MAINTENANCE OF DRINKING WATER SUPPLY SYSTEMS - INFLUENCE ON WATER SAFETY

Viviana Golja[1], Ivanka Gale[1], Bonia Miljavac[2]

[1]National Institute of Public Health, Trubarjeva 2, Environmental Health, Založka 29, 1000 Ljubljana

[2]National Institute of Public Health, Regional Unit Novo mesto, Muzejska ulica 5, 8000 Novo mesto

Introduction

Water is essential for our lives. Drinking water supply system, which provides this important natural resource, may be complex and may supply huge number of users. Figure 1 below shows example of such systems - drinking water supply system in Ljubljana and surroundings.

.

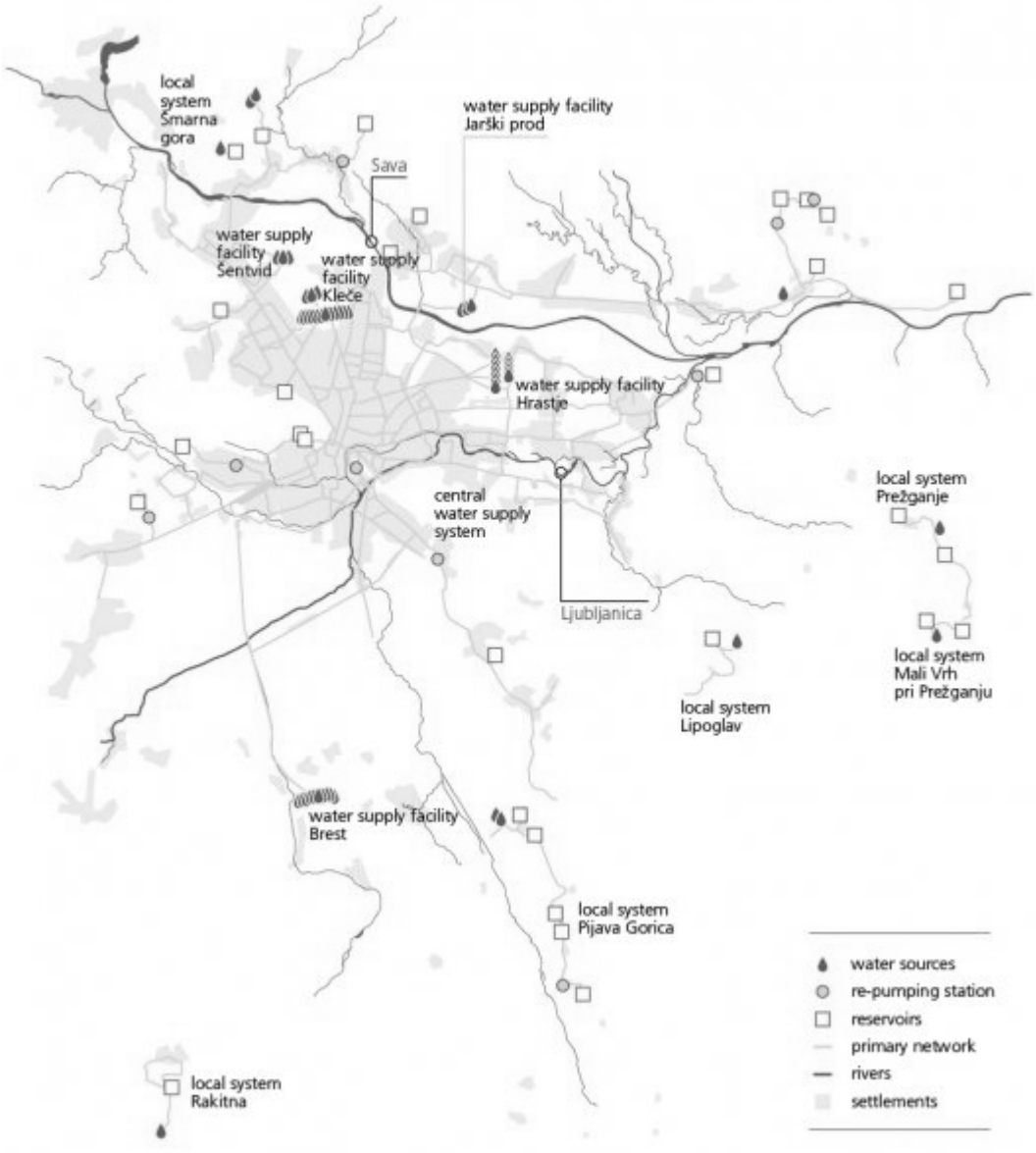

FIGURE 1: Drinking water supply systems in Ljubljana and its surroundings operated by JP VODOVOD-KANALIZACIJA, from the website: http://www.vo-ka.si/en/about-company/drinking-water-supply

Systems consist of water supply facilities with wells, local pumping stations and water supply network. Primary water supply network consists of water pipelines of large diameters, reservoirs and re-pumping stations. From the primary water supply

networks lead water pipelines of smaller diameters towards the users, domestic distribution system. They are connected in a dense network of the secondary water supply network. For more elevated areas, such as the castle hill, re-pumping stations or hydro stations are needed to pump the water into reservoirs due to insufficient pressure. On flatlands, so-called water towers are used to create sufficient pressure in the network. Depending on the quality of raw water, drinking water may be treated (if needed) in a local water supply system, by using technical water treatment procedures. Water treatment procedures include physical, chemical and biological methods (alone or in combination). After treatment, water access internal water supply systems to the point of use for human consumption.

In the entire process of water supply, drinking water comes into contact with many different materials: organic, metallic, cementitious and other. Organic materials are plastics (produced from monomers and other starting substances, additives, polymer production aids and aids to polymerisation, pigments and colourants), rubber, coatings and lubricants. Pipes and linings, fittings, ancillaries, components of fittings, storage systems (in domestic installations, buildings and in water supply) and repair products for storage systems can be made of organic materials. Metals are materials for production of pipes in buildings installation, uncoated pipelines in water supply systems, fittings, ancillaries, parts of pumps in buildings installations, part of valves in building installations, moving parts in water meter, parts of pumps and valves in water supply systems. Different copper alloys, coppers and steels/iron are used for such purpose. Cementitious products are pipes and their linings, storage systems and repair products for storage systems (e.g. coatings). Cementitious products contain cement, inorganic additions, aggregates, water, admixtures, fibres, polymer modifiers, formwork release agents and curing compounds as constituents.

All these materials or substances should be safe and should not release substances into drinking water in quantities which can endanger human health. Materials used for maintenance should be safe as well [1, 2].

Maintenance

Maintenance of the water supply systems is very important process for ensuring the safety of drinking water [1]. Influence of maintenance on water should be taken into account when preparing water safety plan as it is possible hazardous event for contamination of drinking water in distribution of the water and in water preparation procedures [2]. Drinking water can be contaminated if inappropriate materials are used during maintenance, or if procedures of maintenance are not careful and well planned.

It is important that maintenance is done regularly – in such a way negative impact of worn materials on safety of drinking water is avoided. Works such as installation, construction, earthmoving, cleaning, disinfection, pressure tests, monitoring of the pressure-flow conditions, should be conducted regularly on the infrastructure and facilities of public water supply as well as maintenance work in the area of infrastructure of the water supply and maintenance of water connections. However, emergency maintenance is sometimes needed to eliminate damage to public water supply in case of leakage, rupture installations, tampering. Emergency maintenance may lead to a poor quality of service, high costs; faster wear of materials and dissatisfaction of the users. In order to provide safe drinking water, after

maintenance is performed, different aspects should be considered: is the system cleaned, thoroughly washed, disinfected, ventilated, is it taken care for water supply during maintenance work. Maintainers should be qualified, available and reachable when needed. The price of the maintenance and selection of adequate materials may also influence the safety.

To illustrate how inadequate maintenance can influence the safety of water, the examples of lead leaching, legionella growth, contamination of drinking water with organic solvents and asbestos issue are briefly described.

Lead release

Lead is among key chemicals responsible for large-scale health effects through drinking water exposure [4]. The main source of lead in drinking water is secondary contamination from house installation (lead pipes in older distribution systems, zinc galvanised pipes, brass parts, brass fittings, use of lead soldering). The best measure of adequate maintenance is to remove plumbing and fittings containing lead; however it requires both time and money. If it is not possible, other practical measures to reduce total exposure to lead should be implemented e.g. corrosion control and flushing.

Legionella growth

Legionella is bacteria which causes *legionellosis*. Growth of legionella on surfaces and in water-based devices may lead to an inhalation hazard from aerosol. Growth can be controlled through basic measures (e.g. maintaining water outside the range at which *Legionella* proliferate, i.e. > 50 ℃ for hot water and < 25 ℃ for cold water, or maintaining a suitable disinfectant residual). If temperature control is poor (inadequate insulation of hot and cold water systems, heating devices and storage containers, inappropriate location of tempering devices, long branch mains and dead ends) there is increased potential for growth of *Legionella i*n large buildings and in long water distribution systems [5]., for that reason good maintenance of these systems is particularly important. Dead and blind ends should be removed, elevated temperatures in the hot-water system maintained and periodic disinfection and permanent chlorination (if necessary) of the cold-water system performed.

Residues of organic solvents

Part of maintenance may be the replacement of coatings which are needed for reduction of corrosion. Coatings may contain different ingredients; monomers, oligomers, natural macromolecules, additives, organic solvents, impurities, polymerisation production aids, binders, photoinitiators, pigments, resins, lubricants, surfactants, particles, unintentionally added substances (NIAS). Organic solvents (e.g. xylenes) are volatile and may remain in indoor air of premises and in such a way may influence quality of the water. During maintenance which includes use of volatile solvents, attention should be payed to prevent contact of drinking water with residues of volatile substances and the area should be properly ventilated.

Asbestos

Old cementitious water pipes still contain asbestos fibres. Due to erosion of the piping, fibers may be released into drinking water, especially if water is aggressive (low pH, soft water), changes in pressure in the network are present and during

maintenance [6,7]. Old asbestous pipes should not be used. If replacing products containing asbestos; particular attention should be payed to proper removal process.

Recommendations

Slovenian National Institute of Public Health prepared Recommendations for the building's owners regarding maintenance of the domestic distribution systems which are accessible at Institute's website [8]. In the recommendations, importance of suitable maintenance is stressed out. It is recommended that before the first use of the day (and after long stagnation), water at the tap should run at least 2 minutes or as long as achieves constant temperature. Nets and other fittings at the tap should be cleaned (rinsed with running water and (if necessary) limescale removed. Frequency of this procedure depends on particular system (general recommendation is to perform the cleaning every two weeks). Dead and blind ends in the system should be identified and removed. In parts of the system where water is stagnating, water should be flushed weekly to the stabilisation of the water temperature.

Some other recommendations regarding drinking water were also prepared at National Institute: recommendations to the owners of buildings on measures to reduce and eliminate the risk, if the cause of non-compliance of drinking water is domestic distribution network [9], recommendations regarding reducing and elimination of the risk caused by elevated lead concentrations which originate from domestic distribution network [10], recommendation on preventing growth of legionella in domestic distribution network [11].

Conclusions

Regular preventive maintenance of drinking water systems is essential for ensuring the safety of drinking water. Appropriate selection of substances or/and materials used for maintenance and correct maintenance procedures applied are crucial.

References

1. COUNCIL DIRECTIVE 98/83/EC of the quality of water intended for human consumption, OJ L 330, 5.12.1998
2. WHO Guidelines for drinking water quality, WHO 2011, accessible on the website:http://www.who.int/water_sanitation_health/publications/2011/dwq_chapters/en/
3. Water Safety Plans Managing drinking-water quality from catchment to consumer, WHO 2005, accessible on the website: http://www.who.int/water_sanitation_health/dwq/wsp170805.pdf
4. Lead in Drinking-water, Background document for development of WHO *Guidelines for Drinking-water Quality,* WHO 2011, accessible on the website: http://www.who.int/water_sanitation_health/dwq/chemicals/lead.pdf
5. Legionella and the prevention of legionellosis, WHO 2007, accessible on the website: http://www.who.int/water_sanitation_health/emerging/legionella.pdf

6. Asbestos in Drinking-water Background document for development of WHO *Guidelines for Drinking-water Quality,* WHO 2003, accessible on the website: http://www.who.int/water_sanitation_health/dwq/asbestos.pdf
7. Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Asbestos, Health Canada 1989, accessible on the website: http://healthycanadians.gc.ca/publications/healthy-living-vie-saine/water-asbestos-amiante-eau/index-eng.php#s1
8. Recommendations for the building's owners regarding maintenance of the domestic distribution systems, National Institute of Public Health, accessible on the website:. http://www.nijz.si/sl/priporocila-lastnikom-objektov-za-vzdrzevanje-hisnega-vodovodnega-omrezja
9. Recommendations to the owners of buildings on measures to reduce and eliminate the risk, if the cause of non-compliance of drinking water is domestic distribution network, National Institute of Public Health, accessible on the website:http://www.nijz.si/priporocila-lastnikom-objektov-o-ukrepih-za-zmanjsanje-in-odpravo-tveganja-ce-je-vzrok-povisanih
10. Recommendations regarding reducing and elimination of the risk caused by elevated lead concentrations which originate from domestic distribution network, National Institute of Public Health, accessible on the website: http://www.nijz.si/sites/www.nijz.si/files/datoteke/priporocila_lastnikom_objektov_o_ukrepih_za_zmanjsanje_in_odpravo_tveganja.pdf
11. Recommendations on preventing growth of legionella in domestic distribution network, National Institute of Public Health, accessible on the website:http://www.nijz.si/sl/preprecevanje-razmnozevanja-legionel-v-hisnem-vodovodnem-omrezju