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# OVERVIEW OF THE MRGCD WATER MEASUREMENT AND AUTOMATION NEEDS

*by*


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## Introduction

The Middle Rio Grande Conservancy District (MRGCD) was established in 1925 to provide drainage, flood control, and irrigation to the inner valley of the Rio Grande, extending approximately 140 miles from Cochiti Dam to the Bosque del Apache National Wildlife Refuge. The areas served by the district includes parts of metropolitan Albuquerque, Los Lunas, Belen, Socorro, six Indian pueblos, extensive agricultural lands, rural residential areas, and five game and fish refuges. As widely varying demands for water increase, it is becoming critical for the district to improve water management practices. To accomplish this, the district must be able to obtain more accurate and timely information on the amounts of water being diverted, conveyed, delivered, and returned to the river.

Reclamation is responsible under the Middle Rio Grande Project and other project authorizations for promoting efficient delivery of water through the middle Rio Grande valley to ensure delivery of Rio Grande water to Mexico and to assist the State of New Mexico in meeting its Rio Grande Compact obligations. In this role, Reclamation's Albuquerque Area Office (AAO) has worked with the State and the district to outline a Water Management Study Plan and has requested technical assistance from the Water Resources Research Laboratory to provide an overview of possible water management improvements.

## Purpose

The purpose of the trip was to review the facilities of the MRGCD and to provide technical assistance with regard to possible improvements in water measurement, data recording, and data transmission. This report focusses on observations from the site review, comments on existing and possible measurement sites, and the feasibility of obtaining real-time water management data.

## Site Review of Project Facilities

The MRGCD is composed of four divisions, each with a diversion dam from the Rio Grande; Cochiti with Cochiti Dam reservoir and State Park, Albuquerque with Angustura diversion dam, Belen with Isleta diversion dam, and Socorro with San Acacia diversion dam.

***Objective*** - The initial goal of the AAO and MRGCD is to measure and record how much water is being diverted and how much is being returned to the river. There is a pressing need to manage the water from division to division to develop water budgeting plans and to track the water during critical times of low flow. The district is concerned with getting water down to the Socorro division at the southern end of the MRGCD responsibilities. MRGCD would like to be able to have more control over the amounts diverted and needs real-time data at their central office for decision making. The AAO would like to have data to input into their Upper Rio Grande Water Operations Model (URGWOM) which would assist with water management and budgeting.

***Observations from Site Review*** **-** We reviewed several important proposed water measurement sites and typical rated sections currently used for water measurement. David Gensler from MRGCD and Jaci Gould AAO provided valuable input during our tour. David knows which existing stations are producing consistent results and which ones are problematic.

The conveyance system is composed primarily of unlined earth canals, laterals and ditches (acequias). Agricultural areas have an extensive drainage system with riverside drainage canals that also, at times, serve as conveyance canals, and outfalls or returns to the Rio Grande at various locations throughout the system. Few check structures were observed in the system, therefore, most turnouts must be below the level of the water in the conveyance canals. Water delivered from Cochiti Dam takes about 5 days to travel through the system. Water measurement occurs through the use of typical rated sections in the canals with stilling wells and strip chart recorders. Most canals convey 100 to 150 $ft^3/s$ during deliveries. Most of the drains operate with minimal flows from groundwater from about 20 to 70 $ft^3/s$. The rated sections are current metered about twice a week during the irrigation season by MRGCD. Extensive current metering, particularly at southern locations in the district, occurred this past irrigation season due to a drought season putting demands on the water use throughout the system. River flows are gaged by the U.S. Geological Survey (USGS). Table 1 is a listing of the facilities that were inspected.

Table 1. - Facilities inspected during October 1996 travel and referenced to the Water Management Study Plan [1].

| LOCATION | NO | DESCRIPTION | COMMENTS |
|---|---|---|---|
| COCHITI DIVISION | | | |
| Cochiti East Side Main Canal 12-14 mi. d/s of Cochiti Diversion Dam | 7 | Existing rated station with stilling well and Steven's recorder and shotcrete section | Good results. District doesn't think this is an important measurement site |
| Confluence of the Yeso and Algodones drains parallel to Angustura Diversion Dam | 9 | Existing rated station with stilling well and Steven's recorder | Poor results, sediment, weeds District wants measurement to define flow leaving Cochiti Division and combine with Sta. 10 & 11 with DCP and satellite transfer. |
| ALBUQUERQUE DIVISION | | | |
| Angustura Diversion Dam<br>a) Bernalillo Riverside Drain\ Atrisco feeder<br>b) Albuquerque main canal | <br>10<br>11 | No measurement at dam. Existing rated shotcrete sections at stas 10 and 11 have stilling wells with recorders. | Good results at Sta. 10 and 11. Drain flow (#9) enters upstream and must be known to be separated out. District wants to automatically record and transfer readings with satellite. |
| Sandia Lakes Wasteway Sandia Pueblo | 14 | No existing measurement. 2 slide gates from canal into natural channel that curves to return to river. | Difficult site for measurement. The gates are in poor condition, no power, minimal head available between canal and river channel. Possible backwater. |

| LOCATION | NO | DESCRIPTION | COMMENTS |
|---|---|---|---|
| Albuquerque Riverside Drain wasteway between I-40 and Central Ave. bridges | 17 | No existing measurement. About a 9-by 6-ft radial gate controls releases into stilling basin with outfall to short reach before entering river. | High priority measurement site. Excellent possibilities for measurement if not interested in measurement when high river flows would produce backwater. Want real-time measurement. |
| BELEN DIVISION | | | |
| Isleta Diversion Dam and East side canals | 21, 22 | Existing rated sections in canals and upstream from diversion in river on Islet pueblo. | Varying results from rated sections. Would like to accurately measure diversions. |
| Lower Peralta Riverside Drain wasteway | 29 | No existing measurement. Wasteway structure at right angles to canal with two 6-ft-wide gates in middle and a 6-ft-wide stoplog section on both sides. Section converges with flow returning to channel section through large conduits. Good head drop. | Good site for rehab of existing stoplog and gate arrangement to provide measurement. Vandalism concerns high. Data logger w/o transmission. Good head drop. |
| San Francisco Riverside Drain & Unit 7 drain at San Acacia Diversion | 37 | No existing measurement. Typical unlined channel section with turnout to Rio Grande upstream from San Acacia Diversion dam, siphon under road before confluence with flumes from diversion dam. Becomes the Socorro Main canal at dam. | Want to measure the end of the Belen division. Several possibilities for measurement depending upon operations and available head. |
| SOCORRO DIVISION | | | |
| San Acacia Diversion Dam | | Problematic rated river section downstream of dam maintained by USGS. No measurement of diversion separate from Unit 7 drain and before turnouts. | USGS was relocating an orifice/bubbler system at the time of our visit. Problem section. DCP with Sutron and satellite transmission. |
| Heading on the Socorro Main Canal at San Acacia Diversion | 38 | Diversion flow from San Acacia combines with the Unit 7 drain flow below 3 rectangular concrete flumes that carry water from diversions to Socorro Main or from Unit 7 drain from dam. Sheet pile bridge in Socorro main, then turnouts and check structure. Low flow conveyance channel parallels Socorro Main with several rated sections. | Complex system with several possibilities for measurement. Want real-time flow information. Measurement device chosen depends upon operations, water levels, and head available. Possible structure could be designed for Unit 7 drain channel upstream from confluence, bridge in Socorro Main, channel in Socorro Main, and/or the flumes. |

**Evaluation Program for Water Measurement and Recording Devices**

The program for evaluating water measurement devices for the canals, drains, and wasteways must include the following:

1. Prioritize sites. Choose from these sites ones that will produce good results and provide success. Implement one or two sites per year depending upon funding.
2. Obtain available historic hydrologic data for selected sites. These data should include water surface elevations and discharges.
3. Visit the site and collect the following data. This information will help guide the selection of the measurement device to be used.
    - Determine average channel cross section and invert data by surveying
    - Elevations of existing checks, conveyance, or control structures
    - Water surface gradient for about ½ mi. upstream from proposed measurement site.
    - Visual estimate of past normal high water elevation. Inspect banks for vegetation limits and channel erosion.
    - Identify potential backwater effects due to downstream structures or confluences with other canals or drains or the river.
    - Survey the average elevation of adjacent lands if level with or lower than the drain or canal banks.
    - Visually inspect near drain lands for sign of high groundwater and describe vegetative cover of adjacent lands including approximate lateral extent.
4. Use gradient cross section data and historic flow data to design a flume or weir for the site.
5. Evaluate backwater impacts of the structure by running HEC-RAS.
6. Evaluate the likely impacts of the backwater generated by the design on canal or drain freeboard, groundwater levels, and drain performance.

The accuracy of the water measurement data being gathered must be assured prior to recording and transmitting the data. Recording and transmitting poor data can be more harmful than having no data. Recording and transmission of measured water should include the following considerations:

1. Evaluate the performance of the existing rated sections based upon the reliability of the historical data. These rated stations still require current metering to determine the accuracy of the data recorded by the stilling well and strip chart recorder.
2. Evaluate the performance of newly installed measurement devices.
3. Evaluate the priority of receiving real-time (daily) discharge data from the measurement sites.
4. At existing good, critical sites, install shaft encoders to well-functioning Steven's units, DCP's with Sutron RTU's, and satellite transmission.
    - At less critical existing sites, install shaft encoders and electronic data loggers to store data and allow for access with a laptop computer.
5. At new sites, install stilling wells and transducers or ultrasonic water level sensors over the water surface to record the head. The method used should depend upon the capability and reliability of the instrument, cost, and the probability of vandalism. At critical sites, the data should be transmitted,

and at less critical sites an electronic data logger (with capability for later satellite transmission) should be used.

6. Determine how the transmitted data will be managed.

Jaci Gould has a good understanding of the basics involved with selection of data transmitting equipment for the existing sites. Specific instrumentation packages for the new measurement sites can be developed once more is known about the site properties and the importance of the data.

### Suggested Water Measurement Devices

All the existing measurement sites are rated sections with a stilling well, float, and Steven's strip chart recorder. The strip chart is retrieved about monthly and computed into discharge for record keeping purposes. This does not allow for timely water management during low flow periods. Several of these sites are good candidates for upgrading the recording and data transmission equipment to provide effective daily discharge records for water management.

Priority is placed on measuring water that is passing into and out of each district. These measurement sites could be existing sites not working properly or sites where no measurement is occurring now. Of these sites, a top priority has been given to the Albuquerque Riverside Drain outfall between I-40 and the Central Ave. bridge (#17). Also of high priority are the Algodones Riverside Drain (#9) at Angustura Dam, Unit 7 Drain (#37) and the diversion flow from San Acacia Dam, and the Lower Peralta Riverside Drain outfall (#29) in Belen.

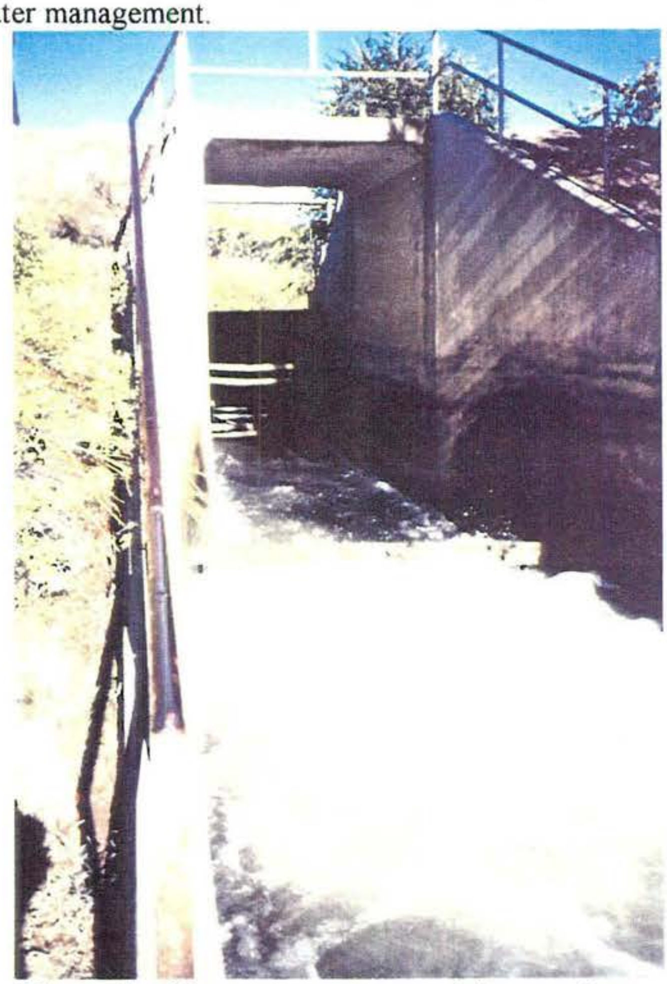

**Figure 1.** - View upstream toward the gate from the end of the stilling basin at the outfall from the Albuquerque Riverside Drain (#17).

The Albuquerque Riverside Drain outfall is a good site to perform water measurement because there appears to be plenty of available head. A general description of the site is given in Table 1 (#17) and shown in figures 1 and 2. There are two alternatives that were immediately apparent:

1) Measure gate position and upstream head and compare to rating curves to determine discharge. This is relatively inexpensive, but would not be overly accurate because of possible errors in determining gate position.

2) Construct a long-throated flume downstream from the stilling basin with upstream head measurement equipment. This will require more initial outlay of capital, but provide an accurate, low maintenance, long-lasting, water measurement device.

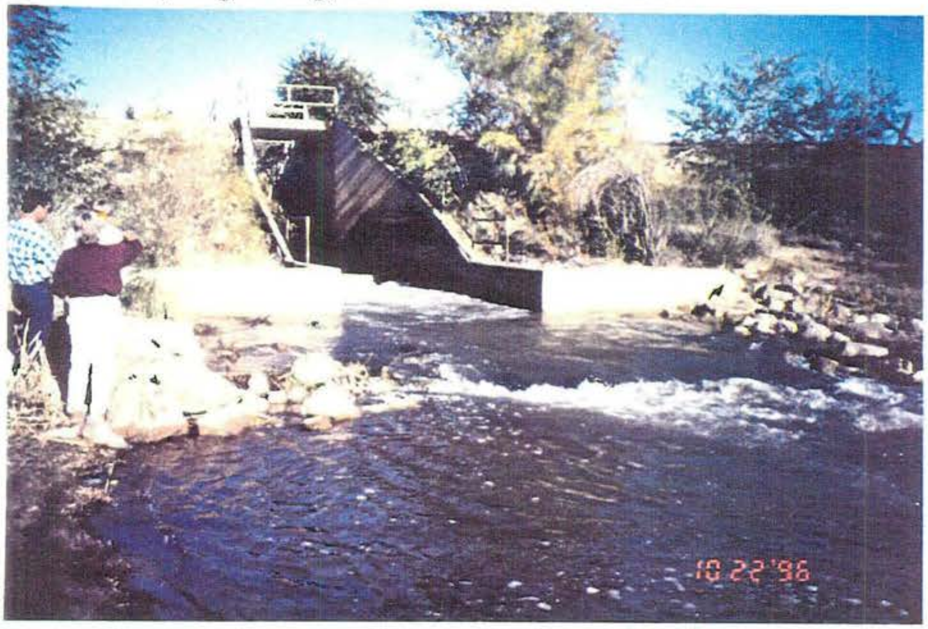


**Figure 2.** - Potential water measurement site at the Albuquerque Riverside Drain outfall to the river (#17). A long-throated flume could be constructed downstream from the stilling basin.

The Algodones Riverside Drain (#9) at Angustura Dam has an existing rated section but is constantly being current metered because of sediment and filimentatious algae problems. This measurement location could likely be moved downstream toward the culvert transferring flow into the Albuquerque Main Canal with water measurement accomplished by constructing a long-throated flume. These flumes are well suited to passing sediment, weeds, and debris. The proposed site is shown in figure 3. The viability of designing a flume for this site cannot be assured until site data outlined previously is obtained.

The situation at San Acacia is quite complicated depending upon the operation scheme. Measurement could be accomplished in the Unit 7 drain (#37) (figure 4) upstream from the confluence with the Socorro Main and/or possibly downstream at the bridge in the Socorro Main (figure 5). The feasibility of either of these two devices would be dependant upon the available head, water surface and invert elevations, backwater effects, freeboard and channel capacity. Meaurement could also possibly be made in the three rectangular flumes with ramp flumes or acoustic meters if flow in both directions is anticipated to continue (figure 6). These sites are all close together and could be compiled at a central DCP with a data transmitter. Operations are critical at this site and should be agreed upon by all parties before proceeding with a water measurement plan.

The Lower Peralta Riverside Drain (#29) has plenty of available head and rehabilitating the existing gates and stoplog arrangement (figures 7 and 8) would be fairly easy to accomplish. A weir, possibly with an adjustable blade elevation, could be used with upstream head measurement at this site. The data could be stored in a data logger.

Structures at these sites could be designed with data obtained from field investigations as outlined.

**Figure 3.** - Proposed site for construction of a flume in the Algodones Riverside Drain (#9).


**Figure 4.** - Proposed measurement site (#37) for the Unit 7 Drain upstream from San Acacia Diversion Dam.

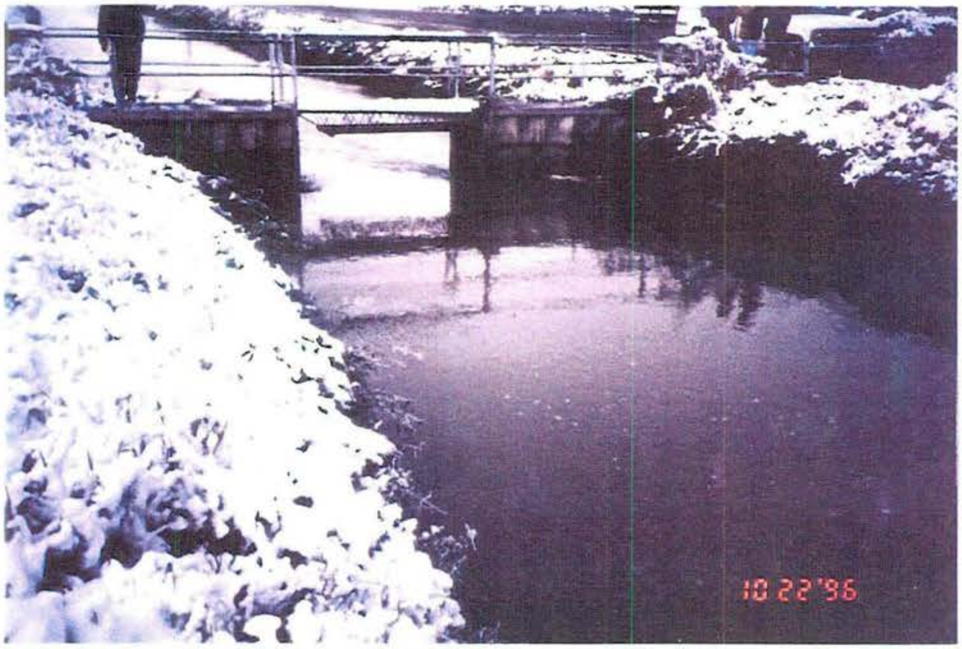

**Figure 5.** - Possible measurement site at the bridge in the Socorro Main Canal downstream from San Acacia Diversion dam and upstream from any turnouts.

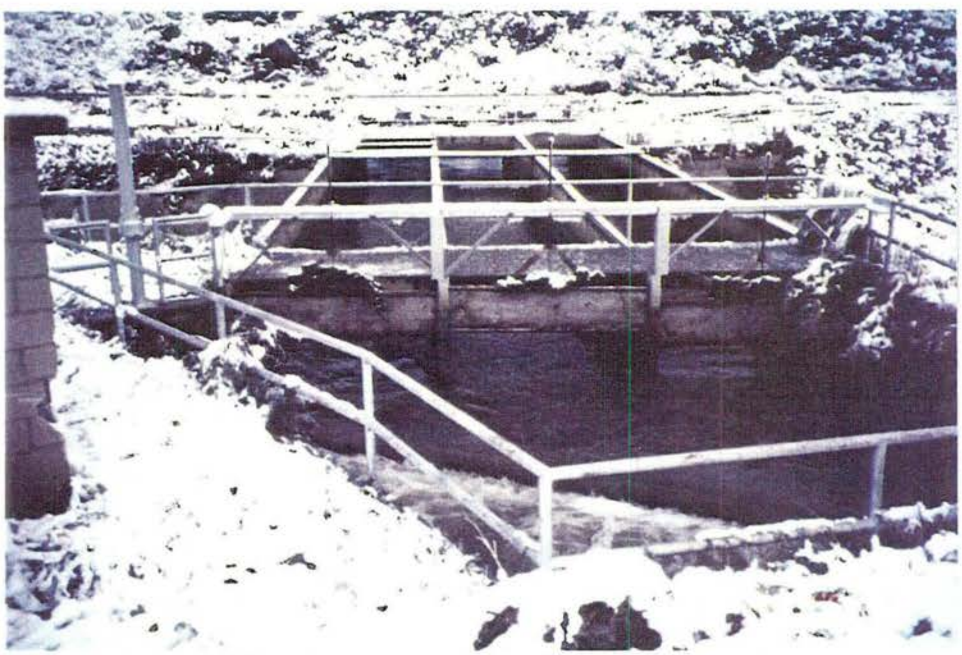
**Figure 6.** - Possible measurement site in the three flumes that carry diversion flow from San Acacia to the Socorro Main Canal.

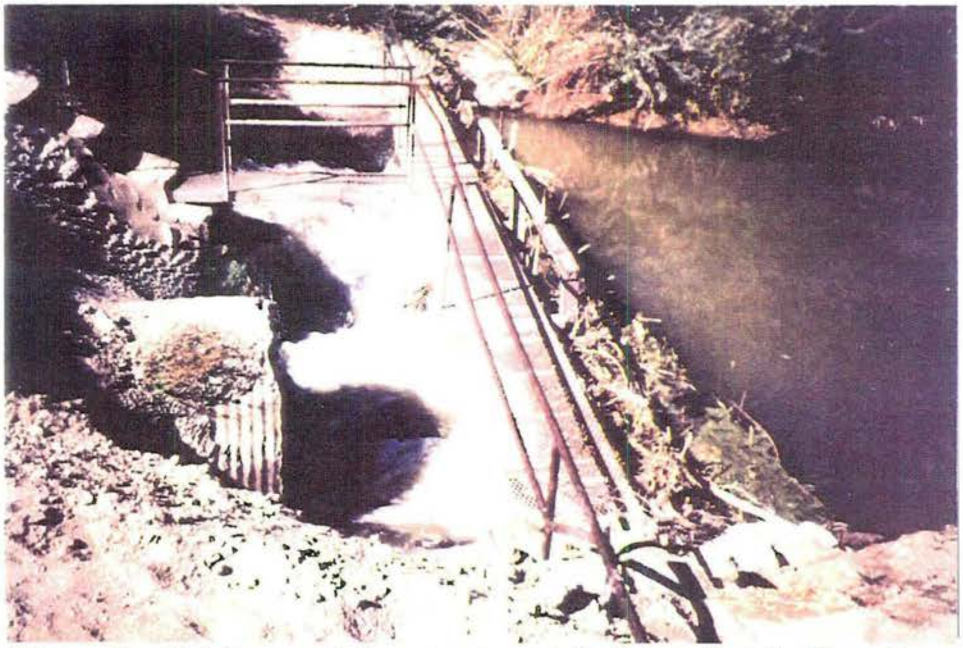

**Figure 7.** - Existing regulating structure at the Lower Peralta Riverside Drain outfall (#29). The existing gate and stoplog structure could be rehabilitated for measurement purposes.

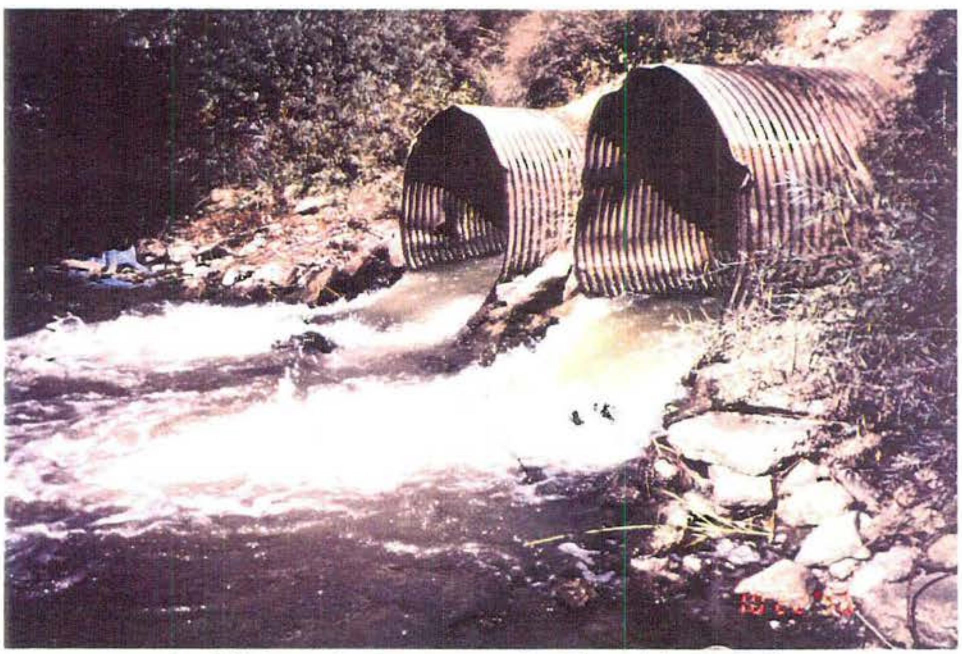

**Figure 8.** - Outfall from the Lower Peralta Riverside Drain into a river return channel (#29). These corrugated metal culverts are below the regulating structure in figure 7.

## Feasibility of a Flume Design for the Albuquerque Riverside Drain Outfall

Obviously, there are any number of water measurement devices [2,3] that could be considered at each site. Not all devices are appropriate, and a device selection should be based upon its expected performance in relation to the design constraints that will be encountered. In addition, an electronic flow totalizer or data logger that will store, and perhaps at a later date, transmit the data to a control center, should be installed with each device.

The potential lack of available head, coupled with weed and debris problems and requirements to keep costs low, led to the conclusion to use a long-throated flume. These flumes, also referred to as Replogle or ramp flumes, are very easy to install and maintain, are accurate, and are easily modified to fit the site situation.

***Flume Design*** - A feasibility level design for the Albuquerque Riverside Drain outfall has been performed using a long-throated flume [4]. Flume design is based upon the work by the Agricultural Research Service (ARS) and the U.S. Bureau of Reclamation [4,5]. The flumes are critical flow devices, meaning that when critical flow occurs in the throat section of the flume, a unique relationship is established between the upstream head and the discharge. The long-throated flume consists of an approach channel, upstream transition, horizontal throat section, downstream transition, and tailwater channel. The parts of the flume design are shown on figure 9. Any of the flume components may be customized for an individual site.

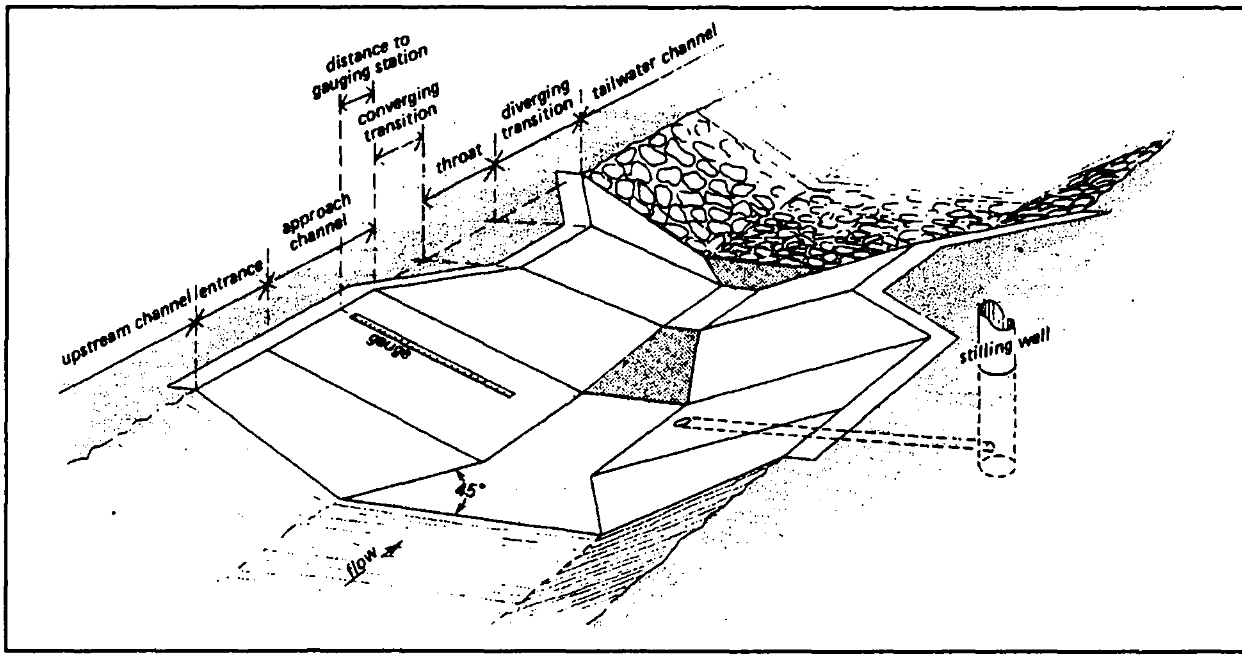


**Figure 9.** - Components of a general long-throated or Replogle flume. A ramp flume is a simplied version with no side contraction and often no downstream transition.

A computer program, FLUME, developed by ARS was used to design a flume for the Albuquerque Riverside Drain outfall [4]. The FLUME program determines the dimensions of the water measurement structure for a given canal geometry with estimates of the water surfaces. Freeboard requirements can be varied to minimize or maximize the height of the sill in the throat. Setting the sill height is critical to preventing submergence of the flume and maintaining accuracy. In general, submergence should be limited to 90 percent or less. Normally, a rating curve or table is computed with an error of about 2 percent or less using the program. The performance of the structure is then verified by initial field measurements of upstream and downstream head and velocity after installation. Continuous monitoring of the installation, i.e. bi-weekly current metering, is not necessary.

Initial assumptions about the discharge range, hydraulic gradient, and bottom slope were made at the site for input into the feasibility level design. The initial design consists of a 20-ft-wide rectangular flume with side contractions. The 2-ft-high horizontal throat or control sill is 4-ft-long and will pass about 100 $ft^3/s$ under 2.5 ft of head, requiring about 3-ft-high walls above the sill. The upstream converging transition has an invert slope of 7.5:1 slope for 15 ft. The walls converge from a 20-ft-wide section to an 8.5-ft-wide section at the control sill. The downstream transition is about 12-ft-long with a 6:1 downstream slope. This downstream section will probably not be needed or may be truncated. This design, figure 10, particularly the sill and wall heights, could change substantially when the final design is completed upon obtaining the necessary physical dimensions and hydraulic properties at the site.

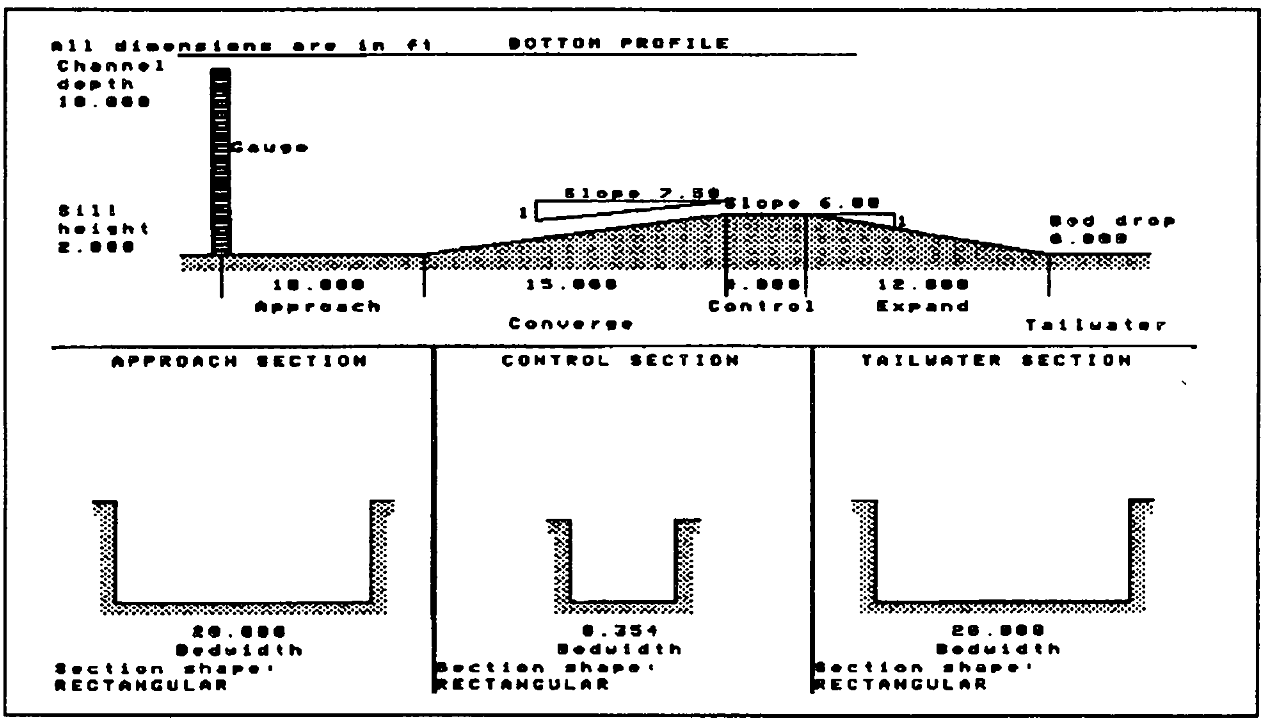


**Figure 10.-** Schematic of the initial flume design for the Albuquerque Riverside Drain Outfall.

The flume would be constructed inside an extension of the existing stilling basin structure. The floor and walls would be extended and raised, respectively, to accommodate the new structure. This flume could be constructed on site requiring about 55 $yd^3$ of ready-mix concrete. The structure would require formed reinforced concrete. The price of the concrete and construction would be dependant upon the local availability of labor and materials, but could be about \$300/$yd^3$ for a total of about \$16,500. The construction cost should also include diversion, if necessary (5 percent), unlisted items (10 percent) and contingencies (20 percent) for a total cost of about \$22,275. The data acquisition, storage, and transmission requirements would also need to be determined.

**Conclusions**

The district facilities are similar to many throughout the West that have been in service for many years. The system was not built with water measurement in mind and must now be able to better manage a limited resource. The first step to better management is better water measurement and timely data collection.

There are several good locations within the district to improve water measurement. Taking steps to improve or provide water measurement and data transmission is the best way for the district to be able to manage their deliveries. The best way to improve water measurement is to install new, more stable measurement structures in the canals and at the returns to the river. After calibration of these devices, only routine maintenance would be required to assure accuracy. There would be no need for intensive current metering. Sites providing accurate water measurement data should then have the recording equipment upgraded to transmit the data through satellites providing data every 4 hours. The district should concentrate on installing new measurement structures and recording and transmitting units where they are easy to install and the success rate will be high. This will encourage more participation in the water management program.

More control of the district will be obtained with knowledge of the water diversions and deliveries. Once the system is being managed, then the district could attempt to provide automated control, particularly at the river diversion structures.

**References**

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