WATER MANAGEMENT ASPECTS OF THE TENN-TOM WATERWAY

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In December 1984 the final segments of the Tennessee-Tombigbee Waterway were completed. The Waterway connects the Tennessee River to the Gulf of Mexico at the City of Mobile. The project starts from the existing Black Warrior-Tombigbee channel at Demopolis and generally follows the Tombigbee River to its headwaters and cuts through the basin divide to connect to the Pickwick Reservoir on the Tennessee River. The total length of the project is 234 miles with 10 locks and dams which raise the water surface a total of 340 feet. The project can be divided into three distinct parts. The first part, known as the river section, consists of 4 low-lift locks and dams and channelization along the existing river alignment. Upstream of this section a series of pools were created along the left bank edge of the river valley. Five locks and dams raise the water level 140 feet in a distance of 46 miles along this Canal Section. At the upstream end of the canal section a high-lift lock and dam (84 feet) raises the water surface to the level of Pickwick Reservoir on the Tennessee River, 414 feet above sea level. A 39 mile channel excavated through the river basin divide completes the project to the Tennessee River. These major features are shown on Figure 1.

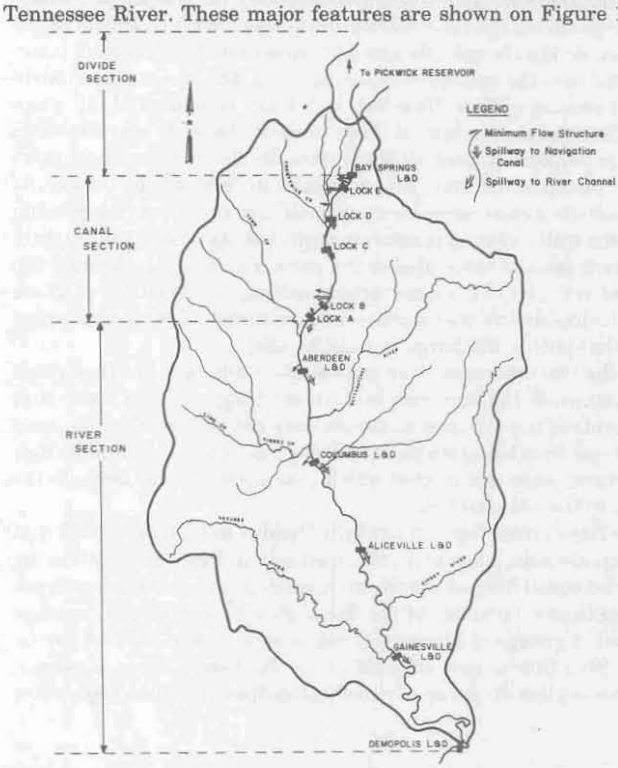

Figure 1 - General location of Tenn-Tom water control structures

The project has greatly changed the appearance of the river channel and valley and will have great impacts on land use and the economy of the region. However, this paper will deal primarily with several features involving the control of water in the project and the impact the project has had on the flow regime and hydraulics of the Tombigbee River basin.

The channelization has vastly changed the natural hydraulics of the river. A channel 300 feet wide and 9 feet deep has been superimposed on a natural river 100 to 200 feet wide and a few feet deep. In addition the channelization has straightened the river so that water has less distance to flow. The natural river channel in the river section of the project traversed a distance of 200 miles whereas the channel has shortened the distance of flow to 149 miles. Bank stabilization and snagging has reduced the hydraulic roughness. The result of these changes is a greatly more efficient hydraulic conveyance. Near the upper end of the channelization, five year to twenty year frequency flows are now accommodated by the channelization. Under natural conditions overbank floods would have occurred for the same discharge. Figure 2 illustrates the effect of the increased hydraulic efficiency resulting from the construction of the waterway.

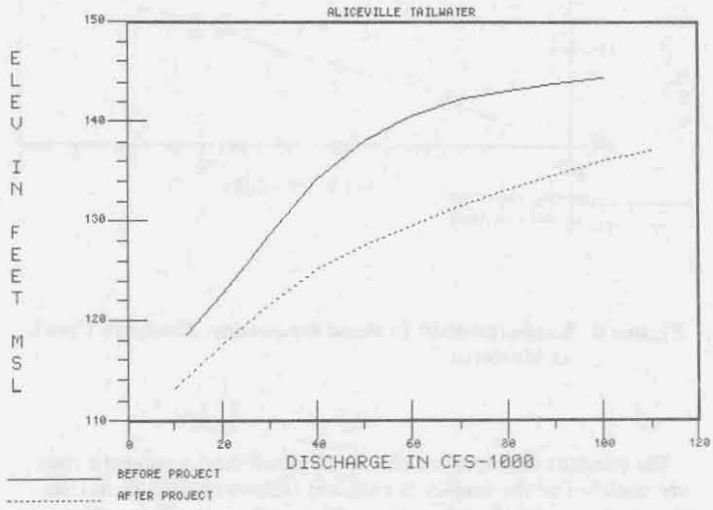

Figure 2 - Approximate change in stage/discharge relationship of the tailwater of Aliceville Lock and Dam.

Studies show that for larger floods the positive effects of the increased channel conveyance are diminished. This is a result of reduced overbank storage and flow area due to dredge disposal areas in the flood plains. The result is that stages for larger floods would not be as affected by the project.

Another change produced by the project is to the timing of the travel of the flood peak down the main stem of the river. At various tributary confluences with the main channel the tributaries peaked before or after the main river. With the project in place and the travel time reduced along the channelization, the coincidence or non-coincidence of the flood peaks has been changed. Locally this phenomena may have minor effects on flood heights, depending on the distribution and timing of the flood-producing rains.

A great impact on the flow regime of the Tombigbee River occurs in the upper basin along the portion of the river which parallels the Canal Section. In the Canal Section the navigation channel leaves the main stem of the river and is excavated in a series of pools along the east (left bank) side of the flood plain. The pools are created and separated from the main river channel by a levee constructed with material from the excavated channel. Five locks and dams raise the water level along this chain-of- lakes running parallel to the river. A number of changes in the flood plain result in a changed hydrologic environment in this section of the basin. Approximately one third of the flood plain has been diked and permanently flooded by the canal. This means that much of the valley storage capacity for storing and attenuating flood peaks has been removed. The result is higher flood elevations for the same discharge. An example of the expected result of this impact on stage frequencies is shown on Figure 3.

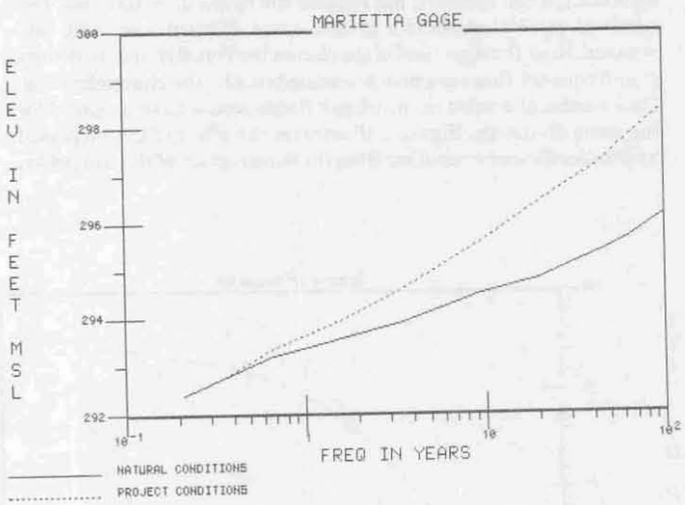

Figure 3 - Expected shift in flood frequency. Mackeys Creek at Marietta.

The points at which flows from east bank tributaries enter the river are modified by the project. Significant inflows into the Canal Section pools are discharged at two spillways from the Canal Section pools to the existing river channel. Between the spillway at Pool E discharging to Mackeys Creek and the spillway at Pool B discharging just downstream of the Tombigbee River's confluence with Bull Mountain Creek, runoff from about 200 square miles of drainage area is collected by the canal and discharged at the Pool B spillway. This would tend to quicken the response of that part of the basin since flows would be by-passing much of the old river channel and flood plain.

Another impact on the flow regime in the upper Tombigbee has been the use of the Canal Section by-pass structures at Lock B and the spillway at Lock A to carry flow - either excess lockage water or runoff from the eastern tributaries to the Canal Section - through the Canal Section. About 1,000 cubic feet per second can be discharged through the Canal in this manner.

To provide sufficient low flow to the bottomland tributary channels cut off by the Canal, structures to pass flows from the Canal pools to several of these tributaries were included in the project. These structures generally were sized to continuously discharge twice the 7-Q-10 flow.

The purpose of these flows is to preserve the environment of the East Fork river channel and associated bottomland. These flows may be modified if it is found that different flows are more satisfactory for the environment. These structures have been troubled - as have the Columbus and Aberdeen minimum flow structures - by accumulated drift blocking the flow passages. The structures are now being cleared on a regular basis and such continuing maintenance should ensure that the structures work properly. Futhermore, trash racks or trash barriers that are being planned should reduce this problem.

The changes in flow regime described above are primarily a result of the structural modifications of the channel system and not the operation of flow control facilities. However, there are some water control features that should be mentioned. Water control of the Tenn-Tom project is fairly simple. It is a slackwater navigation system in which each of the projects hold constant pool levels by adjusting flow control structures. Certain continuous flows are maintained at various points for water quality or environmental reasons.

Maintaining minimum continuous flows with acceptable dissolved oxygen from the river section dams was a design criteria of the project. At the Gainesville and Aliceville projects weirs were incorporated into the spillways of the projects. The weirs pass a fairly small amount of flow. However, in the dry summer and fall when low dissolved oxygen is most likely to occur, the weirs may discharge a large proportion if not all of the flow. Special re-aeration features were incorporated into the downstream side of the weirs. At Gainesville a re-aeration ramp insures that the sheet flow passing over the spillway crest is entirely aspirated. At Aliceville a slightly different feature accomplishes the same aeration. An elevated flip bucket at the toe of the free-overflow spillway aerates the flow. These two devices assure that a continuous minimum flow is discharged and that such a discharge is fully aerated.

At the two upstream river section dams different low-flow situations occur. Both dams were built in bend-ways in such a way that segments of the old river channels were cut off from flow. To keep the water from being stagnant in these cut-off areas, minimum flow structures were constructed which pass about 200 cfs through the dams to the old channel.

The Bay Springs Reservoir and the Divide Cut portion of the Waterway create a unique water control situation. Bay Springs Dam impounded runoff from 66 square miles drainage area of Mackeys Creek - a headwater tributary of the Tombigbee River. Natural average annual discharge of Mackeys Creek is about 100 cubic feet per second. This flow is now diverted to the Tennessee River. However, countering this diversion of runoff is the discharge of lockage water

to the Canal Section. Ultimately, this discharge may exceed ten times the flow diverted to the Tennessee River. Procedures have been established to account for the flow that Mackeys Creek would have carried as well as the volume of lockage water released from the project.

Even with the relatively low traffic on the Waterway during 1985, the net gain of the water to the Tombigbee River was significant. Figure 4 shows the monthly lockage release compared to the monthly Mackeys Creek diversion to the Tennessee River. For the first nine months of 1985 about 59,000 acre-feet of Mackeys Creek runoff flowed to the Tennessee River. About 150,000 acre-feet of water was used for lockages at Bay Springs. The net exchange of water was a gain of 91,000 acre-feet of water for the Tombigbee River.

Much of the discussion above regarding the effects of the project derives from design information which is now ten to twenty years old. A data collection network has been maintained, and in some cases augmented, to be able to assess whether the expected changes in the flow regimes are correct. Post construction data will be analyzed with current available models and state-of-the-art techniques. It should be possible in a few years to confirm and refine the information on the impact of the Waterway on flow regimes.

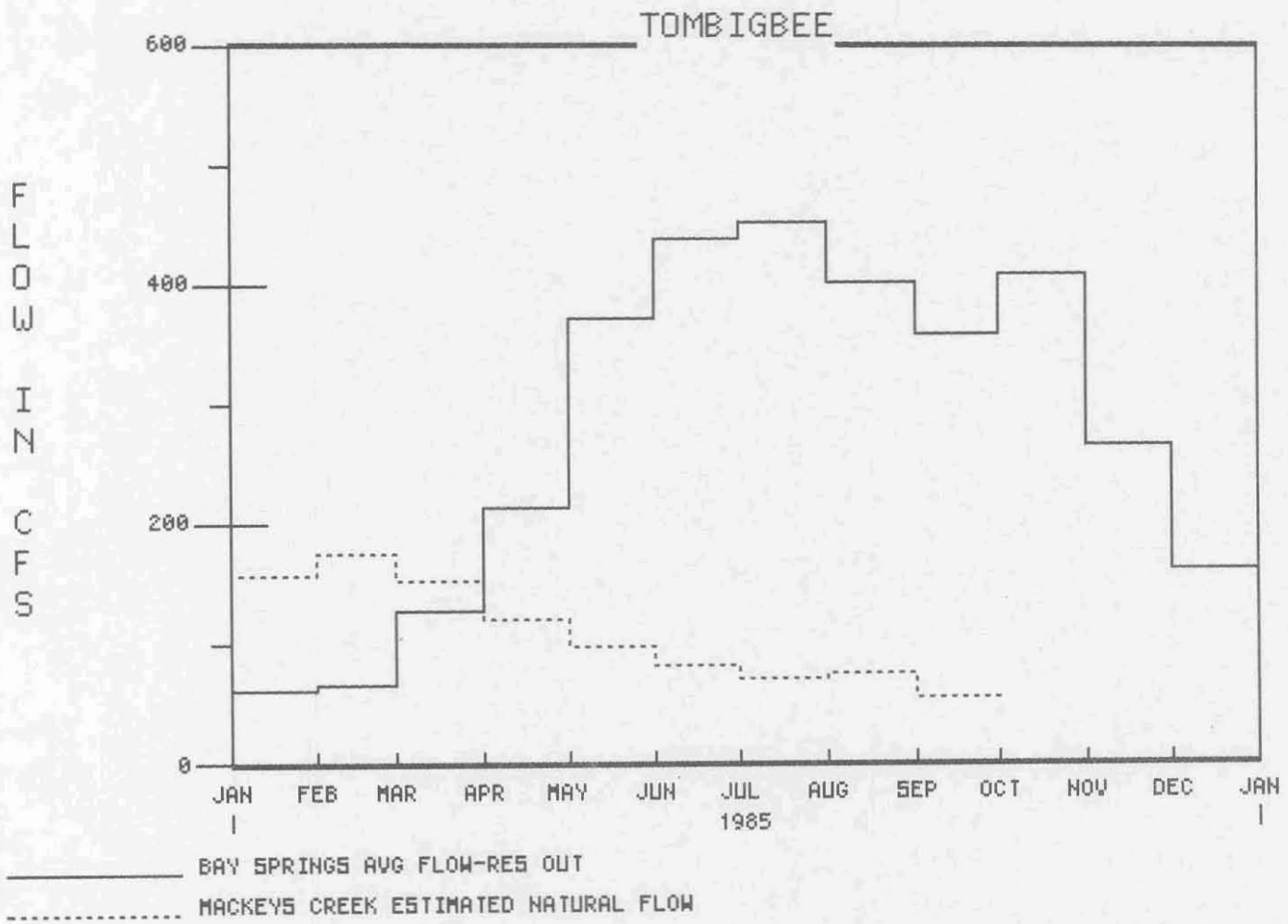

Figure 4 - Estimated monthly flow - Mackeys Creek and monthly discharge Bay Springs Lock.