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Project Summary

Integrated Control of Combined Sewer Regulators Using Weather Radar

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In this study, the possibility of reducing the extent of overflows from combined sewer systems was studied. In general, when no in-line or other in-system storage is used, integrated regulator operation has no advantage over local automatic-dynamic regulator control unless (1) expected flowrates to the interceptors are estimated before they occur, and (2) an operational bias is introduced that either minimizes overflows from only some of the regulators on an interceptor or favors the timing of overflows from all of the outlets, such as after the initial storm period. A review of the capabilities of digital recording weather radar indicates it has the best potential for estimating rainfall needed for flowrate predictions. Other possible uses for such radars in metropolitan areas were considered, particularly their use as part of urban flood warning systems. The possibility of inducing in-line storage in collector sewers to gain greater flexibility with integrated regulator operation was also considered.

This Project Summary was developed by EPA's Municipal Environmental Research Laboratory, Cincinnati, OH, 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

Large construction projects involving extensive new storage, transport, and treatment facilities are often proposed for combined sewer overflow pollution control. The purpose of this study was to explore the technical feasibility of less costly measures that might prove adequate with less stringent abatement requirements or as a first step.

To what extent can overflows from conventional combined sewer systems that typically divert some stormwater via regulators to interceptor sewers be reduced? The real-time, integrated operation of all interceptor dynamic regulators from a central computer was postulated as a way to increase efficiency When no in-line storage in collector sewers or other in-system storage is available, integrated operation can only have an advantage over independently operated regulators when flowrates to an interceptor can be estimated in advance of their occurrence. Recently developed special weather radar with storm tracking and rainfall measurement and prediction capabilities made exploration of the integrated operation hypothesis particularly timely. Because using radar only with the integrated control system limits its attractiveness, other uses for radar in metropolitan areas were considered, particularly its use for urban flood warning systems.

Latitude in operating a combined sewer system is determined by how flexibly the system can be manipulated. In general, only by adding new storage capacity can the flexibility, and hence operational latitude, of a conventional system be increased. Altogether, new

off-line storage is very costly. There have been a few instances where in-line storage has been induced in existing collector and outfall sewers by installing adjustable dams or gates in them at relatively modest cost. The potential for exploiting in-line storage to gain greater flexibility with integrated dynamic regulator operation was considered.

Conclusions

Integrated Regulator Operation

To minimize overflows, automatic-dynamic combined sewer system regulators are operated under a local control mode whereby each regulator is actuated only in response to the stage of flow in the interceptor in its immediate vicinity. Using automatic dynamic regulators is a substantial system improvement over the more commonly used perpendicular weirs, side weirs, and other "static" regulators that are non-responsive to flow conditions In Montreal (Quebec, Canada) where no in-line or other in-system storage is available, the feasibility of integrating the operation of all dynamic regulators on a conventional interceptor system by the use of a centralized automatic control scheme was explored. No advantage over local automatic-dynamic regulator control accrues from this centralized control unless flowrates can be predicted adequately in advance The minimum necessary lead time equals the flow travel time between the regulators furthest upstream and downstream among those to be operated collectively.

Even if flowrate prediction is used, the diversion of flows by the regulators must be programmed to minimize overflows at one or more particular regulator, or at some time period over the duration of storm event (e.g , during the "first flush"), or both. That is, use of a weighting function is also required.

Even if both flowrate prediction and a weighting function are used, the total volume of overflows for an event will not be changed That is, even though overflows are precluded or reduced at designated outlets or for designated time periods, or both, the total volume of overflows for an event will remain unchanged. When a pollutant characteristic that diminishes in concentration over time is considered, however, using integrated regulator operation will possibly reduce emissions at designated outfalls.

Preliminary tests indicate that a storm moving across the tributary catchments of an interceptor in the direction of flow can increase the volume of overflows over the amount for a stationary storm. Although not tested, it is expected that storm movement in the opposite direction would diminish the volume of overflows over that for a stationary storm. storm.

As would be expected, reductions in overflows anticipated via integrated regulator operation may be highly system specific. The potential for overflow reduction in the Montreal case appears to be marginal for a "first flush" pollutant reduction but very promising for pollution reductions at designated outfalls.

In-Line Storage

In-line storage, viewed as a particularly attractive means for reducing combined sewer overflows, exploits the "unused" volume in interceptors and trunk sewers. Such temporary storage can be induced by manipulating existing or added flow-control devices or both In-line storage has been a control component of some central dispatching systems designed for supervisory operation.

Cursory comparison of potentially useable in-line storage in Montreal and Milwaukee (Wisconsin) with that already exploited in Seattle (Washington) revealed two important departures. The volume of useable in-line storage inherent in the Seattle combined sewer system is generous compared with that potentially exploitable in Montreal and Milwaukee. Most combined sewer systems are in the northeast and midwest where rainfall intensities and total storm depths are generally higher than in Seattle. As a result, the success in exploiting in-line storage in Seattle should not be casually presumed to be duplicative elsewhere.

Digital Recording Radars

Newly developed capabilities for measuring and predicting rainfall by digital recording radars show considerable promise for effecting automated combined sewer system operation and for enhancing metropolitan flood warning systems. Meteorologists are cautious about the reliability of radar measurements, but such measurements soon may explain important rainfall characteristics that have implications in planning and design of urban water resources facilities Two rainfall prediction schemes that permit estimating rainfall over discrete catchments up to 2 to 3 hours in advance are of singular importance to combined sewer operations. These include digital recording radar and telemetered raingage networks The weather radar has a range of about 125 miles (200 km), using a telemetered raingage network covering that range is not realistic,however. The digital recording radar is a realistic means for providing the rainfall prediction required for automation of conventional combined sewer systems with long interceptors in large metropolitan areas
areas.

Metropolitan Flood Warning

In the Denver (Colorado) area, a metropolitan flash-flood warning system is being installed on a basin-by-basin accretion basis Adding rainfall and runoff prediction capabilities to existing real-time rainfall and stream-stage observations appear to have attractive advantages Rainfall forecasts based on satellite imagery show considerable promise in filling the prediction time gap between twice-daily synoptic forecasts and the 2- to 3-hour lead time provided by digital recording radars, both for flood warning and for combined sewer system operation Developing flash-flood warnings over the next few years in the Denver area should not only greatly strengthen that capability but should also provide important insights for automation of combined sewer system operations

Recommendations

In terms of pollution impact on receiving water, little is known about the reliability of rainfall prediction—from catchment hydrology to combined sewer system dynamics Although it will be some time before this analytical chain can be adequately tested, much exploratory work remains. It is to be hoped that tentative plans will be implemented to determine the extent to which rainfall and runoff predictions can enhance combined sewer operation. Findings from the predictive

capabilities of metropolitan flood warning systems should be examined carefully for their potential transfer to combined sewer system applications.

Because many combined sewer systems have "static" regulators that are nonresponsive to flow conditions, regulator improvement and management should be considered the first step of abatement programs for combined sewer overflow pollution. Without adding storage, there appear to be limits to the extent that overflows can be minimized from combined sewer systems with automatic dynamic regulators. Because adding in-system storage reservoirs is expensive compared with inducing storage in collector sewers, it is important that the degree of availability of the latter be sampled nationally as soon as possible.

In the meanwhile, observing the qualitative movement and intensity of storms with the use of an inexpensive display device, such as that used in Denver (wherever a suitable National Weather Service radar scanning area exists), might improve understanding of individual combined sewer systems. Comparing areal implications from radar with data from the local raingage network, even if done after the fact, would enhance such surveillance. This modest commitment could be an excellent precursor for later adoption of a digital recording radar capability.

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The complete report, entitled "Integrated Control of Combined Sewer Regulations Using Weather Radar," (Order No. PB 81-175 804; Cost: $9.50, subject change) will be available only from:

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