



Water Fecal/Sewage Contamination and Microbial Source Tracking

Fecal contamination of natural water sources and reservoirs is a significant water quality concern. It poses a serious public health threat, as surface waters contaminated with fecal matter can cause illnesses in humans and outbreaks of gastroenteric diseases when they are used for human consumption and recreational activities. Recreational water pollution results in an estimated 90 million illnesses nationwide and costs of \$2.2- \$3.7 billion annually. Coastal environments and communities are especially vulnerable to fecal water contamination and subsequent economic impact due to closures of beaches and swimming areas.

Pollution of recreational water is associated with human or animal waste, entering the water in a variety of ways, including urban and agricultural sources: field stormwater runoff, leaking sewer pipes, sewer overflows, illegal sewer hookups, poorly functioning septic systems, discharge of sewage by boats, livestock and pet waste. The detection and enumeration of fecal indicator bacteria, predominately *Escherichia coli* and enterococci, have traditionally been used by regulatory agencies and public health officials to evaluate water quality. However, conventional culture test methods to detect these fecal indicator bacteria provide no information on potential sources of the contamination. Microbial source tracking (MST) allows the identification of fecal pollution sources that is critical for management and remediation of water quality. This molecular method relies on the detection of host-specific DNA targets in quantitative polymerase chain reactions (qPCRs).

Most MST methods for human and animal fecal waste are based on the detection of *Bacteroides* and *Bacteroidales*. *Bacteroides* are one of the most abundant bacteria in the mammalian gut, far outnumbering *Escherichia coli*. These anaerobic microorganisms have short survival times outside the host and are unable to multiply in the environment. *Bacteroides* are exclusive to warm-blooded animals and there is a distinct host specificity between different *Bacteroides* species. All of these characteristics make *Bacteroides* qPCR biomarkers a better alternative for fecal pollution investigations when compared to traditional fecal indicator bacteria.

With respect to host specificity, bird GI tract microbiome composition is different from that of the mammalian intestine. A set of biomarkers different from *Bacteroides* has been proposed for MST of environments contaminated by avian waste. As discovered by researchers, genetic markers belonging to the *Helicobacter* genus are abundant and specific in gull, goose, duck, and chicken feces. Molecular testing of avian fecal pollution is based on qPCR detection of these bacteria.

EMSL's DNA Laboratory offers a wide array of the molecular MST qPCR tests:

1. Test code M095: Total *Bacteroides* by qPCR. Broad specificity test for fecal contamination by all warm-blooded animals.
2. Test code M199: Human *Bacteroides* by qPCR. Human feces/sewage contamination test.
3. Test code M410: Bovine *Bacteroidales* by qPCR. Cow-specific fecal contamination test.
4. Test code M411: Ruminant *Bacteroidales* by qPCR. Test for fecal contamination by deer, goat, sheep and other ruminant mammals.
5. Test code M412: Swine *Bacteroidales* by qPCR. Pig-specific fecal contamination test.
6. Test code M414: Canine *Bacteroides* by qPCR. Dog-specific fecal contamination test.
7. Test code M415: Avian *Helicobacter* by qPCR. Bird-specific fecal contamination test.



The above qPCR MST tests can be ordered separately or together as a broad qPCR panel (test code M416). Test results are reported in a quantitative format in cell equivalents per 100 mL of water units. All EMSL in-house developed MST tests have been validated following the highest Environmental Protection Agency (EPA) and National Institute of Standards and Technology (NIST) standards for molecular testing of environmental matrices. Our laboratory is also accredited by the American Industrial Hygiene Association (AIHA).

Improving water and land environments by eliminating pollution sources can be best achieved through accurate environmental testing. MST has become an advanced and informative testing option aimed at identifying the problem sources and determining the effect of implemented remedial actions. Management and remediation of fecal pollution becomes less time and resource intensive when exact sources can be pinpointed with the precision of state-of-the-art molecular MST technology.

