# TOTAL COLIFORM and E-COLI

## FACT SHEET

See related Fact Sheets: Acronyms & Abbreviations; Glossary of Terms; Cost Assumptions; Raw Water Composition; Total Plant Costs; and WaTER Program.

### 1. CONTAMINANT DATA

**A. Chemical Data:** Fecal bacteria are single-celled microorganisms, virtually always associated with fecal contamination of water, but not always harmful. Fecal indicator bacteria are used in determining (indicating) the microbial quality of water. Total coliform bacteria and fecal coliform *Escherichia coli* 0157:H7 (E-Coli) are two types of fecal indicator bacteria. Total coliform bacteria, a particular group of waterborne microbiological contaminants regulated by the SDWA, is the most common indicator organism applied to drinking water. E-Coli is one type of pathogenic fecal coliform bacteria, and the most common facultative, disease-causing bacteria in the feces of warm-blooded animals.

**B. Source in Nature:** By definition, several bacteria can be classified as coliform, and are commonly found in soil, on the surface of leaves, in decaying matter, and can grow in water distribution mains. These types of coliform bacteria aren't fecal contamination related, and do not necessarily indicate unsafe water. The pathogenic fecal coliform bacteria, E-Coli, is naturally occurring in the intestines and feces of most warm-blooded animals, including humans, and when found in water is a direct result of fecal contamination. Almost all surface waters contain some bacteria, while groundwaters are generally free of bacteria unless under the direct influence of surface water. Surface and groundwater contamination can occur as a result of surface runoff through urban areas, woodlands, pastures, or feedlots; on-site septic tank/sewage disposal system leakage/failure; sewage treatment plant/disposal system overload or malfunction; or raw sewage deep well injection. Treatment plant process contamination can occur as a result of filter breakthrough; improper coagulation; use of recycled, concentrated backwash water; process overload; or improper maintenance. Distribution system contamination can occur as a result of cross-connection, broken or leaking waterlines, or back-siphonage.

**C. SDWA Limits**: The TT MCLG for both total coliform and E-Coli is 0 mg/L. For total coliform, >40 samples/month, less than 5% of the samples may be positive; <40 samples/month, no more than one sample may be positive. For E-Coli, the Positive Repeat Sample criteria is applied for MCL.

**D. Health Effects of Contamination:** Self-limiting effects of bacterial ingestion include abdominal cramps and diarrhea. Hemorrhagic colitis (HC) is the acute disease caused by E-Coli. HC results in severe abdominal cramps, watery diarrhea, and lower intestinal bleeding; with occasional vomiting and fever. In some cases, hemolytic uremic syndrome or renal failure can occur. Although not life threatening to healthy adults, these diseases can be fatal to young children, the elderly, and immunocompromised persons. E-Coli is transmitted through fecal-oral ingestion of the bacteria by direct ingestion (i.e. drinking), primary contact recreation (i.e. swimming), or secondary contact (i.e. fishing).

### 2. REMOVAL TECHNIQUES

**A. USEPA BAT:** For community surface and groundwater (under the direct influence of surface water) systems, treatment technique is applied. In this case, the accepted TT is use of the conventional treatment processes filtration and disinfection. Benefits: proven; reliable. Limitations: initial investment.

**B. Alternative Methods of Treatment:** Through proper siting of wells and waste disposal systems, manage, find, or eliminate the source of the contamination. Improving well casing/sealing or drilling deeper wells can improve groundwater quality. Distillation is effective. UV, ozone, and iodine can be effective disinfection methods. Boiling water for 1 minute (5 minutes at higher elevations) is the traditional POU treatment method. Bottled water may be used, although is not regulated for testing for microbial contaminants. Raw water quality can also be improved through complex planning of waste treatment/disposal methods, public watershed, and land management, especially during periods of high precipitation and heavy runoff.

**C. Safety and Health Requirements for Treatment Processes:** General industry safety, health, and self protection practices for process equipment should be followed, including proper use of chemicals and tools. When dealing with waterborne diseases, take precautions to prevent infection through open cuts/wounds, or illnesses from ingestion. Wear PPE and wash hands thoroughly.

### 3. BAT PROCESS DESCRIPTION AND COST DATA

**General Assumptions:** Refer to: Raw Water Composition Fact Sheet for ionic concentrations; and Cost Assumptions Fact Sheet for cost index data and process assumptions. All costs are based on *ENR*, PPI, and BLS cost indices for March 2001. General sitework, building, external pumps/piping, pretreatment, or off-site sludge disposal are not included.

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**3A. Filtration and Disinfection:**

Process - Filtration involves removing contaminant bacteria through screening, settling, or separating. Disinfection refers to inactivation (killing) of the bacteria. Depending on raw water quality and characteristics, filtration of bacteria can be a multi-step process, including screening; coagulation and flocculation; final settling; and final filtering. Screening consists of removing the largest/heaviest suspended solids from the raw water. Chemical coagulation and flocculation consists of adding a chemical coagulant combined with mechanical flocculation to allow fine suspended and some dissolved solids to clump together (floc). Final settling consists of settling of the floc matter. Final filtration consists of removal by filtering (often membrane) of all floc; suspended; and, based on filtration method/size, most dissolved solids, including bacteria. Filtration processes result in lowering overall TSS/TDS and turbidity, which in turn allows greater disinfection contact time on remaining bacteria. Disinfection consists of chemical inactivation of pathogens, bacteria, and viruses. $Cl_2$ effectively treats bacteria and is the most common disinfection method. $Cl_2$ demand refers to the amount of chlorine required to inactivate the bacteria and the amount required to allow an effective residual in the distribution system.

For on-site systems with one time groundwater contamination, whether by maintenance, poor construction, single event contamination, etc., concentrated disinfection of the well, casing, and piping is required; and flushing of the system.

The cost curves presented below are for dual media filtration and $Cl_2$ disinfection.

Maintenance - Proper monitoring, operation, and maintenance procedures, especially of the final filter, are essential to ensure the reliability of filtration processes. Recycled filter backwash or membrane cleaning methods may concentrate bacteria and result in a significant source of increased turbidity and bacteria infestation. As a result, a period of filter-to-waste flow may be required after post-backwash/membrane cleaning periods. Because turbidity removal can parallel bacteria removal, finished water turbidity monitoring (<0.5 NTU) may be a useful tool for indicating the degree of pathogen removal.

Waste Disposal - Pretreatment waste streams and spent filters require approved disposal.

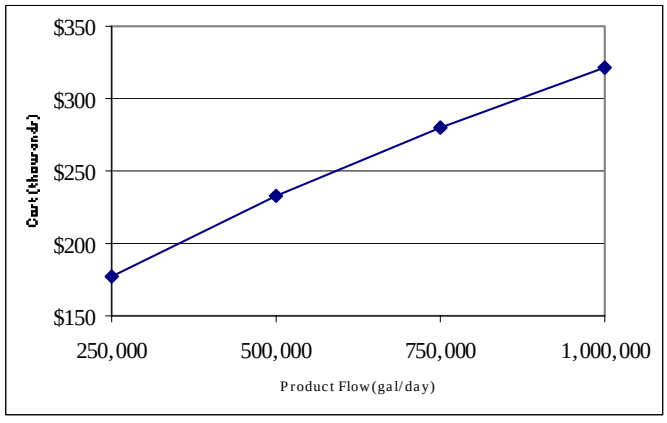
Advantages -

- Well established, conventional treatment processes; readily available.
- Reliable, if properly operated and maintained; provides residual disinfectant.
- Suitable for community or on-site systems.

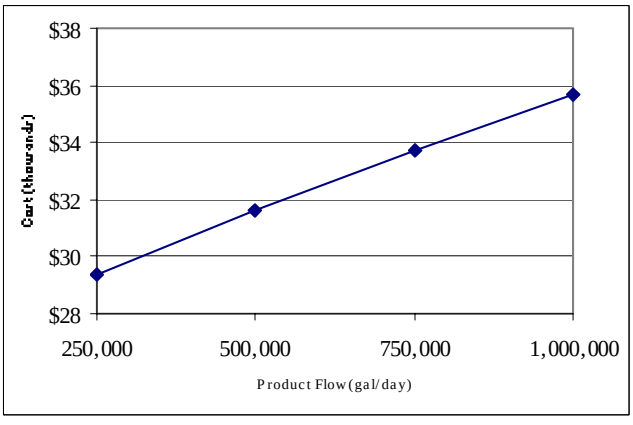
Disadvantages -

- Requires proper $Cl_2$ contact times; can give a chlorine after taste and smell.
- Requires careful handling and proper storage of chlorine.
- $Cl_2$ may combine with organic precursors to form THMs.
- Costly initial investment, and proper operation and maintenance.

**BAT Equipment Cost***




**BAT Annual O&M Cost***




*Refer to Cost Assumptions Fact Sheet. Does not include general sitework, building, external pumps/piping, pretreatment, or off-site sludge disposal.