FLOW MONITORING IN THE UNITED STATES

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I. INTRODUCTION

In the U.S., water pollution problems have become heated political issues. Reports of basement floodings, surcharging manholes and other raw sewage overflows are commonplace. Unfortunately, the cost of building and maintaining sewer systems to contain both dry and wet weather flows is very high, and municipalities across the country are constrained by limited budgets. Given this, cities and sewer authorities are relying more and more heavily upon permanent flow monitoring to help manage their collection systems and control costs. Briefly described below is the monitoring methodology recommended in the U.S. and how three American cities used permanent flow monitoring to help solve their problems.

The Systems Approach to Monitoring: Targeting Only Problem Areas

The American Public Works Association and the U.S. Environmental Protection Agency recommend a "systems approach" to flow monitoring, the same followed by ADS. Basically, the systems approach involves breaking the sewer system into smaller sub- and mini-systems and monitoring on both a permanent and temporary basis. A permanent network is installed to identify the major sub-basins in the sewer system and to provide an initial assessment of leaks. The permanent network utilizes the existing piping network, manholes and telephone system already in place, along with specific sensors, computer hardware and software. The monitoring locations are generally at the base of major basins.

Prioritising for Cost-Effective Management

Once the network has identified areas of major inflow/infiltration, temporary monitors are installed in the mini-systems to provide additional analysis. The temporary meters are generally placed every 1-2 kilometers from each other and are installed for 30-90 days. The cost of monitoring mini-systems is more than recovered by eliminating physical inspections and T.V. work in areas where there are no major problems. Although intensive monitoring is more expensive at the beginning of a project, it pays for itself. Flow monitoring costs approximately $0.50/foot while T.V. inspection costs $1-1.50/foot.

II. INDIANAPOLIS: Inflow/Infiltration Reduction

A good example of how permanent flow monitoring can work for a city is Indianapolis, Indiana in the central U.S. In this case, permanent monitoring was used in conjunction with temporary monitoring to eliminate a bad inflow/infiltration problem.

The fast-growing northside area of Indianapolis had chronic sewer basement flooding

problems, with moderate to heavy rains generating over a thousand basement flooding complaints from residents. Rapid development in the area only worsened the existing problem by putting a further hydraulic load on the collection system. A sewer moratorium was threatened.

The Indianapolis Department of Public Works considered a plan to design and construct major relief lines in the area, but these sewers required several years of construction and could not produce quick results. The Department decided to undertake an immediate I/I reduction program instead, and contracted ADS to install and maintain flow monitors in 400 mini-systems and raingauges in 15 locations. The flow monitoring was performed and data collected from April to August of 1986.

Approximately 80% of the inflow located in 20% of the system

Data gathered in one sub-system indicated that 68% of its inflow came from one mini-system. Five mini-systems representing 15% of the total sub-system footage generated 80% of the system's inflow.

Sewer system evaluation surveys and rehabilitation activities were directed at the problem areas. Siltation frequently caused bottlenecks which in some cases eliminated 15% of the pipes' capacity. Haphazard additions to the sewer system also created hydraulic brakes, or, inflow itself caused bottlenecks. In one case, so much inflow was entering the line that upstream flow could not move downstream during storms.

Basement flooding virtually eliminated, $21 million saved

The I/I reduction program yielded immediate results. Basement flooding reports from Spring 1987 to the present are 90-95% lower than in previous years: According to city officials, the basement flooding was "virtually eliminated." The entire project including rehabilitation was completed in only 11 months at a total cost of $3 million. The project saved 3 years and $21 million over the proposed construction project, including reducing a proposed 70 MGD pump station to 40 MGD.

III. SAN DIEGO: Billing Network

The case of San Diego, California illustrates how permanent meters can be used in billing applications. The San Diego Metropolitan Sewage System has 14 member agencies contributing flows to one regional treatment plant, and each member agency pays for its portion of the transportation, treatment and capital costs based on the flows it generates. Since the rising treatment costs are passed onto users, San Diego Metro officials realized their old mechanical method of billing was out-dated and they needed a new way to produce an accurate, fair bill at low operating costs.

Limitations of the Old Metering System

San Diego's old metering network consisted of a flume and a stilling well with a mechanical float and recording device. The metering stations were expensive to construct (costing from $30,000 to $300,000 each), and required frequent crew visits resulting in high operation and maintenance (O & M) costs. The flow conditions necessary to obtain accurate data were not

always available, and Metro had great difficulty trying to measure peak flows during wet weather. Maintaining a high level of reliability with a mechanical strip chart was also very difficult.

Sewer "Toll Booth" Network

San Diego installed a network of 60 permanent meters to serve as sewer toll booths at points where each agency connects to a Metro interceptor or crosses an agency boundary. The network uses a telemetered acquisition system in which data from each billing station is transmitted by telephone to an IBM-PC central station. San Diego Metro then uses specialised software to process and report flows for billing.

Benefits of the System

- The new monitors required no new construction to install and demand far less O & M than the old equipment, thereby lowering costs.

- The new system allows direct member-agency involvement in the billing process, resulting in a high level of confidence amongst the member agencies. The 14 agencies can participate in the data collection and can cross-check it using their own desktop computers. Reliable data reduces the threat of billing disputes and allows the engineering departments to better form long-range plans.

- While the initial purpose of the monitoring network was to serve as sewer toll booths, they also provide early warning of I/I or capacity problems and provide data for planning relief sewers in the growing San Diego Metro area.

IV. COLUMBUS: Combined Sewer Overflow (CSO) Monitoring

An increasing amount of legislation has been passed in the U.S. regulating combined sewer overflows and other raw sewage overflows. CSO control is now one of the biggest issues in the States, and the case of Columbus, Ohio illustrates one of the most important applications for permanent monitoring -- monitoring CSOs.

Columbus, Ohio is located on three small receiving rivers. Of the approximately 2000 miles of sewer in the collection system, 10% consists of combined sewers with 36 combined sewer overflows. Potential water quality violations of the three rivers resulted in regulatory pressure to eliminate the CSOs as suspected sources of the violations. The State of Ohio Environmental Protection Agency (EPA) requested that the City of Columbus present a detailed plan for eliminating the CSO and sanitary sewer overflows into one of the rivers. Columbus faced the prospect of separating all the sewers in its downtown area at an estimated cost of $145 million.

Flow Monitoring, Raingauge Network

The City sought alternatives to the expensive full-sewer separation. It embarked on a comprehensive monitoring, rain gauging and sampling program to identify the actual flow quantity and quality being discharged from each CSO and their water quality impact on the rivers. 37 telemetered longterm monitors were installed at the overflows, main interceptors

and at key river locations, and each CSO and the receiving waters were continuously sampled for water quality data. The monitors were on-line for over twelve months, during which time dozens of rainstorms were recorded and analysed. During the summer months when the river levels were low and most sensitive to sewer overflow, an additional 70 temporary meters were installed to further isolate the problems.

ADS also installed and maintained 20 telemetered rainfall gauges scattered throughout the collection area. Each raingauge represented approximately ten square miles, the average footprint of a midwestern thunderstorm.

Only 2 of 36 CSOs Caused Violations, $100 Million Saved

A drought worsened the summer low-river stage and created 100-year low river conditions. During the peak of the drought, an intense two-year storm occurred, activating all 36 CSOs. Despite this worst-case scenario, city officials discovered that while most the CSOs overflowed more often than originally thought, only two of the 36 had a significant water quality impact on the receiving streams. Columbus found it needed to spend only $40-50 million on improvements -- a 70% savings over the projected $145 million. The commitment of $1.4 million in monitoring, sampling and gauging ultimately saved $100 million for the City of Columbus.

The intensive raingauging network also proved to be critical to the system analysis and model calibration. Seemingly similar catchments responded very differently to a rain event and therefore dramatically impacted the model calibration. During some storms, raingauges recorded a difference of over two inches in rainfall totals within an approximate 20-mile distance.

The conclusions of the Columbus CSO project provide valuable lessons that apply to many other CSO projects:

- Many CSOs perform as their original designers intended. They capture the first flush, and what does overflow has minimal water quality impact.

- Accurately measuring the key variables of sewer flow, sewer overflow, rainfall and receiving water quality can prove a much more complete assessment than theoretical models or spot measurements.

V. GENERAL CONCLUSIONS

The projects being undertaken in the U.S. is similar to the type of work done in the U.K. with one notable exception. In the States, the nature of the problems and the scale and scope of the work has placed much more reliance on modelling and flow survey verification. The demand for better information has pressured the modellers and the equipment manufacturers to produce more accurate and reliable tools, resulting in a more efficient, systematic approach to solving problems of sewer capacity, flooding and environmental pollution.

WaPUG AUTUMN MEETING 1991 - DISCUSSION

Mini-Paper 1: Flow Monitoring In The USA - J Grandison - ADS

M Osborne (HRL) : Is more monitoring done in the USA because the hydraulic modelling tools are not as good as those in UK?

Ans : This is a principal factor, yes.

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N Scarlet (IHS) : Has a comparison been made between the cost of monitoring and savings in capital costs?

Ans: The value of long term monitoring is perceived to justify the considerable expensive.