Modeling Report
April 20, 2001

North Domingo Baca Extension at Barstow
Altered Transition

(subsequent to North Domingo Baca Extension at Barstow, April 5, 2001)

Prepared for the Albuquerque Metropolitan Arroyo Flood Control Authority

Julie Coonrod, Ph.D., P.E.
Department of Civil Engineering
The University of New Mexico

Introduction

The Domingo Baca Arroyo is located in northeast Albuquerque. The transition structure in question consists of an open channel converging and discharging into a 108" diameter culvert. The 108" diameter culvert is 24 linear feet and discharges into a 96" reinforced concrete pipe running under Carmel Ave., just south of Desert Ridge Middle School. A model built to the original design of Jeff Mortensen and Associates was reviewed in a prior report entitled "North Domingo Baca Extension at Barstow" (April 5, 2001). Photos 1 and 2 show the model from the prior report. The "existing conditions" flow rate is 538 cfs. The "future conditions" design flow rate is 1166 cfs. As the channel converged, oblique waves formed and converged in the center of the channel causing a large splash as shown in Photo 2. The splash occurred under both existing and future conditions.

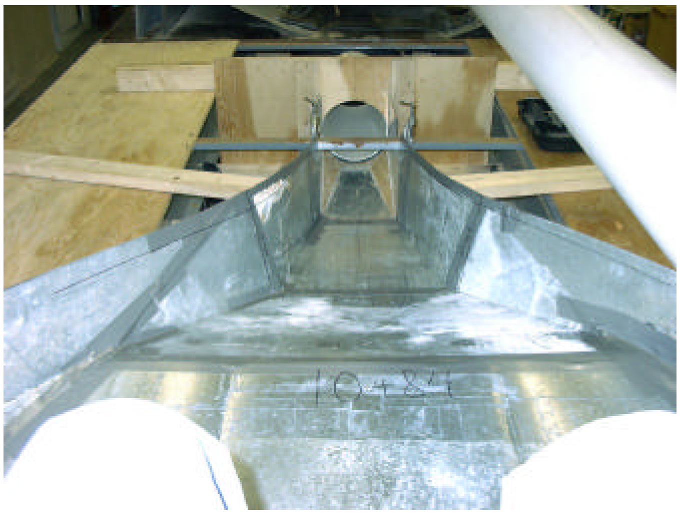

Photo 1.


Photo 2.

Modeling Objective

The objective of this project was to build a scale model altering the (originally designed) transition structure, and to use laws of similitude to determine the behavior of the water flow during existing and future condition flow rates.

Altered Transition

As in the original provided design documents, Stations 13+40 to 10+84 is an earthen transition from a natural sand bed channel to the steep concrete structure leading to a culvert. This earthen channel has a 0.0200 ft/ft bottom slope, 3:1 side slopes, and a bottom width that converges to 40 feet at Station 10+84. From Stations 10+84 to 10+24 is a concrete transition from the earthen channel to the 108-inch diameter culvert. The 108-inch diameter culvert is 24 feet long and discharges to a 96-inch culvert. The culverts do not flow under pressure.

The 60-foot long concrete transition structure (Stations 10+84 to 10+24) was the focus of this study. The redefined invert of the structure, as shown in Figure 1, drops 13 feet vertically from elevations of 5497.00 to 5483.98. The bottom width varies from 40 feet (Station 10+84) to 9 feet at the entrance of the culvert (Station 10+24). The channel sidewalls vary from 3:1 side slopes at Station 10+84 to vertical at Station 10+24. In the prior model, the vertical grade changed as shown with the dashed line on Figure 1. The upstream 30-foot section had a bottom slope of 0.2733 ft/ft. The downstream 30-foot section had a vertical curve as it entered the culvert. The bottom width of the channel varied from 40 feet at Station 10+84 (upstream) to 16 feet at Station 10+64 to 9 feet at Station 10+44. In both designs, grout is used in the bottom corners from Station 10+34 to Station 10+24 (entrance to the 108-inch culvert) to transition from a rectangular bottom to a circular bottom. The 108-inch culvert does not flow under pressure.

Model

Froude number similitude is required for open channel models so that the ratio of inertial and gravitational forces is the same for the model and for that which is being modeled. The pump in the lab has a capacity of approximately 2000 gallons per minute (gpm). A scale model, 1:10.8 of the actual size, was built so that the 108" diameter pipe could be modeled with a 10" diameter pipe. The corresponding "future conditions" design flow rate of 1166 cfs can be modeled using 1365 gpm and the existing conditions flow rate can be modeled using 630 gpm. A larger model (12" diameter pipe) would have required a model flow rate larger than the pump's capacity.

Tom Escobedo, UNM Technician, and Gene Valdez, UNM Civil Engineering student, constructed the model according to the instructions given by Dr. Coonrod. The model is shown in Photos 3 and 4.

Model Experiments

Photos 5 through 8 were taken looking downstream with the future conditions flow rate of 1365 gpm (1166 cfs). Under this future conditions flow rate, the height of the water never exceeds the height of the channel sidewalls. Some intermittent splashing was observed at the head wall of the culvert. In effect, the splash that occurred in the original design has diminished and been moved into the 108" culvert. As this splash hits the top of the culvert, there is a small amount of backwater which causes the splashing on the headwall. The model can only simulate steady state conditions and not a storm hydrograph. It is unlikely that this backwater effect can be achieved with a storm hydrograph that peaks at 1166 cfs. Nevertheless, the splashing observed in the model was contained by the structure under a steady flow of 1166 cfs.

Conclusions & Recommendations

The redefined transition structure as shown in Figure 1 can accommodate both the existing conditions flow rate of 538 cfs and the future conditions flow rate of 1166 cfs. Water flowing through the redefined transition structure maintains a smooth surface.

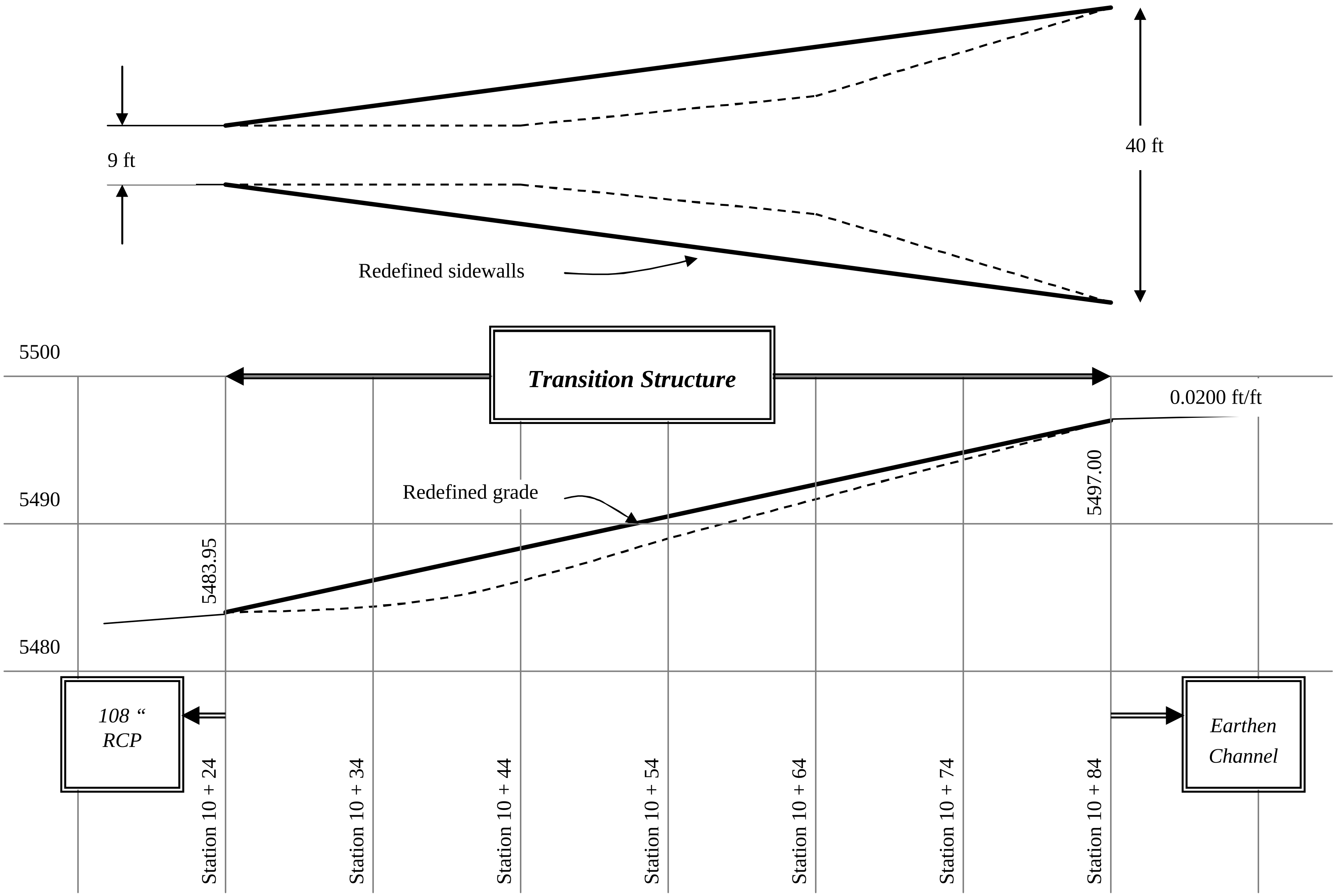

Figure 1. Plan and Profile of Transition Structure (Original Design and Redefined)

Photo 3.

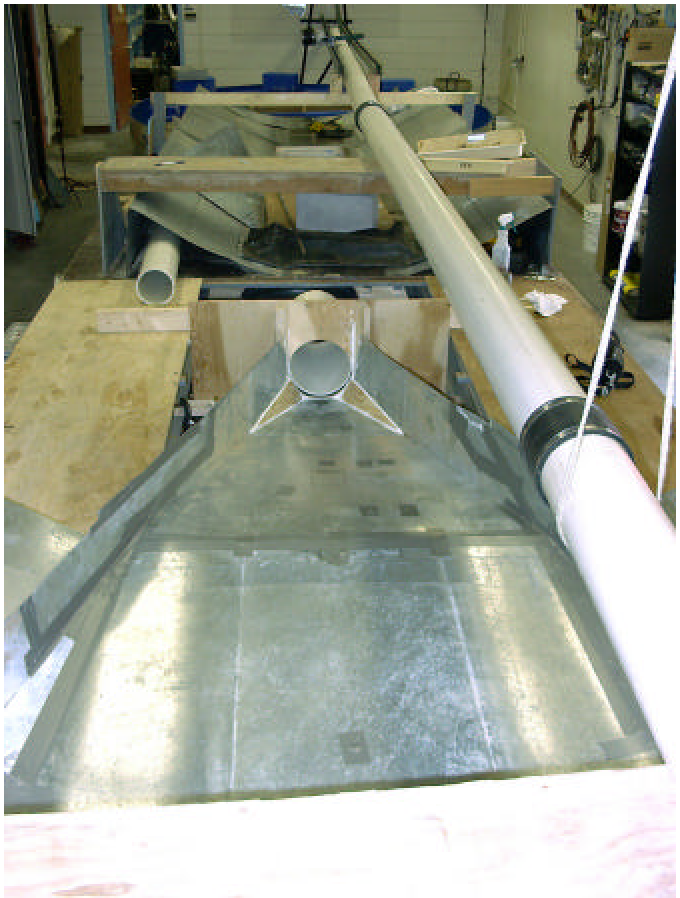

Photo 4.

Photo 5.

Photo 6.

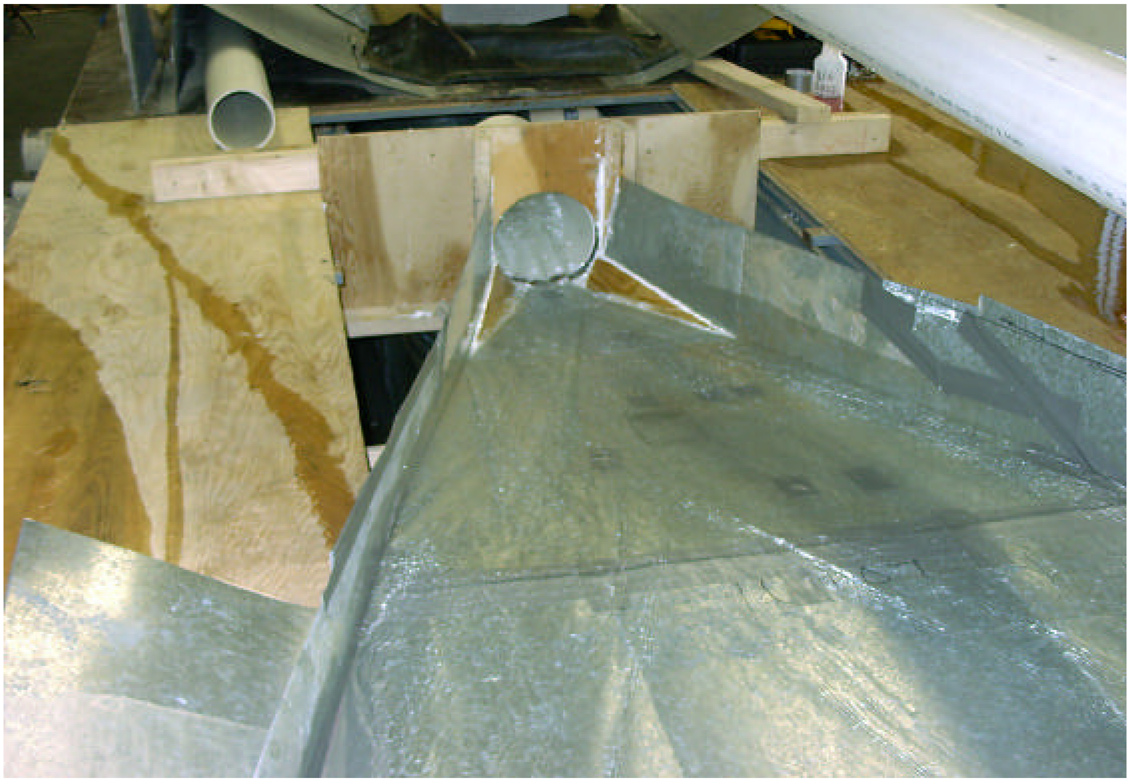

Photo 7.

Photo 8.