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Development of indicators for measuring outcomes of water safety plans

Gabriella Lockhart, **William E. Oswald**, **Brian Hubbard**, **Elizabeth Medlin**, and **Richard J. Gelting**
Water, Sanitation, and Hygiene Team, Environmental Health Services Branch, National Center for Environmental Health, United States Centers for Disease Control and Prevention, Department of Health and Human Services, Atlanta, GA, USA

Abstract

Water safety plans (WSPs) are endorsed by the World Health Organization as the most effective method of protecting a water supply. With the increase in WSPs worldwide, several valuable resources have been developed to assist practitioners in the implementation of WSPs, yet there is still a need for a practical and standardized method of evaluating WSP effectiveness. In 2012, the Centers for Disease Control and Prevention (CDC) published a conceptual framework for the evaluation of WSPs, presenting four key outcomes of the WSP process: institutional, operational, financial and policy change. In this paper, we seek to operationalize this conceptual framework by providing a set of simple and practical indicators for assessing WSP outcomes. Using CDC's WSP framework as a foundation and incorporating various existing performance monitoring indicators for water utilities, we developed a set of approximately 25 indicators of institutional, operational, financial and policy change within the WSP context. These outcome indicators hold great potential for the continued implementation and expansion of WSPs worldwide. Having a defined framework for evaluating a WSP's effectiveness, along with a set of measurable indicators by which to carry out that evaluation, will help implementers assess key WSP outcomes internally, as well as benchmark their progress against other WSPs in their region and globally.

Keywords

drinking water; evaluation; indicators; outcomes; water safety plans

INTRODUCTION

The World Health Organization (WHO) defines water safety plans (WSPs) as the 'use of a comprehensive risk assessment and risk management approach that encompasses all steps in water supply from catchment to consumer', and promotes them as 'the most effective means of consistently ensuring the safety of a drinking-water supply' (WHO 2011). WSPs are currently being implemented in contexts as diverse as Australia, Uganda, Canada and Jamaica; with such widespread adoption, there exists a need for a straightforward means of evaluating WSP implementation and measuring their effectiveness.

Corresponding author: Richard J. Gelting, 4770 Buford Highway NE, MS F-57, Atlanta, GA 30341, USA, rgelting@cdc.gov.

The US Centers for Disease Control and Prevention (CDC) published a conceptual framework for the evaluation of WSPs as a means of standardizing the way that they are evaluated worldwide (see Figure 1; Gelting *et al.* 2012). The framework focuses on a WSP's outcomes and overall impacts, and is designed specifically to support existing WSP evaluation tools, such as the *Water Safety Plan Quality Assurance Tool* developed by WHO and the International Water Association (IWA) (WHO/IWA 2010). The framework presents four principal categories of outcome that represent the changes that occur from WSP implementation: institutional, operational, financial and policy changes. In order to apply this evaluation framework, there is a need for a set of simple and measurable indicators that specifically assess outcomes in the WSP process.

For some of the outcome areas – particularly the operational and financial changes – there are already many standardized and validated performance indicators that exist to monitor water utilities worldwide. A particularly comprehensive resource for monitoring the performance of water utilities is the International Water Association's *Performance Indicators for Water Supply Services* (Alegre *et al.* 2006). There are also various country- and region-specific methodologies for performance monitoring and benchmarking that have been developed. The International Benchmarking Network for Water and Sanitation Utilities (IBNET) is a part of the World Bank's Water and Sanitation Program and presents indicators, comparison data and tools to facilitate benchmarking among water and sanitation systems worldwide (van den Berg & Danilenko 2011). The network's extensive list of regional partners includes the Association of Potable Water and Sanitation Regulators for Latin America (ADERASA) and the South East Asia Water Utilities Network (SEAWUN). These partners conduct benchmarking activities among regional water utilities, and their data contribute to the IBNET global database (available at www.ib-net.org). While all of these resources are valuable for water utilities in various contexts, there is no existing set of standardized indicators to evaluate water safety plans in particular. There is still the need for a list of simple and measurable indicators that apply specifically to WSP outcomes.

Impacts from WSPs, such as improved water quality and health, have been documented in a limited number of cases (e.g. Dyck *et al.* 2007; Gunnarsdottir *et al.* 2012a); however, these impacts often take a long time to become apparent and can be difficult to measure. In addition, impact evaluation typically requires surveillance data or expensive studies that may not be feasible in many locations.

Therefore, we instead focus on evaluating outcomes because they are a necessary 'intermediate change' that then results in impacts such as water supply and health improvements. Outcomes from WSP implementation have also been more widely documented (Gunnarsdottir *et al.* 2012b, Gelting *et al.* 2012). Evaluating the proposed outcomes will help to demonstrate the positive effects from WSPs without requiring the extensive surveillance, studies and time necessary to show impacts such as improved water quality and health (Gelting *et al.* 2012).

In this paper, we aim to operationalize CDC's conceptual framework for evaluating WSP outcomes by presenting a set of specific, measurable and standardized indicators that are applicable to various WSP contexts worldwide. These indicators were selected as practical, straightforward tools that WSP teams, water utilities and regulatory agencies of any size or stage of development can use to evaluate the outcomes of the WSP process. The indicators are designed to be clear and simple enough to be easily measured using data that the water utility or other participating organizations involved in WSPs may already collect for their own records. These indicators would not only facilitate the evaluation of individual WSP programs, but they would also permit benchmarking between multiple WSP initiatives, further incentivizing and increasing the effectiveness of implementing organizations (Alegre *et al.* 2006; Vieira 2011).

The purpose of this paper is not to provide an exhaustive listing of all possible indicators that could be used to measure WSP effectiveness; rather, it is to offer a core list of indicators that are relevant and applicable to the multiple contexts in which WSPs are implemented. Chosen specifically to evaluate WSPs rather than water utilities in general, these indicators will measure the four outcome areas in CDC's conceptual framework for WSP evaluation.

METHODS

CDC's conceptual framework for WSP evaluation identified four categories of outcomes; the changes that are expected to occur within these four outcome areas are listed in Figure 2. Indicators have been selected in order to operationalize the framework and measure changes in the outcomes.

For practicality, various indicators already developed by IWA and IBNET were incorporated into this list and are referenced accordingly. The indicators presented in this paper are examples that may be relevant to any utility. WSP teams and other evaluators can choose and adapt those indicators that will be most beneficial to them in their specific contexts.

RESULTS AND DISCUSSION

The proposed indicators are presented in bold lettering and explained in terms of the relevant outcomes they will measure. The indicators for each outcome area are also listed in Tables 1–4. Some of the indicators for institutional, operational and financial changes include an IWA and/or IBNET code, showing that the indicator was either taken directly from or adapted from IWA's or IBNET's lists of performance indicators for water utilities (Alegre *et al.* 2006; van den Berg & Danilenko 2011).

Institutional outcomes

Increased communication and collaboration—The formation of a complete WSP team itself is a vital first step to the WSP process because it brings together relevant stakeholders to discuss, devise and implement steps to ensure the safety of a water supply. As with any group, communication and collaboration might not occur immediately but instead develop over time. The following areas of focus for evaluating increased communication and collaboration were loosely developed, in part, from the network level of effectiveness criteria presented by Provan & Milward (2001). However, as discussed above, these indicators are designed to be practical rather than comprehensive, so many of them are simplified and process-oriented.

The number of WSP team meetings per year is an indicator that reflects the level of communication within the team by noting the potential opportunities to bring together team members to develop and implement the WSP process. Tracking the number of participating entities on the WSP team can identify the individuals and institutions (e.g. the water utility, ministry of health, etc.) that make up the WSP team and measure how these stakeholders and their active participation may change over time. A broad WSP team is more likely to have the experience and expertise necessary to understand all facets of the water supply system (Bartram *et al.* 2009).

One aspect of a team's development is the institutionalization of the WSP team and process. The existence of inter-institutional agreements or scopes of work related to drinking water are instrumental in two important ways. First, these documents reflect the legitimacy of the WSP team to carry out its activities. Second, these inter-institutional agreements formalize and solidify the relationships between WSP team members or other entities involved in activities related to water supply. Relationships among various participating entities may be tenuous at first and take time to build trust; inter-institutional agreements help to build and strengthen the team and the WSP process.

The production of a WSP team work plan is indicative of greater collaboration and is useful as a baseline record by which to evaluate the team's progress as it moves towards meeting its goals. The work plan provides the structural mechanisms for the coordination and administration of the WSP team – for example, decision-making processes rules and regulations, management structures and resource allocation. The work plan can provide a clear measure not only of the team's effectiveness, but also of its operation and development.

Improved knowledge and attitudes—The existence of a comprehensive description of the water supply system and the identification of actual and potential hazards represent the compilation and documentation of dispersed institutional knowledge. This knowledge is then centralized within the WSP team or the water utility. Periodic review of the WSP document, resulting in a revised draft of the WSP document each year, indicates the iterative nature of this process. However, centralized knowledge will only bring about subsequent improvements to the water supply system if it is shared amongst the system's operators, through additional training and understanding of the changes in the water system.

Improved attitudes regarding WSP activities or, more fundamentally, regarding the provision of safe drinking water, can be reflected in the level of employee satisfaction among the water utility staff. Standard human resource measures of satisfaction, such as job satisfaction and employee engagement surveys, could be employed to measure this within the utility, especially if such information is already being collected. Human resource associations such as the Society for Human Resource Management (www.shrm.org) produce surveys and other measures of employee satisfaction that may be helpful for WSP evaluators. If no other measures are implemented, staff turnover ratio (defined here as the ratio of employees who left over the past year to the total number of employees) is a crude measurement that can be utilized to assess employee satisfaction.

Increased training—Increased training is the most tangible concept within the expected institutional changes, and its measurement is relatively straightforward. All types of training can be encompassed in a single indicator by measuring the amount of time allotted to training. As noted in the WSP evaluation framework, there are many examples of WSPs leading to an increase in training on a variety of issues related to the water system (Gelting *et al.* 2012). Training staff members in areas of weakness identified through the WSP process indicates efforts to improve system performance. In addition, the ongoing education of operators and other relevant staff regarding the principles and findings of the WSP process itself indicates increased knowledge and understanding of the drinking water system.

Operational outcomes

Service-level improvements that are visible to customers –namely, improvements in water cost, quality, quantity, continuity and coverage – often take considerable time to occur; CDC's conceptual framework for evaluation considers these improvements as impacts rather than outcomes. The WSP team can more easily assess the effectiveness of the WSP with outcome indicators of direct actions resulting from the WSP process leading to these impacts (e.g. the implementation of control measures, rehabilitation and improved management of infrastructure, and implementation of improved operating procedures). These operational indicators are primarily taken from the lists of performance indicators put forth by IWA and IBNET (Alegre *et al.* 2006; van den Berg & Danilenko 2011) and are described in the following sections.

Improved system infrastructure—There are various points in a water system where a water utility may identify needed infrastructure improvements, ranging from water sources, storage, treatment to distribution. The indicators discussed here were selected as examples because they can be measured simply, often with information that a water utility may already be collecting for its own records. They also clearly demonstrate improvements in system infrastructure. Examples of water source protection include fencing, wellhead protection or legal protection of watersheds or recharge zones. Simple indicators for water treatment and storage are chlorine residual measurement and the cleaning of water tanks, respectively. Examples of distribution indicators that demonstrate system improvements include the percentage of mains that are rehabilitated, renovated, or replaced each year, as well as the percentage of new mains that are added each year.

Tracking the percentage of water losses per system input volume is also an effective indicator of infrastructural improvements in the system. Reducing water losses – which include leaks as well as illegal connections to the system –can often be a low-cost, effective method by which a utility can increase its system capacity. Thus, diminishing these losses over time can indicate that the system has undergone preventive measures and infrastructural improvements. There is no specific IWA indicator for measuring total water losses as a percentage; however, the IWA variables A15 (Water losses) and A3 (System input volume) can be used to simply calculate this indicator. Alternatively, IWA and IBNET both include indicators for non-revenue water by volume that could be measured (see Table 2). Although these are financial (vs. operational) indicators, they provide easy and straightforward ways to measure water loss.

In some contexts, water metering is not well established. In these cases, an additional sign that a water utility has undergone improvements and is moving towards sustainability is the installation of water meters. Water meter installation can be used as a better alternative to fixed or tiered tariffs for water services. Therefore, tracking customer metering level/density indicates improvements to the water system.

Implementation of improved procedures—In response to operational and infrastructural weaknesses identified throughout the water system through the WSP process, the water utility should develop and implement more streamlined methods of operation and risk reduction (Gunnarsdottir *et al.* 2012b). Therefore, the development and implementation of standard operating procedures is an indicator of positive operational change and marks the increased effectiveness of the WSP (Gelting *et al.* 2012). This process includes both establishing clear standard operating procedures at the outset of the WSP process if they do not already exist, as well as updating and redefining these operating procedures over time, to reflect needs identified during continued monitoring.

One way to measure this indicator is to track the implementation and frequency of key operations within the system, such as the number of inspections of physical assets that are conducted, the number of required maintenance activities that take place, and the number of times the system's equipment is calibrated. It is possible to calculate these measures on a yearly basis, but this is flexible based on the capacities of the water utility staff.

For some water utilities, an appropriate measure may be the number of sanitary inspections that are conducted to examine water infrastructure, as this is a key activity for reducing contaminant loads in water before treatment. In addition, the water utility can measure improved operational monitoring of water quality before treatment, at the treatment works, and within the distribution system. Common operational monitoring parameters that are measurable and simple include chlorine residuals, pH and turbidity. While using an array of microbiological, physical, chemical and radiological water quality tests is the ideal for verification of finished water quality, it may be that a utility has limited financial and technical capacity to carry out more complex monitoring exercises repeatedly. The WSP team and water utility should explore the various options for testing water quality recommended by such institutions as the WHO and IWA (Alegre *et al.* 2006; WHO 2011).

The implementation of improved operations is also demonstrated by the increased documentation of standard operating procedures. Documenting changes to the operating procedures of the water utility not only increases institutional knowledge among the water utility staff and other stakeholders, but it also provides a record that helps track the water utility's operational progress over time.

Improved operating procedures can be assessed by the number of customer complaints that the water utility receives during a set period of time. This is measured, for example, by the number of service complaints received per connection in the water supply network. An increase or decrease in complaints can reflect the effectiveness of its operations. Similarly, the percentage of written complaints that the water utility addresses can indicate an active commitment to improving procedures and increasing customer satisfaction. Indicators related to complaints should be taken in context, however. As Alegre *et al.* (2006) explain, the absence of customer complaints may not always indicate that the utility is functioning well; in some cases, customers whose complaints are habitually ignored or unaddressed by the water utility may simply stop complaining because they believe they hold no influence. Then, as a utility improves its operations, complaints may initially increase as customers feel the utility is more responsive. Therefore, using customer complaints as an indicator of improved operating procedures is only recommended if the WSP's context is taken into consideration. It is important to analyze trends in this indicator over time rather than at any discrete point, so as to fully understand the pattern of customer complaints within the context of that water utility (Alegre *et al.* 2006).

Financial outcomes

A WSP's effectiveness is partly assessed by the financial changes that occur within the water utility. Expected financial outcomes discussed in the CDC's evaluation framework include reductions in costs, increased cost recovery due to clients' greater willingness to pay for improved services, and an increase in either local investments and subsidies or external donor support (Gelting *et al.* 2012). IWA and IBNET have compiled many standardized performance measurement indicators related to finances. A selection are presented and discussed below.

Cost savings—An increase in cost savings is identified by the unit total costs, which indicates the costs of the water utility during a set period of time. Tracking this indicator during the course of WSP implementation may help to identify costs savings resulting from the WSP process.

Cost recovery—Tracking the operating cost coverage ratio allows a utility to determine if their revenues cover operating costs, and track changes in cost recovery over time. As Gelting *et al.* (2012) discuss in their conceptual framework for WSP evaluation, cost recovery can also be influenced by a rise in customer satisfaction due to an improved and more reliable water supply system (Bhandari & Grant 2007; Gelting *et al.* 2012). An increase in the amount or the consistency with which customers pay for water services reflects this satisfaction. Similarly, payments from consumers could reflect a level of dissatisfaction with the services provided by the water utility. Tracking the collection ratio over time provides insight into customer satisfaction and, subsequently, cost recovery. These indicators are practical and feasible for evaluators to use because information about costs and revenues is most likely already collected by the water utility.

Increased donor support and/or increased investment—Finally, unit investment is used to measure an increase in support of and investment in the water utility. Utilities in

Iceland reported improved success in obtaining resources to improve water systems after implementing WSPs (Gunnarsdottir *et al.* 2012b). As previously mentioned, this support can include local investments and subsidies as well as donations or loans from external sources.

It should be noted that the outcomes discussed here refer only to financial changes that occur within the water utility and affect its financial status. Financial changes that the utility's clients experience as a result of the WSP are better classified as impacts, because they reflect socioeconomic effects on consumers. For example, access to an improved and affordable water supply system can reduce consumers' opportunity cost for such behaviors as buying bottled water or traveling long distances to collect water from a safe source. As with other changes that directly affect consumers' health or socioeconomic status, these financial changes should be considered as overall impacts of the WSP rather than outcomes, and are beyond the scope of this paper.

Policy outcomes

Policy outcomes are often the last to become apparent, because policy change often happens gradually and in stages. This process of policy change begins when WSP knowledge is shared and promoted informally among water utilities and other stakeholders, and continues when these institutions consider the WSP model as a standard of best practice and begin to incorporate the WSP process into their guidelines and methodology.

WSP knowledge sharing and promotion—WSP knowledge is shared among water utilities and other institutions as the WSP model gains recognition as a viable option for high-quality water service delivery. This process leads to what DiMaggio & Powell (1983) refer to as 'mimetic isomorphism', which includes the concept that 'organizations tend to model themselves after similar organizations in their field that they perceive to be more legitimate or successful' (DiMaggio & Powell 1983). This acquired understanding of WSP principles can be identified by tracking the increased awareness of WSPs among water utilities in a country or specific region within a country. It should be noted that it can be difficult for many utilities to assess WSP knowledge sharing and promotion, but this indicator is an important measure of a shift towards more formalized policy change. Evaluators can gather this information in a variety of ways, ranging from analyzing informal communication such as email, letters and conversations to written records, media communication such as press releases, or through surveys or questionnaires.

WSPs as norms of practice—Progress in policy change continues when more and more institutions begin to incorporate WSPs as a standard of best practice. This change can be understood within the framework of Tolbert & Zucker's (1996) three-stage process for implementing a new practice; in this process, a practice moves from 'pre-institutionalization' to 'semi-institutionalization' and eventually to 'full institutionalization'. Summerill *et al.* (2010) applied this process directly to the WSP context by describing how the WSP model moves from pre-institutionalization, in which there is low awareness of WSP practice, to semi-institutionalization, in which WSPs are relatively new but have become widely recognized and adopted by some – yet not all – water supply institutions. This evolution of the WSP model into best practice – a move from pre-institutionalization to semi-institutionalization –can be measured by the number of WSP pilot projects that are implemented, as well as by the existence of WSPs being incorporated into non-regulatory guidance documents for use by WSP implementers such as utilities, non-governmental organizations and other stakeholders.

WSP formal regulatory requirements—A more advanced stage of policy change becomes apparent when formal regulatory requirements are developed for WSPs. Summerill *et al.* (2010) suggest that buy-in for WSPs among water utilities is currently in Tolbert & Zucker's (1996) semi-institutionalization stage at the global level, and argue that the model has not yet moved to the final stage of 'full institutionalization' in which the WSP practice is fully accepted and required in the water supply sector worldwide (Summerill *et al.* 2010). Within individual countries, however, it is possible for WSPs to move through all three stages of institutionalization. The incorporation of WSP preventive concepts into national regulations indicates that the concept of active risk prevention at every stage within a water delivery network is included in a country's national guidelines and regulations, even though utilities are not specifically required to develop a WSP.

Subsequently, the most advanced policy outcome is full inclusion of the WSP model in the national drinking water guidelines, at which point WSPs and their principles of risk prevention are required of all water utilities in the country. WSP policy adoption in drinking water regulations easily identifies this final level of policy change.

Limitations

When considering these proposed indicators, it is important to take into account their limitations. As previously noted, the indicators were designed to be applicable to any context in which WSPs are implemented. This flexibility allows the indicators to be adapted to fit a particular WSP. While the simplicity and adaptability of these indicators is necessary in order to be relevant to any individual WSP, it could present a challenge for standardized benchmarking if the indicators become significantly altered in each context. In addition, changes that occur and are tracked by these indicators may not always be direct results of WSP implementation. An additional limitation is that, as previously discussed, these indicators were only selected to evaluate outcomes. While impacts of WSPs may occur, identifying them is beyond the scope of measurement for most institutions implementing WSPs, and they are therefore not addressed in this paper. Future work could develop standard approaches to evaluate WSP impacts.

CONCLUSION

With the increase in WSPs worldwide, there have been a number of valuable manuals, guidelines and case studies developed to assist practitioners in the coordination and implementation of WSPs. Together, these resources make up a toolkit that service providers and WSP team members can use in virtually every step of the process. For example, the WHO's *Water Safety Plan Manual* guides water utilities through organizing a WSP team and developing a WSP plan (Bartram *et al.* 2009). Similarly, WHO's *Water Safety Planning for Small Community Water Supplies* provides guidance in WSP initiation and implementation specifically for community-managed small water systems (WHO 2012).

Some tools such as the WHO/IWA *Water Safety Plan Quality Assurance Tool* (WHO/IWA 2010) focus on WSP performance assessment and are designed specifically to help water utilities track their progress and quality of service.

The set of indicators proposed in this paper is by no means intended to replace these valuable tools. Rather than suggesting another way to monitor performance, the set of indicators proposed in this paper contributes to the WSP toolkit by offering a way to evaluate WSP outcomes. In other words, the Quality Assurance Tool and other existing assessment instruments are designed for the water utility to monitor its progress and ensure that it is consistently meeting its quality standards, while the proposed indicators in this paper were compiled to help the water utility identify and measure the changes that should occur as a result of this progress.

These indicators that measure outcomes hold great potential for the continued implementation and expansion of WSPs worldwide. Having a defined framework for evaluating the effectiveness of a WSP, along with a set of specific and measurable indicators by which to carry out that evaluation, will help implementers assess key WSP outcomes internally, as well as benchmark their progress against other WSPs in their region and globally. It is helpful to note that collaborations among WSPs already exist in various contexts worldwide; for example, there are WSP networks located in Latin America, Africa and the Asia-Pacific region. These networks exist to provide support, share innovations and facilitate cooperation among WSP implementers. They could also become a platform for scaling up internal WSP evaluation activities and promoting increased accountability and benchmarking among WSPs worldwide. It is our hope that these proposed outcome indicators will be a helpful tool in facilitating the evaluation of WSPs worldwide.

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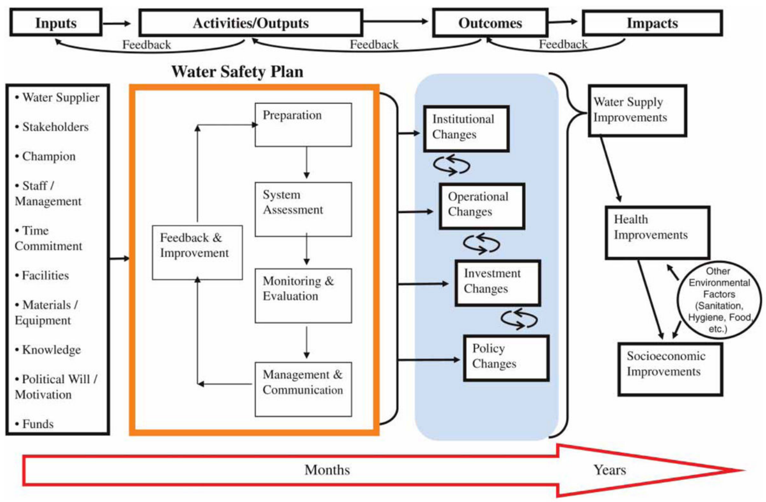

Figure 1.

Conceptual framework for the evaluation of water safety plans (Gelting *et al*. 2012).

Figure 2.

Water safety plan conceptual framework outcomes.

Table 1

Indicators of institutional outcomes

Outcome area	Indicator	Code	Measurement	Data source
Increased communication and collaboration among stakeholders	Number of meetings per year	N/A	# of meetings	WSP team attendance logs
	Number of participating entities on WSP team	N/A	(Number of registered stakeholders represented at WSP team activities / number of registered stakeholders) × 100 (in %)	WSP team attendance logs
	Existence of inter-institutional agreements or scopes of work	N/A	Yes/No	WSP team documents
	Documented WSP team work plan	N/A	Yes/No	WSP team documents
Improved knowledge and attitudes related to the drinking water system among water utility staff and other stakeholders	Existence of a comprehensive description of the water supply system and the identification of actual and potential hazards	N/A	Yes/No	WSP team documents
	Existence of a revised draft of the document each year	N/A	Yes/No	WSP team documents
Improved knowledge and attitudes related to employee satisfaction among water utility staff	Employee satisfaction	N/A	Measurement may vary based on the utility's existing human resources data collection methods; staff turnover ratio (# of employees who left over the past year/total # of employees) if nothing else available	HR documents
Increased training	Total training	IWA Pe19	Hours / employee / year	Training attendance logs

Table 2

Indicators of operational outcomes

Outcome area	Indicators	Code	Measurement	Data source
Improvements to system infrastructure	Source protection	N/A	Yes/No; Specify type (fencing, wellhead protection, legal protection, etc.)	Water utility records
	Water treatment: chlorine residual	IBNET 15.4	Number of tests of treated water for residual chlorine/ required number of tests of treated water for residual chlorine ×100 (in %)	
	Storage tank cleaning	Op2	Volume of storage tanks cleaned during the assessment period/total volume of storage tanks	
	Distribution: Mains rehabilitated, renovated, and replaced	IWA Op 16–18	%/year	
	Mains added	N/A	%/year	
	Water losses per system input volume	IWA variables A15/A3 (see text)	Water losses during the assessment period/ system input volume ×100 (in %)	Water utility records
	Alternative: non-revenue water by volume	IWA Fi46	Non-revenue water/system input volume ×100 (%)	
		IBNET 6.1	(Volume of water produced minus volume of water sold) / volume of water produced ×100 (%)	
	Customer metering level/density	IWA Ph11	Number of meters/service connection	Water utility records
		IBNET 7.1	Total number of connections with operating meter/total number of connections ×100 (in %)	
Implementation of improved procedures	Development and implementation of standard operating procedures	IWA Qp1–4, 6	Inspection and maintenance of physical assets (−/year)	Water utility records
		IWA Op7–11	Calibration of equipment (−/ year)	
		N/A	Number of sanitary inspections conducted (−/year)	
		IWA Op40–44, IBNET 15.3	Water quality monitoring tests carried out / water quality tests required by applicable standards during assessment period (%)	
	Increased documentation of standard operating procedures	N/A	Periodic updates of changes made to standard operating procedures documented: Yes/No	Water utility records
	Customer complaints	IWA Qs26	Service complaints per connection (number of complaints/1000 connections/ year)	Water utility records
		IWA Qs34	Response to written complaints (%)	

Outcome area	Indicators	Code	Measurement	Data source
		IBNET 16.1*	Complaints about water services (total number of water complaints/year, expressed as a % of the total number of water connections)	

*Note: IBNET Indicator 16.1 represents complaints about both water and wastewater services, and is defined as 'total number of water and waste-water complaints per year expressed as a percentage of the total number of water and waste-water connections' (van den Berg & Danilenko 2011). For the purposes of this paper, which presents outcome indicators solely applicable for water supply services within the WSP context, this indicator is modified to exclude measurements of wastewater complaints

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Table 3

Indicators of financial outcomes

Outcome area	Indicators	Code	Measurement	Data source
Cost savings	Unit total costs ($/m^3)	IWA Fi4, IBNET 11.1	(Running costs + capital costs)/ authorized consumption (including exported water), during the assessment period	Water utility records
Cost recovery	Operating cost coverage ratio	IWA Fi31, IBNET 24.1	Total revenues/running costs, during the assessment period	Water utility records
	Collection ratio	IBNET 23.2	Total operating revenue / total operational expenses ×100	
Increased donor support and/or increased investment	Unit investment ($/m^3)	IWA Fi25	Cost of investments (expenditures for plant and equipment) / authorized consumption (including exported water), during the assessment period	Water utility records

Table 4

Indicators of policy outcomes

Outcome area	Indicators	Code	Measurement	Data source
WSP knowledge sharing and promotion	Increased awareness of WSPs	N/A	Number of water utilities with knowledge of WSPs/number of water utilities, measured per year	Analysis of communications such as emails, letters and conversations, other written records Surveys or questionnaires
WSP as norms of practice	Number of pilot WSP projects implemented	N/A	Number implemented	Surveys or questionnaires by water utility associations or regulators
	Existence of WSPs being incorporated into non-regulatory guidance documents (for use by WSP implementers – utilities, NGOs, stakeholders)	N/A	Yes/No	Uniform guidelines for countries or regions Lessons learned documents
Formal regulatory requirements for WSPs	WSP preventive concepts incorporated into drinking water regulations	N/A	Yes/No	National drinking water regulations
	WSP policy adoption in drinking water regulations	N/A	Yes/No	National drinking water regulations