BUREAU OF RECLAMATION
TECHNICAL SERVICE CENTER
DENVER, COLORADO

TRAVEL REPORT

RES-3.50

Code: 86-68560 **Date**: August 8, 2006

To: Clifford A. Pugh
Manager, Water Resources Research Laboratory (WRRL)

From: Robert Einhellig
Hydraulic Engineer

Subject: Travel to Santa Fe, New Mexico, to provide flow measurement assistance to the Pojoaque Valley Irrigation District

1. Travel period: June 5-8, 2006.

2. Places or offices visited: Pojoaque Valley Irrigation District north of Santa Fe, New Mexico.

3. Purpose of trip: To provide the Pojoaque Valley Irrigation District with flow measurement assistance, including advice on operation and maintenance of existing facilities and future system improvements.

4. Synopsis of trip: On Monday, June 5th, I drove from Denver to Santa Fe, New Mexico, arriving late in the evening at the Cities of Gold Hotel (505-455-0515). Tuesday morning I proceeded to the Pojoaque Valley Irrigation District (PVID) office, located directly across the road from the hotel. There I met with Anthony Lopez (ALB-414) and two other colleagues (Anthony Vigil and Michael Sanchez) from the Bureau of Reclamation's (Reclamation) Albuquerque Area Office. We were joined by the District Dam Tender, Alfredo Roybal (cell phone: 504-470-5630), and two representatives from the Office of the State Engineer (OSE), Brian Gallegos (cell phone: 505-699-4925, E-mail: bgallegos@ose.state.nm.us) and Jonathan Martinez (phone: 505-827-6120, E-mail: jmartinez@ose.state.nm.us).

The group met at the district office for about an hour, discussing the status of flow measurement and monitoring in the PVID. From this discussion it became clear that while flow measurement and monitoring upgrades to the PVID system were made approximately 10 years earlier, many of these upgrades were either not functioning or not being used to the extent intended. These upgrades included the installation of a number of commercial pre-fabricated flumes manufactured by Nu-Way Flume and Equipment Co. (360-942-3581), as well as the addition of Sutron (www.sutron.com) electronic data acquisition equipment to many measurement sites.

As a relatively new addition to the district staff, Alfredo was attempting to understand what infrastructure he had and how best to utilize it. He and the OSE representatives had been working together to both evaluate and improve the district's flow measurement capabilities. The OSE representatives indicated that the PVID was in a region determined to be of high importance to the state with regard to water management, and that significant state resources had been allocated to enhancing water management capabilities within the region which includes PVID. OSE and PVID were seeking buy-in from Reclamation concerning the OSE proposal for upgrading and/or replacing existing district equipment. OSE was also seeking any advice that Reclamation might want to offer regarding their plans.

Following the introductory meeting in the PVID office, the group proceeded out to visit the existing measurement structure sites within the district. Eight sites were visited during the remainder of that day and ten sites the following day. Due to illness, Alfredo was not able to accompany the group to all of the sites visited on the first day, but he was able to rejoin the group the following day.

Nine of the measurement locations visited featured Parshall flumes (figure 1) as the primary flow measurement structure, with the remaining nine locations utilizing newer, pre-fabricated Nu-Way Adjust-A-Flume™ ramp flumes. Two of the ramp flume sites (figure 2) also had pre-existing Parshall flumes which had been abandoned as flow measurement devices in favor of the ramp flumes. Each measurement structure was accompanied by a stilling well and equipment shelter to facilitate monitoring water levels and discharges through the structure. Some shelters were equipped with Stevens Recorders (figure 3), while others had Sutron 8210 dataloggers attached to shaft encoders (figure 4).

The OSE and PVID were working to establish a cooperative agreement between their organizations to facilitate district water-management improvements. The OSE representatives indicated that it was their goal to ensure that the flow measurement structures at each site were both functional and reasonably accurate. To accomplish this, they were working with the district to:

- Evaluate existing flow measurement structures.
- Repair or correct problems with existing structures where possible.
- Replace structures that could not be reasonably repaired.
- Institute a program of periodic velocity-meter measurements/discharge calculations (streamgaging) at each site as a check on the performance of the measurement structures.
- Replace existing data collection and recording equipment with a standardized system of shaft encoders, dataloggers, and telemetry equipment. One equipment vendor they were considering was Sutron, possibly with GOES satellite telemetry capabilities.

Figure 1—Parshall flume with stilling well and equipment shelter.

Figure 2—Adjust-A-Flume™ ramp flume with stilling well and equipment shelter. Note the abandoned Parshall flume located upstream.

Figure 3—Stevens Recorder in equipment shelter atop a stilling well.

Figure 4—Sutron 8210 datalogger with shaft encoder.

At each site visited the group discussed the particular concerns relative to flow measurement at the site. These concerns included:

- General condition of the structure—some Parshall flumes had obvious issues with settling and or wall deformation. These were noted and discussed.
- Structure installation and maintenance—many of the sills of the ramp flumes had not been initially installed level, and considerable effort had been expended to make them level and appropriate for measurement. The OSE representatives had a good understanding of the importance of this and were aggressively applying that knowledge.
- Stilling well inlet location and configuration—stilling wells were being cleaned out and revitalized, but there were concerns over the proper location and configuration of the inlet port in the flume. In one example (figure 5) the inlet was located in the transition section upstream of the flume and above the level of the flume crest. The proper location and configuration of stilling well ports for both Parshall flumes and ramp flumes was discussed.
- Staff gage location and reference elevation—there was some uncertainty regarding the proper location of staff gages for both the Parshall and ramp flumes, and the correct vertical datum to use for each case. As with the stilling well inlet issue, the recommended location and referencing of staff gages for both types of flumes was discussed.
- Discharge estimating using staff measurements made on the crest of ramp flumes—there was a question from the district as to whether and how this could be done. Although it is possible to make such an estimate, the practice is discouraged due to difficulties in making an accurate measurement and calculation of flow (the normal device rating curve does not apply to this situation). Use of the proper staff gage location upstream of the crest was strongly encouraged over this practice, as it is both easier and yields more consistent and reliable results.
- Small measurement depths—it appeared that some of the ramp flumes regularly operated with very small approach depths (relative to the crest). While the crest width of these flumes seemed to fit the geometric width of the channel well, it is possible that these flumes are oversized for the actual flows that are being passed and measured by the structure. This results in small depths of flow from which it is more difficult to obtain an accurate flow measurement.
- Submergence issues—the tailwater marks on a couple of the Parshall flumes appeared to suggest that downstream submergence could be an issue for these structures. The effect of downstream water levels on Parshall and ramp flume measurements was discussed.
- Sediment issues—at least two sites were identified has having very large sediment loads. Alternative measurement structure designs such as flumes with converging side-walls and level floors were discussed as possible ways to minimize the sediment impacts on the flow measurement.

The site visits and associated discussions ended at mid-afternoon of the second day onsite (June 7th) and the group concluded the discussions with a late lunch at a local restaurant. Late in the afternoon the group adjourned and I began the return trip to Denver.

Figure 5—improper stilling well inlet location, elevation, and configuration.

5. Conclusions: The PVID is making an excellent effort to both utilize the water measurement and monitoring infrastructure that currently exists in the system, and to upgrade the system to improve capabilities. The close cooperation and participation of the Office of the State Engineer under the direction of the local Watermaster, Brian Gallegos, is significantly contributing to this effort. Brian and his colleague, Jonathan Martinez, have worked closely with Alfredo Roybal to maintain and repair many of the existing flow measurement structures. These efforts have included leveling the crests of many of the prefabricated ramp flumes and cleaning out/rehabilitating the stilling wells used to monitor water levels for the flumes. Periodic current meter measurements have also been initiated at many of the flow measurement sites in an effort to ascertain whether the existing flow measurement structures are performing adequately. These efforts have undoubtedly enhanced both the accuracy of and confidence in the district's flow measurement program.

Specific recommendations related to the flow measurement improvement efforts the PVID and OSE are making were discussed with the group participants throughout the site visit. Anthony Lopez suggested that it would be helpful to document some of those recommendations in this report. These suggestions can be summarized as follows:

- Device Maintenance
    - Flume structures should be checked for structural integrity and proper leveling. Crests of ramp flumes, in particular, need to be level (as OSE and PVID have

been verifying).
  - Stilling wells should be clean and free of sediment build-up. Inlet pipes should be free-flowing and need to be periodically flushed to prevent sediment occlusion.
  - Sites with significant sediment loads may need to consider an alternative measurement structure. A long-throated flume with a level floor (no crest) and contracted sidewalls in the throat is one option that is sometimes effective in passing larger sediment loads.
- Device Accuracy
  - The stilling well inlets and wall-mounted staff gages need to be located in accordance with the specifications and ratings for the particular structure. For Parshall flumes, this location is along the contracting approach walls at a distance equal to two-thirds of the approach wall length upstream of the beginning of the throat section. For the prefabricated Nu-Way flumes, the location of the factory-applied wall gage indicates the location for the stilling well inlet. The zero mark on a Parshall flume staff gage should be at the same elevation as the level floor of the approach section, while the zero mark on a ramp flume staff gage should be set at the same elevation as the level crest of the ramp in the throat section. Stilling well inlets should be located such that they are submerged for the full range of flows to be measured (i.e., below the crest elevation of a ramp flume).
  - Water levels for discharge measurements should be taken at the specified location (see previous bullet item) for a particular flume. Although it is possible to make a discharge estimate for a ramp flume by attempting to measure critical depth on the crest, the difficulties in obtaining an accurate depth measurement under such conditions make the measurement uncertain, at best.
  - Submergence effects should be noted for each flume structure—particularly the Parshall flumes. Submergence in excess of 70% tends to decrease the discharge through a Parshall flume below the value predicted by the free-flow rating table. In this case a submergence correction can be attempted, or the flume can be replaced with a long-throated flume designed such that the downstream water-levels do not prevent critical depth from occurring in the throat of the flume.
  - The estimated accuracy of measurements made with a long-throated flume (such as the Nu-Way ramp flumes) can be determined using Reclamation's WinFlume computer program. For very small depths of flow through the throat, such as occurs with flumes that are significantly wider than necessary to pass the required flows, the estimated error and uncertainty in the measured discharge increases. Flumes should be evaluated based on the range of flows to be measured and passed to determine if the expected error is acceptable. In some cases, a narrower flume may provide better accuracy while still passing the full range of flows that a ditch experiences.
  - Velocity-meter measurements/discharge calculations can be used to periodically verify that a given structure is performing appropriately. In general, individual velocity-meter measurements should not be used to calibrate or adjust the rating of a flume. If adjustment of a flume rating becomes necessary, a series of repeated velocity-meter measurements over a range of discharges is necessary to develop a revised rating with confidence.

- Data Acquisition/Telemetry
  - Electronic data acquisition and transmission can greatly add to the utility of flow measurement data. Use of a standardized, common equipment group at each site simplifies both operation and maintenance issues, since district personnel only have to become familiar with one set of equipment (even if the individual components of the group are from different vendors). This also allows for the seamless interchange of parts and equipment between different sites.
  - Telemetry of data can be achieved in a variety of ways. Satellite transmission can offset terrain difficulties, but it is limited to one-way communication (remote site to base) on a fixed schedule (usually one upload every 4 hours). Radio telemetry offers the possibility of two-way communication and data on-demand, if the terrain allows for radio contact. OSE and PVID should consider radio telemetry when evaluating their communication options.
- Documentation
  - Each data site should be equipped with documentation pertinent to the site, such as instrument set-up guides (including settings used for specific instrument options) and rating tables for the flow measurement structure. A log book for the site is also useful to maintain a chronological record of activities such as stilling well maintenance, staff gage placement, crest leveling, or instrument maintenance/replacement.
  - A master summary of documentation should be kept in the district office. This should include descriptions of each site such as flume type, rating, and equipment. It should also include equipment reference manuals and setup guides.
  - A written summary with more detailed information regarding the state's plans for enhancing the district's capabilities should be provided to the Albuquerque Area Office so that they can more fully evaluate and comment on the planned improvements.

The Office of the State Engineer has indicated that it intends to invest considerable resources in enhancing the district's flow measurement and monitoring capabilities as part of a larger effort to improve water management in the region. The plans discussed with the OSE representatives during the site visit documented herein include continued improvements to existing flow measurement structures, replacement of selected structures as warranted by conditions, and an upgrade of the district's electronic data recording capabilities to more current hardware which will include remote data telemetry capability. These plans, as discussed during the site visit, seem consistent with the stated goal of enhancing the district's water measurement, monitoring, and accounting capabilities to facilitate better management and conservation of district water.

6. Action correspondence initiated: Upon returning to the Denver office, I discussed the district's situation and planned improvements with Tom Gill of this office. We concluded that although the Office of the State Engineer indicated a predisposition to use GOES satellite telemetry to retrieve data from the measurement sites in the PVID, it might be beneficial for them to also consider radio telemetry which could be both less expensive and allow for two-way on-demand communication. We contacted Brian Gallegos and Jonathan Martinez by telephone

and suggested that they include radio telemetry in their evaluation of communication options for the PVID. They seemed open to the possibility of radio communications, if the terrain would allow it. We suggested that they contact David Gensler of the Middle Rio Grande Conservancy District to get his feedback and experience regarding the use of radio telemetry for both data retrieval and two-way communications.

cc: Anthony Lopez (ALB-414)

SIGNATURES AND SURNAMES FOR:

Travel to: Santa Fe, New Mexico

Date or Dates of Travel: June 5-8, 2006

Names and Codes of Travelers: Robert Einhellig, 86-68560

Traveler: _____ **_____**
Robert Einhellig, 86-68560 **Date**

Noted and Dated by:

_____ **_____**
Clifford A. Pugh, Manager **Date**
Water Resources Research Laboratory