Sewer Overflows

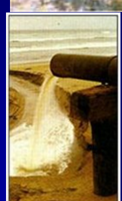
- Combined Sewer Overflows (CSOs)
  - Older, large cities built combined networks to convey sewage and stormwater
  - Stormwater overwhelmed sewage flow, but only for short periods
  - To reduce pipe size and increase velocities during dry periods, overflows were constructed
- Sanitary Sewer Overflows (SSOs)
  - Separate sewers designed to exclude stormwater
  - Nevertheless, stormwater entering because of deterioration and I/I can cause overflows

What is a CSO / SSO?

- CSO: Combined Sewer Overflow
- Older systems tend to be combined
- Peak storm events can see nearly instantaneous flow increases of 10 – 20 X
- Dilute raw sewage to a water body

- SSO: Sanitary Sewer Overflow
- Separated systems may experience I/I
- Peak storm events can see nearly instantaneous flow increased of 5 – 10 X
- Dilute raw sewage to a water body

CSO / SSOs Contaminate natural waters



Prevalence of CSOs in the US

EPA identifies 772 communities with ~40 million people.

Magnitude of Problem (Local)

- CSO's in Seattle
  - 20-100 overflows per year
  - 2 billion gal/yr CSO in King County
- SSO's in East side system overflow to Lake Washington

Causes and Effects of Stormwater Entering Receiving Water

- Insufficient hydraulic capacity in collection system (CSOs and SSOs)
- Insufficient capacity at wastewater treatment plant, leading to intentional bypassing of treatment
- About half of the estuary contamination nationwide is attributed to CSOs

CSO/SSO National Strategy

- Clean Water Act (1972)
  - Goal: reduce pollutant loading to receiving waters
  - Requires dischargers to obtain NPDES permits (Guidelines from EPA, but administered by States)
- 1987 amendments to CWA specify that stormwater discharges are "point sources"; NPDES permits required, with municipalities as applicants

CSO/SSO National Strategy

- Objectives of National CSO Control Strategy (1989):
  - Minimize CSO events, and eliminate them during dry weather
  - Bring wet-weather CSO events into compliance with technology- and water quality-based requirements of CWA
  - Minimize impacts of CSO events on water quality, aquatic biota, and human health

CSO/SSO National Strategy

- CSO Control Strategy revised in 1994 to:
  - provide guidance to stakeholders (permitting and enforcement agencies, permittees)
  - increase coordination among agencies
  - increase public involvement

CSO/SSO National Strategy

- Key Principles of 1994 Revisions:
  - Clearly identify levels of control that are presumed to meet environmental and health objectives
  - Provide flexibility for municipalities to determine site-specific and cost-effective strategies to meet CWA objectives
  - Allow phased implementation based on finances
  - Review and revise permits as long-term CSO control plans are developed

CSO/SSO National Strategy

- Key expectations/obligations agreed to in 1994 Control Policy:
  - Implement the "nine minimum controls" – technology-based actions to reduce CSOs and their effects – as soon as practicable, but no later than 1/1/1997
  - Focus on environmentally sensitive areas first
  - Begin immediate review of WQ Standards
  - Permitting authorities will consider financial capabilities of permittees when reviewing applications

Nine Minimum Controls (NMCs)

- Proper O&M
- Maximum utilization of storage
- Review pretreatment programs
- Maximize flow to treatment plant
- Eliminate dry-weather overflows
- Control solids & floatables
- Contaminant reduction by pollution prevention programs
- Public notification of CSO events and impacts
- Monitoring to characterize impacts and effectiveness of controls

NMC #1: Proper O&M

- List "critical facilities" for combined sewer system (CSS) performance (tide gates, overflow weirs, regulators, etc.)
- Written procedures for routine periodic maintenance, and documentation of such maintenance
- Regular inspections of critical facilities
- Written procedures for emergency situations
- Policies and procedures for training O&M personnel and for revising all policies and documents

NMC #1: Examples

- Lansing, Michigan, has 40 regulators that are inspected twice per week and immediately following any wet weather event.
- Jersey City, New Jersey, has tide gates and 31 regulators that are inspected in sequence by two assigned crews, enabling each regulator to be inspected at least twice per month. Crews perform cleanings and minor repairs when possible. Each inspection is documented.
- Elizabeth, New Jersey, has a CSS with 41 regulators of varying design. All syphons, regulators, and tide gates in the system are inspected daily. All syphons are jet-cleaned.

NMC #1: Examples

New York City has more than 450 regulators that are inspected on a regular schedule. Certain regulators identified as critical are inspected more often. Pump stations, most of which have overflow points, are inspected daily. Of the 183 people who maintain these elements of the sewer system, about 50 are assigned specifically to regulator and tide gate maintenance and inspection, and the remainder are involved with pump station operation. The city also has a shoreline inspection program and has mapped all discharge points, including CSO outfalls, storm water outfalls, industrial outfalls, and highway drains. Several vessels patrol the shorelines on a regular basis. If a dry weather overflow is suspected or observed, the maintenance crews will attempt to correct the problem immediately.

NMC #2: Maximize Storage in Collection System

- Remove/replace items that restrict storage (accumulated debris, undersized pipes)
- Repair tide gates to reduce leakage
- Retard inflows by surface storage
- Upgrade pumps at lift stations, if treatment plant capacity is not limiting

NMC #2: Example

The city of Detroit installed inflatable dams in two long, large-diameter lines that extend from the collection system to the shoreline discharge point. The system layout prevented any risk of upstream adverse effects, and installation was relatively straightforward and inexpensive. Detailed monitoring data are not available to quantify the benefits, but these devices are often effective in completely containing overflows from smaller storms and can reduce the number of overflows. Maintenance is minimal because contained flows drain back into the collection system following the storm, and no real-time operation of the devices is necessary. The dams simply provide more effective use of existing excess capacity within the system.

NMC #3: Review/ Modify Pre-Treatment Requirements

- Review non-domestic inputs to sewer system and determine if they are significant contributors to pollutant discharges during storm events
- Evaluate feasible modifications to permits, such as forbidding batch discharges or requiring on-site detention during storm events

NMC #4: Maximize Flow to Treatment Plant

- Implement O&M improvement to ensure pipes and pumps are operating at full capacity
- Determine relationship between flow and performance of treatment plant
- Identify unused storage capacity at treatment plant
- Note: Regulatory relief options include waiver of percentage removal req'ts at POTW (but not concentration limits) and allowance for discharge of primary-treated water, if that option is more beneficial than other CSO abatement alternatives.

NMC #5: Elimination of Dry-Weather CSOs

- Inspect regulators at high-flow times during dry weather, since mal-functioning regulators are probably the most common cause of dry-weather CSOs (EPA recommends minimum inspection frequency of once per two weeks and after every storm event, more frequent if regulator is considered at risk.)
- Recommended actions are basic maintenance (cleaning) and repair of regulators, tide gates, and interceptors

NMC #5: Example

A study by the city of New York determined that DWOs from its CSS were caused primarily by clogging or blockage of regulators employing weirs, orifices, and drop pipes, as well as by mechanical failure of automatic regulators. The city developed an inventory of the system and implemented a regulator improvement program in 1988. The program reduced DWOs by about 94 percent, from approximately 2 to 0.12 percent of the total dry weather flows (DEP 1991). Principal elements of the program were the reorganization of maintenance operations to clarify the responsibilities between treatment plant and collection system operations, an increase in collection system maintenance staff from 33 to 50, and the acquisition of additional vehicles and equipment (jet flushers, vactors).

NMC #6: Control of Solid and Floatable Materials in CSOs

- Most floatables originate as street litter (plastic bags and wrappers, styrofoam, cigarette butts)
- Baffles retain floating material in wet wells or storage basins, but their effectiveness depends on density of material and minimizing nearby turbulence
- Racks, screens, and nets can retain solids, at the cost of some headloss

NMC #7: Pollution Prevention Programs

- Reduce contaminant entry into sewer system by reducing contaminant use and/or release, and maximizing reuse and recycling.
  - Street cleaning removes large amounts of many contaminants from stormwater
  - Control product use through regulatory or policy actions (restrict use of pesticides, de-icing salts, fertilizers, etc.)
  - Public education can reduce inappropriate dumping of tires, motor oil, household hazardous wastes, etc.
  - Effective pre-treatment program can reduce not only flow, but also concentrations of contaminants

NMC #8: Public Notification

- Does not reduce flows or contaminant releases, but can reduce public health impacts by limiting exposure.

NMC #9: Monitoring CSO Impacts and Efficacy of Control Measures

Regulatory Environment

- CSO / SSO events create health hazards, endanger habitat, lead to closures of beaches fishing areas, and other recreation areas, and are unsightly
- Most utilities are under order to reduce (no more than 1x per year) or eliminate
- Discharges are regulated under NPDES permits – Ecology, EPA, DEQ
- Blending policy is still being negotiated

Response Options & Control Strategies

- Continue to overflow
- Disconnect system
- Real time control
- Pump and treat
- System storage
- Increased treatment capacity

System Disconnection

- Can be simplest solution
- Building codes for new construction
- Assistance to home owners to disconnect gutters
- Parking lots
- Need stormwater control / treatment

Conveyance, Pump, and Treat

- Increase pumping in the system to deliver higher flows to the main wastewater treatment plants
- Treatment plants must be designed to accept additional flow
- Requires significant infrastructure

System Storage

- Build storage tanks in collection system to hold excess flow
  - when inflows subside and treatment plant has available capacity, release stored water back into the system for treatment
  - storage required may be extremely large

Goals for treating peak flows

- Cost effective infrastructure: utilize 0-12 times/yr
- Easy to operate
- Fast start-up
- Minimal footprint
- Regulatory acceptance

Treatment Components

- Hydraulic Capacity
- Screening
- Solids removal
- Disinfection
- Solids handling
- Support systems (chemicals)
- Infrastructure (electrical, I&C, etc)

Solids Removal

- Primary Clarifiers
- Chemically Enhanced Primary Clarifiers
- Chemically Enhanced Lamella Settling
- Microfiltration
- High Rate Clarification

CSO Control: Portland, OR

- 32 combined sewer overflows into Willamette River
- Collect and treat CSOs via 10 miles of new pipe and tunnels on west side of river
- 14-ft tunnel at 50 to 70 ft below surface
- $407 million project
- First phase operation by December 2006
- Handle 3-year storm

Washington D.C.

- East coast city with large portion of combined sewers
- 60 CSO outfalls – to Potomac R. and Chesapeake Bay
- Large variation in CSO versus rainfall due to spatial variations of rain and antecedent moisture
- Computer model developed to evaluate collection system flows as function of rain event characteristics
- Methods employed for partial control effort
  - 400 Mgal/d CSO collection & treatment
    - Swirl separators and disinfection
  - Inflatable dams in pipe line – real time control
    - 12 dams control 8 CSOs

CSO Events

- CSO volume (Million gal/year)
  - No phase I controls - 3254
  - With phase I controls - 2490
- Number of CSO events
  - No phase I controls - 186
  - With phase I controls - 179

Sources of fecal coliform

	Upstream	Stormwater	CSO
Anacostia	25%	14%	61%
Potomac	41%	13%	35%
Rock Creek	22%	36%	42%

Alternatives Evaluated

- Source Control
  - Street sweeping, combined sewer flushing, construction site controls, frequent catch basin cleaning
- Inflow controls
  - Rooftop greening, street storage of stormwater, disconnect roof top leaders
- Sewer system optimization
  - Real time control and storage in system
- Sewer separation
- Storage technologies (tunnels, basins)
- Treatment technologies
- In-stream treatment - aeration

Evaluation criteria

- Regulatory compliance
  - EPA CSO policy
  - NPDES permit
- Cost-effectiveness
- Northeast boundary flooding problems
- Non-monetary factors
  - Complexity, ease of implementation
- Public acceptance

Findings

- Complete separation with no treatment of stormwater most costly ($2 billion capital) and least effective solution
- Reducing overflows to 20/yr had greatest impact on water quality relative to cost
- Construction of collection/storage tunnels, (about 150 mgal) and improved treatment for excess flows at wastewater treatment plant
- Capital cost about $1 billion
- Capital plus O&M would increase annual household cost from $271 to $603 per year