RIVER ATLAS

RED BLUFF

COLUSA

River Atlas Red Bluff/Colusa Appendix to : Middle Sacramento River Spawning Gravel Study. 1984.

California Department of Water Resources, Northern District

APPENDIX TO: MIDDLE SACRAMENTO RIVER SPAWNING GRAVEL STUDY

RIVER ATLAS

APPENDIX TO

MIDDLE SACRAMENTO RIVER SPAWNING GRAVEL STUDY

1984

CREDITS

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT

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INTRODUCTION

Between the City of Colusa and the Red Bluff Diversion Dam, the Sacramento River floodplain shows a long history of erosion, deposition and channel migration. These historical changes are also evident when surveys and aerial photographs are compared. Also apparent is the conflict between man's activities and the river's natural processes. Dams, levees, bank protection, agriculture, urbanization, diversions, gravel extraction, and recreational facilities affect the river. The conflict between man's uses and the river's natural capacity for renewing itself and maintaining its quality and diversity provides the basis for management decisions that seek to balance the requirements of conservation and our use of the river and its resources.

Significant among the resources of a gravel-bed river is the gravel itself. Combined with sand, silt and clay, it forms the river bed and banks, comprises the movable sediment load, and provides fish habitat. Gravel removal or depletion from a river system has a direct impact on channel morphology, bank erosion, and fish populations.

Salmon runs in the Sacramento River have declined since the late 1930s when fish counts began on the river. Because of the diversity of uses and changes that have affected the river, the cause of the decline in fish populations cannot wholly be attributed to any single factor. Once the threat of flooding was reduced, urban and agricultural development quickly expanded onto the flood plain. This brought a need for bank protection and increased diversion of the river's flows. Urban growth accelerated the developer's need for gravel and produced an increased impact through gravel extraction. Along the river, flow release schedules, diversion dams, agricultural development, pollution, water temperature changes and gravel mining all contribute to the decline in salmon runs. Because of these developments, the nonrenewable nature of the gravel resource and its continuing depletion make this a critical consideration in examining and evaluating the fluvial system.

This atlas shows the distribution of spawning areas, gravel sampling sites, bank protection, location of surveyed cross-sections and historic channel meanders. With its companion publication, "The Middle Sacramento River Spawning Gravel Study" (DWR, 1984), this atlas provides information that will permit evaluation of future changes needed to aid in the development of a management program.

Salmon Spawning Areas

Ideal spawning areas have gravel sizes from 1/2 to 4 inches. Smaller sizes decrease the circulation of water that carries dissolved oxygen to eggs buried in the gravel and reduces the flushing action that clears waste products away. Larger gravel is hard for the salmon to move in preparing their "redds" (or nests). In areas with insufficient spawning gravel, the salmon overuse the available areas. This results in the destruction of existing redds by newly arrived spawners, who wash eggs away while excavating their own redds. This greatly increases egg mortality.

In 1964, the Department of Fish and Game (DFG) made an aerial photo survey of the Sacramento River from Colusa to Keswick to determine the distribution of spawning areas. This survey was not detailed and showed only general spawning areas. In November 1983, an aerial survey mapped the extent of fall-run spawning from Colusa to Red Bluff. The results of both surveys are plotted in the atlas so comparison of spawning areas and locations can be made.

DFG estimates of fall run spawners in the study reach totalled 5,000 and 33,000, respectively, in 1964 and 1983. The difference in these run sizes is probably due to two factors. First, the low number of spawners in 1964 is possibly linked to drought conditions in the early 1960s that affected runs for several years; and second, the relatively larger run of 1983 is due to a greater number of fish being forced to spawn below the Red Bluff Diversion Dam since its construction in 1966 (Hallock, 1978).

Gravel Sampling Sites

Between Colusa and the Red Bluff Diversion Dam, sand and gravel was sampled to determine the grain-size distribution. Gravel was also sampled on several of the larger tributaries within the study reach to determine source areas and grain-size distribution. Sample sites are plotted on the atlas sheets except where tributary sites occur beyond the photo boundaries.

A complete discussion of gravel sampling methods and analyses is in the "Middle Sacramento River Spawning Gravel Study".

Bank Protection and Levees

The bank protection (rip-rap) and levees indicated in this atlas are the work of local, State and Federal agencies. The levees that begin near Ord Bend and continue south along the river are part of the Sacramento River Flood

Control Project. The data in the atlas were gathered from aerial photographs and previous river atlases.

Along the middle Sacramento River, most bank protection consists of boulder-size rock and pieces of concrete. In a few places pilings have been driven into the channel to support retaining walls that buttress the riverbank. There are about 29 miles of bank protection between Colusa and Red Bluff Diversion Dam.

Because bank protection reduces erosion, less sediment is available to the river system. Very often, protection of one bank area will displace a bank stability problem to a new site downstream, thus necessitating additional bank protection.

Leveed banks restrict high flows to a narrower, deeper channel. This often results in higher flow velocities, scour, and bank erosion upstream and downstream from a constricted reach. Diminished channel diversity in leveed reaches also reduces fish habitat. There are nearly 14 miles of leveed river bank in the study reach.

There are about 100 river miles (RM) and 200 miles of riverbank between Colusa and Red Bluff. About 14.6 percent of this reach has bank protection and an additional 7 percent has levee rock work forming the river banks. Although there are private berms and levees, most are part of the Sacramento River Flood Control System.

River Cross-Sections

The river cross-sections plotted in this atlas were surveyed for U. S. Geological Survey channel capacity studies and for a Department of Parks and Recreation investigation of channel changes near Woodson Bridge State Recreation Area. Flow data developed for these studies-- discharge, velocity and water surface elevation-- can be used in evaluating channel changes and bedload movement.

Historic Channel Migration

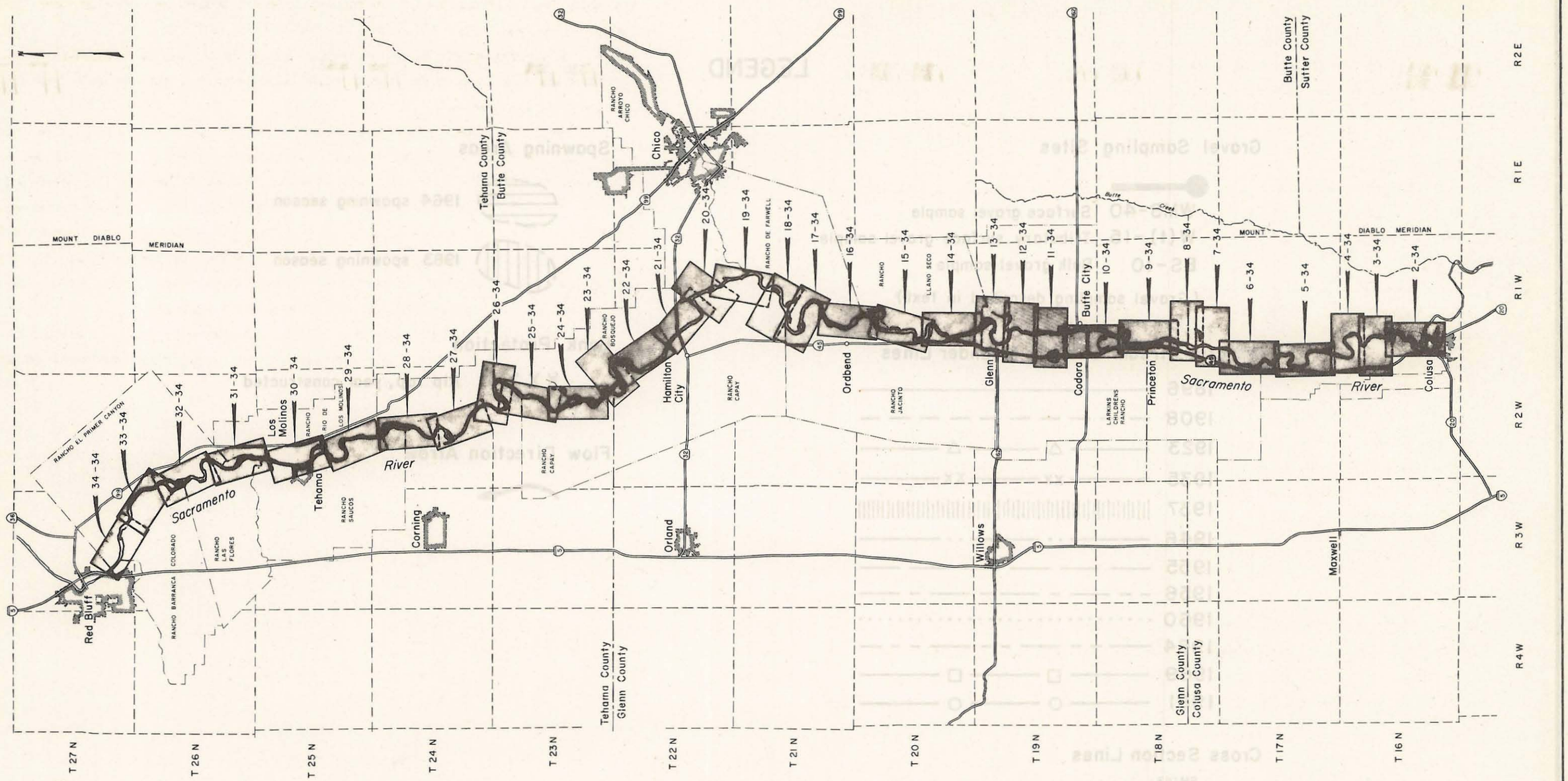
The 1976 photo base used in this atlas is the same as that used in "The Sacramento River Environmental Atlas, 1978". All survey, map, and photo data used to establish historic channel lines was transferred to the photo base at a scale of 1:500, the scale of the oldest surveys.

One of the earliest surveys of the Sacramento River was made by the U. S. Army Corps of Engineers (USCE) in 1896, when detailed studies were conducted on the Feather and Sacramento Rivers. Additional USCE surveys that include the study reach were made in 1908, 1923, and 1935.

From the middle and late 1930s through 1981, the channel location was determined using U. S. Soil Conservation Service aerial photographs, USGS photos and maps, and USCE river atlases.

Between Colusa and the Red Bluff diversion Dam, there are a few reaches that have remained relatively constant since surveys began. These include areas near Woodson Bridge (RM 218.3), Hamilton City (Gianella Bridge) RM 199.3, RM 177, and RM 168. These short reaches are easily identified on the atlas sheets by their coincident channel lines. Generally these areas are characterized by resistant bank materials that inhibit lateral channel movement. In more recent years, project levees and bank protection have created artificial stability in areas that had former periods of active channel movement.

Over most of the study reach, there is abundant evidence of river changes since 1896. Despite this, the river has remained remarkably similar in its overall meander pattern and spacing.



Scale in miles
0 2 4 6

PHOTOGRAPHED AUGUST 1976
SYMBOL WR-AFV SHEETS 10-63 THRU 42-63
FOCAL LENGTH 152.66 mm

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT

SACRAMENTO RIVER
COLUSA TO RED BLUFF DIVERSION DAM

MIDDLE SACRAMENTO RIVER
SPAWNING GRAVEL STUDY

SHEET 1 of 34

LEGEND

Gravel Sampling Sites

WMS-40 Surface gravel sample
W(t)-15 Tributary surface gravel sample
BS-10 Bulk gravel sample
(Gravel sampling described in text)

Historic Stream Channel Meander Lines

1896
1908
1923
1935
1937
1946
1955
1956
1960
1964
1969
1981

Cross Section Lines

RM 143 — U.S. Geological Survey; surveyed periodically 1972 through 1978. Location identification by river mile (RM).

Dept. of Parks and Recreation; surveyed 1974, 1978 and 1979.

③ U.S. Geological Survey; surveyed 1976.

Spawning Areas

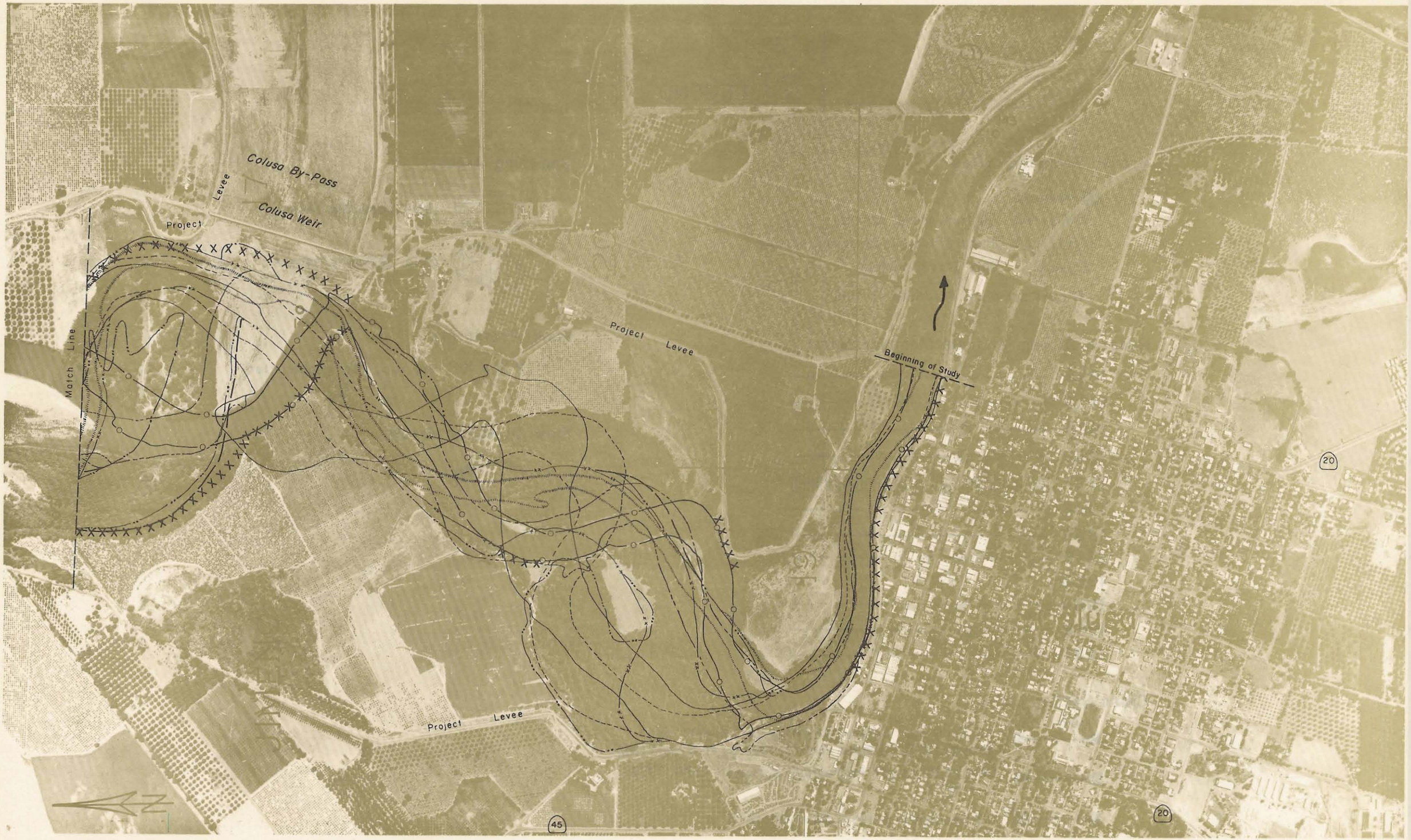
1964 spawning season

1983 spawning season

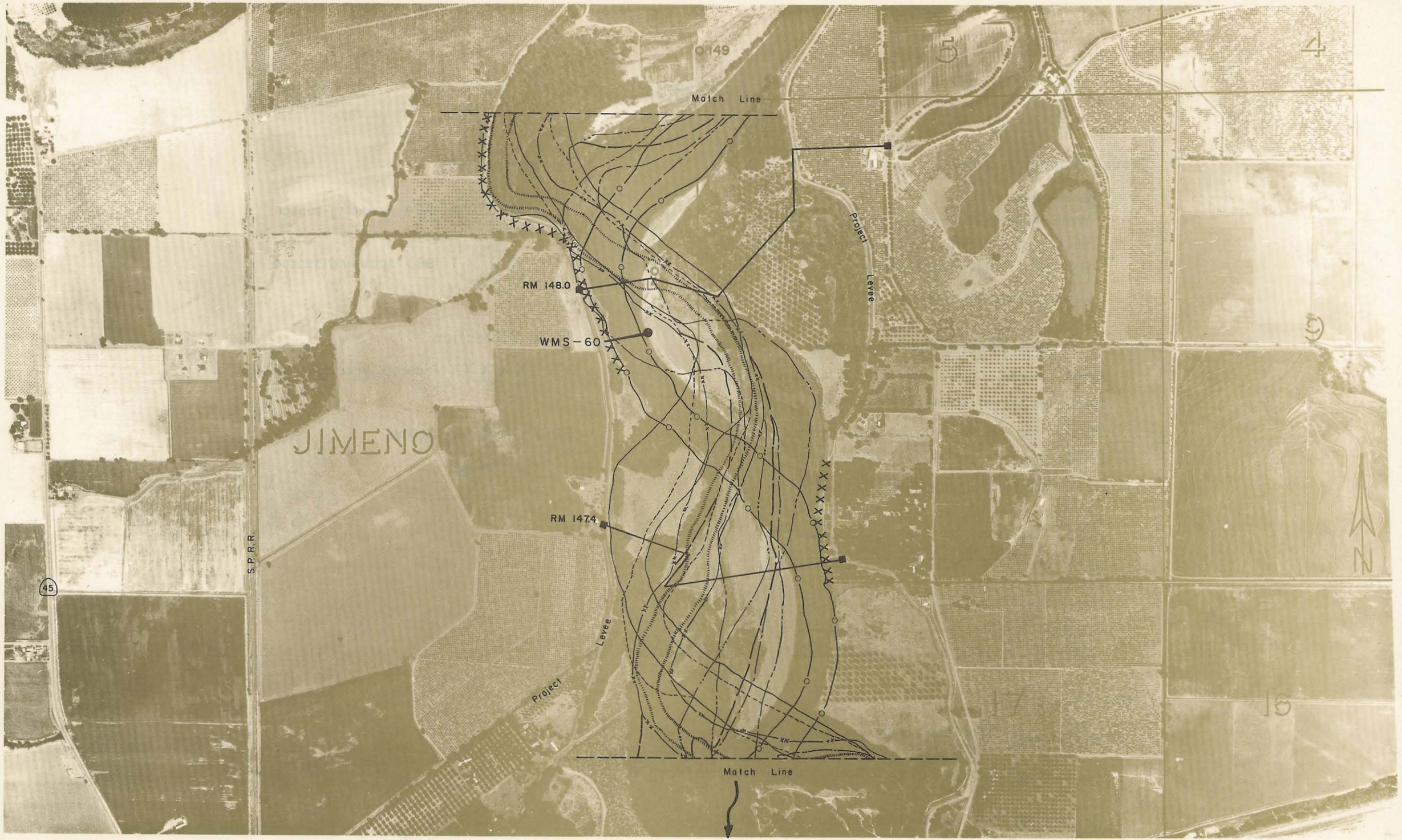
Bank Protection

XXXX 1978 Rip rap, year constructed

Flow Direction Arrow



APPROXIMATE SCALE 1 INCH = 1000 FEET ENLARGED FROM EXPOSURE NUMBER WR-AFV-1-	PHOTOGRAPHED AUGUST 1976 SYMBOL WR-AFV FOCAL LENGTH 152.66mm	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT	SACRAMENTO RIVER COLUSA TO RED BLUFF DIVERSION DAM	MIDDLE SACRAMENTO RIVER SPAWNING GRAVEL STUDY	SHEET 2 OF 34



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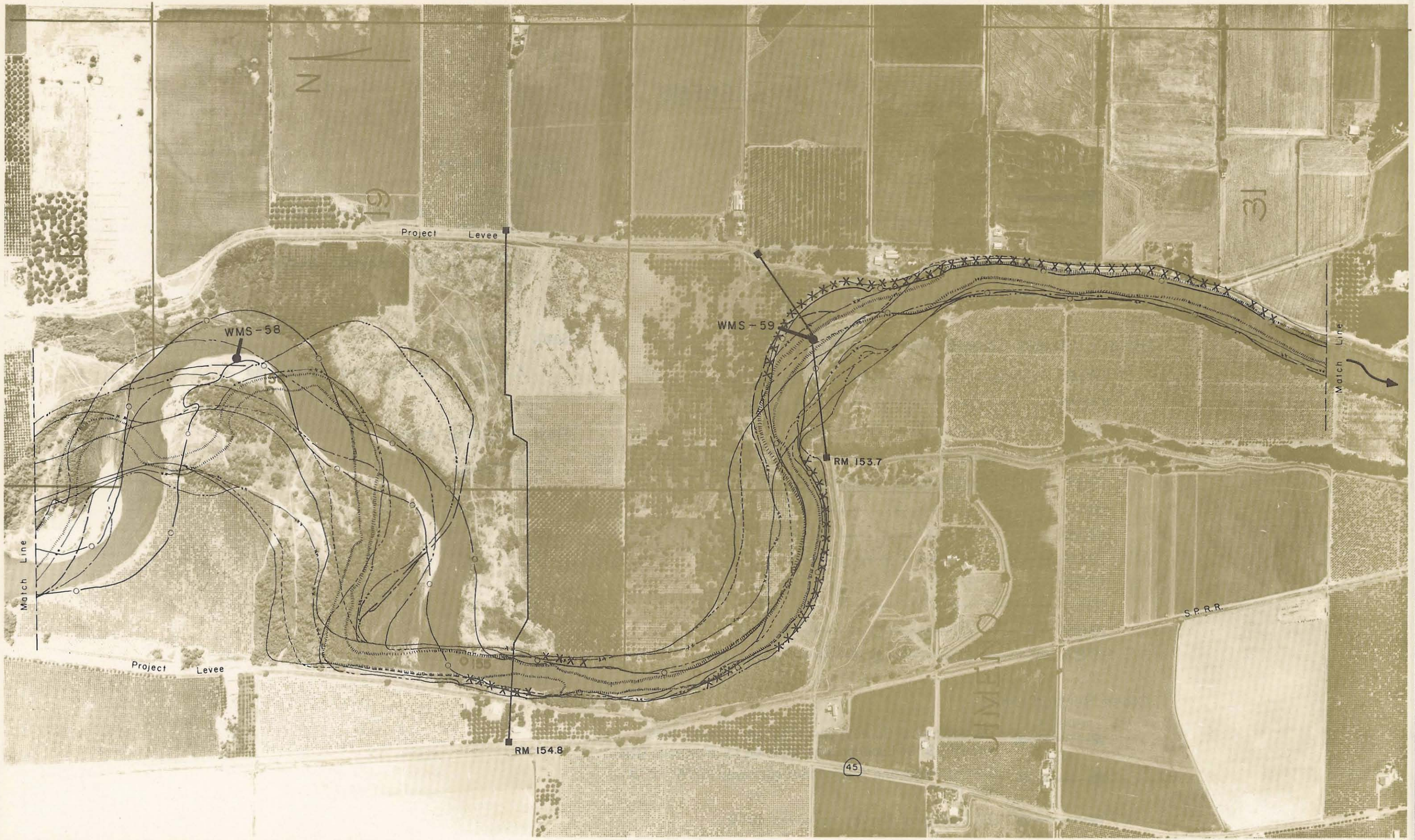

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T18N

R1W

R2W

Match Line

Project Levee

Moulton Weir

RM 158.7

WMS-56

WMS-57

Project Levee

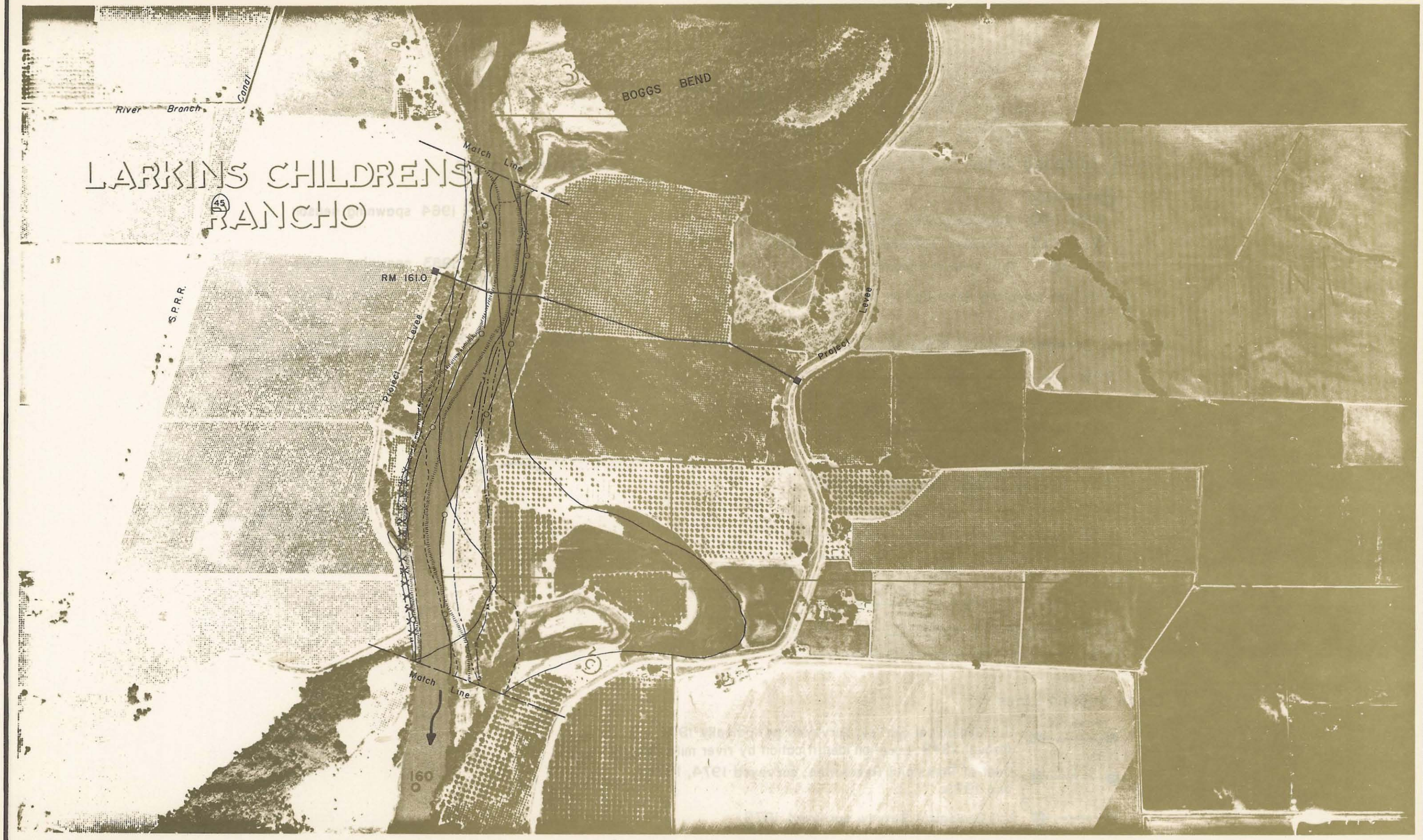
45

S.P.R.R.

Match Line

LEGEND

APPROXIMATE SCALE 1 INCH = 1000 FEET ENLARGED FROM EXPOSURE NUMBER WR-AFV-1-	PHOTOGRAPHED AUGUST 1976 SYMBOL WR-AFV FOCAL LENGTH 152.66mm	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT	SACRAMENTO RIVER COLUSA TO RED BLUFF DIVERSION DAM	MIDDLE SACRAMENTO RIVER SPAWNING GRAVEL STUDY	SHEET 6 OF 34



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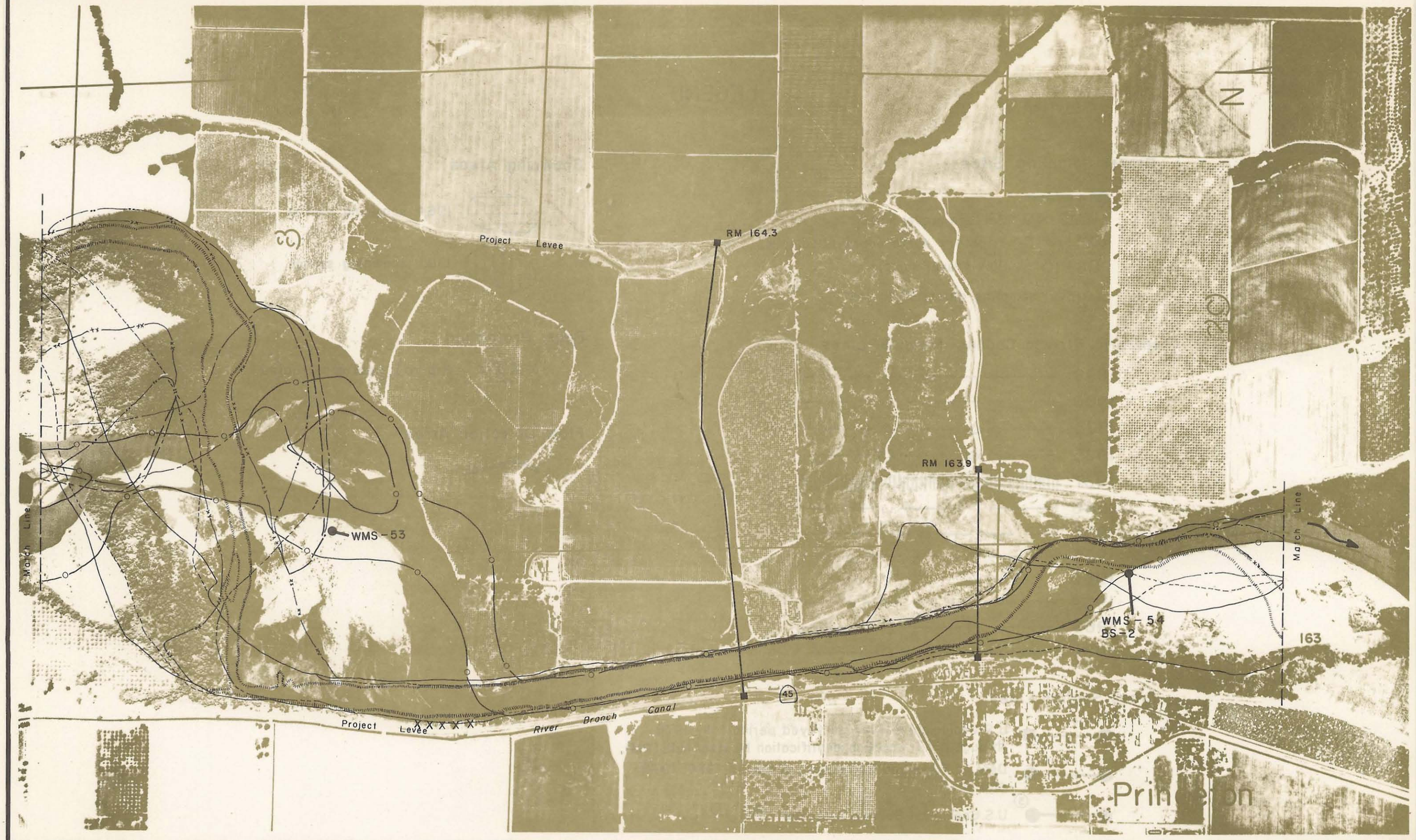

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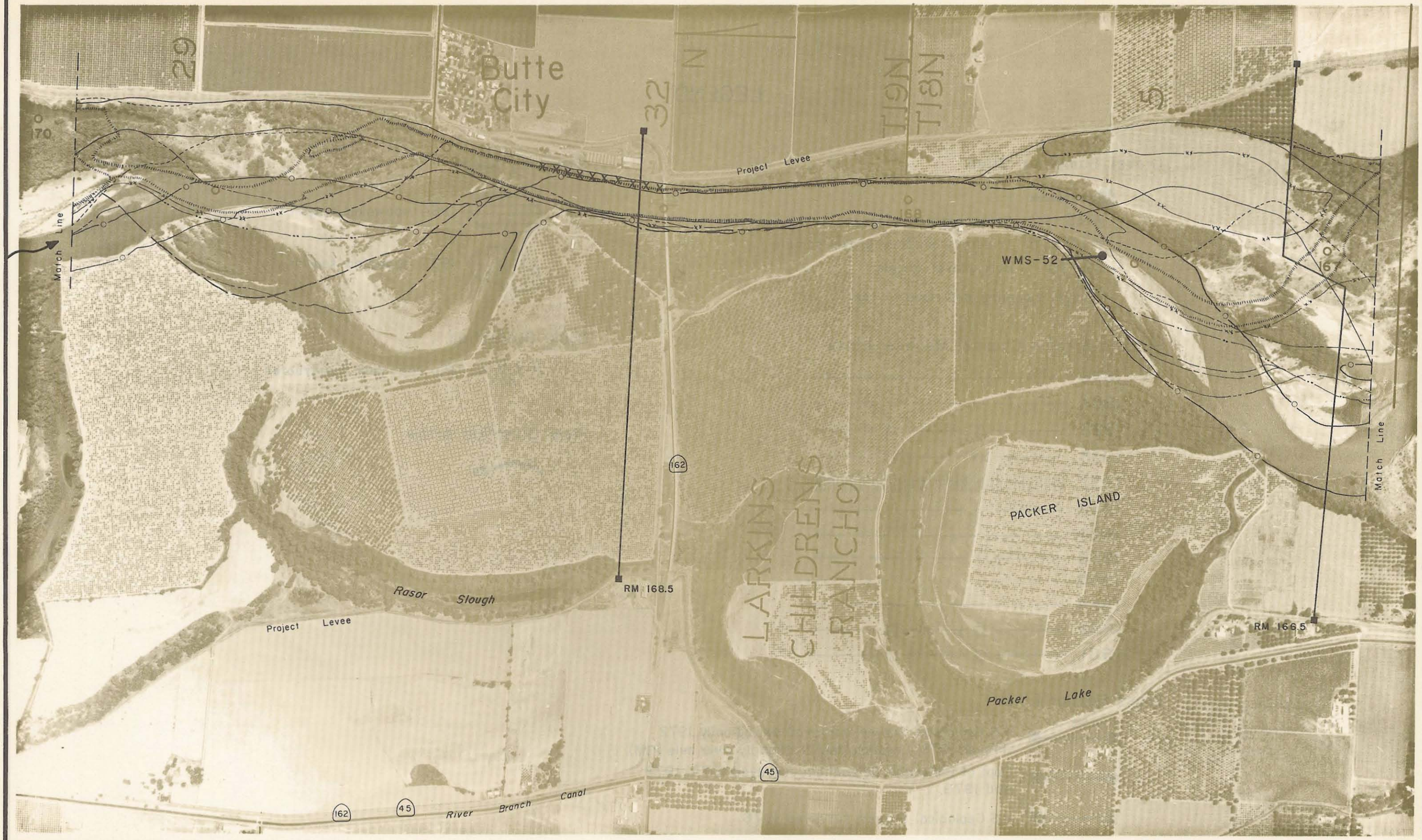

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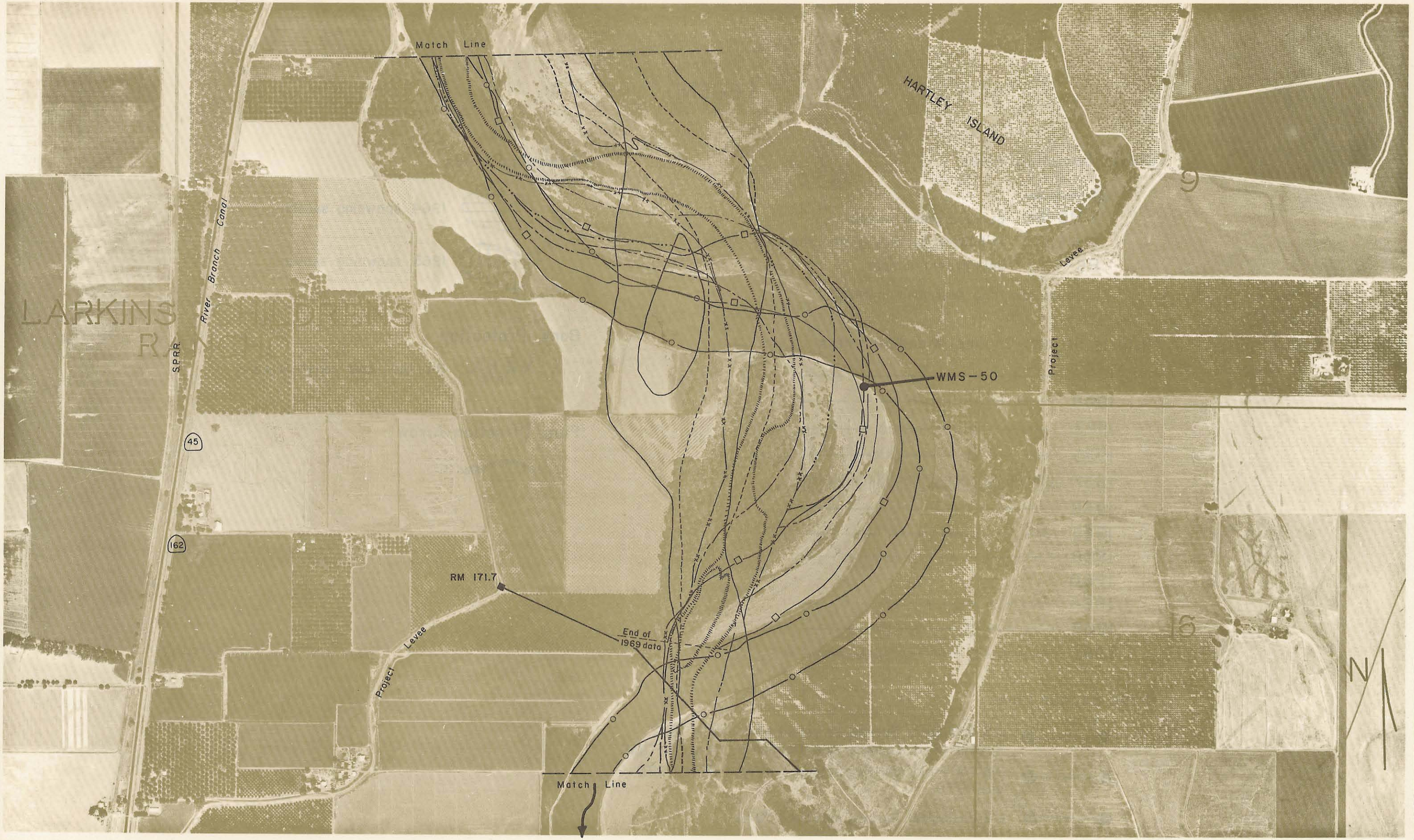

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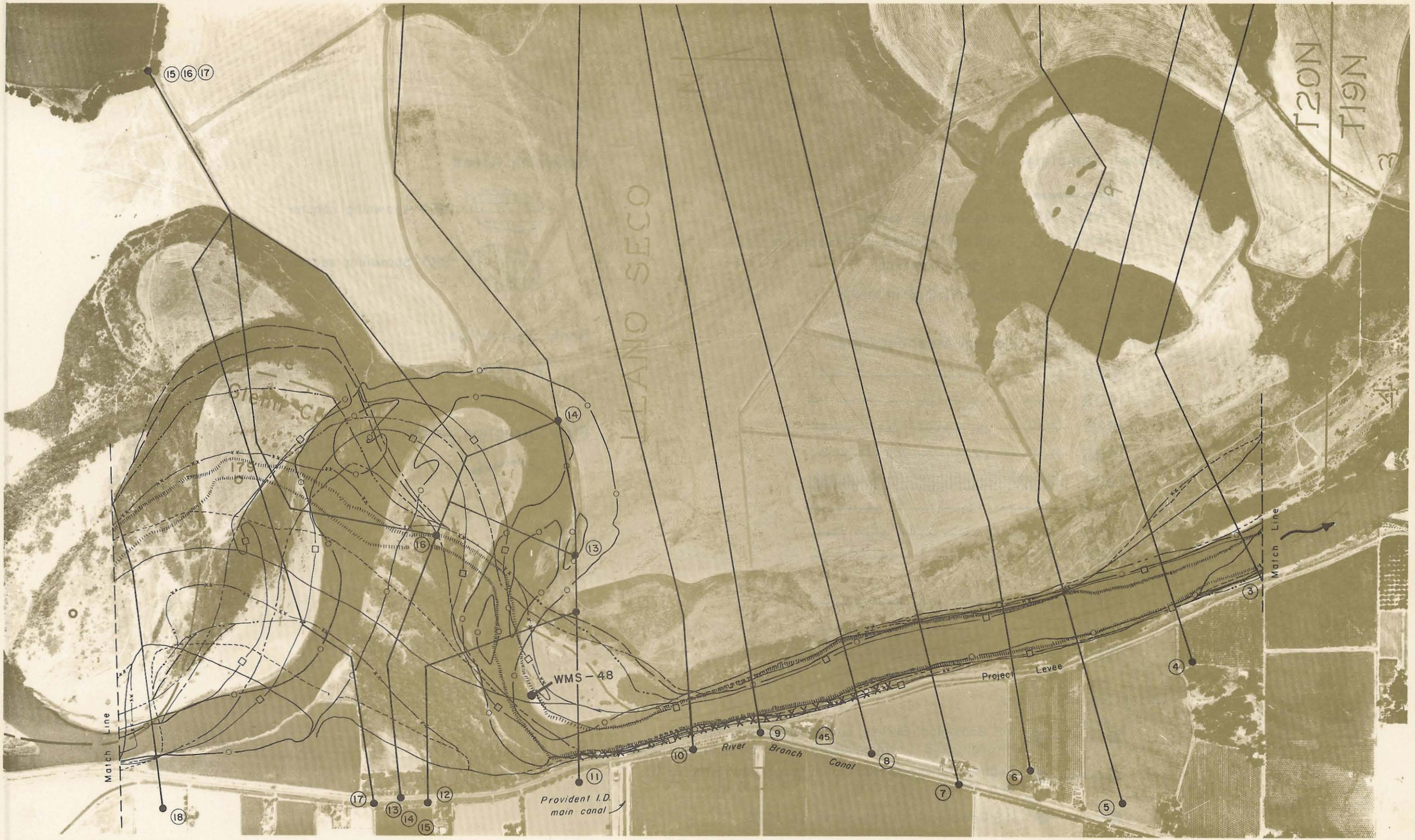

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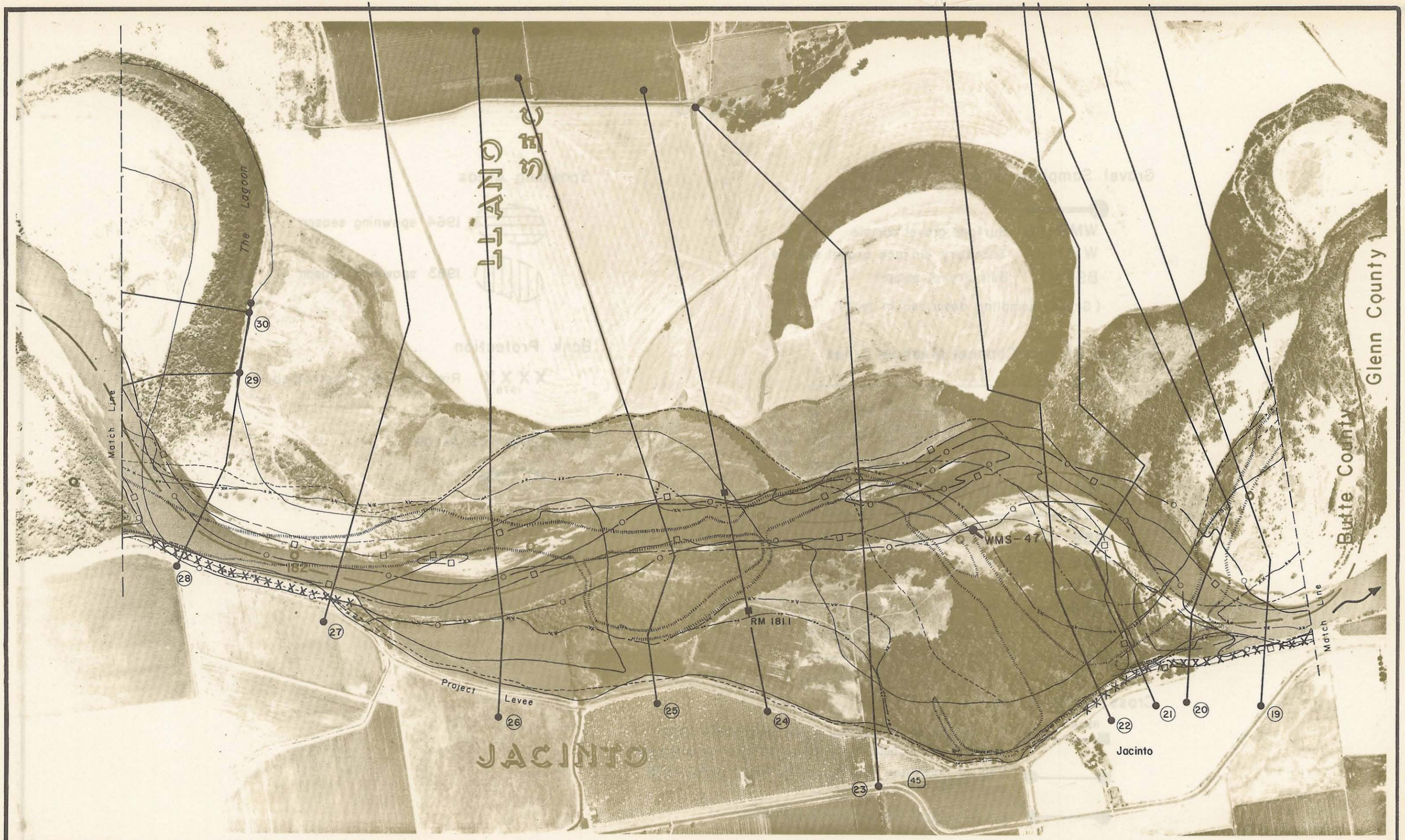

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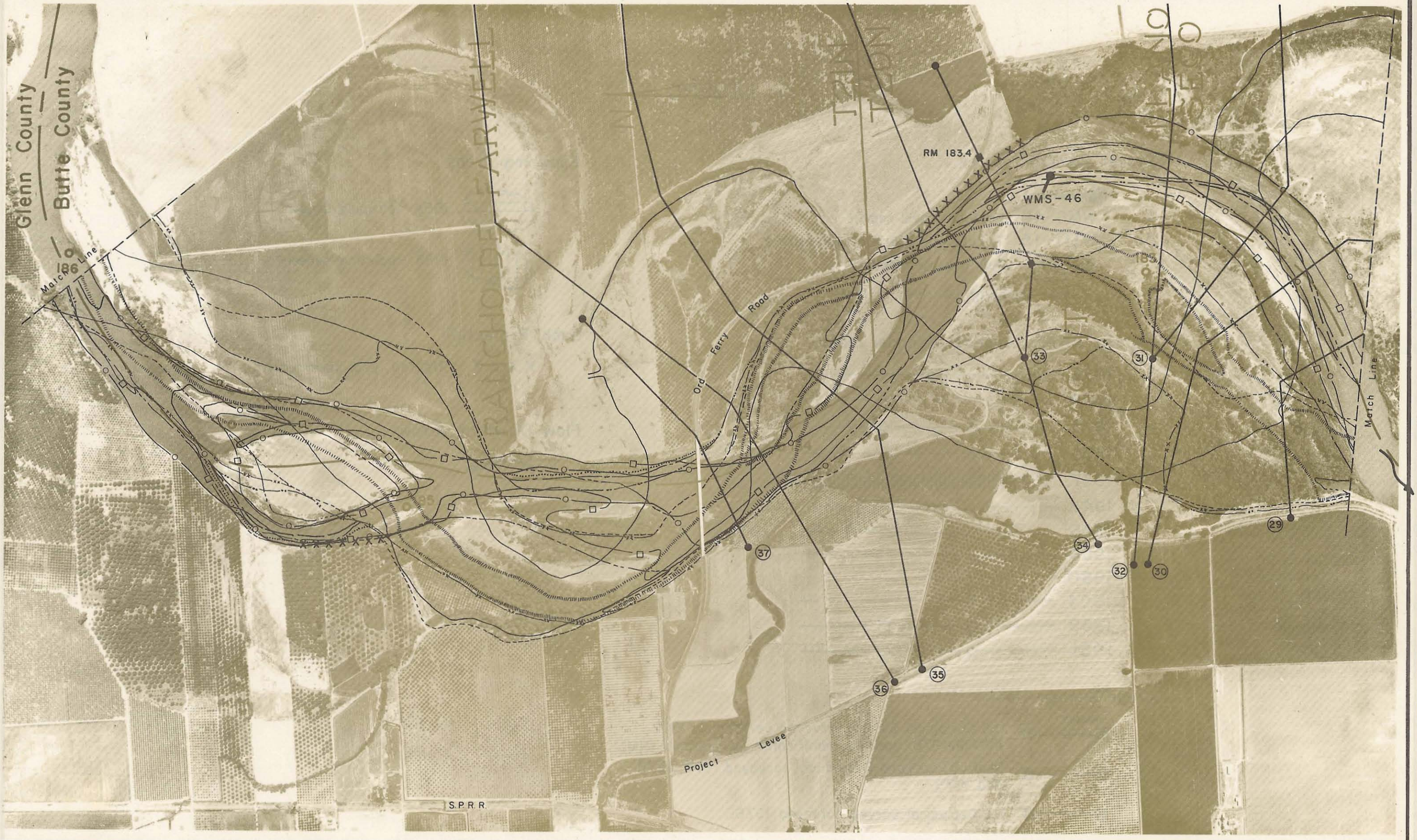

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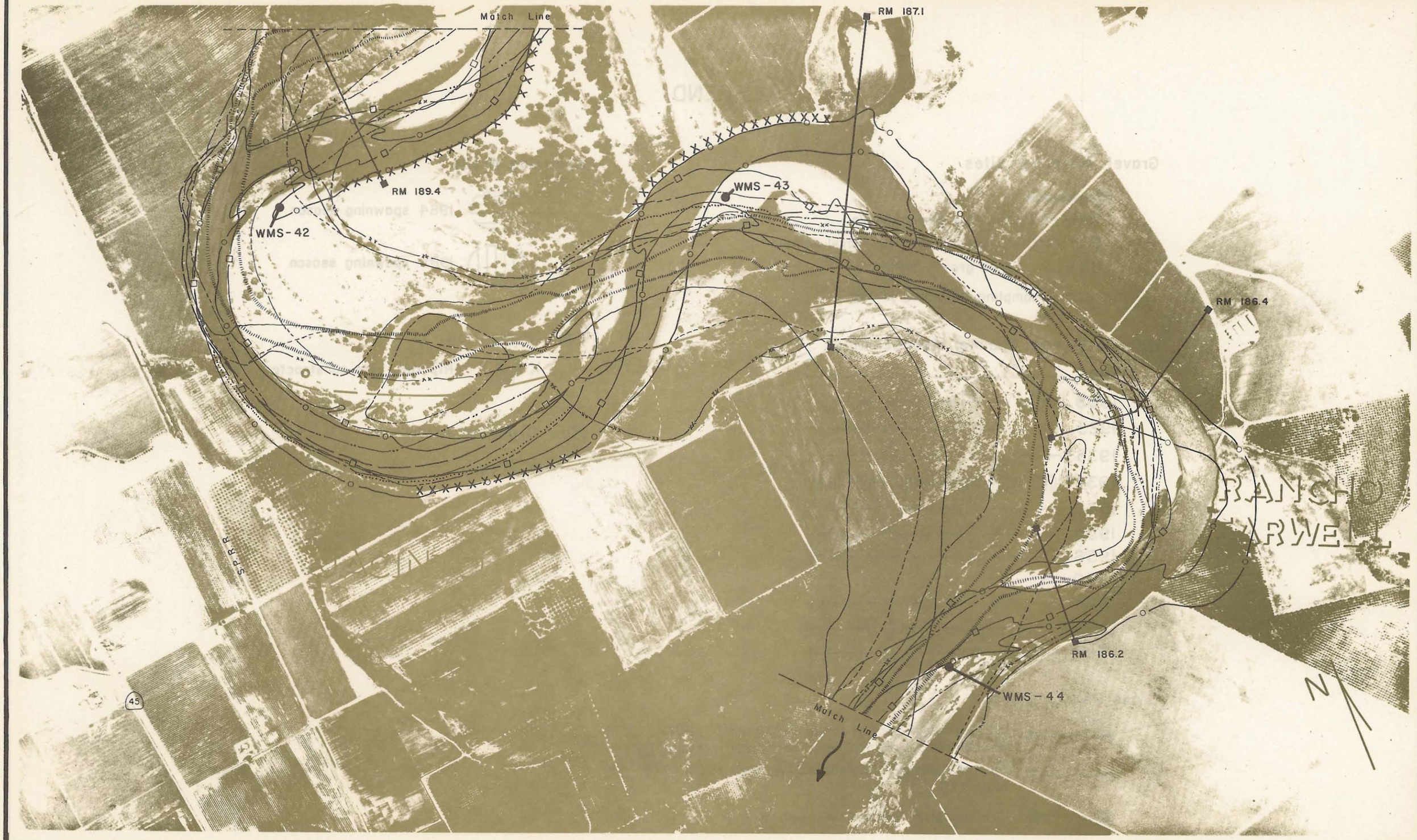

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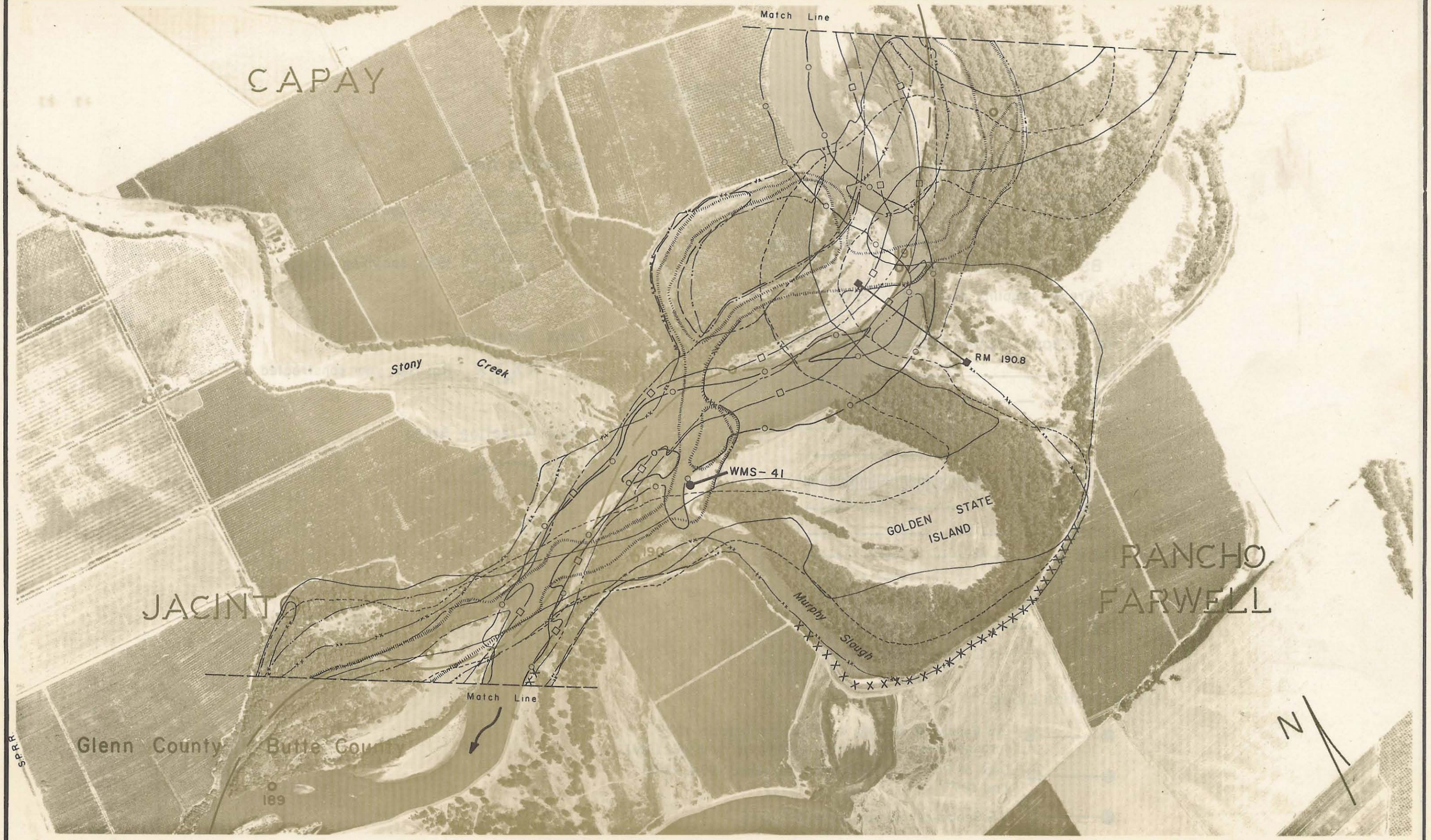

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Big Chico Creek

Mud Creek

Chico Landing

1973

194

193

192

Butte County

Glenn County

195

Match Line

Maps Maps

RM 194.2

RM 192.8

RM 192.5

WMS-38

USCE 6-13-471
USCE 6-13-593

WMS-39

WMS-40

RANCHO DE
LA FARWELL

Match Line

PHELAN ISLAND

CAPAY

T22N
T21N

APPROXIMATE SCALE 1 INCH = 1000 FEET ENLARGED FROM EXPOSURE NUMBER WR-AFV-1-	PHOTOGRAPHED AUGUST 1976 SYMBOL WR-AFV FOCAL LENGTH 152.66mm	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT	SACRAMENTO RIVER COLUSA TO RED BLUFF DIVERSION DAM	MIDDLE SACRAMENTO RIVER SPAWNING GRAVEL STUDY	SHEET 19 OF 34

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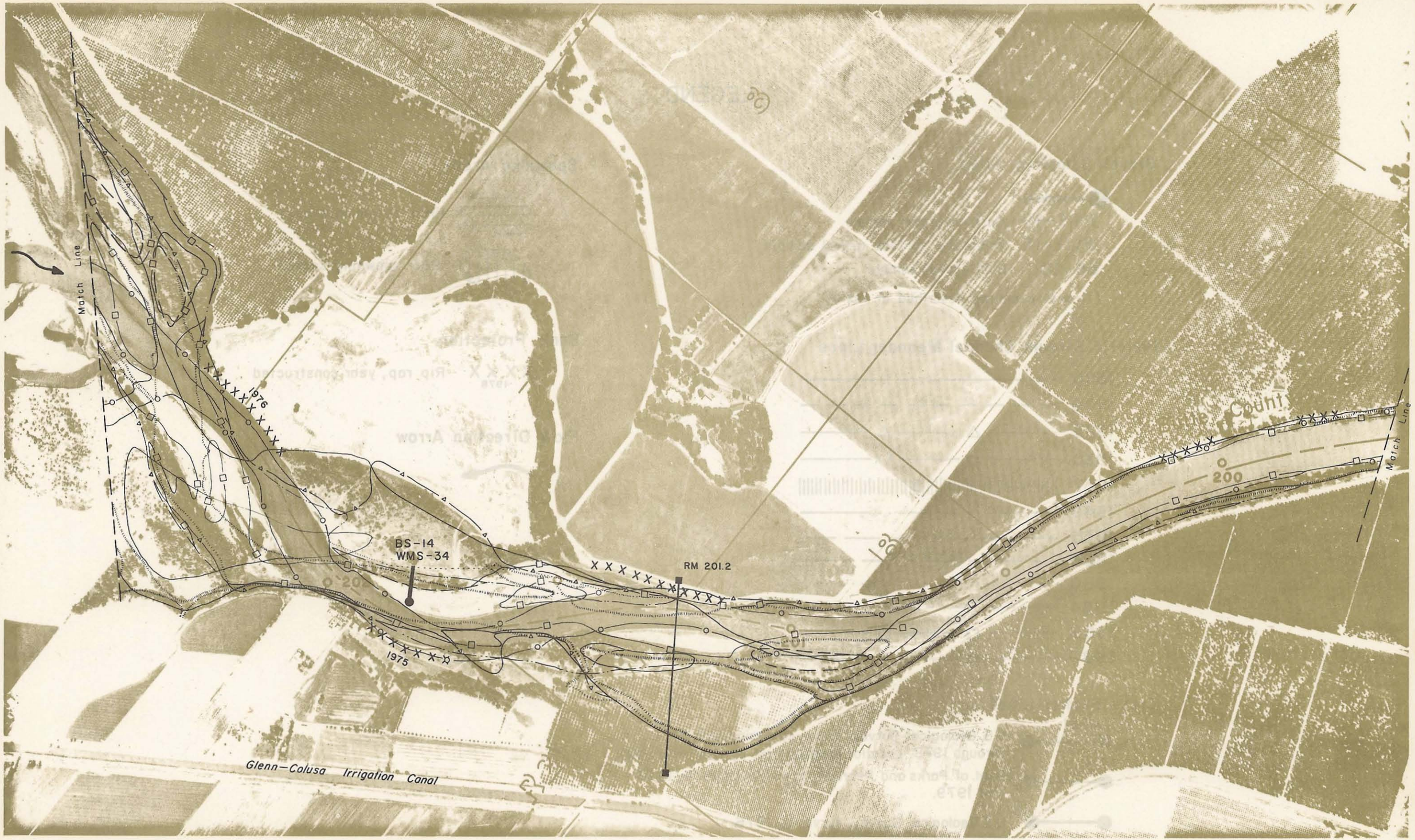

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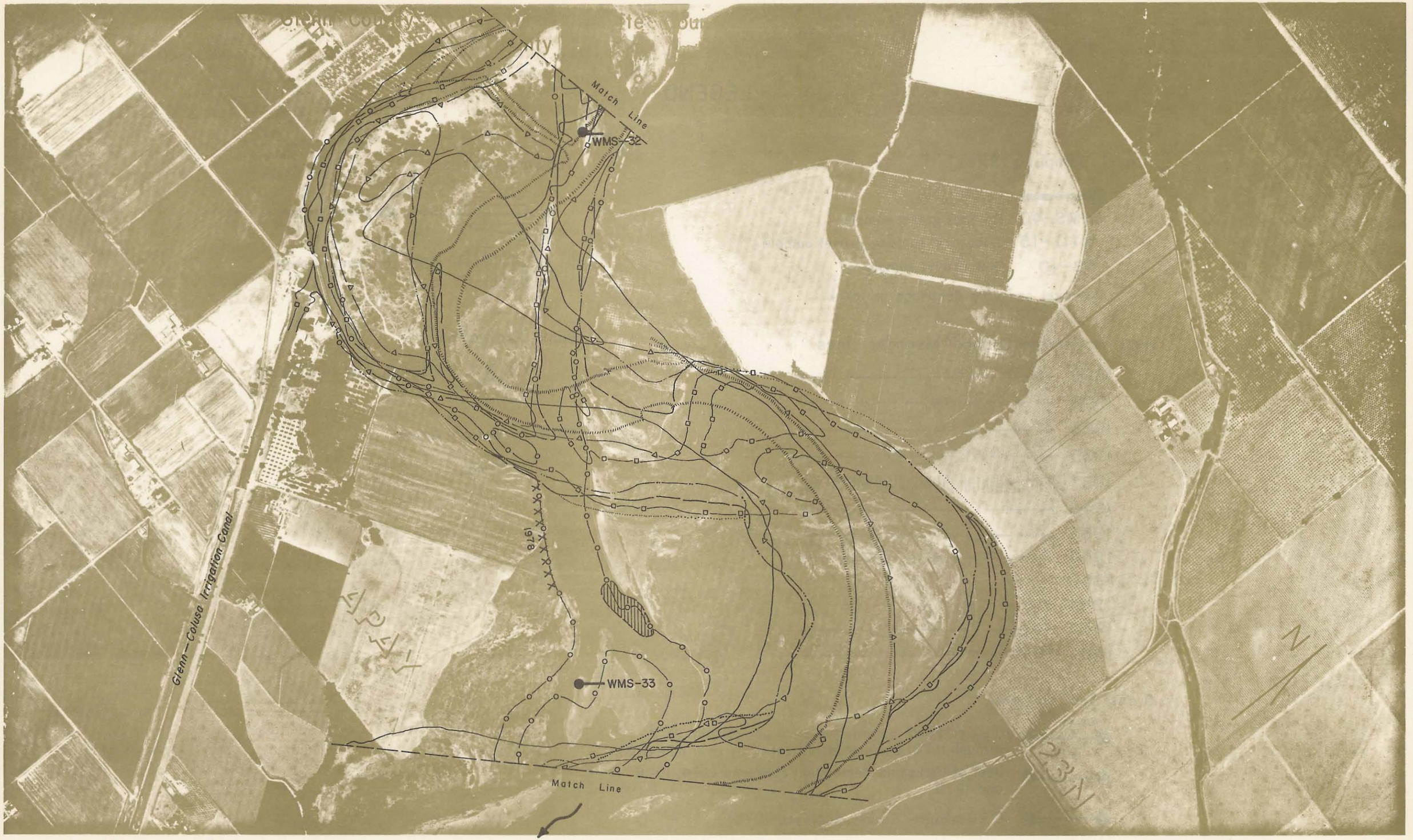

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27

34

3

T23N

Match Line

Hoag Slough

WMS-26

WMS-27, BS-11

Jewett Creek

RM 215.3

1978

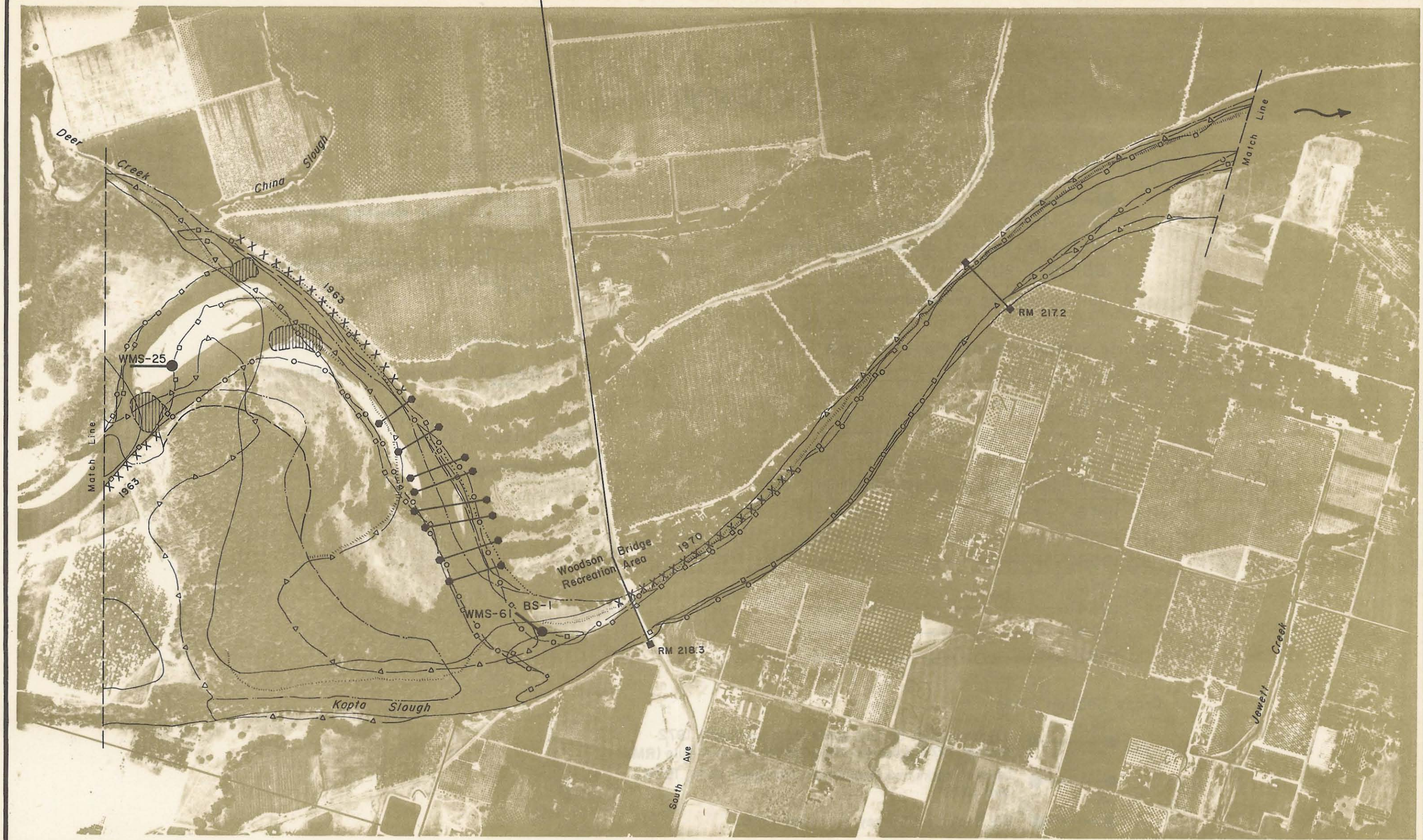
1974

County

e County

Match Line

APPROXIMATE SCALE 1 INCH = 1000 FEET ENLARGED FROM EXPOSURE NUMBER WR-AFV-1-	PHOTOGRAPHED AUGUST 1976 SYMBOL WR-AFV FOCAL LENGTH 152.66mm	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT	SACRAMENTO RIVER COLUSA TO RED BLUFF DIVERSION DAM	MIDDLE SACRAMENTO RIVER SPAWNING GRAVEL STUDY	SHEET 26 OF 34



APPROXIMATE SCALE 1 INCH = 1000 FEET ENLARGED FROM EXPOSURE NUMBER WR-AFV-1-	PHOTOGRAPHED AUGUST 1976 SYMBOL WR-AFV FOCAL LENGTH 152.66mm	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT	SACRAMENTO RIVER COLUSA TO RED BLUFF DIVERSION DAM	MIDDLE SACRAMENTO RIVER SPAWNING GRAVEL STUDY	SHEET 27 OF 34

APPROXIMATE SCALE 1 INCH = 1000 FEET ENLARGED FROM EXPOSURE NUMBER WR-AFV-1-	PHOTOGRAPHED AUGUST 1976 SYMBOL WR-AFV FOCAL LENGTH 152.66mm	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT	SACRAMENTO RIVER COLUSA TO RED BLUFF DIVERSION DAM	MIDDLE SACRAMENTO RIVER SPAWNING GRAVEL STUDY	SHEET 28 OF 34

APPROXIMATE SCALE 1 INCH = 1000 FEET ENLARGED FROM EXPOSURE NUMBER WR-AFV-1-	PHOTOGRAPHED AUGUST 1976 SYMBOL WR-AFV FOCAL LENGTH 152.66mm	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT	SACRAMENTO RIVER COLUSA TO RED BLUFF DIVERSION DAM	MIDDLE SACRAMENTO RIVER SPAWNING GRAVEL STUDY	SHEET 29 OF 34

APPROXIMATE SCALE 1 INCH = 1000 FEET ENLARGED FROM EXPOSURE NUMBER WR-AFV-1-	PHOTOGRAPHED AUGUST 1976 SYMBOL WR-AFV FOCAL LENGTH 152.66mm	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT	SACRAMENTO RIVER COLUSA TO RED BLUFF DIVERSION DAM	MIDDLE SACRAMENTO RIVER SPAWNING GRAVEL STUDY	SHEET 30 OF 34

APPROXIMATE SCALE 1 INCH = 1000 FEET ENLARGED FROM EXPOSURE NUMBER WR-AFV-1-	PHOTOGRAPHED AUGUST 1976 SYMBOL WR-AFV FOCAL LENGTH 152.66mm	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT	SACRAMENTO RIVER COLUSA TO RED BLUFF DIVERSION DAM	MIDDLE SACRAMENTO RIVER SPAWNING GRAVEL STUDY	SHEET 31 OF 34

APPROXIMATE SCALE 1 INCH = 1000 FEET ENLARGED FROM EXPOSURE NUMBER WR-AFV-1-	PHOTOGRAPHED AUGUST 1976 SYMBOL WR-AFV FOCAL LENGTH 152.66mm	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT	SACRAMENTO RIVER COLUSA TO RED BLUFF DIVERSION DAM	MIDDLE SACRAMENTO RIVER SPAWNING GRAVEL STUDY	SHEET 32 OF 34

APPROXIMATE SCALE 1 INCH = 1000 FEET ENLARGED FROM EXPOSURE NUMBER WR-AFV-1-	PHOTOGRAPHED AUGUST 1976 SYMBOL WR-AFV FOCAL LENGTH 152.66mm	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT	SACRAMENTO RIVER COLUSA TO RED BLUFF DIVERSION DAM	MIDDLE SACRAMENTO RIVER SPAWNING GRAVEL STUDY	SHEET 33 OF 34

APPROXIMATE SCALE 1 INCH = 1000 FEET ENLARGED FROM EXPOSURE NUMBER WR-AFV-1-	PHOTOGRAPHED AUGUST 1976 SYMBOL WR-AFV FOCAL LENGTH 152.66mm	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT	SACRAMENTO RIVER COLUSA TO RED BLUFF DIVERSION DAM	MIDDLE SACRAMENTO RIVER SPAWNING GRAVEL STUDY	SHEET 34 OF 34