Taking Stock: Using a Water Quality Model to Assess LTCP Benefits and Guide Future Decisions

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Wendy Reust, PE – City of Fort Wayne

Dante T. Zettler, PE

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Today’s discussion

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- Background
- Key players in the process
- Development of the model
- So we have a water quality model – what do we do now?

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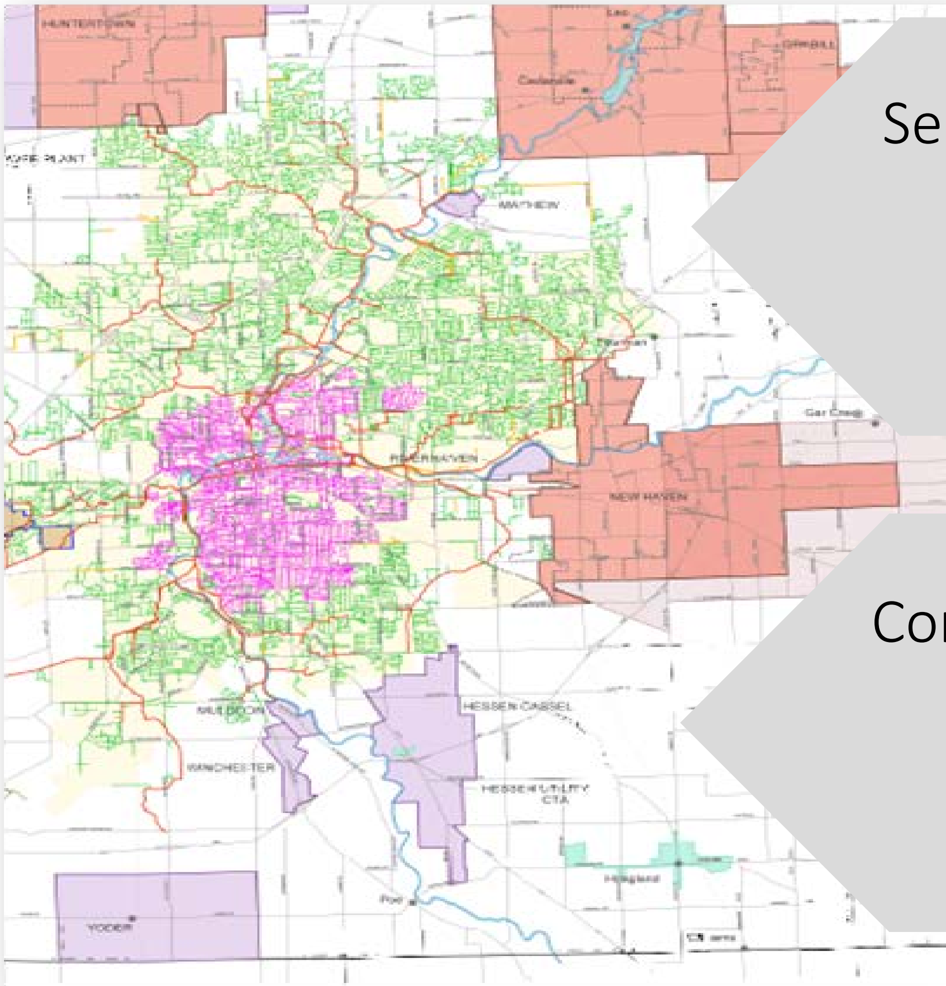
Background – the City of Fort Wayne, Indiana



Separate Sanitary System

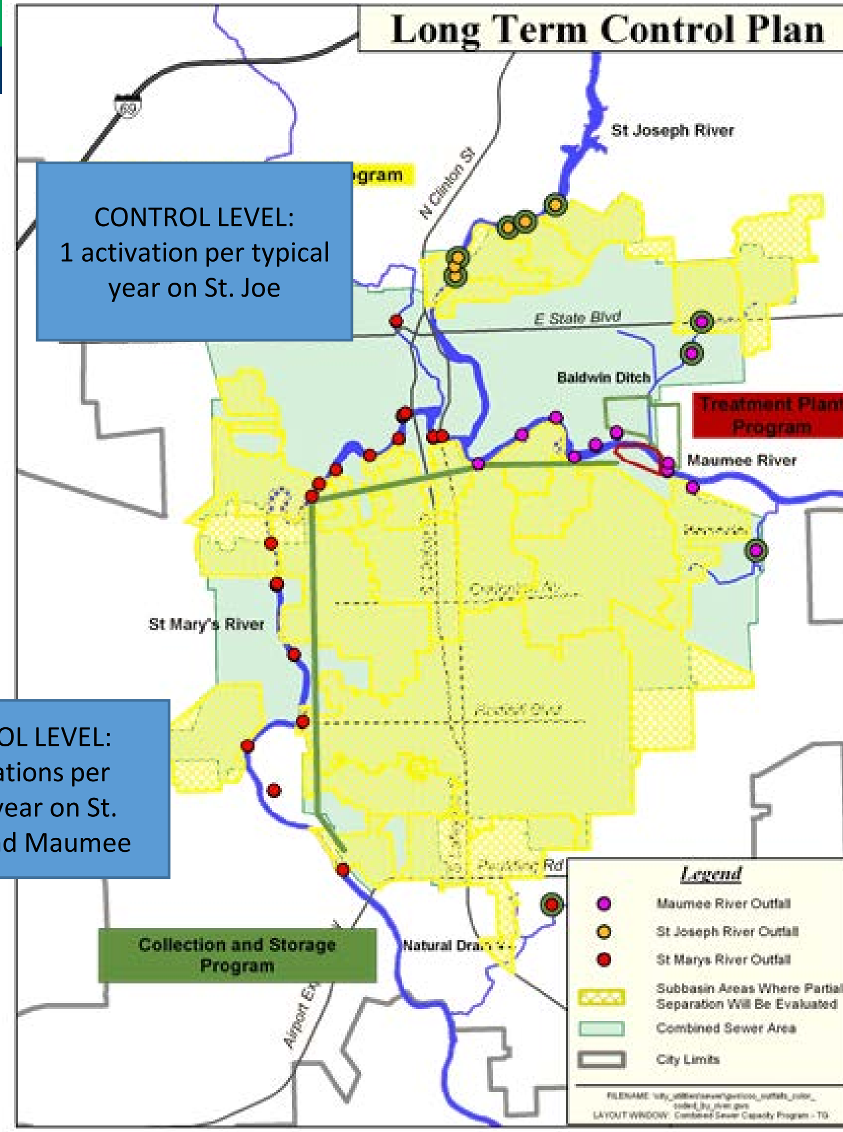
- 45 sq. miles service area
- 892 miles sanitary sewer

Combined System

- 15 sq. miles service area
- 347 miles combined sewer
- 41 CSOs

The City’s original 2007 LTCP

1. Reduce Through Separation
2. Collect More
3. Treat More



CONTROL LEVEL:
1 activation per typical year on St. Joe

CONTROL LEVEL:
4 activations per typical year on St. Marys and Maumee

LEGEND

- Maumee River Outfall
- St Joseph River Outfall
- St Marys River Outfall
- Subbasin Areas Where Partial Separation Will Be Evaluated
- Combined Sewer Area
- City Limits

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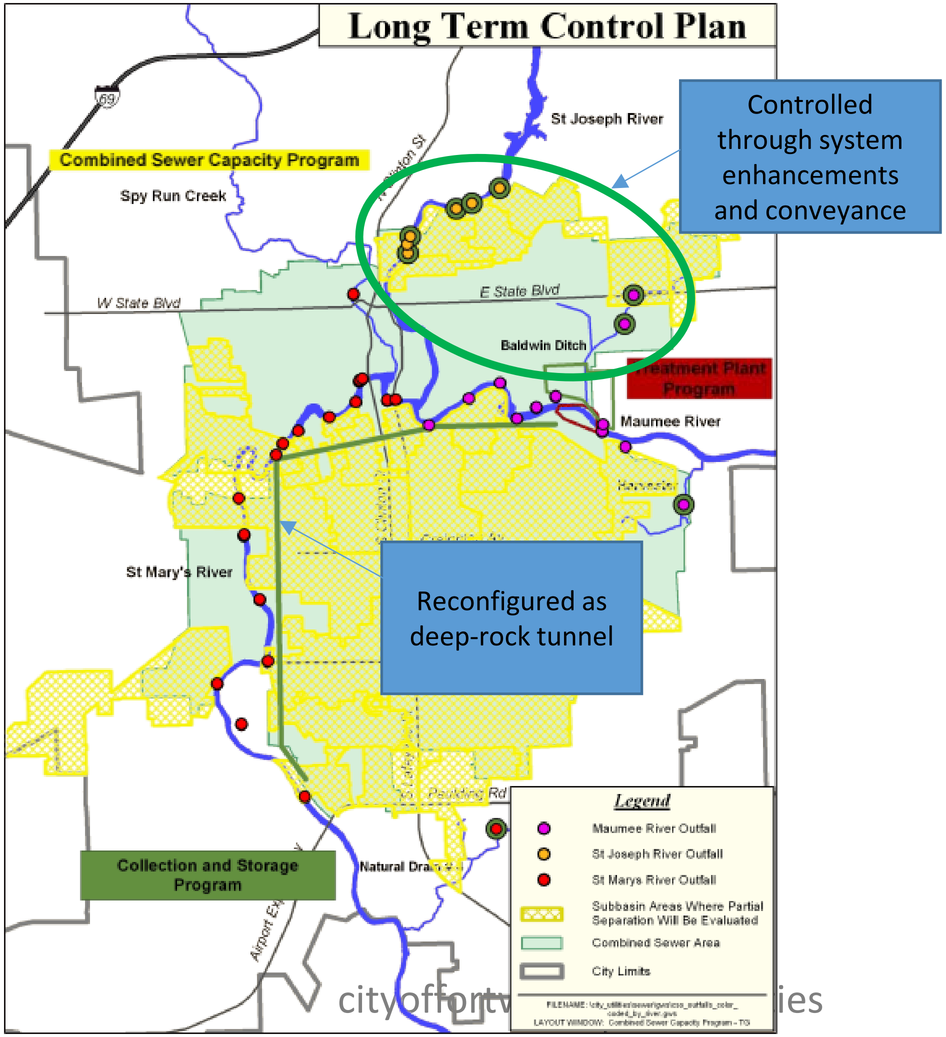
The City's LTCP today

After 10 years of implementation and refinement:

- Most satellite facilities eliminated – control achieved with sewer system enhancements and conveyance to Wet Weather Ponds (completed)
- Near-surface Parallel Interceptor replaced with a deep-rock tunnel (under construction)



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A great plan to control CSOs, but questions remain

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- What impact will CSO control have on water quality?
- Will bacteria WQS be met after LTCP implementation?
- What about sources beyond City control, from upstream watersheds?
- And what about the impact of other City sources, like stormwater?

- In 2014, the City initiated an update of their water quality modeling tools (dating from the late 1990s) to help answer questions like these.

Key players in the process

- City of Fort Wayne
  - Anne Marie Smrchek, Wendy Reust, Brian Robinson, Tom Mann
- HDR was the lead firm for developing the model
  - Jennifer Frommer, Andy Thuman, Tom Newman, Laurie De Rosa, Nitin Katiyar
- DLZ was responsible for support services, including GIS work.
- IPFW (local university) was responsible for implementing the sampling program, with support from additional City staff
  - Professor Bob Gillespie
- Dante Zettler was an on-call adviser to the City.

Development of the WQ model

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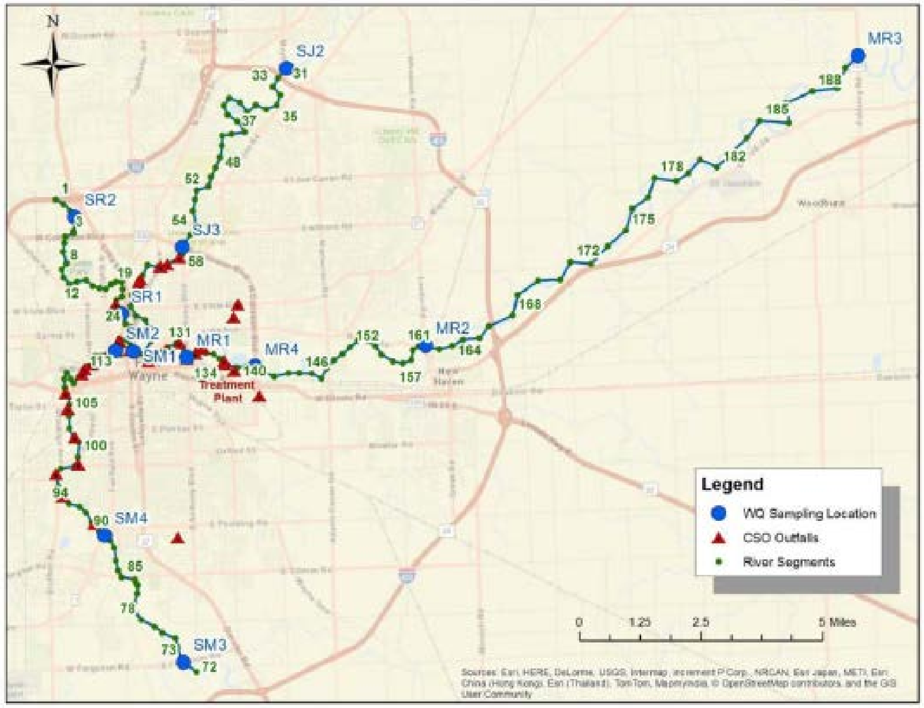
- Start with the City's existing landside (sewer system) model – fully developed, continually maintained
  - Already in SWMM5
- Build a representation of the river system
  - Use EXTRAN, and integrate with the landside model to account for river impacts on collection system
- Build the water quality model
  - Use WASP, linking to an EXTRAN-generated .hyd file
- Account for loads and boundary conditions
- Calibrate to sampled dry-weather and wet-weather events
  - For bacteria, DO, and nutrients



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So we have a water quality model – what do we do now?

- Help answer questions, guide decisions, support communication.

- The process starts with identifying key questions – for example:
  - Will bacteria WQS be met after LTCP implementation?
  - What about sources beyond City control, from upstream watersheds?
  - When and where should we invest in controlling other City sources, like stormwater?
  - Can we use the model to inform a constructive dialogue with the regulatory community regarding WQS compliance?

First, some background on model results and ways to use them

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- Having a calibrated water quality model is like having an unlimited sampling budget (sort of).
- Imagine having the resources to deploy teams to collect samples every hour, 24 hours a day, every day of the week, at hundreds of locations in your receiving waters.
- For as long as you want – 1 month, 1 year, 5 years, …

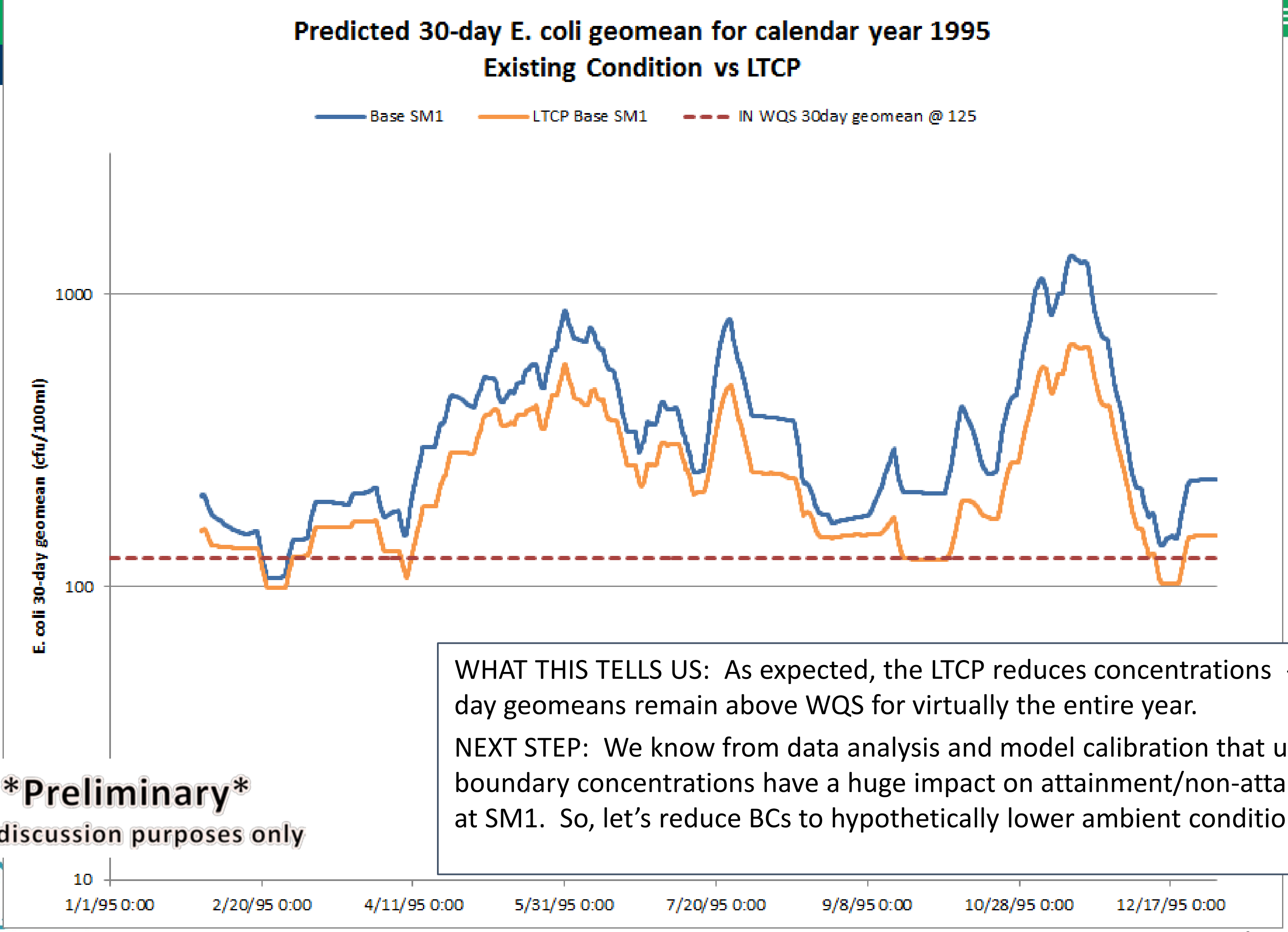
The model provides predicted hourly concentration time series at every location of interest

With model results in hand, there are two methods for using these time series to check attainment of bacteria WQS:

1. Use hourly results to calculate "sliding window" 30-day geomean and 30-day 90th percentile values of in-stream E.Coli.
2. Mimic a discrete grab sampling program – assume a start date and sampling interval, and "grab" single hourly samples from the model results at that interval.

Our following examples will demonstrate both of these methods.

Will bacteria WQS be met after LTCP implementation?



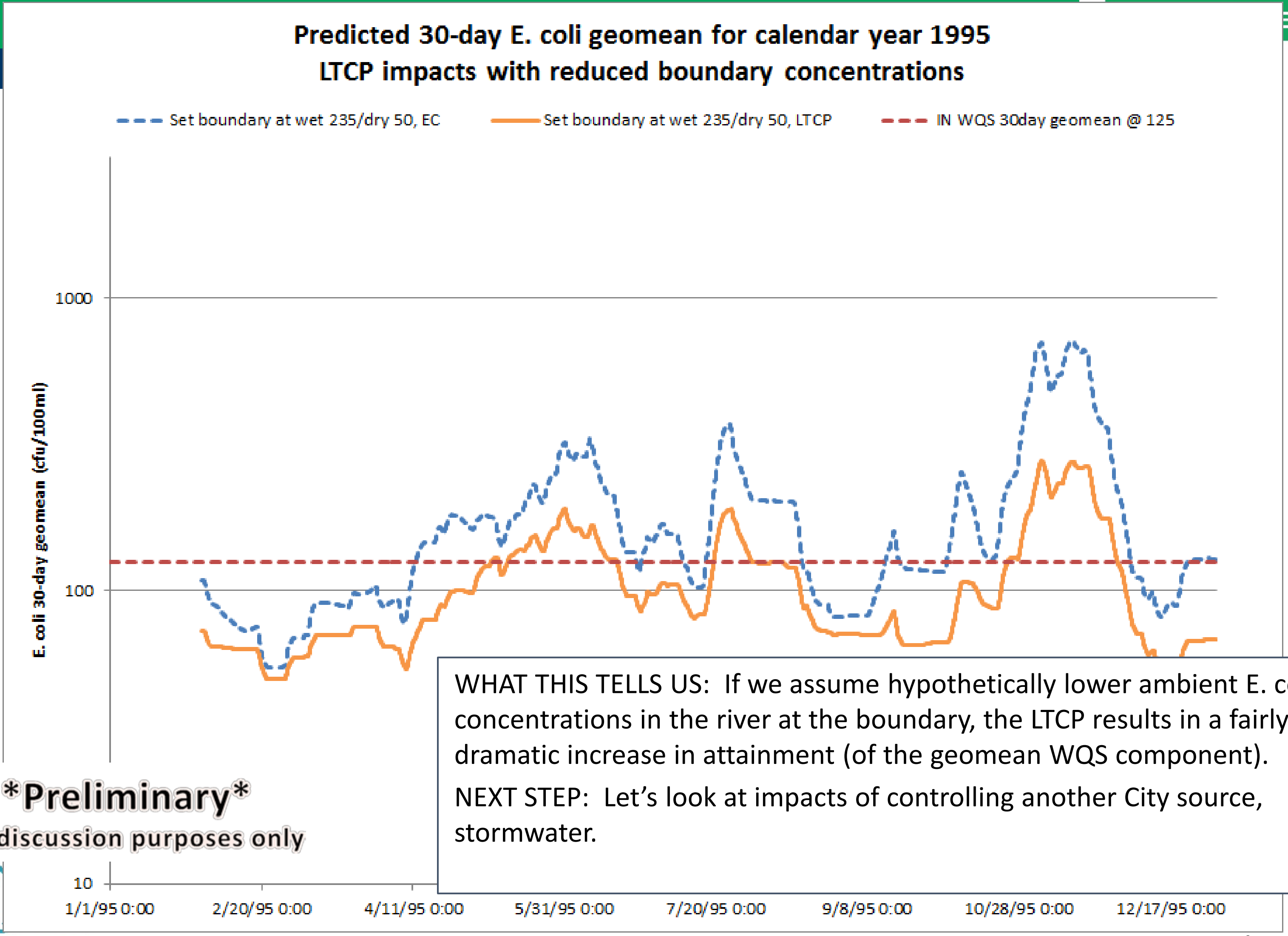
Preliminary

For discussion purposes only

WHAT THIS TELLS US: As expected, the LTCP reduces concentrations - but, 30-day geomeans remain above WQS for virtually the entire year.

NEXT STEP: We know from data analysis and model calibration that upstream boundary concentrations have a huge impact on attainment/non-attainment at SM1. So, let's reduce BCs to hypothetically lower ambient conditions.

What about sources beyond City control, from upstream watersheds?



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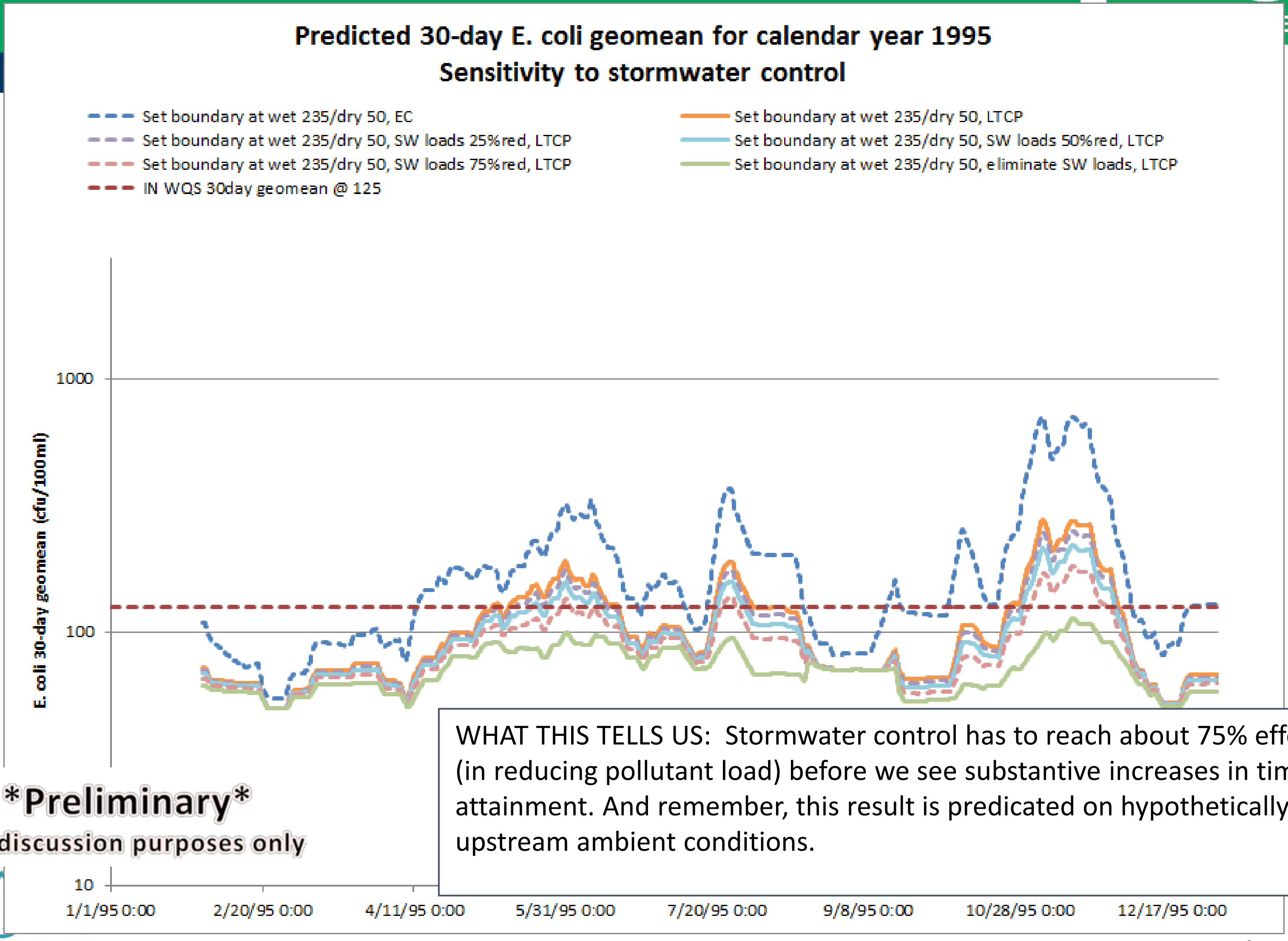
WHAT THIS TELLS US: If we assume hypothetically lower ambient E. coli concentrations in the river at the boundary, the LTCP results in a fairly dramatic increase in attainment (of the geomean WQS component).

NEXT STEP: Let's look at impacts of controlling another City source, stormwater.

When and where should we invest in controlling other City sources, like stormwater?



Preliminary

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WHAT THIS TELLS US: Stormwater control has to reach about 75% effectiveness (in reducing pollutant load) before we see substantive increases in time of attainment. And remember, this result is predicated on hypothetically lower upstream ambient conditions.

So… how are these model results helping us?

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- After spending several hundred million on CSO control and reducing activations to an average of 1-4 per year, model projections indicate that a utility like Fort Wayne could not approach meeting current bacterial WQS unless upstream boundary concentrations (which by the way are beyond their control) are substantially reduced, and all stormwater is treated at a 75% effectiveness level.
- These conclusions aren't surprising to most engineers/scientists in the room.
- But, they're likely shocking to ratepayers and non-technical decision makers.
- **KEY POINT**: the model provides a platform to reveal and explain the reasons for that reality, and to highlight water quality benefits independent of WQS.

Can we inform a constructive dialogue with the regulatory community regarding WQS?

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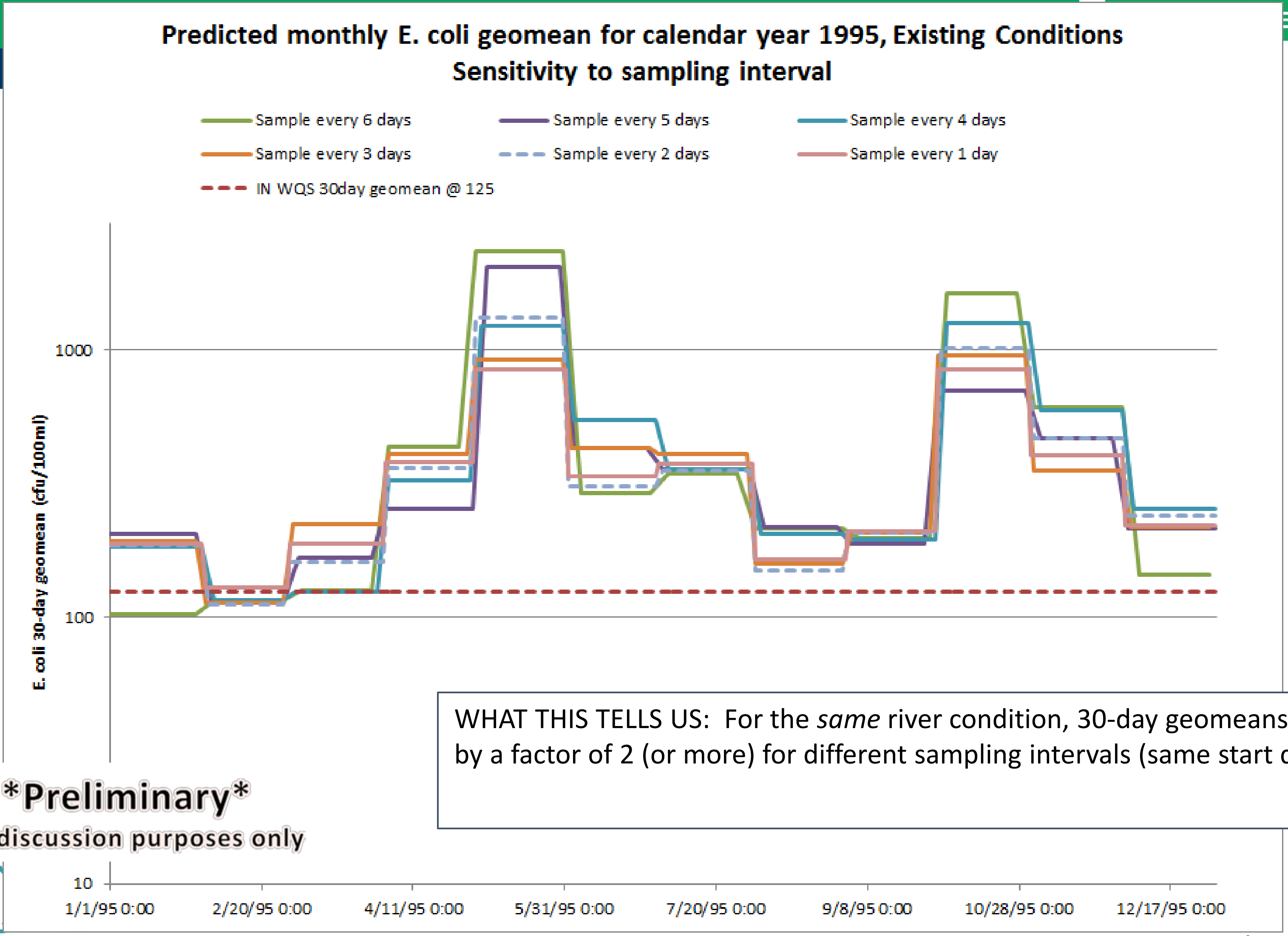
- Yes – and this is a key model application for utilities moving into compliance assessments after LTCP implementation.
- The approach will be utility-specific, river-specific, and system-specific.
- But, Fort Wayne's work can illustrate some of the broader implications concerning the design of WQS and corresponding compliance sampling protocols.

Commenting on recommended/required sampling protocols

The underlying problem:

- In any river, sampled bacteria levels are controlled by the random timing of wet-weather events.
- And, even within the time frame in which a wet-weather event impacts water quality, sampled bacteria levels can vary dramatically (up and down) on an hourly basis.
- So, the *interval* between consecutive samples and *when you start* both have an impact on the result for any given sampling program.
- This impact can be shown by using model results to mimic discrete grab sampling programs.

Different answers for the same river



WHAT THIS TELLS US: For the *same* river condition, 30-day geomeans can vary by a factor of 2 (or more) for different sampling intervals (same start day).

Preliminary

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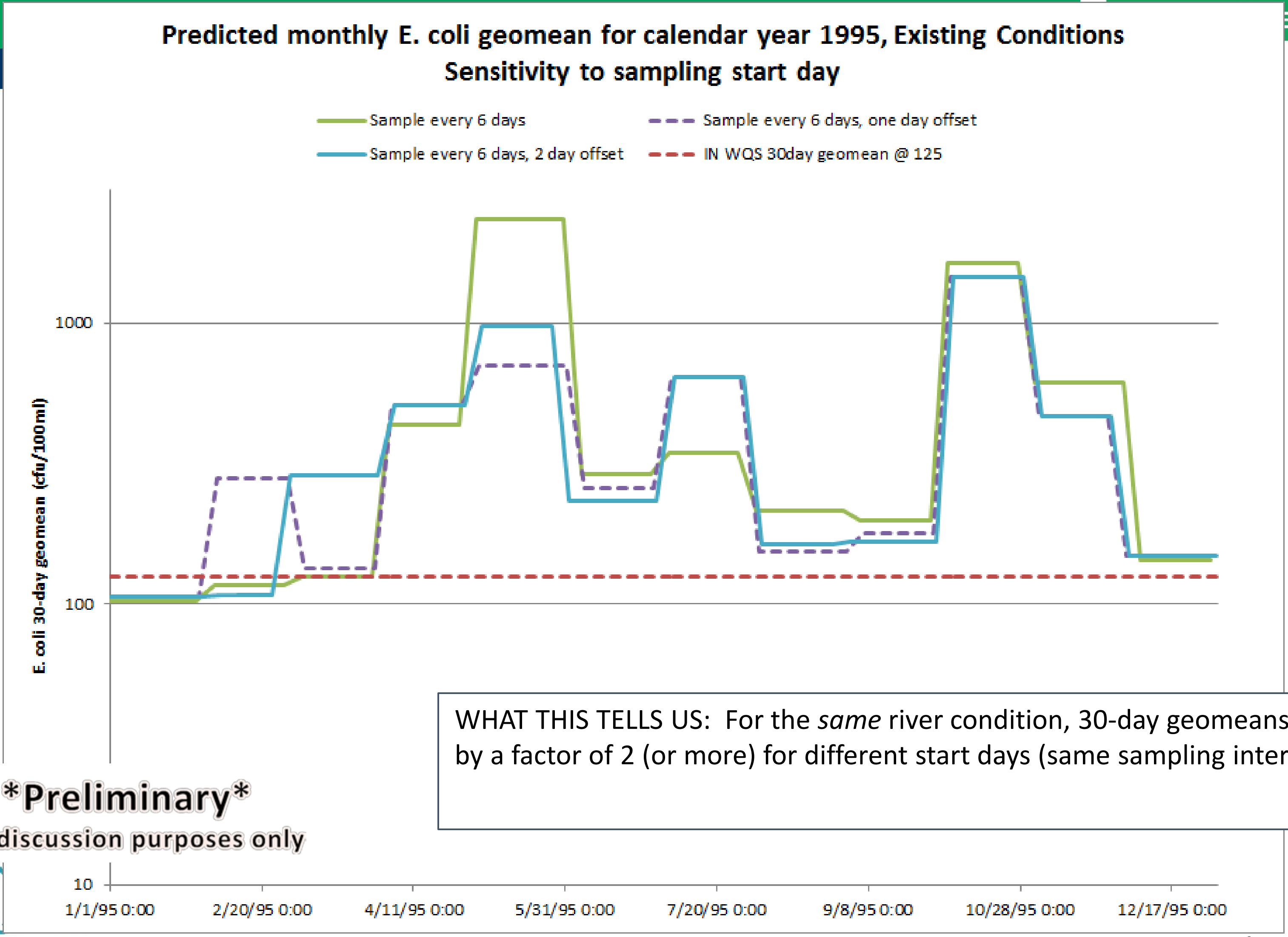
Different answers for the same river



WHAT THIS TELLS US: For the *same* river condition, 30-day geomeans can vary by a factor of 2 (or more) for different start days (same sampling interval).

Preliminary

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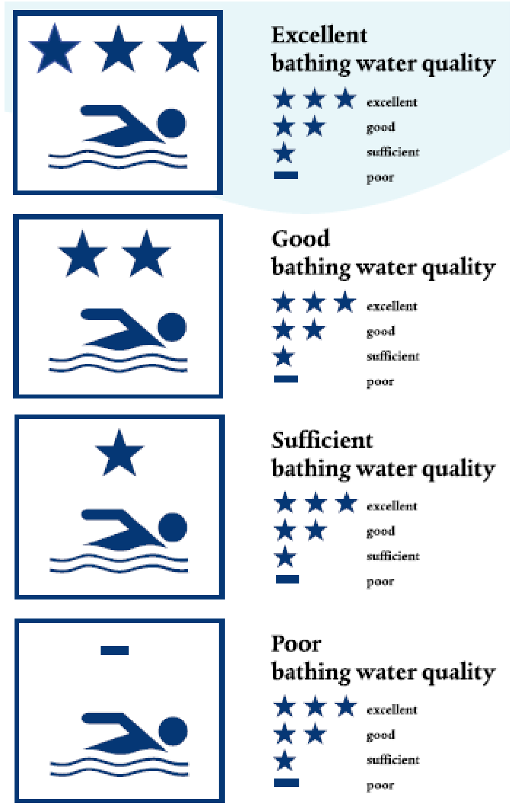
Commenting on magnitudes (and protocols) of bacterial WQS

- Another useful model application: results can be used to "test" an alternate WQS and compliance frameworks.
- For example: The European Union has had bathing water standards dating back to the 1970s, same as the US, and has been implementing a revised WQ Directive since 2006.
- What would this established WQ Directive look like in a US river?



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A tale of two cities

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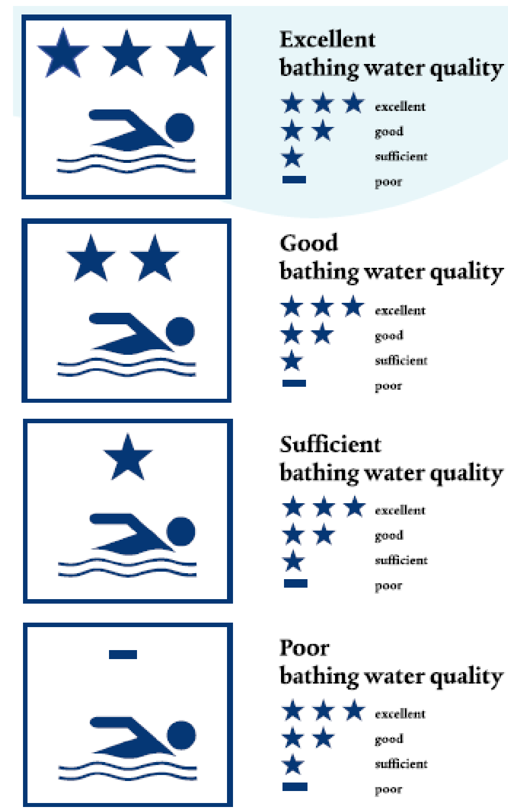
- If we assumed that EU standards were applicable in Fort Wayne, the following conclusions can be drawn:
  - Under existing conditions, the E. coli levels on the St. Marys River would result in a “Poor” bathing classification.
  - With the LTCP in place, and with the associated reduction in CSO activations, the bathing classification would change to “Good,” even with existing upstream water quality conditions.
- In Europe, a city with conditions similar to Fort Wayne would be viewed as having an LTCP that dramatically improved water quality, and specifically for recreational use.



The EU standard – not better, not worse, just different

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- Key differences between the EU and typical State bacteria WQS:
  - There is no geometric mean component to the EU bacteria standards.
  - The peak allowable bacteria levels – defined in terms of 90th and 95th percentile values – are higher than the analogous measures in State WQS.
  - The EU framework allows for disregarding up to 15% of the collected samples, if those samples reflect “short-term pollution.”
- Main take-away is that the model can be used to inform a discussion on alternate WQS components, as part of reaching consensus amongst all parties for the post-LTCP era.

Final points

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- The City has a hugely useful water quality tool to inform decisions on source control strategies, management strategies, and regulatory strategies.
- The water quality model complements, and extends the utility of, the City's in-place collection system model.
- Water quality modeling results fill a "missing link" in communicating results, managing expectations, and highlighting benefits associated with the City's wet-weather management plan.

Any Questions?

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