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RIVERSPILL: A REAL-TIME EMERGENCY RESPONSE AND PLANNING TOOL

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ABSTRACT

Ensuring water quality security is a high priority goal for the nation's public water supply. There are two important aspects to dealing with water quality threats: (1) being able to respond quickly to an actual event; and (2) planning and conducting exercises to be better prepared in the case of an emergency. RiverSpill is a GIS-based tool that provides the ability to model, using real-time stream flow data, the time-of-travel and concentration of toxic substances at public water supply intakes. The system uses a hydrologically connected stream network integrated with USGS gages and public water supply intakes. Riverspill assesses the consequences of a deliberate or accidental release of contaminants (chemical and biological) in surface waters.

INTRODUCTION

RiverSpill is a GIS based system that models the real-time transport of constituents within a river system. RiverSpill calculates time of travel and concentration based on real time stream flow measurements, decay, and dispersion of constituents introduced into surface waters. By selecting a location on a river to introduce a chemical or biological constituent, the model performs the following functions:

- Calculates the leading edge, peak and trailing edge concentrations and travel time using real-time stream flow data.
- Simulate fate and transport of the contaminants from instantaneous and continuous point sources.
- Tracks the chemical or biological constituent, under real time flow conditions, to a water supply intake.
- Determines the concentration of a contaminant as it decays and disperses within the water source.
- Associates an intake to a water treatment plant.
- Identifies the population served by the water treatment plant.
- Performs upstream tracing (by distance or time) to identify potential sources of contamination

INPUT PARAMETERS

The RiverSpill graphical user interface is shown in figure 1 and requires the following inputs:

- Agent Type - The chemical-biological agents in RiverSpill are selected from a pull down menu. The RiverSpill system gives three options for selection of the agents (user defined, list all agents, list agents by category). When an agent is selected, the physical, chemical, and biological properties associated with that agent are extracted from the database and automatically passed as inputs to the model.

Figure 1: RiverSpill Input Interface

- Release Type – RiverSpill can simulate two types of contaminant release, instantaneous and continuous
- Analysis Type - RiverSpill performs two types of analysis: calculation of peak concentration at a public water supply intake; or calculation of concentration at the intake from the time the leading edge of the contaminant plume arrives until the trailing edge of the contaminant plume leaves
- Stream Flow Data Source - There are three options for obtaining flow data: real-time flow, with automatic gage selection; real-time flow from a user-selected gage; or user-defined flow.
- Level of Concern - When a constituent is selected, its level of concern, determined from the literature is extracted from the database.
- Half Life - Half-life for contaminants is needed to calculate their decay rate. Where available, decay rates for all contaminants were taken from literature.
- Release Location – Point and click method to specify the map coordinates of the release.

RiverSpill integrates the following databases in order to perform down stream and upstream analysis:

- USGS Enhanced Reach File (ERF1)

- USEPA Public Water Supply Plants and Intakes (extracted from the Safe Drinking Water Information System, SDWIS)
- USGS Real Time Stream Flow

The following databases are used for post processing the results from RiverSpill:

- USEPA Sewage Treatment Plants (extracted from the Permits Compliance System, PCS)
- Risk Management Plan facilities (obtained from the EPA)
- National Inventory of Dams (obtained from the US Army Corps of Engineers)

The ArcView GIS (version 3.2) along with the Network Analyst extension is used to perform the downstream and upstream tracing analysis. Software (in Avenue and Visual Basic) was developed to perform the time of travel, dispersion and decay calculations.

RESULTS

The RiverSpill system has been developed to allow analysts to rapidly assess the time-of-travel and concentration of a contaminant to a public water supply intake. After a successful completion of the RiverSpill downstream tracing, an animation showing the flow path and the Peak concentration appears. The output from the scenario simulation can be displayed in either tabular or graphical form.
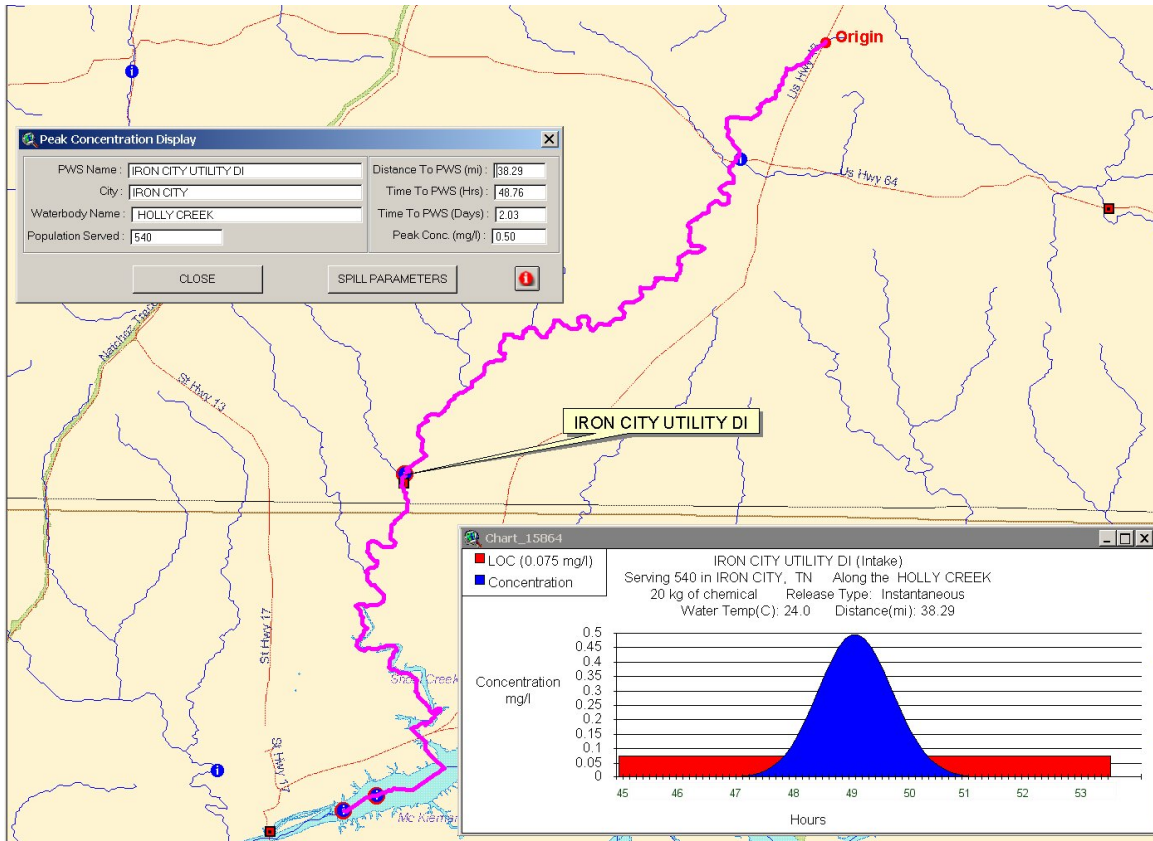

Figure 2: RiverSpill downstream tracing output

Figure 2 shows the RiverSpill output for a hypothetical spill. The figure shows the breakthrough curve for the plume, path of transport, and the following information associated with the intake: name of intake, water temperature, reach name, release type, distance traveled, source strength, and population served. RiverSpill creates a HTML format report that can be save or printed. The format of the report includes concentration-time graph, location map and information, and tabular data used for the graph.

Figure 3 shows the output from the RiverSpill upstream tracing function. The reaches are color-coded based on mean travel time from an intake located at the downstream section of the area of concern (100 hour maximum travel time area). Overlaid on this area are water treatment plants, sewage treatment plants, water supply intakes and risk management plan sites.
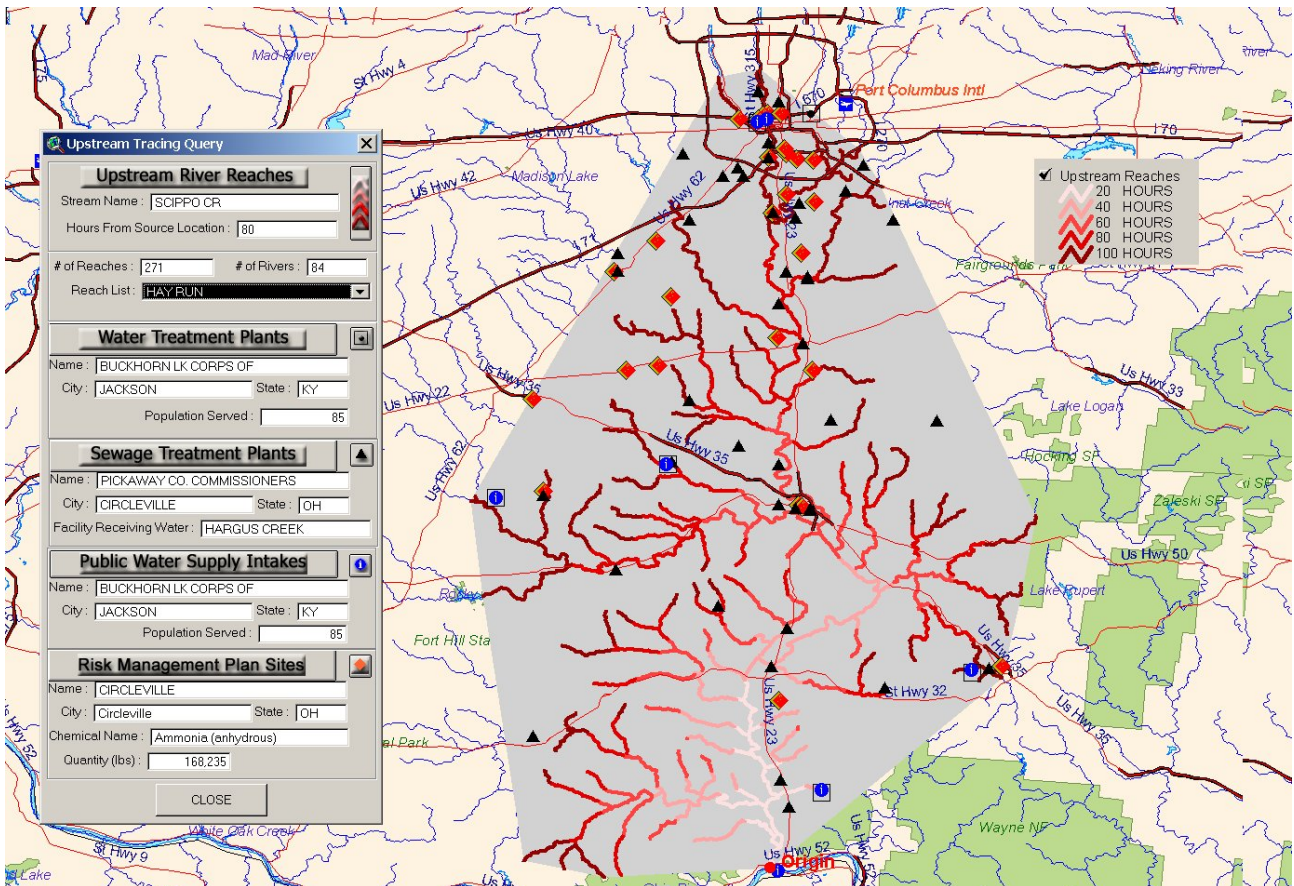

Figure 3. RiverSpill upstream tracing output

CONCLUSIONS

RiverSpill is an operational system for emergency response modeling of toxic spills in surface waters. It can quickly provide time-of-travel (based on real-time flow data) and concentration values to emergency managers who have to make rapid decisions about spill response. It can be used for contingency planning, exercise support and response to actual events. RiverSpill can also perform upstream tracing (based on time or distance) to identify potential sources of contamination. This project was funded by the Technical Support Working Group (TSWG) Infrastructure Protection (IP) sub-group, and the Environment Protection Agency (EPA).