HOLISTIC WATERSHED MANAGEMENT FOR EXISTING AND FUTURE LAND USE DEVELOPMENT ACTIVITIES: OPPORTUNITIES FOR ACTION FOR LOCAL DECISION MAKERS: PHASE 1 – MODELING AND DEVELOPMENT OF FLOW DURATION CURVES (FDC 1 PROJECT)

SUPPORT FOR SUTHEAST NEW ENGLAND PROGRAM (SNEP) COMMUNICATIONS STRATEGY AND TECHNICAL ASSISTANCE

FINAL REPORT. APPENDIX E
UPDATES TO OPTI-TOOL
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This subtask involved updating the user interfaces and developing VBA source codes for the Opti-Tool to adopt the functionality of groundwater/aquifer and FDC evaluation factor for the optimization from the EPA SUSTAIN version 1.2 model needed to meet the project goals. Currently, Opti-Tool is designed to optimize the treatment of overland flow, it does not include groundwater components comparable to those found in the EPA SUSTAIN model. Water that infiltrates to 'active groundwater storage' can move laterally and contribute to baseflow, percolate to the deeper groundwater or leave the groundwater through plant uptake. Adding the functionality of a SUSTAIN aquifer unit into the Opti-Tool provides tracking and attenuating infiltration for the water balance.

SCM Groundwater Recharge

The following steps were carried out to add the Aquifer module in Opti-Tool:

- Reviewed the functionality of GI SCM groundwater recharge linkage to local surface waters in SUSTAIN version 1.2 developed for EPA Region 10.
- Reviewed the GI SCM interfaces and VBA source codes for the current version of Opti-Tool developed for EPA Region 1.
- Developed user interfaces to incorporate the EPA SUSTAIN's Aquifer module into the Opti-Tool spreadsheet.
- Developed VBA source codes to integrate the groundwater/aquifer component for tracking baseflow and infiltrated water from GI SCM controls in Opti-Tool.

The *Implementation Level* interface was modified to add *Aquifer Information* (Figure 1) that requires the basic information including the aquifer name, initial storage, recession coefficient, seepage coefficient, and groundwater pollutant concentration (Figure 2). The user may define multiple aquifer systems depending on the size of the watershed (Figure 3) under the *Watershed Information* user input interface.
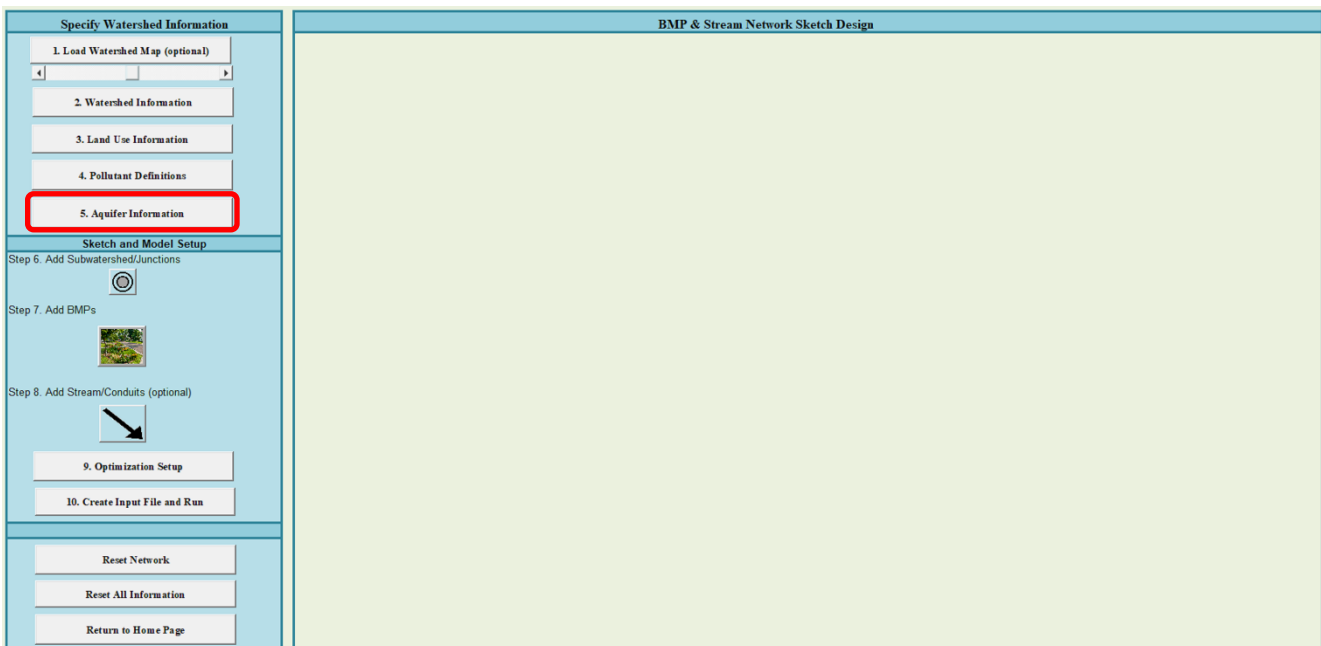

Figure 1. Aquifer information option in Opti-Tool.

Figure 2. Aquifer Information user interface window.

Figure 3. The number of aquifers option under Watershed Information window.

The aquifers are assigned to corresponding BMPs (Figure 4) or Conveyance (Figure 5) or Junction (Figure 6) by selecting Aquifer ID from the pulldown list on the respective interface window. The following notes describe implications for assigning aquifers to Junctions, BMPs, and Conveyance:

- Assigning an aquifer to Junctions: When an aquifer is assigned to a Junction, the groundwater component in the time series files that are added to the Junction are routed to aquifer storage.
- Assigning aquifer to BMPs: When an aquifer is assigned to a BMP, the groundwater component in the time series file that is added to the BMP is routed to the aquifer storage and the flow component that infiltrates into the background soil from the BMP is also added to the assigned aquifer storage.
- Assigning aquifer to Conveyance: When an aquifer is assigned to a stream/conduit, the released groundwater from the aquifer is routed to the conveyance. The aquifer to stream/conduit assignment is a one-to-one relationship. In other words, one aquifer can only be assigned to one conveyance, and only an individual stream/conduit can receive routed water from a single aquifer.

The groundwater inflow data in the HRU time series files are written in the column immediately following the surface runoff flow data. Once the contributing land uses (i.e., HRUs) are linked to an aquifer through either receiving junctions or BMPs, the groundwater inflow data in the time series are routed to the aquifer storage. If no aquifer is defined and linked, that column is ignored. The flow released from the aquifer to receiving streams/conduits is computed using the recession coefficient. In the case when the groundwater flow component in the time series files represents already routed flow (e.g., baseflow outflow from LSPC), the recession coefficient should be set to 1 to allow the groundwater flow directly added to the receiving conduit without further attenuation.
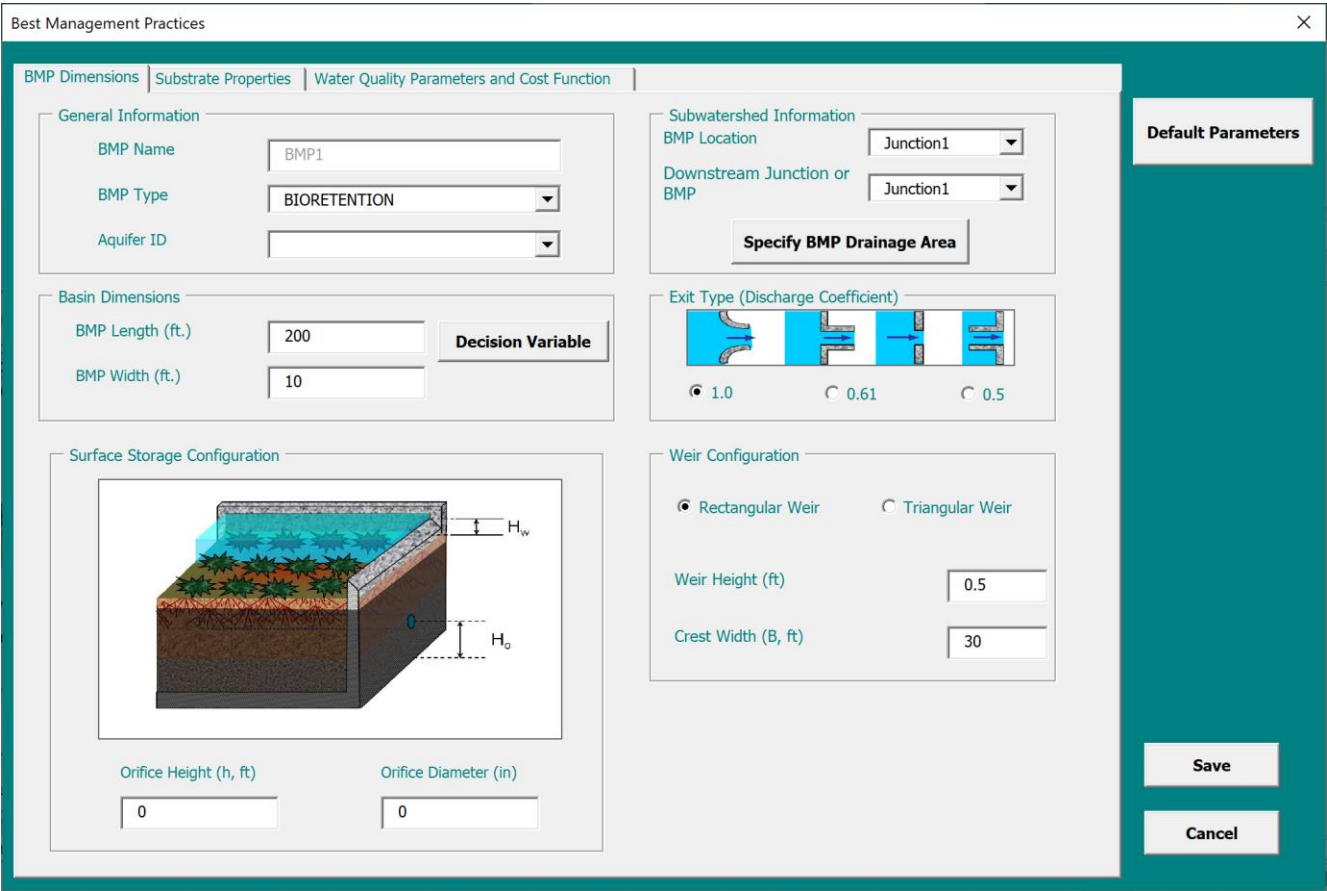
Figure 4. Aquifer selection under BMP Information user interface window.
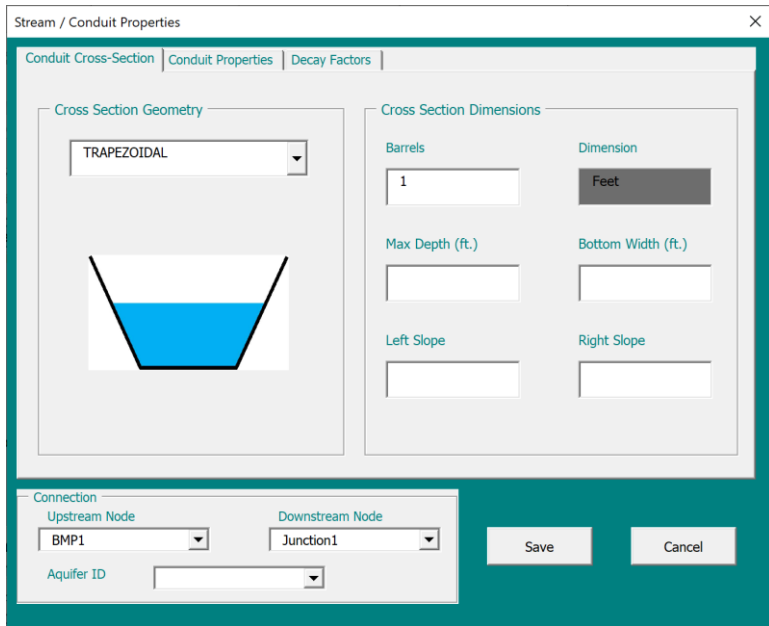
Figure 5. Aquifer selection under Stream/Conduit Properties user interface window.

Figure 6. Aquifer selection under Junction Properties user interface window.

Flow Duration Curve Evaluation

Following steps were carried out to add the Aquifer module in Opti-Tool:

- Reviewed the FDC evaluation factor used in the EPA SUSTAIN version 1.2 model.
- Updated the user interfaces to add the FDC evaluation factor as an option in the current version of Opti-Tool (Figure 7).
- Developed VBA source code in Opti-Tool to integrate the FDC evaluation factor for optimization simulations to identify optimal and most cost-effective management strategies to address impacts associated with the key critical flow regimes.

Figure 7. Flow Duration Curve selection under Optimization Setup user interface window.

The FDC Evaluation Factor is computed as the area between the evaluated condition and pre-developed condition FDCs, measured between the user-defined upper and lower percentile flow limits. In Figure 8, the green line shows the predevelopment FDC, the blue line shows the existing condition FDC, and the brown line is the FDC with BMPs. The dashed lines show the user-defined upper and lower flow limits (or thresholds) that bound the FDC comparison. That range is determined using the predevelopment condition FDC, hence the green-colored dashed line. The orange highlighted area between the red and green lines AND that falls within the upper and lower limits is the area computed for the FDC Evaluation Factor. When using the FDC evaluation factor for optimization, the objective is to minimize the area between the two curves bounded by the green and brown lines and alsobounded by the upper and lower percentile thresholds; flows outside of the target range are not considered.
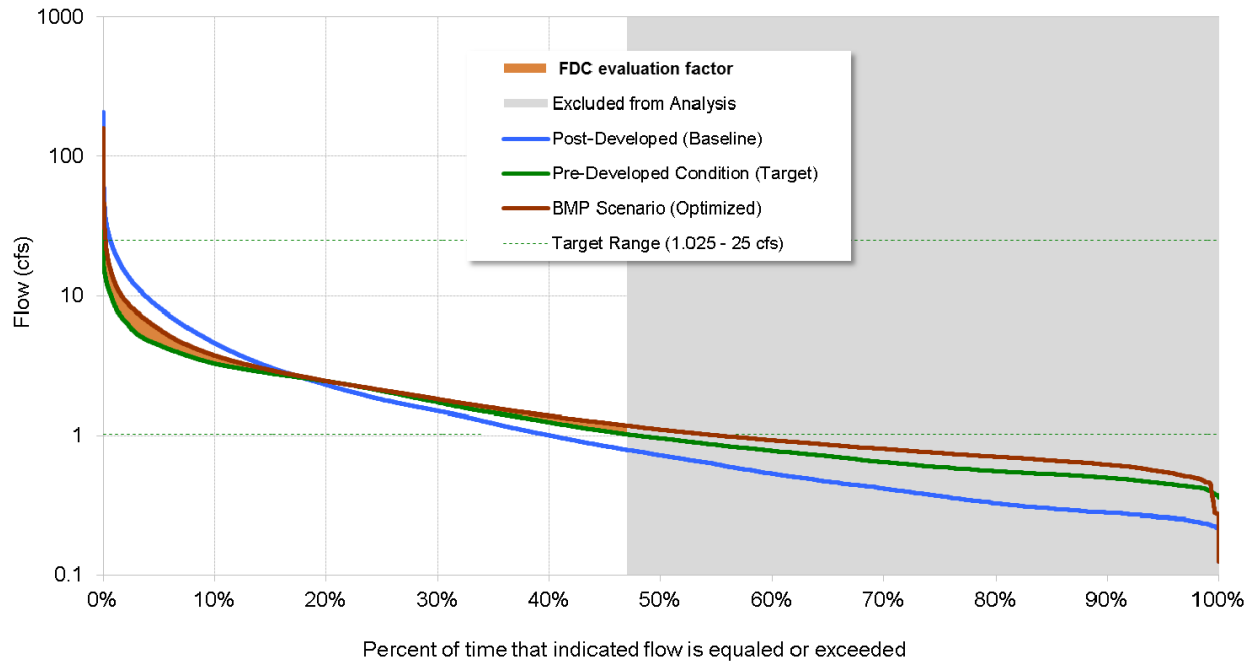
Figure 8. Flow Duration Curve evaluation factor.