City of East Lansing
CSO Control Facility Evaluation
Demonstrative Approach to Meet WQS

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&
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East Lansing CSO Evaluation Study

1. The Problem
2. A Demonstrative Solution
3. WQS Evaluation
4. Results
Combined Sewer System

“One pipe” system:

- **Dry weather flow**
  - Sewage only
  - Regulator directs to interceptor for treatment at WWTP

- **Wet weather flow**
  - Sewage and stormwater runoff combined
  - Smaller storms usually within capacity of interceptor
  - Larger storms cause a CSO

- **Combined Sewer Overflows (CSOs)**
  - Occur during wet weather events that exceed the capacity of the sanitary interceptor and discharge (untreated) to the River, thus causing potential health risks to local citizens and environment
Combined Sewer Overflows

- CSOs impacts to surface waters:
  - Fecal coliform (bacteria)
  - Decreases dissolved oxygen
  - Suspended solids/toxics
  - Floatables
  - Violation of State and Federal law unless permitted

- Surface water discharges are regulated by a National Pollutant Discharge Elimination System (NPDES) permit
Pollutant Loading of Municipal Discharges

Pollutant Loading of Municipal Discharges

MDEQ Water Quality Standards

- Treat all CSO (settling, skimming, and disinfection)
- Protect public health—Red Cedar is protected for “total body contact recreation”
- Discharges meet Water Quality Standards—Red Cedar is protected as a “warm water fishery”
  - Bacteria (Fecal coliform, E. coli)
  - Dissolved Oxygen
  - Physical Characteristics
  - Total Residual Chlorine
  - Health of Biological Community
Alternative CSO Solutions

- No Action
- Separation
- Storage and Treatment (Retention Treatment Facilities)
  - Retention Treatment Basins
  - Tunnels
  - Treatment Shafts
CSO Abatement—Storage and Treatment

- RTFs in Michigan may be designed using either “Presumptive Criteria” or “Demonstrative Criteria”

- **Presumptive Criteria** (Definition of Adequate Treatment):
  - **1 year-1 hour storm**: No overflow, capture entire CSO volume for later treatment at WWTP
  - **10 year-1 hour storm**: Provide min of 30 minutes of detention to provide disinfection for the max avg hour out of the RTB
  - **Flows in excess of the 10 year-1 hour storm**: Treat to maximum extent possible

- **Demonstrative Criteria**
  - Demonstrate that new facilities meet Water Quality Standards
  - Requires extensive evaluation program, including sampling at the RTF and the surface water and biological habitat surveys
## Major RTFs in Michigan

The total storage per 1,000 acres is based upon combined and storm tributary areas only; separated sanitary tributary areas are NOT included.

The above list includes the majority of the CSO facilities in Michigan. Smaller facilities located at WWTPs are generally not included.

<table>
<thead>
<tr>
<th>Community</th>
<th>Basin Name</th>
<th>Basis of Design Criteria</th>
<th>Total&lt;sup&gt;1&lt;/sup&gt; (MG/1000 ac)</th>
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<tr>
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<table>
<thead>
<tr>
<th>Community</th>
<th>Basin Name</th>
<th>Basis of Design Criteria</th>
<th>Total&lt;sup&gt;1&lt;/sup&gt; (MG/1000 ac)</th>
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<td>Detroit</td>
<td>Seven Mile</td>
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<tr>
<td>Bay City</td>
<td>Union &amp; Marquette</td>
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</tr>
<tr>
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<td>Water St.</td>
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<td>Wenonah Pk</td>
<td>Presumptive</td>
<td>11.1</td>
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City of East Lansing:
- Sewer Separation & One RTF
- 911 acre combined sewer watershed

Red Cedar Watershed:
- 465 square miles
East Lansing CSO Area and Control Facilities

Phase A (1995)
- Tunnel Sewer
- WBS & P Sta.

Phase B (1995)
- Sewer Separation

Phase C (2006)
- 2.6 MG RTB

WWTP

MSU CAMPUS
Retention Treatment Facility Data

- East Lansing RTF sized using **Demonstration Criteria**

- **Design Capture Volume:**
  - Total storage volume provided is 7.8 MG
  - RTF will capture runoff from a 0.8” rainfall
  - Will retain approximately 93% of storm events
  - The remaining 7% are skimmed, settled and disinfected (overflow events)
  - Approximately 80% of CSO volume will be captured

- **Design Peak Flow:**
  - Basin is designed for peak influent flow from the 10 Year-1 Hour storm of 650 cfs
  - RTF provides approximately 15 minutes of detention at 650 cfs
Case 1: Dry Weather
Sanitary flow in interceptor

Case 2: Minor Storm
Flow contained in Tunnel and Weir & Baffle Structure
Case 3: Small Storm
Flow contained in RTB

Case 4: Large Storm
RTB discharging settled, skimmed, and disinfected Combined sewage to Red Cedar River
Case 5: Post Storm
RTB is flushed and captured flow and solids pumped to sanitary interceptor for treatment at WWTP
CSO Program Milestone Dates

- **January 2003** – City proposes RTF sized using demonstrative criteria to MDEQ
- **July 2003** – City submits Project Plan update to MDEQ
- **December 2003** – MDEQ approves Project Plan
- **March 2004** – Start Phase C 2.6 MG Basin Construction
- **October 2005** – City submits Work Plan for Evaluation Study to MDEQ
- **March 2006** – Complete RTF construction & begin data collection for Evaluation Study
- **March 2008** – Data collection ends, draft Evaluation Study submitted to MDEQ
- **December 2008** – Final Evaluation Study submitted to MDEQ
Evaluation Study Coordination

- **City of East Lansing Personnel:**
  - Prepared and maintained equipment on standby for rainfall events
  - Collected RTF and River samples during events
  - Collected weekly Dissolved Oxygen data from River
  - Collected flow and rainfall data

- **Hubbell, Roth & Clark Personnel:**
  - Prepared Work Plan and trained City staff on study protocols
  - Processed and analyzed all collected data, prepared summaries and graphical presentations
  - Performed pre & post-operational biodiversity study (GLEAS 51)
  - Prepared Evaluation Study report and made conclusions
Evaluation Study Data Collection

- **RTF Data Collection:**
  - Influent and Effluent samples were analyzed for BOD, TSS, Total P, NH₃
  - Effluent samples were also analyzed for Fecal coliform, DO, pH, temperature and TRC
  - Limited additional Effluent samples were taken for metals, hardness, alkalinity, oil and grease, and CBOD

- **River Data Collection:**
  - River sampling included TRC and DO
  - County health department collected *E. Coli* samples
  - Visual observation made for physical characteristics
  - GLEAS 51 to determine health of the biological community
## Typical RTF Sampling Quantities

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Influent</th>
<th>Effluent</th>
<th>Samples for 2 hr. Overflow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Influent</td>
<td>Effluent</td>
<td></td>
</tr>
<tr>
<td><strong>BOD₅</strong></td>
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<td>7</td>
<td></td>
</tr>
<tr>
<td><strong>TSS</strong></td>
<td>15</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td><strong>Nitrogen (NH₃)</strong></td>
<td>15</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td><strong>Total Phosphorus</strong></td>
<td>15</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td><strong>Fecal Coliform</strong></td>
<td>--</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td><strong>TRC</strong></td>
<td>--</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>--</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>--</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td><strong>DO</strong></td>
<td>--</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td><strong>Alkalinity</strong></td>
<td>--</td>
<td>7</td>
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</tr>
<tr>
<td><strong>TOC</strong></td>
<td>--</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td><strong>Hardness</strong></td>
<td>--</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td><strong>Oil &amp; Grease</strong></td>
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<td></td>
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<tr>
<td><strong>Soluble CBOD</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Total Metals</strong></td>
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<td>7</td>
<td></td>
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<tr>
<td><strong>Ultimate CBOD</strong></td>
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<td>7</td>
<td></td>
</tr>
<tr>
<td><strong>Total Samples</strong></td>
<td>60</td>
<td>112</td>
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</table>
Typical River Sampling

- During large storm events, City personnel collected DO and TRC samples from the Red Cedar River while the RTF was discharging.

- Multiple TRC samples taken at left, middle, and right bank to determine the TRC "plume" downstream of CSO outfall.

- Personnel needed to be prepared to sample on short notice and deal with safety and weather issues.
East Lansing Study Area
Number of Events during Two-Year Study:

- There were nine events where the RTF received flow, but did not discharge.
  - Approximate volume captured was 194 MG.
  - This does not include smaller events where flow did not enter the RTB and was captured in the upstream system.
  - All captured flows are dewatered to the WWTP for treatment.

- There were three overflow events during the Study period.
  - Total treated volume discharged was approximately 36 MG.
  - There are no provisions for bypassing of flows.
Total Residual Chlorine

- River samples were taken during two overflow events to locate the TRC plume from the RTF.

  - June 2007 event:
    - Average RTF effluent TRC concentration was 2.1 mg/l.
    - Maximum River TRC was 0.23 mg/l.
    - Plume was short in duration and length, hugged bank.
    - TRC was non-detect at the outfall three hours into the event.

  - August 2007 event:
    - Average RTF effluent TRC concentration was 2.6 mg/l.
    - No TRC was detected in the River.
June 4, 2007 Event, TRC Results

Approx. 1,500’ downstream of outfall

Approx. 400’ downstream of outfall
Bacteria

- RTF effluent samples were measured for Fecal coliform.
  - The RTF disinfection system (sodium hypochlorite) was not operational during the first overflow event. Geometric mean for Fecal coliform was 6,900 cts./100 ml without disinfection.
  - The geometric means were less than 10 cts./100 ml during the other two overflow events, with an average TRC of 2.2 mg/l.

- *E. Coli* samples are regularly taken from the Red Cedar River by the Ingham County Health Dept.
  - Results are similar up and downstream of the RTF.
  - Public health standard is sometimes not met after wet weather events, whether or not RTF discharges.
Red Cedar River Bacteria (*E. Coli*)

2007 Ingham County Health Department
Red Cedar River E. Coli Sampling

Note:
Hagadorn and Harrison Rd. sites are upstream of the RTB, and Kalamazoo St. site is downstream of the RTB.

RTB Discharged 6/4/07 to 6/5/07
RTB Discharged 8/24/07
Dissolved Oxygen

- Permit required River sampling for DO during three overflow events in “critical months” (May – Sept.). Only two overflow event occurred during critical months.

- Nearly impossible to distinguish impact of RTF discharge on Red Cedar DO because of numerous other inputs and conditions up and downstream of the RTF:
  - DO drops regularly occur at dam approx. 1 mile upstream of RTF.
  - Approx. 60 storm water outfalls located on the MSU campus.
  - Confluence with Sycamore Creek, approx. 1.5 miles downstream, which has DO sags due to sediment.
  - Confluence with Upper Grand River, approx. 2 miles downstream, which has numerous other storm and wastewater inputs.
Dissolved Oxygen

- City therefore revised study approach by reviewing long-term DO trends in the River.
  - City has collected data at locations up and downstream of the RTF and WWTP for more than 20 years.
  - DO sags were found to occur up and downstream of the RTF when there were no CSO discharges.
  - Only three DO sags were observed downstream of the RTF after it was constructed—all were in 2006 when there were no CSO discharges, and were during low flow conditions.
  - **No** DO sags were observed after the CSO overflow events in 2007 and 2008.
  - DO sags that do occasionally occur are generally correlated with low flow conditions.
Red Cedar River Dissolved Oxygen Data

- Upstream of CSO outfall: Okemos DO
- Downstream of CSO outfall: CSO Site DO
- Downstream of Sycamore Crk: Pennsylvania DO
- Farm Lane DO
- Kalamazoo DO
- Harrison DO
- WWTP Site DO

No CSO discharges during "critical months" (May - Sept, in boxes)

2 Phase C CSO discharges
The health of the benthic community upstream and downstream of the RTF was assessed as a surrogate for testing for toxic materials and other pollutants.

Used MDEQ GLEAS Procedure No. 51, “Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers.”

Two surveys were made—one prior to construction of the RTF in August 2005, and one after nearly two years of RTF operation in August 2007.

- No measurable change in the macroinvertebrate community was found between 2005 and 2007.
- In both studies, the macroinvertebrate communities were scored as having “acceptable” biological integrity both upstream and downstream of the RTF.
Pollutant Loading

- Approximately 80% of the total CSO volume and 93% of the pollutant load to the RTF was captured.
- All captured flows are treated by the City’s WWTP.

<table>
<thead>
<tr>
<th>Event Date</th>
<th>Overflow Event?</th>
<th>Influent Pollutant Load (pounds)</th>
<th>Effluent Pollutant Load (pounds)</th>
<th>% Captured</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>BOD$_5$</td>
<td>NH$_3$</td>
<td>TP</td>
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<tr>
<td>3/13/06* Yes</td>
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<td>372</td>
<td>255</td>
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<td>Totals during Study Period</td>
<td>86,244</td>
<td>2,220</td>
<td>1,715</td>
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Pollutant Loading

- RTF effluent pollutant concentrations are similar to expected stormwater concentrations, using NURP data.
- Pollutant loads from the RTF are significantly lower than stormwater due to the significant amount of runoff (>80%) captured for treatment at the WWTP.

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<th>Source</th>
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<td>BOD (mg/l)</td>
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<td>East Lansing RTF Average Effluent</td>
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<td>NURP Median Urban Storm</td>
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<table>
<thead>
<tr>
<th>Source</th>
<th>Pollutant Loading Over Study Period (pounds/year)</th>
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<tr>
<td>NURP Median Urban Stormwater</td>
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Stormwater & Treated CSO Concentrations

Sources:  
CSO Data: Rouge Phase I CSO Basins (www.rougeriver.com)  
CONCLUSIONS

- East Lansing has created a successful Demonstrative Program
- The City is continuously trying to refine basin operations to improve and minimize discharges to Red Cedar River
- RTF originally anticipated to discharge to river 4 times per year but has averaged 2 overflows/year since 1996
- Pollutant load from stormwater runoff is significantly greater than loading resulting from treated RTF discharges
- Wet weather standards should be developed for storage and treatment facilities
- Licensing should be established for operators of storage & treatment facilities
- TRC needs to be further evaluated and understood before current standards are changed