Microbial Source Tracking (MST)

Fecal bacteria in surface water is a serious environmental concern. People can get sick by swallowing or coming into contact with contaminated water in lakes, rivers, or the ocean. Human and animal waste in the water can also cause closure of shellfish harvesting beds and swimming beaches. Fecal bacteria can come from a variety of sources in the environment. People can help keep bacteria out of the water by managing waste from livestock, pets (scoop it, bag it, trash it), and by checking and maintaining their home septic systems.

In the Washington State Water Quality Standards, fecal coliform bacteria is used as an indicator of fecal contamination. In 2008, more than 400 water bodies in Washington did not meet water quality standards for fecal coliform. In recent years, nonpoint (diffuse, hard-to-trace) sources of bacterial pollution have surpassed point (industrial discharge) sources as the major source of fecal contamination to surface water (EPA, 2005).

Identifying bacterial sources is an important first step in controlling fecal contamination and managing microbial risks.

Typical bacteria sources

Bacteria can enter the environment through stormwater runoff, wastewater discharges, combined sewer overflows, failing septic systems, poor livestock management, pet waste, litter, and wildlife.

Why It Matters

- MST techniques are still experimental science.
- There are no standardized and promulgated methods for most MST techniques, and standard operating procedures are lacking.
- Due to the experimental nature and cost of many MST techniques, these methods should be used as a last resort to determine sources of fecal bacterial contamination.

For more information about Ecology's Report:
Review and Critique of Current Microbial Source Tracking Techniques
www.ecy.wa.gov/biblio/1103038.html

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What is microbial source tracking?

Microbial source tracking (MST), also referred to as bacterial or fecal source tracking, is a set of techniques used to determine the sources of fecal bacteria in the environment. MST techniques attempt to determine sources of fecal bacteria introduced into water bodies by humans, wildlife, or domestic animal sources. At this time MST techniques are experimental science, and no MST technique is capable of determining all possible fecal sources accurately.

Overview of MST techniques

MST techniques can be divided into two categories:

- **Molecular and biochemical techniques** assume that there are characteristics unique to the fecal bacteria from a particular host and that these characteristics allow scientists to identify the source of the contamination. Most of these techniques target key genes that can be tied to a specific host.
- **Chemical methods** generally rely on the detection of chemicals associated with human-associated activities. Chemical methods are based on the detection of a chemical directly related to a specific source but not typically found in unpolluted waters.

In December 2011, the Washington State Department of Ecology (Ecology) published a literature review report titled *Review and Critique of Current Microbial Source Tracking Techniques*. This report provides an overview and critique of current MST techniques. The purpose of the report is to assist natural resource managers in making informed decisions about the use of MST techniques and their results. You can find this report online at: www.ecy.wa.gov/biblio/1103038.html.

MST issues

Ecology's *Review and Critique of Current Microbial Source Tracking Techniques* identifies quality assurance issues associated with molecular and biochemical MST techniques (page 37). Current techniques:

- Have no regulatory approval and are still actively evolving.
- Can be reliably performed only by scientists with advanced training.
- Commonly produce both false negative and false positive results.

In the past, many MST "studies" were poorly designed and inadequate in terms of frequency of sampling, number of samples, sampling locations, method documentation, and quality assurance testing. These issues need to be addressed adequately before MST methods can be considered mature and useable.

Users of these techniques need to demonstrate acceptable levels of accuracy and reproducibility to meet project goals. Currently there are no standardized methods for molecular and biochemical techniques. Promulgated regulatory MST methods and a certification program for MST laboratories are needed.

Due to the experimental nature and cost of many MST techniques, these methods should be used as a last resort to determine sources of fecal bacterial contamination.

Ecology's current position on MST

MST is an emerging science that provides useful information, but MST is not a replacement for conventional source tracking methods. MST testing, with proper quality assurance and quality control (QA/QC), may be a useful tool for focusing pollution source control activities in a watershed. However, MST has limitations in its utility and is cost-prohibitive for regular use.

Ecology considers MST techniques to be experimental science and should be used only when simpler and more cost-effective techniques have failed to discriminate sources. MST is not a substitute for direct water quality testing to determine the actual sources contributing to degraded water bodies. As a general practice, conventional sampling methods to identify fecal sources should be used first.

What types of conventional source tracking does Ecology recommend?

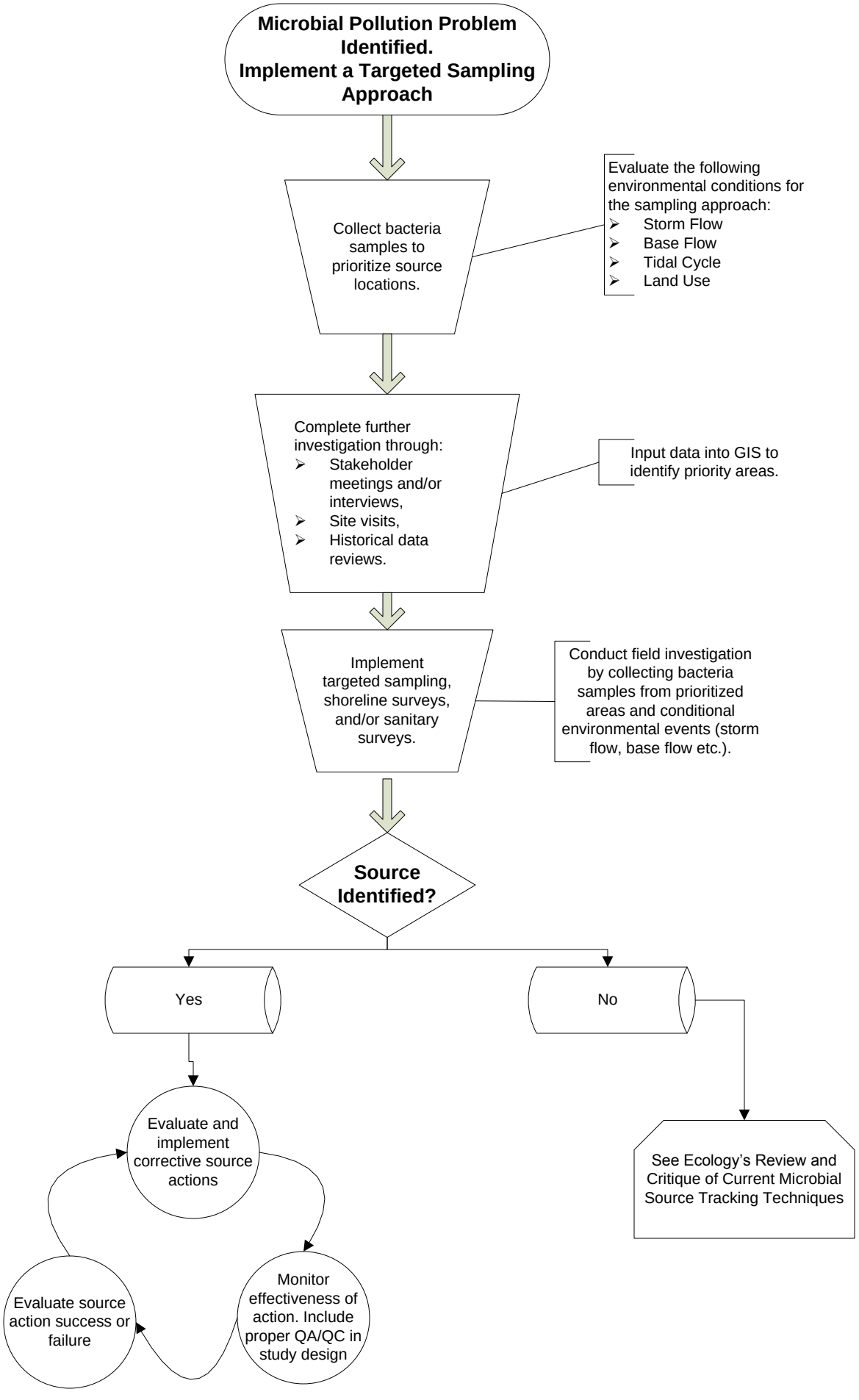
As a first step, Ecology recommends the use of these cost-effective, conventional techniques for bacteria source tracking:

- Targeted in-stream monitoring.
- Sanitary or watershed surveys.
- Dye testing of septic systems.

Targeted in-stream monitoring coupled with sanitary or watershed surveys are effective in identifying sources of bacterial contamination. Sanitary or watershed surveys are site-specific field evaluations that document all potential sources of bacterial pollution. Experts conduct these surveys by evaluating land drainage patterns, wildlife abundance and habitat, stormwater and wastewater discharge points, and nearby on-site septic systems.

The following decision diagram presents tools and techniques to help project managers determine sources of fecal bacteria pollution.

Decision Process for When to Use Microbial Source Tracking Techniques



References/Resources

EPA sources:

EPA, 2005. Microbial Source Tracking Guide Document. EPA/600-R-05-064. Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH.
www.epa.gov/nrmrl/pubs/600r05064/600r05064.htm

EPA, 2011. Using Microbial Source Tracking to Support TMDL Development and Implementation. Prepared for U.S. Environmental Protection Agency, Region 10, Watersheds Unit, by Tetra Tech Inc. and Herrera Environmental Consultants, Seattle, WA.
www.epa.gov/region10/pdf/tmdl/mst_for_tmdls_guide_04_22_11.pdf

In addition, leading MST researchers have published the following documents that include an overview of MST techniques and applications:

- Hagedorn, C., A.R. Branch, and V.J. Harwood, editors, 2011. Microbial Source Tracking: Methods, Applications, and Case Studies. Published by Springer Press, New York.
- Harwood, V.J. and D.M. Stoeckel, 2011. Performance Criteria. Chapter 2 *in* Microbial Source Tracking: Methods, Applications, and Case Studies. Editors C. Hagedorn, A.R. Blanch, and V.J. Harwood. Published by Springer Press, New York.
- Santo Domingo, J.W. and T.A. Edge, 2010. Identification of primary sources of faecal pollution. Chapter 5 *in* Safe Management of Shellfish and Harvest Waters, editors G. Rees, K. Pond, D. Kay, J. Bartram, and J. Santo Domingo. Published by IWA Publishing on behalf of the World Health Organization, London, U.K.
- Santo Domingo, J.W., R. Lamendella, and N.J. Ashbolt, 2011. Microbial Source Tracking: Current and Future Molecular Tools in Microbial Water Quality Forensics. Chapter 10 *in* Environmental Microbiology: Current Technology and Water Applications, editors K. Sen and M.J. Ashbolt. Published by Caister Academic Press, Norfolk, UK.