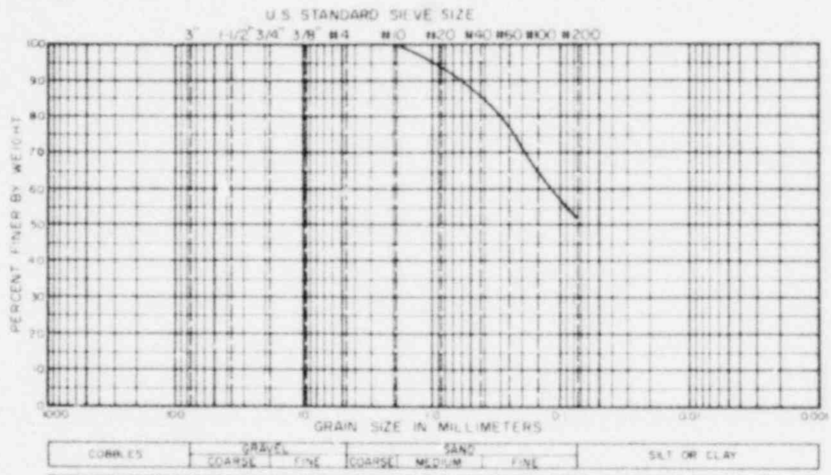
LOCATION	DEPTH	CLASSIFICATION
STDM-8	3'	CLAYEY FINE TO COARSE SAND

GRADATION CURVES

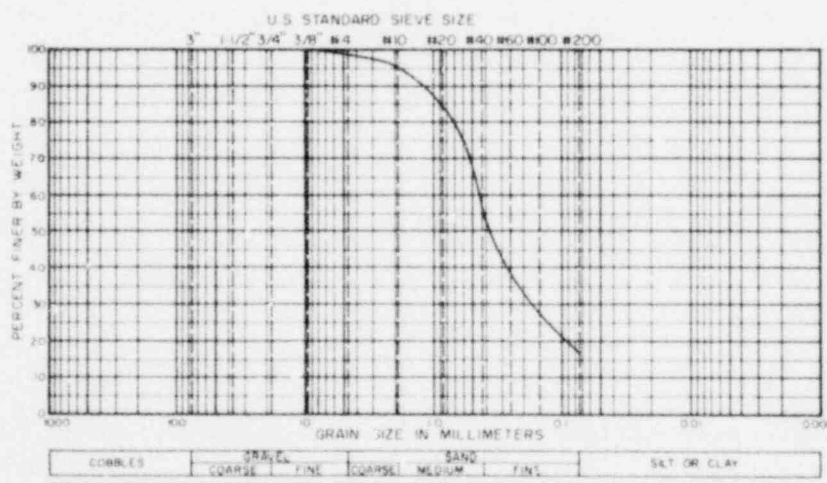
DAMES & MOORE



LOCATION	DEPTH	CLASSIFICATION
STDM-9	SURFACE	SILTY FINE TO COARSE SAND



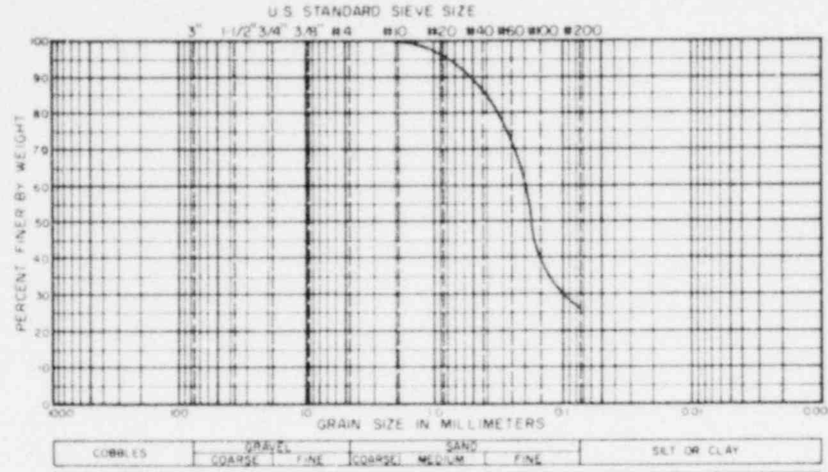
LOCATION	DEPTH	CLASSIFICATION
STDM-10	SURFACE	FINE TO COARSE SAND WITH CLAY



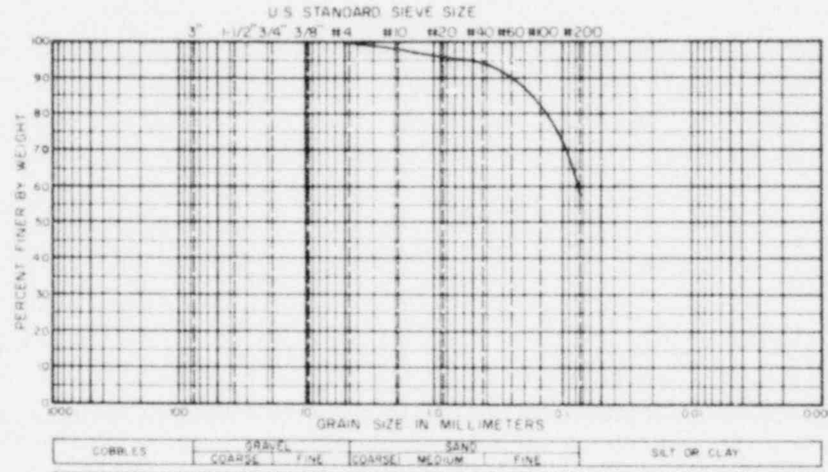
LOCATION	DEPTH	CLASSIFICATION
BR-1	SURFACE	SILTY FINE TO COARSE SAND

GRADATION CURVES

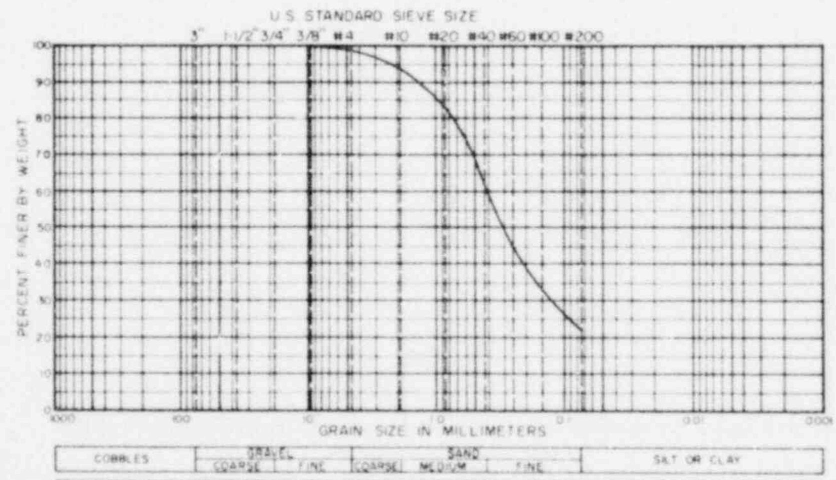
DAMES & MOORE



LOCATION	DEPTH	CLASSIFICATION
CB-1	SURFACE	SILTY FINE TO COARSE SAND



LOCATION	DEPTH	CLASSIFICATION
CB-2	SURFACE	SILTY FINE TO COARSE SAND WITH CLAY

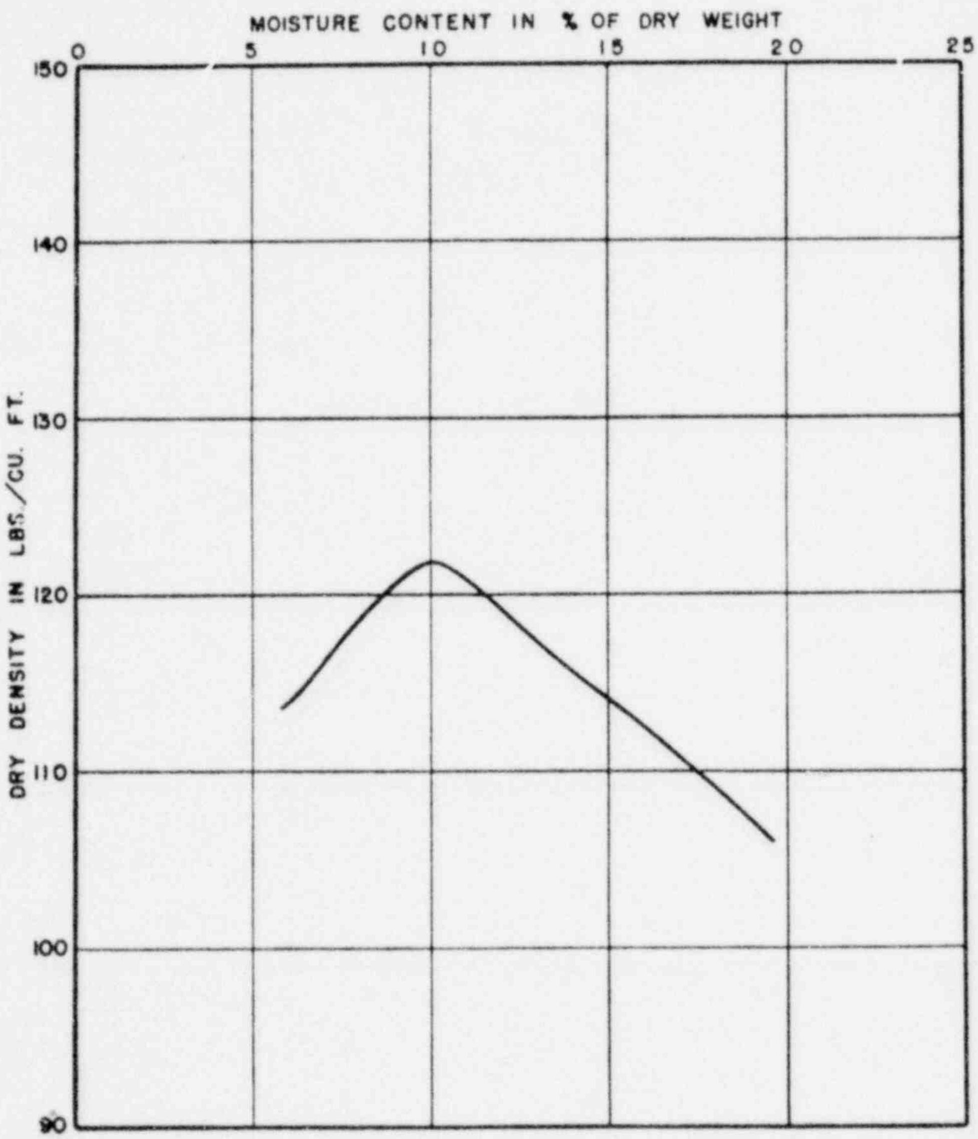


LOCATION	DEPTH	CLASSIFICATION
CB-3	SURFACE	SILTY FINE TO COARSE SAND

GRADATION CURVES

DAMES & MOORE

SAMPLE NO. STDM-2 DEPTH SURFACE ELEVATION 6390
SOIL SILTY FINE TO COARSE SAND
LOCATION SAGEBRUSH-TABLESTAKES, SE CORNER
OPTIMUM MOISTURE CONTENT 10.2
MAXIMUM DRY DENSITY 121.6
METHOD OF COMPACTION AASHO T-180



COMPACTION TEST DATA

DAMES & MOORE

PLATE A-5

DRAWN BY ______ DATE ______
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REVISION 2 BY ______ DATE ______
REVISION 1 BY ______ DATE ______
FILE ______

958.1 (REV. 4-67)

SAMPLE NO. STDM-7 DEPTH 3' ELEVATION 6450

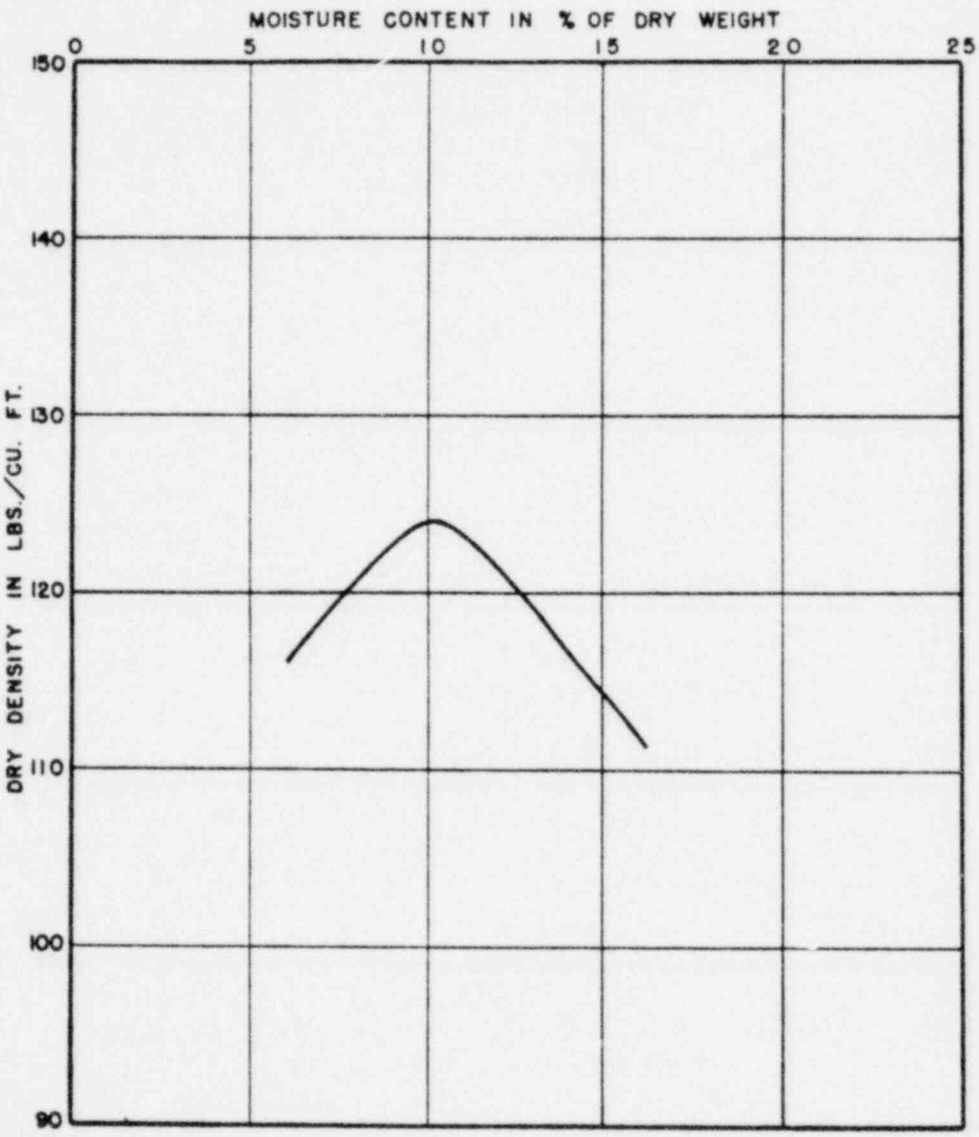
SOIL SILTY FINE TO MEDIUM SAND

LOCATION SAGEBRUSH-TABLESTAKES STOCKPILE

OPTIMUM MOISTURE CONTENT 10.2

MAXIMUM DRY DENSITY 123.7

METHOD OF COMPACTION AASHO T-180



COMPACTION TEST DATA

DAMES & MOORE

DRAWN BY ____ DATE ____
CHECKED BY ____ DATE ____

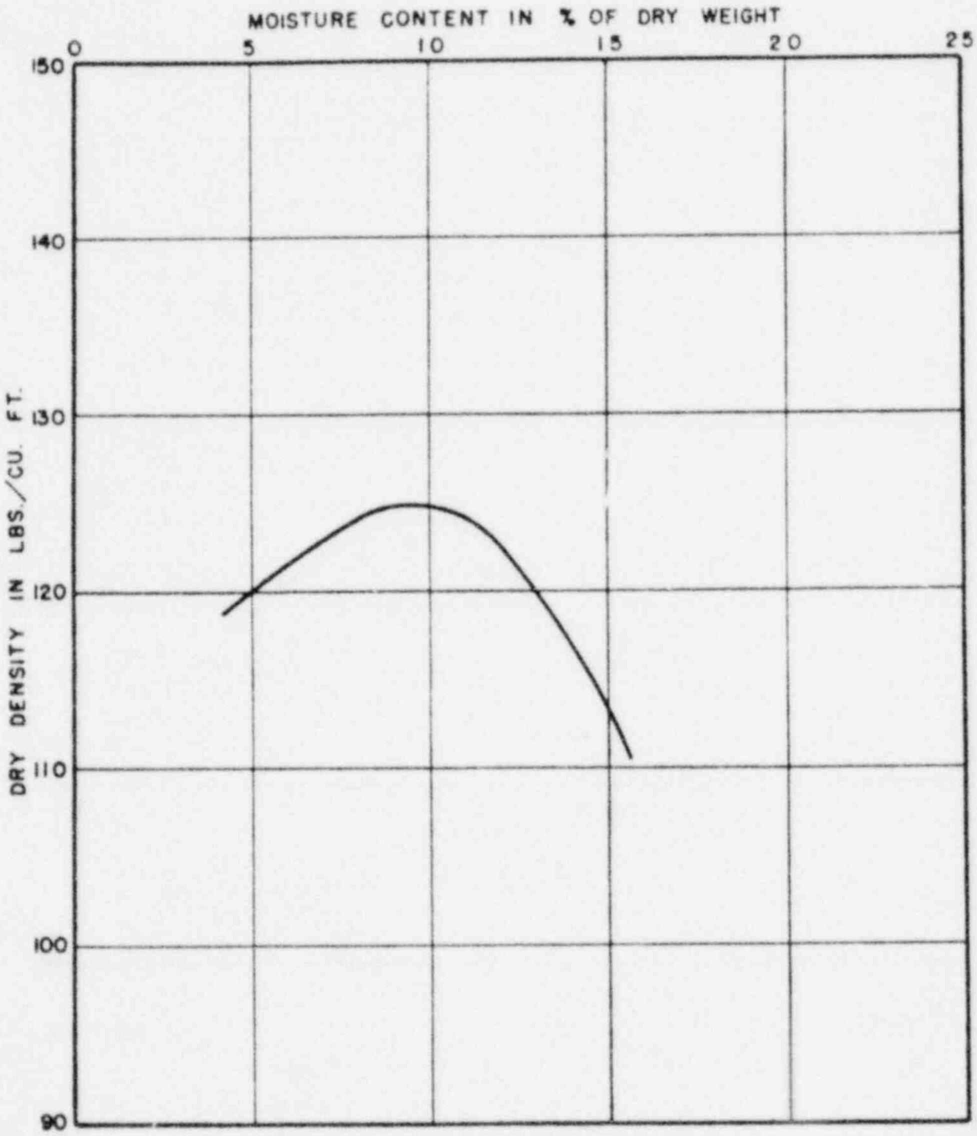
REVISION 2 BY ____ DATE ____

REVISION 1 BY ____ DATE ____

FILE ____

958.1 (REV. 4-57)

SAMPLE NO. BR-1 DEPTH SURFACE ELEVATION
SOIL SILTY FINE TO COARSE SAND
LOCATION BULLRUSH PIT
OPTIMUM MOISTURE CONTENT 10.0
MAXIMUM DRY DENSITY 124.9
METHOD OF COMPACTION AASHO T-180



COMPACTION TEST DATA

DAMES & MOORE

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REVISION 1 BY ____ DATE ____
REVISION 2 BY ____ DATE ____
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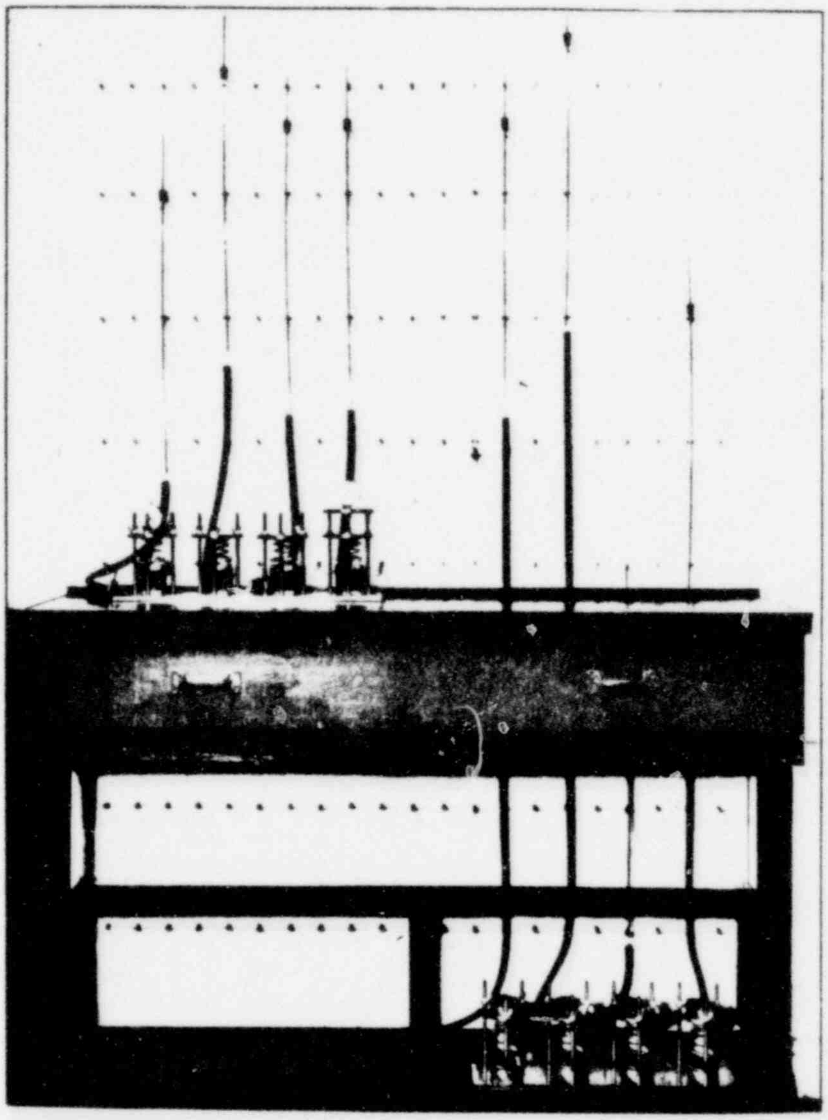
958.1 (REV. 4-67)

The quantity and the velocity of flow of water which will escape through an earth structure or percolate through soil are dependent upon the permeability of the earth structure or soil. The permeability of soil has often been calculated by empirical formulas but is best determined by laboratory tests, especially in the case of compacted soils.

A one-inch length of the core sample is sealed in the percolation apparatus, placed under a confining load, or surcharge pressure, and subjected to the pressure of a known head of water. The percolation rate is computed from the measurements of the volume of water which flows through the sample in a series of time intervals. These rates are usually expressed as the velocity of flow in feet per year under a hydraulic gradient of one and at a temperature of 20 degrees Centigrade. The rate so expressed may be adjusted for any set of conditions involving the same soil by employing established physical laws. Generally, the percolation rate varies over a wide range at the beginning of the test and gradually approaches equilibrium as the test progresses.



APPARATUS FOR PERFORMING PERCOLATIONS TESTS
Shows tests in progress on eight samples simultaneously.

During the performance of the test, continuous readings of the deflection of the sample are taken by means of micrometer dial gauges. The amount of compression or expansion, expressed as a percentage of the original length of the sample, is a valuable indication of the compression of the soil which will occur under the action of load or the expansion of the soil as saturation takes place.

METHOD OF PERFORMING PERCOLATION TESTS

DAMES & MOORE

APPENDIX B

SUMMARY OF WELL AND GEOPHYSICAL LOG INFORMATION

The monitoring well system installed by F. M. Fox in 1979 has largely been destroyed by ongoing mining operations. Table B-1 summarizes the monitoring of water levels that has been performed. Elevations were obtained by taking the difference between reported collar elevations in the Fox report and depth to water measurements. ST-F14 and ST-F15 have had risers added since original installation. Collar elevations were obtained from Federal American personnel. ST-F14 and ST-F15 are screened below the mudstone layer described in the section entitled "Site Soil and Bedrock Conditions." All other monitoring wells are screened above the mudstone layer.

Geophysical logs of drill holes in the Sagebrush-Tablestakes area were obtained from Federal American Partners. The logs were examined to qualitatively estimate the amount of clayey material that exists in future mining areas. Zones of clayey material were identified by noting a combination of low resistivity and high gamma readings. Table B-2 lists the logs that were reviewed.

TABLE B-1

SUMMARY OF GROUND WATER ELEVATION MONITORING DATA
FOR PIEZOMETERS INSTALLED BY FOX

Piezometer Number	Elevation of Water		
	2/28/79	3/13/79	1/23/80
ST-F1	6323	6323	*
ST-F4	6383	6382	*
ST-F5	*	*	*
ST-F6	*	*	*
ST-F7	6403	6404	*
ST-F9	6404	6404	*
ST-F10	6436	6441	6431
ST-F12A	6381	6387†	*
ST-F13	6384	6387†	*
ST-F14	6389†	6389†	6401
ST-F15	6388†	6388†	6396
BUL-F1	6344	6344	*
BUL-F2	6348	6348	*
BUL-F3	6359	6359	*
BUL-F4	6350	6350	*
BUL-F5	6345	6342	*
BUL-F6	6411	6411	*
BUL-F7	Dry	Dry	*
BUL-F8	*	*	*

* Piezometer destroyed
† Water flowing from piezometer

TABLE B-2

LISTING OF GEOPHYSICAL LOGS

SA-1919	SA-2102
SA-2003	SA-2106
SA-2016	SA-2107
SA-2020	SA-2109
SA-2033	SA-2113
SA-2035	SA-2115
SA-2037	SA-2119
SA-2044	SA-2127
SA-2047	SA-2130
SA-2049	SA-2136
SA-2071	SA-2140
SA-2074	TA-499
SA-2075	TA-517
SA-2077	TA-522C
SA-2080	TA-527
SA-2087	TA-530
SA-2092	TA-535
SA-2097	TA-538
SA-2098	TA-544
SA-2100	TA-551

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