Project Status, April 2018: CS-175; Dynamic Collection System Control

Summary
The two areas of focus for the project CS-175; Dynamic Collection System Control are: analysis of dynamic control for the GDRSS system, and an operator decision support dashboard. Here we provide a review of progress made for each of these tasks and discuss future work.

Updates

Decision Support Dashboard

In April, GLWA staff and U of M researchers met to discuss both the decision support dashboard and the dynamic control strategies that we are developing. During the meeting, GLWA staff discussed active work around a real time map interface for the sewer conveyance system called the Wet Weather Map. Following this meeting on April 6th, access to the Wet Weather Map was provided to the U of M researchers. The outcome of this meeting was the decision to supplement the current tools and visualizations provided to the stormwater operators by building on top of already existing wet weather dashboards. This will reduce any duplications that may arise and allow us to focus more time on the real-time control algorisms.

This month, we were provided the opportunity to observe stormwater operations at GLWA System Command and Control during a two-day wet weather event. Many insights were gained while observing the operators for how a control-specific dashboard will effectively integrate into current wet weather observations. Currently operators have access to a wide array of data displayed in tables or system diagrams that are organized in a variety of different tabs. This array of information can be unwieldy to incorporate into an operator's control decision. Instead, we imagine an additional tab that shows just the relevant sensor measurements (flow, level, pump and gate states, etc.) for a control scenario (e.g. control of the Conner Creek – Fairview – Freud complex.) This display would also incorporate an alert feature that would encourage the operator to take an action, such as opening a gate or turning off a pump. A mock-up of how these different tools would interact for the Conner Creek – Fairview – Freud complex can be found in Figure 1. This setup however can be extended to the operation and control scenario of the In-line Storage Dams (ISDs) and other control points in the system.

Dynamic Control for the GDRSS

In last month's update we reported that we had applied our Market-Based Control (MBC) framework to the GDRSS SWMM and were investigating how best to apply the user-defined set-points for downstream and in-line assets. In April, we explored the variability in downstream response when changing both downstream set-points and upstream weightings. We also began to investigate protocols for series of ISDs, such as ISDs 6-10 on the First Hamilton Trunk Line. We are currently investigating how to determine the optimal discharge from each dam in series to simultaneously meet the downstream set-point objectives and achieve advantageous storage volumes upstream of each ISD, while minimizing rapid flow oscillations. This is an ongoing line of investigation. Initial results indicate the ability to accurately regulate and peak-shave flows using the series dams (see Figure 2.)

LIFT Challenge Team Project

In April, GLWA staff and researchers in the Real-Time Water Systems Lab at the University of Michigan formally joined together on a team to compete in the WEF and WERF sponsored 2018 LIFT Intelligent Water Systems Challenge. The intended competition deliverable from this team is a real-time decision support dashboard for stormwater operators. Intentionally, this deliverable has complementary goals to this project (CS-175). Towards this aim, in April we made progress in the back-end development for the cloud-based applications required to deliver a real-time decision support dashboard. This includes a cloud-based

Project Contacts:
Branko Kerkez
bkerkez@umich.edu

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SWMM environment that can accept different precipitation products as inputs, and the scripts to prepare these precipitation products for use in SWMM.

Control Point	Current Status	Action?
Conner Creek Storm PS (Pumps 1-8)	0 of 8 Pumps ON	
Conner Creek Sanitary PS (Pumps 1-4)	4 of 4 Pumps ON	GOAL: 0 of 4 Pumps ON
Freud Storm PS (Pumps 1-8)	4 of 8 Pumps ON	
Freud Sanitary PS (Pumps 1-2)	2 of 2 Pumps ON	
Fairview PS (Pumps 1-4)	3 of 4 Pumps ON	
Conner Creek Backwater Gates (1-9)	32% OPEN	GOAL: SET TO 50% OPEN
Forebay Regulator Gates (1-3)	66% OPEN	
Measurement Point	**Current Measure**	**Setpoint**
DRI Sewer Level [0 to 9]	9.6 FT	4.5 FT
East Jefferson Relief Level [60 to 74]	72 FT	67 FT
DRI @ Jeffersonian [0 to 11]	4.8 FT	5.5 FT
Dubois & Franklin [0 to 13]	0.0 FT	6.5 FT
Freud PS Wet Well [106 to 20]	65.8 FT	75 FT
CC Storm PS: Wet Well [55 to 85]	70.0 FT	75 FT
CC Storm PS: Discharge Channel [79 to 105]	79.1 FT	85 FT
CC Sanitary PS: Wet Well [45 to 85]	68.2 FT	75 FT
CC Sanitary PS: Discharge Channel [75 to 95]	83.7 FT	85 FT
Conner CSO Total Influent Flow	464.1 CFS	–
Outfall B003B	0.00 CFS, Level: 96.95, River: 97.4	–
Outfall B004	0.00 CFS, Level: 79.57, River: 96.9	–
Outfall B005	0.00 CFS, Level: 96.58, River: 97.3	–

Figure 1. Mock Up of proposed control-specific dashboard (Left.) Control Points for a control scenario (e.g. Conner Creek - Freud - Fairview operations) are displayed in the upper table, along with their current sensed state, and whether an action should be taken. This action will be an animated alert, blinking to draw the attention of an operator to the proposed action. Control actions would then be taken through the current computer systems (Bottom Right.) The Measurement Points table (Bottom Left) is a quick look at the combination of measurement points in the system that are used to make the dynamic control decision. Measurement Points will display their current measure from the sensor, and the setpoint used to as objective criteria for our control algorithms. For a holistic view of the conveyance system, operators would continue to use the Wet Weather Map (Top Right).

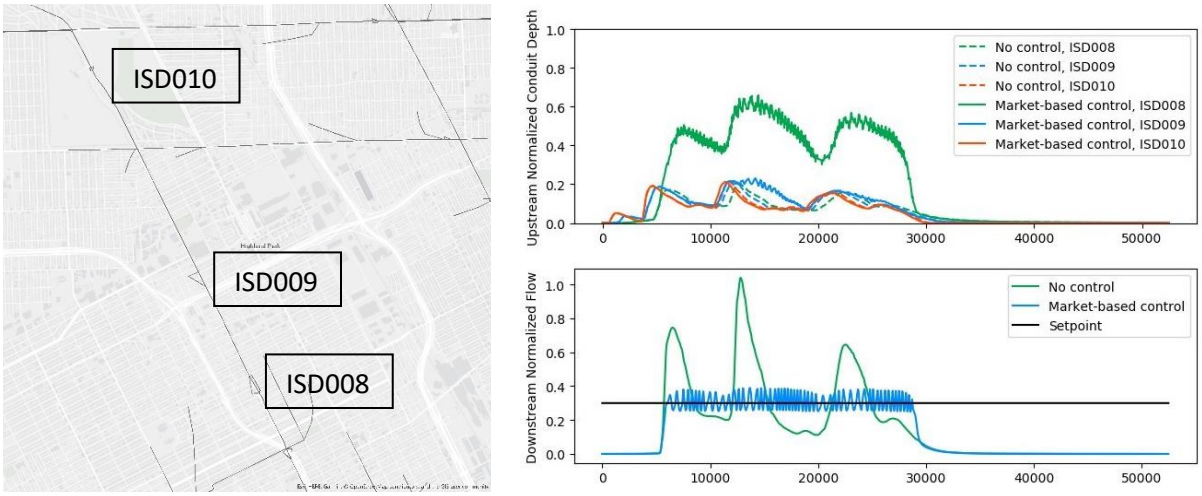

Figure 2. Above are three ISDs (008, 009, 010) in series on the First Hamilton Trunk Line. Results shown (right) are for the implmentation of Market Based Control with a downstream set-point that is 0.3 of pipe-full flow for a storm of one-half inch.

Future Work

We continue to incorporate other control points of the DRI system into the MBC schema, including the Conner Creek – Freud – Fairview complex. As we do so, it is necessary to develop a framework for these subsystems to interact. Therefore, we are beginning to look at the potential to employ a hierarchy of MBC algorithms to meet the downstream objectives.

Reporting

We look forward to providing an update of our progress on May 31, 2018.

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Project Contacts:
Branko Kerkez
bkerkez@umich.edu

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