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A review of current practice in the provision of water and wastewater services by private developers: Key barriers to the adoption of innovation


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Executive Summary

A review of current practice in the provision of water and wastewater services by private developers: Key barriers to the adoption of innovation

Research Questions

- What are the key barriers faced by private developers to the application of innovation in water and wastewater service provision?
- What are the recommendations to inform future guidance in building and managing water and wastewater assets to help overcome these barriers?

Main Findings

- Key barriers for adoption of innovations in water and wastewater service provision identified by survey participants were:
  - Operational (e.g. perceptions on fitness of purpose for innovation, timescales)
  - Legal (e.g. demand for compliance, approvals process, other legal issues)
  - Financial (e.g. costs of innovation (Capex, O&M), no incentives to innovate)
  - Technical (e.g. feasibility of use, performance, lack of accredited supplies or equipment)
- Drivers for innovation are typically top down (utility or regulator demands) or bottom up (community needs), yet neither group typically pays for the innovations through the supply chain. Private sector actors seeking to innovate may thus be taking on risks (e.g. system failure or non-compliance) without the potential for reward meaning that such innovation activities do not often fit well within existing business models of private developers.
- The costs of implementing innovation are borne by the supply chain (developer) yet the benefits of improved quality or service are received by the end user, showing the poor alignment of the value chain and the risk chain.
- Existing procurement systems and the cost of monitoring solutions in compliance-based regulation may discourage innovation.
- On a corporate level, governance and risk in corporate decision making dissuade innovation.

Background

Private developers have two options for service provision for water and wastewater services across developments in Scotland. These include either connection of developments to existing public services at a cost, or the building of private systems that are either privately operated or seek a vesting agreement with Scottish Water to adopt. While connection to existing services is preferred, often geography and distance to public systems is physically or financially prohibitive. Small water and wastewater systems installed by private developers are a common feature across rural Scotland. The use of innovative technologies or approaches may allow for systems to be constructed, operated and maintained at lower cost, however the use of innovations or new technologies within the sector is typically limited. Innovation in the delivery of water and wastewater infrastructure and services is necessary to meet the future needs of our communities and a greater understanding of the drivers for innovation is needed in order to promote this innovation activity.

Research Undertaken

A literature review to identify the key barriers to the adoption of innovations (e.g. technologies, new ways of management) in provision of water and wastewater services in developments, including small scale and decentralised systems, was carried out. To complement this, we reviewed the guidance provided to private developers to identify any barriers to innovation. In addition, we sought views of private developers across Scotland surrounding the use of water or wastewater innovations in developments through an industry survey.

Recommendations

The main recommendation for overcoming barriers to innovation is to identify areas where the value chain can become better aligned with the risk chain for engaging in innovation activities. This can be supported by actions in the following areas:

- Reduce financial risks of innovation.
  - Provide access to shared resource, and systems to assist the innovation process.
    - Access to shared monitoring, modelling or visualisation equipment and skills could reduce risks by providing some early evaluation of potential solutions.
  - Build capacity for innovation amongst key actor groups.

    - improving skills and access to training
    - increasing opportunities for collaborative working and knowledge exchange
  - Increase visibility and dissemination of findings from demonstration projects and best practice case studies.
- Prioritise innovation needs for the sector (utility, regulator or end user needs).
  - Focus on innovations that achieve a specific area of need rather than the technology type itself.
- Provide guidance to developers that allow innovators to plan ahead for collecting and documenting the required levels of evidence needed for technical approvals (focussed on outcomes, rather than process). This includes reducing complexity in the guidance currently provided to developers.
- Assess where flexibility in procurement systems and the regulatory environment could be added to enhance the potential for adoption of innovations. This could include consideration of where alternative approaches to compliance (e.g. compliance algorithms, or compliance credit systems) could be applied, including the use of Publically Available Specifications as an alternative to EU or British Standards where appropriate.

The utility and/or government has a major role to play in supporting private sector actors to engage in innovation. This will require a more collaborative approach, where actors at many levels are involved in driving and developing solutions that will produce benefits across all actor groups, and may include the identification of champions of innovation across key stakeholder groups and decision making levels.

Contents

Abbreviations

BIM	Building Information Modelling
ICE	Institute of Civil Engineers
PAS	Publically Available Specifications
PDE	Pre Development Enquiry
SfS	Sewers for Scotland (guidance document)
SW	Scottish Water
UKWIR	UK Water Industry Research
WfS	Water for Scotland (guidance document)

1 Introduction

The aim of the research was to identify barriers faced by private developers in the provision of innovations in water and wastewater services and to provide recommendations to enhance innovation in building and managing water and wastewater assets. In order to achieve this aim, the project team carried out a detailed literature review using data and information sourced from academic and grey literature to identify barriers to adoption of innovation in water and wastewater service provision. This was accompanied by collection and review of information obtained from key stakeholders and developers. Scottish Water guidance documents provided to developers were reviewed to identify where barriers to innovation may exist within the guidance. A survey of developers was carried out to gain direct feedback from private sector actors on barriers to innovation. A meeting with the Scottish Water asset vesting team was held to discuss any key issues and identify potential case study locations for further review. Unfortunately, no sites were deemed suitable due to commercial or community sensitivities, therefore only generalised observations are presented in this report.

The report is structured as follows:

Section 2 presents the outcomes of the literature review, outlining key innovation challenges in construction and management of water and wastewater assets.

Section 3 presents a summary of the review of the guidance available to developers and results of the developer's survey.

Section 4 summarises the key findings and provides recommendations for improving the uptake of innovations amongst developers involved in building, operating and maintaining water and wastewater systems.

2 Literature review – Adoption of innovation in the water sector

2.1 Introduction

Water and wastewater utilities are under increasing pressure to deliver high-quality provision of service under challenging conditions such as aging infrastructure, population growth and shift, and increasingly stringent health and environmental quality parameters (AwwaRF 2008). Many centralised systems in developing countries were built within the past 100 years, and the scale of upgrades and replacement that will be needed, in addition to servicing new developments, is potentially enormous (Hering et al. 2013). The replacement rate for aging infrastructure of about 1% per year is not coupled with construction materials and techniques that can produce systems that will last in excess of 100 years (Speight 2015). As such, innovation is already being identified as key to improving future water and wastewater system resilience and the ability to cope with changes described above as well as increased frequency of extreme events (Canadian Water Network 2016). Innovations across water and wastewater technologies including new infrastructure, biotechnology, materials, sensors and computing, and use of natural systems as well as models of service provision and asset management will be required to cope with future challenges (Hering et al. 2013). Innovations are particularly needed in technologies or methods that extend the usable life span of pipes, but also allow for more flexible and adaptable systems, particularly for decentralised solutions. The arrangements for water and wastewater asset construction, operation, management, and long-term planning in Scotland present both opportunities and challenges for both private and public sector actors with regards to incorporating innovation in the future-proofing of water and wastewater systems.

2.2 Innovation in the construction sector

Innovation is not a core activity across the construction sector and generally lags behind that of other sectors, particularly amongst SMEs, where resources to innovate are lacking, both internally and externally (Mlecnik 2013; Suh and Kim 2012, ICE 2015). Unlike other industries, where innovation is at the core of business growth and development, the construction sector, and in particular provision of water services by the sector, typically take a conservative approach to innovation. The drivers and barriers to innovation across the construction sector are discussed in further detail, with a view to understanding the barriers to innovation faced by developers in incorporating water and wastewater innovations in their developments.

2.2.1 Drivers for innovation

The Institution of Civil Engineers (ICE) (2015) outline key reasons to innovate in the construction sector. These include:

- Increasing value and exceeding expectations of clients
- Reducing costs and maximising time efficiency
- Adapting to changing markets (both domestic and international)
- Increasing competitiveness
- Developing and retaining skilled workers

- Improving reputation
- Improving safety
- Reducing resource consumption and waste
- Adapting to technological change (e.g. digital technologies)
- Aligning with government targets

For providers of water and wastewater services, the main goal of protecting human health is followed by a secondary goal of keeping systems running. Along with these primary goals of improved quality and service provision, service providers are also seeking to address key financial and environmental drivers such as reduced energy and chemical consumption; reduced leakages; and a wider range of provision based on changing consumer and community needs. In order to achieve some of these key goals, innovation amongst developers involved in the construction, operation and maintenance of water and wastewater systems will be needed, however, innovation activity across the sector is of lower priority (Speight, 2015). Speight (2015) outlines the successful drivers of water sector innovation to include a supportive culture within the utility, coupled with a regulatory regime that allows for and supports innovation. The financial support for innovation is also required, along with consumer buy-in, which may be linked to consumer demand for better service provision.

Drivers for innovation within the provision of water and wastewater services are both top down (e.g. the utility, or the government) and bottom up (e.g. communities and consumers). For private developers working in provision of water and wastewater services, the internal drivers for innovation are not as strong, and while there may be interest in innovation, the incentives to pursue it are often not in place. Communities and consumers, as end users, are the likely beneficiaries of innovations (e.g. improved quality, efficiency or service provision). Similarly, aims of the utility or regulators may be met through innovation (e.g. improved quality, compliance, or lifespan of infrastructure), yet neither group typically pay for the innovations through the supply chain. Private sector actors seeking to innovate may thus be taking on risks (e.g. system failure or non-compliance) without the potential for reward.

The drivers for innovation in the sector thus require some attention. The ICE (2015) present Ofwat as an example of how a regulator has become a driver for innovation. Reduction in maximum allowable water pricing has forced water companies to find ways to improve efficiency and seek less costly alternative ways to comply with regulatory requirements, which in turn will have implications for private developers. While a driver for innovation, this also provides a number of challenges, where cutting costs must not compromise quality and service provision.

2.2.2 Barriers to Innovation

ICE (2015) identified a number of key barriers to innovation in the construction sector, which can be linked to the nature and culture of projects where risk-averse behaviours are present. The supply chain typically has little incentive to innovate, particularly when the benefits are likely to be transferred to the end users. Other barriers to innovation in the sector include the affordability of innovations, the life costs, procurement systems that may discourage innovations, regulation and approvals processes, and inefficient certification and validation processes (Gallant 2017). Brown et al. (2009) used the concept of receptivity in assessing practitioner barriers to innovation in water management in Australia. The study found that Australian practitioners identify acquisition variables such as skills, systems and resources as key limiting factors to innovation in delivery of water services. Interventions focussed on improving skills, resources and systems, including demonstration projects and best practice case studies, which may be important to overcoming barriers, but a critical lag between best practice thinking and current practice may exist (Brown et al. 2009). This can also be compounded by lack of funding for trialling innovations and infrastructural arrangements (Wilcox et al. 2017).

The drive for quicker completion of projects may force less than optimal project planning and implementation, avoiding more strategic and innovative approaches in favour of faster solutions. Innovative approaches can include non-conventional or new applications but there is a need for investment and trialling of potentially disruptive innovations or technologies. There is little incentive across the water sector to incentivise the adoption of innovation in developments, with a focus on clearing the "backlog" of projects. There is recognition that public and environmental safety must be ensured in the implementation of new technologies or approaches, and both small-scale testing and consideration of scale-up requirements must be carried out (Canadian Water Network, 2016). Investment in water infrastructure typically involves large financial commitments, and therefore systems must perform as required, which limits the incentive to innovate (Hering et al. 2013).

Gallant (2017) suggests that innovations should focus on achieving compliance rather than the technology type itself, and addressing barriers to innovation can help the adoption of better technologies and solutions contributing to economic growth. Kaszas (2017) suggests that although barriers to innovation may exist on the side of regulators, innovators themselves must plan ahead for technical and point of use approvals, develop clear value propositions with evidence, and approvals should focus less on process, and more on outcomes. Publicly Available Specifications (PAS) can be important to helping innovations to be adopted more quickly compared to individual product evaluation

and approval to EU or British Standards by providing codes of practice, guidelines for use, and standard vocabularies. Industry, including trade bodies or individual businesses, can take a leading role in development of PAS documents in partnership with regulators helping to ensure collaborative production of trusted specifications that meet a range of stakeholder needs.

2.2.3 Consideration of innovation in small-scale and decentralised systems

Alongside the review of construction sector drivers and barriers to innovation described in previous sections, literature in the context of innovation in small-scale, decentralised systems was also reviewed. A number of drivers for innovation in decentralised treatment systems in new urban developments and rural areas have been outlined by Quezada et al. (2016). These include:

- Reduce capital cost (related to avoidance of cost of connecting to distant central network)
- Green market positioning (new markets for sustainable and community-based solutions)
- Water scarcity (more control with regards to security of supply)
- Environmental impact and standards (more direct appreciation of local impacts)
- Increasing bulk water price (alternative solutions becoming relatively more affordable)
- Innovation for emerging markets (global demand for innovations in small systems)

This study also identified a number of barriers to adoption of innovations with regards to small-scale, decentralised systems (Quezada et al. 2016). These included:

- Perception of technology risk associated with public health and water quality concerns (could have high relative costs if it doesn't deliver)
- Governance concerns as a barrier to adoption of innovations based on the implication that the utility will take over the management if the new entities "fail"; decentralised assets may be seen as a burden upon utilities, and hence may not be promoted by the utility
- Unsupportive regulation and legislation (inhibiting the uptake of alternatives), and costs of compliance related to monitoring of decentralised systems
- Corporate strategy of utilities (risk management, commercial opportunities)
- Locked-in business models and potential for protectionism, where engineering consultancies may lose design work if modular and decentralised systems are widely adopted.

This research demonstrates that concerns over the management of decentralised systems can present barriers to innovation and possible adoption of new types of small scale decentralised systems. Innovations may therefore be needed in the way systems are managed. Various systems of water and wastewater asset management are in place around the world. In general, there is a move away from fragmented ownership, operation and maintenance of water and wastewater assets towards more centralised provision. In large part this is due to the increasingly stringent environmental standards, customer demands for high quality water provision, and efficient wastewater treatment systems, which come at an increasing cost and requirement for a higher level of expert knowledge to operate and maintain systems (Baynard 2006). Lobina (2016) discusses the remunicipalisation of privatised water supply and sanitation back to public management, as a reaction to unsuitable water and sanitation provision by private actors. Some of the key drivers towards remunicipalisation listed by Lobina (2016) include poor quality service provision, high costs to customers, under-investment in infrastructure, lack of financial transparency, and monitoring difficulties – all underpinned by a general conflict between community development, and private sector profit seeking. This relates back to the poor alignment of the value chain and the risk chain, where the costs of implementing innovation are borne by the supply chain (developer) yet the benefits of improved quality or service are received by the end user.

2.3 Overcoming barriers to innovation

Where the value chain is better aligned with the risk chain, allowing more collaborative approaches to be adopted, barriers to innovation observed in water and wastewater service provision may be overcome. The ICE (2015) recommends the following building blocks of innovation, to assist in overcoming some of the key barriers to innovation:

- People – ensure diversity, good leadership, communications, training and skills.
- Strategy and Delivery – incorporate planning for innovation and learning from failure.
- Procurement – consider the role of the client as a driver for innovation. Contractors/supply chain bear most of the risk of innovation, whereas the client or end user receives all of the reward. Integrated supply chain allowing for Early Contractor Involvement, can allow diverse viewpoints, including those of smaller companies to identify opportunities for innovation.
- Investing in Innovation and R&D – allocate human resources and provide adequate platforms to collect good data.
- Knowledge Sharing – promote creative thinking and collaboration with other groups including academia,

consultants and others, removing the "knowledge is power" inhibitor.

- Standards and Regulation – considering how highly prescriptive regulations and standards can stifle innovations, but also provide a driver; a balance must be reached.
- Embracing technology – using digital technologies (e.g. Building Information Modelling, (BIM)) can allow alternative scenarios to be visualised and modelled with low risk. Wider use of sensors and monitoring equipment can also assist in informing effectiveness of innovations, and inform operational and maintenance regimes later.

In the context of decentralised systems, interviews carried out by Quezada et al. (2016) asking participants about the enabling conditions for deployment of decentralised systems provide some ideas on how barriers to innovation for small-scale systems could be reduced. These include:

- Focussing new developments in un-serviced areas provides the value chain benefits of developing innovations that have a ready-made market.
- Direct government support can assist in overcoming the financial barriers, helping to align the value chain with the risk chain.
- Alignment of the project with the business strategy of the utility, and involvement of the utility in selection of technology within the planning framework can assist in overcoming some of the institutional and approvals barriers that could be faced.
- Community support through education and awareness raising provides a direct link between the developer and end user to assist in understanding requirements and capabilities of each.

The Quezada et al. (2016) interviews also suggested however, that proven and acceptable technologies are more likely to enable deployment of decentralised systems. This indicates that there will be reluctance to try new and untested technologies and implies that early support is needed to verify and test approaches to provide proof of acceptability. The study also found that although some actors wish to do more innovation as a future proofing measure, they are constrained by reducing profit margins, high overheads and restrictive regulation. There are also competing objectives within the sector. Achieving environmental improvement such as reduced water consumption is at odds with traditional business drivers of growing the market and selling more product. Suppliers are also operating within a restricted charging regime, and innovations to achieve greater water efficiencies may have no direct returns for the supplier.

2.4 Non-technological innovations

In addition to technological innovations in water and wastewater services, approaches to management of new developments alongside catchment management considerations could allow for greater flexibility in the stringent compliance elements faced by developers. Non-technological innovations can include new ways of thinking about how water and wastewater services are provided.

To overcome barriers linked to developers being able to achieve strict regulatory compliance parameters, a number of alternative approaches can be considered. Szeptycki (2017) suggests that databases of compliance outcomes can be better used across the water and wastewater network to assist decision making. The descriptive (what happened), diagnostic (why it happened) and predictive (what is likely to happen) information could be better used to assess the application of innovative technologies in new developments. The "One Water" approached described by Szeptycki (2017) considers the use of compliance algorithms rather than binary compliance requirements. Compliance is thus less reactive, focussing on matching predicted water quality with its end use or receiving environment. It is suggested that this approach can reduce time for innovative projects to receive approval, if matched to appropriate locations. This information, once compiled can provide useful demonstration sites or case study data that can inform future innovation projects, if made available.

In a similar vein, Crawhall (2017) describes an innovative system of compliance credits, comparable to carbon trading, where net zero loading from wastewater systems (point source discharges) can be achieved by improvements elsewhere in the catchment such as decreases in diffuse source loading to a water body. The system is proposed to provide an alternative approach to catchments where new development is restricted by the ability of the wastewater treatment infrastructure to accept new connections due to compliance concerns. The alternative system would propose that new connections could be approved with a lower compliance level, provided that actions were taken to reduce non-point source loading elsewhere in the catchment, thereby achieving net-zero impact, but facilitating new developments. Examples across the province of Ontario (i.e. Lake Simcoe, Upper York Regional Sewage (Crawhall 2017)) have demonstrated how the approach can work in practice and provide evidence for developers to think innovatively across a development or catchment area as to how to better achieve overall compliance.

Daniell et al. (2014) outline themes that are important in the uptake of innovation in the water sector, particularly where forms of multi-level governance exist. They suggest that researchers, consultants and experts, well-versed in innovation options can act as gate-keepers to facilitate innovation uptake in multi-level governance systems.

Innovations may need to be adjusted or contextualised in the specific receiving environment to increase acceptability. In addition, the consideration of time horizons and different perceptions of time and urgency amongst key actors can be important in how innovation processes progress (e.g. developer and client priorities and timescales, regulator timescales, and innovation cycle timescales) (Eshuis and van Buuren 2014). Daniell et al. (2014) also find that decentralised, integrated and participatory water management innovations are more difficult to implement particularly where entrenched governance systems exist. They suggest that in multi-level governance systems, champions of innovation are needed at more than one level, particularly those involved in decision making processes. Higher levels can help to increase innovation capacity by providing funding, incentives, or policy frameworks that support the adoption of innovations.

2.5 Literature Review Conclusions

The literature finds that the drivers for the adoption of innovation in water and wastewater services are typically top town (regulator or utility drivers) or bottom up (community or consumer driven), whereas the developers or private sector supply chain typically takes a conservative approach to innovation. The reasons for this can be linked to the barriers to adoption of innovation in water and wastewater services, largely applicable across the construction sector.

These barriers include:

- Lack of internal/external financial resources to fund innovations
- Lack of human resources to navigate innovation landscape, including certification and approvals processes
- Lack of financial incentive to innovate, benefits are transferred to end user
- Risk-averse behaviours, technology risks associated with water quality and public health
- Procurement systems and regulatory environment that limit the market for innovations

The review has also identified recommendations for overcoming some of these key barriers in order to increase the uptake of innovation by private developers across the water sector. This includes encouraging organisations to strategically plan for innovation, building up internal capacity, and leveraging support of external stakeholders such as the utility. The utility will be a primary beneficiary of innovation particularly for technological solutions that extend the lifespan of infrastructure and improve quality of service provision. Therefore, utilities have a major role to play in supporting private sector actors to engage in innovation. This could be assisted by closer direct working in the innovation process, including greater knowledge sharing and collaborative practices, or improved procurement systems that do not discourage innovation. Collaboration would also include the shared use of enabling technologies and sharing data (e.g. sensors and monitoring, use of visualisation and modelling techniques) that can help to reduce elements of risk within the innovation process.

The drive to improve water and wastewater service provision in remote areas, provides challenges to both utilities and private sector developers. Literature indicates that there is a trend towards remunicipalisation of decentralised systems elsewhere, as a result of poor technology performance or service provision. Innovative approaches and technologies could assist in overcoming some of these issues, but to be effective will require a more collaborative approach. In prioritising innovation with regards to small water and wastewater systems, enabling factors can include prioritising the market (e.g. focus on un-serviced areas), government or utility support to overcome financial barriers and help to align value and risk chains, involvement of the utility in technology selection within the planning framework, and engagement with communities to raise awareness and educate end users on the capabilities and risks of technology choices. Innovation champions across stakeholder groups can be important to driving change, providing support, and ensuring collaborative approaches are adopted.

3 Provision of water and wastewater services by private developers in Scotland – barriers to innovation.

3.1 Challenges for developers – review of the guidance

In the context of innovation across the water sector in Scotland, a review of guidance for vesting or adoption of assets was carried out to identify where barriers to innovation may exist. Vesting refers to the transfer of newly constructed and privately owned and operated water and wastewater assets into public ownership and operation. The vesting process in Scotland presents a number of challenges for developers. The process consists of several stages that follow the asset from feasibility assessment and pre-planning, through construction, and transfer of the asset, followed by a guarantee period following vesting. The process is not a short one, and the series of steps a developer is required to complete can be complex. Developer's forums have identified challenges such as administrative burdens and complications such as

land title and securing rights of servitude over land. This may increase the reluctance of developers to consider the use of innovative approaches and technologies in their developments, where complications can delay the process, making it less appealing to divert from the status quo.

In Scotland, developers are directed to key guidance on the requirements for assets to be adopted by Scottish Water (SW). A short review of the guidance available to developers was carried out to identify areas of the guidance that may impact adoption of innovation. From the review of the guidance, we identify "Complexity" and "Cost" as the main barriers:

- Complexity – Multiple guidance documents, forms, and cross-referencing adds complexity for developers. The complexity adds to barriers to adoption of innovation, where it could be perceived that the status quo is complicated enough. In addition, forms and guidance are not designed for alternative or non-standard approaches. Along with complexity, there is also lack of clarity within some of the documents, with ambiguous definitions and descriptions of the process, and terminology used interchangeably (e.g. "feasibility" stage, "Pre-Development Enquiry" (PDE), "development appraisal (DA)"). More consistent terminology and communication across all guidance forms and documents could reduce some of the barriers faced by developers.
- Cost –To navigate the vesting process, developers may be required to procure expert consultants at significant costs, in order to ensure compliance. There is limited guidance to the degree to which evidence must be provided to demonstrate the performance of a new product or process, yet there are cost implications associated with this.

From the perspective of adopting innovation into new developments, the guidance is limited, however WfS provides the following guidance on the use of innovations:

> *"In the case of recently developed or innovative products, no current European Standard, British Standard or equivalent will normally be available. This may not preclude the use of a product where its performance or properties can be determined to align with its intended duty and design life. Careful consideration shall be given to any independent assessment or evidence of product performance."*

The guidance suggests that developers can use innovations, however, they must provide robust independent assessment and evidence to prove the ability of the innovation to achieve compliance and design life. The risk of using innovations that have not achieved European or British Standards may limit the scope for developers to adopt new products or approaches. In applying innovations to new water or wastewater service provision, developers may be restricted in the design and procurement of systems, particularly in ensuring that bespoke or new designs align with the site requirements specified in the guidance (Sewers for Scotland (SfS), WfS). The developer can either work with SW to develop a pre-approved design and plant, procuring systems independently; or procure SW design and modules with a fast-tracked technical approval. Each of these options presents developers with potential cost or time implications that must be taken into consideration. Although fast-tracked solutions may be favourable in terms of time considerations, they may also be limited to prescribed set of designs and plant, limiting the ability for innovations to be considered or indeed developed. Despite this, 'fast-tracked' options may still provide greater appeal for developers, particularly where the incorporation of innovations adds risks for the developer, but primarily only benefits the end user.

The initial project scope included a remit to carry out reviews of case study sites to identify barriers in the vesting process. Engagement with key stakeholders was hampered in the early stages of the project, and no case study sites were deemed suitable for review due to sensitivities amongst key actors involved in sites where asset vesting difficulties had been experienced. However some communications with the SW Asset Vesting team assisted in identifying some of the key barriers faced in the process. Vesting of existing assets that have been in operation for an extended time frame provides unique challenges compared to those identified for new developments. Based on communication with the SW Asset Vesting team, some of the key challenges relating to legacy cases communicated with the research team include:

- Technical and legal complexities leading to delays in progress
- Complexity in associated liabilities and responsibilities associated with transferring private assets into public ownership
- Extensive cost of survey and investigation work for private developers prior to any guarantee of vesting (e.g. cctv work, network survey and land ownership investigation)
- Agreement of sewerage charges to be paid and transfer of land title for asset (complicated where multiple owners, and mortgage lenders)
- Required approvals and licences for construction of new asset and associated outfalls, SEPA consent, security works, and access for operation and maintenance
- Multiple owners must agree, multiple legal processes to agree and transfer land, can include multiple mortgage lenders – if one does not agree, the whole process is stopped

There is clearly scope for innovation to assist in reducing some of the challenges experienced in legacy vesting, whether through the incorporation of bespoke technological

solutions, or innovative management approaches that help to overcome the some of the legal, cost and compliance issues faced by stakeholders seeking vesting agreements. Relatively low cost and low impact technologies such as sensors and monitoring equipment could be important in informing potential scale of upgrading requirements as well as operational and maintenance requirements. However, the complexity of the process, the potential cost implications, and the additional timescales that would be required to gain approvals for innovations in these projects may impede their consideration.

3.2 Survey feedback

A survey intended to review the key types of guidance used by developers and key challenges with regards to the use of innovations in developments was issued to more than 100 developers across Scotland. Recipients included Homes for Scotland members and other developers across a range of geographical locations and business sizes. Email contacts, direct phone calls, and sharing of the survey on LinkedIn were also used to publicise the survey. The response rate was low, with only five responses received. There are a number of possible reasons for the low response rate, which may include lack of free time for respondents to fill in the survey, lack of perceived benefits of participation, lack of interest in the subject matter of the survey, or lack of knowledge of the person contacted to respond fully to the survey.

Despite the low response rate, some useful feedback was obtained. All businesses that responded were SMEs; no large businesses responded. The respondents were involved in a range of development types from small single home developments to large and medium sized housing and/or commercial developments.

The survey identified that for water and wastewater connections, developers use the primary WfS and SfS guidance, but also seek guidance elsewhere, through Local Authorities, company's own guidance and specifications, and through onsite discussions and debate. Other forms of guidance used by respondents included SW New Connections guide, CIRIA C753 The SUDS Manual, Water and Drainage Assessment Guide (WADAG), SUDS for Roads, and Sewers for Adoption 7th Ed. (for sites in England and Wales). Typically a downloaded e-copy of the guidance is referred to, rather than live online documents or paper versions. Respondents were asked about who they contact if they require further guidance or advice. The majority of respondents refer to colleagues in the company for advice, followed by direct contact to a Scottish Water operative. Some respondents also sought advice through other contractors, consultants, SEPA, with only one respondent indicating that they would use the Scottish Water help line, or seek assistance through a local authority.

3.2.1 Use of innovations

Three of the five respondents indicated that they consider the use of innovative approaches or technologies in the installation of water or wastewater assets. Water innovations were related to water mains and booster stations incorporating variable speed drives and remote monitoring. Wastewater innovations covered a wider range of applications across sewage treatment and attenuation systems including foul sewer, foul pumping station, underground storage, pond, basins, source control SUDS within residential developments and individual house plots, and sustainable drainage assets other than tanks, basins and ponds. The types of wastewater innovations included surface water assets (not foul), which are largely non-vestable assets (by Scottish Water), but may be accepted by the local authority such as swales, filter trenches, filter strips, wetlands, raingardens (natural and raised), permeable surfaces, in-curtilage soakaways, soakaways, and geocellular/modular tanks.

More respondents indicated a likelihood to use innovation in wastewater treatment than drinking water treatment. While the number of respondents was small, the lack of innovations related to treatment technologies in drinking water systems possibly indicates a greater level of caution with regards to drinking water, for which compliance standards are of utmost importance.

3.2.2 Barriers to innovation

Respondents were asked to identify the types of barriers to innovation they had experienced when using innovative approaches or new technologies in water or wastewater assets. The following possible response options were provided:

- Administrative/IT/web forms etc. (e.g. complicated forms, too many forms, other IT/admin issues);
- Legal (e.g. demand for compliance, approvals process, other legal issues);
- Financial (e.g. costs of innovation (Capex, O&M), no incentives to innovate, other financial issues);
- Operational (e.g. perceptions on fitness of purpose for innovation, timescales for compliance);
- Technical (e.g. feasibility of use, performance, lack of accredited supplies or equipment);
- Other issues (see comments)

Figure 1 presents the survey responses about barriers to innovation faced by developers. Operational factors were listed most often as a barrier to innovation. This was followed by legal, financial and technical barriers, and finally administrative barriers. Other barriers were identified by one

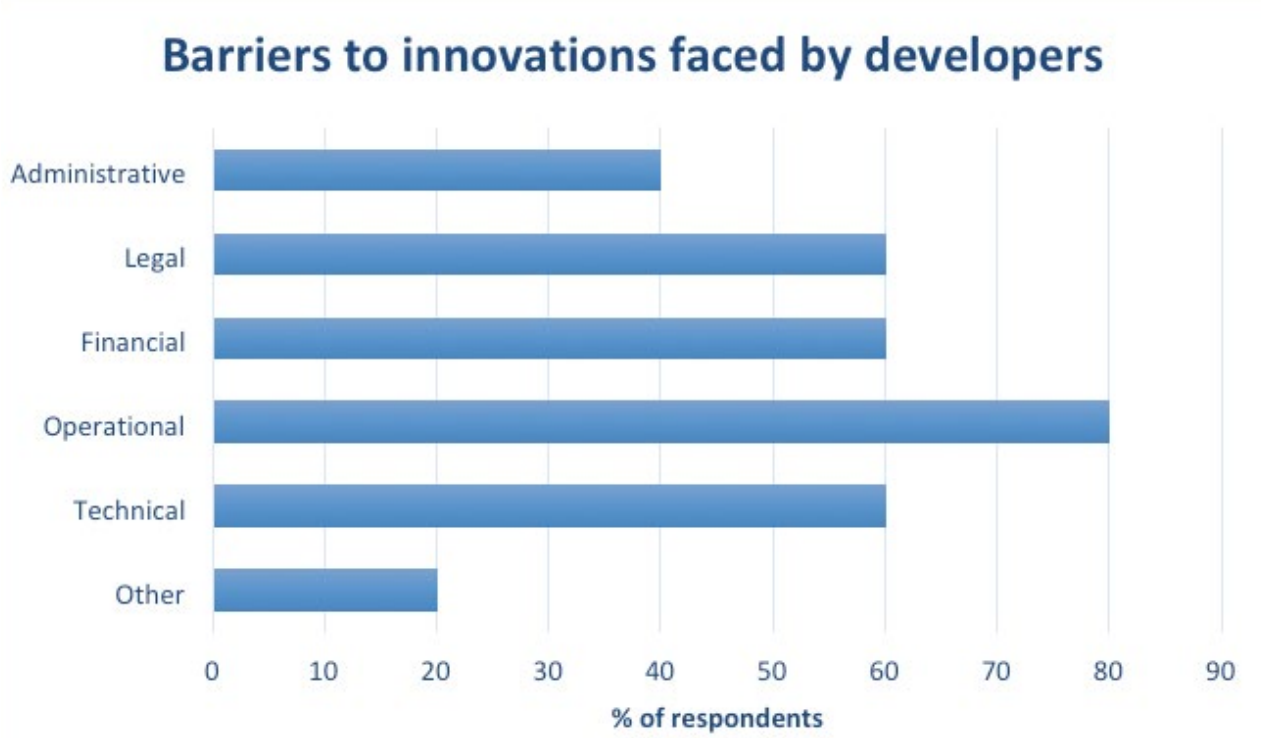

Figure 1 Barriers to innovations noted by survey respondents.

respondent in reference to assets that are non-vestable or adoptable by the managing authority limiting the options for design for surface water systems (e.g. SUDS). This is particularly relevant to legacy SUDS, designed pre-SfS 2, which are non-vestable due to being designed outside the specification.

Another respondent commented on the use of innovation in new assets, and stated that:

> *"Experience has taught that commercially it is just best to stick to the vesting authority's "book", as to try and do otherwise very rarely if, if ever, results in value to a client."*

Another respondent noted:

> *"There are variances by local authority in approval of levels of treatment for new development, and what constitutes adequate treatment. Additionally most, if not all, Scottish local authorities are using CIRIA C697 (2007) as the advisory source and not CIRIA C753 (2015) and this uses the historic guidance for asset selection, effectiveness and design of treatment trains. Whilst it is recognised that the new Simple Index Approach is not without criticism, it creates a level playing field for asset selection and treatment train design."*

The responses suggest that the process of asset vesting is complex, and the guidance may not always be clear or consistent. While some developers are considering innovative approaches, there is indication that doing so does not always provide value to the developer, and therefore incentive to innovate may be limited.

4 Discussion and Conclusions

4.1 Summary of barriers

The barriers to innovation for developers identified in the literature agree in a large part with the observations derived from the survey of developers. Key barriers for adoption of innovations in water and wastewater service provision identified in this study were confirmed as generally a good representation of barriers faced across the sector. The most important barriers identified by participants were:

- Operational (e.g. perceptions on fitness of purpose for innovation, timescales for compliance);
- Legal (e.g. demand for compliance, approvals process, other legal issues);
- Financial (e.g. costs of innovation (Capex, O&M), no incentives to innovate, other financial issues);
- Technical (e.g. feasibility of use, performance, lack of accredited supplies or equipment);

General barriers were identified based on the nature and culture of projects where there is little incentive to innovate. Drivers for innovation are typically top down (utility or regulator demands) or bottom up (community needs), and these may be pulling innovation in different directions. For the supply chain, potential compensation for innovations is not seen to be worth the risk, and as such, innovation activities do not often fit well with existing business models of private developers. Existing procurement systems and the cost of monitoring solutions in compliance based regulation may discourage innovation. On a corporate level,

governance and risk in corporate decision making dissuade innovation. Due to the observation that more developers are willing to innovate in wastewater than drinking water, it may be perceived that innovation in the provision of drinking water treatment carries a greater level of caution than innovations in wastewater or storm-water management.

4.2 List of recommendations

Innovation in the delivery of water and wastewater infrastructure and services is desirable and necessary to meet the future needs, both in relation to existing infrastructure, and new developments, including small scale and decentralised systems. In order to meet the innovation needs of the future, efforts to reduce barriers to innovation amongst private sector actors will be needed. A key element will be a greater understanding of drivers for innovation amongst this group, and seeking to both promote and incentivise innovation activity.

The literature review and survey responses presented themes for overcoming barriers to innovation. The headline recommendation is to identify areas where the value chain can become better aligned with the risk chain for engaging in innovation activities. This can be supported by actions in the following areas:

- Reduce financial risks of innovation
  - Provide access to shared resources, and systems to assist the innovation process
    - Access to shared monitoring, modelling or visualisation equipment and skills could reduce risks by providing some early evaluation of potential solutions.
  - Build capacity for innovation amongst key actor groups
    - improving skills and access to training
    - increasing opportunities for collaborative working and knowledge exchange
  - Increase visibility and dissemination of findings from demonstration projects and best practice case studies
- Prioritise innovation needs for the sector (utility, regulator or end user needs)
  - Focus on innovations that achieve a specific area of need rather than the technology type itself
- Provide guidance to developers that allow innovators to plan ahead for collecting and documenting the required levels of evidence needed for technical approvals (focussed on outcomes, rather than process). This includes reducing complexity in the guidance currently provided to developers.
- Assess where flexibility in procurement systems and the regulatory environment could be added to enhance the potential for adoption of innovations. This could include consideration of where alternative approaches to compliance (e.g. compliance algorithms, or compliance credit systems) could be applied, including the use of Publically Available Specifications as an alternative to EU or British Standards where appropriate.

The utility and/or government has a major role to play in supporting private sector actors to engage in innovation. This will require a more collaborative approach, where actors at many levels are involved in driving and developing solutions that will produce benefits across all actor groups. This could include identifying innovation champions across decision making levels, and stakeholder groups to help align objectives, and approaches.

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