European Commission

JRC TECHNICAL REPORT

Water Security Plan

Implementation Manual for Drinking Water Systems

ERNCIP Chemical and Biological (CB) Risks to Drinking Water Thematic Group

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2022

The research leading to these results has received funding from the European Union as part of the European Reference Network for Critical Infrastructure Protection (ERNCIP) project.

Joint Research Centre

EUR 30954 EN

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EU Science Hub
https://ec.europa.eu/jrc

JRC126684

EUR 30954 EN

PDF ISBN 978-92-76-46484-6 ISSN 1831-9424 doi10.2760/608997

Luxembourg: Publications Office of the European Union, 2022

How to cite this report: Teixeira et al., *Water Security Plan - Implementation Manual for Drinking Water Systems*, EUR 30954 EN, Publications Office of the European Union, Luxemburg 2022, ISBN 978-92-76-46484-6, doi10.2760/608997, JRC126684.

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Acknowledgements

This work has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 775989, as part of the European Reference Network for Critical Infrastructure Protection project.

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Abstract

Water is a core infrastructure sector that serves communities and businesses on a daily basis. Clean drinking water sustains core functions of our society which makes safety and security of water infrastructure a top priority.
The objective of the ERNCIP Chemical and Biological Risks to Drinking Water Thematic Group (TG Water) is to strengthen resilience of drinking water infrastructures against Chemical and Biological (CB) waterborne threats by improvement of detection capabilities and early response actions.

The implementation of security measures to counter hostile actions against the physical and cyber integrity of water supply systems and deliberate waterborne contamination requires an appropriate planning process incorporating risk assessment surveys, establishment of communication strategies, protocols and screening methods.
Water security planning helps to identify security vulnerabilities and establish security measures to detect the intentional contamination of water supply systems, including a communication strategy to facilitate a fast and effective response. Where a water safety plan already exists (European Commission 2015), water security planning should be integrated into the safety planning approach.

This manual supports the development of a separate stand-alone water security plan in cases where a water safety plan is not yet in place and encourages a complementary approach in cases where there are existing water safety plans, including the consideration of an integrated approach where relevant.
This manual aims to disseminate knowledge on how to implement a Water Security Plan, and complements the "Guidance on the production of a water security plan for drinking water supply" published in 2019 by the TG Water. The manual provides a detailed basis for the creation and implementation of a Water Security Plan for drinking water systems, supporting water utility operators with the information and tools they need to develop a plan specifically for the security of their water supply systems.

An effective Water Security Plan, together with a continuously managed implementation, supports the optimization of equipment placement and resource allocation – either of human or economic nature – along the water supply system, as well as increasing the confidence level of water utilities to be able to cope with chemical/biological contamination.

1 Introduction

1.1 Context

Drinking water sustains communities and business activities on a daily basis, which makes it a core infrastructure sector. The recently adopted new Drinking Water Directive (The European Parliament and the Council of the European Union 2020) reinforces the core function of drinking water systems for society and the internal market, introducing new obligations for water operators and national authorities at EU level, such as risk assessment, taking into account hostile actions that jeopardize the physical integrity of water supply systems and the quality of water supplied.
Moreover, resilience of drinking water systems, from source to distribution, is among the pillars of the new EC directive proposal (European Commission 2020b) which designates water infrastructure among the "critical entities" in the face of both physical and digital risks (European Commission 2020a).

To ensure the continuous provision of essential services, the implementation of security measures to protect drinking water infrastructure against deliberate contamination is a top priority. A waterborne contamination may lead to a severe disruption of the drinking water supply system (Riegel and Bethmann 2013) and, in addition, to cascading effects to interconnected critical services (National Infrastructure Advisory Council 2016) that depend on the drinking water distribution system, such as hospitals, industry, and administrative centres, including sanitation during COVID-19 crisis (Gawlik 2020).

Strategic security planning and continuous implementation of security measures by critical water entities enables Member States to enhance and ensure the resilience of drinking water systems. Cooperation and exchange of information is required between relevant entities, through water security planning, to carry out holistic risk assessments, take appropriate technical and organizational measures, and report disruptive incidents to national authorities, whether caused by physical or cyber breaches to the drinking water asset.
The Water Security Plan is therefore essential for prompt response and recovery from intentional or unintentional contaminations affecting the drinking water supply system, reducing the impact severity such as the potential escalation to service disruption and disease outbreaks which could have catastrophic consequences (Teixeira et al. 2019).

1.2 Purpose of the Water Security Plan

A Water Security Plan is designed to provide the operator of a drinking water system with the basis for implementing specific measures to improve the security of the water system against malicious threats.

Water systems are critical to communities and businesses. Protection of drinking water systems must be a high priority for local officials and water system owners and operators to ensure an uninterrupted water supply, which is essential for the protection of public health (safe drinking water and sanitation) and safety (firefighting), as well as for the normal functioning of societies. There are many benefits from implementing a Water Security Plan, in addition to any regulatory requirements:

- A plan will prepare the water system for all kinds of emergencies: natural disasters, man-made events, cyber-attacks and pandemics.
- A plan will set out specific instructions about who to involve if there is an emergency that may affect the water system.
- A plan will help to develop procedures for responding to events that affect the drinking water, such as a contaminated water source, or in the distribution

network.
- A plan identifies appropriate security measures for the water system.
- A plan will address remediation, recovery and rehabilitation activities to return to normality, as soon possible, in case of an unexpected event occurring.
- A plan will collate several important management and operations procedures into one document.

Adequate security measures will help to prevent loss of service due to terrorist acts, vandalism, or accident. The appropriate level of security is best determined by the water utility operator at the local level, working together with intelligence services and any other relevant authorities for a more comprehensive design and implementation.

1.3 Purpose of this document

The purpose of this document is to support water utility operators to create and implement a Water Security Plan, as recommended in the "Guidance on the production of a water security plan for drinking water supply" published in 2019 by the ERNCIP Chemical and Biological (CB) Risks to Drinking Water Thematic Group[1]. To accompany this Guidance, a test-bed is being developed as a pilot project for its implementation in the field. This pilot initiative, proposed by the ERNCIP TG Water, aims to engage water utilities from different countries with diverse water security awareness and concerns.

This implementation manual provides a detailed framework for the creation and implementation of a Water Security Plan for drinking water systems, supporting water operators with the information and tools they need to develop a plan specifically for the security of their water systems. It will provide the basis for the pilot project in the form of a practical and operational support document to water utilities, as well as assistance to operators in the implementation process.

This implementation manual will set out how a water operator can organise its Water Security Plan, embedding it within its normal operational processes.

1.4 Content and structure

The Water Security Plan Guidance (Teixeira et al. 2019) sets out four design phases for the Water Security Plan, fully aligned with the European Counterterrorism Strategy (Council of the European Union 2005) and the EC's CBRN Risk Action Plan 2017 (European Commission 2017).

This implementation manual document is structured according to these four design phases, which in turn correspond to the timeline of the development of a potential contamination emergency (as adapted from Council of the European Union 2005):

Section 2.1 — covers Phase 1: Security Planning and Preparation
The first section provides guidance on the security risk assessment for the drinking water system, covering threat, vulnerability and exposure; the development of the emergency planning process based on contamination scenarios; team building, coordination and preparedness; and actions necessary according to event severity.

Section 2.2 — covers Phase 2: Protection: Event Detection and Analysis
The second section supports the implementation of early event detection systems and laboratory analyses after a contamination event; physical, chemical and cyber warning

[1] https://erncip-project.jrc.ec.europa.eu/sites/default/files/2019.4805_EN_JRC116548.pdf

systems; surveillance and control measures for continuous monitoring; and further analytical support to be considered.

Section 2.3 — covers Phase 3: Response and Cooperation

Information exchange and pre-defined communication systems are covered in the third section for strengthening coordination and cooperation among the interested parties and prompt notification to the public. Additionally, actions for event management and operational response to support impact mitigation are described.

Section 2.4 — covers Phase 4: Remediation, Rehabilitation and Recovery Measures

In this section the narrative documents the actions to be taken to overcome the emergency and restore, as quickly and safely as possible, the service back to normality, as well as the guidance on the authorisation process that may be necessary, depending on the severity of the contamination.

Section 2.5 — covers Review Planning and Dissemination Activity

The last section provides focus on the importance of implementing a continuous review planning, dissemination and exploitation of results.

Finally, the implementation manual concludes with some final remarks and recommended best practices.

Each section of this implementation manual is designed to be 'independent and autonomous' so it can be completed on its own using the checklist, narrative and tools for that section, while the other sections can be completed in parallel, or subsequently. However, it is strongly recommended that Section 2.1, covering the planning phase, is undertaken first, followed by the others in a logical chronological order.

It is anticipated that all components of the relevant supporting documents will be completed in creating a Water Security Plan, i.e. all checklists and tools completed for every section of this implementation manual. Each section provides a narrative explaining 'the what and the why' for the material in that section, summarized in a "to-do list" in the form of a checklist of actions relevant for that section, providing a guide through each section and enabling each completed task to be recorded. Each checklist comprises detailed sub-sheets whose extended templates are provided in the Annexes of this document and are to be used as the guidance material for assessing and managing the various sub-tasks, e.g. team building within the Planning phase. As some templates are relevant to more than one Section, the sub-sheet may be repeated in multiple annexes, so that all relevant templates are grouped together.

Appropriate protection of security-related information will form part of implementation of a Water Security Plan. While relevant documentation will need to be made available to those who need this information to ensure the security of the system, this sensitive information will need to be stored in a secure location. This applies also to the checklists and completed templates produced during the implementation process.

When it concerns small water utilities, where capabilities and resources are often limited, the implementation of a Water Security Plan could prove to be a demanding task. Typical characteristics of 'small' utilities are (Teixeira et al. 2019):

- No technical staff (often, one town official is responsible for all public infrastructure);
- outsourced technical services;
- no monitoring equipment and no resources for maintenance;
- no digital infrastructure;
- long-standing 'other problems', 'other priorities', etc.

Therefore, the implementation of a Water Security Plan for small utilities might need to be tailored to a more realistic level. Rather than invest more in infrastructure, the main focus would be to assess the possible points of vulnerability, and add security as an important aspect to the general tasks list. Even if there was a desire to implement the security aspect, it may be more effective to collaborate with neighbouring utilities, and develop a security strategy by 'joint effort' in a regional network of utilities. Such networks or associations or 'utility neighbourhoods' already exist in many European countries, and could be used as 'organisation templates'.

Many security tasks, including emergency response, can be better managed centrally, maintaining professional capacity at one location only, serving several small utilities in the network. The daily operation of monitoring infrastructure, the necessary IT infrastructure, and the design, training and auditing of the security plan can all be done more efficiently from a central location. In this way, fixed costs can be shared and at the same time, the quality and sustainability of the implementation can be compared between partnering utilities.

2 The Water Security Plan Implementation

2.1 Security Planning and Preparation

Drinking water utilities must be prepared for the threat of deliberate attacks, including terrorist activities aiming to contaminate the water supply or damage the water system itself. Planning represents the first "action" to be taken in order to mitigate water security incidents.

2.1.1 Team building and partnerships

The responsibility for producing and owning the Water Security Plan (WSecP), which will include the responsibility for maintaining/updating the plan, should be allocated at the senior management level of the water utility. Normally, this would be the Operations Director, who should delegate the role of the Water Security Plan Manager, whose primary function will be to produce the WSecP. This person could be, but not necessarily, the same person nominated to be the Emergency Event Manager, who will take control of invoking the WSecP when a potential security event occurs.

Event coordination team
The WSecP manager should establish a multidisciplinary Event Coordination Team, which is the internal team responsible for coordinating the execution of the WSecP. This team will support the Emergency Event Manager in the proper assessment of any potential security situation and in the decision-making. The coordination team should therefore involve the top management and will need to have access to the various operational areas with direct involvement in the water supply system.
The members of the Event Coordination Team must have a clear definition of their roles, particularly the person responsible for collecting the data from operational areas, as well as the person responsible for the classification of the severity level of the event, as determined from the data received.
Once a security event occurs, the Event Coordination Team will function as the "emergency team", so the team members need to be trained to tackle diverse emergencies/level of event severity (see Section 2.1.3).

Coordination role and event severity
Composition of the Event Coordination Team may vary according to the degree of severity of an event, taking into account the level of responsibility and the tasks to be performed, as well as the risk to the continuity of the service. The event management and/or coordination role can also be defined according to the level of severity (minor, major, or catastrophic) to ensure most effective organization and management of the emergency, including the support of external entities, as needed.

External entities identification, roles and responsibilities
In the identification of relevant external entities, all stakeholders should be engaged, including the regulator, the public health authorities, the firefighter organisation, the hospital centre, local government, the most-exposed consumers, the law enforcement authorities, the national environmental agency, the industrial sites, the intelligence services, military authorities, civil protection, and any other interested entities, such as laboratories and specific suppliers.
All stakeholders should be made aware of the need to include the water facilities in their routine surveillance, particularly organisations operating near the critical water infrastructure. The general public should be encouraged to watch for unusual activity around drinking water system facilities, with clear instructions (e.g. phone numbers) for quick and easy reporting of suspicious behaviour (see Section 2.3.1).

Appointment of task assignments

In a catastrophic event, the management of the event should be performed by senior management of the water utility, although the coordination of the response to the event could be taken by the civil protection authority, or the law enforcement/security force. The water utility may therefore need to implement mitigation measures, according to instructions provided to the Emergency Event Manager.

Crisis Office

In such catastrophic cases, it is imperative that a Crisis Management Office is created as quickly as possible, managed by the Crisis Office Coordinator, appointed by the highest decision-making hierarchy of the water utility to coordinate events at catastrophic level.
Indeed, the functional areas of the Crisis Management Office will need to manage any catastrophic event in the most appropriate way, following the guidelines set by the Crisis Office Coordinator, focusing on ensuring that the service safely returns to normal functioning as soon as possible. Logistics services (warehousing, suppliers, etc.) as well as the allocation of external service resources will be essential in emergency situations whose coordination among the parties is entrusted to the Crisis Office Coordinator.
Note that deliberate contamination, which could be categorised as a terrorist situation, will probably be considered as a crime, and therefore be treated as a police incident. While the exact designation of such an incident may vary in different countries, the overall management of the incident will probably rest within the national security authorities, including the coordination with the relevant security forces and emergency services.

Rehabilitation Advisory Committee

Equipment and control systems concerning remediation, recovery and rehabilitation activities should be included to overcome the emergency and restore the service back to normality. In this regard, the possibility of establishing a dedicated and specialized Rehabilitation Advisory Team can be considered and nominated in advance of any contamination event (see Section 2.4) to support the Event Coordination Team - and report to it -, where indoor technical capacities are missing or lacking.
The Rehabilitation Advisory Committee is constituted when the water operator does not have the internal technical capacity to manage the remediation, recovery and rehabilitation phase and needs outdoor specialized technical support. This committee is formed by members of the in-house team, the external entities involved, and by the members of the contracted consulting entities, reporting directly to the Event Coordination Team.

All roles must be set in advance before any contamination event. In particular all teams must be established in the preparation and planning phase of the WSecP where all persons involved must be promptly defined and identified as well as the respective functions to be performed.

Table 1. List of managers for assessing and coordinating contamination events (source: Teixeira et al. 2019)

	Leading person	Role/Task	Appointed by	Entry into force	Team members
WSecP Manager	Director of operation and maintenance of the water supply system	Implementation of the WSecP. (S)he leads all security teams	The administration of the water utility	Always	Internal
Emergency Event Manager	WSecP manager or other person	Management of emergency events with minor/major severity	WSecP manager	If minor/major security events occur	Internal

Crisis Office Coordinator	President of the Municipality, Chairman of the Board or other person	Management and coordination of emergency events with catastrophic severity	Emergency event manager, WSecP manager	If catastrophic security events occur	Internal
Rehabilitation Advisory Manager	WSecP manager or other person	System rehabilitation to return to normality after a security event occurred	The administration of the water utility	If water utility has the appropriate capability to overcome the security event	Internal
	Consultant	System rehabilitation to return to normality after a security event occurred	The administration of the water utility	If water utility does not have the appropriate capability to overcome the security event	External

Establishing security protocols

The need for interaction with emergency authorities requires security protocols to be established between the parties to guide what should be done when an emergency occurs. In particular, a protocol with the hospitals should be established for syndromic surveillance, determining the periodicity and the contacts of both entities for the exchange of information.

A protocol with one or more laboratories should be established, to include pre-defined procedures to be followed in case of physical/cyber events to drinking water systems. The protocol should include access outside normal working hours and weekends, especially for water utilities that do not have their own laboratory, or those who do, but may need support for more specific analyses.

In Table 2, the "to-do list" is provided to help support the process of building internal teams and external partners, addressing respective roles and responsibilities.

This checklist identifies the sub-sheets whose extended templates are provided in the annexes of this document (directly accessible via hyperlinks), to be used as the guidance material for assessing and managing the task of team building and partnerships. Once completed, a copy of the documents must be placed in a secure location and sensitive information restricted to public disclosure.

Table 2. Checklist for emergency team building and partnerships

1A – Organization chart of the event coordination team
1B – Constitution of the coordination team according to the severity of the event
1C – External entities identification, roles and responsibilities
1D – Appointment of assignments for a catastrophic event

2.1.2 Risk assessment

The water utility, through its nominated Water Security Plan Manager, with the support of the relevant external entities, is responsible for developing the security risk assessment of the water utility.

Risk assessment identifies threats of malicious activities that should be considered and managed, in conjunction with the vulnerabilities of the water system infrastructure, to identify the potential impact from an incident, in terms of casualties and numbers of people affected by loss of access to drinking water.

The following paragraphs outline the relevant processes to support the development of the water security risk assessment.

Security vulnerability assessment
Every drinking water utility should conduct a security vulnerability assessment to determine whether there are areas needing improved security measures, according to the identified vulnerabilities and the most relevant scenarios, in terms of likelihood and/or impact severity. The assessment should be carried out in collaboration with the national intelligence services and/or other security authorities, if necessary, using outside consultancy, if the operator is not sufficiently experienced.

Vulnerability assessment tools are available, and drinking water utilities should evaluate them and choose a tool appropriate to their needs and size. The use of a security vulnerability "Self-Assessment Tool" and a "Certification of Completion" form which can be submitted to the security authorities and regulators as a confirmation that the assessment was completed is strongly recommended for all water utilities ((EPA) 2002b, 2002a).

The following are common elements of security vulnerability assessment, and any evaluation method should incorporate these points:

- Characterization of the drinking water system;
- Identification and prioritization of adverse consequences to avoid;
- Determination of critical assets that might be subject to malicious acts;
- Assessment of the likelihood/impact of such malicious acts;
- Evaluation of existing countermeasures;
- Analysis of current risk and development of a prioritized plan for risk reduction.

Preventive screenings and controls
Security responsibilities should be assigned to qualified individuals with the appropriate level of knowledge and experience, especially when it applies to physical access of authorized personnel only. Procedures for restricting entry to authorized personnel, contractors, vendors, and visitors, should involve proof of identity, check-in and check-out. Screening personnel through an identification/appropriate clearance system (e.g. badge, security authorization) controls access to sensitive facilities (e.g. process control rooms, computer and data storage rooms) to authorized employees. Moreover, establishing tracking policies to collect keys and other security items when employees terminate their daily work/contracts reduces the risk of insider threats[2].
Access outside the usual patterns, either in terms of the authorized users or in terms of unusual times, can generate warning alerts for investigation, as part of the prevention strategy to reduce security risks.

Among the main security practices to be implemented for ensuring physical security, each utility should:

- Protect drillings, intake structures, reservoirs, etc. with fencing;
- Secure doors, windows, hatches, etc. using locks, seals, alarms, motion sensors, and other appropriate means;
- Account for all keys to all areas of the system;
- Use video surveillance and security guards where appropriate;

[2] https://www.enisa.europa.eu/publications/enisa-threat-landscape-2020-insider-threat

- Provide adequate interior and exterior security lighting;
- Implement a system of controlling vehicles authorized to park on the premises (e.g., using placards, decals, etc.);
- Run periodic penetration tests (e.g. on- and off-site access).

Furthermore, early warning aspects should be considered to support suspicious activity detection and early notification through staff preparedness and alerts, as follows:

- Encourage staff to be alert to any signs of suspicious activity;
- Immediately investigate all information about suspicious activity and alert local law enforcement and intelligence services when appropriate;
- Conduct a frequent (e.g. daily) check of the water system for signs of damaging or other unusual activity.

Planning the response to an emergency event

Simple security precautions and procedures should be a first priority for all water utilities. Developing and practicing an emergency plan, in cooperation with local law enforcement and local emergency response entities, prior to an incident, is essential for a proper management, response and recovery from emergencies when an event occurs.

The Emergency Response Plan is a vital part of the WSecP, aiming at eliminating or lessening further losses and/or impacts after a contaminant has been detected in the drinking water system.

The drinking water system, from source to distribution, should be prepared to manage and respond to contamination events in a timely manner. Therefore, the Emergency Response Plan should be designed when the WSecP is initially established, identifying all the immediate response measures, as well as the event communication plan, needed to quickly manage and mitigate public exposure, and reduce the amount of damage caused.

To summarise, each utility should:

- Conduct a vulnerability assessment;
- Certify completion and submit a copy of the assessment to the security authorities and regulators;
- Prepare or revise an Emergency Response Plan that incorporates the vulnerability assessment;
- Certify to the authorities that the utility has completed or updated the Emergency Response Plan.

Risk-based scenarios

As guiding tool for the identification of potential risk scenarios and the suggestion of corresponding measures for risk reduction, water utilities could take advantage of the Risk Identification Database (RIDB) and the Risk Reduction Measure Database (RRMD)[3].

The RIDB helps to identify potential risk events, related to physical and cyber threats, which can occur in water distribution systems. The RIDB identifies the type of threats, the sources of risk, the description of the events and the type of consequences produced.

The purpose of the RIDB is not to substitute the comprehensive identification of risk events for each application. Instead, the examples given in the RIDB allow the users to commence the process by drawing attention to some possibilities that should be investigated, when local conditions evolve, indicating that an event might occur.

In the same way, the RRMD provides suggestions on actions to be taken to reduce the risk related to a specific event, through measures appropriate for each event. However, the user is free to identify alternative measures which are more cost-effective for their specific case.

[3] http://tl.stop-it-project.eu/

Prioritization of identified actions
Security deficiencies identified in the security risk assessment should be addressed as quickly as possible. However, it is not usually feasible to do everything immediately, and so the main improvements need to be prioritised, based on the most likely and/or impactful scenarios to the drinking water system, investing in the most critical and cost-effective security improvements immediately and budgeting to complete other actions later.

To facilitate the prioritisation process, a written Water Security Plan should be produced. The WSecP will include a complete description of the security requirements, including details such as procedures for daily checks of the water system infrastructure and information about alarm systems. This documentation must be only available to those who need this information to ensure the confidentiality of the information and must be stored in a secure location. The following are basic security-related components to be considered in the WSecP, for which several guiding checklists have been developed.

In some Member States, it may be necessary to notify the security authorities and/or regulator that such assessment has been conducted. In these cases, the collected information may need to be sent to the appropriate security and regulatory authorities so that the "Certification of Completion" can be included in any records that the Member State maintains on the specific water system.

Table 3. Checklist for security risk assessment

2A – Security Vulnerability Self-Assessment 2A.1 – Security Vulnerability Self-Assessment Completion 2A.2 – Inventory of Water System Critical Components 2A.3 – Questions for the Entire Water System 2A.4 – Water Sources 2A.5 – Treatment Plant and Suppliers 2A.6 – Distribution 2A.7 – Personnel 2A.8 – Information Storage/Computers/Controls/Maps 2A.9 – Public Relations
2B – Risk Assessment and Management Survey
2C – Definition of potential scenarios of contamination Form
2D – Prioritization of Needed Actions
2E – Certification of Completion

2.1.3 Training programmes and exercises

Awareness-raising programme
Security is a common goal and responsibility for all stakeholders. Therefore, it is very important that a security culture is created among the employees of the water utility. Various measures are available to improve the security culture, including threat characterization, system monitoring, and event response preparation, which can all be implemented as part of a broad security awareness-raising programme.

Police authorities and other relevant entities, as well as the local community, should be involved and engaged in developing awareness and capabilities for a more comprehensive emergency preparedness.

The collaboration of communities can be promoted through public campaigns of improved awareness on water supply issues, avoiding undue alarms. Water utility operators need to be attentive to the source of potential contamination event warnings, and should rely on a set of indicators. In case something unusual or suspicious is reported, it must be immediately verified and notified to the managing body and/or the competent authorities so that they can make the proper determination of the next steps to be taken (see Section 2.3.1).

Training development and exercises

Many authorities, agencies, and public or private entities have created resources for developing security training programmes for utilities, and periodically conduct general training and large-scale exercises.

There are several resources that can be used to assist with training development, including technological (equipment, IT tools), economical (budget), and organizational (logistic tools, checklists). Local emergency planning committees may also have local training opportunities that allow water utilities to practice response functions with local emergency partners.

The training recommended for an effective and adequate response is a suite of core courses, augmented by a training programme involving discussion and operational exercises based on realistic and plausible scenarios. This training programme concerns "Discussion-Based" exercises (seminars, workshops, and tabletop exercises) to introduce and teach new concepts and to assess plans and procedures with contamination scenarios and/or "Operations-Based" exercises (drills, functional exercises, and full-scale exercises) to test and evaluate procedures and programme effectiveness under more advanced simulated or real-world "what-if" scenarios. The exercise typology must fit the needs and the audience involved, internal gaps and priorities, as well as budget/time constraints. The exercise typology and execution must be progressive in term of objectives and complexity.

Training execution and objectives

To ensure an effective and adequate incident response, training should be conducted to familiarize utility personnel and response partners with the response procedures and their corresponding tasks. The development of a schedule for periodic training and exercise activities for management and staff is recommended.

Training should include information on how the Emergency Response Plan is organized (e.g., investigation activities, response activities with an interactive programme of activities planning for remediation, recovery and rehabilitation), as well as roles and responsibilities of personnel and response partners (e.g., emergency team). Additionally, training activities associated with specific response activities (e.g., field sampling, site characterization) should be conducted to carry out both technical tasks and organizational activities (e.g., coordination and group work).

Training should also stress coordination between utility personnel and external response partners to establish a consistent, shared understanding of roles and capabilities during investigation of, and response to, a contamination incident. The roles of all parties during an incident should be clearly understood, including the process of collaboration under an incident. This implies that partners know what they must deliver/provide each other (information, support, means, etc.) during the emergency.

Training on technology usage

Being technology dependant almost throughout the whole drinking water supply system, competent operating personnel are vitally important to sustain safe and secure operations.

Training should be organized on conventional/unconventional technologies, control systems, electronic devices - in case a new device installation or technological upgrade has been made to the water supply system - as well as on the usage of sensors and software for event detection and online monitoring.

Knowledge of technological tools and design parameters, patterns, limits and indicators, supports water utilities in the decision-making process, enabling better identification of false alarms, as well as increasing the level of confidence necessary for an early response action.

Revision of existing training programmes
Utilities with an existing emergency preparedness training programme should incorporate specific trainings and exercises. The training programme should include internal exercises to maintain the response and its supporting procedures, such as site characterization and public notifications, as well as maintaining the competence of personnel in their respective procedural roles. Maintenance and continuous revision of existing exercise programmes must be ensured and aligned every time there are internal changes (e.g., to processes, procedures, or equipment) or external updates (new regulations or standards, new users, etc.)

Revision of the actions needed to improve a utility's security culture programme should be applied not only inside the organization but also with the external entities that are involved, as well as with the local communities, including individual customers, industries, and all interdependent assets/services - public and private - to which water is supplied.

For this purpose, the following checklist can be used, detailed in the respective Annexes.

Table 4. Checklist for awareness-raising programme, training and exercises

3A – Awareness-raising on threat characterization
3B – Prioritization of Needed Actions
3C – Training and Exercises Form

2.1.4 Emergency equipment and service continuity

A natural disaster or a malicious attack could interrupt the normal power supply to the water system, where vital equipment and supplies may be damaged or destroyed. An emergency event may cause an unavoidable interruption of water system operations. Preparations should be made to continue water system operations by having emergency power capability and an adequate inventory of extra equipment, parts, and supplies.

Emergency power
Natural disasters or intentional damage may cause loss of electrical power, thereby shutting down drilling pumps, booster pumps, treatment systems, and possibly alarms. Some areas have a history of regular power outages, e.g. transmission lines damaged by strong winds. All water utilities should prepare for power outages by providing auxiliary power. Typically, this would be a portable generator, or more than one, if necessary, that

can supply the minimum electrical power the system requires, for a short period while the main power source is being repaired. The generator and other emergency power equipment should be checked at least monthly to ensure that they remain in good operating condition. If no auxiliary power can be provided on site, generator rental companies should be identified, listing the equipment needed, and 24hr emergency contact names and numbers (see Section 2.3.1).

Equipment redundancy

Redundancy means the water utility has adequate "backup" for the essential equipment and supplies it needs to maintain normal operation. Here are a few key points:

- Redundant equipment may require complete units - spare pumps, filter assembles, testing devices – or spare parts and supplies.
- Have an extra supply of parts that need regular replacement, such as filters, and always stock enough chemicals to maintain operations for at least 30 days.
- Undertake a monthly inventory of redundant equipment and supplies.
- Store the redundant equipment and supplies in a secure area of the water utility.
- Maintain a list of after-hours phone numbers for suppliers/technical assistance people.
- Arrange with at least one water testing lab - approved for Drinking Water System work - to provide after-hours/weekend testing services on an as-needed basis.
- Water systems using computerized system control/data acquisition (SCADA) programmes should provide manual backup in case the automated systems fail or are sabotaged.

Stored emergency water

Every household is responsible for its own emergency preparedness and should have an emergency supply of potable water. A good rule of thumb: each household should store fourteen days[4] supply of water for drinking and hygienic uses, using a minimum of four litres per person per day.

An adequate emergency supply of drinking water in each household represents an important asset to the water system. Therefore, operators should encourage every household to properly store enough potable water to meet their emergency needs, making this recommendation public, for example, on the water utility's website.

Storage of critical chemicals for water treatment

Chemicals are essential in treating drinking water when a contamination event occurs. In fact, water treatment process requires the use of chemical agents to be able to promptly implement traceability and disinfection measures (see Section 2.4).

So, it's important to properly and safely store the chemicals that are used in the water treatment process for a timely drinking water supply, ensuring potability and service continuity.

Storage solutions of chemicals depend on chemical properties and quantity. A chemical–tailored storage ensures adequate storage conditions with cost savings. This maximizes the operation and performance of the chemical agents, as well as the longevity of the chemical storage tank for an optimal and more effective water treatment in emergency situations involving the use of the chemical.

Water rationing plan

Water system operators should be prepared to implement water rationing if an emergency limits the normal water supply. Many existing water rationing plans use various levels of water rationing that correspond to the current water supply. Here are some general considerations for water rationing plans:

[4] The Red Cross provides detailed information about potable water storage; recommended storage quantity and duration may vary per country. For more details see www.redcross.org

- Plan/develop the fundamental framework for water rationing plans before being faced with the actual crisis.
- Keep the public well informed on the water supply situation.
- Make every effort to develop a fair and equitable system for allocating water to customers. The extra effort required to develop a more sophisticated system will generally be rewarded with better customer cooperation and fewer variance requests.
- Provide information on what customers can do to conserve water, and prepare for many inquiries.

Alternative water supplies and mutual aid
The Emergency Response Plan should provide the names and phone numbers of suppliers capable of delivering bulk quantities of drinking water, ensuring that interested parties are familiar with the recommended procedures for hauling drinking water. The Plan should include mutual aid agreements with neighbouring water suppliers sharing critical resources, including equipment, supplies, and water.

Water distribution plan
A natural or man-made disaster could damage all or part of the distribution system while leaving the source and storage facilities intact and operational. The Emergency Response Plan should make provisions for using alternate methods of distributing the water. Examples of such methods include temporary distribution piping and central access points to stored water.

2.2 Protection: Event Detection and Analysis

Traditionally, cyber and physical security have been considered and managed as two separate issues. However, sophisticated attacks are now disrupting both virtual and physical network elements, giving rise to a wide number of vulnerabilities and complex cyber-physical attacks with potentially disastrous consequences. Bio-chemical security complements these aspects, especially in the areas of research where hazardous contamination agents have the potential to be weaponized.

The Water Security Plan should clearly link the detection in real-time of events based on online monitoring systems with the interfaces to the laboratory for identification and confirmation testing. Installation of online monitoring technology along the network at identified critical or key points is recommended.

In addition to technological monitoring, staff involvement for real-time detection of any suspicious activity, vandalism or sabotage, should be taken seriously and highly encouraged. In this regard, documentation and photos of suspicious activity should be considered when a discovery or receipt of threat has been made.

2.2.1 Online detection systems

Early detection sensors, parameter analyses and contamination warning systems play a key role in supporting water security through the protection of water supply systems and distribution networks.

Online monitoring and sensor parameters (e.g. chlorine, conductivity, pH, turbidity, redox potential, O2, temperature, spectroscopic sensors) are central to fast detection of contamination and should be integrated into normal operations. Locations of sensors need to be decided not only on security aspects but also on other operational aspects as well as according to vulnerabilities, population at risk, etc. The water utility needs to embrace the installation of sensors and have a clear verification and maintenance process to make sure data is robust/reliable.

The Online Water-Quality Monitoring report (Carmi 2019) emphasizes the importance of hydraulic models and GIS application, sensor placement optimization, type of sensors and number of monitoring stations needed, data communication and event detection systems to manage big data and false alarms, contamination dissemination look-ahead simulation model and event management system. There are many types of security-related systems that should be considered; the first three listed below, requiring limited implementation effort, are particularly recommended:

- Implement online sensors also in treatment and distribution systems on critical places (OS) (Raich 2013).
- Implement a continuous water quality monitoring system (CWQMS) to monitor in real time the water quality, very important to establish a standard pattern of the drinking water (Carmi 2019).
- Implement an event detection system (EDS) to be able to detect changes in the standard pattern of drinking water and thus be able to confirm with some reliability a contamination event.

Further suggested security-related systems complementing the above are:

- Use a contamination dissemination model system (CDMS) to evaluate, in a confirmed contamination, what is the affected area which is critical, for the response measures.
- Implement an event management system (EMS) to support the management of the event.
- Perform scenario-based simulations to stress-test the system and assess its performance under single and/or multiple scenarios of attack. This practice aims at increasing preparedness if the event will happen.

Contamination warning systems

Online contaminant monitoring systems or simple Contamination Warning Systems (CWS) are valid tools that reduce the consequences of a deliberate contamination attack from either a chemical or biological contamination. These systems provide drinking water utilities with a systematic approach for monitoring and surveillance of the distribution system (EPA 2007).

A CWS should be designed to detect contamination events and to provide information on the location of the contaminants within the system, including an estimation of the injection characteristics (i.e., contaminant type, injection time and duration, concentration, and injected mass flow rate). Once the type and the characteristics of the contaminant are discovered, a containment strategy can be implemented to minimize the contamination spread throughout the system and to determine which parts of the system need to be contained and/or flushed.

CWSs have been envisioned to include multiple approaches to monitoring (Teixeira et al. 2019). For instance, water quality sensors located throughout the distribution system, combined with a public health surveillance system and a customer complaint monitoring programme, are believed to be capable of detecting a wide range of contaminants in water systems.

<u>Early detection through syndromic surveillance</u>

The first indication of a waterborne disease outbreak may be the observation that an unusual number of water system users are experiencing symptoms of gastrointestinal illness since a waterborne disease outbreak is caused by contaminants in drinking water. They may be biological agents – bacteria, viruses, or microscopic parasites – or chemicals that cause an acute reaction. In a typical outbreak, some water users will develop similar signs and symptoms of illness within a few hours and/or days of each

other. Additional cases of disease may follow as other system users and visitors drink the water. An investigation that definitely links the cases of disease with exposure to the contaminated water will confirm a waterborne illness outbreak. This situation should be managed by health authorities in collaboration with water utilities.

Syndromic surveillance conducted by the public health authorities might serve as a warning of a potential drinking water contamination incident. This surveillance includes information such as unusual trends in over-the-counter sales of medication, and reports from emergency medical service logs, 112 call centres, and poison control hotlines. Information from these sources can be integrated into a CWS by developing a reliable automated link between the public health sector and drinking water utilities.

Early detection through customer complaints tracking

Another important step in the protection phase is the feedback that can be provided by consumers, the health authority and the other entities involved in this process, such as the regulator of water services, civil protection, local government, the environmental agency, and police authorities. Some sensitive consumers such as hospitals, health centres and dialysis clinics are of particular importance since they have very tight control of water quality for obvious reasons and whose feedback can be very valuable in detecting something abnormal.

Another important point to consider is a possible and sudden increase of people entering hospitals and health centres with symptoms that may be linked to contaminated water consumption.

Water utilities should also regularly track and map consumer complaints regarding unusual taste, odour, or appearance of the water, and record what steps they took to address these water quality problems. The development of a process to automate the compilation and tracking of information provided by consumers could be very useful. Such a system, coupled with anomaly detection software, might be able to rapidly identify unusual trends that indicate a potential contamination incident.

Immediate actions could include warning endangered customers not to drink the water, cutting off water supply in the endangered area, stopping pumps, closing main valves, etc.

Impact assessment

The water utility should carry out a rapid survey of the situation - ideally within 3 hours of the immediate response phase - by professional and experienced water system and water quality personnel, in coordination with the Rehabilitation Advisory Committee (see Section 2.4). According to the survey and system characterization, the output of the impact assessment will be used to determine further field investigations and to define the main and intermediate goals of the response process that permits a range of remedial alternatives to be used, and to activate the communication plan.

Table 5. Checklist for online detection systems

4A – Threat Identification Checklists 4A.1 – Water System Telephone Threat Identification Checklist 4A.2 – Water System Report of Suspicious Activity
4B – Record of anomalous occurrences in the water supply
4C – Online monitoring and enhanced security form

4D – Contaminated system survey
4E – Impact assessment
4F – Prioritization of needed actions

2.2.2 Bio-chemical detection systems

Security breaches can be monitored and documented through enhanced security practices that detect anomalous conditions. A tampering event can potentially be detected in progress, thereby possibly preventing the introduction of a harmful contaminant into the drinking water system.

To determine and confirm if potential contamination detected by the online water quality monitoring system is a credible threat, sampling field and laboratory analysis of water samples should be completed.

The contribution of laboratories to the Water Security Plan is to provide the water utilities with rapid detection methods as well as the analytical capabilities and capacity to support monitoring and surveillance, but also response and recovery in contamination events involving chemical, biological, and other types of contaminants (i.e., radiological, nuclear, etc.).

Sampling and laboratory analysis
A progressive approach, starting with an initial assessment of the detection of chemical toxic compounds and/or microbial agents using simple, non-targeted technologies, followed by an assessment of the subsequent more precise identification of the contaminant using targeted rapid analysis technologies, aims to identify the widest possible range of contaminants and minimise the response time. Therefore, all the analytical technologies should preferably share the following characteristics:

- give a fast response (minutes/hours);
- provide reliable results;
- are easy-to-operate (can be used by non-specialised staff);
- are commercially available on the market.

An improper sampling process can endanger the identification of the source and nature of the contaminant. Sampling in response to potential drinking-water contamination has to follow accepted procedures, which need to be properly documented and familiar to the personnel implementing them. Staff collecting samples must be trained and/or be under the direct supervision of a trained staff member (see Section 2.1.3).

Contact with contaminated water, or even with residues of the contaminant or other materials at the site of contamination, may pose serious health and safety threats to laboratory staff, emergency responders, or other water utility staff. Anyone collecting, handling or analysing samples that may contain unknown contaminants should ensure their own safety and that of their staff. This highlights the need of training the sampling and analytical teams to act with accuracy, safety and rapidness by doing periodic exercises.

The step following the sample collection and transport will be the analysis with non-targeted technologies (measuring toxicity and Adenosine Triphosphate (ATP)) in order to identify whether the compound responsible for the contamination is chemical or microbial in nature. There are several devices available on the market to measure toxicity and ATP, with various prices and modes of measurement (qualitative and quantitative), so utilities

can select devices according to their specific objectives (Coimbra, Coelho, and Batlle Ribas 2020).

For the results to be useful in emergency situations, as with toxicity, a pattern of normal ATP levels should be obtained beforehand so that results are based on clear changes from the status quo. Furthermore, routine measurement of ATP and toxicity provides background information that can also be useful for operational monitoring of drinking-water systems.
In this regard, relevance should be given to storage and use of chemicals for laboratory testing and analysis. In particular:

- Secure chemical storage areas, and limit access to authorized personnel.
- Keep track of hazardous chemicals.
- Use only known properly labelled chemicals.
- Inspect incoming chemicals for signs of damage or counterfeiting.

Water contamination emergencies could result in a surge of water sampling and analysis that can quickly overwhelm resources or require laboratory expertise unavailable to most utilities. Depending on their specific objectives and risk management options, water utilities and laboratories must select an appropriate analytical approach, that should be prepared when the Water Security Plan is initially established and should include: pre-identified sampling sites, procedures for sample collection of both known and unknown contaminants, chain of custody, sample preservation, sample transport, as well as a list and locations of contract analytical laboratories.

Site characterization
The utility will need to determine the level of threat and will require evidence concerning the type of contaminant, and how serious the contaminant may be in terms of public health.

The investigation site is the focus of site characterization activities and is the location where it is suspected that the contaminant was introduced into the system. In addition to the investigation site, other sampling sites potentially impacted by contamination might be identified, if it is suspected that the contaminant might have spread. The process of collecting information from an investigation site to support the evaluation of a drinking water contamination threat includes the site investigation, field safety screening, rapid field testing of the water, and sample collection.

External analytical support
It is recommended that water utilities be capable of collecting water samples and performing basic field analysis, internally, on the shortest possible notice. If external laboratories are contracted, specific requirements for emergency situations should be included.

A utility's own laboratory may not be able to perform analyses for all contaminants in all emergency scenarios. Thus, as far as possible, utilities should identify in advance any contaminants or scenarios for which they will require analytical support and identify external laboratories, if needed, and emergency response partners.

For an event classified as catastrophic, external consultants/specialists may be needed to assist the multidisciplinary coordination team in obtaining a fuller assessment of the situation, as should have been identified in the Water Security Plan.

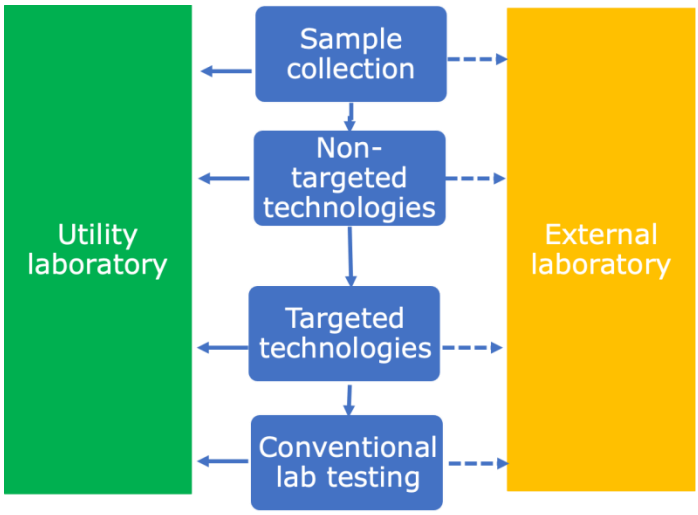

Figure 1. In-house and external laboratory procedures for compound testing

The national supervisory authority/agency for laboratories provides a consistent and national approach to coordinated laboratory response to water contamination events.
The laboratories may need to address water contamination incidents that, due to their suspected cause or size, require additional analytical support and a broader response than they can provide. If the response needs to be at another level, e.g. regional or national, procedures should be provided for a coordinated response to water contamination incidents that threaten public health and safety. Moreover, information from laboratories should be used to inform decision-makers who will establish what control/remedial action should be taken.

Table 6. Checklist for bio-chemical detection systems

5A – Site characterization and sampling form
5B – Identification of the contaminant
5C – Prioritization of needed actions

2.2.3 Cyber detection systems

As well as for the online monitoring of the physical/bio-chemical system components, solutions for online monitoring of the cyber part should be implemented. Examples of solutions are[5]:

- Network Traffic Sensor and Analyser systems using unsupervised algorithms to create a model of the normal behaviour of the system - e.g., by modelling the number of packets transferred during a given period of time, the volume of packets sent/received, the IP sources/destinations used in the communications, the port sources/destinations required for communications, the protocols used, etc. - therefore, any traffic data falling outside the model will be considered as suspicious, and the tool will alert the utility accordingly;
- Real-time Sensor Data Protection systems used to guarantee the integrity of all data generated within the critical-infrastructure operation (logs, sensor data, etc.) both against intentional attacks and/or malfunctions;

[5] https://stop-it-project.eu/results-and-downloads/#toggle-id-2

- SIEM (Security Information and Event Management) or enhanced SIEM with added high-performance correlation, able to raise alarms from a business perspective by considering different events collected at different layers.

2.3 Response and Cooperation

The term 'Response time' describes the overall time that a utility will take to respond effectively to a contamination detection, to eliminate or lessen further public exposure. In particular, response time includes reacting to all potential contamination events, including those where contamination is subsequently ruled out (e.g. false alarms).The WSecP should aim at minimizing response time, not only by implementing early detection and analysis systems, but also through a comprehensive communication strategy and efficient operations management, once the event has been confirmed.

2.3.1 Emergency communication and notification

Since the risk of natural disasters or attacks on water systems cannot be eliminated completely, operators must be prepared to control the impact of such events on the water source and system infrastructure. Operators should have a clear emergency communication plan for timely notification in case of contamination, as well as effective emergency response measures, including isolating the contaminated area of the system, disinfecting the system, disseminating advisories to boil water, and the discharging of contaminated water. Utilities should have the necessary basic chemicals, equipment, and procedures ready for response to an emergency.

The emergency authorities and other interested parties, such as interdependent critical services, should be listed in an Emergency Notification List for prompt contact. This document is an essential part of the Emergency Response Plan (ERP[6]) and contains the names and telephone numbers of people that might need to be called in an emergency. This is a critical document to always have readily available.

Emergency contacts – external authorities
Events that pose a threat to the quality or quantity of drinking water may require an immediate response by the police authorities. Examples of events of this kind include intentional chemical or biological contamination of the water in a water supply system. In these cases, the water utility personnel - and/or the general public - observing the event should call the national emergency number at any time day or night.

Emergency contacts – water authority
All known or suspected threats to a drinking water system, e.g. suspected waterborne disease outbreaks or disruptions of water system treatment/supply due to equipment failure, need to be notified to the water authority, regardless as to whether the police or fire services have been involved.

Information and data collection
The operator receiving notification of a possible contamination event should obtain and record the following information:

- The name, address, phone number, and present location of the person(s) observing the event.
- Type of incident (i.e., toxic spill, radiological incident, pipe ruptures, interruption of treatment, or other emergency disruption of a drinking water supply.), substance spilled (if spill), magnitude of incident, and number of injured or contaminated persons, if possible.

[6] https://www.epa.gov/waterutilityresponse/develop-or-update-emergency-response-plan

- The exact location of the incident, if possible.
- The time frame between the incident and the point when it was recognized, if possible.
- The date of the incident.
- The recognized or perceived threat to the water system and/or user.

Operators and external entities will need to contact each other quickly in an emergency. Therefore, key personnel should have access to critical phone and pager numbers both on and off duty. These numbers must be kept up to date.

Communication channels

Communications during an emergency can prove difficult. A standard response might be to call "112" for local fire and police authorities. But this may not be possible if the emergency has disrupted telephone lines, or over-loaded cell phone lines. Alternative ways of communication should therefore be agreed with local authorities and regulators[7] as part of emergency preparedness, planning it in advance.

Local authorities, such as the civil protection service, may have secure lines of communication with limited access. It might be worth establishing the feasibility of access to such lines of communication.

Public notification and coordination

In the event of a waterborne contamination, the water utility must provide public notice to its customers as soon as possible. Health and security authorities, as well as public water system regulatory agencies, must also be contacted during this time to coordinate with them, if it is suspected that the water system is involved. More information on dealing with waterborne disease outbreaks and emergencies will be available from health authorities.

In particular, if there is an incident of contamination in the water supply, the operator of the water system is responsible for designating a spokesperson and notifying the public and those third parties indirectly impacted by the event:

- Non-technical utility staff: it is especially important for utility employees that do not usually operate the system, and rely on the WSecP, to be guided through an emergency situation (i.e. administration, financial staff). Informing them on behaviours to be adopted would also facilitate the emergency team in its duties.

- Drinking water users: drinking water operators should have a complete and current list of all users' names - including customers, industries and interdependent operators to whom drinking water is supplied -, addresses, and phone numbers (as in the billing system) in their Water Security Plan so that users can be contacted as quickly as possible in the first 24 hours of an emergency. Likewise, each user should have the name, address, and phone number of the operator(s), as in the billing system. There should be one "spokesperson" for the water system so that messages are communicated clearly and consistently.

- Institutional customers: the Water Security Plan should clearly state how to contact the appropriate public water system and institutional services in case a contamination event occurs. In particular, this applies when large numbers of people or with special needs are involved, some of whom may be immune-compromised (i.e. nursing homes, hospitals, schools, prisons).

- Civil Protection, Intelligence and Police Services, Public Competent Authorities: A prompt notice must be issued if the water utility is experiencing a waterborne

[7] https://www.iwa-network.org/filemanager-uploads/WQ_Compendium/Cases/Portugal%20Drinking%20Water.pdf

emergency with potential cascading effects to third entities. It also applies when the emergency is caused by flooding or treatment failure whose effect can impact the surrounding environment (i.e., groundwater pollution) and dependent supply chains (i.e., agriculture, livestock, etc.).

- Regulatory Agencies: they play an important role, especially when the emergency severity tends to turn into a catastrophic one. By notifiying regulatory agencies, ad-hoc support, such as local law enforcement, can be provided, facilitating the water utility in the prompt resolution and overcoming of the incident.

- The Media: notifying customers through newspaper, social media, radio, or television announcements may, in some cases, be the most efficient means of communication. The emergency response plan should include basic information for contacting the media, including phone numbers and contact persons. A single person in the water system should be authorized to make all public statements to the media.

Since users could be the first persons to make observation on water quality, it is important that they know how to contact the water system operator and related authorities. Establish a complaint procedure with the users so there are open lines of communication any time users have water quality concerns.

The following checklist can be used for establishing emergency communication, detailed further in the respective Annexes.

Table 7. Checklist for emergency communication and notification

6A – External entities to contact according to the severity of the event
6B – Emergency Notification List 6B.1 – System Identification 6B.2 – Notification/Contact Information 6B.2.1 – Local Notification List 6B.2.2 – Service/Repair Notification List 6B.2.3 – State Notification List 6B.2.4 – Media Notification List

2.3.2 Event management and operations

This phase deals with the immediate response in the event of a confirmed contamination, and helps develop procedures for responding to events that affect the drinking water, involving communication with the public and with local/national emergency authorities, as set out in Section 2.3.1, to ensure a safe drinking water supply.
The planning of the immediate response, including the identification of redundancy and alternative water supply, must be undertaken when the Water Security Plan is first established. As response time increases, monitoring becomes less relevant even with larger number of monitoring stations. It is of little use to invest heavily in a Continuous Water Quality Monitoring (CWQM) system if the utility does not know how to respond effectively to the alert the system has provided.

Water utility – initial evaluation

An initial evaluation must be made by the system owner or operator to make appropriate decisions on any actions that should be taken. The initial evaluation should include a review of:

- Physical evidence such as containers or material in the intrusion area.
- A quick check for chlorine residuals in all parts of system.
- A visual check of finished water as to turbidity, odour, colour, or pH.
- Intrusion or incident location in relation to critical system components such as finished water supply.
- Other items and areas relevant to the system operation and environment.

Actions can range from a determination that the incident is a prank with no action needed to implementing additional monitoring as a precautionary measure. If contamination is indicated, the water system may declare an emergency and implement its Emergency Response Plan.

Water utility – response actions

Most drinking water utilities have many employees involved in the operation of the system, working to a clear chain of command. The Water Security Plan should be clear about each employee's authority and responsibilities in an emergency. The plan should include:

- Emergency response actions requiring approval from a supervisor. For instance, if a chemical spill contaminates the source, the water system supervisor may want to make the decision regarding resuming normal operation of the system. The plan should clearly state that only the supervisor has the authority to make this decision.

- Emergency response actions each staff member can perform independently. For example, the plan states that the employee on duty has the authority to shut off water from the source if notified of real or potential contamination affecting the source. These situations will always have to be carried out in collaboration with the health authorities and validated by them.

Collaborative decision-making

Lines of authority and responsibility are not limited to local water systems with full-time staff. The water utility must make decisions as to what level of actions must be taken to perform due diligence in protecting the public health and provide a safe quality water supply. The water utility may need assistance in the evaluation process and in obtaining input as to the appropriate actions to take. This input is best obtained from those with complementary competences and expertise to work with in the decision-making process so as to:

- Do not disturb evidence and document what you see.
- Keep notes and take photos as you go.
- Collect samples for future analysis and store them appropriately.
- Alert other officials as appropriate and keep the public informed.
- Designate one spokesperson to deal with public communication.
- Use the expertise in public drinking water supplies and public health in the decision-making process.
- Preventative measures are the best practice to prevent such an incident.
- Prior communication with the local law enforcement authorities and local emergency response entities prevents confusion and defines who has responsibility for what and when an incident occurs.

These decisions must be made jointly to ensure public health protection and to avoid adverse effects. For example, a non-water person (person without expertise in water issues) may suggest that the system gets drained. This has ramifications in fire

protection and could impact the integrity, safety, quality and continuity of the water supply, among them. Technical assistance to support the implementation of preventive or remedial measures is available from regulators and other national authorities.

Prioritization of mitigation measures

After the risks associated with the contaminated system have been assessed, the possible actions to mitigate damage and improve security should be reviewed. To help prioritize the actions to be taken, the latest and most reliable information from the monitoring systems should be used. The following corrective actions should be considered as appropriate:

- Switching to an alternate drinking water source.
- Increasing sampling, tests, and analysis to determine the source of the contamination (i.e. disease-causing organisms).
- Repairing the filtration system.
- Repairing the drilling head seal.
- Repairing the storage tank.
- Restricting water intake from the river/lake/reservoir to prevent additional contamination from entering the water system.
- Restricting water use to emergencies.
- Etc…

<u>Isolating areas of the water system</u>

Operators should be prepared to isolate contaminated areas of the water system to prevent further spread. For example, if a chemical spill is approaching the drilling head, shutting off the drilling pump and closing a gate valve in the inlet line to the reservoir will protect the water in the reservoir from contamination. The Emergency Response Plan should clearly describe how to isolate the source, storage, and distribution components of the system, and should include maps and diagrams to indicate where switches and valves are located. Implementation and managing a GIS system will improve the efficiency and efficacy of this measure.

Public advisory and outreach

It is essential to make public health recommendations (e.g., boil water, or use bottled water) that should be applied after the contamination is confirmed (within 24 hours).

In particular, properly boiled water allows users to meet basic water requirements until microbiological problems are corrected and the water system returns to normal operation. A boil-water advisory is required when the water system has certain violations – E. coli/fecal coliform bacteria contamination or exceeding maximum turbidity levels – or is implicated in a waterborne disease outbreak. The boil-water advisory is part of the public notification for these violations.

The local health authorities may also require the issuance of a boil-water advisory in other situations that threaten the quality of the water. The public notification should be part of the emergency response plan. Since these violations are all potentially serious health risks, the public notification should be issued immediately as well as a plan for distributing, publishing, or posting the required public notice as quickly as possible.

Issuing a problem corrected notice

A copy of each type of notice and a certification that the water utility has met all the public notice requirements must be sent to the security and health authorities, as well as to the regulator, within 48 hours from the time the issue was noticed. It is recommended that health authorities notify health professionals in the area affected by the contamination, so that health professionals have the information they need to respond appropriately.

People may call their doctors with questions about how the situation may affect their health, and the doctors should have the information they need to respond appropriately.

In addition, health professionals, including dentists, use tap water during their procedures and need to know of contamination so they can use bottled water. It is a good idea to issue a 'problem corrected' notice when the contamination is solved.

The following checklist can be used to identify relevant event management and response options, further detailed in the respective Annexes.

Table 8. Checklist for event management and response

7A – Authority and Responsibility Form
7B – Drinking water warning form
7C – Prioritization of mitigation measures

2.4 Remediation, Recovery and Rehabilitation Measures

The remediation and rehabilitation process aims to minimize the exposure of the public to contaminated water, and will be determined after the contamination incident has been confirmed. Therefore, all remedial activities leading to the full return to the normal provision of uncontaminated drinking water should be identified, evaluated and implemented as soon as possible.

During the remediation, recovery and rehabilitation phase, the Rehabilitation Advisory Committee, health authorities, regulator, water samplers, laboratories, suppliers, environmental agency, civil protection, military authorities and local and/or national governments are the most relevant partners to facilitate the return to normality. During this phase, internal communication and with the public remains essential, and only official and trustworthy communications channels should be used.

Reporting activity
After approval of the remediation, recovery and rehabilitation plan by the Event Coordination Team or Rehabilitation Advisory Committee and the relevant government authorities, the plan should be executed accordingly. In each stage, the actions taken and the sampling tests results will be reported to the advisory committee and a decision to progress to the next stage will be taken accordingly. If problems arise and changes need to be made to the plan, additional approval by the advisory committee will be required.

The rehabilitation process will be carried out by the designated team in such a way as to compromise as little as possible the continuous supply of water throughout the system. All the activities should be documented in a report, which will be the basis for determining that the remediation goals were attained. The report should include:

- Description of the event;
- The pre- and post-remediation impact assessment surveys;
- The Rehabilitation Advisory Committee decisions;
- The remedial actions;
- The sampling tests results during the remediation process;
- The public notifications.

Post-monitoring and periodic controls
Post-remediation monitoring should be done to provide long-term assurance that the system can maintain normal operation and business continuity. The monitoring activities

may include periodic sampling and tests, periodic inspection and maintenance of the water distribution system components and treatment equipment as well as public communication of monitoring activities and results.

Final investigation will be done by the Rehabilitation Advisory Committee after the end of the remediation and final clean-up. It will include:

- Collecting additional water samples from previously contaminated areas as well as from adjoining non-contaminated areas according to the sampling and analysis plan;
- Perform field/laboratory tests and types according to the sampling and analysis plan;
- The human health and environmental safety use of the water network at the end of the process;
- The use of the water for various purposes:
  - Agriculture use, such as agricultural or gardening irrigation and livestock;
  - Industrial/institutional/commercial use, such as cooling towers, steam systems, food, drugs and cosmetics preparation, medical and dentist operations, dialysis and recreational water;
  - Home use, such as sanitation, laundering, cleaning, dish wash, washing, food preparation and drinking.

Termination of Emergency

The exit from an emergency situation will be the responsibility of the Emergency Event Manager who will decide, based on the information available, the moment of deactivation of the emergency plan, as well as the restoration of the normal operation of the water supply system.

The Emergency Event Manager is also responsible for ensuring the transfer of the coordination of all the actions developed during the event, or in development, to the respective functional areas, passing in this phase to the implementation of the measures to return to normality. After that, the final report should be produced which should include a clear evaluation of the causes that gave rise to the event, the actions taken, the control measures implemented, the indication of when, and on what basis, the return to normality was assumed, the public notifications during the remediation and recovery process, and what are the lessons learnt.

Treatability and disinfection

A contaminant treatability database provides referenced information on the control of contaminants in drinking water systems over regulated and unregulated contaminants, including contaminant properties to support the treatment[8] and clearance processes. In particular, water system disinfection uses relatively high levels of chlorine in the water to kill microorganisms that have contaminated the water system. Situations that require water system disinfection include flooding at a drilling head, water system repair, and a positive coliform (bacteria) test. Preparations should be made to disinfect the system by having the necessary equipment and procedures in place and data to calculate the amount of chlorine needed to disinfect the reservoir[9] before the water supply system can return to normal operation.

Moreover, definition of the amount of chlorine needed must be accompanied with a customer notification that a chemical disinfection to the water system will be run, so that customers use an alternate water source until notified that the system has resolved the microbiological contamination problem.

[8] https://tdb.epa.gov/tdb/home/
[9] https://www.publichealthontario.ca/en/health-topics/environmental-occupational-health/water-quality/chlorine-dilution-calculator

Furthermore, it is important to make sure the water system has the necessary fittings, and that the required equipment and tools are stored in a central location, such as the pump house. It is highly recommended that drinking water suppliers have portable disinfection equipment always in place that allows installing a disinfection process anywhere in the network, in case of necessity.

In some situations, it may be necessary to temporarily maintain a chlorine residual in the distribution system using an online chlorinator. Preparations should be made to do this by making prior arrangements with a local water system service vendor to install a chlorinator on an emergency basis.

Finally, appropriate protocols and procedures should be applied for the discharge of contaminated water, to be considered as integral part of the treatment process for drinking water decontamination.

Clearance process of decontamination
Clearance involves additional sampling and analysis throughout the contaminated areas of the distribution system to verify that clearance goals have been met. The regulators and public health agencies play a lead role in assessing whether the goals have been achieved and providing final clearance, but the decision could also include other stakeholders and subject matter experts such as the Rehabilitation Advisory Committee.

If the goals have not been met, adjustments to the security risk assessment may be necessary or additional decontamination activities may be required. If the clearance goals have been achieved, the system can return to service. As part of returning to service, the regulators and public health agencies may require a long-term monitoring programme to demonstrate that the contaminant concentration remains below the remedial goal.

Depending on the specifics of the incident, different sections of the system may be cleared at different times or the clearance may occur gradually, which allows different uses of the water (e.g., toilet flushing, bathing, consumption) at different stages in the clearance process. Laboratories and online real-time monitoring through sensors are very important to help dealing with this process, because the operators can control the process constantly on a daily basis operation and then request the necessary analysis to confirm the results, which makes the process of returning to normality more efficient and faster.

Table 9. Checklist for remediation, recovery and rehabilitation measures

8A – Rehabilitation advisory committee constitution
8B – Chlorine dosage calculator
8C – Materials and methods for rehabilitation of contaminated water systems
8D – Remediation, recovery and Rehabilitation Plan form 8D.1 – Disinfection procedure
8E – Certification of Completion

2.5 Review Planning and Dissemination

Regular revision of the WSecP forms an essential part of its lifecycle. Fortunately, the likelihood of a terrorist attack on water infrastructure remains comparatively low, albeit

the consequences could be very severe. It is nevertheless essential that the WSecP is constantly reviewed and updated so that the planned security and response measures, including the Emergency Response Plan, can be validated against actual events whenever possible, and the plan is kept operative and up to date.
Natural disasters and malevolent acts or terrorist activities can't be prevented, but the water utility must be prepared for them by providing a properly constructed and maintained Water Security Plan, which will reduce the risk of a waterborne disease outbreak.

Water system inspection
The WSecP should include an annual complete inspection of the water system infrastructure to:

- Identify and immediately correct any construction deficiencies.
- Eliminate – or reduce if not possible to eliminate - potential hazards to the system.
- Eliminate – or reduce if not possible to eliminate - potential vulnerabilities to the system.
- Ensure the system is receiving proper maintenance.

This part of the WSecP can be organized by looking at the water system from the starting point, the source, and following it through to the "end of the line" – the last connection, fixture, or hydrant in the distribution network.

<u>Water source check</u>
There are two basic types of sources – groundwater wells and surface water intakes.

- Identifying potential hazards: activities near the water source could create an emergency affecting the water. Examples of such activities are chemical storage and public roads (spill risk) among many others. Drinking water systems should maintain control of the area of the source and ensure this area is completely protected from hazards. Forbidding specific activities and substances close to the source, and restricting them in a wider area, is a recommended way to ensure this goal.

- Assessing system vulnerabilities: if wells and intake structures do not meet minimum construction standards and/or requirements, the entire water system may be at risk. Reviewing the most recent water system sanitary survey and immediately correcting any well or intake structure deficiencies is recommended. The public water system regulatory agency should be contacted, as needed. The provision of an alternative potable water supply for basic drinking, cooking, and sanitation needs should be considered.

<u>Water storage check</u>
Storage facilities for drinking water systems range from few cubic meters of storage to reservoirs holding millions of cubic meters of water.

- Identifying potential hazards: there should be a zone around all reservoirs controlled by the water system and free of any potential hazards to the integrity of the structure.

- Assessing system vulnerabilities: the most recent water system sanitary survey should be reviewed and any deficiencies immediately corrected. All storage facilities should have bypass plumbing in case they must be temporarily taken out of service. Larger reservoirs, in particular, should be evaluated against natural hazards which can make them highly vulnerable (earthquakes, landslides, extreme-weather events etc.).

Water distribution check

While not as visible as other parts of the water system, the distribution network may be the most vulnerable to damage and contamination. An accurate, complete map or schematic of the distribution system is essential, and a copy should be part of the WSecP, especially regarding isolating areas of the distribution system from contamination and use of the distribution system schematic.

- Identifying potential hazards: the distribution system should be protected by a strong cross-connection/redundancy programme to safeguard against accidental or deliberate backflow contamination.

- Assessing system vulnerabilities: larger distribution systems should have valves to isolate areas of the system, and the valves should be "exercised" once a year to ensure they are working. Hydrants or "blow-offs" are required on all dead-end lines to adequately flush the system after contamination, disinfection, or repair. The most recent water system sanitary survey should be reviewed and any deficiencies corrected.

As part of the annual review of the WSecP, backflow prevention devices should be tested as necessary. This part of the WSecP involves gathering and applying a significant amount of information. Furthermore, involvement of the public water system regulatory agency is recommended for assistance with the annual review of security risks, if needed.

The inclusion of lessons learned from past damaging or other security events, including terrorist incidents is a good practice to take into account as well as the consultancy of external experts to periodically evaluating the quality and completeness of the WSecP implemented. An annual review of the effectiveness of the security plan through cyclical security assessment activities is highly recommended, supported by scenario-based simulation tests, where applicable.

The Event Coordination Team should ensure the dissemination of the WSecP, on a need-to-know basis, to all the parties involved, including internal collaborators and external entities.

The WSecP should contain some criteria related to its dissemination also to new employees, for instance that new employees must be evaluated and vetted before being given access to the plan.

Table 10. Checklist for review and dissemination

9A – Review and dissemination form
9B – Annual System Risk Review 9B.1 – Annual System Threat Assessment 9B.2 – Annual System Vulnerability Assessment
9C – Certification of Completion

3 Conclusions

The WSecP is designed to assist water utilities in determining the level of security risk in the event of a contamination threat to the drinking water system. It aims to assist the utility in preparing appropriate decision-making and response actions in the shortest possible time and to minimize or eliminate losses and exposure of all consumers, including citizens, dependent services, industries, health professional service.

The WSecP plan should be an integral part of the water utility's routine operations. It is an ongoing element that should include regular inspection of the utility's facilities, a procedure that is best done alongside other operational tasks. For example, when the operator checks the stock of regular supplies, the operator should include an inventory of emergency supplies and equipment. Ongoing training of water utility staff should also include the actions outlined in the plan.

Implementation of the WSecP should be complementary to compliance with legal drinking water quality requirements, and with any existing water safety plan. The incorporation of security-driven measures into the daily operations of a water utility's system could also help to detect other safety issues or outbreaks of waterborne diseases as well as supply chain disruptions (e.g. shortage of key workers; shortage of key chemical supplies).

Specific actions should be undertaken in consultation with the security authorities and regulator. Technical assistance is normally available from state drinking water agencies or national water associations for prevention initiatives such as vulnerability assessments, emergency planning, and security enhancements.

The various steps and implementation actions recommended in this document can be adjusted to meet the needs of specific situations, such as small water utilities, and to comply with individual state requirements.

Decision-making for security purposes is a task that requires expertise from multiple actors to make sure all aspects are considered and properly addressed. Security decision-making should be a participatory process with a holistic approach for enhancing emergency preparedness, planning, event management and response, recovery and rehabilitation phases during the whole drinking water supply process, through the implementation of the WSecP.

In conclusion, the Water Security Plan must be kept active and updated periodically as necessary. Revised versions of the WSecP must be shared with staff and all stakeholders involved, on a need-to-know basis, immediately, ensuring all outdated copies of the plan are replaced.

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List of abbreviations

ATP	Adenosine Triphosphate
CB	Chemical-Biological agent
CBRN	Chemical, Biological, Radiological and Nuclear
CDLAS	Contamination Dissemination Look-Ahead Simulation Model
CDMS	Centralized Data Management System
CWQMS	Continuous Water Quality Monitoring System
CWS	Contamination Warning System
DWS	Drinking Water System
EDS	Event Detection System
EMS	Event Management System
ERNCIP	European Reference Network for Critical Infrastructure Protection
ERP	Emergency Response Plan
ESS	Enhanced Security System
GIS	Geographic Information System
IED	Improvised Explosive Device
OS	Online Sensors
RIDB	Risk Identification Database
RRMD	Risk Reduction Measure Database
SCADA	Supervisory Control and Data Acquisition
SIEM	Security Information and Event Management
TG	Thematic Group
WSecP	Water Security Plan

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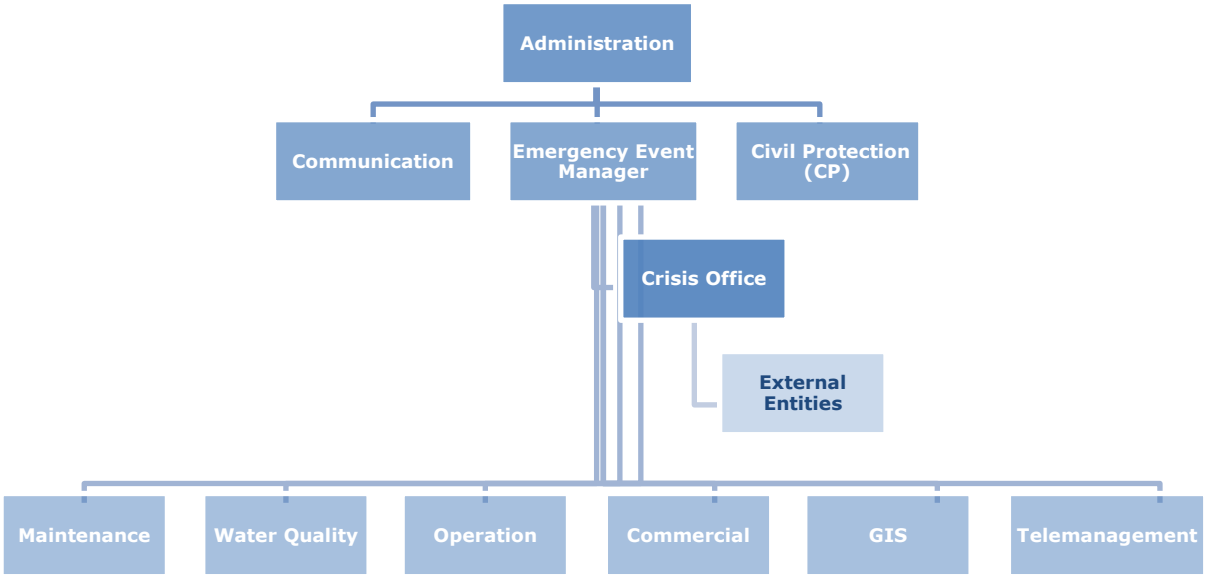
Annexes

1A – Organization chart of the event coordination team (source: Teixeira et al. 2019)



1B – Constitution of the coordination team according to the severity of the event (source: Teixeira et al. 2019)

Event severity	Emergency Event Manager	Crisis Office Coordinator
Minor event		
	Substitute:	Substitute:
Major event		
	Substitute:	Substitute:
Catastrophic event		
	Substitute:	Substitute:

1C – External entities identification, roles and responsibilities (source: Teixeira et al. 2019)

	Name	Function	Telephone	email	Roles & Responsibilities
Regulator					
Environmental agency					
Hospital					
Firefighters					

	Name	Function	Telephone	email	Roles & Responsibilities
Health authorities					
Intelligence services					
Civil protection					
Local governments					
Water samplers					
Military authorities					
Law enforcement authorities					
Academic community					
Main users/sensitive users					
Suppliers					
(…)					

1D – Appointment of assignments for a catastrophic event (source: Teixeira et al. 2019)

Role	Responsible for the assignment	Functions to be performed
Emergency Event manager		
Crisis Office coordinator		

Back to "Team building and partnerships"

2A – Security Vulnerability Self-Assessment (source: EPA 2002a)

2A.1 - Security Vulnerability Self-Assessment Completion

Name:	
Title:	

Area of Responsibility:			
Water System Name:			
Water System WSID:			
Address:			
City:			
County/Province:			
State/Region:			
Postal Code:			
Telephone:			
Fax:			
E-mail:			
Date Completed:			
Date Revised:		Signature:	
Date Revised:		Signature:	
Date Revised:		Signature:	
Date Revised:		Signature:	
Date Revised:		Signature:	

2A.2 - Inventory of Water System Critical Components

Component	Number & Location (if applicable)	Description
Source Water Type		
Ground Water		
Surface Water		
Purchased		
Treatment Plant		
Buildings		
Pumps		
Treatment Equipment (e.g., basin, clear drilling, filter)		
Process Controls		
Treatment Chemicals and Storage		
Laboratory Chemicals and Storage		
Storage		
Storage Tanks		

Component	Number & Location (if applicable)	Description
Pressure Tanks		
Power		
Primary Power		
Auxiliary Power		
Distribution System		
Pumps		
Pipes		
Valves		
Appurtenances (e.g., flush hydrants, backflow preventers, meters)		
Other Vulnerable Points		
Offices		
Buildings		
Computers		
Files		
Transportation/ Work Vehicles		
Communications		
Telephone		
Cell Phone		
Radio		
Computer Control Systems (SCADA)		

2A.3 - Questions for the Entire Water System

	Question	Answer	Comment	Action needed/taken

	Question	Answer	Comment	Action needed/taken
1.	Do you have a written emergency response plan (ERP)?	Yes ☐ No ☐	It is essential that you have an ERP. If you do not have an ERP, you can obtain a sample from your state drinking water primacy agency. As a first step in developing your ERP, you should develop your Emergency Contact List (see Annex 6B). A plan is vital in case there is an incident that requires immediate response. Your plan should be reviewed at least annually (or more frequently if necessary) to ensure it is up-to-date and addresses security emergencies. You should designate someone to be contacted in case of emergency regardless of the day of the week or time of day. This contact information should be kept up-to-date and made available to all water system personnel and local officials (if applicable). Share this ERP with police authorities, emergency personnel, and your regulator. Posting contact information is a good idea only if authorized personnel are the only ones seeing the information. These signs could pose a security risk if posted for public viewing since it gives people information that could be used against the system.	
2.	Is access to the critical components of the water system (i.e., a part of the physical infrastructure of the system that is essential for water flow and/or water quality) restricted to authorized personnel only?	Yes ☐ No ☐	You should restrict or limit access to the critical components of your water system to authorized personnel only. This is the first step in security enhancement for your water system. Consider the following: - Issue water system photo identification cards for employees and require them to be always displayed within the restricted area. - Post signs restricting entry to authorized personnel and ensure that assigned employees escort people without proper ID.	
3.	Are facilities fenced, including wellhouses and pump pits, and are gates locked where appropriate?	Yes ☐ No ☐	Ideally, all facilities should have a security fence around the perimeter. The fence perimeter should be walked periodically to check for breaches and maintenance needs. All gates should be locked with chains and a tamper-proof padlock that at a minimum protects the shank. Other barriers such as concrete "jersey" barriers should be considered to guard certain critical components from accidental or intentional vehicle intrusion.	

	Question	Answer	Comment	Action needed/taken
4.	Are your doors, windows, and other points of entry such as tank and roof hatches and vents kept closed and locked?	Yes ☐ No ☐	Lock all building doors and windows, hatches and vents, gates, and other points of entry to prevent access by unauthorized personnel. Check locks regularly. Dead bolt locks and lock guards provide a high level of security for the cost. A daily check of critical system components enhances security and ensures that an unauthorized entry has not taken place. Doors and hinges to critical facilities should be constructed of heavy-duty reinforced material. Hinges on all outside doors should be located on the inside. To limit access to water systems, all windows should be locked and reinforced with wire mesh or iron bars and bolted on the inside. Systems should ensure that this type of security meets with the requirements of any fire codes. Alarms can also be installed on windows, doors, and other points of entry.	
5.	Is there external lighting around the critical components of your water system?	Yes ☐ No ☐	Adequate lighting of the exterior of water systems' critical components is a good deterrent to unauthorized access and may result in the detection or deterrence of trespassers. Motion detectors that activate switches that turn lights on, or trigger alarms, also enhance security.	
6.	Are warning signs (tampering, unauthorized access, etc.) posted on all critical components of your water system? (For example, well houses and storage tanks.)	Yes ☐ No ☐	Warning signs are an effective means to deter unauthorized access. "Warning - Tampering with this facility is an offence punishable by law" should be posted on all water facilities. These are available from your local authorities. "Authorized Personnel Only", "Unauthorized Access Prohibited", and "Employees Only" are examples of other signs that may be useful.	
7.	Do you patrol and inspect your source intake, buildings, storage tanks, equipment, and other critical components?	Yes ☐ No ☐	Frequent and random patrolling of the water system by utility staff may discourage potential tampering. It may also help identify problems that may have arisen since the previous patrol. Consider asking your local police authorities to conduct patrols of your water system. Advise them of your critical components and explain why they are important.	
8.	Is the area around the critical components of your water system free of objects that may be used for breaking and entering?	Yes ☐ No ☐	When assessing the area around your water system's critical components, look for objects that could be used to gain entry (e.g., lighting or communications poles, large rocks, cement blocks, pieces of wood, ladders, valve keys, and other tools).	

	Question	Answer	Comment	Action needed/taken
9.	Are the entry points to your water system easily seen?	Yes ☐ No ☐	You should clear fence lines of all vegetation. Overhanging or nearby trees may also provide easy access. Avoid landscaping that will permit trespassers to hide or conduct unnoticed suspicious activities. Trim trees and shrubs to enhance the visibility of your water system's critical components. If possible, park vehicles and equipment in places where they do not block the view of your water system's critical components.	
10.	Do you have an alarm system that will detect unauthorized entry or attempted entry at critical components?	Yes ☐ No ☐	Consider installing an alarm system that notifies the proper authorities or your water system's designated contact for emergencies when there has been a breach of security. Inexpensive systems are available. An alarm system should be considered whenever possible for tanks, pump houses, and treatment facilities. You should also have an audible alarm at the site as a deterrent and to notify neighbours of a potential threat.	
11.	Do you have a key control and accountability policy?	Yes ☐ No ☐	Keep a record of locks and associated keys, and to whom the keys have been assigned. This record will facilitate lock replacement and key management (e.g., after employee turnover or loss of keys). Vehicle and building keys should be kept in a lockbox when not in use. You should have all keys stamped (engraved) "DO NOT DUPLICATE".	
12.	Are entry codes and keys limited to water system personnel only?	Yes ☐ No ☐	Suppliers and personnel from co-located organizations (e.g., organizations using your facility for telecommunications) should be denied access to codes and/or keys. Codes should be changed frequently if possible. Entry into any building should always be under the direct control of water system personnel.	
13.	Do you have a neighbourhood watch programme for your water system?	Yes ☐ No ☐	Watchful neighbours can be very helpful to a security programme. Make sure they know whom to call in the event of an emergency or suspicious activity.	

2A.4 - Water Sources

	Question	Answer	Comment	Action needed/taken
14.	Are your drillings heads sealed properly?	Yes ☐ No ☐	A properly sealed drillings head decreases the opportunity for the introduction of contaminants. If you are not sure whether your drillings head is properly sealed, repair with internal teams, contact your drilling maintenance company, or other technical assistance providers.	

15.	Are drillings vents and caps screened and securely attached?	Yes ☐ No ☐	Properly installed vents and caps can help prevent the introduction of a contaminant into the water supply. Ensure that vents and caps serve their purpose and cannot be easily breached or removed.	
16.	Are observation/test and abandoned drillings properly secured to prevent tampering?	Yes ☐ No ☐	All observation/test and abandoned drillings should be properly capped or secured to prevent the introduction of contaminants into the aquifer or water supply. Abandoned drillings should be either removed or filled with concrete.	
17.	Is your surface water source secured with fences or gates? Do water system personnel visit the source?	Yes ☐ No ☐	Surface water supplies present the greatest challenge to secure. Often, they encompass large land areas. Where areas cannot be secured, steps should be taken to initiate or increase patrols by water utility personnel and law enforcement agents.	

2A.5 - Treatment Plant and Suppliers

	Question	Answer	Comment	Action needed/taken
18.	Are deliveries of chemicals and other supplies made in the presence of water utility personnel?	Yes ☐ No ☐	Establish a policy that an authorized person, designated by the water utility, must accompany all deliveries. Verify the credentials of all drivers. This prevents unauthorized personnel from having access to the water system.	
19.	Have you discussed with your supplier(s) procedures to ensure the security of their products?	Yes ☐ No ☐	Verify that your suppliers take precautions to ensure that their products are not contaminated. Chain of custody procedures for delivery of chemicals should be reviewed. You should inspect chemicals and other supplies at the time of delivery to verify they are sealed and in unopened containers. Match all delivered goods with purchase orders to ensure that they were, in fact, ordered by your water system. You should keep a log or journal of deliveries. It should include the driver's name (taken from the driver's photo I.D.), date, time, material delivered, and the supplier's name.	
20.	Are chemicals, particularly those that are potentially hazardous or flammable, properly stored in a secure area?	Yes ☐ No ☐	All chemicals should be stored in an area designated for their storage only, and the area should be secure and access to the area restricted. Access to chemical storage should be available only to authorized employees. You should have tools and equipment on site (such as a fire extinguisher, dry sweep, etc.) to take immediate actions when responding to an emergency.	

	Question	Answer	Comment	Action needed/taken
21.	Do you monitor raw and treated water so that you can detect changes in water quality?	Yes ☐ No ☐	Monitoring of raw and treated water can establish a baseline that may allow you to know if there has been a contamination incident. Some parameters for raw water include pH, turbidity, total and fecal coliform, total organic carbon, specific conductivity, ultraviolet adsorption, colour, and odour. Routine parameters for finished water and distribution systems include free and total chlorine residual, heterotrophic plate count (HPC), total and fecal coliform, pH, specific conductivity, colour, taste, odour, and system pressure. Chlorine demand patterns can help you identify potential problems with your water. A sudden change in demand may be a good indicator of contamination in your system. For those systems that use chlorine, absence of a chlorine residual may indicate possible contamination. Chlorine residuals provide protection against bacterial and viral contamination that may enter the water supply.	
22.	Are tank ladders, access hatches, and entry points secured?	Yes ☐ No ☐	The use of tamper-proof padlocks at entry points (hatches, vents, and ladder enclosures) will reduce the potential for of unauthorized entry. If you have towers, consider putting physical barriers on the legs to prevent unauthorized climbing.	
23.	Are vents and overflow pipes properly protected with screens and/or grates?	Yes ☐ No ☐	Air vents and overflow pipes are direct conduits to the finished water in storage facilities. Secure all vents and overflow pipes with heavy-duty screens and/or grates.	
24.	Can you isolate the storage tank from the rest of the system?	Yes ☐ No ☐	A water system should be able to take its storage tank(s) out of operation or drain its storage tank(s) if there is a contamination problem or structural damage. Install shut-off or bypass valves to allow you to isolate the storage tank in the case of a contamination problem or structural damage. Consider installing a sampling tap on the storage tank outlet to test water in the tank for possible contamination.	

2A.6 - Distribution

	Question	Answer	Comment	Action needed/taken

	Question	Answer	Comment	Action needed/taken
25.	Do you control the use of hydrants and valves?	Yes ☐ No ☐	Your water system should have a policy that regulates the authorized use of hydrants for purposes other than fire protection. Require authorization and backflow devices if a hydrant is used for any purpose other than firefighting. Consider designating specific hydrants for use as filling station(s) with proper backflow prevention (e.g., to meet the needs of construction firms). Then, notify local authorities and the public that these are the only sites designated for this use. Flush hydrants should be kept locked to prevent contaminants from being introduced into the distribution system, and to prevent improper use.	
26.	Do you have installed in your system online sensors? Do you have systems to monitor the water quality and systems to detect, manage and to model da dissemination of contamination?	Yes ☐ No ☐	To be the best prepared possible for intentional water contamination, your system must have implanted a network of online sensors in the distribution network strategically located so that when any contamination occurs it can be detected as quickly as possible. Your system should also have event detection systems that help you deal with the huge volume of data produced and with the issue of false positives, being able to detect changes to the normal drinking water pattern, with good efficiency. Also, to help in the response and management of a contamination event, a system which models the spread of contamination and with event management system are highly recommended.	
27.	Do you have installed in your system an enhanced and integrated monitor system to detect and confirm an event of contamination?	Yes ☐ No ☐	Enhanced security system improves security of your system integrating all the information so that it is possible to detect with more certainty and more quickly a water contamination event. In order to complement the data coming from online sensors we can have tools that integrate consumer complaints, information coming from local and national health authorities, regulator, security authorities and also from haemodialysis clinics and hospitals for example, thus giving feedback of a syndromic surveillance.	
28.	Does your system monitor for, and maintain, positive pressure?	Yes ☐ No ☐	Positive pressure is essential for firefighting and for preventing back siphonage that may contaminate finished water in the distribution system. Refer to your authorities and regulator for minimum drinking water pressure requirements.	

	Question	Answer	Comment	Action needed/taken
29.	Has your system implemented a backflow prevention programme?	Yes ☐ No ☐	In addition to maintaining positive pressure, backflow prevention programmes provide an added margin of safety and security by helping to prevent the intentional introduction of contaminants. If you need information on backflow prevention programmes, contact your authorities and regulator.	

2A.7 - Personnel

	Question	Answer	Comment	Action needed/taken
30.	When hiring personnel, do you request that local police perform a criminal background check, and do you verify employment eligibility (as required by the authorities)?	Yes ☐ No ☐	It is a good practice to have all job candidates fill out an employment application. You should verify all professional references. Pay special attention to the gaps in the curriculum vitae. Background checks conducted during the hiring process may prevent potential employee-related security issues. If you use contract personnel, check on the personnel practices of all providers to ensure that their hiring practices are consistent with good security practices.	
31.	Are your personnel issued photo-identification cards?	Yes ☐ No ☐	For positive identification, all personnel should be issued water utility photo-identification cards and be required to always display them. Photo identification will also facilitate identification of authorized water utility personnel in the event of an emergency.	
32.	When terminating employment, do you require employees to give back photo IDs, keys, access codes, and other security-related items?	Yes ☐ No ☐	Former or disgruntled employees have knowledge about the operation of your water system and could have both the intent and physical capability to harm your system. Requiring employees who will no longer be working at your water system to give back their IDs, keys, and access codes helps limit these types of security breaches.	
33.	Do you use uniforms and vehicles with your water utility name prominently displayed?	Yes ☐ No ☐	Requiring personnel to wear uniforms and requiring that all vehicles prominently display the water utility name, helps to inform the public when water utility employees are working on the system. Any observed activity by personnel without uniforms should be regarded as suspicious. The public should be encouraged to report suspicious activity to law enforcement authorities.	
34.	Have water utility personnel been advised to report security vulnerability concerns and to report suspicious activity?	Yes ☐ No ☐	Your personnel should be trained and knowledgeable about security issues at your facility, what to look for, and how to report any suspicious events or activity. Periodic meetings of authorized personnel should be held to discuss security issues.	

	Question	Answer	Comment	Action needed/taken
35.	Do your personnel have a checklist to use for threats or suspicious calls or to report suspicious activity?	Yes ☐ No ☐	To properly document suspicious or threatening phone calls or reports of suspicious activity, a simple checklist can be used to record and report all pertinent information. Calls should be reported immediately to appropriate law enforcement officials. Checklists should be available at every telephone. Sample checklists are included in Annex 4A.2. Also consider installing caller ID on your telephone system to keep a record of incoming calls.	

2A.8 - Information Storage/Computers/Controls/Maps

	Question	Answer	Comment	Action needed/taken
36.	Is computer access "password protected?" Is virus protection installed and software upgraded regularly and are your virus definitions updated at least daily? Do you have Internet firewall software installed on your computer? Do you have a plan to back up your computers?	Yes ☐ No ☐	All computer access should be password protected. Passwords should be changed every 90 days and (as needed) following employee turnover. When possible, everyone should have a unique password that they do not share with others. If you have Internet access, a firewall protection program should be installed on your computer. Also consider contacting a virus protection company and subscribing to a virus update program to protect your records. Backing up computers regularly will help prevent the loss of data if your computer is damaged or breaks. Backup copies of computer data should be made routinely and stored at a secure off-site location.	
37.	Do you use appropriate and secured SCADA software? Do you use strong passwords and keep them secure?	Yes ☐ No ☐	It is very important to use appropriate SCADA software that allows a secure operation of your infrastructure. You must not use simple or obvious passwords and not put them near your computer accesses.	
38.	Do you have a SIEM system that monitors your information access?	Yes ☐ No ☐	It is very important to have SIEM platforms, which are platforms to event management and security information that centralize a set of activity records and allow their users to monitor the security of the infrastructure in real time, as well as, to automate the analysis process.	
39.	Is there any tool to trace computer activity and generate alarms?	Yes ☐ No ☐	Establish a system to trace computer activity by individuals and to generate alerts if something goes outside the usual usage patterns, either in terms of authorized users or in terms of inappropriate times.	

	Question	Answer	Comment	Action needed/taken
40.	Is there information on the Web that can be used to disrupt your system or contaminate your water?	Yes ☐ No ☐	Posting detailed information about your water system on a Web site may make the system more vulnerable to attack. Web sites should be examined to determine whether they contain critical information that should be removed. You should do a Web search (using a search engine) using key words related to your water supply to find any published data on the Web that is easily accessible by someone who may want to damage your water supply.	
41.	Are maps, records, and other information stored in a secure location?	Yes ☐ No ☐	Records, maps, and other information should be stored in a secure location when not in use. Access should be limited to authorized personnel only. You should make back-up copies of all data and sensitive documents. These should be stored in a secure off-site location on a regular basis.	
42.	Are copies of records, maps, and other sensitive information labelled confidential, and are all copies controlled and returned to the water system?	Yes ☐ No ☐	Sensitive documents (e.g., schematics, maps, and plans and specifications) distributed for construction projects or other uses should be recorded and recovered after use. You should discuss measures to safeguard your documents with bidders for new projects.	
43.	Are vehicles locked and always secured?	Yes ☐ No ☐	Vehicles are essential to any water system. They typically contain maps and other information about the operation of the water system. Water utility personnel should exercise caution to ensure that this information is secure. Water utility vehicles should be locked when they are not in use or left unattended. Remove any critical information about the system before parking vehicles for the night. Vehicles also usually contain tools (e.g., valve wrenches) that could be used to access critical components of your water system. These tools should be secured and accounted for daily.	

2A.9 - Public Relations

	Question	Answer	Comment	Action needed/taken

44.	Do you have a programme to educate and encourage the public to be vigilant and report suspicious activity to assist in the security protection of your water system?	Yes ☐ No ☐	Advise your customers and the public that your system has increased preventive security measures to protect the water supply from vandalism. Ask for their help. Provide customers with your telephone number and the telephone number of the local law enforcement authority so that they can report suspicious activities. The telephone number can be made available through direct mail, billing inserts, notices on community bulletin boards, flyers, and consumer confidence reports.	
45.	Does your water utility have a procedure to deal with public information requests, and to restrict distribution of sensitive information?	Yes ☐ No ☐	You should have a procedure for personnel to follow when you receive an inquiry about the water system or its operation from the press, customers, or the public. Your personnel should be advised not to speak to the media on behalf of the water utility. Only one person should be designated as the spokesperson for the water utility. Only that person should respond to media inquiries. You should establish a process for responding to inquiries from your customers and the public.	
46.	Do you have a procedure in place to receive notification of a suspected outbreak of a disease immediately after discovery by local health agencies?	Yes ☐ No ☐	It is critical to be able to receive information about suspected problems with the water at any time and respond to them quickly. Procedures should be developed in advance with your local authorities, local health agencies, and your local emergency planning committee.	

47.	Do you have a procedure in place to advise the community of contamination immediately after discovery?	Yes ☐ No ☐	As soon as possible after a disease outbreak, you should notify testing personnel and your laboratory of the incident. In outbreaks caused by microbial contaminants, it is critical to discover the type of contaminant and its method of transport (water, food, etc.). Active testing of your water supply will enable your laboratory, working in conjunction with health authorities, to determine if there are any unique (and possibly lethal) disease organisms in your water supply. It is critical to be able to get the word out to your customers as soon as possible after discovering a health hazard in your water supply. In addition to your responsibility to protect public health, you must also comply with the requirements of the Public Notification Rule. Some simple methods include announcements via radio or television, door-to-door notification, a phone tree, and posting notices in public places. The announcement should include accepted uses for the water and advice on where to obtain safe drinking water. Call large facilities that have large populations of people who might be particularly threatened by the outbreak: hospitals, nursing homes, the school district, jails, large public buildings, and large companies. Enlist the support of local emergency response personnel to assist in the effort.	
48.	Do you have a procedure in place to respond immediately to a customer complaint about a new taste, odour, colour, or other physical change (oily, filmy, burns on contact with skin)?	Yes ☐ No ☐	It is critical to be able to respond to and quickly identify potential water quality problems reported by customers. Procedures should be developed in advance to investigate and identify the cause of the problem, as well as to alert local health agencies, your local authorities, and your local emergency planning committee if you discover a problem.	

2B – Risk Assessment and Management Survey

	Question	Answer	Comment	Action needed/taken
1.	Has the characterization of the entire water system been made, including its mission and objectives?	Yes ☐ No ☐ Low ☐ Medium ☐ High ☐		
2.	Is there any potential threat to the water supply system? If so which ones?	Yes ☐ No ☐		

	Question	Answer	Comment	Action needed/taken
3.	Is there any possibility that these threats could materialize? How likely is it to materialize each of these threats (based on previous incidents, information from national authorities, etc.)?	Yes ☐ No ☐ Low ☐ Medium ☐ High ☐		
4.	Is there a potential impact from exploiting each of these vulnerabilities? If so, to what level?	Yes ☐ No ☐ Low ☐ Medium ☐ High ☐		
5.	Is the modus operandi defined as to how the most likely threats can be materialized (since they are the ones that must be addressed first)? If so, how?	Yes ☐ No ☐		
6.	Are there security issues that can be exploited by threat agents to materialize threats? If so, which ones?	Yes ☐ No ☐		
7.	Is it possible to collect additional water samples from a wider area according to the sampling and analysis plan?	Yes ☐ No ☐		
8.	Is it possible to carry out more field/laboratory tests and types according to the sampling and analysis plan?	Yes ☐ No ☐		
9.	Do you have an internal laboratory for sampling and analysis?	Yes ☐ No ☐		
10.	Is there any existing agreement with external laboratories for sampling and analysis?	Yes ☐ No ☐		
11.	Are there records of any event of possible sewage, flood or unusual industrial or agricultural activity that may have influenced water quality, etc.?	Yes ☐ No ☐		
12.	Is it possible to collect morbidity information?	Yes ☐ No ☐		
13.	Is it possible to collect information on the nature of the contamination? Type, concentration, toxicity, infectivity, health and environmental aspects, persistence/stability of the contaminant in the water system, degradation characteristics of the contaminant, solubility, volatility, aerosol production potential?	Yes ☐ No ☐		

	Question	Answer	Comment	Action needed/taken
14.	Is it possible to collect information on the composition of the water? Especially parameters that can impact treatment efficiency, such as turbidity or alkalinity?	Yes ☐ No ☐		
15.	Are protection and safety measures for rehabilitation teams guaranteed?	Yes ☐ No ☐		
16.	Is it possible to collect information on the limits of the contamination area, the volume of contaminated water and the direction of flow as determined by the CDLAS model to define the extent of corrective action? Was this information verified by tested water samples?	Yes ☐ No ☐		
17.	Is it possible to obtain information on the physical characterization of the part of the system where the contamination occurs (for example, the water source, treatment plant, distribution network)? For example, if it is a distribution network: is it possible to collect information on water demand, population size, diameters and types of pipes, hydraulic water devices, pressures, flows, sediments, public and important buildings, etc.?	Yes ☐ No ☐		
18.	Has a public health impact assessment been carried out?	Yes ☐ No ☐		
19.	Has an environmental impact assessment been carried out for the discharge of contaminated water into the sewage or drainage system?	Yes ☐ No ☐		

2C – Definition of potential scenarios of contamination Form

1. Water System Identification:

Name:
Address:
Telephone:
DWS Owner or Manager's Name

2. Risk assessment and management made by:

Date/Time:

☐ DWS ☐ Other: _____

☐ Intelligence service

3. Potential scenarios defined: **Date/Time:**

☐ Deliberate CBRN contamination against the water supply system - Direct contamination inserting CBRN materials into the water infrastructure by using insider access or knowledge

☐ Deliberate CBRN contamination against the water supply system - By adulteration of the chemical parameters used in the treatment plant and/or chlorination points facilities. This possibility could be attempted by intrusion, by internal agent or contracted supplier, and also by cyber-attack.

☐ Deliberate CBRN contamination against the water supply system - By direct contamination with CBRN materials at any point connected to the water supply network.

☐ Threat of attack (deliberate CBRN contamination) against the water supply system

☐ Attack with Improvised Explosive Device (IED) against the water supply infrastructures

☐ Armed attack against critical assets of the water supply system

☐ Other(s): _____

4. Validated By (Name, Address, and Telephone Number):

Date/Time:

5. Action(s) Taken Following scenarios validation:

_____
_____
_____
_____
_____

2D – Prioritization of needed actions (source: EPA 2002a)

Question number	Needed action	Scheduled completion

2E – Certification of Completion (source: EPA 2002a)

Certification of Completion			
Drinking Water System (DWS) ID:			
System Name:			
Address:			
Town/City:		**State/Province:**	
Postal Code:			
Telephone:		**Fax:**	
E-mail:			
Person Name:			
Title:			
Address:			

Town/City:		**State/Province:**	
Postal Code:			
Telephone:		**Fax:**	
E-mail:			
I certify that the information in this vulnerability assessment has been completed to the best of my knowledge and that the appropriate parties have been notified of the assessment and recommended steps to be taken to enhance the security of the water system. Furthermore, a copy of the completed assessment will be retained at the drinking water system, in a secure location, for state review as requested.			
Signed:		**Date:**	

Back to "Risk Assessment"

3A – Awareness-raising on threat characterization

	Question	Answer	Comment	Action needed/taken
1.	Does all your staff receive updated security awareness training?	Yes ☐ No ☐ Low ☐ Medium ☐ High ☐	Security awareness training is the base for the correct conception and implementation of an adequate security plan. It empowers your staff to actively participate in your security plan. Depending on the country and on the specific subjects covered, such awareness training may be performed by intelligence services, law enforcement authorities or regulator bodies.	
2.	Is your utility training staff in security procedures, such as handling hazardous materials and maintaining and using self-contained breathing apparatus)?	Yes ☐ No ☐ Low ☐ Medium ☐ High ☐		
3.	Is your equipment secure such as vehicles and spare parts?	Yes ☐ No ☐ Low ☐ Medium ☐ High ☐	Vehicles: Are the vehicles locked? Is there any register of people that use the cars? Equipment in between vehicles and spare parts: Is there any kind of restricted access to field equipment? Is there any kind of restricted access to consumables like chemicals? Is there any kind of registered chemical storages?	

	Question	Answer	Comment	Action needed/taken
4.	Are requests for potentially confidential information being monitored?	Yes ☐ No ☐ Low ☐ Medium ☐ High ☐		
5.	Are buildings, rooms, and storage areas secure that are not in regular use?	Yes ☐ No ☐ Low ☐ Medium ☐ High ☐	Are the buildings, rooms, and storage areas locked? Is there any kind of access system to them? Is there any register of people with access to them?	
6.	Is there a list of secure areas or facilities maintained and activity in those areas monitored?	Yes ☐ No ☐		
7.	Are all requests for tours of the facilities carefully analysed before approving? If allowed, are security measures implemented to include a list of names before the tour, requested to identify each participant before the tour? Are backpacks banned, cameras prohibited and are parking restrictions identified?	Yes ☐ No ☐ Low ☐ Medium ☐ High ☐		
8.	Does your organization inspect the interior and exterior of buildings in regular use daily for suspicious activity or packages, signs of tampering, or indications of unauthorized entry?	Yes ☐ No ☐ Low ☐ Medium ☐ High ☐		
9.	Are security procedures implemented in the mail room? Are post office guidelines followed?	Yes ☐ No ☐ Low ☐ Medium ☐ High ☐		

	Question	Answer	Comment	Action needed/taken
10.	Were visits interrupted and public access to all operational facilities prohibited?	Yes ☐ No ☐ Low ☐ Medium ☐ High ☐		
11.	Do you consider requesting greater surveillance by law enforcement, especially of critical assets and unprotected areas?	Yes ☐ No ☐		
12.	Do you assign security responsibilities to qualified individuals (e.g. with training certificates)?	Yes ☐ No ☐		
13.	Encourage staff to be alert to any signs of suspicious activity?	Yes ☐ No ☐	Risk perception is part of training programmes. It supports early warning starting from personnel.	
14.	Immediately investigate all information about suspicious activity and alert the intelligence services and police authorities when appropriate?	Yes ☐ No ☐		
15.	Do you report all suspicious activities or anomalies? Even if they lead to false alarms?	Yes ☐ No ☐		
16.	Conduct a daily check of the water system for signs of tampering or other unusual activity?	Yes ☐ No ☐		
17.	Do you establish procedures to restrict entry to authorized personnel, contractors, suppliers and visitors only – do you require proof of identity and check-in and check-out?	Yes ☐ No ☐		
18.	Do you restrict access to the necessary areas of the water system? Do you accompany visitors as needed?	Yes ☐ No ☐		
19.	Do you have concerns about security and authentication in the design, deployment, and operation of SCADA networks?	Yes ☐ No ☐		

3B – Prioritization of needed actions (source: EPA 2002a)

Question Number	Needed Action	Scheduled Completion

3C – Training and Exercises Form

1. Water System Identification: Name: Address: Telephone: DWS Owner or Manager's Name:				
2. Exercise Types:				
☐ Seminar ☐ Workshop ☐ Tabletop Exercise ☐ Drill		☐ Functional Exercise ☐ Full-Scale Exercise ☐ Other: _____		
3. Group: ☐ Discussion Based-Exercises ☐ Operation Based-Exercises				
4. Objective:				
☐ Raising-awareness ☐ Site Characterization and Sampling ☐ Utility Functional Exercise ☐ Communication and info sharing	☐ Governance ☐ Development ☐ Full-Scale Exercise ☐ Utility and Response Partner	☐ Orientation Training ☐ Laboratory Analysis ☐ Logistics and cooperation ☐ Client management	☐ Tabletop Exercise ☐ Remedial and rehabilitation implementation ☐ Business Continuity ☐ Team Building	☐ Online Monitoring (sensors) and/or EDS (software) ☐ Public Notification ☐ Other: _____
5. Description:				
6. Reported to:			**Date/Time:**	
7. Responsible:				
8. Action(s) Needed/Taken Following Exercise: _____ _____ _____ _____ _____				

Back to "Training programmes and exercises"

4A – Threat Identification Checklists (source: EPA 2002a)

4A.1 - Water System Telephone Threat Identification Checklist

1. Water System Identification:

Name:
Address:
Telephone:
DWS Owner or Manager's Name:

2. Types of Tampering/Threat:

☐ Nuclear contamination	☐ Threat to tamper
☐ Radiological contamination	☐ Biological contamination
☐ Bombs, explosives, etc.	☐ Chemical contamination
☐ Other (explain):	

3. Alternate Water Source Available: **If yes, give name and location:**

☐ Yes, _____ ☐ No

4. Location of Tampering:

☐ Distribution Line ☐ Other (explain):	☐ Water Storage Facilities	☐ Treatment Plant	☐ Raw Water Source	☐ Treatment Chemicals

5. Contaminant Source and Quantity:

6. Type of Contamination:

☐ Intentional ☐ Unintentional ☐ Unknown

7. Date and Time of Tampering/Threat:

8. Caller's Name/Alias, Address, and Telephone Number:

9. Is the Caller (check all that apply):

☐ Male	☐ Female	☐ Foul	☐ Illiterate	☐ Well Spoken	☐ Irrational	☐ Incoherent

10. Is the Caller's Voice (check all that apply):

☐ Soft ☐ Slurred ☐ Deep ☐ Old	☐ Calm ☐ Loud ☐ Nasal ☐ High	☐ Angry ☐ Laughing ☐ Clear ☐ Cracking	☐ Slow ☐ Crying ☐ Lisping ☐ Excited	☐ Rapid ☐ Normal ☐ Stuttering ☐ Young

☐ Familiar (who did it sound like?)

☐ Accented (which nationality or region?)

11. Is the Connection Clear? (Could it have been a wireless or cell phone?)	
12. Are There Background Noises?	
☐ Street noises (what kind?)	
☐ Machinery (what type?)	
☐ Voices (describe)	
☐ Children (describe)	
☐ Animals (what kind?)	
☐ Computer Keyboard, Office	
☐ Motors (describe)	
☐ Music (what kind?)	
☐ Other	
13. Call Received By (Name, Address, and Telephone Number): Date Call Received:	Time of Call:
14. Call Reported to:	Date/Time
15. Action(s) Taken Following Receipt of Call:	

4A.2 - Water System Report of Suspicious Activity

1. Water System Identification: Name: Address: Telephone: DWS Owner or Manager's Name:	
2. Types of Suspicious Activity:	
☐ Breach of physical security systems (e.g., lock cut, door forced open) ☐ Breach of cyber security systems (authorized / unauthorized user, number of login attempts, simultaneous login, brute force attack, etc.). ☐ Eavesdropping ☐ Denial of Service ☐ Manipulation ☐ Spoofing ☐ Destruction ☐ Unvalidated redirects and forwards ☐ Bypass login ☐ Compromise security via trojan malware ☐ Client-server protocol manipulation ☐ Session Fixation ☐ Cross Site Request Forgery ☐ SQL injection ☐ Buffer Overflow ☐ Relative Path Traversal	☐ Changes in water quality noticed by customers (e.g. change in colour, odour, taste) that were not planned or announced by the water system ☐ Unauthorized personnel on water system property. ☐ Suspicious activities performed by internal staff. ☐ Presence of personnel at the water system at unusual hours ☐ Other (explain):

3. Alternate Water Source Available: **If yes, give name and location:**

☐ Yes, _____ ☐ No

4. Location of Suspicious Activity:

☐ Distribution Line ☐ Other (explain): _____	☐ Water Storage Facilities	☐ Treatment Plant	☐ Raw Water Source	☐ Treatment Chemicals

5. If Breach of Security, what was the Nature of the Breach

☐ Lock was cut or broken, permitting unauthorized entry. Specify location:

_____

☐ Lock was tampered with, but not sufficiently to allow unauthorized entry. Specify location:

_____

☐ Door, gate, window, or any other point of entry (vent, hatch, etc.) was open and unsecured. Specify location:

_____

☐ Other. Specify nature and location:

_____

6. Unauthorized personnel on site?

Where were these people? Specify location:

_____

What made them suspicious?
☐ Not wearing water system uniforms
☐ Something else? (Specify): _____

What were they doing?

_____

7. Please describe these personnel (height, weight, hair colour, clothes, facial hair, any distinguishing marks):

8. Call Received by (Name, Address, and Telephone Number):

Date Call Received: Time of Call:

9. Call Reported to: Date/Time:

10. Action(s) Taken Following Receipt of Call: _____

4B – Record of anomalous occurrences in the water supply (source: Teixeira et al. 2019)

Potential Event indicator (anomalous situation)	Who identified the potential event	What caused the potential event	What was done	By whom	Perception as to the level of certainty

4C – Online monitoring and enhanced security form

1. Water System Identification:

Name:
Address:
Telephone:
DWS Owner or Manager's Name:

2. Online sensors for water quality CMS:

☐ Yes, since when: _____

☐ No

3. If yes, give location and number of sensors:

☐ Distribution Line N.: _____	☐ Water Storage Facilities N.: _____	☐ Treatment Plant N.: _____	☐ Raw Water Source N.: _____	☐ Treatment Chemicals N.: _____	☐ Other (explain): _____ N.: _____

4. Enhanced security:

☐ Event detect system ☐ GIS Mapping of water network	☐ Hydraulic model ☐ Contamination dissemination model	☐ Physical security ☐ Customers Complaints ☐ Laboratory support	☐ Syndromic surveillance ☐ Event management system ☐ Other: _____

5. Sampling probes provided by: **Date/Time:**

☐ DWS personnel

☐ Laboratory personnel

☐ Other: _____

6. Source of data:

☐ Online sensors monitoring results	☐ Laboratory analysis
☐ Rapid target and non-target analysis	☐ Data from syndromic surveillance
☐ Data from customers complaints	☐ Data from physical security
☐ Other: _____	

7. Confirmation of event contamination: Date/Time:

☐ Yes

☐ No

8. Reported to: Date/Time:

☐ Health Authorities

☐ Regulators

☐ Security Authorities

9. Action(s) Taken Following confirmation of an event of contamination:

_____
_____
_____
_____
_____

4D – Contaminated system survey

	Question	Answer	Comment	Action needed/taken
1.	Do you have information on water quality and operational data relevant to the event, for example, data from event detection systems?	Yes ☐ No ☐		
2.	Do you have known information about contamination, including results of field / laboratory tests already carried out?	Yes ☐ No ☐		
3.	Is the location of relevant sampling points known for future field / laboratory tests known?	Yes ☐ No ☐		
4.	Were there any special operational events such as pipeline rupture, maintenance work (in a treatment plant, reservoirs, or network), lack of water, which preceded the contamination event?	Yes ☐ No ☐		
5.	Was there a record of environmental problems caused by contamination?	Yes ☐ No ☐		
6.	Is it possible to obtain details of the water supply system, including water source, hydraulic information (flow rate and directions, pressure, reservoir level, etc.), reflux devices, etc.?	Yes ☐ No ☐		
7.	Is it possible to collect additional water samples from a wider area according to the sampling and analysis plan?	Yes ☐ No ☐		
8.	Is it possible to carry out more field/laboratory tests and types according to the sampling and analysis plan?	Yes ☐ No ☐		
9.	Are there records of any event of possible sewage, flood or unusual industrial or agricultural activity that may have influenced water quality, etc.?	Yes ☐ No ☐		
10.	Is it possible to collect morbidity information?	Yes ☐ No ☐		

	Question	Answer	Comment	Action needed/taken
11.	Is it possible to collect information on the nature of the contamination? Type, concentration, toxicity, infectivity, health and environmental aspects, persistence/stability of the contaminant in the water system, degradation characteristics of the contaminant, solubility, volatility, aerosol production potential?	Yes ☐ No ☐		
12.	Is it possible to collect information on the composition of the water? Especially parameters that can impact treatment efficiency, such as turbidity or alkalinity?	Yes ☐ No ☐		
13.	Are protection and safety measures for rehabilitation teams guaranteed?	Yes ☐ No ☐		
14.	Is it possible to collect information on the limits of the contamination area, the volume of contaminated water and the direction of flow as determined by the CDLAS model to define the extent of corrective action? Was this information verified by tested water samples?	Yes ☐ No ☐		
15.	Is it possible to obtain information on the physical characterization of the part of the system where the contamination occurs (for example, the water source, treatment plant, distribution network)? For example, if it is a distribution network: is it possible to collect information on water demand, population size, diameters and types of pipes, hydraulic water devices, pressures, flows, sediments, public and important buildings, etc.?	Yes ☐ No ☐		
16.	Has a public health impact assessment been carried out?	Yes ☐ No ☐		
17.	Has an environmental impact assessment been carried out for the discharge of contaminated water into the sewage or drainage system?	Yes ☐ No ☐		

4E – Impact assessment

	Question	Answer	Comment	Action needed/taken
1.	Are there any potential risks to human health? If so, what level?	Yes ☐ No ☐ Low ☐ Medium ☐ High ☐		

	Question	Answer	Comment	Action needed/taken
2.	Are there any potential risks to environmental? If so, what level?	Yes ☐ No ☐ Low ☐ Medium ☐ High ☐		
3.	Is it urgent to restore different levels of decontaminated water for various purposes (for example, just sanitation)?	Yes ☐ No ☐		
4.	Is there a danger for water consumers due to the level of disinfection / neutralization of the contaminant? If so, what level?	Yes ☐ No ☐ Low ☐ Medium ☐ High ☐		
5.	Are there risks to basic remediation teams? If so, what level?	Yes ☐ No ☐ Low ☐ Medium ☐ High ☐		
6.	Are there any weaknesses in the water supply system? If yes, what are your locations?	Yes ☐ No ☐ Locations: _____		

4F – Prioritization of needed actions (source: EPA 2002a)

Question Number	Needed Action	Scheduled Completion

Back to "Online monitoring systems"

5A – Site characterization and sampling form (source: EPA 2018)

Investigation Site	
Site Name:	**Additional Site Information:**
Site Address:	

Type of Facility:	☐ Source water ☐ Ground storage tank ☐ Tap ☐ Treatment plant ☐ Elevated storage tank ☐ Hydrant	☐ Pump station ☐ Finished water reservoir ☐ Service connection ☐ Water quality monitoring station ☐ Other: _____
Initial Information Known:	☐ Customer complaints ☐ Water quality anomaly ☐ Reported illnesses ☐ Security alert ☐ Other: _____	

Field Activities	
☐ Visual site hazard assessment ☐ Site safety screening ☐ Water quality parameter testing	☐ Rapid field testing ☐ Sample collection for laboratory analysis

Site Safety Screening

☐	Parameter	☐	Parameter

Water Quality Parameters

☐	Parameter	☐	Parameter

Rapid Field Testing

☐	Parameter	☐	Parameter

Sampling Plan

☐ Distribution main ☐ Service line ☐ Premise ☐ Other: _____	☐ Composite sample ☐ Grab sample ☐ Large volume sample collection without sub-sampling ☐ Large volume sample collection with sub-sampling ☐ Contaminant or class listed below ☐ Contaminant or class described in attached plan

☐	**Contaminant or Contaminant Class**	☐	**Contaminant or Contaminant Class**

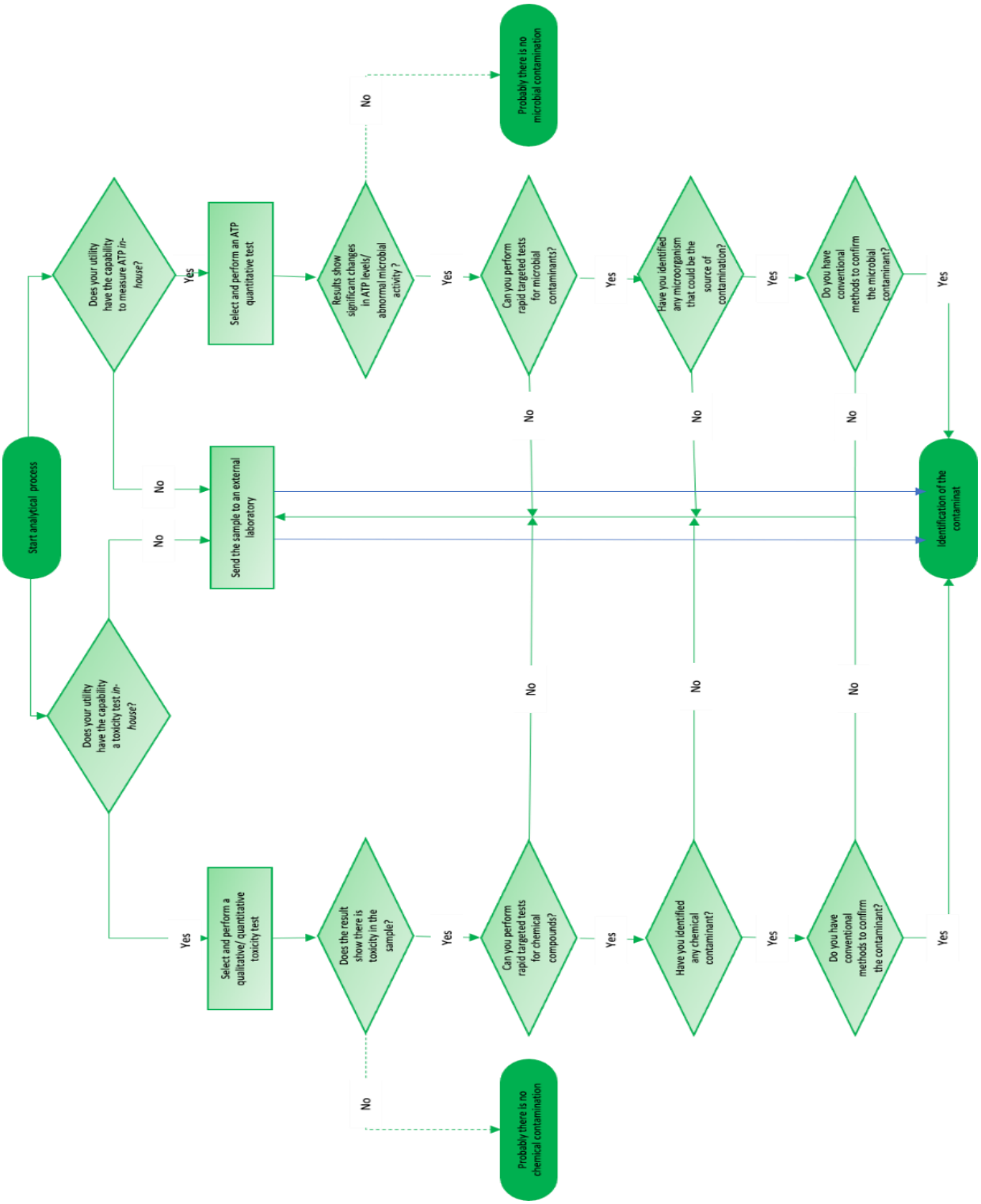
Sample Delivery:	☐ Return samples to utility ☐ Ship samples to pre-arranged laboratories ☐ Recipient listed below
Name:	
Address:	

Phone No.:		
Field Response Personnel		
Utility	☐Site Characterization Team:_____ ☐Water quality technician:_____ ☐Field samplers:_____ ☐Security officer:_____ ☐Distribution system operator:_____ ☐Other: _____	
Participating Agencies	☐ Local law enforcement ☐ Fire department ☐ Civil Support Team ☐ Primacy Agency ☐ Other: _____	**Participating Agency will:** ☐Deploy with utility personnel ☐Meet at location site at (specify time)
Communications		
Mode of Communication:	☐Phone ☐2-way radio ☐Digital ☐Other: _____	
Reporting Events:	☐Upon arrival at site ☐During approach ☐Site entry	☐Site exit ☐After field testing ☐Other: _____
Report To: **Phone No.:**		
Health and Safety		
Health and Safety Plan:	☐Reviewed ☐Modified If modified, describe:_____	

☐	**Personal Protective Equipment**	☐	**Personal Protective Equipment**

Approvals	
Health and Safety Officer	Name (PRINT): Signature: Date:
Utility Manager or Incident Commander	Name (PRINT): Signature: Date:

5B – Identification of the contaminant



5C – Prioritization of needed actions (source: EPA 2002a)

Question Number	Needed Action	Scheduled Completion

Back to "Bio-chemical detection systems"

6A – External entities to contact according to the severity of the event (source: Teixeira et al. 2019)

Event Severity	Authorities (Responsible person/Substitute)	Other Entities	Users	Social Communication
Minor				
Major				
Catastrophic				

6B – Emergency Notification List (source: EPA 2002a)

6B.1 - System Identification

Drinking Water System (DWS) ID Number		
System Name		
Town/City		
Telephone Numbers	System Telephone	Evening/Weekend Telephone
Other Contact Information	System Fax	Email
Population Served and Number of Service Connections	People Served	Connections
System Owner (The owner must be listed as a person's name)		
Name, title, and telephone number of person responsible for maintaining this emergency contact list	Name and title	Telephone

6B.2 - Notification/Contact Information

6B.2.1 - Local Notification List

	Contact name/title	Telephone (day)	Telephone (night)	Email
Fire Fighters				
Police authorities				
Intelligence services				
Health authorities				
Regulator				
Local Hospital				
Local Emergency Civil Protection				
EMS				
Local Pharmacy				
Local Nursing Homes				
Local Schools				
Local Prisons				
Local Government				
Local Hazmat Team				
Water System Operator				
Neighbouring Drinking Water System				
Neighbouring Drinking Water System				
Other				

6B.2.2 - Service/Repair Notification List

	Contact name/title	Telephone (day)	Telephone (night)	Email
Electrician				
Electric Utility Company				
Gas Utility Company				

	Contact name/title	Telephone (day)	Telephone (night)	Email
Sewer Utility Company				
Alternate water suppliers				
Plumber				
Pump Specialist				
"Dig Safe" or local equivalent				
Soil Excavator/Backhoe Operator				
Equipment Rental (Power Generators)				
Equipment Rental (Chlorinators)				
Equipment/supplies vendors				
Equipment Rental (Portable Fencing)				
Equipment Repairman				
Radio/Telemetry Repair Service				
Bottled Water Source				
Bulk Water Hauler				
Pump Supplier				
Drillings Drillers				
Pipe Supplier				
Chemical Supplier				
Local/Regional/National Analytical Laboratory				

6B.2.3 - State Notification List

	Contact name/title	Telephone (day)	Telephone (night)	Email
Regulators				
Environmental Protection authorities				
Health authorities				
Intelligence Service				

	Contact name/title	Telephone (day)	Telephone (night)	Email
Security authorities				
Emergency Civil Protection				
Hazmat Hotline				
Other…				

6B.2.4 - Media Notification List

Organization	Contact name/title	Telephone (day)	Telephone (night)	Email
Designated Water System Spokesperson				
Newspaper - Local				
Newspaper – Regional/National				
Radio				
Radio				
Radio				
Television				
Television				
Television				
Other…				

Back to "Emergency Communication and Notification"

7A – Authority and Responsibility Form (source: Oregon Health Authority 2002)

1. Water System Authority and Responsibility: Name: Position: Telephone (on duty): Telephone (in emergency):
2. Actions to be taken independently in an emergency:

1. _____
2. _____
3. _____
4. _____
5. _____

3. Actions which require approval (by the hierarchy):

1. _____
2. _____
3. _____
4. _____
5. _____

4. Water system chain of command:

Name:

Position:

Emergency Phone:

Name:

Position:

Emergency Phone:

7B – Drinking water warning form (source: Oregon Health Authority 2002)

1. Actions to be taken in case of (unknown) contamination in the water supply:

☐ DO NOT DRINK WATER WITHOUT BOILING IT FIRST. Bring all water to a boil, let it boil for at least five minutes, and let it cool before using, or use bottled water. Boiled or bottled water should be used for drinking, making ice, brushing teeth, washing dishes, and food preparation until further notice. Boiling kills bacteria and other organisms in the water.

☐ DO NOT DRINK WATER. Using Boiled water is not an alternative because water vapour and skin contact can cause risks. Bottled water or other alternative source of water should be used for drinking, making ice, brushing teeth, washing dishes, and food preparation until further notice. It is important to mention that in any case the consumer should not use water from an untreated water source like private water wells or boreholes or water fountains.

☐ DO NOT USE WATER. Using Boiled water is not an alternative because water vapour and skin contact can cause risks and/or if treatment is not possible at the moment. Bottled water or other alternative source of water should be used for everything until further notice.

2. Observations and notes (i.e. symptoms, special health effects, people at risk, etc.):

1. _____
2. _____
3. _____
4. _____
5. _____

3. Corrective actions being implemented. Provide the description:

1. _____
2. _____
3. _____
4. _____
5. _____

4. Water system point of contact for information-sharing and guidelines:
Name: Phone: Email:
This notice is being sent to: _____ Drinking Water System (DWS) ID: _____ Date distributed: _____

7C – Prioritization of mitigation measures (source: EPA 2002a)

Question Number	Needed Action	Scheduled Completion

Back to "Event Management and Operations"

8A – Rehabilitation advisory committee constitution

Utility team/Advisory committee	Name	Function	Telephone	email	Roles & Responsibilities

8B – Chlorine dosage calculator (adapted from: Oregon Health Authority 2002)

DESIRED PPM	1	1	1	1	5	5	5	5	25	25	25	25
STRENGTH OF CHLORINE SOLUTION	5%	25%	70%	100%	5%	25%	70%	100%	5%	25%	70%	100%
NUMBER OF LITRES TO BE CHLORINATED												
200	3,8 L.	0,8 L.	0,3 L.	0,2 L.	18,9 L.	4,0 L.	1,4 L.	0,8 L.	94,6 L.	19,1 L.	7,1 L.	4,9 L.
100	1,9 L.	0,4 L.	0,15 L.	0,10 L.	9,5 L.	2,0 L.	0,7 L.	0,5 L.	47,3 L.	9,5 L.	3,5 L.	2,5 L.
40	0,7 L.	0,2 L.	0,06 L.	0,04 L.	3,8 L.	0,8 L.	0,3 L.	0,2 L.	18,9 L.	4,0 L.	1,4 L.	1,0 L.
20	0,4 L.	0,1 L.	0,03 L.	0,02 L.	1,9 L.	0,4 L.	0,1 L.	0,1 L.	9,5 L.	2,0 L.	0,7 L.	0,5 L.
10	0,15 L.	0,03 L.	0,012 L.	0,009 L.	0,77 L.	0,18 L.	0,06 L.	0,04 L.	3,8 L.	0,8 L.	0,3 L.	0,2 L.
5	0,07 L.	0,02 L.	0,006 L.	0,006 L.	0,38 L.	0,09 L.	0,03 L.	0,02 L.	1,9 L.	0,4 L.	0,15 L.	0,1 L.
2000	0,04 L.	0,01 L.	0,003 L.		0,19 L.	0,04 L.	0,01 L.	0,01 L.	0,9 L.	0,2 L.	0,07 L.	0,05 L.
750	0,015 L.	0,003 L.			0,074 L.	0,018 L.	0,006 L.	0,006 L.	0,4 L.	0,1 L.	0,03 L.	0,02 L.
400	0,009 L.				0,038 L.	0,009 L.	0,003 L.	0,003 L.	0,02 L.	0,04 L.	0,015 L.	0,01 L.
200	0,003 L.				0,018 L.	0,006 L.			0,01 L.	0,02 L.	0,009 L.	0,006 L.
100					0,009 L.	0,003 L.			0,006 L.	0,01 L.	0,003 L.	0,003 L.
40					0,006 L.				0,003 L.	0,006 L.		
20					0,003 L.					0,003 L.		

DESIRED PPM	50	50	50	50	100	100	100	100	200	200	200	200
STRENGTH OF CHLORINE SOLUTION	5%	25%	70%	100%	5%	25%	70%	100%	5%	25%	70%	100%
NUMBER OF LITRES TO BE CHLORINATED												
200	189,3 L.	38,1 L.	14,2 L.	9,9 L.	378,5 L.	76,7 L.	27,2 L.	19,8 L.	757,1 L.	151,5 L.	54,0 L.	37,6 L.
100	94,6 L.	19,1 L.	7,1 L.	4,9 L.	189,3 L.	38,1 L.	13,6 L.	9,9 L.	378,5 L.	76,7 L.	27,2 L.	19,1 L.
40	37,9 L.	7,9 L.	3,8 L.	2,0 L.	75,7 L.	15,0 L.	5,4 L.	4,0 L.	151,4 L.	31,3 L.	11,3 L.	7,9 L.
20	18,9 L.	4,0 L.	1,4 L.	1,0 L.	37,9 L.	8,8 L.	2,7 L.	2,0 L.	75,7 L.	15,4 L.	5,6 L.	4,0 L.
10	7,6 L.	1,6 L.	0,6 L.	0,4 L.	15,1 L.	3,2 L.	1,2 L.	0,8 L.	30,3 L.	6,3 L.	2,2 L.	1,6 L.
5	3,8 L.	0,8 L.	0,3 L.	0,2 L.	7,6 L.	1,6 L.	0,6 L.	0,4 L.	15,1 L.	3,2 L.	1,1 L.	0,8 L.
2000	1,9 L.	0,4 L.	0,1 L.	0,1 L.	3,8 L.	0,8 L.	0,3 L.	0,2 L.	7,6 L.	1,6 L.	0,6 L.	0,4 L.
750	0,8 L.	0,2 L.	0,06 L.	0,04 L.	1,5 L.	0,3 L.	0,1 L.	0,08 L.	3,0 L.	0,7 L.	0,2 L.	0,2 L.
400	0,4 L.	0,08 L.	0,03 L.	0,02 L.	0,8 L.	0,16 L.	0,06 L.	0,04 L.	1,5 L.	0,3 L.	0,1 L.	0,08 L.
200	0,2 L.	0,04 L.	0,01 L.	0,01 L.	0,4 L.	0,08 L.	0,03 L.	0,02 L.	0,8 L.	0,16 L.	0,06 L.	0,04 L.
100	0,1 L.	0,02 L.	0,009 L.	0,006 L.	0,2 L.	0,04 L.	0,015 L.	0,012 L.	0,4 L.	0,08 L.	0,03 L.	0,02 L.
40	0,04 L.	0,01 L.	0,006 L.	0,003 L.	0,08 L.	0,02 L.	0,006 L.	0,006 L.	0,15 L.	0,03 L.	0,01 L.	0,01 L.
20	0,02 L.	0,01 L.	0,003 L.		0,04 L.	0,01 L.	0,003 L.	0,003 L.	0,08 L.	0,02 L.	0,006 L.	0,006 L.

8C – Materials and methods for rehabilitation of contaminated water systems (source: EPA 2003; Ministry of Health Israel 2016)

Material/Method	Materials examples*	Treatment target	Recommendations*	Test for cleaning the contaminant
WASHING				
Washing with large volume of water		* Hydrophilic water-soluble materials * Light microbial contamination	* Change several water volumes * Flow velocities according to the structure and diameter of the pipe * High flow will cause turbulent flow in the side of the pipe	
Washing with high pressure and pressurized air		* Hydrophilic water-soluble materials * Heavy microbial contamination * Biofilm removal		
Washing with pressurized steam (Reservoirs)		* Greasy materials * Heavy microbial contamination * Biofilm removal	Steam in the exit of the machine: 80-100˚C, 150-200 bar. Spraying distance: 30 cm.	
CHEMICAL NEUTRALIZATION				
Chlorine solution		* Microbial contamination * Biofilm removal * Neutralization of major part of the chemical's materials	Chlorine -> 18,000 mg/L.	Free chlorine measurements
Chlorine dioxide	Twin oxide			Chlorine dioxide measurements
Washing with high pH - with Caustic soda Washing with low pH - with acid		* Hydrophobic materials including organic solvents and surfactants	* Use carefully * May damage pipeline parts	pH measurements
Detergents	PL4	* Hydrophobic materials * Biofilm removal * Pesticides * Organic Microcontaminants * Petrol products	* Materials is inserted with the water * The examples materials are environment friendly * After the treatment the materials should totally washed out of the system * Beware the appearance of foam and typical smell and taste	pH measurements
	Sulfonic TDA-6			Laboratory test
	Simple green			
	Perform LF			pH measurements
Potassium Permanganate		* Good oxidant for metal contaminants	* Washed well with dissolved material	
Ozonation		* Microbial contamination	* Unstable disinfectant and disappear quickly from the system - according to the literature	
activated carbon filtration				
activated alumina				
ultraviolet disinfection				
MECHANICAL METHODS				

Hard pigs	Threading to the inside of the pipe with the water flow and physical cleaning of the contaminant from the inner side of the pipe
Ice pig	
Sand wash (reservoirs)	
New sleeve	Threading to the inside of the pipe
Pipeline replacement	
Air stripping	
Air scouring	
Lining and coating with cement	
Epoxy resins or tubing	
Sand filtration	

*According to the event and by the internal team or advisory committee

8D – Remediation, Recovery and Rehabilitation Plan form (source: Teixeira et al. 2019)

1. Technology Category: ☐ Containment technologies ☐ Extraction/removal technologies ☐ Treatment technologies		☐ Natural attenuation ☐ No further action ☐ Other (explain): _____		
2. Utility ID: Name: Address: Telephone: Water Utility Manager's Name:		**3. Rehabilitation Utility team or Advisory Committee Manager:** Name: Address: Telephone: Water Utility/Entity:		
4. Alternate Water Source Available: ☐ No ☐ Yes, specify: _____ **If yes, give name and location: _____**				
5. Location of Contamination:				
☐ Distribution Line (attached marked map) ☐ Other (explain): _____	☐ Water storage facilities	☐ Treatment Plant	☐ Raw Water Source	☐ Treatment Chemicals

6. Contaminant Source (Type and origin) and Quantity (estimated):

7. Date and Time range of Contamination:

8. Location for drainage, when possible, or special evacuation (define the sewage and drainage systems that may be necessary for flushing water pipes, or alternative solution to empty the water from the pipelines):

_____

_____

_____

9. Alternatives for the rehabilitation of the system components (see Annex 8C):

☐ Chemical Neutralization	☐ Washing	☐ Mechanical methods	☐ Other: _____

10. Describe the materials, methods and equipment used for rehabilitation of the water system (see Annex 8C):

☐ Materials: _____

☐ Methods: _____

☐ Equipment: _____

11. Rehabilitation technologies for treatment/disinfection of system components (see Annex 8C):

Chemical Neutralization:

☐ chlorination	☐ Detergents
☐ Washing with high pH - with Caustic soda	☐ Potassium Permanganate
☐ Washing with low pH - with acid	☐ Ozonation
☐ activated alumina	☐ ultraviolet disinfection
☐ activated carbon filtration	☐ Other: _____

Washing:

☐ Washing with large volume of water	☐ Washing with pressurized steam (Reservoirs)
☐ Washing with high pressure and pressurized air	☐ Other: _____

Mechanical methods:

☐ Hard pigs	☐ air scouring
☐ Ice pig	☐ lining and coating with cement
☐ Sand wash (reservoirs)	☐ epoxy resins or tubing
☐ New sleeve	☐ air stripping
☐ Pipeline replacement	☐ Other: _____
☐ Sand filtration	

12. Rehabilitation By (Name, Address, and Telephone Number):

Date of Rehabilitation:
Time of Rehabilitation:

13. Rehabilitation reported to: **by:**

Date/Time:

14. Action(s) Taken Following Rehabilitation process

☐ Online monitoring results	☐ Laboratory analysis
☐ Location of relevant sampling points for:	☐ Other: _____
☐ Rapid target and non-target analysis	

15. Public Notifications

1. Main of the notice_____ By: _____ Date/Time:
2. Main of the notice_____ By: _____ Date/Time:
3. Main of the notice_____ By: _____ Date/Time:

16. Rehabilitation Validated by:

☐ Advisory Committee Date/Time:
☐ Health Authorities Date/Time:
☐ Regulators Date/Time:
☐ Environmental Authorities Date/Time:

17. Return to normality:

☐ Yes Date/Time:

☐ No _____

8D.1 - Disinfection procedure

1. Water System Identification:

Name:
Address:
Telephone:
DWS Owner or Manager's Name:

2. Disinfection procedure being implemented:

☐ Yes, since when: _____

☐ No

3. If yes, provide further details:

Location:

Type of solution:

4. Sampling analysis:

Date:
Frequency:
Location:
Modality:

5. Sampling probes provided by: **Date/Time:**

☐ DWS personnel

☐ Laboratory personnel

☐ Other: _____

6. Sampling test results:

☐ Successful (absent coliform bacteria)

☐ Not successful, provide the reason: _____

☐ Other: _____

Date/Time:

7. Sampling findings reported to: Date/Time:

☐ Health Authorities

☐ Regulators

☐ Security Authorities

☐ Customers

8. Action(s) to be taken following confirmation of contamination (e.g. amount of chlorine solution needed):

1. _____
2. _____
3. _____
4. _____
5. _____

9. Repetition scheduled for further sampling test/disinfection:

Date/Time:

Location:

Provider:

8E – Certification of Completion (source: EPA 2002a)

Drinking Water System (DWS) ID			
Subsystem Name:			
Address:			
Town/City:		**State/Province:**	
Postal Code:			
Telephone:		**Fax:**	
E-mail:			
Manager Name of Internal Team or Advisory Board Committee			
Person Name:			
Title:			
Address:			
Town/City:		**State/Province:**	
Postal Code:			
Telephone:		**Fax:**	
E-mail:			
I certify that rehabilitation process has been completed to the best of my knowledge and that the appropriate parties have been notified of the results on the water system. Furthermore, a copy of the completed rehabilitation process will be retained at the water utility, in a secure location, for authorities review as requested, attesting that it does not present any risk to public health and for that the system can return to normality.			
Representative of Health Authorities			
Signed:		**Date:**	
Representative of Environmental Authorities			

Signed:		**Date:**	
Representative of Regulator			
Signed:		**Date:**	

Back to "Remediation, recovery and rehabilitation measures"

9A – Review and dissemination form

1. Water System Identification:

Name:
Address:
Telephone:
PWS Owner or Manager's Name:

2. Motives for Revision:

☐ Any emergency occurs	☐ significant change in the laboratory tests
☐ significant change in the water supply system	☐ significant change in the field methods
☐ significant change in the Water Quality Monitoring (CWQM) system	☐ significant change in the laboratory methods
☐ significant change in the field tests	☐ possibility of improvement of the plan
☐ Annually review	☐ Other: _____

3. Revision reported to: **Date/Time:**

☐ Health Authorities

☐ Regulators

☐ Security authorities

4. Action(s) Taken Following Revision process:

_____
_____
_____
_____
_____

5. Revision Validated by:

☐ Health Authorities Date/Time:

☐ Regulators Date/Time:

☐ Security authorities Date/Time:

6. Disseminated to:

☐ internal collaborators Date/Time:

☐ external entities

☐ Others: _____

9B – Annual System Risk Review (source: Oregon Health Authority 2002)

9B.1 - Annual System Threat Assessment

Drinking water system name _____

DWS #ID _____

Date of review _____

Reviewed by: _____

SOURCE	Yes	No	Comments	Initials
Uncorrected sanitary survey deficiencies	☐	☐		
Minimum area for control zone	☐	☐		
Chemical storage within certain area	☐	☐		
Pesticide application within certain area	☐	☐		
Sewage system within certain area	☐	☐		
Fuel tanks within certain area	☐	☐		
Animal grazing/housing	☐	☐		
Risk of flooding	☐	☐		
Roads/driveways	☐	☐		
Solid waste storage/disposal	☐	☐		
Earthquake vulnerability	☐	☐		
RESERVOIRS (WATER STORAGE TANKS)				
Uncorrected sanitary survey deficiencies	☐	☐		
Zone of control around reservoir	☐	☐		
Earthquake vulnerability	☐	☐		
DISTRIBUTION SYSTEM				
Uncorrected sanitary survey deficiencies	☐	☐		
Adequate valving provided	☐	☐		
Valves exercised annually	☐	☐		
Blow offs/hydrants provided	☐	☐		
Blow offs/hydrants exercised	☐	☐		
Cross-connection programme current	☐	☐		

9B.2 - Annual System Vulnerability Assessment

System name_____**DWS ID**:_____

Date of review _____

Assessment by_____

Drilling/spring/intake protective structures, pumphouses, offices, treatment plants

	Yes	No	Comments	Initials
Locks on all doors	☐	☐		
All windows secured	☐	☐		
Adequate alarms, motion sensors,	☐	☐		
video cameras	☐	☐		
Adequate security lighting	☐	☐		
Entry restricted to authorized personnel	☐	☐		

"Employee only" signs posted	☐	☐ _____
RESERVOIRS		
Locked gate	☐	☐ _____
Ladder guard locked	☐	☐ _____
Access hatches locked	☐	☐ _____
Adequate security lighting	☐	☐ _____
"Employee only" signs posted	☐	☐ _____
DISTRIBUTION SYSTEM		
Manholes, hydrants, and other access points secured	☐	☐ _____
PROCEDURES		
All facilities locked and alarms set during prescribed times	☐	☐ _____
Background checks before hiring employees	☐	☐ _____
Employees regularly trained/drilled regarding security programme	☐	☐ _____
Access restricted to authorized persons	☐	☐ _____
Visitors and contractors checking in and out	☐	☐ _____
Passcode/keys/access cards changed when an employee is dismissed	☐	☐ _____
Keys never stored in equipment or vehicles	☐	☐ _____

9C – Certification of Completion (source: EPA 2002a)

Certification of Completion			
Drinking Water System (DWS) ID:			
System Name:			
Address:			
Town/City:		**State/Province:**	
Postal Code:			
Telephone:		**Fax:**	
E-mail:			
Person Name:			
Title:			
Address:			
Town/City:		**State/Province:**	
Postal Code:			
Telephone:		**Fax:**	

Certification of Completion			
E-mail:			
I certify that revision process has been completed to the best of my knowledge and that the appropriate parties have been notified of the improvements. Furthermore, a copy of the completed reviewed plan will be retained at the public water system, in a secure location, for authorities review as requested, attesting that it completed and improved.			
Representative of Health Authorities			
Signed:		**Date:**	
Representative of Security authorities			
Signed:		**Date:**	
Representative of Regulator			
Signed:		**Date:**	

Back to "Review Planning and Dissemination"

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KJ-NA-30954-EN-N

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Publications Office of the European Union

doi:10.2760/608997
ISBN 978-92-76-46484-6