Modeling for Combined Sewer Storage Reservoirs and Tunnels in Chicago Metropolitan Area

David Kiel, US Army Corps of Engineers, Chicago District, Chicago, IL 60606, David.L.Kiel@usace.army.mil

Abstract: Due to a combined (sanitary and stormwater) sewer system, the Chicago metropolitan area has experienced significant combined sewer overflow (CSO) discharges to the Chicago River system. These CSOs have contributed to local flooding and a reduction in water quality for the river system and Lake Michigan. To alleviate the problem the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) has constructed a total of 103 miles of deep tunnels to capture the "first flush" of the combined sewers. These tunnels are constructed from 200 to over 300 feet below the ground surface and range from 10 to 33 feet in diameter. Vertical dropshafts intercept the CSO before it is discharged to the rivers.

To provide the necessary storage for flood reduction, three surface reservoirs with a combined capacity of over 15 billion gallons have been designed by the U.S. Army Corps of Engineers (USACE). All three reservoirs are connected to the deep tunnel system. Outflows from the reservoir are treated at the nearest water reclamation plant before being discharged to area waterways.

In order evaluate the effectiveness of the tunnel and reservoir systems the USACE, Chicago District conducted a 52-year period of record hydrologic and hydraulic modeling of the tunnels and reservoirs, in addition to modeling various synthetic storm events. The Hydrologic Simulation Program Fortran (HSPF) was used for the continuous simulation of the rainfall runoff process within the modeled basins. Combined and separate sewer systems were modeled using the hydraulic model Special Contributing Area Loading Program (SCALP) which simulates sewer overflows as well as interceptor flow conveyed to treatment plants from a total of 200 sub-areas. Recently, water quality modeling capability was added to the SCALP model including biological oxygen demand (BOD), dissolved oxygen (DO), and total suspended solids (TSS). The Tunnel and Reservoir (TARP) system deeps tunnels are modeled using TNET, a special application of the one-dimensional, unsteady flow model UNET, through a full network of open channels. This model routes the simulated SCALP overflows to 258 tunnel dropshafts, while also simulating the overall operation of the TARP system, including the operation of the main reservoir inlet gates, the operation of the dropshaft control gates, gravity inflow from the tunnels to the reservoir, pumping from the tunnels to one of the reservoirs, pumping from each reservoir to its treatment plant, and pumping from the tunnels to the treatment plant. The TNET model outputs flow and stage data both within the tunnels and the reservoirs, as well as water quality data within the reservoir. The model also predicts the canal system overflows from the individual dropshafts. Event inflow data, stage-duration data and water quality data are useful in determining the extent of potential odor problems and the design of the aeration and mixing plan. Stage-duration data is also useful in estimating duty cycles of the high and low head pumps. Overflow data is used in

determining the effectiveness of the reservoir in reducing CSOs and estimating flood benefits.