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Project Summary

Receiving Water Quality Database for Testing of Mathematical Models

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Many mathematical models exist for *simulation of quantity and quality* parameters of receiving waters. Such models are frequently used in the evaluation of effects on receiving waters of pollution control alternatives such as advanced waste treatment and non-point source runoff abatement practices. Data for testing of such models, however, are hard to obtain.

This project has assembled detailed data sets, sufficient for model calibration and verification, for four rivers, two lakes and one estuary: Otter Creek, Vermont; Winooski River, Vermont; Chattahoochee River, Georgia; Lower Fox River, Wisconsin; Lake Okeechobee, Florida; Lake Jackson, Florida; Potomac Estuary, Maryland and Virginia. The data—contained in a report, on magnetic tapes and in addenda—include physical descriptions (e.g., reach lengths, cross sections), hydrologic and hydraulic information, inflows and outflows, pollutant loads, and in-stream concentrations.

This Project Summary was developed by EPA's Environmental Research Laboratory, Athens, GA, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Properly formulated and operated mathematical models, when coupled with appropriate data for calibration and verification, are tools of tremendous importance as aids in decision making for maintenance of receiving water quality. For example, models can aid in the evaluation of effects on receiving waters of advanced waste treatment and non-point source runoff controls.

This project focused on the collection of data for proper validation of mathematical representations of actual receiving water processes as well as for calibration (parameter adjustment) and verification (a check on previous parameter adjustments using new data) of models. The results are documented in the project report, with most of the data points available on magnetic tapes. The project focused on use of only a few good, well-documented sites, rather than inclusion of several sites for which only sketchy documentation would be available.

Data Sources

Many different groups were approached for data during the course of the project, of which most possessed candidate data sets. Major contributions were made by several offices of the U.S. Environmental Protection Agency (EPA), by the Geological Survey, U.S Department of Interior (USGS), and by the Corps of Engineers, U.S. Army. Other contributors included several state "environmental regulation" departments, river basin commissions, councils of governments, water management districts, universities, consultants, municipalities and the National Council for Air and Stream Improvement. Not all of these groups possessed complete data sets, but many contributed information to add to other data sets.

Site Characteristics

The seven sites included in the database are discussed briefly below, and their characteristics are summarized in Table 1 (rivers), Table 2 (lakes) and Table 3 (Potomac Estuary).

Table 1. Characteristics of the Selected River Locations

River Name	Length of Study Section (miles)	7Q10 Flow (cfs)	No of Point Sources	Parameters Measured	Approximate Frequency & Duration of Measurements	No of Stations	No of Independent Data Sets	Other Data****
Otter Creek	21	79	5	Temperature, D O, BOD_5, NO_3-NO_2-N, NH_3-N, TKN	4 hourly (for 3 days)	22	2	Point source BOD, NO_3-NO_2, NH_3, TKN loads Stream bed profile Daily precipitation + max & min air temperatures
Upper Winooski River	7.6	60	2	Temperature, D O, BOD_5, NO_3-NO_2-N, NH_3-N, TKN (Ortho-P Total-P, Chlorophyll a, one data set only)	4 hourly (for 2-3 days)	12	2	Point source BOD, NO_3-NO_2-N, NH_3-N TKN loads Stream bed profile Daily precipitation + max min air temperatures
Chattahoochee River	43	980*	7	Temperature, D O, BOD_5, pH, Total-N, Organic-N, NH_3-N, NO_2-N, Total-P, Ortho-P, Fecal Strep, Trace metals, Suspended solids**	1-9 per day (for 1-4 days)	31	4	River bed profile. 41 river cross-sections 41 Mannings Coeffs limited land use data.
Lower Fox River	39	950	33	Temperature, D O, BOD_5, Secchi depth, Organic N, NO_3-NO_2-N, Total-P, Soluble-P, % volatile solids***	Daily (for 1 day)	49	9	49 mean cross-sectional depths. River bed profile Point source BOD loads

*Estimate Flow is regulated
**Some parameters not measured at all stations
***Not all measured in all surveys Some surveys contain only temperature & D O
****Measured flow rates are available for all except the Lower-Fox River, which was estimated Measured and/or estimated flow velocities are available for all rivers

Table 2. Characteristics of the Selected Lake Locations

	Lake Okeechobee	Lake Jackson
Watershed Area* (sq miles)	4,600	42 2
Lake Area (sq miles)	706	6 25**
Mean Depth (feet)	9 2	5 6**
Trophic State	Eutrophic	Mesotrophic
Residence Time (years)	1 0	0 7**
Parameters Measured	Temperature, D O, Specific Conductance, pH, Secchi Depth, Turbidity, Color, Total Suspended Solids, Ortho-P, Total-P, NO_x-N, NO_2-N, NO_3-N, NH_4-N, TKN-NH_4-N, Total N, Total Fe, A^- Alkalinity	Temperature, pH, alkalinity, turbidity, suspended solids, Secchi Depth, Specific Conductance, Color, NO_3-N, NO_2-N, NH_3-N, Ortho-P, Total-P, Total dissolved P, D O, (+ some chloride & sulfate)
Approximate Frequency & Duration of Measurements	Biweekly to monthly (for 7 years)	Monthly (4 studies covering 10 years)
Number of Stations	8 & 40	10 (not in same position for all studies)

*1 square mile - 640 acres.
**These figures are based on a stage of 87 ft-MSL In recent years the stage level has varied considerably

In general, suitable data for rivers and streams are plentiful; these data were the easiest to obtain for the project, and several alternative data locations exist The four selected river sites, which were among the best documented of those encountered during the project, were chosen so that both small and large rivers would be represented.

Although lake data are numerous, well-documented comprehensive studies are not. The two lakes selected were chosen primarily because of their comprehensive nature and proximity to the University of Florida, which made it possible to obtain the necessary ancillary information Most other comprehensive lake studies (e g, Lake George in New York) are not concisely documented and/or have non-computerized data sets.

Sites for estuaries and bays have similar problems to those for lakes The selected site (the Potomac Estuary) possesses an enormous history of studies and data, but has the advantage of a recent, computerized database Although the Delaware Estuary also has a long history of water quantity and quality studies, it has not received as much recent attention as the Potomac, and its

Table 3. Characteristics of Potomac Estuary Location

Length (miles)	*117*
Average Flow (cfs)	*10,000*
Point Sources	*13 POTW's monitored and estimated*
Non-Point Sources	*CSO's monitored in D C, others estimated*
Parameters	*Temperature, D O, Salinity, BOD_5, Nutrients, misc*
Frequency and Duration	*1968-1981, intensive, 1979-80, weekly plus some storm event and diel*
Number of Stations	*25 EPA, 34 USGS*
Other Data	*Miscellaneous cross sections, meteorological, navigation, maps, etc*

data are mostly contained in the STORET files During the course of this project it was found that documentation of even one estuary of the degree of complexity of the Potomac was a large task, hence, only one estuary site was included

Otter Creek, Vermont

Otter Creek is a stream in the Champlain Valley in western Vermont It is about 100 miles long and empties into Lake Champlain. Intensive surveys during the low-flow conditions on August 1-3, 1977, and August 1-3, 1978, were performed as part of a wasteload allocation study by the State of Vermont Agency of Environmental Conservation on a 21-mile segment of the stream

Upper Winooski River, Vermont

The Winooski River flows from Washington County westwards through Montpelier to Lake Champlain It is about 90 miles long and has a drainage area of 1080 square miles. The study area contains 3.4 miles of the Stevens Branch immediately upstream of its junction with the Winooski River, and 4.2 miles of the Winooski River from just above its junction with the Stevens Branch downstream through Montpelier This section of the Winooski has two small tributaries in addition to the Stevens Branch

The studies on this river also were performed as part of a wasteload allocation study by the State of Vermont Agency of Environmental Conservation. Intensive water quality surveys were performed under low-flow conditions on August 22-24, 1978, and July 9-11, 1979.

Chattahoochee River, Georgia

The Chattahoochee River flows southwards from the mountains of north Georgia to Lake Seminole on the Georgia-Florida border The section used in this study is a 43-mile segment from Atlanta downstream to Whitesburg In addition to effluent from seven sewage treatment plants, this segment receives runoff from urban and cultivated areas Several small tributaries enter the river Extensive water quality data are available on this segment of the Chattahoochee River, collected by the USGS, State of Georgia and others. The main difficulty is to choose a cohesive data set Four low flow studies from 1976 and 1977 that have been used for model testing by the USGS and others were selected

Lower Fox River, Wisconsin

The Lower Fox River is 38.9 miles long and flows from Lake Winnebago to Green Bay. The river is heavily utilized, receiving effluent from 32 sources, including 13 sewage treatment plants Five small tributaries enter the river and water is withdrawn at 15 points (mostly for industrial use). The data presented in the full report are drawn from a wasteload allocation study by the Wisconsin Department of Natural Resources from 1972 to 1977

Lake Okeechobee, Florida

Lake Okeechobee is situated in south Florida, north of the Everglades. With an area of 706 square miles, it is the second largest freshwater lake in the United States. This eutrophic lake is surrounded by a large dike to protect surrounding areas from flooding during a hurricane. All inflows and outflows are controlled as they pass through the dike so that the lake level can be regulated. The water budget for the lake is not well determined, however, because of difficulties in calculating the amount of precipitation and interactions with ground water

Lake water quality was monitored extensively from 1973 to 1980 by the South Florida Water Management District, which is responsible for regulation of the lake. Input-output, systems, and complex hydrodynamic models have been applied to Lake Okeechobee The dynamics of nutrient cycles in the lake have been investigated, and some spatially lumped models for nitrogen and phosphorus have been developed.

Lake Jackson, Florida

Lake Jackson is situated on the outskirts of Tallahassee in northwest Florida. This mesotrophic lake has an area of 4,000 acres and is situated in a watershed of 27,500 acres. The lake is largely flat bottomed, and few areas are deeper than 14 feet. There are no exit channels from the lake, so that the only inputs are rainfall and runoff, and the only outlets are evaporation and groundwater recharge. The hydrologic history shows wide fluctuations in the lake level in response to annual rainfall. The data presented in the full report are based on studies by several Florida agencies from 1971 to 1981

Potomac Estuary, Washington, D.C.

The Potomac Estuary extends 117 miles from Chain Bridge in Washington, D.C., to Chesapeake Bay. The estuary is well mixed vertically so that saline wedge effects rarely occur. Mathematical modeling of the Potomac Estuary was begun in the 1960s by predecessor agencies to the EPA, and many programs of data collection have been reported The selected period (1979-1981) includes intensive and synoptic studies sponsored by the USGS, EPA and Washington, D.C., Council of Governments Modeling activity on the Potomac is also extensive

Other Locations

Alternative data locations also discussed in the full report include Willamette River, Oregon; Arkansas River, Colorado; Ouachita River, Arkansas and Louisiana, Lake George, New York, Onondaga Lake, New York, Delaware Estuary, and San Francisco Bay.

Database Format

Site descriptions, maps, pollutant sources, rate constants, etc., are given in the full report as much as is possible. Measured receiving water quality data values are presented on magnetic tapes Modeling data for several sites are also included on the magnetic tape available from the EPA's Environmental Research Laboratory, Athens, GA. In some instances (e g , the Fox River) the modeling data also serve to document point and non-point source loads to the receiving water. In a few instances, some useful but bulky information (e.g., stream cross sections) is available as an addendum to the full report This information has been retained in files at the University of Florida

Sufficiency of Project Data for Model Testing

Can the information supplied for the seven sites by this project be used by itself for model testing? Probably not. Considering that most sites are documented with multiple reports of hundreds of pages, it is unrealistic to assume that all the information anyone would need about a particular site could be included in a single report. Modelers will want to obtain some of the references listed for a site in order to obtain needed information, although it is intended that the material presented in this project could certainly initiate a modeling study. In addition to the site summaries and references, the primary value of this project is the presentation of the voluminous in-stream data in a machine readable format on magnetic tapes This should eliminate a considerable task of most modeling projects.

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The complete report, entitled "Receiving Water Quality Database for Testing of Mathematical Models," (Order No. PB 84-220 300; Cost: $23.50, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
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