

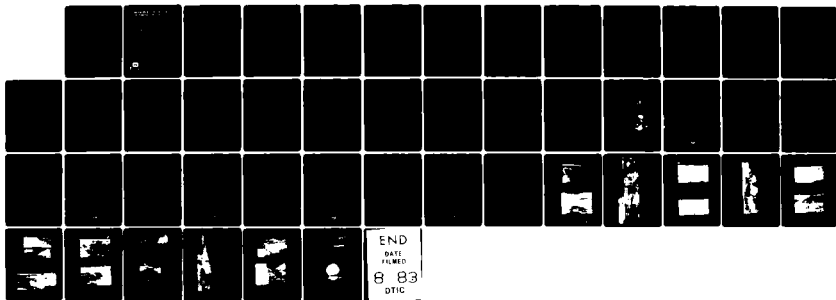
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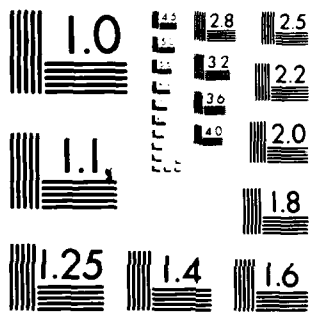
EMBANKMENT CRITERIA AND PERFORMANCE REPORT CHEYENNE
RIVER BASIN SOUTH DAK. (U) ARMY ENGINEER DISTRICT OMAHA
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EMBANKMENT CRITERIA AND PERFORMANCE REPORT



January 1983

Cheyenne River Basin, South Dakota

CEDAR CANYON DAM RAPID CITY, SOUTH DAKOTA

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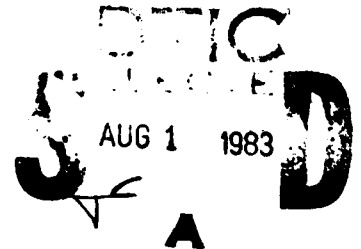
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CHEYENNE RIVER BASIN, SOUTH DAKOTA
RED DALE GULCH AREA
CEDAR CANYON DAM

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

U.S. ARMY ENGINEER DISTRICT, OMAHA ✓
CORPS OF ENGINEERS
OMAHA, NEBRASKA



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CHEYENNE RIVER BASIN, SOUTH DAKOTA
 RED DALE GULCH AREA
 CEDAR CANYON DAM
 EMBANKMENT CRITERIA AND PERFORMANCE REPORT

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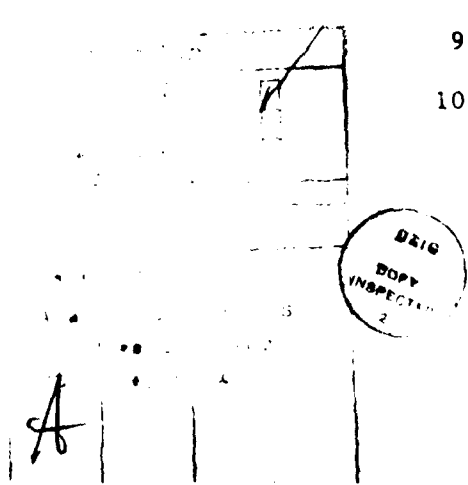


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APPENDIX A - DRAWINGS

<u>Plate No.</u>	<u>Title</u>
A1	General Map
A2	General Plan
A3	Record of Borings and Test Trenches
A4	Excavation and Embankment Plan
A5	Excavation and Embankment Sections
A6	Embankment Profile and Details
A7	Outlet Pipe Construction Details

NOTE: Many of the Plates used are the original Construction Plates and contain notes referring to the construction of the dam.

APPENDIX B - PHOTOGRAPHS

<u>Plate No.</u>	<u>Photo No.</u>	<u>Description</u>
B1	1	View of test trench no. 2 - shows borrow material used for compacted fill.
	2	View of the crest of the embankment looking towards the left abutment.
B2	3	Panoramic view of the upstream slope of the embankment.
B3	4	View of the upstream slope of the embankment looking towards the left abutment.
	5	View of the upstream slope of the embankment looking towards the right abutment.
B4	6	Panoramic view of the downstream slope of the embankment.
B5	7	View of rock slope protection on the upstream face of the dam.
	8	View of rock slope protection on the downstream face of the dam.
B6	9	View of embankment during construction.
	10	View of borrow area during construction of the dam. (Embankment is shown on right hand side of photo.)
B7	11	View of the emergency spillway looking upstream.
	12	View of the emergency spillway looking downstream.
B8	13	View of outfall channel (natural terrain) below the emergency spillway.
	14	View of the emergency spillway channel relative to the embankment.
B9	15	Panoramic view of the right excavated side slope of the emergency spillway.
B10	16	View of the conduit inlet headwall and trashrack structure.
	17	View of the outfall channel below the downstream terminus of the conduit.
B11	18	View of downstream terminus of the conduit.
	19	View looking up the conduit towards the reservoir area.

PERTINENT DATA

CEDAR CANYON DAM

1. RESERVOIR AND HYDROLOGICAL DATA.

Drainage Area Controlled	261 acres
Peak Inflow - SPF at damsite	1,120 c.f.s. (design flood)
Peak Inflow - MPF at damsite	2,860 c.f.s.

PERTINENT STORAGE LEVELS

<u>Feature</u>	<u>Elevation</u> <u>(ft. m.s.l.)</u>	<u>Storage</u> <u>(acre-feet)</u>	<u>Area</u> <u>(acres)</u>
Top of Dam	3554.0	268	18.5
Maximum Probable Flood (MPF)	3550.6	210	15.0
Standard Project Flood (SPF)	3545.5	155	11.5
Spillway Crest	3545.0	136	11.0
Sediment Allowance	3528.2	20	3.3
Outlet Works Invert	3526.0	13	2.7

2. EMBANKMENT.

Type	Compacted homogeneous earthfill
Crest Elevation	3554.0 feet m.s.l.
Maximum Height Above Flood Plain	42 feet

(No discernible channel)

PERTINENT DATA (CON'T)

Crest Width	15 feet
Crest Length	1,320 feet
Slope Protection	Riprap (both faces of embankment)
Side Slopes	Symmetrical 1V on 3H
Compacted Fill Quantities	Approximately 139,200 cubic yards

3. SPILLWAY.

Type	Uncontrolled-excavated in Minnekahta Limestone Bedrock
Location	Right abutment of dam
Crest Elevation	3554.0 feet m.s.l.
Width	60 feet
Length	650 feet
Discharge Capacity (MPF)	1,750 c.f.s. at El. 3550.6 feet m.s.l.
Slopes	See Section 6, pg. 9

4. OUTLET WORKS.

Type	Uncontrolled
Intake Structure	Cast in place, reinforced concrete slab and headwall with galvanized trash racks

PERTINENT DATA (CONT'D)

4. OUTLET WORKS (CONT'D)

Invert Elevation of Intake	3526.0 feet m.s.l.
Invert Elevation of Outlet	3516.0 feet m.s.l.
Conduit	24" CMP, bituminous coated
Conduit Length	230 feet
Design Capacity Discharge (SPF)	49 c.f.s. at El. 3545.5 feet m.s.l.
Outlet Channel	Excavated rock

5. DOWNSTREAM DISCHARGES. Cedar Canyon Dam was not designed for permanent storage of water but only as a detention structure with the capacity to reduce peak discharges for floods of all magnitudes. Under full operating conditions the standard project flood will be completely discharged in 5 days if no additional inflow is received.

6. REFERENCES. For additional information and description on the construction background, operational data, or procedures regarding this dam, reference is made to "Periodic Inspection Reports Nos. 1, 2, and 3," dated May 1970, September 1975, and September 1980, respectively; "Operation and Maintenance Manual," dated December 1981; and "Plans and Specifications for Cedar Canyon Dam," dated April 1959.

CHEYENNE RIVER BASIN, SOUTH DAKOTA

RED DALE GULCH AREA

CEDAR CANYON DAM

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

1. INTRODUCTION.

1.1. PURPOSE OF REPORT. This report provides a summary record of significant design, construction, and operational data on Cedar Canyon Dam for use by engineers to familiarize themselves with the project, re-evaluate the embankment when unsatisfactory performance occurs, and provide guidance for designing comparable future projects. It was prepared in accordance with MRD-R 1110-1-8, subject; "Construction Foundation Reports and Embankment Criteria and Performance Reports," dated 27 February 1978, and ER 1110-2-1901, subject: "Embankment Criteria and Performance Reports," dated 31 December 1981.

1.2. AUTHORIZATION AND PURPOSE OF PROJECT. Construction of Cedar Canyon Dam was authorized by the Chief of Engineers on 3 June 1957, pursuant to provisions of Public Law 685, 84th Congress, 2nd Session, 11 July 1956. The authorization provided a plan to provide flood protection for the Red Dale Gulch Area of Rapid City, South Dakota.

1.3. LOCAL COOPERATION. The city of Rapid City, South Dakota, was the local sponsor for the project. As a condition for construction of the project, assurances from the city to the Secretary of the Army included the following:

- The city would
- (a) provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project.
 - (b) hold and save the United States free from damages due to construction works.
 - (c) maintain and operate the works after completion in accordance with regulations prescribed by the Secretary of the Army.
 - (d) construct an adequate storm sewer system in the development area, prior to construction of the project.

1.4. LOCATION AND DESCRIPTION OF PROJECT. Cedar Canyon Dam is located in Pennington County in southwestern South Dakota. It is on the northwest edge of Rapid City, South Dakota, and protects a residential section of the city (Red Dale Gulch Area) from the damaging effects of swift, short duration floods. The embankment of the dam crosses a normally dry gulch (Deadmans Gulch) which lies within Cedar Canyon. See Plate A1: The reservoir operates as a detention dam with the capacity to reduce peak discharges for floods of all magnitudes.

1.5. HISTORY OF CONSTRUCTION CONTRACTS. Cedar Canyon Dam was built by contract under the supervision of the Corps of Engineers, Department of the Army. Contract No. DA25-066-CIVENG-59-492, Cedar Canyon Dam, was advertised on 17 April 1959, and bids were opened 14 May 1959. Summit Construction Company of Rapid City, South Dakota, was awarded the contract with a bid of \$68,469. Work on the project began on 12 June 1959 and was completed 30 September 1959. No unusual construction problems were encountered.

1.6. PROJECT MAINTENANCE. The city of Rapid City, South Dakota (the project sponsor), is responsible for all necessary maintenance required to assure proper performance of the project.

2. GEOLOGY. The foundation beneath the earth embankment in the valley consists of 4 to 10 feet of red clay overburden underlain by Minnekahta limestone bedrock. This overburden soil contains a rather large quantity of gravel boulders and hard gray limestone pockets. The clay overburden soils in the abutment areas are very shallow as evidenced by limestone outcrops from the valley floor to the crest.

3. SUBSURFACE EXPLORATION AND LABORATORY TESTING. The subsurface investigations at this dam consisted of three borings and one test trench in the spillway area and four test trenches in the upstream borrow area. The locations and identifying numbers of the borings and test trenches are shown on Plate A2, and a view of test trench No. 2 is shown on Plate B1.

Disturbed moisture and classification samples were taken at each boring and test trench at every change in material. Boring depths ranged from 3.4 feet to 10.8 feet depending on the depth of the underlying limestone bedrock, and test trenches were excavated to a depth of 10 feet. The overburden soils in the spillway and reservoir (borrow) areas were classified as lean, silty, and gravelly clays. Moisture contents ranged from 0.5 to 10.7 percent in the spillway area and 9.0 to 14.0 percent in the reservoir area. Liquid limits and plastic indexes ranged from 27 to 30 and 7 to 20, respectively, in the spillway area and 29 to 42 and 3 to 20, respectively, in the reservoir area. Logs of the borings are shown on Plate A3.

Compaction tests were performed on sack samples obtained from test trenches nos. 4 and 5. An optimum moisture content of 9.0 percent and a maximum dry density of 127 lbs/ft³ was obtained.

4. FOUNDATION PREPARATION. Before work began, all vegetation, such as brush, heavy sod, heavy growth of grass, and all decayed vegetable matter, rubbish, and other unsuitable material within the area upon which fill was to be placed was removed. After completion of the clearing and stripping, all depressions were filled and steep slopes flattened. Following filling the depressions, and immediately prior to the placement of embankment fill, the foundation was loosened thoroughly by scarifying, plowing, or harrowing to a depth of 4 inches. After the removal of roots or other debris turned up in the loosening process, the foundation was compacted in preparation for placement of fill material.

5. EMBANKMENT.

5.1. GENERAL. A discussion of the design and construction of the embankment is presented below. It includes a description of the embankment section, embankment materials, and procedures followed in constructing the embankment.

5.2. EMBANKMENT SECTION. The embankment is a rolled, homogeneous, impervious earthfill. It has a crest length of 1,320 feet and a crest width of 15 feet. It is 42 feet high and has a crest elevation of 3554.0 feet m.s.l. The embankment slopes are symmetrical (1V on 3H) and both faces are protected by rock slope protection. Details of the embankment are shown on Plates A4, A5, and A6. Views of the embankment features are shown on Plates B1 through B4.

5.3. EMBANKMENT DESIGN. The design of the embankment and structures was based upon the following criteria:

- (1) Flood storage capacity sufficient to retain the volume of a Standard Project Flood from the contributing drainage area less releases from an uncontrolled outlet.
- (2) Outlet capacity sufficient to discharge a Standard Project Flood within 5 days.
- (3) Spillway capacity ample to pass the Maximum Probable Flood occurring 5 days after inflow from the Standard Project Flood. (NOTE: Since the SPF is discharged in 5 days by the conduit, the reservoir level will be at the conduit invert when the MPF occurs.)

- (4) Embankment freeboard of 4 feet above the maximum pool elevation.
- (5) Capacity for a sediment volume of 20 acre-feet, equivalent to about 1.0 acre-feet per square mile per year during the life of the project.

Based on this criteria, the dam was expected to reduce annual flood damages below the project by 80 percent.

5.4. SEEPAGE. Since Cedar Canyon Dam was not designed for permanent storage of water, seepage through the embankment and foundation was expected to be negligible, and therefore, underseepage control structures were not provided.

5.5. EMBANKMENT MATERIALS.

5.5.1. Earthfill. The embankment was constructed from the lean clay material located within the reservoir area. The material provided a relatively impervious embankment section consisting of 139,200 cubic yards of homogeneous rolled earth fill.

5.5.2. Slope Protection. Both faces of the dam are protected by rock slope protection to elevation 3554.0 (Crest of Dam). The rock used was excavated Minnekahta limestone from the spillway and reservoir (borrow) areas. The minimum thickness of the slope protection was 1.5 feet upstream

and 0.75 feet downstream, with the maximum rock size allowed being 0.5 foot greater than the layer thickness. Details of the slope protection are given on Plates A5 and A6, and views of the rock slope protection are shown on Plates B2, 3, 4, and 5.

5.6. EMBANKMENT PLACEMENT.

5.6.1. General. Specifications required that the gradation and distribution of materials throughout the earthfill section of the dam be such that the embankment be free from lenses, pockets, streaks, and layers of material differing substantially in texture or gradation from surrounding material. See Plate B6 for views of the embankment during construction.

5.6.2. Compacted Embankment Fill. The more impervious of the compacted fill materials were placed toward the upstream section of the embankment, and the more pervious of the fill materials were placed toward the downstream section of the embankment; this was to provide a transition in permeability from the upstream to the downstream portions of the embankment.

After dumping, the material was spread in approximate horizontal layers over fill areas. The thickness of the layers before compaction was specified as follows:

<u>Material</u>	<u>Maximum Thickness of Lift</u>	<u>Type of Roller</u>
Compacted Fill	12-inch Loose Measurement	Rubber-tired*
Compacted Fill	8-inch Loose Measurement	Tamper-type

*Available information indicates that only tamper-type rollers were used for embankment compaction.

The moisture content of the layers was required to be uniform throughout the layer. The upper limit of moisture content was that which permitted excavating, hauling, placing, and compaction of the fill materials without excessive deformation of the embankment. The lower limit was one percent below the optimum moisture content. The surface of the fill was crowned with a 5 percent grade to insure good drainage during the construction period. Before compaction, each layer of fill was harrowed, if required, to break up and blend materials and to obtain uniform moisture contents. When the moisture content and the condition of the layer was satisfactory, it was compacted by six complete passes of a tamping roller. If, in the opinion of the Contracting Officer, the required density of any area was considered insufficient, additional passes were made until the desired compaction was obtained. Portions of the fill which could not be compacted with rollers because of space restrictions were placed in 4-inch loose lift layers and compacted with power tampers to the same degree of compaction as that obtained on other portions of the fill performed by rolling.

5.6.3. Slope Protection Placement. Rock slope protection was placed in such a manner as to produce a reasonably well-graded mass of rock with a minimum percentage of voids, and was constructed to the layer thickness, lines and grades as shown on the drawings. A tolerance of 6 inches above the layer thickness was allowed for the maximum size stone, but in order to permit the use of available rock, an occasional rock was allowed to protrude above the 6 inch tolerance on that portion of the embankment where larger stones were used.

6. EMERGENCY SPILLWAY. The emergency spillway is an uncontrolled channel located in the right abutment of the dam. See Plate A4. It has a crest elevation of 3545.0 feet m.s.l., is 60 feet wide and 650 feet long. The channel has vertical side slopes from the crest elevation to elevation 3556.4 feet m.s.l., has 20-foot berms, then 1V on 2H side slopes to the top of the existing ground. The vertical side slopes and berms were excavated in the Minnekahta limestone bedrock and the 1V on 2H slopes were excavated in the lean clay overburden. The overburden soils on the 1V on 2H slopes were loosened, pulverized, and seeded with crested wheat and smooth brome for protection against wind and water erosion. The spillway is capable of passing the Maximum Probable Flood occurring 5 days after inflow from the Standard Project Flood. Sections and details of the spillway are shown on Plates A5 and A6, and views of the spillway are shown on Plates B7, B8, and B9.

7. OUTLET WORKS. The outlet works consist of an uncontrolled conduit, a concrete headwall structure and metal pipe trashrack located at the inlet, and a concrete support pedestal at the outlet. The conduit is a 230-foot long, 24-inch diameter, bituminous coated corrugated metal pipe. It has an inlet invert elevation of 3526.0 feet m.s.l. and a 4.3 percent slope to the outlet invert elevation of 3516.0. Four seepage diaphragms were constructed along the conduit to prevent piping due to seepage through the embankment along the conduit. An outfall channel was excavated below the outlet of the conduit and terminates in a rock walled canyon approximately 150 feet beyond the outlet. Location, sections, and details of the outlet works are shown on Plates A4, A6, and A7, and views of the structure are shown on Plates B10 and B11.

8. INSTRUMENTATION. Cedar Canyon Dam has no instrumentation. A staff gauge for the reservoir was recommended in Periodic Inspection Reports Nos. 2 and 3, but has not as yet been installed.

9. OPERATIONAL HISTORY.

9.1. GENERAL. The city of Rapid City, South Dakota, the project sponsor, is responsible for the operation and maintenance of the embankment, spillway, and other structures which comprise the project.

9.2. INSPECTIONS. In-depth inspections of Cedar Canyon Dam are conducted in accordance with ER 1100-2-100, "Periodic Inspections and Continuing Evaluation of Completed Civil Works Projects." These inspections are reported in Periodic Inspection Report Nos. 1, 2, and 3, dated May 1970, September 1975, and September 1980 respectively. The next periodic inspection of Cedar Canyon Dam is scheduled for 1985. The inspections are made jointly by representatives of the Operations and Engineering Divisions of the Omaha District Corps of Engineers and by representatives of the Missouri River Division Office. The reports include the evaluation of the embankment and structural performance, plus recommendations for necessary repairs.

In addition to the periodic inspections, semi-annual reports to the District Engineer covering inspection, maintenance, and operation of the project are required. The reports are made by the "superintendent" of the project, who is appointed by the local sponsor.

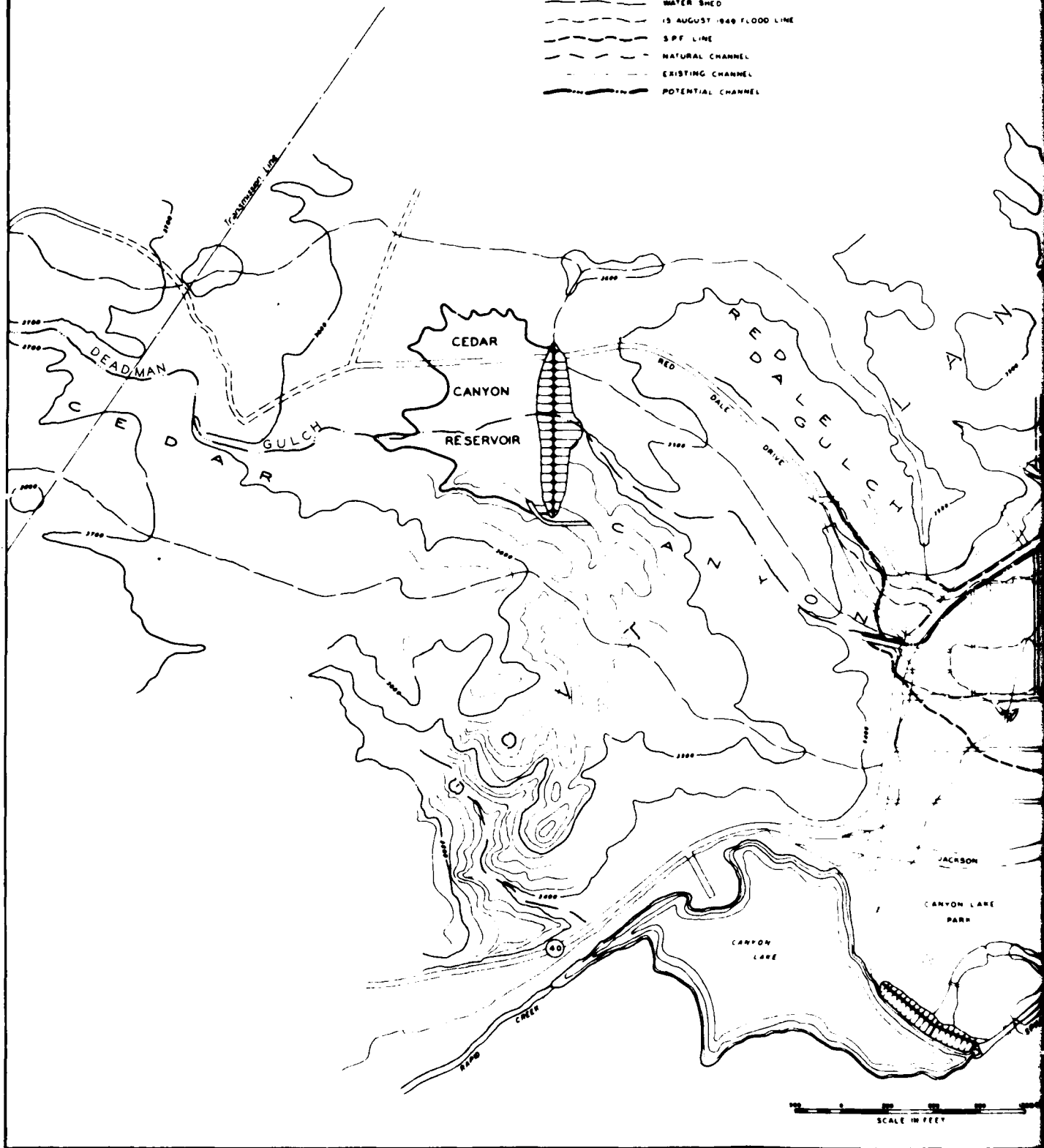
9.3. RESERVOIR LEVELS. There has been little water impoundment in the reservoir since the construction of the dam, and it is believed that water has never discharged through the conduit. Since there are no gauges at the dam, the monitoring of reservoir stage and conduit flow is dependent upon onsite inspections.

10. PERFORMANCE. Cedar Canyon Dam and appurtenant structures are in good condition. Since 1959, when the project was completed, inspections have revealed no significant problems concerning the safety of the dam. The dam though, is normally dry and has never been tested by a serious flood event. It was recommended in the periodic inspection reports (1975, 1980) that the project be inspected whenever the pool reaches the invert of the outlet conduit so that it can be checked for seepage and performance at high pool levels.

APPENDIX A
DRAWINGS

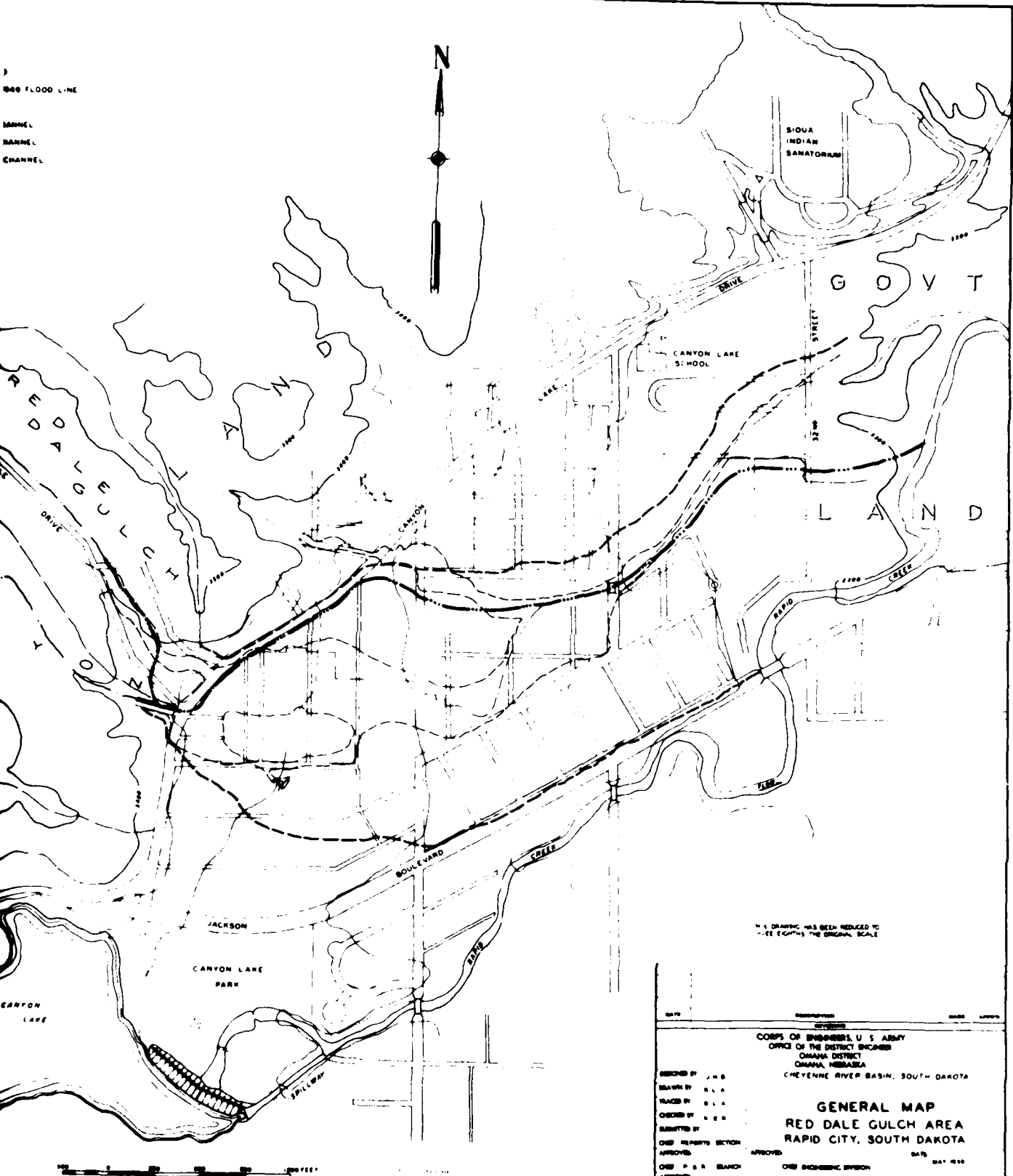
LEGEND

- WATER SHED
- - - 13 AUGUST 1940 FLOOD LINE
- - - S P F LINE
- - - NATURAL CHANNEL
- - - EXISTING CHANNEL
- - - POTENTIAL CHANNEL



1000 FLOOD LINE

MANUEL
MANUEL
CHANNEL



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ONE EIGHTH THE ORIGINAL SCALE

SCALE IN FEET

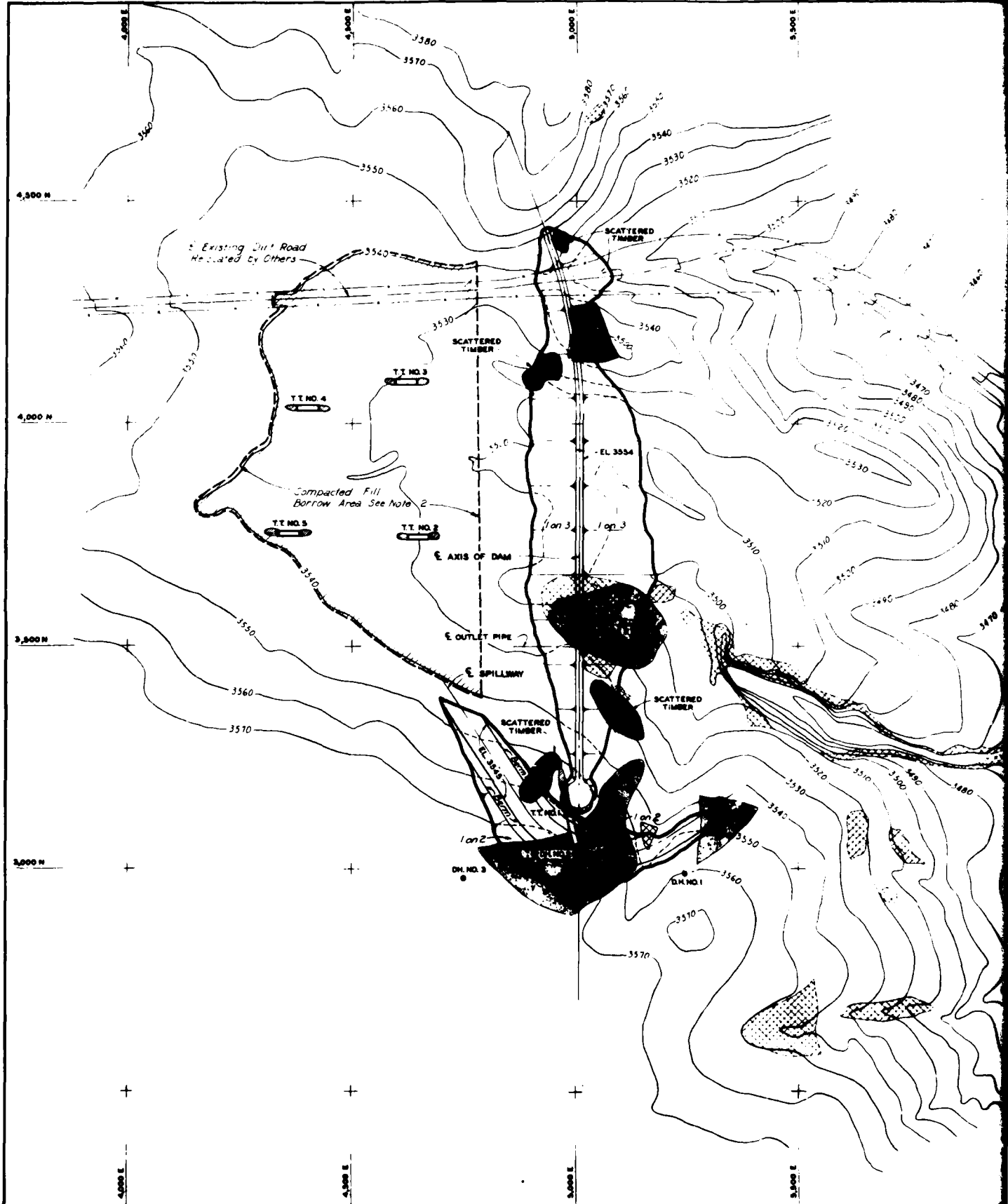
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DA-35-088-400 MODIFICATION NO

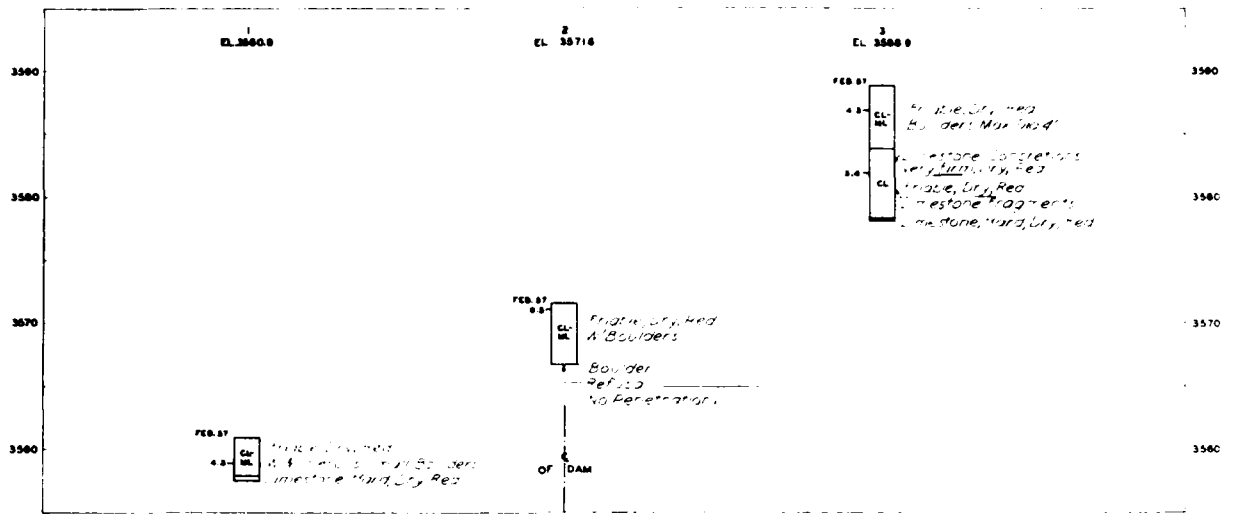
DESIGNED BY	J. H. B.	DATE	MAY 1942
DRAWN BY	S. A. S.	SCALE	AS SHOWN
TRACED BY	S. A. S.	ENGINEERING DIVISION	CHICAGO
CHECKED BY	S. A. S.	SECTION	CHICAGO
SUBMITTED BY	S. A. S.	APPROVED	DATE
CHIEF REPORTS SECTION	APPROVED	CHIEF ENGINEERING DIVISION	DATE
CHIEF P. & S. BRANCH	APPROVED	SCALE AS SHOWN	SEE NO
APPROVED		DRAWING NUMBER	

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
OMAHA DISTRICT
OMAHA, NEBRASKA
CHEYENNE RIVER BASIN, SOUTH DAKOTA

GENERAL MAP
RED DALE GULCH AREA
RAPID CITY, SOUTH DAKOTA

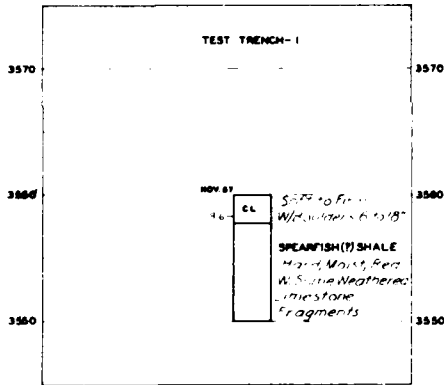
COL. C. E. BERRY, DISTRICT ENGINEER



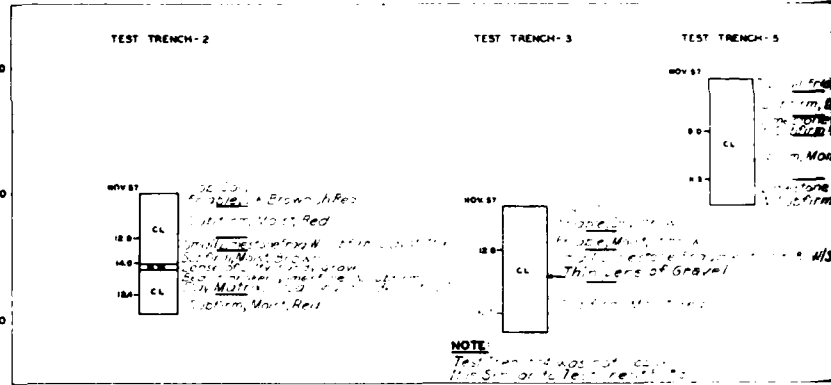


BORINGS IN SPILLWAY AREA

NO HORIZONTAL SCALE



TEST TRENCH IN THE SPILLWAY AREA



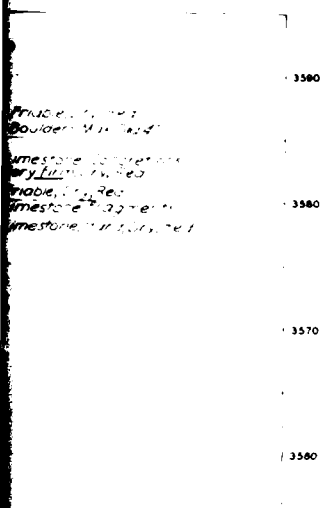
TEST TRENCHES IN THE RESERVOIR AREA

NO HORIZONTAL SCALE

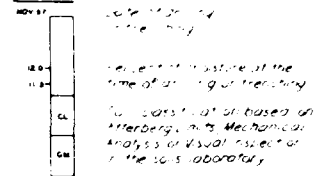
NOTES

1. The soil in the spillway area is highly variable in composition and structure. The soil in the reservoir area is more uniform in composition and structure.

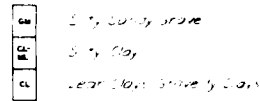
2. The soil in the spillway area is highly variable in composition and structure. The soil in the reservoir area is more uniform in composition and structure.



LEGEND



CLASSIFICATION OF SOILS

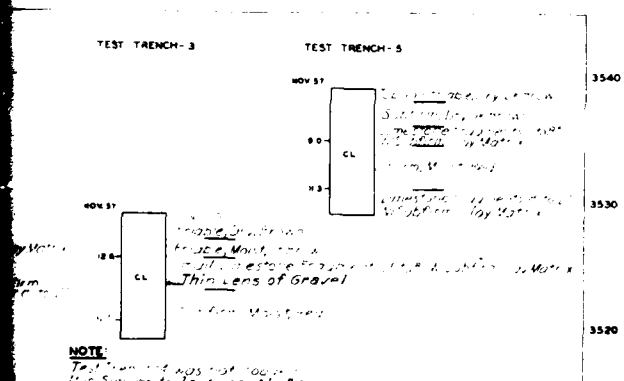


DESCRIPTIVE NOTES

- OVERBURDEN** - Consists primarily of dark reddish brown to red earthen clay and limestone fragments in clay matrix. The limestone fragments ranging from 1/8" to 1/2" are interspersed in clay.
- SPEARFISH FORMATION** - This formation consists of red sandstone and silty sandstone with quartz pebbles occurring near the base.
- MINNEKAHTA FORMATION** - This formation is a thin bedded pink to dark silty limestone.

GENERAL NOTES

1. Elevations shown refer to feet M.S.L. 1929 General Adjustment.
2. The data shown graphically and by symbols in this report represent borings and test trenches representing the actual geological features observed and logged at the location given on the drawings while the borings and test trenches are representative of subsurface conditions at their respective locations and for the respective vertical reaches. Local minor variations in character of the subsurface materials at the location are indicated and described such variations will not be shown as a differing material with the curves of surface of the contract.
3. Information on material has been condensed in the graphs. Additional information is shown on the field logs which may be selected at the Omaha District Office.
4. Locations of borings and test trenches see drawing.



TRENCHES IN THE RESERVOIR AREA

NO HORIZONTAL SCALE

REFERENCE DRAWINGS:
1. General Plan and Index

DWG. NO.
21-23-401

DATE	DESCRIPTION	MADE	APPROV

U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

CHEYENNE RIVER BASIN, SOUTH DAKOTA
RED DALE GULCH AREA
RAPID CITY, SOUTH DAKOTA
CEDAR CANYON DAM
RECORD OF BORINGS AND TEST TRENCHES

DESIGNED BY: A E R
DRAWN BY: C W G
TRACE BY: C W G
CHECKED BY: A E R

APPROVED: *[Signature]*
CHIEF FIELD ENGINEER SECTION

APPROVED: *[Signature]*
CHIEF ENGINEER SECTION

DATE: APRIL 1954

SCALE AS SHOWN

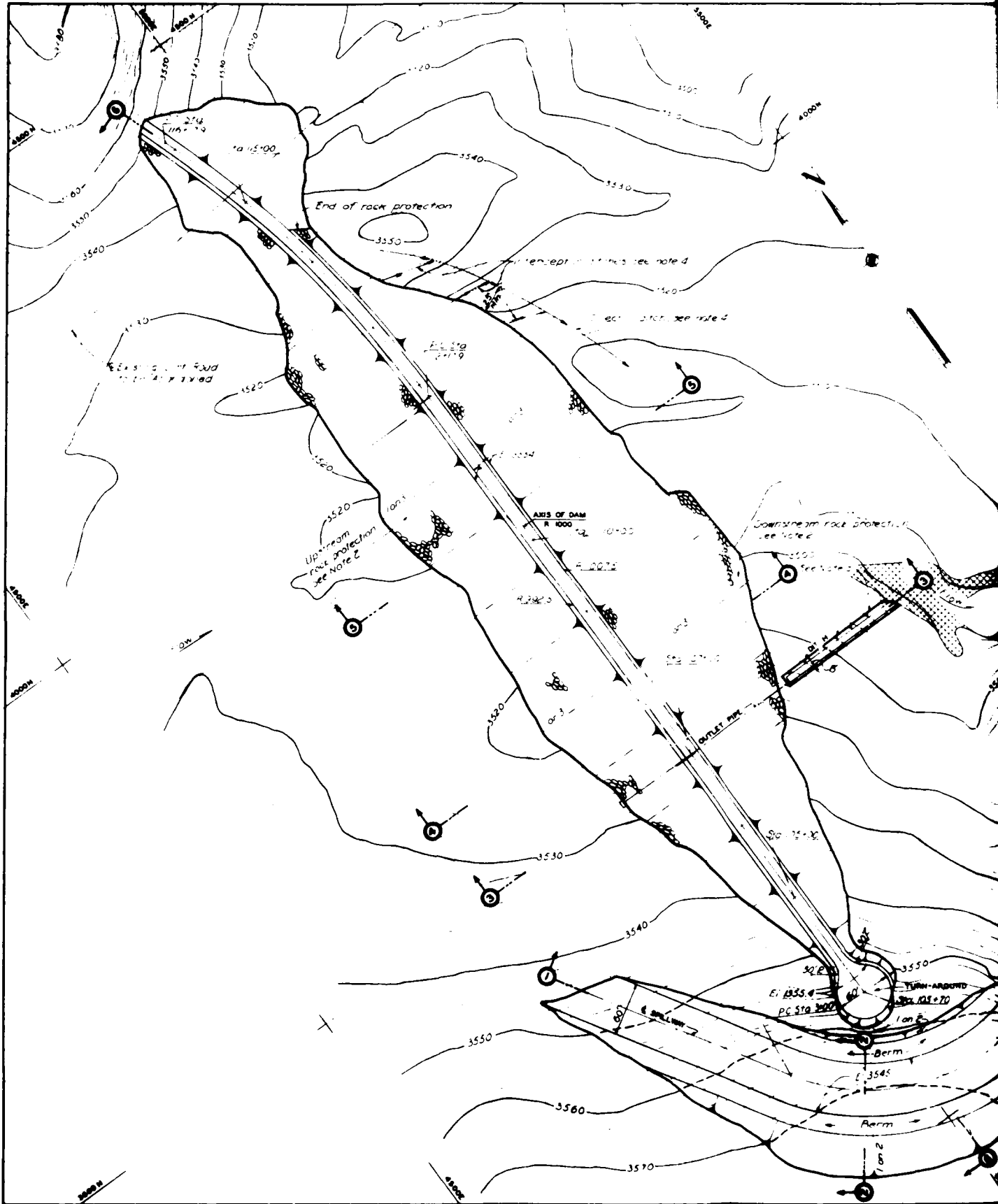
DATE OF ISSUE: APRIL 1954

PROJECT NO.: **CY25c1-40E71**



THIS PLAN ACCOMPANIES CONTRACT NO. DA-28-088-00
MODIFICATION NO.

NOTES
1. This data is based on...
2. The test results...
3. The soil is...
4. The...
5. The...





GENERAL NOTES:

1. All elevations shown refer to feet above M.S.L., U.S.C. & S. 1929 General Adjustment.
2. For rock protection see notes on plan.
3. Excavate an 8' minimum width ditch 3' in depth or to bottom of overburden, whichever is higher, graded to drain. Minor adjustments in alignment may be made by the Contracting Officer to accommodate for field conditions.
4. Interceptor and Collector ditches to be excavated in a manner to prevent excessive erosion of the ultimate toe. Additional ditches will be provided at locations as directed by the Contracting Officer. See "Typical Section".

DATE	DESCRIPTION	BY	CHKD BY
11/10/58	Revised to show AS Built conditions		
11/14/58	Revised rock protection & spillway excavation		

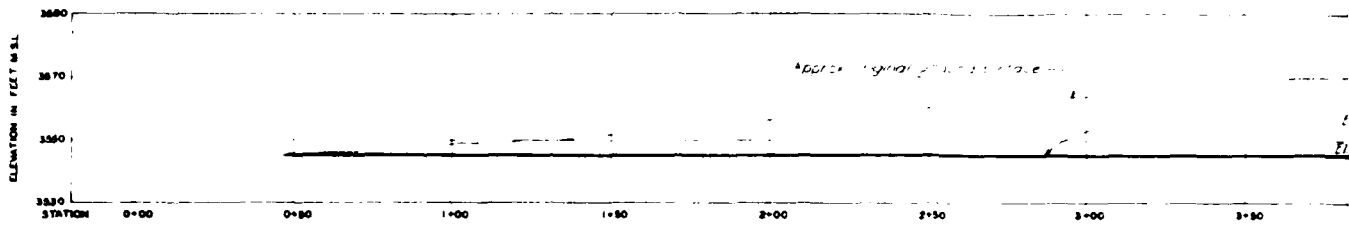
U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

CHEYENNE RIVER BASIN, SOUTH DAKOTA
RED DALE GULCH AREA
RAPID CITY, SOUTH DAKOTA
CEDAR CANYON DAM
EXCAVATION AND EMBANKMENT PLAN

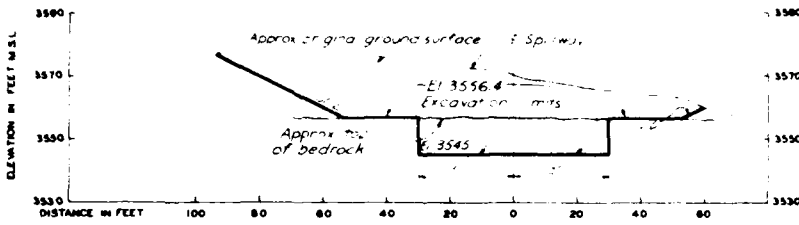
DESIGNED BY: J. B. W.	APPROVED: <i>J. B. W.</i>	DATE: APRIL 1958
DRAWN BY: C. H. B.	SCALE: AS SHOWN	SHEET NO:
CHECKED BY: C. H. B.	BY: <i>B. J. Hammond</i>	OF: CY25c1-40E32
DATE: 11/10/58	BY: <i>B. J. Hammond</i>	OF: CY25c1-40E32
DATE: 11/14/58	BY: <i>B. J. Hammond</i>	OF: CY25c1-40E32

COL. C. L. HENRY, ENGINEER

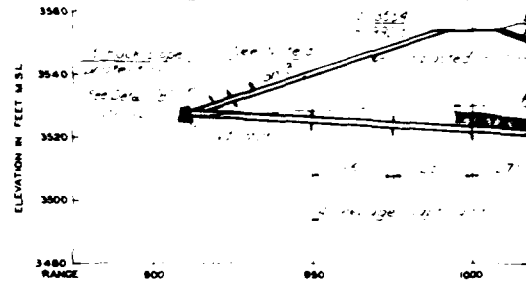
SCALE: 1 INCH = 80 FEET
THIS PLAN ACCOMPANIES CONTRACT NO. DA-88-088-CIVENS-80-492



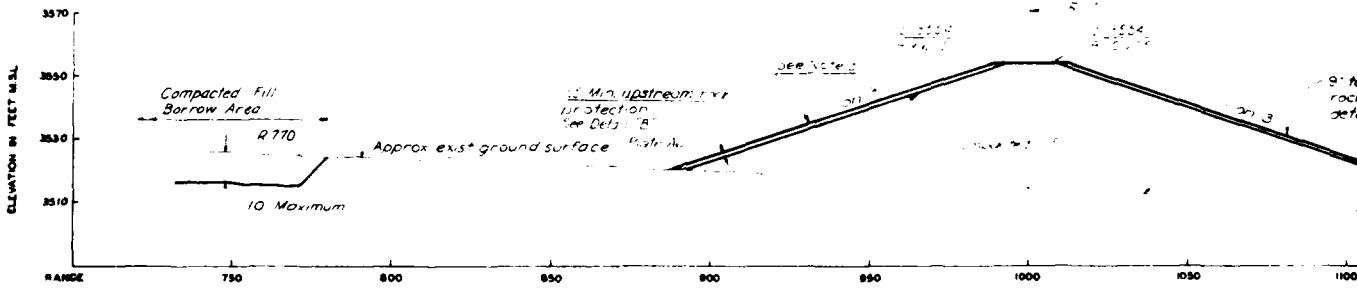
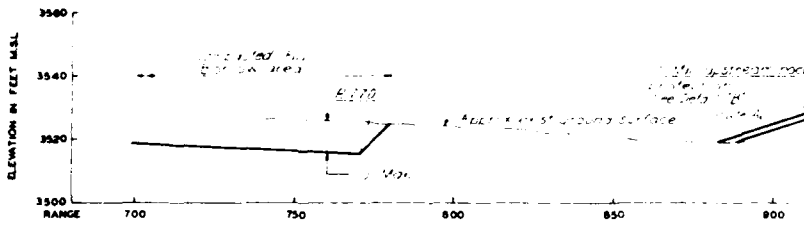
SPILLWAY PROFILE 1-1
SCALE 1 INCH = 20 FEET



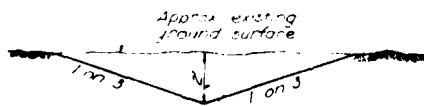
SECTION 2-2
SCALE 1 INCH = 20 FEET



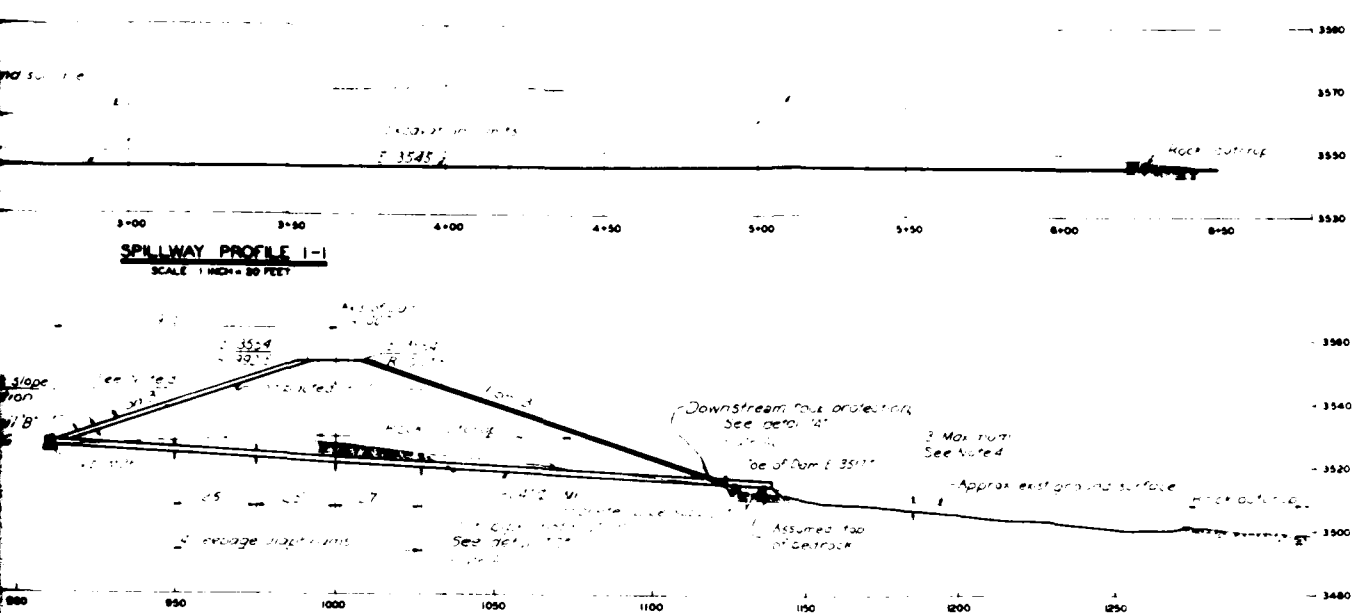
SECTION 4-4
SCALE 1 INCH = 20 FEET



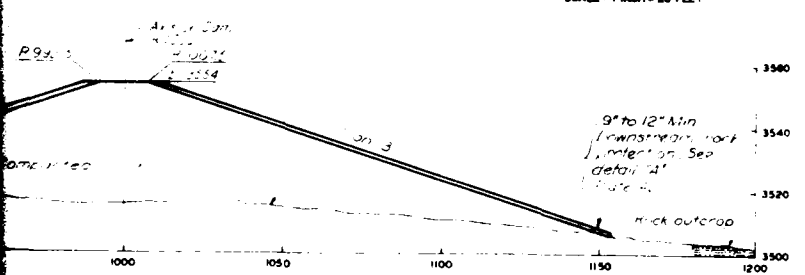
SECTION 5-5
SCALE 1 INCH = 20 FEET



TYPICAL SECTION
COLLECTOR & INTERCEPTOR DITCHES
NO SCALE

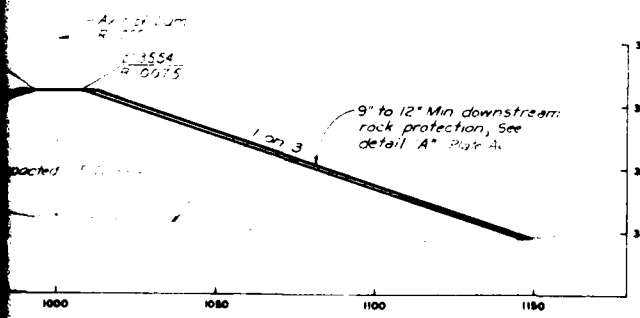


SECTION 3-3
SCALE 1 INCH = 20 FEET



GENERAL NOTES:

1. All elevations shown refer to feet above M.S.L., U.S.C. & G.S. 1929 General Adjustment.
2. Due to a limited subsurface investigation of the construction area, no attempt has been made to show the approximate top of bedrock on the sections. The location of the field investigations are shown on [redacted] and the field information obtained is shown on [redacted].
3. Place upstream and downstream rock protection to El. 3554.
4. Ditch to be excavated 3 feet in depth or to the top of bedrock, whichever occurs at the higher elevation.
5. Ditch depth may be reduced in area where existing overburden is less than 2' thick.



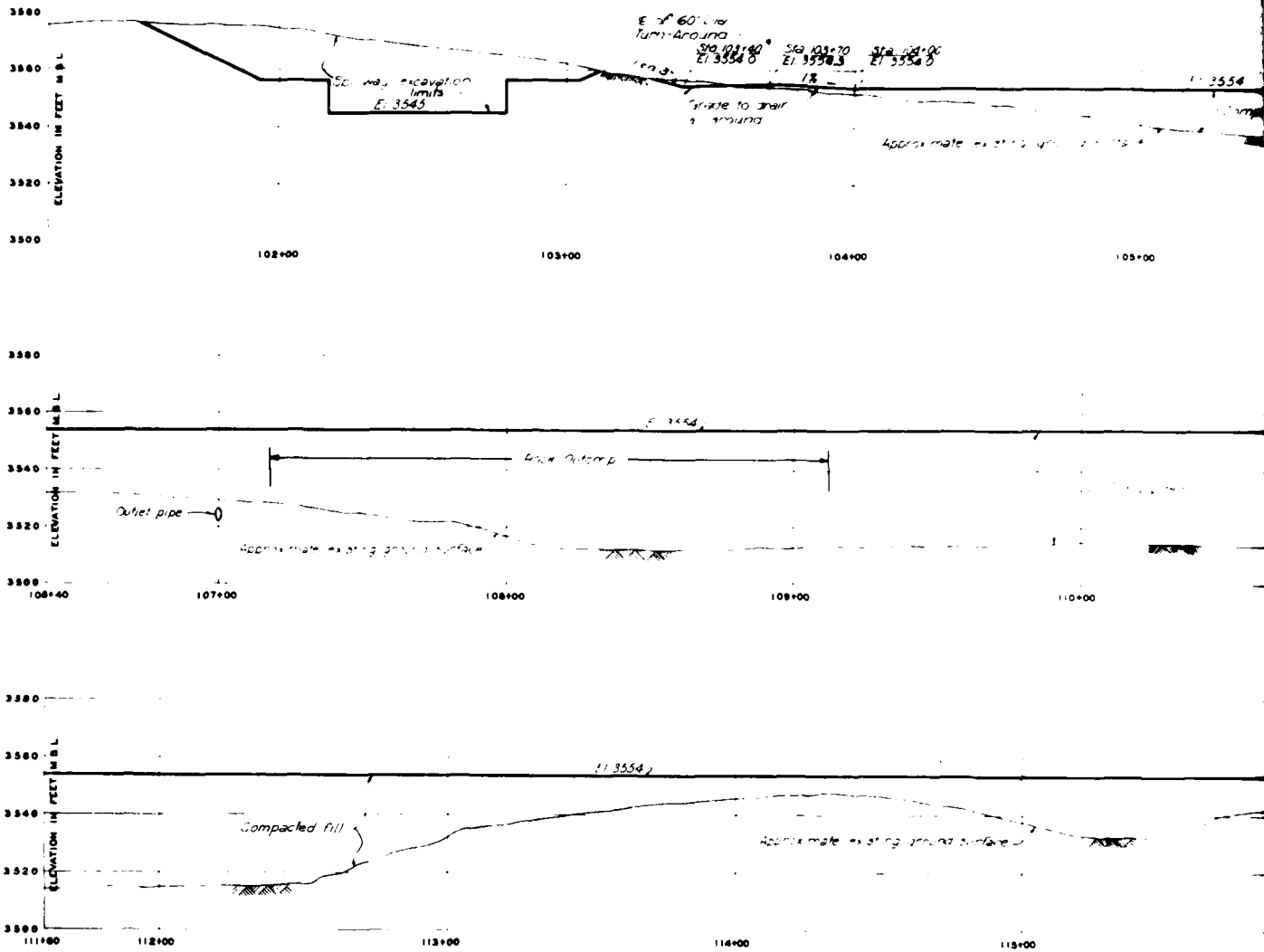
DATE	DESCRIPTION	BY	APPROVED
11-19-58	Revised to show 'As Built' conditions	[Signature]	[Signature]
M. 8-14-59	Revised to show 'As Built' conditions	[Signature]	[Signature]



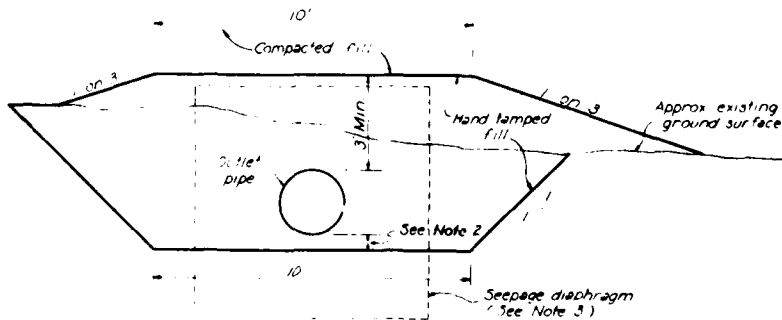
SCALE 1 INCH = 20 FEET

THIS PLAN ACCOMPANIES CONTRACT NO. CA-28-066-CIVENG-58-492

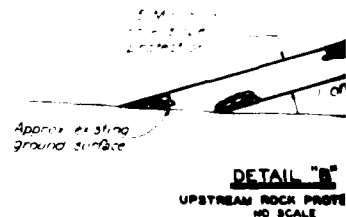
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA	
DRAWN BY: J. J. B. CHECKED BY: L. J. B.	CHEYENNE RIVER BASIN, SOUTH DAKOTA RED DALE GULCH AREA RAPID CITY, SOUTH DAKOTA CEDAR CANYON DAM EXCAVATION AND EMBANKMENT SECTIONS
APPROVED: [Signature] COL. C. E. DISTRICT ENGINEER	DATE: APRIL 1959 DRAWING NUMBER: CY25c1-40E42



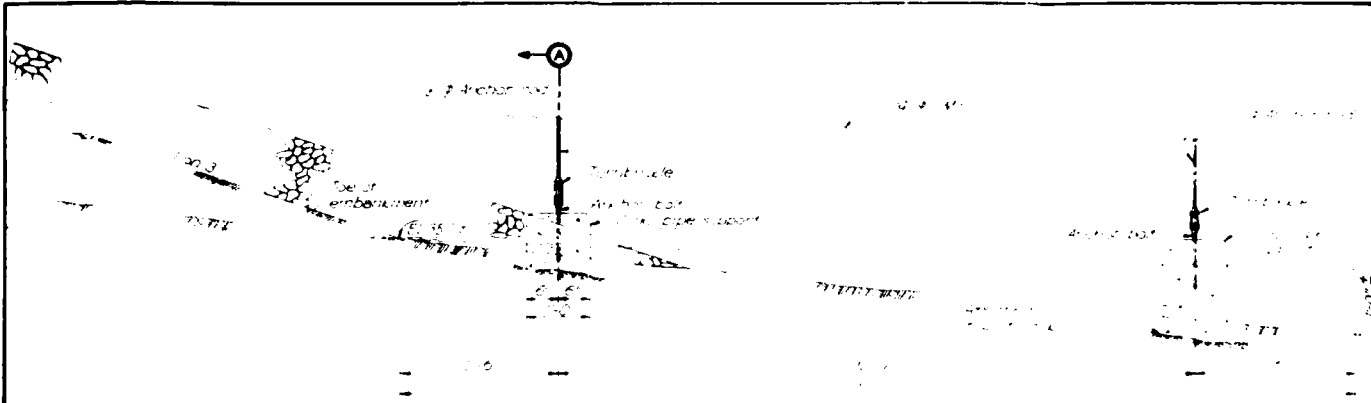
PROFILE 6-6
 SCALE 1 INCH = 20 FEET
 0 20



DETAIL "C"
EXCAVATION AND BACKFILL DETAIL
 OUTLET PIPE INSTALLATION
 NO SCALE

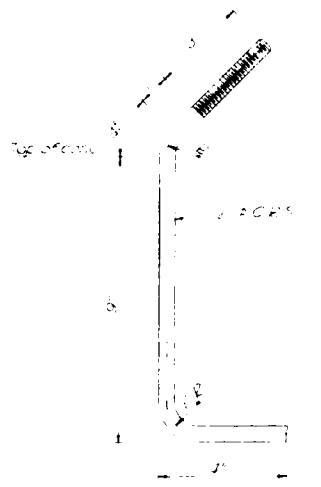


DETAIL "B"
 UPSTREAM ROCK PROTECT
 NO SCALE



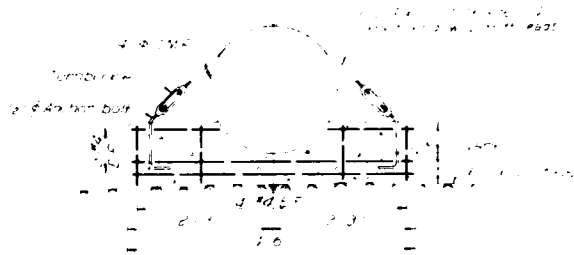
ELEVATION - DOWNSTREAM END

SCALE 1 INCH = 1 FOOT



ANCHOR BOLT DETAIL

FOUR REQUIRED
SCALE 3 INCHES = 1 FOOT



SECTION A-A

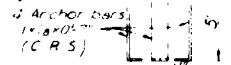
SCALE 1 INCH = 1 FOOT

2 # 1/2" x 6" x 0.6" (C.R.S.)



Use 1/2" dia holes, to match lost flange, for 1/2" x 1 1/4" hex hd cap screws
Drill 1/4" for 1/2" anchor bolt

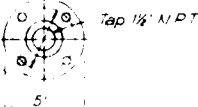
1/4" V



ANCHOR PLATE DETAILS

FOUR REQUIRED
SCALE 3 INCHES = 1 FOOT

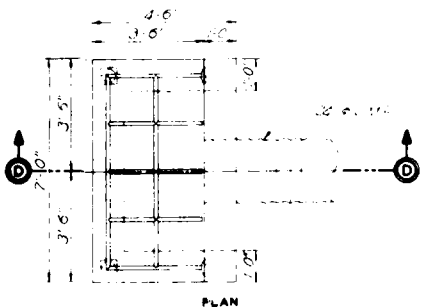
3/8" dia bolt circle
Drill 1/4" dia holes
equally spaced



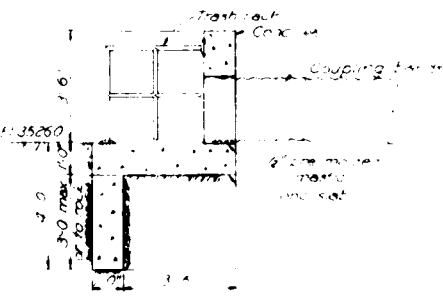
Break edges

PIPE FLANGE DETAILS

FOUR REQUIRED
SCALE 3 INCHES = 1 FOOT

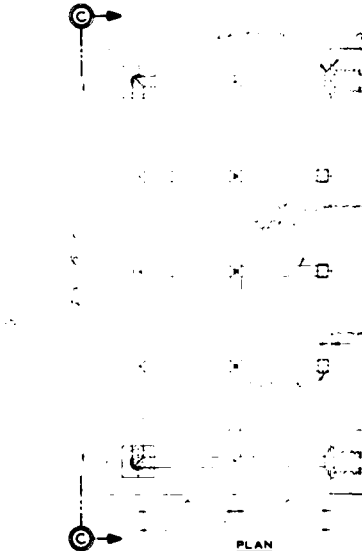


PLAN

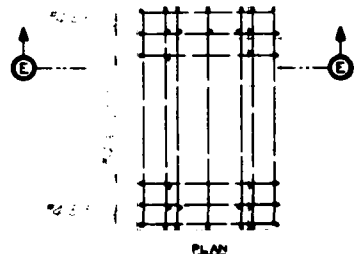


**SECTION D-D
CONCRETE DETAILS**

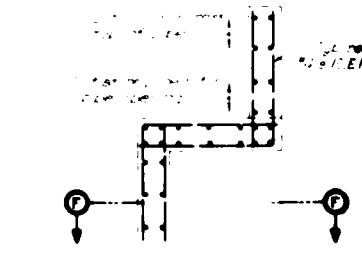
SCALE 1 INCH = 1 FOOT



PLAN



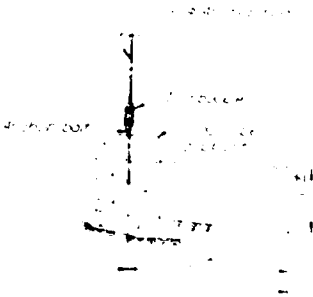
PLAN



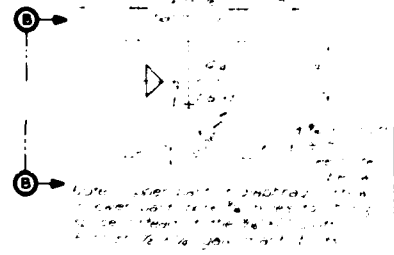
SECTION E-E

REINFORC
SCALE

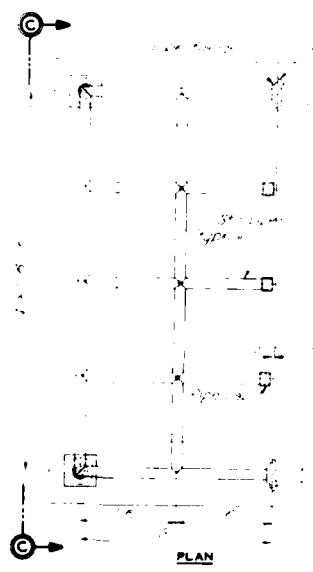
INLET STRUCTURE



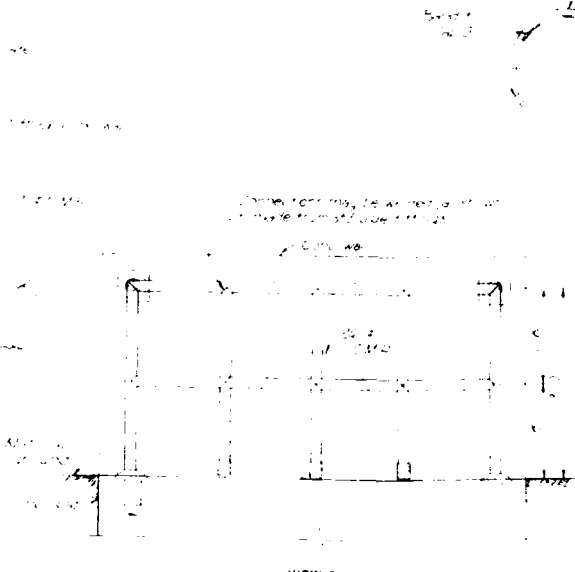
ELEVATION B-B
NO SCALE



SEEPAGE DIAPHRAGM
NO SCALE



PLAN



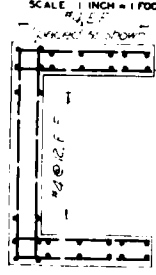
VIEW C-C

COUPLING BAND
NO SCALE

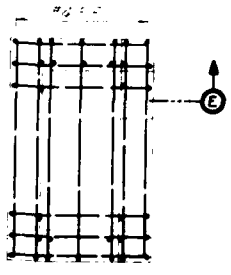
GENERAL NOTES:

1. Provide minimum concrete cover for reinforcement as follows:
Concrete poured against earth or rock, 3".
Formed faces, 2".
2. Provide 1-1/2" minimum clearance between reinforcement and miscellaneous metals.
3. Chamfer all exposed edges 3/4".
4. All splices shall be lapped 30 bar diameters.
5. All metals, except C.H.S., shall be galvanized after fabrication.
6. All elevations shown refer to feet above M.S.L., U.S.C. & G.S. 1929 General Adjustment.

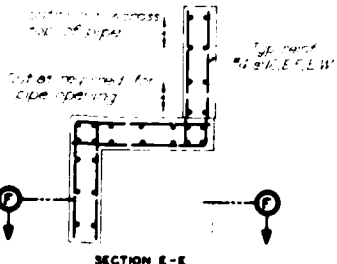
TRASH RACK DETAILS
SCALE 1/2 INCH = 1 FOOT



SECTION F-F



PLAN



SECTION E-E
REINFORCING DETAILS
SCALE 1/2 INCH = 1 FOOT

11/19/50 Revised to show As Built conditions		DATE	DESCRIPTION	MADE	APPROVED

U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

CHEYENNE RIVER BASIN, SOUTH DAKOTA
RED DALE GULCH AREA
RAPID CITY, SOUTH DAKOTA
CEDAR CANYON DAM
OUTLET PIPE CONSTRUCTION DETAILS

DESIGNED BY: H.W.H.	CHECKED BY: A.G.D.	DATE: APRIL 1949
DRAWN BY: A.G.D.	APPROVED: <i>[Signature]</i>	SCALE: AS SHOWN
IN CHARGE: <i>[Signature]</i>	APPROVED: <i>[Signature]</i>	PROJECT NO.: CY25C1-40E 61
CHIEF CIVIL ENGINEER: <i>[Signature]</i>	APPROVED: <i>[Signature]</i>	UNIT: COL. C. E. DISTRICT ENGINEER



THIS PLAN ACCOMPANIES CONTRACT NO. DA-28-066-02
MODIFICATION NO.

APPENDIX B
PHOTOGRAPHS



66 - 4778 -

PHOTO NO. 1 - View of test trench No. 2 - shows borrow material used for compacted fill.



PHOTO NO. 2 - View of the crest of the embankment looking towards the left abutment.

80 SEP

Reproduced from
best available copy.

PLATE RI



PHOTO NO. 3 - Panoramic view of the upstream slope of the embankment. 19 SEP

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best available copy



80 SEP

PHOTO NO. 4 - View of upstream slope of the embankment looking towards the left abutment.



80 SEP

PHOTO NO. 5 - View of upstream embankment slope looking towards the right abutment.

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best available copy. 

PLATE 83



Fig. 1. - Panoramic view of the downstream slope of the dam. (Photograph taken on 11 SEP 1964 at 10:00 AM, the left - right).

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best available copy.



80 SEP



PHOTO NO. 7 - View of rock slope protection on the upstream face of the dam.

80 SEP



PHOTO NO. 8 - View of rock slope protection on the downstream face of the dam.

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best available copy.



59 JUL

PHOTO NO. 9 - View of embankment during construction.



PHOTO NO. 10 - View of borrow area during construction of the dam. (Embankment is shown on right hand side of photo.)

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best available copy.

PLATE B6



PHOTO NO. 11 - View of the emergency spillway looking upstream from the ridge located to the right of the spillway.



PHOTO NO. 12 - View of the emergency spillway looking downstream from the ridge located to the right of the spillway.

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best available copy.



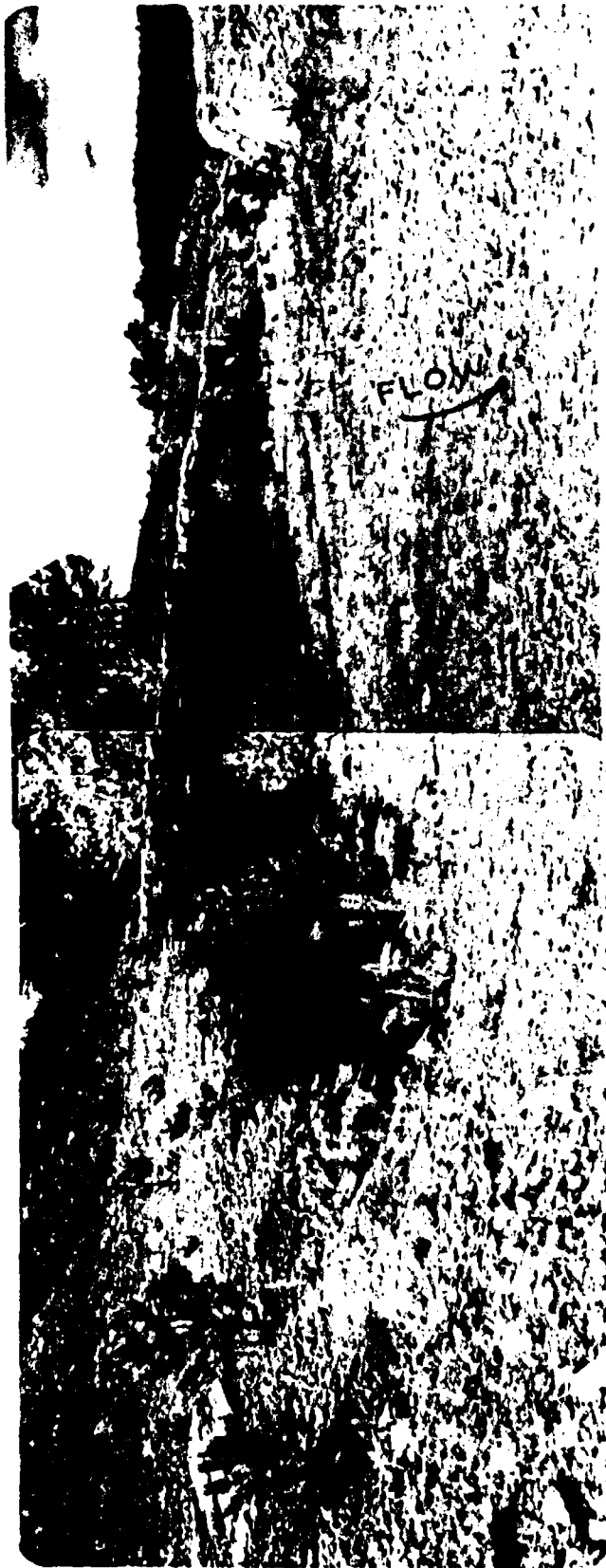


SEP 10

FIGURE 14 - View of the natural channel (natural terrace) below the emergency spillway.



FIGURE 15 - View of the emergency spillway channel relative to the embankment.



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best available copy. 

80 SEP

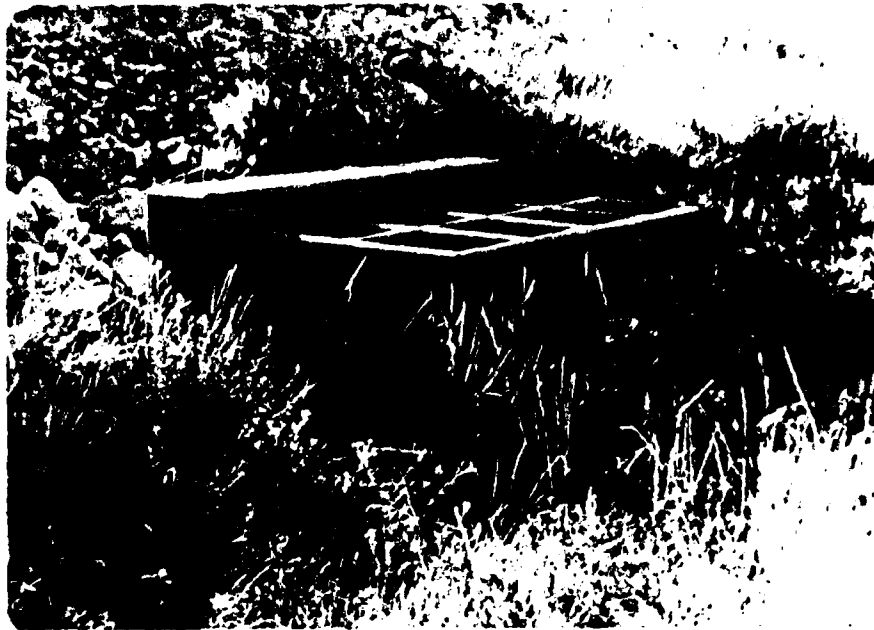


PHOTO NO. 16 - View of the conduit inlet headwall and trashrack structure.



PHOTO NO. 17 - View of the outfall channel below the downstream terminus of the conduit.

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best available copy.



CAV 010

80 SEP



PHOTO NO. 18 - View of dam down from terminal of the conduits.

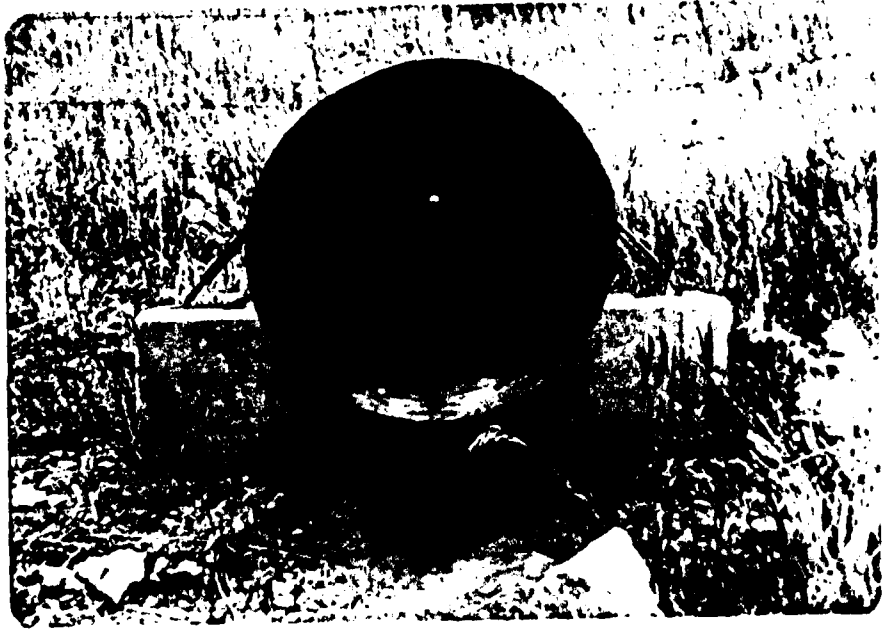


PHOTO NO. 19 - View looking down into conduit from reservoir area.

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best available copy.

EN

DATE
FILME

8 - 8

DTI