Towards Dynamic Wastewater Discharge Management: River Water Quality Modelling

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STREAM Challenge Week Conference
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Project Inception & Drivers

• Strategic Review of Prices 2010 (SR10)
  • 01/04/2010 to 31/03/2015

• Ministerial Directive for Climate Change & Adaptation

• Carbon & Energy Footprinting
  • Increasing Energy Use – Past 10 Years
  • Quality Drivers (UWWTD, WFD)
  • More Aeration & Tighter Licenses

• Policy Approaches & Strategic Direction – Scottish Water & SEPA
  • Seasonal Licensing
  • Variable Licensing – Environmental Capacity

• Building on wider interest and support within U.K. wastewater sector.
Current Practice

Upstream Flow & Quality Distribution

Urban Drainage Network

Combined Sewer Overflows to River

WwTW Flow & Quality Distribution

Downstream Flow & Quality Distribution

WwTW Final Effluent & Storm Overflow to River

‘Point A’

‘Point B’

Catchment
River Eden (Fife) - Flow & Rainfall - 01/07/2010 to 01/07/2011 (15 Min. Time-step)

Rainfall (mm/hour) & Flow (m³/s)

Rainfall = Red, Flow = Black
The Projects

Industrial Project (SR10)

- 2 Trial Sites
  - Cupar WwTW & River Eden, Fife
  - Selkirk WwTW & Ettrick Water, Scottish Borders

  Attempting dynamic control within current treatment headroom based on monitored data.

STREAM Projects

- 2 STREAM Projects
- Going beyond industrial project to use more advanced predictive modelling.

Data, Information & Experience.
Conceptual Model & Framework

- Wastewater Influent Generator
  - Influent Flow & Quality Data

- BSM2 WwTW Model
  - Predicted Assimilative Capacity
  - Revised Flow & Quality of Final Effluent

- Artificial Neural Network of Urban Drainage Network Response
  - CSO Chamber Level Data
  - CSO Spill Warning

- Lumped Rainfall-Runoff Model for Flow Prediction
  - Predicted Flow

- Advection Dispersion Equation Based Model of Water Quality (DO, NH3)
  - Predicted Water Quality
  - Upstream Water Quality Data

- Assessment of Predicted Assimilative Capacity of River
  - Point A
  - Point B

Feedback if Downstream Quality Compromised by Control Strategy
River & CSO Monitoring Campaign
Initial Work & Potential

Forecast Flow (l/s) vs. Timestep (1=15 Minutes)

- Observed Flow
- WwTW Final Effluent Ammonia Concentration (mg/l)

WwTW Final Effluent Ammonia Concentration (mg/l)
WwTW Final Effluent Ammonia Concentration (mg/l)

- Observed Flow
- Modelled Flow
- Modelled Flow with Safety Factor

Timestep (1=15 Minutes)
Forecast Lead Time (Hours)

Ammonia Saved Over Baseline (mg/timestep/l)

ANN Forecasts
PDM Forecasts
Observed Flow
Delays & Issues

- SR10 Industrial Project Delayed
  - Technical Issues on Site
  - Unexpected Equipment Failures
- Additional Data Required
  - Time to Scope & Plan Monitoring Regime

Further Work

- Finalise Development of Transport & Decay Model
- Develop Final Water Quality Model Code
- Develop ANN Models of CSO Performance
- Integrate with Biniams WwTW Model

Interim Conclusions

- Identified the potential and scope for the approach.
- Identified a framework with which to achieve control of small to medium sized WwTW.
- Identified a parsimonious and minimal set of data requirements to achieve the objectives of the study.
- Identified model types and approaches suitable in data scarce predictive environment.
- Developed a framework for quasi-integrated urban wastewater system modelling in the Scottish context.
Thank You for Listening!

Any Questions?