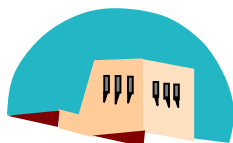


*Modeling Report
October 20, 2002*

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West Bluff Design Recommendations **- Based on physical model study at UNM -**

Prepared for the Albuquerque Metropolitan Arroyo Flood Control Authority



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Introduction

The West Bluff pond storm water drainage channel was designed by AMAFCA to be located cross section of Juniper and Amor Dr. in northwest Albuquerque. The designed channel will play a role of the storm water controller, especially removing the floating debris for the relatively clean storm water to the ordinary channel. The channel was designed for the peak 100-year design flow rate, 663 cfs for open channel part (upstream), and 682 cfs for culvert (in a pipe shape) inflow part (downstream). To prevent storm water debris entering an existing channel, a baffle and weir combination structure was designed in the drainage channel. This “controlled” storm water in upstream channel will be merged to the culvert inflow in downstream channel, and flow out the channel. The design engineers were concerned that the designed baffle and weir combination structure would keep storm water debris effectively, and the drainage channel would behave as they designed.

Modeling Objective

The objective of this project was to build a scale model of the West Bluff pond storm water drainage channel design, to use laws of similitude to simulate the safety of the design, and to suggest the modified design. For this objective, the maximum preventing debris capacity was focused on the baffle and weir device experiment, and the simple and smooth flow streamline that decreases the flow dead zone was simulated in the channel model.

As-designed Model

The design channel is an irregular rectangular shape of 312 ft in length and 112 ft in width of a concrete lining conduit (Figure A1, Appendix A). The design peak water surface elevation is 93.10 ft in the downstream channel. The design channel bottom elevation varies from 88.42 ft to 86.60 ft, and is sloped 4% to the downstream direction, 6% to the southeast, in other words, to the baffle and weir. The baffle and weir in 206 ft length are to prevent floating debris from entering storm water channels. The baffle and weir structure was designed 1.5 ft apart from each, and the baffle is 1.4 ft high from the bottom, therefore the baffle works as a sluice gate.

Tom Escobedo, UNM Technician, and Jeremy Anderson, Jungseok Ho, UNM Civil Engineering graduate student constructed the storm water drainage channel model in the open channel lab at the University of New Mexico according to the instructions given by Dr. Julie Coonrod. The constructed model measures one-sixteen of the design so that model design flow rates were scaled as 0.65 cfs (663 cfs in full scale) and 0.67 cfs (683 cfs in full scale). The scale channel model is 18.5 ft in length and 7.0 ft in width of a steel plate lining on the 4 % sloped bed. The flow supply to the model is controlled by

electric pump system, and the flow velocities are measured at the entrance of the channel model and at the culvert exit for the scale design flow rate.

The baffle and weir combination structure were experimented in full scale separately at the experimental flume for better simulation results. The full-scale weir model is 4.5 ft in height, 1 ft in length along the 3 ft unit width flume, and the 0.5 ft length baffle is 1.5 ft apart from the weir as Figure A2 in Appendix A. This model were constructed of plywood and painted to seal the wood and more closely match the roughness of concrete surface. Debris was compromised primarily of 0.5-liter plastic bottles. The success of the experiment was reported in reference to how many (few) bottles passed over the weir.

Model Scenarios

The “as-designed” model had several “dead zones” in entrance and middle section of the upstream channel, and the storm water overflowed the design water elevation at the vertical wall right at the culvert exit as Figure A5 in Appendix A. The flow dead zone should be removed for better drainage channel flood control capacity and maintenance. The baffle and weir combination structure allowed most debris (bottles in this experiment) to pass over the weir. The baffle worked only when the water level is higher than the baffle bottom, so that any debris in the vicinity of the baffle and weir will be passed over the weir as flow passes the structure. It is concluded that the as-design model needs to modify for better performance of the structure.

The modified model has a wedge and a stair at the front of the weir, and it greatly reduced the amount of debris that passed over the weir. The wedge is 1.4 ft in height and 2.3 ft in length on the 0.25 ft stair as Figure A3 in Appendix A. This configuration caused the first flush of the water to flow back upstream and remain front of the baffle as the water level increased. The wedge and stair changes super-critical flow (first flush) to sub-critical flow, and it makes the hydraulic jump, which helps keeping debris front the baffle. The final alteration to the model is a decreasing distance between the baffle and weir. The baffle was moved to 0.85 ft distance from the weir. This model made the best results so far, and allowed only one bottle in two times experiment. In additions, there was no significant difference in water head with the baffle closer to the weir than in the “as-designed” model. Detailed experiment results are in Appendix B.

The figure 1 shows comparisons between the “as-design” channel and the modified channel. Two additional channel walls were installed around the upstream entrance, instead of removing the “upstream weir”, and the side weir (the drainage channel also) were extended 56 feet (42 inches in experiment) following to the longitudinal flow direction. As results, the new channel removed the flow dead zone in the entrance and middle section of the channel except the end of upstream channel. It could more convenient to clean the collected debris after storm water passing. The culvert-dividing wall in downstream channel was removed, and the curved wall was offset slightly from the culvert exit and straightened to prevent over the design water surface elevation. Moreover, the riprap energy dissipation was constructed at the channel bottom of the culvert exit. The figure 2 shows the measured velocity vectors and the water depths

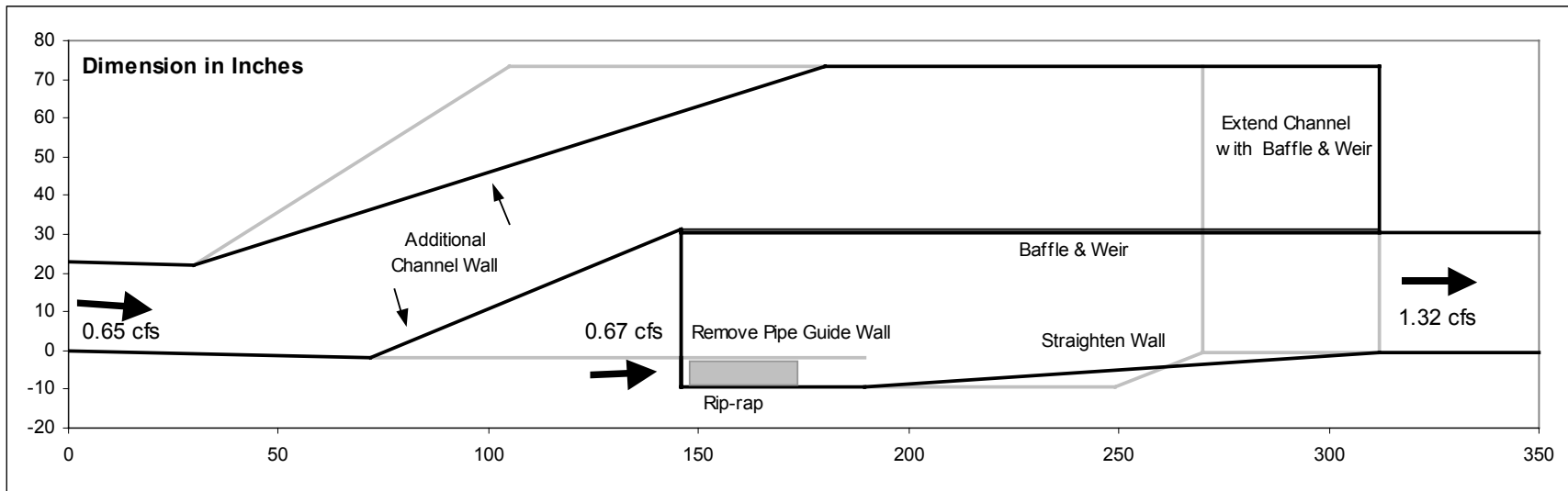


Figure 1. Channel Dimension Comparison between “As-Design” and “Modified” Model (inches).

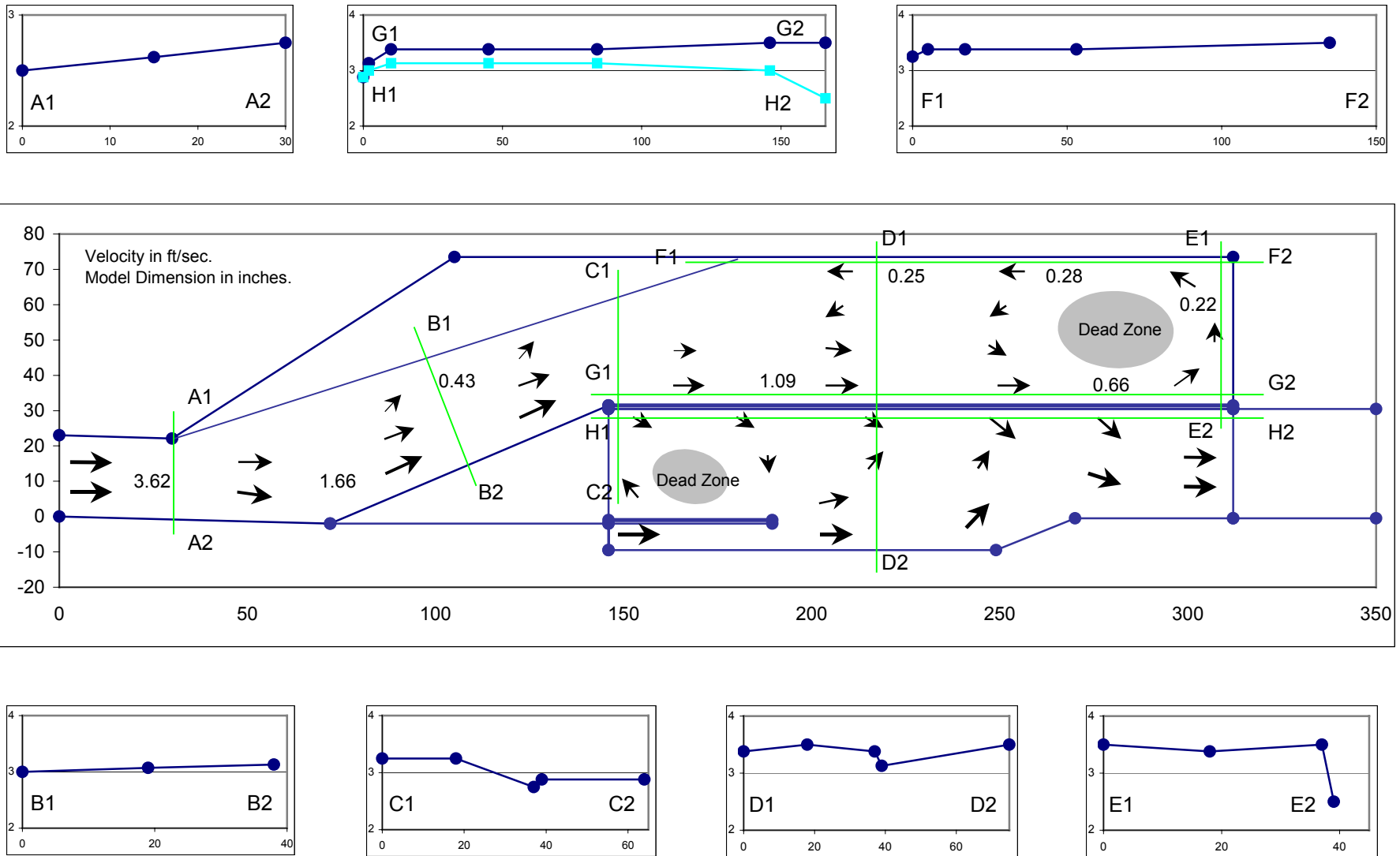


Figure 2. Measured Velocity Vector and Water Depth (inches).

of the modified channel. The flow streamlines are simple, and the floating debris should be collected in the dead zone of the end of the upstream channel. Detailed experiment results and figures are in Appendix C.

This modified model was simulated numerically also for more dependable experimental results by the SMS (Surface water Modeling System) computer model. SMS is a two-dimensional finite element hydrodynamic computer model developed by the WES (Waterway Experimental Station) of the U.S. Army Engineer Research and Development Center. The figure 3 shows the numerically simulated flow velocity vectors and water depths for the modified channel design. These computation results are slightly different with the measurements in flow directions. It seems that the numerical model computations are an average values at each point (finite element node), as contrary the measurements are surface velocities mostly. As the same method, the “as-design” model was simulated by SMS. The computed velocity vectors are more complex than the modified model simulations as Figure D2. Detailed simulation proceeding descriptions, figures, and results are in Appendix D.

Conclusions and Recommendations

The modified baffle and weir combination structure can prevent the most floating debris from the entering river-bound storm water. The wedge and stair should be constructed at this combination structure, and the distance between baffle and weir should be decreased to improve preventing rate of debris. The weir should be constructed horizontal in elevation through the channel instead the channel bottom is in sloped bed. In addition, the collected storm water debris could be cleaned easily after storm event, since the modified channel made simple streamline and removed flow dead zones around the entrance of the upstream channel. The side weir and channel should be extended at least 56 feet to decrease the water surface elevation to prevent over the design water surface elevation. The curved wall was offset slightly from the culvert exit and straightened, the culvert-dividing wall was removed, and a riprap should be added on the channel bed also. The full-scale model SMS simulation result is in Figure D4. The streamline is simple so we can conclude that the modified model could be a reasonable design. The dimensions of the final modified channel should be as shown on Figure 4.

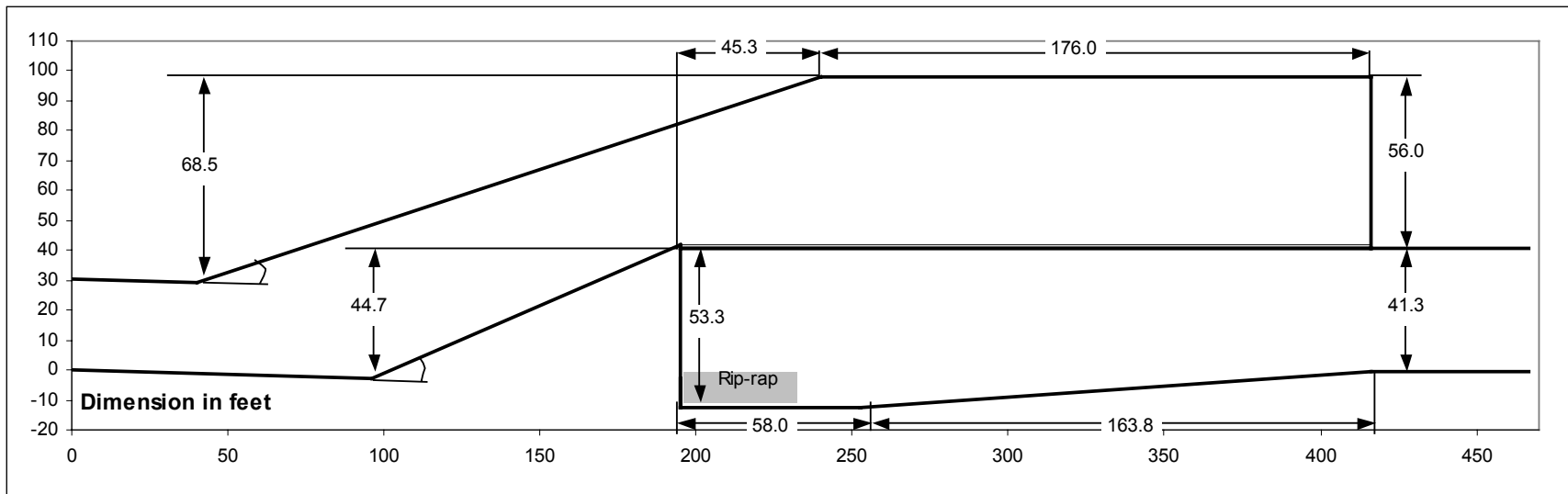


Figure 3. "Modified" Channel Model Full-Scale Dimension (feet).

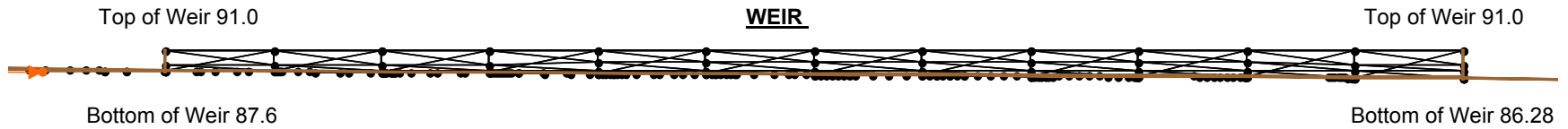


Figure 4. Weir Plan View (feet).

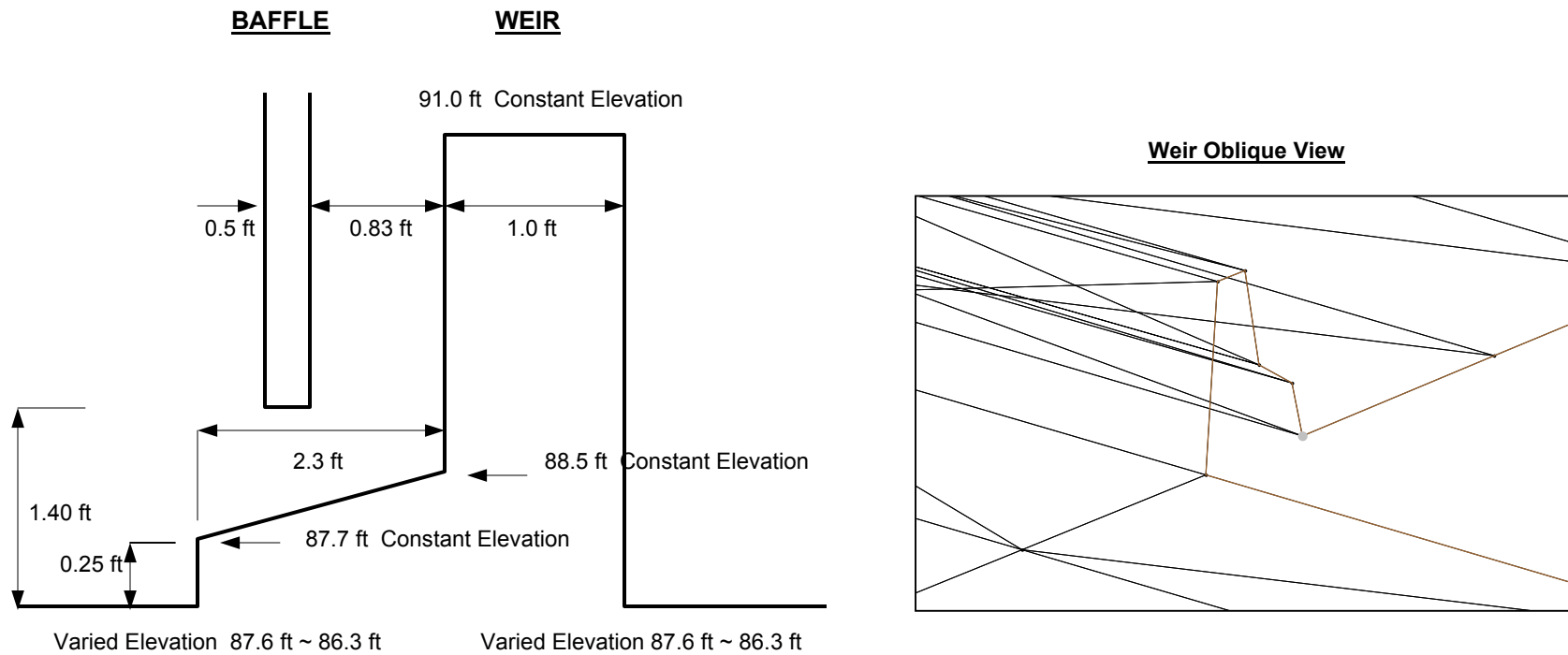


Figure 5. Modified Baffle and Weir Design Dimension (feet).

