BUREAU OF RECLAMATION
Technical Service Center
Denver, Colorado

TRAVEL REPORT

Code : D-8560 Date: December 13, 2005

To : Manager, Water Resources Research Laboratory

From : Tony Wahl

Subject: Travel to Altus, Oklahoma to Visit Flow Measurement Sites and Check Structures on the W.C. Austin Project

1. Travel period: November 21-26, 2005

2. Places or offices visited: Oklahoma City Field Office - Oklahoma City, Oklahoma
Lugert-Altus Irrigation District - Altus, Oklahoma

3. Purpose of trip: To meet with area office and irrigation district personnel and review sites of potential new or improved structures for flow measurement and canal control on the W.C. Austin Project.

4. Synopsis of trip: I flew to Oklahoma City on Monday, November 21. I met James Allard and Matthew Warren at the Oklahoma City Field Office, and we drove together to Altus, Oklahoma on Monday afternoon. We met up there with Thomas Michalewicz who had traveled to Altus earlier on Monday morning.

We spent Tuesday visiting numerous sites on the project where new or improved flow measurement structures are desired. We also visited a number of canal check structures that are scheduled for improvement during the next two years. The majority of the improvements will be made as part of a two-year Water 2025 grant recently received by the district. A few structures previously identified will be improved under the Water Conservation Field Services Program (WCFSP). Reclamation has been providing assistance to the District and the OTAO for the past two years, primarily through the WCFSP. Many of the structures we visited on this trip had also been recently reviewed by the Irrigation Training and Research Center (ITRC) in August 2005.

We all returned to Oklahoma City on Tuesday evening. Following the Thanksgiving holiday and a period of personal leave in the Oklahoma City area, I returned to Denver on Saturday, November 26.

Specific observations about particular structures follow. The sites are discussed in the order in which we visited them. Sites at which future involvement of the WRRL is not anticipated are omitted. We were accompanied on the site visit by District Manager, Tom Buchanan, Dam Tender, Glen Barker, and District Water Operations Foreman, David Southall.

Structures Visited

Altus Main Canal bench flume – This long-throated flume was installed into a rectangular concrete-lined section. The flume performed well during the first season of operation in 2005. To allow for accurate measurement at maximum possible flow rates, a downstream diverging ramp was included in the design. This ramp produces an energetic hydraulic jump below the structure at lower flow rates (i.e., at lower tailwater levels) that surprised some District and Area Office staff. The ITRC report expressed concern over the possible scouring potential of the flow and potential increased loading on the channel walls due to the raised water surface created by the flume. There was no evidence of scour during our visit, but there is a joint in the floor (probably an old repair) just downstream from the flume that could potentially experience a high uplift pressure. This joint should be repaired so that there is no offset into the flow. Regarding the issue of the increased loading on the flume walls, the ITRC report stated that water levels had increased several feet following installation of the flume. This is true only at very low flows. The water level increase at maximum design discharge (1000 ft^3/s) is only about 4 inches, and at more typical high flow rates (up to 750 ft^3/s), the water level in the canal never exceeds the original design maximum water surface.

James Allard and Matthew Warren shared results of the past summer's comparison of the measurements from this flume with measurements made at the Altus Dam outlet gates. The agreement between the two sets of data is quite good, with a systematic difference between them that is generally less than 3% of the flow. Preliminary work has shown that a minor adjustment to the gate rating equations can bring them into agreement with the flume measurements. When this adjustment is performed, it should take into account the estimated flow through the drainage pipes installed through the flume, even though that flow is very small compared to the total flow.

Figure 1. — Altus Main Canal bench flume.

Figure 2. — Joint in concrete about 8 ft downstream from measurement flume.

Figure 3. — Altus Main Canal bench flume in operation during the summer of 2005.

A4.8 Check and Drop Structure – This is one of the sites being considered for improvement with a long-crested weir. We discussed some issues related to determining the design height and length for the weir. The general plan for modifying these structures is to construct the long-crested weir on one half of the 2-bay structures, or two-thirds of the 3-bay structures, and leave one bay available to be operated as a traditional stoplog check.

Figure 4. — A4.8 Check Structure.

W10.6 Check Structure – The district would like to add flow measurement capability here in the West Canal just below the check structure. This is a 10-ft base width trapezoidal earthen channel with 1.5:1 side slopes. A structure with a rectangular-shaped throat and vertical side walls would probably be easiest to construct. I will develop a design for the district.

Figure 5. — W10.6 check structure, looking downstream toward the planned site for the new long-throated flume.

West Canal Wasteway – This site is the tail end of the West Canal. A delivery is made through a CHO (Constant-Head Orifice turnout) and additional flow is spilled over a roughly constructed concrete sill and through a gate-controlled turnout structure leading to the same spill channel. The majority of the spilled flow goes through the gated turnout. A large culvert about 75 yards downstream presently establishes the water level in the spill channel. This culvert is installed on a slope, and drops about 1 to 1.5 ft over its length.

Figure 6. — End of the West Canal. The last turnout is the CHO at left. Water not delivered is spilled over the rough concrete section at center, or through the gate-controlled turnout at left. To operate the CHO, a water level is maintained in the West Canal that is approximately equal to the crest elevation of the rough concrete sill.

While at the site we discussed measurement alternatives for this site. We concluded that the best approach was probably to modify the culvert either by replacing it or adding a second parallel culvert at a lower elevation, to reduce the water level in the spill channel, and then construct a long-throated flume about halfway between the head of the spill channel and the culvert.

Later, while visiting the Ozark Canal wasteway we came to a different conclusion about measuring waste flows. Rather than measuring the actual spill, we could measure the total of the spill and the tail-end delivery in the canal itself. Knowing the amount of water billed for and the amount measured, the district would know that the difference was either wasted water or water that was used but not billed for. In either case, that water would represent an opportunity for the district. The same logic could be applied to this site, and a flow measurement structure would then be constructed in the West Canal itself, just upstream from the tail end structures. This approach would depend on there being additional channel freeboard available above the water level normally maintained to supply water into the CHO, since a measurement structure would require some head.

Figure 7. — Spill channel at tail end of West Canal. Culvert in spill channel is visible in far right of photo.

Figure 8. — Close-up of culvert in spill channel at end of West Canal.

Ozark Canal Check – This turnout from the Altus Canal is the head of the Ozark Canal. We briefly visited a flow measurement structure constructed last year. A similar design may be used at the A17.6 lateral (discussed below).

Figure 9. — Flow measurement structure near head of Ozark Canal. The wedge of fresh concrete on the downstream side was added recently to minimize accumulation and recirculation of abrasive material at the base of the drop.

Altus A6.8 and A9.9 Check Structures — At the A6.8 check structure the district is considering lowering the turnout and the pipe that delivers water to the lateral. This would allow the canal water depth to be lowered. A pump would be required to deliver water to two seldom used turnouts adjacent to the canal. The feasibility of this modification will be investigated by the OTAO. At the A9.9 check structure the district would like to install a long-crested weir, as suggested by the ITRC.

Ozark 4.6 Lateral – This lateral receiving water from the Ozark Canal is located just upstream from Altus Air Force Base. Flow measurement is desired in the lateral itself. A drop structure about 900 ft downstream from the head gates was modified many years ago by addition of a Cipoletti weir blade. The weir is inaccurate because there is a lack of approach depth (the blade is only about 9 inches above the approach channel floor), causing the weir to operate with partial contraction. Also, the time required for the pool to stabilize between the head gate and the weir is quite long. The ITRC recommended a Doppler-type flow meter for this site, due to the lack of available head. The head required for the Cipoletti weir means that the Ozark Canal must be operated at a very high depth to make the delivery into the O4.6 lateral.

Figure 10. — 5-ft wide drop structure on the Ozark 4.6 lateral, retrofitted in the past with a 4-ft wide Cipoletti weir.

I suggested a two-phase approach to this site. For the upcoming season the district could remove the Cipoletti weir blade and install two rounded approaches (vertical half-sections of large-diameter PVC pipe) on the upstream corners of the existing concrete structure. With this modification, the structure could be rated as a long-throated flume using WinFlume. This would provide workable flow measurement and would reduce the water levels in the lateral, presumably also allowing the district to operate the Ozark Canal at a lower level. This would not significantly change the time required for the measurement to stabilize following a flow change.

If, after a year of operation, the district still wanted to reduce the lag time between making a flow change and obtaining a stable measurement, a long-throated flume could be designed for installation just downstream from the O4.6 lateral head gates. With the removal of the Cipoletti weir, enough head should be available to allow for a functional structure. This would raise water levels back up somewhat, but the level could probably still be kept lower than the present condition.

Ozark 15.2 Lateral – This diversion from the Ozark canal is controlled by two gates that discharge into a box culvert passing beneath the canal maintenance road. A 4-ft Parshall flume is located about 50 yards downstream, but appears to operate fully submerged based on high-water stains. The ITRC recommended making measurements at this site by a stream gaging technique using a FlowTracker positioned at the box culvert outlet. Gradually, a gate calibration might be developed. I suggested the possibility of modifying the Parshall flume to create a long-throated flume that operates in free flow. This would depend on whether additional head could be consumed. If some head is being dropped at the gate now, it may be possible to transfer some of that head loss to a modified flume and open the gates further to make the delivery. I asked Glen Barker to survey the high water marks in the lateral and in the Ozark Canal to determine how much head loss might be occurring across the turnout gates with the present arrangement. This site was originally designed for a flow of 50 ft^3/s, but the district reportedly never delivers more than 40 ft^3/s. The head gates consist of two 24-inch by 24-inch rectangular slide gates. Glen Barker later related that the ditchrider typically operates these gates about three quarters open. Survey data collected by Glen Barker following the site visit showed that the head loss from the Ozark canal into the lateral is about 1.38 ft.

Figure 11. — Downstream end of box culvert at head of Ozark 15.2 lateral.

Figure 12. — 4-ft Parshall flume in Ozark 15.2 lateral.

Ozark Wasteway – This site was surveyed extensively early in the summer by Bob Einhellig during his visit to the Altus area to present a ditchrider training short course. At its tail end, the Ozark canal enters a division box from which a final delivery is made and excess flow enters the wasteway channel. The Ozark canal itself offers a good location for installation of a long-throated flume. Such a measurement would tell the district the total flow being supplied to the division box. Comparing that measurement to the amount of water billed to the last delivery would tell the district how much total water is lost to spillage and overdelivery. The survey data collected by Bob Einhellig should be sufficient for design purposes.

Figure 13. — Division box at end of Ozark Canal. The canal enters from the bottom of the photo. The wasteway proceeds to the left, and the final delivery goes out the far side of the box.

Figure 14. — Ozark Canal looking upstream from the tail end division box. A long-throated flume could be installed in this reach.

A17.6 Check Structure and Lateral – This site was also surveyed by Bob Einhellig during the summer of 2005. The plan for this site is to remove an existing 8-ft Parshall flume and transfer flow measurement to a drop structure located a short distance downstream (or possibly relocate the drop to approximately the existing flume location). This will lower the water level in the head of the A17.6 lateral, allowing the district to reduce the operating level of the Altus Canal, thereby increasing system capacity by reducing the tailwater below an upstream inverted siphon. We asked the district to recheck some of the survey data before we proceed with developing a design.

Figure 15. — Looking downstream from the head of the A17.6 lateral. The first structure is the Parshall flume. A drop structure is located in the distance, to the right of the car on the highway.

5. Conclusions: The site visit was very productive, and plans for addressing water measurement needs at many sites were made. The WRRL will proceed with hydraulic design of the water measurement structures. Design information will be transmitted to the Oklahoma-Texas Area Office and Oklahoma City Field Office. Some designs will be completed with funding from the Water Conservation Field Services Program. That work will be coordinated with Brenton Johnson of the Oklahoma-Texas Area Office.

6. Action correspondence initiated or required: None

cc: Thomas Michalewicz, Brenton Johnson (via e-mail)

bc: D-8560 (Travel Report file)

<u>**SIGNATURES AND SURNAMES FOR:**</u>

Travel to: Altus, Oklahoma

Date or Dates of Travel: November 21-26, 2005

Names and Codes of Travelers:

Traveler	**Date**
Tony L. Wahl	12/13/05

Noted and Dated by:

Clifford A. Pugh	12/13/05
Signature	Date