Storm Water Management Model Analysis
ORNL Storm Water Collection System Up To Outfall 211

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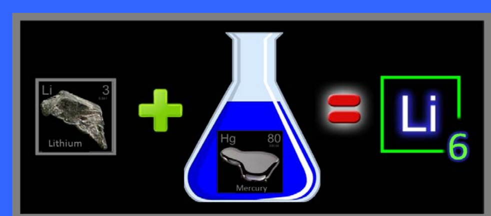
Introduction

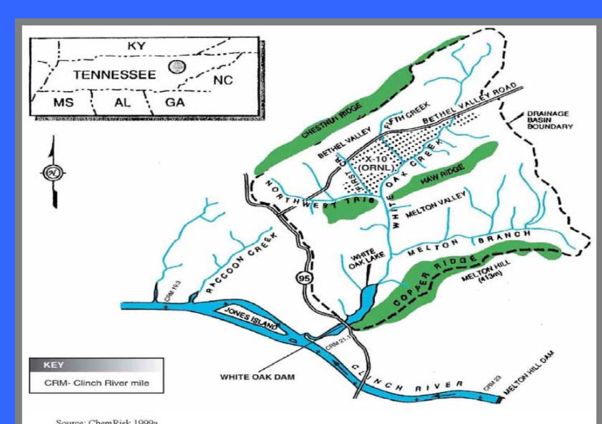
1950's DOE began the production of thermonuclear weapons in support of the Cold War. A key active ingredient in the design of the thermonuclear weapon was lithium-6 (Li-6) which is produced by separating lithium isotopes using an aqueous solution containing mercury (Hg).



Three separation processes that were utilized to extract Li-6 requiring large amounts of Hg:

OREX ELEX COLEX

1953 ORNL's Building 4501 was built as pilot plant to evaluate the OREX process for Li-6 separation to support the production of thermonuclear weapons. During the operations, it is estimated that 56,200 lb of Hg had been released to the environment causing soil and sediment, groundwater, and surface water contamination. As a result, the ecosystems surrounding the ORNL facilities — specifically White Oak Creek, White Oak Lake, and the Clinch River — have been contaminated.



Location of the White Oak Creek, White Oak Lake, and the Clinch River

The area of interest is approximately 4.5 acres composed of mostly impervious and rooftop areas. This storm water system is unique in that sources from the adjacent buildings, such as cooling water and condensate from various AC units contribute to the Outfall 211 drainage system as well as process water from the Creep Laboratory (Building 4500S). ORNL receives their water supply, public drinking water and process water, from the Oak Ridge Water Treatment Plant. The Oak Ridge Water Treatment Plant chlorinates the water for disinfection purposes hence the dechlorinator prior to its discharge into WOC. The boundary of the study is immediately after OF-211. The dechlorinator is not modeled in the simulations.

Area of Interest, ORNL 4500

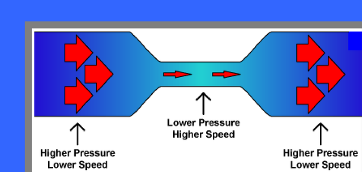
Outfall 211

Objective

In order to understand the transport of contaminants, it is critical to understand the flow of water. Thus, a hydraulic-hydrologic computer model has been developed in order to provide a better understanding of surface water flow rates and water stages during rainfall events. The resulting flow rates from the model may be utilized in conjunction with contaminant data to assess where remediation may be necessary.

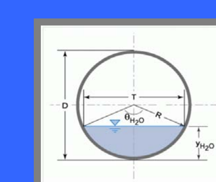
XPSWMM Model

- Spatially distributed link/ node network to analyze the hydraulic, hydrologic, and quality of a SW or WW system.
- GIS and CAD integration
- Applies the Saint-Venant equations to solve for the **1D unsteady open channel flow.**
- The Saint-Venant equations are composed of the **CONTINUITY, MOMENTUM, & ENERGY EQUATIONS** for incompressible fluids.



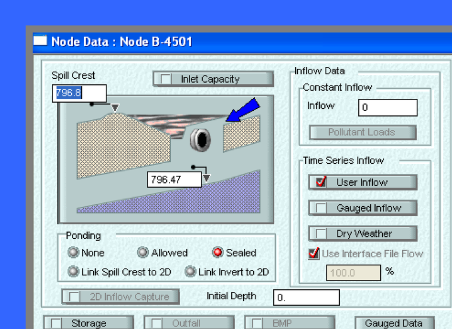
$$Q = A*v = (1.49/n)\, A\, R^{2/3}\, S^{1/2}$$

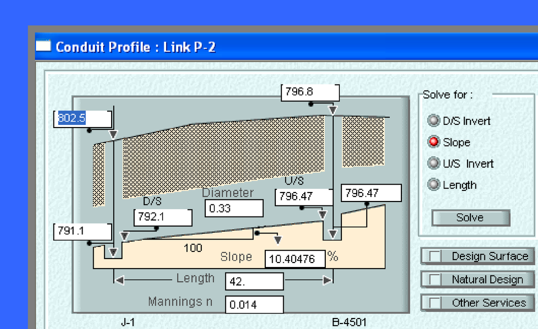
$$p_1/\rho + v_1^2/2 + z_1 = p_2/\rho + v_2^2/2 + z_2 + f$$

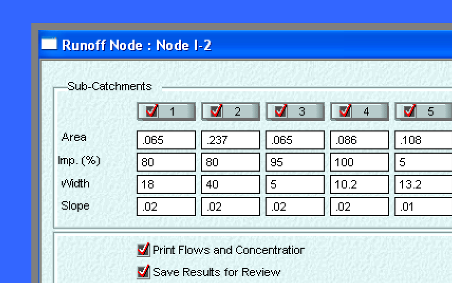


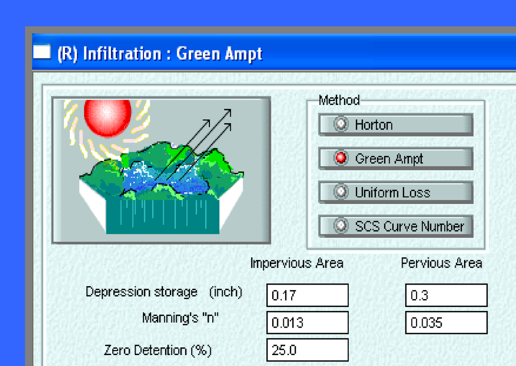
Where, Q is flow rate, A is area, v is velocity, n is Manning's roughness coefficient, R is hydraulic radius, S is slope of pipe, p is atmospheric pressure, ρ is density of water, z is elevation, f is friction

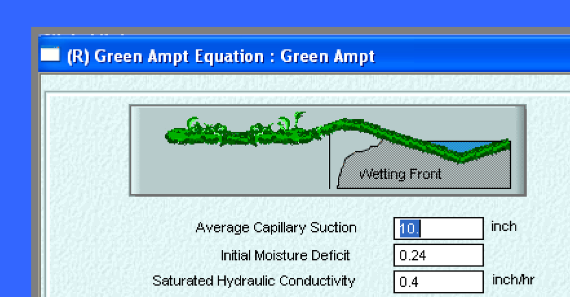
Input Data

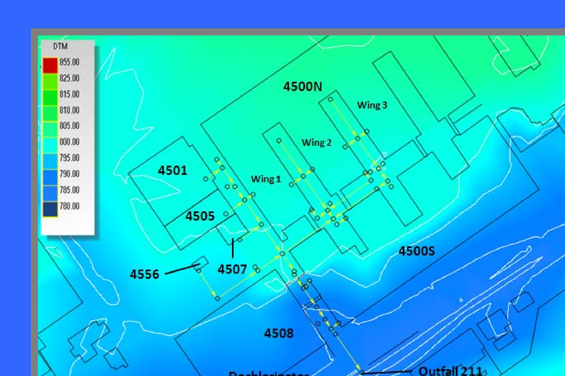








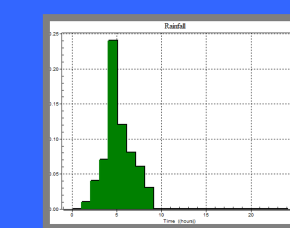




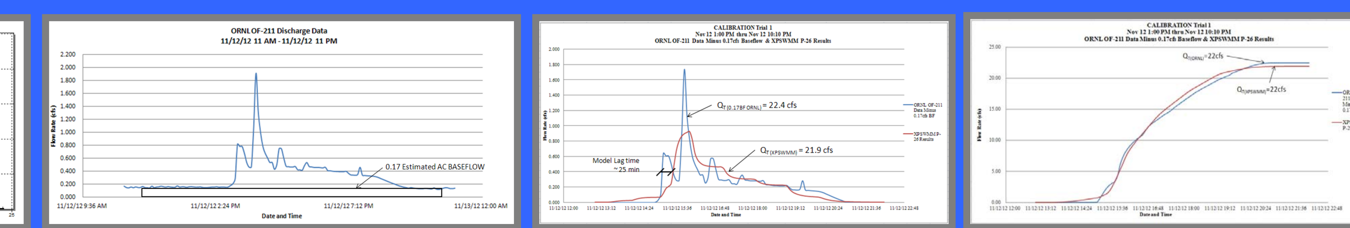
Digital Terrain Model

780 ft NAD to 810 ft NAD

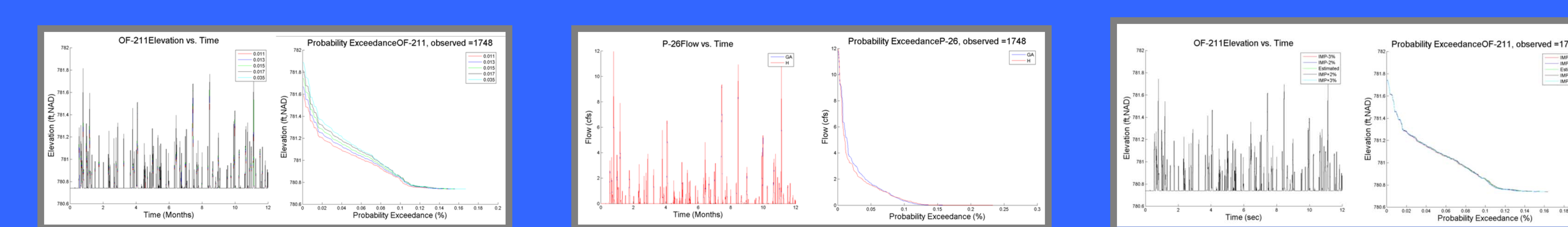
Calibration

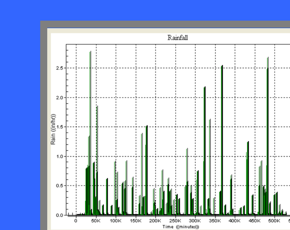


24 Hour
Rainfall Hyetograph

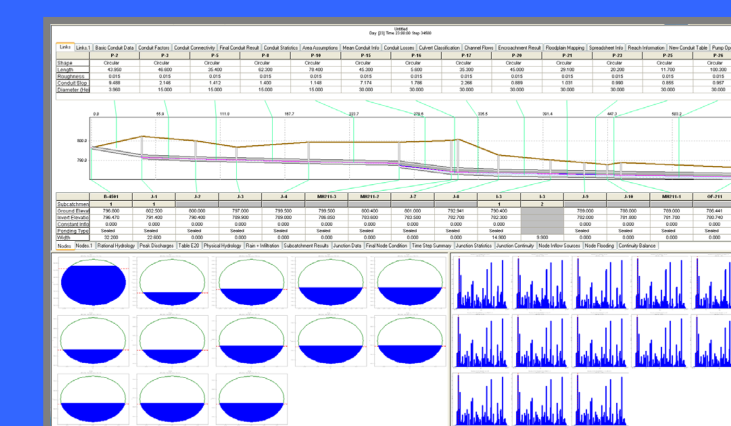


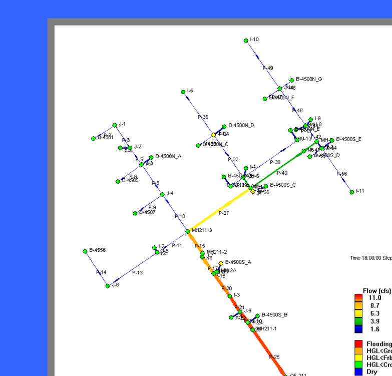
Sensitivity Analysis



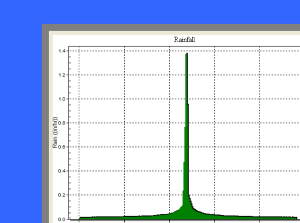


Year 2010
Rainfall Hyetograph

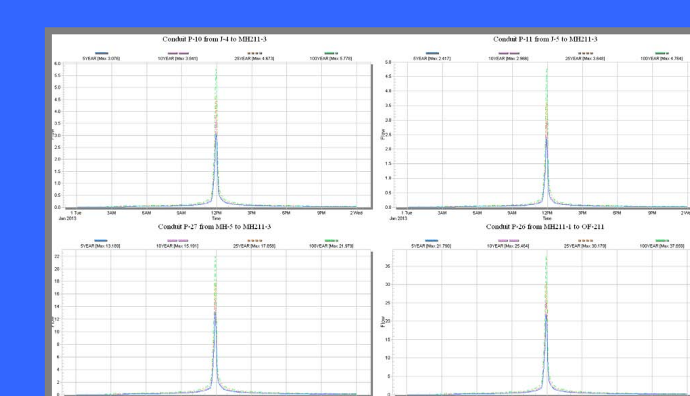


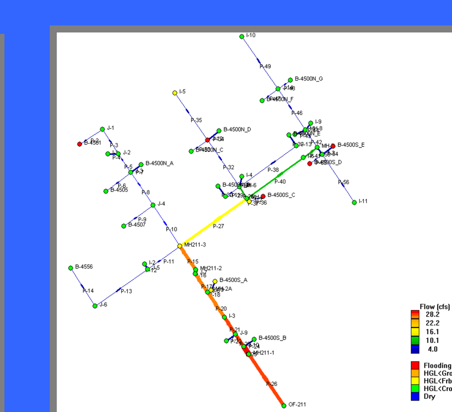


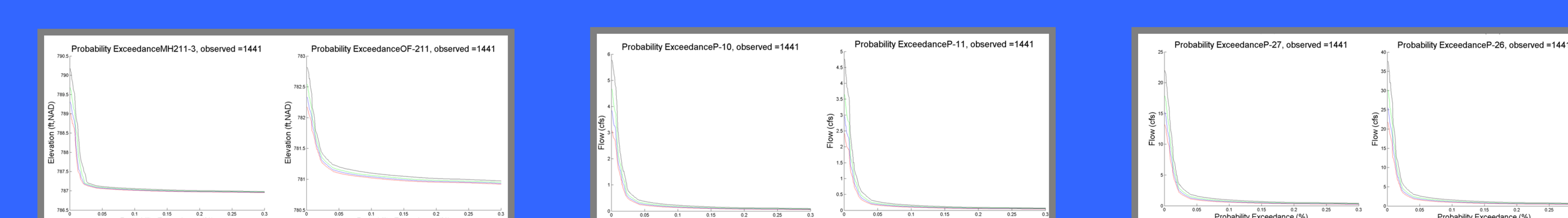
Design Storms



SCS Type II Rainfall Distribution
Unit Hyetograph







Conclusion

The model proves to be responsive to the precipitation by indicating similar cumulative flow rates during the calibration timeframes. Based on the nature of the model and that one would agree that the base flow rate of 0.17 cfs, once-through cooling water and steam condensate, occurs during the calibration duration then for the purposes of this study the model should be considered a valid source to aid in the prediction of flow rates within the system.

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