Transitioning to a sustainable urban water future in the Netherlands

HOW DECISION-MAKING PROCESSES AND INSTITUTIONAL FACTORS CONTRIBUTE TO CLIMATE ADAPTATION IN URBAN DRAINAGE SYSTEMS

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Executive Summary

Changing climate conditions, and associated climate hazards such as flooding, drought and the urban heat island effect are threatening the livability of cities and urban areas. The Netherlands is particularly vulnerable to the impacts of climate change and increased urbanization, especially urban flooding. Therefore, increasing the implementation of climate adaptation measures, specifically within the urban drainage system is particularly important. Yet, despite the recognized need for climate adaptation, implementation of adaptation measures is occurring at a slower pace than necessary to cope with the problem, resulting in an "adaptation deficit" or "implementation gap".

Understanding how current decision-making processes can limit or facilitate implementation of climate adaptation measures provides an opportunity to reduce this gap. However, the decision-making processes in urban drainage and climate adaptation within Dutch municipalities are poorly understood. Furthermore, they occur in a complex decision-making environment involving multiple actors and are often influenced by institutional factors.

This thesis aims to understand if decision-making processes and institutional factors in Dutch municipalities hinder or enable the implementation of climate adaptation measures in urban drainage systems, and consequently climate adaptation efforts in the Netherlands. To answer the research questions, qualitative research methods were used based on a deductive and semi-inductive research approach. A theoretical framework was developed based on an extensive literature review and used to analyze data collected via interviews. Overall, 14 exploratory interviews were completed with 13 participants.

Interview findings showed that decision-making processes are evolving to incorporate climate adaptation efforts where possible. Implementation of climate adaptation measures was identified to occur when there was an opportunity to incorporate them into other necessary infrastructure projects, such as large-scale neighbourhood redevelopments, however taking advantage of these opportunities depended not only on their existence, but also on current institutional factors. Frequently identified hindering and enabling factors included the availability of financial resources, the current regulatory framework, fragmented roles and responsibilities within municipalities and the availability of sufficient and appropriately skilled personnel. Factors such as cultural/cognitive resistance and political incentive to action were also identified as hindering and enabling climate adaptation efforts.

Interview findings also showed that in addition to the institutional factors, the actors involved in the decision-making process and the resources available to these actors played an important role in the decision-making processes. Four key actors were identified from the data: technical designers/ decision-makers, the local community, the municipal council and housing developers. The support or resistance of these actors strongly impacted the duration of the decision-making process and success implementing climate adaptive measures.

In conclusion, though the decision-making processes are evolving, the use of opportunity-based initiation tactics and ineffective bargaining tactics resulted in processes were often stalled or blocked

prior to decision implementation. Improvements can be made to the decision-making tactics used by practitioners, however, the processes by themselves were not found to act as distinct hinderances. The institutional context within which these decisions are made has significant influence on the outcomes of the process and the institutional factors identified indicate that the current context is more hindering than enabling. Strategies to address some of these hindering factors can therefore also facilitate the decision-making processes and lead to an increase in implementation of climate adaptation in urban drainage systems.

These strategies include the recommendation that municipal councils formalize legislation requiring climate adaptation on new developments and redevelopments to increase implementation of measures on both private and publics lands. Furthermore, increasing collaboration with local communities and involving them in earlier stages of decision-making process, such as the design development phase, can help to reduce stalled processes. Additional strategies to address the most frequently identified hindering factors include the recommendation to dedicate a percentage of sewer tax to climate adaptation measures, increase training for insufficiently skilled practitioners and restructuring organizations to allow for better integration of practitioner roles and responsibilities.

Further research is recommended to identify the relative importance of hindering factors and identify which of them have the strongest impact on decision-making processes.

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1 Introduction

1.1 Background

Changing climate conditions, and associated climate hazards such as flooding, drought and the urban heat island effect are threatening the livability of cities and urban areas (van de Ven et al., 2016). The projected increase in urbanization (Elmjid, 2018), and its consequent need for infrastructure can further aggravate the impacts of climate change in cities due to an increase in impervious ground surface resulting from urban land uses. Climate adaptation, defined as "*the process [in human systems] of adjustment to actual and expected climate and its effects, in order to moderate harm or exploit beneficial opportunities*" (IPCC, 2018, p.3), is therefore essential to building resilient cities. However, despite the recognized need for climate adaptation, implementation of adaptation measures is occurring at a slower pace than necessary to cope with the problem (Eisenack et al., 2014). This "adaptation deficit" or "implementation gap" is well recognized in the literature (R. Biesbroek et al., 2015; Eisenack et al., 2014; Ekstrom & Moser, 2014; Runhaar et al., 2018; Uittenbroek, 2016).

The Netherlands is particularly vulnerable to the impacts of climate change and increased urbanization, especially that of urban flooding. The risk and probability of urban flooding in the country are expected to increase due to the combined effects of a rising sea level and more frequent high intensity, short duration rainfalls resulting from climate change (NKWK, 2021).Without climate adaptation measures, direct and indirect damages from urban flooding are estimated to range from 33 to 87 billion euros under the current climate trajectory or increase to between 55 and 124 billion euros if climate trends increase (Ministry of Infrastructure and Water Management, 2020a; Climate Damage Atlas, 2021). The Dutch Delta Programme, established in 2010, includes as one of its aims rendering the country "climate-proof and water resilient" (Ministry of Infrastructure and Water Management, 2020b). It includes urban flooding as one of four issues to tackle in order to address the impacts of climate change (NKWK, 2021).

Water management in cities, known as urban water management (UWM), plays a key role in tackling urban flooding. UWM encompasses the management of stormwater, wastewater and groundwater infrastructure and systems. Within UWM, the urban drainage system is particularly important in addressing urban flooding due to its role in managing stormwater runoff (i.e. rainfall that runs off the ground surface). In the Netherlands, the responsibility for managing urban drainage and urban water systems predominantly falls under the jurisdiction of local municipalities, with some responsibilities shared with district water boards. There are 390 municipalities in the Netherlands, each of which is responsible for managing excess stormwater runoff and wastewater through the sewer systems, in addition to groundwater (Ministry of the Interior and Kingdom Relations, 2017; Ministry of General Affairs; 2019). This research focuses on the "implementation gap" of climate adaptation in urban drainage systems due to its importance in managing urban flooding.

A number of factors have been identified in the literature that contribute to this adaptation "implementation gap" in urban drainage systems. These include: institutional and governance issues such as lack of legal and regulatory guidelines, "attitudinal" issues such as a lack of motivation and willingness to act, and resource and funding issues, such as limited available funds (Biesbroek et al., 2013; Ekstrom & Moser, 2014). One factor is the need for collaboration between a wide range of actors due to the multi-

sector, multi-level nature of climate adaptation (Biesbroek et al., 2013; Dąbrowski, 2018). Due to the sub-surface (i.e. pipes) and ground surface components of urban drainage systems, implementation of climate adaptation measures (i.e. both infrastructure and policies) requires collaboration and coordination between professionals from different disciplines in the public and private sectors such as engineering, urban planning and design and spatial planning (Fryd et al., 2012; Yazdanfar & Sharma, 2015, van de Ven et al., 2016). However, this collaboration can be hampered by institutional fragmentation, defined as a "*lack of connection and coordination among institutions, organizations, individuals and policies at different levels and scales*" (Biesbroek et al., 2013, p.186).

Within urban drainage systems in the Netherlands, the need to manage the existing ageing sewer infrastructure is also an important consideration for addressing the adaptation implementation gap. Sewers play a critical role in managing and preventing urban flooding (van Riel, 2016a). And, due to the long design-life of sewer infrastructure, decisions taken in the present on how to manage these assets will have an impact on the level of service they provide in the future (Tscheikner-Gratl et al., 2019), particularly how well they perform under different climate conditions. In the Netherlands, a substantial proportion of sewers were built in the 1950s to 1970s (van Riel, 2016a) and are reaching the end of their design life, which can range from 50 – 100 years (Tscheikner-Gratl et al., 2016). The activities necessary to manage the performance of this infrastructure are termed "sewer asset management" (SAM) and can include cleaning, replacement, budget allocation and strategy formulation (van Riel, 2016a, p.1). SAM already requires significant economic investment, even without the need for climate adaptation. A case in point, in the Netherlands, approximately 1.5 billion euros is spent on sewer rehabilitation and replacement every year (van Riel et al., 2016b).

Understanding how decisions are made in practice (i.e. decision-making processes) is essential for understanding the cause of, and addressing the climate adaptation implementation gap (Biesbroek et al., 2015). Research highlights that the actions taken by actors play a key role in addressing barriers to climate adaptation notes that these barriers (Eisenack et al., 2014), actions which are preceded by decisions. The research also recognizes that the institutional context within which these decisions are made are important, and that different institutional contexts can result in different barriers (Biesbroek et al., 2013; Eisenack et al., 2014).

The existing infrastructure issues in SAM, and the multi-actor collaboration required to implement climate adaptation measures in urban drainage systems results in a particularly complex decision-making environment. However there is limited understanding of these decision-making processes and the institutional factors that influence them.

This research investigates current decision-making processes in urban drainage systems and climate adaptation in Dutch municipalities, and the institutional factors that influences these processes. It aims to understand if and how these decision-making processes and institutional factors hinder or enable the implementation of climate adaptation measures in urban drainage systems, and consequently climate adaptation efforts in Dutch cities.

1.2 Societal and Scientific Relevance

From a societal perspective, this research supports the Delta Programme objective of making Dutch cities "climate-proof and water resilient" (Ministry of Infrastructure and Water Management, 2020a). It also supports the actors and decision-makers who are responsible for building sustainable cities that can meet future challenges and provide healthy environments for human development, in line with the United Nations (UN) Sustainable Development Goal (SDG) 11, "*sustainable cities and communities*" (UN DESA, 2020). In addition, the UN "Valuing Water Initiative" highlights a need for *"better decisions impacting water*" to meet SDG 6 (The Valuing Water Initiative, 2020, p.4), highlighting the importance of decision-making in achieving large-scale societal goals.

From a scientific perspective, the research will further clarify existing decision-making practices and decision-making context in urban drainage and climate adaptation in Dutch municipalities. It will provide insights on how the current practices and institutional context can contribute to decreasing the climate adaptation implementation gap in urban drainage systems. Findings from this research will also contribute to the body of research on the role of decision-making process in the implementation of climate adaptation measures (policy and infrastructure) in the urban water sector.

1.3 Definition of key concepts

A number of key concepts are mentioned in this research and defined as follows.

"Sewers" are defined by van Riel (2016) as "urban underground [pipe] infrastructure for collecting and transporting wastewater and/or excess stormwater, to a treatment facility prior to discharging it to surface water" (van Riel, 2016a, p.1).

The urban drainage system consists of an overland (i.e. ground surface) component and underground sewers, as defined above. This research focuses on increasing the implementation of climate adaptation measures in urban drainage systems.

"Climate adaptation measures" include strategic policies and plans aimed at addressing urban flooding, in addition to physical infrastructure measures such as sustainable urban drainage systems (SUDS). SUDS are defined as "*a range of technologies and techniques used to drain stormwater/surface water in a manner that is more "sustainable" than conventional solutions*" (Fletcher et al., 2015, p.529). They are similar in concept to other stormwater management measures that incorporate natural or designed landscape components into the urban drainage system such as "green infrastructure" (GI), nature-based solutions" (NbS), "low impact development measures" (LIDs), or blue-green infrastructure (BGI). They can include green roofs, rain gardens, urban wetlands and swales (O'Donnell et al., 2021).

"Decision-making process" refers to both the "decision process" and the "decision". These are defined by Mintzberg & Theoret (1976) as the "*set of actions [and] dynamic factors that begin with the identification of stimulus for action"* (i.e. the process), and *"ends with a specific commitment to action*" i.e. the decision. (p1, Mintzberg & Theoret, 1976)

1.4 Research Questions

In order to develop the main research question, a purposive literature review was undertaken to identify the knowledge gap. The literature reviewed fell into four broad categories: literature on decision-making in urban drainage systems, literature on decision-making, institutional change in urban water management, literature on decision-making in climate adaptation, and literature on decision-making processes.

1.4.1 Literature on decision-making in urban drainage systems

The literature on decision-making in urban drainage systems is split between literature on decision-making in urban drainage systems more generally and decision-making in sewer asset management (SAM).

The literature on decision-making in urban drainage systems focuses on the use of decision-support tools aimed at identifying optimal infrastructure solutions to meet a range of criteria, including climate adaptation.

Babovic et al. (2018) propose the use of decision-making under deep uncertainty (DMDU) methods to aid in design and selection of urban drainage infrastructure in an uncertain future. Methodologies proposed include Dynamic Adaptive Policy Pathways (DAPP), Adaptation Tipping Points and Pathways (ATPP) and the use of exploratory modelling approaches such as Robust Decision-Making models. Yang & Zhang (2021) propose a multi-criteria decision-making (MCDM) framework with eight indicators from flood mitigation capacity to life-cycle cost to "political criteria" aimed at assessing the performance of SUDS compared to "gray infrastructure" i.e. conventional sewers. And, Lahtinen et al. (2017) also discuss how the use of decision-analysis methods and decision support tools can support the complex and collaborative decision-making necessary for transition of socio-technical systems.

This literature combines the use of quantitative assessment tools and simulation models with multiple non-technical criteria (e.g. cost, decision-maker preference etc.). However, while it is able to capture decision-maker criteria in the assessment and selection of infrastructure (or other) options, it does not address factors that might influence the implementation of these decisions, once the preferred option is selected. There is also little discussion regarding whether or how existing institutional contexts might prevent or limit the use of these decision support tools

The literature on decision-making in SAM generally highlights the need for better quality information to understand and support decisions on which sewers need replacing or maintenance.

Van Riel et al. (2014) note that decision-making processes for managing sewer assets are intuition-based and can be hard to understand or replicate, reducing decision transparency which is important for the use of public funds. They discuss how decision-maker intuition and other sources of information, such as pipe and camera inspections, influence decisions on the need for sewer replacement.

Tscheikner-Gratl et al. (2019) highlight the need for improved information to support decision-making in sewer asset management. They discuss how, for example, sewer deterioration modelling can be used to forecast future pipe conditions to aid decision-making.

In a separate work, van Riel et al. (2016b, 2016c) also discuss how operational decision making for sewer replacement differs from the theoretical frameworks and decision support-tools that focus on individual managers. They note that decision-making processes in SAM occur within a complex multi-actor context that necessitates compromises and negotiations with other infrastructure managers (van Riel et al., 2016c).

Overall, this literature is predominantly infrastructure focused, with the purpose of decision-making geared towards improving the availability and quality of information used to decide which infrastructure needs replacing and how they are identified and prioritized. There is some recognition of the institutional context within which these decisions take place but limited discussion on how the institutional context influences these decisions. Furthermore there is little discussion or mention of how sewer infrastructure fits into the larger urban drainage context, or the use of alternative infrastructure to complement sewer systems.

1.4.2 Literature on decision-making, institutional change in urban water management

Literature on urban water management was also reviewed to identify whether barriers to climate adaptation implementation were identified in the broader institutional context and whether decision-making processes were identified as playing an important role to climate change adaptation in the urban water sector.

Most of the literature reviewed in urban water focused on different governance and management approaches that contribute to fundamental changes in the institutional context. This institutional change and the need for "transition" of the sector was identified as crucial to address challenges facing the urban water sector, including climate adaptation. "Transition" is defined by Wen et al. (2015) as "*socio-technological co-evolution processes leading to a fundamental structural shift in the way systems operate*." (Wen et al., 2015, p.125). A socio-technical system can be defined as one in which multiple actors are involved in maintaining and changing the system (Geels, 2004) and in which infrastructure and technology play an important role (Loorbach et al., 2017). Consequently a socio-technical system transition (such as that of the urban water sector) is one in which both the actors and institutions (i.e. norms, values, practices) and technology are co-evolving (Geels, 2004).

Van de Ven et al. (2011) and Daniell et al. (2015) discuss transitions in the urban water sector however, there is little discussion on the decision-making practices necessary to facilitate this transition. Kiparsky et al. (2013) and Fuenfschilling and Truffer (2016) discuss how the institutions implicit in decision-making processes in urban water management need to evolve to support a more sustainable future, however there little detail on what these decision-making processes involve.

Adaptive management approaches in the urban water sector are discussed by several authors (Frantzeskaki, 2019; Hoffmann et al., 2020; Larsen et al., 2016; Pahl-Wostl, 2007; Pot, 2019; Wen et al., 2015) as a way to encourage transition into a more sustainable urban water future that can cope with future challenges such as climate change. Adaptive management, is defined as "*learning to manage by managing to learn*" (Bormann et al., 1994, as cited in Pahl-Wostl, 2007) and would require a shift from the predominant water management regime of "*prediction-and-control*." (Pahl-Wostl, 2002).

Overall, this literature focuses on changes in the institutional context from a governance perspective. However, there is with little discussion of how these governance changes are reflected in the decision-making processes of practitioners.

1.4.3 Literature on decision-making in climate adaptation

The literature on decision-making in climate adaptation is very limited. Biesbroek et al. (2015) note that research on climate adaptation simplifies decision-making processes into "*simple input-output models in which internal dynamics and processes are absent*" and calls for the "*opening up of the black box of adaptation decision-making"* (Biesbroek et al., 2015, p.493) to better understand and address the climate implementation gap. Ekstrom & Moser (2014) outline how barriers to climate adaptation in urban areas align with phases of a stylized adaptation decision-making process/cycle, and Eisenack et al. (2014) highlight how actor-centered research uses decision-making as starting point for analysing barriers to climate adaptation.

These works provide insight into barriers to climate adaptation implementation and recognize the role of decision-making in addressing these barriers. They also emphasize the need for further research to aid in understanding the role of decision-making in climate adaptation implementation, however, they provide little insight on the actual decision-making processes.

1.4.4 Literature on decision-making processes

The literature on decision-making processes provides an overview of important theories and models of decision-making processes developed over time.

Mintzberg & Theoret (1976) identify a basic structure to strategic decision-making processes centered on three main phases and propose a general model showing the interrelatedness of sub-elements in these phases. Weber & Coskunoglu (1990) review how insights from the field of behavioural decision-making that described decision-making in practice (i.e. descriptive) challenged the underlying assumptions of prescriptive models of decision-making. Similarly, Lerner et al. (2015) assess how emotions influence decision-making in reality and propose a new model which synthesizes rational choice models of decision-making and newer emotion research.

Collectively, the literature reviewed on decision-making processes provides significant insights to organizational and individual decision-making processes however they are predominantly focused on application in management science and private organizations. There is limited discussion on how the processes described in these literature manifest in public infrastructure planning and decision-making, the implementation of climate adaptation in urban drainage systems and few works applying them in a Dutch municipal planning context. **Table 1** provides an overview of the literature that was reviewed and the topic areas covered by each paper.

Table 1 – Overview of literature reviewed and classification by main topics

Title	Authors (Year)	Decision-Making	UDS/ SAM	UWM/ Inst. Change	Climate adaptation
Sewer Asset Management: state of the art and research needs	Tscheikner-Gratl et al. (2019)	✓	✓		
Decision-making under deep uncertainty for adapting urban drainage systems to change	Babovic et al. (2018)	✓	✓		~
Decision-making for sewer asset management: Theory and practice	van Riel et al. (2016a)	✓	✓		
Intuition and information in decision-making for sewer asset management	van Riel et al. (2014)	✓	✓		
Valuing information for sewer replacement decisions	van Riel et al. (2016b)	✓	✓		
Assessing the performance of gray and green strategies for sustainable urban drainage system development: A multi-criteria decision-making analysis	Yang & Zhang (2021)	✓	✓		
Creating water robust urban environments in the Netherlands: linking spatial planning, design and asset management using a three-step approach	van de Ven et al. (2011)	~		✓	
Transitions in urban water management and patterns of international, interdisciplinary and intersectoral collaboration in urban water science	Wen et al. (2015)			✓	
Transitions towards adaptive management of water facing global and climate change	Pahl-Wostl (2007)	✓		✓	
The interplay of institutions, actors and technologies in socio-technical systems — An analysis of transformations in the Australian urban water sector	Fuenfschilling & Truffer (2016)	~		✓	
The Innovation Deficit in Urban Water: The Need for an Integrated Perspective on Institutions, Organizations, and Technology	Kiparsky et al. (2013)	✓		✓	
Seven lessons for planning nature-based solutions in cities	Frantzeskaki (2019)	~		✓	
Portfolio decision analysis methods in environmental decision making	Lahtinen et al. (2017)	✓		✓	
Understanding and Managing Urban Water in Transition	Daniell et al. (2015)	~	~	✓	
From sectoral systems of innovation to socio-technical systems – Insights about dynamics and change from sociology and institutional theory	Geels (2004)			✓	
A Research Agenda for the Future Urban Water Management: Exploring the potential of Non-grid, Small-grid and Hybrid solutions	Hoffmann et al., 2020			✓	

Table 1 (continued) - Overview of literature reviewed and classification by main topics

Title	Authors (Year)	Decision-Making	UDS/ SAM	UWM/ Inst. Change	Climate adaptation
Emerging solutions to the water challenges of an urbanizing world	Larsen et al., 2016			✓	
Towards sustainability in the water sector – The importance of human actors and processes of social learning	Pahl-Wostl, 2002			✓	
Sustainability Transitions Research: Transforming Science and Practice for Societal Change	Loorbach et al., 2017			✓	
Opening up the black box of adaptation decision-making	Biesbroek et al., 2015	✓			✓
Explaining and overcoming barriers to climate change adaptation	(Eisenack et al., 2014)	✓			✓
Identifying and overcoming barriers in urban climate adaptation: Case study findings from San Francisco Bay Area, California, USA	Ekstrom & Moser, 2014	~			✓
The Structure of "Unstructured" Decision Processes	Mintzberg & Theoret, 1976	✓			
Descriptive and Prescriptive Models of Decision making: Implications for the Developments of Decision Aids	Weber & Coskunoglu, 1990	✓			
Emotions and Decision Making	Lerner et al., 2015	✓			

The presence of main topic areas within the articles was indicated by a checkmark in the appropriate column. Where a similar concept was mentioned but there was limited discussion of it, a tilde (~) was placed in the appropriate column

1.4.5 Main Research Question and Research Sub-Questions

As demonstrated in the literature review, each of the four topic areas focuses on some aspects of decision-making, urban drainage systems (including sewers and SAM), urban water management and climate adaptation. However, none of the research encapsulates all aspects i.e. decision-making processes in urban drainage systems and climate adaptation and the institutional context and factors that influence these processes.

A more integrated perspective is necessary to understand how these topic areas intersect to impact implementation of climate adaptation measures. A more integrated perspective will allow for a better understanding of the dynamics and interrelations between these topic areas which may not be evident or easily identifiable from the literature in separate research areas. As these dynamics are better understood, they can provide insights into how to increase the implementation of climate adaptation measures in urban drainage systems.

The following academic/scientific knowledge gap was therefore identified:

- a lack of research integrating the decision-making processes and institutional context of climate adaptation and urban drainage systems in Dutch municipalities that identifies whether they hinder or enable the implementation of climate adaptation measures in the Netherlands.

Based on this gap, the main research question is:

Are current decision-making processes and institutional factors a hinderance or enabler to implementation of climate adaptation measures in urban drainage systems in the Netherlands?

Four sub questions were developed to identify the knowledge and information needed to answer the main research question, based on the research approach and methods:

1. ***How does the literature (a) define decision-making processes, and (b) identify institutional factors that hinder or enable climate adaptation implementation, particularly in urban drainage systems?***
2. ***How are decisions currently made in climate adaptation and urban drainage systems in Dutch municipalities?***
3. ***Which institutional factors occur most frequently in Dutch municipalities, and in what ways do they hinder or enable decision-making processes and climate adaptation in urban drainage systems?***
4. ***In what ways can current decision-making processes and the institutional context evolve to improve climate adaptation implementation in urban drainage systems in Dutch municipalities?***

1.5 Report Outline

The structure of this research is as follows: Chapter 2 discusses the literature reviewed and develops a theoretical framework based on this literature. Chapter 3 describes the research methods used in this work and Chapter 4 discusses the interview results and summarizes research limitations. Chapter 5 provides research recommendations based on the interview results and recommendations for further study. Finally, Chapter 6 summarizes the research conclusions.

2 Theoretical Framework

The following sections are a summary of the main literature reviewed and used to develop the theoretical framework. This theoretical framework was used to analyze the interview data collected in to answer sub-research questions 2, 3 and 4. The methodology used to conduct the literature review and generate this framework is summarized in **Chapter 3 (section 3.2)** of this report.

2.1 Literature on Decision-making processes

The literature on decision-making processes was reviewed in order to develop a framework for categorizing and defining the processes identified in the interview data.

Parsons (2018) identifies characteristics of a good quality decision, independent of the outcome. These include clear values and objectives, creative alternatives to choose from, good information and clear trade-offs, and sound reasoning (Parsons, 2018). This need for good information to support decisions is also mentioned in the literature on sewer asset management, climate adaptation and urban drainage systems (de Klerk et al., 2021; Tscheikner-Gratl et al., 2016; van Riel et al., 2014).

Parsons (2018) also notes that an appropriate decision frame, which takes into account the context in which the decision is made is also a characteristic of a good quality decision. Van de Ven et al., (2016) highlights a similar finding from Pyke et al. (2007), which notes that decision-support systems are more effective when they balance information with organizational and political processes (Pyke et al., 2007 as cited by van de Ven et al., 2016)

Mintzberg and Westley (2001) identify not only a particular decision-making process but also different approaches to decision-making. It distinguishes between a "*thinking first*", a "*doing first*" and a "*seeing first*" approach, and discusses when each approach is most suitable (Mintzberg & Westley, 2001). They note that a "thinking first" approach generally follows the process "define-diagnose-design-decide", whereas a seeing first approach is based on creative discovery and consists of "preparation, incubation, illumination and verification". They also note that a "doing first" approach is based on experimentation or learning-by-doing and consists of "enactment-selection-retention" (Mintzberg & Westley, 2001).

Mintzberg & Westley (2001) highlight that that the rational/"thinking first" process is most suitable in contexts where issues are clear and data is available and structured, though it is not commonly used in practice, where complex decision-making scenarios involving other actors, insufficient information or institutional pressures such as limited time or financial resources result in the use of different types of processes, such as the "seeing first" or "doing first" approaches. They highlight the cyclical or iterative nature of decision-making and recommend all three decision-making styles be utilized in organizations.

Nutt (1999) identifies a range of decision-making tactics evident in organizational decision-making processes. These tactics range from how direction is established to how options are identified and decisions are implemented (Nutt, 1999). The paper recommends "clear thinking" and "diplomatic action" and "thoughtful idea development and adroit idea promotion" as essential tactics (Nutt, 1999); which is consistent with the "thinking first" approach identified by Mintzberg & Westley (2001).

Nutt (1999) also identifies the influence of institutional pressures on the type of decision-making processes used in practice and highlights multiple reasons why organizational decisions fail to achieve their desired results. The reasons include decision-makers taking short cuts under pressure (e.g. time pressures); simplistic problem framing by decision-makers, and a lack of engagement with other actors/stakeholders in the process (Nutt, 1999).

Teisman & van Buuren (2012) discuss the role and influence of external actors in their paper on how complex decision-making can be analyzed. They identify three conceptual models of decision-making: the streams model, the rounds model and the phase model, (Teisman & van Buuren, 2012).

The streams model (i.e. the multiple streams framework (MSF)), developed by Kingdon & Stano (1984) consists of three "policy streams" (i.e. politics, problems and solutions) within which the objectives and resources of different actors exist. The intersection of all three streams provides a "window of opportunity" for action; however the types of actors in each stream and the mechanisms of the actual decision-making processes undertaken by individual or collective actors is unclear.

Mukherjee & Howlett (2015) provide a clearer discussion of the types of actors involved in, or representative of the policy streams in the MSF model and extend the model past the policy "agenda-setting stage" to capture the full policy-making process. This full policy-making process explicitly mentions "decision-making" as a phase, however, the decision-making referred to in this model is decision-making during the policy process (e.g. in selection of a preferred policy) and prior to policy implementation. It does not refer to the decision-making processes that occur during the policy implementation phase by other actors.

Goyal et al. (2019) conceptualize a six-stream version of the MSF model, however, there is still no distinction made between decision-making during the policy process versus that at the actor and policy implementation level.

The "rounds" model, developed by Tesiman & van Buuren (2012), also includes the presence of various actors, however in this model decisions are taken by various actors in different "rounds". This model highlights the interactions between actors in multiple decision-making rounds, which can be consecutive or simultaneous. It also highlights how each decision-making round is related to the outcomes of a preceding or successive round, emphasizing the interdependent nature of decision-making. Even though the inclusion of multiple actors in decision-making is beneficial, this model also focuses on decision-making in the policy process, which obscures the interaction between decision-making at the policy formulation level (e.g. policy agenda setting stage) and decision-making at a local level (e.g. at the policy implementation stage).

The "phase" model defines distinctive, and sometimes successive stages in the decision-making process (Teisman & van Buuren, 2012). These stages can be undertaken by an individual actor or collective actors. Examples of this model are "thinking first" approach by Mintzberg & Westley (2001) and the decision-making process models by Nutt (2008) and Mintzberg & Theoret (1976).

These “phase models” of decision-making by Nutt (2008) and Mintzberg & Theoret (1976) are especially useful in identifying the main stages and tactics in the decision-making processes. Both papers identified typical decision-making processes and models which were based on both empirical assessments and a systematic review on the available literature. Nutt (2008) describes four decision-making process types, whereas Mintzberg & Theoret (1976) highlight seven conceptual models/processes, including a general model for the strategic decision process. Each model identifies four to five stages or phases in the decision-making process, and associated tactics.

The four decision-making process types by Nutt (2008) include the most successful “discovery” process which is based on a need to solve a problem, versus the less successful “idea imposition”, “emergent” or “redevelopment” processes which are based on opportunities to implement a specific solution. Mintzberg & Theoret (1976) identify processes such as “political design decision processes” and “blocked design decision processes” which account for the effect of political or strategic action on different phases and integrate them into the decision-making process.

Overall, the decision-making literature reviewed discusses common phases and tactics of a decision-making process, different types of decision-making processes and highlights how decision-making processes in practise can be influenced by organizational and institutional contexts. The literature also discusses how the presence of multiple actors with different objectives and goals can result in multiple rounds of decision-making and how the different types of decision-making processes are better suited to different institutional contexts.

However, there is limited discussion of the decision-maker characteristics and how these might influence the process, for example, in the types of tactics used or the preferred style of decision-making, regardless of the context. Furthermore, even though the context within which decisions are made is mentioned as important, its influence is usually considered external to the decision-making process, not integral to it.

2.1.1 Theoretical Framework - Decision-making process

The two papers from Nutt (2008) and Mintzberg (1976) were used as the basis for developing the decision-making process framework. Mintzberg & Theoret’s (1976) framework was selected for its model of decision-making process that integrate the impact of external actors into the decision-making process, as well as the institutional context. Nutt’s (2008) framework was selected because in addition to specific decision-making phases and tactics, it also identifies decision-making processes which are more or less successful at achieving their goals. The combination of both works in a framework allows an integrated understanding of the decision-making processes in practice.

There is some overlap in the phases identified by both models therefore in order to develop the framework, the structure of decision-making processes in both frameworks were compared side-by-side and where possible, overlapping phases and/or tactics were combined to generate a blended framework. **Table 2** shows a side-by-side comparison of the phases and tactics in both works. **Table 3** shows the blended model used in the theoretical framework, as well as definitions of each of the phases and tactics from the literature.

Table 2 – Comparison, DM Processes by Nutt (2008) and Mintzberg & Theoret (1976)

Nutt (2008)	**Mintzberg & Theoret (1976)**
Intelligence Gathering by:	**Identification:**
• Needs	• Opportunity
• Opportunities	• Problem
Directions from:	• Crisis
• Ideas	**Development & Solutions**
• Problems	• Search Routine –
• Objectives	○ Given solutions
Solutions from	○ Ready-made solutions
• Ideas	• Design routine –
• Benchmarking	○ Custom made solution
• Solicitation	○ Modified ready-made solution
• Innovation	**Selection**
Evaluation by	• Screening
• Analysis	• Evaluation-choice
• Bargaining	○ Judgment
• Subjective	○ Bargaining
• Judgement	○ Analysis
Implementation by:	**Authorization:**
• Persuasion	• Authorization needed
• Edict	• No Authorization needed
• Participation	
• Intervention	

Table 3 – Combined decision-making process showing literature-based definitions of tactics

Decision-making phase/tactic	Definition (Reference)
Initiation	
• **Opportunity**	- Action-driven, offering the ready-made plan suggested by a stakeholder (Nutt, 2008) [1] - Decisions initiated on a purely voluntary basis (Mintzberg & Theoret, 1976)**
• **Need/Problem/ Crisis**	- Need: Performance driven, calling for better results based on performance (Nutt, 2008) [1] - Crisis: Decisions initiated in response to intense pressures (Mintzberg & Theoret, 1976)[2] - Problems: Decisions initiated in response to mild pressures (Mintzberg & Theoret, 1976) [2]
Development	
• **Ideas**	- No-search (impose a ready-made solution) (Nutt, 2008) [1] - Given: solutions given fully developed at the start of decision-making process (Mintzberg & Theoret, 1976) [2]
• **Benchmarking/ Solicitation**	- Ideas found in the practice of others; Ideas found in the bids submitted by vendors (Nutt, 2008) [1] - Ready-made: solutions found fully developed in the [decision-making] environment, during the process (Mintzberg &Theoret, 1976) [2]

Table 3(continued) - Blended decision-making process with literature-based definitions of decision-making phases and tactics

Decision-making phase/tactic	Definition (Reference)
Development	
• **Innovation**	- Design a custom-made solution (Nutt, 2008) [1] - Custom-made: solutions developed especially for decision (Mintzberg &Theoret, 1976) [2] - Ready-made and custom-made: ready-made solutions modified to fit a particular solution (Mintzberg &Theoret, 1976) [2]
Selection/Evaluation:	
• **Analysis**	- Manipulate performance data found in archives, pilots or mock-ups, creating summative information to prioritize options (Nutt, 2008)[1] - Factual evaluation carried out, by "technocrats", followed by managerial choice by judgement or bargaining (Mintzberg & Theoret, 1976) [3]
• **Bargaining**	- Group interprets data found in records, archives, or user views to prioritize options (Nutt, 2008) [1] - Selection is made by group of decision-makers with conflicting goal systems, each exercising judgement (Mintzberg & Theoret, 1976)[3]
• **Judgement/ Subjective**	- DM draws facts from experts and personal experiences that support a favoured choice; No public justification offered (Nutt, 2008) [1] - Individual makes choice independently, through (unclear) internal procedures they may not be able to explain (Mintzberg & Theoret, 1976)[3]
Authorization/ Implementation	
Authorization (from others) needed:	- Individual making the choice does not have authority to commit organization and resources to [chosen] course of action (Mintzberg & Theoret, 1976) [3]
• **Persuasion**	- Calling for adoption by listing the benefits of a preferred option (Nutt, 2008) [1]
• **Intervention**	- Document current performance, network to demonstrate performance gap, hold back until agreement about the need to act emerges (Nutt, 2008) [1]
No authorization (from others) needed:	
• **Edict**	- Install plan by drawing on power, indicating what people must do to comply (Nutt, 2008) [1]
• **Participation**	- Delegate to a task force, indicating expected results (Nutt, 2008) [1]

1 - Nutt (2008) – Definitions taken from Table 1, p.428 (Nutt, 2008)

2- Mintzberg & Theoret (1976) - Definitions based on definitions on p.5 of Mintzberg & Theoret, 1976)

3- Mintzberg & Theoret (1976) - Definitions based on definitions on p.14, p15 of Mintzberg & Theoret, 1976)

The first phase in the decision-making process is the "Initiation" phase and is comprised of the elements of the "Identification" phase from Mintzberg& Theoret's (1976) work and the "Intelligence gathering, Directions from" phase from Nutt (2008). These phases are combined because they are very similarly defined by both authors and based on the idea of need-based or an opportunity-based direction that triggers the decision-making process.

The "Development" phase and "Selection/Evaluation" encompass the "Selections from" and "Evaluation by" phases identified by Nutt (2008) and the "Development & Solutions" and "Selection"

phase from Mintzberg & Theoret (1976). As shown in **Table 3**, the tactics described in both works contain significant overlap and are therefore combined.

The "Authorization/Implementation" phase combines two different phases from both works because they are implicitly connected, in that a decision is (typically) only implemented after any necessary authorizations are received. Nutt (2008) highlights that the strategic processes identified by Mintzberg & Theoret (1976) do not account for the important implementation phase and four tactics of the implementation (of a decision): persuasion, intervention, edict and participation (Nutt, 2008).

Based on Nutt's (2008) definitions of the "persuasion" and "intervention" tactics in **Table 3**, the implementation of a decision can be interpreted to involve persons other than the "lead" decision-maker (or decision-making team). This aligns with Mintzberg & Theoret (1976) definition of the need for "authorization" which occurs when "*the individual making the choice doesn't have authority to commit organization and resources to [chosen] course of action*." (Mintzberg & Theoret, 1976, p.15). Similarly, decisions implemented by "edict" or "participation" can be interpreted as not requiring the authorization of others to implement a decision. In the case of the "participation" tactic which requires delegation, the authority to implement the decision lies with the actors doing the delegating.

Both Nutt (2008) and Mintzberg & Theoret (1976) note that these phases may not be as distinct in reality as shown in their frameworks. They also note that the phases do not necessarily occur in a sequential manner and highlight the iterative nature of the decision-making process. However, they note that the identification of a need or opportunity usually occurs first, with the process terminated by the implementation (or authorization) of the decision. The development, selection/evaluation and authorization/ implementation phases may occur in any order and can be iterative over time. **Table 4** summarizes the four decision-making process types identified by Nutt (2008), comprising different combinations of tactics.

Table 4 – Four processes of decision-making (Nutt, 2008)

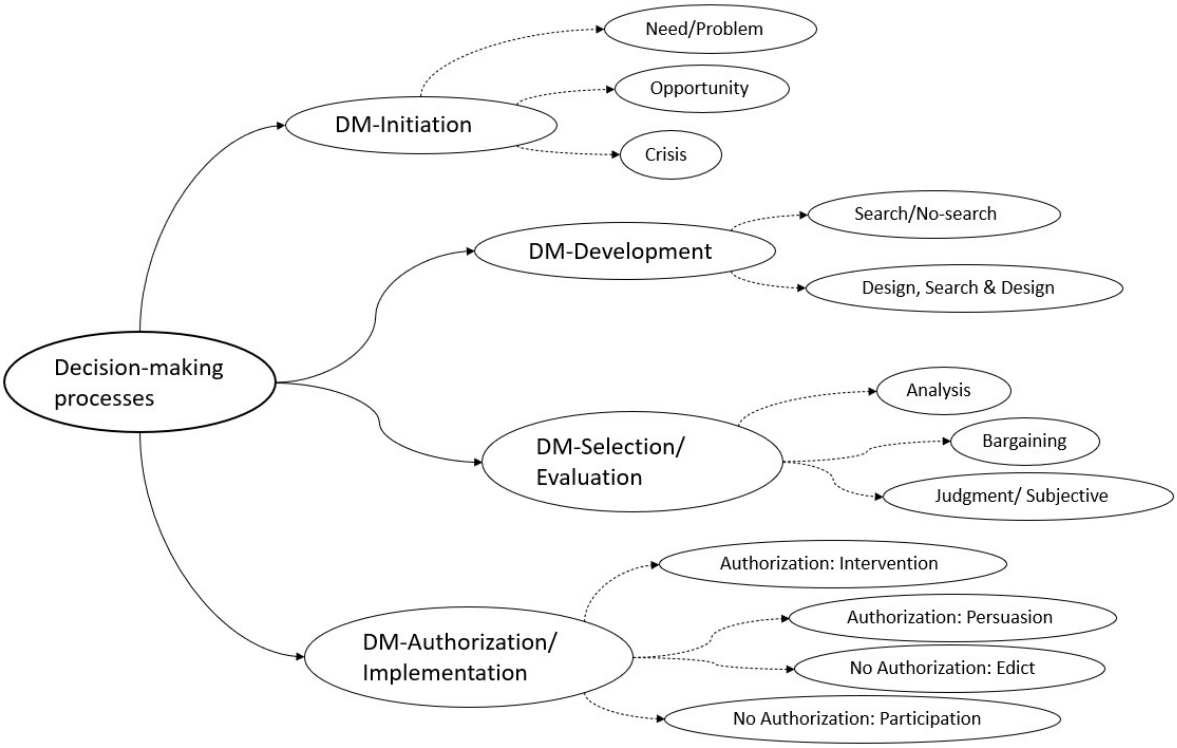
DM Process Type	**DM Phase/Tactic**			
	Initiation	**Development**	**Selection/ Evaluation**	**Authorization/ Implementation**
Discovery Process	Need-based, Objectives/ Problems	Design, Search & Design (i.e. solicitation, benchmarking/ innovation)	Analysis/ Bargaining/ Judgement/ Subjective	Proactive: Intervention/ Participation
Idea Imposition	Opportunity-based, ready-made plan	No search (N/A)	Analysis/ Bargaining/ Judgement/ Subjective	Reactive: Persuasion/Edict
Emergent Opportunity	Need-based, Objectives/ Problems	Ready-made idea emerges	Analysis/ Bargaining/ Judgement/ Subjective	Proactive: Intervention/ Participation Reactive: Persuasion/Edict

Table 4 (continued) - Four processes of decision-making (Nutt, 2008)

DM Process Type	DM Phase/Tactic			
	Initiation	**Development**	**Selection/ Evaluation**	**Authorization/ Implementation**
Redevelopment Process	Opportunity-based, ready-made plan fails	Design, Search & Design (i.e. solicitation, benchmarking/ innovation)	Analysis/ Bargaining/ Judgement/ Subjective	Reactive: Persuasion/Edict

Based on the phases and tactics in **Table 3, Figure 1** was created to provide a schematic of the main phases and their tactics/elements for this framework. It reflects the four main phases and associated decision-making tactics. A mind map configuration was chosen above the typical process diagram to highlight the non-sequential nature of the phases while acknowledging their presence. It is recognized that this schematic represents a "thinking first" decision-making approach (Mintzberg & Westley, 2001), and that other schematics may exist for a "seeing first" or "doing first" approach.

Figure 1 – Theoretical framework for decision-making processes



2.2 Literature on Hindering and Enabling factors

The literature on barriers to climate adaptation identifies numerous factors that hinder climate adaptation implementation efforts at both the institutional and individual (i.e. actor-specific) levels.

Based on an online survey of 264 professionals involved in climate change adaptation projects in the Netherlands, Biesbroek et al., (2011) identify seven categories of climate change adaptation barriers. These include conflicting timescales, a lack of financial resources, unclear division of tasks and responsibilities, fragmentation between scales of government and motives and willingness to act (Biesbroek et al., 2011).

Dąbrowski (2018) supports these findings in a study investigating how the regional institutional context influences multi-level governance of urban adaptation policies in the cities of The Hague and Rotterdam, located within the Dutch urban region of Zuidvleugel. They identify three categories of barriers for the cross-sectoral collaboration necessary for climate adaptation, namely "interests", "institutions" and "ideas" (Dąbrowski, 2018). The barriers identified under "interests" refer to actor-specific interests in dealing with climate adaptation such as "*disagreement on which institutions should finance urban adaptation measures*" and "cl*ashing temporal perspectives and uneven commitment to long-term adaptation goals*" Barriers identified under "institutions" include "*institutional patchwork*", "*territorial administration reform*" and "*fragmented or blurred accountability for flood safety*." And barriers identified under the ideas category include "*cognitive gap between urban planners and water managers*" and "*complacency about the water management system [which] undermines public support for long-term adaptation solution*s." (Dąbrowski, 2018, p.850).

Similarly, Runhaar et al. (2018) identify six categories of factors influencing the mainstreaming (i.e. integrating) climate adaptation objectives into existing policies and practices. These include political, organizational and cognitive factors, as well as resources and timing factors (Runhaar et al., 2018). Ekstrom & Moser (2014) also identified six categories of barriers to climate adaptation implementation including institutional, attitudinal, political and financial barriers.

The substantial overlap in barriers/factors in the literature is confirmed by Eisenack et al. (2014) who note that multiple studies are finding a large number of common barriers to implementation of climate adaptation (Eisenack et al., 2014). Biesbroek et al. (2013) note that a lot of the barriers are not only specific to climate adaptation implementation but can also be found in other similarly complex studies on the environment and policy implementation (Biesbroek et al., 2013).

This point is confirmed by the fact that some of the barriers identified to the implementation of climate adaptation measures are also evident in the literature on institutional change and transitions in the urban water sector. While the literature on institutional change in urban water management does not explicitly focus on climate adaptation as its goal, it does focus on achieving more "sustainable" urban water management (SUWM), with goals very much aligned with climate adaptation.

For example, Brown et al. (2009) highlight the need for a shift from "Sewered" and "Drained" cities which were developed out of the need for public health protection and flood protection, to "Waterways", "Water Cycle" and "Water Sensitive" cities, which are driven by environmental

protection, limits on natural resources and intergenerational equity and resilience to climate change, (Brown et al., 2009). They note that this transition requires both the use of innovative infrastructure solutions to address urban water and urban drainage problems, and a shift in the dominant cultural values, regulation, knowledge and ways of thinking about and managing water (Brown et al., 2009).

Within the urban water management literature, Brown & Farrelly (2009) identify twelve factors that hinder institutional change to a more sustainable water management sector. The paper undertakes a systematic review of 53 studies of barriers to institutional change and developed a list of the most frequently occurring institutional barriers. These include an uncoordinated institutional framework, insufficient resources (human and capital) and a lack of political and public will.

Kiparsky et al. (2013) explore how the existing urban water (including urban drainage) infrastructure (e.g. sewers) interact with the institutional context to result in an "institutional inertia" (i.e. stagnation of practices, values and leadership in the industry*)*. This institutional inertia can be a significant hinderance to the type of institutional change deemed necessary to address complex issues such as climate adaptation. Kiparsky et al. (2013) explain that this inertia in the water management sector can result from "*existing infrastructure systems with long-design lifetimes and the entrenched institutions that have evolved to support them*" (Kiparsky et al., 2013, p.404). Hekkert et al. (2007) also mention institutional inertia as an impediment to innovation and technological change, stating that it can "*lead to lock-in that results in relatively rigid technological trajectories "* (Hekkert et al., 2007, p.415).

While there is substantial literature on barriers or hinderances to the implementation of climate adaptation measures and to the evolution of the urban water sector, there is less literature on factors that enable or facilitate both. A few of these enablers are summarized below.

One enabling factor identified is that of extreme weather events. Fuenfschilling & Truffer (2016) anticipate that these events will result in fundamental change of existing inert institutional structures in the urban water sector, a finding which is confirmed by literature on climate adaptation implementation in urban drainage systems (Eisenack et al., 2014)

A second enabling factor identified by Brown & Farelly (2011) is *intra and inter-organizational collaboration*. This is unsurprising due to the need for multi-disciplinary cooperation to increase implementation efforts, and current institutional fragmentation.

Bryson et al. (2015) explore this factor of collaboration more deeply by focusing on prerequisites for successful cross-sectoral collaboration. They identify many of the same factors as Brown & Farelly (2009, 2011) including available and dedicated resources, a conducive institutional environment and, importantly, the need to address a public issue. Interestingly, they note that *"a clear collaborative advantage"* is necessary to justify collaboration and that collaborators should be able to *"gain something significant together that they cannot achieve alone."* (p.647, Bryson et al., 2015). This "need-based" incentive for collaboration is consistent with one of the tactics for initiation a decision-making process, as discussed in **Chapter 2 (Section 2.1.1).**

Additional drivers for cross-sectoral collaborative success discussed by Bryson et al (2015) include an *agreement on initial aims,* a *shared understanding of the problem* and *pre-existing relationships* between collaborators. These factors highlights the fact that it is not only the need to engage in collaboration that acts as an enabler, but also the willingness to engage in collaborative processes, echoing previous findings about actor motivation in the climate adaptation literature (Biesbroek et al., 2013; Dąbrowski, 2018; Eisenack et al., 2014; Runhaar et al., 2018).

A third enabling factor, opposite to a barrier identified by Brown & Farelly (2009) is the need for increased community engagement, empowerment and participation. Interestingly, Nutt (1999) also mentions limited community engagement as one reason why organizational decisions fail to achieve their objectives, highlighting the overlap in literature.

A fourth enabling factor is found within sustainability transitions literature. Loorbach et al. (2017) identify experimentation or "learning -by-doing" as an essential part of transforming existing, dominant cultures, structures and practices (p.614, Loorbach et al., 2017). They highlight the role experimentation can play in highlighting new roles and practices that are required in transformed institutional contexts. Experimentation is also highlighted as important by Farrelly & Brown (2011). They note not only a need for more experimentation but also a shift in the values and thinking of practitioners to allow more experimentation and learning (Farrelly & Brown, 2011).

The importance of practitioner (actor) mindset in facilitating change is also well documented in the climate-adaptation literature. Multiple studies highlight a cognitive element to barriers in climate adaptation implementation (Biesbroek et al., 2013; Dąbrowski, 2018; Eisenack et al., 2014; Runhaar et al., 2018). These include factors such as level of uncertainty, sense of urgency (Runhaar et al., 2018) and even, level of interest (Ekstrom & Mosler, 2014). The literature also notes that actor norms, values and goals can influence decision-making for climate adaptation and recommends further research on how it interacts with the institutional, socio-economic and bio-physical context (Eisenack et al., 2014).

The ways in which the institutional context interacts with actor norms and values to impact actions and decision-making is well studied in the literature on behaviour change (Cane et al. (2012); Contzen & Mosler (2015); Jeffrey & Seaton (2004).

The COM-B model by Michie et al. (2011) identifies three elements that interact to result in a particular behavior: capability, opportunity and motivation (Michie et al., 2011). The model also identifies seven policies and nine interventions in a Behaviour Change Wheel (BCW) that can be used to address gaps and result in desired behaviour, implying that the three elements can act as either hinderances or enablers for desired behaviours.

The capability element in the COM-B model is defined as "the individuals psychological and physical capacity to engage" in a specific activity and includes having the necessary knowledge and skills. The motivation element is defined as a combination of underlying factors that direct behaviour such as goals, habitual processes, emotional responding and analytical decision-making. The opportunity element is defined as "*all the factors that lie outside the individual that make the behaviour possible or*

prompt it" (Michie et al., 2011, p.4) – which is consistent with the "external" institutional context identified in the urban water and climate adaptation literature.

For example, Uittenbroek (2016) highlights how organizational routines contribute to difficulties in implementing climate adaptation policies. They define organizational routines as "*repeated behaviours that reflect the rules and culture of an organization"* (Uittenbroek, 2016, p.162). They note that organizational routines can be limiting for actors who are willing to integrate climate adaptation in practice, especially when coordination with other non-willing actors is necessary (Uittenbroek, 2016).

Overall, the literature reviewed demonstrates a large number of potential hindering and enabling factors to implementation of climate adaptation, generally and specific to urban water management. A lot of the literature notes that the barriers and enablers identified are predominantly socio-institutional in nature, and do not relate to the technical feasibility of infrastructure solutions. However, there is a growing recognition of the importance of how the interaction between the institutional context and individual actors results in specific behaviours, decisions and actions.

Understanding and exploring this interrelation between factors is identified in the literature as essential for addressing barriers that result in the climate adaptation implementation gap (Eisenack et al., 2014). A "systems thinking" approach is recommended to understand the interrelationships between factors (Frantzeskaki et al., 2021; Hoffmann et al., 2020; Loorbach et al., 2017).This systems thinking approach is described by Senge (1991) as seeing interrelationships rather than linear cause-effect chains and seeing processes of change rather than snapshots (Senge, 1991, p. 73) and was used as the basis for developing the theoretical framework of hindering and enabling factors.

2.2.1 Theoretical Framework - Hindering-Enabling Factors

A higher level of categorization was used for the theoretical framework to more clearly classify the large number of hindering and enabling factors. This categorization was based on three interrelated "pillars" necessary for institutional change identified by Scott (2008): the *cognitive, normative and regulative* pillars. The cognitive pillar (or category) refers to the dominant knowledge, thinking and skills within a particular sector; the normative category relates to the dominant values and leadership within the sector, and the regulative category relates to the administration, rules and systems in place which are typically designed to protect the dominant values (Brown et al., 2009).

This categorization was selected because it succinctly captures the main categories of hindering and enabling factors identified in the literature. Furthermore, Scott's (2008) recognition of the interactions between these categories is consistent with the systems thinking/systems approach underlying the framework.

In order to develop the framework, a simple visualization of the interaction between these categories was developed to conceptualize the interactions between these pillars (**Figure 2**). This visualization aims to demonstrate how the factors influence each other.

Figure 2- Conceptualized relationship between regulative, normative, cognitive categories

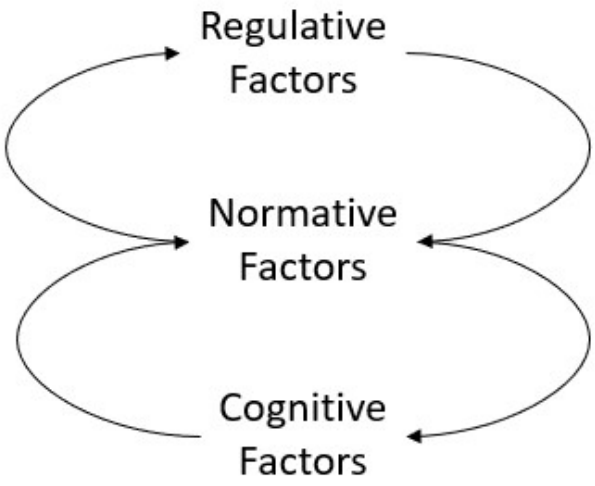


Figure 2 represents how the cognitive (i.e. individual/behavioural) factors influence the normative structures (i.e., commonly accepted practices), which in turn influence regulations and regulative structures, which then influence the normative and cognitive practices. This cyclical relationship between factors is actually an example of "feedback behaviour" which is one of the basic concepts of a systems thinking/systems approach. "Feedback behaviour" can be simply described as a cycle of action and response in a system. Two types of feedback behaviours or "loops" exist: reinforcing or balancing loops (Senge, 1991). A reinforcing or amplifying feedback loop is the underlying process beneath accelerating growth or decline (Senge, 1991). A balancing or stabilizing loop underlies goal-oriented behaviour and will result in system adjustments to maintain a particular goal, similar to that of a thermostat (Senge, 1991).

Understanding these underlying mechanisms between the three categories identified by Scott (2008) can shed light on how these factors work together to result in the current adaptation implementation gap, but also help identify "leverage" points through which the gap can be reduced.

However, in order to identify leverage points for change within these broader categories, specific hindering and enabling factors were incorporated into these larger categorizations. These factors were based on the barriers and enablers identified by Brown and Farelly (2009), Bryson et al. (2015) and Michie et al (2011).

The factors identified by Brown & Farelly (2009) were selected because they captured most of the barriers identified by the climate adaptation implementation literature and were specific to the urban water management sector. The factors identified by Bryson et al. (2015) were selected because they highlighted enablers of "collaboration" which counteracts one of the most consistently identified barriers in the literature i.e. institutional fragmentation. Finally, the factors identified by Michie et al.

(2011) were selected because they provided a nuanced categorization of the "cognitive" barriers identified in the literature (i.e. cognitive barriers could be classified as motivational or capability related – which helps identify how to address them). The factors identified in all three papers were based on systematic reviews of literature and therefore represent factors consistently identified in each discipline.

Table 5 summarizes how these factors were divided into the three categories of Regulative, Normative and Cognitive. These categorizations are not mutually exclusive, and a factor can occur at multiple levels. However, for simplicity factors were divided into each category based on whether they were within the power of an individual, or whether they resulted from norms and practices of the collective group. For example, whether or not community engagement was present in an organization was dependent on the formal or informal rules governing that organization.

As shown in the table, there is overlap between some of the factors, and there are two factors that do not fall strictly into the three categories. Communication is implicit in most of the other factors, and "power imbalances" can be a result of the other factors categorized factors such a*s an uncoordinated institutional framework and/or multiple institutional logics.*

The table also shows that most factors fall within the Regulative and Normative categories, with few falling within the Cognitive. Furthermore, the levels or scales at which the pillars occur varies: the Regulative and Normative categories (formal and informal institutions) can occur at both the national (and regional) and municipal levels, and similarly factors in the Normative and Cognitive categories (Informal institutions) can occur at the municipal and individual or team level.

Table 5 – Overview hindering and enabling factors framework

Category	Scope	Literature Used	Factors
Regulative – Structural (Legislative, Administrative)	Formal Institutions • Laws, Regulations • Aims, goals, purpose (what needs to be achieved) • Institutional mandates, roles and responsibilities (who is in charge of what) • Funding sources, allocation (where does the money come from)	Brown & Farrelly (2009) Bryson et al. (2015)	• B&F-Uncoordinated institutional framework (Bry – General Antecedent: Institutional environment, Bry – Conflicts and Tensions: Multiple Institutional Logics) • B&F-Limits of regulatory framework • B&F-Insufficient resources (human, capital) (Bry – General Antecedent: Resources) • B&F-Unclear, fragmented roles & responsibilities • B&F-No long-term vision, strategy • B&F-Technocratic path dependencies • Bry – General Antecedent: Need to address public issue • Bry – Accountabilities: Complex accountabilities • Bry – Outcomes- Immediate, Intermediate and long-term outcomes

Table 5 (continued) - Overview hindering and enabling factors framework

Category	Scope	Literature Used	Factors

Normative (continued)	Formal Institutions (as above), plus
	• Organizational structure/hierarchy, formal roles and responsibilities
	Informal institutions
	• Social norms, values, practices (what is acceptable, typical, generally expected)
	  ○ What is rewarded or punished
	  ○ What is important to achieve
	  ○ Which performance metrics matter
	• **Decision-making processes**
		Brown & Farrelly (2009)
		Bryson et al. (2015)
		Michie et al. (2011)
			• B&F-Limited community engagement, empowerment & participation
			• B&F-Little or no monitoring and evaluation
			• B&F-Lack of information, knowledge and understanding**
			• B&F-Lack of political & public will
			• B&F-Poor organizational commitment
			• Bry- Initial Conditions: Agreement on initial aims
			• Bry- Initial Conditions: Pre-existing relationships
			• Bry- Collaborative processes: Legitimacy
			• Bry- Collaborative processes: Formal and emergent planning
			• Bry- Collaborative processes: Shared understanding of problem
			• Mich– COM-B: Social, Physical Opportunity

Cognitive	Informal institutions (as above) • Individual incentives, disincentives • **Decision-making processes**	Bryson et al. (2015) Michie et al. (2011)	• Bry- Collaborative processes: Trust & Commitment • Bry – Tensions: Inclusivity vs efficiency, autonomy vs interdependence • • Mich – COM-B: Physical, Psychological Capability • Mich – COM-B: Automatic, Reflective Motivation
Other			• B&F-Lack of communication • Bry – Conflicts and Tensions: Power Imbalances

*B&F = Brown & Farrelly (2009)

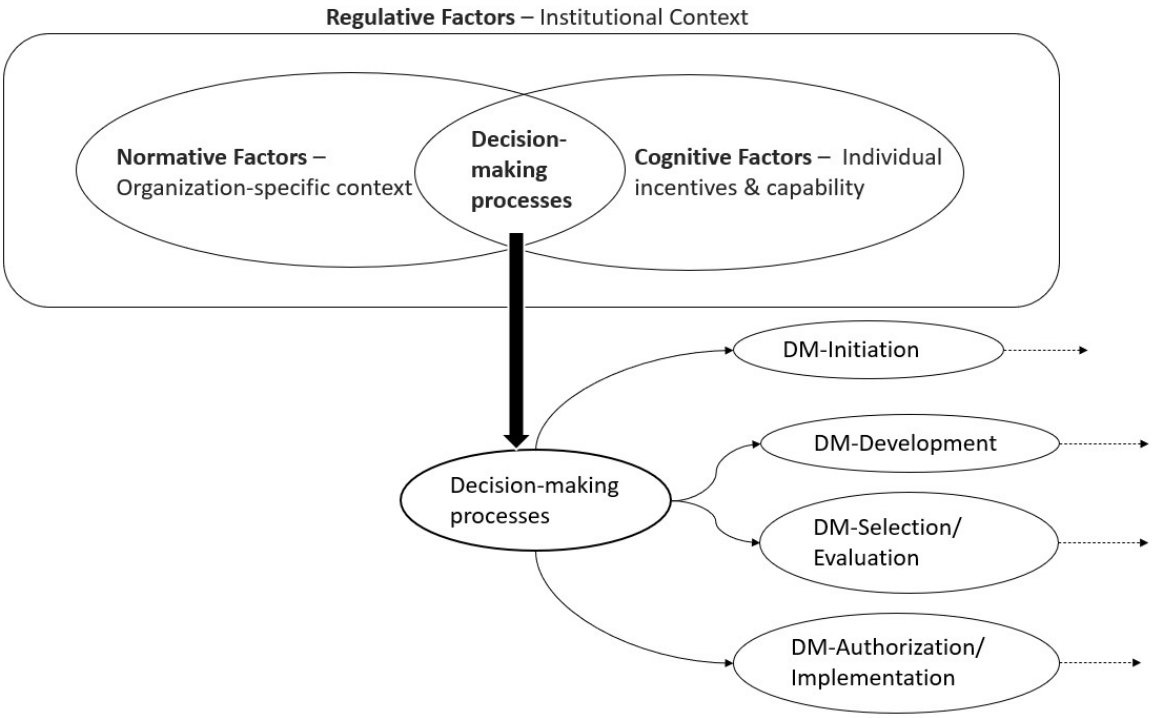
*Bry = Bryson et al. (2015)

*Mich = Michie et al. (2011)

2.3 Combined theoretical framework

A single theoretical framework was developed to integrate the hindering and enabling factors in the institutional context with the decision-making processes identified in literature. As noted previously, the decision-making processes in the literature have not typically been embedded within the larger institutional context, and/or included the influence decision-maker perspective and attitude have on the choices and decisions that are made. **Figure 3** was developed to address this gap. It shows the combined theoretical framework showing interaction of institutional categories with decision-making processes:

Figure 3 - Detailed theoretical framework showing expansion of phases in decision-making process



Based on **Figures 3,** the Regulative category acts as the larger formal institutional context within which Normative and Cognitive categories exist. This category encompasses factors such as the laws and regulation that govern and provide guidance for practitioners, institutional mandates, and specific roles and responsibilities within those institutions i.e. which organization/level of government is responsible for what. It also includes factors such as funding sources and budgets, and goals and strategies at both the national and municipal level (e.g. for urban drainage systems, climate adaptation and urban flooding).

The above factors are also assumed to be present within the Normative category, which also includes informal institutions such as social norms, values and practices. These social norms can be implicit, but generally reflect the actions/behaviours that are rewarded or punished, the performance metrics that are considered important (for example, cost-effectiveness) and important goals within an organization. These social norms are the culture within which decisions are made and are both an influencing factor on the behaviour of actors, and a result of the cognitive perspectives and attitudes of individuals and teams.

The Cognitive factors that influence actor behaviour and action and include factors such as individual incentives/motivation, as well as perceived capability. It is at this interaction between cognitive and normative factors that the decision-making processes are located.

3 Research Methods

3.1 Research Approach

To answer the main research question, a deductive and semi-inductive research approach was used, alongside qualitative research methods.

Bryman (2016) notes that a deductive approach is one where scientific or academic theory is used to generate a hypothesis about a system, after which the hypothesis is empirically tested using real life observations and findings. As demonstrated in the literature for the theoretical framework, there is extensive research on the different types of decision-making processes and factors in the institutional context that can hinder or enable implementation of climate adaptation measures. The decision-making processes and institutional categories and factors in the theoretical framework were used as the basis for determining and classifying whether current decision-making practices and the institutional context in climate adaptation and urban drainage systems hinder or enable implementation. This is a predominantly deductive strategy, however, an element of induction was also incorporated, as the concepts from the literature were reassessed and revised based on observations and findings from the interview data.

One advantage of a deductive approach is that the theory provides an initial framework for categorizing data and observations of a given system, however, there can be limits to the application of theory. For example, for this research, the dynamics of decision-making and the institutional context in practice may not strictly fall into the categories generated from the theory and could lead to some observations being classified as extraneous. Despite this, a deductive approach can still be useful since non-categorized observations can lead to beneficial insights on how to improve decision-making processes and the institutional context in Dutch municipalities and account for the constraints faced by decision-makers.

One advantage of qualitative research is that can provide a contextual understanding of theory (e.g., an understanding of decision-making in the specific Dutch context) and generate "rich, deep data" (Bryman, 2016, p. 401). However, limitations of qualitative research include that it can be difficult to replicate, that findings may be difficult to generalize, especially if a small sample size is used, and that the research can be too subjective (Bryman, 2016). In this research, these limitations are clearly stated for transparency.

3.2 Methodology - Literature reviews

A preliminary literature review was conducted to understand the scientific and academic knowledge gap in order to generate the main research question and sub-question. This was followed by a detailed literature review to gather the information needed to answer research sub-question 1 (RQ1): ***What does the literature describe as (a) decision-making processes, and (b) hindering and enabling factors to climate adaptation implementation in urban drainage systems?***

A purposive literature review was conducted due to the limited time available and broad scope of the research. The literature search was limited to the Netherlands and a list of key words and search terms were used to find relevant literature. Similar search terms and key words were used for both the preliminary and detailed literature reviews. Search terms included *"decision-making processes", "decision-making & urban drainage systems & Netherlands", "climate adaptation & urban drainage*

systems"; "barriers & climate adaptation implementation"; "*transitions in urban water*" and "*decision-making & sewer asset management*". Key words such as "*hindering" or "enabling"* as well as *"barriers*" and "*facilitators*" were also used to increase the scope of results. The search engine Scopus was used, due to its large database of recent scientific literature.

Literature recommended by the thesis committee was also reviewed for additional insight. As the literature review progressed, additional search terms were generated, including *"systems thinking, systems approach*" and "*sustainability transitions*" based on useful and relevant concepts identified through readings.

Where possible, literature that synthesized large amounts of data and previous research in their respective fields were selected for review. This was done to ensure that to ensure that the findings used to develop the theoretical framework was supported by a larger body of work and not a single study. Resources referenced in the literature were also used to identify relevant and additional sources of information.

Literature was reviewed from a wide range of topic areas. These included literature on decision-making processes, climate adaptation and implementation, urban drainage systems, systems thinking, institutional change, sustainability transitions and behavioural change theories. Due to the large volume and fragmented nature of the literature, a theoretical framework was developed to allow for a more integrated, systems perspective.

The theoretical framework that was developed integrated decision-making processes from the literature within a wider institutional context that accounted for three different categories of factors (i.e. regulative, normative and cognitive). The framework was based on the works of Nutt (2008), Mintzberg & Theoret (1976) and Scott (2008). The rationale for selection of these works, as well as a full discussion of the literature and framework is located in **Chapter 2**.

The decision-making phases and tactics used in the theoretical framework were used to develop interview questions to collect the data necessary to answer sub-research question 2 (RQ2). The theoretical framework was also used as the basis for analysis of the interview data required to answer sub-research question 3 (RQ3).

3.3 Methodology – Interview Format and Respondent Selection

Interviews were used to collect the data required to answer RQ2: ***How are decisions currently made in climate adaptation and urban drainage systems in Dutch municipalities?***

A semi-structured explorative interview approach was used for data collection because it allowed information of interest to be collected from participants, and also provided the freedom to engage with/discuss items of importance that came-up during the interviews (Bryman, 2016, p. 201).

One interview was conducted per participant, lasting approximately one hour. One follow-up interview was conducted as agreed to by the respondent. Participants were selected based on their experience working in or with Dutch municipalities, and their area of expertise as relevant to the research question.

Relevant areas of expertise included urban drainage or urban water, sewer asset management, climate adaptation/strategic policy planning and urban planning/design.

Participants were taken from a convenience sample based on individuals who had previously participated in similar research studies. These participants were also asked to recommend other potentially suitable candidates, who were then contacted. One interview participant was found through this method. A convenience sample was used mainly because of the ease of access to participants.

Overall, 14 exploratory interviews were completed with 13 participants. **Table 6** provides a breakdown of the interview participants and their roles.

As shown in the table, a wide range of professionals were interviewed. Three university professors were interviewed, two of whom also worked part-time as consultants for Dutch municipalities (interviewees R6 and R8). The third professor (R1) was previously involved with projects for a specific municipality but from an academic/research perspective.

Table 6 – Overview interview and participants breakdown

Interview ID	Respondent ID	Participant Role/Expertise	Organization Type
D1	R1	Professor, Urban Water Management	University
D2	R2	Senior Engineer, Water Policy Advisor	Consultancy
D3	R3	Architect, Urban Designer, Climate Adaptation	Consultancy
D4	R4	Advisor, Urban Drainage – SUDS & SAM	Municipality
D5	R5	Senior Policy Advisor, Urban Design & Climate Adaptation	Municipality
D6	R6	Professor, Sewer Asset Management	University
D7	R7	Asset Manager	Municipality
D8	R8	Professor, Urban Drainage, SAM	University
D9	R9	Manager- SAM, Urban Water, Policy	Consultancy
D10	R10	Engineer, Urban Planner and Designer	Consultancy
D11	R11	Policy Advisor, UWM & Climate adaptation	Municipality
D12	R12	Senior Policy Advisor, SAM	Consultancy
D13	R13	Senior Infrastructure (Asset) Manager	Municipality
D14	*R10*	*Same as D10*	*Same as D10*

Five individuals at five separate municipalities were also interviewed: from two large municipalities and three medium-sized municipalities. Out of the municipality respondents (R4, R5, R7, R11 and R13), two interviewees (R7, R13) worked in an asset/infrastructure management role (specifically water and sewer/drainage infrastructure); two interviewees (R5, R11) worked in a senior policy, urban planning and development role; and the final municipality respondent (R4) worked as an urban drainage advisor in a maintenance and asset management department, with the role of identifying how SUDs can be incorporated into replacement/renovation projects.

The remaining five participants (R2, R3, R9, R10 and R12) worked as consultants. One participant worked as a senior water policy advisor (R2), another participant worked in urban planning and design (R3); and another participant worked in urban planning and design and engineering design (R10). Two participants worked specifically in sewer asset management (R9 and R12), of which one participant had a policy development background (R9) and the other and engineering design background (R12). Interview responses are therefore varied and influenced by the backgrounds and areas of specialty of the participants.

Prior to conducting the interviews, a data management plan (DMP) was developed to ensure safe management and secure storage of the interview data. Human ethics approval was obtained from the Delft University of Technology Human Research Ethics Committee (TU Delft HREC) for this DMP before interviews commenced. A detailed explanation of the proposed data storage and use was developed as part of the DMP. At the start of each interview, this data use plan was read aloud to interview participants in order to secure informed consent from interview participants. A written copy of this plan was also developed in the format of an informed consent letter. A copy of this letter is attached in **Appendix A.**

To assist in conducting the interviews, an interview guide was prepared with prompting questions. Due to the varied expertise of interviewees, two types of interview questions were developed. Project-specific decision-making process questions were developed for interviewees in municipalities, or the consultants that worked with municipalities who had direct project experience, and more general industry related questions for respondents in senior management positions with less direct project experience. Each interviewee was asked about their role in their organizations and project experience at the start of the interview to determine the most suitable questions. A text copy of the interview guide is located in **Appendix A.**

Interviews were conducted via online platforms (i.e., MS Teams, Zoom). Data from these interviews were collected by video and audio recording and subsequently transcribed using Atlas.ti. Interview transcripts are located in **Appendix B.** Interview transcription was completed manually and simultaneously with interviews to incorporate findings into interview questions where possible. Transcripts were pseudonymized to ensure participant privacy and comply with TU Delft HREC and European General Data Protection Regulation (GDPR) requirements. The interview data was then used in the analysis undertaken to answer RQ3.

3.4 Data Analysis

Both a qualitative and quantitative approach was used to analyze the interview data in order to answer RQ3: ***Which institutional factors occur most frequently in Dutch municipalities, and in what ways do they hinder or enable decision-making processes and climate adaptation in urban drainage systems?***

First, a qualitative approach was undertaken using thematic coding to identify all the hindering or enabling institutional factors occurring in the data. This was followed by a quantitative analysis in order to determine the most frequently factors and understand how they impact decision-making processes and climate adaptation implementation.

3.4.1 Qualitative Data Analysis

The thematic coding was based on a deductive and semi-inductive approach. Initial coding was completed deductively, by applying factors identified in the literature to the interview transcripts, where applicable. Once this was completed, a semi-inductive approach was used to identify recurring themes across interviews and generate unique codes based on these themes.

In total, 77 codes were generated based on the theoretical framework and the interview data. Qualitative coding was completed iteratively in order to refine the code categories and avoid significant overlap. Where applicable, some "quotations" (i.e., coded sections of text) had multiple codes applied to them, for example, both an interview-generated code and a literature-based/theoretical frameworks code.

Table 7 shows the code distribution by type. The complete list of codes, definitions and example quotations is located in **Appendix C.**

Table 7 – Coding results overview

Code Type	Literature Reference	Number of codes per category
Theoretical Framework – Decision-Making Process Factors (DMF)	Mintzberg (1976) Nutt (2008)	13
Theoretical Framework – Hindering & Enabling Factors (HEF)	Brown & Farelly (2009) Bryson et al (2015) Michie et al. (2011) Scott (2008)	18
Interview Data (INTV)	N/A	46
TOTAL		**77**

All the factors from the decision-making processes in the framework (i.e. the combined phases and tactics of Nutt (2008) and Mintzberg & Theoret, (1976)) were converted to codes. All factors from Brown & Farelly (2009) within the theoretical framework were converted into codes and used as the basis for the deductive coding. In order to minimize the total number of codes, factors from Bryson et al. (2015) were converted into codes only if they differed significantly from the factors of Brown & Farelly (2009) or if they emerged from the semi-inductive coding of the data. The factors from Michie et al. (2011), were only included as code groups (and not individual codes) as they represented categorization of cognitive or contextual factors. Similarly, the three categorizations from Scott (2008) were included as code groups not individual codes.

Table 8 shows the literature-based decision-making codes and their definitions. **Table 9** shows the literature-based hindering and enabling codes and their definitions. Codes were applied to interview data when there was explicit mention or discussion of the factors in the tables.

Table 8 – Code Definitions – Decision Making Process: Phase & Tactics

Code	Definition
DM-Initiation _Need	Decisions/ projects initiated solely by the need to address reduced performance (i.e. performance gap)
DM-Initiation _Need-Opportunity	Decisions/ projects initiated by the need to address reduced performance, that also provide an opportunity to undertake unplanned works
DM-Initiation _Opportunity	Decisions/projects initiated solely by an opportunity (or desire) to undertake unplanned works
DM-Development _ Design	Idea development by designing a custom-made solution
DM-Development _ No Search	Idea development by implementing a ready-made solution
DM-Development _Search + Design	Idea development by modifying existing solutions or technologies to fit specific purpose
DM-Selection/Evaluation _Analysis	Solution selection/evaluation by completion of technical analysis to compare or select between a range of choices/options
DM-Selection/Evaluation _Bargaining	Solution selection/evaluation by negotiation between multiple actors, to select, compare or modify a range of choices/options
DM-Selection/Evaluation _Judgement/Subjective	Solution selection/evaluation by drawing on technical expertise and experience with no additional justification required
DM-Authorization/ Implementation _ Edict	Authorization (to implement) not needed: decision-makers have power to commit resources to action Implementation by issuing a directive or indicating what people must do to comply
DM-Authorization/ Implementation _ Intervention	Authorization (to implement) needed: decision-makers do not have power to commit resources to action Implementation based on demonstrating improvements in performance due to proposed solution (i.e. reduced or eliminated performance gap)
DM-Authorization/ Implementation _ Participation	Authorization (to implement) not needed: decision-makers have power to commit resources to action Implementation by consensus among colleagues/between different actors
DM-Authorization/ Implementation _ Persuasion	Authorization (to implement) needed: decision-makers do not have power to commit resources to action Implementation based on convincing/persuading other actors of benefits of proposed solution

Table 9 - Code Definitions – Hindering and Enabling Factors (Institutional Context)

Code	Definition
B&F-Communication	Explicit mention or discussion of communication with external or internal actors as an important factor
B&F-Community Engagement, Participation, Empowerment	Explicit mention or discussion of public participation in project or decision-making process
B&F-Fragmented Roles and Responsibilities	Explicit mention or discussion of separate roles and/or unclear responsibilities of practitioners
B&F-Information, knowledge, understanding	Explicit mention or discussion of the presence (or lack) of technical information, knowledge and understanding of practitioners
B&F-Institutional Framework (Uncoordinated)	Specific mention of lack of coordination across institutions or institutional mandates
B&F-Long-term vision/strategy	Explicit mention or discussion of a long-term vision or strategy, either at the municipal, regional, or national levels
B&F-Monitoring and Evaluation	Explicit mention or discussion of the presence of monitoring and evaluation of projects (pilot or established)
B&F-Organizational Commitment	Explicit mention or discussion of the presence (or lack of) organizational commitment (i.e. private organizations, not public/governmental)
B&F-Path dependencies (technocratic)	Explicit mention or discussion of a dependence on previous or traditional ways of working, or institutional organization
B&F-Public/Political Will	Explicit mention or discussion of the presence (or lack) of public and/or political desire and will to act (in a climate adaptive manner)
B&F-Regulatory Framework	Explicit mention or discussion of regulations and legislation that influence options available to decision-makers, infrastructure managers
B&F-Resources - Financial/Capital	Explicit mention or discussion of the availability (or lack) of financial resources
B&F-Resources - Human/Capacity	Explicit mention or discussion of the availability (or lack) of human resources or capacity, such as personnel, or time
Bry - Accountability (complex accountabilities)	Explicit mention or discussion of how municipalities, practitioners, held accountable for climate-adaptive action/decision-making
Bry- Trust and Commitment	Explicit mention or discussion of trust or commitment between actors as a factor in collaboration and collaborative decision-making
Bry-Immediate, Intermediate, Long-term goals	Explicit mention or discussion of presence (or lack) of goal-setting and goals over short, medium and long-term time frames
Bry-Multiple Institutional Logics	Explicit mention or discussion of different institutional aims and/or approaches
Bry-Pre-existing relationships	Explicit mention or discussion of pre-existing relationships between actors as a factor in collaboration or collaborative decision-making

All hindering and enabling factors were categorized as either Regulative, Normative, Cognitive or other, as per the framework. For instances where the definitions of factors in the literature differed from those used in the framework, the factors were re-categorized as regulative, normative or cognitive as appropriate. Six code categories were generated based on these categorizations. **Table 10** provides an overview of these categorizations and their definitions:

Table 10 – Code Category Definitions

Category ID	Description
REG-LEG	Regulative-Legislative systems (e.g. laws, regulations, policies)
REG-ADM	Regulative-Administrative structures (e.g. financing, organizational structure etc.)
NORM	Normative values, leaderships, norms, practices (i.e., "how things are done"), at organizational level
COG	Cognitive category: thoughts, knowledge, skills (at individual actor level
OTHER - DES	Project/Design-specific factor
OTHER - N/A	No category

The 46 interview-generated codes were generated through semi-inductive coding. These codes were generated when the factors from the framework did not sufficiently capture concepts emerging from the interview data. They were generated if (a) they provided a specific example of how a code applied to the Dutch context (b) they described concepts specific to urban drainage/sewer asset management; and (c) they were a sub-set of a literature-based factor and reflected how the factor manifested in practice. The codes could also be considerations for decision-making or institutional hindering or enabling factors. Some codes could be classified under multiple sub-categories.

Table 11 provides the definitions of selected interview-generated codes, as well as their relationship to the literature-based codes, where applicable. A full list of the 46 codes and their definitions is located in **Appendix C.**

Table 11 – Code definitions - selected interview-generated codes

Interview Generated Code	Definition	Associated Literature-Based Code* (*if applicable)
B&F-Fragmented Roles and Responsibilities	Explicit mention or discussion of separate roles and/or unclear responsibilities of practitioners	
B&F-Resources - Financial/Capital	Explicit mention or discussion of the availability (or lack) of financial resources	
B&F-Information, knowledge, understanding	Explicit mention or discussion of the presence (or lack) of technical information, knowledge and understanding of practitioners	
B&F-Long-term vision/strategy	Explicit mention or discussion of a long-term vision or strategy, either at the municipal, regional, or national levels	
B&F-Resources - Human/Capacity	Explicit mention or discussion of the availability (or lack) of human resources or capacity, such as personnel, or time	
B&F-Public/Political Will	Explicit mention or discussion of the presence (or lack) of public and/or political desire and will to act (in a climate adaptive manner)	
B&F-Community Engagement, Participation, Empowerment	Explicit mention or discussion of public participation in project or decision-making process	
B&F-Regulatory Framework	Explicit mention or discussion of regulations and legislation that influence options available to decision-makers, infrastructure managers	
Alignment with road works	Explicit mention or discussion of sewer/urban drainage works undertaken at the same time as road or street work, specifically	
Cognitive/cultural resistance, barriers	Explicit mention or discussion of practitioner hesitation, resistance to incorporation of climate adaptation	
Collaboration with others (internal, external)	Explicit mention or discussion by interviewees of working with others, both internal and external to their area of expertise, organization	
Cost consideration	Explicit mention or discussion of cost or money as a factor or consideration in projects, decision-making, or other	B&F-Resources - Financial/Capital
DM Perspective/Attitude	Explicit mention or discussion of decision-maker perspective or attitude regarding climate adaptation	
GRP	Specific mention of GRP, or "municipal sewerage plan"	B&F-Regulatory Framework
Learning-by-doing, experimentation	Explicit mention or discussion of experimentation, for example - to develop rules, test or identify solutions that work etc.	B&F-Information, knowledge, understanding

Table 11 (continued) – Code definitions - selected interview-generated codes

Interview Generated Code	Definition	Associated Literature-Based Code* (*if applicable)
Local conditions, available space	Explicit mention of how local conditions or available space limit or allow the use of particular solutions	
Incentive to action: societal or environmental good	Explicit mention or discussion of underlying societal or environmental motivation for political action regarding climate adaptation	B&F-Public/Political Will
Integrated approach	Explicit mention or discussion of an integrated approach to working	
Municipal Council	Explicit mention or discussion of municipal council, councillors and their role in climate adaptation and infrastructure/asset management	
Multiple climate adaptation goals	Explicit mention or discussion of multiple climate adaptation goals including drought, subsidence, heat island effect; also energy transition	
Neighbourhood-scale renovation	Specific mention of large-scale neighbourhood renovations due to Dutch planning and designing approaches	
Performance criteria, durability	Explicit mention or discussion of important performance criteria for infrastructure, including long-term durability	
Private Landowner Responsibility	Explicit mention or discussion of private citizens'/landwoner responsibility to manage rainwater (on their property and at its source)	
Public-private space interaction	Explicit mention or discussion of need to consider both private and public space in climate adaptation efforts	
Practitioner skill set (operational v strategic)	Explicit mention or discussion of practitioner skills (or lack thereof) and suitability for task	
Risk consideration, aversion, novelty, uncertainty	Explicit mention or discussion of risk, risk aversion, discomfort/dislike of novelty or uncertainty as factors in behaviour or decision-making	
Sewer tax	Explicit mention or discussion of Dutch sewer tax	B&F-Resources - Financial/Capital
Stress tests (sewer)	Explicit mention or discussion of need for/use of stress tests to inform analysis or projects or decision-making	
Timing and aligning multiple projects	Explicit mention or discussion of how coordination between different asset/infrastructure works result in project	
Wider system perspective	Explicit mention or discussion of interaction between different elements of (sewer, urban drainage) infrastructure system	

3.4.2 Quantitative Data Analysis

The quantitative data analysis was also completed iteratively using Atlas.ti. To begin with, the codes were ranked in numerical order from most frequent to least frequent. All text quotations associated with each code was then reviewed in detail, with particular focus on code occurrences larger than 14 (i.e. the total number of interviews). This was done to ensure that code occurrences higher than the total number of interviews did not skew the results, since frequency of codes across interviews was used as a proxy for recurring patterns across municipalities.

Consequently, multiple instances of the same code in one interview were eliminated unless the code was discussed in a completely different context (i.e. not a repetition or emphasis of an original point). Thus, the occurrence of a single code in a document should be interpreted as "occurring at least once", and not that the code "only occurred once." This was done to reduce artificially high occurrences of each code and facilitate the comparison of themes across interviews.

Code-document tables were created for both the literature-based codes and the interview-generated codes using Atlas.ti. These tables were used to distinguish between the number of times a code occurred (absolute) versus the total number of interviews within which a code was present.

In order to determine the "most frequently occurring codes" as per the research question, codes were categorized as "high", "medium" and "low" frequency. "High frequency" codes were codes that were identified in 10 or more interviews, "medium frequency" codes were codes that were identified in five to nine interviews, and "low frequency" codes were codes that were identified in zero and four interviews. High and medium frequency coded were considered to be the "most frequently occurring codes" and were used to generate key insights from the interview data.

3.5 Methodology - Recommendations

The insights generated from the qualitative and quantitative analysis formed the basis of recommendations to answer sub-research question 4 (RQ4): ***In what ways can current decision-making processes in Dutch municipalities evolve to foster climate adaptation in urban drainage systems***

Recommendations were made based on the interview results and focused on potential interventions and policies to minimize the hindering factors and maximize the enabling factors. The behavioural change wheel (BCW) from the COM-B model by Michie et al. (2011) was used to identify these interventions and policies. It was selected because it provides mechanisms for increasing "desirable behaviours" (or stopping undesirable ones) that account for the external context within which individuals operate. It also provides recommendations for changing the context itself, and policies by which to achieve this.

Recommendations were also made for further research based on study limitations and gaps in the literature.

4 Interview Results

This chapter summarizes the interview results on decision-making processes and hindering and enabling factors to the implementation of climate adaptation measures in the institutional context.

4.1 Decision-making process

This sub-chapter provides an overview of the decision-making phases, tactics and processes identified in the interview data.

4.1.1 Phases and tactics identified

Table 12 summarizes the decision-making process phases and tactics identified in the interviews. The numbers in the table represent the number of times a phase or tactic was identified in each interview.

As shown in the table, nine of the fourteen interviews have three or more decision-making phases present. These were the interviews in which decision-making was tied directly to a project, regardless of whether climate adaptation measures were implemented. In the remaining five interviews, some tactics and phases were identified but these were based on general observations by the participants and not related to the decision-making process in a particular project. These non project-specific interviews were the ones within which a broader industry perspective was discussed.

The "Initiation" phase of the decision-making process was the most frequently identified phase and was present in all interviews, regardless of tactic. The "need" tactic was the most frequently identified tactic in this phase and was present in eight out of 14 interviews. It is identified in the literature as the first step in two types of highly successful decision-making process types (Nutt, 2008). It is also mentioned as a facilitator of effective cross-sectoral collaboration (Bryson et al., 2015) which is necessary for increasing the implementation of climate adaptation measures in urban drainage systems.

Within the interview data, two types of "needs" were identified regarding the urban drainage system – the need to manage ageing sewer infrastructure and the need to adapt to climate change. A third type of need was also identified, regarding the large-scale renovation and redevelopment of neighbourhoods. Respondents R2, R1 and R4 discuss these needs and how they are mostly considered simultaneously.

Respondent R2 notes "*everyone has seen, felt the effects of climate change…we're at the level that they want to act, we're at the level that the sewer systems are very old at the moment so they have to replace the sewers."* (Interview D2.R2)

Similarly, respondent R1 notes *"…because a lot of our sewer systems have been installed up to 50 till 70 years ago so they need renewal. And then we have this climate change urgency that comes together".* (Interview D1.R1)

Respondent R4 also notes "*we had decided around 2014, 2015 to renovate the sewer system and we then did research on how we can integrate the renovation of the sewer system combined with climate adaptation measures.*" (Interview D4.R4)

Table 12 – Decision-making phases and tactics identified in interviews

	DM Initiation Phase-Tactics			DM Development Phase-Tactics			DM Selection/Evaluation Phase-Tactics			DM Authorization/Implementation Phase-Tactics				
Interview & respondent ID	Need	Opportunity	Need-Opportunity	Design	No Search	Search & Design	Analysis	Bargaining	Judgement/ Subjective	Edict	Intervention	Participation	Persuasion	Totals
D1.R1	1	0	0	0	0	1	0	0	0	0	0	0	0	2
D2.R2	0	0	2	0	0	0	0	0	0	0	0	0	0	2
D3.R3*	1	0	1	1	0	0	0	1	0	0	1	0	0	**5**
D4.R4*	0	0	1	1	0	1	0	2	0	0	0	0	1	**6**
D5.R5*	0	1	0	1	0	1	1	0	0	1	0	0	0	**5**
D6.R6	1	0	0	0	0	0	0	0	0	0	0	0	0	1
D7.R7*	1	0	0	1	0	0	1	0	0	0	0	1	0	**4**
D8.R8	1	0	0	0	0	0	0	0	0	0	0	0	0	1
D9.R9*	2	1	0	1	0	1	0	1	0	0	1	0	0	**7**
D10.R10*	0	1	0	0	0	1	1	0	0	0	0	0	1	**4**
D11.R11*	0	0	1	1	0	0	1	0	0	0	0	0	0	**3**
D12.R12	0	0	1	0	0	0	0	0	0	0	0	0	0	1
D13.R13*	1	1	0	0	0	2	2	0	1	1	1	0	0	**9**
D14.R10*	1	0	0	1	0	0	1	1	0	0	1	0	0	**5**
Total number of times code identified	**9**	**4**	**6**	**7**	**0**	**7**	**7**	**5**	**1**	**2**	**4**	**1**	**2**	
Number of interviews within which code identified	**8**	**4**	**5**	**7**	**0**	**6**	**6**	**4**	**1**	**2**	**4**	**1**	**2**	
% occurrence**	64%	29%	29%	50%	0%	43%	43%	29%	7%	14%	29%	7%	14%	

*D0.R0 – Orange text indicates presence of three or more decision-making phases in this interview

**calculated based on "number of interviews within which code identified" divided by total number of interview conducted (N=14)

However, despite recognizing the need for action to address the impacts of climate change, few projects (or decision-making process for projects) were initiated based solely on this need. Respondents R9 and R11 explain:

"It is quite difficult to plan climate adaptation projects because quite often they [asset managers] already make a project in a street so there's a reason to start the project…so it [climate adaptation] is not the starting point." (Interview D9.R9)

"*I always say, there are not so many climate adaptation projects – there are a lot of projects who want to change buildings, who want to change the outer space [external environment] or something like that, and then the main goal is to do it in a climate adaptive way."* (Interview D11.R11)

Consequently, implementation of climate adaptation measures typically occurs only when there is an opportunity to incorporate them into other pre-existing or necessary infrastructure projects, particularly large-scale neighbourhood redevelopments. These "opportunity" or "need-based opportunity" tactics were identified in only four of the interviews conducted. The literature notes that decision-making processes initiated by an opportunity are generally less "successful" (Nutt, 2008). However, the definition of opportunity used in the literature is based on the use of a "ready-made" plan or solution to direct the decision-making process. In this research, the decision-making process triggered by the opportunity for implementing climate adaptation measures was always associated with an innovative, custom-designed solution.

In the "Development" phase**,** all decision-making processes involved either a full "design" or "search and design" tactics. These tactics were identified in more than six of the fourteen interviews, sometimes occurring simultaneously. Both of these tactics are recognized as being necessary for a more successful decision-making process (Nutt, 2008).

In the "Selection/Evaluation" phase, the "Analysis" tactic was present in most decision-making processes. It is the most frequently identified tactic in this phase, occurring in six out of 14 interviews. It was followed by the "Bargaining" tactic, which was identified in four out of the fourteen interviews. The "Judgment/Subjective" tactic was only identified in one interview. The literature does not identify any particular "Selection/Evaluation" phase tactics as resulting in more or less successful decisions (Nutt, 2008).

The "Judgement/Subjective" tactic was used in a sewer replacement project that did not involve climate adaptation measures. Respondent R13 notes in response to a question on how the sewer replacement solution was decided upon: "*Just thinking and looking at the map."* However, they discuss an analysis that was completed to test replacement options, indicating the presence of an analysis tactic as well.

The "Bargaining" tactic was frequently identified in interviews regarding the implementation of climate adaptation measures, especially those involving external actors such as the public.This type of bargaining (between actors) differs to that in the literature which is more focused on how internal stakeholders evaluate options available to them (Nutt, 2008).

Respondent R4 provides an example of the bargaining tactic and highlights how it resulted in modifications in idea development and implementation of a particular climate adaptation measure. They note: "*we did the infiltration foundation of the road...but it's encased in some kind of material and the other network providers didn't want to be under it…so there was quite some struggle about where to we position the other mains and the other pipes…but there have been a lot of conversations between the different network providers, and we gave in – multiple parties gave in sometimes…"*(Interview D4.R4)

The modification or changing of a chosen solution due to discussions with other actors also demonstrates the iterative nature of the Selection/Evaluation phase and the Development phase – a fact recognized by both Nutt (2008) and Mintzberg & Theoret (1976) as part of the decision-making process.. In this research, it was not only the iterative nature of the two phases that was observed, but also the difficulty in distinguishing between the two.

One example of this merged process was described by respondent R10 (interview D14): "*So I've been speaking to ten percent of all the local people…giving them the opportunity to codesign "we'd like to do this one – well, we're paying it together so what is the best thing we can do, you think?". And we also divided the city in little districts, three four blocks/streets. And for every block we made a small plan and we discuss this plan with the owners, house-owners. And give them the opportunity to [contribute]…[we would say] "this is the goal for this area, we have a proposition on how we can solve it, so we have the money [to do it] in one way, but…your ground is your castle so you have to say yes, otherwise we can't work there.*" (Interview D14.R10)

These merged phases reflect a combined use of the custom "design" development tactic and "analysis" and "bargaining" selection/evalutaion tactics. They were the result of a collaborative approach to the decision-making process, which the respondent credited as key to the project's success.

In the "Authorization/Implementation" phase, the tactics identified in the interviews were hard to classify into the four tactics identifed by Nutt (2008) and used in the framework. There were two instances where actions similar to a "persuasion" or "edict" tactic were identified, and only one instance where a "participation" tactic was deemed present. Most of the tactics were categorized under the "intervention" tactic. This was because the majority of these projects were initiated by a need to address a particular issue (i.e. ageing sewers or redeveloping neighbourhoods) and therefore there were specific performance goals to be met or improvements to be made.

However, sometimes the "Authorization/Implementation" tactic used did not only apply to the specific project being discussed, but were implemented at a different level of decision-making, such as that of the municipal council. This was particularly the case when there was a conflict between the (usually shorter-term) goals of technical (i.e. infrastructure) designers and decision-makers, and the (generally longer-term) goals of politicians and policy-makers, such as those of climate adaptation.

Respondent R10 (interview D14) discusses an example of this. They note the influence that a municipal council had on redirecting the engineering approach of a controversial project – one in which the initially proposed solutions resulted in a public outcry: *"…the first engineering [approach] was the different approach – private owner, private price, and my thing was we have to counter [change] it. I*

brought it [my proposal] to the council and that's where the discussion takes place - as a city civil engineer you cannot change things unless the council agrees…". (Interview D14.R10)

Respondent R9 further illustrates the point by noting how conflicting goals between a municipal council and technical decision-makers can impact implementation of climate adaptation measures: *"I think if you look at the [municipal] council, their focus is mainly on climate change and public participation and that kind of topic. If you look where the money is, it's mainly sewer replacement. So there is a difference – the money is spent on replacement - it costs a lot and it's where the money goes."* (Interview D9.R9)

These responses demonstrate that the authorization/implemenation phase can occur at a different "organizational" level than rest of of the decision-making phases. The existence of different levels in decision-making is made by Nutt (2008), who notes "level of analysis" as an important consideration in analyzing decision-making processes. This is an especially important consideration for the implementation of climate adaptation measures, particuarly if the different levels of decision-makers have conflicting goals.

4.1.2 Decision-making processes identified

In order to better understand the relationships between all phases of the decision-making process, a comparison is made to Nutt's (2008) four process types, Mintzberg's seven process models, and the "*thinking first*", "*seeing first*" and "*doing first*" approaches to decision-making identified by Mintzberg & Westley (2001).

Table 4 (in Chapter 2) shows the four decision-making process types generated by Nutt (2008). **Table 13** provides a short overview of the projects within which decision-making processes were identified. It includes a description of the project, project type, and decision-making phases and tactics. There are a total of 11 decision-making processes in the nine interviews, due to the fact that some interviews discussed multiple projects/processes.

A comparison of the two tables highlights similarities and differences between the decision-making processes theorized by Nutt (2008), and those that were discussed in the interviews conducted. Using the process classification by Nutt (2008), the decision-making processes in three interviews (D7, D13-P2 and D14) can be categorized as a "discovery process" since they each contain all of the tactics Nutt (2008) identified in this type of process. The "discovery process" is an example of the "rational" or "thinking first" approach discussed by Mintzberg & Westley (2001).

All three processes (and projects) were triggered by a need, with an aim of solving a specific problem or meeting a particular objective.

For example, the reason for the project in interview D14 was to solve an existing flooding problem, described by respondent R10 as follows*: "So imagine this little village, there's a rain in 2014 and it's a heavy heavy rain, 40, 50mm in an hour and water is coming through the sewer system, up in the village below and there's…dirt everywhere, and this is the so many time in twenty years or something. So the local city says "this is the end of it, we're going to change this, we're going to do something about this."*

Table 13 –Breakdown of phases and tactics in project-specific decision-making processes

Interview ID	Project Description	Project type	DM Phase – Tactic			
			Initiation	**Development**	**Selection/ Evaluation**	**Authorization/ Implementation**
D3	Neighbourhood-scale project to incorporate "blue-green" measures into residential/commercial area	New development/ redevelopment	Need-Opportunity	Design	Bargaining	Intervention
D4	Neighbourhood-scale redevelopment and sewer replacement	Redevelopment	Need-Opportunity	Design/ Search &Design	Bargaining	Persuasion
D5	Neighbourhood scale redevelopment – urban planning and design	Redevelopment	Opportunity	Design/ Search & Design	Analysis	Edict
D7	Sewer replacement projects	Sewer replacement	Need	Design	Analysis	Participation
D9	Project 1 – Municipality scale climate vulnerability mapping Project 2 – Sewer asset management plan for municipality	Strategic Plan Strategic Plan	P1 – Opportunity P2 – Need-Opportunity	P1 – Search & Design P2 - Design	P1 – N/A P2 - Bargaining	P1 – N/A P2 – Intervention
D10	Neighbourhood scale redevelopment – urban planning and design	Redevelopment	Opportunity	Search & Design	Analysis	Persuasion
D11	Plan for incorporating climate adaptation into urban drainage projects	Strategic Plan	Need-Opportunity	Design	Analysis	N/A
D13	Project 1-Neighbourhood scale new development and sewer renovation project Project 2 – General sewer replacement process	P1 - New development, redevelopment P2 – Sewer replacement	P1 – Need-Opportunity P2 - Need	P1 – Search & Design P2 – Search & Design	P1 – Analysis P2 – Judgement /Analysis	P1 – Edict P2 – Intervention
D14	Neighbourhood-scale redevelopment and sewer renovation	Redevelopment	Need	Design	Analysis & Bargaining	Intervention

All three "discovery process" projects undertook either a "design or search and design" development phase. Selection and evaluation of options was undertaken using all three tactics: an analysis or bargaining tactic was identified in each interview, and a judgement/subjective tactic was identified in only one interview. The Authorization/Implementation tactics used in these projects also aligned with those identified in the discovery process, with two projects using the proactive tactic of "intervention" and one project using the proactive tactic of "participation."

The remaining eight projects/decisions (D3, D4, D5, D9-P1, D9-P2, D10, D11 and D13-P1,) did not fall into any of the four process categories identified by Nutt (2008). They seemed to follow a hybrid decision-making process that combined both the "discovery process" and "idea imposition" process. They were either initiated by an opportunity or a need-based opportunity tactic and undertook extensive design or search and design tactics to develop custom-made solutions.

These projects were generally projects that integrated climate adaptation infrastructure into the built environment or included a requirement for climate adaptation in strategic plans. They provided an opportunity to learn which climate-adaptive solutions work best in which contexts, and how to use that knowledge, gained through experimentation, monitoring and evaluation, to improve future projects/implementation efforts.

For example, respondent R5 notes " *in the first part [of the project] we had the first rule but now we have the fifth rule or something because we concluded it wasn't the right rule to get the goals so there's an evaluation, it changes, it changes in the time. But I think we have to make more rules to get it right."*

In the Authorization/Implementation phase, implementation of decisions in these hybrid processes was mostly undertaken using "persuasion/edict" tactics. Respondent R10 discusses an example of the "persuasion" tactic, used to encourage municipal staff to participate in a community-led neighbourhood redevelopment program: "*And the city is sometimes they are very enthusiastic about it, and sometimes they are scared, because it's totally different than they are used to. And the project I was showing – this one with the relining system, it's actually to convince the city to work in another order."*

Nutt (2008) concluded that a discovery process was generally more efficient (i.e. it typically takes less time) than other process types, which is one indicator of success. However, this does not take into account the impact of delays caused by disagreements with external actors.

This research showed that, especially in projects where a bargaining tactic was present (which was the case in the hybrid decision-processes), the presence of external actors can delay a decision-making process considerably, which may then impact the perceived success of a decision. In fact, Mintzberg & Theoret (1976) identify exactly this phenomenon as a "blocked design decision process", which is predominant in public works projects and consistent with the findings in this research.

Respondent R4 provides an example of this, regarding a stalled project to implement more climate adaptation measures in one neighbourhood "*it took us three to four years to convince them [the community], and a lot of talking. So, what we did was, we created a community with the inhabitants,*

and the housing company, housing corporation and that water authority as well, and we actually took a step back from the plans that we had and actually made new plans…" (Interview D4.R4)

This blocking/stalling of decision-process by the public or other entities usually occurs during the final "selection" stages of the process and may mean that the "success" of a discovery process as defined by Nutt (2008) may differ in a different context, depending on the number and types of actors involved.

4.1.3 The role of multiple actors

One additional finding from the interview data was the multiple actors involved the decision-making processes. Four main types of actors were identified: technical decision-makers (or design team), the local community, the municipal council and other private stakeholders, particularly housing developers.

Technical decision-maker (or design team):

This actor was a technical or knowledge expert and were involved in the decision-making process based on their area of expertise in sewer asset management, urban planning or climate adaptation. They could be either municipality staff or external consultants.

For example, respondent R7 notes how a group of asset managers in their municipality collectively decide on which projects to pursue *"...we do that [make decisions] together. And when we decide that we can do it better next year, then it is important that we talk with each other and talk about the reason, and decide together, then that's the best decision..."* (Interview D7.R7).

Respondent R3, an urban planner and external consultant specializing in the implementation of climate adaptation measure explains how they got involved in a neighbourhood scale redevelopment incorporating "green and blue" infrastructure "…*there was this project team which was led by the municipality, and I was involved as an external expert designer from outside…*" (Interview D3.R3).

Local Community:

The local community actor was involved in the decision-making process mostly through their activism for or against works that impacted their community.

For example, respondent R3 notes, regarding the difficulties with one group of local citizens who were opposed to a neighbourhood redevelopment project "…*in this process, the local citizens were very involved. I think, throughout the whole process – they were, all the time, trying to block more and frustrate the process more. Because their main goal was, I think they didn't want any developments – so they wanted to block all the development*" (Interview D3.R3).

In contrast, respondent R5 notes how a collaborative effort between local citizens and politicians resulted in a neighbourhood redevelopment project. They note: "*It was the inhabitants and the politicians of the city who said we have to change the railway into a tunnel – and that was the start of the whole project."* (Interview D5.R5)

Respondent R1 highlights how socio-economic demographics can play a role in the level of participation of different communities. They note as a general observation "…*particularly in urban areas is that the areas that are most sensitive to climate change and most in urgent need for climate adaptations are also*

the areas where participation is traditionally difficult. The areas where you have lower levels of education, a lot of renting, little organization there." (Interview D1.R1)

Municipal council

The municipal council was identified multiple times in the interviews. Their role in the decision-making process varied depending on the type of projects discussed.

Respondents R12 highlights the role of the municipality in approving any extra funds needed for sewer asset management/urban drainage projects. They note: "*Because for these extra investments, the sewer manager has to ask the municipality for additional investment money, to build extra storage capacity or whatsoever…"* (Interview D12.R12)

Respondent R9 reinforces how municpality approval of municipal sewer asset management plans (known as GRPs) which include funding budgets, is important for sewer managers: " *I think it [municipality approval of GRP] is important for them [sewer managers] because the council agrees on the taxes so the income is fixed.*" (Interview D9.R9)

Respondent R5 noted their role in formalizing climate adaptation rules to apply to new private property development : "*Climate adaptation especially brings [gives] us much space to make our own rules but we have to make them formal by the city council. And that process didn't succeed at this moment, so we're in that process with the city council to make new rules*." (Interview D5.R5)

And, respondent R2 notes the role they can play in championing climate adaptation at a municipality level "*we now have an alderman [councillor] who is very into blue and green…and that brings a lot of power to the organization, but when you have the wrong alderman, who says "let's do it just the way we always did" – then you can do what you want but the change won't come…you need those aldermen to create the power*" (Interview D2.R2)

Other stakeholders: private housing developers:

A number of external stakeholders were identified in the interviews as being involved in the decision-making process however private housing developers were identified across multiple interviews as playing an important role, especially for new development and redevelopment projects.

For example, respondent R5 notes how the loss of one housing developer from a project required a revision of the redevelopment plan, changing the project trajectory *"At the beginning there was a Master Plan …but afterwards we have made a new plan because [due to] the direction of the housing developers, we had to change [direction]… a big amount of the money that was needed for the tunnel had to be arranged by the housing [developers], and we had two developers who would build the housing. [But], they said you're going to get half of the money, and we said "that's not possible we have to get the total amount", [but] then we [had to make] a reassessment of the plans…[so] from the two developers who had the rights to realize [develop] the area, we changed the contract with them, and one was still on board"* (Interview D5.R5)

From a financing perspective, respondent R12 noted the importance of housing developers in providing income for municipalities: *"…investments are financed by financial institutions, like banking, building companies, construction companies – so for the municipality, they can finance a lot of things through selling the houses".* (Interview D12.R12)

Interestingly, respondent R3 notes how reluctant housing developers were only present in a decision-making process for the implementation of climate adaptation measures because they required permit approval for their development "*So, there was the developer of a lot of houses, but also the developer of the student housing. And they weren't voluntarily in this team. They were there because there was this urban zoning plan and it was rejected by the authority that talks about the urban zoning plans…"* (Interview D3.R3)

4.1.4 Sub-chapter summary

In summary, most of the phases and tactics identified in the literature were also identified in the interviews. The most frequently identified initation tactic was by "need" and usually associated with the need to maintain or replace ageing sewer infrastructure or redevelop older neighbourhoods. Implementation of climate adaptation measures typically occurred when there is an opportunity to incorporate them into other necessary infrastructure projects, particularly large-scale neighbourhood redevelopments (i.e. a need-based opportunity). Solutions were mostly custom-designed, and analysis and bargaining were the main tactics used to select and evaluate options. Authorization and implementation of decisions were mostly based on achieving performance metrics (intervention) but other tactics (i.e. persuasion, edict and participation) were also used.

Only three of the decision-making processes identified could be categorized as a "discovery process" as described in the literature. The remaining eight decision-making processes could not be strictly categorized using the processes identified the literature and seemed to combine at least two processes: the "discovery process" and the "idea imposition" process. These eight projects were generally projects that integrated climate adaptation infrastructure into the built environment or included a requirement for climate adaptation in strategic plans.

Four main actors were identified as involved in the decision-making processes: the technical designers/decision-makers, the local community, the municipal council and private housing developers. The presence of external actors combined with the use of ineffective bargaining tactics were noted to delay a decision-making process considerably.

4.2 Hindering & Enabling factors – Interview Results and Discussion

The institutional factors identified in the interviews were categorized into Regulative, Normative and Cognitive factors as per the framework. They are categorized as hindering or enabling, based on the literature reviewed to develop the framework. Factors that were classified as high and medium frequency are discussed in the following sections. A full list of factors, including low frequency factors are included in **Appendix D.**

4.2.1 High frequency factors

Table 14 summarizes the "high frequency" codes that were identified in 10 or more interviews.

Table 14 – High frequency hindering and enabling factors

Code	Type	Category (REG, NORM, COG)	Frequency of occurrence across interviews*
B&F- Fragmented Roles and Responsibilities	Literature-based	NORM	14 (15)
B&F Resources – Financial/Capital	Literature-based	REG-ADMIN	14 (15)
Multiple climate adaptation goals	Interview-generated	REG-ADMIN	13 (14)
B&F – Information, knowledge, understanding (technical)	Literature-based	COG	13 (13)
B&F- Regulatory Framework	Literature-based	REG-LEG	12 (12)
Sewer tax	Interview-generated	REG-ADMIN	12 (12)
Cost consideration	Interview-generated	COG	12 (12)
B&F – Long-term vision/strategy	Literature-based	REG-LEG	11 (11)
Collaboration with others (internal, external)	Interview-generated	NORM	10 (11)
Cognitive/cultural resistance, barriers	Interview-generated	COG	10 (13)
Municipal Council	Interview-generated	REG-ADMIN	10 (13)
B&F-Community Engagement, Participation, Empowerment[1]	Literature-based	N/A	10 (11)

**number in brackets indicates absolute frequency of occurrence due to some factors occurring more than once in some interviews*

1 – The community engagement factor is discussed in Section 4.1.3 and is therefore not discussed in this section.

As shown in **Table 15,** all three types of factors are frequently identified in the interview data. Six of the factors are regulative, three are cognitive and two are normative.

Only two factors were identified in all 14 interviews: “Fragmented Roles & Responsibilities” (a normative factor) and “Resources – Financial/Capital” (a regulative factor).

The first factor, “Fragmented Roles & Responsibilities” was identified in the interview data as a clearly hindering factor, which is consistent with the literature (Brown & Farelly, 2009). It was identified in two different instances. In one instance it was explicitly mentioned as a hinderance because it resulted in unclear responsibilities for maintaining climate adaptation measures. This was noted by respondent R2: “*Sometimes the people of green think the people of water or blue will take care of it, and the people of water think the people of green will take care of it…so with all those mixtures, everybody thinks…[somebody else will take care of it…]”*. (Interview D2.R2)

In another instance, it was identified as a reason why the integrated working between departments that is necessary for implementation of climate adaptation measures can be a challenge. Respondent R10 notes: *“…we all want to work [in an] integrated [manner] but that’s really a big issue. They [practitioners] all have their own tasks, their own policies, they have their own targets so working integrated is pretty difficult and climate change asks for a bit more working [collaboratively]...” (*Interview D14.R10)

In contrast, the factor “Collaboration with others” was also identified frequently across interviews (i.e. in 10 out of 14 interviews). It is noted in the literature as an enabler of the institutional change needed to tackle complex challenges such as climate change (Bryson et al, 2015, Farelly & Brown, 2011).

Respondent R13 notes how collaboration takes place between asset managers in their municipality: *“It differs, we have all the cable companies, water, gas - we have four times a year, a meeting to discuss our plans when on where we have to replace our pipes. Because we have a good inspection of the system – so if a pipe needs to be replaced, we can say that from the inspection, this kind of damage it will take about 10, about 10 or 20 years, then we have to replace it.” (*Interview D13.R13)

Respondent R7 reinforces this asset management based collaboration “*What we do, is with a map table session… I have the map from the sewer system…then my colleague from the streets has the same map but done for his streets…and also my colleague from the public space..So we stand around the map, and then for the whole city we look, we start with one area…then we take what we want to do the same time as the sewer. So everything in that street, we will combine...And then we start a project….”* (Interview D7.R7)

The second factor that was identified in all interviews “Resources – Financial/Capital” was neither entirely hindering nor enabling but context-dependent. This is consistent with the literature which recognizes a lack of sufficient financial resources as a barrier to institutional change and climate adaptation (Brown & Farelly, 2009, Ekstrom & Moser, 2014).

Respondent R11 notes: *“I think the financing is mostly also a problem, because when you want to innovate something, you mostly first have to – you first make the costs and then you get the benefit. And you need people who want to invest first, and that’s not so common…”* (Interview D11.R11)

Respondent R2 notes how climate adaptation efforts face challenges with the availability of resources: *"that's kind of a problem because for the green, there is always short of money – now they get a little extra money from climate adaptation budget – that's now, the coming five to ten years, but after that, when we have another focus – maybe we are focused on cyber security, and then [maybe] the money goes to cyber security…"* (Interview D2.R2)

In contrast, Respondent R7 notes the availability of funding for the sewer system: "*We have a tax, and that tax is only – you may only, that's by law, you may only use that for the sewer system. And for my sewer system, I can do the research and so on. But the tax is only, they are not allowed to use that for other stuff. So it's only used for the sewer system."* (Interview D7.R7)

Related to the availability of funding, the interview-generated factor "Cost consideration" was identified in 12 out of the 14 interviews and shows the connection between a regulative/ institutional factor (i.e. availability of financial resources) and cognitive factors/considerations of decision-makers (i.e. how expensive is the solution).

Respondent R13 shows how this applies in sewer asset management "*Cost is the most important one of course, and in the Netherlands, sewer management is paid by taxes and these are very strict, so we may only put our money in the sewer system, not other functions… you have to know how much money you need, for maintenance…"* (Interview D13.R13)

References to the existing regulatory framework were identified in 12 interviews under the factor "Regulatory Framework". It was often identified alongside two other factors "Long-term vision/strategy" and "multiple climate adaptation goals."

The presence of a long-term vision of or strategy for climate adaptation at the municipal level was identified in the interview data as a strong enabler for implementation of climate adaptation measures, which is consistent with the literature (Brown & Farrelly, 2009). The factor "long term vision/strategy" was identified in 11 out of 14 interviews and was highlighted by interview respondents as essential to their inclusion of climate adaptation measures in their municipality.

For example, respondent R4 notes in response to a question asking why climate adaptation was integrated with sewer management in their municipality: *"it's [because] we have some policies that we already have been introducing around 2014, I think, where we already told ourselves that we have to focus on climate adaptation".* (Interview D4.R4)

And respondent D5 notes: *"we have a strategy for climate adaptation in [municipality] X, so there's a form of [policy brief]. So that's for us a starting point for development, and you have several kinds of developments*." (Interview D5.R5)

The presence of a long-term vision/strategy for climate adaptation at a national level was also identified in the interviews and was typically in reference to the Delta Programme (DP) and Delta Plan on Spatial Adaptation (DPRA). These national strategies were identified as enablers of climate adaptation overall, but in some cases identified as a hinderance for climate adaptation in urban drainage systems

specifically, due to the existence of multiple climate adaptation goals which could result in multiple priorities. The factor "multiple climate adaptation goals" was identified in 13 of the fourteen interviews. Respondents R4 and R11 provide examples of the conflicting priorities caused by multiple climate adaptation goals.

Respondent R4 notes: *"…now we have the dilemma are we going to be, energy adaptive (or climate adaptive), so yeah, that's a new dilemma…"* (Interview D4.R4).

Respondent R11 highlights the complicated interaction between climate adaptation funding, the sewer tax and implementing climate adaptive measures: "*We also see that we cannot reach every goal we want to reach within climate adaptation by using the sewer tax and using the [urban drainage] measures [supporting] the sewer systems. We also [want to have] more green, more trees, more shadow in the streets and therefore it is very difficult to pay that from the sewer tax… that is why we are struggling now…we have, with some colleagues with whom we are [working on] a policy on the green area [and] we say we need a lot of more green area in [municipality]. Therefore you have to change mostly paved area into green area, and it costs a lot of money – and where to pay that from? …"* (Interview D11.R11)

In addition, respondent R1 and R7 highlight how addressing one climate adaption goal (urban flooding) could inadvertently result in future problems dealing with a different goal (i.e. drought). They note: *"I do think we need to be very careful when it comes to drought and water management, when we're thinking about greening our cities…one tree can cost up to 120 L of water a day, and I think if we don't carefully design also the water aspect of all the greening then we might run into some issues"* (Interview D1.R1)

"I'm worrying about less water…and the heat and the drought periods…when you don't have rainfall for a long period, the groundwater becomes salty from the sea – and that's very bad for the trees and so on. But also, in our city, we decided less pavement and more green. More green, more trees, but also on our roofs – but green needs water." (Interview D7.R7)

This uncertainty about the future impacts and lack of knowledge about the cumulative effects of current measures was linked to two cognitive factors identified in the interview data: "Information, Knowledge and Understanding (technical)" and "Cognitive/cultural resistance".

The factor "Information, Knowledge and Understanding (technical)" was identified in 13 out of the 14 interviews. Whether or not information/knowledge was a hinderance to climate adaptation in urban drainage systems was context-dependent, in that a lack of information, knowledge or understanding was a hinderance, and vice versa. Both instances (i.e. the lack or presence) of this factor were identified in the interviews.

For example, respondent R4 noted how knowledge acquired from a previously completed large-scale climate adaptive project was useful in supporting growth and learning for practitioners within the municipality *"…we have learned a lot from that approach and now we can do it more ourselves. We have an internal engineering company as well in the municipality so they now also advise on how to change from combined sewer systems to separate sewer systems and put in innovative SUDS."* (Interview D4.R4)

In contrast, respondent R11 notes how a lack of knowledge on what qualifies as sufficiently climate-adaptive can hinder efforts to incorporate measures in projects: They note *"…everybody wants to do climate adaptation, and they ask – what do I have to do then? Then it becomes difficult, [so we say, for example] "now you have to bring trees in" and they say "how many trees do I have to bring in?" – and then everybody becomes silent because we don't know."* (Interview D11.R11)

A lack of knowledge can also result in a more cautious approach to implementation due to uncertainties regarding system-wide performance. For example, respondent R1 notes: *"I think specifically for this field of climate adaptation, what is mostly not helping is that we still have a lack of understanding of what the system effects are. So you see that all these innovations, they are like isolated developments but I don't know what the total means on my area."* (Interview D1.R1)

The point was further emphasized by respondent R2, who makes a direct comparison to knowledge about the sewer system and how a lack of knowledge about system effects of new climate adaptive infrastructure could result in future challenges for maintenance. They note: "*when you have the sewer system, then you know, normally you know where the pipes are and how it functions. When you have the system in the upper ground, then it's like a substrate… so you create a structure with a lot of different types of assets because underground, above the ground.. and you use [everything] to catch the water… but maybe within ten or twenty years, we cannot remember how we thought it would function and we can't reproduce it anymore… Because a lot of infiltration assets and bodies, when you look at the maintenance systems – they are a lot of times, they don't know where they are. So we are creating a new upper ground environment, but we have to be careful that we know how it has to function. We have to log the data…"* (Interview D2.R2)

A lack of technical knowledge about system wide effects, uncertainty about the current and future performance of climate adaptive infrastructure, and a resistance to changing established ways of working were identified as a few of the reasons underlying reasons the "cognitive/cultural resistance" factor. This factor was considered a hinderance to implementation of climate adaptation measures and identified in 10 out of 13 interviews.

Respondent R12 notes this factor as a reason for the slow pace of change in urban drainage systems to incorporate climate adaptation measures "*…the cultural blockages, maybe [blockages is] too strong – the sector [urban drainage -sewers specifically] is a bit hindered by cultural aspects as well. The craftsman, they always did it in this way, it appeared to work well so why should you change…*". (Interview D2.R2)

Respondent R5 also notes a similar phenomenon, particularly regarding established ways of working, and how it interacts with the climate adaptation efforts in their municipality: " *we have a project group for climate adaptation and there are members from also those departments in the municipality are involved just to make them ambassador for the overall thoughts and the goals we are trying to achieve, and the changes you can see. But that's very difficult because every person thinks "Oh I'm doing the right thing, and we have always done it that way.*" (Interview D5.R5)

Respondent R5 further highlights how this cultural/cognitive resistance can be related to the time and effort required to include climate adaptive measures, the cost of the measures and the practitioners' level of comfort with taking risks. They continue: "*…[the] specific solution for every part of the city can be different – and that's costs a lot of energy to investigate, to search for the right solution. It's also difficult because the right solution are not always easy, or available, so sometimes you have to think [of] new solutions. And the technical asset [managers] don't [always] have open mind for new solutions because they have to look for [how it performs in] the future, and that it will be within costs, so they have low risk level. So a new solution has a higher risk because it's not known and they don't know what problems will exist. So they are always short of money, so they are trying to get the risk as low as possible."* (Interview D5.R5)

4.2.2 Medium frequency factors

Table 15 shows the factors that were identified in the "medium frequency" category – i.e. factors occurring across five to nine interviews. The two most frequently identified factors in this category are "incentive to action" and "resources – human/capacity."

In contrast to the hindering factor cognitive/cultural resistance, the "incentive to action" factor was identified as an enabler in eight of the fourteen interviews and reflected two reasons why municipalities increased their climate adaptation efforts i.e. when it provided social and/or environmental benefits for their citizens..

Respondent R2, a strategic advisor on climate adaptation in a municipality notes:*"…So we now realize that we have to mold the upper ground to catch the rain…because we don't see it as a threat but as a chance to get a better environment. Because when you take blue-green measures in the upper ground, you don't have to enlarge the sewers. You also create a better living area so it's nice to work."* (Interview D2.R2)

The "incentive to action" factor can be categorized as an example of "Reflective Motivation" (Michie et al., 2011) because it highlights a reflection by municipalities of the effects of becoming more climate adaptive and an evaluation of the benefits of climate adaptation for society as whole. It was also identified as one of the underlying motivations for the literature-based "Public/political will" factor.

The "public/political will" factor was also identified as an enabler of climate adaptation implementation efforts, which is consistent with the literature (Brown & Farelly, 2009). It was identified in seven out of the fourteen interviews.

Respondent R10 provides an example of how one municipality's political will/desire to address flooding issues from a societal perspective, and not only as an urban drainage problem resulted in action: *"And the city council was not interested in how any other government doing it, [they said] "we want to have this problem[of flooding] solved"... so by accepting it as a civil problem, as a problem for the whole village, it kind of gets solved that way..."* (Interview D14.R10)

Table 15 – Medium frequency hindering and enabling factors

Code	Type	Category (REG, NORM, COG)	Frequency of occurrence across interviews*
Incentive to action: societal or environmental	Interview-generated	COG	8 (8)
B&F Resources – Human/Capacity	Literature-based	REG-ADMIN	8 (8)
Private Landowner responsibility	Interview-generated	REG-LEG	7 (7)
Practitioner skill set (operational v strategic)	Interview-generated	COG	7 (7)
B&F – Public/Political Will	Literature-based	NORM	7 (8)
Timing and aligning multiple projects	Interview-generated	NORM	7 (7)
Integrated approach	Interview-generated	NORM	7 (7)
Public-private space interaction	Interview-generated	NORM	7 (7)
Risk consideration, aversion, novelty, uncertainty	Interview-generated	COG	7 (7)
Local conditions, available space	Interview-generated	NORM	6 (8)
Alignment with road works	Interview-generated	NORM	6 (7)
Learning-by-doing, experimentation	Interview-generated	COG	6 (7)
Wider system perspective	Interview-generated	COG	6 (6)
GRP	Interview-generated	REG-LEG	6 (6)
Performance criteria, durability	Interview-generated	NORM	5 (6)
DM Perspective/Attitude	Interview-generated	COG	5 (5)
Neighbourhood-scale renovation	Interview-generated	NORM	5 (5)
Stress tests (sewer)	Interview-generated	NORM	5 (5)

**number in brackets indicates absolute frequency of occurrence due to some factors occurring more than once in some interviews*

This public/political was identified was sometimes translated into policy documents such as the municipal sewerage plan or GRP (*Gemeentelijk Rioleringsplan*). The factor "GRP" was identified in six out of the fourteen interviews.

Respondent R9 provides an example of a GRP that incorporated a climate change budget. They note:*"…you can see that every part of the municipality has a different time frame where they would replace the sewers….so everybody knows that within this period those sewer probably will be replaced and there is budget for it….here you can see the yearly tasks and the costs associated with it. The research that is done, the budget, groundwater research, climate change budget, and all the sewer replacement projects."* (Interview D9.R9)

Yet, despite public/political will, the lack of human resources (i.e. people) and capacity (e.g. time), especially in smaller municipalities was identified as a hinderance to implementation efforts. The literature-based factor "Resources-Human/Capacity" was identified in eight of the fourteen interviews and is noted in the literature as a barrier to institutional change in urban water management when absent (Brown & Farelly, 2009).

Respondent R2 notes: *"…[In] the smaller cities, the people always have to do a lot of things..the sewer systems, the green, the roads – they are always busy, they don't have time to think about tomorrow and sometimes, the bigger cities, you have people like me – who have time to think about the future…"* (Interview D2.R2)

Similarly, Respondent R3 notes the differnce between cities in the number of urban planners (who are typically responsible for climate adaptation implementation in the urban space): "*the smaller municipalities have several problems: they have very small urban design section in their municipalities – mostly there are actually two urban designers for the whole municipality. I think, Amsterdam has 500 or so, so the difference is huge"* (Interview D3.R3)

The interview generated factor "Practitioner skill set" further highlighted the distinction between municipalities not having a sufficient number of people to undertake the tasks versus not having people with the right skill set. This lack of the appropriate skill set within practitioners is an example of the "Psychological Capability" factor identified by Michie et al. (2011) which captures whether the individual possess the appropriate or sufficient knowledge to undertake the desired task/behaviour.

"Practitioner skill set" was identified in seven of the fourteen interviews, and identified as a hinderance to adaptation implementation efforts if practitioner skill set (e.g. asset management) was mismatched with need (e.g. urban design and climate adaptation).

For example, respondent R10 notes the differences in practitioner skill set can impact implementation of adaptation measures. They highlight the difference between the tasks (and skills) required of sewer managers and those required of designers who are responsible for incorporating climate adaptation measures into the urban landscape. They note: *"if you look at this problem, we ask a group of people, asset managers, who are trained to do their work as efficiently as possible, who are also educated for continuation and maintenance and not design [to undertake design]…*[*and] design is completely different isn't it? You have to think back and do things different…"* (Interview D14.R10)

Experimentation or "learning by doing" was identified as one method of expanding practitioner skill set and increasing implementation of climate adaptation measures. The factor was identified in six out of twelve interviews and was identified as an enabler to climate adaptation implementation which is consistent with the literature (Loorbach et al., 2017).

For example, respondent R4 notes how "learning-by-doing" provides knowledge about how to maintain climate adaptation measures in their municipality: *"…we still have to learn, because quite a lot of the climate adaptation measures are quite innovative and we haven't had a lot of experience with maintaining it so we are learning by doing"* (Interview D4.R4)

Experimentation/"learning-by-doing" was often identified alongside two other factors: "decision-maker attitude/perspective and "risk consideration/aversion". Both of these factors were identified as cognitive characteristics that influenced a decision-maker's openness to experimentation. This openness to experimentation is also identified in the literature as an enabler to fundamental institutional change (Farrelly & Brown, 2011). It can also be categorized under the element "Automatic Motivation" in the COM-B model (Michie et al, 2011), since it is specific to individual characteristics and preferences.

Respondent R1 notes how a shift in practitioner mindset can increase experimentation *"…sometimes it's a little more that the notion "this is just an experiment, we're just going to try it out and we have back-up plan for things that fail". A little bit more of that added, I think would help."* (Interview D1.R1)

In contrast, respondent R11 notes how a lack of interest by practitioners who prefer established ways of working can limit experimentation in municipalities. They note "…*to make the pilot the norm, you have to also convince the people who are not really interested in the pilot and want to do it the way they are used to doing it…*".(Interview D11.R11)

Finally, respondent R1 highlight how monitoring and evaluation of experimental projects would help in reducing the uncertainty associated with the performance of climate adaptation measures, and therefore lower the risk involved with experiments: "*And the other thing is also, is when we are doing pilots is that we give more consideration to collecting the evidence that it works or that it doesn't work – the honest evidence. That's a thing that I think would also help."* (Interview D1.R1)

In addition to a need for better monitoring and evaluation, local conditions were also identified as hindering or enablling opportunities for experimentation and the implementation of climate adaptation measures. The factor "local conditions/available space" was identified in six of the 14 interviews. It was identified as an enabler for implementation when local conditions such as soil type, support the use of climate adaptation measures and if there was space available within the public realm. This factor can be categorized under the "physical opportunity" element in the COM-B model (Michie et al., 2011).

Respondent R4 discusses this point: *"I think the surroundings helps, and with the surrounding I mean, how has the public space been designed already, how are the people, inhabitants, are they cooperating or not, is there enough space in the surface…"* (Interview D4.R4)

Respondent R5 notes the impact local conditions have on creating climate adaptation guidelines for local developments: "...*you have to think about what will be the logic or goals in this specific situation, because it's always specific for the spot, which kind of rules you have to make for climate adaptation. Because, it's very much dependent, depends on the ground and the height of the water, that kind of stuff."* (Interview D5.R5)

With regard to available space, the ability to implement climate adaptation measures on public lands (for which the municipality is responsible), and on private lands (for which private citizens are responsible) was also identified as an enabler in the interview data. Increasing implementation on both public and private properties was noted to provide an opportunity for larger-scale implementation of

climate adaptation measures. Two factors “public-private space interaction” and “private landowner responsibility” were both identified in seven of the 14 interviews.

Respondent R11 highlights the importance of the climate adaptation efforts by private landowners to supplement efforts of the municipality. They note *”We always say, when you look at the area of the municipality, 40% is about the municipality, is common ground [public space] and 60% [is] all of the inhabitants – so when you want to be climate-proof, also the 60% of the inhabitants have to do a lot of work - you can’t solve it only on the 40% of the area*.” (Interview D11.R11)

From a legal perspective, respondents R1 and R9 note that Dutch law requires homeowners to make attempts at managing rainwater on their property prior to discharging to local urban drainage systems. They both also highlight that this legal requirement is not very well known by homeowners or enforced by municipalities.

Respondent R1 notes*:” and also, there is a lack of knowledge on what the legal responsibility is on house owner in adapting their own house because they do have some but that’s not known and it’s also not enforced by municipalities…”*(Interview D1.R1)

Respondent R9 notes: *“if you look at Dutch law, it gives quite explicit tasks for houseowners. And if you look at the rainwater part of it, the law says that, they should be able to process their water themselves and only if they’re not capable of processing the rainwater themselves, then they can bring it to the sewer system or the utility. And that means that, the starting point should be that houseowners should process it themselves, that’s what the law says. But in practice, everybody brings it to the sewers, all the rainwater goes to the sewers. So you have a law that says one thing, and you have reality that does something completely different…”*(Interview D9.R9)

Another group of factors that were either technical in nature or focused on the logistics of coordination for project implementation was identified in the interview data. The technical factors consisted of “stress tests” and “performance criteria”, while the logistics/coordination factors included factors such as: “neighbourhod-scale renovation”, “timing and alignment of different projects”, “alignment with road works”, “wider system perspective” and “integrated approach”.

The “alignment with roadworks” and “performance criteria” factors were identified as context-dependent hinderances or enablers, in that they both acted as enablers of implemenation when there was municipality regulation that mandated climate adaptation be considered in all projects or included in infrastructure performance criteria.

The “neighbourhood scale renovations” and the “timing and alignment of different projects” and “integrated appraoch” were identifed as enablers of implementation since they usually entailed multiple infrastructure works to be undertaken simultaneously, thus providing opportunities for climate adaptation measures to be included.

Respondent R4 provides an example of the different approaches to project planning: *“…we have two types of sewer system replacements – when we actually are just doing the sewer replacement, so*

between the curbs, we're excavating the ground and just replacing the system and putting it back, and that's what we call singular, so only the sewer system. And we also have, an integrated scope, and then we're doing the whole street from one part of the street to the other part, and every asset, so the street, the sewer system, the lanterns, greenery is all being taken care of…". (Interview D4.R4)

Having a "wider system" approach to the urban drainage system, and the use of the stress test results to inform infrastructure planning and design, were identified as strong enablers of climate adaptation implemenation efforts.

Respondent R5 provide examples of how a system-wide approach is used in their municipality. They note "*I mentioned the scale because some things you can not arrange on a plot [level]. For instance, for water safety you have to arrange [it for the city], but you can't arrange the water safety of the city on plots [only]. So you have to do that in the public space, you have to do it on a bigger area, on a bigger level…you have also to look at that system as well, it's not only the plots, not only the land but also the system that it is part of. And then you can think of what is the best solution to keep the water on the place where it falls.*" (Interview D5.R5)

Respondent R6 notes how use of stress tests helps [in infrastructure planning] because it identifies previously unknown problem areas, or potential unforeseen issues in [the sewer and urban drainage system] network. This allows a better system understanding of sewer network; and therefore, can identify areas of focus for implementation of measures. (Interview D6.R6)

4.2.3 Sub-chapter summary

This sub-chapter summarizes the most frequent institutional hindering and enabling factors to the implementation of climate adaptation measures identified from the interview data. The most frequently identified hinderances included the fragmented roles and responsibilities, the lack of technical knowledge and understanding and cognitive/cultural resistance. Other frequently identified hinderances included limiting local conditions (e.g. available space, ground conditions), a lack of technical knowledge and understanding and insufficient human resources.

Frequently identified enablers included the presence of a long-term vision/strategy at the municipal level that prioritized climate adaptation, an underlying political incentive to action such as a recognition of the societal and environmental benefits of climate adaptation measures, collaboration between practitioners and experimentation with climate adaptation infrastructure or other measures for the purpose of learning and increasing knowledge.

Some of the identified factors acted as both hinderances and enablers depending on the context. For example, the presence of multiple climate adaptation goals or the availability of financial resources.

5 Discussion and Recommendations

This chapter provides a brief discussion of how interview results impact the implementation of climate adaptation measures in urban drainage systems. It also highlights a number of recommendations for minimizing the hindering factors and increasing the enabling factors in order to improve the implementation of climate adaptation measures.

5.1 Discussion

Interview findings demonstrate that implementation of climate adaptation measures typically occurred when there was an opportunity to incorporate them into other necessary infrastructure projects, particularly large-scale neighbourhood redevelopments (i.e. a "needs-based opportunity"). However, taking advantage of these opportunities depended not only on their existence, but also on institutional factors, as well as the actors involved in the decision-making process and the resources available to these actors.

For example, one of the most frequently identified hindering and enabling factors was the availability of financial resources. Some respondents noted that having sufficient funds facilitated the incorporation of climate adaptation measures in the urban landscape, while others noted that insufficient funds was a substantial hinderance to implementation of these measures. Within the Dutch context, the availability of financial resources was observed to be associated with the role of the decision-maker/practitioner. Sewer managers noted that the presence of the "Sewer tax" was immensely beneficial for planning and executing sewer asset management projects, whereas climate adaptation specialists and urban planners noted that insufficient funding dedicated solely to climate adaptation implementation limited implementation efforts.

This difference in financial resources is important when it comes to deciding who funds climate adaptation measures, particularly within a multi-disciplinary project context. Interview findings highlight that the sewer tax can be used for climate adaptive measures in cases where it can be proven that these measures would support urban drainage functions. However, access to sewer tax funds for climate adaptation measures depends heavily on the alignment of goals, timing of projects and effective collaboration between departments – which may not always be the case, especially if departments are fragmented.

Respondent R13 provides an example of how the availability of funding influences coordination between projects: "*…so the new street, other dimensions, parking, trees, all kinds of things. Those are things that are more difficult - they sometimes don't have a budget to participate with our sewer replacement. We have a budget - we have thirty million a year to do things, but they have to go to the city council say "oh, we're going to do that project, we need that much money". So, [it is] very difficult for them to plan these kind of things… And so it can differ in time, so these projects are not parallel, they differ"* (Interview D13.R13)

Consequently, an increase in funding dedicated to climate adaptation measures would be beneficial in reducing ad-hoc approaches to implementation.

Respondent R2 highlights how additional funding would be especially useful: *"maybe we need a kind of extra tax to enlarge the [amount of money available]. We have the sewer tax, we have the tax for the rubbish, and we have the OZB – the tax for the buildings – and maybe we have to create an environmental tax, just to have the money to maintain the new environment because it will cost extra money…"* (Interview D2.R2)

As noted by respondent R13, this increase in funding would need approval from a municipal council and Respondent R3 confirms this. They note: "it would be good if municipalities start putting budgets aside for climate change and climate adaptation. And I think municipalities like Amsterdam and Rotterdam are doing that but not the small municipalities" (Interview D3.R3)

Having sufficient resources and the capacity to implement climate adaptation measures is especially important during the development phase of the decision-making process. Interview results showed that "design" or "search and design" tactics were used to develop projects solutions. These tactics involve the use of custom-designed solutions to fit the particular problem, need or opportunity being addressed. However, these custom-designed solutions require significant effort to develop and an almost experimental approach to design.

This additional effort and experimental approach to solution development require alternative ways of working and can be a significant barrier to the implementation of climate adaptation measures. This is especially the case if practitioners or decision-makers do not have sufficient resources and capacity (i.e. money time, knowledge/skills, personnel).

Respondent R11 discusses this point: *"..it is important how difficult it is, how much work it is to implement such a technique – [it raises the question] "will people really do that?" So it must be easy to do a pilot, if it's too difficult to do a pilot, then I think, even when it's very promising most people will not start a new technique… mostly, it's because most people do it besides their normal jobs and when you have to do a new technique, you have to [put in] some extra effort. And that must not be too much because otherwise people will say "I can't do it"…we don't have people who have much time to do pilots"* (Interview D11.R11)

A lack of human resources and capacity has a very direct impact on the implementation of climate adapation measures in urban drainage systems. It means that in some instances, there simply are not enough practitioners to undertake the planning and design of these measures, and that those practitioners that are available have multiple responsibilities and limited capacity (time) to spend on developing custom-made solutions.

In constrast, some muncipalities do have personnel but these practitioners do not have the technical knowledge for design and planning climate adaptation measures i.e. their skill sets or technical backgrounds are specific to managing or designing sewer assets.

The lack of personnel or capacity shows how an institutional factor has an effect on the ability of individuals to undertake specific tasks that could contribute to implementation efforts.The lack of technical knowledge demonstrates how individual characteristics can also result in less implementation

of climate adaptive measures. Addressing both the institutional and individual factors that impact a practitioner's ability and willingness to undertake the planning and design of climate adaptation measures would help increase implementation efforts.

With regard to the institutional factors, strategies to increase the number of appropriately-skilled personnel, especially in smaller municipalities would provide some of the human resources and capacity necessary to undertake more planning and design of climate adaptation measures.

Respondent R1 notes a need for multi-skilled personnel has already been recognized and is leading to changes in higher education courses: *"one of the examples of that is actually the program that we started in 2008. And that was really motivated by this notion from the sector, from the municipalities, from the waterboards, that we need in addition to the technical specialists, we also need people that understand that understand both spatial planning and the technical and the governance. So I think you can see that as a reflection of, that it was recognized by the sector that we needed that more integral design."* (Interview D1.R1)

Respondent R8 notes how additional training of existing personnel would be beneficial: *"[I] would recommend increased training for construction and maintenance of [green infrastructure] systems, [it] would be increasingly beneficial."* (Interview D8.R8)

The additional effort and experimental design approach can also be a barrier to implementation efforts if practitioners lack the motivation to change established ways of working. Interview findings identify a "cognitive/cultural resistance" of some practitioners regarding climate adaptation, which was often related to a practitioner's resistance to changing habitual processes, openness to experimentation and tolerance for risk and uncertainty.

Strategies to increase decision-maker awareness of the importance of climate adaptation, and their desire and capability to implement measures would also be beneficial in addressing this resistance. The creation of a collective vision may provide an opportunity to do this.

Respondent R2 discusses how an inclusive vision generation can influence practitioners: "…*First, I think you have to write down a vision that is not too far away, that they think we'll never make. So make a vision that they [practitioners] can bridge the gap, so like about 10, 20 years, where they think "okay, what I do can make a little difference to reach that point, that vision"…"* (Interview D2.R2)

Strategies to increase openness to experimentation could also help reduce cognitive/cultural resistance. An increase in experimentation would also increase information, knowledge and understanding about the technical performance of climate adaptation measures, which could in turn reduce the risk and uncertainty associated with these measures, and further reduce cognitive/cultural resistance.

Respondent R3 notes how similar values between towns can be successful in encouraging smaller municipalities to experiment or attempt new ideas: *"I worked for this small municipality and I used a lot of references from projects in bigger cities… if I showed a reference from Amsterdam, they say "oh, it's Amsterdam". [But] If I show what's happening Rotterdam they say, "Oh is that happening in Rotterdam?*

Rotterdam is nearby, these are people that are hands on, if they can do it in Rotterdam, maybe we can do it too." So, this role of the bigger cities setting the example is also very important role for them." (Interview D3.R3)

Interestingly, a more integrated institutional structure may also increase practitioner willingess to experiment/increase implementation efforts, as well as address the issues caused by fragmented roles and responsibilities.

Respondent R4 illustrates how a different organizational context, supported by a strong climate adaptation policy at the municipal level facilitates collaboration, and increases the initiative for incorporating climate adaptation into urban drainage systems *"For us, it is quite convenient that the climate adaptation is put with the maintenance department, which is responsible for the sewer system. So it's good that it's not a different department, otherwise they would make us put it in our sewer system but now we're actually doing it ourselves."* (Interview D4.R4)

However, limiting local conditions such as high groundwater tables or insufficient space were also identified as external factors in that determined the feasibility and success of implementing climate adaptation measures. The factor "local conditions/available space" was identified in the interview data and also limits the possibilities of implementation of climate adaptation measures. These practical consideratations cannot be changed, therefore, strategies to cope with limiting local conditions are necessary to increase the implementation of climate adaptation measures.

Interview findings indicate that a wider system/spatial perspective can be used to mitigate issues with local conditions. Respondent R5 provides an example.

They note: " …*some things you can not arrange on a plot. For instance, water safety you have to arrange, but you can't arrange the water safety of the city on plots. So you have to do that in the public space, you have to do it on a bigger area, on a bigger level… you have also to look at that system as well, it's not only the plots, not only the land but also the system that it's part of*." (Interview D5.R5)

Addressing local physical limitations also needs to be supplemented with strategies to address ineffective collaboration with external actors. The presence of a bargaining tactic between internal and external actors was identified to cause substantial difficulties and delays to the decision-making process, particularly during the Selection/Evaluation and Implementation phases.

The delays and blocked design process identified in the interview data were usually a result of different or conflicting objectives between the different actors identified. For example, the objective of the technical designer/decision-maker was identified as needing to address the issue they were faced with according to specific performance goals or criteria. In comparison, the objectives of local communities vary and were hard to determine. Interview results showed that the public had limited interest/involvement in simple sewer works, however their interests increase significantly for above-ground works in the public space, especially those involving trees. In addition, the objectives of housing developers were identifed as being concerned with maximizing the values of properties they developed.

Despite their varying objectives, effective collaboration between these actors can play a significant role in increasing the implementation of climate adaptation measures due to the resources each actor possesses.

For example, the public can exert political pressure on decision-makers, and, if incentivized with subsidies for climate adaptation, may also contribute their physical resources (land) to further bolster the incorporation of climate adaptive measures into both the public and private spaces. Their interest in above-ground works can also be leveraged to involve the public in climate adaptive projects and increase implementation.

Respondent R2 provides an example of this and describes how public interest was used to support a municipal project for climate adaptation : "*the municipality – ten years ago – they started a project to get more green into the environment – and a lot of people said "I want to help to maintain a bit of green in the surroundings, in the area"... At that time [for the municipality], it was the more like "we don't have the money to maintain all the green so people can you help us, you may have a piece of the area but you have to maintain [it]."* (Interview D2.R2)

Successfully engaging the public is also important since they can cause significant delays in implementation. Strategies that better incorporate local communities into the design and decision-making process would contribute to increasing climate adaptation efforts by reducing resistance and opposition to their implementation.

Respondent R4 notes how a similar approach is being incorporated in their municipality, with an innovative twist of highlighting the conflicting priorities faced by technical decision-makers to the public: "*We're actually trying to involve the people earlier and explain or at least show them the difficulties we have with all the different opinions, and especially because we tried to keep in mind the bigger picture and the common wishes and demands...we try to have the most common grounds and people tend to only see their own perspective, so if we try to show them the difficulties, we have to weigh them, we're hoping at least that they can at least back our plan*" (Interview D4.R4)

Successfully engaging with private housing developers is also important for climate adaptation implementation efforts, especially on privately owned lands. They play an important role in the new development and redevelopment projects, yet their implementation of climate adaptation measures seemed to be mostly voluntary, unless they were required to do so by law.

Respondent R5 highlights this issue and the importance of legislation in increasing the implementation of climate adaptation measures on private lands. They discuss the current challenges caused by a lack of legislation, especially with private developers: *"We make concept rules and when they [the municipal council] finalize it, then the rule is a rule for every development in our municipality. [If they don't approve it] there will be discussion on what is possible, so we have to change the rule so they will approve them, and in between we will try to convince developers they have to follow the concept rules because it's good for a better city… but it's difficult when the developer says "I don't want this", you don't have many [options], [that's when] you need rules to say you have to do something."* (Interview D5.R5)

Therefore, strategies or policies requiring the implementation of climate adaptation on new private developments and redevelopments would also significantly help climate adaptation efforts by reducing the likelihood of non-implementation by private landowners. These strategies and policies would need to be implemented by the municipal council since they possess the appropriate decision-making authority and legislative resources.

Respondent R5 explains the process: "*The city council [have] the political [power] so they have to make the judgement whether it's the right rules, and they make that judgement on political grounds…we advise the city council – [for example, we say] "when you want to do something about climate adaptation, you have to [use] these kind of rules to manage that"…So in the end, we bring the proposal towards the city council and they stamp on it. They have to formalize it, otherwise it's not a rule.*" (Interview D5.R5)

However, interview findings also note that supplementing the legal requirements with a collaborative co-creation process was more effective in encouraging the implementation of climate adaptive measures by private developers. Engaging them in the design development process and providing them with a range of climate-adaption measures to choose from increased their willingness to implement climate adaptation measures.

Respondent R3 highlights how such a unique approach resulted in a successful project: *"…we had these 180 measures and they were all over the area, and, it never became a plan, it always was a opportunity map… And that was, I think very revolutionary in the process and it worked very well, because the developers, development parties were not forced in, so they could chose the measures which suited them best."* (Interview D3.R3)

A legal requirement for climate adaptation in public spaces and public infrastructure is also instrumental to increasing implementation of measures. It reduces the reliance on alignment of institutional factors, and practitioner motivation and means that technical designers and asset managers must include climate adaptation metrics within their projects.

Respondent R7 highlights how their municipality-specific requirement for climate adaptation is to be considered by all asset managers. They note: "*Climate adaptation, must be done for every project. Every new project it is our job, that our mayor says, every new project includes climate adaptation. That's a must, no doubt about it…for every asset - for the streets, we must in each project aim for less pavement…ten percent less. And more green – that's for the part of the green asset managers, and more trees. And buffering water rain water – that's my part. In my projects, I must hold a rainfall and we call that 10 plus 10%, and that's 40 mm in 45 minutes."* (Interview D7.R7)

Since the need for climate adaptation is not specific to one asset, inclusion or consideration of climate adaptation metrics in these collaborative processes typically occurs more consistently if there is a municipal policy or mandate for climate adaptation to be considered across all assets. This implies that the use of policies and technical guidelines to formalize the consideration and inclusion of climate adaptation metrics in projects could contribute to increasing the implementation of climate adaptation

measures. As previously discussed, the municipal council is especially instrumental in formalizing climate adaptation regulations in their jurisdiction.

5.2 Recommendations

Based on the above discussion, interview findings, the following recommendations are proposed to facilitate the decision-making processes and address the main hindering and enabling factors.

In order to minimize the ad-hoc and voluntary approach to the implementation of climate adaptation measures, it is recommended that municipal councils formalize regulations that incorporate climate adaptation criteria for private developments in their jurisdictions.

Legislating climate adaptation for new developments and redevelopments results in the proactive authorization/implementation of climate adaptive decisions and increases climate adaptation measures on private property, which can supplement the efforts of asset managers to incorporate such measures within the public space.

Furthermore, municipal guidelines and policies for climate adaptation for public works, such as sewer replacements should also be developed to increase the implementation of climate adaptation measures in public infrastructure projects.

Fiscal policies or regulation can be used in order to address the insufficient financial resources for climate adaptation. For example, a fiscal policy that dedicates a specific percentage of the current sewer tax to climate adaptive urban drainage infrastructure could contribute to long-term funding for climate adaptation measures. This potential “climate-adaption tax” would then provide a reliable budget for this type of infrastructure, reducing the need for constant negotiation between potentially competing priorities (i.e. sewer maintenance and climate adaptation).

Addressing the limited human resources (i.e. lack of personnel) can be achieved through social planning policies that focus on educating future practitioners with a wide range of skill sets. Similarly, addressing capability factors such as a lack of appropriately skilled practitioners can follow a multi-level approach. Dedicated training of current staff to impart the necessary skills could be one way to achieve this. This training could exist in the form of professional development courses, which could either be voluntary or mandatory for practitioners, for example as part of professional certifications.

Cognitive/cultural resistance of practitioners could be reduced through the use of “modelling” (e.g. role models). Providing practitioners examples of innovative climate-adaptive urban drainage projects to aspire to, especially from municipalities with similar values (or local conditions) can also contribute to increasing implementation efforts.

Addressing the issue of “fragmented roles and responsibilities” will require more integrated organizational structures and experimentation with different types of governance approaches. This can be achieved through “environmental restructuring” – i.e. structural reorganizations in municipalities or embedding climate adaptation specialists within existing departments. These embedded specialists team could also act as an internal committee for holding decision-makers and technical designers

accountable for implementation of climate adaptive measures and also be responsible for understanding the system-wide effects of local climate adaptation measures.

In order to address the difficulties caused by prolonged bargaining between internal and external actors, more effective collaboration is recommended.

Local communities and other stakeholders have the ability to significantly delay projects, particularly if they are only consulted in the later stages of the decision-making process, or not consulted at all. Therefore it is recommended to involve local communities earlier on in the decision-process and as much as possible be included in the design development stage. This approach could foster a co-design approach between infrastructure designers and local citizens that might broaden local citizens perspective and reduce the likelihood of communities rejecting proposed project alternatives and stalling decision-making processes.

Housing developers provide important financial investments to municipalities and therefore can also play an important role in the development phase of the decision-making process. Similar to local citizens, it is recommended that housing developers are included earlier in the process, particularly if climate adaptation is desired but not legally required. Furthermore, providing a range of potential climate adaptation measures for developers to choose from is highly recommended as it provides them flexibility to use tailor-made solutions that meet their needs as well as those of the municipality.

6 Conclusions

This research considered whether current decision-making practices and the institutional context in Dutch municipalities are hinderances or enablers to the implementation of climate adaptation measures in urban drainage systems in the Netherlands.

In order to answer this question, a detailed literature review was undertaken to identify how decision-making processes are described and defined in the literature, as well as what factors in the institutional context are identified as hindering or enabling the implementation of climate adaptation.

The literature reviewed highlighted a wide range of decision making process types and a diverse range of hindering and enabling factors but did not identify decision-making processes as a hindering or enabling factor to climate change. The literature is fragmented and lacks an integrated perspective of decision-making processes within an institutional context. Therefore, a single theoretical framework was developed to integrate the different topic areas and address this gap. Decision-making processes (phases and tactics) were conceptualized to exist at the intersection of normative and cognitive factors, within a regulative context. This framework was based on the new institutionalism pillars of Scott (2008) and a combined decision-making process framework based on Nutt (2008) and Mintzberg & Theoret (1976).

Interview findings showed that decision-making processes are evolving to incorporate climate adaptation efforts where possible. Most decision-making processes were triggered by a need to address infrastructure problems such as ageing sewers or neighbourhood redevelopments. Decision-making processes initiated solely by an opportunity to address climate adaptation were rare. Instead, implementation of climate adaptation measures typically occurred when there was an opportunity to incorporate them into other necessary infrastructure projects, particularly large-scale neighbourhood redevelopments.

Three of the decision-making processes identified in the interview data were similar to the “more successful” discovery process identified by Nutt (2008). However the remaining decision-making processes, particularly those involving bargaining and climate adaptation projects did not fit into one specific process type.

Decision-making processes to incorporate climate adaptation measures were strongly influenced by bargaining with external (i.e. non-municipality) actors. In addition to the technical designers and decision-makers, three key actors were identified as playing a role in decision-making processes that involved climate adaptation measures: the local community, municipal council and housing developers. The support or resistance of these actors strongly impacted the duration of the decision-making process and success implementing climate adaptive measures.

The institutional context strongly influenced whether or not climate adaptation was incorporated into decisions of urban infrastructure renewal. All three categories of factors from the literature (regulative. normative and cognitive) were identified in the interview data. The most frequently identified regulative factor was the availability of financial resources. It was identified in both hindering and enabling

capacities and was often linked to the role of the decision-maker – sewer managers noted its presence was beneficial (due to the sewer tax) and climate adaptation specialists noted its absence was a significant hinderance to incorporating climate adaptation. Another frequently identified regulative factor was the regulatory framework, consisting of legislation, regulation, or policy guidelines. It acted as an enabler only if it explicitly prioritized climate adaptation. The most frequently identified hindering normative factor was that of fragmented roles and responsibilities within municipalities. Other frequently identified normative factors identified were: the presence of collaboration with other practitioners, the availability of sufficient and appropriately skilled personnel and the amount of experimentation undertaken by practitioners. These factors were identified as enablers to the implementation of climate adaptation when present. Frequently identified cognitive factors include cultural/cognitive resistance which acted as a hinderance to implementation efforts, and political incentive to action which was identified as an enabler to climate adaptation efforts.

In conclusion, though the decision-making processes are evolving, the use of opportunity-based initiation tactics and ineffective bargaining tactics resulted in processes were often stalled or blocked prior to decision implementation. Improvements can be made to the decision-making tactics used by practitioners, however, the processes by themselves were not found to act as distinct hinderances.

implementation of climate adaptation measures typically occurred when there was an opportunity to incorporate them into other necessary infrastructure projects. However, taking advantage of these opportunities depended not only on their existence, but also on institutional factors, as well as the actors involved in the decision-making process and the resources available to these actors. The institutional factors identified indicate that the current context is more hindering than enabling. Therefore, strategies to address some of these hindering factors can also facilitate the decision-making processes and lead to an increase in implementation of climate adaptation in urban drainage systems.

These strategies include the recommendation that municipal councils formalize legislation requiring climate adaptation on new developments and redevelopments to increase implementation of measures on both private and publics lands. Furthermore, increasing collaboration with local communities and involving them in earlier stages of decision-making process, such as the design development phase, can help to reduce stalled processes. Additional strategies to address the most frequently identified hindering factors include the recommendation to dedicate a percentage of sewer tax to climate adaptation measures, increase training for insufficiently skilled practitioners and restructuring organizations to allow for better integration of practitioner roles and responsibilities.

6.1 Reflections and Study Limitations

This research revealed the complexity and difficulty associated with approaching climate adaptation attempts from one specific technical discipline, such as that of urban drainage. Most of the climate adaptation implementation efforts discussed were undertaken for large-scale neighbourhood redevelopments, thus it was hard to determine which measures were specifically implemented for the urban drainage systems. Furthermore, it was unclear whether or how these large-scale redevelopments were integrating their efforts to become climate adaptive or if the measures were also isolated within these developments. Due to the interconnected nature of urban drainage system and urban wastewater

systems, a broader urban water management perspective may also be beneficial to account for the impacts of measures in system on the other.

Interestingly, there was little discussion in the interviews of methods of accountability for implementation of climate adaptation measures within municipalities. It is unclear whether this lack of accountability in interview discussions actually reflects a broader pattern of limited accountability for implementation of climate adaptation measures or not. However, an exploration of how municipalities are held accountable for climate adaptation might reveal additional strategies for increasing the implementation of climate adaptation measures.

A number of study limitations impact interview results and are discussed below:

The relatively small number of participants (N=14) involved in the interviews limits the applicability of the results to all municipalities in the Netherlands. Participants were predominantly from mid-sized and large-sized municipalities, further limiting the applicability of the findings to smaller municipalities. There were a limited number of participants directly involved with climate adaptation in urban drainage/urban water. The wide range of participant backgrounds means that climate adaptation was discussed in a broader context. This was especially the case for interviews discussing large-scale neighbourhood redevelopment projects which involve the renovation of all infrastructure assets in the public realm.

The large number of codes generated from the interview data reduces the depth of the analysis conducted. The discussion of results therefore does not capture all of the insights from the data, or the context within which certain factors were discussed. Furthermore, due to the combined deductive and semi-inductive nature of the analysis, there is some overlap in code definitions which affects accuracy of interpretation of the results.

The number of times a code was identified across interviews (i.e. frequency of occurrence) does not necessarily reflect its importance. The detailed discussion of high and medium frequency codes should therefore not be interpreted to mean that these factors are more important in hindering and enabling decision-making processes for climate adaptation than the low frequency codes/factors.

The decision-making processes from Mintzberg & Theoret (1976) have been developed further since their creation and therefore the use of alternative decision-making process literature may identify different tactics and processes than found in this research. Due to the large number of hindering and enabling factors in the literature, it is also likely that there are other barriers to climate adaptation in urban drainage systems in Dutch municipalities that are not identified in this research.

Interview questions directly asked about decision-making processes in “innovative” or “climate-adaptive” projects. The explorative nature of the interviews meant that interviews covered a wide range of topics, not always related to the research questions. Therefore, results may be skewed towards projects that succeeded in implementing climate adaptation measures and therefore do not provide insight on tactics and processes that resulted in unsuccessful attempts at climate adaptation.

6.2 Recommendations for further study

A systematic literature review is recommended for the core areas of interest: decision-making processes, climate adaptation and urban drainage systems. This will strengthen the scientific basis of the framework and may uncover different types of decision-making processes and tactics that are more representative of processes in reality. Theoretical frameworks for a “doing first” and “seeing first” decision-making approach are highly recommended for comparison to the “thinking first” model used in this research.

A more in-depth study of how the institutional context factors interact with specific decision-making phases and tactics is also recommended. This granular and integrated approach can help identify precise areas for interventions and more clearly identify exactly how and at what point in the decision-making processes these hinderances and enablers occur.

Finally, incorporating a temporal element to the decision-making processes and institutional factors identified is highly recommended. The relatively short timescales of decision-making processes for infrastructure projects versus the longer time-scales of climate adaptation and institutional change could be a significant factor in whether implementation of climate adaptation measures is considered a priority in municipalities.

A number of recommendations are also proposed to address the limitations of this research and summarized below.

Additional interviews with municipalities across the Netherlands, especially small municipalities is highly recommended. These interviews will increase the sample size of the interviews and lead to more robust conclusions that can be applied to a larger context. Interviews with municipalities across the Netherlands might also highlight local contextual factors that play a role in implementation of climate adaptation measures, which are difficult to capture with a small sample size. They will also increase the applicability of the results to the country.

To further increase the applicability of results, it is also recommended that additional interviews be conducted with participants specializing in urban drainage systems and urban water systems. The integrated nature of stormwater and wastewater infrastructure means that climate adaptation efforts in one area will affect the other. Therefore, an integrated perspective of climate adaptation in urban water systems could reveal alternative possibilities for increasing implementation efforts.

To strengthen robustness and validity of the results, the use of multiple coders is recommended. This will improve and clarify code definitions and consistency of code application across interviews. Furthermore, validation interviews are recommended to identify the relative importance of the hindering and enabling factors identify and allow for more targeted interventions for high importance factors.

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Appendices

APPENDIX A

Version 31-03-2021

INFORMATION SHEET FOR INFORMED CONSENT

Research Project: Decision-making, innovation and sewer asset management in the Netherlands

The purpose of this research is to understand decision-making processes in sewer asset management (SAM) in the Netherlands, and how they might hinder or enable transition to a sustainable urban water future. It is conducted as part of my MSc research thesis in the Engineering and Policy Analysis programme at TU Delft.

This research is solely for academic purposes and your participation is upon your own free will.

You are able to withdraw from the study at any time or refuse to answer any questions during the interview process.

Interview data will involve an audio, or video-recorded interview, (depending on your preferences), which will be subsequently transcribed as text and anonymized. An interview transcript will be shared with you for review, should you wish to make any changes. The audio/video recording will be retained only for the purposes of creating the interview transcript and shall be deleted upon completion of this MSc thesis project.

The anonymized and reviewed transcript of the interview will be used for data analysis and kept in an appendix as part of the documentation of my thesis. Should information from the interviews be used in publications (for example, research, academic papers), the publication will be shared with you prior to completion and submission for your review and explicit consent.

No personal data will be collected other than your role in your organization. This data will not be included in any documentation without your explicit consent. Should you not consent to this, the data will only be included in an anonymized ('de-identified') format.

Any identifying data that could relate the transcript to you personally will be treated as confidential and will be stored within a secure location for the duration of the project, whereafter it will be deleted. You can request access to, or erasure of your personal data at any time.

An informed consent form is attached to this information sheet. Please fill and return it to confirm your participation in the study.

Should you have any questions or comments, please contact:

Yena Ahadzie
Faculty of Technology, Policy, Management
Delft University of Technology
d.y.ahadzie@student.tudelft.nl

Version 31-03-2021

Consent Form for *Decision-making and innovation in SAM*

Please tick the appropriate boxes	**Yes**	**No**
Taking part in the study		
I have read and understood the study information dated 16/03/2021, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	○	○
I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	○	○
I understand that taking part in the study involves an audio, or video-recorded interview, (depending on my preferences), which will be subsequently transcribed as text. The audio/video recording will be deleted upon completion of the project and I will be provided the anonymized transcript for review.	○	○
Use of the information in the study		
I understand that information I provide will be used for academic research purposes	○	○
I understand that personal information collected about me that can identify me, such as my name, will not be shared beyond the study team.	○	○
I give permission for the name of my organization and my position within in the organization to be mentioned in the research project, and project documentation.	○	○
Future use and reuse of the information by others		
I give permission for the anonymized interview transcripts that I provide to be archived in the TU Delft data repository so it can be used for future research and learning.	○	○

Signatures

_____	_____	_____
Name of participant [printed]	Signature	Date

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____	_____	_____
Researcher name [printed]	Signature	Date

Study contact details for further information: *Yena Ahadzie, d.y.ahadzie@student.tudelft.nl*

Yena Bassone-Quashie
version April, 16 2021

INTERVIEW QUESTIONS/GUIDE:

MAIN QUESTIONS

Part 1 - Introduction

Could you tell me about your role in your organization (e.g., main tasks etc.)?

Part 2 – Project Context

1. Can you think of an "innovative" SAM project that you are currently working on or have been recently completed?
    a. *Ideally within the last five years and a replacement project*
    b. If not replacement, what type of project was this? (e.g., new development)
2. What was the project and what did it involve?

**Innovation defined as:*

- New technologies
- New approaches to management
- Techniques used to increase efficiency of existing systems

Part 3 – Decision-making process

The next few questions are to understand the decision-making process through out the project (from beginning to end). I'll ask some prompting questions, but feel free to talk about how the decisions were made, who was involved, any difficulties, limitations of the process or things that made it easy/easier than others… etc.

Identification Phase:

1. Why was the project started?
    a. Sparked by an idea/opportunity, problem/crisis, larger objective (examples…)

Development Phase:

2. *How were alternatives developed, what alternatives were considered and when were they considered (project start, middle, ending?)*
3. *Why were traditional/non-traditional alternatives selected?*
    a. Were there multiple iterations of design, alternative evaluation?
4. *Were other departments involved in the decision-making process? How were they engaged (in person/on-going collaboration, review/commentary, approval)?*

Selection/Implementation Phase:

5. Once the final choice is made, what happened next? I am specifically interested in:
    a. Are there additional authorization/approval processes once decision is made?
    b. How does project move from final decision to implementation? Is implementation considered in earlier stages?
    c. What happens if there are changes between alternative selection and implementation?

Part 4: Bigger picture:

6. *Was there any public involvement/consultation for any of the alternatives? Why, Why not?*
7. *In your experience,*
    a. *Why do you think this project was able to be innovative compared to say other urban planning/SAM replacement projects? (People involved, pilot project etc, funding? timing)*
    b. *Why do you think other projects are not successful or more innovative?*

b. Is there anything that you'd like to add that I haven't thought to ask?

c. Is there anyone else you recommend I speak with? Within your organization, at a municipality?

EXTRA QUESTIONS:

- At the municipality level, how much collaboration, interaction, design involvement between S.A.M & urban planners/designers…specifically for replacement/redevelopment projects? Why?
- What are the main considerations taken into account/prioritized in water management (urban drainage redevelopment projects?) E.g., time, scope, budget etc.…
- What are some of the difficulties/limitations encountered in encouraging use of "innovative alternatives" in SAM, adaptation planning, urban drainage? Why?
- What are some of the things that make innovation easier? How? Why?
    - What could change to reduce the difficulties being faced as mentioned above? Why do you think it hasn't? Do you think it will?
- In your opinion, is there a lot of "innovation" in "water management" – focus on urban water and urban drainage (SAM, adaptation planning) in the Netherlands? In Dutch municipalities? Why? Why not?
    - Innovation defined as:
        - New technologies
        - New approaches to management
        - Techniques used to increase efficiency (enhance performance) of existing systems
- Any other recommended areas to look into/read upon prior to speaking with others?

APPENDIX B

Interview Transcript D1.R1

INTV: So the first question would be for me to understand a little more about the work that you do right now and what that involves

R1: I have two positions – I'm an Associate Professor of Water management, and also a professor– also in water management, urban water management. I have developed with colleagues a Bachelor program specifically focusing on urban water management, where we focus on the technical, spatial planning and the governance aspect. So my experience with Dutch municipalities, when it comes to water management and climate adaptation is mostly indirect because of the conversations that I have with them through my students and in terms of research projects that we try to kick off with them. So I have never been in the decision-making process. And I have technical background, I'm a civil engineer but I think I can share some of the more indirect views that I have, or sometimes more anecdotal ends

INTV: Perfect, I think that is good because it will give me a sense of the industry as whole instead of municipality specific projects. The next question is a bit general, but in your opinion, is there a lot of innovation at the moment in water management in the Netherlands, or in Dutch municipalities?

R1: Yeah, that depends a little bit on how you, what you see as innovation. I see that the field of – I think that there is getting more attention towards innovation, or more sustainable solutions for water management. So I see it increasing…I'm not sure to which extent it is, if you would compare it to other sectors, obviously I think it's still low, but if you see it in time, then I see some increase in innovation

INTV: Okay, and so …why do you think compared to other sectors it's not as high currently?

R1: I think it's a traditionally quite conservative sector and that also has to do with, lack of impact on the living environment and experimenting can be expensive is I think one factor. The other thing is it's more the organization that we have a governance model that is very much inline with the traditional way of water management so basically, arranging our sewer system for example – the more technical aspects of the water management which are the traditional sewer design are [in] most municipalities separated from the spatial planning design. So if I want to redevelop an area and I want to have, rather than a traditional sewer system, I want to have an infiltration system with parks and so on, then that doesn't align with the current governance structure that we have. So I think that is also a factor that makes it traditional. That also is nested in the financial streams. That doesn't hold for all municipalities but for example in some municipalities we pay specific tax for sewer, and that tax should also be directed towards the water system. And if I want to have a more broader, more integral solution that mainly also helps biodiversity or another city function – then I have to allocate the budget from other budget streams, so I think this traditional sector but it's amplified by the fact that you have this organizational and also these financial streams organized accordingly to the traditional system where we just have rain water via mixed sewers to our sewer system.

INTV :And so, is there…there is getting to be more innovation now – is there more interaction between the spatial urban planning side, and the sewer design and management..?

R1: Yeah, you see. Actually, one of the examples of that is actually the program that we started in Rotterdam, we started that in 2008. And that was really motivated by this notion from the sector, from the municipalities, from the waterboards, that we need in addition to the technical specialists, we also need people that understand that understand both spatial planning and the technical and the

governance. So I think you can see that as a reflection of, that it was recognized by the sector that we needed that more integral design. And I think you see that wider in the Netherlands, and also – does the term “omgevingswet” ring a bell?

INTV: It does.. but I can look it up

R1: So I think that’s also a reflection of that more integral thinking. So that is basically, previously we would have water law and a lot of different laws and now, there is a lot of debate still going on because the law, I think it’s not ready for implementation yet still, and it was supposed to be implemented already two years ago but it’s also a reflection of that

INTV: Picking up on the funding side of things: so there is the sewer tax for sewer maintenance, and so green infrastructure, innovative projects, is there a separate budget specifically for that?

R1: Depends from municipality to municipality, so that is shifting – in the most traditional municipalities it was really because the sewer tax is really a separated tax on my tax bill that I get from the municipality. The intention was really nice, so they allocated specific budget so that vital function would be guaranteed so in some municipalities it’s really set as a rule that you can use that for that, and then you need to allocate other budget. But differs a little bit from municipality to municipality how that is organized. I don’t know the details but I think it’s nice to ask that if you’re talking to people from different municipalities

INTV: Yeah, I’ll definitely ask that. So you know or think how they decide whether or not to have that separate budget? Is that a strategy from the municipality? Do you know how they decide to build out their budgets in general

R1: No, what I said before – that I think the reason that they separate it was to make transparency to the citizens to say that this budget is used for that…I think that was the motivation but I’m not sure

INTV: This environmental law, which is supposed to be integrating all the laws: does it give any guidance on climate adaptation, spatial planning, all of that stuff?

R1: Yeah, it is more a process instrument so I think it gives you the guidance on who to target but there is another instrument that is interesting to study – that is the “water toets”.. have you heard of the “water toets” – water assignment I think they translate. But that’s interesting because I think that can be also used to see the transition. So in the Netherlands we have waterboards right? And they are responsible for a lot of the water management tasks, also in urban areas. But, they don’t own any land. So when a municipality is redeveloping land, and for example they would pay for everything and leave no space for water, then the waterboard has a problem but they did not really have a voice. And the “water toets” was developed in such a way that municipalities, when they are redeveloping an area – they need to actively have discussions with the water boards to make sure that the “water assignment” is arranged. But that is in theory and I don’t know how that plays out in practice – I think there are still a lot of struggling with that. And I also think, but that’s more personal opinion, I think it would be nice to broaden the “water toets” process. I think, right now it’s very much oriented towards, I think, right now it’s very much towards what to do with heavy rainfall, and I think it would be nice to broaden that process also with regard to drought and maybe even heat stress, but that’s very much a personal opinion

INTV: So this is another thing that's interesting to me…what I've been finding so far in the literature is that some, one of the things that facilitates innovation is collaboration and cross-sectoral cooperation and so, I'm interested in how much in practice the water board and the municipalities actually engage. But also, a follow-up question would be how much the public…is engaged or involved in innovative projects, in the decision-making process…can you speak to that a little bit?

R1: Yeah, also that is a field very much under development and one of the challenging things, particularly in urban areas is that the areas that are most sensitive to climate change and most in urgent need for climate adaptations are also the areas where participation is traditionally difficult. The areas where you have lower levels of education, a lot of renting, little organization there. So that's an issue there. Because, you also have areas in the Netherlands, neighbourhoods where they pick-up everything themselves and even come up with an alternative plan when the municipality…but those are the exceptions. And I think there is a lot of effort in there…for example, what would be nice to look at is Rotterdam's "weerwards" – water sensitive Rotterdam. Water sensitive Rotterdam is really like a public participation movement basically. And that's interesting to have a look at – how that works. But, this is a difficult…and especially, it becomes even more urgent because we need also adaptation on private land so that basically we have to engage house owners. And there are a lot of examples where they try to do that with subsidies and stuff like that but still to mainstream that is quite a challenge

INTV: And why do think it's a challenge? Do you think people aren't interested or…yeah, why do you think it's a challenge?

R1: Yeah, I have a student that is doing research on that - I think he would be happy to share his thoughts with you. Now, what comes out of his research are basically a couple of factors. One is simply, not knowing it, or not feeling the urgency...and also, there is a lack of knowledge on what the legal responsibility is on house owner in adapting their own house because they do have some but that's not known and it's also not enforced by municipalities. And sometimes, it's also really practical that they think I'd rather put stones in my garden because that saves me maintenance, and that's always nice instead of greening my garden….

INTV: So now, I'd be interested in your opinion on what considerations make innovation easier in general

R1: I think sometimes, some more notion on trying to see things as experiments. So that you allow failure, so that you say okay, we're just going to try and we're going to monitor it and if it fails, no harm done because sometimes, I find myself negotiating about doing pilot projects which cost like in the order of 20,000 to 50,000 euros – and talking for hours and hours with people, then I think, okay if we put our salary, add our salary while we've discussed – then we are already at that budget…so sometimes it's a little more that the notion "this is just an experiment, we're just going to try it out" and we have back-up plan for things that fails. A little bit more of that added, I think would help. And also, some playing money basically – I think that would help a little bit. And the other thing is also, is when we are doing pilots is that we give more consideration to collecting the evidence that it works or that it doesn't work – the honest evidence. That's a thing that I think would also help……Another name…..so I think, and the other thing that's also a little bit – because you were saying before right, something about collaboration and innovation. And I think, that one, that has a little bit two sides. I think on the one hand, it's right indeed, thinking together can inspire innovative ideas. But on the other hand, if you want to just try out some new innovations in an urban area, then the fact that it needs to be a cooperative

decision also slows down the process a lot. So, for example if I want to test a new sewer pipe, but if I want to test an integral solution… I think then the decision...so I'm not policy analysis so if I use the wrong words then please correct me on that, but I think sometimes then the decision power – because these innovative ideas fall in between so no one feels responsible for taking a decision on whether or not, or no one dares. So I think that's also an issue here. But I in general feel some more sense, that we dare to experiment more and that we have more sense of okay that we just have a back up plan, and we just monitor more what happens

INTV: And, what do you think increase that sense?

R1: I think really allocating some experimental budget and accepting more that idea...I think in our sector, civil engineering design, we typically design for 50 – 70 years so I think the whole idea of shorter evaluation cycles that that would help. Recognizing that we cannot foresee the complete future, we're just going to have more adaptive [thing]…and then there's one other thing that I think specifically for this field of climate adaptation is mostly not helping is that we still have a lack of understanding of what the system effects are. So you see that all these innovations, they are like isolated developments but I don't know what the total means on my area. And I think that it is still also quite difficult for them to assess based on all these isolated developments. So…and then. Because sometimes, solutions they can be really comparable, or even have synergy but because they are all isolated things, it's not clear what it does in total here

INTV: Those are really good points. You mentioned that civil engineering design is 50-70 year time frame and I'm also a civil engineer by trade so I get that time frame. One of the things I've been interested in, is if the "urgency" of climate change comes into the design life and how that's addressed. Is the tendency more to go towards let's make existing things better, so let's make bigger pipes…or is the tendency let's combine the pipes the pipes we do have with green?

R1:…the tendency is more towards the latter

INTV: Okay...

R1: Although, there are a lot of concerns still...I do not see… I think the bigger pipes. they did that recently…but in the Netherlands in general, I think, I hear more towards the latter. And that's positive, I think.

INTV: I've spoken to a couple of urban planners and designers and they are very much focused on greening cities and towns, so now I want to get the engineering perspective to see how the engineers think of that and how they incorporate that into the design…?

R1: So, but this is a good point that you're raising because this brings me back to the system knowledge thing because I do hear that a lot, the greening of towns, and I like it, I am very positive about it, I see all the positive effects but sometimes it is mentioned as a no-regret measure. I do think we need to be very very careful when it comes to drought and water management, when we're thinking about greening our cities. And I think because, one tree can cost up to 120 L of water a day, and I think if we don't carefully design also the water aspect of all the greening then we might run into some issues.

INTV: Yeah, that links back with your point with about how a lot of the focus is on heavy rainfall but the effect of drought haven't yet really been…

R1: No, and in the urban community there is a lot of focus on greening – that's what I see. But I really think, we should really see how we arrange... because it should all be possible because in the Netherlands we have more rain that can potentially evaporate but there is a storage issue there and I think that is not sufficiently addressed yet

INTV: And do you see a difference between the approaches that urban areas are taking versus rural areas?...

R1: Yeah, rural in the Netherlands…

INTV: …Right, big municipalities versus small municipalities...

R1: I think right now in rural areas, we have, I think in the eastern part of the Netherlands, the drought is the main issue – in the western part, the salinity intrusion problems, the subsidence problems…and they also play in cities but that's the concern rather than the extreme rainfall. And the other thing in rural areas at this moment, is the nitrogen debate…So I think there is a slightly different focus between the urban and the rural areas. But that has to do with how it is – so the extreme rain events have more impacts on the urban areas than in the rural areas

INTV: What makes innovation harder? I think we've touched on some of the points already but if there are any others you can think of…?

R1: Yeah, I think, the things are the separated – the cross-domains that are created separated in municipalities, this long time cycles of design, the budget allocation we already discussed…yeah and perhaps, one other thing that's more than my own work that's also maybe the young people – because if you ask a class of civil engineers who wants to become an entrepreneur, then I think the response rate will be much lower than if you ask a class of students in industrial design. I think also, in industrial design engineers – they will not directly think let's make innovative projects for the civil engineers, so I think also there it's little hampering factor

INTV: …In your experience so far, so you mentioned how if the approach leans towards experimentation, then innovation might increase, what in your experience, what has this moment, triggered innovation – so it is because there's an opportunity to build a blue-green in here, or is there a problem that needs solving…so right now, what is the trigger for innovation?

R1: Yeah, it's basically a little bit both, because a lot of our sewer systems have been installed up to 50 till 70 years ago so they need renewal. And then we have this climate change urgency that comes together with it. So I think it's a little bit of both at this point. And the biodiversity challenge – so I think you see both a window of opportunity because we have major restructuring, together with the other drivers

INTV: so when the discussion comes up to replace pipes, for example, where in the process of decision-making do the alternatives, the "innovative" alternatives come up, do they come up in the beginning and get put aside, do they come up in the middle when they're looking at design alternatives.

R1: I think, but this is something you need confirmation with the municipalities, but I do think that they are that much on the table that they come up directly. For as far as it goes, I think to things that can be done in the public space. I think the wider system perspective, for example, if they would renovate the

street then also directly see what types of innovations can be done in the surroundings more on private land – I think that's not really [possible?]…that's an assumption, what my assumption would be

INTV: Okay, I will definitely see what the municipalities say as well

R1: Yes, because you have to weigh their opinions on this stronger on this than mine

INTV: I'd be curious to get your thoughts on this question…the GRP…how much influence do you think that has both in the decision-making towards innovation, versus in keeping the same – just doing more of the same at the moment…?

R1: so you have...sectoral planning…one department in the municipality government…and so it depends very much on the people developing it, how much open they are still for things that they can connect to the GRP. So what I think is, that is one of these sectoral planning instruments – it can hamper innovation if, for example, the basic example, you want to innovate also in relation to the building surrounding it, then it is difficult that…it can help because it can give the other sectors insight in when new developments in sewers are there so that they can connect, but if it's used too strictly, it can also hamper innovation because then "can we plan it" but they say "no, it's not [renovation time] yet" – it's a little bit two fold

INTV: Yeah, from what I've been seeing, there's sometimes mention of climate adaptation in the GRPs but there isn't much detail on exactly what that means and how that is incorporated into the sewer works…

INTV: …Is there anything else you can think of that might be a good question to ask….in regards to innovation and urban water management

R1: I would really recommend to interview……and the other tips I already gave, I think…

END…

Interview transcript – D2.R2

INTV: To begin, could you tell me a little bit more about your role in Arcadis and a little bit more about the work that you do?

R2: Yes, I worK, I think about 30 years now. That's a long time – I started my job in designing sewer systems, and it was in a period that pollution from sewer systems was a hot topic, and they wanted to model the transport and settlement and diffusion of sludge, and they wanted to model that because then you could predict where the pollution was bigger or smaller. So I made a computer model to calculate those things. That was the start of 30 years involvement with sewer systems because we started, in that period, sewer systems were only the pipes, the objects and then you got like, after 10 years we didn't look at the object but we looked at the system, more as when it functions it has a lot of interaction with other systems so it was a kind of shift in the approach. And then after that, we got the shift from systems to environment – now you see, the underground sewer systems and the upper ground sewer systems to catch the rain and everything...and my role now is to make policy to get the cities water-robust and sustainable for water system role, heat, drought and water safety. Mainly I'm involved in policy-making and writing down the vision and the strategies, how to reach it and what to do. A lot of writing, I'm mainly a writer – everything I write together – I'm always trying to synchronize things so that's a bit of what I'm doing

INTV: Okay, so far in my interviews, you're one of the few people who has started from an engineering background and is now working in policy…so I'd be interested to see what you think of the intersection between the policy and the nitty-gritty design and implementation. So our discussion will go towards that direction…So you have you worked on "innovative" sewer projects recently, or have you been focusing on the higher level policy?

R2: I think majorly, the higher level policy. I haven't really been involved with the designing of sewer systems but I have seen things, I know what to focus on but when you ask me what are the blue-green solutions, I know a lot to mention but about designing – whether you design it for a period of 1 in 100 years or…that's not my kind of thing – it's more that I know what is possible

INTV: Okay, we won't go to that level of detail so we're okay…and do you work predominantly with Dutch municipalities to help them become more robust?

R2: It's all that because my English is not so good anymore so me, myself, I have a lot of Dutch municipalities. I'm working for the municipality of Breda for one day a week for a long time, over there I'm trying to synchronize the sewer management policy with the environment, you know the "omrewsignwet" environmental law…you have the vision, you have plan and you have the program, and to get everything at the right position. Trying to, [going round] something, or it's a rule or it's a measure – so you can reach your vision

INTV: okay, so I have two follow-up questions. Let's do the one that came to me in the beginning: how or why are municipalities, now developing these plans – so what triggers them coming to you to help them become more climate robust?

R2: In the beginning, they said climate change maybe it's not...[real, as bad]. But now, every one has seen, felt the effects of climate change so there's no question anymore, they know they have to act. We're at the level that they want to act, and we are at the level that the sewer systems are very old at

the moment so they have to replace the sewers so five to ten kilometers a year in a big city and when you have to replace the sewers then it's there for 60 -80 years so you have to think about the future and it's a long time. You know you have to act for sustainability, but also the money is there because sewer systems, sewer management, in Dutch, they call it the sewer tax and that usually provides a lot of money to do something. And, the other fields like green and roads, they always have to keep their hands up to get money – but the ones who have the sewers have the money so they're kind of in the lead and because they are in the lead, you know that for the underground making bigger pipes is not very cost-effective because there will always be a shower that doesn't fit. So we now realize that we have to mold the upper ground to catch the rain…because we don't see it as a threat but as a chance to get a better environment. Because when you take blue-green measures in the upper ground, you can, you don't have to enlarge the sewers. You also create a better living area so it's nice to work – we've always worked in the underground but now we come at the upper ground. And it's not easy to do because water is everywhere. It has so many aspects, water quality, water quantity, you have a lot of stakeholders, and that's it's a new field, new playing field – and a lot of technical – the technicians, are not used to having so many interactions because they have [are used to] a new system, you make the system, the system is holy but now the environment is holy and the system has to support it

INTV: That's a really good point…so the people that are working on sewers are usually pretty [focused on] I'm going to fix my sewer, and now that the discussion is becoming larger so they have to work with other people like urban planners, and spatial planners. So, are you finding that kind of collaboration is happening more and more now, or is it still, are they still pretty separated?

R2: No, I think it's slowly going better, so now we have [-in Dutch-] "risk asset management" and then you look at the risk, at the cost and the results and somewhere…what we do now, we take some extra risk in an area where you can have extra risk and in other areas, you can't have extra risk so you have to reduce risk. And, by reducing or taking more risk, you can keep the money in the pocket – and the money you can keep in the pocket, we can spend on climate adaptation. And now you see that the traditional technical people, that they slowly adapt to that idea you don't replace a sewer when it's sixty years but maybe you can stretch until, the upper ground is ready to do something – now we can synchronize it. And that's the kind of thinking process which they are majorly at that point now. But it has taken a long time. Normally, they do it like, they have a list – these sewers have to be replaced, let's do it – instead of taking everything together and let's see…that's kind of changed.

INTV: So, two things comes to mind – if the typical process is that "we have this list of sewers, let's replace them" and the sewer tax is also really focused on replacing sewers, I'm assuming, can you think of some reasons why people would try something else? Especially on the engineering side, what would cause them to not just replace like with like but instead say, let's look at the green stuff?

R2: I think when we all have the same vision, we can grow to a better living environment. Everybody knows that with the environment we have a lot of problems but when we all have the same vision like, we can help to create a better living environment for health and safety and things like that. Then they know, I'm also part of it and I can really contribute to it. And when they don't have the feeling that they cannot contribute to it, then they will not do. But when you make the vision together, you ask them, how do you want it? When you do it like "this is our vision, don't ask" but you don't inform, you don't ask those people, they won't cooperate. But when you drag them with you and you create it together, then they will better think about "okay, when I do this, it's easy...but I can also do that, it takes a lot

more effort, but then I can help to create the vision." And it's always with cooperation and working together - in the beginning it's more effort and costs more time but at the end, you have better results if you do it together. But it's not always easy because, especially the older people, they are a bit like….but the next generation, they can do it….so use have to use the new power, the new generation – give them space. And what's more important, I think is that it's a very interesting field of work – but not everybody knows that it's interesting and when you give them a little space, they can do a little bit of this, and a little bit of that…and you create a better culture instead of "we're always busy, do this, do that and then after two, three years they think, no that's not my kind of thing" - but give them a little space, they will come with things and create together, co-creation

INTV: And, what role do you see for policy in facilitating this vision and pulling people together so that they can start to work towards more sustainable…?

R2: First, I think you have to write down a vision that is not too far away, that they think we'll never make, so make a vision that they can bridge the gap so like about 10, 20 years, where they think okay, what I do can make a little difference to reach that point, that vision. So not too far away. It must have traction, like in Noord Brabant, we have what we call Van Gogh National Park…now to create the Van Gogh National Park, they just put that name on a lot of projects and now people have something "I'm working for the Van Gogh national park", it's very simple but you create a higher level of vision for the people so I think a good vision, like not too far away but also they think, that would be nice… that's also one of the ways. You see, when you make policy, you have to take into account that you need people, and the technical people always think, I can do it myself, I don't need other people. But when you create as policy maker, more space for extra people, then they will see that with those extra hands you can come further. You have to do it together, and that will cost a lot of labour…and so that can make a difference. Just keep your hand up for the management – like, we need people, and we have to create an environment that people to come to us or they are interested in the field…we have to create something as a policy maker, and you have to synchronize all the different tracks. Because when you don't synchronize, somebody's doing this, another one is doing that…but when you synchronize and it comes together, then you see hey we are creating something together, and then it goes up. I think that are some factors you have to do. Always try to mould everything in the same lines - and that's the power of the vision, the [omrevingswet], with the new environmental law – you start with the vision, and that vision, you have to – those lines, you have to draw them completely through all fields of the organization, and then everybody can work in the same direction. That process is going on right now, at the moment – at the bigger cities. The small villages, they are kind of more sectoral – not everybody, but the bigger the city, the more you see the power of the vision is getting…

INTV: So why do you think there's that difference between the bigger cities and the smaller cities?

R2: Because the smaller cities, the people always have less – they have to do a lot of things, they have to do a lot of things, the sewer systems, the green, the roads – they are always busy, they don't have time to think about tomorrow and sometimes, the bigger cities, you have people like me – who have time to think about the future…that may be the difference. And you know the "wethouder", the mayor and [councillors, alderman]…like in Breda, we now have an alderman [councillor] who is very into blue-and green and at all kind of, you see him on internet on linked in, and everywhere you see him and everytime it's about the blue-green transformation and that moves [brings?] a lot of power to the organization, but when you have the wrong alderman, who say let's do it just the way we always did –

then you can do what you want but the change won't come…you need those aldermen to create the power

INTV:: And is that an elected office?

R2: Yes, and that's the problem – because sometimes you have very good aldermen [councillors], and then you get another one, and you have to start over again…?

INTV: And so, you don't really have control over who they are – so their role setting the vision for the municipality and water management?

R2: Yeah, I want to say something else as well – the aldermen – 5-10 years ago, water and green was not like sexy, it always costs money but now lots of aldermen, they turned it into a chance – we can make a better environment and it will cost money, but we can make a better environment. And we have an alderman who is already in that stage that he can make it sexy, that he can make it a new perspective, then you have a good one..

INTV: So the impetus for blue-green is shifting from just need into an opportunity, now it's a way that we can make things…[better]. I wonder, do you think it will ever reverse, where people are like okay we're tired of blue-green, this is not performing the way we need to, can we just stick with our sewer pipes…? What do you think?

R2: Well, we are creating a lot of green and green means maintenance – it's like when you have your own garden – I have a very big garden my self and it's very nice but you're always at work to keep it a little bit…it will be the same with the cities, it's nice and it creates a healthy environment but when you forget that it will create a lot of maintenance and you don't change your organization to have the money or have the people to maintain, then maybe about 20, 30 years we will say, let's skip the green because it's too much. So you have to do both – not just create but you always have to think about the future and the maintenance and add that to that..

INTV: And as it stands right, which departments are in charge of the maintenance of green infrastructure?

R2: Yeah, that's kind of a problem because for the green, there is always short of money – now they get a little extra money from climate adaptation budget – that's now, the coming five to ten years, but after that, when we have another focus – maybe we are focused on cyber security, and then the money goes to cyber security. But now, the money is coming to us but if you don't act on it, in about five or ten years, then you don't have that money to maintain so there must, you must create a new balance, a new equilibrium between the extra green and the maintenance of the green. So maybe, when green has a function in the water system, like it can capture the rain, then you can use the sewer tax to pay for it. But like a tree, you're not all owed to use the sewer tax for a tree. I think, maybe we need a kind of extra tax to enlarge the, we have the sewer tax, we have the tax for the rubbish, and we have the OZB…tax for the buildings – and maybe we have to create an environmental tax, just to have the money to maintain the new environment because it will cost extra money

INTV:: And I can imagine, it would be a hard sell to keep taking money from the sewer budget for green stuff because the sewer infrastructure needs replacing

R2: Yes, so we are always stretching until we have found the boundaries of the law…you may use the sewer tax but only when it supports the function of the sewer system, of the total system

INTV: So this climate adaptation funding, is that coming from a national level?

R2: Yes, at this moment it's coming from a national level, from the [drijk] from the Netherlands going to the provinces, the provinces to the waterboards and the municipalities, and sometimes the municipality has a program and the province gets 50% of the money from that budget so they…in Breda, they created the Niuewe Maark – the new market – is a new river in the city –with nature-inclusive walls – but they started with a budget from, say they had 10 million, but they needed 30 so you can say, okay it's not possible, but then they asked the province, they asked the waterboard, everywhere they were asking for money – and now they have the budget of 30 million. So it is possible but you have to work on it. And then, you create the structure but then you have to maintain the structure. And the maintenance part, they don't see it at this moment, I think… do you know the "wonderwall" – it's a tower with trees – "wonderwoods", it's a very nice tower with trees growing on the top but now they have to maintain the trees hanging on the building, and cutting the trees so it's very expensive..it's nice but

INTV: And right now, I'm also interested in what are barriers to innovation so do you think the later maintenance expense is one of those barriers?

R2: Yes, that's one of the barriers. What I think can be a growing barrier is…[mosquitoes] – that can be because a lot of pools, water bodies have no, is not deep, is shallow water, is not streaming so you create very good place for mosquitoes – so green attracts red, so that might be a coming obstruction. Because the Netherlands is land of water, but what I saw last is people saying we don't want this waterbody in our neighbourhoods because the children can drown in it. And normally we grow up, we learn to swim – but we also have a lot of people who can't swim and that number is also growing and those people say, we don't want the water here. Maybe that could be a problem….so it's the money, the risk, the space – you need space, you have to build higher so you can create space for other (all) things. Maybe within five or ten years, people don't want to live with someone here and someone there [in close proximity]..now a lot of people come to the city and they don't mind to live in a building with a lot of people around but maybe if there's a lot of noise around them, then they think I just want a normal house with a garden and things like that- that could be a problem. And, let's see, when you have the sewer system, then you know, normally you know where the pipes are and how it functions. When you have the system in the upper ground, then it's like a substrait because then you have green, you have water body, you have the "houder" the streets who are catching the water in little streams – [drainage swale]… so you create a structure with a lot of different types of assets because undergournd, above the ground.. and you use [everything] to catch the water. So, now when you design and you create you know how it functions. But maybe within ten or twenty years, we cannot remember how we thought it would function and we can't reproduce it anymore. So we create now, we also have to write it down in the systems. Because a lot of infiltration assets and bodies, when you look at the maintenance systems – they are a lot of times, they don't know where they are. So we are creating a new upper ground environment, but we have to be careful that we know how it has to function. We have to log the data…

INTV:: It's making me think if asset management then becomes this whole separate thing that isn't necessarily tied only to the infrastructure – so it's not just tied to sewer maintenance, or green maintenance.. so to be able to have a more synchronized system, asset management by itself has to be it's own part of a municipality…do you think that would work?

R2: Maybe, like the sewers we know where they are because they are in the systems but with all those new assets, you better first put them in the system and then you can think about how to drag everything together and then it becomes like a substrate, everything together – you have a sewer but you don't know that maybe the tree is growing above that sewer or the roots are growing…when you, you have to, be in control and I think when we build it now and we just don't look at is as those are assets – within ten, twenty years we are not in control anymore…that's something I think you have to think about now

INTV:: And it sounds like at the moment, a lot of these innovative projects are done on a piecemeal basis so there's one on one side of the town and they are spread all over, and there doesn't really seem to be a cohesive approach for the whole city so it will be hard to know how that substrate, how that is connected itself..

R2: because maybe, sometimes the people of green think the people of water or blue will take care of it, and the people of water think the people of green will take care of it…so with all those mixtures, everybody thinks…[somebody else will take care of it…]

INTV:: So we're probably as we solve problems now, we're probably creating newer ones that we will need to address as we go forward

R2: ….But it's not a nice a job to enter all those data, you have to find a way to, maybe you can make a picture of it, and that picture is transformed into digital data which is directly going into a database without…I think there must be a smooth way to have the actual data

INTV: So yeah, data management will probably be essential going forward

R2: Yes, so when I started at Arcadis 30 years ago, we always said that the sewer department, always the light is burning because we were always missing the data because we wanted to have good models and we were trying to fill in those gaps in our time because there was no money for it.. so that's always been an issue, data

INTV: A question regarding public consultation and engagement…for example, you mentioned that sometimes, people don't want water in their area, whereas there are other locations where people are more open to blue-green…so how do you see public engagement as part of the decision-making process or the policy-generating process – is it a pro, is it a con..? what do you think of that?

R2: It depends what people, which people you have – I think when you have an area with people who are living there and you know they will live there also within 20, 30 years – they will be eager to think and to create and to mold the environment, and that's nice. But you also have areas where people they live, for four or five years and they already know that they will transfer to another place – so they are on the move, and those people on the move – I think it's hard to get them to think about the environment, but they are also not – they don't matter [worry as much?] maybe – because when there's a problem they will say, within about five years we are somewhere else so whatever – so you have to take into account the different kind of customers, the people who are living

INTV: Are people currently pretty involved in policy-making and sewer replacement projects?

R2: I think when you look at the smaller villages then, they are pretty good involved. Sometimes you have a very small community, they do a lot of things together. But in bigger cities, normally, they want to be served – just make it for us… we have other things to do…but also again, municipality of Breda,

they started ten years ago – they started a project to get more green into the environment – and a lot of people, they said, I want to help to maintain a bit of green in the surroundings, in the area. So it is possible but it took a lot of time, it took a lot of effort from the personal

INTV:: And the Breda approach, did that start with the alderman – what he the incentive for all of this green?

R2: Mmm, I don't know, I don't think at that time it was the alderman, I think at that time it was the more like we don't have the money to maintain all the green so people can you help us, you may have a piece of the area but you have to maintain. So that was kind of the first move

INTV:: That's unique – it's creative as well – last thoughts….

R2: I was getting the vision when we were talking – we have to take care of maintenance for the systems we are building now, because now we have the money but in ten years maybe we don't have the money and then what to do

INTV: So good long term perspective that a lot of people don't have

END….

Interview Transcript_D3.R3

INTV: Ok, great. So to begin with, could you tell me your role in the organization and some of the main tasks that you do?

D3: I am an independent, architect and urban designer of my own firm. And I work mainly for municipalities and I advise them on how to adjust their city to climate change and I do that by research by design. So I research the problems related to climate change and in the Netherlands, that's mainly too much water of heavy rainfall causing flooding. Also, possibility of flooding by failure of dikes and so flooding from the sea and from the rivers. And it's also heat stress caused by warmer temperatures in summer, and drought and subsidence of the soil. So these five topics are mainly the topics that are considered relevant for climate adaptation in the Netherlands. And what I do most of the time is make a study for several locations in a certain municipality where I analyze the problem and then show how they in their urban, in the organization of the urban fabric can search for solutions

INTV: Okay, great, that sounds very good. So the next question is a little bit more on the project context and so you can either think of a specific project that you've worked on, or in general the innovative projects that you've worked on. And so, can you think of an innovative project that was related to sewers, storm sewers, for example, that you worked on in your organization?

D3: Er, and what is the definition of an innovative project?

INTV: Ah, yes. That is a good question. Right now, it is defined as the use of new technologies or techniques that are used to increase the efficiency or adaptation of existing technologies. So it's either, the newer non-typical alternatives to design or interesting and new ways to work with existing technologies.

D3:: I think the. It's a difficult question because I mainly work in the preliminary stages of a project. So not in the…so what I do for example, there was this project. And it's a project where it's about, in this area, a lot of new houses were planned for that area and then the municipality had to make a sea…in dutch "mer". And, as a government organization you have to show what the impact on the environmental aspects is with this new development. So the municipality did this sea. And it said, well this new housing development can go on but the green-blue system has to grow with the amount of housing we add. And, make sure that the water system had to be capable of handling more water because flooding was a part of the problems in this location. And then with all the stakeholders in the area, I designed a different system for the water system, what was based on more efficient use of the water. So, in the Netherlands we use the waterways to store the water, so the level between the water level and the mijvout – is the amount of water you can store. And you can specify that for certain areas, so you can say , we have this large area, and then always the area with the smallest area with the smallest space is leading. Because if it's 20 centimeters and the water level rises 20 centimeters, then on other places where the water level can rise for a meter, it doesn't rise because the 20 centimeters is the bottleneck. So when we looked specifically into this location, we could see that it is by more specific monitoring and adjustment of the "stews" in the water – and you could actually store a lot more water in this area by making more specific, looking at the smaller scale or making more specific adjustments.

INTV: Okay, to the water levels? Making more specific adjustments to the water levels?

D3:: Yes, because you can say because in the whole area the water can only rise for 20 centimeters but if you look closer there are actually areas where the water can rise for 80 centimeters or 60 centimeters, but of course you have to make compartments so that the water actually can rise there

INTV: Okay, so more localized measures for the areas depending on how much storage they can handle

D3:: Yeah

INTV: Ok, great. That's a great example of a project. One of the things I'd like to understand is how did that project even start? Who came up with the idea to start that project?

D3:: Yeah, I think that's a very good question. Most of my projects don't start with the question that is "how can we enhance the blue-green infrastructure". So I only work in the Netherlands and mainly in the South of Holland province so I'm very locally based, and this is a very densely built area and so all the questions come from development here, and mainly there is a problem with rules…well, look for the, see how you can improve the impact on the environment. And, most of the times, that is rule-driven. Sometimes it's also ambition-driven, then the municipality actually say we want to increase the living environment. But it's always about increasing the quality of the urban space in combination with a development. So if you look at, what kind of improvement you can make, then it's a lot about adding green and water. And also, I think more recently in the Netherlands, we have this Delta Programma, and it's focused mainly on big national issues like drought and lack of drinking water and safety against flooding by sea or river. But there's also one chapter that's about climate adaptation, and it prescribes that municipalities make a strategy for climate adaptation on these points I just mentioned. And that is another aspect which makes municipalities come to me. So they are working on this strategy and they say we don't understand what we're actually doing, can you help us? And I say well, I'm very good at showing what this actually means so that I can do for you. So that is another aspect, the driver of the Delta Programma, and the program of the [klimaat adaptatie] from the national government to the local government

INTV:: Great, I'll be jotting down some notes and maybe have follow-up questions

D3:: Is your thesis focusing on project in the Netherlands or worldwide?

INTV:: It's projects in the Netherlands, specifically municipalities in the Netherlands

D3:: Okay, then this [in dutch] climate adaptation is something that is very important. So all municipalities have to develop a strategy for climate adaptation

INTV:: Okay, and what happens after they develop that strategy? Do they have to follow-through or do they just know that they have the strategy and they're good?

D3: Well, they committed, all the municipalities together committed that they will be climate-adaptive in 2050. And they have to work climate adaptive already in 2030. But that's actually very broad, so this national programme, the Delta Programma, doesn't say what it means to be climate adaptive in 2050. So, they are obliged now to do this stress test, which means they have to make maps of the consequences for flooding, heat and drought and flooding by the sea. And that is kind of an obligation. And they have to show that they are actually working on it in 2030. And then, of course, in 2050 – so it's kind of a long run but this Delta Programma it's actually tightening the knot. First it was very very [vague], and only you have to be climate adaptive in 2050 and then, this is getting more and more

specific. So every year the Delta Programma is updated, and also this programma of climate adaptation is also updated. And this is done with talks with the municipality and representatives of the municipality. So, I'm sounding a bit negative now but there is actually progress in putting this…making it more clear what has to be done.

INTV: Okay, perfect. So with the green-blue project, I'd like to understand a little bit how the alternatives were developed, where the ideas for the design of the area came from, what alternatives were considered. So you mentioned that Delft wanted to look at the new development in this area…and have the green-blue increased with the new development, or the capacity of the sewers increased, and so when you were working with Delft, how were the conversations had, and who was involved and did you have to go through multiple iterations of blue-green examples. What was that discussion process like to end up with the final choice?

D3: Well, there was this project team which was led by the municipality, and I was involved as an external expert designer from outside. And then there were all the parties that wanted to develop there. So there was the developer of a lot of houses, but also the developer of the student housing, and a university was a partner, and the waterboard was a partner. And, they weren't voluntarily in this team. They were there because there was this urban zoning plan, and it was rejected by the authority that talks about the urban zoning plans. And the municipality…then they had to make a new urban zoning plan, and in that zoning plan, they had to follow the advise that came from this environmental assessment, so they had to add more green and blue. So then they were in this project team together, and they were not really happy about it but they wanted a new urban zoning plan. And then, I made an inventory of all the wishes of all the different parties, and first they could explain: "well, my wishes, I want to build student housing here" That's very clear. But it's very good to acknowledge that: "so you're here to build student housing, okay". But then of course, the waterboard said: "we're here because we need to make this". And then the municipality could explain, "yeah we have to put more..". And then of course, the attitude changed in [to] "okay, how are we going to do that". And in the end, we made a opportunity map with 180 measures, measurements, on specific points which could be implemented. And they were, it was based, of course, on a more structural plan with the compartments of the parts where more water could be added and also where green infrastructure and how animals relate to that. So there were a few basic layers. But then because we had these 180 measures and they were all over the area, and, it…became a, never became a plan, it always was a opportunity map. And then the developers could say, "well in my area, where I want to develop this student housing, I see there are like 20 opportunities." And then we said, "well you don't have to follow, you don't have to exactly make it like this, you can do something else – only the opportunity map shows what the result will be for the water and the green structure. If you want to do it another which suits your business more, that's also fine. This is just a way to show you can have this kind of result here, so you can have more water storage and more green – you can do it like this if you want or you can also do it in another way." And that was, I think very revolutionary in the process and it worked very well, because the developers, development parties were not forced in, so they could chose the measures which suited them best.

INTV:: did they end up choosing more or less measures, do you know?

D3:: well for example, the student housing company, they were developing on the terrain, so there is this new student housing with corroded steel red façade but behind that is a green area. And that is a huge area for water storage, and the student housing company was very afraid that it had to cost a lot

of money but in the end they discussed it with the waterboard, and the waterboard actually paid some money also. And they just, dig three pools and that's it. And they said, well we have students so well, we put a walking path which is wild also, and some tables where you can picnic. But it doesn't matter because for the students it's great. So they could make this huge water storage area which didn't cost them extra because the waterboard actually paid for digging the holes and it fit their own goals because it fit very well for students who are living there. So that was actually, much more than anybody hoped would develop on that location. But on other locations, there were, for example, a developer of housing, they wanted to, I also showed example of storage on the roads, in plastic storage crates, but also we needed a very large water body there, and then they started negotiating "well can we make the water body smaller, and put more crates under the road?". And then the municipality had to say no, crates under the road is actually a solution for if when you don't have enough space but you have enough space here" And but they said "but if we don't do this, we can build two more houses". So there are a lot of discussions also, about this development party misusing the information to choose less sustainable options. And then you have to explain why that is less sustainable, and that storage under the road – for a municipality it costs money to, you have to clean it and stuff like that. And of course it's only storage while a waterbody also makes space for green and for animals and for stuff like that. So, in that case, less measures were chosen than if it was another kind of process. So it depended very much on the site, and on the party

INTV: So, and were the development permits dependent on how much green and blue each developer put in or was it more for the entire area, if you had this percent of green and blue then you would get the urban zoning through?

D3: Yeah, it wasn't that hard, it was that – you have the people who work for the city, and you have the council who, which are the representatives which are chosen to represent the public, and they control the..So this council had decided that they wanted every year, an update on the development on the green-blue project. So our project leader from the municipality worked very hard to convince the council to not put this hard ambitions, but to let them, to give the development parties freedom, and they said "well okay, we can do that but then we want an update every year on how it's going". And they did that, and also the developing parties themselves sometimes spoke in this committee to explain what they did. So it was a soft pressure – not a hard pressure

INTV: Ah, that's interesting. Okay, so the council then you said, from what I'm understanding they are representatives of the public, correct?

D3: Yeah, it's like the senate

INTV: Oh I see, is it the municipality council, or people that live in the neighbourhood?

D3: It's the municipality- it's like the senate of the municipality…

INTV: Okay, so the other thing that I was interested in, and you mentioned it a little bit earlier about stakeholders being involved in the decision-process but in terms of public engagement and consultation, outside of the formal council…were the local citizens involved at all or was it more of the formal process?

D3: No, in this process, the local citizens were very involved, they were actually, they were the ones that addressed that this urban zoning plan wasn't correct. And then it went to court, and the judge decided

well, this committee of inhabitants is right – this urban zoning plan isn't correct – and then they were very happy and I think, throughout the whole process – they were, all the time, trying to block more and frustrate the process more. Because they came from that, their main goal was, I think they didn't want any developments – so they wanted to block all the development – and the municipality and the developers, and my role was to see how this development could be implemented in a right way, and as an expert, I also thought and think that could happen. It wasn't that it was a development, sometimes there is actually no space, and then you could say maybe you shouldn't develop here but that wasn't the issue. But the representatives, or the people who call themselves representatives of the people who are living around there, stayed in this modus of always blocking everything. And they didn't, we asked them, a lot of times, maybe, you can also rally the people you represent to cooperate in this process, also by doing things yourselves, and planting and greening your gardens, and that never came to pass. It was always, so it depended very much on this very small group of people who were very focused on blocking everything this project wanted to achieve

INTV: And why do you think that is?

D3: I think it's, I actually know, these persons, because they live in my area. I think it's just person dependent. I think you have In the Netherlands, you have two kinds of civilian projects: ones that are driven by people who want to make change in a positive way, and they start from, with the question- what can we do, how can we make a positive change? And they start their own corporations for energy and they start greening their streets and stuff like that – and there is another group, and that group is, their question is always, how can we stop as much as we can. And that is, both groups are very small, but in this case, it was actually only three or four people, who represent they say a large group of people, but these people actually they represent are actually [not there?] thinking there's a group that's representing our neighbourhood, that's good I will join, but they don't actually know what's happening. So it's depending on very much on people who, what their aim is, and we heard that also from other municipalities who also had very much trouble with public groups which actually consist of very few people who block, who try to block all kinds of developments and also who ask a lot of questions from the government. So in the Netherlands we have this "wet", or "bop" – it's, you can, it's about public, transparency in public service and you can ask all kinds of documents. And they keep asking the municipality for all kinds of documents. And that means that people who work at the municipality need to spend a lot of their time answering all these questions which come from a negative impact, and they could also work on making on making a positive change. So [that's what happens] when [some] neighbourhoods are involved

INTV: Yeah, that's a really good insight because a lot of the literature really encourages public engagement as part of the decision-making process, but you're right in pointing out that public engagement isn't always positive. Sometimes, the public is more against the project than they are for the project and so it's harder for the municipalities to be open to public engagement if all they're getting is negative feedback instead of positive. So that's a great insight

D3: Yeah, and I think the question is a lot about to which, or what subject do you want the public to engage. Some things are very technical, so if a road is needed in a city, there's nobody who will say, put this road in my backyard. But the road has to come there, so then, it's a decision, I think more specialist people have to decide where the road can be best and then of course, you have to discuss with the people living there "how can we put this road, how can we implement this as best as we can, with your

wishes, what do you wish" but you cannot discuss that the road doesn't have to come there. And that is the big mistake, I think is made in engaging public. You really have to think about with, in what kind of decisions do we engage people.

INTV: And perhaps, also when in the decision process do you engage the public

D3: Yeah, because if you engage the public also very early in the process..Also we see in the Netherlands now that the public is engaged very early stage in really large scale "omrevingschivie", and there's nobody who actually can understand how you practice spatial organization on the level of a city if you didn't study it.

INTV: Yeah, size and scale and context is always good to help in when you have multiple parties who have conflicting ideas and perspectives – you kind of need some context to set so it doesn't get too messy. Okay, this is an interesting question, I don't know if it still applies: from what I understand the developers had the choice of the opportunities they wanted build, so did they have to go through a final approval process before building, or once they decided what they wanted, they just went ahead and built what they needed to build

D3: Er, so for every development, an urban zoning plan was necessary, so they had to – this urban zoning plan had to be approved by the city council, and in that urban zoning plan, there was an explanation of how they related to this green-blue project and it was a little bit on a high scale, so it was not very detailed. But in the urban zoning plan, they had to explain in what way they were addressing the green-blue problems and improvements they were making

INTV: And this zooms out a little bit in terms of the bigger picture of innovation versus non-innovation. So we've gone through a couple of these points in our conversation already – but why do you think this particular project was able to be more innovative versus other projects in general, other than the council saying you need more blue-green what else helped facilitate the innovation of this project?

D3: I think the – in Dutch there's a saying, you need a "stick and a carrot" – and so we had this stick – and the stick was that the environmental assessment said you need to add green and water, so the zoning plan was rejected - so the developers knew they couldn't come with a zoning plan to the council without making improvements. So that was the stick. And the carrot was, that – municipalities are working on a very high scale level so the green infrastructure plan that was available – it showed only lines – there's a green line here – it has to be a green corridor but nobody really knows what a green corridor is. This is a green line on a map, and a dotted green line – what's this?...I think that is something that is my work, and I do that all the time – I translate this kind of lines into examples of what it actually is. And then they could understand that this green line means there has to be a tree row, oh this blue line means we have to make this waterway a bit larger…this dotted line means we have to make from the water way this a natural bank instead of this hard bank. And then they could understand that it wasn't always this scary "we have to change all our plans" but insight into what it actually meant, they could choose which measures that had the least impact for them, or maybe impact that they wanted – like a nice living area for people who are going to live there. So the municipality was very scared to do that, and said "we're going to draw on their land, we can't do that, we only can give guidelines, say make an ecological connection…" But nobody knows what an ecological connection actually is, if you're a developer and your business is developing houses. So I think, that was also an innovative part of the project – that we actually showed what it could be and of course, didn't say you have to do this, but

showed how it could be, and they could also do something else [which] could get them the same goals. But without the stick, they would never have been on the table to start with.

INTV: That leads nicely to my next question: In your experience so far: have there ever been projects that start without the stick and if so how and why did those projects start that way?

D3: Well, I think, now, in my more recent projects the stick is this climate adaptation plan that municipalities have to make. And there are also, I think it is getting more clear that cities are more important for living and that we have to increase the living quality in cities. So many people are going to live in cities and we don't want them to overflow their basements, and we don't want the people to die in their houses because it's too hot and they can't go out. Also this current corona crisis shows that there's a huge need of green garden space – so cities who are in the front, like Amsterdam, Utrecht and Rotterdam, they are now stating that the greening of their city is necessary for quality of life. That is a different approach, which I hope will spread also to all… so the view on why green and blue infrastructure is necessary, changes also from it is something we have to do otherwise we don't apply to the rules to this is something we have to do because we want to make a nicer, better living space.

INTV: Yeah, that makes sense. You're right, I think the corona crisis has shifted perspectives a little bit because it has felt in my reading and speaking to other people… green and blue is kind of this stressful thing that people think about only if they have to and they don't really tend to incorporate it in projects naturally. And so now that, like you mentioned, the reason for green and blue is changing – instead of it being forced, it's more like this is probably a good idea – maybe that will help more innovation and more new project incorporate blue-green infrastructure

D3: Yeah, it's a race against money and big investors who – the fear is that if we leave everything to the market, we will have another space which is only money driven and the amount of square meters of housing space generates the most money. And that is something which is still very very loud but this idea of we actually have to make a city which is in 50 years still a nice city to live in – is gaining more and more momentum- that's hopeful.

INTV: I'm interested – the forward-thinking municipalities seem to be the bigger municipalities, can you speak to what the smaller and medium municipalities, what they are thinking of with regards to innovation – are they looking to the bigger municipalities or really just focused on dealing with what they have to deal with and "innovation" is secondary for them

D3: So I think the medium cities, for example, they are looking up to the bigger cities. And also the municipality has this kind of progressive government and people living there, and the smaller municipalities have several problems: they have very small urban design section in their municipalities – mostly there are actually two urban designers for the whole municipality. It's like I think, Amsterdam has 500 or so, so the difference is huge. And, so they don't have, most of them have one climate adaptation policy maker now – so that is actually good. But this person is a loner in the organization and they have this more conservative municipality – and you can see that in the recent elections – and it's a very, you could be afraid that the cities will, the gap between the cities and the small, places outside the city –in the Netherlands, which actually is such a country that you can say you're nowhere outside the city, because it's very dense but also here, the gap between cities and people who don't live in cities is getting bigger and it's also changing in how we relate to nature. Do we take from nature because it's there for us, or do we want to conserve it and improve it…so that is a sentiment which small

municipalities have to deal with, and if you're an "wethouder" from a small municipality with maybe farmers or greenhouses, then the economic interests of the people in your municipality is very important and it's much more important and you know these people because they are your neighbour – so it's very difficult to make the more sustainable decisions, than if you're a city representative and you have to represent the city with five hundred thousand people, then it's easier to say, well we need to make a park in this area – than if it's a very small municipality and it's actually your neighbours. So I think the small municipalities also have to reach these goals that this Delta Plan, ramplek adaptatie is telling them, so they're doing that but it's much more difficult because they lack means, they lack knowledge and they lack people who actually support their decisions. So bigger cities, it's a lot easier for bigger cities to work on innovative projects than smaller cities but that is also kind of logical – because I worked for this small municipality – Westland – and I used a lot of references from projects in bigger cities – but at least they are references in the Netherlands. So if I show a reference from what's happening in the United States, or in Australia …then it's way out of their league…if I show reference from Amsterdam, they say "oh, it's Amsterdam". If I show what's happening Rotterdam they say, "oh is that happening in Rotterdam? Rotterdam is nearby, these are people that are hands on, if they can do it in Rotterdam, maybe we can do it too." So, this role of the bigger cities setting the example is also very important role for them.

INTV: I can see that there's a similar dynamic between urban Ontario and rural Ontario… where the big cities are kind of very…… and the more rural plains and farmers are like……so there's that divide between the urban and the rural populations. A few questions just before we wrap up ---funding, how does that play into decisions to use green-blue or to be innovative...if you can speak to that? Is there funding available in municipalities, or is it usually from the developers? How does that work...?

D3: Well, extra funding – so what you have to do is use the funding that is located for the sewer system, or for green infrastructure. And then, hustle that and make sure that you use it for the…because the green-blue infrastructure is of course, it's adding to both- it can be a benefit for the sewer people but also the benefit for the green people. And you actually have to work with those budgets

INTV: And in medium to large municipalities – is there a separate green infrastructure budget?

D3: Yes, I think most of them – but it's very small of course and the sewer budget is enormous so that is the most interesting budget but of course it's relocation of the budget so you have to explain that, and not only because people don't want it but the municipality, it is public money that they spend so they have to spend it in a way that having the most benefit. So they actually have to, be very clear that for that goal – it's the most, best solution. And when it's not the most optimal solution for that goal but also another goal, then it's already much more difficult because these sewer people, it's the sewer tax actually that going to this sewer system – so if you're planting trees from that budget then you have to be really careful as a municipality to explain that very well. So that's also a difficult regulation in all these budgets. And it would be good if municipalities start putting budgets aside for climate change and climate adaptation. And I think municipalities like Amsterdam and Rotterdam are doing that but not the small municipalities

INTV: Do you think having that requirement at a national level would help?

D3: Yes. Everything at a national level helps.

INTV: In some of my interviews, I get the sense of let the local people decide….so I'm always hesitant to ask if what happens at a national level is going to be any use?

D3: I don't think that, what I said before – I think local people should help with local problems. So, for example, we're here in the Netherlands, so let's say in 50 years, sea level is one meter. In a 100 or 200 years, the question is can we actually stay in this Ransdtad area or should we move to Nijmegen? I don't think local people can have a normal conversation about that….So all the local people should discuss what kind of tree has to be in there, and where they let the dogs out and where the sitting areas are…but there are a lot of problems that are so difficult that I think you have to give the lead from national regulation, and if the national regulation says climate adaptive for a city means that when there's 70 mm rain an hour, no houses will overflow – then that's still – they're not saying do this in this street, do this in that street, that's still up to the local people. But they can say what the ambition is and what the goal is that you have to reach and then the municipalities can see, how am I going to do that in my municipality. But without these national regulations, it's also difficult for municipalities already to, when they want to put their budget… they can't put the budget for the sewer actually now in green because that's not allowed by the rules for municipalities. So that is something that national government could play a huge role in.

INTV:: Is there a law that says they aren't able to use the sewer tax for green?

D3: I think it's something like that, but there are rules on how they should use the tax money they collect from their [citizens]

INTV: This is good because it helps me identify how the decision-making process is linked to the legislation because if you have rules that say you can't use it for this, or there are restrictions – then when you're making the decision, you won't even think about it because you don't have the money for it…

END….

Interview Transcript_D4.R4

INTV: So, could you tell me about your role at the municipality

R4: I'm an advisor in urban drainage and I, with coworkers of mine, decide where we have to do renovation of the sewer systems and check if we can implement, SUDS – sustainable urban drainage systems, as well. So, I am actually, responsible if we can do it if we combine the two…

INTV: Okay, in the projects that you've worked on, is there a specific one you'd like to talk about, as the basis of this interview

R4: So you were especially looking on, working on the sewer system, right? Because there is two different kind of projects, so we have when we are changing the outdoor space so for instance, a square and we are changing it's looks and we are trying to look can we put in a SUDS, for instance the water squares. So then we're looking at the outdoor public space instead of the sewer system. And most of the sewer systems we're doing now is actually, we're also checking for climate adaptation measures – it was the sewer system right?

INTV: It was, but I'd also like to talk later in the interview about the distinction between those two types of projects as well

R4: And, do you want a project that we are already now doing [implementing], or do you want a project that we're now in the middle of decision-making?

INTV: One where the decision has been made already…

R4: Okay, is it okay if I do one that has been discussed already quite often…there's also more information on it on the internet as well…So we had decided around 2014, 2015 to renovate the sewer system and we then did research on how we can integrate the renovation of the sewer system combined with climate adaptation measures. And we also communicated about it,[that it was] the first neighbourhood that has been fully climate adaptive. And because we were sewer renovations, sewer system renovation, we also went on doing a whole renovation of the outdoor public space

INTV: Okay, did the sewer renovation, was that the starting point for the whole project?

R4: Yes

INTV: Okay, and why that particular sewer renovation? What was the reason for renovating it?

R4: we assume that the sewer system has a life of about 40-60 years and most of the sewer systems are concrete, and concrete could have a longer lifespan but the ground subsides quite heavily therefore our sewer systems susbside as well. And because it's about gravity flowing sewer systems so when it susbsides too heavily, the water doesn't get anymore to the pumping station. Therefore the sewer system is subsiding and every sixty years we have to bring it back up to a higher level

INTV: Okay so it was time for the sewer to be replaced. So in terms of the decision-making process, how did it come about that climate adaptation was then considered as part of the sewer renovation, what was the decision-making process for that…

R4: It is quite difficult because I've been working here for five, six years and the decision making process has been – it already started before I was working here, but looking at other projects we now have done

later on, it's [because] we have some policies that we already have been introducing around 2014, I think, where we already told ourselves that we have to focus on climate adaptation…so we have policies that we focus on climate adaptation and we're now trying to implement it even more – so around, I don't know the exact timespans – first we mostly were looking for climate adaptation that we implemented and now we're actually focusing on, not only we have to implement climate adaptation measures, but also the civilians of O as well. So we're trying to do, we are deciding what we have to do together.

INTV: Okay so the policy has been around for a while and that is slowly being built into urban drainage and sewer renovation projects. So for this particular project, how were the alternatives developed, or what to do and who was involved in that process?

R4: So this was one of the first projects where we had a plan on this scale…so in the past we mostly went from one street where we had to do sewer renovation, and then another street and then another street, but if you're only doing one street at a time, you can't really do the whole system. So you have to maintain the existing system, and so we're now changing it to whole systems – we want to switch them to a non-combined sewer system, a separated sewer system – and this was one of the first neighbourhoods where we were actually looking at the whole neighbourhood and the whole system changing. So it was one of the first neighbourhoods that we were doing this so we actually asked an external expertise who made the plan and they checked on what kind of options did we have, alternatives. And in the A, it's also the B – which is one of the most known water squares so that was the starting point of their whole plan for the whole neighbourhood

INTV: So the water square was already existing before?

R4: Well, it was originally designed by the same company, same experts and then – I'm not sure if it was one and the same plan and this water square was the first tile, or that we first checked we were doing the water square and how can we, sort of like an oil stain, take the rest of the neighbourhood as well

INTV: Okay, and the experts, were they urban planners, urban designers or was it an engineering firm?

R4: Urban planners…

INTV: And so, the reason you went for their expertise was because of the scale of the project, is that correct?

R4: Yeah, and as well we didn't really have the expertise yet to do it full scale. And because they were actually more creative than – so we didn't want to do the usual, we actually wanted to do something different. And now we have learned a lot from that approach and now we can do it more ourselves. We have an internal engineering company as well in the municipality of O so they now also advise on how to change from combines sewer systems to separate sewer systems and put in innovative SUDS

INTV: Okay, and would you say that, right now and for this project, the urban planning and engineering departments worked closely together, or did they kind of have separate roles in the project?

R4: In that project, we were actually already working more closely together, especially because we have two types of sewer system replacements – or where we actually are just doing the sewer replacement so between the curbs, we're excavating the ground and just replacing the sewer system and putting it back, and that's what we call singular, so only the sewer system. And we also have, an integrated scope

and then we're doing the whole street from one part of the street to the other part – and every asset, so the street, the sewer system, lanterns, greenery, is all being taken care of, and we actually raise the streets again to a certain level because of the subsidence. Sometimes we actually have to do the whole street

INTV: Okay, so what's the difference between the singular project and doing the whole street – what triggers each of those two types of projects

R4: Two things: the subsidence, especially in O, if you walk through it, but also Gouda and Dordrecht, they are quite subsiding quite heavily and you can actually see the street level not really fitting the doorways anymore. So you actually see some stairways put on the street to get in their houses, and then when it's more than 30 or 40 centimeters of subsidence we actually have to go back, and if the subsidence hasn't been that bad, then we can actually stay on that level. So that's one of them. And the other thing is that all the different assets have a different budget, and if the budget for the assets, streets or roads and sidewalks, if that has already had maintenance for about five to ten years ago, and it already has new stones, pavement – if it already has been renewed in the past and not too long ago, then we can't put in more budget for the pavement again.

INTV: Okay, I see – so with the subsidence, if it's almost at the same level and it's been renewed fairly recently, that's more on the singular side but if it's dropped quite and it's an older road then that's on the integrated side

R4: Yeah, and we're actually checking, so what we're trying to do in the last couple of years and we're looking ahead five to ten years on when we want to renew the sewer system then we're actually trying to fit the different needs of the different assets to put on each other to check what's the best time to replace everything at the same time so we only have the inconvenience for the inhabitants only once. And to make sure that we're not, to make sure that we're not "screwing up" work that has been done just recently – so if the pavement has been done five years ago it's quite a waste of money if you're then renewing the sewer system and taking all the pavement out again.

INTV: Okay, and has that happened in the past?

R4: Yes, and that was also because the budgets were more separated and it was also because in the past, our assets so the sewer system, didn't have much money. So in the past, the pavement asset had a lot more money than sewer systems so the pavement was renewing already and the sewer system now is still old while the pavements are now. But at this moment, the sewer system ahs more budget than the roads, so actually now we're "in charge" or at least, more in charge than pavements.

INTV: Oaky, alright…that's something that's come up in some of my interviews in terms of the sewer replacement being supported by the sewer tax, and aligning the replacements with the road replacements. It's interesting because in a lot [some] of the other interviews it seems like it's the road replacement that triggers the sewer replacement, so even if the sewer doesn't need to be replaced and the road is getting replaced the sewer gets replaced…is that something that happens at [the municipality, in] O as well?

R4: It happens as well but we're actually trying to keep the sewer system in lead, instead of the pavements because we're actually more trying to change the whole systems and then we can't really

follow the streets. So, if one or two streets are actually renewing and there is an old sewer system, then we join them, but we're actually trying to keep the whole sewer system in mind as well.

INTV: Okay, so after this project, after that design was done – did it need to go through an approval process, or it was already pre-approved?

R4: It did have to go through approval but more so because of, if we change the outdoor space and it changes function – so it first was a pavement and now turns into greenery, or a parking space changes into a road, or whatever – then we have to have an agreement by the municipality and by the council to change it's function. But because we're actually changing a sewer from one sewer to another sewer, combined to separate, it's still underground and it's not visible, we didn't need an acceptance of some kind of council. But because this was one of the first projects that we actually did the whole neighbourhood, we tried to participate with the inhabitants of the neighbourhood and tried to convince them of joining us as well to implementing SUDS on their private property. But also explaining to them that we were trying to implement climate adaptation measures. So we had to have the acceptance of the neighbourhood as well…that didn't work that well….

INTV: that was going to be my next question, how did that go?

R4: That was one of the biggest learning curves for us as well because mostly people would be and were quite happy because of the climate adaptation measures, they weren't against it – but they were against the probable negative effects that climate adaptation measures could also have. So – that's also a problem in O, we have houses on wooden foundations, and if they get dry because of the subsiding groundwater tables then they can rot so we actually want to have a higher groundwater table, but [so] there's houses with wooden pole foundations as well as people with basements and those basements are in houses from 1900 or something and they're not waterproof anymore. So there were different opinions on should the water table be higher or lower. And for the SUDS, we're actually trying to keep the rainwater there where it falls, and infiltrating the rainwater, but infiltrating leads to higher water tables, at least not always, but for some time when it rains. And that means that their basements could flood, and that could lead to nuisance

INTV: Okay, so how did that eventually get resolved then?

R4: It took us three to four years to convince them, and a lot of talking. So what we did was, we created a community with the inhabitants and the housing company, housing corporation and the water authority as well and we actually took a step back from the plans that we had and actually made new plans about what kind of climate adaptation measures can we implement. So we wanted originally to put in pavements that are water – permeable pavements – but the inhabitants were too scared that that would increase the water table too much. So actually we did a hollow foundation of the roads, which then infiltrated a little, but not all, the whole package. But it took us, three years as I said, it's actually been, because we had to regain their trust because they didn't trust our opinion, they didn't trust what we suggested on what could work, they were especially just scared that we were screwing them over. So

INTV: Okay, so overall then how long did the project take, including the public back and forth?

R4: It's still taking…so we're actually still doing it but the whole decision-making ahs been finalized. So we started the work in January 2020. And because it's a whole neighbourhood, it's about 2-3km I think

of roads and sewer systems that we have to work on, so it's probably taking us another two years to complete…

INTV: Right, and it's been six, seven years already…?

R4: Yeah, I think we actually wanted to start in 2017, to start the work [building]

INTV: Okay, so the public pushback – was that a big pause in the planning process…?

R4: Yeah – it isn't the easiest case

INTV: So, with the pushback, was it about the measures in the public space and the private space or was it more about measures in the private space?

R4: No, especially measures in the public space, because, the annoying thing [for residents] is that we were taking measures and it has an effect on their property. So they were quite angry about – you are changing the water levels and now I'm experiencing the nuisance of it. And it is true, we're not debating that, but the problem is the water table has actually been subsiding as well, because our sewer systems are actually below water table, groundwater tables, and because they are quite old they are draining. So they are actually draining the groundwater. So we actually lowered it, all this time and they benefited from it, and now we're actually trying to get it back, and now they area experiencing the nuisance. But they actually should have been experiencing the nuisance all these years but because of the drainage… that's the whole debating step…

INTV: Yeah, they sound like very aware citizens of what the problem is and how your work affects them…

R4: Yeah, and that was because we actually did the neighbourhood next to it, and people experienced the nuisance, but as well – there was the division as well because a lot of the inhabitants had the wooden pole foundations and they actually asked the municipality [to] bring up the groundwater table. So we did, not really contemplating about the nuisance it could give in basements. And some people had friends over there so that's why they were already quite…they did quite a lot and were quite aware. And the interesting thing especially, is that they were very good able to voice their opinion. And they always told us they were with a lot of people, they were backed up by a lot of people and they represented a lot of people. But in hindsight, they were maybe five to ten people on 2000-3000 inhabitants, so you can imagine we could have done it completely different – pushed through our initial plan and maybe compensated those people who were really sacred. But yeah, it's money of the municipality and we can't invest just in private property so yeah, this was the best way

INTV: Okay, so those five to ten people – were they part of a committee that joined you in the design…?

R4: Yep

INTV: Okay, so that's how they got involved. Yeah, in one of my other interviews that came up as well, that a small group of people were very resistant to the project and they kept pushing and asking for more and trying to specify it to their needs, as opposed to the bigger project so that's consistent….so, this project was one of the first on a neighbourhood scale, so now that you've done more on a neighbourhood scale, what are you finding different, how are you making decisions differently than when this project was started?

R4: We're actually trying to involve the people earlier and explain or at least show them the difficulties we have with all the different opinions, and especially because we tried to keep in mind the bigger picture and the common wishes and demands – and we try to have the most common grounds and people tend to only see their own perspective, so if we try to show them the difficulties, we have to weigh them, we're hoping at least that they can at least back our plans. And as well, we're trying to help them more because in Agniesebuurt, what they also were quite scared about was that we were, so the houses were let's say in the middle so the streets, everything was subsiding, and now we're saying, we're actually levelling the streets again but their backywards were still quite low. So we're trying to come up with a plan to level their gardens as well. And the problem is if you only do one garden and your neighbours aren't joining you, it's quite difficult. So we're trying to mobilize the whole block to level their gardens as well, if they want to. So we can't make them, but we're trying to at least facilitate more of the conversations between the neighbours.

INTV: Okay, and how are you doing that?

R4: We haven't had a lot of experience yet because we're now focusing on in Agniesebuurt, we're trying to focus more on the public space and afterwards on the indoor space and private space. But in other projects, in the city center, you have the building and when you step outside it's public space. In other areas, there's also a front garden and we have the same problem because we're raising the pavements in the public space, and the gardens are quite low and we now in some suburbs, we have introduced we have introduced a garden coach which explains on how you can raise your garden as well, but also design it in a climate adaptive way

INTV: Okay, so that's having support for the people to become more climate adaptive. Okay, so public involvement was one of the challenges involved in this project, were there any other challenges that you faced in getting it done?

R4: Yes, because we did the infiltration foundation of the road – it is a granulate, so a coarser granulate which created bigger pores in between which is still quite dense, not dense but can hold the structure of the road in place, but it's encased in some kind of material and the other network providers didn't want to be under it, so gas and water mains didn't want to be laying under it. Because in the next twenty to thirty years if they have to reach their own mains, they have to excavate through the foundations. So there was quite some struggle about where do we position the other mains and the other pipes

INTV: So how was that resolved, not so much what was the final decision but how did you work through the differences?

R4: Well, I haven't been present with the conversations, but there have been a lot of conversations between the different network providers. And, we gave in, multiple parties gave in some times. So actually we wanted to have the AquaFlow it's called, the foundation stuff – we wanted to have it under all the street but we had tried to reason and on the intersections we actually excluded the infiltration foundation and I think in some streets, the gas and water provider have reached the decision to move away from under it, so they're not under it anymore.

INTV: Okay, so are the gas and water providers external to the municipality?

R4: Yep, because the outdoor space is property of the municipality we can decide, but we have to share the public space so we can't just decide okay we're doing it so you just have to. So it took us quite some convincing to make it happen.

INTV: Okay, that leads to the next part of decision, once it's been decided and the kinks have been worked out and it's being built now. So what happens once it's finished, when it's built…I'm thinking more the maintenance – who is responsible for the project once it's all built and done?

R4: The municipality…or at least, the climate adaptation measures is for the municipality, so the gas main is for the gas company, and the water main is for the water company. But the sewer system and the SUDS are maintained by the municipality

INTV: Is it the same department in the municipality that does both?

R4: Yes, and no. We have a urban planning department and they usually come up with how it is looking, and how the outdoor space is being designed. And we have a maintenance department that maintains the outdoor space.

INTV: Okay, so the urban planning department has within it a maintenance part, or is maintenance separate?

R4: Yes, maintenance is separate. But, and, normally the design the outdoor space and they create, and then we as a maintenance division, get it in our maintenance. But, because we're actually changing the sewer system which is actually an already existing system, which actually is just maintaining the normal system…so actually, it's quite difficult. So normally, when the maintenance department only changes one thing one on one to the same thing, but because we're actually, we're responsible for the whole system and we wanted to have a system change, we actually designed a new different system. So normally, the designing is for the urban planning department but because we're responsible for the existing system, we actually designed it now. So it's different than the normal other assets

INTV: Yeah, okay, so you designed it and will be maintaining it…

R4: Yeah, but the urban planning department was also – they were cooperating with the maintenance department to create it

INTV: Okay, it sounds like that's not the typical process – it's that the urban designers design and then maintenance…

R4: Yeah, but we're trying to make it more normal and every time now the urban planners are creating something and designing something, the maintenance department is already included because we have to maintain it, and we want to make sure that it is maintainable. But it has been something from the last 5-10 years or something, and we were actually. In the past, the maintenance department sort of got it – we created it, here it is – but now it's actually more of a co-creation part

INTV: And how are you finding that's working out, from the perspective of the project itself, but also the people who are working together?

R4: I think it's, well, so for me, it's actually quite good I think. But we have different within the municipality of O – not departments, but we divided O in different regions - so in my region, the urban landscaper, I can work with him quite well and he makes sure that I'm present and I make sure that he is

present, so there's a good cooperation between us. But I can't really speak for the other colleagues, I'm not really sure – I think it's going better and better, and we still have to learn. Because quite a lot of the climate adaptation measures are quite innovative and we haven't had a lot of experience with maintaining it so we are learning by doing. So for instance, the Benthemplein, one of the first water squares in the Netherlands, we did think of a cleaning cart that could be in the square but we didn't think of how the cart could go in the square, so now we have to pick it up with a crane and put it in there. So the next water square we did, we made sure there was a ramp so the cart could actually drive into the square, so you still have to think about those things but you don't really… you try to think about everything but most of the time you actually forget something, because it's still new

INTV: That's a really good example, it's kind of experimentation and like you said learning by doing. One of the things I wanted to ask, from your perspective, why do you think some projects are able to be more innovative than others

R4: I think the surroundings helps, and with the surrounding I mean, how has the public space been designed already, how are the people, inhabitants, are they cooperating or not, is there enough space in the surface.. Now in a couple of neighbourhoods that I'm working on, we're actually trying to do - in the Netherlands, we're trying to get off gas, and we only want to do all electric or city warmth, thermal, geothermal, so from the industry – some industries produce a lot of heat and they put it in the water and then the water is transported to cities and they use the warmth again - but it takes quite big mains as well, sewer pipes, and a lot of the streets in O, and in Amsterdam and all the big cities, they are quite small because they've been created in the 1800s or further ago, and so there isn't space for a separate sewer system which has two mains and the gas main which still has to be there because people sometimes still use gas, but other people already want the city warmth, so that has to be in there as well and it just doesn't fit. And now we have the dilemma are we going to be, energy adaptive (or climate adaptive), so yeah, that's a new dilemma

INTV: Yes, that's something I was also curios about – climate adaptation is a very big term and I wasn't sure how well urban drainage fit into that, and like you said, there's this energy transition, so how those two things work together at the municipality…

R4: For us, it is quite convenient that the climate adaptation is put with the maintenance department, which is responsible for the sewer system. So it's good that it's not a different department, otherwise they would make us put it in our sewer system abut now we're actually doing it ourselves

INTV: Yeah, speaking with you that's one of the instances [I've come across] where climate adaptation is embedded within the sewer department. Most of the time it's separate and on the urban design side so the sewer people are like "I have my sewers, I'm doing it, and then all that climate stuff can be done by someone else" so that's a very distinct…

R4: We we're actually thinking, we have a municipality on sewer systems which is actually mandatory for the Netherlands, and every five years you have to redo the whole policy, and this policy it started in January 2021 and it actually has the title "From sewer pipe to outdoor space". So we're actually not trying to put it in the pipes anymore, we're actually trying to use the whole outdoor space for a sewer system for the whole urban drainage……As well for the A, we had some international or European subsidy, grant so we have made a website as well, so there's some more information on it. So with the European Grant, we actually looked at the common ground in participating in climate adaptation

measures. So in the one thing we went wrong, we actually thought we were doing it right so…you learn by doing

INTV: Do you think there is a lot of innovation in general in urban drainage in the Netherlands?

R4: In O, we think that we're quite innovative as well – but the problem with sewer systems is that because it's such a big system you can't really do that much because you can't really do one link and expect that the whole link is also changed as well. Especially, if you want to do it at the end of the line, you can't change it before the whole thing is already changed. So, it's going very slowly but there is some innovation, especially on infiltration systems and systems that are on the verge of urban planning and sewer systems. But that's especially on what we call the "little veins" of the distributive system, and not the big ones. So it's not the "aortas" of the system, it's mostly the little ones

INTV: So do you think it will ever become the aortas, or do think they'll stay on the little veins, these new innovations?

R4: I'm still hoping that we're eventually getting to the bigger systems, but it going to take a long time. Because we have 60 years of changing it, and everywhere in O we want to have a separated sewer system, but at the moment sometimes we still can't do it. Which means that if we're now still putting in combined systems, it means in the next 60 years there is still a combines sewer system. So because of the life time is quite long, it's just going to take a lot of time

Interview Transcipt_D5.R5

INTV: So to begin with could you tell me about your role at the municipality of X?

R5: I'm an advisor of the, about the urban space…

INTV: Okay, and what does that role involve?

R5: Yeah, how do you explain that. On several levels, I give advice on behalf of projects who don't match with the Bestemingplan – the ground use plan. I assume you know what the Bestemingsplan is?

INTV: No, I hadn't heard of that one

R5: Oh, in the Netherlands, we have regulations about the size of buildings and the function of buildings, there's a plan for, it's a public plan. And that rules what possibilities you have to make buildings, and function – so roads will be on a map and rules, and it's regulated [….a kind of destination plan, where everything should be and how big or tall…]. There's a small part of my job, so we make also plans for the future of whole X, and afterwards, parts of X. And I'm involved with projects with a bigger scale, for instance Nieuwe X in the center of X, around the railway station, as an advisor. So I'm involved with the plans for new housing and new offices and new shops, and so on

INTV: Okay, great...throughout this interview, I'd like us to speak of a specific project that you're working on, which has elements of climate adaptation and is linked to urban drainage or the sewer ….so can you think of any projects like that?

R5: yeah, I'm also involved with the [policy] of climate adaptation, so I was involved with – we have a strategy about climate adaptation in X, so there's a form of [policy brief] so that's for us a starting point for development and you have several kinds of developments – there are developments where the municipality is the owner of the ground and then we can point other rules than when we're not the owners. So you have developments from owners outside the municipality, and then we only can make formal rules which are implemented in our policy. So that's an important difference between municipality developments and not municipality developments. And I'm involved with Niewue X, that's the development around the railway station and the municipality is the owner of the ground so we can make more rules for the development. And also, we made rules for climate adaptation in that part

INTV: Okay, so can you speak to the difference in rules between the municipality-owned lands, and non-municipality owned lands. In the municipality owned lands, are the rules more strict…what's the difference?

R5: The strategy is rather global, so we have to make collaborations – one of the issues from the strategy is the City is like a sponge so we think it's important to keep all the water which is falling down, the rain, in the city, instead of sending it to the North Sea. That's the old movement from the water [the water province], was the last decade – they were sending all the rainwater to the North Sea to keep our feet dry. But now we have learned that it's important to keep as much water as possible at the spot where it falls. So it can be green and it can cool the city – that's the main principle. The other main principle was the city should not become hotter than it is at this moment. But that's global goals and we have to translate them into strict rules by development. And we are, these strict rules are in progress and when the ground is from the municipality we can exercise those rules, we can say let's try this as a rule and look what it brings us in the development. And for the not municipality ground development,

we have to first make formal rules before we can use them. That's the Dutch practice, in Holland you have two kinds, legal rules – so they are implemented in regulation, and you have policy from the municipality, we have a big possibility to make our own rules but not on the same issue as the formal rules. But climate adaptation especially brings [gives] us much space to make our own rules but we have to make them formal by the city council. And that process didn't succeed at this moment, so we're in that process with the City Council to make new rules. But for developments in our ground, we can practice with those rules. That's the different

INTV: Okay, I see, so the Nieuwe X project has the trial rules that you're thinking of implementing. And so what does that project involve specifically?

R5: It's about 1500 housing, and 40, 50, 000 square miles of non-housing, so offices, shops, other kinds of function, café's bars, restaurants, practice for doctors, that kind of stuff

INTV: And is it a redevelopment of an existing area?

R5: Yeah, it was the railway – many cities have rather big areas from the railway station where the trains will stand for longer times and will be transportation was arranged, this was more an industrial area and we transformed it to more of a city area with mixed-use functions.

INTV: And so, which rules are you trying out in that development?

R5: In the first part we said, the rain which fell, half of them has to go to the backyard of the housing, the private property, the gardens, and the other half would go to the public space, the water canals we make in the area. Later on we said, that's not the right goal, we have to keep the water where it falls, so not towards the canals but keep them on the spot. And the last rules we have, we said every parcel of a dwelling must be for 50 percent green, intensive green. And you have to keep enough water to have enough for two dry, hot summer months. And we calculated that and we said that's 200 liter per square meter of green. So, we have made other kind of, in between we had rules – you have to keep 24 mm of rain, but that was also which didn't bring the goal near so we changed it and said actually the main challenge has to be make the city greener, because green is nice and it cools. And to keep the city green in that hot period, you have to maintain enough water to let it grow and let it be green. In the summer, many hot areas, the grass will become yellow and yellow grass doesn't cool the city. So we said the grass has to be green otherwise it doesn't cool. So we made a practical rule of it, and we are trying that on, and one of the points of it, we said is that it has to be intensive green, otherwise you have mosseden [moss] – it's a small plant which doesn't need water actually, and the cooling capacity from mossseden is different from intensive green. So we said you have to make green which really cools the city. And sometimes on roofs they make a seiden roof because it's easy, it's cheap and it's easy because it's not that big weight [heavy], a thinner package on the roof than intensive green. And sometimes they say we have to use sedum – so we made rules from what calculation you have to make – we said you have to make twice as much intensive green with sedum. So we made several smaller rules to fill that global rule of 50 percent intensive green

INTV: Okay, great. So with these rules, is it up to the developers to actually implement the solutions?

R5: Yes, yeah. So the developer has the freedom to choose the way he [they] fill in that rule. And that it a rather dense area so they don't have big back-gardens – it's a challenge to fill the 50 % green. And,

otherwise, in the public space we make it as green as possible. But that's our part, we can do that ourselves.

INTV: So, how did this project get started? Who at the municipality had an idea that this area needed to be redeveloped, why…?

R5: It was the inhabitants and the politicians of the city of X who said we have to change the railway into a tunnel – and that was the start of the whole project. Because this [classification/zoning of this area was railway] – there was a rather big area near the inner city of X, so it was a very interesting spot to make new housing, and new offices etc. And it was an opportunity when we got the tunnel, to make another part of the city in between.

INTV: So the citizens were the ones that pushed the project forward?

R5: Yeah, actually the railway infrastructure is managed on the level of the whole country and they didn't think it was necessary at that moment to make a tunnel. And we said it's necessary, and they said, the country said there's no money for it so we said we will pay for it ourselves and we are going to earn a lot of money with the development of the part [land] that came free when we made tunnel. And after all [that], it went the right way, so now we have the tunnel and we make that development on top of the tunnel, on actually the site of the tunnel, on the tunnel we make a park, and a few buildings, but most buildings are beside the tunnel because the tunnel is difficult and very expensive to build on

INTV: Okay, and in the works that are going on, are the sewer pipes also being redone?

R5: Yeah, everything is new in this part. So we make a modern system, so we make a separation between the dirty water and the rain water – the rainwater system is mostly here in the ground water because we can regulate the level of the groundwater with that same system, so that's totally new. And we had to make for the waterboard, the total redevelopment is 24 hectares and we have to make hectares of water and that's for the water board, and that's the first rule for climate adaptation because with that 2 hectares you can make a safe part of the city. So, it's the peak, when it's raining very hard you have too much water and less time, so then we have the two hectares of water to manage that. But we manage it also through the public space, so that water can run easily because the sewers, the pipes are never big enough for that peak so we are going to arrange it in the public space so it's going on the road – "river on the road"

INTV: So in terms of the collaboration between the municipality, the developers and the citizens, how does that work?

R5: …The collaboration with the citizens had ended, it's in a different phase. So we have the phase of the tunnel had first to become a project, it wasn't a project the tunnel. So there was no – for the Netherlands, it was no issue to make the tunnel and before it was/is an issue – so we had first to make it a tunnel project, and there was a big amount of push by the citizens. Afterwards it became a project, the firm in the Netherlands who rose the railways is Prorail and they were involved after all because they were the only institution who can build a tunnel for the railway – it's regulated, only Prorail can build tunnels. They had to, there was no order to build, so we ordered Prorail and they ordered the builder to make the tunnel. So that was a triangle relationship, and during that process there was always discussion with the inhabitants of X because they were also the ambassadors of the project. But a few years ago, the tunnel was finalized, and the municipality had a separate organization, OBS named, a

development company [located?] in X, that was separate from the municipality to realize that project and that project was some years ago it was finalized. And afterwards we went on with the development of the area above the tunnel. So we are in a different phase and the collaboration with the people of X and the future inhabitants has a different form.

INTV: What form is that?

R5: We have to make some formal plans, land use plans – the Bestemingplan – and there's always the possibility to participate in that project. But at the moment, they are formalized by the City Council and that participation ends…and now, the development is more concrete, so we don't have to participate with all the people because the direction of the development is quite obvious. And we have the formal plans where you can realize the buildings in – the Bestemingsplan, the land use plan – you need a permit, a building permit and they are already there, the Bestemingsplan, and everyone can ask for a permit within the rules which are based in that plan

INTV: Okay, so the plan has already been approved by the council, correct?

R5: Yeah, we have several plans. At the beginning there was a Master Plan, so that was a plan over the whole area, including the Spoor tunnel, the tunnel for the railway station, and afterwards we make the Bestemingplan - to build the Spoor tunnel, you need a Bestemingplan, a land-use plan - but afterwards we have made a new plan because the direction of the development of housing, we had to change – we had a crisis in holland – so the first time a big amount of the money that was needed for the tunnel had to be arranged by the housing, and we had two developers who would build the housing and we should get very much money instead – and the crisis, they said you're going to get half of the money, and we said that's not possible we have to get the total amount, and then we made a reassessment [re-judgement] of the plans and that was also concluded by the City council – that's IOP – [Integral Ops…Plan] - integral development plan – and we changed the name from Spoor zone to Nieuwe X because the tunnel was already finished, it was fixed and we had only to look after the development of the area. We made it a new paper with the rules and the goals we were going to achieve and based on that plan, we also made new land use plans – new Bestemingsplan – for part of the area, with the rules. So you have different tools for different levels, different phases.

INTV: Okay, and are the developers involved in the making of those plans or do they just follow?

R5: Yeah, they were involved because from the two developers who had the rights to realize [develop] the area, we changed the contract with them, and one was still on board. So there was still one and we made a new contract with that developer and we said you can make one third of the development in time and of the different phases in the time – so we have to discuss with them what were the new dates, appointments [responsibilities?] between us and the developers. And afterwards we made a scheme with several parts in the plan. So we have an overall plan, but we have several parts, we call it fields – so we have field 1-10, and some fields have also sub-fields, smaller parts of them, and we made plans for every part of them. And plans do not mean that we drew the housing or the layout of the buildings but we drew the context of the development so like a tent in which you can design your own building

INTV: And that context, that included the rules for green and for holding the water back..?

R5: Yeah, the rules of climate adaptation are included inside that tent – for the fields, they have the rules because we say you have to make quality on the fields. And we make it in the public space around. So the fields are the part where the developments take place and there is mainly buildings and private parcels, and the other part is the public space and we do that, the municipality

INTV: Okay, the private space the developers are working on that side of meeting climate adaptation, and in the public space the municipality is also working on the climate adaptation elements, is that correnct?

R5: Yes, that is correct yes. We said, when we make rules for the developers, then we ourselves also have to do something.

INTV: Okay, so who or which departments at the municipality are involved with the public space climate adaptation works

R5: …the regular departments…we have a project which designs and realizes the public space, that's the project Nieuwe X. And afterwards it's going to the regular departments of X who are responsible for public space, for maintenance, we call it [beheeropenbarramter]…the normal people who are cleaning the streets and repairing, when there's something broken they repair it – and after the development it will go to them so we have to, on the front side, when we make a plan we have to show the plan so they can judge whether it's about their standards, they can check their standards.

INTV: Okay, so there is a department that works on the design, and there is another one that works on the maintenance?

R5: Yeah, the design is involved in the project, it's part of the project. The project is a rather solitary organization to design and realize the project

INTV: Okay, and then once that's done it goes on to maintenance…

R5: When it's finished, for instance, one part, the […buurt], that's finished so we are not responsible for it, it's now with [boor] – the part of the city which is about the maintenance of the public space.

INTV: And that's kind of the end piece of the work then? Once it's moved from development and design and it's at maintenance, that's the end?

R5: Yeah,

INTV: Okay, alright. A couple of follow up questions: you mentioned in the beginning that the Council hadn't approved some of the formal, legal development rules that you wanted to implement for developers – can you explain more about the role of the council in these projects…what they do?

R5: The Council? The City Council is the politic so they have to make the judgement whether it's the right rules, and they make that judgement on political grounds and sometimes, they are rather on details but actually that's not the way it should [usually goes] go…actually we advise, the city council when you want to do something about climate adaptation, you have to do this kind of rules to manage that

INTV: Okay, so which rules are they not approving and why?

R5: At this moment, we didn't make a proposal – we are making a proposal. So at the end of the system is that we bring the proposal towards the City council and they stamp on it. They have to formalize it, otherwise it's not a rule. We make concept rules and when they finalize it, then the rule is a rule for every development in X. So you get, in other municipalities, the possibility of other rules. So every municipality can make their own rules

INTV: And if they don't approve of the rules, what happens then?

R5: …We have a problem…we call Houston :P. When they say it's not right, there will be discussion on what is possible, so we have to change the rule so they will approve them, and in between we will try to convince developers they have to follow the concept rules because it's good for a better city, there's always a great amount of possibilities you can - there are no single issue elements, they are all connected – we say a green surrounding is good for the dwelling so you have to make it green, and it's also good for climate adaptation so when you do it in the right way – so you can talk about very much things to try to get them into a plan. But it's difficult when the developer says I don't want this, you don't have many, then you need rules to say you have to do something.

INTV: Do national rules have any weight, do they help at all, or the rules are at the municipality level only?

R5: There are no national rules, I think about climate adaptation, which are practical on local level. So the national plan is about the water safety, mostly… about the north sea, the sea level changing, especially a framework where you can make the, where provinces, so they make also strategies from a provincial level. And then you get the municipality rules. So they are about water safety especially on the higher level, and they are especially, to put it on the agenda, to make it important so "guys we have to do this, otherwise it's not going good" so we have to change our policies, but they have not specified rules from the level of the whole country for the local situation.

INTV: Okay, so X has policies for climate adaptation and land use planning, how are those two related?

R5: Climate adaptation is rather new - we did something earlier but it wasn't called that way - water was always the issue, also with the waterboard in the formal space organization [ruimteplekohording, we call it in Holland] – the way you organize the space and the use of space [spatial adaptation] - the waterboard was always involved because there was a rule, you had to do the water check-up in a legal plan, procedure, so the two hectare of water in Nieuwe X was already inside the plan because we and the waterboard thought it's a good idea to make that much water in a good system. It is always a combination of system and volume, that was already common practice to do that. So now [next] we are going to look at what's new, fifty percent of the parcel has to be green, intensive green – it's a new rule and that wasn't implemented. So the land use plan was not that detailed on that point, so for the development we made a [gaavo passpoort] – lot passport. So what we tried in Nieuwe X was to make a contract at the front [start] with all the rules you have to do on that spot. So you know them in front instead of during the process or at the end of the process. Some people were very frustrated when you came halfway with "oh, you have a new rule, you have to do this". So we tried to make a kaavo passport at the front with all the rules on every subject you can think of, so about sewers, about the land use, about the height, about the parking…that kind of stuff, relevant for urban transmission – we did that at front, so we make all the rules about climate adaptation, we did that at the front.

INTV : That's a very unique approach, because most of what I'm finding is that the discussion of climate adaptation happens throughout the process of the project, and not at the front. So it comes up as something that should be considered and then when alternatives for solutions are being looked at, then that question comes up, how can you be climate adaptive…

R5: Yeah, but that's a bit an issue of scale…we are, with the plots, they are rather concrete developments so we have to be sharp in the rules because otherwise we don't get anything. In front of you, you have to think about what will be the logic or goals in this specific situation, because it's always specific for the spot, which kind of rules you have to make for climate adaptation. Because, it's very much dependent, depends on the ground and the height of the water, that kind of stuff. So we say you have to make a special plan in which you have to think about the solution for this area. And it's, what makes it difficult, we don't know exactly what kinds of rules you have to take or make to do it good for climate adaptation, because it's rather new. And we don't have a very good recipe book for solutions. So it's trial and error.

INTV: So will you be trying different rules in different areas to see how they work?

R5: Yeah, in the first part [of the project] we had the first rule but now we have the fifth rule or something because we concluded it wasn't the right rule to get the goals so there's an evaluation, it changes, it changes in the time. But I think we have to make very more rules to get it right. And it has also to be specific for the location – that's the search every time, from how do I get at my goals. And the goals are rather global – it said [they are] X should not become hotter in the coming years, and the world is getting hotter, 2 degrees, and how can we make the city become not hotter. And that's a search, we don't have the solution for that. So we are going to try and it's rather difficult to investigate the impact of solutions – there's some ideas, when you make ten percent more green, it's going to make 0.1 degree so you have to do very much to make the 2 degrees difference. So it's a search without a good recipe

INTV: And it's hard to see your results as well…

R5: Yeah, for the park in the plan, we have a collaboration with the TU X, with….., and they are going to measure the differences in the time, to check their research models, so we can better understand which things you have to do to get a good result

INTV: Yeah, and then you can incorporate that into the rules going forward

R5: Yeah, you can sharpen your rules or change them in another direction. And, the city has many different places so the solutions will be very different, we presume. So it is the search for the right solutions and the combinations

INTV: The other thing you mentioned was scale, and the fact that at the development – for this specific project, the lot is very self-contained so you can list the elements… what about at a bigger scale, what happens then?

R5: …I mentioned the scale because some things you can not arrange on a plot. For instance, water safety you have to arrange, but you can't arrange the water safety of the city on plots. So you have to do that in the public space, you have to do it on a bigger area, on a bigger level. Otherwise, the spot makes part, some parts of polders – water units – in the Netherlands we have different water units

which are organized differently because the water level and the level of the land is different, you have different parts in the system – the inner city of X is the highest level, and is totally different that the parts in the west side of the city. And they also exist at different parts. So you have also to look at that system as well, it's not only the plots, not only the land but also the system that it's part of. And then you can think of what is the best solution to keep the water on the place where it falls.

INTV: And so at that city-wide level, then you look more at solutions in the public space and not in the private space…?

R5: No, that's not entirely true but the municipality is the organization who rules the public space so that is the most easy for us to do. But also, it's rather difficult because we don't have money for anything and we have several developments which are very separated. For instance, the renewal of the sewerage, the new system for the energy - so the city heating system, they are not integrated to each other, and we have the renewal of the streets, as well as the renewal of the green, and we have the measures for climate adaptation. So there are very much different looks about the public space and they are not integrated in one brilliant scheme or something like that. So that's the difference. And the other difference is that the half of X is from [owned by] the municipality, the public space, some parts are from the waterboard but we can talk with them on the right way. And the other half is from the citizens and we can't influence it that much because it's existing city or so. And my neighbour, when he's changing his garden or his roof, it's very difficult to influence that but it's also a part of the solution – we have the problem of many gardens are from stone, with tiles, and we try to make it greener. But we can only influence the citizens, and at this moment, we can't, we don't have rules to say this is not right, you have to do it otherwise, you have to do it another way. But in the end, it has to be a total solution because the urban heat island is formed by the whole city not only the public space, the buildings. And the way buildings are heated or are cooled in the summer - when you skip all the air condition in Paris, it will be one degree cooler. But the whole purpose is not from the municipality the air goes, so we can't influence that direct with rules - it's very difficult and political, and cannot be] are not addressed in that kind of discussion.

INTV: So to get the citizens to partake a little bit more, you would need rules from the municipality but that's a political thing that could get very messy, correct?

R5: Yeah, the way you can change that is to influence them

INTV: Instead of making rules for them to follow

R5: In X we have an organization, outside of the municipality who is trying to make that influence. Because when the government says you have to do this, people say "oh that's for me myself to do decide" but when a non-municipality organization says "it's better to make your garden green and it's more interesting and you can do it this way..", they will be more willing to do that. And has this organization had luck so far?

R5: Yeah, there's an organization in the whole of the Netherlands – Steen Breek – breaking of stone it's called, and as a municipality you can be part of that, a member of it, and that organization will be connected to our organization. Our organization we call the Klimaat Maat, the climate friend, and it's a network of people hwo are known with solutions so they can help the citizen find the right solution. So

they are promoting the activity of Steen Breek. That's, you can't do everything with rules, so you have to use also other ways to make the change.

INTV: I have one very quick question…you mentioned that there are separate departments at the municipality, the energy and lighting, the climate, the sewer, the urban planning – the fact that they are separate – does that make it harder to make climate adaptive decisions?

R5: That's a difficult question – you have this thing called assets – the public space is separated into several assets, assets of pavements, assets of bridges, assets of water, assets of green, assets of sewer – the best place to influence that is at the design level. So, as an urban designer, we try to influence that and combine climate adaptation and the goals for green and the goals for housing, and the goals for interesting public space, we try to integrate that. But that's the [far from my best show sometimes…?] because the are very focused on their own assets. So it's an art to make them sensible for [sensitive to] the combination, and that's a long way [away]

INTV: I can imagine – that is consistent, in a lot of my interviews, the way municipalities are structured is according to the assets and people are very focused on their piece of the work so integrated is a little bit harder

R5: And it's, we have a project group for climate adaptation and there are members from also those departments in the municipality are involved just to make them ambassador for the overall thoughts and the goals we are trying to achieve, and the changes you can see. But that's very difficult because everything, every person thinks "oh I'm doing the right thing, and we have always done it that way", so it's very important to have a discussion inside to look what solutions you have and what you should do in ways. Also, that specific solution for every part of the city can be different – and that's costs a lot of energy to investigate, to search for the right solution. It's also difficult because the right solution are not always easy, or available, so sometimes you have to think new solutions and the technical assets are not always, they don't have open mind for new solutions because they have to look for the future that it will be, within costs, so they have low risk level. So a new solution has a higher risk because it's not known and they don't know what problems will exist. So they are always short of money, so they are trying to get the risk as low as possible. And that's the right solution for a new development, new ideas, new solutions. You have to have an open mind, you have to take some risks, you have to say "okay, let's try this and let's look how it works and what it brings us", and that not their kind of job.

INTV: Yeah, difficult

R5: Yeah, that's the difference you have between several worlds at the municipality – you have the people who are for the new policies, the new solutions, the new elements you have to provide. And you have the people who have to manage the streets of that moment and tomorrow, and they are not that much involved in thinking about what will the problem be in 20 or 30 years, and what's my problem related to other problems. So, the walls between the several assets makes it possible for them to do their job, but it's also a barrier between new solutions…

END

Interview Summary_D6.R6

- **INTV:** Description of mi of work (research v industry base)
    - **R6:** lectures, consulting focusing on applied research, water quality, effluent/pollutant, cleaning of gully pots and impacts on sewers, calls and complaints, asset management.
- **INTV:** what factors, considerations are taken into account/prioritized in SAM redevelopment projects
    - **R6:** Budgeting: completed on a high level. Based on estimate of service life; for example: if pipe has approximately 60 years remaining, [budget for repairs and maintenance accounts for this]
    - Realization that money could be used for improving water system; better understood now that only increasing capacity doesn't help
    - Also, a split in considerations between replacing pipes and climate adaptation
    - Typically, complex procedure:
        - First roads department undertake road planning and renovation: different approach because roadworks dependent on other factors such as weather therefore hard to plan ahead (e.g., if particularly harsh winter, more cracks, or more roads with cracks – influences decision for road works
        - Planning and budgeting also completed on a shorter timescale than SAM
        - In addition, urban development/planning department completes their planning, budgeting, as do SAM
        - Plans from multiple departments overlaid and if there is opportunity to combine works, then larger, more complex projects occur. Process is more integrated than it was ~20 years ago, for example
- **INTV:** Clarifying: restriction on tax levy for sewer pipes only?
    - **R6:** No, tax needs to be used on/related to urban water needs – can be pipes, blue-green or other etc.
    - Note: budget is estimated based on anticipated sewer works, but typically (in reality); actual spending is based on infrastructure needs in the system, throughout the year
- **INTV:** In your opinion, is there a lot of "innovation" in SAM replacement projects?
    - **R6:** important to make the distinction between "replacement" projects, where the driver for replacement of pipes is ageing versus "improvement" projects, where there are other reasons for project and other considerations can be taken into account (e.g., roads, urban/spatial planning etc.).
    - In the case of typical "replacements", usually approach is to replace "like with like", so limited opportunities for "innovation" (which in this case is defined as different from original system, so e.g., blue green or switching from combined to separate sewers).
    - There is no incentive/impetus for changing system if current pipe or system or "like with like" approach is optimal – opportunities for change/innovation arise (or more justifiable?) if current system not optimal
    - However, if municipalities have overall strategy or policy towards more "greening" etc., then even typical "replacements" will incorporate aspects of this
- **R6:** change for the sake of change not always best, e.g., combined system suitability…
    - Interesting discussion: specifically regarding "best system" especially WRT combined systems

        - General trend is moving towards separated systems, but in some instances types of pollutants (e.g., oils and grease, micropollutants from car tires) in stormwater runoff may "encourage" consideration of where runoff ends up: untreated and in water source if in storm system, or in groundwater etc.; with (blue-green) infiltration measures; whereas turns into sludge and burnt if ends up in WW system
        - If WW treatment plant has large enough capacity and efficient enough processes, then it can be viable alternative
        - Summary: no best system, approaches very dependent on local conditions and desired outcome (where water ends up)
- **R6:** For example, project of reed bed, storage tank above sewer pipe successful but no blue-green infrastructure
- **INTV:** is this typical?
    - No, unique approach
- **INTV:** Noticing some bias in questions towards "blue-green" as basis of definition of "innovation", will need to broaden definition, to include unique ways of using grey
- **INTV:** Could you speak to/clarify interaction between waterboards and municipality re: water?
    - **R6:** Three areas of interaction between the waterboards and municipalities
        - For stormwater: waterboard jurisdiction is surface water quantity and quality; therefore, can impose restrictions that municipalities need to meet
        - For wastewater: waterboards responsible for treatment and plants, municipalities responsible for collection and conveyance
- **INTV:** Are there national/policy guidelines for asset management/sewer replacement
    - **R6**: No, only local rules and regulations, and national policies likely would not work; local conditions differ significantly so no universal best practices or approaches; there is knowledge and information sharing between municipalities and regions
- **INTV:** what do you think are some limitations to innovation in SAM?
- **R6**: Education/lack of qualified professionals, in the field at operational stage:
        - Why: predominant skill level in SAM is operational, therefore ability to tackle day to day; but bigger picture-conceptualization needed for innovation hard to find
    - Limited number of PhD's, professionals, applied scientists but slowly changing as educational pipeline fills (delay from students to in industry/in practice work).
        - Reasons why: not all trained engineers stay in the field; in general, risk-aversion of professionals due to importance of infrastructure and/or impacts of errors/mistakes/accidents (e.g., contaminant leaks) << thought risk aversion is not necessarily a bad thing
- **INTV**: What about some facilitators for innovation?
    - **R6**: Problems; "big enough" problems that will galvanize/incentivise change or require creative thinking and new ways of doing things
- **INTV**: is climate change not big enough?
    - **R6**: No, there are other more urgent drivers. E.g., urban flooding, which is due more to high densification, increasing urbanization, significant paved surfaces, ageing sewer

systems than to climate change. So existing issue to tackle which have more priority but somewhat linked to climate change

- **R6:** use of stress tests helps because it identifies previously unknown problem areas, or potential unforeseen issues in network; allows system understanding of sewer network; and therefore, can identify areas of focus
- **INTV**: final questions on money/budgeting: how is sewer tax estimated/calculated?
- **R6:** based on anticipated maintenance/operational needs budgeted, and then necessary taxes calculated
    - Tax rate influenced by range of factors including property values, how depreciation is calculated, number of members of household, connected area (hard to estimate) etc.
    - Consequently, large municipalities don't necessarily have large budgets than smaller municipalities
        - Distinction made between absolute and relative values so in absolute terms, large municipalities do have more, but value per linear m of sewer network (for example) might be less than for smaller municipalities
- **INTV**: Do most municipalities have "enough money"?
    - **R6**: depends on what is meant by "enough": for sewers, yes, generally they do, but definitely not in other areas

Interview Transcript_D7.R7

INTV: Could you tell me about your role in your organization?

R7: Yeah, okay, I'm by the city of T, the asset manager for water and sewer systems. And that's for the whole part of what happens between water and the sewers, and there's not only projects but the whole assets of the sewer management.

INTV: So, there's two levels to the interview – there's me trying to understand the decision-making process with regards to the sewer assets, urban drainage as whole and how that interacts with climate adaptation.

R7: So climate adaptation is a huge problem but that is part of my job

INTV: So are this point, are there any projects that you are currently working on, or that you have worked on that incorporate urban drainage, sewers specifically, and climate adaptation?

R7: Yes, of course – I'm happy to say now, of course

INTV: The next question, this can be for a specific project, or the projects in general, so I'll ask and we can decide…in general, how do these projects get started – these projects that incorporate sewer and climate adaptation?

R7: What we do, is with a map table session – it's called map table session. I'm the asset manager for sewer, let's talk about sewer – but I have also colleagues with the asset manager for the streets, asset manager from the public green, asset manager from the traffic lights – and so everything in the public space, we have asset managers. And we have also, data on what we are, so I'm the asset manager, [data] for the sewer, and my colleague has the data from his streets and so on and so on. But I make a map on the whole sewer system of the city of T. And I know which sewer system is very good, which sewer system is very bad or sewer system that okay, I come back over 10 years to look it over again. But I have a map, I make a map from the sewer system from okay, I must do in about now and 5 years, and between five and ten years…so I have the map from the sewer system, I must do about zero and five years and five to ten. Then my colleagues from the streets have the same map but done for his streets – okay, this is the street I must do something about between 0 and 5 years, and 5 and 10 years, and also my colleague from the public space, from the parks, says here must I do something between zero and five years, and five and ten years. And so everyone has the map, and then I explain my map, my colleague about the street he explains his map, and at the map table session, there's a big table and we stand all around that table. And also have sometimes, someone from the police is also there and he can tell us what the problems are in one area – and that's the problems from social problems. So we stand around the map, the table and then from the whole city we look, we start with one area. And then, I show my map but also the map from my colleague from the streets come above my map, and so on. And then can we see, okay in this street – I must do something, but my colleague he must do about five years. Then we take what we want to do the same time as the sewer. So everything in that street, we will combine to another. And then we start a project. And it is also possible that I have a sewer system that I must do in about ten years, but the street is very bad, and the street must be done now. And then it is possible that I do the sewer system, not over ten years, but also now. So the cost that I reserve of ten years that I take it to 2021 [bring the cost forward]. So we try to find so much to do everything in one – in the streets or in the area. That's how we plan our projects. But it is also possible, that in one

street – only the sewer [needs replacing] – that's also possible, but with so our projects built in T [?]. So that's very important that the data is okay. That's a whole job of course, but that's important that the data from the sewers, from the traffic lights, from the streets, that that is very good. And then you can make the maps on each other and then you can talk about it, what will you do there, what will you do there, and then you start a project. So that's the first step.

INTV: Okay, I have two follow-up questions and then we will go to the second step. So the first question is: how often do these map table meetings happen?

R7: Once a month, and each city area. And on the [we look at] an area, an area, then the whole city

INTV: Okay, so you look at the whole city every month?

R7: Yes, each month…and now by corona, we do that with a screen against the wall and in a big room so we can sit [away] from each other. But still with corona, it will go on

INTV: Okay, that's very good. And then the second question I have – is what happens when there is one street where you only have to do the sewer?

R7: Then it's, we call that autonome and that's an only sewer project

INTV: And in those projects, do you typically do green stuff just because, or no? In the autonome projects do you incorporate any climate adaptation at all?

R7: Yeah, that's for everybody, every asset – that's very important. So for example, for the streets, we must by each project look about less pavement. And ten percent pavement in our projects. That's the normal, the basic start. Ten percent less. And more green – that's for the part of the green asset managers, and more trees. And buffering water rain water – that's my part. But less pavement, less asphalt, ten percent for the whole city – and that's a lot. And then it's important, that for the rain, in my projects, I must hold a rainfall and we call that 10 plus 10%, and that's 40 mm in 45 minutes. So in my project, I must hold that rainfall.

INTV: So the sewers would be designed to hold that rainfall…

R7: Yeah, and not only the sewer. So we want to let our citizens that they can see that we hold the water. So the most we have in the greens, a little bit that the water can stay in the greens, and then [go into] our sewer system. But the whole project, in the sewer, in the green or whatever, I must hold that rainfall of 40 mm in 45 minutes, and then it can go to the area of my project..

INTV: Okay, and is that a guideline? Where does that number come from?

R7: That's our rainfall in the Netherlands, that happens one the 10 years.

INTV: And do all municipalities,, in your experience, is this something specifically that T does, or…?

R7: Yeah, not only T but there are more cities, municipalities in the Netherlands and I know there are [some] with, not like T, 40 mm but 60 mm...so more. But there are also municipalities that have less

INTV: Okay, and who decides that number?

R7: Yeah, it's the sewer asset management [team]

INTV: Okay, so we'll go now to step 2 – once you've decided that the street project is going to be done in collaboration with all the other asset managers, what happens next?

R7: Okay, then we have a project, then we look very close to our data and then we talk with the people who live there, in that area to talk about, okay what problems do you have? It is possible that our citizens know the area the best because they live there. Then we talk about the social problems, we talk about the parking of the cars, we talk about everything, the playground for the children, which is very important of course. And then we go look about, if this street can be, if this street, how it is now is also good for the future. And then we go to make drawings, calculations, and so on. But also, it's important – not each project, but the most projects we do that, with the citizens who live there?

INTV: And when don't you do include the citizens?

R7: That's in the park, where there are not citizens, or in the river, in our rivers…where we have other stakeholders

INTV: Okay, fair enough. The next question: how is the interaction with the citizens…are they usually happy with the project or…? They don't protest, there isn't pushback…?

R7: No, by the projects from the sewers and the streets, no, that's not… when we are, when trees are involved in the project, when they must go, then we have a problem. But also, we also want more trees in our city. But it is all, every time when we have a project where trees are involved, and the trees must go, then we have a problem

INTV: Yeah, it's the same here in Toronto, definitely. Okay, so there's a few bigger questions but before we go into those – what are your main considerations when you're planning your sewer projects, so like time, costs, people…what are the things that come to mind/factor into your decision?

R7: Can you repeat the question?

INTV: Yes, what are the main considerations for you as an asset manager when you're replacing a sewer or improving a sewer?

R7: I'm worrying, if that's what you mean, I'm worrying about less water…and the heat and the drought periods. That's what I'm worrying about. So I told you about the heavy rainfall, okay – I think we can manage that – but the heat in our cities and also no rain for a long period, that's I'm worrying about. Because also, the Netherlands and then we have the sea, but a lot of the Netherlands is under the sea level so when you don't have rainfall for a long period, the groundwater becomes salty from the sea – and that's very bad for the trees and so on. But also, in our city, in T, we decided less pavement and more green. More green, more trees but also on our roofs, green – but green needs water. And I think that will [be], our main problem in the future. So in the Netherlands, we also have to do our job against the water, with dikes and so on. But I think in the future, we have a job to need against the water but we want water. And when we have water, who's the owner of it? We don't know, is it the citizens, is it our main government, is that for our asset managers for the drinking water. But I think the main problem in the future, and I hear it not very much, and that's what, that's strange for me. Everyone in the Netherlands talks about less pavement, more green, more trees, green on the roofs and so on but every [all] of that needs water, and that will be the problem in the future, I think. So that's what I'm personally worried about.

INTV: Okay, great, thank you…

R7: But I know, and there's was a program on television here in the Netherlands, about the city of Milan in Italy, but there are now also cities in Germany or France or Spain, every city talks about less pavement, more green but nobody talks about okay, but they need water. And when there is no water, what then? I'm worrying about that…

INTV: That's a very good point because thinking of what happens in the future and who's going to deal with that, that incorporated in plans every now and then…so next question: is there a role of cost, the cost of something- does that play into your decision-making on what to do?

R7: No, what we have in T, for one year, we have a budget and that budget we have also the next year, and the year after. So we do a lot of projects sometimes, too much projects for the people that must do it, but when we have too less money, we can also decide to do the project next year. Or we can also decide to take the money from next year to this year. So I think honestly, money is not the main problem in T, to do the projects, no

INTV: And how about people? Is people also a problem or not?

R7: Yeah, we can't find the people to do the job like me. So I'm often also in the sewer systems, and nobody wants that. I love it, it's very very interesting, a whole adventure all the time and not only in T, but I also have nice pictures of Toronto, and also in Germany in France and Italy, I go in the sewers to look what's the problem of that, and nobody wants to go with me…it's dirty and…but I like it, I love it, but too less people are going with me to learn.

INTV: So why do you think that is?

R7R7: Yeah, dangerous, you smell, what you see is not also very cool. So when I go in Germany, I go with one, also I have [work with one person] from Germany, but not, one [person] from the Netherlands, in T, I work often with one [person] in Belgium, there are too less people like me.

INTV: So more general questions now, why do you think T is a forward-thinker, one of the municipalities that's taking it [climate adaptation] on, and moving forward with it?

R7: Yeah, because, my boss he told me do what you want, I'm trusting you. So I, but also some colleagues of mine, have a lot of freedom to do what we think is the best decision. And that's very important. So my boss is not talking with me about, the technical part of the job – he talks with me okay, how are you doing, what do you need [to do your job?] and he believes that I [will] do the right thing for my city. But that is very important, for me

INTV: And is your boss also an asset manager?

R7: He is facilitating [middle manager…?]

INTV: Facilitating between you and…

R7: Yes, how can I do my job the best…but also when I need more money for my projects, he can talk with another boss to arrange that…but there's no boss in the city on T who is a technical boss. So that's very fine. And, that's the main reason that we can do - and that also one part of my job - to go and to try with innovation. And we have also a budget of finance to do research, with the university of Delft, or

with Deltares… but also with IKT from Gaustenheren, Germany. So we have a budget, each year to do research with those companies.

INTV: Ah, so where does that budget come from?

R7: We have a tax, and that tax is only – you may only, that's by law, you may only use that for the sewer system. And for my sewer system, I can do the research and so on. But the tax is only, they are not allowed to use that for other stuff. So it's only used for the sewer system

INTV: And, do the asset management plans and projects, do they have to get approved by anybody else or are you the final person?

R7: No, we do that together. So it's not how we work in T, we do that together. And when we decide that okay, we can do it better next year, okay then this is important that we talk with each other and talk about why and the reason and then decide together, okay then that's the best decision. But when I'm not, agree, or my colleagues not agree – then it's my boss to say [who decides], okay, I'm not going with you the project is next year

INTV: That's a very good structure and a model, and you said that really helps with innovation and experimentation which is the bigger question that I have. So in your opinion, in the Netherland, in Dutch municipalities, is there a lot of innovation happening right now?

R7: No, no, in T, there is a lot of innovation, [but] not every city.

INTV: And why do you think that is?

R7: I like to do innovation, and you must try it, and I talk about it, what we do in the Netherlands, and not everyone wants to do that, are not capable enough to do that, not feeling free enough to do that. But yeah, it's for me a part of the job. And I like to talk about all that – what we try to do. Also, when it's a disaster…of course, not everything goes well, sometimes it also goes wrong but when you don't try it, then you will never do it

INTV: so how do you deal with the things that go wrong?

R7: That's not a problem, when I always can look in the mirror, then, also for my boss but also for the [??] I'm not a problem, but that's very important, that I always for myself, explain why it is, and that I'm always able to look in the mirror. I do my best, I try my best, and then it's not a problem. Of course, it must not happen every time because then you have a big problem but it's part of the job

INTV: Yeah, okay, the other thing I'm interested in from your perspective – what do you think innovation a difficult thing to do?

R7: It's new, it's not expected - what you think it will be, it's a path that is not already good [laid out] but it's an adventure…

INTV: Okay, and what makes it easier

R7: Easy for someone else is when I do it first and then explain what all about it, and that I can help the other one to try it. And think about a little bit this, but the main problem – yeah, try it themselves. So let them do it, with a little bit of pushing

INTV: So, they need to see how it's done and then they can try and do it?

R7: Yeah, or okay, that's a good idea, let's try it or okay, he did it that way but I can do it that way, then I can [say], okay fine, try it, do, with a little bit of pushing

INTV: Okay, so encouraging people to try new things and see how that goes

R7: Yeah, and talk about what you are doing. I love to talk about what, in our sewer system and what we've done. I talk a lot in Germany but also in the Netherlands, everywhere, and that helps people to try also other things. That helps, talk about, let people see what you are doing. And that's also a very important part of our job in T, that we talk about our projects but also take our citizens with the projects. But also, the children on the school. We often do, when we have a sewer renovation nearby a school, that we make with the children, a treasure, and when we are laying the sewer, then we hide the treasure underneath… and then you have a whole story, from okay, but why is the sewer, why are we doing the job, and then you can tell everything, and you can make with the children a nice drawing, and nice happy wishes for the future.. and you can talk with the children about how do you see the future. We also take, Pokemon, we make our golden [item], but I hide that in the city of T but when I do that hiding then it came on facebook, on Instagram, where it was [where was it] - from the Facebook from the City of T. And then it became a Pokemon race for citizens to find that one because when you find it, you take a place with me to look in the sewer

INTV: Ah, very nice

R7: So that's also very important, let's see what you are doing [to show citizens] because it's their money…talk about it, let's see it and so on, very important

INTV: So two follow-up questions: do you interact with the surrounding municipalities? Do you work on projects with them together, or is it more information sharing

R7: Yeah, it's more information sharing. And thinking with them how they can do it. But also, the big old sewers, they ask me, okay can you come, cany you look at it, what do you think about it. And then I give them advice, and I go with my advice and make it a good project

INTV: Okay, very cool. In the beginning, you mentioned sewer and water systems and being the asset manager for both – are those integrated in T?

R7: They are integrated,

INTV: Has it always been this way?

R7: Yeah, but it's growing of course, because to design our sewer systems, now we calculate also with 3D but of course, five years ago it was 2D – it is growing

INTV: Do you find that having an integrated system makes it easier to manage the assets?

R7: Yes, because it's not only the asset. Because the public space is not only the sewer, it's the sewer, it's the street, it's the lighting, it's the trees, it's the green, there are the buildings – it's all together. So that's I think very important, when you do a project in the public space, it's very important to do that with the other asset managers. Because my citizens in T, they are looking at the public space and they see everything, not only the sewer, not only the buildings, not only the trees. So you must do it

together. And that's also the main for our climate, you must do the climate adaptation from above the ground and under the ground and bring them together. Not only above the ground, not only below the ground, now, it must be together.

INTV: And that's something that T does?

R7: Yeah, not every, not all the time but we're working on it. It's very important to connect also the ground water and buffering above the water, the buildings with the green, everything must connect to another

INTV: And last two questions: One of the things that is coming in my interviews is that climate adaption not only happens in the public space, but also in the private space, so, how is the municipality addressing that private property aspect of climate adaptation?

R7: it is also that the private property, the new, they also, they need to buffer that rainfall on ten plus ten percent. It is also not only for my project but it is also for the projects on private spaces.

INTV: New private spaces? And old don't have to do anything?

R7: No that's not possible, but when we have a big renovation or new, then it's for the rainfall but also less pavement or more green. We told that to the public and they must also do that.

INTV: Okay, is a new development form renovation? Or are those two the same thing?

R7: Yeah, new is easier. And renovation, that's when you make an old building new. Then you can also, the sewers in the building can you fix new.

INTV: Okay, alright – that distinction is definitely important. Okay so overall, percent-wise, how many climate adaptive, innovative projects do you think T does per year

R7: Climate adaptation, must be done by every project. Every new project it is our job, that our mayor says, every new project includes climate adaptation. That's a must, no doubt about it.

END….

Interview Summary_D8.R8

- **INTV***: What are main considerations taken into account in SAM and "urban drainage" decisions/decision-making?*
- **R8:**
    - **Money and financing** were initially the main consideration and concern; management of assets (water) was mainly based on incident management (i.e., addressing issues as and when they arose)
        - Municipalities were then required to develop a Sewer Master Plan, which included planning maintenance and replacement efforts, as well as funding and how it would be spent.
        - Funding for asset management is from resident tax/levy, and increasingly more demands are being made on the fund: including groundwater and potentially blue-green infrastructure asset management.
            - Interesting question: how can NbS be funded from levy/tax budget?
    - Secondly, **environmental impact** increased in importance over time: particularly regarding CSOs which are important sources of pollution
        - Addressed by an increase in storage capacity, and use of retention tanks, followed by separation of stormwater and wastewater system (switch from combined to separate systems) and disconnection of paved areas from sewers
    - Next, managing the **changing hydraulic loads** at wastewater treatment plants was also a key consideration, and focused mainly on refining the discharges to the plants.
        - Of special note is the interaction between the municipality and waterboards. Municipalities are responsible for all infrastructure within and up to geographic boundaries (collection, conveyance), however water boards responsible for treatment plants so interaction is needed between both
    - More recently, **climate resilience** and the need for nature based solutions as options to address is becoming a larger consideration. In addition to **spatial planning and adaptation** considerations.
        - Interesting point: funding system has been in place for a while, therefore there is a decent budget, even though prioritization of needs can be debated
        - However, any change in funding (for example, to cover NbS costs) is highly political and can be met with significant pushback from political and residents alike.
- **INTV***: What do you think are the main barriers/hinderances in decision-making in SAM/urban drainage field?*
- **R8***: Using PRIMO framework, where PRIMO stands for:*
    - Policy (and maybe Politics): where policy is influenced by/result of politics so "politics" may already be embedded in "policy" and no need for distinction/separation
    - Regulatory Framework
    - Implement (Capacity to)
    - Maintenance (Capacity for)
    - Organization of financing

- **R8***: Factors can be explored for each aspect of the framework, especially in the Netherlands. For example,*
    - For **policies**: generally/fundamentally, policies promoting "sustainability" exist in the Netherlands and are slowly improving. There are existing policies on climate resilience, urban flooding etc. at national level, and most municipalities are aware of the need and include planning for these
        - Of note: there is a growing tendency to select blue-green alternatives over grey solutions however, it may be desirable to promote hybrid solutions where the benefits of both grey and blue-green can be combined
    - In the Netherlands, the **regulatory framework** allows for the building of NbS, though some additional improvements can be made:
        - As an example, building code and green roofs: Dutch roofs tend to be light, and not built to withstand heavy loads therefore, only limited use of green roofs possible. However, if building code were to require stronger/large load-bearing capacity for roofs then green roof measures can be more widely/easily implemented
        - New law on environment to be released (in the works) that will be comprehensive regulation covering water, air, noise, energy etc. Idea is to simplify and streamline/coordinate regulations/requirements for development (new and existing).
    - With **capacity to implement**: there is room for improvement, even though much has already been learned from 30+ years of building and implementing blue-green infrastructure (this is linked to maintenance capacity which is discussed later).
        - Contractors responsible for building systems prioritize different things e.g., expediency, simplicity etc. therefore systems not always built exactly according to engineering design/drawing specifications which impacts performance, or ability to maintain. For example, rain gardens.
    - A similar scenario for **capacity to maintain**: e.g., original rain garden systems built without ability to maintain (but lessons learned), and typical maintenance currently also sometimes focused on expediency, simplicity etc.
        - Would recommend increased training for construction and maintenance of systems would be increasingly beneficial
        - Of note: some municipalities contract out both implementation (construction) and maintenance of such systems for long-term, multi-year contracts.
    - Regarding **organization of financing**, previously discussed in considerations but additional points:
        - In the Netherlands, "retain-store-drain" approach to water management gained prominence, especially after the year 2000. More and more, the "retain-store" aspect is being recognized as essential part for managing larger volumes of water
            - E.g., requirements for 60mm storage over catchment area (which is significant)
            - Rainwater harvesting is increasing in NL however, not necessarily because of need for additional sources of water, or to mitigate effects

of drought but more to encourage “circular economy”/sustainable consumption
        - Also of note: increased discussions on the responsibility for financing and ownership of assets, especially hybrid assets: e.g., Drainage square in Rotterdam
            - How is this considered in asset management and who is responsible?
        - Finally, organization of financing was not developed for this context so worth keeping in mind
- **INTV*:*** *At the operational level, what is the interaction, is there an interaction between the asset managers and policy division/experts in Dutch municipalities?*
- **R8:** Currently both fields are predominantly siloed – generally separate divisions e.g., policy and maintenance with limited interaction. But increasingly, this is changing, and more collaboration is happening, driven in part by the recognition of the need for spatial adaptation and climate resilience.
- **INTV*:*** *What do you think might be some drivers for change and innovation in asset/infrastructure managers (different to opposite of barriers)?*
- **R8:** a few drivers
    - Energy transition: new impulse program, revision to energy directives and how these relate to water, provide space for maneuvering in S.A.M
    - Addressing the urban heat island effect: increases the need for green space and therefore also provides opportunities/acts as a driver
    - Similar case with the need to address drought and requirements for infiltration; and issues with subsidence which require groundwater management
    - Overall, increased awareness of the need for climate adaptation and resilience is a big driver

Interview_D9.R9

INTV: So to begin with, could you tell me about your role in your organization and the works that you do?

R9: Yes, I work as a team leader for a group of around 50 persons working with water - all kinds of water, so a lot of urban water systems. Part of the group works with modelling and designing sewer systems, part of the group works on groundwater research, part of the group works on dikes and flooding, and there's also part of the group that works on asset management, policy, organizational project. That's also the part where I came from, I worked there before I was team leader and I still do these kinds of projects….And do you know the Gemeente Riolersingsplan – I've seen SAM plans from other countries and they are different in every country, I think they are more policy based in the Netherlands than what I've seen for other countries.

INTV: It's interesting to me the GRP, that this long term planning exists, I've taken a look at a few and it seems like the emphasis, there's definitely a lot of discussion on the sewer assets and then the some mention on the plan of maintenance so I do find it unique, because here in Toronto, we do have Master Plans for the whole city but for the sewer assets themselves that doesn't really exist

R9: And it's becoming more and more, it's widening – from my perspective. In the beginning it was really focused to the sewers but now it's getting close to that kind of that Master Plan…it's taking a lot of perspective

INTV: And what do you think of that? Do you think it's more effective…? What do you think of that?

R9: I think, yes, it's more effective, but it's also getting further away from the original perspective. So , the sewers they represent a large value of the transport system for wastewater so the more you focus on climate change and all kinds of other aspects, you're getting away from the value of the sewers. So there's an attention shift towards climate change, and okay, that's important but that means there's less attention for the sewers…and I'm not sure whether that's not so good. I don't really have an opinion yet but it feels like we're doing something different, that's also important, but we're missing a part of the original sewer asset management

INTV: Do you think that it would be better to separate the two…?

R9: Perhaps, but they are both important and they do have a lot in common so it would good if the Dutch municipalities have the task that they should make a plan for the water within the municipality boundaries, so perhaps an even broader perspective. It's also a lot combined with the financing system and that's more focused – if the municipalities can put a tax on the water system, especially on the sewers – it's called the sewer tax

INTV: Yeah, so the shifting focus makes it hard…?

R9: Yeah, because the financing system is not up to date with the broader perspective that you put into those plans

INTV: And so, municipalities doing about that? Are they using the financing for the broader perspective…how are they handling that?

R9: Well, every municipality, in general I would say more and more the municipalities will try to get the taxes from the sewers and use it for climate change. But it's not the general rule, there are exceptions

INTV: ….So, in your team can you think of innovative projects that are currently being worked on or have been completed in urban drainage?

R9: Yeah, different ones. But if I focus on sewer asset management plans, because I looked up, projects and there are many different ones…[screen shared @7:38] – it's a small municipality – WBD…this is their GRP. What we did here was we focused on, we used public participation – we did a questionnaire online, where we asked different questions about sewers – what do you think is important about sewers? So, should it be cheap, should it be sustainable, should it simply just function well – and we used those answers to put some perspective, some different emphasis on parts of the plan

INTV: And what were your findings, if you don't mind my asking?

R9: Well, I was surprised that the people involved they often think that the citizens they want the cheapest taxes, that should be the lowest and it's all they focus on. But this questionnaire showed that they were more focused on sustainability and no problems with water, and that kind of general things were more important than the taxes they were paying. And also, sustainability, climate change we also had a map and we asked them where they have seen water on the streets and that kind of question, and we thought all those dots were people were saying something about water on the streets it's not generally the problem, but we got a lot of information where there were possible problems with sewers. But they had a lot of information, a lot of knowledge that you could get from the public this way.

INTV: That's interesting because in the interviews I've done, there's a focus on cost and efficiency as opposed to the bigger picture sustainability – so that's interesting…

R9: For example, this question, is it acceptable for you if there's temporary water in the streets? Only a small part said no, it's not acceptable and the biggest part did have some form of acceptance – and even this question [response] said as long as it's not longer than one day on the street – I thought, a full day – that's too long in my opinion but 27% even agreed with it

INTV: So, how did you take these findings and apply them to the GRP?

R9: We discussed them within the municipality, we discussed it first with the MPs then we went on to the council, we discussed it with a small group within the council and we put it on the table, and I presented it, and I asked them, what do you think of it? And they had some problems with it but often they focus on the opinion of the public because that means a lot to them, and they said it was okay, they could use it. We had some proposals for them, and they often used the questionnaire from the public and their answers to choose one of the options.

INTV: So, did the public results did they change the options that you made available for the municipality?

R9: Well, it's difficult to say because I presented all the information and they simply choose so I'm not sure that I can say if, I don't know what happened if they didn't choose it…

INTV: So, what kinds of options did you provide the municipality…?

R9: Well, one of the bigger questions here – if you're talking about climate change, how much water do you accept – what kind of rainfall events will be – do you want to cope with, at what point can there be water on the streets and for what rainfall event is it acceptable if water gets into the houses and if water prevents you…there should be some difference in it. Quite often it's said, once in every two years, it's acceptable if there's water on the streets and once every 100 years it's acceptable if water gets into a house. So to them, they can choose everything on there – but that's really much standard for the Netherlands. And that's pretty much what the public said

INTV: Well, that's good – at least it's consistent. So, the plan as it is now, it mentions climate adaptation – did you propose anything other than sewers to address this managing of the urban flows, or was it really just kind of you can use sewers to contain the smaller flows and then the rest on the surface?

R9: No for example, this part says – if the rainwater goes to the sewers or not, and do you agree to change it…so there was a focus is on more the green-blue solutions, and more green industries…[screen share]…it's a pretty green-blue area already

INTV: Okay, we'll come back to the green-blue but I had a question about the role of the council and the what part they play in the sewer planning. So you said that this had to be sent to them for approval, is that the typical process?

R9: Yes

INTV: Okay, are they the final authority on approving the plan then?

R9: They, it's even mandatory by law – they agree to the plan, it's their plan. So, I write it more like a proposal to them but they have to agree with it.

INTV: And do they have technical backgrounds,

R9: Often not, so the kind the kind of questions you get are more--- then it's important that the public have said something in the questionnaire, because that's something they can relate to. If I talk about rainfall events, I can lecture them on it but it's more about what the public wants and green-blue solutions because it sounds good and it's the change they want to see in the plan. But, the quality of the sewers, that's not a topic they can relate to – they understand that it's important, they understand it costs money but it's a really technical questions so it's not something for the average council to decide on

INTV: Okay, so from that perspective, is the plan useful to the sewer managers themselves?

R9: From that perspective… I think it's important for them because the council agrees on the taxes so the income is fixed, there is planning in it, there's more general planning and it helps them to show it to the other people to show it to the other people within the municipality because of the organization. So here we made a small map with the age of the sewers and we had an assumption that they would be 80 years old, most of them would be 80 years old, so that would be the year they were built plus 80 years. Then you can see that every part of the municipality has a different time frame where they would replace the sewers. And it's more communication kind of map now, and we made sure that, the financing system that there would be income in this period. So for example the purple ones are between 2020 – 2030, so everybody knows that within this period those sewer probably will be replaced… and there is budget for it. Also, there's also more like a year plan – all the different – it's mainly about the

money, but here you can see the yearly tasks and the costs associated with it. The research that is done, the budget, groundwater research, climate change budget, and here all the sewer replacement projects

INTV: So, the sewer replacement projects, are they a separate line item to the climate adaptation projects?

R9: Yeah they can be separated, the climate adaptation projects were more – we discussed it with them and they were not sure where to take measures yet, they didn't know what they wanted to do. So we said, "above-ground level projects" and there's a budget and they can decide what to do with it every year. So they were less specific than the other projects

INTV: So as a general rule with the sewer replacement projects, do they replace like with like? Do they replace sewers with sewers, and blue-green happens as a second thought?

R9: It's quite difficult to plan climate adaptation projects yet because there is not a, quite often they make a project in a street so there's a reason to start the project, and discussing it with the people working on green infrastructure, water, urban housing and together they make a project out of it. And climate adaptation is taken into account from that point on. So as soon as they start a project, they take it into account from that point on. So it's not the starting point. And sometimes it's a starting point but there's a really big problem, so then some houses already have been flooded

INTV: So in those cases, climate adaptation is starting point because there's already an existing problem

R9: Yes, but if you have the idea of making a whole country and every street climate adaptive, then every street has to, [go through] some changes to make it climate adaptive, or you should do some studies to see what can be done in every street [to make it climate adaptive…] – but should it be the starting point or should it be done at the point where somebody wants to do something else in that street…? And most of the municipalities, will wait for other projects - you know the "conserver mecouple"? It's often said on a national scale that climate adaptation should be connected to other projects …so if there is something being done in the public space then climate adaptation should be taken into account. Because climate adaptation is often not the starting point for a project

INTV: Okay, so could you talk through what you've noticed so far about what the decision-making process is so far in terms of more innovative projects in general in municipalities?

R9: Yes, I saw one of your questions was also – is the Dutch water sector innovative? To be honest, it's difficult to answer and maybe that's also partly the answer to the question, if I think about innovation in water management – for me it's specific to a project – but is it possible for it to become more normal, I'm not sure

INTV: So you're relationship is related to specific projects but it may not be the larger tendency?

R9: Yeah, I'm not sure, every project there are very small differences compared to earlier projects but there are around 350 municipalities in the Netherlands and they all have sewers and they all have to maintain them… and sewers in the Netherlands are generally around, they can become up to 60 years old, if they become 60 -80 years old then they replace them and to do that, the quality of the sewer is important but also climate change, hydraulic capacity, urban planning, housing zones, when they come up to the point that they have to be replaced, all the different departments, they come together and there's a project. It's not so easy to give the exact arguments, it's different for every municipality, for

every project. I think that's why I think innovation is difficult because every project in a way for me it's the same because maybe there's a set of 10 arguments to replace a sewer, I don't know 10, 20, I don't know, but the combination of arguments makes a project and in a way that can be really innovative.

INTV: So it's project- based so it's hard to say across the industry whether there's a lot of innovation. So, the definition of innovation I'm using might be problematic – what I'm trying to get at is more to understand is there a new way of doing things, so overall in general, are the practitioners doing anything differently than they did before, or are they kind of doing the same thing still?

R9: From before I started doing this work, I know that in the 80s, there was almost no attention for sewers in the Netherlands. But I think halfway the eighties, there started to become some attention and they started to do research and they started to do camera inspections and those kinds of things. So they get to know where the sewers were, the location, the condition and all those kind of things. So the focus in that period was more on getting to know the sewer system. Then they started, from the 90s, then they used it to improve overflows and they did a lot of work on that – and that was the main point of attentions for 10 to 15 years, and also before I started so it's hearsay, but I think from 2005 to 2010, there was more about cooperation with the waterboards and drinking water systems – it was more mainly focused on cooperation. And then from 2015 on, it became more and more about climate change…so in the base of it still was sewer asset management plan but the attention changes every now and then. And of course when the attention shifts, the planning process and everything around it will be different

INTV: Okay, so there have been shifts in different time periods and right now it's climate change and that's slowly finding it's way into some of the work, but it may extend the scope so far that the sewer piece get's missing

R9: Yes, yes

INTV: Okay, so right now, what do you think is the main priority of municipalities, when they are deciding what to do with a sewer project…?

R9: I think if you look at the council, they're focus is mainly on climate change and public participation and that kind of topics. If you look where the money is, it's mainly sewer replacement. So there is a difference – the money is spent on replacement, it costs a lot and it's where the money goes. Yeah, it's different, a questionnaire, it doesn't cost a lot, you have some questions and people give some answers but there's no action afterward

INTV: And so what do you think would help the action to actually occur?

R9: Well, should we do something afterwards, that's more what I wonder…well, public participation it's good to do, I think we should do more. But well, what's the perspective for an average houseowner to do with his groundwater? It's a house, it's already there for 10, 20 years, rainwater falls, there's a system for it, they [houseowners] are not too interested in it – I can understand it – they want to think about it but what's next, of course they can do more, they can infiltrate it into the ground, they can store it, they can do a lot. But can we say that, if one household infiltrates this water into the ground, will it actually help in the bigger picture? I think if it's only one household, or it's just a few then it doesn't mean too much. But if all municipalities do the same, then I think it will help a lot

INTV: That makes me think of scale, and so two questions: what do you think the role of the sewer managers could be in terms of that level of scale, and also the role of the private citizens?

R9: I think it's quite a difficult topic, because I'm not sure what's best in it – if you look at Dutch law, it gives quite explicit tasks for houseowners. And if you look at the rainwater part of it, the law says that, they should be able to process their water themselves and only if they're not capable of processing the rainwater themselves, then they can bring it to the sewer system or the utility. And that means that, the starting point should be that houseowners should process it themselves, that's what the law says. But in practice, everybody brings it to the sewers, all the rainwater goes to the sewers. So you have a law that says one thing, and you have reality that does something completely different, and how do you bridge it?

INTV: Do you have any thoughts on how that can get bridged?

R9R9: Nope :), but I know that the municipality of Laren, they tried to – they went back to the houseowners and they said, well from the perspective of the law, you should process the rainwater yourself, but there was an uproar and there were so many discussions that they had to scale it back, they couldn't do it like that because then they you get back to the public council – they listen to the public – and if they disagree with the policy then…

INTV: So, is this law a recent law and are people aware of this law?

R9: It's been there since 2008, and yeah – some people know it but yeah…but it's like who knows the law...

INTV: So that sounds like that's one of the things that makes it difficult, the responsibility of the private citizen versus the public. So do you see, sewer managers ever getting to a point where they incorporate climate adaptation into their replacement projects, just because, or do you think there is always this external push that they might need?

R9: I think many of them already do it, but there's also – when we talk about taking it into account, climate change, climate adaptation – because when I look back at the older plans, I see that they started with quite low requirements for sewer assets. And those they requirements shift, and they did it all the time, [so] what part of it is climate adaptation? Can we speak about climate adaption if we simply look at where the water goes to – that has always been the tasks of asset managers – to think about where the water goes to. So for example, the with the newly built sewers, you should think about where the water flows to when there is too much water and it's not about asset management anymore, but simply asking what is the lowest point of the [sound?], water will flow to the lowest point. And there's no difference in it, but now you think about larger amounts of water and that's the difference

INTV: Yeah, so it's already incorporated in their work…

R9: Yeah, it's a different rainfall event.. that's one way to look at it. There's another way if you think about green-blue infrastructure and that kinds of projects then you can easily talk about climate adaptation – it's easier – but many of those projects, they also think about biodiversity and circular materials and…if you start with that there's a sewer system and you should maintain it in a proper way etc. etc. then climate change is a factor you should take into account when you work on the water

system. So is it a different topic or is it simply one of many influences on the normal work of sewer system

INTV: You're right, what I'm curious about is how, if it's a case of managing different volumes, what kinds of solutions are used to manage those different volumes and what happens in the thought process to use a different solution versus the regular solution?

R9: Yes, but that's also – let me show you – [screen share] – this project in the south of the Netherlands, we're working on it for quite some time now. So if you look at a situation like this, well, this was once every 30 years rainfall event, well the solution can be green blue, the solution can be more capacity, and the main problem is there's too much water… there's a lot you can do about it, but the solution can be green-blue but it's already green blue in part of the city so what's exactly the climate adaptation type of measure, is it really such a different thing to do – I'm not sure. Sometimes, it is – for some municipalities it is, some people, but that's more a personal thing – I think there are many persons already working on it for many years so already before we are talking about climate adaptation in the Netherlands in this way, they already did many of these [projects], or you could say it was already green-blue…

INTV: …

R9: I'll look up a project we did in Leuwarden …the difference is, there's more information and because there's more information, it's sometimes gets to different outcomes. This project we put a lot of information together – it was specifically about climate change, climate adaptation – we looked up for example information on how many public spaces there are, say 60%, 40%, private, we put it on maps, how many trees are there, what part of it is green, where do we expect the problems?.. over here it shows the places/cases where we expect the water on the streets, once in a hundred year rainfall event and then we started thinking about the locations, the areas where the should be something done – not giving a solution yet, but just these areas there is a problem over there. And then we looked up information which was about opportunities in public space, and a map where we showed the height differences – so thinking about where can we put water in, it's relatively high or low. And we, built up groundwater levels for example, this one was – also with satellite data you can see if theres a flat roof or a pointed roof. Also space we looked at the backyards, you can see if there it still, if they are already green or not, so you can have a project where you have greener gardens and that kind of thing…And then we put it all together, also the sewers and we made lists for every problem area, we said okay it's possible to take these kinds of measures. And we budgeted it… So you have a problem, and you have the solution, for every location

INTV: So how did this project start then?

R9: I was discussing it with the municipality, let's try to put all the data together, like everything we have – let's see what we can do

INTV: So they weren't planning any works or anything in this area, it was kind of an opportunity came up to combine all this information?

R9: Yeah

INTV: Okay, and so who from the municipality was involved in that discussion?

R9: The policy employee, and he was discussing climate change, climate adaptation – we were discussing and he said there was a question from the council about what will we do to become climate-adaptation proof, when will we be climate adaptive? They were talking about it, discussing it and thought okay, we should start with "where aren't we climate-adaptive?" and try to get those areas into the map and then try to discuss what's the solution for every different area

INTV: So the basis was information based – you had this information and you kind of wanted use it to see how you could answer the question that the council was asking…

R9: Yeah, there were already climate stress tests so that information is available so it's still only a map. So it's good that it's there but you need to do something more than that. We also made it for heat stress and droughts, we made the same kind of maps

INTV: So did this also go to the council for their approval?

R9: Yes

INTV: And they get to pick and choose what happens?

R9: No, they approved the whole project and it was a total of 40 million euros for a time frame of 50 [15?] years

INTV: And so now you're working on projects from this proposal?

R9: Yes, we are

INTV: And are you finding that the implementation is going well? Working with people from the municipality and finding they're on board?

R9: They just started this year, so I'm not sure – but I hope they are

INTV: This sounds like the kind of things I'm hoping to tease out, so when do these kinds of projects occur and what makes them start and why would Leeuwarden, why were they kind of open to this first move, as opposed to other municipalities – I don't have an answer…

R9: I think it's mainly about curiosity. Of course, there's a general we have to do something with climate adaptation and so, there's a feeling that something has to be done – and then some curious people come together and see whether we can do

INTV: Do you find that people know what they have to do, or do they just know something has to be done and then they try to figure it out

R9: Yeah, the last thing – because there are so many uncertainties with climate change, so something has to be done that's for sure but it's difficult to say that you're done then you can have [handle?] a rainfall event of once in a hundred years. I know a small city in the south of the Netherlands, and there was a rainfall event of, I'm not sure, once in fifty years, something like that, and there was a lot of problems, water in houses so they went there and they [municipality] explained to them "well, it was a really special event and we cannot be prepared for this". Two days later, the same rainfall event… four times in one week. So, I know many of those examples, therefore it's really difficult to say you're climate adaptive at a certain point – I cannot say it, I'm not sure about it

INTV: Yeah, that's a really good point because where do you stop if things are constantly changing and you're not quite sure what you're being faced with…

R9: And there's also the question, there's certain amount of acceptance and you accept that there's a certain amount of water in houses, and that's fine – you can still be climate adaptive. But it means that you should be some insurance, or a clean-up crew or something else should be done, and if there's more than that acceptance part, in my opinion, just accepting it, it's not a bad thing - you're not doing anything. But if you have a clean-up crew and you think, everybody knows it, that's how the system works, then it's fine. Then you can also speak about climate adaptation. But that means there's an atlas, a range of where you can choose from: from acceptance, less measures, less safety – so do you focus on prevention or do you focus on acceptance?

INTV: What do you think most people are focusing on now?

R9: Well, the sewer asset managers they focus on prevention – because they are the builders, the engineers, it's how they think, that's their world…

INTV: I like that because it makes me think of different mechanisms of becoming climate adaptive – I'm definitely coming from the perspective of infrastructure solutions but you're right there are other things that could help cities and municipalities be more adaptive that aren't only infrastructure based

R9: What I think is really difficult is how to choose between those because quite often acceptance is a lot cheaper than prevention

INTV: And who do you think that decision might fall to then?

R9: In the Dutch system, the city council has the right to decide on it. But their problem is well, we already started from – they don't have technical perspective, they just do what the public thinks – so their task in the system is not really difficult – they mostly [follow] the public

INTV: Yeah, that's a tricky and interesting situation

R9: Yes, because maybe you're a bit locked into going into prevention all the time. Only when it comes to the money, to income taxes, that's the point where there might be a conflict because, prevention costs a lot more than acceptance so there's a point when you should – where you should get their attention

INTV: That's a really good point because if city council is going towards prevention because that's the public wants, but then they come up against the fact that they may have to raise taxes to get the level of prevention that the public wants then that might be…interesting. Before we wrap up, is there anything else you were thinking off, that you'd like to share…

R9:…Do you know the Delta Plan Ruimtelikj Adaptatie?

INTV: I've heard about it but I haven't yet….

R9 : Do you know this picture [image of 7 ambities]? It's seven ambitions for water sustainable and climate-proof Netherlands…this is part of the Delta Plan – most of the Delta plan was about dikes, sea level rise and things – this is the part that says about the climate adaptation on a more local scale, what should be done – it's a task for all the municipalities to – they say ambitions but it's more like steps. You

start with climate stress test, and you have to have a risk dialogue and put up a strategy, and then you have an adaptation plan, this one that the "[in Dutch] and then there's facilitation, this one is especially focused on the house owners, this one is about new build houses, and this one is about the acceptance part, clean up crews, that kind of thing

INTV: So are these recommendations, obligations, suggestions…?

R9: Also a bit, it was more like – it comes from the – it was a plan made by the Dutch government so overall but the made some agreements with the association of municipalities...and they agree to follow these steps, but I'm not sure what the status is – you could say it's an obligation but on the other hand, it's not like it's in a law or something

INTV: So, it's voluntary so you don't really get in trouble if you don't do it but you probably should do it…?

R9: Yeah, but then what they do is they send questionnaires to all the municipalities, and if you don't score high on it, they publish it, and they send that kind of information to the city councils, then you get the questions from… why did you have such a low score. So, it's not really an obligation but they use it in a way as an obligation

INTV: Ah, okay

R9: Yeah, I speak with the municipalities – they know this small picture (from DRPA), they use it a lot – it's really important for the…

END

Interview Transcript – D10.R10

…Pre-recording discussion on if private and public spaces showing up in interviews so far

R10: It's easier to not address private owners than to address them because there's so many of them in a way and it's difficult, you have to come to a contract every time again. It's a kind of first instinct/impulse not to cooperate with. And then the thing is, so how do you see this problem then – is it a problem which is -- if you make every private object climate adaptive, if you adapt every private space to the climate – is that enough then? Is the sum of all these actions…the total action or is it the..and that was something I wanted to show you…especially because of this kind of...there's two different – there's a thing which you can call integral - integrated – so there's many different sectors, we talked about these silos, those columns last time – if you look at your own column, and also if in this column is also only the public space then we try to make the public space climate robust, then we hope that everybody [else] is doing the same thing, which is totally not working I think…So that's the difficulty. And another thing is, if you talk about cities/villages where there is difference in height [slope] and all of a sudden, when I do something here, there's an effect somewhere else…then collective action is actually the only thing that's working to come to a solution. So these are two different things in a way. And a third one is, what I try to show…is from the point of view of the riolers, or the drainage specialists, the nicest thing you can do is to reline your sewer system, so what we're doing now, in a project where calculating what the cost will be if you reline all the old sewer systems, sewer pipes and we have this assumption, which is pretty correct I think, that the cost of relining would be reduced with 45% if you reline, and if you look at the GRP, they have a prediction for the future and this prediction is not calculated on relining but is calculated on renovation. So imagine yourself, [3:07 – switch to video/screen-share] –

So this is a kind of neighbourhood where these buildings are built just after the war (in the 50s), so there's flat buildings around here and around there. And you can imagine that the sewer system in this particular neighbourhood is from the 60s so it's about 60,70 years old. So within now and 10 years, maybe 15 years, the sewer system has to be renovated. So if you look at plans for the neighbourhood, they are actually not in the coming five years – which if you do that then you know the costs are coming. But in the GRP they are looking ahead. So in the GRP you'll see somewhere of a point coming up because all this stuff has to be replaced – so if we ask them whether we can change something here or do something, they say there's no urgency because the sewer system will only be done in 15 years. And our thing is that imagine that we would do things now, we would discharge – [disconnect] concrete surface- since the rainwater is connected to the sewer system so how much do we have to cut from the sewer system to… two things: imagine that we would reline the whole system here – the pipes would become a little bit smaller. So it's designed for 20 mm/h system, now we're going to reduce the system [size] a little bit so it can't handle 20 mm any more, we have to have less surface connected to it, so we can calculate how much surface that it. We combine and tell them, okay so we say okay we have climate change so this 20 mm is not 20 mm anymore it is 24mm so now we have to even disconnect more surface and we calculate how much surface that is. So we look at the neighbourhood and we say okay, what you see here [on screen] are the hydrolical [hydrological] basins, so if a drop of water falls in somewhere here…it first goes into the sewer system, if the sewer system is full it will [flow overland] towards a water system, which is here…in fact everything will go pretty much that way, but very slowly but it will get there in the end. So in this area [basins], it will stay in this area [within the basin]…so these are hydrological small areas, catchments. So in the first thing we do is we look at this area, and we try to design, we try to find places where it is really rather easy to disconnect the sewer system. And you can

imagine that this[screen] is a flat building, which is four stories high with the green in the middle – kind of a common in the middle – and there's a road next to it, and road next to it…so it's actually pretty easy to disconnect that kind of surface to something we have to do here in this green common. On top of that, it's actually part of the private space so what we do is we check out [where] it's easy – this area is pretty easy, actually we can disconnect more than necessary in that area, this area as well….this one is a more difficult one, and this is a really difficult one because it's all small houses [densely packed together].. so first we look at it this way, then we start to check out whether we can disconnect enough, how much we can disconnect – and whether the 45 percent of the money is enough to redesign those area – so these green commons – are now very sad, slow, stupid, green things but we try to make a nice little park, stuff like that. And the next thing we do, so this is for a 24mm rain, this rainfall is not allowed to give any hinder [overflow] so now the next thing is that we go look at a period where there is, we try --- and we see this picture, this is a stress-test, we call it and we look at where goes the water when there's 70 mm or something... and now we have changed the surface, by making those different, by making those commons into [parks], and we check out whether there is still a problem at 70 mm. And if there is, then we have to do something extra, and if there isn't then we have fixed, created a new solution for a problem which is one, paid by the sewer system and on the other hand… okay. So what we try to do, in a very short thing [simply] is like, okay you want to reline? Great, you can reline but you save the money for renovation. So we're going to try to use in this area, to recreate…so if you look at it and you can find like in [this area – screen], there is a small zoo, where lots of people come and we look at that and say can we do something in this area to get the water into the zoo and make the zoo kind of a place where water flows through with…we can connect it to something else, open water again – and we start calculating whether this works or not, and can we connect pipes and stuff like that. And in the end the idea is actually that we can create this difference in public and private surroundings of this neighbourhood which is a boring neighbourhood in a way, and use this 45% to redevelop the area actually.

INTV: Excellent, that is a very unique approach – I have a question about the flat buildings – were those originally planned to have that much green space? Why are those flat buildings but others flat buildings…

R10: Yeah, this is from an area, after the war… the Dutch started to [stemple], to stamp, if you look at it you can actually see that this is a stamp… there was lots of shortage on living space so we had to build, build build build, so we started to plan the building. So this whole neighbourhood was built within five years or something or six or ten years. And the way it's built it's actually pretty funny… this is a map of the Netherlands where you can find neighbourhoods which are almost completely like this neighbourhood. And we calculate that 3.3 million Dutch people live in those areas which is, 20% of our households. And another thing which is important in this area, is that as a consultancy, we do more in this area, like we've adopted this neighbourhood and we're doing all kinds of things that, physical things that we can do in the neighbourhood to make this whole neighbourhood more sustainable. We've tried lots of different approaches like water, climate adaptation, CO2, like how we can capture, house from the gas

INTV: So where did the idea come from to adopt the neighbourhood and how did you work with the municipality to be able to do all these works that you're doing?

R10: Okay, that's interesting if you start to think integrated. We work on several subjects, but the two main subjects are climate adaptation and energy transition. And as I started for Zwolle, to make an energy transition plan, we were thinking about where we could, how can we reduce CO2, and how can we change stuff in neighbourhoods in the areas. And the thing we did was, there are several neighbourhoods that can take care of themselves in a way but there are also neighbourhoods that are lagging behind. Our idea was to combine those two things, so if the city invests in a neighbourhood, in energy transition or in climate adaptation, it would be nice to do that in an area where you have other goals as well, such as work, social enterprise, whatever things to… so we, I made a plan for this area and by integrating all those things, we could, we called it keeping the money streams within an area. It sounds pretty stupid, but the idea is that you live there and you pay rent, the rent goes to a corporation or whatever and is used to repair your house in a way. And what those corporations do is they ask a contractor to restore the buildings, and they ask everybody, a whole group [and see] who's going to be the cheapest and they combine tasks all the way through this neighbourhood and within five days they do the whole thing and go again. And the idea is that if you don't do that, if you try to do local, then you create work, you create social structures, you create – we try to start at that point of view of what can I do in this neighbourhood to make the neighbourhood stronger? So we look at every project, again, how can we use this to make the neighbourhood stronger. So energy and water are two things that can be really used to contribute to the sustainability of the neighbourhood. That's where it started.

Since then, in our solutions – so why did we adopt this place, because we wanted to learn. And because the plans we made, we tried to do this together with a corporation of citizens who lived in the area. And they were like, that's a very good idea…maybe you should join us. So we're already like five to seven years, we're already working in this area, and I'm a member of the board of this area. And my job is to find new projects that we can do in the neighbourhood. So we do projects with solar systems, projects with, this presentation is for environment, which is a collective warm heating system – so we try here, and you see the same thing happening – knowing the sewer system, we're like okay this is a place where there's a sewer pump which pumps the water to the water treatment system [plant], that's 80 cubic meters per hour and if you calculate how much warmth is in it, then you can combine it with the warm and cold in the subsoil. So in the summer you take the heat, well it's about 17 degrees, you take delta T is 7 degrees, you put it in the soil, so you push groundwater with this temperature in the soil, then in the winter time you can take this water out and use it for a heat pump to heat the… So we're actually taking the knowledge we have about the sewer system and water system, and we do this the same [repeat this] so the system grows, much more houses connect to them, and then we take a second loop of it, where there's open water – this is going to be recirculated, when the sun is shining on it, you can do the same thing – take the water out in the summer and in the winter…and then put in the soil and take it out in the… so here again, our goal is to get the energy costs for people lower, and at the same time with as little risk as possible. So we start small and we grow in it, and what we try to do is to combine this with the reconstruction of the public space and the private space. So try to do it at the same time, so if you start talking to people, okay we're going to invest in your surroundings – this is what we're going to do, what are your ideas, what do you want to change in your area, and can we negotiate between the city council and the neighbourhood, what they want..

And the city is sometimes they are very enthusiastic about it, and sometimes they are scared, because it's totally different than they are used to. And the project I was showing – this one with the relining system, it's actually to convince the city to work in another order. So our thing is, you want to change

this area, we're putting money into it by changing the sewer system. We know we can do it cheaper and our money actually is the public space we have and they can use to actually make it easier to disconnect concrete from the system. Because the only thing they can do themselves is change the pavement, for example by make it water-transparent [permeable pavement] – that's five mm and that's gone and you still have to use the sewer system. So by combining it, we show them that with the same amount of money, they can actually change the whole area.

INTV: So, is it that you know the projects that they're [city/municipality] going to do, and you also know the projects that are going to happen in the neighbourhood and then you try to combine the two

R10: and the thing with those silos we were talking about, in the city council – there's these public workers (servants, employees], one that's totally with heat, and the other is totally with water, and the next one is totally with climate – so you see that we kind of have to shop and talk with one and the other and try to make kind of a community practice to actually make them speak together, show them there are different things going on in the neighbourhood – so it's not easy

INTV: Do you ever get them in the same room at the same time…?

R10: Yeah, we try, we're working on it…which is pretty difficult but okay, that's why we adopted it. For us, it's kind of like, what works, what doesn't and for us and for us, the idea is if it works, we can do it in several places. So we try to make kind of a community – you call it landscape, a landscape so we can show people that it works, and we show that we are doing our job like this – and maybe they want to invite us to do it

INTVso how many projects have you done in the area?

R10: In this area, I think five or six projects in this way

INTV: and how long do they typically take?

R10: Well, depending on the project – only the water projects? Any of them… well it depends…we're working on three projects now, totally beside the point of water but I'll show you that they are very much connected – if you look at the flat buildings, they are co-owned by everybody that's living in the flat – so together they are the owner of the flat. If they decide to change something, they have to come in a meeting and vote, and change it. And what you see now is that there's two things going on, there's an investment by foreign money actually to, if you buy a flat and give the money to the owner, they can rent it – so they get the money and then they start paying rent, and the rent is something which is value, and it's more value than putting the money in the bank. So what the investors are trying is to make money on housing, which we don't like as much because there's not interest in the building – it's just money, just capital. The other thing is that, if this meeting has to be called together by a person in the flat, and if there's nobody doing anything because of the sleeping flat buildings – and sleeping flat buildings you cannot talk with them, you cannot communicate with them. So what we tried to do is to, as a corporation, we try to buy one apartment in it, if we have it, get the community together so we can ask them to… so one of the projects we're pretty far into get is done, because you need the money to arrange it – but then you ask, what does this have to do with water – well, if you want to use the commons between those flat buildings you have to be able to communicate with those flat buildings. So these are all instruments to get this neighbourhood in a new – actually we use physical projects to reanimate, to make this neighbourhood sustainable, to create social structures… we did this with solar

panels, or with green gardens, or with a project where we called it [roningverbater…in Dutch] which means isolate …make your house more sustainable – people cannot afford it so first we need to create money…and now we have this water project going, and we have this heat project going

INTV: And how are the citizens finding it? Are they super engaged? Have you had any pushback at all?

R10: Engaged..something on this page [on screen] says 53% of the people who are living in these areas belong to the people with, the poorest families in the Netherlands [with the lowest income].That doesn't say much, but you see also, this is called the curve of Roger [Roger's curve] – this is the pioneers, early adaptors, the laggards etc…and what you see in this kind of areas, there are now pioneers, they are just living from day to day. And one of the things, which in climate adaptation – we're very keen on involvement of ordinary people, and in these areas, they are not going to be involved unless there is something in it for them. So we're just talking highly-educated people that's it. And the lower-educated people are just falling out of the system. So that's what we try to change in a way…

INTV: I'm very curious as to how the municipality reacts to your projects… do they support you..?

R10: Sure, yes they support – depends on the public servant you're talking to – but we do this in collaboration with the city council. At least we try to do it, not every project is the same thing but we have to do it together. Like the civil servant of the neighbourhood manager [urban planner…] somebody who is into social systems and stuff like that, but the straight man who is into pipes and sewer system, they are like…[hesitant]… So that's why we have to make a big detour to show them, there's no extra money involved. And the other thing we have to do is we call it [aim for] "perfect timing" so if they put the money – this money is – according to the GRP, is in the future somewhere – like fifteen years, ten years…then this amount of money is coming so the tax will go up, just to be prepared. And they have done that, they are prepared – actually it's not in the coming five years, so it's not in their planning yet but it will be in their planning. And their actually focused on everything that's in their planning – the next five years, the program [for those] years, and what we do is that we ask them to look a little bit further, this is coming your way, what we're trying to do is take a little bit of money from that area [time] and use it now so we can slowly build within 10, 15 to a system that you can say, now you can reline everywhere. Because you need that time, if we cannot, and we don't want to do this in one year – we want to do it slowly and go from street to street, neighbourhood to neighbourhood

INTV: Yeah, so instead of waiting for this fifteen year peak in pipes that you need to replace, if you can slowly do it sooner and sooner, then you don't have that big hill to climb when you're ready to [tackle it..]

R10: And that's pretty possible because in another project we're doing, that's– this is a village where there's a …. The problem is that it's a village which is on a hill, and this is like a stress-test looking from [an aerial] point of view (on screen). And what you see is that when it's raining really hard all the water just flows down to the center of the village and it will create scenes like this – loads of water everywhere, too much water – so what I showed them, their first instinct was so we have to disconnect everything from the sewer system, and everybody has to stop and do it the way we talked about – everybody does it on his own area and the problem is solved. And I showed them that – and what we see is that climate will change and this [flooding in village center] will become worse. So they made a plan and said everybody has to start disconnecting from the sewer system, and actually this is Laren, this is rijk een, neighbourhood two, three four five, and as you see this is a date under it, and on that date

the neighbourhood had to be disconnected – do your thing. Well, nobody did, and they got really angry. So there was a "forwarding" which means that you're forbidden to put your water on the sewer system by penalty of like, 15,000 euros or something – so they wrote it as a city council and so everybody had a note in the mailbox, and go – do your thing. And they felt it wasn't going really well so I was flown in, like – you know how to talk to people. And the first thing I did, was, let me stop the system because this is not going to work. And what I showed them was, if you disconnect your roof from your sewer system – there are houses, this is the surface of the roof and this is the cost per square meter [on screen] to disconnect them. And what you see is that there is not a straight line, the more square meters, the more space, the more cost –no, it's like [scattered] all over the place – some have to pay a lot, some have to pay a little – which is not kind of [fair] – some people have to pay a lot, but why should they. And what I could also show them is like if you're living on this hill, you don't have any water problem because they sewer system is gone [takes the flow away quickly]. So why ask people to pay a lot for something that doesn't contribute to their welfare to their [benefit]… okay… So, what I showed them as well, which is a pretty interesting thing from the point of payment – I showed them that within every two years, less than once in two years, the sewer system – there's water from the sewer system gets into the public space [vakking - backs up]. Which is not allowed, so our system has to be this sustainable that it can handle rain which can fall once in two years – 20 mm, and now 24 mm. So what I showed them is that actually, this is a sewer system model, at about 19.5 mm, there's already loads of spaces where the water is already coming out of the sewer system. So you're failing in your city task [duty]. So that made it possible to say, we can pay this solution from our common sewer space [tax]. So I showed them there four solutions, you can do a totally new rainwater system, you can make big sewers where you can store the water, so we can prevent the pressure from going too much up in the higher system [storage tank], we can also make bigger pipes to prevent the system or we can try to get less water in it. And I showed them the difference in money and from that point of view, disconnecting the surface was cheaper than the other solutions. So from this approach, I could put this in the GRP and the city council voted on it and said we will go for the most efficient solution which is this one. So now, all of a sudden, we had a situation in which the city could say we're going to do this, we're not going to do it the same way as we used to do it – we know that some places are expensive and some places are useless – we're not going to disconnect the sewer system in the lowest part so we know we have to go in the highest parts. So we made a plan, in the high place of the area we have to disconnect but in the low place we can still use the sewer system. [It's similar to the flat area]. So we came to an, we call it atlas, there's lots of different areas and every area has it's own purpose, it's own goal – to maintain so much water – and we can actually say, these houses have to be disconnected, these houses don't have to be disconnected and we try to do it from the projects their doing already in the neighbourhood so we try to connect them to each other. And so this is like an example of it – this is the center of the village [on screen] and here is a big common and this is a public department – and you can see which is the higher area, which is the lower area – normally water coming down, extra water will be coming down from this area [high areas] and would all go here [low areas in town center], and now if we prevent everything to come into this area [low area], we only have to solve our own problem in this area [low area]. So what we showed is that there are several places where we still have to do something about the water system, which is here in the center and you can see how the water flows… we talked endlessly with people from this area and asked them what kind of a solution they wanted. And so we have three different solutions and we had a argument about trees that had to be chopped and… in the end we have a really beautiful – now we have a solution – this is going to be water in the natural space – yes it's a roof – this is the natural situation

there's water [on screen] and this is park and there's a small restaurant building. And what we suggested is that we can make kind of a body [water] here, or lower the surface and collect water there, or we can do something really technical under this [underground], or we can lower the surface of the water system because this is not really – it used to be the groundwater but now it's higher up so there's a basin. Well, they got angry about all these things because you could fall in here, and this was not nice enough to cut trees and this was too expensive so we came to a solution which is under the water system – instead of this or this, we have a make first pick [big] sewer and the water is coming on top of that, we have in the middle we have a kind of system, if the water goes too high, it gets in and goes under the… [it can overflow], and the people are enthusiastic so this is it, we're going to build this. And we do this by, we pay this because we could shoe it was cheaper than the other way round

INTV: I have three questions which will take us to the end – from what I'm hearing, when these municipalities come up with these ideas, there is pushback, so why do you think they are getting it so wrong on the first attempt? The second one is related to upscaling this to other neighbourhoods in the Netherlands – how do you see that happening and linked to that, what might be the limitations and difficulties with that?

R10: So starting with the first one – well, I think this has to do with – well, if you're looking at this problem from an asset management point of view…actually, what I'm telling them, with this thing, approach – first of all they have to accept that their sewer system is not correct at the moment, and there has to be a reconsideration about the program that, the context in which their system has to [operate]. So if you're an asset manager and there's not pressure on feeling that your sewer system is not working correctly, first of all this is something you have to accept in a way, because you're working on something which is there for years and years and years and all of a sudden, there's somebody has to have the self-consciousness to say this is not a correct system, we have to start all over again. This is difficult for an asset manager – this is something that a city planner can do, or an urban designer, or somebody else but not somebody who is in the asset management. So by putting the problem in their hands, for an example – I worked on soil remediation and you can imagine there's probably four million projects in the Netherlands which are contaminated sites. Loads of them are just gas stations, loads of them are just stuff in the soil… a couple of them, maybe 30 or maybe 200 are difficult site plannings where huge sites, and if you ask one guy to do both things – he'll really enjoy the big one but it's not his thing, his thing is to do the same thing all over again and to do it as efficiently as possible and not do it different than they used to do it. So in a way, if you look at this problem, we ask a group of people, asset managers, who are trained to do their work as efficiently as possible, who are also in education, educated for continuation and maintenance and not design – design is completely different isn't it? You have to think back and do things different. So that's one thing. The other thing is, the effect is that we're looking at it from two points of view: one – that climate change is a problem, and we have a sewer system. So from the point of view of the asset manager, this is okay – go away with your climate stuff… that's only to do with 70 mm, extensive [extreme] rain – it's easier. So it's kind of a reflex I think – you can call it a policy reflex – so you see a problem coming, you try to solve it the way it's easiest, in a way. So what you see also is the way we're handling it – this presentation, I was giving to the Delta Comissares [Delta Commission], which is the supreme staff – because they are making everybody try to do the same thing and I presented this somewhere, and someone saw it and said this has to be seen – we have to see this on a more governmental [scale]. And the thing is that this is a very expensive thing we have to do as the Dutch so how are we going to.. so the background of the people is a thing, this

reflex in policy, and then next thing is – everything that is integrated, makes life more difficult. You have to work with other people together, and those columns [silos] are a problem again, you have together – this asks for collaboration with green people, so you have to go up to make a plan for green – can you imagine? Problem, problem, problem. So integration, if you don't have to integrate, we don't integrate. We tell each other we have to but we don't. Then the other thing I showed was that if you look at these solutions – these solutions are all coming from the idea that you're working in the public space – but this solution where you look at a total space, a live space, and then you say who's space is this? So we're not used to… so what I told the commisares, if you look at responsibilities – if you're from a jurisdictional [perspective] – if there's damage, who is responsible for the damage? Well, the site owner himself. So who is going to do something about it? The site owner himself. So, in a time era where we were thinking about change and the cities were thinking about their asset and supposed to do it like the market and efficiency was the most important thing – they have forgotten that they are there to do something for the common good. It sounds a bit crazy but the sewer system is something that if we had to do it now, we would ask the market to do it. Well, that's not going to happen because everybody has to put a signature first, before someone starts with…Same thing with heat systems… so the role of the government – the role-taking is very important. Now back to this first thing, we've got this asset manager, we ask him to work integrated, we ask him to go to city council to get more money, ask him to collaborate with six thousand people in a neighbourhood – this is pretty heavy stuff [a lot], isn't it. So then asking why they are not doing it? It's asking for trouble to deal with it all – unless we make it easier for them. Unless we help them to make it more attractive – to make it easy…

INTV: And it makes me wonder, do you think the change will ever happen, it will be government led or do you think it will be an external push?

R10: Okay, I think it has to come from the bottom-up in a way. So what I'm doing is slowly but surely – there's this thing about change – where you have a landscape – it's a bit theoretical this – but you have a landscape is what everybody thinks should happen. And the landscape is changing and everybody thinks there has to be something done about climate change. There's also kind of a consensus or a thought that this is a governmental thing – "don't ask me, help" [citizens say], you know like you see this change in the politics. So then you have regime, regime stands for so this is what happens and how is the system is reacting, the system is reacting old fashioned – public space, silos [same}. And there are niches, small things that are changing, and if those small things are a good example, landscape can say, oh you see that happens as well, and then the regime can slowly change. So you see this is a very slow process which will take time. Example, what I tried to do with cities that are like Laren, what I'm doing now to get this change is I'm trying to – so what we're doing is I've found three other villages, cities like Laren, Lijkhelm and Heuvelsem, and what we did is we created a nexus – tried to collect money and we looked at other villages in the Netherlands that have the same problem. So what we're doing now is we try to reach to those villages and build a community of villages with the same kind of problem. And over the country, it's divided in small regions and every region has maybe one or two small villages with height problems. So this is not a common problem in their region but if we connect them, we can make a new kind of work region and start to work together on these [problems]. So slowly but surely I think, and this for me, is a way to get my knowledge to other regions so like we're doing this, join us and maybe we can do something for you as well, but this is our goal…

INTV: So this is kind of how you're upscaling, you're connecting the different…

R10: Yep, so what I try as well is to make it a more pubic thing but I do presentations…in corona times difficult.. and address it at the Delta Commissares… but it's step by step I think…

END….

Interview Transcript_D11.R11

INTV: To begin, I'd like to understand what your role is at the municipality?

R11: I'm a policy advisor on urban water management, on urban water management and on climate adaptation.

INTV: Okay, do you write policy or do you interact with other departments at the municipality?

R11: Yeah, both – I'm trying to bring policy further on all projects which go on…change the sewers, water problems, all kinds of water projects

INTV: Okay, could you talk a little bit about how you are doing that?

R11: We're now making – we have to make a policy report every four or five years – it's useful in the Netherlands about our water management. It's where we are busy now, and there we write down our goals, what we'd like to achieve on urban water management. And for us, in relation to climate adaptation that's very important. Normally, in Holland it is to bring the water away as fast as possible, get it as fast to the sea, and we like to change it now to use rainwater more, to infiltrate it in the bottom, for periods of droughts…and it makes which you have change, which you have to separate for water and rainwater and also bring water in the bottom

INTV: So, in the types of things that you're proposing, how do you see the link between the work that you do and how it's implemented by the sewer managers?

R11: We have to decide that every time when we start a sewer project and we try to repair or change sewers, we have to go to separate the most common system in M and the common system is that the wastewater and rainwater is discharged by the same pipe, so a combined system. And therefore, we have to separate it. And we also have decided that we'd like to try to improve the outer space [above ground], the common space and therefore, the most improvement we can do is get more surface area from the sewers, we try to achieve more green area, instead of paved area. So that's mostly what we try to achieve

INTV: So, can you think of an innovative project that's been completed in M recently that has some link to sewer management?

R11: Not really to sewer management, we are already also busy with new information systems, that comes a lot easier to get our data from how the sewer systems are functioning. But not something, really innovative in the ground

INTV: Okay, the question I have is why, do you think there isn't that much innovation on the sewer side yet… or why would that be the case?

R11: The most common goal about sewer system is to bring water from the houses to the sewer plant. And it's mostly a very easy process. So there's not so much to innovative about that. I have one colleague who is researching to get warmth [heat] off the sewer water, but we still, it's just in the research phase but we don't have a project to do that. On our sewer plans, they have already a lot of, some instrument which is capable to get the warmth out of the water and we can use it to warm ten thousands of houses

INTV: So, based on your work in policy and in research, are you finding that as a whole in urban water management there is a lot of innovative ideas or innovation?

R11: I think when you look at mostly rainwater management, there there is a lot of innovation – working on a lot of techniques to make it easier to bring water in the bottom, to reuse it for our plants and for our trees, in that case, yeah, you have a lot of innovation. When you look at our foul water, I think it's, there are not so many innovations now

INTV: And why do you think that might be?

R11R11: I think the stormwater management, rainwater management is the most in relation to climate adaptation, it's the most important subject now – so everybody is concentrating on what to do with the rainwater and less on what to do with foul water. Twenty, thirty years ago there was a lot more attention to foul water and to sewer overflows and that kind of things but nowadays it's not so

INTV: So, do you think that that will change or do you see this trend continuing?

R11: I think, what can help us is that we all want to get to a circular system which produces no garbage anymore. So we like to reuse all the materials which are in sewer water, and I think there, there is still a lot of innovation possible. And now the only place where we do some innovations is at the sewer plants but I can imagine that it also can be interesting to do it in sewers or even better in the houses itself.

INTV: And are you incorporating that kind of bigger thinking in your policy writing, or is a lot of it focused on the rainwater side of things.

R11: Mostly it's now focused on the rainwater, and I think one of the main reasons why is that drinking water is very cheap in the Netherlands – it's not so interesting to take a lot of measurements where it leads to where you have to use less drinking water because it's still very cheap. So I think the water cycle in the Netherlands is maybe even functioning too good – so there's not really an incentive to…

INTV: So what do you think are the main considerations that people take into account when they are making their projects and trying to decide whether to go with traditional or more climate adaptive solutions?

R11: What I heard from most people, is that what is very important is that it must be clear which goal you want to reach, that you have to make clear goals, then you need to know some techniques and you have to know what the benefit is of each technique, so is it working? And when you think okay, I have a goal that I have to reach and this technique could be helpful, and it's possible you can pay it, costs are also important, then I think people want to try it. And then it's important how difficult it is, how much work it is to implement such a technique – will people really do that. So it must be easy to do a pilot, if it's too difficult to do a pilot, then I think, even when it's very promising most people will not start a new technique

INTV: Why don't they do it when it's difficult? Is it they don't want to put in the effort or because the skills and the knowledge are there yet to actually do it?

R11: I think the first one, they don't want to do the effort. Mostly, it's because most people do it besides their normal jobs and when you have to do a new technique, you have to do some extra effort and that must not be too much because otherwise people say I don't do it…We don't have people who have

much time to do pilots. Always our people have a normal job and then, in your normal job, you have to do also a pilot. So the pilot mustn't be too difficult

INTV: So is there a separate climate adaptation department at the municipality of M?

R11: Yes, but it's very small, we just have four people. We are the main project team which is dealing with climate adaptation and we have a bigger group which advises and helps us, but we do it with just us four so its…and even all those people also have other things to do. They tell you when you want to change things, you have to bring techniques and ask people something which is easy to do – and then [that will?] help them with their normal work, then people want to do it, but if it's too difficult or they don't know why they are doing and there's no clear goal, and it's always failing is my opinion

INTV: So do you work much with the urban planners and urban designers at the municipality?

R11: Yes, I'm working a lot with planners and designers

INTV: And what's their role in the discussion with you

R11: They have to bring all those techniques in the projects and they almost say to me, we want to do it but tell me when is it good enough? You can say, you always have to try to make it as best as possible but that's not realistic so you have to also say that is good enough… and the second [best] is which techniques I can chose [from] and what is the result of, the output of all those techniques and what it brings to me. And when you can make that clear for them and you can give them, arrange for them that they can pay this new measurements then they are mostly, they want to bring it in the project

INTV: From what I understand, there is a national fund or budget that is used for climate adaptation?

R11: Yes, yes

INTV: And do you get access to funds from the sewer tax?

R11: Yes, we also use the funds of the sewer – a lot of funds from the sewer tax

INTV: and in what cases are you able to use those funds?

R11: Because we have, say if I'm at climate adaptation is one – every time when we change the sewer system, we have to do it in a climate adaptation way, therefore we can also the sewer tax to pay for the measurement [measures]

INTV: Okay, so the municipality is now going forward with the vision and the strategy to incorporate climate adaptation into all it's works – do you find that that is helping projects be more innovative, or is there a pushback against always having to think about climate adaptation?

R11: No, I think it's helpful. We also see that we cannot reach every goal we want to reach within climate adaptation by using the sewer tax and using the measurements on the sewer systems – we have also, you have to green, you want more trees, more shadow in streets and therefore it is very difficult to pay that from the sewer tax so you need another tax or another income – that is why we are struggling now, where can we pay – we have, with some colleagues, we are doing a green, and the policy on the green area, we say we need a lot of more green area in M therefore you have to change mostly paved area into green area, and it costs a lot of money – and where to pay that from. Okay, we have decided to pay a small part from the sewer tax but we cannot pay everything from the sewer tax. And it's difficult

when you look at, regarding laws and so on, if it's allowed to pay it from sewer tax. So we have to find another fund to pay it out of. Therefore, that's the discussion now, where to pay it out of, the greening of the city

INTV: So, do you think that the upcoming environmental law "omrevingwet" will have an influence on the work that you're doing, or the larger municipality?

R11: Yes, yes, it's already had impact – we are still preparing for it but – the main difference I think is that mostly now, the different themes like water green urban planning are more separated and the omrevingvet will bring it more together, so we have to work more intensive together – a different way of working. And I think that will help us to give more quality to the inhabitants of the city. First off, it's not really directly easier but I think it will help – it's a good initiative

INTV: Does it require any obligations or is it more guidelines?

R11: No, it's also more obligations – you can use it to bring in more obligations, so we are working on it to say if people are obliged to keep more water in their own area or do something about their pavement or something like that – about the amount of green area they need to have, green roofs also. So that can help us to, it will be easier, you can apply more with the new law

INTV: I wondered if you have any thoughts on the role the public can play in climate adaptation, and if you had any thoughts on that, especially in your municipality?

R11: We always say, when you look at the area of the municipality, 40% is about the municipality, is common ground [public space] and 60% of all the inhabitants – so when you want to be climate-proof, also the 60% of the inhabitants have to do a lot of work - you can't solve it only on the 40% of the area. So everybody has to do their part, and you can oblige them but it's not the way you want to start with, first we try to stimulate them, give some er [money], and to [educate] them to make it easier own area more climate proof.

INTV: Are you finding that they are taking it up, and they are actually doing it?

ER: Some people are doing it, we always call them the green people…and for the other people we need off-taxes or something like that to change their habits – that's still in discussion what to do with that. There are also people who are using social media – we are trying to, people with a lot of paved area – today in the news that there was somebody on twitter which was also making examples of people which had a house with earlier on a green garden and which had now paved completely their garden because it's easy with maintenance and so on, and on social media, he's making those examples and hoping that it will work for "everybody says that's a bad example" – the hope is people want to change their policy…we also have thoughts about to write on the paved area "paho lover" which means lover of paved area – and we're hoping people say "okay, we don't want to be a [lover of paved area]" so we have to change.

INTV: So, in the policies that you're developing, are you looking at encouraging climate adaptation in both new developments, as well as existing areas, or are making the distinction between those two?

R11: Yes, we are now mainly focused on climate adaptation with usual techniques, and when it helps we will also want to use new techniques or new innovations but it's not the main focus now.

INTV: And why is that?

R11: You want first, to change the way you are working, and when also bring in new techniques then you make it more difficult to make the main step, to change. So we think, let's just do it the normal way we doing it, and only work on another way and further on, bring in new techniques

INTV: So what changes to the way working is happening are you focusing on?

R11: The main changes that we want to make, we want the city to be greener, there must be an improvement of the green area – there must be better green area, more green area. And also we want rainwater, to keep it on the way where it's fallen, don't bring it to the sewer plants, don't bring it to the canals or to the sea, as we might need it because of drought periods. The last three years, we've had very dry spring seasons and even also summer so it's very important that we keep the rainwater and we use it in our own bottom to, because of the buildings, because of the green. So that's the main change we want to reach, and everybody has that in mind

INTV: So, what are some of the difficulties and limitations that you've found that hinder people being innovative, or trying new things?

R11: One of the most difficult thing is when you try new things, it will not always work so you have to accept that they can fail and that you can do something for nothing. Today I had a discussion with a colleague…a model, GIS system with some consultancy firm and we just gave a lot of money to them, and it's still not the result we want so the question, what to do? We go on, we stop? So we said we already make a lot of money to do so – and it's very frustrating to stop. On the other hand we are just thinking no we just have to accept, we have tried it, we have to accept it's not possible at this moment so just accept that you can fail… and for Dutch people it's difficult to accept they can fail, Dutch people find it difficult to go on with uncertainty and things like that – that makes it always difficult when you start new techniques, you want to innovate something, also to accept that you can fail. And I think the second problem is always when you have done an interesting pilot project, to make, to bring the pilot project to make it the common way to do something – that's also a very difficult process, and mostly not a process that most people are interested in. Everybody wants to do a nice pilot, "ah, see what we can do, ah, what a nice result we have", then to bring a pilot further on – that's the most difficult part, factors and people who are leading the city are mostly not so interested.

INTV: Why do you think that it?

R11: It's also sexy, I think – mostly it's hard working to bring this, it's not very – you can score with it or you can make a nice, advertised moment – when you have a pilot and the pilot is working, it's always interesting for papers and on social media. But to say okay, we have got the pilot and now we have to make it 30 percent, 40 percent, 50 percent – it's not easy

INTV: That brings to mind what you said before, that's it's difficult and pilots by their nature require more effort so by asking people to make a pilot the norm, you're asking them to do more and…they usually don't

R11: And to bring the pilot to the norm, for pilot you only need the good-willing who are interested to do the pilot. To make the pilot the norm you have to also convince the people who are not really

interested in the pilot and want to do it the way they are used to doing it – I think it's even harder to reach this phase..

INTV: And are there any other difficulties you can think of, other than fear of failure, difficulties upscaling, pilots…?

R11: I think the financing is mostly also a problem, because when you want to innovate something, you mostly first have to – you first make the costs and then you get the benefit. And you need people who want to invest first, and that's not so common – mostly people who want to do that, they have their own firm, they work for themselves – but they are not working within the municipality also.. mostly have the more…

INTV: Do you see that changing at all? Especially with young graduates?

R11: Yes, I think young graduates help very much but I also see a lot of young people are disappointed because of how things work and how difficult it is…

INTV: And, is there anything else that make it easier? Things that make it easy for people to innovate

R11: I think most people are lazy from nature, so you have to make the new thing very easy for them. So they must have benefits directly from it then it's easy to change. And it helps also if you, they help also in the initiation phase, because then if you're responsible for it, and then they will easier [for them] to go on with it. If you go on to people and say, hey, I have invented a nice thing, but now you have to use it, not so many people want to use it anymore…

INTV: Do you think that's what happening now? That people are brought in only at the end?

R11: Sometimes yes, and on the other hand you can't ask everybody to help with inventing something. There's always a group which is not involved with new innovations. Therefore, I think you have to show some good examples and when people see the good examples are working and their nice, I think it will be easier to do it. When you look about paved gardens and green gardens, I heard once a guy who was designing gardens say, the best way is to make a new technique that looks very fancy and so on, so everybody wants to have it just because it's so fancy – and then they want to change their garden – because when a neighbour has it and it looks nice, then we also want it. Don't ask them to do good for nature or something like that, and they have to bring gardens and take paved areas out….it's not working, just bring something which is they can easily maintain and looks like the fancy thing… then people will change.

INTV: I like that because it's the incentive behind change, why do they change, and climate adaptation is not a big enough incentive at the moment for a lot of people?

R11: No, no…

INTV: I'd like to understand what you see as the decision-making process at the municipality in terms of projects, in general – maybe climate adaptation projects specifically, how do they start, and what is the process, once they've started?

R11: I always say, there are not so many climate adaptation projects – there are a lot of projects who want to change buildings, who want to change the outer space [external environment] or something like that, and then the main goal is to do it in a climate adaptation way. And therefore, you have to decide,

when do I find it – [how] do I do it in a way that helps to prevent climate change, and everybody wants to do climate adaptation, and they ask – what do I have to do then? Then it becomes difficult, [so we say, for example] "now you have to bring trees in" and they say "how many trees do I have to bring in?" – and then everybody becomes silent because we don't know. But then some designer wants, you ask them to make a design for a new outside area, then you ask but when is good enough, how many trees do I have to bring in? So you have to say something about the amount of trees you have to bring in, and that's a difficult question. So we have studied a lot about the question, when do we think, what do we really have to do to be climate adaptive – [we've thought] I think two, three years about it and now we have some design rules where we're saying, we do this and this: we keep so much rainwater on the place where it's fallen: then we think it's good enough. And we have so much shadow in the street by trees, then we think it's good enough. But yeah, now the decision-making has to take place – some decisions, also when you become so concrete, when you bring in some design rules, it becomes really realistic and some say ah, here we can plant so many trees... here we can…. I think it's a good decision

INTV: And it really highlights the point, sometimes that the words are very vague and it's hard to interpret what that means technically and in reality, and if you don't know exactly what it means, how do you measure that you've achieved it… Are you putting in any monitoring and evaluation in your policy as part of recommended approaches?

R11: yes, we decided we want to evaluate about three years – let's just start and do something, and also see if what we have now as design rules work in practice. And we also want to do a lot more measurements outside, also, maybe on heat and something like that…all to make the design rules by modelling but we don't have so many measurements which makes us want to do a lot more measurements. And we are also looking at the relation because, I think the main goal of what we are doing, climate adaptation is because of safety, people want to be safe, and of health, of the health of people – and the relation with health, and even with heat, that's a difficult relation and I hope we can do more some research on that

INTV: Are you working with other municipalities, or is this mostly led by your group or municipality?

R11: No, we are working with the municipalities in the neighbourhood of M but they are all a lot smaller than M so we also work with municipalities from mostly the same size as M – they mostly have the same problems as M, it's difficult if you work in a city with more people

INTV: That makes sense, if you keep it local then you are addressing similar problems

R11: And we have a historic center so it's also different – M is a bigger Delft I guess but same sort of city

Interview Transcript_D12.R12

D12: Let me first ask a few questions to get a broader idea of the framework and the purpose and goal of your study. I'm a little bit mixed up – you're talking about climate adaptation, and also replacement and sewer, maybe or maybe not in combination with asset management. So I expect actually, your scope is urban drainage, so it' much broader than only sewer…

INTV: It is but part of why I narrowed it down to sewer asset management is that when speaking with the municipalities, we're speaking with the people that are in charge specifically of the sewers – so the sewer replacements, maintenance – and if we can we're also interviewing urban planners, and so because those are two separate departments, it helps when sending out the emails to specify, specifically what I'm hoping to get

D12: But on the other hand, it's a bit odd to talk about "sewer asset", because it's double, sewer is one of the assets needed for the asset management in urban drainage

INTV: Yes, and that's one of the things I'd like to tease out because, really, it's such a broad term – sewer asset management, that it's a little bit hard to define what that is and so I'm hoping to get out is that once we start talking about sewer asset management, the conversation expands to include urban drainage and the need for climate adaptation of the system

D12: I think we should talk about sewer asset management

INTV: You and I, definitely, but in some of the interviews in speaking with sewer asset managers, they don't – their scope really is just the sewers

D12: So maybe they are sewage asset managers

INTV: So, how do you define sewer asset management then?

D12: I can't define it because it's only, it's twice an asset – sewer is an asset – and asset, we have asset asset management – either you have sewer management or you have asset management related to urban drainage or sewerage, or - nobody is managing only the sewer, I hope, it will be a very small-scoped job - but it's a definition question. I'm pointing this out because one of the major goals of our foundation, [redacted], is to get more specific use of terms and what we are talking about – and the term sewer asset management is incorrect.

INTV: I appreciate that, and it's funny that you should say that because a lot of the literature says sewer asset management but I think it's a good point. So I'll definitely keep that in mind as I go through the study.

D12: Maybe you can write a short sentence in the introduction of your thesis

INTV: Okay, so you're making the distinction between sewer management as a thing by itself, and asset management separately – is that what I'm understanding?

D12: No, see, asset management is an approach in management. It's an – we call it in Dutch – a container concept because it has a lot of meaning and a lot of definitions. But the most used in the Netherlands, is that it's a kind of management in which you try to balance the performances, the risks and the costs of the assets. And performance is related to the goal of the asset, the primary goal – why

the assets are installed – and risks relate to the surroundings of the infrastructure, like the environment and health, but health related to sewer, and overall cost to balance those things. Then there are a lot of sub-activities for completing asset management. Actually, all the work a sewer manager is doing is related to asset management, only most of the time, he's not aware of that. And I think the big change, what asset management could bring is the aspect of risk, so focusing on the big risks and forgetting about the little risks so they have more focus and more efficiency in their work. That's one thing of asset management. And the other thing is it should relate all your activities, and also the risks to the objectives of your organization. And one of the objectives is climate robustness, or sustainability, or circular economy, so, all the different societal goals that are related to urban drainage.

INTV: Okay, I'd like to follow up on this thread – are you finding that, that link exists between the risks of performance, that side of the asset management, and linking it to the organizational goals and climate adaptation – are you finding that exists now?

D12: It's beginning, people are getting more aware of the fact that it's not so important that everything is looking stable and is looking nice, but actually you should define the performances related to the quality of service you deliver to your customers. And in the case of urban drainage or sewerage, it's of course the service that the inhabitants of a certain area stay healthy, have a comfortable surrounding, living and working, and have a safe area, it's not flooding and you are aware of the impacts of the urban drainage on the environment. So these goals, and actually, in the Netherlands, we have these guidelines that implicitly already mentioned these goals and it's also in the European standards – the EN752 – it's a guideline on… I believe it's also called sewer asset management – it's a guideline about management of, I prefer the term urban drainage, where the planning and designing and maintenance of the sewage infrastructure is related to the goals of it – and the functional requirements and the performance indicators – there's a different word for it – key performance indicators…

INTV: And captured in those key performance indicators would be climate change adaptation…?

D12: For example, storage capacity could be one related to climate change…

INTV: One of the things I'm coming up against, is how to really explore the idea of balancing the technical performance efficiency requirements against these climate adaptation requirements and I'm trying to tease that out from the different interviewees, because so far it seems like they are two separate things but what you said just now, is good because it can link performance to climate adaptation – so storage capacity for example, which is something that technical managers are interested in, how would that look like if it was linked…Okay, to start with my questions: innovation, from your perspective, how much is there, is there a lot in urban drainage in the Netherlands right now?

D12: Innovation is also a container concept that – you could call every job innovative, because it's always new, it's always different than the day before. But on the other hand, I think the designing and construction, and also maintenance guidelines are very traditional, based on – the design of the sewer system, it's newly as a science, it was always more a craftmanship…because craftmanship is more skill with your hands, and less related to creativity, so it's a craftmanship, based on simple rules. For a long time, say, for the last 20 years, there's beginning to be a change to relate the design to the societal goals. For instance, the separation of rainwater and wastewater, in order to use the rainwater in the built environment to reduce drought, and, as long as it's rain water of good quality, to help to improve the quality of surface waters, and housing areas – to provide a nice environment…and let's say, for

maintenance, there are always fixed periods of time, every seven year there's an inspection and before an inspection there's cleaning, and before cleaning we have some indicators, and [it] never makes a difference if the sewer is under a very important road, or it's just a rural area – they always have the same period. If you approach it from a risk-based urgency of maintenance, then you say okay, maybe the sewer in the rural area, we can clean it only every twenty years, or inspect it or don't inspect – when it's broken, they call us. And in a high-density urban area, maybe we should inspect it every year, to be sure this road is never blocked, or never stopped because of a sewer collapse. So this kind of differentiation is starting to begin in planning of all activities. And also the flooding in this area has much more impact related to the…because there's a hospital, than in this area where there's only sporting are. And that's the new driver for innovation because you see this, that there's more attention to the impacts of the environment of the sewer. Then you see okay, it's worthwhile to invest in this sewer and to have more, to get better performances for higher price because the risk to the environment are much lower so it's paying back…So the last twenty, ten years, you see scientists are getting interested in the area. Of course, there's a lot of innovation- we have every year, we have a contest for the innovation of the year, and every year we have a lot of ideas from circular sewer pipes to infiltration systems or software packages for efficient registration…and then in our yearly meeting with some 800 sewer managers, they vote for the best innovation – so there's a lot of innovation on one hand, on the other hand, it's not huge like, a helicopter on Mars….but also in the sewer systems, we have drones for inspection – which is an innovation.

INTV: So on the one hand, there are things that are happening that's new and different and that's good. And you also mentioned that in some ways, it's not as innovative as other sectors…

D12: Yeah, it's always difficult to measure, how much is something, is it a lot of innovation, or is it small innovation…

INTV: Yes, one of the things you said earlier was that the technical guidelines are really more for the traditional design…can you think of any other reasons why the innovation is low on one hand…?

D12: Yeah, I'm representative of the sector – it's all older men so maybe if we have, just recently we see that we have more women interested so less technical approach, and a more human approach and I think because of the younger people, more skilled with working with data and data science and data analysis that, from that new input, innovation is starting. But in the municipalities, a bit more, currently, there's a lot of old men still working as sewer managers…

INTV: And they've been kind of trained in the way of doing things…

D12: And they don't like innovation because, it's only new, that doesn't work

INTV: So there's a tendency not to risk the new…

D12: Also the cultural blockages, maybe too strong – see the sector is a little bit hindered by cultural aspects as well. The craftsman, they always did it in this way, it appeared to work well so why should you change

INTV: Yeah, I think that's a battle that's fought across the board – I think it's the managers, it's the whole industry knows what works and…

D12: Yeah, it's not only the managers, it's also the suppliers and the consultancy. But I think the consultants also have the creative ideas, most of the time they're well educated and trained but I think, especially the smaller municipalities, it's, the people in charge for sewer management are not so high educated, most of them it's the middle technical education and well, they don't know what's happening under the ground but it's working and as long as it's working, don't touch it

INTV:…So, what right are the main considerations of sewer managers when they are replacing sewers? What do they think of?

D12: There are different situations - one situation it's driven from the sewer itself, because it's collapsing and it's quality is very bad – but I think these cases are in the minority. Most cases, there are external reasons for replacement and improvement, mostly together, not only replacement also, improvement – changing from a combined sewer system to a separate sewer system, or at the same time trying SUDS, sustainable urban drainage systems, or infiltration systems, and mostly it's done – on a block of houses, that's built in the same period, a quarter – so part of a city, which has one part of the sewer system with one pumping station and mostly they have – it depends on the urban design of course. But in the Netherlands, the most cities, they are built in, like grapes, so it's growing [expanding] – and each area has distinctive architecture and it's own sewer system and everything is built in a short period, and after 30,40,50 years this specific area will be renovated totally – so all the greens getting out, all the sewers getting out, the roads are re – changed, so mostly it's become integrated redesign of an urban area. And then, we don't look if that particular sewer is old or not, because everything is going out. Because, at one time, a complete renovation…it means anyway, that the driver for sewer replacement or other investments for climate change in the Netherlands, are very related to the other elements in an urban area, like roads or green or parking lots, in the housing – we call it integrated working. It's quite common because we don't build one house, then another house…most times it's the municipality that does the urban planning, and they plan not for a few houses, no, sometimes mostly they plan for a large area, maybe 5000 houses, it's a big development, then it's 5000 almost same houses with schools and everything… so like a small village, new village connected to the city – and after 50, 60 years, everything needs to be renovated. But also, there's a group of investment drivers, coming from flooding, also in the Netherlands. So we had a lot of nuisance from rainwater flooding, stormwater floods and they say okay, we have to redesign this urban drainage system because we need to re-route the stormwater to other areas, we have to build storage underground or above ground or everywhere…it's a complete new redesign

INTV: Okay, so you talked about the drivers from flooding, and the drivers from the scale at which urban renovations, integration of urban innovations happened…so now, what are the blockages then, to innovation?

D12: I think they are the same as for any innovation, it's new, there's no experience with it. You have to take a risk, and you have to invest in something which you're not sure will work. Mostly, the central government supports investments for innovative solutions, and allows that to make way, to get this block away because the risk is often too large for one organization so if you can spread the risk, then you also get a reward because you can tell to the other municipality – we are innovative, we get money from the government. But also, another block to innovation is when there is a failure of a new system, nobody talks about it. And the one who took the risk, he has to solve it and nobody is going to help him – only when it's working, everybody is coming and everybody is having big parties. But when there's a

failure, nobody wants to talk about it – and then we don't learn what are the factors to make it work, or to learn what conditions will it work, and what conditions it will not work, or what are challenges one has to take care of to make it work. So the learning from innovations is not good organized because we are only celebrating the successes and don't talk about the failures, also a cultural aspect.

INTV: I wanted to ask you about investment – especially with regard to the sewer tax, which is for dealing, maintaining the sewers – so can you speak to whether it can be used for something green, or innovative projects?

D12: So the law in the Netherlands is quite clear about this – the sewer tax is related to the duties of the government related to wastewater, rainwater and groundwater. So the storage facilities for rainwater can be funded from sewer tax - it's no problem. It's just a name suggesting it's only for sewers, but that's not the case – it's better to talk about an urban drainage tax, and urban drainage management… then we're starting from the beginning – the sewer is only a small part of the infrastructure needed for the duties a municipality has related to wastewater, rainwater or stormwater and groundwater. And also, some surface water – but that's a bit mixing with the duties for the water boards

INTV: Okay, thank you that clarifies it very well…

D12: On the other hand, also, the municipality has also other funds for investing in water infiltrating surface of the roads, permeable pavement. A permeable pavement is on the one hand is for the road, for the traffic, but on the other hand it's also for drainage. So you can combine, the funding of it – so you can say it's 50% coming from the sewer tax, and 50% coming from the road tax. And municipalities have freedom to choose that as their own – as they think is good. It's a democratic body, and as long as it's written down – we do it this way, and it's consequently done, there's no problem with it.

INTV: Okay, regarding collaboration across departments in municipalities, you mentioned it before on the scale of housing departments, do you find that there is a lot of collaboration between the sewer managers, and the urban designers and planners at this point, or are they still very separate?

D12: It's improving – most of the time, there's not a division in sectors, like green, roads, water, sewage, electricity – so most of the times it's well integrated. It's more divided in the phases in the life-cycle. So, design and development is one, then there's a giant gap, and then comes maintenance. And people from maintenance are not involved in what they think is important, it has to be done in the design, and in the construction. It's also because of the strict difference in the financing – so for the new building, so developments – it's financed in another way than maintenance. You have the exportation {?}, maintenance and development is investment. So each municipality has two bills, they have an investment bill and they have the exploitation (?) bill. And investment bills, can't be big enough – the more you invest, the better you are. Exploitation – it should be as little as possible. So that's one of the reasons there's always a lot of attention for new developments, there's very little attention to the maintenance of all infrastructure.

INTV: So, why would that be?

D12: It's because the exploitation is financed from taxes, and taxes has to be paid by voters, and it seems that governments think people vote for who has the smallest taxes… and investment are financed by financial institutions, like banking, building companies, construction companies – so for the municipality, they can finance a lot of things through selling the houses and that's one part of financing.

And then there's a gap, so that when it's built and it's ready, another department gets it and [they say] "now you have to maintain it, we are ready" then they go to the next development. Yes, from the government aspect, from the municipalities, that's one of the big problems, good maintenance.

INTV: So if the maintenance budget is kept as low as possible, does it usually match the need? Is it enough to do the annual maintenance?

D12: No, most times not. So there's very little money for investigating the condition, and for the assessment of the quality of sewers. And as an example, the large pressure pipes of the transportation system (conveyance), they are constructed, on average say between 50 and 40 years, so they are getting a little bit old now but most of them are never inspected before so there's no idea of the condition. But they are very crucial in the functioning because if one breaks, the total transport stops….And their invested [in] 40, 50 years ago with a lot of money but there hasn't been saving for the replacement of them – so most of the time they are not on the balance of this organization because they're paid for at once, and okay ready. But actually, you should have to activate them, and depreciate them by a certain amount, and at the same time you save for replacement. That's a normal corporate financing approach but municipalities don't do that, because the investment was done from the development, the housing, and then it was paid for. And only, there's a small amount for maintenance like cleaning, or small repair but there's no, there's never been economically based approach for if we inspect it, then we know which are the bad parts and which are the good parts, and we can repair the bad parts before it's collapsing, we can save a lot of money

INTV: My next question was about the stress test, and if the purpose of the stress test is to find those potentially weak points and re-direct maintenance money…

D12: But that's focusing on the functioning of the, hydraulic performance of the sewer system but I was more related for inspection we're more focused on the conditional performance of the sewers. But of course it's also interrelated, and these stress-tests, they are obligatory in the Netherlands, they are focusing on the risks for flooding – where are the risks for flooding in urban areas. So it's a 100 year return period storm event used for calculation, model simulation – where are the flooded areas to know where should we take measures for the climate adaptation. They could also contribute for replacement or system improvement

INTV: But they're intention isn't condition-based, it's performance based..

D12: But a related question could be, how will climate adaptation be financed? Because if the sewer taxes are even not enough for regular maintenance, they are surely not enough for extra investments. Because for these extra investments, the sewer manager has to ask the municipality for additional investment money, to build extra storage capacity or whatsoever…

INTV: Do you think that will happen?

D12: It starts to get better because, thinking in risks is getting more usual so if we say, related to the flooding, we have this much damage, every 50-year, and we have so many dissatisfied inhabitants – it's also a performance indicator – so it's worthwhile to invest this amount of money and then everything will be okay. The problem is that after the first time this was invested, and it will be flooded again – then it becomes interesting...because it's difficult to make a solution that it will never occur again – because climate change is very unpredictable and the 100-year return storm, can fall every year.

INTV: Okay, and would that thinking of weighing the risks versus investments and future implications, would that happen at the sewer manager level? At the municipality level, national level? Who would be leading that discussion?

D12: this distinction between these levels depends on the size of the organization, so like City of Amsterdam can really point to these different levels and this investments will be coordinated at least with the urban development level, but initiated and executed at the sewer level. But in a small municipality, maybe 20,000 inhabitants, it's almost the same, they don't distinguish these levels – but also the smaller villages, if you take a look at the whole village for these measurements – they have a master plan for the village, saying these are the principles and this is the strategy we will follow and it will be executed in projects when there's time to work in that area. And they say, okay we put in also the strategic measurements in this specific project…for instance, some municipalities used to have creeks, all these creeks are buried because we don't want creeks we don't want parking lots. And now they experience a lot of flooding and nuisance from soil water, and then they remember, we used to have creeks – maybe they were not for nothing and they want to restore those creeks, and it comes together with positive, nice to look at people say, and it's green and we can recreate there, and we can put houses there and we can sell those houses for a lot of money because everybody wants to live close to a creek…and then they have the master plan to make a creek throughout the city but they can't build it at once so they build a piece here, when this area is renovated then they build another piece when this other area is renovated, then in a period of 10, 20 years, it will be completed. So it's on different levels, but there should always be a master plan because without a master plan, I don't think it will come up, - it's no good – like shopping, running from one shop to another…

INTV: Without a list…

END

Interview Transcript – D13.R13

00:07 – INTV: So to begin with, first I'd like to understand a little bit about your role at the municipality and what it is that you do.

00:19 – D13: Yes, I'm a department head with about twenty five technical staff members . I am responsible for the sewer management , road management soil remediation, and energy management for almost of all technical installations of the city (So public lighting, tunnels, bridges, pumps, Harbor installations all these kind of installations). So I have four parts of my job, not only management (maintenance and replacement) of sewer systems.

01:10 – INTV: OK, that's excellent and this will, definitely, I hope this be interesting interview for you. So, I can give you a little bit of background about my research and what I'm hoping to find. One of the things I'm trying to understand is why in some cases projects, for example, with sewer asset management, are able to be innovative. And innovative in the way that I've defined it is…It's two things: it's either the use of non-traditional solutions, so for example blue-green, or innovative ways of using existing sewer solutions. So maybe infiltration pits around sewers, that kind of thing. So I'm trying to understand why some projects are innovative and why others aren't. What are the factors that make that innovation easier versus what makes it harder? And how, perhaps are those factors related. And so for this interview, I would like to speak specifically about one project, if you can think of one, but if not, we can kind of think about your general experience in your experience so far. So the first question would be, is there a project that you can think of in the last five or so years that you consider innovative in the way that I've defined it?

02:32 – D13: Yes, several were. I think one of the technical most interesting subjects next to modeling [and] solutions in improvement of systems is our city has sewer systems about, 1880, 1890, and in the past the part of our system was bringing all the wastewater to the sea without passing a wastewater treatment plant . So the direction of the flow was down to sea. This was a pipe from one and a half meter high and the wastewater went trough a sieve installations and into the sea. That was about 1910, 1920. Because the directions of the wastewater is changed from the sea to the water treatment plant. Because of this nowadays it's always clogging. We built a new residential area, next to the sea so the wastewater transport is going the other way. So what we did , and this was a sewer which lays 6-7 meters deep with large pressured effluent pipes from the wastewater treatment plant to the sea next to it.. So it was very difficult and costly to do replace this sewer. So I made project to reverse the slope of the pipe internally. We built an internal slope into the pipe with concrete and we added a constructive liner into it. So we had a smaller diameter, we calculated it was more than enough, of course, so we were very cheap in bringing the right solution. Because the pipe has the correct slope we don't have to clean it that often, the flow is exactly as we like it, we have a new pipe that will stay for another 100 years. The new construction together with the liner withstands the pressure of the soil. It was a very old sewer, and the calculation said it would collapse, but it's the old pipe was in perfect order and there's were no problems. So we calculated, it's calculatable correct now OK, with the liner and so we have a large new sewer for a little money, in comparison by traditional replacement. So that's one.

I can name several other things, pumping stations - for example, if you optimize pumping stations when you have an older city, it's grown…you have first design and then everything is stick together and you got a system. So you have to think how can I improve this system? And pumping stations are very expensive, they go on for 100 years. So if you can cleverly connect systems in any way without having a the need for a pumping station, you don't have maintenance for it, it's much more secure, it's a more resistant to extreme weather…there are all kinds of advantages to those kind of solutions. So you don't have to worry about it, is always functioning - you know a pump can go bust or it can't function, or the power can flow away - so the less mechanical systems you have in your sewer system the better.

06:30 – INTV: OK, great, those are two really good examples. I'd like to focus on the sewer one because that's the one that I'm interested in, and understand the decision making process. But before we do that, so from what I'm understanding, the innovation was instead of replacing the pipe, it was relined and the direction of flow was reversed, correct?

06:53 – D13: Yes, of course.

06:55 – INTV: Alright OK, and was this done in conjunction with any other department? Because you mentioned the road department?

07:05 – D13: No, this was pure [our] own invention - because everything is working underground, we had a little bit space necessary above the ground, and an important problem in cities these days is [that] you have to take space off the roads when you do works and if we do sewer replacement on the main roads, we have to have a permit to two years in advance on main roads w before we even can start. So the planning is very close because there's a lot of building, and a lot of the protest, and all kinds of other things that involved with before you can do any work. And with this solution we hardly didn't need anybody, we need a place to put a shed where we go in with the liner, so we needed only a very small working space, instead of grabbing the whole street open, very deep piling then, constructions

08:21 – INTV: Yeah, I can imagine. OK, so the other thing that you mentioned was that there was a new development in the area and so was the project started because of that new development?

08:37 – D13: No, it catalyzed, it speeded up…you know what I mean?

08:46 – INTV: Yes, so the project was kind of in the works but the new development kind of speeded up the process…

08:56 – D13: Because there's a lot of wastewater coming from that side.

08:58 – INTV: OK alright very interesting. What I'd like to understand is the decision making process and how you came to the option of relining and reversing as opposed to replacement, and so can you talk me through a little bit how you came to that final…?

09:21 – D13: Just thinking and looking at the map. In the past, before I was head of this department, I was also project leader and I led the small team, that maintained systems, and with my colleague, I

calculate pumping stations, all kinds of pressure pipes and seeking improvements of the sewer system. And with the colleague who did modelling for the sewer system, we always on Friday afternoon put our feet on there on the table and we took a very big marker and, [said] well, let's look at the map - what can we improve? So it's a thinking process, but you need a lot of experience to see these kind of things. So that's always the difficulty when you are managing in a department - you have to be a manager or you have to be someone who knows the technical details. And the manager is always preferred by the people above, and therefore the technical part of it is left to the staff. I am a very technical person - I still am, and I wanted to do this job as manager because with all my ideas and all the things I'd like to do, I always ran against my manager, who had other interests/priorities. And at the end I became the manager. So I thought two things I can decide myself what's good, not good, I can combine all kinds of budgets with roads or kind of things, I can decide myself. So because I have the background from improving things, I did modeling, I did calculating, I've done all the things in my past including supervision…outside. So I knew exactly what all the things I could improve, and I can decide now myself what I want to improve. I'm putting the signature to it, so that makes it very easy to educate people to think on the way, how can I improve systems? And that's our job, our thought is we have to do thinking ourselves and hence we can do [it with] other people - people who build..

One of my main priorities is to educate people about thinking how to improve the system each time we replace a sewer. And how we improve it is, of course we model, we know which kind of rainfall or extreme weathers there's going to be in 2050. So each time we replace small sewer and we've done this for almost 20, 30 years - we had modeling for 20 years so - we looked in the model "what did we improve, larger pipe, smaller pipe, spillway or large pump, or larger this…what is the effect on the function of the system? And if we have to put a pipe of 60 centimeters instead of 30 centimeter?" The material is not relevant due to [size of] the whole investment…so if you put a bigger pipe in, what has better effect, if it's only two or three centimeters, on water level your system? But it's an improvement.

And then you if you do, all these years, this kind of thing, you can get the system that's every time stronger and you don't notice the cost. If you don't do that, you have to do it now - we have extreme rainfall, we have to calculate all kinds of things - but [if] you have a process, each time you replace something, you have to ask, what can I do to improve it? And we do this with for example with sewer systems of course, and pumping stations, all kinds of things. But we also do drought management and road management, in road management, we have [*an analysis*] where pavements doesn't need to be. So you have a city, it's all paved or asphalt, or other kinds of things, and lots of these places you don't need pavement. Pavement is more expensive, it's hot, it can't take water…and if we don't need to have it we don't bring it back. So we have plants or grass or other green to infiltrate water. And it doesn't cost any penny more in our project. So if you think advanced thinking about what you can do with projects, or other things in the future, you can improve your sustainability - make robust - your system is more stronger to withstand extremes. But it's a long process

14:48 – INTV: I can see that. So is the whole sewer already set up in a model? And then every time you need to replace the pipe, you kind of check in that model what effect that has on the whole system?

15:01 – D13 : Yes, yes.

15:02 – INTV: OK, OK, very cool. So one of the things you mentioned with this replacement project was that the cost of lining was less than the cost of replacing the whole pipe. So is cost one of the main considerations in sewer management projects, and what other considerations are there when you are replacing sewers?

15:29 – D13: Cost is the most important one of course, and in the Netherlands, sewer management is paid by taxes and these are very strict, so we may only put our money in the sewer system, not other functions. So we can't do reconstruction for it or planting trees - that's absolutely not allowed. And we are checked with the accountant each year, he takes a lot of bills out and says "what's this?". So that is one thing, the cost is very important, and you have to know how much money you need, for maintenance. So you inspect all your system, you have a program to inspect each year your system so you know to plan which pipes you have to replace in the future. So if you know that you have, you can inform others – "do we have to do something there too? Do you have to replace the trees, the streets and other measurements [measures], or all kinds of things?" So you're cost effective if you integrate sewer replacement to other projects for efficient usage of sewer funds. So then your cost of your sewer replacement goes down and that means you can replace more. What's in the Netherlands also very important is the ground conditions, soil conditions. Our system lays in average 80 to 100, 110 years the ground. Other community, other municipalities, they have very, very poor soil conditions and because of this the pipes need to be replaced after 30 years or so. So this three times more money than us for sewage. So that's important. So costs are very important, if you don't have money, you can't do anything. And the second one is how can we improve the system more, that I told you…how can we improve my system?

17:49 – INTV: OK alright, so in improving the system you mentioned that you kind of have to have a plan of what you're going to maintain and then you check with other department. How does that collaboration work? I guess, it's a two fold question - you just kind of send them all the plans that you're replacing and then you all sit at a table and see where you can align the work or how does that part work?

18:25 – D13: It differs, we have all the cable companies , water, gas we have four times a year, a meeting to discuss our plans when in were we have to replace our pipes. Because we have a good inspection of the system –so if a pipe needs to be replaced, we can say that from the inspection, this kind of damage it will take about 10, about 10 or 20 years, then we have to replace it. So if we know that, we take mostly the pipes that are built in the same period, a large quarter or war area and we're going to replace it all. We take this whole area and then we discus with al the above companies and we say, "well, this has to be replaced in 10, 20 years, what is your replacement cycle?" So we put them in the same period as us, they go first and than we go. So we make a connection with them, how to do that? - that's common, I think.

Another part is all kinds of other things, so the new street, other dimensions, parking, trees, all kinds of things. Those are things that are more difficult - they sometimes don't have a budget to participate with

our sewer replacement. We have a budget - we have thirty million a year to do things, but they have to go to the city council say “oh, we're going to do that project, this, this, this, we need that much money”. So, [it is] very difficult for them to plan these kind of things. So that's largely, we have money to do things so we can plan. We know what we want, what we have to do, we have money so we can plan it. There you have all kinds of plans to do things, but if you don't have the money, you still have to go to the council. And so it can differ, differs in time, so these projects are not parallel, they differ. And the importance is with our system is that we indicate we have five years, sooner or 10 years sooner or 10 years to plan for example with the road pavement or other projects paid by somebody else. It's very attractive for it for us to replace our sewer 10 years sooner because it's more cost effective for us. So these are all kinds of things that determine how we, I think, are working the most effective.

21:20 – **INTV**: It sounds like there is longer term planning in terms of, looking 5-10 years ahead. Do you find that you generally stick to those plans? And so if you say the sewer is going to need replacing in 10 years, then around the time it does get replaced?

21:40 – D13: Yes, it can differ for five years or perhaps, the period that these sewers are constructively strongly built , then it’s not problem. And another point is we have, our own finances and is separated from influence by others. So you pay your sewer tax, it's going right into my departments pocket. It's our money to spend (of course within rules and our policy) nobody could say anything about it. And so I get each year steady income to make my plans and realise them. If I have to little money I am allowed to borrow it to realise my plans and I can write it off in a longer periods. It's not the best way but we can do that, it's allowed so I can borrow it on the market money, replace my sewer systems if it's more. So, we are more flexible with money and time. But other things, other developments are more difficult.

23:06 – **INTV**: OK, two things come to mind that have come up in some of my previous interviews, and one of them, I think we're kind of talking about now, which is the GRP and kind of the longer term maintenance planning for you, and so I’m guessing that's kind of the base plan for how you were spaced every year?

23:32 – D13: Yes,

23:35 – INTV: The other thing is the stress test. Does W do a stress test?

23:38 – D13: We did one of the first in 2014. There weren't any formal stress test rainfalls, and I decided we'll use 100 millimeters in two hours. So we did our first stress test with a advanced model where you can see the flow of water and maximum height of the water level in the street. And the results of stress test, you can see them everywhere – there are used as a risk analysis, not as an objective occurrence because you see only the maximum moment of the water level in your public space. But that's not how it happens - if you can play, the movie of the model, you'll see that it's varies, each half by half meter, it varies. So you see the top of it, so what you see is not the reality. So you have to think very [carefully], warn people, what you see is not what happens. So you see a chart, you have the water, but you have to be very careful with it that you don't have the wrong conclusion about it. Because you see the maximum, in every small part in the public space and the reality is much different. But we did

that - we are now doing also calculations with the whole region, with 12 cities, 12 municipalities, waterboards to drinking water companies. So for our whole area and we're working well together and that's for, because of the personnel problems, there's a large difference in knowledge between smaller towns and larger towns, cities - so there's a large difference in knowledge, in possibilities. So then we bring it together to be stronger with each other, together.

25:42 – INTV: OK difference in knowledge in terms of how to manage the sewer systems or…?

25:48 – D13: For example. Or of how to find solutions for problems, large problems is for, a lot of surrounding municipalities in our area more difficult. That is – [if] they have to build a lot of houses and what to do with wastewater, system is to its max, what are we going to do? These kind of solutions, to think for how we can improve things or, we have a few large water treatment plants, we can use the waste water by more intensive cleaning of the effluent water so we can use it in agriculture. [In] Part of our area they need water, because they're pumping up groundwater and it's forbidden after 2022 so they need a lot of water. And we are making water in the water treatment plant, it's only left a few extra steps to improve it so the circle [goes] around.

26:50 - **INTV**: OK, so why do you think there's that difference in knowledge?

27:00 – D13: Why there's a difference - small towns pay less for people, probably they are less attractive, those kinds of things. But there are exceptions there are. There are exceptions…

27:39 – **INTV**: One of the things that came up in some of my other interviews is lack of personnel, and you mentioned that as well, and so is that a bigger problem, is that a problem that W faces or..?

27:53 – D13: At the moment not, at the moment we are, we have enough staff and we have also the right people. You can have a lot of people, but we have, yes, we have the right [people] and the amount is good.

28:09 – INTV: There was another few questions: is there another approval, since you're the manager - I'm guessing you're the one who approves the final plans for replacement? So I was going to ask if there was an approval process once the decision is made to replace the sewer or reline - is there somebody else that is has to go by?

28:45 – D13: I have project managers who prepared all kinds of replacements and once a week, we speak with each other, we will talk about their project, what's good, what's improving, what their problems are, how we can solve it. We decide together based on alle the information we haven.

29:11 – INTV: And then if you have some thought you let them know and then it gets addressed at that point?

29:18 – D13: Yeah, as I said we decide together and if there is no agreement I decide

29:21 – INTV: OK, good. OK now this one is a bit bigger picture, but public involvement and engagement in sewer replacement projects - is that something that happens, is it required? Can you speak a little bit to how, if the public is involved in any [projects]?

29:39 – D13: No, it is a technical process, but they can give input when we make our policy (GRP). Often their interest lies in something else because they don't know how the sewer functions. They find it interesting, but they have no input for it. Mostly in our projects, they talk about a new design for the street om stead of just bring the same situation back. They wanted more beautiful stone, want more trees, more lights, and that's not our thing. So that's mainly a problem, they also like to know when we're working for their door, so we can't put up the car for [in front of] the door. Parking problems, another design of the street, new materials for al these wishes sometimes there's no money available so we don't do it" and then we have often discussions with people.

30:41 – INTV: So, I guess the greens and the urban planning all of that stuff is a different department at W?

30:50 – D13: Yes.

30:52 – INTV: OK alright, and do you interact with them much?

30:54 – D13: We have to check what's the condition of the trees and take measures for there safekeeping and also keep them informed. We deal with, the people from roads and myself, it's better to replace materials because they're aging, they're not good anymore, so we pay from roads to the sewer project or we put money into another project because they replace the sewer for us, because they do a large reconstruction of everything – then [I say] "okay, I'll take sewage and okay, it will cost you so much." - that kind of interaction.

31:38 – **INTV**: So, is there any discussion about blue green infrastructure? Have those discussions happened?

31:47 – D13: Yes, , we are for years involved in those, of course, blue-green [discussions]. An another department who are responsible for the city development and also the measures regarding the climate change like heat stress, drought water, climate change. We did years for discussing all kinds of things, and for example, we have together we made a description about everybody who builds new building, on the term has to withstand 50 millimeters of water of rain on their hard surfaces. They must discharge it delayed after 24 hour after infiltrate, if possible - they have to all kinds of things. So all these kind of things we've developed during the time. So we do this quite together and the only problem is they don't have money to finance their own measures. Money is the most important influence of changes.

32:58 – INTV: OK so I was going to ask two things, but have you collaborated with them on any blue green sewer replacement project?

33:18 – D13: Well, if it's necessary for blue green, it's our job. So we do this all the time: so separated water streams, two pipes - that's our problem. We do that. That's the only link we have with sewer system. All the other things, infiltration, we also do, so the only link is the building, the building area and new development . There we have contact moments where we optimize if we have to put some money for that, or because we can say that this is a positive development for the sewer system, then we can pay it for my sewer money. So we do these things, money, or different sewer systems, but most of the time it's information exchange and knowledge exchange. Either has its own tasks.

34:24 – INTV: OK alright, there are a few general questions that I'd like to ask you. In your opinion, is there a lot of innovation right now and in sewer asset management in the Netherlands, and why do you think that's the case?

34:53 – D13: Well, there is a lot that we but there's problem with the technical people…the job, we do every day - it's just not very special but it is special if you talk to someone else, for example - the 2D, 3D modeling which we're doing with our sewer data, together with RS and an external engineering company, we have to subsidize from the Ministry to make sure that our sewers data is 3D, so 3D format so we can put it in 3D surrounding. So then you can very effectively look where their space to build for example sewer systems or tunnels. So you go into a 2D map to a 3D map so that's a step for example. But well the pumps have more efficient calculation methods, change liners they are better developments but –most of the time we're still digging a hole, getting a pipe out and put a new pipe in. On the water treatment plant side, there are changes, lots of change, but the interaction between the changes that were for 10 years, 10 years ago, 15 years ago were separated developments - we were sewer system, the water treatment plant, the water system. There was always fighting about who's right and who's going to pay it and others. But now we're more working together in a water system. Thoughts are it's one system - it's not a sewer, wastewater treatment plant, drinking water system - now we're seeing it as one function , one system. So the thought about these things coming together as one system is growing. OK, so that's an important change. And it is logical and if we do, for example, have to build a new water treatment plant or change it, it's costs hundreds of millions. And suppose in our sewer system we put fifty million in infiltrating water by which the wastewater treatment plant can be build smaller and cheaper. Then as a community wins. So we make a deal - you could pay this to me, I do this and you saves the build of the wastewater treatment plant more money. So the thoughts about this kind of more mutual gains approach is growing. Because I pay the sewer system [tax] to the municipality, I pay to the water board for the water treatment plant, I pay to the water board for the water system. So I think it's already, we're coming more together as one system.

38:12 – INTV: OK, and do you think that that trend is going to continue, and do you see any issues with it?

38:21 – D13: Yes, of course. Well, I think we are picking separate things out of the basket that we can do together, and which still aren't politically difficult or financially difficult. We put work together for example modeling, measuring overflows together with for six other municipalities and we have one system now and all these systems should communicate with each other. So that's the goal we are going

to. We need these model first, so sewer models, water treatment models - these must interconnect to them to get the most optimal optimize results so we can take the most efficient measures. That is what is changing.

39:14 – INTV: And how did this come about? Was it led by the technical people or [others]?

39:22 – D13: No, it was led by the, the country's government. We have spent in about since 2012 1.4 billion euros for the water system, the sewer system, the water treatment plants. And the government said - we see if you work together, you can save money So we had to work together. There was no [choice], we had to work as water board and municipalities together on these issues. At first we didn't trust each other, of course, lots of miscommunication and distrust We solved this by using the mutual gains approach, and through this method we came more together. So we work with each other more than 10 years together in a community, in a network of municipalities, the water board, and now since several years, two of the drinking water companies together. Because they all, the water is the start of the change - the drink water, the wastewater in the sewer system, the wastewater in the water treatment plants and the wastewater we can in the future use agricultural purposes. So it's a circle what we're working on…

40:57 – INTV: And is this approach specific to the W region?

41:02 – D13: No, every region has this obligation

41:12 – INTV: There is, a couple of bigger questions that I'm trying to get, like: what makes it perhaps easier to work with, collaborate, be creative with other teams and what makes it difficult? Do you have any thoughts on this?

41:30 – D13: Personal connections - if you, if you know each other, it works well and you have to, learn to know each other, that's quite important. And if you're in a meeting - you're quite different than if you know each other. So, we had a whole series of meetings and all kinds of things to know each other and our different problems- That's it - so the first I have to know my counterpart, if I don't know him, can I trust him? So you have to build trust with each other and then you do something for eachother, you do something for me – that works much better. So the first thing is to trust each other, and when you trust each other and you have a good connection, you can create thing. So that's the part that's most essential

42:25 – INTV: Yeah,, you kind of have to have a relationship before you can start.

42:28 – D13: Exactly

42:29 - INTV: And so is the opposite, the things that make it harder not trusting people, not really knowing them? That makes it harder?

42:37 – D13: Yes, of course yeah. And well, different interests, different goals. Money is always important. Those are the most important things, I think.

42:56 – INTV: You mentioned different interests and different goals, which I'd like to understand a little bit more, but it reminds me of what you mentioned about your having a conflict with a manager who had different goals. So two questions coming out of that: Are managers typically like technical people, or are they not so much?

43:19 – D13: A lot are the more technical people, but the job we do is not only technical, it's a small, very small part from my job. Financially, personal problems, financial problems, complaints, uh administrators or complaints, letters, policy pieces. A lot of meetings, and then we have a part to do our technical jobs so that and they are very busy with all these other kinds of things.

44:00 – INTV: So, they have to have some technical, but they the bulk a lot of the work is more of the managerial side of things?

44:11 – D13: Yes, yes

44:12 – INTV: And how do you align or manage different goals and different conflicts? Is that something that you've had experience doing?

44:31 – D13: Well, there are two sides to a problem - you can face it from above from a larger, works - I hate also all kind of policy pieces that are using large words – or you can do things from another basis perspective I'm trying to say that, if you have your basic job, well done - so if you know alle about your sewer system, do I know how does it functions? Do I have enough money for it, enough people for it? And that's basic -then all the other things can go much better. But your basic information has to be good then you can solve or answer each question. So the basic things you have to do have to be OK. You have to know what your system is. I have to know when I have to replace it, you have to know if you got enough money, you have to have a policy. You have to have all kinds of information so you can show I'm in control of my work for that part. And then the other parts is related to that work, but it's much easier if you have those kind of things dealt with.

46:13 – INTV: OK, alright so you kind of need to make sure the essentials are in place and you know you understand exactly your system and then…

46:24 – D13: Because we have the term asset management, yeah well, what's asset management? I still don't know. It's, a word that is invented to right things that are wrong. If you don't have the data in your system in order, then we do asset management services – so an asset manager checks it. But what you need is someone who sits, everyday behind the computer and compares - that's good etc. - that's something else than asset management…very expensive, asset managers who use lots of graphics and nice with boards, but the most important job is the man who puts the figures into the computer, who checks facts, who does his work right – then you don't need as many things, you have it already. So

that's the difference, where you now see lots of asset managers to change the things that were going wrong, but if you have these things right then you don't need the asset management. You know when you have something great, you know if you have some money - that's asset management. But we say it's just an ordinary job, which you always have to do it - you didn't do his job right…then, you don't need it.

47:49 – INTV: Yeah, that's a very good point if the people that work with the system are conscious of how it operates and where the weak points are, then in essence they are already managing the asset….

48:01 – D13: Exactly, why do I need this and management? That's just doing your work, but you have to define, everybody defines doing the job well [differently], there's a difference in it, and it depends on what kind of you view you have on your job - I want to improve the system, so I find weak points, and how can I improve them? How can I better the system? I have people who are very good, better than me, often in systems and how can we change it? So you have to attract those kinds of people to do the good job. That's the most important.

48:49 – INTV: Yeah, and so improving the system, not just replacing it with the way it's performing, is one of your goals?

48:58 – D13: Yes, it's a continuous process, right?

49:05 – INTV: So we're almost at time. Do you think that, or have you replaced all the sewer systems? Do you think you can improve them all? Like where is W in the process of updating its whole system? Are you close to being done?

49:33 – D13: Oh no, but we will. It's a continuous process. We have 1800 kilometers, we can do about 17, 18 kilometer year. So every year we have to replace 18 kilometers to be up to date. It's very simple it won't never stop.

49:58 – INTV: OK, final question I have for you and this is still picking up with something that you mentioned about policy documents with big words. Do you find that policy has an effect, influences any of your decisions?

50:16 – D13: Of course, policy dictates my GRP, of course. The policy maker has to defend my GRP in the council. And policymakers for example decide on our advise of it is necessary to raise taxes so policymakers always have influence on plans.

50:46 – INTV: I read about this environmental law, I think that's coming into play, laws that are really speaking about kind of the climate change and the sustainability. Are you finding that feeding more and more into your work or not so much?

51:07 – D13: Yeah it, it's already but what you now see is an energy transition. For example, those kind of things, that more pipes in the ground - that will become a difficulty because there's no space, so it is difficult to do that. Other environmental [issues], heat stress so we have to have more trees, more

cover of the trees, for example - more trees in a space where there's no space for tree roots to grow because of all the pipes - so how we going to do that? They say we want 5% more but they don't say how we are going to do it and who's going to pay for it.

51:55 – INTV: They leave the details to those who have to actually deal with it work on it…

51:59 – D13: Exactly, and therefore it's not going to work- those kind of things - we have, in the city, we have the advantage when you replace the whole area with new buildings - that's for us advantage for all systems to replace with new systems which are more effective and more environmentally friendly. So all these kind of developments in the cities are positive for us.

52:31 – INTV: Yeah, great, excellent, yes.

52:33 – D13: And we don't have invest into it, we only have to advise so the right discission is taken, like . - the dimension of the sewer is mostly for the rainwater, so we do something to get this rainwater from the buildings at location to the groundwater that is, it's perfect.

END

Interview Transcript – D14.R10

R10: So from my perspective, there's a real steady, a little bit boring drainage systems knowledge and politics and it's something that's going on and it's very stable and nothing happens. And we always have to deal with rainwater, was the main thing – in the design of our systems, and say like in the 70s all of a sudden there was an urge for cleaning of the water from – we called it in Dutch "integralwaterweer" – which means that it's not just hindering for people but also the environment, so we had to protect the environment. And then we see all of a sudden, there's cleaning systems – water sewer systems – treatment plant – so in the 70's, we introduced the treatment plants and from then on it was really boring again in a way – and all of a sudden we see this urge for climate change and it comes and we see two things happening, I think, important for the sewer system, is the extreme (weather/rainfall), but also the change in the normal rainfall. This implies innovation in the sewer system but not everybody is doing that so – this is an urge for innovation and it asks for a new governance to be able to do that….

INTV: So, the first question is for me to understand your role and what you do exactly

R10: we work on three issues – maybe four, one is climate change, the other is climate is adaptation – so the energy change, the water aspects and the drought and the heat – we work on participation of civilians, normal civil world – not just in the public space but in the private space, we combine those two and how can you interact and get people to collaborate together in those…so my projects are mostly on a combination of those three. Not always because, the combination of energy transition – less CO2 – if you look at our work, on one side we're just trying to get less CO2 but on the other is okay, it's going to be there so we have to do something to prevent our country from flooding – so we try to do these two. And it is interesting to combine them in the neighbourhood, for a city mostly very difficult to combine. So it's one of the two but sometimes you can combine them but it's always in combination with civilians but it's inherent in our work for these solutions. So we work in cities like Zwolle, which is in a delta but also in Laager, we call it the "heuvoldemede" – there are a couple of towns in the Netherlands that have a little bit more altitude difference so we call it the "heuvol"…so there's quite different than Zwolle – one is completely flat, the other one has lots of difference in height. And the interesting thing is that the villages with this changes in height have more problems with sewer systems and with rainwater because it just gets from high to low. So if you look at, governmental cities in the flat areas – I see a tendency to see sewer system and the controlled sewer system as asset management – and that's their main goal. So if they write anything, any policy, it's always about this asset management. While the program [in Dutch] has changed because all of a sudden you have the normal rain rates, once 20 mm is going to be 24 mm – so things have changed but they close their eyes to it in a way – their just maintenance, how am I going to get the money…

INTV: and why do you think that i…

R10: So my working area is different in those areas - we combine it with …if I would think about your question – in those areas where there is more slope, you see there is a bigger urgency towards doing things against climate change because all of a sudden, the stress tests, you know stress tests? The stress tests in those villages is life because it happens, it happens first time, second time again and again, and the "wethouders" which are the councillors, they see it as an [gaplakproblem?], as a problem of society and not a problem of maintenance. So they think of it as this problem has to be solved and we have to solve it together. And one of the things that must be done is that the solution is not just everybody doesn't do the same thing but the solution is sometimes on the hill we have to do something different

than down in the village. So the urgency in those areas is bigger than in the flat areas. And, you probably know or governance system, law system with the [afvaalwater…soortgelwatersort…]….For your knowledge there is this "waterwet" which is the water law…and government has three obligations: one is sewer water (afvaalwater) and they have to collect all this water and bring it to a treatment system – that's an obligation – they have to do it, it's called a [zurecht…plithing]. The second thing they have to do is collect rainwater if it is for an individual not reasonable to collect and manage it themselves. So what we see in the Netherlands is that 95% of the […..flak] is waters through sewer system to the treatment system. So in normal systems we probably think it's normal to collect the rainwater as well. The third thing they have to take care of it the groundwater level – they are not responsible for the effects of high GW levels but if they can do something against it, then they have the obligation to try and do it – which is different from an obligation to – they are not responsible. But it makes a big difference in approaches. So the real obligation is towards the collection of the sewer water and there's a favour, they have to check whether they can do it, towards rainwater and ground water. This is legally, in every policy piece there has to be something on how are we going to do this in our water system, in our city in our village.. so this is an obligation. Now all of a sudden, we get this climate change – and the question is what is the impact of climate change on those three issues? And you can easily say – the extreme weather…you have to take care of the rainwater, isn't it? So you can do something gif you want to. But from the perspective of the sewer system guys, that's something that's far-fetched, that's something that has to do with surface change so it's different…and it's extreme…so what you see in some cities is that they have separate policies on sewer system and groundwater and rainwater, which is connected to the sewer system so your normal rainfall, once every two years, so many millimeters etc. Then they have governance and policies towards climate change, they separate it actually really so there's two different things: these things have to be paid by whoever, and the other things have to be paid by sewer system payment tax – so there's two completely different and if you integrate them, you have to want it. You have to want it – you cannot say, I'm not doing this because I have enough problems with my asset management – this is the difference where some cities see "let's try to integrate it because there's possibilities to integrate" and others say "we don't' have to because we only have to do more connected to the sewer systems and so we don't see it as a different thing". And there's not just rain, there's also drought – there's heat…that's all climate change, it's more than just water...

INTV: So it's kind of separate in their mind: sewer is one part and everything else is climate which they don't really have to deal with

R10: yes, and it comes from another money system so it's not the same tax thing, it's a little different

INTV: And will it be different people as well? The sewer guys are just like sewer and…

R10: Yeah, and you know the Netherlands, we're very organized – and the civil servants – they are working on the sewers, they are working for the green…they have their own… problem area that their working. And we all want to work integrated but that's really a big issue. They all have their own tasks, their own policies, they have their own targets so working integrated is pretty difficult and climate change asks for a bit more working. So this is.. they are civil engineers and they are like "let us do our jobs, don't talk about those difficult…"

Y: it's a hard ask. You mentioned, that to even to integrate – that people have to want it, in projects you've worked on where they are integrated, how did those projects start? Did it come from the municipality…?

R10: Okay, so one which is in example in the Netherlands which is unheard of is in Laaher. I was hired to help after the city council had said we have to solve to this problem which is a [maashaplak…] which means it's an issue which is more of a society problem. So imagine this little village, there's a rain in 2014 and it's a heavy heavy rain, 40,50mm in an hour and water is coming through the sewer system, up in the village below and it's sewer system, dirt everywhere, and this is the so many time in twenty years or something. So the local city says this is the end of it, we're going to change this, we're going to do something about this. So they hire an engineering company and they made a plan and they say if every private owner will disconnect his rainwater from the sewer system, the problem is solved. And we do somethings in the public space, some [water] bodies and it's ready. So they calculated the cost – they calculated the cost for the public space, they didn't calculate the cost for the private owner because it's his responsibility. So this law that we talked about, which says it's not our obligation to do it, we don't have to take the water, if you can, you can do it yourselves then you have to do it yourselves. So they took this separation, and what happened was a big riot, everybody was very much against it, and they say "we'll start rioting, we have to pay so much money for it, we don't have any benefits from it because everything is happening down there" and "why doing it down there…….you can't even take the rainwater from the sewer system because there's everywhere water…." So, entering me, what I showed is that under normal circumstances, with normal rain, the sewer system wasn't functioning already. So I could prove that in normal rain, 20mm an hour, water was going into the sewer system and came out already a little bit – and [I] noted that this is an obligation – it's already not allowed to happen. So I could show, if you have this you can do two things – you can change the system and do water system works, 60 million and you can do big, big sewer systems to collect the water, __ million, or you can do it together with the private owners for 50 million, which is cheaper. And if you chose from these three, four [options] and you choose the most cheap one which is 50 million, then you can also say, this is for your benefit as a village to pay it for them. So I could change the whole system and say "we're going to do this" but it's not going to be the owner who's going to pay, but the city is going to pay. And we just raise the sewer tax, 50 euros a year – and the city council can do it themselves. So I told them, loads of people and they said, okay this is a good solution. And the good thing was, now we don't have to do everywhere the same thing, we're taking the responsibility so we can do the right thing, the right place, the right moment. So we made a whole plan – this means that we looked very much to where water could be collected and where we could put water in the soil, and things like that. And brought it back to the council, and loads of people again and now it was okay. And we made it into a plan, and now we are doing it. So this is a totally different approach but it was solving an actual problem. And the city council was not interested in how's any other government doing it – we want to have this problem solved. And they saw that sharing of the cost was the way to solve the problem. So by accepting it as a civil problem, as a problem for the whole village, it kind of gets solved that way. And try it in other areas and it's a much more difficult because there is no urge for government to do something

INTV: So,these city councillors, when the discussion was being had on what to do – were the engineers and urban planners involved or was it more at the city council level that that discussion happened?

R10: At the city council level. I did all the groundwork.. the first engineering was the different approach – private owner, private price, and my thing was we have to counter it – I brought it to the council and that's where the discussion takes place. As a city civil engineer you cannot change things unless the council agrees

INTV: And so after the city engineers had come up with this plan, there was a lot pushback from the local citizens – which makes me ask, did they involve the citizens in that decision?

R10: No, and I did so, what I could do, city council told me to do that as well – as I explained, and that's why they always ask me as well, because we always try to do those three things together – work together with people as well. So I've been speaking to ten percent of all the local people, loads of people, giving them the opportunity to codesign, like we'd like to do this one, this one, this one – well, we're paying it together so what is the best thing we can do you think. And we also divided the city in little districts, three four blocks/streets. And for every block we made a small plan and we discuss this plan with the owners, house-owners. And give them the opportunity to – this is our goal in this area because we have to keep the water here, or we have to take water from another area or whatever - - this is the goal for this area, we have a proposition on how we can solve it so we have the money for it in one way, but we cannot [sell it, check to] see if we can do it another way – your ground is your castle so you have to say yes, otherwise we can't work there. Although we did put in a little line, as it is important that everybody cooperates otherwise the system wouldn't work and we had to choose this more expensive alternative. So what we said is that in every area, we discuss the solution, the contract is paid by the city, we do the talks, we do everything, and if you're not cooperating and the rest of the area is cooperating, then you get one last chance then you're not allowed to connect, to be connected anymore – we gave you an alternative, we paid for the alternative and if you don't want to cooperate then sorry it's your problem. And that's the moment that they can go to the judge, and our thing is that in that specific moment then we can fall back on this two sides and say we did everything we could, we gave them a reasonable alternative, we're not obliged to do it – so who's wrong or right…we're right so…but it's a different approach

INTV: So, did the measures, have they been implemented already?

R10: Yeah, we're working on them now – it's I think 400 houses now, three or four areas

INTV: And when the city tax was raised to cover the cost, were people okay with that? Or was there pushback?

R10: Actually, it was an electoral thing, it was 2, 3 years ago when there was elections. There was one party that was like, we don't have to do this, nobody wants it, they're just trying to look away from different problems from the past, but it was really an issue in the election – but they didn't win – they won three extra city in the council – so there were some people who didn't want it but…

INTV: Eventually it happened

R10: Yeah, yeah…but another thing, in a sense – one of the projects we started with, in the center of this village, there's this common area, like a square, park and there's a water thing in it and it used to be groundwater useful but it's [hiver] and there were trees on it… and the plan of the city council is to…when it was really raining very hard, all the water gets there [to the square] in the old system so we had separated all this areas, and this area in the center where all the water comes from [goes to] – everybody had taken control of their water but in this little area, they have to control their water as well. So we had to find a space so we could collect the water so it had to be in that park, in this common. And there were a lot of trees in it and we had a plan to lower the surface and make kind of an arena in it. And the folks around it were very angry about it and wanted to save the trees. So again there

was a political issue about it and now we changed it and now we changed it and we had a more subsoil thing to take the water – but there's always lots of discussion about it but it's good I think..

INTVYeah, with the locals. So, when the locals pushback on design, when they have reservations do you, re-do the design, between the choice that you make and implementation, how many iterations go round and who is in charge of approving the final thing and saying this is what we're going with in the end, no matter what?

R10: Yeah, that's difficult because, in a way, if you look at it as the public space, and the private space. The owner of the private space ahs to agree with your approach. So from a helicopter view, we see between the roads, the private space and we have an issue for those space – so we try to keep as much water as possible and we talk about it with certain – so we have, we said okay, there has to be an alternative for the rain collection to the sewer system which is for normal rain and if it starts raining heavier then in normal situations, the sewer system couldn't handle it as well. So we try to keep the water that will flow through your garden, we try to keep it on the borders of your property. And, about these things we discuss with individuals how we do it on their property. So there's an overall view on it, which is a goal for this area – that's something we discuss in fact they have a master plan, which is discussed in the city council. And this master plan connects little areas which have all their own goal. What we've done is we've designed the solution which is not definite, this could be it, it could work like this – this could be the price, we think this would be a fair price. And now we discuss with locals, and say "what do you want" and if it's getting more and more expensive, because you want something special – okay we can do the special but you'll have to pay for yourself for the extra money..does that answer your question?

INTV: Mostly,….the second part was who decides?

R10: There's an opening, our thing is if nobody accepts it – we have our own solutions, own design – but most of the time, 80% of the locals think it's okay and maybe 20% says no. Then because we paid for the 80%, because we gave them an alternative, then we can say we decided as a community to pay for this solution, that means everybody has to do it otherwise the solution doesn't work. So we are not allowed to put your water on the sewer system anymore, we gave you an alternative, you don't want it, okay then you're responsible yourself. And if you don't go agree, go to a judge and you'll see we can settle it because now the "waterwet", the water law helps us – we've done our best, we've done what we can, so there is a hierarchy.

INTV: …From your perspective, what would make it easier for more smaller municipalities, or municipalities in general to be innovative, to try the blue-green, to do something different from what they are doing now?

R10: First thing is depending on what kind of an area they have, then the urgency is big and the attention is different.. if you look at small counties, small cities, there's a big problem with the number of people, the capacity so they have an undercapacity, so if they can do something else they prefer to do something else. And if you look at innovation, they work together in work regions so that's the place where they would connect and pass on innovations. But, as they are selected on their asset management qualities, there's a different level than being a strategic…so in the same, if you look at the big city, there's somebody at the level of strategics, there's somebody at the level of tactics and somebody for operations. And in the smaller cities, you see people it's mostly on operational level, so

it's difficult for them to go up towards the level of strategic things so they ask engineering companies to do that, or they ask other villages or cities how to do that. And the problem is, that the creativity and the innovation has to come from engineering companies or from – it sounds very complicated but there's a tendency to – if there has to be something strategic, the can either renting (hiring) an engineering company and the question of them, the job description of it is already so so based on implementation, that there's not much room for innovation. And companies nowadays are not that much interested in showing that you can do it some other way – they are much more into, you ask, I'll do whatever you say. So we have really big engineering companies and they have very standard solutions. I think it's very important that there's more small companies doing innovative things, different things. Sure there's policy makers but I think the issue in the, for example, in Amsterdam, they have Rainproof, and rainproof is a program where they, with the starting point is climate change has to be something that you have do yourself, it starts with the property owner and he has to be conscious of the change in the world and he has to do things differently, and they give examples of how you can do it. And it fits a little bit, if you look at the flat [areas], if everybody is keeping a little bit of water then probably…but if you look at the problem with heavy rainfall, and it flows to someplace and they look at how can we protect this place, and they're not looking at how can we solve that the water flow to that direction. So it's very end of pipe solution, on the one side, and on the other one [veustsijn] which is consciousness is a very important thing. So when they came to Laar[ge] to give their help, we're like so sorry this is not about consciousness, this is about a good solution and how we do this together and how we are going to see this as a communal problem and not as a private problem. But it's a big difference, and there's a tendency to see it as a private problem and not as a communal problem and I think as soon as we start as a communal problem then you can use a different approach, then you can look at it from a perspective of okay, where can I do this, where can I do that. But from a private ownership, you cannot do that – you see I'm trapped, I have to keep the water here, but it comes from here…but that's not really a solution, it's too small a [scale]…

INTV: Yes, and it puts the impetus on the landowner to do stuff whereas if it were at a larger, more communal scale, people would feel like they were all working towards something…And how, would that work in reality – would it have to be that the council says, we're doing this for the society or the citizens are the ones who say, we want to do this, can you help us?

R10: Well, there's several ways to do that – I try two roads for it – so if they ask me to work out a strategic plan, I show them what happens if you do it collectively, together, or what happens if you do it alone. And I calculate all the costs, so I calculate the costs for the private owner as well as for the [municipality]…so I compare costs and the next thing I do is I change rainfall, I make it more and more and more.. so is there a point of return, is there a point of okay, until 60mm, collective measures do work, and after that it's protection, then your project/system changes from preventing into to protecting. So, that's a way – but that works mostly if you have difference in height. The other thing that I'm trying to do now in the experiment is in an area which is built in the 50s, just after the war – we started rebuilding "doink" places – if you look at the Netherlands, our neighbourhoods are very - it was built in five years [block, block, block, ready] – so there's all those areas that were built just after the war, and their sewer systems were also built just after the war – in ten years time the whole sewer system in built, the buildings are built, the roads are built, the whole thing…and now it's 60,70 years later and the sewer systems have to be replaced after 60, 70 years. So if you look at these neighbourhoods, the asset manager has a great idea about maybe we can reline them and okay, that's a

nice idea so we just keep them there. Okay, but if you reline them, the diameters become smaller and in a way we have this problem with the extensive rainfall now. So at the start of a project, when you put down your aims – let's call this the start program – in a way that program has changed because nowadays, the rain that falls once in two years was 20 mm per hour and it's 24 mm per hour – and now that is a problem because this is something that has to do with your sewer system which is collecting the water – so what we show them is we could reline them and we just calculate how much concrete and how much space we have to detach from the sewer system. And we use the difference in cost for that area, so imagine it cost 500euros per m to change the sewer system, [but] if you reline it's 50 percent cheaper. So what we do is we take this 50% and we try to change the neighbourhood with different things, and we say now it's in your own good, we save the money because in our plans, in your policies we know this is coming – if you really follow your program, you have to conserve more water – so relining is not an issue unless you do it differently. So, it's to open the discussion, to see okay, we could do it this way. So we can still reline which is cheaper and but then we use the money to… and sometimes it's a bit more expensive but it's another way… To stay in the asset management area a bit, show them that they could do different things, and collect a little bit of money from other things if necessary just to show them that they can solve the excessive rainfall as well

INTV: So do you think from the asset management perspective is really just to reline or replace with the exact same thing… do they ever start to consider other options or is it just usually pipe?

R10: In a way it is, sure there are enlightened civil engineers but they're in a pattern so the money that's there, if it's not really an issue, it's difficult to show that it might be an issue so stress test helps but it's still a bit surreal… so they have to make – if you look at the role of a civil engineer in a city, it's not really, it's somebody who's working on sewer systems things – so they're not that important, they're not developers…if they all of a sudden come with a big issue… it's not their nature to put themselves in the foreground, I think

INTV: And, cost – is that a big consideration

R10: Yes, sure. So far, we've got this system, I think it's a very good system of the sewer tax. So all the money which can only be spent on sewer systems, but in the total costs of citizenship, we pay taxes and we pay taxes for the water system, for the waste, buildings, and so if you – I think it's about 300 euros, some cities more expensive, some a little less. So if you go to the city council and say, look we see this big change coming, in the future because this whole neighbourhood has to be done, it's sixty years ago, we see it coming so we'll just put the tax a little bit higher – so for example they are very happy if they can, say you have this policy and you look ahead, not just four years ahead…more years because there might be a really big thing coming toward, which is true because, if it's true that sewer systems only exist for sixty years then one of these neighbourhoods, all of a sudden that's lots of kilometers and lots of euros. So we start looking ahead and we say if we start raising the sewer tax now, just a little bit and a little bit more, then we can already flatten the curve in a way…but if you see that they can, instead of they can have a technical life of 80 years instead of 60 years then we can postpone the tax raise and that's nice…raising is always a difficult unless the city council sees it as a communal problem, like we have in those villages where it is more urgent and it is more – just because of is not good enough – the urgency is not felt in a way. So my other ways to do, for the same money, try to solve the whole problem is more convenient for them.

INTV: And is the money generally enough to deal with the problems now, is the sewer tax enough?

R10: Yeah, I think it is yeah – I'm not sure but I know that if you look at the worth of these assets, it's 180 million/billion, and we pay 1.7 billion per year for maintenance – s o that's two percent or something which is normally pretty good. I think there's an undercapacity which is a problem, which is more of a problem in this case than the money in this case.

INTV: and the undercapacity, do you think more engineers, more enlightened engineers, more urban planners, where do you think that capacity needs to happen?

R10: Yeah, there's just not enough technicians. So they have too many tasks and too little capacity and they tried to find a new one, but there's not enough enthusiasm and, the other thing is the levels. So if you look at Amsterdam, they have 15 strategic engineers. But they probably need 16 or 17, so there's an under capacity always and if you have a real low capacity, it starts to be a problem with the technical, operational and strategic. Everything cannot be in one person. So imagine there's one person and you select this person on his qualities and the most important quality is maintenance, which is really operation projects – do it, contractors whatever, and now you ask the same person to make a strategic plan and to talk with the mayor, that's different. So the bigger the city, the more engineers, so there can actually be 2, 2.3 FTEs, say one for maintenance, one more strategic, technical probably…Arnhem is a good example – in sofar that Arnhem is city where there is a difference where there's a height difference but it's also a larger city. So what you see there is that the problem is big enough for council to see it as a [communal problem] and there's enough engineers to fill the gaps – so those are cities that have got more innovation

INTV: Why don't the small cities have as many people? Why do they just have one person, for example?

R10: First of all, there's not enough technicians, not enough civil engineers – coming through school – interested in sewer systems, to study sewer systems, and then it's easier, more interesting, if you're higher educated to work in a bigger city because then you can also talk about technical and strategic things. So if you're for innovation, you're probably more from university and not every, only the bigger cities have university schooled engineers, mostly it's just MBO…HBO and university, we have…and the operational guys are mostly the MBO and a little bit of the HVO and their tendency is to do it according to the rules, they are not educated to innovate – probably innovate in their project but not innovate as a concept, not a system change…

INTV: That's really good to know….

R10: Because the engineers are paid by – there's a benchmark for how many people you should have – in the GRP you have to check whether you have enough capacity and most of the – so you use the benchmark, you check whether you have enough capacity, you pay the engineers by the tax, so there's no problem actually so there must be enough money, so then you check if there's enough and every year you see there's a lack of engineers. And they are conventional, civil engineers are not the most…

INTV: creativity is low on the list

R10: I think the most interesting part of civil engineering is the urban design. Like my company, we're not claiming to be civil engineers, we're claiming to be urban designers so we think we think the biggest issues nowadays are climate change and enery transition and most of the money is involved there. So we see it as an issue to reshape the existing urban areas. So I think it's very interesting to work on this nowadays so it's not the main --- I'm not very interested in the – If you look at civil engineering in the

structural side of things…but we had an interesting things and I've been in the [dutch] which means…Rioned have a report of the state of the sewer union…. And they looked up on how many people working in it.. this bench mark is also something that must be from rioned…

INTV:….

R10: that's definitely a big problem – one of our issues, this is definitely the big problem, the silos – so what we're experimenting with, we do this around five years now – we adopted an urban area of the 50s and we're trying to use all physical projects to sustain this area – so every project we try to develop in a way that they contribute to the people, planet profit aspects of the area – so can we do with local engineers, can we do with local contractors and what we discover is that, as a urban enterprise, corporation of civilians, and what we do is as an engineering company, we sustain, cooperate with them, I'm actually in the council of them. And what we try to do is look at the projects that the city is doing and challenge them in we can do it better as a local contractor in a way, and in that way we can combine projects of the city council. But the problem is we look at all this project from our point of view, from this neighbourhood, everything that happens in this neighbourhood we like to combine and use it for the development of this neighbourhood and we talk with all this silos that have to do something in our neighbourhood and one says in has to be done in 2025, one says now, the other says never, 2050…and what we try to do is to combine this so as we do this, I think this might be a solution, because this way we can just pick the right things from this silos – and they don't really mind as long as they can fit it in their program. Like, what I explained, we know in this area, that the sewer system has to be relined, they want to reline it – we show them that the program has changed but we understand that they want to reline them – and we say if you reline them, we'll take care of the change of the development plan, planning system where we combine things… and I think that might be a way to get more integrated projects and to challenge them to innovate. So that's a completely different approach which is something, I think, that might, we truly believe in it more, we're thinking of trying to do this in more areas as a --- can you imagine?

INTV: yes, it sounds like it takes advantage of local capacity which is important especially if you want to do work in a local area

R10: because it's too hard for those columns to change from asset management to integrated…so you put the area first, so you look at an urban area – that's your goal to improve it -- so you see like a puzzle, and everything you have to do in an area, so you try to use it to get the area better so you try to get the economy better, get to make systems stronger… just a different approach from the silos..where you look and you need [pick] a contractor for those kinds of problems, and those kinds of problems..and never mind where it is. So it's a totally different approach.

END…

APPENDIX C

Code (Hindering & Enabling Factors, HEF)	Definitions	Example Quotation
B&F-Communication	Explicit mention or discussion of communication with external or internal actors as an important factor	-
B&F-Community Engagement, Participation, Empowerment	Explicit mention or discussion of public participation in project or decision-making process	**D9:R9**: *"What we did here was we focused on, we used public participation – we did a questionnaire online, where we asked different questions about sewers – what do you think is important about sewers? So, should it be cheap, should it be sustainable, should it simply just function well – and we used those answers to put some perspective, some different emphasis on parts of the plan.."*
B&F-Fragmented Roles and Responsibilities	Explicit mention or discussion of separate roles and/or unclear responsibilities of practitioners	**D2:R2:** *"sometimes the people of green think the people of water or blue will take care of it, and the people of water think the people of green will take care of it…so with all those mixtures, everybody thinks…[somebody else will take care of it…]"*
B&F-Information, knowledge, understanding	Explicit mention or discussion of the presence (or lack) of technical information, knowledge and understanding of practitioners	**D5:R5:** *"And it's, what makes it difficult, we don't know exactly what kinds of rules you have to take or make to do it good for climate adaptation, because it's rather new. And we don't have a very good recipe book for solutions. So it's trial and error. "*
B&F-Institutional Framework (Uncoordinated)	Specific mention of lack of coordination across institutions or institutional mandates	-
B&F-Long-term vision/strategy	Explicit mention or discussion of a long-term vision or strategy, either at the municipal, regional, or national levels	**D4:R4:** *"it's [because] we have some policies that we already have been introducing around 2014, I think, where we already told ourselves that we have to focus on climate adaptation…so we have policies that we focus on climate adaptation and we're now trying to implement it even more "*
B&F-Monitoring and Evaluation	Explicit mention or discussion of the presence of monitoring and evaluation of projects (pilot or established)	**D1:R1:** "*..And the other thing is also, is when we are doing pilots is that we give more consideration to collecting the evidence that it works or that it doesn't work – the honest evidence. That's a thing that I think would also help.."*
B&F-Organizational committment	Explicit mention or discussion of the presence (or lack of) organizational commitment (i.e. private organizations, not public/governmental)	-
B&F-Path dependencies (technocratic)	Explicit mention or discussion of a dependence on previous or traditional ways of working, or institutional organization	**D1:R1:** " *The other thing is it's more the organization that we have a governance model that is very much inline with the traditional way of water management so basically, arranging our sewer system for example – the more technical aspects of the water management which are the traditional sewer design are [in] most municipalities separated from the spatial planning design.."*
B&F-Public/Political Will	Explicit mention or discussion of the presence (or lack) of public and/or political desire and will to act (in a climate adaptive manner)	**D2:R2:** *" And you know the "wethouder", the mayor and [councillors, alderman]…like in Breda, we now have an alderman [councillor] who is very into blue-and green and at all kind of, you see him on internet on LinkedIn, and everywhere you see him and everytime it's about the blue-green transformation and that moves [brings?] a lot of power to the organization, but when you have the wrong alderman, who say let's do it just the way we always did – then you can do what you want but the change won't come…you need those aldermen to create the power.."*
B&F-Regulatory Framework	Explicit mention or discussion of regulations and legislation that influence options available to decision-makers, infrastructure managers	**D3:R3**: *"So that is another aspect, the driver of the Delta Programma, and the program of the [klimaat adaptatie] from the national government to the local government.."*
B&F-Resources - Financial/Capital	Explicit mention or discussion of the availability (or lack) of financial resources	**D11:R11:** *" I think the financing is mostly also a problem, because when you want to innovate something, you mostly first have to – you first make the costs and then you get the benefit. And you need people who want to invest first, and that's not so common – mostly people who want to do that, they have their own firm, they work for themselves – but they are not working within the municipality also"*
B&F-Resources - Human/Capacity	Explicit mention or discussion of the availability (or lack) of human resources or capacity, such as personnel, or time	**D13:R13:** *"So for our whole area and we're working well together and that's for, because of the personnel problems, there's a large difference in knowledge between smaller towns and larger towns, cities - so there's a large difference in knowledge, in possibilities"*
Bry - Accountability (complex accountabilities)	Explicit mention or discussion of how municipalities, practitioners, held accountable for climate-adaptive action/decision-making	**D9:R9:** *" Yeah, but then what they do is they send questionnaires to all the municipalities, and if you don't score high on it, they publish it, and they send that kind of information to the city councils, then you get the questions from… why did you have such a low score. So, it's not really an obligation but they use it in a way as an obligation"*

Code (Hindering & Enabling Factors, HEF)	Definitions	Example Quotation
Bry- Trust and committment	Explicit mention or discussion of trust or commitment between actors as a factor in collaboration and collaborative decision-making	**D13:R13:** *"So you have to build trust with each other and then you have, I do something for you, you do something for me – that works much better. So the first thing is to trust each other, and when you trust each other and you have a good connection, you can create thing. So that's the part that's most essential"*
Bry-Immediate, Intermediate, Long-term goals	Explicit mention or discussion of presence (or lack) of goal-setting and goals over short, medium and long-term time frames	**D3:R3:** *"Well, they committed, all the municipalities together committed that they will be climate-adaptive in 2050. And they have to work climate adaptive already in 2030. "*
Bry-Multiple Institutional Logics	Explicit mention or discussion of different institutional aims and/or approaches	**D9.R9**: *" I think if you look at the council, their focus is mainly on climate change and public participation and that kind of topics. If you look where the money is, it's mainly sewer replacement. So there is a difference – the money is spent on replacement, it costs a lot and it's where the money goes."*
Bry-Pre-existing relationships	Explicit mention or discussion of pre-existing relationships between actors as a factor in collaboration or collaborative decision-making	**D13:R13:** *"Personal connections - if you, if you like each other, it works good and you have to, learn to know each other, that's quite important. And if you're in a meeting - you're quite different than if you know each other. So, we had a whole series of meetings and all kinds of things to know each other - That's it - so the first I have to know my counterpart if I don't know him, can I trust him? "*

Code (Decision-making phases/tactics, DM)	Definition	Example Quotations
DM-Initiation_Need	Decisions/ projects initiated solely by the need to address reduced performance (i.e. performance gap)	**D9:R9**: *"if they become 60 -80 years old then they replace them and to do that, the quality of the sewer is important but also climate change, hydraulic capacity, urban planning, housing zones, when they come up to the point that they have to be replaced, all the different departments, they come together and there's a project"*
DM-Initiation_Need-Opportunity	Decisions/ projects initiated by the need to address reduced performance, that also provide an opportunity to undertake unplanned works	**D11:R11:** *"I always say, there are not so many climate adaptation projects – there are a lot of projects who want to change buildings, who want to change the outer space [external environment] or something like that, and then the main goal is to do it in a climate adaptation way."*
DM-Initiation_Opportunity	Decisions/projects initiated solely by an opportunity (or desire) to undertake unplanned works	**D5:R5**: *"It was the inhabitants and the politicians of the city of X who said we have to change the railway into a tunnel – and that was the start of the whole project. Because the classification/zoning of this area was railway – there was a rather big area near the inner city of X, so it was a very interesting spot to make new housing, and new offices etc. And it was an opportunity when we got the tunnel, to make another part of the city in between."*
DM-Development_Design (custom, innovation)	Idea development by designing a custom-made solution	**D14:D10:** "*So I've been speaking to ten percent of all the local people, loads of people, giving them the opportunity to codesign, like we'd like to do this one, this one, this one – well, we're paying it together so what is the best thing we can do you think. And we also divided the city in little districts, three four blocks/streets. And for every block we made a small plan and we discuss this plan with the owners, house-owners. And give them the opportunity to – this is our goal in this area because we have to keep the water here, or we have to take water from another area or whatever - - this is the goal for this area, we have a proposition on how we can solve it so we have the money for it in one way, but we cannot [sell it, check to] see if we can do it another way – your ground is your castle so you have to say yes, otherwise we can't work there"*
DM-Development_No Search (ready-made)	Idea development by implementing a ready-made solution	-
DM-Development_Search+Design (mod, solicitn, benchm)	Idea development by modifying existing solutions or technologies to fit specific purpose	**D9:R9**: *"..we looked up for example information on how many public spaces there are, say 60%, 40%, private, we put it on maps, how many trees are there, what part of it is green, where do we expect the problems?.. over here it shows the places/cases where we expect the water on the streets, once in a hundred year rainfall event and then we started thinking about the locations, the areas where the should be something done – not giving a solution yet, but just these areas there is a problem over there. And then we looked up information which was about opportunities in public space, and a map where we showed the height differences – so thinking about where can we put water in, it's relatively high or low. And we, built up groundwater levels for example, this one was – also with satellite data you can see if theres a flat roof or a pointed roof. Also space we looked at the backyards, you can see if there it still, if they are already green or not, so you can have a project where you have greener gardens and that kind of thing…And then we put it all together, also the sewers and we made lists for every problem area, we said okay it's possible to take these kinds of measures. And we budgeted it… So you have a problem, and you have the solution, for every location.."*
DM-Selection/Evaluation_Analysis	Solution selection/evaluation by completion of technical analysis to compare or select between a range of choices/options	**D13:R13:** "*So each time we replace small sewer and we've done this for almost 20, 30 years - we had modeling for 20 years so - we looked in the model "what did we improve, larger pipe, smaller pipe...[in Dutch], spillway or large pump, or larger this…what is the effect on the function of the system? And if we have to put a pipe of 60 centimeters instead of 30 centimeter?"*
DM-Selection/Evaluation_Bargaining	Solution selection/evaluation by negotiation between multiple actors, to select, compare or modify a range of choices/options	**D4:R4**: : "*It took us three to four years to convince them, and a lot of talking. So what we did was, we created a community with the inhabitants and the housing company, housing corporation and the water authority as well and we actually took a step back from the plans that we had and actually made new plans about what kind of climate adaptation measures can we implement."*
DM-Selection/Evaluation_Judgement/Subjective	Solution selection/evaluation by drawing on technical expertise and experience with no additional justification required	**D13:R13:** *"Just thinking and looking at the map. In the past, before I was head of this Department, I was also project leader and I led the small team, that [did] the maintained systems, and with my colleague, I calculate pumping stations, all kinds of pressure pipes, all kind of things I did. And with my colleague who did modelling for the sewer system, we always on Friday afternoon put our feet on there on the table and we took a very big stick writer and, [said] well, let's look at the map - what can we improve? So it's a thinking process, but you need a lot of experience to see these kind of things."*
DM-Authorization/Implementation_Edict	Authorization (to implement) not needed: decision-makers have power to commit resources to action	**D5.R5**: *"Climate adaptation especially brings [gives] us much space to make our own rules but we have to make them formal by the city council. And that process didn't succeed at this moment, so we're in that process with the City Council to make new rules"*
DM-Authorization/Implementation_Intervention	Implementation by issuing a directive or indicating what people must do to comply	**D9.R9**: "*We discussed them within the municipality, we discussed it first with the MPs then we went on to the council, we discussed it with a small group within the council and we put it on the table, and I presented it, and I asked them, what do you think of it? And they had some problems with it but often they focus on the opinion of the public because that means a lot to them, and they said it was okay, they could use it. We had some proposals for them, and they often used the questionnaire from the public and their answers to choose one of the options."*
DM-Authorization/Implementation_Participation	Authorization (to implement) needed: decision-makers do not have power to commit resources to action	**D7.R7**: *"No, we do that together. So it's not how we work in Arnhem, we do that together. And when we decide that okay, we can do it better next year, okay then this is important that we talk with each other and talk about why and the reason and then decide together, okay then that's the best decision. But when I'm not, agree, or my colleagues not agree – then it's my boss to say [who decides]"*

Code (Decision-making phases/tactics, DM)	Definition	Example Quotations
DM-Authorization/Implementation_Persuasion	Implementation based on demonstrating improvements in performance due to proposed solution (i.e. reduced or eliminated performance gap)	**D10:R10:** "*And the city is sometimes they are very enthusiastic about it, and sometimes they are scared, because it's totally different than they are used to. And the project I was showing – this one with the relining system, it's actually to convince the city to work in another order*"

Code (Interview-generated, INTV)	Definition	Example Quotations
Alignment with road works	Explicit mention or discussion of sewer/urban drainage works undertaken at the same time as road or street work, specifically	**D7.R7:** *"And then can we see, okay in this street – I must do something, but my colleague he must do about five years. Then we take what we want to do the same time as the sewer. So everything in that street, we will combine to another. And then we start a project. And it is also possible that I have a sewer system that I must do in about ten years, but the street is very bad, and the street must be done now. And then it is possible that I do the sewer system, not over ten years, but also now"*
Climate change uncertainty	Explicit mention or discussion by interviewees of uncertainty associated with the impacts of climate change, especially in the future	**D9.R9**: "*...because there are so many uncertainties with climate change, so something has to be done that's for sure but it's difficult to say that you're done then you can have [handle?] a rainfall event of once in a hundred years."*
Cognitive/cultural resistance, barriers	Explicit mention or discussion of practitioner hesitation, resistance to incorporation of climate adaptation	**D12.R12:** " *Also the cultural blockages, maybe too strong – see the sector is a little bit hindered by cultural aspects as well. The craftsman, they always did it in this way, it appeared to work well so why should you change"*
Collaboration with others (internal,external)	Explicit mention or discussion by interviewees of working with others, both internal and external to their area of expertise, organization	**D2.R2:** *"But when you create as policy maker, more space for extra people, then they will see that with those extra hands you can come further. You have to do it together, and that will cost a lot of labour…and so that can make a difference. Just keep your hand up for the management – like, we need people.."*
Community demographics - income, education level	Explicit mention or discussion of community income level, education level or other socio-economic characteristics	**D1.R1**: "*...particularly in urban areas is that the areas that are most sensitive to climate change and most in urgent need for climate adaptations are also the areas where participation is traditionally difficult. The areas where you have lower levels of education, a lot of renting, little organization there. So that's an issue there* "
Community pushback	Explicit mention or discussion of community protest or pushback, in general or in relation to a specific project	**D9.R9:** "*...they went back to the houseowners and they said, well from the perspective of the law, you should process the rainwater yourself, but there was an uproar and there were so many discussions that they had to scale it back, they couldn't do it like that because then they you get back to the public council – they listen to the public – and if they disagree with the*
Community Representation	Explicit mention or discussion of size of community representation and how reflective of general opinions this representation is	**D3.R3**: "*So it's depending on very much on people who, what their aim is, and we heard that also from other municipalities who also had very much trouble with public groups which actually consist of very few people who block, who try to block all kinds of developments and also who ask a lot of questions from the government.* "
Cost consideration	Explicit mention or discussion of cost or money as a factor or consideration in projects, decision-making, or other	**D13.R13:** *"Cost is the most important one of course, and in the Netherlands, sewer management is paid by taxes and these are very strict, so we may only put our money in the sewer system, not other functions."*
Delta Programma/DRPA	Specific mention of the Dutch Delta Programme or DPRA (Delta Plan on Spatial Adaptation; in Dutch - Delta Plan Ruimtelijk Adaptatie)	**D3.R3:** *" So that is another aspect, the driver of the Delta Programma, and the program of the [klimaat adaptatie] from the national government to the local government"*
Design-maintenance (project phase) separation	Explicit mention or discussion of separation between design and maintenance tasks/responsibilities of a project	**D4.R4:** *Yes, maintenance is separate. But, and, normally they design the outdoor space and they create, and then we as a maintenance division, get it in our maintenance* "
DM Perspective/Attitude	Explicit mention or discussion of decision-maker perspective or attitude regarding climate adaptation	**D13.R13:** *"...it depends on what kind of you view you have on your job - I want to improve the system, so I find weak points, and how can I improve them? How can I better the system?"*
Ease of construction	Explicit mention or discussion of ease or simplicity of construction (of infrastructure measures) as a consideration in decision-making on alternative options	**D8.R8:** *"Contractors responsible for building systems prioritize different things e.g., expediency, simplicity etc. therefore systems not always built exactly according to engineering design/drawing specifications which impacts performance, or ability to maintain."*
External technical expertise	Explicit mention or discussion of the need for/use of external technical expertise by municipal staff	**D4:R4**: "we actually asked an external expertise who made the plan and they checked on what kind of options did we have, alternatives…"
Extra effort required	Explicit mention or discussion of the amount of effort, level of difficulty, extra work required to do things differently than current practices (design or structure)	**D11.R11**: "*...then it's important how difficult it is, how much work it is to implement such a technique – will people really do that. So it must be easy to do a pilot, if it's too difficult to do a pilot, then I think, even when it's very promising most people will not start a new technique..."*
Flooding - existing urban drainage issues	Explicit mention of existing urban flooding issues	**D12.R12:** *" there's a group of investment drivers, coming from flooding, also in the Netherlands. So we had a lot of nuisance from rainwater flooding, stormwater floods and they say okay, we have to redesign this urban drainage system because we need to re-route the stormwater to other areas, we have to build storage underground or above ground or everywhere…it's a complete new redesign "*
Freedom of choice, implementation flexibility	Explicit mention or discussion of freedom of actors to pick and choose which solutions to implement, out of pre-selected or approved list	**D5.R5:** *" So we made several smaller rules to fill that global rule of 50 percent intensive green... [and] the developer has the freedom to choose the way they fill in that rule."*
GRP	Specific mention of GRP, or "municipal sewerage plan"	**D8.R8:** *Municipalities were then required to develop a Sewer Master Plan, which included planning maintenance and replacement efforts, as well as funding and how it would be spent* "

Code (Interview-generated, INTV)	Definition	Example Quotations
Incentive to act: individual benefits	Explicit mention or discussion , of underlying motivation for public in undertaking climate adaptive measure	**D11.R11:** *"Therefore, I think you have to show some good examples and when people see the good examples are working and they are nice, I think it will be easier to do it...so everybody wants to have it just because it's so fancy – and then they want to change their garden – because when a neighbour has it and it looks nice, then we also want it..."*
Incentive to action: societal or environmental good	Explicit mention or discussion of underlying societal or environmental motivation for political action regarding climate adaptation	**D2.R2**: *"So we now realize that we have to mold the upper ground to catch the rain…because we don't see it as a threat but as a chance to get a better environment. Because when you take blue-green measures in the upper ground, you can, you don't have to enlarge the sewers. You also create a better living area so it's nice to work."*
Integrated approach	Explicit mention or discussion of an integrated approach to working	**D10.R10**: " *then next thing is – everything that is integrated, makes life more difficult. You have to work with other people together, and those columns [silos] are a problem again, you have together – this asks for collaboration with green people, so you have to go up to make a plan for green – can you imagine? Problem, problem, problem. So integration, if you don't have to integrate, we don't integrate. We tell each other we have to but we don't* "
Learning-by-doing, experimentation	Explicit mention or discussion of experimentation, for example - to develop rules, test or identify solutions that work etc.	**D4.R4**: *" I think it's going better and better, and we still have to learn. Because quite a lot of the climate adaptation measures are quite innovative and we haven't had a lot of experience with maintaining it so we are learning by doing."*
Local conditions, available space	Explicit mention of how local conditions or available space limit or allow the use of particular solutions	**D13.R13:** *"What's in the Netherlands also very important is the ground conditions, soil conditions. Our system lays in average 80 to hundred 110 years the ground. Other community, other municipalities, Rotterdam, Gouda, they're very, very poor soil conditions so the pipes always go this, they don't settle and they have to replace it after 30 years or so..."*
Maintenance consideration	Explicit mention or discussion of how or whether maintenance of infrastructure is a factor or consideration for decision-makers (DMs) or other technical experts	**D2.R2**: *"we are creating a lot of green and green means maintenance... it's nice and it creates a healthy environment but when you forget that it will create a lot of maintenance and you don't change your organization to have the money or have the people to maintain, then maybe about 20, 30 years we will say, let's skip the green because it's too much."*
Multiple climate adaptation goals	Explicit mention or discussion of multiple climate adaptation goals including drought, subsidence, heat island effect; also energy transition	**D14.R10:** *"we work on three issues – maybe four, one is climate change, the other is climate adaptation – so the energy change, the water aspects and the drought and the heat..."*
Municipal Council	Explicit mention or discussion of municipal council, councillors and their role in climate adaptation and infrastructure/asset management	**D9.R9:** *"We discussed them within the municipality, we discussed it first with the MPs then we went on to the council, we discussed it with a small group within the council and we put it on the table, and I presented it, and I asked them, what do you think of it?"*
Neighbourhood-scale renovation	Specific mention of large-scale neighbourhood renovations due to Dutch planning and designing approaches	**D13.R13:** *" we have, in the city, we have the advantage when you replace the whole area with new buildings - that's for us advantage for all systems to replace with new systems which are more effective and more environmentally friendly"*
Omgevingsvet	Specific mention of upcoming environmental law "Omgevingswet"	**D2.R2:** *"I'm trying to synchronize the sewer management policy with the environment, you know the "omgevingwet" environmental law…you have the vision, you have plan and you have the program, and to get everything at the right position."*
Performance criteria, durability	Explicit mention or discussion of important performance criteria for infrastructure, including long-term durability	**D7.R7:** *" then it's important, that for the rain, in my projects, I must hold a rainfall and we call that 10 plus 10%, and that's 40 mm in 45 minutes. So in my project, I must hold that rainfall."*
Practitioner skill set (operational v strategic)	Explicit mention or discussion of practitioner skills (or lack thereof) and suitability for task	**D14.R10:** *"So imagine there's one person and you select this person on his qualities and the most important quality is maintenance, which is really operation projects – do it, contractors whatever, and now you ask the same person to make a strategic plan and to talk with the mayor, that's different."*
Private Landowner Responsibility	Explicit mention or discussion of private citizens'/landwoner responsibility to manage rainwater (on their property and at its source)	**D9.R9:** *"if you look at Dutch law, it gives quite explicit tasks for houseowners. And if you look at the rainwater part of it, the law says that, they should be able to process their water themselves and only if they're not capable of processing the rainwater themselves, then they can bring it to the sewer system or the utility. And that means that, the starting point should be that houseowners should process it themselves, that's what the law says."*
Project type - new development	Explicit mention or discussion of new development project type	**D13.R13:** *"...But we built a new area, residential area, next to the sea so the wastewater transport is going the other way"*
Project type - renovation/redevelopment	Explicit mention or discussion of (neighbourhood scale) renovation/redevelopment project type	**D10.R10:** "*so this is a kind of neighbourhood where these buildings are built just after the war (in the 50s), so there's flat buildings around here and around there. And you can imagine that the sewer system in this particular neighbourhood is from the 60s so it's about 60,70 years old. So within now and 10 years, maybe 15 years, the sewer system has to be renovated."*
Project type - sewer replacement	Explicit mention or discussion of only sewer replacement project type	**D4.R4:** *"where we actually are just doing the sewer replacement so between the curbs, we're excavating the ground and just replacing the sewer system and putting it back, and that's what we call singular, so only the sewer system."*
Public-private space interaction	Explicit mention or discussion of need to consider both private and public space in climate adaptation efforts	**D11.R11:** "*We always say, when you look at the area of the municipality, 40% is about the municipality, is common ground [public space] and 60% of all the inhabitants – so when you want to be climate-proof, also the 60% of the inhabitants have to do a lot of work - you can't solve it only on the 40% of the area. So everybody has to do their part..."*

Code (Interview-generated, INTV)	Definition	Example Quotations
Risk consideration, aversion, novelty, uncertainty	Explicit mention or discussion of risk, risk aversion, discomfort/dislike of novelty or uncertainty as factors in behaviour or decision-making	**D12.R12:** *"they [blockages] are the same as for any innovation, it's new, there's no experience with it. You have to take a risk, and you have to invest in something which you're not sure will work."*
Risk-based approach	Specific mention of the use of a risk-based approach to assess solutions and alternatives	**D2.R2:** *"So now we have... "risk asset management" and then you look at the risk, at the cost and the results and somewhere…what we do now, we take some extra risk in an area where you can have extra risk and in other areas, you can't have extra risk so you have to reduce risk. And, by reducing or taking more risk, you can keep the money in the pocket – and the money you can keep in the pocket, we can spend on climate adaptation."*
Sewer condition (ageing)	Specific mention of ageing sewers/sewer infrastructure	**D1.R1**: *"a lot of our sewer systems have been installed up to 50 till 70 years ago so they need renewal."*
Sewer inspection, data on condition	Specific mention of need for/ presence of sewer inspection/condition data	**D13.R13:** *"So you inspect all your system, you have a program to inspect each year your system so you know to plan which pipes you have to replace in the future."*
Sewer tax	Explicit mention or discussion of sewer tax	**D7.R7:** *" We have a tax, and that tax is only – you may only, that's by law, you may only use that for the sewer system. And for my sewer system, I can do the research and so on. But the tax is only, they are not allowed to use that for other stuff. So it's only used for the sewer system."*
Sewer tax-ClimAdaptFunding	Explicit mention or discussion of need for/presence or lack of climate adaptation funding	**D11.R11:** *"We also see that we cannot reach every goal we want to reach within climate adaptation by using the sewer tax and using the measurements on the sewer systems – we have also, you have to green, you want more trees, more shadow in streets and therefore it is very difficult to pay that from the sewer tax so you need another tax or another income..."*
Stakeholder involvement	Explicit mention or discussion of stakeholder involvement	**D3.R3:** *" And then with all the stakeholders in the area, I designed a different system for the water system, what was based on more efficient use of the water."*
Stress tests (sewer)	Explicit mention or discussion of need for/use of stress tests to inform analysis or projects or decision-making	**D6.R6:** "*So use of stress tests helps because it identifies previously unknown problem areas, or potential unforeseen issues in network; allows system understanding of sewer network; and therefore, can identify areas of focus"*
Timing and aligning multiple projects	Explicit mention or discussion of how coordination between different asset/infrastructure works result in project	**D4.R4***:" So what we're trying to do in the last couple of years and we're looking ahead five to ten years on when we want to renew the sewer system then we're actually trying to fit the different needs of the different assets to put on each other to check what's the best time to replace everything at the same time so we only have the inconvenience for the inhabitants only once"*
Unintended future consequences (of climate adaptation, maintenance)	Specific mention of possible unintended consequences of climate adaptation, including maintenance considerations	**D7.R7:** *"But I think the main problem in the future, and I hear it not very much, and that's what, that's strange for me. Everyone in the Netherlands talks about less pavement, more green, more trees, green on the roofs and so on but every [all] of that needs water, and that will be the problem in the future, I think. So that's what I'm personally worried about."*
Vagueness of rules, practical application	Explicit mention or discussion of difficulty interpreting or applying strategic rules and guidance	**D11.R11:** *"...everybody wants to do climate adaptation, and they ask – what do I have to do then? Then it becomes difficult, [so we say, for example] "now you have to bring trees in" and they say "how many trees do I have to bring in?" – and then everybody becomes silent because we don't know..."*
Wider system perspective	Explicit mention or discussion of interaction between different elements of (sewer, urban drainage) infrastructure system	**D5.R5: "** *So you have also to look at that system as well, it's not only the plots, not only the land but also the system that it's part of. And then you can think of what is the best solution to keep the water on the place where it falls."*

APPENDIX D

Table D.1 – High Frequency Factors

Code	Type	Category (REG, NORM, COG)	Frequency of occurrence across interviews*
B&F- Fragmented Roles and Responsibilities	Literature-based	NORM	14 (15)
B&F Resources – Financial/Capital	Literature-based	REG-ADMIN	14 (15)
Multiple climate adaptation goals	Interview-generated	REG-ADMIN	13 (14)
B&F – Information, knowledge, understanding (technical)	Literature-based	COG	13 (13)
B&F- Regulatory Framework	Literature-based	REG-LEG	12 (12)
Sewer tax	Interview-generated	REG-ADMIN	12 (12)
Cost consideration	Interview-generated	COG	12 (12)
B&F – Long-term vision/strategy	Literature-based	REG-LEG	11 (11)
Collaboration with others (internal, external)	Interview-generated	NORM	10 (11)
Cognitive/cultural resistance, barriers	Interview-generated	COG	10 (13)
Municipal Council	Interview-generated	REG-ADMIN	10 (13)
B&F-Community Engagement, Participation, Empowerment[1]	Literature-based	N/A	10 (11)

**number in brackets indicates absolute frequency of occurrence due to some factors occurring more than once in some interviews*

Key:

REG-LEG – Regulative category, legislative

REG-ADM – Regulative category, administrative

NORM – Normative category

COG – Cognitive category

OTHER-DES – Technical design factor

OTHER – N/A – No category

Table D.2 – Medium Frequency Factors

Code	Type	Category (REG, NORM, COG)	Frequency of occurrence across interviews*
Incentive to action: societal or environmental	Interview-generated	COG	8 (8)
B&F Resources – Human/Capacity	Literature-based	REG-ADMIN	8 (8)
Private Landowner responsibility	Interview-generated	REG-LEG	7 (7)
Practitioner skill set (operational v strategic)	Interview-generated	COG	7 (7)
B&F – Public/Political Will	Literature-based	NORM	7 (8)
Timing and aligning multiple projects	Interview-generated	NORM	7 (7)
Integrated approach	Interview-generated	NORM	7 (7)
Public-private space interaction	Interview-generated	NORM	7 (7)
Risk consideration, aversion, novelty, uncertainty	Interview-generated	COG	7 (7)
Local conditions, available space	Interview-generated	NORM	6 (8)
Alignment with road works	Interview-generated	NORM	6 (7)
Learning-by-doing, experimentation	Interview-generated	COG	6 (7)
Wider system perspective	Interview-generated	COG	6 (6)
GRP	Interview-generated	REG-LEG	6 (6)
Performance criteria, durability	Interview-generated	NORM	5 (6)
DM Perspective/Attitude	Interview-generated	COG	5 (5)
Neighbourhood-scale renovation	Interview-generated	NORM	5 (5)
Stress tests (sewer)	Interview-generated	NORM	5 (5)

**number in brackets indicates absolute frequency of occurrence due to some factors occurring more than once in some interviews*

Table D.3 – Low Frequency Factors

Code	Type	Category (REG, NORM, COG)	Frequency of occurrence across interviews*
Design-maintenance (project phase) separation	Interview-generated	NORM	4 (4)
Extra effort required	Interview-generated	COG	4 (4)
Sewer tax-clim adapt funding	Interview-generated	REG-ADM	4 (4)
Unintended future consequences of climate adaptation	Interview-generated	COG, OTHER-DES	4 (4)
Vagueness of rules, practical application	Interview-generated	REG-LEG	4 (4)
Project type – sewer replacement	Interview-generated	NORM	4 (4)
Omgevingswet	Interview-generated	REG-LEG	4 (4)
Freedom of choice, implementation flexibility	Interview-generated	COG	3 (4)
Climate change uncertainty	Interview-generated	COG	3 (3)
Community demographics, income	Interview-generated	OTHER – N/A	3 (3)
Maintenance consideration	Interview-generated	COG	3 (3)
Community Representation	Interview-generated	OTHER	2 (2)
Delta Programme	Interview-generated	REG-LEG	2 (2)
Ease of construction	Interview-generated	COG	2 (2)
Flooding – existing urban drainage issues	Interview-generated	OTHER -DES	2 (2)
Incentive to act – individual benefit	Interview-generated	COG	2 (2)
Project type – new development	Interview-generated	NORM	2 (2)
Risk-based approach	Interview-generated	NORM	2 (2)
Sewer inspection, data on conditions	Interview-generated	NORM	2 (3)
Bry – Trust & committment	Literature-based	COG	2 (2)

Code	Type	Category (REG, NORM, COG)	Frequency of occurrence across interviews*
Bry – Accountability	Literature-based	REG-ADM	1 (1)
Bry - Multiple institutional logics	Literature-based	REG-ADM	1 (1)
Bry - Pre-existing relationships	Literature-based	COG	1 (1)
B&F – Communication	Literature-based	OTHER – N/A	0 (0)
B&F Organizational commitment	Literature-based	REG-ADM	0 (0)
B&F – Institutional Framework (Uncoordinated)	Literature-based	REG-ADM	0 (0)

**number in brackets indicates absolute frequency of occurrence due to some factors occurring more than once in some interviews*