DRINKING WATER SECURITY: DETERMINING THE LONG-TERM BACKGROUND VARIABILITY OF WATER QUALITY AND PERFORMANCE OF SENSORS IN A DISTRIBUTION SYSTEM

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ABSTRACT

Real-time water-quality monitoring is an essential component of a comprehensive drinking-water-security program. Accidental or intentional contamination of drinking-water distribution systems may be detectable as unexpected changes in easily measured (traditional) water-quality characteristics. Although the specific contaminant(s) will not be immediately identified, the observed changes can alert operators and managers that a water-quality problem may be occurring and additional water testing or other measures may be appropriate. Background variability of drinking-water quality must be known throughout a distribution system before such data can be used to detect unusual patterns in one or more water-quality characteristics.

The U.S. Geological Survey (USGS), in cooperation with the U.S. Environmental Protection Agency (USEPA) National Homeland Research Center collected water-quality data at 12 locations in a regional drinking-water-distribution system for periods varying from six months to more than two years. Sensors used to monitor water quality were evaluated to determine sensor performance in a real-time monitoring network. Sensor data collected in fifteen-minute intervals included temperature, specific conductance, pH, oxidation/reduction potential (ORP), and free chlorine residual. Data were evaluated and archived using standard U.S. Geological Survey procedures.

Sensor reliability and frequency of need for sensor maintenance were evaluated. The temperature and specific conductance sensors were highly reliable and required little maintenance. The pH sensors were reliable, but required occasional recalibration. The ORP sensors experienced slight decreases in response after about two weeks of service due to oxide build-up, which was easily removed by rinsing with deionized water. The free chlorine sensor required more frequent recalibration and failed more often than the other sensors.

The variability in sensor responses was strongly dependent upon the type of source water. The three sampling sites from a surface-water source were more variable in specific conductance, temperature and pH than were the eight sampling sites from ground-water sources. This is because the surface water is generally more variable than ground water, and because the doses of chemicals used to adjust surface-water alkalinity, turbidity and chlorine demand are more variable for surface water than for ground water. Because variability in water quality is source-specific, it should be characterized for each portion of the distribution system that uses a different source. Statistically-defined thresholds can then be set for each water-quality characteristic or for combinations of characteristics so that unexpected changes in water quality can be quickly identified.

KEYWORDS: continuous water-quality sensors, drinking water, homeland security, distribution systems, source water, surface water, ground water, temperature, pH, conductance, oxidation-reduction potential, chlorine residual