Ten Years of In-System Storage For Combined Sewer Overflow Control

Prepared for WEFTEC 2010

October 2010

Bradley L. Moore, Superintendent,
City of Bangor, Maine Wastewater Treatment Plant

Keefe C. Cyr, Instrumentation Technician/Electrician,
City of Bangor, Maine Wastewater Treatment Plant

John L. Murphy, P.E., Assistant City Engineer
City of Bangor, Maine Engineering Department

*

ABSTRACT

This paper will provide information concerning the expected and unexpected benefits of in-system storage for combined sewer overflow (CSO) control in Bangor, Maine, which is of interest to planners, engineers and operators striving to comply with state and federal regulations. Information reviews ten years of operation of in-line and off- line storage facilities.

KEYWORDS: CSO control, in-system storage, collection system.

INTRODUCTION

The City of Bangor, Maine, has been addressing control of Combined Sewer Overflows since 1987. In 1992, a Combined Sewer Overflow Facilities Plan was prepared, which included a variety of recommendations for CSO control. For three locations, in-system storage was the recommended method of controlling combined sewer overflows. These three facilities, having a total storage capacity of 14,385 m^3 (3.8 mil. gal), were placed into service on June 1, 1999, May 10, 2001 and January 13, 2003.

Today, Bangor has a number of years of experience in the operation of these in-system storage facilities. This paper presents the impact in-storage facilities has had on the operation of the collection system and the wastewater treatment plant. The information should be of interest to designers and operators alike who are striving to comply with state and federal regulations concerning CSO abatement.

FACILITIES

The City of Bangor operates a 68,137 m^3/d (18 mgd) trickling filter/activated sludge secondary treatment plant. Annual average flow is 37,854 m^3/d (10 mgd) and during wet weather flow increases to 162,773 m^3/d (43 mgd). Maximum flow through the secondary treatment is 113,562m^3/d (30 mgd) and the remaining 49,210 m^3/d (13 mgd) receives primary treatment and disinfection before blending with the secondary effluent and subsequent discharge to the Penobscot River. The City collection system includes 253 km (157 mi) of sewer line and 14.5 km (9 mi) of interceptor sewers some of which date back to the 1850's. The City maintains five pump stations, three regulating structures and three storage tanks. A supervisory control and data acquisition system maintains communication with remote facilities and provides real time information the operators use in controlling the collection system during wet weather.

The impact of the storage facilities on operations is the focus of this paper. Two of the three tanks are in line storage. These tanks have sewage running through them all the time and the storage capacity is utilized by activating downstream valves during wet weather. When the wet weather event is over, the sewage stored in these tanks is metered back into the collection system and eventually to the wastewater treatment plant. One tank is a traditional off line storage facility. When the level of the adjacent interceptor reaches a weir level, the combined wastewater enters the storage tank. When wet weather event is over, the tank drains partially by gravity and the remaining volume is pumped back into the interceptor.

OPERATIONAL EXPERIENCE

Following a period of monitoring, testing and Storm Water Management Model analysis, it was determined that the most cost effective control strategy would be to install storage tanks at three locations in the collection system. Even before all the storage tanks were installed in the collection system, the operators recognized a sizable impact in the reduction of CSO's and wet weather treatment at the wastewater treatment plant. The high flow management plan was adjusted as the storage tanks were added to the collection system. The high flow management plan addresses procedures as the influent flow rate exceeds 113,562m^3/d (30 mgd). Utilizing the SCADA system to remotely control facilities in the collection system, operators limit the flow rate entering the wastewater treatment plant to 113,562 m^3/d (30 mgd) until the storage capacity of the collection system is met. Then the flow rate entering the wastewater treatment plant is allowed to increase to a maximum of 162,773 m^3/d (43 mgd). Any flow rates exceeding 113,562 m^3/d (30 mgd) receive primary treatment and disinfection before blending with the secondary effluent and discharge into the Penobscot River. The goal is to maximize the storage in the collection system before wet weather treatment is initiated at the wastewater treatment plant. Computers alert staff when certain criteria are met and the assigned operator monitors conditions in the collection system and follows the guidelines outlined in the high flow management plan. During unstaffed hours the computer initiates a call in when predetermined levels in critical areas of the collection system are exceeded.

Besides the obvious beneficial impact of these storage facilities, the staff has recognized several other operational benefits and strategies which include:

- Real time flow management within the collection system
- Avoiding wet weather treatment at the wastewater treatment plant
- Stopping influent flow for headwork's maintenance
- Control of peak electrical demand at the wastewater treatment plant

REAL TIME FLOW MANAGEMENT

Figure 1 and 2 demonstrate the overall reduction of CSO discharge events as Bangor has implemented its Long Term Control Plan (LTCP). The 15 plus years of collection system rehabilitation along with the added component of storage facilities has reduced volumes and occurrences of CSO's. As mentioned above, the storage facilities were placed in service June 1999, May 2001 and January 2003.

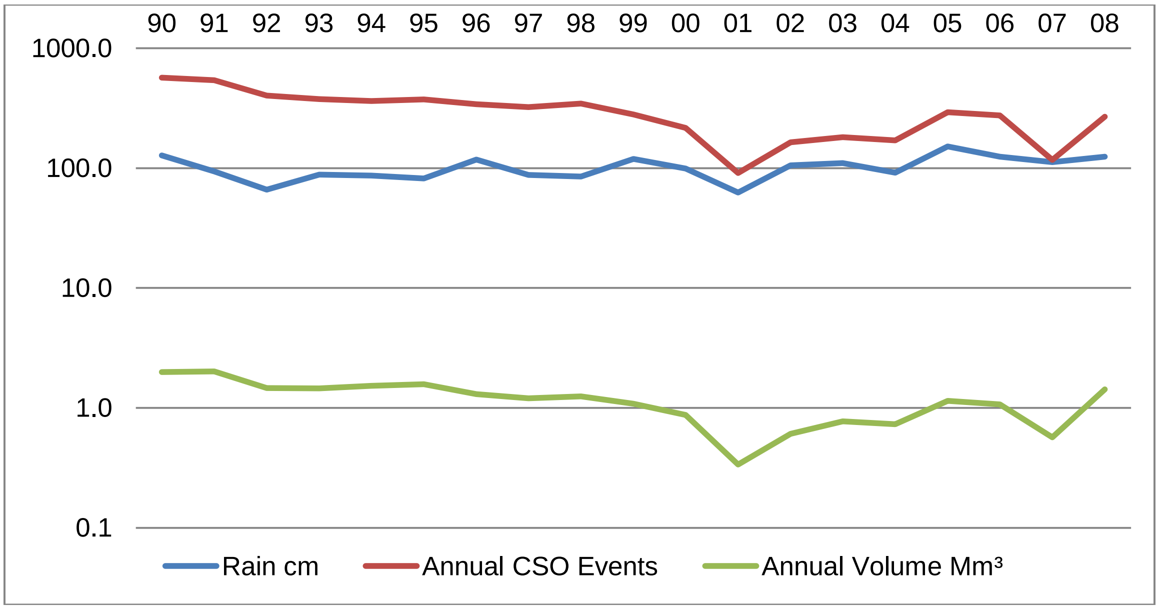

Figure 1. CSO Events and Volume

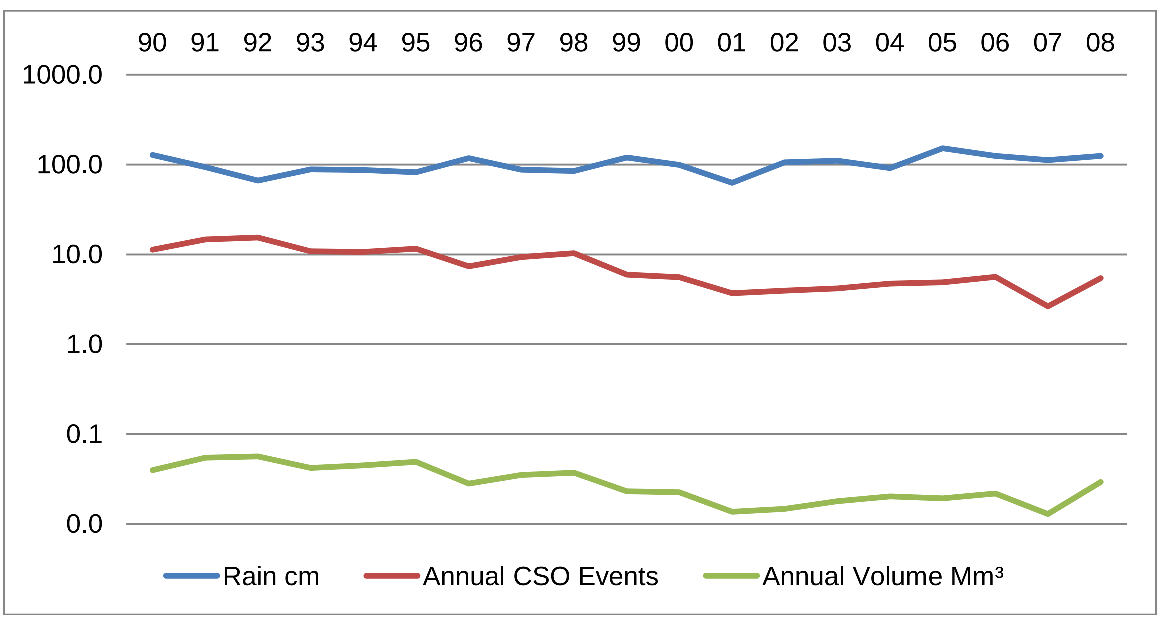

Figure 2. CSO Events and Volume per Centimeter of Annual Rainfall

AVOIDING WET WEATHER TREATMENT

Using the storage facilities and the interceptor leading to the wastewater treatment plant, staff is able to avoid wet weather treatment and subsequently provide secondary treatment to the wastewater stored in the collection system. Figure 3 highlights the storage capabilities and data received through the SCADA system on critical points in the collection system. Regulators 1 and 3 (REG1, REG3) are simply regulating structures with valves that can control the flow of wastewater in the interceptor leading to the wastewater treatment plant. Two storage facilities are displayed; Davis Brook (DB_LVL) and Barkersville (BARK_LVL). As the flow reached 113,562 m³/d (30 mgd), the storage capabilities were utilized and wet weather treatment at the plant was avoided. The precipitation during this event was 2.31 cm (0.91 in) in eleven hours. Previous to the construction of the storage facilities, an event such as this would have resulted in wet weather treatment where the portion of wastewater entering the plant over 113,562 m³/d (30 mgd) would have only received primary treatment and disinfection.

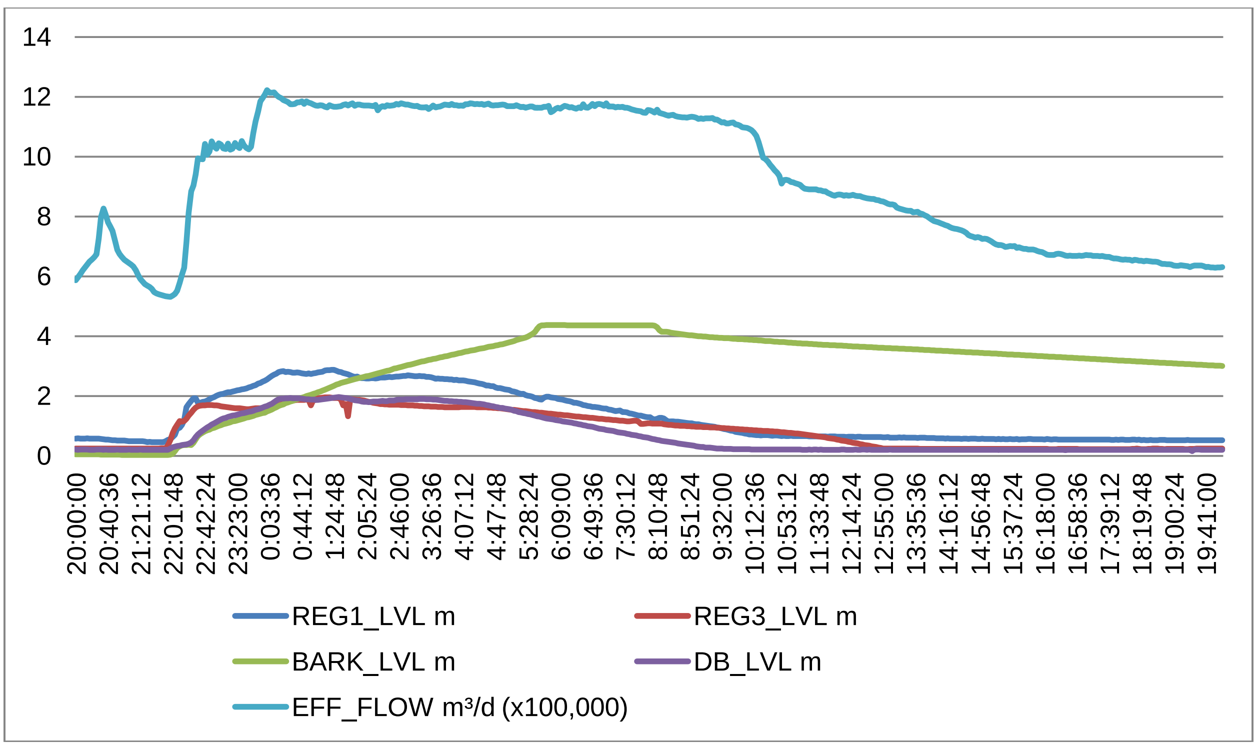

Figure 3. Collection System – Rain Event April 9-10, 2010

HEADWORKS MAINTENANCE AND ELECTRICAL DEMAND CONTROL

Maintenance in the headworks section of a treatment plant can be problematic as the ability to greatly reduce or shut off influent flow may be impractical. The collection system storage allows plant staff to stop influent flow for maintenance activities. When these activities are in conjunction with low flow conditions, the staff has the ability to shutdown the influent flow for up to ten hours. During the last three summers the staff has also used the storage capacity to control forward capacity charges levied by ISO New England. ISO New England is a regional transmission organization, serving Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont. ISO New England's mission is to meet the electricity demands of the region. The organization instituted a forward capacity charge as an avenue to generate funds to cover infrastructure maintenance and expansion. The capacity charge is based on a user's demand during the highest annual 15 minute demand for the region. Significant savings can result if the facility demand can be reduced during that highest regional demand period. The wastewater treatment plant receives daily demand forecasts through the summer and when a new demand peak is projected the staff prepares to idle the plant. The staff, for the last two years, has been able to idle the plant during the peak demand period resulting in savings exceeding $25,000 per year. Figure 4 graphs a shutdown that occurred on July 6, 2010, to control the plant electrical demand. This graph is also indicative of a plant shutdown for maintenance activities in the headworks area.

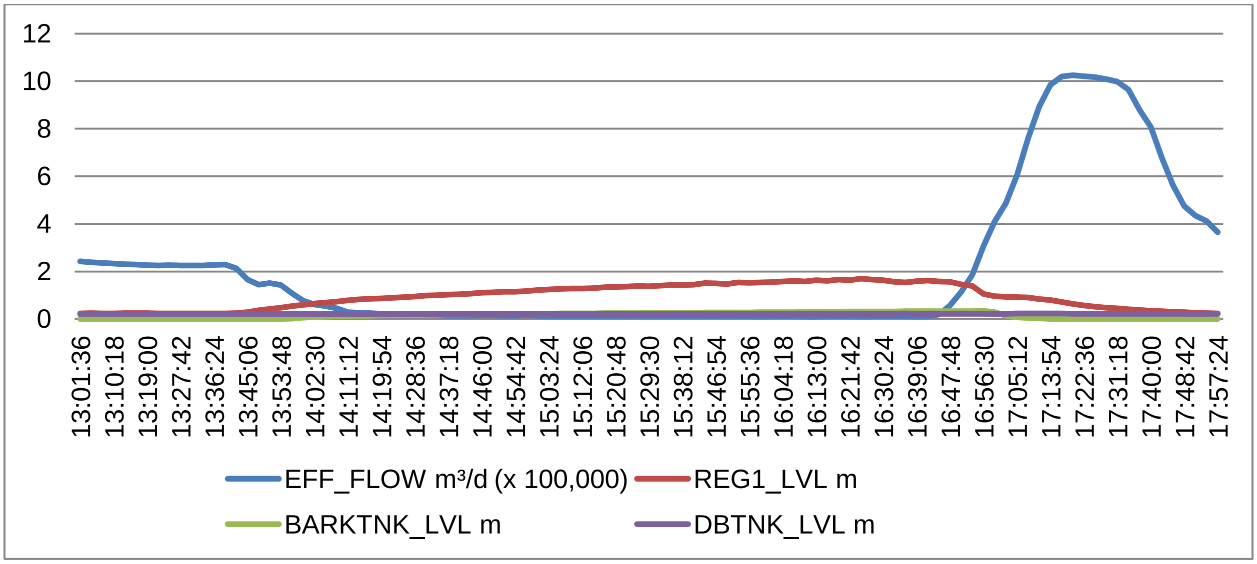

Figure 4. Electrical Demand Control

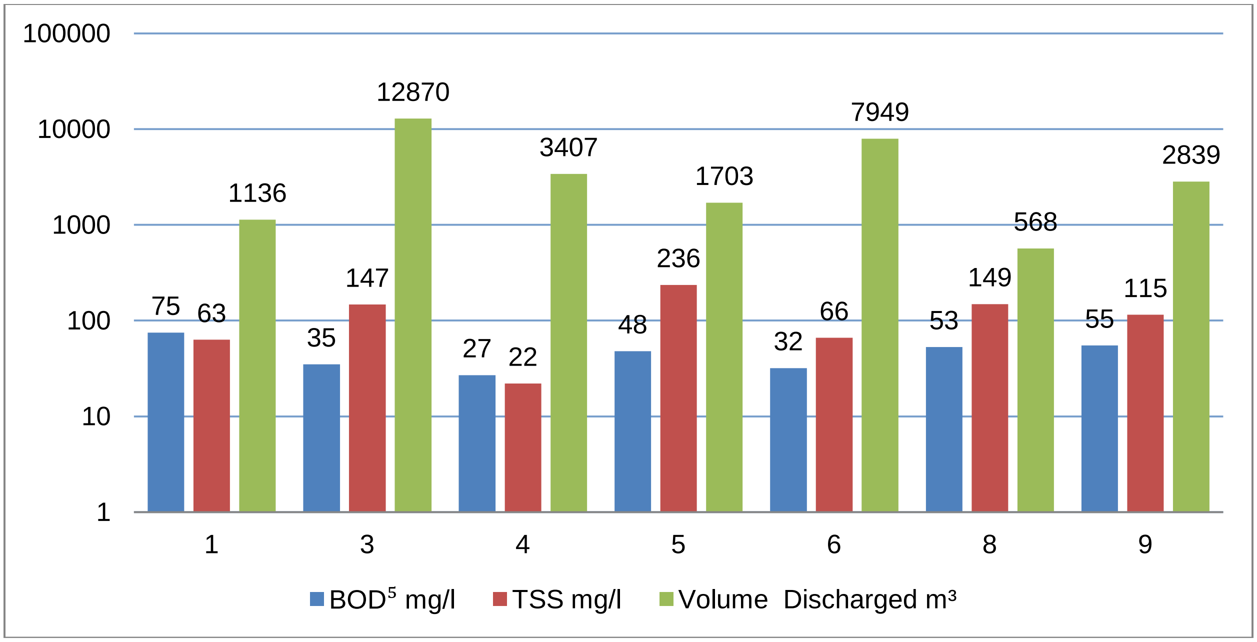

Figure 5. Davis Brook Discharge Analysis

DAVIS BROOK STORAGE TANK

The Davis Brook storage tank has been in service since June 1999. This tank is 731.5 m (2400 ft) long with a storage capacity of 4,543 m^3 (1.2 mil. gal). During extreme rain events this tank can reach capacity after which the combined wastewater flows over a weir and out the original Davis Brook CSO to the Penobscot River. The overflow weir is approximately 76 m (250 ft) downstream from the upstream end of the tank. Flow weighted samples are taken of the discharge and analysis suggests the tank is producing primary treated effluent quality for most events. The solids that settle in the tank do eventually reach the wastewater treatment plant when the tank empties as normal flows are restored. Figure 5 displays the events that occurred during 2008.

CONCLUSIONS

The City of Bangor's previous presentations at WEFTEC and WEF Technical Conferences have highlighted the process and decisions the City made in implementing its LTCP which included the use of concrete box sections to construct storage tanks. After years of operation, tangible benefits other than reduction of CSO events can be identified.

- Operations staff should be given the tools to monitor and control facilities remotely using a SCADA system that provides real time data. In Bangor's case, this flexibility gives the staff opportunities to use their knowledge of the system and maximize the potential for reduced CSO activity. The numerous adjustments to the high flow management plan are the result of staff tweaking the control of the collection system to the City's advantage.
- Facilities that are allowed, during wet weather, to treat a portion of the influent through primary only can use collection system storage to their advantage. If staff can control remote facilities, the high flow management plan can dictate that the storage capacity of the collection system be maximized before treating a portion of the influent through primary treatment. Bangor's experience is that many wet weather events can be contained within the collection system allowing all the wastewater to receive secondary treatment.
- Collection system storage facilities should be sited such that the staff can shut the influent flow off at the treatment plant. This provides two advantages in Bangor; one, maintenance activities in the headworks can take place over an extended period of time and; two, Bangor uses the storage to shut down the plant during peak electrical demand periods which can last several hours. Both situations have a positive effect on the budget.

REFERENCES

Murphy, J.L.; Ring, J.D.; Moore, B.L. (2003). *Insystem Storage Capacity Enhances Sewer System Operation.* Water Environment Federation Collection System Specialty Conference, Austin, Texas, June 2003

Murphy, J.L.; Ring, J.D. (2001). *Kenduskeag East CSO Storage Facility in Bangor, Maine.* Water Environment Federation 74th Annual Conference, Atlanta, Georgia, October 2001

Murphy, J.L.; Ring, J.D.; Seiler, J.F. (1999). *Precast Tunnel is Cost Effective Option for CSO Storage Project.* Water Environment Federation 72nd Annual Conference, New Orleans, Louisiana, October 1999