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Proceeding Paper

Seawater Contamination of Potable Water Shoreside during Freight Ferry Bunkering at an International Port †

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Abstract: In January 2019, complaints of an intermittent salty taste in drinking water were received from locations in close proximity to an international seaport. Preliminary testing indicated the presence of seawater within the potable water system. A multi-disciplinary incident management team was immediately convened and a "Do Not Consume notice" was issued. Subsequent investigations revealed contamination was likely due to a mis-connection to the seawater firefighting system during freight ferry bunkering of potable water at the port. Following this incident, new procedures were introduced at the port to prevent reoccurrence of this issue. No associated cases of illness were reported.

Keywords: bunkering; environmental health; freight ferry; potable water; population health; port health; public health

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1. Introduction

In the Republic of Ireland, public health doctors have a statutory responsibility for population health protection via the Medical Officer of Health role which includes mitigation of environmental risks and implementation of the 2005 International Health Regulations in conjunction with the Environmental Health Service [1]. In this case report, we detail the notification and management of a potable water incident, which was ultimately deemed to be related to freight ferry bunkering of potable water at an international seaport.

2. Materials and Methods

In January 2019, complaints were received regarding a taste of salt in drinking water at a number of urban locations in close proximity to a seaport. The investigation proceeded as follows:

- Widespread potable water testing was performed shoreside in the urban area around the port.
- Pressure and flow measurements of the drinking water supplies were taken.
- A physical investigation of potential sources of the contamination was undertaken, including; seawater firefighting system, saline ingress via groundwater, and ship refilling of potable water bunkers at the port.
- A ferry inspection was carried out.
- Potable water testing was repeated.

3. Results

Preliminary testing revealed abnormally high conductivity levels in one of the four sections of the potable water system at the port (40,000 uS/cm at one site versus 150 uS/cm normal level versus 2500 uS/cm exceedance limit). This confirmed the presence of seawater in the shoreside drinking water supply on three occasions between December 2018 and January 2019.

Upon receipt of preliminary test results, a multidisciplinary team with representatives from the Health Service Executive (Public Health and the Environmental Health Service), the Environmental Protection Agency, the port and city council was immediately established. A "Do Not Consume" notice for the entire port urban area, and a notice to cease potable water bunkering at the port were issued with immediate effect, along with advice on the health effects of consuming seawater. Subsequent drinking water testing revealed free residual chlorine levels > 0.1 mg/L and clear microbiological results.

Upon the analysis of the bunkering schedules and the timing of the abnormal results, there was a correlation noted with one particular freight ferry. Upon further investigation, evidence suggested that the hose from the shoreside potable water main (without a non-return valve) may have been inadvertently connected to this ferry's seawater fire-fighting flushing connection which was at a higher pressure (8 bar) than that of the drinking water main (2 bar), rather than to the ferry's potable water connection. These ferry connections were atypically directly adjacent (Figure 1). Thus, the ferry's attempts to refill the potable water bunkers instead caused seawater to enter the shoreside drinking water supply. In addition, the ferry's seawater fire-fighting system was not flushed with potable water after a recent test with seawater, and the ferry's potable water and seawater fire-fighting system both had male connections.

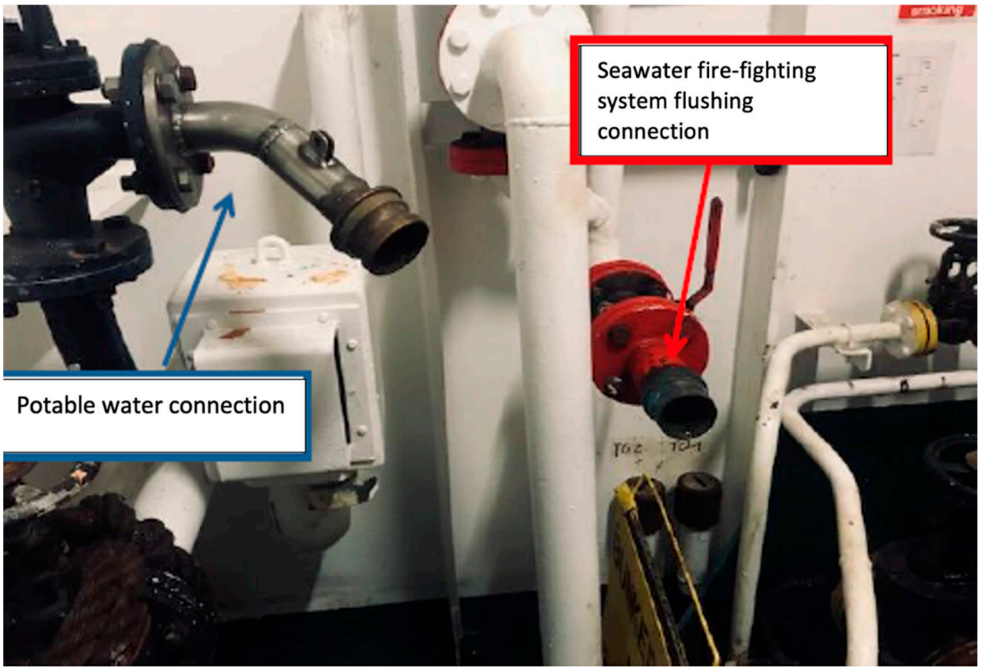

Figure 1. Ferry connections.

Repeat shoreside potable water testing yielded near-normal values, suggesting the contribution of operational activity. These results enabled the lifting of the "Do Not Consume" notice and the restrictions on bunkering.

Due to this incident, new procedures were introduced at the port. These are as follows:

- The bunkering of ships is now only undertaken by experienced potable water services personnel.
- Non-return valves are fitted to all stand-pipes that are used for filling ships.

- Regular disinfection of all equipment is advised.
- Lines are flushed before connecting to the ships' potable water system.
- The volume and timing of all filling events are recorded for water quality, leakage and revenue purposes.
- Alarms, based on constant monitoring of key data, have been set up and will alert personnel in the event of excessive pressure occurring in the drinking water network.
- Non-return valves are also fitted on the potable water inlets to the port area, which would limit the area affected if all other control measures were bypassed.

4. Discussion and Conclusions

The taste threshold concentration for sodium in water depends on both the temperature and the concentration of the anion that is present. At room temperature, water tastes salty at sodium levels of approximately 200 mg/L [2]. As per the 2014 European Union (EU) Drinking Water Regulations, the parametric value for sodium in drinking water is 200 mg/L [3]. Seawater has sodium levels of 10,000–16,000 mg/L [4]. Therefore, in the event of seawater intruding into potable water supplies, it is possible for a very high exceedance of the parametric value to occur.

Consumption of potable water contaminated by seawater poses significant risks to population health including:

1. Ingestion of high levels of sodium can lead to hypernatremia and dehydration. This poses particular risks for vulnerable populations such as babies (due to immaturity of kidneys) and those on a low sodium diet [5,6].
2. Infection risk, especially gastroenteritis, as seawater is contaminated with bacteria, viruses and other pathogens [7,8].
3. Risk from chemical contamination of seawater [9].

However, in this incident, there was rapid identification of seawater in the shoreside potable water system, appropriate actions were taken, and measures to prevent recurrence were implemented. No associated cases of illness were reported.

Sufficient availability of potable water is a prerequisite for population health, making the appropriate management of drinking water supplies an issue of paramount importance. Of note, as climate change intensifies, increased ambient temperatures, sea-level rise and extreme weather events will threaten the availability of potable water, globally [10]. In this context, protection of potable water supplies will become even more important.

In conclusion, it is well documented that ships and their surrounding infrastructure can significantly impact public health. Through the implementation of sensible control strategies, it is possible to mitigate ship-related health threats. Where possible, these strategies should take an upstream approach and aim to minimize the contamination at the source, such as when one is bunkering potable water [11].

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