



Bacteria-little things with a big impact

Water Quality Standards Academy

March 12-14, 2012

Anchorage

Water Quality Criteria for Bacteria

- Objectives:
- Provide an understanding of DEC current WQS for bacteria;
- Information regarding the adoption and implementation of WQC;
- Role of the BEACH program;
- Update on EPA's development of new/revised recreational WQC;

Why do we have standards for bacteria?

- Bacteria has the potential to cause illness in humans- both from ingestion as well as contact;
- EPA has estimated 3.5 million people become ill due to contact with raw sewage
- The presence of bacteria in concentrations above certain levels caused 24,091 beach closures and advisories to be issued in 2010 (NRDC 2010); b1
- Bacteria sources may be human or animal based-it can even be traced to sand and high concentrations of plant matter on beaches.

Slide 3

b1

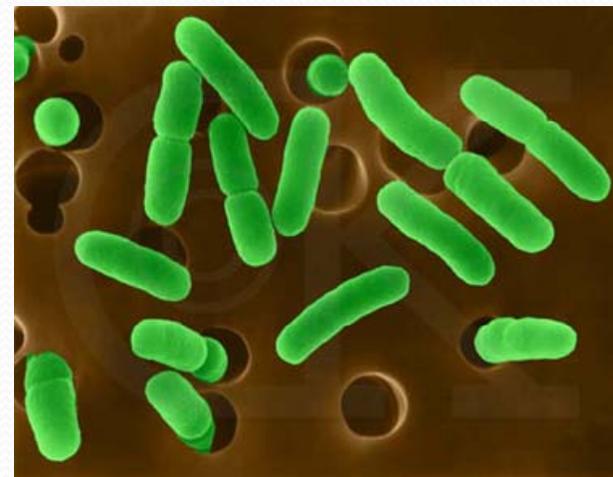
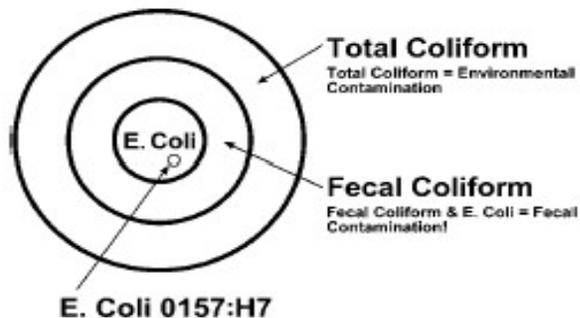
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bntabor, 2/9/2012

Indicators

- EPA's recommended bacteria water quality criteria (WQC) are for indicator organisms (indicating fecal contamination)
- Pathogens are disease-causing microorganisms that include viruses, protozoa, and bacteria
- Fecal pathogens is difficult and costly since there are many to choose from so we monitor for **fecal indicators**.

TOTAL COLIFORM, FECAL COLIFORM AND E. COLI



Some terms you might hear

- Criteria v. Standard (*in the context of this presentation*)
 - Acceptable performance level v. a value adopted by regulation as a numeric value
- Geometric Mean (GM)
 - $4\sqrt{(2 \times 14 \times 0.07 \times 56)} = 7.84$
- Most Probable Number (MPN)
 - "The more tubes that show growth, especially at greater dilutions, the more organisms were present in the sample."

More terms...

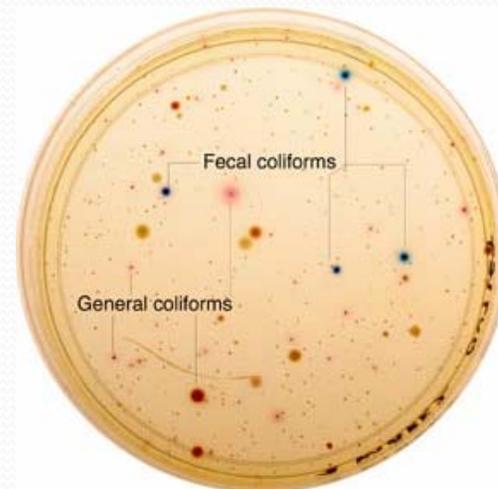
- Coliform Forming Unit (CFN)
 - Used to determine the number of bacteria present-the amount of bacteria on the plate counts!
- Single Sample Maximum and Statistical Threshold Value (STV)
 - SSM is the maximum allowable amount per 100ml
 - The STV method combines pooled epidemiological studies (Fecal Indicator Bacteria (FIB) data) with weather variations to provide a more comprehensive approach to setting criteria.

AWQS for Bacteria

- Water Supply (i) drinking, culinary, and food processing
 - In a 30-day period, the geometric mean may not exceed 20 FC/100 ml, and not more than 10% of the samples may exceed 40 FC/100 ml.
 - Groundwater must be less than 1 FC/100 ml using a membrane filter or <3 FC/ 100 ml for MPN technique



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AWQS for Bacteria Cont.

- Water Supply
 - (ii) Agriculture:
 - Geometric Mean of samples taken in a 30 day period may not exceed 200 FC/100 ml and no more than 10% of samples may exceed 400 FC/100ml
 - (iii) Aquaculture (Freshwater)
 - For products normally cooked, the geometric mean of samples taken in a 30-day period may not exceed 200FC/100 ml, and not more than 10% of the samples may exceed 400 FC/100 ml.
 - : For products not normally cooked, the criteria for drinking water supply, (2)(A)(i), apply. (<20FC/100ml in 30 day period)

AWQS for Bacteria Cont.

- (ii) seafood processing (Marine waters)
 - Geometric Mean of samples taken in a 30 day period may not exceed 20 FC/100 ml and no more than 10% of samples may exceed 40 FC/100ml
- (iv) Industrial (Fresh and Marine Waters)
 - Geometric Mean of samples taken in a 30 day period may not exceed 200 FC/100 ml and no more than 10% of samples may exceed 400 FC/100ml

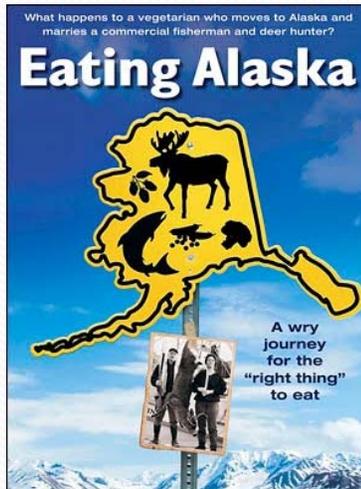
AWQS for Bacteria Cont.

- Water Recreation (Fresh and Marine Waters)
 - Contact Recreation
 - In a 30-day period, the geometric mean of samples may not exceed 100 FC/100 ml, and not more than one sample, or more than 10% of the samples if there are more than 10 samples, may exceed 200 FC/100 ml.
 - Secondary Recreation
 - In a 30-day period, the geometric mean of samples may not exceed 200 FC/100 ml, and not more than 10% of the total samples may exceed 400 FC/100 ml.



AWQS for Bacteria Cont.

- Harvesting for Consumption of Raw Mollusks or other Raw Aquatic Life
 - Based on a 5-tube decimal dilution test, the fecal coliform median MPN may not exceed 14 FC/100 ml, and not more than 10% of the samples may exceed a fecal coliform median MPN of 43 FC/100 ml.



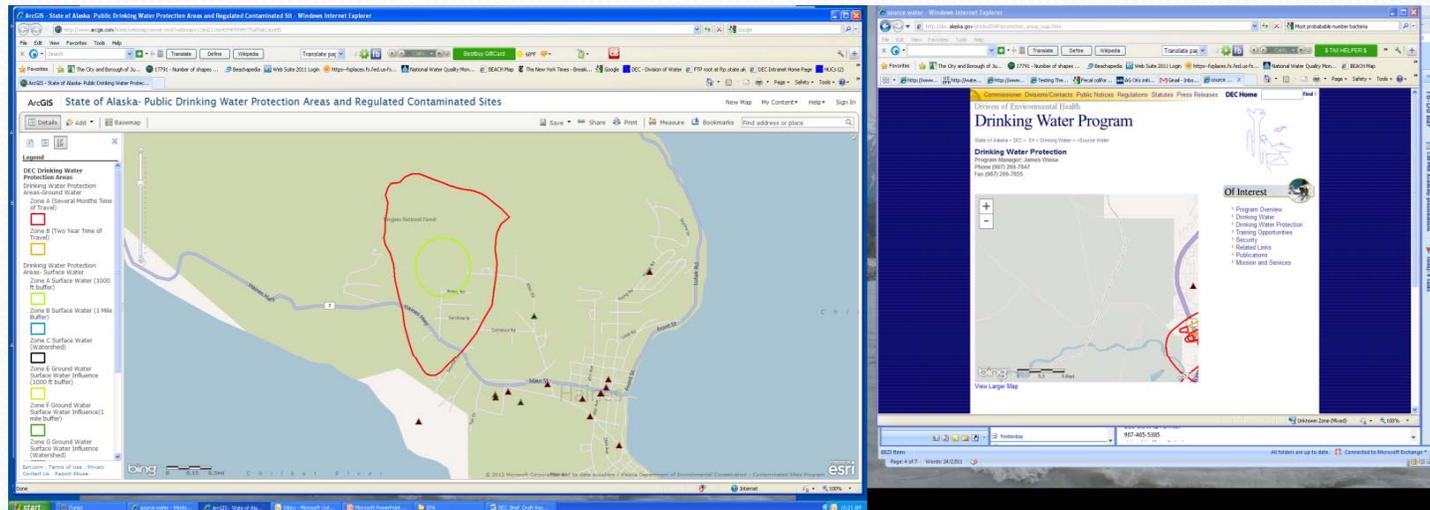
What about critters?

- Nope. Critters get a pass on this one. Essentially, since humans have a higher response to the presence of pathogens, we focus on these issues and have not developed standards for aquatic life.



Water Supply (i) drinking, culinary, and food processing

- Majority of responsibility for monitoring falls under the auspices of Environmental Health; Drinking Water Program.
- Tools:
 - Sanitary Surveys to review the water source, equipment, operation, etc.
 - Engineering Plan review
 - Endorsed Drinking Water Protection Plans
 - Drinking Water Protection Maps



Back at the beach....



Recreation Criteria History



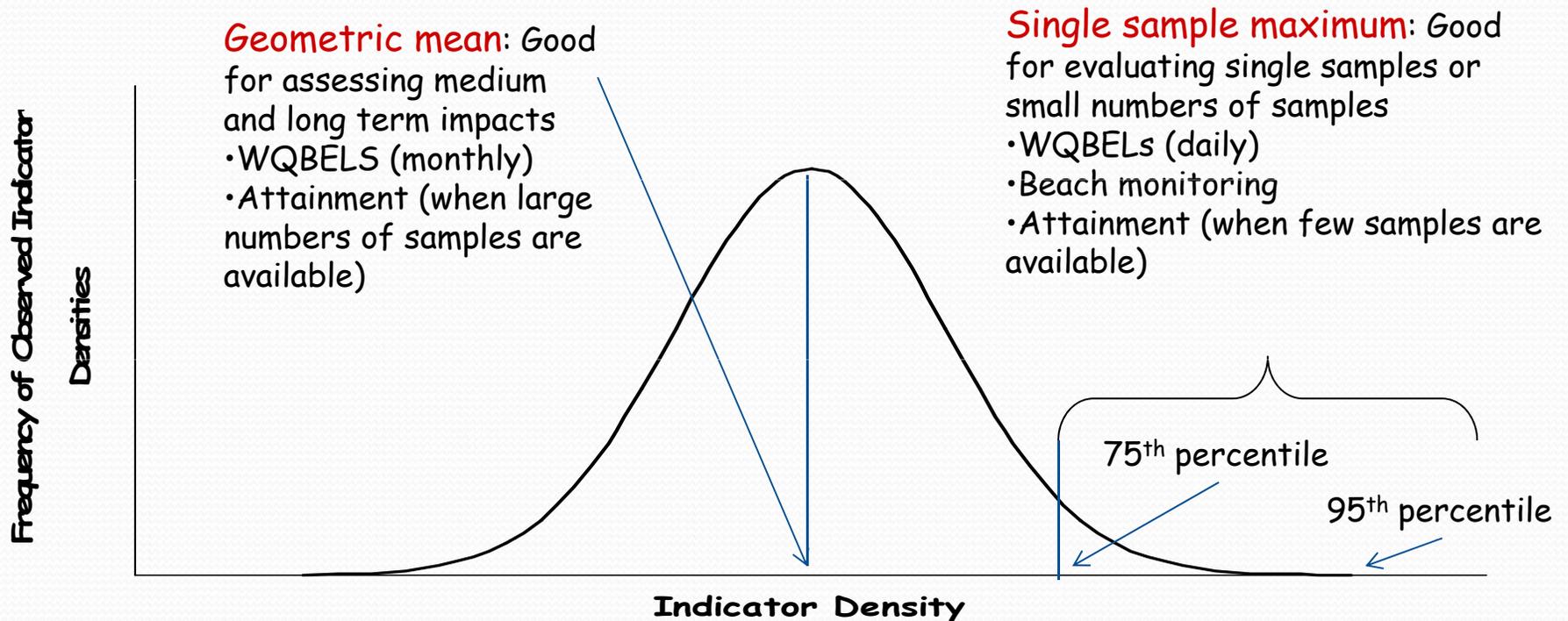
- Federal bacteria criteria recommendations were introduced in 1968
 - Studies measured total coliforms
 - Recommended a limit of fecal coliforms of 200 CFU/ 100 ml
- In 1972 EPA initiates multiyear epidemiological studies at marine and freshwater locations (bathing beaches)

Results of Studies in the 70s/80s

- E. coli and enterococci showed the strongest correlation to swimming-associated gastroenteritis, rashes, fevers, and other ailments
- The results and formal guidance was issued in the 1986 Bacteria Criteria document
- Criteria is used for:
 - Protection of Rec. designation H₂O's
 - Inc. permit limits, listing decisions, and TMDL development
 - Beach monitoring and notification program
 - Protect public health via beach advisories and closings



- *E. coli* and enterococci criteria have two components:
 - Geometric mean
 - Single Sample Maximum or Upper Percentile Value





Key Implementation points: Geo Mean and SSM

- Geometric mean is the value most closely linked to illness rates (up to 19 illnesses/1000 swimmers in marine waters);
- Single Sample Mean is used for beach advisory and closure programs;
- States have (had) flexibility to determine which SSM to use;
 - SSM is good for small datasets (e.g., not enough for GM)
 - Addressing short-term spikes (2 consec. exceedances=notification)

Beach Act Cont.

- States must adopt criteria “for the coastal recreation waters of the State for those pathogens and pathogen indicators for which [EPA] has published criteria under section 304(a)”
- If a state fails to adopt criteria “that are as protective of human health as” EPA’s criteria, EPA “shall promptly propose” regulations for revised criteria
- Research activities
 - Better and faster water quality indicators
 - Improved detection methods
 - Modeling and monitoring research
 - Exposure and Health Effects Research
 - Epidemiological studies

Water Quality Notice

All natural bodies of water contain microscopic organisms. This area is monitored for *E. coli* bacteria, an indicator of the possible presence of human health risks. If bacteria levels are above state health standards, an advisory or closure sign will be posted at this location. Do not ingest lake water and, as always, swim at your own risk.

For latest water conditions: www.idem.in.gov/beaches

Beach Act Cont.

- **And \$\$!** (sometimes...)



- The Beach Act provides funding for:
 - “pass through” grants to municipalities and watershed council groups
 - DEC program implementation (admin/QA/QC)
 - Submission of data to AQWMS  STORET

Standards adopted via regulation and by the BEACH program

<i>MARINE WATER QUALITY INDICATOR STANDARDS</i>	
<i>Fecal Coliform Standard (Alaska's Limit)</i>	
Single-sample	Not more than 10% of samples may exceed 200 fecal coliforms per 100 mL
Geometric mean (average) of 5 samples within 30 days	100 fecal coliforms per 100 mL
<i>Enterococcus Standard¹ (EPA's Limit)</i>	
Single-sample	No sample may exceed 276 enterococci per 100 mL
Geometric mean (average) of 5 samples within 30 days	35 enterococci per 100 mL

¹ 40 CFR Part 131, Water Quality Standards for Coastal and Great Lakes Recreation Waters; Final Rule (<http://www.epa.gov/fedrgstr/EPA-WATER/2004/November/Day-16/w25303.pdf>)

Bacteria Criteria in AWQS

- AWQS for Contact Recreation
 - Includes seasonal and intermittent uses
 - 30-day period, GM < 100 FC/100 ml, No more than 10% of the samples may exceed 200 FC/100 ml.
- AWQS for Secondary Recreation
 - 30-day period, GM < 200 FC/100 ml. No than 10% of the total samples may exceed 400 FC/100 ml.



Key Implementation Points: Non-human Sources

- Non-human source exclusions to the criteria can be allowed when:
 - Sources are from only non-human sources (supported by sanitary surveys/watershed assessments/source tracking)
 - Non-human sources are shown to pose no risk to human health (i.e. epi-studies)



2012 : Draft Recreation Criteria

- Why?
 - Beach Act requires new/revised criteria ;
 - Incorporate new science—over 20 years since 1986 criteria; CWA requires updates “from time to time”;
 - Improve scientific foundation and implementation based on what we’ve learned over the past 20 plus years;
 - Ease implementation for BEACH Act states: no double standards;
 - Makes providing protection for downstream rec. waters easier;
 - 2012 is Consent Decree deadline.

EPA's Position on the Draft RWQC (1)

- Recommend 304(a) criteria that apply to all waters (not just the BEACH states, territories and tribes)
 - Encourages consistency, as waters flow between states
- Derive criteria based on the NEEAR research at POTW-impacted sites
 - Consistent with 1986 criteria values
 - Aim to carry forward into new criteria level of water quality protection afforded by current criteria recommendations

EPA's Position on the Draft RWQC (2)

- Recommend culture methods for Enterococcus and *E.coli* in freshwaters, and Enterococcus in marine waters
- Clarify the expression of criteria construct
 - Maintain Geometric Mean and something akin to SSM (STV)
 - Eliminate “use intensity” risk range- **Alaska has used the 90th % in the past – EPA wants universal adoption of the 75th %**
- Provide tools for site-specific criteria derivation (QMRA with sanitary survey) and other flexibilities
 - Science does not permit us to recommend different, nationally applicable criteria values for different sources (e.g., gulls).
 - Predictive models as tool to enhance implementation of criteria, particularly for beach programs

EPA's Position on the Draft RWQC (3)

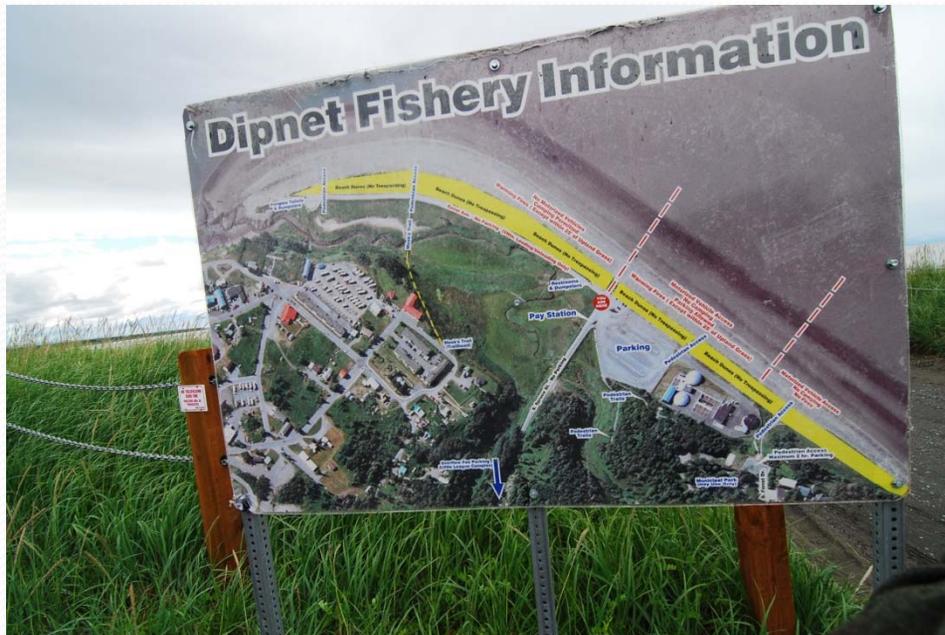
- Provide tools for rapid analysis
 - Enterococcus qPCR method in freshwater and marine waters for beach closure notification. Faster approach to measuring fecal indicator bacteria
- Predictive modeling
- Alaska labs are not set up for this method at the moment



Take home messages

- State WQS for recreation are based on Geometric Mean and Single Sample Maximum (SSM).
- Criteria is designed to be protective of human health
- Changes are on the horizon...
 - Potential application of RWQC to all waters;
 - States will have to adopt standards for *E. coli* and *entero.*;
 - Level will be set at the 75th Percentile (104 instead of 276);
 - New methodology is being developed but it's still too expensive for easy adoption.

Questions?





Here's a few for you...

- Which designated use does not have WQ Criteria?
- What's so important about the geometric mean?
- Why should we care about revisions to the 1986 criteria in AK?

Special thanks to:

- EPA Office of Science and Technology for their bacteria PPT;
- Chris Miller from the DEC Drinking Water Program;
- Erin Strang and Alex Edwards for photos;
- The many folks that I shamelessly took photos from off of Google Images.

Application to POTW

Cordova Wastewater Treatment Plant





Bacteria Permitting Issues

- Previous permit contained only a maximum daily limit (MDL) for fecal coliform bacteria and the new permit needed an average monthly limit (AML) and average weekly limit (AWL)
- Additional daily data submitted by applicant showed errors in reporting
- Enterococci bacteria monitoring needed to be added to the permit in compliance with the BEACH Act

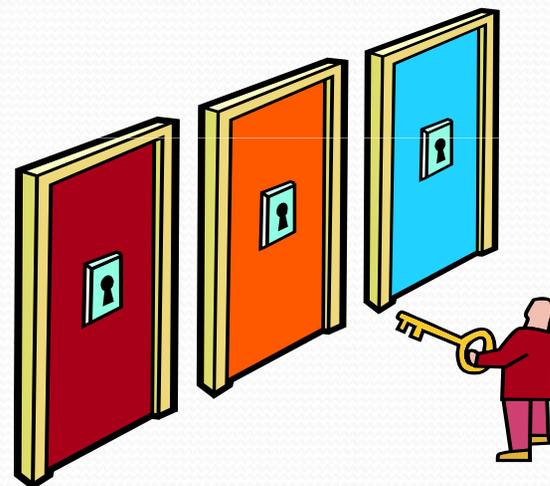
Approach to Solutions



The Appropriate WQS

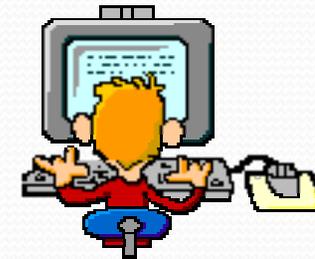
Fecal Coliform Bacteria **Enterococci Bacteria**

- Criteria for harvesting of raw mollusk or other aquatic life for consumption
 - Shall not exceed 14 FC/100 mL and not more than 10% of samples shall exceed 43 FC/100 mL
- With no State developed WQS must apply federal standards



Fecal Coliform Bacteria

- Evaluated data
 - Collected and reported during the previous permit cycle
 - Requested additional data from permittee – all daily data
- What was determined
 - Effluent could not meet fecal coliform bacteria WQS at the end of the pipe – therefore needing a mixing zone
 - Increased understanding of the facilities capabilities
 - Discovered inaccuracies in reporting



Result

- A mixing zone size and available dilution was determined
- Calculated water quality based effluent limits
- Included an average monthly limit, an average weekly limit, and a maximum daily limit
- The Compliance and Enforcement program began working with the city to correct reporting errors and exceedence violations





Enterococci Bacteria

- No data available to evaluate but assumptions could be made
 - With a fecal coliform bacteria concentrations at a level requiring a mixing zone
 - Enterococci bacteria would also need a mixing zone
- Adopted WQS must be met at the boundary of the mixing zone but can't determine what limits to impose at the end of the pipe
- Where and at what frequency should enterococci bacteria be monitored



Result

- Continue monitoring fecal coliform bacteria as in the previous permit
- Enterococci bacteria monitoring of the effluent and at a shoreline location
- Monitoring to take place once a month for the months May through September – receiving water most likely to be used for primary contact recreation
- Data collected during this cycle will be used to make determinations in the next permit reissuance

Comments / Discussion

