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Upstream pollution control by water utilities in Sweden: incentives and challenges

Emma Fältström [a,b,*] and Sara Gustafsson[a]

[a] Environmental Technology and Management, Department of Management and Engineering, Linköping University, 581 83 Linköping, Sweden
[b] Sweden Water Research AB, 223 70 Lund, Sweden
*Corresponding author. E-mail: emma.faltstrom@liu.se

EF, 0000-0003-4207-2005

ABSTRACT

Wastewater treatment plants (WWTPs) are not designed to handle many harmful substances that are present in wastewater. The substances can also be transferred to the sewage sludge, which can make it unsuitable as a fertiliser. To alleviate these problems, Sweden has a practice called upstream work (uppströmsarbete) that aims to prevent harmful substances from entering the wastewater via efforts to control the pollution closer to the source. Upstream work has produced positive results in terms of reduced pollution in water and sludge and is seen as an important practice by both practicians and policymakers. In this paper, we investigate the incentives and challenges for upstream work as experienced by practitioners at municipal water utilities. The results show that there are two types of incentives: one related to practical problems and the other related to a perceived responsibility for the wastewater system and for the environment. The challenges were primarily related to an insufficient organisational structure for upstream work, manifested in unclear responsibilities, lack of prioritisation, and insufficient resources. The findings can be used to expand and initiate pollution control upstream of the WWTP as part of the urban water management, as well as decision support for policymakers.

Key words: Barriers, Drivers, Pollution prevention, Sewage sludge, Source control, Wastewater

HIGHLIGHTS

- This study advances the understanding of incentives and challenges to controlling pollution before it enters the water cycle.
- Increasing sewage sludge quality and protecting the environment are two incentives for upstream pollution control in Swedish water utilities.
- Insufficient resources hinder the development of upstream pollution control in Sweden.
- The results are important for urban water management and policy making.

INTRODUCTION

Environmental pollution in wastewater is a large pathway for urban pollution (Revitt *et al.*, 2013). Wastewater treatment plants (WWTPs) are primarily designed to retain organic material, phosphorous, and nitrogen, but not to retain many other potentially harmful substances that are used in society (Davis, 2010). This means that there is a risk that harmful substances are released into receiving waterways. In addition, some substances may harm the treatment processes at the WWTP (Grüttner *et al.*, 1994; Juliastuti *et al.*, 2003). The pollution

can also be transferred to the sewage sludge. The high nutrient content of sewage sludge makes it suitable as a fertiliser, but a contaminated sludge poses a risk of transferring pollution to the terrestrial environment. This issue leads to conflicting environmental goals: on the one hand, the goal of minimising pollution in the environment, and, on the other, the goal of closing nutrient cycles (Bengtsson & Tillman, 2004; Oberg (Öberg) & Mason-Renton, 2018).

To alleviate these problems, there are several pollution control initiatives with the purpose of decreasing pollution in the wastewater before it enters the WWTP. One example is the 'national pretreatment program' in the United States. The purpose with the programme is to control pollution, from industries and commercial activities, that will not be retained in the WWTP, that may harm the treatment processes, or that makes the sludge unfit for reuse (U.S. Environmental Protection Agency, 2011). The programme is a requirement for the largest WWTPs (and some smaller under specific circumstances), and most of the wastewater in the United States is subject to the control programme. There are also examples of initiatives that are not based on requirements, such as the Swedish 'upstream work' (*uppströmsarbete*). Upstream work consists of different efforts to prevent harmful substances and other pollutants from entering the water cycle (Swedish Water and Wastewater Association, 2017). Most of the upstream work is carried out locally by municipal water utilities. Examples of efforts that can be part of the local upstream work are contact with enterprises, information to the public, and source mapping (Fältström *et al*., 2018). Nationally, the central organisation for water and wastewater operators in Sweden, the Swedish Water and Wastewater Association, works for substitution of harmful substances, more stringent laws and regulations regarding pollution, and information to households (Swedish Water and Wastewater Association, 2017). Although not being a legal requirement, upstream work is still practised by many water utilities (Swedish Water and Wastewater Association, 2020) and can be presented in the environmental reports to the authorities.

Whereas much of the current practice in urban wastewater management is characterised by centralised treatment (Larsen *et al*., 2016), efforts to control the pollution closer to the source, such as upstream work, are different. The system focus is on the discharge points to the collection system instead of end-of-pipe treatment. In that way, they share similarities with more non-traditional approaches in urban water management. Specifically considering that while traditional urban water management approaches largely focus on treatment in a linear centralised urban water management system, non-traditional approaches move towards a water cycle perspective (Brown & Farrelly, 2009). However, such approaches require new forms of working, and urban water management has been argued to be inadequately equipped to handle such changes (Larsen *et al*., 2016). Previous research has identified a number of barriers to the implementation of non-traditional or new approaches in the urban water system (Brown & Farrelly, 2009; Wihlborg *et al*., 2019). These barriers were found to be primarily institutional and related to issues such as coordination, legislation, and responsibility, rather than technical problems.

Upstream work has been practised to increasing extent in Sweden since the beginning of the 1960s. First, it was primarily used to protect the collection system and the treatment processes at WWTPs, and its usefulness for sludge quality has been highlighted since the 1990s (Fältström *et al*., 2018). Upstream work has also been highlighted as important by policy. In 2013, a national inquiry suggested that upstream work should be legislated (Swedish Environmental Protection Agency, 2013) and in 2018, the Swedish government initiated an investigation into a potential ban on sludge reuse, while still ensuring a continuing practice of upstream work (Statens offentliga utredningar, 2020). Concern has been raised that the incentives for upstream work will be lost following such a ban (Dagerskog & Olsson, 2020). However, the incentives for upstream work, as well as the challenges that water utilities face with their upstream work have yet to be analysed in depth, to increase the understanding of how proactive environmental work can be utilised to achieve goals of reduced pollution.

The aim of this paper is to analyse incentives and challenges for the current and future upstream work from the perspective of Swedish water utilities. With the term incentives, we refer to the motivations behind practising upstream work, and as to challenges, we speak of aspects that hinder the work but that the water utilities can, at least partly, influence. Water utilities were chosen as they have the most experience with upstream work in Sweden. To address this aim, we conducted a survey and interviews with practitioners working with upstream work at Swedish water utilities. This study contributes to the understanding of what drives and hinders public organisations, such as water utilities, in proactive environmental work that might not be part of their core assignment or traditional management. An increased understanding of such incentives and challenges is also relevant for policymakers when making strategic plans for urban pollution control.

BACKGROUND

Wastewater management in Sweden

The law on water services (SFS 2006:412) regulates the responsibilities related to the provision and use of water services in Sweden. The law states that the water utility only must accept wastewater that resembles household quality. This means that the water utility can demand a certain quality of the water that is released from enterprises to the WWTP. The law also gives the water utility the opportunity to add regulations. These regulations specify emissions of substances or other parameters (such as conductivity or pH) that may harm the collection system, treatment processes, or sludge or water quality. Furthermore, specific arrangements can be made with individual industries regarding the release of wastewater that deviates from the characteristics of household wastewater or large discharges of treatable substances (Swedish Water and Wastewater Association, 2019).

Water services in Sweden are a municipal responsibility. Most municipalities (78%) handle this responsibility on their own, while 22% of the municipalities are co-operative efforts with other municipalities (Swedish Water and Wastewater Association, 2016). Independently of the organisational structure, the water utility is municipally owned, non-profit, and is, at the highest level, governed by a politically elected board. In addition to water utilities, local and regional authorities, specifically the municipal environmental departments and regional county administrative boards, are important upstream work actors. They are responsible for issuing environmental permits to enterprises and for ensuring compliance. In general, smaller enterprises are controlled by the municipal environmental department and larger by the county administrative board, but the latter can also delegate the responsibility to the former (Statens offentliga utredningar, 2020). WWTPs also require environmental permits, which mean that the municipal environmental department and the county administrative board have two roles in relation to the water utility. One role is as a collaborating partner regarding permits and control of the enterprises connected to the WWTP, and the other role is as a control organ of the WWTP. The water utility can give the local and regional authorities water-related recommendations for permits for connected enterprises, but it is the authorities that give permits and make the final decisions (Swedish Water and Wastewater Association, 2017).

Sewage sludge management in Sweden

In Sweden, 39% of the sewage sludge is used as a fertiliser on agricultural land, which makes it the most common application in the country (Statistics Sweden, 2020). Other common applications for the sludge are admixture in soil (26%) and to cover closed landfills (17%). In addition to legislation for sludge quality, there is a voluntary certification system called Revaq with limitations that, for some parameters, are stricter than the national legislation (Malmqvist *et al.*, 2006). A Revaq certification requires that the organisation carry out upstream work, but organisations without a certification still perform upstream work.

Revaq requires continuous improvements (Revaq, 2020a). Revaq certifies individual WWTPs, and systematic upstream work is a core requirement. In practice, this requires monitoring of substances in the influent water

of the WWTP and a selection of priority pollutants to be investigated in detail. Cadmium should always be included as a priority pollutant, but other priority pollutants are dependent on the conditions of the specific WWTP. Another part of the upstream work in Revaq is to screen the chemicals used by connected enterprises (Revaq, 2020a). The Revaq project in its initial form was initiated in 2002 and later developed into a certification system, and the first WWTP was certified in 2008. In 2019, 41 WWTPs were certified, which is 10% of the WWTPs (>2,000 population equivalents (pe)), but it still corresponds to half of the sludge generated in Sweden (Revaq, 2020b). The upstream work that was proposed to be legislated in 2013 had similar requirements as in the Revaq certification system (Swedish Environmental Protection Agency, 2013).

The results from the national inquiry that was initiated in 2018 were presented in 2020, and two alternatives were proposed: (1) a complete ban of reuse of sewage sludge and (2) a complete ban with the exception of high-quality sludge that could be used on agricultural land (Statens offentliga utredningar, 2020). The inquiry further proposed that large WWTPs (above 20,000 pe) should be required to recover at least 60% of the phosphorus in the sewage sludge. This would concern 27%[1] of the WWTPs (above 2,000 pe), and these WWTPs generate 76% of the sewage sludge volume, and this sludge contains 82% of the phosphorous (Statens offentliga utredningar, 2020). The Swedish Environmental Protection Agency (EPA) was suggested to be responsible for coordinating the national upstream work and provide contact opportunities and dialogue between actors that can be involved in the upstream work.

METHODS

Since there is limited knowledge in this field, this study takes an explorative approach to uncover the incentives and challenges for upstream work. This calls for an initial screening of the field followed by a more in-depth approach. The research design is therefore two-fold, with (i) an initial survey followed by (ii) qualitative interviews departing from the outcomes of the survey. This type of qualitative research approach can be useful when a detailed understanding of the topic and the context in which the respondents operate is needed. It can also be useful for identifying variables that cannot be easily measured (Creswell & Poth, 2016). The interview material was thematically analysed inspired by previous research that had investigated incentives and challenges related to non-traditional or emerging urban water management or neighbouring subjects. Figure 1 gives an overview of the research process for this study, and the following sections give more details about the methods.

Survey

The initial online survey was conducted in 2017 with the aim to develop an overview of the status of the upstream work, what tasks were carried out, and how the work was perceived. It was sent to 58 organisations that had showed an interest in participating in the study. In total, 44 organisations answered the survey, and it reached 87 municipalities (since some of the organisations are intermunicipal co-operations).

The survey consisted of two parts. The first part included questions that aimed at receiving an overview of the water utilities. Questions on, for example, size, certifications, and organisational structure were asked in this part. The second part consisted of questions related to the upstream work, such as what tasks the practical work consisted of, as well as the respondents' view on issues like the need for guidance, resource allocation, and collaboration. The results from the initial survey highlighted issues to be further explored in the qualitative interviews.

[1] Sweden has 426 WWTPs above 2,000 pe. Of them, 312 are 2,000–19,999 pe, 91 are between 20,000 and 99,999 pe, and 23 are above 100,000 pe (Statistics Sweden, 2020).

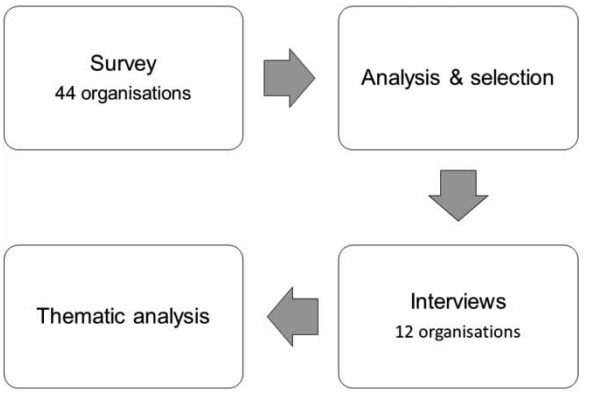

Fig. 1. | Overview of the research activities performed for this study.

Interviews

The interview study was conducted with employees at water utilities that work practically with upstream work to get a more in-depth understanding of the reasons behind choices, incentives, and challenges. Twelve organisations were selected for interviews, based on the organisations that answered the survey (Table 1). The respondents were selected to achieve a representation of different types of organisations. Geographical location, size, and organisational structure (one municipality or operating in cooperation) were aspects that were considered. Furthermore, both organisations with and without a Revaq certification were interviewed, as well as

Table 1. | Overview of interview respondents.

Role/title	Type of organisation	Size (no. of employees)[a]	Geographic location in Sweden	Phase[b]	Revaq
Investigative engineer	One municipality	<10	South	Planning	No
Energy and environmental engineer	One municipality	<10	Middle	In place	Yes
Environmental engineer	One municipality	10–49	South	In place	Yes
Investigative engineer	One municipality	10–49	South	Planning	No[c]
Water and wastewater strategist	One municipality	10–49	Middle	In place	No
Group leader quality and environment	One municipality	10–49	North	In place	No
Environmental engineer	One municipality	10–49	North	Start-up	No
Environmental engineer	One municipality	50–99	South	In place	No
Environmental engineer	One municipality	50–99	South	In place	Yes
Process engineer	Cooperation	50–99	Middle	Start-up	No
Environmental engineer	Cooperation	100–200	South	In place	No
Environmental engineer	Cooperation	100–200	North	In place	No

[a]The size category is derived from fixed size spans in the survey (<10, 10–49, 50–99, 100–200, and >200).
[b]The three phases of development (planning, start-up, and in place) are also categories from the survey.
[c]Was changed from 'in process' to 'no' between the survey and interview.

organisations that were in different phases of developing upstream work in order to capture challenges and incentives at different stages. Some organisations were performing upstream work when the survey was conducted (marked *in place* in Table 1), some were starting in time for the survey (*start-up*), and some planned to initiate upstream work within a year (*planning*). Specific responses from the survey related to, for example, how the work was perceived, how the collaboration with other actors worked, and the need for guidance were also used in the selection.

The interviews were divided into three themes. The first theme concerned how and why upstream work was initiated and a description of the practical daily work. This theme primarily gave insights into the incentives of upstream work. The second theme focused on laws and guidelines used in the work and if something was perceived as missing or redundant to further the understanding of organisational needs. The third theme was primarily related to answers from the survey and aimed to increase the understanding of needs and opportunities, beyond legal and guiding frameworks, and capture the different realities in the organisations. Specifically, the third theme concerned the type of guidance that was requested, the collaboration with the environmental department and the county administrative board, and how the upstream work was perceived. This theme primarily gave insights into challenges that the respondents might experience.

The interviews were conducted via phone from November to December 2017. All interviews were recorded with the respondents' consent and transcribed word for word. The interviews were conducted in Swedish, and the quotes presented in this paper are translated by the authors. Because some of the interview questions were based on the survey answers, the respondents received a copy of their survey answers one week before the interview. The respondents also had the opportunity to extend their answers after the interview in case some new thoughts arose after the interview session.

Analysis of interviews

To analyse the interviews, inspiration was taken from previous research that had investigated incentives and challenges related to emerging and non-traditional approaches in urban water management. Although stormwater is not the focus of the present study, research on incentives and challenges related to stormwater were also included. Including stormwater was considered relevant as stormwater management involves several urban actors, which is also the case for upstream work. In addition, studies that investigated new practices in solid waste management, particularly sustainable waste management, were also investigated. This was motivated by the similarities between sewage sludge and solid waste in that both can be seen as waste to be disposed or valuable resources to be utilised. Initially, studies that investigated incentives and challenges related to sewage sludge application on agricultural land were also identified. These studies were later excluded because they were not easily applicable to upstream work as such, although they might influence the possibility to apply sludge on agricultural land. This concerned, for example, reluctance from the food industry and farmers, which is connected to attitudes of their consumers (Bengtsson & Tillman, 2004; Malmqvist *et al*., 2006).

Based on the above-mentioned literature searches, six studies were chosen. These studies concerned sustainable urban water management (Brown & Farrelly, 2009) and experimental approaches in urban water management (Farrelly & Brown, 2011), integrated stormwater management (Brown, 2005) and blue-green stormwater measures (Wihlborg *et al*., 2019), as well as drivers and barriers to sustainable waste management (Wilson *et al*., 2001; Pollans, 2017). The results from these studies, in terms of incentive and challenge-related factors, were compiled and organised in themes (Table 2). Some of the incentives found in the selected literature were originally presented as pre-requisites for successful management (Wilson *et al*., 2001) or 'critical success factors' (Farrelly & Brown, 2011). A few of the identified incentives and challenges from the literature were found not to

Table 2. | The themes of incentives, pre-requisites, and challenges identified in the literature.

Incentives and pre-requisites	*Resources*	
	• Knowledge and dedication of employees	Wihlborg *et al.* (2019)
	• Dedicated and persistent individuals	Farrelly & Brown (2011)
	• Economically preferable	Wihlborg *et al.* (2019)
	• Available funding and access to capital	Wilson *et al.* (2001)
	Sustainability	
	• Ecosystem services	Wihlborg *et al.* (2019)
	• Climate change	Wihlborg *et al.* (2019)
	• Environmental sustainability	Farrelly & Brown (2011)
	• Social sustainability	Farrelly & Brown (2011)
	Institutional pre-requisites	
	• Public support	Wilson *et al.* (2001)
	• Enough, and not fragmented, power over the flows	Wilson *et al.* (2001)
	• Enabling legislation that gives management flexibility	Wilson *et al.* (2001)
	• Stability (in terms of personnel and the managerial/political environment)	Wilson *et al.* (2001)
	View on the organisation	
	• Demonstrating corporate commitment[a]	Farrelly & Brown (2011)
	• Reputation and leadership (lead by example)	Farrelly & Brown (2011)
Challenges	*Legislation and policy*	
	• Limits of regulatory framework	Brown & Farrelly (2009)
	• Legislation – limited or hindering	Wihlborg *et al.* (2019)
	• Limited enforcement of policy	Pollans (2017)
	Lack of organisational and political motivation and possibilities	
	• Poor organisational commitment	Brown & Farrelly (2009)
	• Lack of political will/low political priority	Brown (2005); Brown & Farrelly (2009)
	• Advocates lack access to decision processes	Pollans (2017)
	• Values and priorities of managers	Pollans (2017)
	• Limited implementation power	Pollans (2017)
	• Political interests	Wihlborg *et al.* (2019)
	Insufficient resources	
	• Lack of knowledge and time	Wihlborg *et al.* (2019)
	• Insufficient resources (capital and human)	Brown & Farrelly (2009)
	• Limited funding	Pollans (2017)
	Unclear roles and responsibilities	
	• Institutional and physical fragmentation	Pollans (2017)
	• Unclear, fragmented roles and responsibilities	Brown & Farrelly (2009)
	• Numerous organisations with unclear responsibilities	Brown (2005)
	• Unclear division of responsibility	Wihlborg *et al.* (2019)

(*Continued.*)

Table 2. | Continued

No long-term vision/strategy	
• No long-term vision/strategy	Brown & Farrelly (2009)
• Lack of sector-wide vision	Brown & Farrelly (2009)
Lack of interorganisational collaboration	
• Poor communication	Brown & Farrelly (2009)
• Uncoordinated institutional framework	Brown & Farrelly (2009)
• Other governmental priorities	Brown (2005)
• Municipal organisational structure	Wihlborg *et al.* (2019)

[a]Water utilities are not corporate organisations, and this was interpreted as the water utility demonstrating commitment.

be applicable to upstream work. This includes, for example, densification as a driver and barrier to blue-green stormwater solutions (Wihlborg *et al.*, 2019) and private interests related to waste management (Pollans, 2017).

The interview material was examined in relation to the themes of incentives and challenges that had been identified in the literature. Even if the analysis was structured by the pre-identified themes, it was not limited to them. In the interview material, new challenges and incentives were found, and these were also included in the results.

RESULTS AND DISCUSSION

Incentives for upstream work

The survey indicated that there was a variety of motivations for upstream work, but the most common reasons were related to sludge quality (including keeping a Revaq certification), followed by protecting the treatment processes at the WWTP (Fältström *et al.*, 2018). The incentives found in the interview material can be grouped into two overarching categories, where one has more practical reasoning with similarities to the incentives found in the survey, and the other is more related to responsibility.

Upstream work as a response to practical issues

In some organisations, the upstream work was reactive and carried out when problems arose. These problems were in some instances due to the environmental department making the water utility aware of a water-related issue at an enterprise or that something unusual was detected in the influent water of the WWTP. This was then traced via sampling to find the source of the pollution. There was also one example of when upstream work was the result of an injunction from the environmental department. In practice, this injunction included the formation of a sampling plan and a request to identify the most pressing pollution problems in the wastewater. Upstream work was also used for increasing water quality in the effluent as the treatment processes at the WWTP do not retain 100% of the pollution and the retention capacity differs between substances. For organisations with urban drinking water reservoirs, upstream work for wastewater could also be seen as upstream work for drinking water quality.

The survey results indicated that increasing or maintaining sludge quality was a common motivation for upstream work. This can have its basis in a need to dispose of the sludge. Two organisations used the sludge to cover landfills. However, it was uncertain for how long this could continue, and an improved sludge quality

would open up the possibility for application on agricultural land. For another organisation, using the sludge to cover a closed landfill was no longer possible, and there was, therefore, a need to find a new disposal route for the sludge. Furthermore, one respondent described that increasing sludge quality had economic reasons. The current disposal was expensive, and if the sludge quality could be improved and the sludge certified to make it attractive as a fertiliser, it would be economically preferable, even if a certification and upstream work also imposes some cost. This answer corresponds with Wihlborg *et al*. (2019), who also saw an economic driver in that when the traditional way got too expensive, one looks in new directions and to new alternatives. Another respondent explained that a review of the sludge disposal alternatives had been carried out, and application on agricultural land with a Revaq certification was seen as the most suitable option for the organisation. With this decision, the upstream work was initiated. These types of urgent needs or 'crises', which some organisations experienced in relation to sludge disposal, have been suggested as a factor that brings about change for blue-green stormwater measures as well (Wihlborg *et al*., 2019).

Upstream work as part of a responsibility

One respondent described that upstream work is in each water utility's own interest, at least to prevent substances that may harm the treatment processes from entering the plant. For another organisation, upstream work was perceived as a risk assessment. The respondent explained that an overview of the chemicals used by the connected industries was needed to be able to trace problematic substances urgently if problems arose at the WWTP. In comparison, Farrelly & Brown (2011) found that investing in experimental techniques for urban waters was sometimes motivated as a way to show leadership and get a good reputation. This was not voiced as an incentive related to upstream work. Instead, upstream work was promoted as something that helps the water utilities achieve their assignment, or that upstream work is part of the water utilities' general responsibility.

Persistent and dedicated individuals have been identified as a critical success factor when implementing experimental techniques in urban water management (Farrelly & Brown, 2011). Dedicated individuals also influenced the presence and extent of upstream work, as reflected in this study. In one organisation, the manager had previously worked with upstream work and found it important, a view that was spread to the employees. Moreover, some respondents had taken on the work themselves because of a strong personal belief in the benefits of upstream work or the benefits of sludge application on agricultural land. Previous research has found that new employees with new ideas can spark the implementation of new solutions (Wihlborg *et al*., 2019). This was not the case in the present study. There were examples of dedicated respondents who had just started working with upstream work, as well as one respondent who had been working with the issue for 30 years. This might be because upstream work is not new for the sector. Instead, upstream work in various forms has been practised for a long time in Swedish water utilities, and there have been enthusiasts throughout its development. The perceived reliance on devoted employees for upstream work may be both a strength and a weakness. One strength is that enthusiasts have contributed to creating engagement and momentum for upstream work despite that it is not legislated. However, the reliance on enthusiasts could also be a weakness if the work is not also integrated into the organisation. This can cause problems if the individual leaves. Furthermore, as noted by Pollans (2017), it may be difficult to bring about the change in a larger level if the devoted individuals do not have access to decision-making.

Several respondents viewed upstream work as environmental work. This could both be related to returning nutrients to agricultural land and for water quality. One respondent explained: 'in any case, the release of environmentally hazardous substances into the water is reduced, which there might not be requirements for in the

permit'.[2] Another respondent described how upstream work to control the release of grease decreased combined sewer overflows, which led to less untreated wastewater entered receiving waterways. Two respondents also referred to the Swedish national environmental quality goals as a reason for upstream work, as well as a responsibility for future generations. Farrelly & Brown (2011) argued that there can be tension between these sustainability viewpoints and the traditional water management that promote economic efficiency and a belief that the traditional way is adequate. Yet, such a tension has also been argued to be the pressure needed for a system change (Wihlborg *et al.*, 2019).

Challenges for upstream work

Seven challenges to upstream work were identified in the interviews. Some of these were found to be closely related, such as insufficient resources and lack of organisational or political motivation, and are, therefore, presented together. Ways to overcome some of the challenges were also touched upon by some respondents, and this is addressed in relation to the specific challenge.

Unclear expectations

Upstream work was initiated by water utilities and not enforced from a higher level. This might be one reason why some respondents pointed out that it is not clear what upstream work should consist of and what results are expected. It was also brought up that the results can be difficult to measure and, therefore, it is difficult to show progress. This challenge seems to reinforce several other challenges. There was an example where the management did not understand the purpose of upstream work, and therefore, not enough resources were allocated. The respondent described that 'the management does not have enough knowledge about what it means and why; they do not understand why we need to work with this issue'.[3] Furthermore, when it is not clear what should be a part of upstream work, it can be difficult to clarify responsibilities among the actors involved.

The Revaq certification can be one way to define the work, as there are routines for evaluating progress, and there are specific requirements that should be fulfilled before and in different intervals after the certification is issued (Revaq, 2020a). Using a Revaq certification to structure the upstream work was viewed differently among the respondents. While some respondents argued that a certification would force management to allocate resources, others argued that a certification was not possible due to a lack of resources. Furthermore, one respondent did not wish to certify because there is too much administration attached to a certification, while another would like to have a certification to prioritise and visualise the work within the organisation.

Insufficient resources and lack of motivation

Resource problems related to knowledge, time, and capital were mentioned in the interviews. The lack of time can also be the result of a lack of financial means to be able to prioritise the work. The lack of adequate knowledge to perform upstream work among the professionals was only mentioned by one respondent, whereas the lack of capital and time were mentioned more often. Other tasks were perceived as more pressing, and there were no financial means to hire consultants to carry out tasks related to upstream work. One respondent described that upstream work was initiated, only to be cancelled due to a lack of resources.

Insufficient resources were found to be related to a lack of organisational or political motivation. Even if the professionals working with upstream work understood the value, it was not understood, and hence not

[2] Author translation, original quote: 'Hur som helst så minskar man ju utsläppet av miljöfarliga ämnen till vattnet, som man kanske inte har villkor på i sitt tillstånd'.

[3] Author translation, original quote: 'Att cheferna inte har tillräcklig kunskap om vad det innebär och varför, de förstår inte varför man behöver jobba med frågan'.

prioritised, in the wider organisation. One respondent also raised the point that the absence of legislation on upstream work, in combination with no demand on phosphorus return, led to limited motivation.

For the Revaq certification specifically, there could be practical reasons behind a lack of motivation. For example, some organisations had a low sludge quality that was difficult to improve with upstream work and/or no access to agricultural land. There could also already be an established disposal route for the sludge, and therefore, there was no motivation for a certification, which was described as administratively heavy.

There was one example of an organisation where there was organisational motivation, but the political will was lacking. A policy had been formulated in the organisation, but was not approved by the city council; therefore, it did not get wide municipal acceptance. The lack of motivation from the political side has also been found to be a problem for the implementation of blue-green stormwater measures (Wihlborg *et al.*, 2019). However, there is a more apparent conflict regarding these measures, where the confined space in urban areas must be prioritised between real estate development and stormwater measures, than for upstream work.

Problems with interorganisational collaboration and unclear roles and responsibilities

Problems in relation to the collaboration with the local or regional authorities were raised as an issue in the interviews. One reason for such problems can be the organisational set-up. Pollans (2017) found that one barrier to sustainable waste management was physical fragmentation. In some municipalities, the water utility and the environmental department were neighbouring departments and physically situated near one another. In other municipalities, where the water services are organised as a company, the water utility and the environmental department can be physically further away from each other. For organisations including several municipalities, it can even mean that the water utility responsible for upstream work is located in a different municipality. Water utilities that were responsible for several municipalities further described that the collaboration could differ between municipalities. Other reasons for the insufficient collaboration raised in the interviews were lack of personnel and lack of prioritisation of problems related to urban water pollution at the environmental department. These more resource-related problems can have their basis in the structure of the municipalities. According to Wihlborg *et al.* (2019), municipal collaboration can be difficult as each municipal department has its own budget, interests, and primary responsibility related to the issue.

The two-sided role of the environmental department and the county administrative board was sometimes brought up as problematic. Two respondents perceived that the environmental department focused more on their role as a controlling organ for the WWTP than their role as a collaborative partner in relation to enterprises. One of these respondents believed that this problem had its basis in that the water utility was organised as a separate company and not as a department in the municipality. The WWTPs were then viewed as enterprises similar to other enterprises in the municipality and not as municipally owned and operated facilities.

In addition to problems concerning the two roles that the environmental department and the county administrative board have in relation to the water utilities, the responsibilities in relation to connected enterprises were sometimes unclear. This problem has similarities with what Pollans (2017) describes as institutional fragmentation. When the collaboration worked well, the environmental department reported water-related issues found at inspections to the water utility, or the water utility was invited to join inspections. When it did not work, enterprises could have to submit information twice, and the water utility would have limited capabilities to control water releases. In one organisation, the respondent had previously worked at the environmental department and now worked at the water utility. This simplified both the collaboration and division of responsibility as the respondent had good insights into the mandates of both organisations.

One respondent participated in establishing a policy with requirements for enterprises that are or want to be connected to the WWTP. The process of developing the policy helped to clarify the roles and responsibilities

among enterprises, the environmental department, and the water utility. In the suggestion for a new sludge regulation in Sweden, the Swedish EPA is recommended to coordinate and guide the upstream work. Several respondents mentioned a need for a network, and some already participated in networks. It was also highlighted in the interviews that small municipalities do not have the financial resources to be part of a network. In addition, one respondent raised the issue that organisations in the north of Sweden (where the distance between municipalities is longer) do not have the same possibilities to form regional networks as municipalities in the south. A network operated by the Swedish EPA will be accessible for all municipalities while not using their own resources. This coordination has the possibility to strengthen interorganisational collaboration and help clarify roles and responsibilities, as the Swedish EPA would coordinate and provide guidance for environmental departments and county administrative boards in addition to the water utilities.

Limited legal possibilities

The water utility is only obligated to accept water that, in terms of quality, resembles household wastewater. However, there are few legal means to use if the enterprise does not follow the regulations. The water can be turned off, but the respondents saw this as a last resort. One respondent described the problem: 'we have several enterprises that exceed the limit values over and over again, but there is not so much that happens, more than that we point it out'.[4] Furthermore, how much the environmental department or the county administrative board took the water utility's input into consideration when forming legal permits for enterprises differed between the organisations in this study and, again, seemed dependent on the relationship.

A functioning collaboration between the environmental department and the water utility has the possibility to make the limited legal capabilities of the water utility less influential. For example, one respondent asked the environmental department to give an injunction to an enterprise that had violated the terms, as water utilities do not have the authority to do so. However, such informal successful ways of solving issues are difficult to transfer to other contexts. In this study, two respondents mentioned the legal limitations as particularly problematic. These respondents also raised the non-functioning collaboration as a large issue.

In 2013, the Swedish EPA recommended the Swedish government to make upstream work compulsory by law (Swedish EPA, 2013). The opinions about a legislation of upstream work differed among the respondents interviewed in this study. On the one hand, a legal demand could be used as an argument towards enterprises, help highlight the importance of upstream work, and increase allocated resources. One respondent argued that the lack of legal requirement makes upstream work a neglected issue. On the other hand, a legally required upstream work would need clear demarcations concerning which WWTPs to include and what the compulsory work would consist of. One respondent raised the issue that it is difficult to define what upstream work is, and therefore, it would be difficult to define what should be legally required. These differences in opinions may be related to differences in how the upstream work functions in the organisations. For example, if there is upstream work for aspects that are viewed as meaningful in the organisation and resources for this work are provided, a legislation might only be perceived as forced and bring about more administration. For other organisations that are struggling with recognition, resources, or what to include in the upstream work, a legislation can be a way to alleviate the problems.

One respondent pointed out that a legal requirement would place too much responsibility on the water utility to handle urban pollution problems, which is a larger societal issue. Sörme *et al.* (2003) also showed that water utilities often had limited capacity to influence pollution flows to the WWTP. On the other hand, if upstream work is

[4] Author translation, original quote: 'Vi har flera verksamheter där det [gränsvärdet] överskrids gång på gång, men det händer inte så mycket, mer än att vi påpekar det'.

not required, it might not be seen as a core activity in comparison to activities that are legally required and, as a result, not be given sufficient resources.

No long-term strategy

Several of the above-mentioned challenges result in that upstream work is not prioritised and that there is no long-term vision or strategy for the work. Brown & Farrelly (2009) found that the lack of a sector-wide vision hinders the establishment of long-term strategies. This does not seem to be an issue for upstream work. The Swedish Water and Wastewater Association works actively with upstream work, and it is often highlighted as important. The importance of upstream work were also shown in how the national inquiry was formulated, where ensuring the continuation of upstream work was one of the aspects to be investigated. However, the organisational system might be an issue. Wilson *et al*. (2001) point out that stability in the political environment is an important factor to enable long-term planning. For sludge management, which impacts upstream work, this has largely been lacking. Between 2013 and 2020, the debate in Sweden has gone from potentially legislating upstream work to increase sludge application on agricultural land to potentially banning sludge reuse in all. Several respondents raised these uncertainties as an issue. One respondent explained that the organisation was awaiting a new sludge regulation before making any decisions about the sludge management in the municipality.

CONCLUSION

In this study, we analysed incentives and challenges for upstream work from the perspective of practitioners at water utilities. The results show that there are two types of incentives for upstream work, one related to practical problems and the other related to responsibility, both for fulfilling the organisation's assignment and for reducing the amount of pollution in the water to protect the environment. Some of the challenges can be attributed to an insufficient structure to support this type of work or that it was difficult to understand what should be included in upstream work and what results were expected. Upstream work could, therefore, despite having environmental benefits, be subject to a lack of organisational or political motivation, as well as insufficient resources. That it is difficult to grasp what upstream work entails can have its basis in that upstream work originally was initiated 'bottom-up' by water utilities based on the needs to protect the collection systems and treatment processes and not 'top-down', for example, based on legislation.

A new sludge regulation may have implications for the future developments of upstream work. For example, a ban on sewage sludge reuse may have implications for the substances that are primarily targeted with upstream work. Substances that are largely bound to the sludge fraction might receive decreased attention, while upstream work targeting substances that may harm treatment processes or the collection system, and substances that are not retained at the WWTP, would receive the same attention. Some of the respondents described that they currently weighed alternatives for sludge management and awaited the new sludge regulation. If sludge of high quality will be allowed to be used on agricultural land, this may increase the incentives for upstream work for organisations that currently use the sludge for purposes that would be prohibited. Two identified challenges were lack of motivation for upstream work and insufficient resources to perform upstream work. A ban on all use of sewage sludge may reinforce these challenges as the possibility to use sewage sludge on agricultural land was an important motivation and sometimes the most economically viable option.

Sludge management is not only a debated issue in Sweden; it is discussed in other countries as well. Upstream work is one way to increase sewage sludge quality as a possible strategy to mitigate the problems of conflicting goals related to sludge management. Furthermore, the incentives and challenges identified in this study can more generally inform water utilities and other public organisations in developing or initiating various types of pollution control. The results can also be used on a more strategic level to develop national and local policies

that strengthen the incentives and decrease the challenges. Future research should broaden the perspective to include more urban actors that can influence urban water pollution.

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DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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