APPENDIX B

UPDATES TO RIVER AND DRAIN STAGES

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MEMORANDUM

Date: August 22, 2016

To: Fatih Gordu, P.E.

Doug Durden, P.E.

Doug Hearn, P.G.

From: Tim Desmarais, P.E.

Subject: NFSEG – Updates to RIV and DRN Input (Abridged version)

Note: The following is an abridged version of the technical memorandum prepared yesterday August 21. Please refer to the complete version for processing details, files, and filepaths.

Introduction

The purpose of this memorandum is to document the procedure used to update the River (RIV) and Drain (DRN) MODFLOW input files for the North Florida Southeast Georgia (NFSEG) groundwater flow model. The updates consist of the following:

- Update the water surface and bottom elevation calculations to incorporate the 'new' USGS 3DEP topographic Digital Elevation Model (DEM).
- Adjust the water surface elevations as necessary to ensure a positive gradient in the downstream direction, incorporating the lake stage data (NHD-derived or from the SJR hydrodynamic model) along the way. This was done for all of the streamline segments (USGS's NHD+2 dataset), which incorporates the input to both the RIV and DRN packages:
    - RIV: Stream order 2 or greater
    - DRN: Stream order 1 or null (excludes 0 – coastlines)
- Bring the revised elevations into the appropriate pre-processing input files (RIV) or MODFLOW input files (DRN).

The updates to the RIV and DRN input consisted of two major changes:

- Update the water surface elevation and bottom elevation calculations to incorporate the 'new' USGS 3DEP topographic Digital Elevation Model (DEM).
- Revise previous methodology to ensure a positive gradient of water levels in the downstream direction, incorporating the lake stage data (NHD-derived or from the SJR hydrodynamic model) along the way. This was done for all of the streamline segments (USGS's NHD+2 dataset), which incorporates the input to both the RIV and DRN packages.

In the first step, the NHD+2 flowlines were intersected by the model grid and the lakes and a new unique identifier "SEG_ID" is created. Then, the polylines are converted to 3D polylines by assigning the land surface elevation from USGS 3DEP DEM (10m resolution). This creates additional vertices (in 3D space) at every change in DEM elevation (See **Figure 1**). Lastly, statistics for each polyline are computed (e.g., Mean/Min/Max elevation & slope, vertex count) and added as new columns in the flowlines.

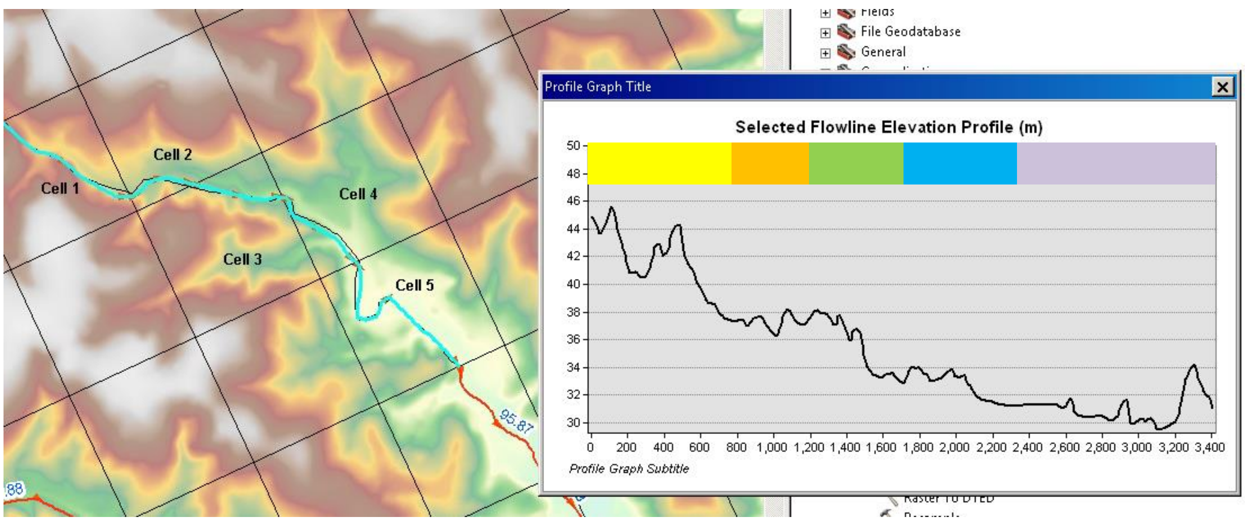
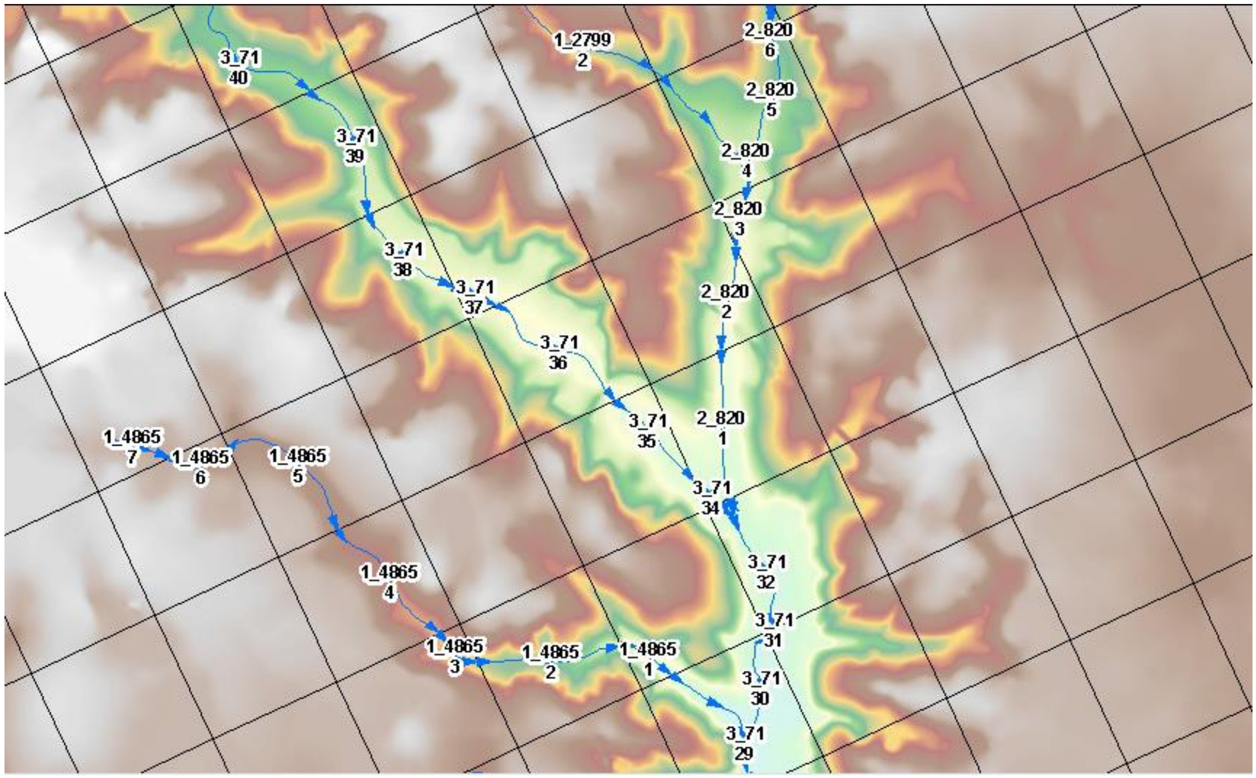


Figure 1. Plan and Profile Example for NHD 3D Flowlines

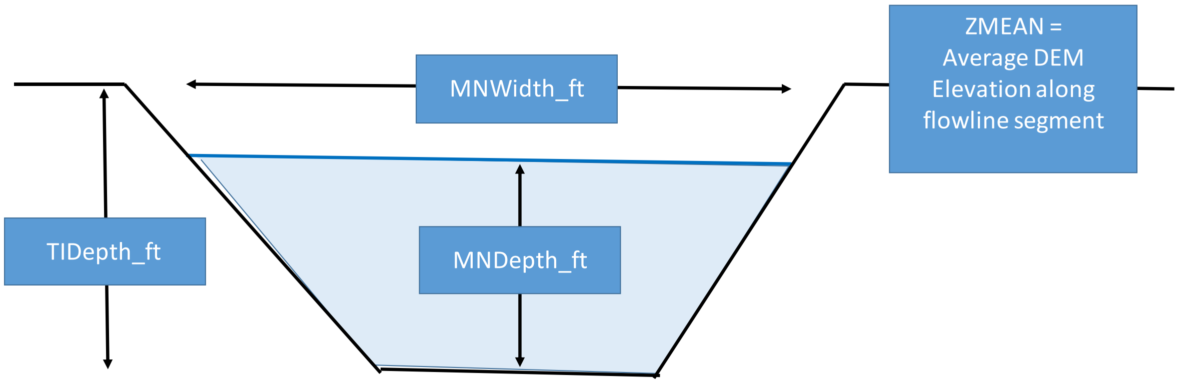
Next, a stream ordering system is applied based on an analysis of the starting and ending vertexes of the 3D flowlines (**Figure 2**). The resultant naming convention creates a group of 'strings', or groups of connected polylines, with a new group identifier (STRING_ID). The position of each 3D flowline segment within it's string is defined by the STRING_NUM column.



Note: the value on top is STRING_ID and the value on the bottom is STRING_NUM

Figure 2. Example showing Flowline Upstream/Downstream Naming Convention

After this, the DEM-derived elevations associated with the 3D flowlines are converted into an average stage and depth using data provided in the NHD dataset (EROM tables) and the empirical equations (with the Piedmont coefficients) from Appendix A of the EPA BASINS Technical Note 2 (EPA, 2007). The parameters and equations from this method, as well as how the depth term was converted to an elevation, are depicted in **Figure 3.**



$$\text{MNWidth\_ft}=11.95 * Q_{cms}{}^{0.47} * 3.28083\left(\frac{ft}{m}\right)$$

$$\text{MNDepth\_ft}=0.28 * (Q_{cms}{}^{0.22})*3.28083\left(\frac{ft}{m}\right)$$

TIDep_ft = 1.25*MNDepth_ft
Stream Bottom (RBotEl) = ZMEAN – TIDep_ft
Avg Stage (RStg) = RBotEl + MNDepth_ft

Figure 3. Calculation of River Stage and Bottom from Average Flow Estimates and DEM

Lastly, the lake stages were combined with the NHD-derived flowline stages and adjusted to produce water level profiles that both honor the lake stage data, the stages from higher-order connected streams, and comply with the upstream-to-downstream rules within the string itself. In the process, the NHD-derived strings (stages and bottom elevations) are thus ‘straightened’ by themselves first (see **Figure 4**) and the lake stages (and bottom elevations) are incorporated in a later process (see **Figure 5**).

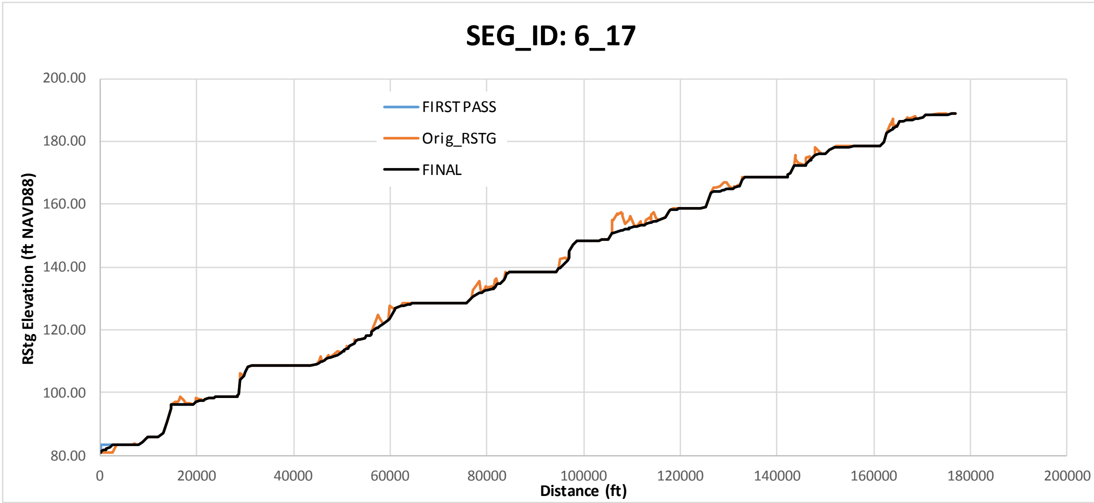


Figure 4. Examples of Typical NHD-only Adjustments

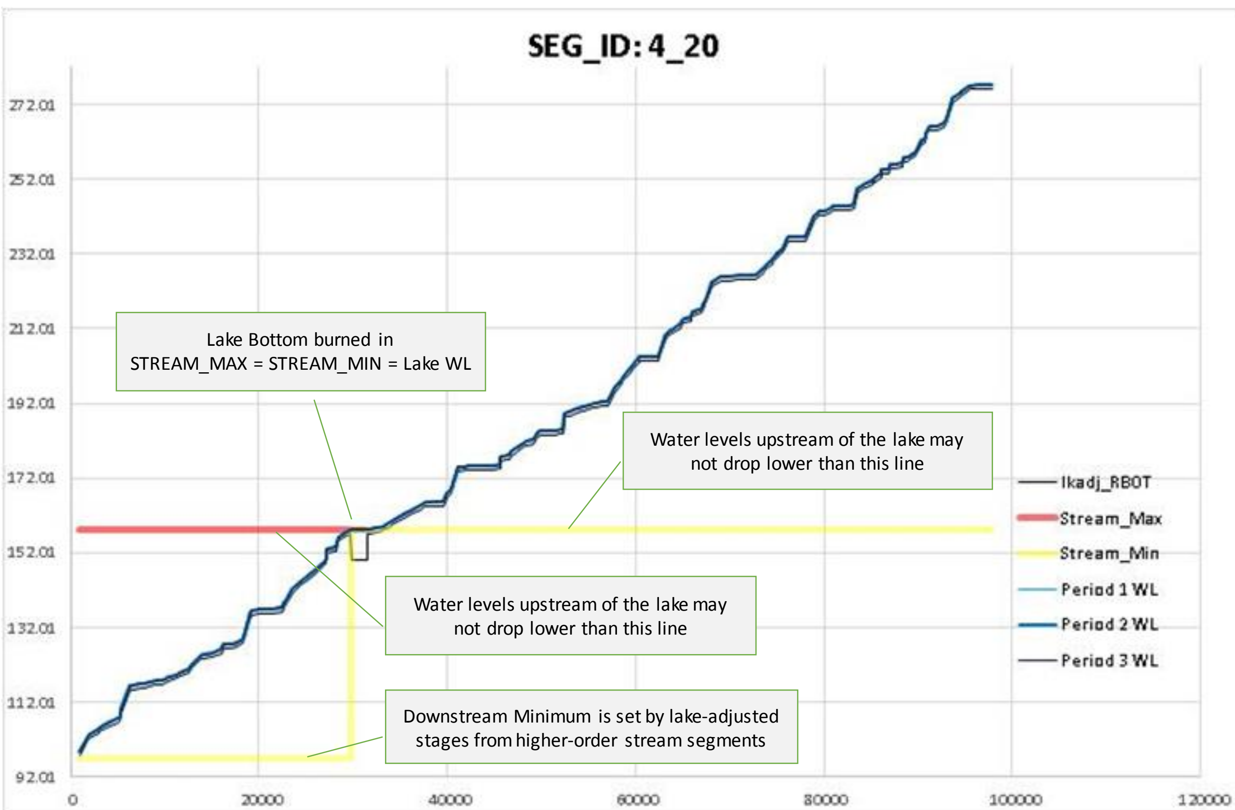


Figure 5. Example of Lake Water Levels Adjustment Step