SPECIAL FLOOD HAZARD INFORMATION

SALINAS NATIONAL MONUMENT

Part 2 of 2

QUARAI UNIT

Vicinity of Punta de Agua, New Mexico

Ref. MT 7072-2-0060 NPS

Prepared for

U. S. Department of the Interior

National Park Service

by

Department of the Army

Albuquerque District, Corps of Engineers

Albuquerque, New Mexico

Introduction

This flood study was prepared by the Albuquerque District U. S. Army Corps of Engineers (COE) for the U. S. Department of the Interior National Park Service (NPS) Southwest Regional Office. The study was authorized in a letter by Mr. Jack Nechels of the NPS dated August 12, 1982. The hydrologic and hydraulic computations were performed by Thomas Ryan, Hydraulic Engineer, of the Hydrologic Engineering Section, Planning Branch, Engineering and Planning Division, COE.

The study addresses the requirements set forth by Executive Order 11988. Briefly, Section 2(a)(1) of E.O. 11988 (May 24, 1977) requires that, "Before taking an action (". . . Federally undertaken, financed or assisted construction and improvements," Section 1), each [federal] agency shall determine whether the proposed action will occur in a floodplain . . ." The term floodplain is defined "as a minimum, areas subject to inundation by a flood with a one percent chance of occuring in any year (i.e., "100-year or base flood")."

The Salinas National Monument, located in Torrance and Socorro Counties of New Mexico, contains three separate units: Abo, Quarai and Gran Quivira. This report is Part 2 of a two-part report and covers only the Quarai Unit in Torrance County near Punta de Agua, New Mexico. Part 1 of this report is on the Abo Unit in Torrance County near Scholle, New Mexico. The Gran Quivira Unit in Socorro County near Gran Quivira, New Mexico, was not requested under this contract and will not be presented.

Mr. Nechels' previously mentioned letter requested the "2-, 5-, 10-, 50-, 100-, 500- year frequency and Q maximum flood events for both the Abo and Quarai Units" (Salinas National Monument). No need was seen to evaluate the Gran Quivira Unit at present. 'Q maximum' was interpreted to mean probable maximum flood (PMF) peak. PMF is defined as the runoff from the theoretically greatest depth of precipitation for a given duration that is physically possible over a given size storm area at particular geographical location at a certain time of the year. It was agreed upon verbally between Mr. Garland (Gary) Moore, NPS, and Mr. Thomas Ryan, COE, that only the peak discharge for each event would be calculated and presented.

Mapping for this study and report was provided by the NPS to the COE. The work maps are at a scale of 1 in = 100 ft with a contour interval of 1 ft and are based on aerial photography exposed on July 6, 1982. The mapping was produced under a NPS contract to the Remote Sensing Division of the NPS located at the Bandelier West Building on the University of New Mexico Campus, Albuquerque, New Mexico. The datum is arbitrary and is in no way related to mean sea level. No attempt was made by the COE or the NPS or any other agency to reference the arbitrary datum to a national or state datum. The initial contracting officer for the NPS was Mr. Garland Moore.

Quarai Unit, Salinas National Monument

1. Hydrology:

There are no stream gages on any of the flowpaths in the study area. Runoff patterns in the area by observation are due to thunderstorms of varying intensities with the stream beds remaining dry a large portion of the time except for the flow in Canon Sapato (Stream 1000) from the spring as shown in Figure 3. No significant detention or diversion structures were found in any portion of the watershed.

Figures 1 through 3 following this text are respectively Regional, Location and Site maps of the project area. Figure 4 is an area map with the major concentration points where peak flows were calculated. Figure 4 also shows the stream numbering system used in this report. The main arroyo, Canon Sapato, is labeled Stream 1000 with its tributaries being designated 2000, 3000, 4000 and 5000.

Peak discharges for the 2-, 5-, 10-, 50-, 100- & 500- year floods were computed using equations and procedures contained in the U. S. Geological Survey's manual, Techniques for Estimating Flood Discharges for Unregulated Streams in New Mexico, Water Resources Investigations 82-24, published in March 1982. The manual contains equations for estimating flood magnitude at selected reoccurance intervals from 2- to 500- years. For all drainage areas greater than one square mile, the equations used for this study are found on page 9 of the report. Frequency curves for discharge per square mile vs. drainage area in square miles were developed in Part 1: The Abo Unit, Salinas National Monument as follows: The two variables, drainage area and site altitude, were taken at various concentration points from U.S. Geological Survey (USGS) 7-1/2 minute quandrangle sheets of the Abo area. After the peak flows were calculated, expected probability was added according to the procedure found in Appendix 11 of Guidelines for Determining Flood Flow Frequency, Bulletin #17B, Revised September 1981 with Editorial Corrections March 1982, by Interagency Advisory Committee on Water Data published by U. S. Department of the Interior, USGS, Office of Water Data Coordination. The frequency peak flows for drainage areas less than one square mile were computed by first plotting all peak flows, including representative PMF peaks, on logarithmic paper, plotting drainage area vs discharge per square mile. The PMF peaks were obtained from previous Corps studies and represent drainage areas between 0.13 and 26 square miles. A best fit curve was drawn. The frequency curves for the drainage areas below one square mile were adjusted to reflect the same curvature as the PMF curve below one square mile. The curves from the Abo Unit study were extrapolated to include drainage areas to .001 square miles. The final series of curves are shown in Figure 5. There are two split flow locations of notable consequence. The first is along stream 5000 with a portion of flow being diverted along the north of the contact station and a small amount through the open area at the center of the station. The second is just east or below concentration point K+L. The bulk of the flow will be trained to the south toward concentration point S while an increasing percentage, corresponding to the frequency, will run to the east toward concentration point T. See Figure 4. The corresponding peak flows for the 2-, 5-, 10-, 50-, 100-, 500- year floods and PMF are shown in Table 1 as follows:

Table 1

Peak Flows in C.F.S.

Concentration Point Number	Stream	Peak Flows (CFS) Q2	Q5	Q10	Q50	Q100	Q500	QPMF
A1	4000	44	131	221	622	915	2100	6825
A2	3000	6	18	30	84	124	284	921
A3	2000	41	123	208	586	856	1966	6417
A	1000	64	196	334	915	1350	3075	11400
B	1000	69	201	342	934	1382	3109	11775
C	1000	77	221	374	1002	1470	3324	13608
D	1000	77	222	376	1010	1480	3335	13620
E	5000	3	10	17	46	69	159	516
F	5000	3	10	17	48	71	163	527
G	-	1	1	1	4	6	13	43
H	-	1	2	3	8	11	24	93
I	-	1	1	2	5	8	18	58
J	-	1	1	1	3	4	9	28
K	-	1	2	4	10	15	34	124
L1	-	1	4	6	17	26	59	199
L2	-	11	32	54	154	228	516	1677
L	-	12	35	59	163	243	552	1794
M	-	1	2	3	8	11	25	197
N	-	12	37	63	175	258	589	1932
O,4	-	13	38	65	179	267	608	1981
P	-	22	65	111	312	457	1050	3396
Q	-	1	3	4	12	18	42	136
R	-	2	5	8	24	35	80	258
K+L	-	12	35	60	167	247	565	1830
S	-	12	34	57	150	210	452	1281
T	-	0	1	3	17	37	113	549

2. Hydraulics

Water surface elevations were calculated using the COE's HEC-2 computer program and critical depth calculations made using a desk calculator for the areas labeled "Approximate Study". Cross sections were taken from the work maps provided by the NPS. Channel and overbank roughness values were based on field observations and expressed as Manning's 'n' values. HEC-2 calculations were made in a backwater mode. Where the streambed exceeded critical slope the minimum calculated water surface elevation used was critical depth. Experience, observations and engineering judgment have shown that a natural channel can rarely, if ever, sustain supercritical flow over an appreciable distance and/or time period in the non-turbulent flow range. Critical depth is used to provide a safety factor for the obviously turbulent, unstable flow. In reaches where the streambed has a less than critical slope the water surface depth will be greater than critical depth. For streams 1000, 2000, 3000, 4000, and the upper half of stream 5000, the flood depths may be determined at a particular point from the flood profiles on plates 1 through 10. The streambed profile shown on those plates are based on the lowest point in the streambed along each cross section. The actual ground may vary from the profile for a number of reasons. These include, but are not limited to, errors in mapping, changes in the streambed since mapping was accomplished, "straightlining" the profile between cross sections and the estimations of lowest point elevation taken from the mapping. However, these errors should not appreciably affect the flood depths at any particular point along the streams. The stream beds are being eroded at varing rates. These channel features make the flood depths and flood plains susceptible to sudden change. In the area of the pueblo ruins any excavation can affect drainage boundaries, flow paths and flood plains and depths. However, except in extremely rare circumstances, the changes are not anticipated to be significant.

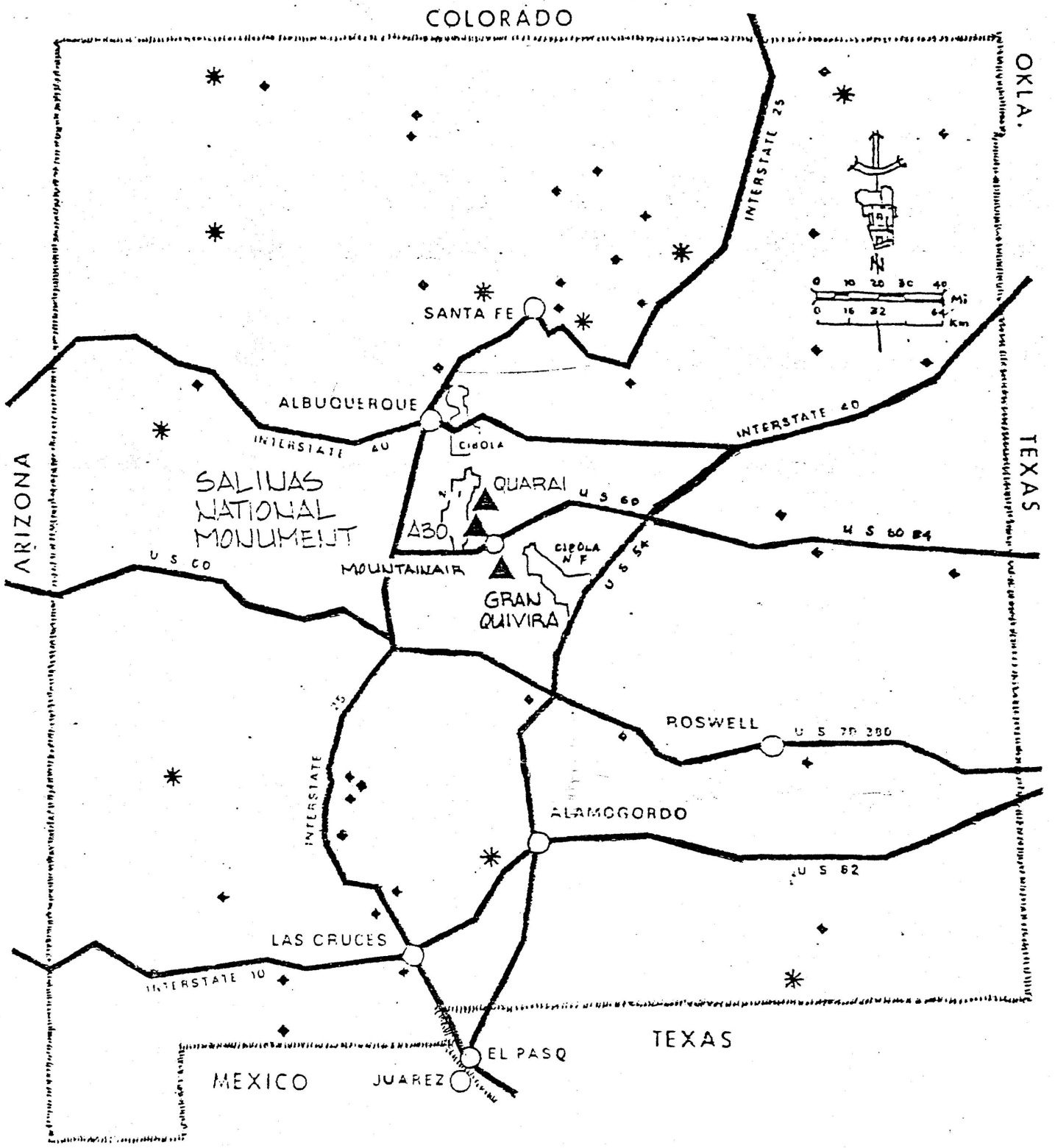
Figure 4 shows the 100-year frequency floodplain map of the Quarai Unit and the study limits. Areas marked "Approximate Study" are adjusted critical depth averages and would apply to the lowest point along any cross section taken perpendicular to the direction of flow, sheet flow where the flow path is poorly defined. Table 2 is a summary of the approximate depths for all frequencies and the PMF just above and below each concentration point shown in Figure 4.

Table 2

Summary of Approximate Depths

Referenced Concentration Point	Water Depth 2 Yr. Freq. (FT)	5 Yr. Freq. (FT)	10 Yr. Freq. (FT)	50 Yr. Freq. (FT)	100 Yr. Freq. (FT)	500 Yr. Freq. (FT)	PMF (FT)
E*	.2	.3	.4	.4	.5	.8	1.4
F*	.2	.3	.4	.6	.8	1.1	1.7
G	.0	.0	.0	.1	.1	.2	.4
H	.1	.1	.1	.2	.3	.4	.8
I	.1	.1	.1	.2	.2	.3	.6
J	.0	.0	.0	.1	.1	.2	.4
K	.1	.2	.2	.4	.5	.7	1.3
L1	.1	.2	.3	.5	.6	1.0	1.7
L2	.5	.8	1.0	1.6	1.9	2.7	4.4
L	.2	.3	.4	.8	1.0	1.6	2.8
M	.2	.2	.3	.4	.5	.7	1.2
N	.1	.2	.2	.5	.6	1.0	2.2
O	.4	.8	1.0	1.6	1.9	2.7	4.5
P	.2	.4	.5	1.0	1.3	2.2	4.5
Q	.2	.4	.4	.7	.9	1.2	2.0
R	.3	.5	.6	1.0	1.2	1.6	2.7
K+L	.1	.2	.4	.7	.9	1.6	3.3
S	.2	.4	.5	.8	1.0	1.4	2.3
T	.0	.0	.1	.2	.4	.7	1.5

* Downstream of Station 5+00



NF NATIONAL FOREST (NEAR PROPOSAL)

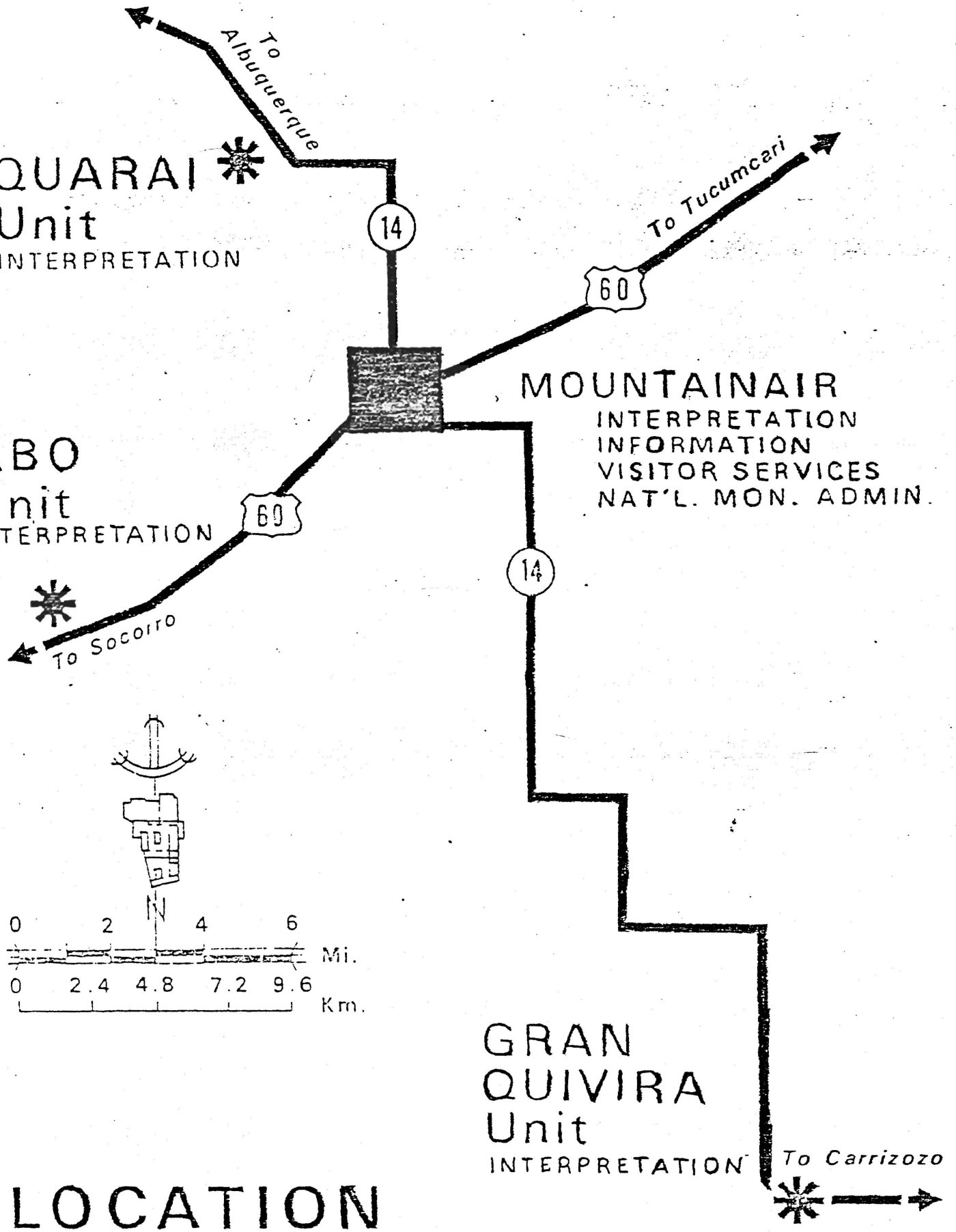
STATE PARKS & MONUMENTS

NATIONAL PARKS & MONUMENTS

THE REGION

Salinas National Monument New Mexico
United States Department of the Interior / NPS

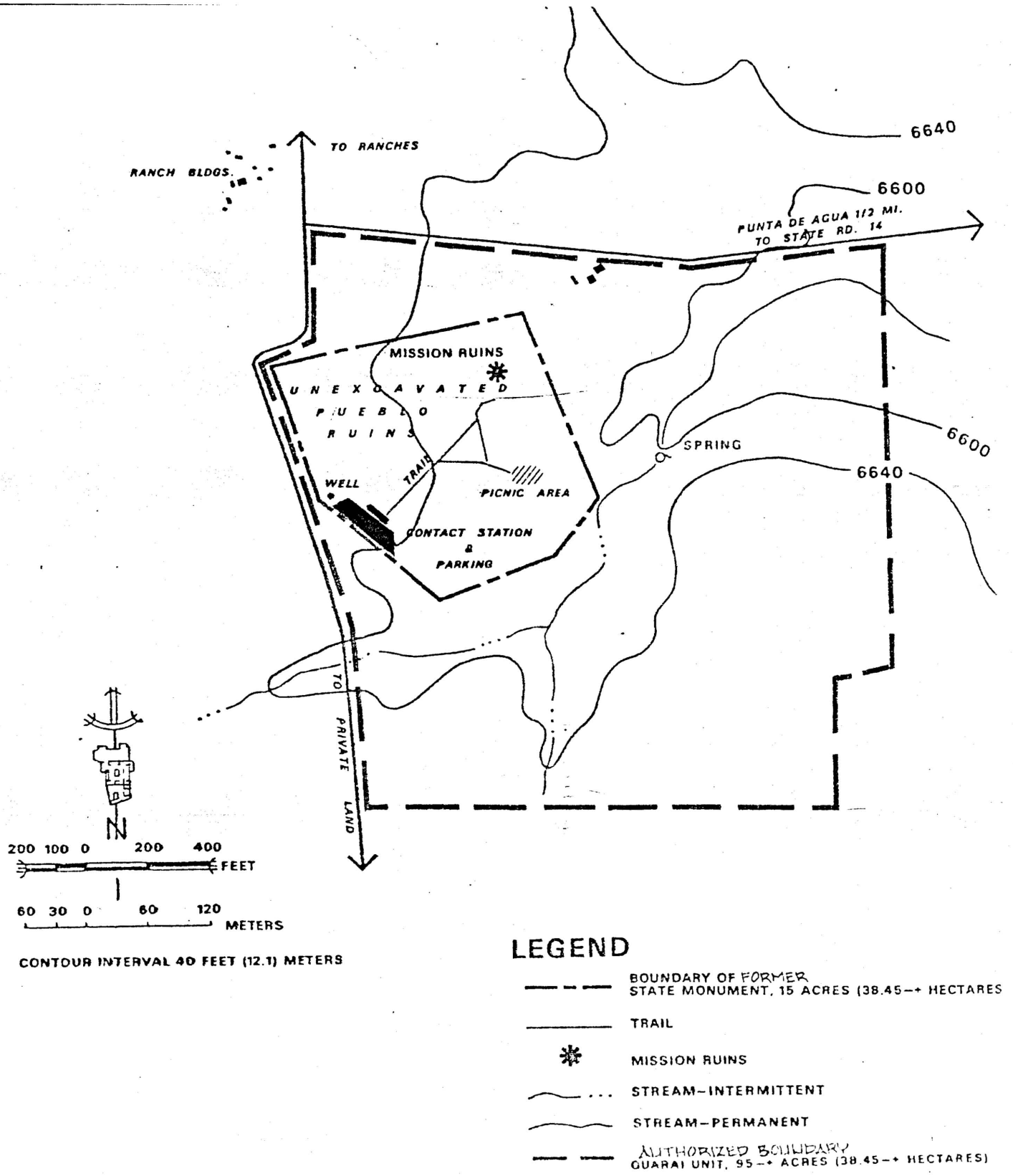
FIGURE 1



LOCATION

Salinas National Monument, New Mexico
United States Department of the Interior/NPS

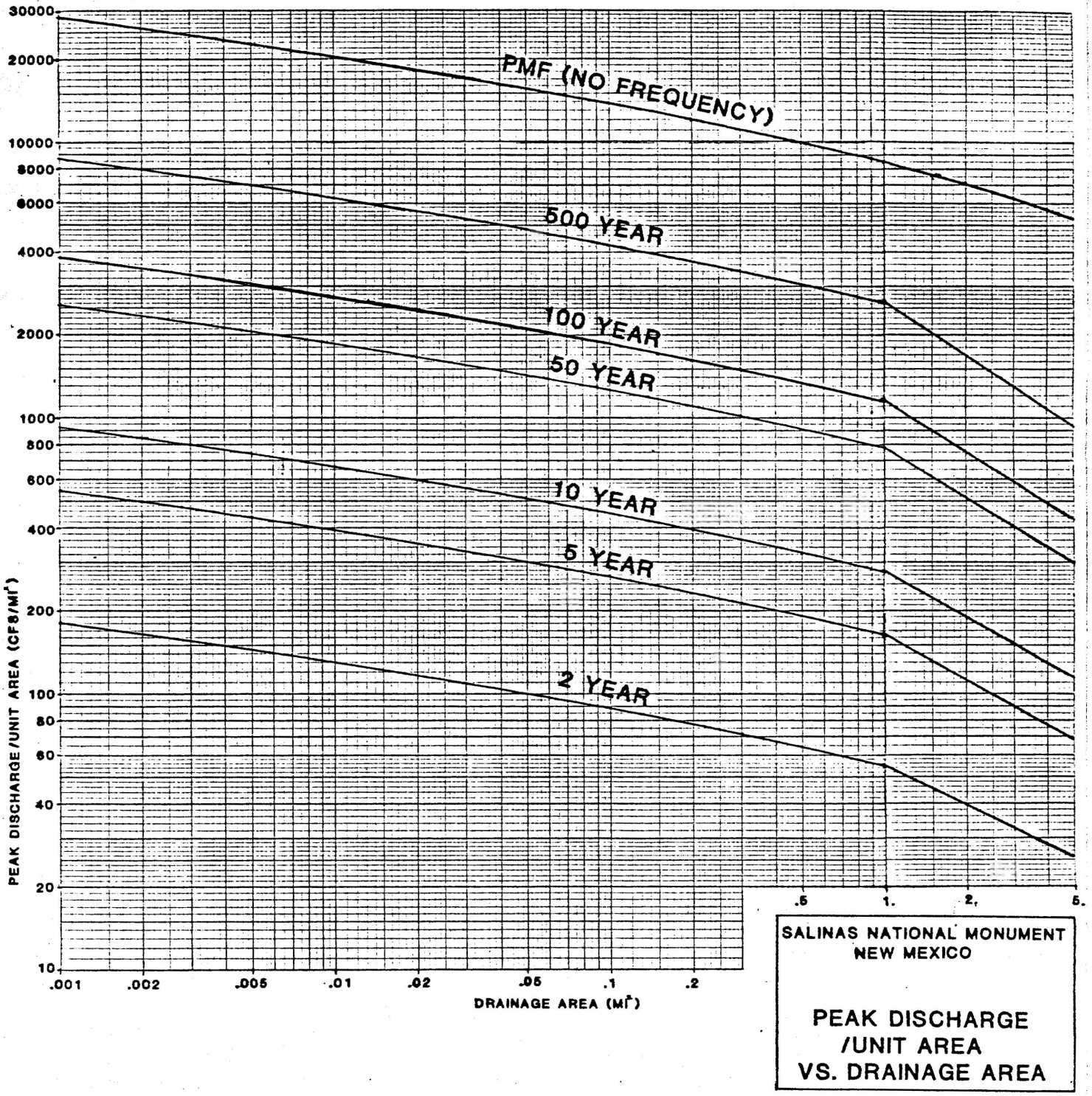
FIGURE 2



QUARAI UNIT

Salinas National Monument, New Mexico
United States Department of the Interior/NPS

FIGURE 3



SALINAS NATIONAL MONUMENT
NEW MEXICO

PEAK DISCHARGE
/UNIT AREA
VS. DRAINAGE AREA

FIGURE 5

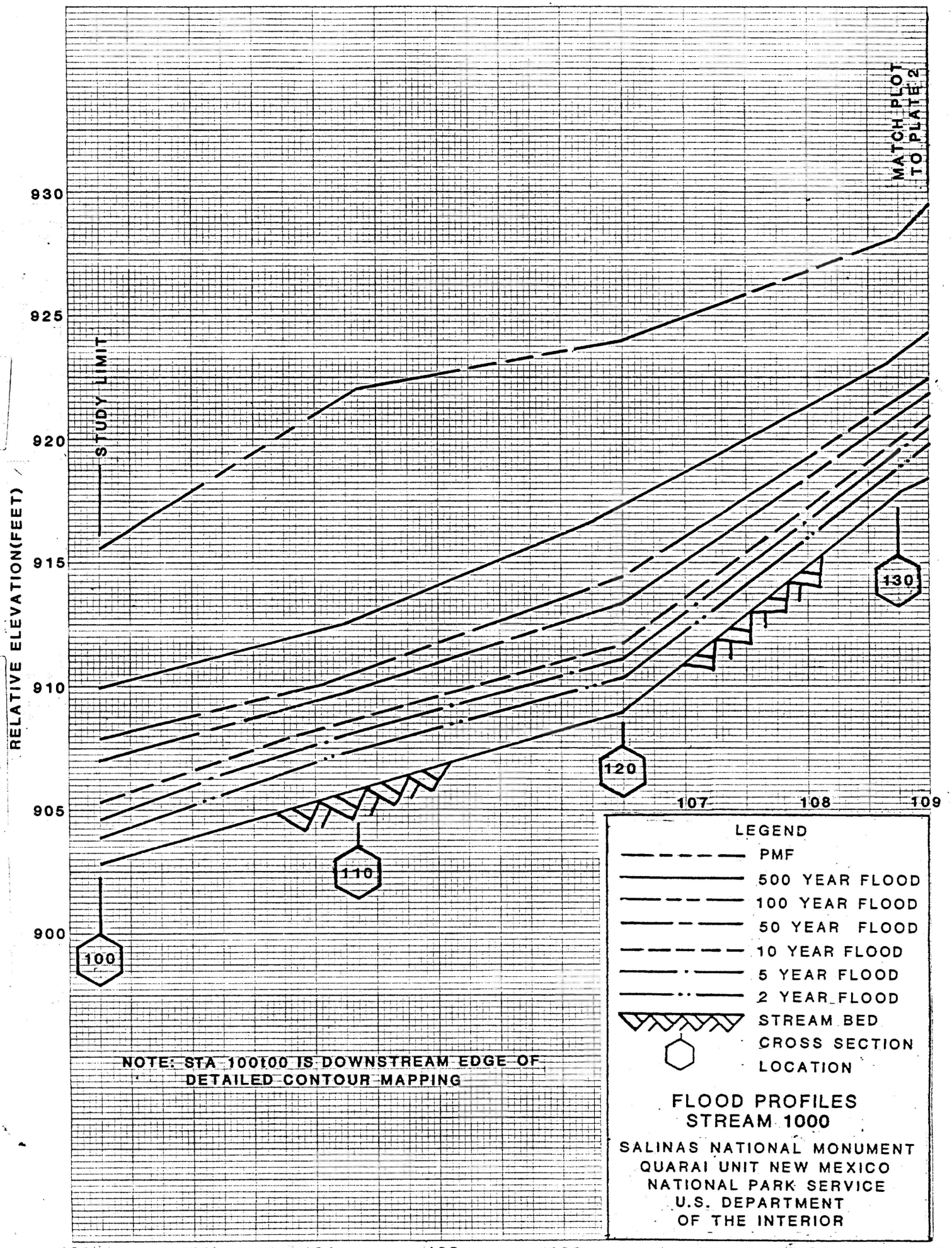

MATCH PLOT TO PLATE 2
STUDY LIMIT
RELATIVE ELEVATION(FEET)
930
925
920
915
910
905
900
100
110
120
130
107
108
109
102
103
104
105
106
STREAM DISTANCE (FEET X 10²)
NOTE: STA 100100 IS DOWNSTREAM EDGE OF DETAILED CONTOUR MAPPING
LEGEND
PMF
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
5 YEAR FLOOD
2 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
STREAM 1000
SALINAS NATIONAL MONUMENT
QUARAI UNIT NEW MEXICO
NATIONAL PARK SERVICE
U.S. DEPARTMENT
OF THE INTERIOR

PLATE 1

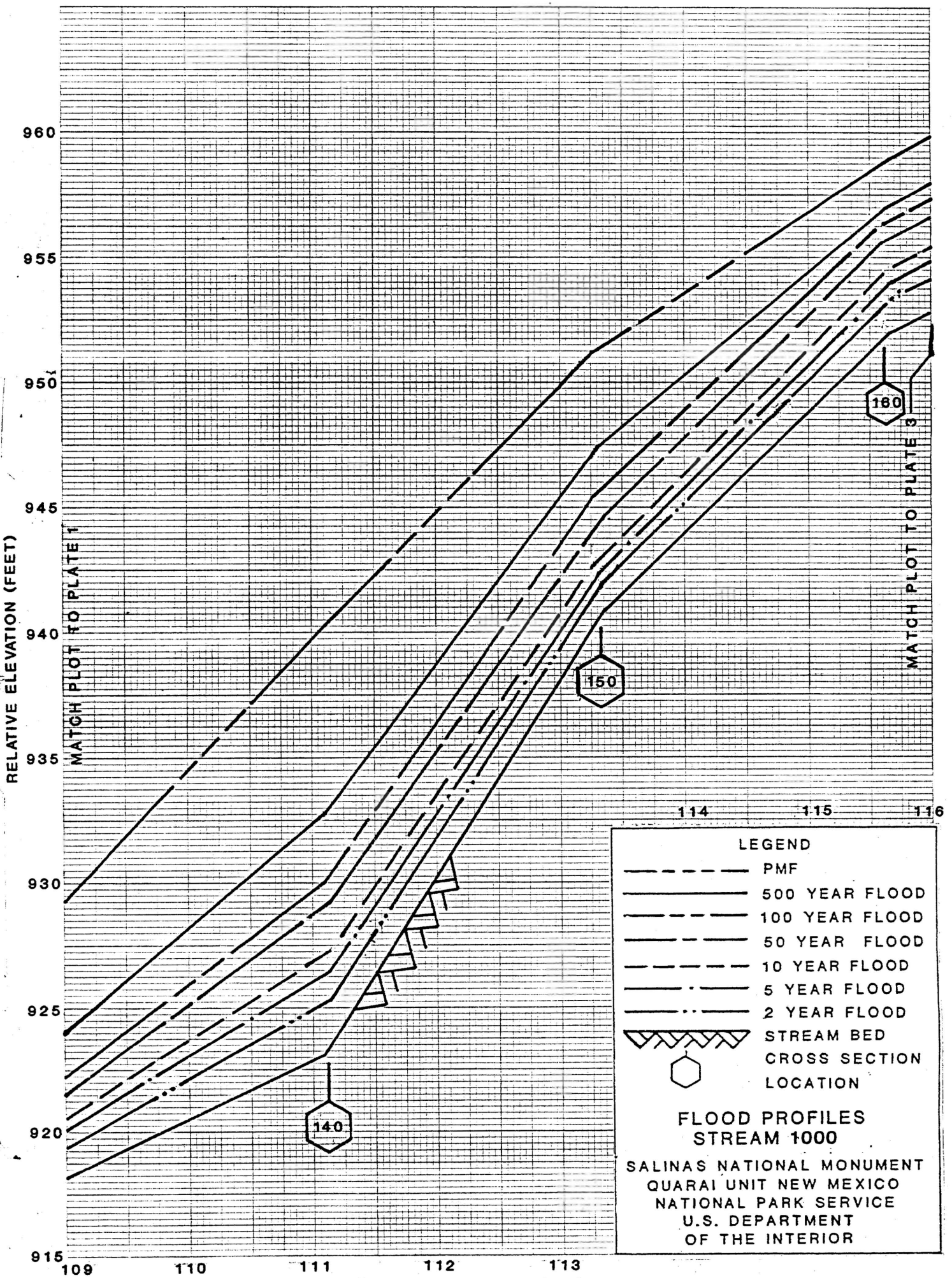

960
955
950
945
940
935
930
925
920
915
RELATIVE ELEVATION (FEET)
MATCH PLOT TO PLATE 1
MATCH PLOT TO PLATE 3
109
110
111
112
113
114
115
116
STREAM DISTANCE (FEET X 10²)
140
150
160
LEGEND
PMF
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
5 YEAR FLOOD
2 YEAR FLOOD
STREAM BED
CROSS SECTION
LOCATION
FLOOD PROFILES
STREAM 1000
SALINAS NATIONAL MONUMENT
QUARAI UNIT NEW MEXICO
NATIONAL PARK SERVICE
U.S. DEPARTMENT
OF THE INTERIOR

PLATE 2

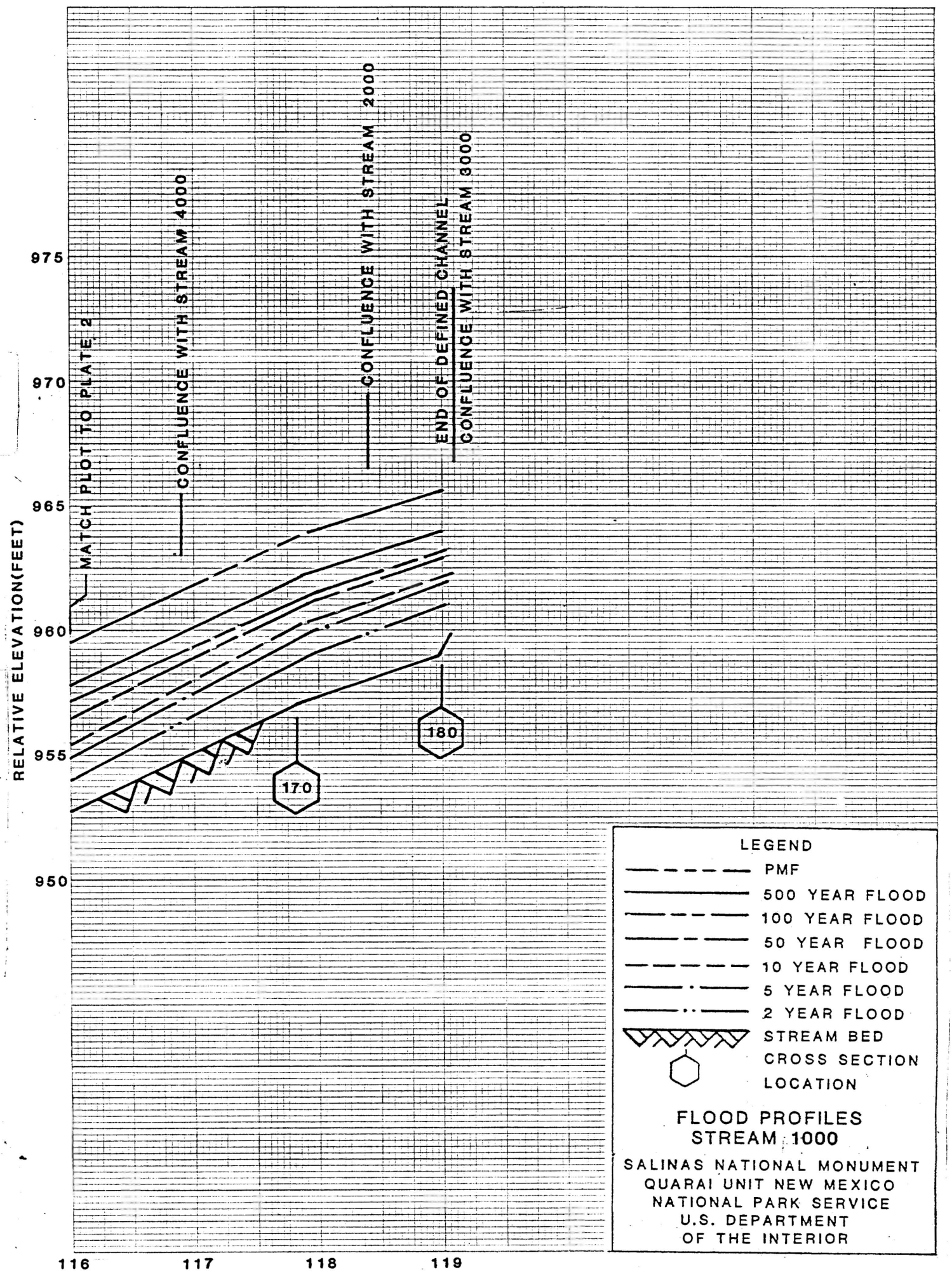

MATCH PLOT TO PLATE 2
CONFLUENCE WITH STREAM 4000
CONFLUENCE WITH STREAM 2000
END OF DEFINED CHANNEL
CONFLUENCE WITH STREAM 3000
180
170
975
970
965
960
955
950
RELATIVE ELEVATION(FEET)
116
117
118
119
STREAM DISTANCE(FEETX10²)
LEGEND
PMF
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
5 YEAR FLOOD
2 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
STREAM 1000
SALINAS NATIONAL MONUMENT
QUARAI UNIT NEW MEXICO
NATIONAL PARK SERVICE
U.S. DEPARTMENT
OF THE INTERIOR

PLATE 3

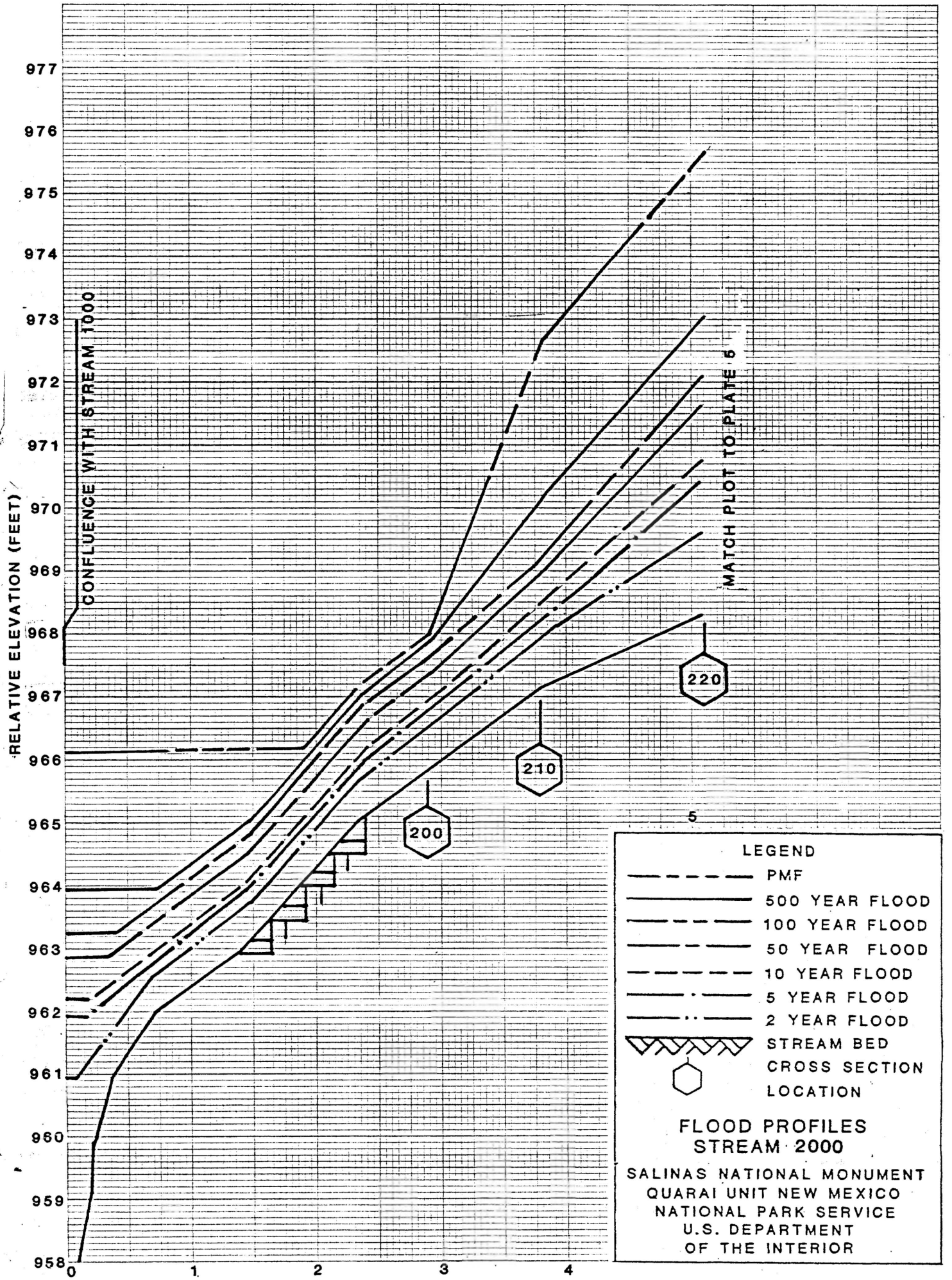

977
976
975
974
973
972
971
970
969
968
967
966
965
964
963
962
961
960
959
958
RELATIVE ELEVATION (FEET)
CONFLUENCE WITH STREAM 1000
MATCH PLOT TO PLATE 6
220
210
200
5
0
1
2
3
4
STREAM DISTANCE ABOVE CONFLUENCE (FT.X10²)
LEGEND
PMF
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
5 YEAR FLOOD
2 YEAR FLOOD
STREAM BED
CROSS SECTION
LOCATION
FLOOD PROFILES
STREAM 2000
SALINAS NATIONAL MONUMENT
QUARAI UNIT NEW MEXICO
NATIONAL PARK SERVICE
U.S. DEPARTMENT
OF THE INTERIOR

PLATE 4

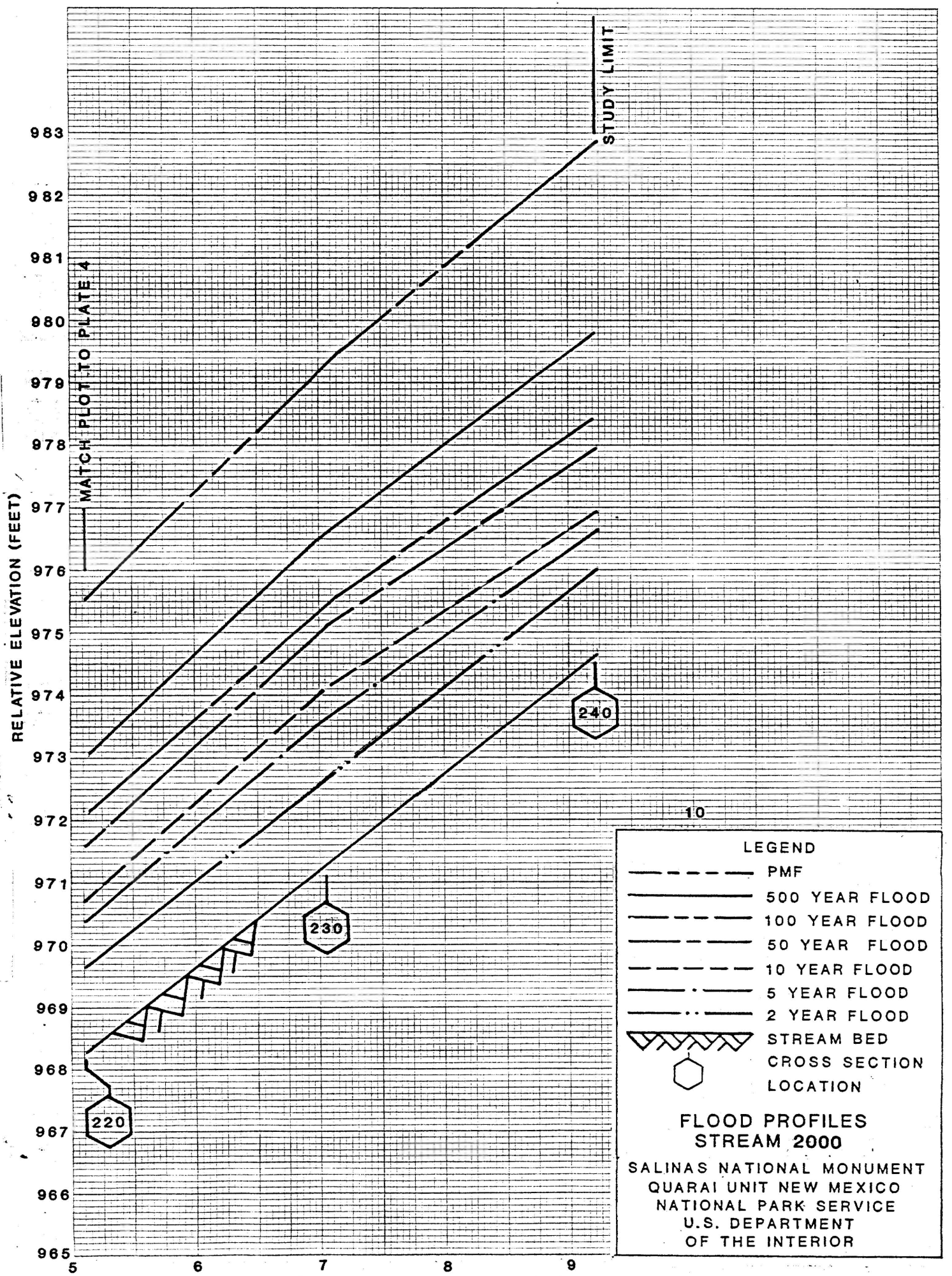

STUDY LIMIT
MATCH PLOT TO PLATE 4
RELATIVE ELEVATION (FEET)
983
982
981
980
979
978
977
976
975
974
973
972
971
970
969
968
967
966
965
5
6
7
8
9
STREAM DISTANCE ABOVE CONFLUENCE(FT.×10²)
240
230
220
10
LEGEND
PMF
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
5 YEAR FLOOD
2 YEAR FLOOD
STREAM BED
CROSS SECTION
LOCATION
FLOOD PROFILES
STREAM 2000
SALINAS NATIONAL MONUMENT
QUARAI UNIT NEW MEXICO
NATIONAL PARK SERVICE
U.S. DEPARTMENT
OF THE INTERIOR

PLATE 5

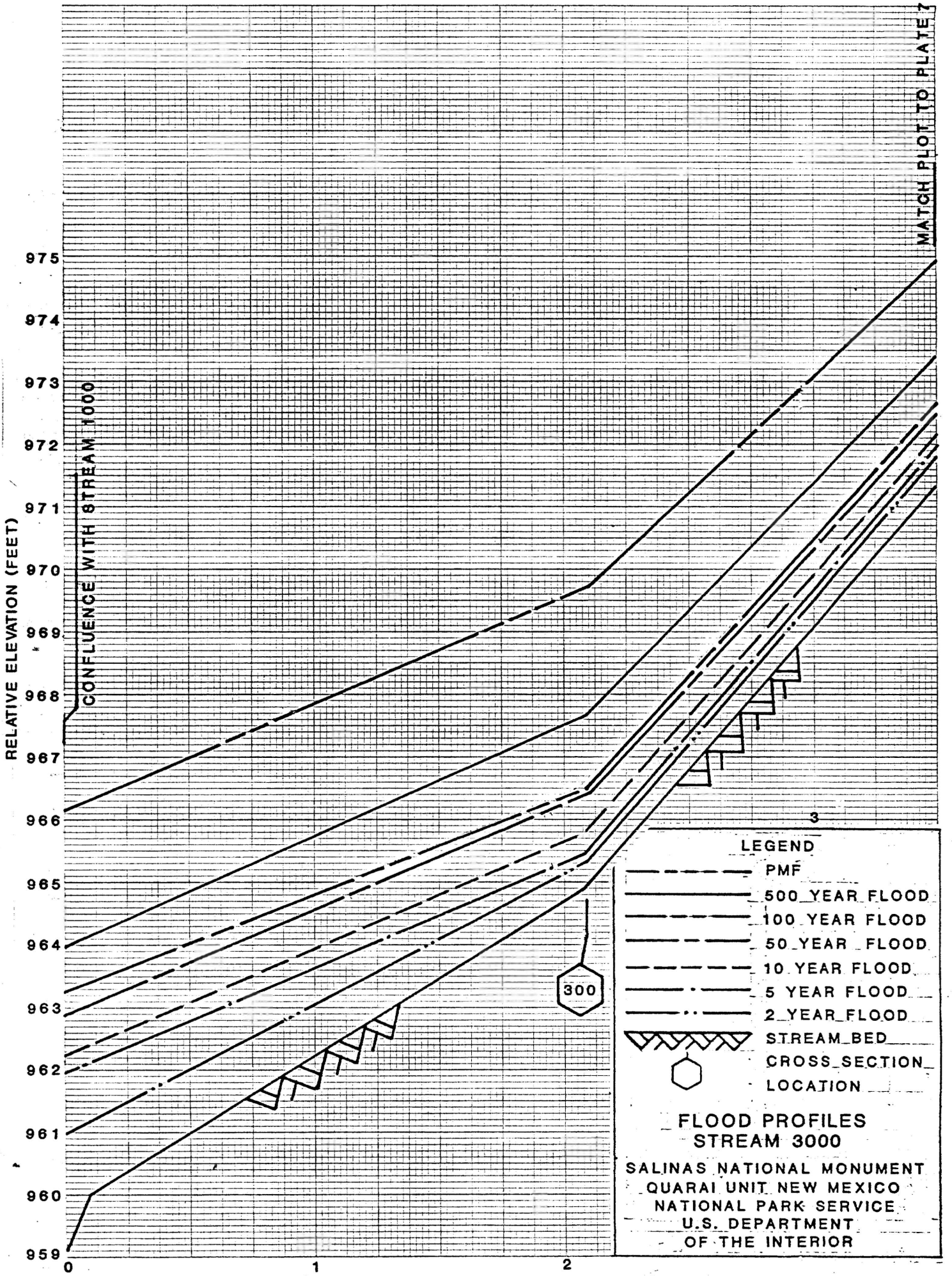

MATCH PLOT TO PLATE 7
CONFLUENCE WITH STREAM 1000
RELATIVE ELEVATION (FEET)
975
974
973
972
971
970
969
968
967
966
965
964
963
962
961
960
959
0
1
2
3
300
LEGEND
PMF
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
5 YEAR FLOOD
2 YEAR FLOOD
STREAM BED CROSS SECTION LOCATION
FLOOD PROFILES
STREAM 3000
SALINAS NATIONAL MONUMENT
QUARAI UNIT NEW MEXICO
NATIONAL PARK SERVICE
U.S. DEPARTMENT
OF THE INTERIOR
STREAM DISTANCE ABOVE CONFLUENCE(FT.×10²)

PLATE 6

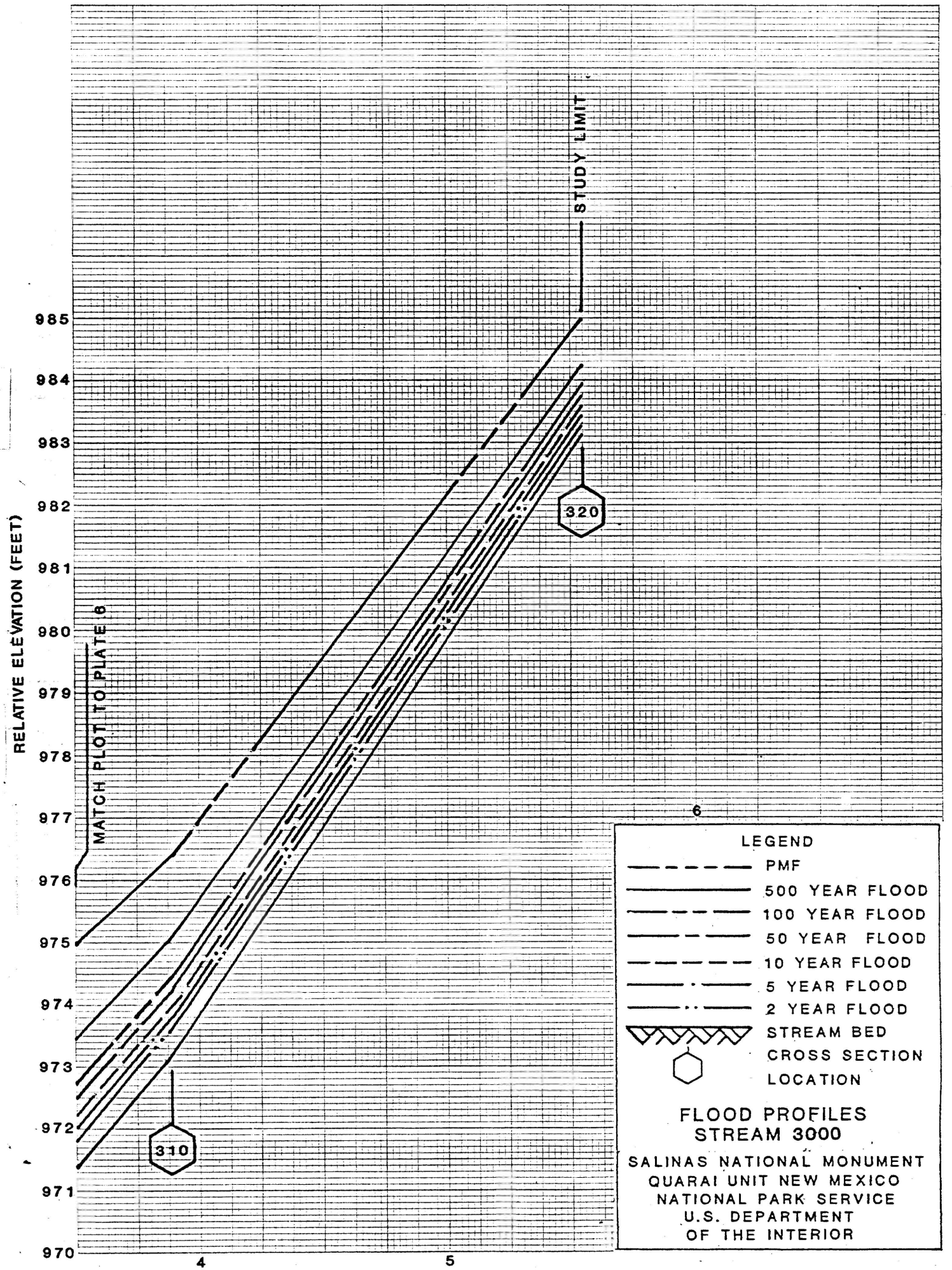

STUDY LIMIT
MATCH PLOT TO PLATE 6
320
310
985
984
983
982
981
980
979
978
977
976
975
974
973
972
971
970
RELATIVE ELEVATION (FEET)
4
5
6
STREAM DISTANCE ABOVE CONFLUENCE(FT.x10²)
LEGEND
PMF
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
5 YEAR FLOOD
2 YEAR FLOOD
STREAM BED
CROSS SECTION
LOCATION
FLOOD PROFILES
STREAM 3000
SALINAS NATIONAL MONUMENT
QUARAI UNIT NEW MEXICO
NATIONAL PARK SERVICE
U.S. DEPARTMENT
OF THE INTERIOR

PLATE 7

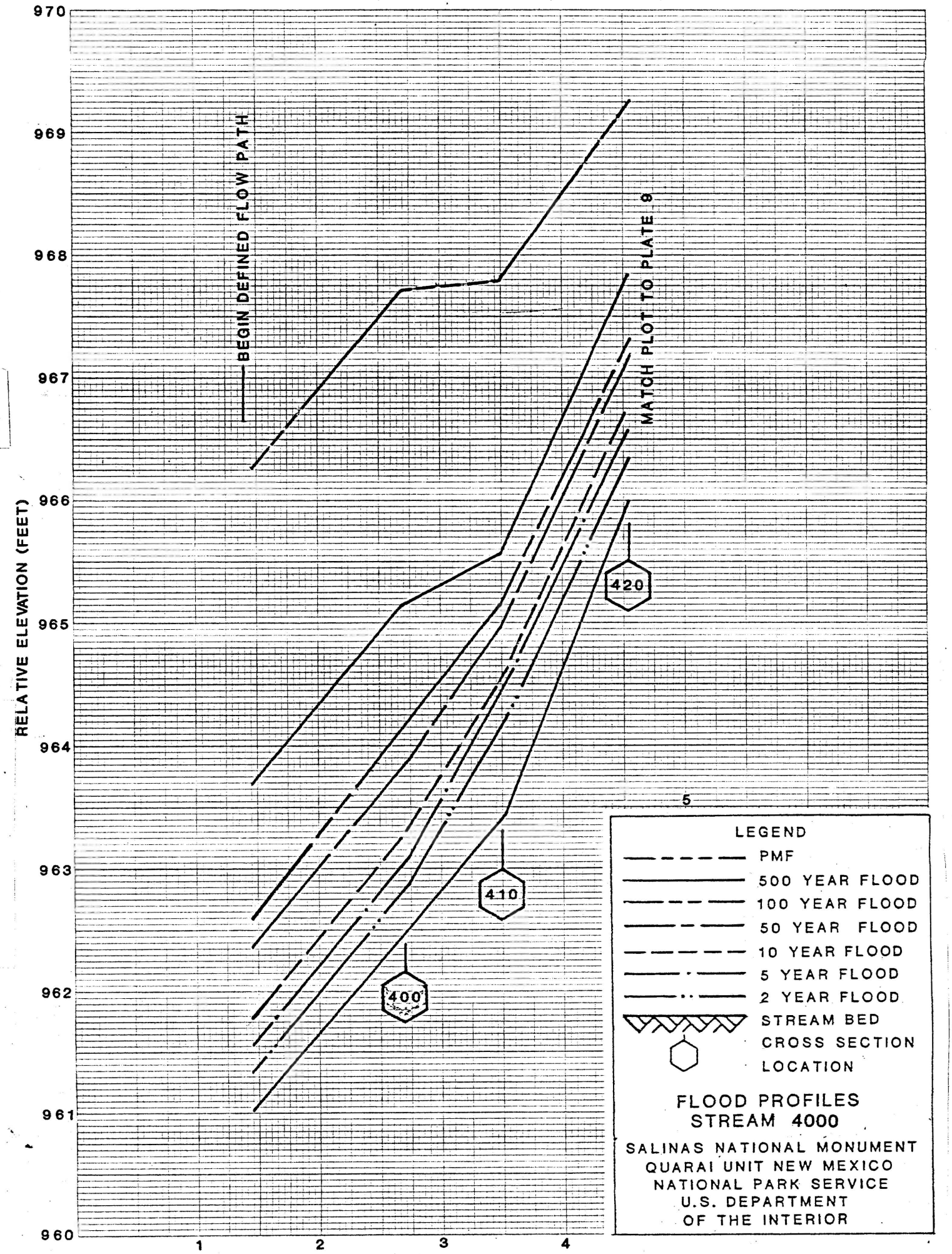

970
969
968
967
966
965
964
963
962
961
960
RELATIVE ELEVATION (FEET)
BEGIN DEFINED FLOW PATH
MATCH PLOT TO PLATE 9
420
410
400
1
2
3
4
STREAM DISTANCE ABOVE CONFLUENCE (FT.X10²)
5
LEGEND
PMF
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
5 YEAR FLOOD
2 YEAR FLOOD
STREAM BED
CROSS SECTION
LOCATION
FLOOD PROFILES
STREAM 4000
SALINAS NATIONAL MONUMENT
QUARAI UNIT NEW MEXICO
NATIONAL PARK SERVICE
U.S. DEPARTMENT
OF THE INTERIOR

PLATE 8

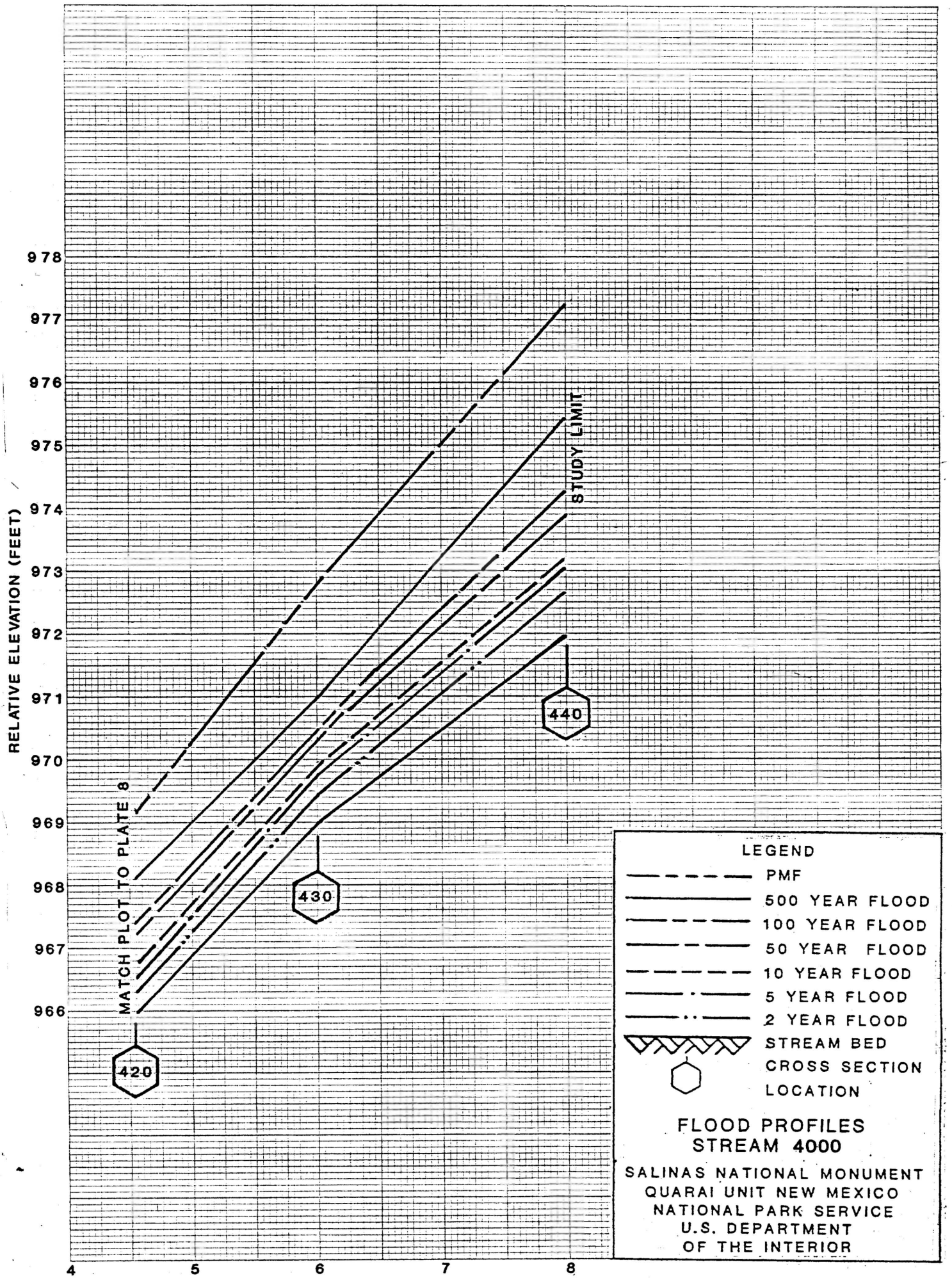

978
977
976
975
974
973
972
971
970
969
968
967
966
RELATIVE ELEVATION (FEET)
MATCH PLOT TO PLATE 8
STUDY LIMIT
420
430
440
4
5
6
7
8
STREAM DISTANCE ABOVE CONFLUENCE (FT. X 10²)
LEGEND
PMF
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
5 YEAR FLOOD
2 YEAR FLOOD
STREAM BED
CROSS SECTION
LOCATION
FLOOD PROFILES
STREAM 4000
SALINAS NATIONAL MONUMENT
QUARAI UNIT NEW MEXICO
NATIONAL PARK SERVICE
U.S. DEPARTMENT
OF THE INTERIOR

PLATE 9

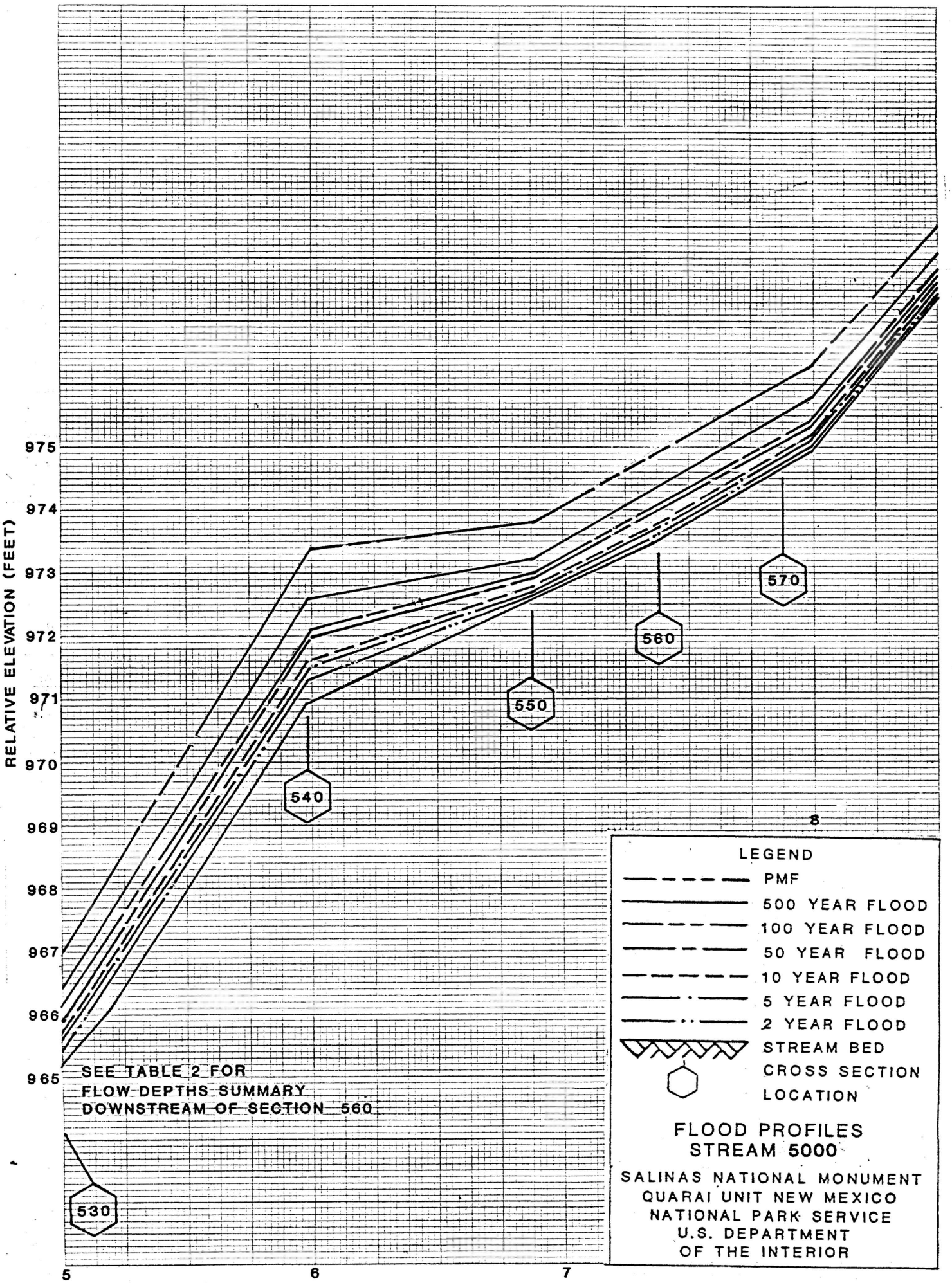

RELATIVE ELEVATION (FEET)
975
974
973
972
971
970
969
968
967
966
965
530
540
550
560
570
5
6
7
8
SEE TABLE 2 FOR
FLOW DEPTHS SUMMARY
DOWNSTREAM OF SECTION 560
LEGEND
PMF
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
5 YEAR FLOOD
2 YEAR FLOOD
STREAM BED
CROSS SECTION
LOCATION
FLOOD PROFILES
STREAM 5000
SALINAS NATIONAL MONUMENT
QUARAI UNIT NEW MEXICO
NATIONAL PARK SERVICE
U.S. DEPARTMENT
OF THE INTERIOR
STREAM DISTANCE ABOVE CONFLUENCE (FT. X 10²)

PLATE 10

3. Response to Review Comments by National Park Service Personnel.

During the review process for this report comments were received from the NPS by the Albuquerque District, U.S. Army Corps of Engineers. The comments were directed through the Superintendent of Salinas National Monument and The Water Resources Division of the NPS in Fort Collins, Colorado. The following is a summary list of questions and comments made by NPS personnel and a response where appropriate. The comments in full are shown in the Appendix.

A. Mr. Jim Trott, Park Archaelogist, Salinas National Monument listed several features in the area which were not addressed.

1. Comment: A small earthen dam exists in the northwest corner of the study area. It is located southwest of the curve of the road, into the Quarai Unit, approximately 50-75 feet west of the road.

Response: This structure has no evidence of being designed by a qualified engineer or knowledgeable layman to withstand any hydrostatic pressures or hydrodynamic flows. Park Service personnel's verbal statements confirmed that it indeed has failed a number of times in the recent past and, by observation, will continue to do so. The structure is highly unstable and cannot be relied upon to provide any flood control for protection downstream.

2. Comment: Below the dam and connected to it, is a water control device which channels water from the dam into culverts beneath the road, thus directing the flow into entrenched arroyos.

Response: Since the dam itself is unreliable, any device connected to it can be assumed to be unreliable also. The culvert beneath the road will divert water directly into the entrenched arroyos until its capacity is exceeded by upstream flows or until debris partially or fully blocks the intake opening. Once this occurs, water will overtop the road on the east and south. A lack of detailed topography restricted the hydraulic study to the east side of the main access road to the park.

3. Comment: A small dam-like feature exists on the northeast side of the church, outside the monument fence, however this should not be a feature in the flow of water from the northwest corner.

Response: The earthen-mound structure was estimated to have little or no impact on any flows. It has the appearance of a non-engineered structure and should not be relied upon for any flood control purpose. The structure seems to be abandoned as confirmed by park personnel.

B. Thomas Carroll, Superintendent, Salinas National Monument.

1. Comment: References to Stream 5000, flooding through the Contact Station and on to the east and water depths in Table 2 with respect to Concentration Point E.

Response: The ditch dug by the State Monuments that has been labeled Stream 5000 was analyzed separately with a backwater run. Note the profile in the report showing levels of flooding above Station 5+00. For the most part the ditch is inadequate to carry high frequency flows, it is anticipated that

flood waters in the parking lot will become deep enough to eventually partially flow through the open breezeway and to the east, though this is not expected to be a significant amount of the total flow.

2. Comment: It may well be that with careful analysis of the data in this report that in rehabilitation of the parking lot it may be possible to protect the contact station from flood hazards as the depth of the water indicated in Level 2 appears relatively shallow.

Response: As discussed at the site on 29 May 1985 by NPS personel and Mr. Thomas Ryan of the COE, a final decision to divert the water at the site might combine flows routed from the north. Detailed hydraulic analysis of any future proposed changes to the flow patterns should be evaluated reflecting detailed drainage configurations. These future plans and considerations are beyond the scope of this report.

3. Comment: A diversion ditch was built by the Museum of New Mexico around the north and west side of the church. When Thomas Ryan, Hydraulic Engineer was asked about the effectiveness of this diversion ditch he replied that he felt the runoff would go right over the ditch and hit against the church.

Response: In its present state the ditch appears to be capable of diverting small peak flows of low frequency occurance. However, the topsoil upstream from the ditch as well as the spoil berm on the east side of the ditch appear to be highly erodable. Deposition and sloughing of the ditch sides prior to peak flow conditions could be significant. This expected action combined with an anticipated bank full capacity due to prepeak flow buildup is expected during high frequency, high velocity peaks such as the 100-year frequency flow, to allow the peak to force water over the sedimented and/or water filled ditch and berm and against the church. The full peak flow is not expected to impact against the church but a more refined analysis would be needed to show more accurate results than available at this point. Mr. Glenn M. Fulfer's comments bear out the expected flow impact on the ditch and against the church once the ditch is overloaded. Note that all flow depths are the maximum depths expected along a line perpendicular to the main direction of flow. If the existing ditch could be stabilized and berm raised and protected then it could be relied upon to provide adequate protection.

SPECIAL NOTE: As a result of discussion of past flow history and field checking of preliminary flood plains it is noted that flow will be trained to the south along the swail to the west of the west wall of the church. This will subject that area to flood flows deeper and higher than shown in the draft report. A flow split just west of the northwest corner of the church would train as much as 85% of the 100-year peak flow to the south and direct 15% of the flow toward the east and parallel the north wall of the ruins. These changes in flows and flow depths are reflected in this final report.

APPENDIX

Comments to Draft Report

United States Department of the Interior
NATIONAL PARK SERVICE
Salinas National Monument
P. O. Box 496
Mountainair, New Mexico 87036-0496

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IN REPLY REFER TO:

L54

March 7, 1985

Memorandum

To: Regional Director, Southwest Region

From: Superintendent, Salinas National Monument

Subject: Review of Corps of Engineers draft report regarding a flood hazard study at Salinas National Monument, Quarai Unit

Attached are two memorandums, one from Park Archeologist Joseph James Trott and the other from Park Technician Sue F. Schofield, that I am forwarding to you for inclusion with my memorandum of February 21 and the memorandum of February 22 by Supervisory Park Ranger Glenn M. Fulfer on this subject. The memorandums of Jim and Sue contain data and concepts that help to give a broader perspective to the resource questions at Quarai.

It is good to see these two studies, Abo and Quarai, being completed and I know that the final reports and the accompanying raw data and input will continue to be utilized through the years in park management at Salinas.

Thomas B. Carroll

Attachments

A1(L54)SAL

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L54

6 March 1985

Memorandum

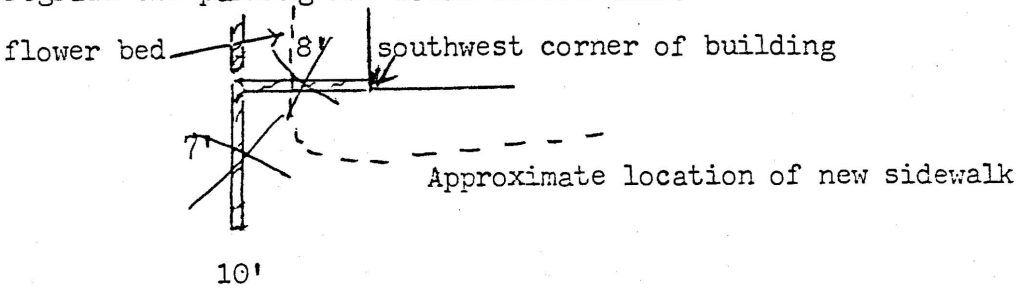
To: Superintendent, Salinas National Monument

From: Park Technician, Salinas National Monument, Quarai

Subject: Observation of flooding at Quarai Ruins; physical changes in contact station; past changes at mission complex affecting drainage

In the summer of 1984, there was a heavy thunderstorm covering the immediate area of Quarai and westward to the mountains. The storm lasted about an hour and must have produced several inches of rain. The runoff from the west came down the paved road into both the diversion ditch (stream 5000) and the parking lot. The diversion ditch could not contain the water and the overflow also ran into the parking lot where it accumulated in the southeastern two-thirds to an approximate depth of 5" in the corner. It slowly drained away to the southeast.

Stone walls protected the contact station on the west side (see diagram). The marked walls have been removed at this time and the stone lined flower bed will some be replaced by a side walk. The sidewalk should be about the same height (approximately 1') above the level of the parking lot and will extend to the south of the building for 4 feet. Any project to regrade the parking lot would affect this.



During the same thunderstorm, the diversion ditch on the north and west of the mission complex centained all the water, diverting it southward across the trail and down into the picnic area.

In support of the suggestion that historical dirt deposits could have protected the church foundations, refer to A.G. Ely's 1935 report, The Excavation and Repair of the Quarai Mission. He quotes Bandelier as

saying in 1882–83 that the walls were "at least fifteen feet high." Today, after several crews worked at Quarai in the 1920's and 1930's, the walls are much higher than 15 feet. Photographs from the 1920s suggest that at least 4' – 5' of dirt were removed from the church exterior during the 1934 excavation. Ely estimates that the excavated fill from the church interior averaged 6 feet (p. 7). He did not give a figure for the amount of fill excavated from the exterior but stated that after "...the removal of debris to the original ground level ... grading was done in such a manner as to permit the drainage of water away from the walls and foundation of the church." (p. 8)

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IN REPLY REFER TO:
L54

March 5, 1985

Memorandum

To: Regional Director, Southwest Region

Through: Superintendent, Salinas National Monument TBL

From: Park Archaeologist, Salinas National Monument

Subject: Review of Corps of Engineering draft report regarding a hazard study at Salinas National Monument, Quarai Unit.

Upon reviewing the Flood plain Information Study for Quarai, it is evident that some features were not addressed. Developments have taken place in the northeast section of the study area, which may account for a reduced flow of water from this direction. These alterations are listed below.

1. A small earthen dam exists in the northwest corner of the study area. It is located southwest of the curve of the road, into the Quarai Unit, approximately 50 - 75 feet west of the road.

2. Below the dam and connected to it, is a water control device which channels water from the dam into culverts beneath the road, thus directing the flow into entrenched arroyos.

3. On the north side of roomblock mounds F, G, H, I, and J the land is fairly even, because of archaeological excavations carried out there by Wesly Hurt in the 1930's. These excavations cut into the north side of the mounds, and were backfilled, resulting in a more even landscape on this side of the pueblo.

4. The old road entered the park from the north side, and ended up on the north side of the church.

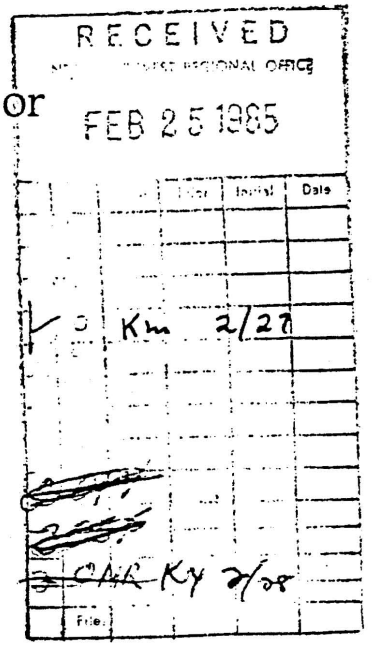
5. A small dam-like feature exists on the northeast side of the church, outside of the Monument fence, however, this should not be a feature in the flow of water from the northwest corner.

The above features could have an impact on the flow of water from the northwest corner of the study area. The dam could have a major impact on the flow of water towards the church. This coupled with directed water flow in entrenched arroyos, has probably prevented any major flooding of the area.

Jim Trott

Jim Trott

United States Department of the Interior
NATIONAL PARK SERVICE
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IN REPLY REFER TO:
L54

February 21, 1985

Memorandum

To: Regional Director, Southwest Region

From: Superintendent, Salinas National Monument

Subject: Review of Corps of Engineers draft report regarding a flood hazard study at Salinas National Monument, Quarai Unit

In general the review comments proposed by the Water Resources Branch appear appropriate to the material contained in the subject draft report. As in my review of the Abo report, I feel somewhat hampered by my lack of technical knowledge on flood hazard study. I do have some observations which may or may not be important in reviewing this study:

1. A question of major importance is the relationship of the Quarai contact station to the various flood levels. The answer to this question will be important in terms of utilization of the present facility, or even as to its suitability for visitor use and artifact display. This type of information needs to be quickly determined as it will have an impact upon recommendations which will be developed for the Interpretive Prospectus. If the site is totally unaccepteble, then stronger consideration will need to be given to Phase III development outlined for Quarai in the GMP/DCP.

The map entitled "100 Year Flood Plains, Quarai Unit" has a line that seems to indicate the 100 year flood plain. This line appears to encompass the northern two-thirds of the contact station. Stream 5000 runs to the west of the structure and at a flood stage seems to go right through the structure and on to the east. Concentration Point "E" is just to the southwest of the structure and has the following water depths, according to Table 2:

2 Yr. Freq. (FT)	5 Yr. Freq. (FT)	10 Yr. Freq. (FT)	50 Yr. Freq. (FT)	100 Yr. Freq. (FT)	500 Yr. Freq. (FT)	PMF (FT)
.2	.3	.4	.4	.5	.8	1.4

A ditch was dug by the State Monuments that has become Stream 5000. This ditch carries water along the west side of the dirt parking lot and down to the south. The majority of the water comes from the west side of the road, from what was used not too many years ago as agricultural fields. The clearing of this land is supposed to have increased the problems with flooding. The present contact station, and probably the parking lot, was built in 1971. It is likely that at least part of the structure is on top of an Indian house mound.

We are presently finalizing plans for interim rehabilitation of the Quarai contact station and as a part of the package the dirt parking lot is to be improved. It may well be that with careful analysis of the data in this report that in rehabilitation of the parking lot it may be possible to protect the contact station from flood hazards as the depth of the water indicated in Level 2 appears relatively shallow.

This ditch along the edge of the parking lot was designed as a diversion ditch and from my inexperienced point of view it would seem relatively significant. If this is the case then the last sentence of the first paragraph under "Hydrology" is incorrect: "No significant detention or diversion structures were found in any portion of the watershed."

In view of the still unknown location of buried cultural resources and the relatively high probability that such resources are indeed in the parking lot led us to plan on just adding material for proper grading. This decision will need to be reviewed once the exact nature of the flood problem is determined.

Basically, it would appear that with appropriate grade changes in the parking lot and proper precautions on artifact display in the contact station the present contact station can be used as outlined in the GMP/DCP. Further examination of the data may reveal that this is not the case. Clarification on this point would be most helpful.

2. Another major point is of course the water flow that is indicated in the report that would come along the north wall of the church and convento.

One consideration may be that as floods through the years washed against the church that dirt was deposited around the base of the church. If this did happen then it might help to explain how the great walls of the Quarai church could have withstood centuries of flooding with no one providing any protective maintenance. The Museum of New Mexico did check the foundation depth of the west church wall and found that it extended seven feet down into the ground, about five feet above the water table.

A diversion ditch was built by the Museum of New Mexico around the north and west side of the church. This diversion ditch is not indicated on the map in the report but it can be seen in the aerial photograph in the GMP/DCP and it has snow in it in the copy of the aerial photograph I have attached to this memorandum. This diversion ditch seems to have been built in the mid-1960s and was cleaned out in the early 1970s. The water depths for concentration points J, K, L, and K + L are as follow, according to Table 2:

Ref. Con. Point	2 Yr. Freq. (FT)	5 Yr. Freq. (FT)	10 Yr. Freq. (FT)	50 Yr. Freq. (FT)	100 Yr. Freq. (FT)	500 Yr. Freq. (FT)	PMF (FT)
J	.0	.0	.0	.1	.1	.2	.4
K	.1	.2	.2	.4	.5	.7	1.3
L	.2	.3	.4	.8	1.0	1.6	2.8
K+L	.1	.2	.4	.7	.9	1.6	3.3

When Thomas Ryan, Hydraulic Engineer, was asked about the effectiveness of this diversion ditch he replied that he felt the run-off would go right over the ditch and hit against the church.

This diversion ditch is evident on the one foot topo map and would seem some-

what more effective than would be expected. We have had some heavy rains in recent years and flood waters do not seem to run againt the main church walls, as far as we know.

It would seem beneficial for the Park Service to analyse the effectiveness of this diversion ditch. If it can be made to work with only minimal improvement then this may well be the best course of action to follow. The ditch has already disturbed resources present and maintenance of the ditch should not represent a new threat to the resources. Other alternatives would very likely have much more serious negative impacts upon the original cultural resources of the site. If, as indicated by Mr. Ryan, the ditch has no significant impact upon flood waters or if significant alterations to the present ditch would be required to make it effective then it would probably be most appropriate to fully consider a wide range of alternative actions.

Concentration point K + L appears especially threatening to the lower convento as the lower portion of the convento could suffer severe damage if heavy amounts of water were to run through and over the walls.

As a part of the stabilization of the Quarai church and convento, we are planning to install a drainage system in portions of the structure. It seems unlikely that outside flooding water would come into the central portion of the church or convento but we do get large pools of water in the lower convento.

3. As essentially the whole valley floor and the sides of the valley are full of cultural resources it would be appropriate to consider the various flood data contained in the report in conjunction with the one foot topo map of the site that has the Quarai archeological reconnaissaince, map on file in Southwest Regional Office (Archeologist Jim Bradford should know the location of this map). Their appears to be 17th C. terracing across the floor of the valley at about topo line 940 on the map in this flood hazard report. The wall has been broken through by stream erosion.

Another factor is the 19th C. water ditch built for the Punta de Agua community. There is a map of the irrigation ditch in the Southwest Regional Office.

4. The peak flows shown in Table 1 will be helpful to determine how much damage would be done by flooding waters.

5. With the entrance road projected for improvement and some realignment in the GMP/DCP there may well be an excellent opportunity to help resolve some of the flood hazards that relate to the present road alignment or drainage provisions.

6. As a large pueblo in a dry country it would be to the advantage of the native inhabitants and early Spaniards to locate where water would be close for human consumption and possibly for irrigation. We do have records of a 17th C. irrigation ditch at Tajique but as yet no such records have been found for Quarai. It would certainly not be bwyond the realm of possibility that there was indeed an intensive and comprehensive water system for Quarai as may be indicated in part by terracing and the later 19th C. irrigation system for Punta de Agua.

This is a valuable report and there is little doubt that this data will be examined closely for many purposes. The more complete and defined the data base is the better we will be able to develop and implement effective management programs utilizing the data base.

Park Archeologist Jim Trott is not present at this time to give input into this review but I know that he will be more than happy to assist if there are any questions which you would like to have considered more closely than I have done in this memorandum.

Archeologist Trott may be sending his own comments to the Regional Office once he has completed his review of the subject report.

Thomas B. Carroll

Thomas B. Carroll

Attachment

United States Department of the Interior
NATIONAL PARK SERVICE
Salinas National Monument
P. O. Box 496
Mountainair, New Mexico 87036-0496

IN REPLY REFER TO:

L54

February 22, 1985

Memorandum

To: Superintendent, Salinas National Monument

From: Supervisory Park Ranger, Salinas National Monument

Subject: Past Observations of Flooding at the Quarai Unit

As per our conversation this morning, I have quickly written down some information for you concerning flood patterns I observed at Quarai while an employee of the Museum of New Mexico, Monuments Division.

In 1976(?), State Ranger Charlie Coffman and I, after a very heavy rain at and to the west of the ruins, observed approximately 10-12 inches of water running the entire width between the north boundary fence and the pueblo mounds. When the water came to the diversion ditch on the north and west side of the church ruins, it overflowed and ran primarily to the west side of the church. During the heaviest run-off time, the water was approximately 6-8 inches deep against the church's west wall. Very little water was against any northern walls.

During this time most of the water turned and ran south between the Church and the pueblo mounds. The ditch seemed to carry alot of the water but because it had filled in with past years sediment from other rainfalls, it's effectiveness was greatly impaired. We contracted with C.N. Fulfer to clean out this ditch and to install a new culvert under the entrance gate and one just south of the entrance and to clean out the ditches along the west side of the parking lot and west side of the entrance gate to help divert the water draining down the entrance road and out of the Silva family's then cultivated fields to the west of the monument.

Glenn M. Fulfer