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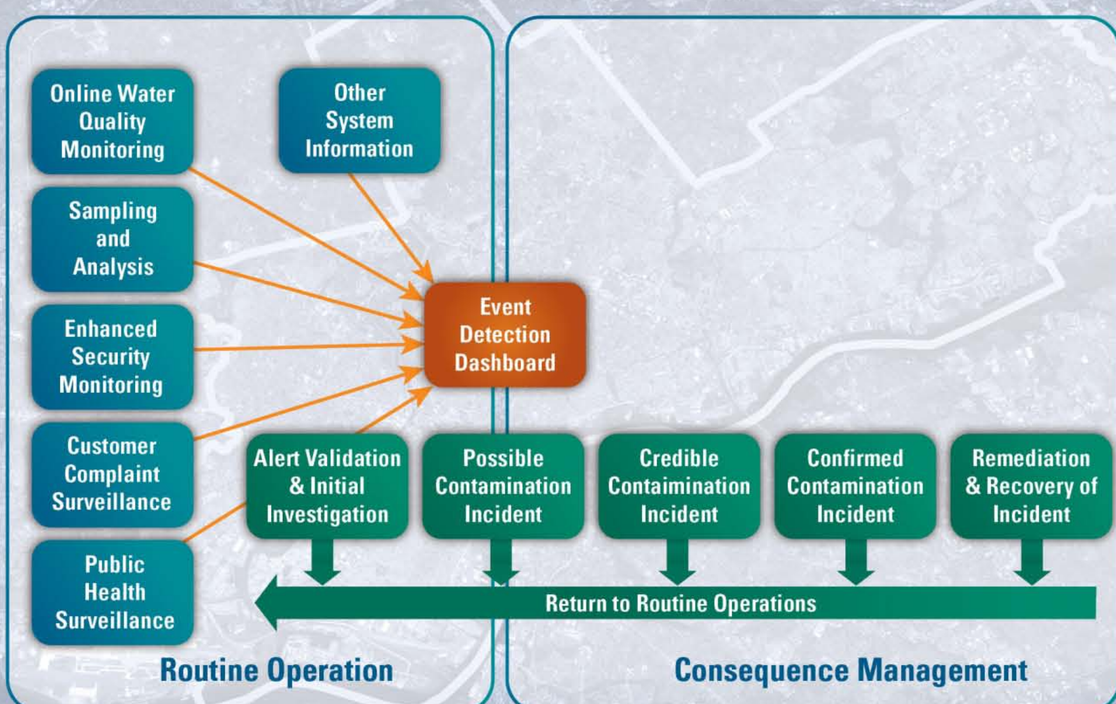
Philadelphia Water Department
Contamination Warning System Demonstration Pilot Project:

Safety Screening for Radiological Contaminants During Site Characterization





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This paper can also be downloaded from www.ch2mhill.com/iws.

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Abstract

The Philadelphia Water Department (PWD) developed a comprehensive contamination warning system (CWS) for its drinking water system under a Water Security (WS) initiative grant from the U.S. Environmental Protection Agency (EPA). Field safety screening is part of the Sampling and Analysis (S&A) component of a CWS and an activity associated with site characterization, that is, the collection of information at the site for use in supporting the evaluation of a water contamination incident. Monitoring for radiologicals is an important aspect of site characterization and a new monitoring activity for most water utilities. This paper provides an overview of site characterization, detailed information on site safety screening tests for radiologicals, a Radiological Fact Sheet, and safety levels.

Project Background

PWD developed a comprehensive CWS for its drinking water system under a WS initiative grant. WS initiative is a program developed by the EPA in partnership with drinking water utilities and other key stakeholders in response to Homeland Security Presidential Directive 9. The WS initiative involves designing, deploying, and evaluating a model CWS for drinking water security. A CWS is a systematic approach to the collection of information from various sources, including monitoring and surveillance programs, to detect contamination events in drinking water early enough to reduce public health or economic consequences. The WS initiative goal is to develop water security CWS guidance that can be applied to drinking water utilities nationwide.

The project has six major components:

1. Online water quality monitoring
2. Sampling and analysis
3. Enhanced security monitoring
4. Consumer complaint surveillance
5. Public health surveillance
6. Consequence management

Field safety screening is an important sampling and analysis component activity associated with site characterization. Site characterization involves the collection of information at the site for use in supporting the evaluation of a water contamination incident. Site characterization results assist in identifying safety procedures, protocols, and resources to be used to protect the health and safety of field responders and laboratory personnel. Sampling and analysis activities performed as part of site characterization include field safety screening tests, rapid field screening tests, and water sampling. Identification and development of appropriate monitoring procedures for radiologicals during field safety screening is an important aspect of site characterization.

CH2M HILL served as the project contractor and supported PWD in development of its CWS. CH2M HILL supported PWD in the design, implementation, and evaluation of the S&A component, including site characterization.

Site Characterization Background and Objectives

Site characterization is a process adapted to the needs and objectives of a specific water contamination incident. It consists of collecting information from an investigation site to support the evaluation of a drinking water contamination threat. Site characterization activities include site evaluation, field safety screening, rapid field testing of the water, and sample collection. The results of site characterization are of critical importance to the threat evaluation process (EPA 2003).

The site characterization process consists of the following six stages (EPA 2003):

1. **Customize the Site Characterization Plan.** A site characterization plan is developed for each specific incident using a pre-established generic plan.

2. **Approach the Site.** Before entering the site, an initial assessment of site conditions and potential safety hazards is conducted at the site perimeter.
3. **Characterize the Site.** The customized site characterization plan is implemented by conducting a detailed site investigation and rapid analytical field testing of the water.
4. **Collect Samples.** Water samples are collected for laboratory confirmation analysis.
5. **Prepare Samples.** The water samples are prepared for transport to the designated laboratory.
6. **Exit the Site.** Following completion of site characterization, the site is secured, and personnel exit and undergo any necessary decontamination.

Depending on the nature of the contamination threat, other agencies and organizations may be involved or otherwise assume some responsibility during planning and implementation of site characterization activities. Various organizations that may be involved include HazMat, technical assistance providers, laboratories, local law enforcement, and federal law enforcement. Federal roles and responsibilities are dictated by the Federal Response Plan (EPA 2003).

Site Safety Screening for Radiological Hazards

The site characterization process begins with an observation of site conditions for signs of hazards and field safety screening to identify potential environmental hazards that might pose a risk to the site characterization team. Radionuclides emit energy through ionizing and non-ionizing radiation. Ionizing radiation is high-frequency, low-wavelength radiation that includes, in order of increasing energy and penetration ability, alpha, beta, gamma, and x-ray radiation. A Radiological Fact Sheet prepared by PWD and CH2M HILL summarizes some common radionuclides, typical background radiation levels, health risks, EPA drinking water standards, detection methods, and the ways by which to minimize radionuclide exposure. This fact sheet is appended at the end of this paper.

Water is an effective shield to some forms of radiation. For example, weak forms of radiation may not have enough energy to escape the insulating properties of water or penetrate the water at all. Thus, a negative result from a detection system designed to detect radiation in air and on surfaces does not provide assurance that the water is free of radioactive contamination.

Field instruments are available to screen for radiation in the air and on surfaces. These detection systems commonly are grouped into two categories. Pocket-sized instruments alert the user but do not resolve radiation energy. Handheld systems include a rate meter and various detectors (probes) that can resolve the type and amount of radiation energy.

PWD uses the handheld Ludlum 2241-3RK Nuclear Emergency Response Kit for radiological site characterization safety screening. The 2241-3RK detection system costs approximately $3,000. It is capable of quickly identifying alpha, beta, and gamma radiological hazards. The Ludlum response kit includes a handheld rate meter and the following detectors: pancake Geiger-Müller (GM), Scintillation high energy gamma, and a halogen-quenched GM detector for high-range gamma measurements. PWD conducts radiation monitoring twice per month to develop background data, screen sample receiving areas, and stay familiar with the instrument. Both the pancake probe and scintillation counter are used. Table 1 presents characteristics of the Ludlum 2241-3RK detectors.

TABLE 1
Ludlum 2241-3RK Nuclear Emergency Response Kit Detectors

Ludlum Detector Model	Detector Type	Detection Capability	Sensitivity
44-9	Pancake GM	Alpha, beta, gamma	3,300 cpm/mR/hr ^{137}Cs, gamma
44-2	Scintillation	High energy gamma	175 cpm/mR/hr ^{137}Cs, gamma
133-7	Halogen GM	High range gamma	4.2 cpm/mR/hr ^{60}Co, gamma

GM tubes are most accurate for cesium-137 and isotopes of similar energies. Isotopes detected well by GM tubes include cobalt-60, technetium-99M, phosphorus-32, strontium-90, and many forms of radium, plutonium, uranium, and thorium. However, some sources of radiation, such as tritium, are difficult to detect using a GM tube.

Pocket-sized instruments can be used to screen for radiological contaminants in the field or in the laboratory. The pocket-sized alert instruments range in price from $500 to $1,500. Most pocket-sized monitors sense ionizing radiation by means of a GM tube within a thin mica window. When ionizing radiation enters or passes through the tube, it is sensed electronically and displayed by a red count light. It detects the four main types of ionizing radiation: alpha, beta, gamma, and x-ray. Pocket-sized instruments are considered counters as opposed to detectors because they do not resolve the radiation energy and only alert the user. The resolution capabilities of these instruments make it difficult to resolve low-level radiation from background levels. Most are calibrated to cesium-137 and serve as an excellent indicator for many other sources of ionizing radiation.

If radioactivity levels are detected at a level that poses a risk to life or health, the site will be characterized as a radiological hazard. Without a radiation measurement kit, it may be impossible to determine whether a site has been contaminated with radioactive material (EPA 2003). PWD uses the following general action limits and procedures:

- Readings above 200 µR/hr or 200 cpm require the support of the Pennsylvania Department of Environmental Protection. Areas where readings are high are roped off. If background readings are above 200 µR/hr or 200 cpm, staff are evacuated and the Department of Environmental Protection is contacted.
- Sample shipping: Any package that reads above 500 µR/hr on the outside requires special shipping requirements beyond the capabilities of most water utilities.

Table 2 lists the federal shipping guidelines.

TABLE 2
Federal Shipping Guidelines

		Maximum Reading at Package Surface	
Transport Index	**Label Category**	**As Listed in 49 CRF Parts 172–173**	**44-2 or 44-9 Probe**
0	White I	≤ 0.5 mR/hr	< 500 µR/hr
0 to 1	Yellow II	> 500 µR/hr	500 to 50,000 µR/hr
1 to 10	Yellow III	50 to 200 mR/hr	50,000 to 200,000 µR/hr
> 10	Cannot go by air	> 200 mR/hr	> 200,000 µR/hr

Recommendations and Conclusions

Enhancing field capabilities to support the site characterization process during a water quality incident provided PWD with the ability to evaluate a threat through site characterization, safety screen the site, and improve field staff safety. The Ludlum Nuclear Emergency Response Kit provided PWD with an effective tool to conduct radiological site safety screening. This project demonstrated the importance of developing a baseline profile for radiological safety screening as the Ludlum detects a range of background radiation levels at various urban locations.

It may not be practical for smaller utilities to develop field radiological screening capability. In this instance, it is important to reach out to other utilities, consultants, contract laboratories, and local, state, and federal agencies to develop relationships and understand each others' capabilities. For example, a regional Hazmat team may be available to support the utility during an incident. Developing relationships and agreements with those who can provide robust incident response capabilities should help to minimize the need to develop advanced and specialty analytical capabilities in-house, thereby reducing utility labor and equipment costs.

Abbreviations and Acronyms

µR	microRoentgen
cpm	Counts per minute
CWS	Contamination Warning System
EPA	United States Environmental Protection Agency
GM	Geiger-Müller
hr	hour
mR	milliRoentgen
PWD	Philadelphia Water Department
S&A	Sampling and Analysis
WS	Water Security

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