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Introduction

This report quantifies the potential for a conjunctive use project involving Reclamation District 108, Colusa County Water District, and the Yolo-Zamora Water District. It also documents the development of preliminary designs and cost estimates for facilities required to implement the proposed project. The project area is bounded by the Sacramento River on the east, Interstate 5 on the west, Southern Pacific Railroad to the north, and Cache Creek to the south.

Project Description

This report evaluates two conjunctive use project alternatives. Alternative I is a conjunctive use project utilizing 12,300 acres of irrigated agricultural land within YZWD for in-lieu groundwater recharge. Alternative II is a project utilizing CCWD for recharge operations. Both alternatives involve RD 108 for groundwater extraction. The Project area is shown in Figure 1. The 12,300 acres within YZWD and CCWD were selected as potential in-lieu recharge areas for their dependence on groundwater. Also, their proximity to an existing surface water supply (Sacramento River) is a geographic consideration necessary for project recharge operations. Reclamation District 108 was chosen for potential groundwater extraction operations due to its relative location to the proposed recharge areas and its water rights on the Sacramento River.

The project is comprised of two components: project recharge and project recovery. Project recharge would occur during wet and above normal water years as defined by the

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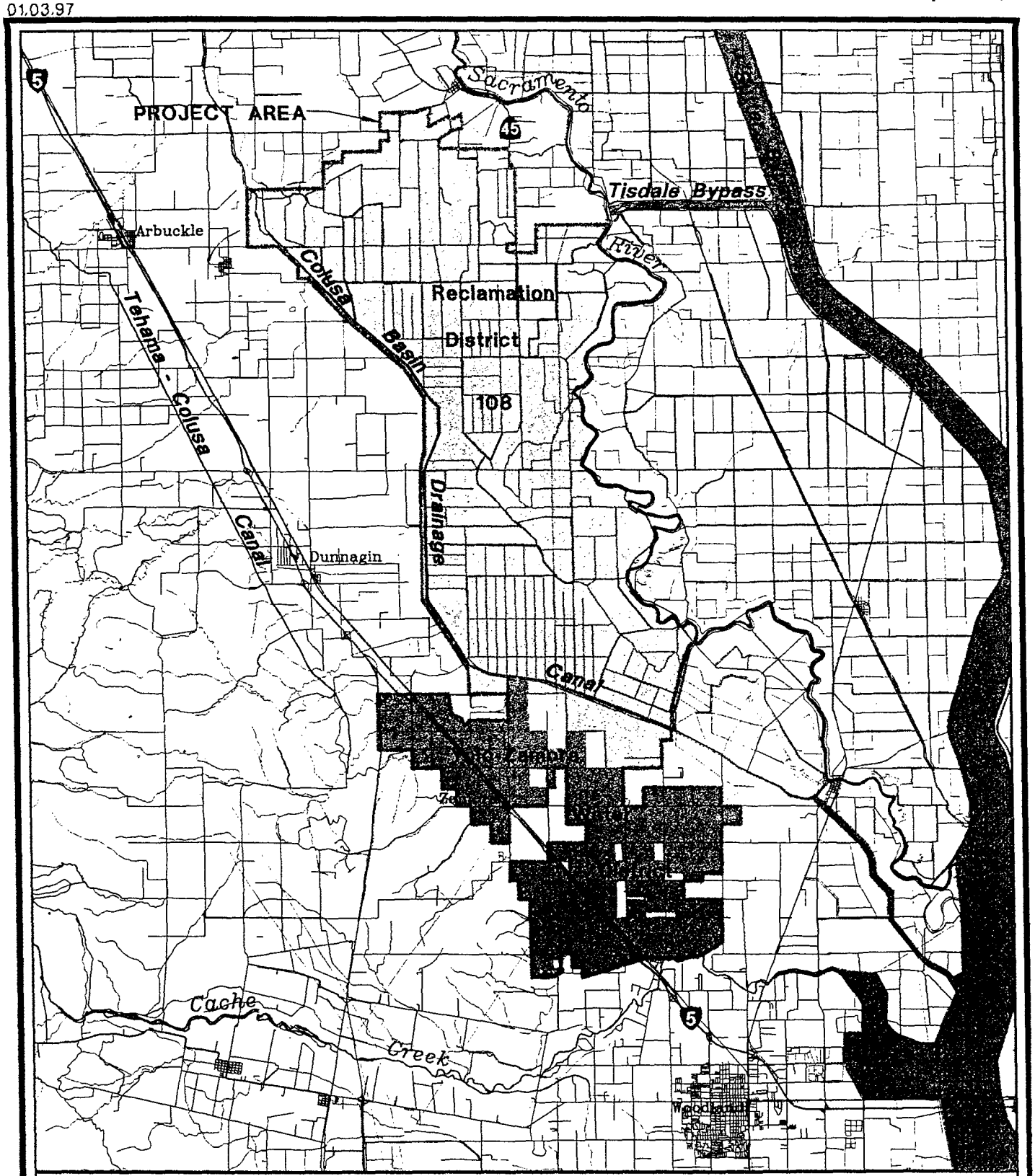

Lower Colusa Basin
Conjunctive Use Project
Figure 1

C—058054

Sacramento River Index. Based on historical data, there would be 20 recharge occurrences during a forty year project life. To facilitate in-lieu recharge operations, the feasibility of the two alternatives were evaluated. Alternative I involves development of a surface water conveyance system with the capability for an annual delivery of 38.3 taf to YZWD. Alternative II involves developing a separate surface water conveyance system capable of delivering 15.6 taf per year to CCWD. These annual deliveries were determined by estimating groundwater demand that can be offset by a surface water supply with cost effective delivery facilities. The key to the recharge component however, is the fact that surface deliveries will offset demands on groundwater which will allow the aquifers to naturally replenish.

The second component involves recovery of the recharged water. Project recovery would occur during below normal, dry and critical water years (20 out of 40 years). This would be accomplished by groundwater substitution. RD 108 would reduce diversions from the Sacramento River which would make the water available to the State Water Project. RD 108 would substitute a like amount of groundwater to obtain a full supply.

There is no opportunity for direct groundwater recharge because all of the land within the project area is being used for agriculture. The proposed in-lieu recharge system could be expanded to serve additional areas if necessary. Also, the area served could be selectively reduced which would result in a lower unit cost as the less efficient portions of the system would be eliminated. The flexibility in the quantity of area served provides an opportunity to control the proposed project yield and optimize the annual cost/project yield ratio.

Project Recharge Facilities

Alternative I - Yolo-Zamora Water District

This section describes the proposed surface water delivery facilities required to facilitate in-lieu recharge in Yolo-Zamora Water District. The 12,300 acres of proposed in-lieu recharge area within YZWD currently contains no universal (multi-user) conveyance facilities. YZWD is composed of numerous land owners with individual irrigation and drainage patterns and methods. Therefore, no existing facilities are available for incorporation into the proposed distribution system.

The design flow rates, conveyance facilities, and pumplifts were designed using the criteria outlined in this section. The proposed delivery system is designed to convey 350 cfs from the Sacramento River to the Colusa Basin Drain and ultimately to the Yolo-Zamora Water District for distribution. The proposed surface water delivery system for Alternative I is shown in Figure 2.

An alternative delivery system configuration was also developed and evaluated for YZWD. Although these systems serve the same proposed areas, the alternative configuration is based on a Colusa Basin Drain diversion near the northern boundary of the District while the proposed system is based on diversion near the southern boundary. Further details of this alternative configuration are described under *Alternative I, Conveyance Facilities.*

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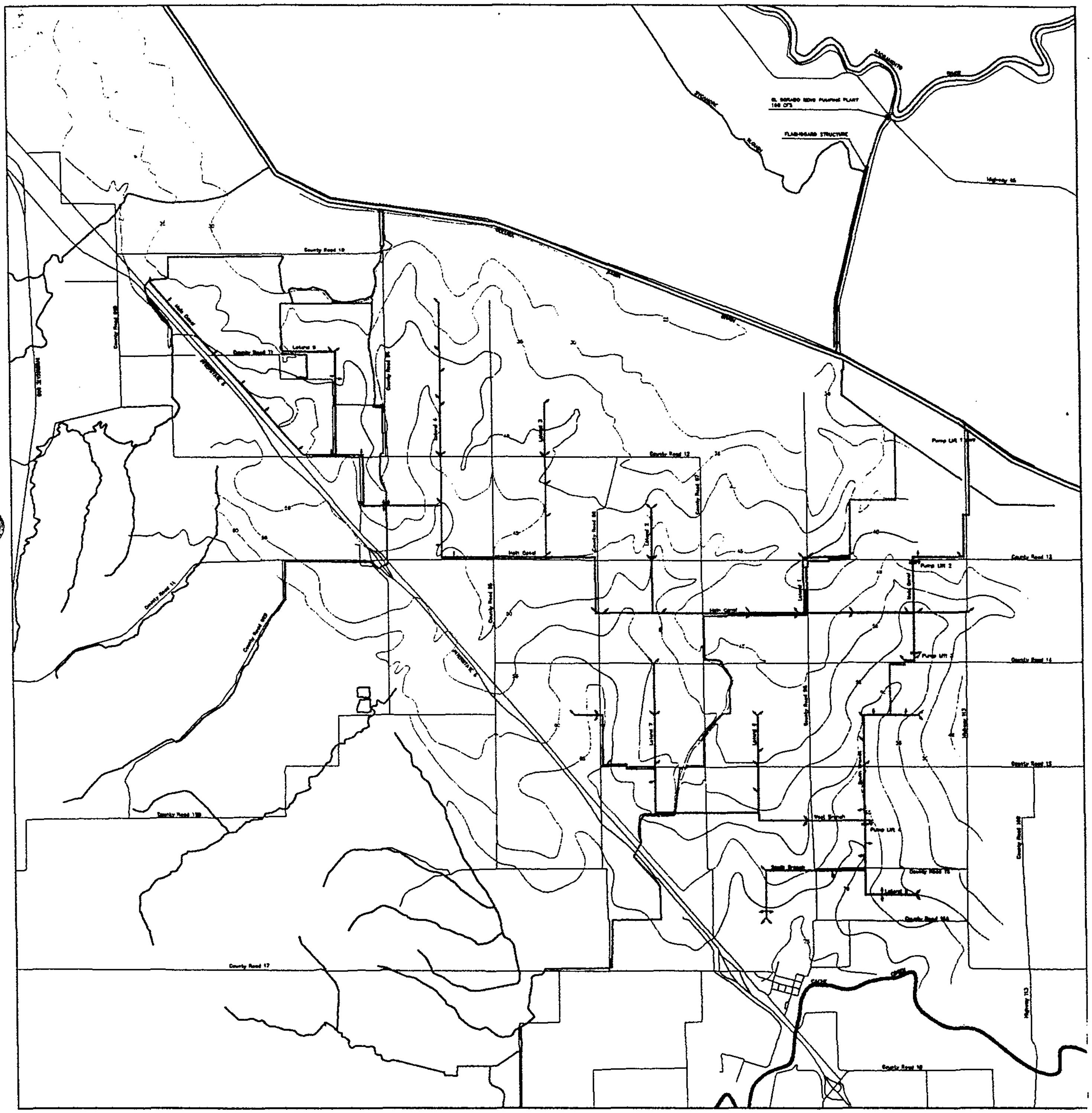

State of California
The Resources Agency
Department of Water Resources
CENTRAL DISTRICT

LOWER COLUSA BASIN
CONJUNCTIVE USE PROJECT

YOLO ZAMORA WATER DISTRICT
SURFACE WATER DELIVERY FACILITIES

SCALE
0 1 2
MILES

LEGEND

YOLO ZAMORA WATER DISTRICT
EXISTING FACILITIES
PROPOSED CONVEYANCE
PROPOSED LIFT STATION
PROPOSED TURNOUT

C-058057

C-058057

Design Flow Rates

The design flow rates used to design the conveyance facilities are based on the following criteria and assumptions: (1) The smallest increment of area served by the system is 160 acres. If an individual's acreage is less than 160 acres however, a turnout (field headgate) was provided. (2) Open channel capacities were determined by assuming 12.5 gpm per acre for segments of the system that serve more than 4,000 acres; 22 gpm per acre for areas less than 2,500 acres; and for areas in between the flow rate varies linearly with the area served. (3) Pumplift capacities were determined using the same assumptions applied to the acreage downstream of the lift.

The design flow rate for the entire project area is 350 cfs and the capacity at the field headgates is 7.8 cfs or 3,520 gpm. These capacities are conservative and include an allowance for transportation losses, flexibility for varying crop mixes, irrigation efficiencies, reliability for pump outages, and the capability of meeting peak demand while irrigating in 12 hour per day increments.

Conveyance Facilities

The proposed conveyance facilities will consist of a proposed pump-turnout structure at the Knights Landing Outfall Gates to divert water from the Sacramento River to the Colusa Basin Drain. The proposed facilities are designed to divert water into the Drain at a rate of 350 cfs. The water is then ponded in the Drain as far north as College City. An additional option for conveying water to the Drain is to utilize the tailwater from RD108. Sycamore Slough Pumping Plant has a capacity of 155 cfs and discharges tailwater into Lateral 14A. The water could then

gravity flow into the Drain. Although the scheduling for such a water source would vary based on tailwater availability, this regime could be used in conjunction with the proposed pump-turnout from the River which reduces the required pump design capacity at the Knights Landing Outfall Gates.

From the Drain the water is lifted through Pumplift #1 and discharged into the proposed Main Canal of the distribution system. The water is again lifted through Pumplift #2 which is located one and one-quarter mile south of the Drain. This is the last lift on the proposed Main Canal which continues for 10 miles and terminates at the northwest corner of the Yolo-Zamora Water District. This channel also has five laterals which deliver water north (down slope) of the channel. This portion of the system delivers water to 6,200 acres (one-half of the entire recharge area).

The south branch ties in to the Main Canal 1,000 feet north of Pumplift #3. This branch serves 4,100 acres of the recharge area. The Western Lateral turnout is located approximately 1.5 miles south of Pumplift #3 and which serves an area of 2,000 acres. The remainder of the deliveries are lifted through Pumplift #4 and conveyed to the southern portion of the district via the South Branch and Lateral 8.

This distribution system has delivery cost/quantity of area served ratios that vary based on the elevation of the area served and the distance from the Colusa Basin Drain. The most efficient portion of this system is the Main Canal and its five gravity laterals. Once the water is lifted through Pumplift #2 it will gravity flow to 50% of the project recharge area. Conversely, the South Branch conveys water normal to the natural contours, up slope from the water source.

After being lifted through the first two pumplifts the water must then be lifted again by Pumplift #3 to be distributed through the Western Lateral. The least efficient portion of the system is the remainder of the South Branch which is lifted a fourth time by Pumplift #4 to serve 1,375 acres where the average required head is 50 feet higher the water surface elevation at the drain.

Several assumptions were made regarding the design of the conveyance facilities. The invert dimensions were sized to accommodate common sized excavation equipment, the maximum velocity in an unlined open channel is 1.0 foot-per-second. The water surface elevation within the delivery channels was kept a minimum of 1.0-foot above the high point of the field. The canal alignments were selected to minimize the number of lifts as well as the static lift at any given location, avoid existing infrastructure, and utilize existing road and power transmission line corridors.

The control structures (check/drop structures and turnouts) were designed based on the alternatives detailed in *Design of Small Canal Structures*; U.S.B.R., 1974. The concrete box culverts were designed based on the guidelines detailed in *Standard Plans*; California Department of Transportation, July 1992. Other assumptions are as follows: the maximum velocity in a CMP culvert is 5 feet per second; road crossings were provided for existing traffic corridors only; and field headgates are provided for 160 acre areas or less (depending on property ownership boundaries).

Assumptions regarding the earthwork and associated costs are as follows: hydraulic excavation will be required for depths greater than 10 feet below the ground surface; spoil material will be spread over adjacent fields for an additional cost; and an attempt was made (given

the pumplift locations, canal alignments and required head at field headgates) to balance the cut and fill material for each reach of the open channels. An attempt was made to develop the capability to deliver water to the entire district however, (given the high project yield that will be realized with the proposed 12,300 acres, the physical barrier that the Interstate creates, and the high elevations west of the Interstate) it was decided that the initial study will be focused on the east side of Interstate 5.

A design and cost estimate were developed for the alternative system configuration (based on the northern Drain diversion). Although this is a viable configuration, the capital cost is 10% greater than the system proposed in this report. This is due to an increase in earthwork required for open channel construction and the construction of an additional pumplift. These additional earthwork and pumplift requirements are both due to the existing topography relative to the diversion from the Drain. Although an estimate of the operation and maintenance costs was not developed, it is assumed that these costs would be similar to that of the proposed system since the water surface elevations at the diversions and field headgates and the canal alignments are the same for both configurations. A detailed cost estimate of the alternative configuration is shown in the *Economic Analysis, Project Capital Costs* section of this report. Figure 3 shows the configuration of this system.

The construction of two turnouts from the Drain is not recommended since it would require a greater capital expenditure with similar energy requirements. Although the cumulative capacity would be the same as the one turnout alternative, additional construction costs would be incurred associated with the structural/mechanical components, required earthwork, and

mobilization/demobilization of construction equipment.

Pumping Plants

Several assumptions and criteria were considered in siting and sizing the four pumping plants for Alternative I. A typical pumplift configuration is shown in Figure 4. The sites were chosen to minimize conflict with existing utilities, ease of access, proximity to power supply, and the distance between lifts was maximized to simplify operation of the system. The construction of the structural components (sumps, structural members, and platforms) are consistent with all the lifts for ease of construction, operation, and maintenance. Other assumptions include: sump dimensions were determined using Floway Pumps Handbook, canal inverts downstream of lifts were placed at or below stripped ground level, vertical propeller pump efficiency is 75%, and a reliability factor of 1.15 was applied to the braking horsepower to size each electric motor. Table 1 presents the pumplift parameters for each of the four proposed stations.

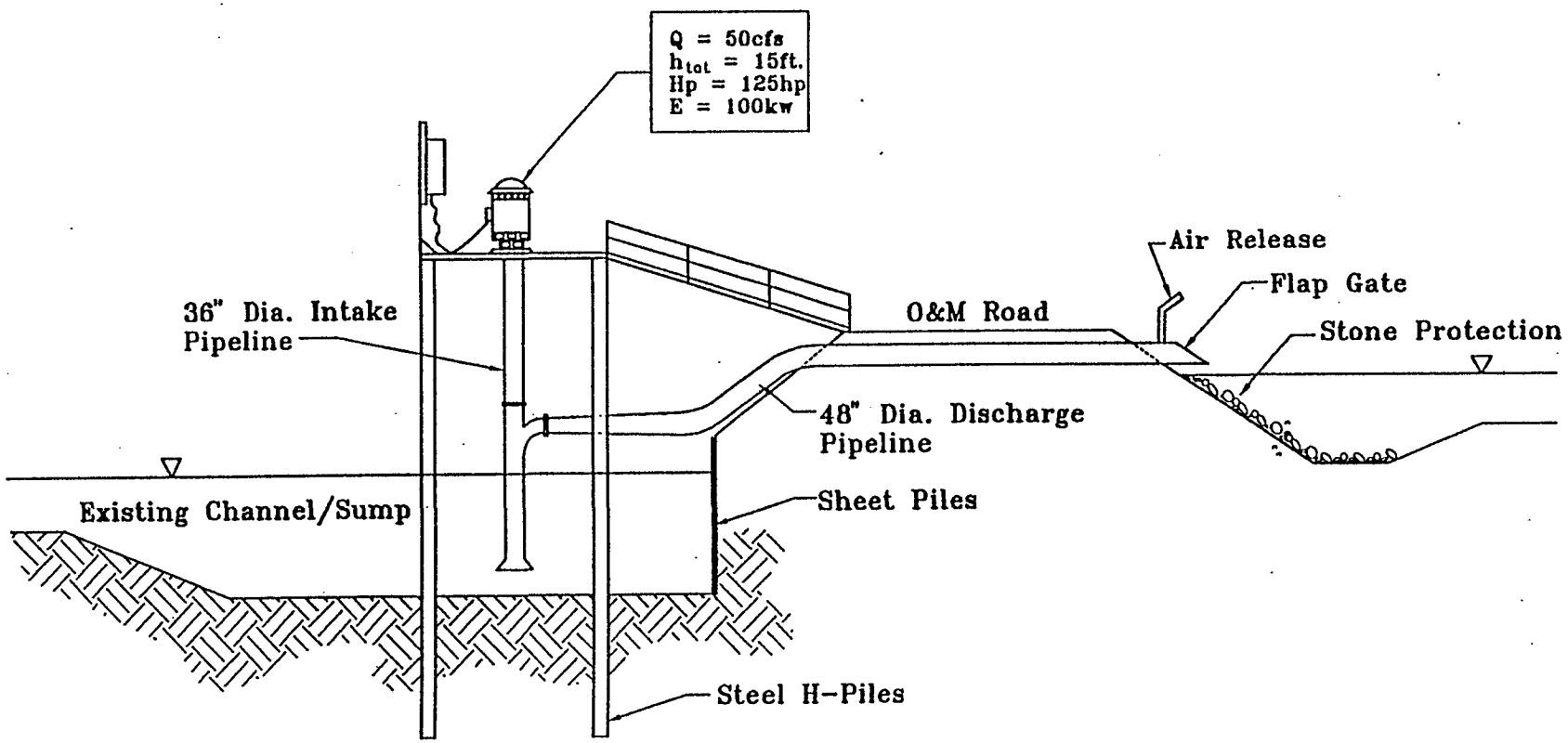

Figure 4

Los Rios Farms
Conjunctive Use Study

Lift Station #1
Modification Profile

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Table 1

Summary of Alternative I Pumplift Parameters

PUMPLIFT #	UNIT #	MOTOR SIZE	STATIC LIFT (FT)	CAPACITY (CFS)
Pump-Turnout	1,2	200 hp	10	100 (ea)
1	1,2,3	300 hp	15	88 (ea)
1	4	200 hp	15	58
1	5	100 hp	15	29
2	1,2,3	300 hp	15	88 (ea)
2	4	200 hp	15	58
2	5	100 hp	15	29
3	1	300 hp	15	84
3	2	200 hp	15	56
4	1	75 hp	7	28
4	2	50hp	7	42

Pumplift #1 is located in the Colusa Basin Drain and serves the entire project area. It lifts the water out of the drain and discharges into the Main Canal at station 0+00. The static lift is 15 feet, the design flow rate is 350 cfs, the total plant horsepower is 1,200 hp, and the total plant demand is 900 kilowatts. The mechanical components are listed in Table 1. Pumplift #2, which is located one and one-quarter miles south of the drain, also serves the entire project area and has identical structural/mechanical components and capacities as Pumplift #1.

Pumplift #3 is located at station 10+00 of the South Branch and serves 4,700 acres. The static lift is 15 feet, the design flow rate is 140 cfs, the total plant horsepower is 500 hp, and the

total plant demand is 375 kilowatts.

Pumplift #4 is located at station 150+00 of the South Branch and serves 1,375 acres. The static lift is 7 feet, the design flow rate is 70 cfs, the total plant horsepower is 125 hp, and the total plant demand is 95 kilowatts.

Alternative II - Colusa County Water District

The design flow rates, conveyance facilities, and pumplifts were designed using the criteria outlined in this section. An existing surface water delivery system exists within the CCWD. The system receives water from the Tehema-Colusa Canal and distributes it through 105 miles of underground pipeline. The entire district is served by the existing distribution system. The design objective in Alternative II is, therefore, to convey additional surface water supply from the Colusa Basin Drain to the Tehama-Colusa Canal for distribution throughout the district.

An existing pipeline that can convey water from the Colusa Basin Drain to the T-C Canal would be utilized in this alternative. The quantity of project recharge was based on the capacity of this pipeline instead of the estimated groundwater demand within the District. The proposed project recharge, based on this assumption, is 15.6 taf.

The District's CVP contractual supply is 68.2 taf while the current demand ranges from 125 taf to 166 taf (depending on the quantity of fallowed area). Therefore, the potential for project recharge is 57 taf to 98 taf. However, since RD 108 would need to reduce diversions proportionately and since the pipeline is in place, the 15.6 taf recharge component is consistent with the scope of the project and results in a lower unit recharge cost than if additional

conveyance facilities were constructed. The proposed surface water conveyance facilities for Alternative II are shown in Figure 5.

Design Flow rate

The design flow rate for Alternative II was dictated by the capacity of the existing pipeline (Lateral 2A) that originates near the Colusa Basin Drain and discharges into the T-C Canal. It is assumed that this pipeline will be the sole source of delivery into the District. The pipeline diameter increases in a westerly direction from 48 inches to 60 inches. A maximum velocity of 5 fps was assumed in order to define the design flow rate for project recharge. The resulting discharge rate is 65 cfs.

Conveyance Facilities

Surface water diversions from the Sacramento River to the Colusa Basin Drain will occur as described in Alternative I Conveyance Facilities. Construction of new recharge conveyance facilities within the District would not be required for Alternative II. Lateral 2A will be used to convey water from the Drain to the T-C Canal. Since the District has an existing delivery system with additional capacity, project water would be conveyed and distributed through these facilities. The District Manager indicated that the system can serve the entire district and was sized to meet 100 percent of its demands.

Pumping Plants

A pump-turnout will need to be constructed at the Knights Landing Outfall Gates that will lift water out the Sacramento River and discharge into the Colusa Basin Drain. The static head is 10 feet, the capacity is 65 cfs, the total horsepower is 135 hp, and the plant demand is 100 kilowatts.

Two pumping plants were constructed along Lateral 2A; they area Pumping Plants 2A and 2A1. Pumping Plant 2A is located approximately 1.5 miles west of the Colusa Basin Drain and north of White Road. The design capacity at Pumping Plant 2A is 65 cfs with a static head of 50 feet, a total horsepower requirement of 700 hp, and a plant demand of 522 kilowatts. Pumping Plant 2A1 is located approximately 1.5 miles east of Highway 99 and north of White Road. The design capacity of Pumping Plant 2A1 is also 65 cfs with a static head of 80 feet, a total horsepower requirement of 960 hp, and a plant demand of 716 kilowatts. The Pumping Plant configuration is similar to that of Pumping Plant 2A.

Although the some of the structural components of the pumping plants are still in tact, the mechanical components have been removed. The costs estimates presented in this report reflect construction and installation of new structural and mechanical components at both locations. Gated by-pass lines are provided to allow deliveries to continue to be made from the T-C Canal to the portion of District east of Highway 99. Table 2 presents the pumplift parameters for the two proposed stations. A plan and Profile of Pumping Plant 2A is shown in Figure 6.

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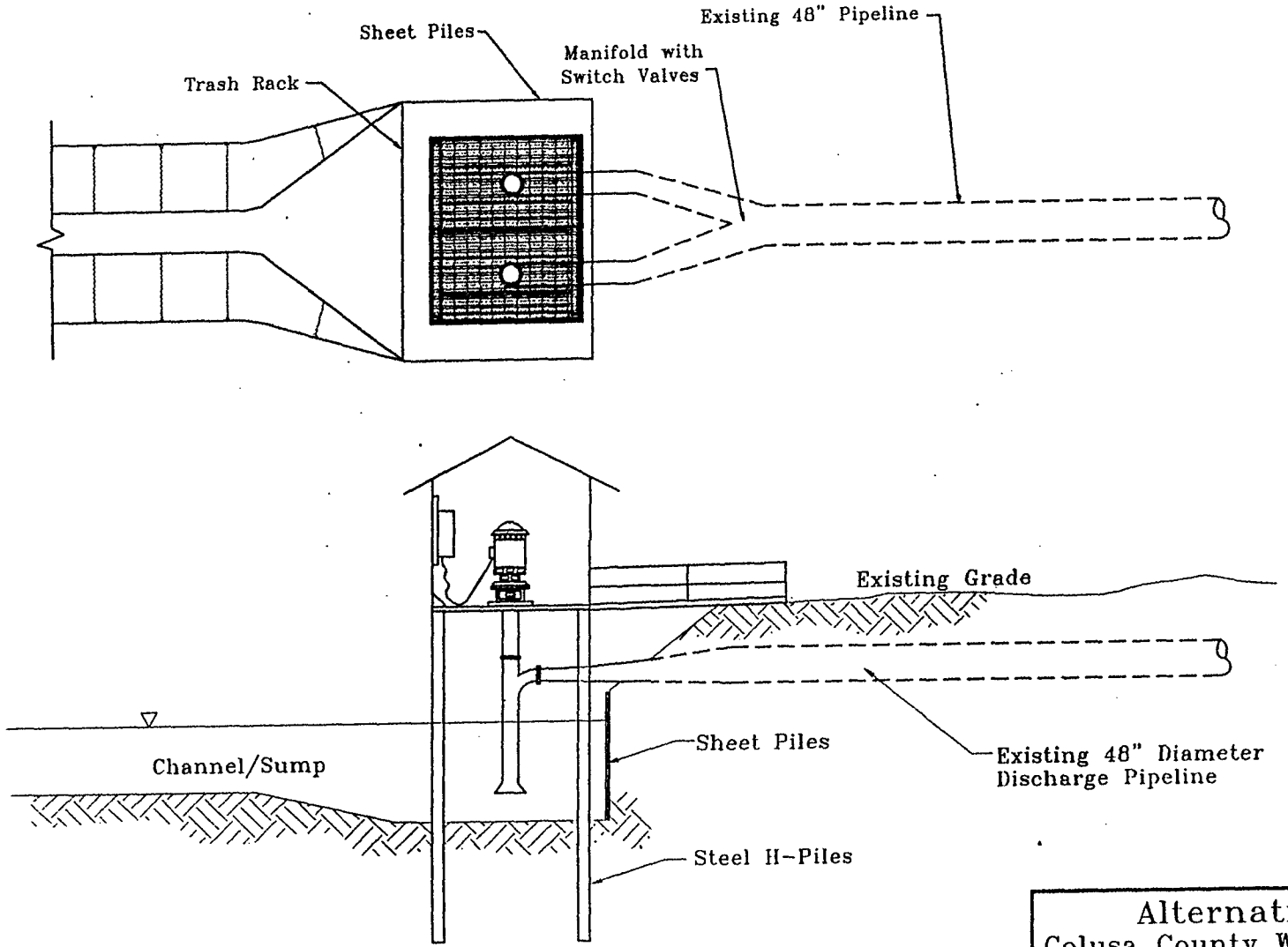

Figure 6

Alternative II
Colusa County Water District

Pumping Plant 2A
Plan and Profile

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Table 2

Summary of Alternative II Pumplift Parameters

PUMPLIFT #	UNIT #	MOTOR SIZE	STATIC LIFT (FT)	CAPACITY (CFS)
Pump-Turnout	1	135 hp	10	65
2A	1	250 hp	50	24
2A	2	450 hp	50	42
2A1	1	350 hp	80	24
2A1	2	610 hp	80	42

Project Recovery Facilities

Alternative I - Yolo-Zamora Water District

The annual project recovery associated with Alternative I is based on an estimated annual recharge of 38,300 acre-feet with occurs during wet and above normal years (20 out of 40 years). It was assumed that the total project recharge would be 10% less than the volume of water delivered to account for losses due to deep percolation, aquifer losses, and a net increase in aquifer storage at the end of the project life. The total project recharge is 696,400 af. Based on the assumptions that extraction also occurs twenty times during the forty years of operation (below normal, dry, and critical years) and total project recovery equals total project recharge, an extraction occurrence would result in a project recovery of 34,800 acre-feet.

A groundwater extraction and delivery system will be developed in Reclamation District 108 to provide the capability to substitute groundwater for the reduction in surface water

diversions. The design of the system is based on the following criteria and assumptions: (1) The proposed production wells will be capable of supplementing the total groundwater substitution demand independent of all existing wells. (2) The total design capacity is 145 cfs based on a delivery of 34,800 acre-feet over a 120 day period and 29 wells each with a flow capacity of 5 cfs. (3) Since an extraction occurrence of 34,800 acre-feet is less than 20% of RD 108's annual demand, no peaking or reliability factor was applied to the well field design capacity. (4) The proposed production wells will be located so that they discharge directly into the existing conveyance facilities, therefore no new conveyance facilities are proposed within RD 108. (5) The proposed pump motors will be electric and are sized to produce 5 cfs with a static head of 100 feet plus 15 feet of dynamic head (column losses). (6) Each well is designed to be 900 feet deep with a 16 inch diameter, 1/4 inch casing. (7) Well drilling/construction, and pump and motor costs were obtained from Eaton Drilling Co. of Woodland.

Alternative II - Colusa County Water District

The annual project recovery associated with Alternative II in Colusa County Water District is based on an estimated annual recharge of 15,600 af which would also occur 20 out of 40 years. Assuming the same losses occur for both alternatives, the total project recharge is 283,600 af. Based on the assumptions that extraction also occurs twenty times during the forty years of operation and total project recovery equals total project recharge, an extraction occurrence would result in a project recovery of 14,200 af.

The groundwater extraction and delivery system proposed for Alternative II in

Reclamation District 108 is based on the criteria and assumptions detailed for Alternative I extraction facilities with a modification to the capacity. The total design capacity is 60 cfs based on a delivery of 14,200 af in a 120 day period. This is achieved with 12 wells each with a flow capacity of 5 cfs.

Economic Analysis

The capital, operation, and maintenance unit costs were obtained from Means Heavy Construction Cost Data; 1995, American Basin Conjunctive Use Pre-feasibility Study, Los Rios Farms Conjunctive Use Study, manufacturer price quotes, and service price quotes.

Project Capital Costs

The cost of constructing the proposed surface water delivery and groundwater extraction systems is $14.9 million for Alternative I and $3.9 million for Alternative II. The cost of the proposed Alternative I and Alternative II recharge systems are $9.1 million and $1.6 million, respectively. Construction of the alternative recharge system configuration in YZWD is $10.9 million. The costs of the proposed extraction well fields in RD 108 are $5.6 million for Alternative I and $2.3 million for Alternative II. A summary of the capital costs required to construct the proposed recharge and recovery facilities is shown in Tables 3 through 6. A construction cost summary for Alternative I - alternate recharge facilities configuration is shown in Table 7.

The construction estimates include a right-of-way acquisition fee of $2,000 per acre for land that is permanently disturbed by the construction of open channels and pumplifts. The capital cost is increased by 25% for contingencies and 25% for project engineering and administration during planning, design, and construction activities.

Yolo-Zamora Conveyance System
Summary of Construction Costs

Item	Quantity	Unit	Unit Cost	Item Cost
Main Channel (0+00 - 596+00)				
Excavation	438,600	CY	$1.50	$657,900
Placement and Compaction	404,800	CY	$2.75	$1,113,200
Spoil Material - Haul and Spread	33,800	CY	$3.00	$101,400
Lateral Turnouts	5	LS	$5,000	$25,000
Road Crossings (Box Culverts)	6	EA	$41,000	$246,000
Main Channel Laterals (1 -5)				
Excavation	26,100	CY	$1.50	$39,150
Placement and Compaction	24,400	CY	$3.75	$91,500
Spoil Material - Haul and Spreading	1,700	CY	$3.00	$5,100
Check/Drop Structures	6	EA	$1,500	$9,000
Turnouts (Field Headgates)	25	EA	$2,500	$62,500
South Branch Channel (0+00 - 211+20)				
Excavation	157,400	CY	$1.50	$236,100
Placement and Compaction	148,900	CY	$3.75	$558,375
Spoil Material - Haul and Spreading	8,500	CY	$3.00	$25,500
Lateral Turnouts	5	LS	$5,000	$25,000
Road Crossings (Box Culverts)	2	EA	$41,000	$82,000
South Branch Laterals				
Excavation	18,500	CY	$1.50	$27,750
Placement and Compaction	17,200	CY	$3.75	$64,500
Spoil Material - Haul and Spreading	1,300	CY	$3.00	$3,900
Check/Drop Structures	7	EA	$1,500	$10,500
Turnouts (Field Headgates)	38	EA	$2,500	$95,000
Open Channels Subtotal				**$3,479,375**
Road Crossings				
4 - 24" CMP Road Crossing	160	LF	$70	$11,200
5 - 30" CMP Road Crossing	200	LF	$90	$18,000
20 - 48" CMP Road Crossing	800	LF	$110	$88,000
Road Crossings/Control Structures Subtotal				**$117,200**
Pumplifts				
Pumplift #1	1	EA	$732,700	$732,700
Pumplift #2	1	EA	$732,700	$732,700
Pumplift # 3	1	EA	$271,900	$271,900
Pumplift #4	1	EA	$137,700	$137,700
Pumplift Subtotal				**$1,875,000**

Facilities Subtotal	**$5,471,575**
Contingencies (25%)	**$1,367,894**
Subtotal	**$6,839,469**
Engineering and Administration (25%)	**$1,709,867**
Compensation for Lost Crop Land (300 acres @ $2,000/ac)	**$600,000**
Surface Water System Cost Total	**$9,149,000**

TABLE 3

Project Operation and Maintenance Costs

Average annual costs were developed by obtaining an annual cost for each occurrence and then applying 50% for a recharge occurrence and 50% for an extraction occurrence to each year of the project life. The operation and maintenance costs associated with project recharge included power costs, canal maintenance, pump refurbishing, and motor overhaul. Administration costs were not considered in this analysis.

The operation and maintenance costs associated with project recharge and recovery were determined using the following criteria and assumptions: (1) Pump and motor maintenance (pump refurbish and motor overhaul) occurs after 20,000 hours of operation. (2) The unit power cost is $.09 per kilowatt-hour which considers operation rate schedules and stand-by charges. (3) Extraction power costs were determined based on an average total head of 115 feet. (4) The unit energy requirement for extraction is 171 kilowatt-hours per acre-foot which, under these project assumptions, results in a unit energy cost of $15 per acre-foot. (5) Maintenance costs associated with conveyance facilities within RD 108 were not considered in this analysis.

Unit Cost

Based on the design, operation, and maintenance parameters for Alternative I detailed in this report the unit cost required to recharge and recover one acre-foot of water is $85. Similarly, based on the considerations detailed for Alternative II, the unit cost is $60 per acre-

RD 108 Ground Water Extraction System
Summary of Construction Costs

Item	Quantity	Unit	Unit Cost	Item Cost
Ground Water Wells				
Test Hole and E-Log	32	EA	$7,000	$224,000
Well Construction (900' deep w/ gravel pack, casing, and seals)	32	EA	$69,500	$2,224,000
Well Development and Testing	32	EA	$3,500	$112,000
Ground Water Wells Subtotal				**$2,560,000**
Mechanical Equipment				
Turbine Pump (240' bowl setting)	32	EA	$15,000	$480,000
150 Horsepower Electric Motor	32	EA	$20,000	$640,000
Mechanical Equipment Subtotal				**$1,120,000**

Facilities Subtotal	**$3,680,000**
Contingencies (25%)	**$920,000**
Subtotal	**$4,600,000**
Engineering and Administration (25%)	**$1,150,000**
Extraction Facilities Cost Total	**$5,750,000**
Surface Water System Cost Total	**$9,149,000**
Total Project Capital Cost	**$14,899,000**

TABLE 4

Alternative I - YZWD
Economic Analysis

0	0	0	14,899	0	0	14,899	14,899	0
1	38,300	0	0	192	0	192	181	0
2	0	34,800	0	0	460	460	409	30,972
3	38,300	0	0	192	0	192	161	0
4	0	34,800	0	0	460	460	364	27,562
5	38,300	0	0	192	0	192	143	0
6	0	34,800	0	0	460	460	324	24,534
7	38,300	0	0	192	0	192	128	0
8	0	34,800	0	0	460	460	288	21,820
9	38,300	0	0	192	0	192	114	0
10	0	34,800	0	0	460	460	257	19,418
11	38,300	0	0	192	0	192	101	0
12	0	34,800	0	0	460	460	229	17,296
13	38,300	0	0	192	0	192	90	0
14	0	34,800	0	0	716	716	316	15,382
15	38,300	0	0	276	0	276	115	0
16	0	34,800	0	0	460	460	181	13,711
17	38,300	0	0	192	0	192	71	0
18	0	34,800	0	0	460	460	161	12,180
19	38,300	0	0	192	0	192	64	0
20	0	34,800	0	0	460	460	144	10,858
21	38,300	0	0	192	0	192	56	0
22	0	34,800	0	0	460	460	128	9,674
23	38,300	0	0	192	0	192	50	0
24	0	34,800	0	0	460	460	114	8,596
25	38,300	0	0	192	0	192	45	0
26	0	34,800	0	0	460	460	101	7,656
27	38,300	0	0	192	0	192	40	0
28	0	34,800	0	0	716	716	140	6,821
29	38,300	0	0	276	0	276	51	0
30	0	34,800	0	0	460	460	80	6,055
31	38,300	0	0	192	0	192	31	0
32	0	34,800	0	0	460	460	71	5,394
33	38,300	0	0	192	0	192	28	0
34	0	34,800	0	0	460	460	63	4,802
35	38,300	0	0	192	0	192	25	0
36	0	34,800	0	0	460	460	57	4,280
37	38,300	0	0	192	0	192	22	0
38	0	34,800	0	0	460	460	50	3,793
39	38,300	0	0	192	0	192	20	0
40	0	34,800	0	0	460	460	45	3,376
TOTAL	766,000	696,000	14,899	4,008	9,712	28,619	19,959	254,179

Cost/AF = $79

TABLE 3

foot. This unit cost represents the cost of project build-out, operation, and maintenance. However, it does not include possible costs incurred during project negotiations (to promote participation), costs associated with further investigations prior to implementation, administrative costs, and the cost of delivery to the user. The project unit costs are shown in Tables 8 and 9.

The unit cost was developed using the following assumptions and criteria: (1) A discount rate of 6% was used. (2) Total project recharge equals total project recovery. (3) A forty-year project life and amortization period was used and the capital costs were discounted accordingly.

Conclusions

From an engineering and economic perspective the feasibility of the conjunctive use projects detailed in this report is high. The unit cost required to recharge and extract one acre-foot of water for Alternatives I and II are $85 and $60, respectively. The geographical, topographical, and hydrological considerations appear favorable for the proposed project. Factors such as the proximity of the groundwater-dependent in-lieu recharge area to a surface water supply, the proximity of the adjacent surface water user, the small elevation differential between the proposed recharge area and the Sacramento River, and the potential for groundwater substitution contribute to the relatively low unit cost developed in this analysis.

The proposed facilities presented in this report represent one possible means of achieving in-lieu recharge and ground water extraction. Variations of the proposed facilities and recharge capabilities to better facilitate non-project usage or to accommodate local considerations is a possibility that will need to be discussed with potential participants.

Pumplift Cost Summary - YZWD Alternative 1
Pumplift #3

Item	Quantity	Unit	Unit Cost	Item Cost
Excavation	150	CY	$20	$3,000
Sheet Piling	2,580	SF	$25	$64,500
H-Piles	300	LF	$35	$10,500
88 cfs Pump	1	EA	$60,000	$60,000
300 HP Pump Motor and Controls	1	EA	$50,000	$50,000
58 cfs Pump	1	EA	$48,000	$48,000
200 HP Pump Motor and Controls	1	EA	$38,000	$38,000
Misc. Equip, Start-up and Testing Equip.	1	LS	$5,000	$5,000
48" Welded Steel Discharge Pipeline	50	LF	$180	$9,000
48" Steel Flap Gate	1	LS	$3,700	$3,700
42" Welded Steel Discharge Pipeline	50	LF	$160	$8,000
42" Steel Flap Gate	1	LS	$3,400	$3,400
18" Stone Protection	100	CY	$43	$4,300
Sump, Platform, Trashrack Structures	1	LS	$70,000	$70,000
Total				**$377,400**

Pumplift Cost Summary - YZWD Alternative 1
Pumplift #4

Item	Quantity	Unit	Unit Cost	Item Cost
Excavation	200	CY	$20	$4,000
Sheet Piling	1,500	SF	$25	$37,500
H-Piles	200	LF	$35	$7,000
42 cfs Pump	1	EA	$43,000	$43,000
75 HP Pump Motor and Controls	1	EA	$22,000	$22,000
28 cfs Pump	1	EA	$37,000	$37,000
50 HP Pump Motor and Controls	1	EA	$18,000	$18,000
Misc. Equip, Start-up and Testing Equip.	1	LS	$5,000	$5,000
42" Welded Steel Discharge Pipeline	30	LF	$160	$4,800
42" Steel Flap Gate	1	LS	$3,400	$3,400
36" Welded Steel Discharge Pipeline	30	LF	$135	$4,050
36" Steel Flap Gate	1	LS	$3,100	$3,100
18" Stone Protection	100	CY	$43	$4,300
Sump, Platform, Trashrack Structures	1	LS	$40,000	$40,000
Total				**$233,200**

Sacramento River Pump-Turnout
Alternative II - 65 cfs

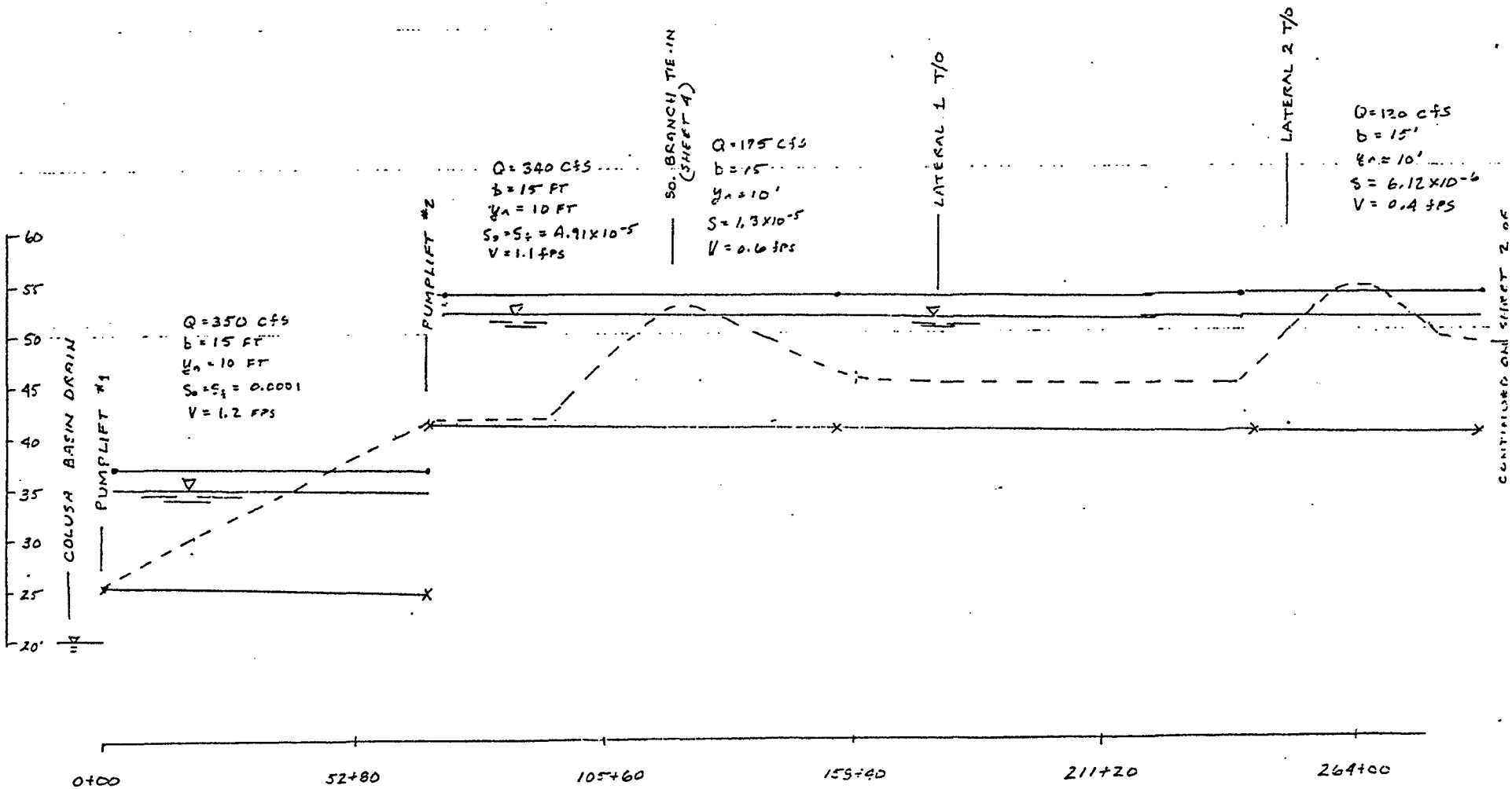
Item	Quantity	Unit	Unit Cost	Item Cost
H-Piles	200	LF	$35	$7,000
65 cfs Pump	1	EA	$54,000	$54,000
135 HP Pump Motor and Controls	1	EA	$34,000	$34,000
Misc. Equip, Start-up and Testing Equip.	1	LS	$5,000	$5,000
48" Welded Steel Discharge Pipeline	30	LF	$180	$5,400
48" Steel Flap Gate	1	LS	$3,700	$3,700
18" Stone Protection	100	CY	$43	$4,300
Sump, Platform, Trashrack Structures	1	LS	$52,000	$52,000
Fish Screening Provisions	65	CFS	$5,000	$325,000
Total				**$490,400**

Pumplift Cost Summary - CCWD Alternative II
Pumpin Plant 2A

Item	Quantity	Unit	Unit Cost	Item Cost
Excavation	250	CY	$20	$5,000
Sheet Piling	1,350	SF	$25	$33,750
42 cfs Pump	1	EA	$43,000	$43,000
450 HP Pump Motor and Controls	1	EA	$68,000	$68,000
24 cfs Pump	1	EA	$37,000	$37,000
250 HP Pump Motor and Controls	1	EA	$46,000	$46,000
Misc. Equip, Start-up and Testing Equip.	1	LS	$5,000	$5,000
42" Welded Steel Discharge Pipeline	15	LF	$160	$2,400
36" Welded Steel Discharge Pipeline	15	LF	$135	$2,025
Manifold W/ In-Line Check Valves	1	EA	$35,000	$35,000
Sump, Platform, Trashrack Structures	1	LS	$40,000	$40,000
Total				**$317,200**

Pumplift Cost Summary - CCWD Alternative II
Pumpin Plant 2A1

Item	Quantity	Unit	Unit Cost	Item Cost
Excavation	250	CY	$20	$5,000
Sheet Piling	1,350	SF	$25	$33,750
42 cfs Pump	1	EA	$43,000	$43,000
610 HP Pump Motor and Controls	1	EA	$82,000	$82,000
24 cfs Pump	1	EA	$37,000	$37,000
350 HP Pump Motor and Controls	1	EA	$57,000	$57,000
Misc. Equip, Start-up and Testing Equip.	1	LS	$5,000	$5,000
42" Welded Steel Discharge Pipeline	15	LF	$160	$2,400
36" Welded Steel Discharge Pipeline	15	LF	$135	$2,025
Manifold W/ In-Line Check Valves	1	EA	$35,000	$35,000
Sump, Platform, Trashrack Structures	1	LS	$40,000	$40,000
Total				**$342,200**



— — — EXISTING GRADE

—×— INVERT ELEVATION

—•— LEVEE CREST ELEVATION

COLUSA BASIN CU STUDY

YOLO-ZAMORA DELIVERY SYSTEM

OPEN CHANNEL PROFILE

SHEET 1 OF 5

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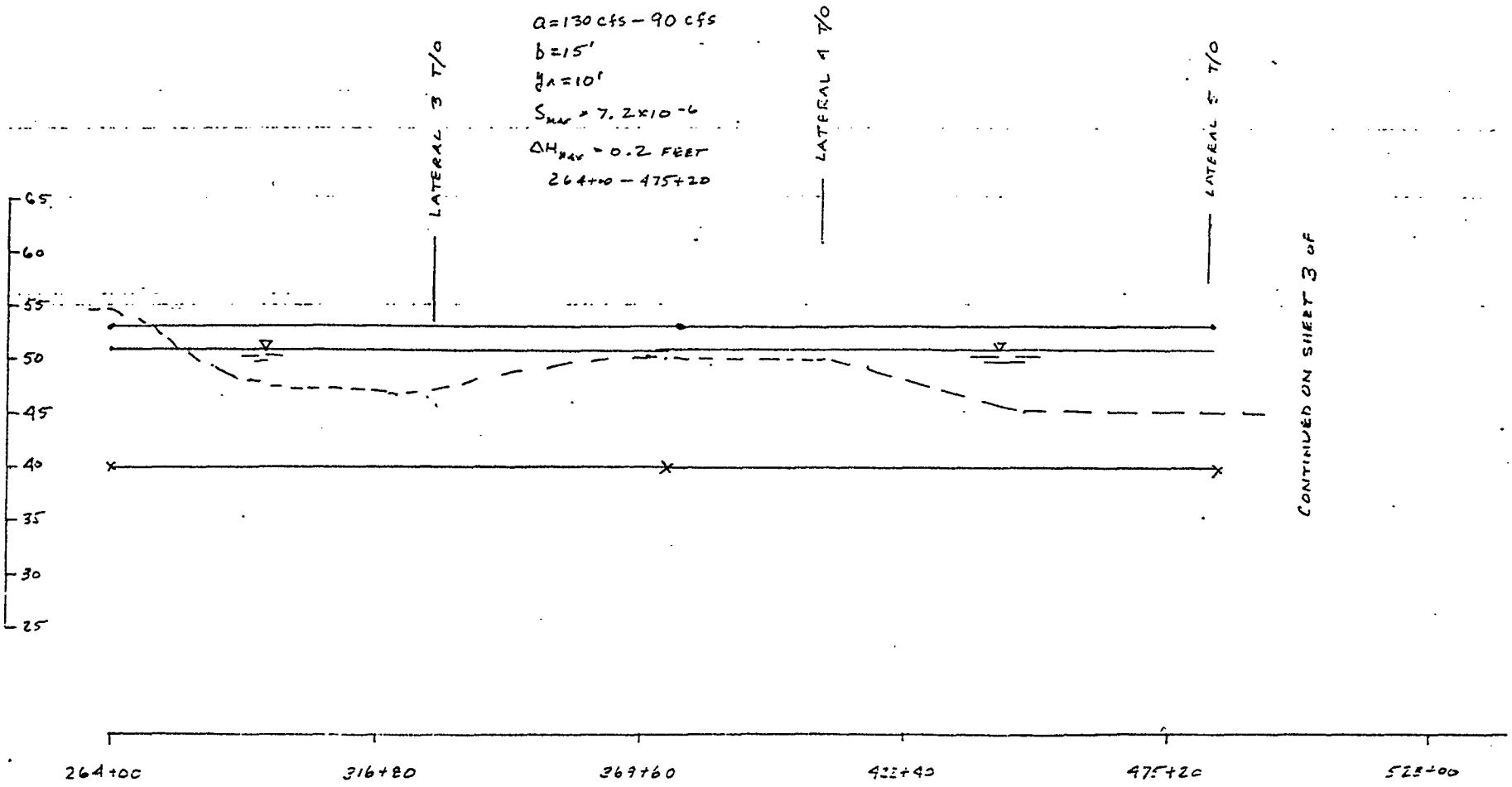

COLUSA BASIN CU STUDY
YOLO-ZAMORA DELIVERY SYSTEM
OPEN CHANNEL PROFILE
SHEET 2 OF 5

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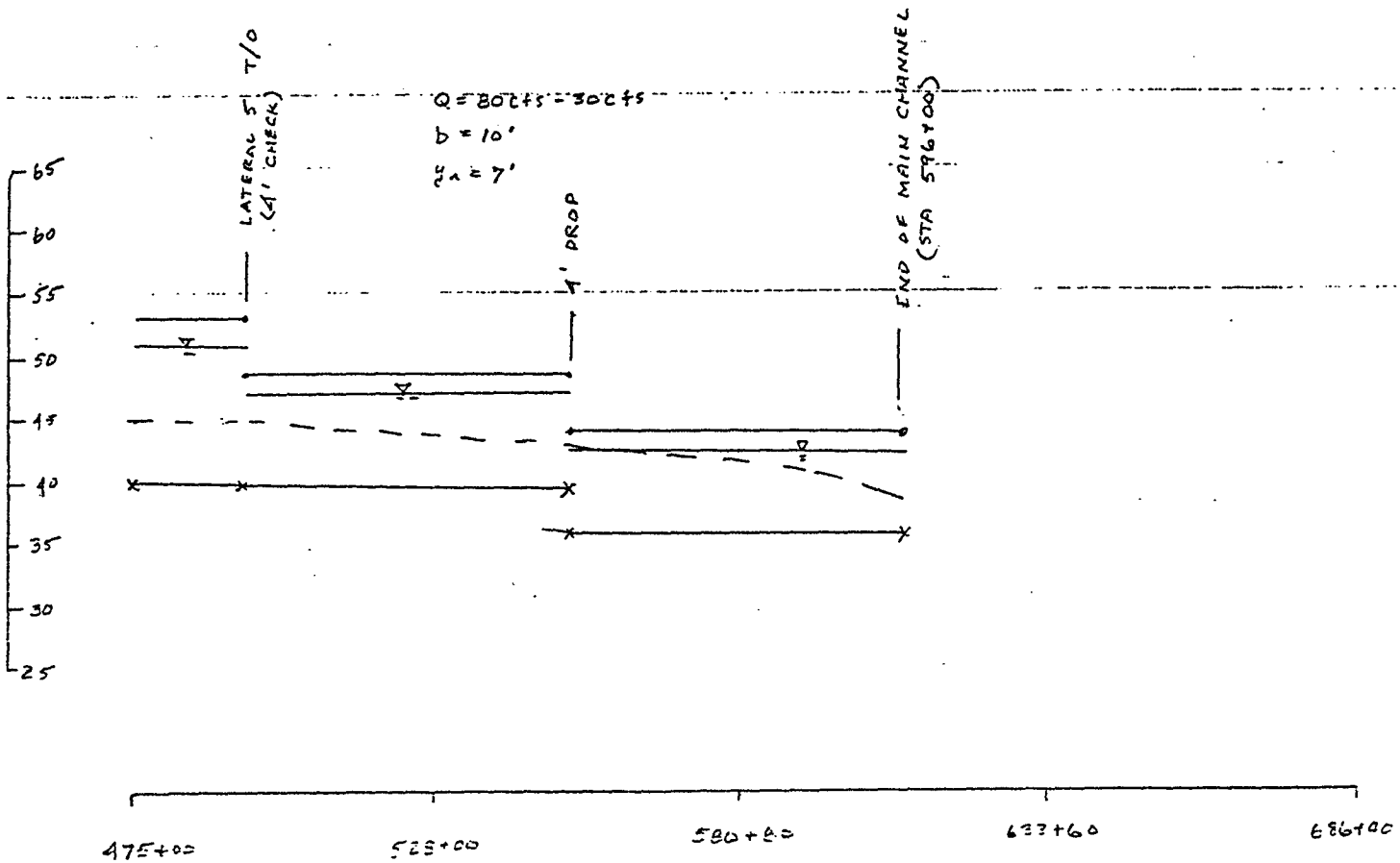

COLUSA BASIN CU STUDY

YOLO-ZAMORA DELIVERY SYSTEM

OPEN CHANNEL PROFILE

SHEET 3 OF 5

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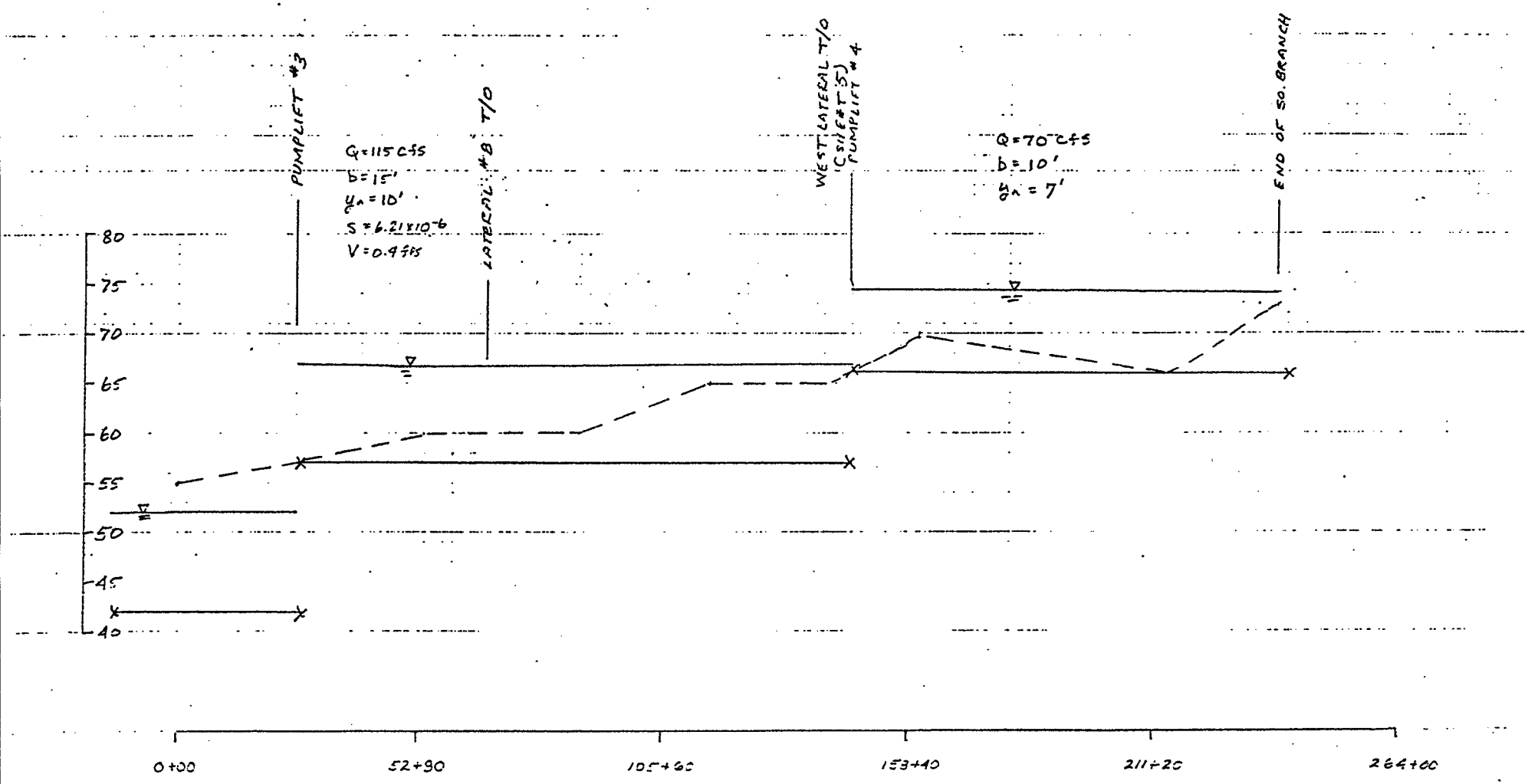

COLUSA BASIN CU STUDY
YOLO - ZAMORA DELIVERY SYSTEM
OPEN CHANNEL PROFILE
SHEET 4 OF 5

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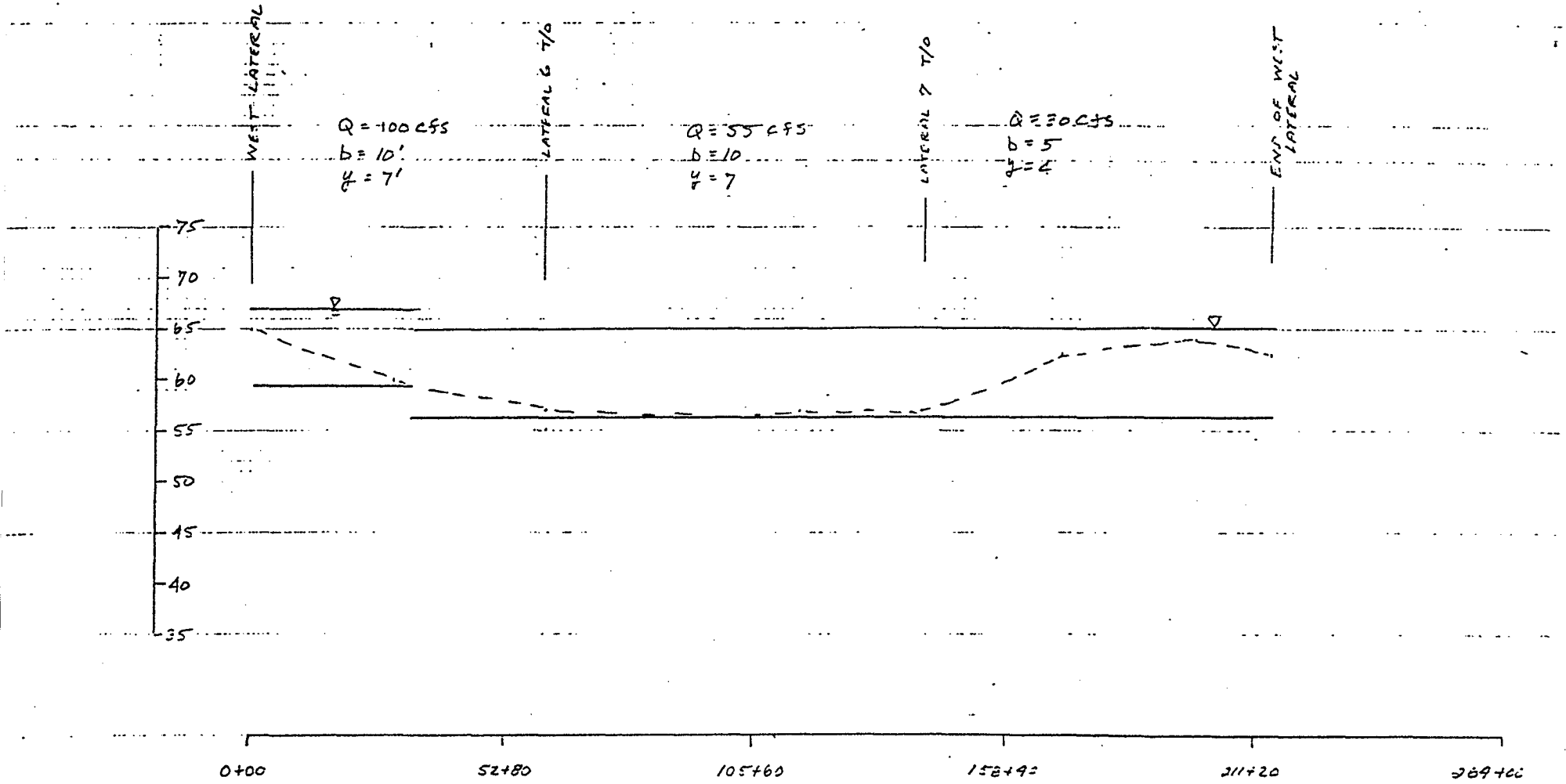

COLUSA BASIN CU STUDY
YOLO-ZAMORA DELIVERY SYSTEM
OPEN CHANNEL PROFILE
SHEET 5 OF 5

C-058085

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