Implementation of CSO Controls Based on a Watershed Approach

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ABSTRACT
The Rouge National Wet Weather Demonstration Program is implementing watershed planning in the Rouge River Watershed. The Rouge River is located in southeastern Michigan and includes portions of the City of Detroit and three counties. The watershed encompasses 467 square miles and 48 communities. As part of the wet weather demonstration program, CSO and stormwater quality controls are being implemented. An assessment of project prioritization and the determination of level of control is influenced by the current limiting factors in the river conditions which impact its viability as a resource.

To identify limiting factors which impact river use, a group of water quality indica
tors and public use categories were developed to provide a measure of existing river quality. The indicators resulted in a good, fair or poor ranking of the river based on parameters of dissolved oxygen, river flow, bacteria, aquatic life and stream habitat. Use categories were used to rate representative river sites on the basis of fishing, wading/ body contact and general aesthetic conditions.

Instream water quality monitoring was used to help assess the role that CSO discharges play in limiting the river characteristics and uses. CSO controls, including ten CSO basins, are currently being implemented in the Rouge watershed for approximately half of the combined sewer area. An evaluation of these controls will help to determine the extent of future CSO control implementation. The identification of limiting factors of stream viability will play a role in designing future facilities.

The primary CSO impacts on the river which limit its use were identified as bacteria and oxygen demand. Solids and nutrients discharged from CSOs were not identified as a limitation of river viability. The level of control required to limit the impacts to those comparable to stormwater will be a consideration for future CSO facility sizing. CSO basin facilities which have recently gone into service appear to be of an adequate size to eliminate river impacts from the primary pollutants of concern.

KEYWORDS
Combined sewer overflows, Watershed planning, River use attainment, Water quality

INTRODUCTION

The Rouge National Wet Weather Demonstration Program is implementing watershed planning in the Rouge River Watershed. The Rouge River is located in southeastern Michigan and includes portions of the City of Detroit and three counties. The watershed encompasses 467 square miles and 48 communities. As part of the wet weather demonstration program, CSO projects have been constructed to control or eliminate CSO discharges to the river. An assessment of project prioritization and the determination of level of control is influenced by the current limiting factors in the river conditions which impact its viability as a resource.

At the present time, six CSO retention facilities have started operation, and four additional facilities are under construction. These facilities are part of Phase 1 controls. The basis of design for these facilities resulted in smaller total capture volumes than would be required under standard Michigan CSO presumptive criteria. Hence, these basins are considered “demonstration basins” which will be used to determine the sizing and design criteria for additional CSO facilities which will be constructed in future years. The result of this determination will, in turn, impact the cost of these facilities. Thus, identifying the significant impacts on the receiving stream as a result of CSOs, and designing facilities which are sized appropriately to control these impacts, will optimize expenditures and will help to improve the availability of funds which could be used for other river restoration activities. The

range in potential CSO costs for the Rouge watershed, based on a potential range in size of facilities, is between *$1 billion and $3 billion*.

Water quality indicators provide a tool for better allocation of resources by identifying those projects which will result in the greatest improvement in river conditions. Current data analysis and monitoring efforts will include an identification of the sources and impacts of pollutant loads. Of particular interest will be CSO and stormwater contributions of oxygen demand, bacteria, and solids. This data can then be used to refine projected improvements as other projects are implemented and what further efforts will result in the greatest benefit.

METHODOLOGY

The watershed evaluation of CSO impacts and level of CSO control incorporated efforts to a) evaluate the existing river condition and impacts, b) determine the portion of the impact which was associated with CSO discharges and c) determine the appropriate design criteria for CSO facilities

Evaluate Existing River Impacts

Limiting factors which impact river use were identified, in part, by the use of a group of water quality indicators and public use categories (1). The indicators resulted in a good, fair or poor ranking of the river based on parameters of dissolved oxygen, river flow, bacteria, aquatic life and stream habitat. Use categories were used to rate representative river sites on the basis of fishing, wading/ body contact and general aesthetic conditions / picnicking.

Once the indices were developed, an assessment of existing conditions was performed. The assessment utilized existing chemical, biological and aesthetic data which had been collected as part of the ongoing river monitoring efforts. Then, an estimate was made of the improvement which could be expected in each use category following implementation of various CSO and stormwater control projects. This effort helped to identify both the maximum improvement which could be expected from certain types of controls, and also additional projects which could provide improvement for relatively small costs.

The factors limiting each indicator were identified for various locations in the river system. For example, stream habitat was limited by low dissolved oxygen, highly fluctuating flows and eroding stream banks.

Determine Portion of Impact Attributable to CSO Discharges

River monitoring, a ongoing effort, includes the evaluation of bacterial levels and dissolved oxygen concentrations in the river during dry and wet weather events. This effort provides a comparison of conditions in CSO areas and non-CSO areas, which in turn can help to identify the source of problems, and may suggest actions required to eliminate these problems.

CSO basin evaluation monitoring includes river monitoring upstream and downstream of CSO basins which are in operation. The intent of this monitoring effort is to distinguish the relative impact of the treated CSO discharge on the receiving stream, relative to background water quality. In essence the question to be answered is: Does the CSO basin discharge have a detrimental impact on the stream?

Monitoring during basin discharge events occurred during the summer of 1997. The most significant wet weather event, and the only event which resulted in a discharge of CSO from basin facilities, occurred on July 2, 1997. During this event, river and basin discharge monitoring was performed. Other efforts have included the monitoring of essentially all flows influent to the CSO basins. The portion of the flow which is completely captured also contributes to a reduction in the total pollutant load to the river from combined sewer areas.

Identify Appropriate CSO Basin Sizing

In 1997, CSO control work was completed on a branch of the Rouge River, referred to as the Upper 1. In this location, all CSO outfalls have been controlled. The majority of CSO control was accomplished by the construction of the Redford CSO retention - treatment basin. This basin, which was designed to provide 20 minutes of detention for the peak transport flow of the tributary sewers, is intended to provide settling, skimming and disinfection of flow prior to discharge. The basin has captured approximately 50 percent of the influent flow to the facility (an estimated __ % of total wet weather flow). This basin has approximately half the volume which would be provided using

standard state of Michigan design criteria, and is also smaller than what would be required to meet EPA presumptive criteria.

The effort of determining the appropriate CSO basin size and design criteria involves an evaluation of the river response to various storm events and basin discharges. This effort is currently underway and will be ongoing in 1998 and 1999.

RESULTS

River monitoring performed prior to CSO control implementation identified various limiting river characteristics. Characteristics were typically identified as either related to wet weather or dry weather conditions, and these can also be identified as associated with various causes.

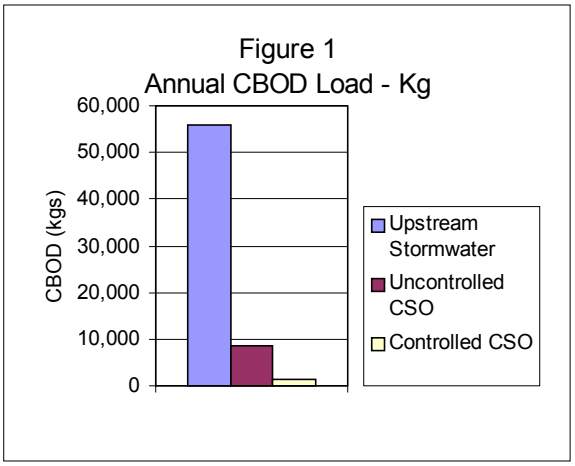
Table 1: River Conditions of Dissolved Oxygen and Bacteria, and Related Causes

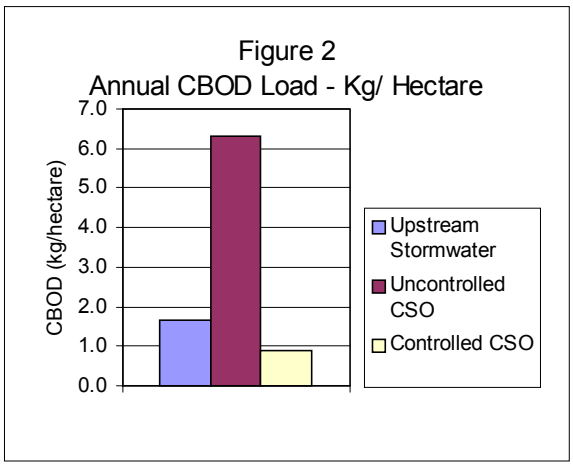
Characteristic	Found where	Related to
Low dissolved oxygen during dry weather conditions	CSO impacted areas Non - CSO impacted areas	Annual CBOD load Poor Stream Reaeration Annual CBOD load Low streamflow with some stagnant conditions
Dissolved oxygen sags during wet weather conditions	CSO impacted areas (prior to controls)	Event CBOD load CBOD concentration in discharge
Bacterial concentrations in excess of partial body contact standards (range: 1,000 - 10,000 cts e coli/ 100 ml)	All areas	CSO discharges Illicit connections Failing septic systems Other unidentified sources
Bacterial concentrations during wet weather events, range of 100,000 - 1,000,000 cts e coli/ 100 ml	CSO impacted areas (prior to controls)	CSO discharges

Primary goals for CSO control, become

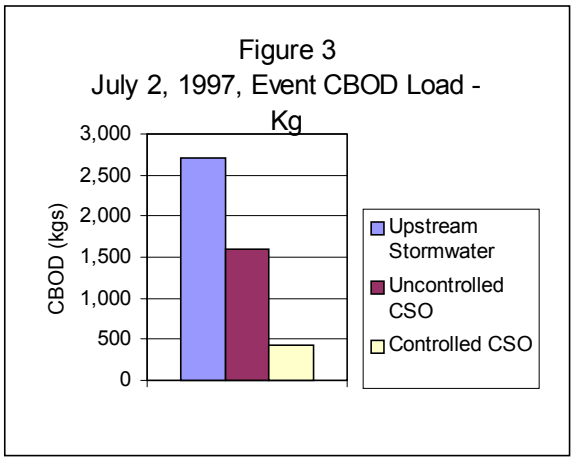
- Limit annual CBOD load to what the river can assimilate, and no more than stormwater annual load
- Control bacteria from CSO discharges
- Control CBOD event loads, to prevent dissolved oxygen sags

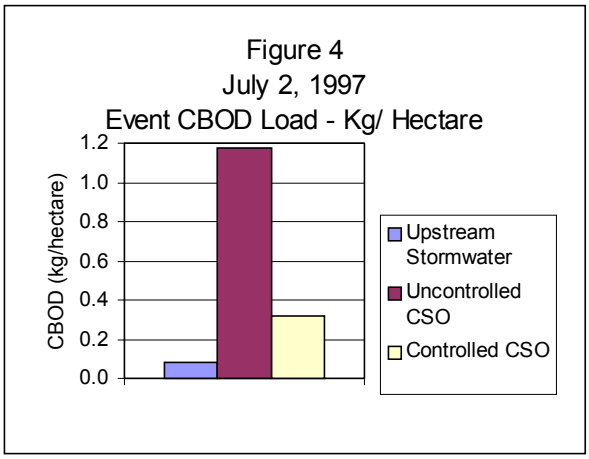
The effectiveness of the newly constructed, "demonstration"-sized facilities was estimated for the 1997 period. Annual loadings of CBOD from CSO areas, both before and after controls, was compared to the annual loading of CBOD from stormwater areas. The resultant annual CBOD load to the Upper Rouge from controlled CSO's is less than the load from non-CSO tributary areas (Figures 1 and 2).



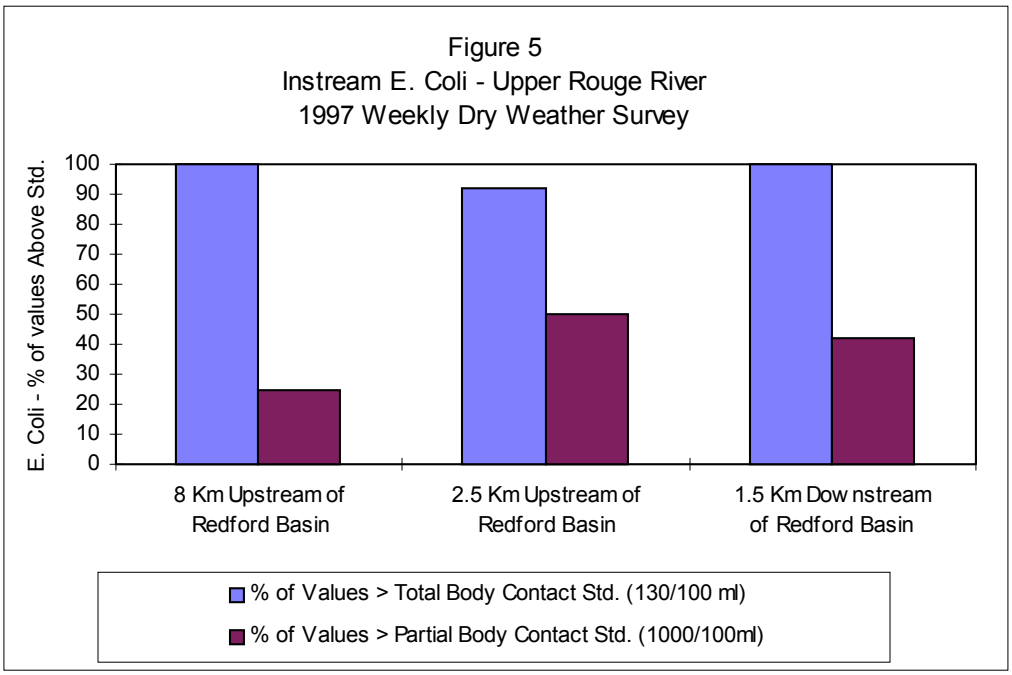


As wet weather dissolved oxygen sags are believed to be primarily due to large quantities of CBOD entering the river from CSO outfalls during early stages of a CSO event, the load associated with CSO basin discharges during wet weather events will be a primary determinant in the satisfactory control of CSO. For the July 2, 1997 event, the following event loads occurred (Figures 3 and 4).

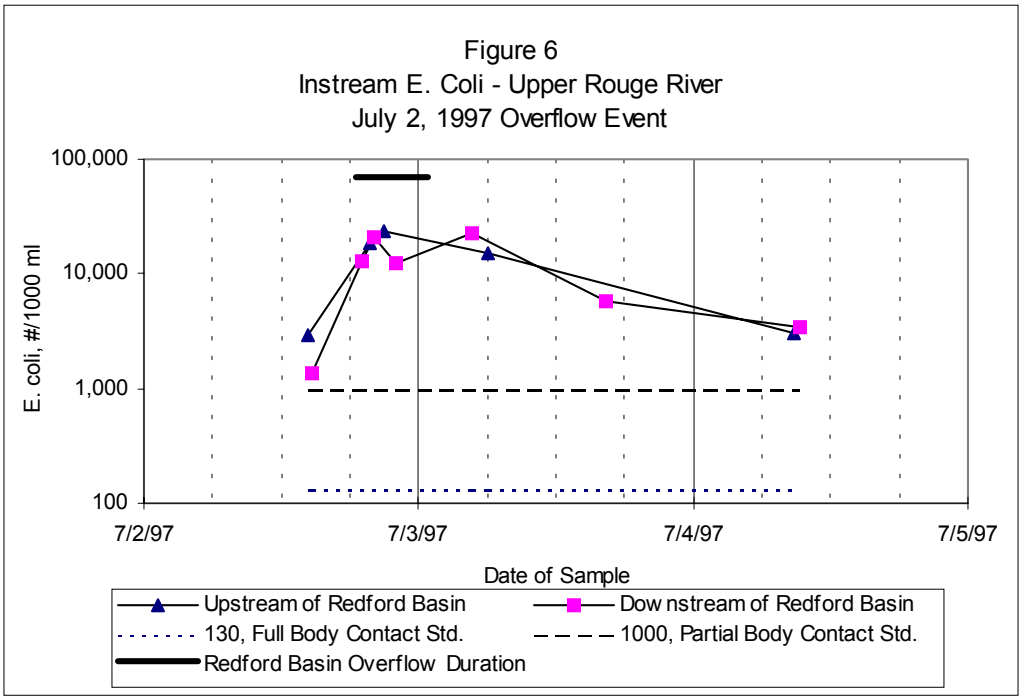




Bacterial impacts on the river are know to be a result of both CSO and non-CSO related discharges. With the implementation of CSO retention - treatment facilities, bacterial levels in the basin discharge are reduced to levels which are generally less than 40 cts / 100 ml. In order to assess the ongoing dry weather and wet weather conditions, weekly sampling of the river quality is performed. This sampling showed that conditions are comparable upstream and downstream of the treated CSO location (Figure 5).



Previous sampling conducted downstream of CSO discharges had shown bacterial levels of 10^5 - 10^6 counts of e. coli per 100 ml for instream samples during CSO discharge events. Following CSO control, instream bacterial levels during discharge events were similar upstream and downstream of the basin facilities. (Figure 6)



DISCUSSION

The size of CSO control projects currently being implemented are expected to result in a significant improvement in dissolved oxygen levels in the river, but larger facilities are likely to have little additional benefit. However, significant improvements in habitat could be achieved by flow control projects and streambank stabilization efforts. Thus, the indices provide a tool to help allocate of financial resources by assisting in project selection and magnitude.

The indicators were originally developed as a method of communicating with the public and non-technical policy makers regarding the current status of the health of the Rouge River, and as a means to track trends. However, this effort also showed that a number of use attainment concerns were present in both CSO impacted areas and non - CSO impacted areas. It also helped to identify types of projects which could be implemented to provide the greatest benefit to the river. A demonstration of how this type of analysis can facilitate a watershed approach is shown in Table 2.

Table 2: **Demonstration of Impact of Using Indicators in Decision Making**

River Use Goal	Limiting Factors	Watershed Approach	Traditional CSO Only Approach
Body Contact - wading and swimming	Bacterial levels	Disinfect CSO discharges Identify illicit connections to storm sewers; failing septic tanks/ systems	Disinfect CSO discharges
	River flow regime	Attenuate peak flows; augment low flows	
	Hazards due to steep banks; debris	Improve bank stability Remove trash and debris	
Fish Population	Dissolved Oxygen Levels	Reduce CSO oxygen demand load Reduce stormwater oxygen demand load Remove sediment oxygen demanding material	Reduce CSO oxygen demand
	Habitat Conditions	Improve stream reaeration Improve stream habitat Provide streambed cover	
Aesthetics	High sediment load	Improve streambank stability Enforce soil erosion control	Reduce CSO related solids
	Trash and debris	River cleanup	

A watershed approach allows for the assessment of river problems which result from all sources or impacts, and the benefits which can be achieved from addressing multiple types of use limitations. With a approach focused only on CSO, the level of control sought for CSO may be more extensive, in an effort to compensate for other pollutant sources.

CONCLUSIONS

A good understanding of the causes which result in poor river quality can be achieved, in part, by a review of the desired use attainment. Once the limiting conditions are identified, remedial measures which maximize the desired use attainment can be identified. In the case of the Rouge River CSO Control effort, the goal is to apply the optimal level of control to CSO's. This will limit the financial impact of CSO control, while also helping to

identify measures not related to CSO control which are necessary for desired use attainment to be achieved.

This focus also helps to identify what the goal of a river restoration effort is, rather than identifying a particular level of control, which may not achieve any specific use attainment.

REFERENCES

1. Smith, V. Elliot, Communicating Rouge Project Findings: Use of Quality Indicators to Report on Rouge River Status and Trends. Document RPO-WMGT-TPM42.00, Rouge Program Office, Detroit, MI. 1997