PAP-725

Review of Facilities for Automation
Glenn-Colusa Irrigation District
Willows, California

Prepared by
Clifford A. Pugh
Roger Hansen

U.S. Department of the Interior
Bureau of Reclamation

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Willows, California

RECOMMENDATIONS

GCID is interested in implementing remote monitoring and automated control at its major structures, prototype laterals, and several key drains. The vicinity map (figure 1) shows the location of GCID and the major sources of water. The district wants to approach this effort in an incremental fashion, becoming familiar with the concepts of remote monitoring, and automatic control in a manner that allows personnel to operate, maintain, and expand the system at a comfortable pace. Reclamation has the expertise to assist in these efforts, and the project would serve as a good demonstration site for modern automation technologies applicable to Reclamation and non-Reclamation projects.

Short-term: The short term plan is to use several existing check structures with motorized gates and instrumentation enclosures to install new remote terminal units (RTU's) and radios, and to replace instrumentation, relays and limit switches as necessary. The master station would be equipped with a new computer, communication equipment, and software to collect data from and send control signals to the RTU's. GCID is also interested in telemetering data from the drainage weirs and eventually setting up automated control on the drainage relift stations to control the amount of flow leaving the irrigation district.

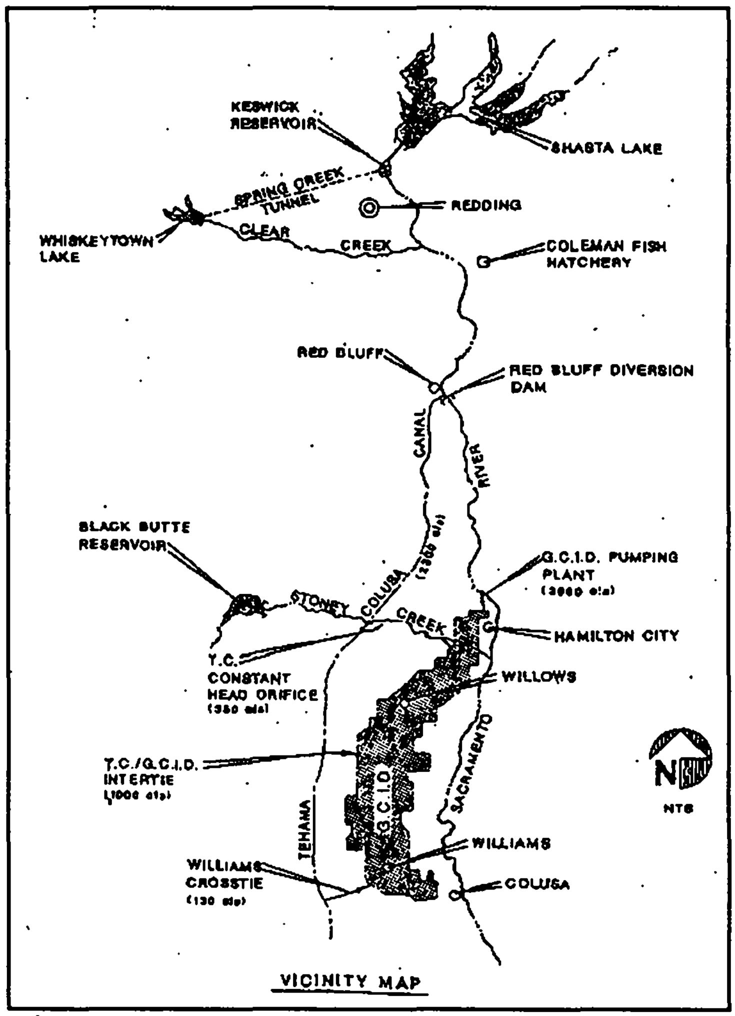
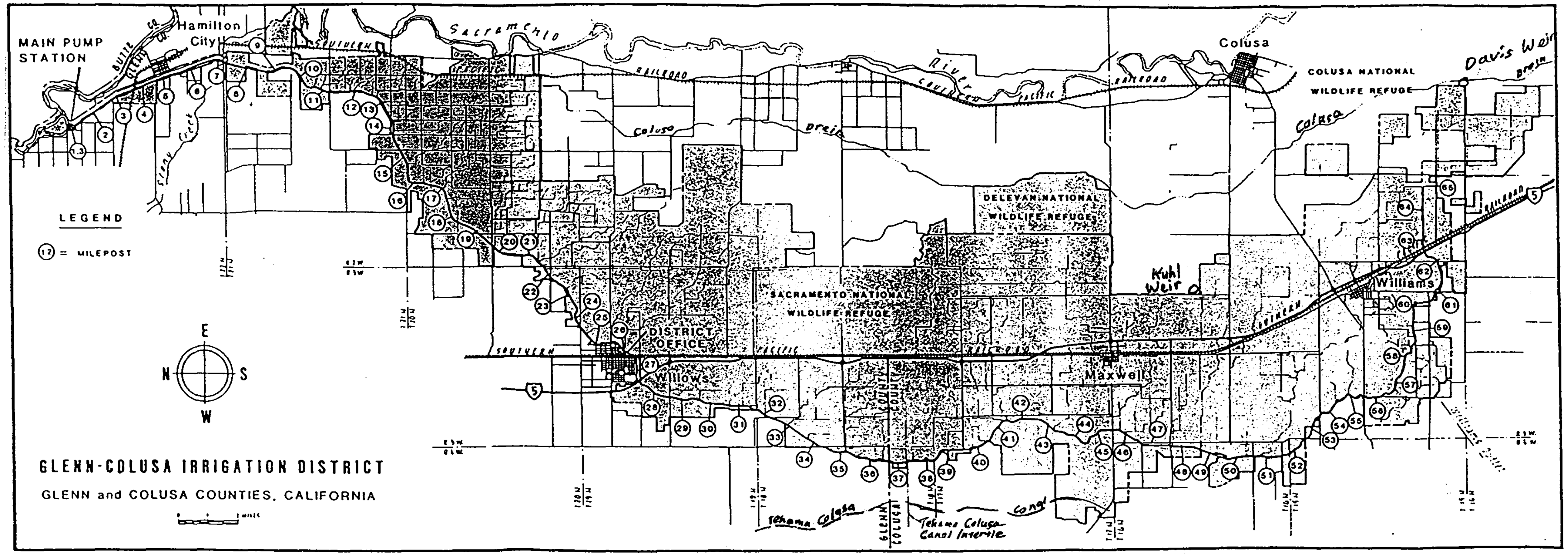


Figure 1



Main Canal Structures by Mile Post

(P)=Powered (S)=Slide Gate (R)=Radial Gate (B)=Board Structure (UC)=Local Automatic Upstream Control (C)=Sierra Controller (M)=Metering Point

MI	Structure
1.39	Sacramento River Main Pump Station
7.23	Stony Creek Gates (P/S/M)
13.75	Jacinto Check (P/R)
17.68	Willard Check (P/S/B/C/UC)
21.75	Tuttle Check (P/S)
24.00	Walker Check (P/R/C/UC)
26.21	Willows Check (P/R/C)
26.60	Railroad Siphon (M)
31.71	Spooner Check (P/R/C)
35.?	Baker Creek Siphon
36.63	Norman Check (P/R/C)

MI	Structure
41.30	Funks Check (P/R/C)
43.?	Sheehy Bridge (M)
44.95	Stone Corral Siphon
45.48	Stone Corral Check (P/S)
48.74	Abel Check (P/S)
49.95	Lurline Siphon/Check (S/P/M/C)
52.42	(Freshwater Check) (A/R) Siphon
53.93	Terkildsen Siphon
56.45	Salt Creek Siphon and Check (P/R/C/UC)
57.?	Stovall Check (B)
58.?	Spring Creek Siphon (M)

MI	Structure
60.87	Zumwalt Check (P/R/C)
62.04	Husted Check (P/R)
62.60	I-5 Check & Freeway/Railroad Siphon (P/R)
62.72	I-5 Check & Railroad Siphon (Weir) Fixed weir with slide gate in center
62.89	Check (R)
63.35	Check (R)
63.67	Check (R)
64.11	Check (R)
64.36	Check (R)
64.59	Check (R)
64.95	Check (R)

Figure 2

Long-term: The automation-monitoring-remote control network would be expandable to include the entire irrigation district. Figure 2 is a map of the entire irrigation district indicating the locations of main canal check structures and some of the drains. The lateral system is not shown on this map. The flow to lateral distribution canal systems and deliveries to wildlife refuges would be monitored and controlled by local automatic equipment and the master station. Long-term control of the entire canal may include upstream control in the upper part of the district (supply oriented), and downstream control (demand oriented) in the downstream portion. An in-line storage reservoir between the upstream and downstream control systems would probably be necessary to temper the fluctuations. The canal system should be modeled with an unsteady flow model to develop optimum control schemes. The equipment and communication schemes used in the early phases need to be expandable to accommodate the ultimate long-term plans.

Communications: Since long-term plans are to continually expand the system to include additional remote sites, a communications system between RTU's and the master station based on a local area network (LAN) type of communications network using VHF or UHF radio is recommended. This communications network will allow virtually continuous radio communications and updating of the data base over two radio frequencies, one frequency would transmit commands from the master to the RTU's and the other frequency would receive data at the master, transmitted by the RTU's. LAN systems allow all of the RTU's to continuously transmit and receive while intermediate peer-to-peer communications are taking place. If any of the transmissions do not get through from the RTU's to the master, the data are retransmitted by the RTU until a confirmation signal is received by the RTU. Typically, the data updating rate can be set by the watermaster. The RTU's could also be programmed to update only when data change by a specified amount. This LAN system prevents the typical radio communications problem of multiple transmissions "walking over" each other.

Systems which use a poll and respond system between the master station and the RTU's are limited in the data collection rate and the peer-to-peer communications because each RTU must be polled individually and the radio frequency is tied up during the communication. Peer-to-peer communications using the same radio frequency as the master can interfere with communications between the master and the RTU's.

All of these improvements will allow the water managers to precisely control and distribute the water available to the district. The overall effect will be to make more consistent and responsive deliveries to the water users and to reduce the "administrative spill" that is needed to assure adequate deliveries to all of the customers. The amount of water leaving the District through the drain weirs will be precisely measured and controlled according to water quality considerations and agreements with downstream users on the Colusa Drain, which continues another 40 miles south before returning drainage flows to the Sacramento River near Knights Landing.

Particular care will need to be taken with the design of the base station software to allow for expandability. With most of the major control companies moving into the Windows environment, it is recommended that the base station hardware should be adequate to run a true multi-tasking operating system (Windows 95 or Windows NT). A 100 Mhz (minimum) Pentium computer with 16 Mb of RAM and at least 1 gigabyte of storage is recommended.

BACKGROUND

Diversion Facilities and Conveyance System

Water is delivered to the GCID through the main pump station located on the Sacramento River, 3 miles north of Hamilton City, through a diversion located on Stony Creek and through the Tehama-Colusa Canal (see figure 1).

The farms have been irrigated by GCID diversions from the Sacramento River and Stony Creek for over 80 years. GCID is also the sole means of water delivery for three Federal wildlife refuges containing approximately 25,000 acres of land. Another 10,000 acres are flooded for waterfowl habitat after crop harvest. GCID's delivery system also provides water for an estimated additional 40,000 to 50,000 acres of land located along the Colusa Basin Drain. The District owns and operates approximately 900 ft^3/s of return and recapture pump capacity and, in addition, drain flows are rediverted by gravity into the supply system at 18 locations.

Storage Facilities

The District relies primarily on storage from two reservoirs: Lake Shasta and Black Butte Lake. Both are components of the Central Valley Project and have capacities of 4.5 million and 150,000 acre-feet, respectively. The District can divert these waters directly from the Sacramento River at its main pump station or can have a portion (up to 1,000 $ft^3/s \pm$) wheeled to its system through the Tehama-Colusa Canal which diverts flows at the Red Bluff Diversion Dam near Red Bluff, California. GCID does not presently operate any regulation reservoirs directly. The main canal system does allow for approximately 500 acre-feet of temporary storage. This lack of storage within the District requires diversions to be regulated continuously through the main pump station on the Sacramento River.

District Drainage

The GCID operates only open-surface, earth-lined interceptor and collector drains. The network entails over 400 miles of open drains which collect into 11 major drains. These outflows are measured on a daily basis during the irrigation season. Flows are diverted through 36 gravity and pumped drain water recapture systems.

Water leaves GCID through drains. The principal drainage point is the Davis weir, located on the Colusa Basin Drain at the southern end of the District (see figure 2). At this point GCID has extensive relift pumps which lift the water approximately 30 feet in elevation back into the GCID service area.

Delivery Management

The GCID delivery system operates on a combination of scheduled and rotation basis. Water orders are attempted to be filled within 24 hours and revert to a rotation standby basis when system capacity requires; primarily in the early part of the season.

Replacement of the existing fishscreen at the main pump station is the District's highest priority. High priority is placed on this project because the fishscreen capacity presently restricts the District's ability to divert water supplies and make deliveries.

Site Review and Recommendations

The attached photographs show the sites visited. Check structures are shown on figure 2. The sites shown are typical of the other sites on the canal.

- The Willows check structure is a typical radial gate structure. Because of its proximity to the District's office, it would be an excellent site for first phase modernization activities.

- The turnout to the Sacramento Wildlife Refuge at mile post 26.2 (photograph 4) with a flowmeter would be another good site to add to the telemetry network in the early phases. The turnout flows could be continuously controlled and recorded by adding a solar powered RTU, motorizing the gates in photograph 4, and adding a current output to the flowmeter to telemeter the flow data to the master (photograph 5.)

- The control unit at Walker check (photograph 6) should be replaced since it is a key control site on the canal.

- Tuttle check and Willard check (photographs 7, 8, and 9) have vertical slide gates. Some of these gates have problems with binding. Simultaneous operation of all of the gates may be helpful in alleviating this problem. When an additional gate is opened from a fully closed position under a large head differential to increase flow, binding occurs. Automatic control of several gates operating in unison would avoid the need to open additional gates from fully closed positions.

- Clint lateral turnout (photograph 10) would be a excellent site for automation of a lateral turnout structure. The canal water surface elevation experiences quite a bit of fluctuation at this point and the ditchriders try to keep a constant water surface elevation in the pool just downstream of the turnout structure. An automated algorithm could do this job continuously and make more consistent deliveries.

- Photograph 11 shows the main pumping plant. The plant is controlled by Allen-Bradley controllers. These controllers are well suited to plant operations; however, they need to be updated. If newer generation Allen-Bradley controllers are chosen, the data could be interpreted by an Allen-Bradley driver for the Genesis or Wonderware software at the master site or at the alternate master site (the pumping plant). The data from the canal control system can then be used in a supervisory control mode to make flow changes at the pumping plant.

- The powerplant operation at the Tehama-Colusa Canal inflow (photograph 13) could also be automated or remotely controlled from the master station.

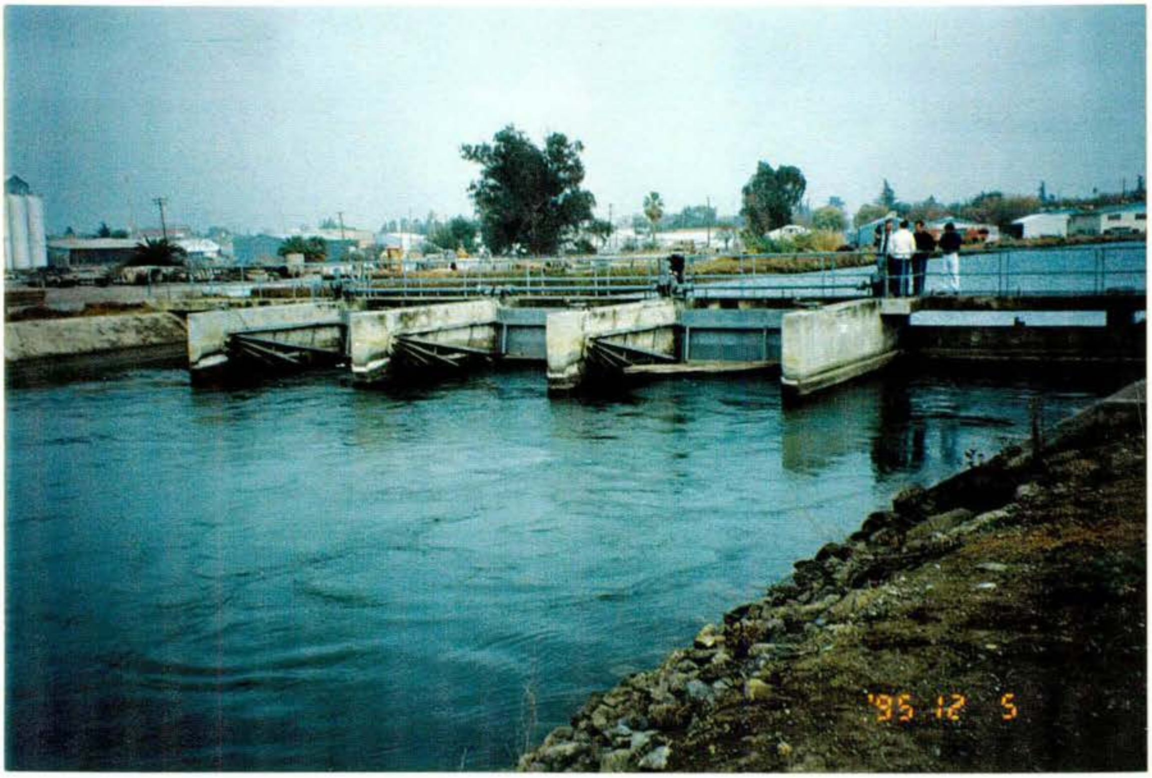
- Many of the lateral/sub-lateral branches of the system (photograph 14) could eventually be automated if some simple motorized gates and solar power are installed at key delivery points in the lateral system.

CONCLUSIONS

The district would like to pursue automating some sites prior to the 1996 irrigation season. The first stage of automation at these sites would be remote monitoring and control. Automatic control at the Willows check structure could be accomplished first since it is close to the GCID headquarters and most of the equipment is currently in place. Some of the main check structures along the canal and solar powered sites at the key turnouts and laterals could be added. One of the District's highest priorities is to better control and monitor the relift and reuse stations at the major drainage weirs where drain water leaves the irrigation district. Installing computer hardware and software at the master station and establishing a communications system that will monitor and control the remote sites are a major priority.

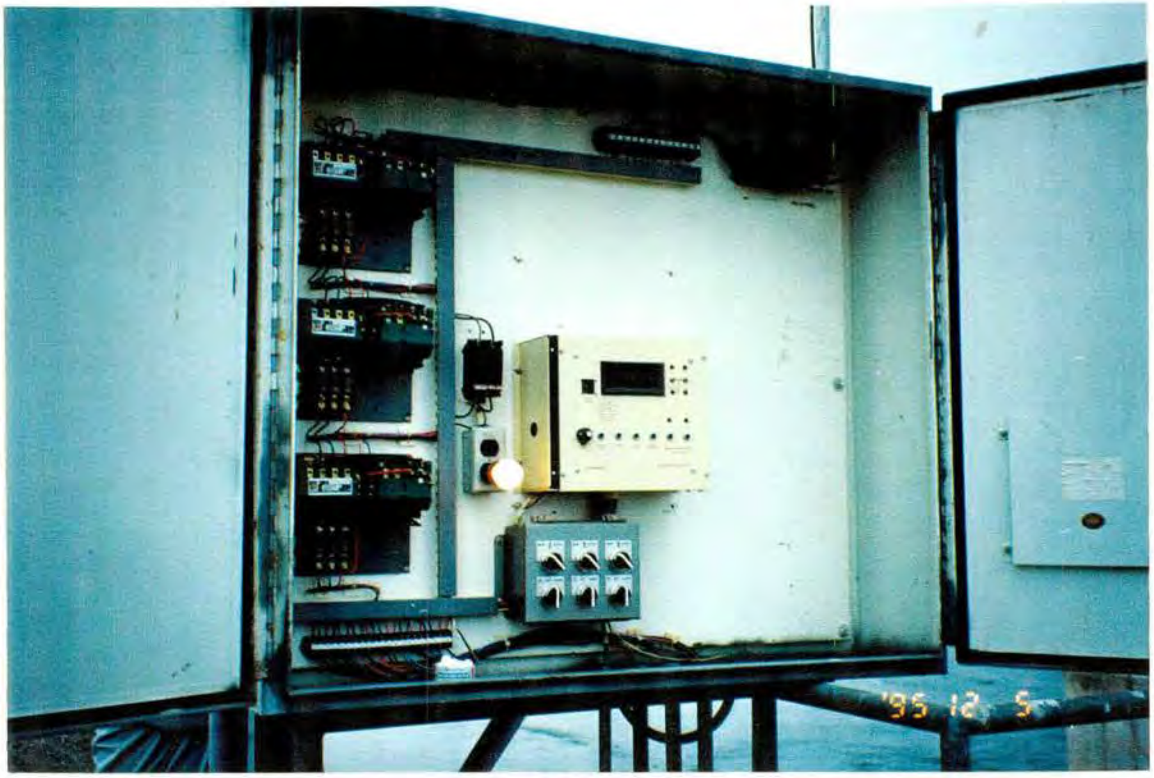
The Water Resources Research Laboratory and the Provo Office are available to assist in determining the needed hardware and software to accomplish various stages of the project. A simple Cooperative Research and Development Agreement (CRDA) could be drawn up to cover this consultation.

A CRDA for $10,000 would cover about 15 staff-days of consulting and a trip to GCID to make detailed plans for the first phase of installations.



Photograph 1. - Willows check - typical radial gate check structure on Glenn Colusa canal.

Photograph 2. - Willows check.



Photograph 3. - Willows check - controller by Sierra Controls. (Not used in automation mode in 10 years.)

Photograph 4. - Lateral 26.2 - to Sacramento National Wildlife Refuge, 80-100 ft^3/s in winter.

Photograph 5. - Lateral 26.2 - Micrometer propeller flowmeter. Flow measured in one of two outlets to FWS refuge and lateral.

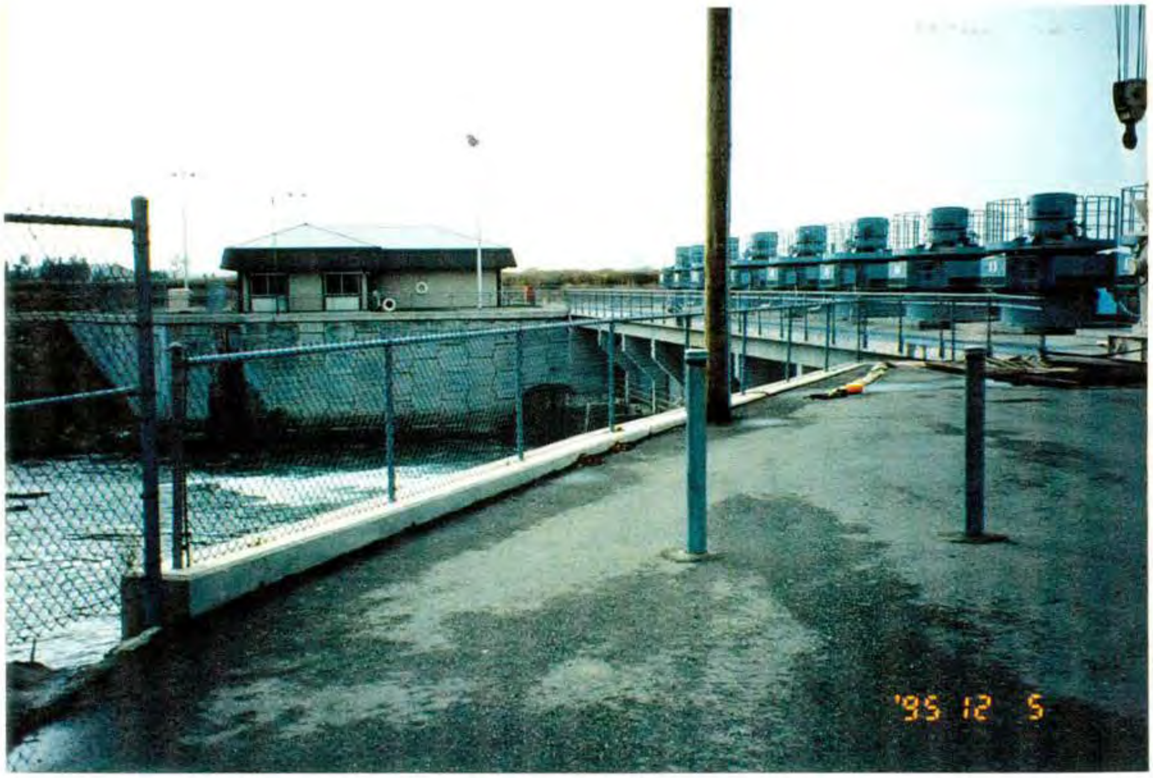
Photograph 6. - Control unit (Sierra Controls) at Walker check. Still automatically controls upstream water level.

Photograph 7. - Tuttle check.

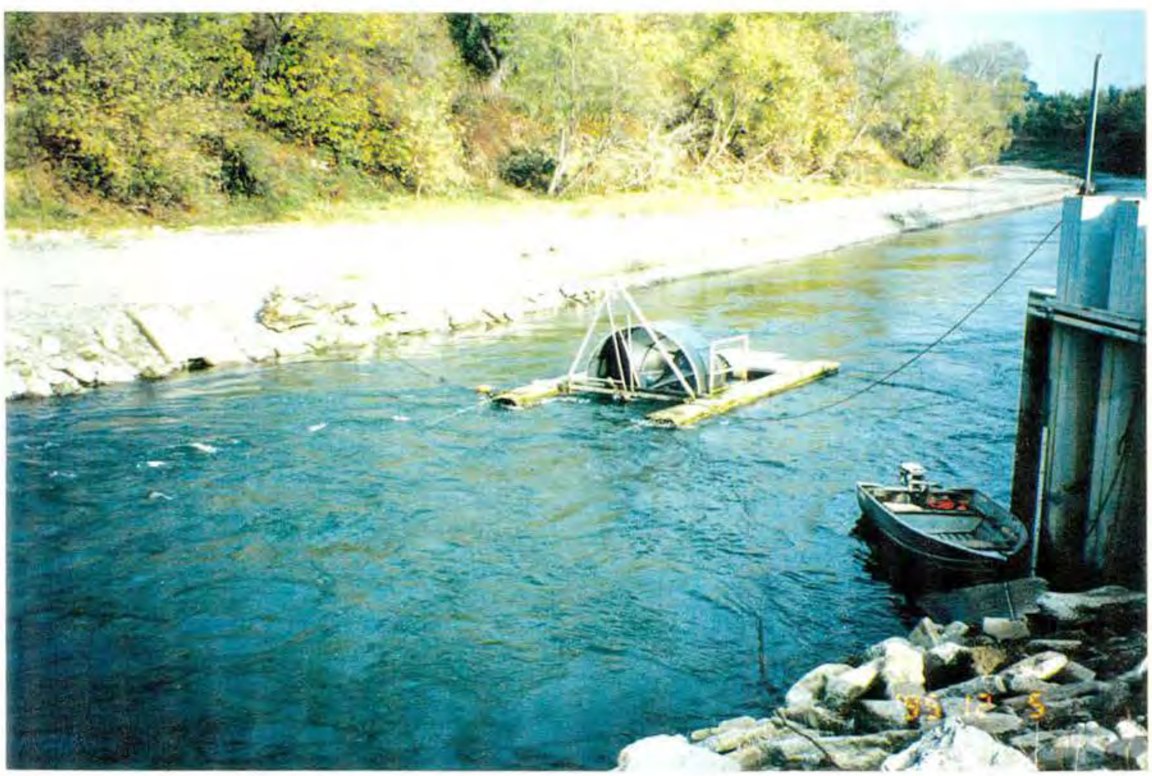
Photograph 8. - Willard check - vertical slide gates in bulkhead slots. Some problems are encountered with binding gates.

Photograph 9. - Willard check.

Photograph 10. - Clint lateral - bifurcates into two lateral canals downstream.



Photograph 11. - Glenn Colusa canal - main pumping plant on the Sacramento River.



Photograph 12. - Glenn Colusa pumping plant bypass flow (note fish trap).

Photograph 13. - Powerplant on Tehama Colusa intertie. A 19-ft head drop and 150 ft^3/s generate electricity with two turbines.

Photograph 14. - Turnout site from a lateral canal to a sublateral. Possible site for a motorized gate to control flow distribution in a lateral/sublateral distribution system.