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Tilden E. McDowell
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GEOLOGY OF LOS ESTEROS DAM SITE

by

TILDEN E. McDOWELL
United States Corps of Engineers

INTRODUCTION

The Los Esteros Dam, as proposed, will be on the Pecos River approximately 7 miles upstream from Santa Rosa, New Mexico, at river mile 766.4. The general reach of the Pecos River between Santa Rosa, New Mexico and Colonias, New Mexico has been investigated intermittently since 1942. During this period, various Federal and State agencies, as well as private consultants, have conducted reservoir and site studies. The present site was selected from the best of three sites on the basis of geology, economics, ease of construction, and materials availability.

PHYSIOGRAPHY

The Pecos River begins in the Sangre de Cristo Mountains in north-central New Mexico and flows southeastward and southward to its confluence with the Rio Grande near Comstock, Texas. The Pecos River, in the project area, flows through a canyon incised into an eastward-draining regional surface. The canyon walls are capped by the Santa Rosa Sandstone of Triassic age. Relief within the area east of Horseshoe Bend generally is low and characterized by scattered small hills and mesas. The major storage area of the proposed project will be located in this vicinity.

GENERAL RESERVOIR GEOLOGY

The bedding within the region dips 1 to 2 degrees to the east-southeast. The significant regional anomalies interrupting the eastward-dipping bedding and influencing the direction of flow of both the Pecos River and ground water are: (1) The Bar "Y" dome, (2) the Guadalupe anticline, and (3) the Esterito dome. The general project plan is shown on Plate 1.

Within the planned reservoir area localized folding and faulting has been found. An anticline, for purposes of this report called the River Ranch anticline, which trends approximately east-west and plunges eastward, lies in the upper part of the reservoir site. Minor bed distortions, due mainly to erosion, were observed in the project area. Electric log correlation and interpretation infer the location of two bifurcating and intersecting normal faults in the area of the upper reservoir. These faults intersect at nearly right angles, and are oriented northwest-southeast and northeast-southwest.

The regional stratigraphic sequence as shown on Figure 1 includes interpretations of drill-hole data obtained from subsurface investigations. The stratigraphy within the proposed project area includes rocks of Quaternary, Tertiary, Triassic, and Permian age.

The Quaternary is represented by surficial unconsolidated deposits along the river bed. The deposits vary from large boulders to fine sand, silt and clay. Thin terrace gravel deposits occur on higher points throughout the project area.

Rocks of Tertiary age are represented by a northeast-trending basaltic dike. The dike is located north and east of the dam site in the eastern part of the proposed reservoir, and is the only igneous rock known to occur within the project area. The dike can be traced for a distance of three-quarters of a mile.

The Triassic is represented by the Chinle and Santa Rosa Formations of the Dockum Group.

The Chinle Formation consists of alternating shale, siltstone, and sandstone that will form the high floor in the eastern part of the proposed reservoir. The Chinle is found in the reservoir area east and north of Horseshoe Bend and is predominantly a brownish-red shale, siltstone and reddish-brown and gray sandstone. Locally, the Chinle contains thin limestone conglomerate layers, and petrified wood.

The Santa Rosa Sandstone consists of massive sandstone and shale layers. Sandstone layers of this formation form the prominent canyon rim of the Pecos River within the project area. The Santa Rosa Sandstone is subdivided into four members which are described in Figure 1. This formation will form the floor of the reservoir in the area west of the exposed Chinle sediments. The proposed rock sources for protection stone and rockfill will be in the upper and middle sandstone members of this formation. Geologic mapping and core borings show the presence of asphalt in the upper member of the Santa Rosa. The occurrence of the asphalt is primarily limited to the east side of the river.

The Permian period is represented by the Bernal Formation, San Andres Limestone, and Glorieta Sandstone.

The Bernal Formation crops out in the upper reaches of the reservoir (around River Ranch). The Bernal is composed of fine-grained sandstone, siltstone, shale, dolomite, and evaporites. The contact between the Bernal and overlying Santa Rosa is marked by a gray to white siltstone at the top of the Bernal and is easily recognizable in the field. The bedding within the upper reservoir (River Ranch) locally exhibits distortion.

The San Andres Limestone is the oldest exposed unit in the reservoir. Its outcrop is limited to one localized area within the upper part of the reservoir (River Ranch) (Pl. 1). This formation consists of anhydrite, limestone, dolomite, gypsum, and shale. The San Andres within the project area varies from 210-265 feet. Bore-hole data shows the section thickening to the southeast, in part, by an increase in anhydrite.

The Glorieta Sandstone does not crop out within the reservoir. This formation, a hard, well-cemented sandstone, was used as the structural mapping horizon and for control in the preparation of geologic cross-sections. The Glorieta was the oldest formation penetrated during subsurface investigations.

GEOLOGY OF THE DAM SITE

The dam will be constructed in a canyon 180 feet wide at the bottom and 2,200 feet wide between the high points of the abutments. Surface erosion normal to the river channel has provided a concavity in each abutment forming excellent natural foundation features into which the embankment will be fitted (Pl. 2).

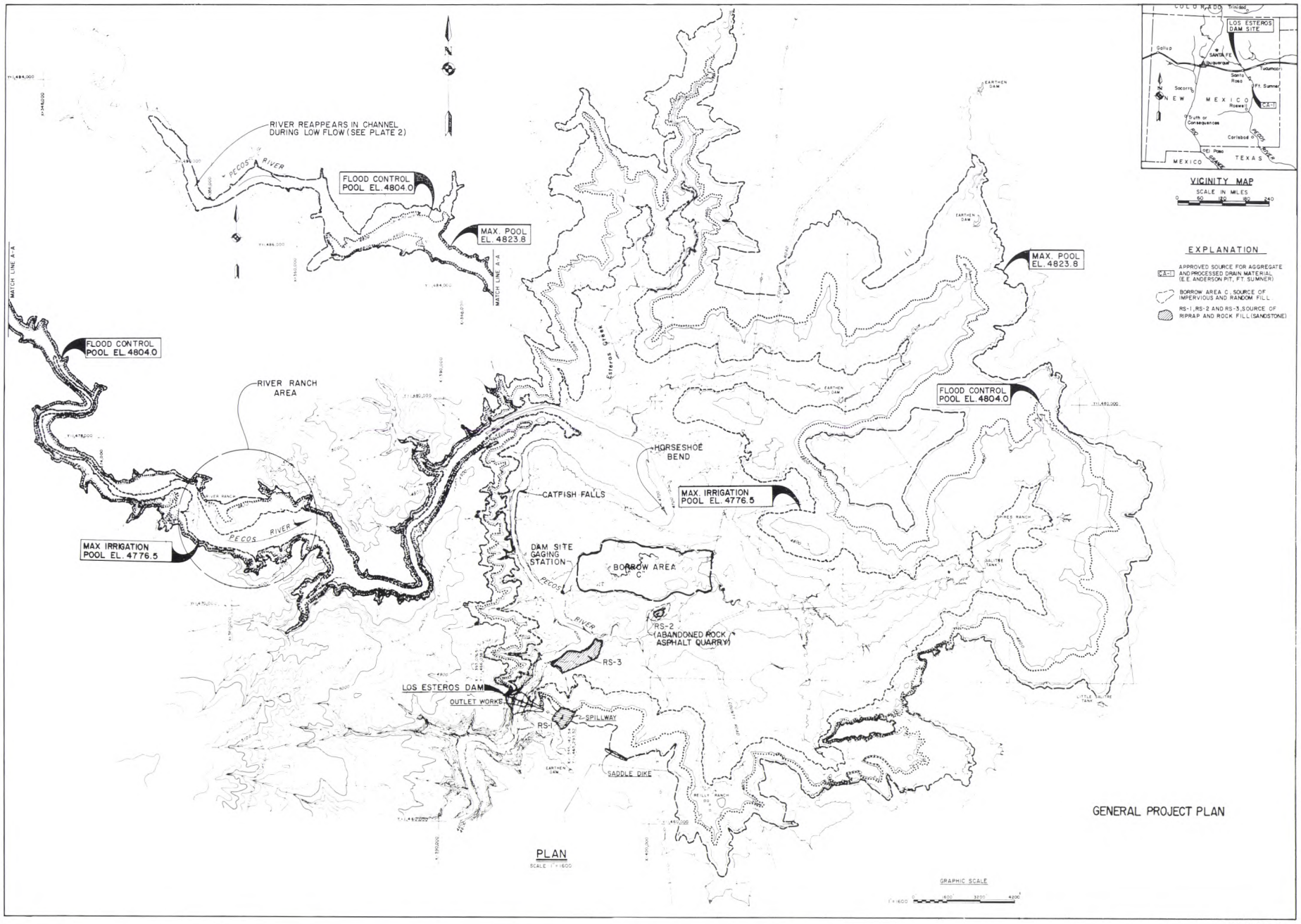

RIVER REAPPEARS IN CHANNEL DURING LOW FLOW (SEE PLATE 2)
PECOS RIVER
FLOOD CONTROL POOL EL. 4804.0
MAX. POOL EL. 4823.8
MATCH LINE A-A
FLOOD CONTROL POOL EL. 4804.0
RIVER RANCH AREA
MAX IRRIGATION POOL EL. 4776.5
PECOS RIVER
Esteros Creek
HORSESHOE BEND
CATFISH FALLS
MAX. IRRIGATION POOL EL. 4776.5
DAM SITE GAGING STATION
BORROW AREA C
RS-2 (ABANDONED ROCK ASPHALT QUARRY)
RS-3
LOS ESTEROS DAM
OUTLET WORKS
SPILLWAY
RS-1
SADDLE DIKE
MAX. POOL EL. 4823.8
FLOOD CONTROL POOL EL. 4804.0
EARTHEN DAM
PLAN
SCALE 1"=1600'
GRAPHIC SCALE
1"=1600'
LOS ESTEROS DAM SITE
COLORADO
NEW MEXICO
TEXAS
MEXICO
VICINITY MAP
SCALE IN MILES
EXPLANATION
CA-1 APPROVED SOURCE FOR AGGREGATE AND PROCESSED DRAIN MATERIAL (E.E. ANDERSON PIT, FT. SUMNER)
BORROW AREA C, SOURCE OF IMPERVIOUS AND RANDOM FILL
RS-1, RS-2 AND RS-3, SOURCE OF RIPRAP AND ROCK FILL (SANDSTONE)
GENERAL PROJECT PLAN

PLATE 1

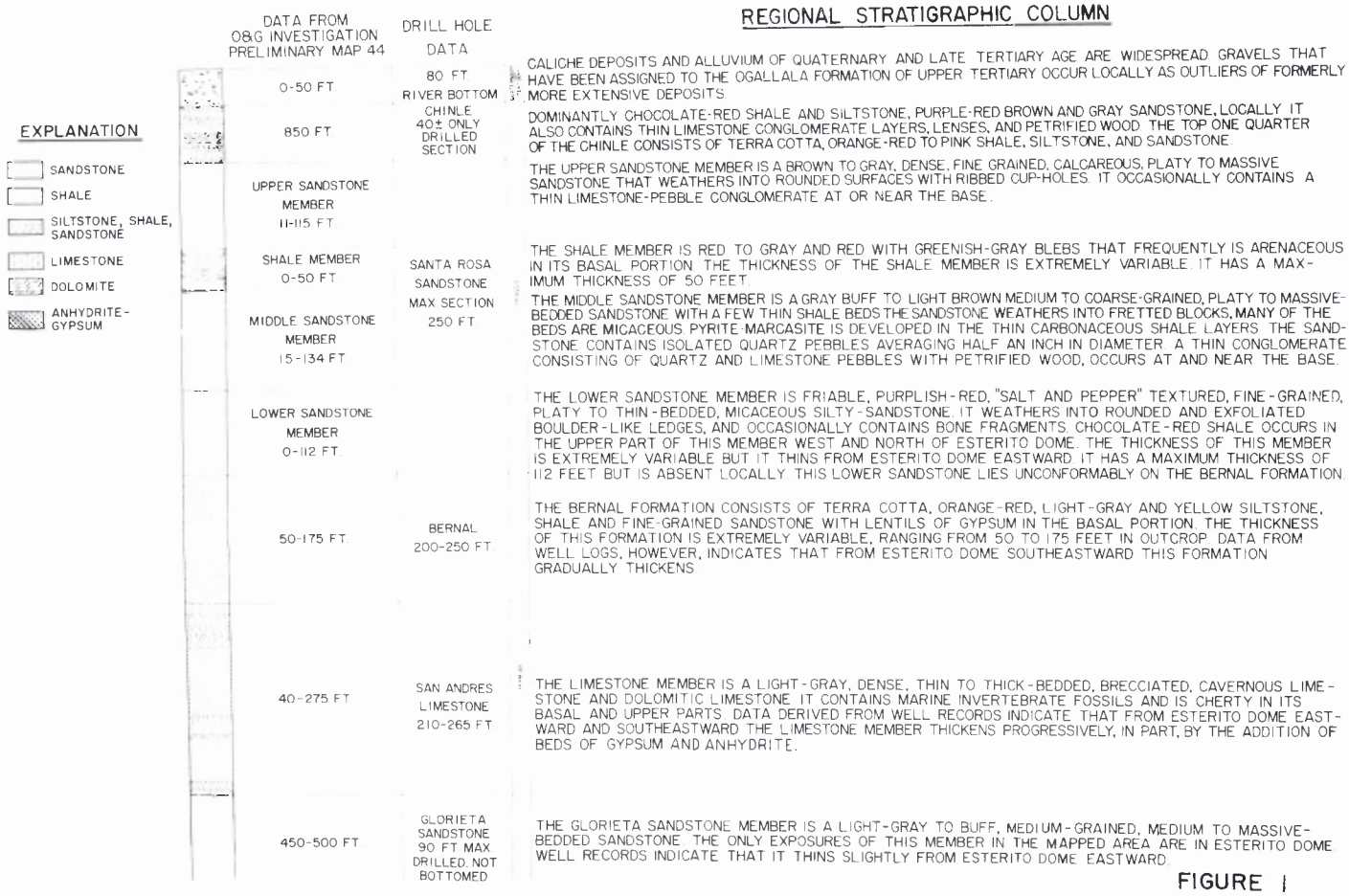


FIGURE 1

The abutments are capped by the upper sandstone unit of the Santa Rosa Sandstone. The Santa Rosa has been divided into the following members:

Member	Reported Regional Thickness (feet)	Thickness at Dam Site
a. Upper sandstone	11 to 115	82
b. Shale	0 to 50	103
c. Middle sandstone	15 to 134	99
d. Lower sandstone	0 to 112	(absent at dam site)

The upper sandstone member of the Santa Rosa is 82 feet thick, cross-bedded, moderately jointed, having only a few shale layers, the thickest being approximately 1.5 feet. The shale member, which underlies the upper sandstone member, is 103 feet thick and is composed of shaly siltstone in the upper part, overlying a deep maroon, red, gray, and blue-gray shale sequence. The middle sandstone, which underlies the shale member is 99 feet thick at the dam site, exhibits minor jointing, and is a massive sandstone with thin scattered shale and conglomerate layers. The majority of the embankment structure will rest on the middle sandstone member. Approximately 65 feet of this sandstone member will underlie the structure at river level. The lower sandstone member is not present at the dam site.

The Bernal Formation underlies the Santa Rosa and has a total thickness of 237 feet. The formation is made of dense, hard dolomite; red, calcareous, hard shale; siltstone; and greenish-gray and gray shale. There are some scattered horizonal gypsum seams and gypsum filled high-angle fractures which appear in core samples in the lower 165 feet of the formation.

The San Andres Limestone underlies the Bernal and has a thickness of 278 feet. The San Andres at the dam is predominantly anhydrite. The Glorieta Sandstone is the oldest formation penetrated by drilling operations and is a well-cemented medium-grained sandstone.

The dam structure will be a zoned embankment and will consist of an upstream rolled rockfill section, an impervious central core and a random fill downstream section. The maximum height of the embankment above the stream bed will be about 212 feet. The crest width of the embankment will be 36 feet with a paved roadway for maintenance and public use. The embankment will be founded on bedrock with the impervious core zone incised 2 feet into unweathered rock.

Special foundation treatment in the form of a grout curtain will be required along the axis of the structure. Pressure grouting will be along a single line curtain from the dam foundation surface to a depth of approximately 100 feet. The cut-off curtain will be constructed on 10-foot centers using stage grouting procedures with the location, direction, and inclination of the grout holes to be determined in the field after the foundation is exposed. Pressure testing data show low permeabilities in the shale sequence and higher values in the slightly to moderately jointed sandstone members. (Pl. 3).

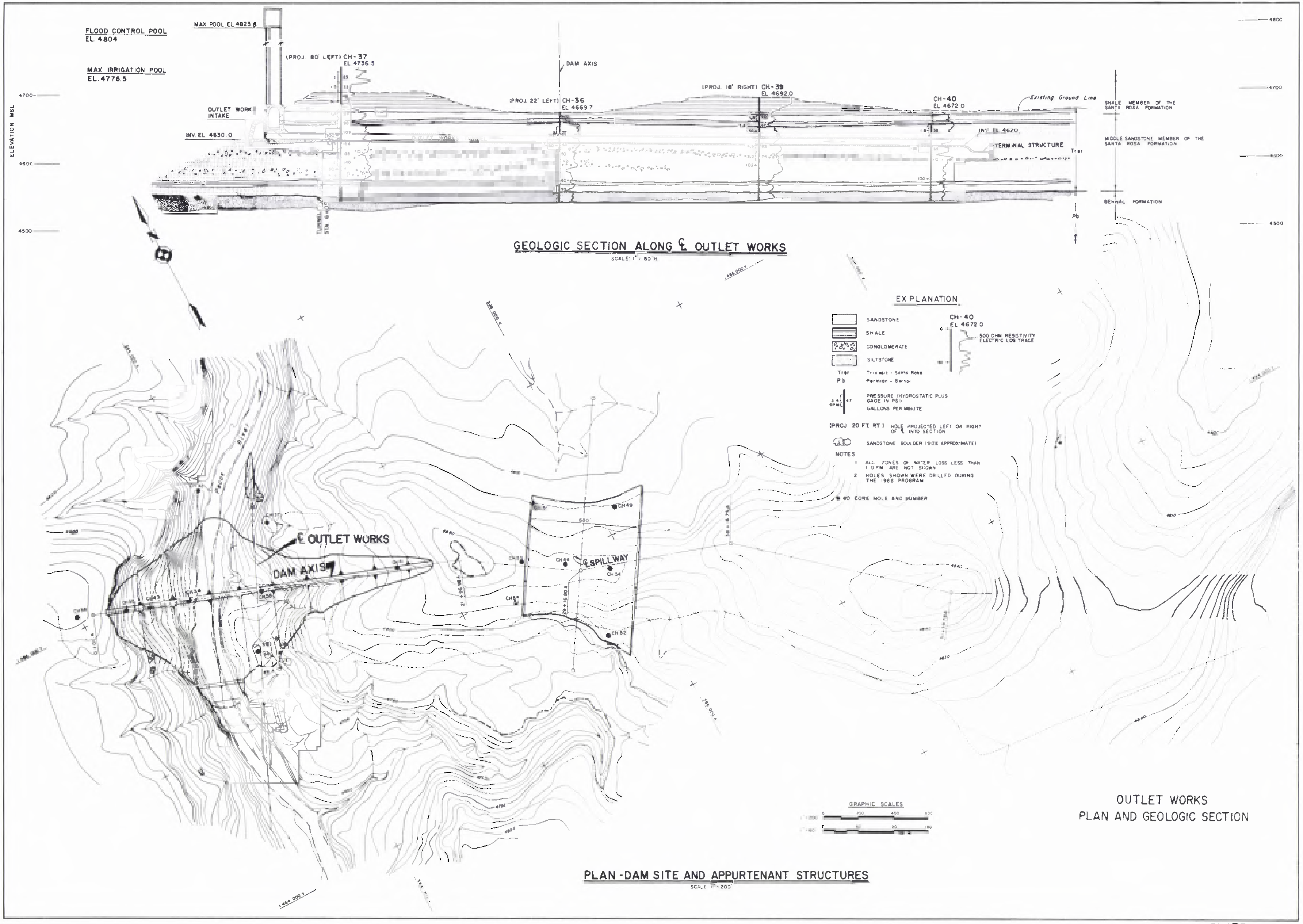
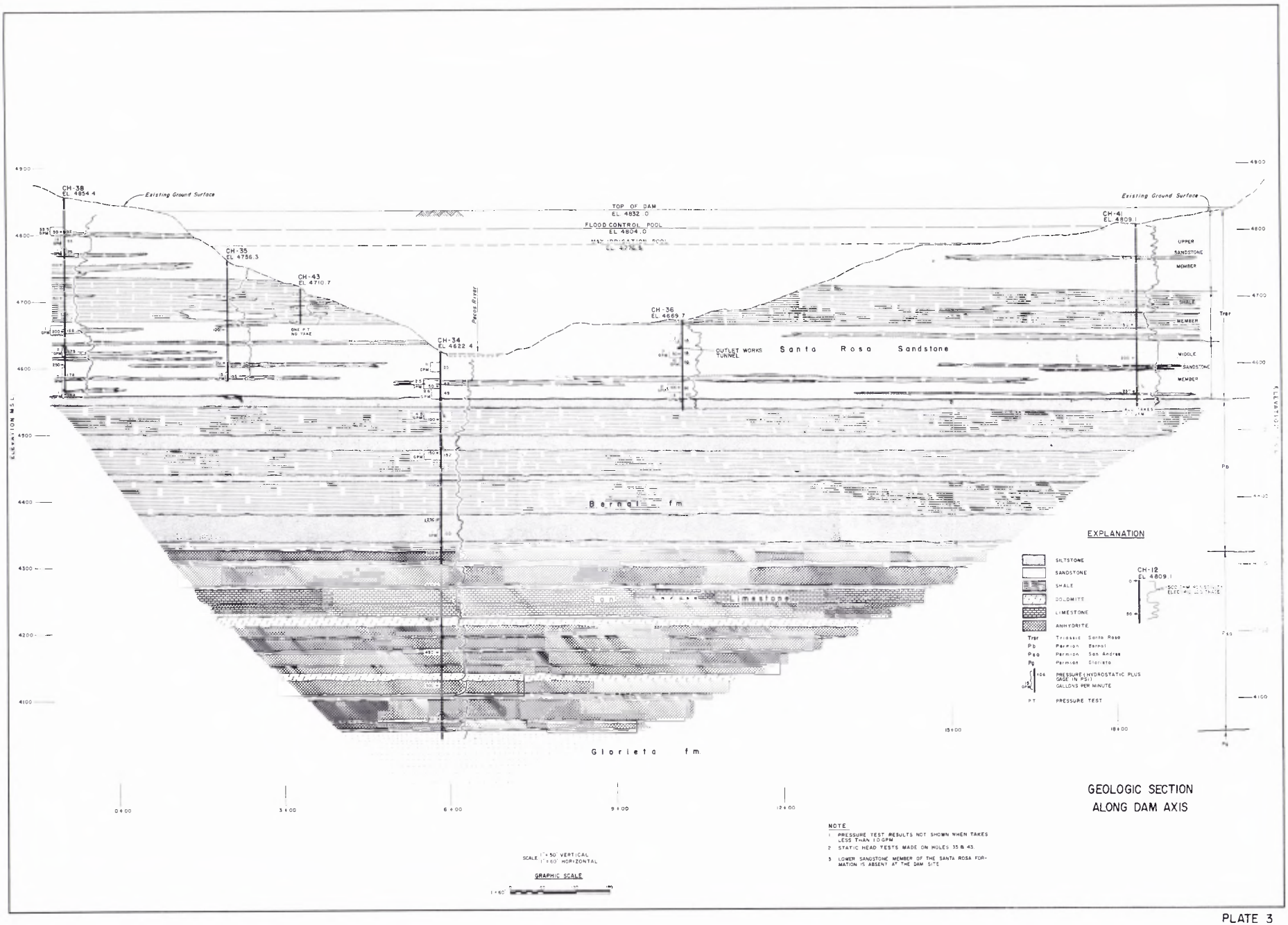

FLOOD CONTROL POOL
EL. 4804
MAX POOL EL 4823.6
MAX IRRIGATION POOL
EL. 4776.5
(PROJ. 80' LEFT) CH-37
EL 4736.5
DAM AXIS
(PROJ. 18' RIGHT) CH-39
EL 4692.0
(PROJ. 22' LEFT) CH-36
EL 4669.7
CH-40
EL 4672.0
Existing Ground Line
OUTLET WORK INTAKE
INV. EL 4630.0
INV. EL 4620
TERMINAL STRUCTURE
ELEVATION MSL
SHALE MEMBER OF THE SANTA ROSA FORMATION
MIDDLE SANDSTONE MEMBER OF THE SANTA ROSA FORMATION
BERNAL FORMATION
Trsr
Pb
GEOLOGIC SECTION ALONG ℄ OUTLET WORKS
EXPLANATION
SANDSTONE
SHALE
CONGLOMERATE
SILTSTONE
Trsr Triassic - Santa Rosa
Pb Permian - Bernal
500 OHM RESISTIVITY ELECTRIC LOG TRACE
PRESSURE (HYDROSTATIC PLUS GAGE IN PSI)
GALLONS PER MINUTE
(PROJ. 20 FT. RT.) HOLE PROJECTED LEFT OR RIGHT OF ℄ INTO SECTION
SANDSTONE BOULDER (SIZE APPROXIMATE)
NOTES
1. ALL ZONES OF WATER LOSS LESS THAN 1 GPM ARE NOT SHOWN
2. HOLES SHOWN WERE DRILLED DURING THE 1968 PROGRAM
CORE HOLE AND NUMBER
℄ OUTLET WORKS
DAM AXIS
℄ SPILLWAY
Pecos River
GRAPHIC SCALES
PLAN - DAM SITE AND APPURTENANT STRUCTURES
OUTLET WORKS
PLAN AND GEOLOGIC SECTION

PLATE 2



GEOLOGIC SECTION
ALONG DAM AXIS

PLATE 3

OUTLET WORKS GEOLOGY

The proposed outlet works will be a tunnel conduit constructed through the left abutment of the structure (Pl. 2). The 10-foot diameter tunnel will be approximately 1,200 feet long and will be excavated through the massive middle sandstone member of the Santa Rosa formation. The rock along the alignment is massive sandstone that contains some scattered conglomerate and shale layers. The rock quality is acceptable for tunneling operations and all subsurface data indicate the tunnel will have adequate cover along the alignment. The sandstone will require only nominal structural support, and the lithologic description of this member is presented in Figure 1.

SPILLWAY GEOLOGY

The uncontrolled spillway will be located approximately 1,000 feet east of the left abutment of the dam and will be excavated into the upper sandstone member of the Santa Rosa Sandstone. The spillway excavation will be 700 feet long, 680 feet wide, and have a 30-foot maximum cut near the centerline of the structure. Crest control of the spillway will be provided by a 10-foot concrete sill. The spillway will discharge into a deep side canyon which will, in turn, empty into the Pecos River approximately 1,000 feet downstream from the toe of the dam.

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