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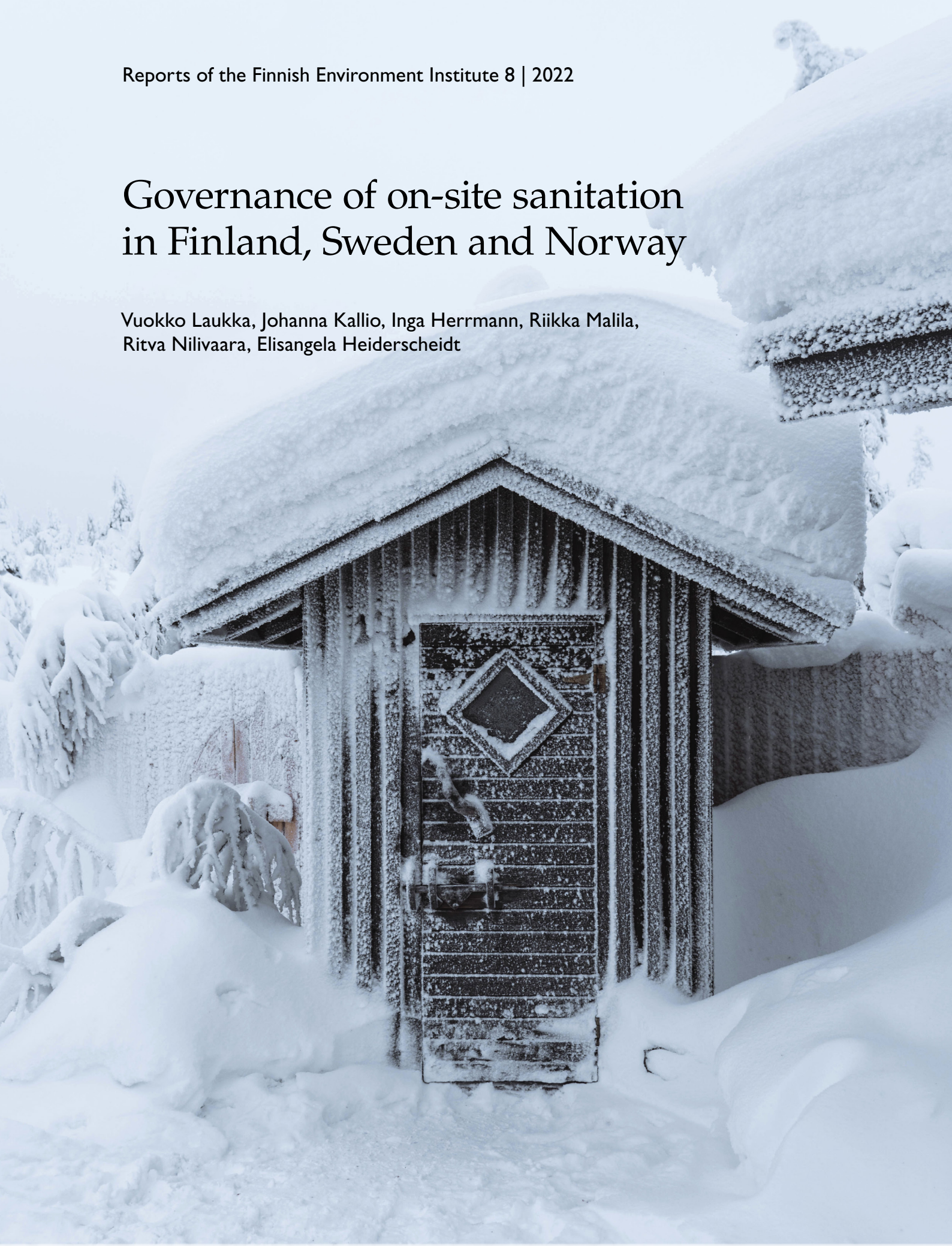

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Abstract

Governance of on-site sanitation in Finland, Sweden and Norway

Wastewaters from properties outside centralized sewer networks are a significant source of diffuse pollution and can have a considerable impact on the quality and usability of local water sources if not well managed. Furthermore, sanitation-related regulations, strategies, and implementation have broad socio-economic impacts. This study describes the governance of on-site sanitation in Finland, Sweden, and Norway based on information gathered via literature review as well as a compilation of documentation and statements from project team members with years of experience in the sector and interviews with representatives of stakeholders. It presents a comparison among the three countries, highlighting the key similarities and differences in governance principles, implementation strategies, regulatory framework, stakeholders' roles and responsibilities, main challenges, and good practices.

Altogether, about three million inhabitants live outside the centralized sewer network in Finland, Sweden, and Norway, representing about 13 percent of their combined population. Furthermore, about half a million leisure homes exist in each country, with the majority situated outside centralized sewer network areas. To mitigate the environmental pressures from non-connected areas, Finland, Sweden, and Norway, have introduced national regulatory frameworks. Besides setting treatment requirements for on-site sanitation systems, these frameworks enable the clarification of the roles and responsibilities of various stakeholders and establish a fluent permit procedure. However, non-compliance issues hinder the implementation of regulations in all three countries. Despite support mechanisms, such as guidance efforts and information sharing, a significant number of properties still lack an adequate treatment system for domestic wastewater. In this study, the main challenges in improving decentralized sanitation management and compliance with current regulations were identified within the following categories: resources, knowledge and competence, public awareness, and data availability.

Various on-site wastewater treatment systems are available, for example, holding tanks, septic tanks, followed by sand filters or infiltration fields, package plants, and dry toilets. Traditionally, however, on-site wastewater treatment in all three countries is still carried out using septic tanks only without secondary treatment. Treatment efficiency provided by septic tanks is not sufficient to reach the requirements where discharge limits apply. In addition, the efficiency of other types of treatment units is also a cause for concern due to reported variations in the systems' efficacy normally blamed on construction errors or the lack of adequate maintenance or operation. Overall estimates, although sometimes vague, suggest that more than half of the on-site sanitation systems located in areas subject to treatment requirements would not meet the requirements.

Based on the information gathered from Finland, Sweden, and Norway, as well as experiences from other European countries, general recommendations for the governance of on-site sanitation are provided: i) A coherent national regulatory framework is of critical importance as the basis for good governance practices and functioning sanitation service-chain; ii) Implementation of the regulations requires adequate support mechanisms in all levels of implementation (national, regional, and local), for example, risk-based national inspection plan, service-oriented approach to support professional management, multichannel communication, information-sharing and education, systematic data collection, and monetary aid for property owners; iii) Public awareness needs to be increased to strengthen the policy relevance of on-site sanitation; iv) Common platforms are required for presenting the results of various studies, sharing good practices, coworking, and learning from each other both on national and international levels.

Keywords: decentralized sanitation, water governance, diffuse pollution, regulatory framework, Nordic countries

Tiivistelmä

Haja-asutusalueen jätevesihuollon hallintokäytänteet Suomessa, Ruotsissa ja Norjassa

Keskitetyn jätevesien käsittelyn ulkopuolella olevien kiinteistöjen jätevedet ovat merkittävä hajakuormituksen lähde, ja voivat huonosti hoidettuna vaikuttaa merkittävästi lähivesistöjen laatuun ja käytettävyyteen. Jätevesien hallintaan liittyvillä määräyksillä, strategioilla ja täytäntöönpanolla on myös laajat sosioekonomiset vaikutukset. Tässä raportissa kuvataan Suomen, Ruotsin ja Norjan haja-asutusalueiden jätevedenkäsittelyyn liittyviä hallintokäytänteitä. Tiedot perustuvat kirjallisuuskatsaukseen, alalla vuosia toimineiden projektitiimin jäsenten tietämykseen ja käytännön kokemukseen sekä sidosryhmien edustajien haastatteluihin. Raportissa vertaillaan ja tuodaan esiin keskeisiä yhtäläisyyksiä ja eroja tutkittujen kolmen maan hallintoperiaatteissa, täytäntöönpanostrategioissa, säätelykehyksessä, sidosryhmien rooleissa ja vastuissa, tärkeimmissä haasteissa ja hyvissä käytännöissä.

Keskitetyn viemäriverkoston ulkopuolella asuu Suomessa, Ruotsissa ja Norjassa yhteensä noin kolme miljoonaa asukasta, joka on noin 13 prosenttia maiden yhteenlasketusta väestöstä. Lisäksi kussakin maassa on noin puoli miljoonaa vapaa-ajan asuntoa, joista suurin osa sijaitsee keskitetyn viemäriverkoston ulkopuolella. Suomi, Ruotsi ja Norja ovat ottaneet käyttöön kansallisen säätelykehyksen lieventääkseen viemäriverkoston ulkopuolisten jätevesien aiheuttamia ympäristöhaittoja. Sen lisäksi, että sääntelykehykset asettavat talousjätevesille puhdistusvaatimukset, ne mahdollistavat eri sidosryhmien roolien ja vastuiden selkiyttämisen ja luovat sujuvan lupamenettelyn. Säädösten noudattamatta jättäminen on kuitenkin täytäntöönpanoa häiritsevä tekijä kaikissa kolmessa maassa. Ohjauksesta, tiedon jakamisesta ja muista tukimekanismeista huolimatta huomattavalla osalla kiinteistöistä puuttuu edelleen riittävä jätevesien käsittelyjärjestelmä. Suurimmat haasteet hajautetun jätevesihuollon parantamisessa ja nykyisten säännösten noudattamisessa voidaan jakaa seuraaviin kategorioihin: resurssit, tieto ja osaaminen, yleinen tietoisuus ja tiedon saatavuus.

Verkoston ulkopuolisten talousjätevesien käsittelyyn on tarjolla erilaisia vaihtoehtoja, esimerkiksi umpisäiliö, maahanimeytys tai maasuodatus, laitepuhdistamo ja kuivakäymälä. Perinteisesti haja-asutusalueen jätevesien käsittely kuitenkin kaikissa kolmessa maassa koostuu edelleen vain saostuskaivosta ilman jälkikäsittelyä. Saostuskaivojen puhdistusteho ei useimmilla alueilla riitä täyttämään jätevesienkäsittelylle asetettuja vaatimuksia. Muiden käsittelyjärjestelmien tehokkuuteen on myös kiinnitettävä huomiota, koska niiden tehokkuudessa on havaittu vaihtelua, joka yleensä johtuu rakennusvirheistä, puutteista järjestelmän huollossa tai käyttövirheistä. Yleisesti voidaan arvioida, että yli puolet jätevedenkäsittelyjärjestelmistä, jotka sijoittuvat sääntelyn piirissä oleville alueille, eivät täytä asetettuja puhdistusvaatimuksia.

Suomesta, Ruotsista ja Norjasta kerättyjen tietojen sekä muista Euroopan maista saatujen kokemusten perusteella raportissa annetaan yleisiä suosituksia haja-asutusalueen jätevesihuollon hallintaan: i) Johdonmukainen kansallinen säätelykehys on ratkaisevan tärkeä pohja hyville hallintokäytänteille ja toimivalle jätevesienkäsittelyn palveluketjulle. ii) Säännösten täytäntöönpano edellyttää riittäviä tukimekanismeja täytäntöönpanon kaikilla tasoilla (kansallinen, alueellinen ja paikallinen); esimerkiksi riskiperusteinen kansallinen valvontasuunnitelma, palvelukeskeinen lähestyminen järjestelmien ammattitaitoiseen hoitamiseen, monipuolinen viestintä, tiedon jakaminen ja koulutus, järjestelmällinen tiedonkeruu ja taloudellinen tuki kiinteistönomistajille. iii) Yleisön tietoisuutta on lisättävä haja-asutusalueiden jäteveden käsittelyn tärkeydestä. iv) Yhteisiä foorumeja tarvitaan tutkimustulosten esittelyyn, hyvien käytäntöjen jakamiseen, yhteistyön ja vertaisoppimisen edistämiseen sekä kansallisella että kansainvälisellä tasolla.

Avainsanat: haja-asutusalueiden jätevesihuolto, vesihuollon hallintokäytönteet, hajakuormitus, sääntelykehys, Pohjoismaat

Sammanfattning

Styrning och organisation av små avlopp i Finland, Sverige och Norge

Utsläpp från små och enskilda avloppsanläggningar är en källa av diffus förorening och kan ha betydande effekter på vattenkvaliteten av lokala recipienter om inte avloppsanläggningar sköts på ett bra sätt. Samtidigt har regelverket kring små avloppsanläggningar en socio-ekonomisk effekt, t.ex. när kostnaden av ett nytt avloppssystem är hög i förhållande till värdet av den enskilda fastigheten. Denna studie beskriver hur de små avloppssystemen styrs och organiseras i Finland, Sverige och Norge baserad på information som sammanställts genom litteraturstudier och genom att sammanställa redovisningar och budskap från projektdeltagare med flerårig erfarenhet i branschen. Dessutom intervjuades representanter av olika aktörer inom branschen. Studien jämför hanteringen av de små avloppssystemen i de tre länderna (Finland, Sverige och Norge) samt påpekar likheter och olikheter mellan hur dessa organiseras och styrs. Studien beskriver dessutom de olika aktörernas roller och ansvar samt de största utmaningarna med de små avloppssystemen, samt tar upp hur regelverket används i prövning och tillsyn.

I Finland, Sverige och Norge bor sammanlagt ungefär tre miljoner människor som inte är anslutna till det kommunala avloppssystemet och detta motsvarar ca. 13 procent av ländernas sammanlagda befolkning. Dessutom finns ungefär en halv miljon sommarstugor i varje land av vilka de flesta ligger utanför det kommunala verksamhetsområdet. I de tre ländernas regelverk finns det bl. a. reningskrav för små avloppsanläggningar men dessa krav uppfylls inte alltid och fortfarande saknar ett mångtal fastigheter fungerande avloppsrening. Detta fastän det har gjorts och görs insatser för vägledning, informationsutbyte och annat för att stödja tillsynsmyndigheter och fastighetsägare. De huvudsakliga utmaningarna med att förbättra de små avloppsanläggningarna så att de uppfyller kraven identifierades i denna studie och kunde grupperas i följande kategorier: resurser, kunskap och kompetens, allmänhetens medvetenhet och tillgång till data.

Det finns ett stort antal olika reningssystem för små avloppsanläggningar, t.ex. slutna tankar, markbaserad rening (slamavskiljning med efterföljande markbädd eller infiltration), minireningsverk och torra system. I alla tre länder finns det dock fortfarande fastigheter som använder sig av enbart slamavskiljning utan efterföljande rening och sådana anläggningar uppfyller inte reningskraven som ställs i regelverket. Även anläggningar som redan har uppgraderats har i många fall visats inte fungera som avsett eller uppvisa stora variationer i reningskapaciteten. Detta beror t.ex. på att anläggningarna har konstruerats eller installerats på fel sätt eller att drift och underhåll är undermålig. Uppskattningar visar att mer än hälften av de små avloppssystemen idag inte uppfyller kraven, dock är dessa uppskattningar inte noggranna.

Baserad på information som sammanställts från Finland, Sverige och Norge samt på erfarenheter från andra Europeiska länder, har generella rekommendationer för styrning och organisation av små avloppssystem tagits fram: i) Ett övergripande nationellt regelverk är viktigt och skulle hjälpa tillsynsmyndigheter samt underlätta implementeringen av ett fungerande VA-system utanför verksamhetsområden. ii) För upprätthållande av regelverket behövs lämpliga stödmekanismer på olika nivåer (nationell, regional och lokal nivå); t.ex. riskbaserade nationella tillsynsplaner, service-orienterat stöd för optimal drift av avloppsanläggningar, kommunikation genom olika kanaler, informationsutbyte och kunskapshöjande åtgärder, systematisk datainsamling och –sammanställning samt finansiellt stöd för fastighetsägare. iii) I vissa avseenden skulle den allmänna medvetenheten behöva ökas för att öka policy-relevansen av de små avloppssystemen. iv) Gemensamma plattformar är viktiga för att presentera resultat från projekt relaterade till små avloppsanläggningar, dela goda exempel och god praxis samt lära från varandra på nationell och internationell nivå.

Nyckelord: enskilda avlopp, decentraliserad avloppsrening, tillsyn och prövning, diffus förorening, regulativ ramverk, Nordiska länder

Sammendrag

Styring av sanitær på stedet i Finland, Sverige og Norge

Avløpsvann fra sprett bebyggelse er en betydelig kilde til diffus forurensning som kan ha en betydelig innvirkning på vannkvaliteten og brukbarheten til lokale vannkilder dersom det ikke forvaltes godt. Videre har reguleringer og implementering av vann- og avløpsløsninger brede sosioøkonomiske konsekvenser. Denne studien beskriver styringen av lokale avløpsløsninger i Finland, Sverige og Norge basert på informasjon samlet inn via litteraturgjennomgang, samt sammenstilling av dokumentasjon og uttalelser fra prosjektmedlemmer med mange års erfaring i sektoren og intervjuer med representanter for interessenter. I tillegg presenterer den en sammenligning mellom de tre landene, og fremhever de viktigste likhetene og forskjellene i styringsprinsipper og implementeringsstrategier som regelverk, interessenters roller og ansvar, hovedutfordringer og god praksis.

Til sammen bor rundt tre millioner innbyggere utenfor det sentraliserte kloakknettet i Finland, Sverige og Norge, som representerer rundt 13 prosent av deres samlede befolkning. Videre eksisterer det rundt en halv million fritidsboliger i hvert land, hvorav de fleste ligger utenfor sentraliserte avløpsnettområder. For å dempe miljøbelastningen fra ikke-tilknyttede områder har Finland, Sverige og Norge innført nasjonale regelverk. Foruten å sette rensekrav for lokale løsninger, klargjør disse rammeverkene rollene og ansvaret til ulike interessenter og etablerer en prosedyre for godkjenning av renseløsninger. Problemer med manglende oppfølgning er imidlertid en hinder for implementeringen av regelverk i alle tre landene. Til tross for veiednings, informasjonsdeling og andre støttemekanismer, mangler et betydelig antall eiendommer fortsatt en tilstrekkelig renseløsning for avløps. Hovedutfordringene med desentralisert avløpsløsninger og gjeldende regelverk ble identifisert innenfor følgende kategorier: ressurser, kunnskap og kompetanse, offentlig bevissthet og datatilgjengelighet.

Ulike systemer for lokale kloakkrensetiltak er for eksempel oppsamlingstanker, septiktanker etterfulgt av sandfiltre eller infiltrasjonsanlegg, kompaktanlegg og ulike typer biodoer. Tradisjonelt utføres imidlertid behandling av avløpsvann lokalt i alle tre landene ved bruk av septiktanker uten sekundær behandling. Renseeffekten gitt av septiktanker er ikke tilstrekkelig for å nå utslippskrav. I tillegg er effektiviteten til andre typer behandlingsenheter også en grunn til bekymring på grunn av rapporterte variasjoner i rense-effekt som vanligvis skyldes konstruksjonsfeil eller mangel på tilstrekkelig vedlikehold eller drift. Overordnede estimater, selv om de noen ganger er vage, tyder på at mer enn halvparten av lokale renseløsningene som er underlagt behandlingskrav, ikke ville oppfylle dem.

Basert på informasjonen som er samlet inn fra Finland, Sverige og Norge, samt erfaringer fra andre europeiske land, gis generelle anbefalinger for styring av lokale renseløsninger fro kloakk: i) Et nasjonalt regelverk er av avgjørende betydning som grunnlag for god styringspraksis og fungerende VA løsninger. ii) Implementering av regelverket krever tilstrekkelige støttemekanismer på ulike nivåer (nasjonale, regionale og lokale); for eksempel risikobasert nasjonal inspeksjonsplan, serviceorientert tilnærming for å støtte profesjonell forvaltning, kommunikasjon, informasjonsdeling og utdanning, systematisk datainnsamling og økonomisk bistand til eiendomseiere. iii) Offentlig bevissthet må økes for å styrke den politiske relevansen av lokale renseløsninger. iv) Felles plattformer er nødvendig for å presentere resultatene fra ulike studier, dele god praksis, samarbeide og lære av hverandre både på nasjonalt og internasjonalt nivå.

Nøkkelord: desentralisert, kloakk, avløp, rensing, diffus forurensning, regelverk, nordiske land

Preface

This report is part of the ON-SITE project (Small-scale wastewater treatment systems: governance, efficiency, resources, recovery, environment contamination risks, and innovative solutions for processes optimization, 2019–2022), carried out by the University of Oulu (coordinator), the Finnish Environment Institute (SYKE), and Luleå University of Technology. The project was funded by the Interreg Nord programme and aimed to address the lack of knowledge regarding the management of decentralized sanitation systems, the efficiency of on-site treatment units, and the risks of environmental contamination from discharged pollutants (regulated and unregulated substances). The work reported in this document focuses on the governance of on-site sanitation in Finland, Sweden, and Norway; thus, research tasks related to on-site treatment systems efficiency and environmental impacts are not reported here. Some special characteristics of the northern areas (funding programme area) of the studied countries are described but national-level governance practices were investigated and reported.

The information gathered for the elaboration of this report was derived from the review of literature, expert interviews, and the expert testimony of the authors who have long term experience in the field. In addition, stakeholders' interactions events were organized by the project team (e.g., an online webinar for Finnish stakeholders with 77 participants) who also participated in other events such as the consultation panel organized by WHO under the Protocol on Water and Health: Expert consultation on on-site sanitation in the pan-European region, 5–7 October 2021. This event provided some comparative experiences from several European countries.

The authors would like to acknowledge the funding programme, i.e., Interreg Nord, and national financiers Lapin Liitto and Region Norrbotten. Furthermore, Bodil Aronsson Forsberg, Åsa Gunnarsson, and Margareta Lundin Unger from the Swedish Agency for Marine and Water Management in Gothenburg are acknowledged for their valuable advice and comments on the Swedish part of this report; and Gjertrud Eid and Sara-Anna Magnusson are acknowledged for valuable comments and information sharing regarding the Norwegian on-site sanitation and governance. In addition, the authors are grateful to Jyrki Laitinen for reading and providing feedback on the content, Sanna Vienonen for leading the project in its initial stages, Alexandra Bokareva and Lina Büngener for helping with information gathering, as well as Prof. Bjørn Kløve for helping in elaborating the abstract in Norwegian language.

Helsinki February 2022,

Authors

Contents

1 Introduction

On-site sanitation consists of the whole wastewater treatment service chain in the areas of dispersed settlements without a centralized sever network, including installation and selection of a treatment system, operation, maintenance, treatment, and disposal. Altogether, about three million inhabitants in Finland, Sweden, and Norway live in those areas. This report describes and assesses the on-site sanitation related governance principles and implementation strategies, regulatory framework, stakeholders' responsibilities, main challenges, and good practices within the three countries.

Nordic countries share a number of similarities related to environmental protection and sanitation regulations. However, there are differences among these countries regarding the governance of wastewater treatment systems outside sewer networks. In sparsely populated areas, where the establishment of conventional wastewater treatment plants for the treatment of wastewater is not feasible (e.g., due to excessive distances), small-scale on-site wastewater treatment facilities are normally used. These usually consist of systems that can serve from one household to small communities and other dwellings such as holiday resorts, schools, etc. The work reported here is a result of the research carried out in the ON-SITE project funded by Interreg Nord 2014–2020 programme. One of the project's goals was to examine the governing principles of wastewater treatment in non-connected areas in Finland, Sweden, and Norway. A special feature of the Interreg Nord programme area (Figure 1) is that it encompasses vast extents of sparsely populated areas and thus contains a significant number of inhabitants not connected to sewer networks. Another critical feature is the pristine and often sensitive environment, which supports the culture and way of life of local communities. Degradation of this environment can have a direct social-economic and cultural impact on its inhabitants. Although the programme area covers only the northern most regions of the three countries (Figure 1), governance related issues were assessed on a national level.

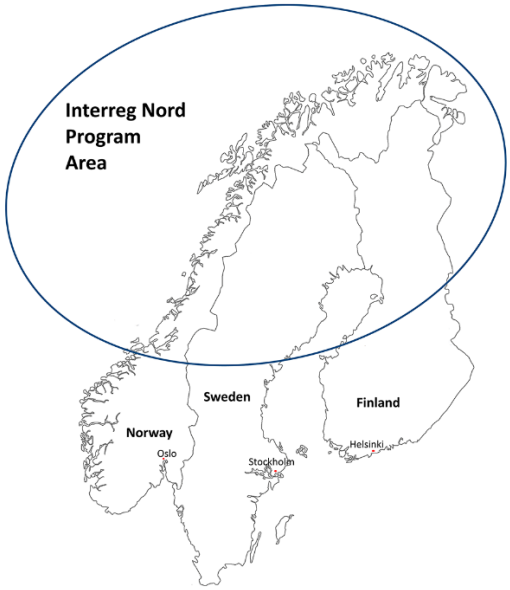

Figure 1. Map of studied countries highlighting the Interreg Nord programme area (i.e., North and Central Ostrobothnia and Lapland regions in Finland; Norrbotten province and the municipalities Norsjön, Malån, Skellefteån and Sorselen in Sweden; Finnmark, Troms and Norland regions in Norway.).

The portion of the population not connected to centralized sewer networks is around 15% in Finland (Lapinlampi 2021), 12% in Sweden (Statistics Sweden 2019b) and 15% in Norway (Statistics Norway 2021), while the average in Europe is approx. 11% (Eurostat 2019). Altogether, there are approximately three million inhabitants living outside sewer network areas within the three countries. In addition, the tradition of having leisure homes leads to a high seasonal influx of people inhabiting non-sewered areas especially during the summer. Non-connected dwellings can be a significant source of diffuse pollution. On a European level, they cause more than 10% of the diffuse pollution pressure to water bodies in 19 reporting countries (Grebot et al. 2019). Traditionally, in rural areas, wastewater is led directly or through a one- or two-compartment septic tank into the ground or to a ditch and further to the closest water body. In general, one person living outside the sewer network in Finland contributes on average to a seven times larger phosphorus (P) load and a two-and-a-half times larger nitrogen (N) load to water bodies than a person living in a property connected to a network (Vienonen 2007).

National regulatory frameworks have a significant role in mitigating environmental pressures from non-connected areas. In Finland, Sweden, and Norway, regulations have been introduced and treatment requirements set for wastewater treatment outside sewer networks. Generally, for older properties, this means either improving the existing on-site treatment system or constructing a new one. While sanitation strategies in the three countries prioritize the connection of properties to municipal sewer networks, there are (and will always be) unconnected properties as it is not an economic or environmentally sound option to extend networks to distant villages and single properties. Therefore, for the effective implementation of legislation, coherent policy making as well as intensive cooperation between several stakeholders is required. In general, water governance can be interpreted as an overarching framework of water policies, which determine the implementation of strategies and interaction of stakeholders from public, private, and third sectors. In addition to the interorganizational perspective, governance addresses linkages and processes within organizations and social groups involved in decision-making (Rogers & Hall 2003; Tropp 2007).

The information gathered in this report was combined via the compilation of documentation and statements from project team members with years of experience in the sector, interviews with representatives of stakeholders' groups, and systematic review of governance related literature. Nevertheless, it is important to note that governance literature concentrating on on-site sanitation remains little. In general, Finnish studies mainly concentrate on institutional arrangements of the water services sector as a whole. In terms of rural areas, the focus is mainly on water cooperatives and only some mentions of on-site wastewater treatment are presented (Takala 2007; Pietilä et al. 2007; Katko 2016; 2018; Inha et al. 2019). Yet, some studies have grasped the on-site problematics more profoundly. For example, Mattila (2005) examined the appropriate management of on-site sanitation in Finland, including aspects from legislation, public acceptance, and cooperation between stakeholders. O'Neill (2015) analysed the ecological sanitation from the institutional development point of view, and its feasibility as a potential alternative to the mainstream waterborne toilet institution, including Finland as well as Zambia, Ethiopia, and New Zealand as case-studies. In Sweden, on-site sanitation has evoked interest especially from the perspective of source separation. Johansson (2000) has studied urine separation from multiple perspectives – case-studies, technical features, resident's attitudes, nutrient recycling – as an attractive option to on-site sanitation. Although Sweden can be seen as a pioneer, source separation has remained a marginal option in a large context, as studied and reported by McConville et al. (2017). In terms of resource recovery and circular economy, McConville and others (2017) emphasized that source separation is a key element in the paradigm shift in wastewater sector and provided some policy recommendation related to better communication and interaction of various stakeholders.

Information regarding the governance, efficiency and possible environmental impacts of on-site sanitation in Norway has mostly been produced by governmental authorities and stakeholder funded institutions. Therefore, the majority are contained in reports in Norwegian with the main authors being

the Norwegian Water (Norsk Vann), the Norwegian Institute for Bioeconomics (NIBIO), Statistics Norway, and the Norwegian University of Life Sciences (NMBU). The latter has also produced a master thesis and manuscripts published in scientific journals in recent decades (e.g., Telkamp 2006; Jenssen et al. 2010; Johannessen et al. 2012; Todt & Jenssen 2015; Abbas 2017; Khan 2018; Kelova et al. 2021) as deliverables of several projects run mostly in partnership with Norsk Van and the NIBIO. Governance related studies and status overview have been published mainly by Norsk Vann in several reports (e.g., Norsk Vann 2018; 2020). These contain information on the regulations linked to the implementation, supervision, and operations of small-scale on-site sanitation systems. Of particular interest are the Norsk Vann report (2018), which contains detailed information on the implementation and inspection of soil-based systems, and the Norsk Vann report (2020), which describes regulations and the role and responsibilities of different stakeholders. A large portion of the information contained in the Norwegian part of this report was retrieved and compiled from Norsk Vann literature.

Some comparative studies have analysed similarities and differences among on-site sanitation in various countries. Ruokojärvi (2007) compares rural wastewater treatment options, related legislation, and development needs in Finland, the United Kingdom, and Hungary. Kattainen (2012) presents regulations, standards, as well as testing and maintenance practices of on-site sanitation systems in 12 European countries and the USA. A survey made in the EU-project "VillageWaters" lists available wastewater treatment technologies for on-site sanitation and presents related EU and national legislation in six countries around the Baltic Sea: Estonia, Finland, Latvia, Lithuania, Poland, and Sweden. The aim of the project was to find the most cost-effective treatment solutions to decrease wastewater emission locally and into the Baltic Sea. (Vorne et al. 2019). Furthermore, Grebot et al. (2019) assessed non-connected dwellings as sources of diffuse pollution and how they affect the surface water and groundwater bodies in five European countries: Bulgaria, Finland, France, Ireland, and Poland. The study concluded that although on-site sanitation is not fully regulated by EU-legislation, all the studied countries had introduced national regulations to mitigate the diffuse pollution pressures. Nevertheless, all of the countries had issues with non-compliance and data-gathering. The above studies did not present the governance structure, related actors, and governance practices related to on-site sanitation.

This report describes the governing principles of wastewater treatment systems not connected to sewer networks in Finland, Sweden, and Norway. It details the structure and the framework of on-site wastewater governance while the interaction of various stakeholders is acknowledged but not extensively analysed. Related EU legislations (Chapter 2) are presented. National regulations, stakeholders, current practices, and strategies are described in individual chapters for Finland (Chapter 3), Sweden (Chapter 4), and Norway (Chapter 5). Finally, the report evaluates the differences and similarities regarding governance, i.e., regulations, strategies, and practices among the three countries, and outlines the lessons learned (Chapter 6).

2 EU legislation

The EU legislation concentrates mainly on centralized wastewater treatment, and most of the relevant directives regulate on-site sanitation only partially or indirectly. However, along with the evaluation and revision of certain directives, the importance of on-site sanitation will be better acknowledged in the future.

2.1 EU Directives

The EU regulations are supranational laws which come into force automatically in all the EU Member states without requiring a further national transposition. However, the directives must be implemented in the legislation of each country. Generally, EU legislation will also apply to European Economic Area countries (EEA), including Norway. The following EU Directives have a partial or indirect effect on on-site wastewater treatment:

- Urban Waste Water Treatment Directive (91/271/EEC)
- Water Framework Directive (2000/60/EC)
- Bathing Water Directive (76/160/EEC).

The Urban Waste Water Treatment Directive (UWWTD) protects the environment from the adverse impacts of wastewater discharges from urban areas and the food and drink sectors. It regulates the collection, treatment, and discharge of urban wastewater comprising domestic wastewater or the mixture of domestic and industrial wastewaters and run-off rain. In general, the collection and treatment of wastewaters are required in all agglomerations with a population equivalent (PE) of more than 2,000. In addition, more stringent treatment is required in all agglomerations over 10,000 PE discharging in designated sensitive areas. (European Commission 2019b; Grebot et al. 2019)

Wastewater treatment in agglomerations of less than 2,000 PE is governed by the UWWTD only if there is an existing wastewater collection system and it discharges in freshwaters or estuaries. Regulations for such settlements could exist on a national level. However, if the construction of a wastewater collection system incurs unreasonable costs or has no environmental benefits, on-site wastewater treatment systems providing an acceptable level of treatment could be applied. This means that the same level of environmental protection should be met than is required in the UWWTD for municipal wastewater treatment plants. Where the wastewater from on-site wastewater treatment systems is discharged in sensitive areas, more stringent treatment should be applied. Furthermore, local authorities should make adequate arrangements for the wastewater collection from cesspools. (European Commission 2019b; Grebot et al. 2019)

Under the reporting requirements of the UWWTD, the level of connectivity to sewer networks in the EU is reported only for agglomerations of more than 2,000 PE. One of the reporting categories refers to the use of on-site wastewater treatment systems. However, these systems are required only in areas where connection to the wastewater collection system is technically complex or economically challenging. Member States are also free to define the boundaries of individual agglomerations, and the rural area of a municipality is often omitted in the reporting of on-site wastewater treatment systems. The UWWTD applies to all European Free Trade Association (EFTA) countries, however, these do not have to meet the same reporting requirements. (European Commission 2019b; Grebot et al. 2019)

The Water Framework Directive (WFD) aims to protect surface and groundwater bodies. The directive indirectly concerns the on-site wastewater treatment systems, as it requires that they do not impose significant pressure on the aquatic environment. The WFD requires EU Member States to introduce comprehensive packages of measures to attain a good ecological and chemical status of surface and groundwater bodies. These include basic measures for the attainment of the goals of EU water policy such as the UWWTD, including the development of wastewater collection and treatment

infrastructure, as well as supplementary measures for the attainment of the broader goals of the WFD. The WFD does not regulate the on-site wastewater treatment directly. However, the discharges from the on-site wastewater treatment systems should be of such quality to allow the receiving waters to meet the relevant quality objectives of the WFD. (Grebot et al. 2019)

The Bathing Water Directive (BWD) protects human health and the aquatic environment in coastal and inland areas from faecal pollution. Bathing waters can be affected by both point and diffuse pollution sources, including scattered houses with inadequate or poorly installed or maintained on-site wastewater treatment systems. In order to minimize risks to bathers, the BWD requires EU Member States to create management plans for each bathing water site based on an assessment of the sources of contamination that are likely to affect it. It also imposes a monitoring requirement and an obligation on Member State authorities to inform the public about the status of the waters they bathe in. Furthermore, if the quality standards are not met, remedial measures must be taken which may include the construction or improvement of sewage collection and treatment works or disinfection plants. Bathing waters may be designated as 'sensitive areas' under the UWWTD, meaning that more stringent wastewater treatment should be applied prior to discharging wastewater to these bodies. This level of treatment should also be applied in dwellings not connected to the sewer network. (Grebot et al. 2019)

EU water policy has been extensively evaluated in recent years. As part of the EU Better Regulation initiative, the Urban Waste Water Treatment Directive (UWWTD) and the Water Framework Directive (WFD) have been evaluated according to the Regulatory Fitness and Performance Programme (REFIT). The evaluations aimed to determine if the current regulatory framework is fit for purpose according to the Better Regulation Guidelines and to assess the effectiveness, efficiency, coherence, relevance, and EU added value of EU Water Legislation. As a result, the evaluations concluded that the objectives of both Directives are still as relevant as when they were adopted, but that there is still room for improvement. Currently, the UWWTD is being revised on the basis of the evaluation. (European Commission 2019a), with the revision acknowledging the importance of on-site sanitation in terms of preventing health risk and environmental pollution (Sponar 2021).

2.2 Construction Products Regulation and technical standards

The Construction Products Regulation (CPR) (305/2011) lays down harmonized conditions for the marketing of construction products. Construction products are products that become an integral part of a building, such as concrete elements, windows, and steel structures as well as on-site wastewater treatment systems. The CPR is designed to simplify and clarify the existing framework for the placing on the market of construction products. Provisions of the CPR seek to clarify the affixing of CE marking (Conformité Européenne) to construction products, define the roles and responsibilities of the various parties (manufacturers, distributers, authorities, etc.) in the application of this EU regulation, and provide a clear framework for the harmonized technical specifications. The aim of the CE marking is to promote the free movement of products within the European Economic Area.

CE-marking is mandatory for all construction products for which a European harmonized product standard has been defined. Some on-site wastewater treatment systems fall within the scope of the harmonized standards, while others are outside the scope of standards. Thus, non-CE marked products also exist on the market, such as soil infiltration and sand filtration systems, treatment plants only for grey water, and retrofit plants utilizing existing wells and structures. Typically, those construction products that need to be CE-marked are prefabricated septic tanks and package plants.

The harmonized product standards are developed by the European Organization for Standardization (CEN) following a request from the European Commission. For each product group, they define properties to be determined from the products and their possible testing methods, requirements for product quality control, the roles of the various parties (manufacturer, testing facility, etc.), the

requirements for production quality control, and the information to be indicated on the CE marking. These standards are used to demonstrate that products comply with relevant EU legislation.

The manufacturer is always responsible for ensuring that the characteristics of the CE marked product correspond to a harmonized product standard. The manufacturer must constantly monitor and test the quality of the product and make a written report of the quality control. In some cases, such as on-site wastewater treatment systems, a third-party testing is also required (e.g., water tightness, treatment efficiency, structural characteristics). The testing required for the CE marking may be performed by so-called notified bodies. The European Commission's NANDO database (i.e., New Approach Notified and Designated Organizations) contains information on notified bodies and the related legal bases (Nando 2020).

A group of standards, EN 12566 - Small wastewater treatment systems for up to 50 PE, specifies the general requirements for packaged and/or site assembled wastewater treatment plants used for domestic wastewater outside sewer networks. This set of standards includes five harmonized products standards:

- EN 12566-1 Part 1: Prefabricated septic tanks
- EN 12566-3 Part 3: Packaged and/or site assembled domestic wastewater treatment plants
- EN 12566-4 Part 4: Septic tanks assembled in situ from prefabricated kits
- EN 12566-6 Part 6: Prefabricated treatment units for septic tank effluent
- EN 12566-7 Part 7: Prefabricated tertiary treatment units.

Basically, a CE-marking is a manufacturer’s declaration that the product complies with the relevant harmonized product standard. Before CE-marking and placing a product on the market, a manufacturer shall draw up a declaration of performance (DoP) in which the product properties are given. However, the CE-marking does not indicate automatically that the product complies with the national regulations of any EU country. Therefore, an on-site system may be appropriately CE- marked, even though it does not meet the national requirements, for example, in Finland. Therefore, the end user is responsible for ensuring that the product is suitable for its intended use.

3 Finland

About 15% of the population are dependent on on-site sanitation in Finland. An extensive regulatory framework regulates the diffuse pollution from non-connected dwellings. While several actors are involved in the implementation of the regulations, municipalities have the main responsibility in the supervision, enforcement and general guidance of property owners. This chapter concerns the governance of on-site sanitation in Finland and highlights some examples and aspects related especially to the Finnish parts of the Interreg Nord programme area, which covers northern Finland: North and Central Ostrobothnia and Lapland.

3.1 Introduction to Finnish on-site sanitation

In Finland, about 15% of the population (800,000 inhabitants) permanently lives in non-connected dwellings (Lapinlampi 2021) and there are approximately a half million leisure homes, 95% of which are not connected to a municipal sewer. Furthermore, requirements have risen; for example, the amount of leisure homes having a shower has almost doubled and the amount of those having washing machines has tripled in 17 years. The amount of water closets has slightly increased as well. (Voutilainen et al. 2021)

In 2004, the regulation concerning on-site sanitation was established and treatment requirements were set for those properties situated outside municipal sewer networks. Options for improving the wastewater treatment system for these households are either connect the property to the closest sewer network – either municipal or managed by a wastewater consortium – or improve the existing on-site treatment system or construct a new one. According to the Association of Finnish Municipalities (2014), the primary option is always to connect a property to a sewer network if it is easily available. However, in many cases the network is not available and constructing one would not be economically feasible.

In Finland, on-site systems typically serve one or a few households not connected to networks, but also small water associations serving fewer than 100 inhabitants. Various options are available, and they can be divided, for example, into the following categories: a holding tank, a soil treatment system (e.g., sand filter or infiltration field), a package plant, and a wetland (e.g., willow tree systems). The applicability of the latter into northern conditions has been studied by Postila and Heiderscheidt (2020), and Amofah et al. (2012). Dry toilets are used to some extent in leisure homes, but they are not gaining any growing interest in permanent residences.

However, the statutory process has not been straightforward. After several amendments, the current regulation entered into force in 2017. Implementation of the legislation has not proceeded smoothly during the past 17 years and despite numerous implementation efforts, the figures for upgrading the wastewater treatment system to meet requirements remain low.

3.2 State of on-site sanitation

While assessing the prevailing state of on-site sanitation in Finland, an assumption is that properties constructed after 2004 have proper on-site sanitation systems (in 2004, legislation related to on-site sanitation entered into force). Altogether, about 286,000 permanent residences and about 441,000 leisure homes built before 2004 are not connected to a sewer network. From these properties, about 67,000 and 343,000 are situated in coastal or groundwater areas which belong to a transition period area and that is automatically regulated by the Environmental Protection Act (527/2014). (Kallio & Suikkanen 2019.) The legislation related to on-site sanitation is presented in Chapter 3.3. The national average of the types of wastewater treatment systems can be estimated from the data collected by the guidance personnel (see Chapter 3.6.3 for more information about the guidance) (Kallio 2020). The

guidance visits were targeted to properties constructed before 2004 and the targets were mainly properties situated in transition period areas. Presented in Table 1, the estimation has been made on the basis of properties that were visited without the active initiative of the property owner during 2013–2019. The figures present an indicative estimation of the whole of Finland.

Table 1. Estimation of the percentages of different types of on-site wastewater treatment systems in permanently inhabited properties constructed before 2004 (n = 18,942). The systems are divided according to how they meet the requirements of the Regulation. BW = black water, GW = grey water.

Treatment system presented by efficiency and type	Percentage (%)
System does not meet the required treatment efficiency	
Septic tank (1, 2 or 3-departments), no secondary treatment	42
Other (not sufficient treatment)	16
Source separation (treatment system varies)	9
Total	**67**
System meets the requirements, but requires minor maintenance work, or it will need upgrading in the next 5 years	
Old sand filter or infiltration field	4
Source separation (treatment system varies)	6
Other	4
Total	**14**
System meets the requirements	
Functional and sufficient sand filter or infiltration field	6
Functional and sufficient package plant	5
All wastewater to holding tank	2
Holding tank (BW) + functional and sufficient sand filter or infiltration field (GW)	3
Holding tank (BW) + functional and sufficient package plant (GW)	0.3
Holding tank (BW) + other sufficient greywater treatment system	0.1
Dry toilet + functional and sufficient sand filter or infiltration field	0.3
Dry toilet + functional and sufficient package plant	0.1
Other (sufficient system)	0.1
Total	**16.9**
No treatment requirement, amount of wastewater small	
Dry toilet	**1.8**

The data shows that in permanent habitation, the most typical wastewater treatment system is (a) septic tank(s) with no secondary treatment (42%), which does not meet the requirements of the regulation. Of those systems that meet the requirements, the most used are different types of sand filters or infiltration fields, followed by package plants and holding tanks. In leisure homes, holding tanks and dry toilets are the most used systems. Overall, almost half of all the leisure homes fall into the category where no treatment is required because of the small amount of wastewater. (Kallio 2020)

According to the estimations, 67% of permanent residences and 20% of leisure homes built before 2004 and situated in transition period areas would need to upgrade their wastewater treatment system (Kallio & Suikkanen 2019; Kallio 2020). However, this estimation is probably too high since the guidance was intentionally directed towards those regions assumed to have properties with insufficient treatment systems. Furthermore, due to the age exemption (see Chapter 3.3.2) and an uncertainty factor related to the raw data concerning the number of properties outside the sewer network[1], these are approximate figures. Thus, according to conservative estimates, there are altogether some 37,000–45,000 permanent residences and about 69,000 leisure homes which still have inadequate treatment systems that do not meet the legislative requirements (Kallio 2014; 2020; Kallio & Suikkanen 2019). In Figure 2, the proportions of those properties are presented.

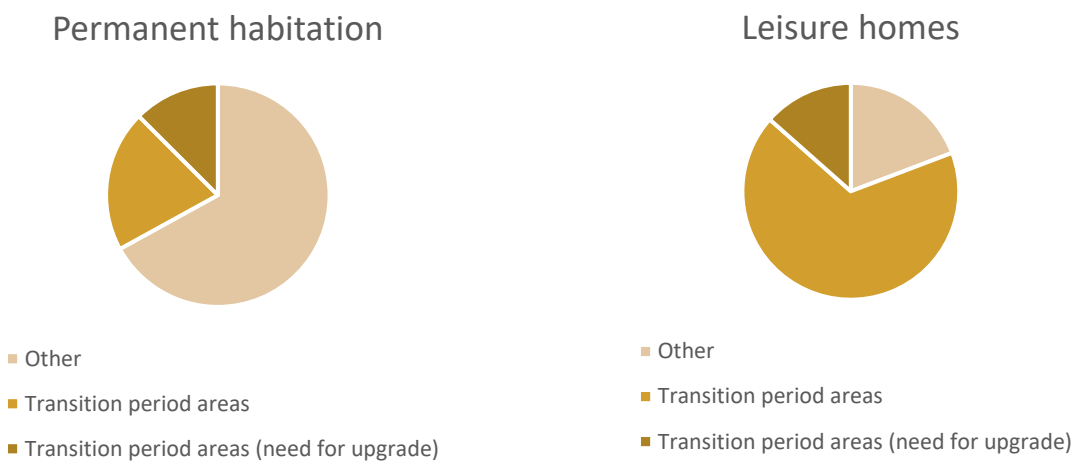

Figure 2. Properties situated outside the sewer network and built before 2004. Transition period areas refer to coastal and groundwater areas (compiled from Kallio 2014; 2020; Kallio & Suikkanen 2019).

In Finland, an environmental permit is required for units equal to or larger than 100 PE (Environmental Protection Act 527/2014); thus, the 20-99 PE units form an important group in the field of on-site sanitation. They are larger than single properties but smaller than those subject to an environmental permit, typically schools, leisure or course centres, or restaurants situated outside the centralized sewer network. The amount of these units is not very large, but their environmental load can be significant. For example, Luodeslampi et al. (2019) estimated that by improving the 20 malfunctioning 20-99 PE treatment units in the Vantaa and Helsinki Region, a reduction of biological oxygen demand (BOD) and phosphorus (P) load would equal the load from a 10,000 PE wastewater treatment plant. To guarantee an adequate performance of those units, the authors recommend that municipalities should set an obligation to monitor the units and use professional service providers for the monitoring and maintenance.

3.3 Legislation

3.3.1 Introduction to the regulatory framework

In Finnish legislation, acts and decrees are equally binding. Only in cases of interpretation conflict does an act overrule a decree. In addition, municipalities may be given a mandate, defined in an act, to

[1]Since there are no exact statistics on those properties, Kallio and Suikkanen (2019) assumed that areas of dispersed settlements, which are outside population centres with more than 200 inhabitants, were not connected to the sewer networks. However, those areas are also partly connected, especially after the National Sewerage Programme (Vasama et al. 2018).

enforce local regulations upon specific issues. To implement legislation, there are guidelines and collections of best practices, though guidelines are not binding.

Finland has been appointed a nutrient sensitive area under the UWWTD (Grebot et al. 2019), and it has a rather strict wastewater treatment policy in the areas of dispersed settlement when compared to many other EU countries (Matikka 2013). The first related regulation was based on the Water Act (264/1961), which required a septic tank treatment for wastewater from water closets prior to discharge into the environment. Furthermore, local administrations were given a mandate to enforce more efficient wastewater treatment than the Water Act required. Over three decades later, in 1997, the decision in principle of the Government outlined the objectives for water conservation including measures also to reduce the wastewater load of dispersed settlements. In 2000, the Environmental Protection Act (86/2000) entered into force, followed in 2004 by the Government Decree on Treating Domestic Wastewater in Areas Outside Sewer Networks (542/2003) which defined the required reduction of pollutants and set the transition period of ten years. Subsequent assessment of eutrophication loads revealed that wastewaters from dispersed settlement caused the second largest phosphorus load after agriculture (Tarasti 2009).

Between 2009 and 2010, public confusion grew around the theme. After a vivid media discussion and extensive regulatory background work, both the Environmental Protection Act (527/2014) and the Government Decree were amended in 2011. The transition period was postponed by two years. Concurrently, the Parliament required adequate on-site guidance (Eduskunta 2010), and the Ministry of the Environment launched funding to organize guidance on three pilot areas. In 2012, the guidance network was expanded around the country (Kallio 2012). However, in particular, the populist parties of the Parliament continued the public discussion demanding that the treatment requirements should be abandoned. In 2015 and in 2017, legislation was amended again. The latest amendments to the Environmental Protection Act and the Government Decree entered into force on 3 April 2017 and the transition period of the legislation ended on 31 October 2019.

3.3.2 Legislation regulating on-site sanitation

The Water Services Act (119/2001) regulates water utilities with a defined area of operation. However, the Act does not define the size of the organization taking care of water services. The Environmental Protection Act (527/2014) defines that the 100 PE and larger wastewater treatment plants are subject to an environmental permit. Thus, treatment plants with less than 100 PE are regulated with the legislation related to on-site sanitation:

- Environmental Protection Act (527/2014), Chapter 16, and
- Government Decree on Treating Domestic Wastewater in Areas Outside Sewer Networks (157/2017), later in this text Government Decree (157/2017).

The Environmental Protection Act (527/2014) defines the required treatment efficiencies based on the person-equivalent load for dispersed settlements as defined in the Government Decree (157/2017). The amount of organic matter in untreated domestic wastewater per resident is 50 grams per day, expressed as biological oxygen demand over seven days (BOD7), the amount of total phosphorus is 2.2 grams, and the amount of total nitrogen is 14 grams per day. Different waste portions are identified in Table 2.

Table 2. Composition of the person-equivalent load for dispersed settlements: the origin of loads and the amounts for various types of loading as grams/person/day (g/p/d) and their percentages (%).

Origin of loading	Organic matter (BOD_7) g/p d	%	Total phosphorus (P_{tot}) g/p d	%	Total nitrogen (N_{tot}) g/p d	%
Faeces	15	30	0.6	30	1.5	10
Urine	5	10	1.2	50	11.5	80
Other	30	60	0.4	20	1.0	10
Person equivalent load	50	100	2.2	100	14	100

By defining a person-equivalent load, the usage of a dry toilet or separate treatment of black wastewater are included in calculating the reduction. In other words, the reduction of the load is calculated from the total load of the property, not from the wastewater discharge.

According to the required treatment efficiencies defined by the Environmental Protection Act, the wastewater treatment must reduce the daily person equivalent load by 80% for BOD_7, by 70% for total phosphorus, and by 30% for total nitrogen (Table 3, basic requirements). If toilet wastewater is transported to municipal wastewater treatment or is not produced at all, the treatment requirement of the remaining grey water (see the row "other" from Table 1) is significantly less: there is no need to remove phosphorus or nitrogen at all and only 67% of the BOD. In addition, if the amount of greywater is negligible, it can be conveyed into the ground without treatment on the condition that it poses no risk of environmental pollution.

Municipalities may enforce municipal environmental protection regulations with more strict requirements for wastewater treatment in areas particularly sensitive to contamination (Table 3, sensitive areas). The stricter limits are defined by the Government Decree (157/2017). Nevertheless, municipalities may not mitigate the requirements of the Environmental Protection Act.

Table 3. Minimum percentage removal of BOD_7, total phosphorus and total nitrogen from domestic wastewater in on-site facilities, based on the person-equivalent load.

Parameter	Basic requirements (%)	Sensitive areas (%)
BOD_7	80	90
Total phosphorus	70	85
Total nitrogen	30	40

In North and Central Ostrobothnia and Lapland, 21 of the 59 municipalities have enforced municipal environmental protection regulations, which have some notions regarding on-site wastewater treatment. For example, the Oulu area has common local regulation for the municipalities of Hailuoto, Kempele, Liminka, Lumijoki, Muhos, Oulu, and Tyrnävä. In the groundwater areas, it is required that all wastewater is collected in holding tanks and treated outside the groundwater area. Therefore, on-site treatment is not allowed at all. (Oulun seudun ympäristötoimi 2017)

Basic treatment requirements of the Environmental Protection Act apply to all new construction automatically (built after 2004). Old buildings – permanently habited houses, leisure homes, farmhouses etc. – situated either on a groundwater area or closer than 100 metres from the mean water level of a water body were required to fulfil the treatment requirements by 31 October 2019. These areas are called transition period areas. The other buildings do not have a date-bound transition period. The

wastewater treatment system must meet the requirements when another significant construction work is performed on the premises[2].

There are two types of exceptions from the requirements. First, the requirements do not apply to any wastewater system of a property where the permanent resident or residents were born before 9 March 1943, and if the domestic wastewater of the property does not pose a risk of environmental pollution. This type of exception does not require an application.

Secondly, the competent local authority may, on application, grant an exception to a specific applicant for a maximum of five years at a time; however, if the property is sold, the exception is no longer valid. The exception may be justified by the negligible environmental load compared to the load from untreated domestic wastewater, taking into account the use of the property. The exception may also be granted if the measures required for upgrading the treatment system are deemed unreasonable for the property owner due to high costs or demanding technical requirements. When assessing the unreasonableness of measures, the following shall be considered:

- the property is located in an area intended for coverage by a sewerage network,
- the property owner or holder and those living permanently on the property are of an advanced age, as well as other, corresponding special factors related to the current circumstances of the occupants,
- the property holder is affected by long-term unemployment or illness, or some other comparable social hindrance to the performance of the provisions under the Environmental Protection Act.

3.3.3 Other legislation related to on-site sanitation

An essential part of on-site wastewater treatment is sludge management which is regulated in Finland by the Waste Act (646/2011) and municipal waste management regulations. The municipal waste management authority is responsible for organizing sludge collection and it can be done through two different ways: First, municipalities may decide to organize waste transport from properties by mutual agreement between the property holder and the waste carrier. The property owner decides when and from whom the sludge transport is ordered. Second, municipalities may decide to organize waste transport systematically. In such a case, the property owner is notified when the sludge will be collected, typically once a year. However, the latter option is more rarely used. If the on-site or shared treatment is small-scale and the treatment has been approved in the municipal waste management or environmental protection regulations, the waste holder may also treat the wastewater sludge on the property or deliver it for treatment at a neighbouring property or another property located in the vicinity. In Finland, some legislative changes are expected to be implemented in the near future which will affect the wastewater treatment in areas of dispersed settlement. For example, the Waste Act (646/2011) reform will affect the definition of septic- and holding tank sludge. In addition, the responsibilities of the property owner and municipality in this respect are under inspection.

The Land Use and Building Act (132/1999) defines the permits required for the construction of a wastewater treatment system. A building permit is required for the systems in new buildings and an action permit for the systems built as a separate construction in existing buildings, while the renovation of old systems does not require a permit. More information on permits is provided in Chapter 3.6.2. However, the current reform of the Land Use and Building Act (132/1999) includes changes in licensing system which will probably affect the issuing of permits for an on-site treatment system. If the licensing process is lightened and a building permit is no longer required for the renovation of on-site treatment facilities, it decreases the possibilities of the supervision of those systems. Furthermore, the Health Protection Act (763/1994) and the Health Protection Decree (1280/1994) regulate the prevention of health hazards related to planning, constructing, maintaining, and using the on-site wastewater treatment systems, dry toilets, and composting.

[2] A significant construction work is either a) a water closet or reparation subject to permit concerning water and wastewater equipments or b) reparation work which requires a building permit.

3.4 Strategic planning and development of wastewater treatment outside sewer network

According to the Water Services Act (119/2001), municipalities have the responsibility to develop their water services according to the needs of community development. Producing a Water Services Development Plan (later in the text Development Plans) was obliged by the Act until 2014, when the obligation was removed. However, updating the plan is still recommended (Luukkonen 2016). The Development Plan should clearly state the extent and timetable for the intended expansion of the sewer network so that single properties and small water consortiums can assess the future options for organizing their wastewater treatment, whether it is an on-site system or connection to the municipal network (Poijärvi 2006). In addition to the development of the water and sewer networks, the Development Plan should include an assessment of the current status, development needs, and options for water services outside the network. Furthermore, the implementation and supervision of the Government Decree (157/2017) can be planned. (Association of Finnish Municipalities 2014; Luukkonen 2016.) A reform process concerning the Water Services Act (119/2001) is under consideration. An assessment of the functionality of the Water Services Act (Saarinen 2020) recommended restoring the municipalities' obligation to prepare a Water Services Development Plan which would enhance continuity, predictability, and the systematic planning of water services as part of land use planning.

The Development Plans have considered wastewater treatment outside the sewer network in varying ways. For example, in Central Finland, some municipalities made plans for establishing wastewater cooperatives and for expanding sewer networks to the areas of dispersed settlement, but thorough strategic planning was lacking in most municipalities. Moreover, the plans seldom included a specific assessment of on-site sanitation. A few municipalities had admitted subventions for the implementation of on-site wastewater treatment systems, and some had a specific programme for supervision. However, most of the municipalities were waiting for the transition period of the Government Decree (157/2017) to end. (Lammila & Nummelin 2014)

Regional planning and development of water services is commonly performed by the Centres for Economic Development, Transport and the Environment (ELY Centres). The municipalities are obliged by the Water Services Act (119/2001) to participate. (Belinskij 2015). Generally, the regional Development Plans analyses the reliability performance and crisis preparedness of water services as well as the need for inter-municipal cooperation. They also offer some perspectives to the development of water services outside the sewer network. An overview of the regional Development Plans and programmes showed that the inclusion of water services outside the sewer network in the Development Plans varies among the regions. For example, the Water Services Development Programme of Northern Ostrobothnia only mentions that the aims of expanding the sewer networks to areas of dispersed settlement will be achieved and probably even exceeded (Kangaskokko & Hentilä 2017). Instead, the development plans of Central Finland (Viitaniemi 2010) and Southwest Finland (Lammila & Nummelin 2014) considerably assess the current state and future needs of the wastewater treatment outside the sewer network. Remarkably, the former strongly emphasizes the promotion of dry toilets as an option for on-site sanitation.

Furthermore, the Häme Region has a distinct strategy concentrating entirely on the implementation of water services in the areas of dispersed settlement (Hämeen ympäristökeskus 2004). It defines the roles and responsibilities of different actors within three options: an on-site solution, a water consortium, which is a private law body, for example, a water cooperative, or a municipal water utility. The strategy emphasizes the role of the municipal Development Plan: it needs to cover the whole area and clearly point out the areas implementing the wastewater treatment through common solutions and those areas where on-site solutions will prevail. The municipality needs to ensure that on-site solutions are developed only in areas where it is appropriate. A reform of this strategy was implemented, and the new strategy was published in 2022. It clarifies the development needs for on-site sanitation in the

Häme Region until 2030: increasing public awareness and the general appreciation of water services, the clarification of roles and responsibilities of various actors and strengthening their interaction and collaboration, as well as increasing customer services for property owners. (Virola & Leino 2022)

At a regional level, River Basin Management Plans (RBMP) consider wastewater treatment in the areas of dispersed settlement to some extent. They assess various actions producing nutrient load and causing eutrophication, dispersed settlement being one of them; propose different measures in order to minimize the nutrient load from those areas, and estimate the investment costs for these measures. The measures are based on the Government Decree (157/2017). Furthermore, the RBMP for the River Tornionjoki, for example, estimates the costs according to the number of households and their need to either maintain or update the wastewater treatment systems (Lapland ELY Centre 2020). Instructions for the planning particularly emphasize the maintenance and proper use of the treatment systems (Ministry of the Environment 2020). The RBMPs for 2022–2027 will be approved by the Finnish Government at the end of 2021.

In addition to regional strategies, several national strategies frame the development and planning of water services both at municipal and regional levels. Wastewater treatment outside the sewer network is considered especially in national water conservation strategies. For example, in 2002, the Baltic Sea Conservation Programme – Finnish Government decision-in-principle set objectives for preparing the regulation for reducing the load from wastewaters from dispersed settlements (Ministry of the Environment 2002). Consequently, the Government Decree (542/2003) came into force. Five years later, the Finnish Government decision-in-principle on Water Protection Policy Outlines proposed guidelines based on the implementation of the Government Decree (542/2003) and the presented measures for expanding the sewer network and enhancing the development of on-site wastewater treatment options and maintenance services. (Ministry of the Environment 2007). In contrast, the national Water Resources Management Strategy 2011–2019 includes water services but only mentions the areas of dispersed settlement in respect of expanding the sewer networks to those areas (Ministry of Agriculture and Forestry, 2011). In addition, two Guidelines for Water Services have been published in cooperation of the Ministries and the Association of Finnish Municipalities. (Silfverberg 2007; 2017). However, these publications concentrate on the water services produced by the water utilities, thus only slightly acknowledging the water services outside the municipal networks.

The expansion of sewer networks to areas of dispersed settlement was promoted through a National Sewerage Programme, established for 2012–2016, and thus supports the implementation of the Government Decree (157/2017). The programme presented common principles and criteria to meet the goal of the sewer network expansion as well as guidelines for distributing the government subsidy to the regional sewerage projects (Ministry of Agriculture and Forestry 2012). While the aim of the programme was to connect 20,000 properties to the sewer network, altogether 19,800 were realized. For example, Northern Ostrobothnia and Lapland exceeded their aims and Central Ostrobothnia reached their target. (Vasama et al. 2018.) Recently the rate of expansion has significantly decreased. The reason for this is evidently the ending of the government subsidies, but also changes in legislation. In 2014, the reform of the Water Services Act lightened the property's obligation to connect the sewer network in areas of dispersed settlement. Subsequently, the on-site wastewater regulations defined in the Government Decree (157/2017) were mitigated and the transition period was postponed; thus, the willingness of property owners to connect their properties to a sewer network decreased. Silfverberg (2017) estimates that the emphasis in areas of dispersed settlement will move to on-site treatment. However, the assessment related to the reform concerning the Water Services Act (119/2001) suggested that the obligation to connect a property to the sewer network in areas of a dispersed settlement should be reconsidered so that everybody in the operating area should be connected (Saarinen 2020).

Finally, an essential aspect of the strategic planning of wastewater treatment in the areas of dispersed settlement is the integration of water services and land use planning. Decisions concerning the expansion of sewer networks permanently influence the community structure and vice versa, which on

the other hand, sets the framework for the on-site sanitation. Municipalities are responsible for the interaction of water services as well as land use planning, and that their statutory requirements are fulfilled. (Helminen et al. 2013)

3.5 Stakeholders and their responsibilities

While the Water Services Act (119/2001) sets the responsibility of water services and their development to the municipalities, in households outside the municipal sewer network, the property owner has the responsibility of having an adequate and suitable treatment system for domestic wastewater. In addition, there are various stakeholders which have different responsibilities and influence on on-site sanitation (Figure 3).

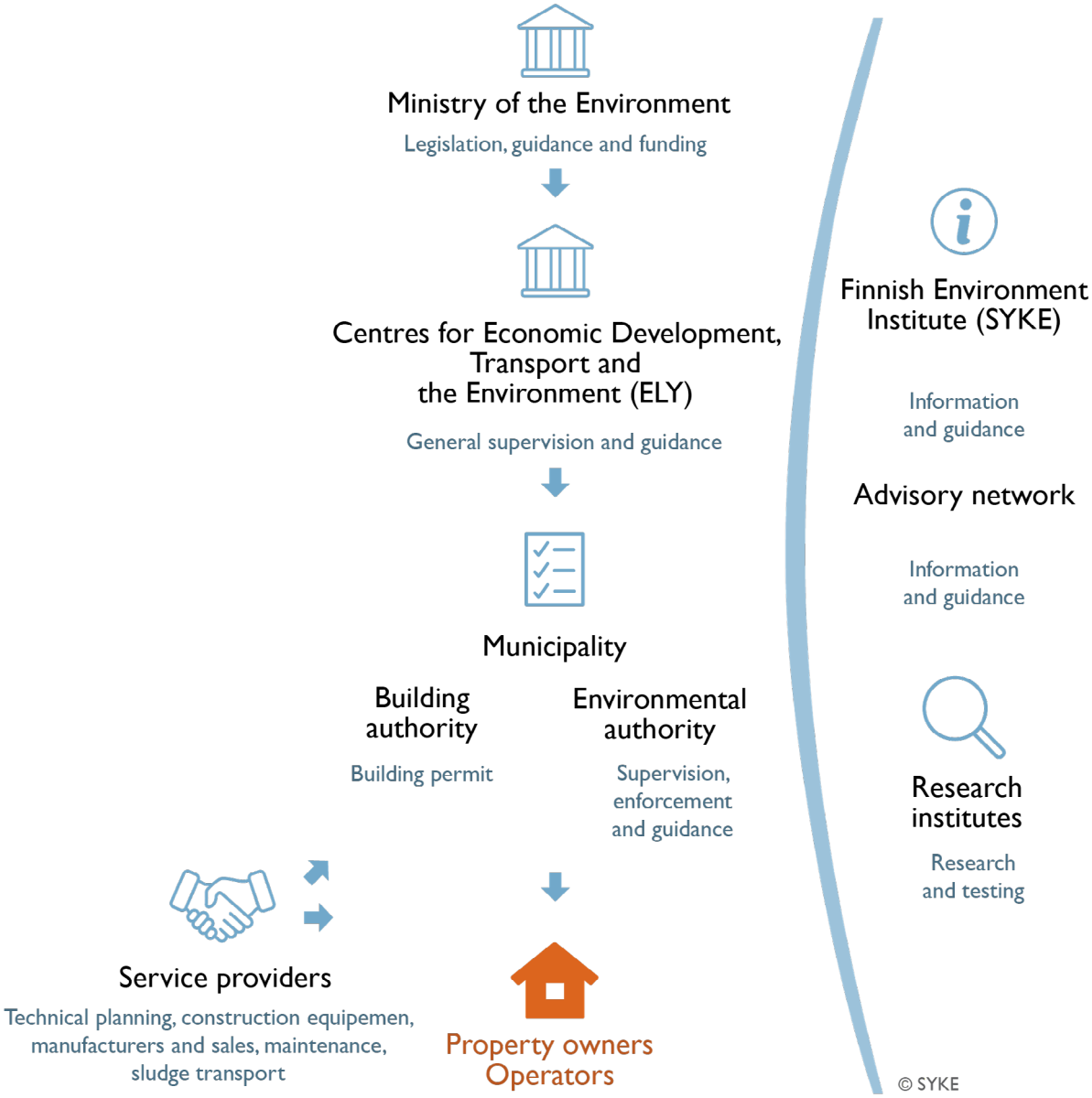

Figure 3. Stakeholders related to wastewater treatment outside the sewer network in Finland.

Authorities

The Ministry of the Environment is responsible for the general guidance, monitoring, and development of activities under the Environmental Protection Act (527/2014). Within their own regions, the ELY Centres implement general supervision: they guide and promote the management of duties stated in the provisions issued under the Environmental Protection Act; thus, they provide guidance to the municipal authorities. They also exercise their right to defend public environmental interests in decision-making.

The municipal building administration is the authority responsible for evaluating the technical design of and for granting a permit for an on-site treatment system. Before granting the permit, it is common that the building control authority requests an evaluator statement from the municipality's environmental authority. The environmental protection authority is responsible for the environmental enforcement duties of a municipality. Thus, they are also responsible for enforcing the Government Decree (157/2017) and Environmental Protection Act; however, since the transition period ended recently, the practice for enforcement and supervision is gradually taking shape. In addition, the environmental authority may, on a case-by-case basis, grant an exception from the required treatment requirements on the grounds specified in the Environmental Protection Act. The possibilities for the exception concerning on-site wastewater treatment are presented in Chapter 3.3.2. The environmental protection authority is usually responsible for answering the numerous questions of property owners. They may provide guidance in the implementing of regulations, but they do not provide any property specific guidance in order to secure impartiality (Taina 2011).

Information providers

The Finnish Environment Institute (SYKE) is not an authority; however, the Government Decree (157/2017) defines its role as an information provider. SYKE offers general guidance mainly to municipalities but also to single property owners. SYKE has a legal obligation to monitor the generally available wastewater treatment systems, and the treatment results achieved by an independent and reliable actor. All this information must be made easily available to the public. Consequently, SYKE administers a database which includes all the above-mentioned data concerning on-site wastewater treatment systems.

In 2011, parallel to the changes made to the Government Decree (157/2017), the Parliament of Finland required that the Ministry of the Environment provides sufficient and objective guidance for habitants outside sewer networks. An annual funding (1.0–1.5 M€/year) was granted to organizations providing intended guidance. Thus, altogether, about 16 individual projects formed an advisory network which operated during 2011–2019 (see also Chapter 3.6.3). SYKE coordinated the advisory efforts and educated the staff of these organizations. (Kallio 2020)

Property owners

According to the Environmental Protection Act (527/2014) the property owner is responsible for having adequate and suitable equipment for the treatment of domestic wastewater. The treatment shall be suitable for its intended use, considering the load of untreated wastewater resulting from the use of the property, attributes of other parts of the wastewater system, the risk of environmental pollution – such as the location of the property in a coastal area, or in an important or other groundwater area suitable for water supply, and other environmental conditions.

The property owner needs to ensure that the treatment system is planned, built, used and maintained properly. Furthermore, the property owner is responsible for the adequate maintenance of the system as well as having maintenance instructions available and ensuring that they are followed. The property owner is also responsible for a wastewater system report being on the premises, which includes the operating principle, structure and performance of the wastewater treatment system, as well as a map of the property area.

Service providers

Elements of the technical planning of a wastewater treatment system are defined in the Environmental Protection Act (527/2014) and the Government Decree (157/2017). The main aim of the technical planning is to select a proper treatment solution for a particular site and determine the actual place for the installation or construction of the selected system. The process includes several steps such as a field examination, a report on produced wastewater and existing equipment, a comparison of available treatment systems, a selection of the appropriate system, and plans for the installation. The planner needs to be a professional with a sufficient level of knowledge on wastewater treatment technologies and special conditions in rural areas.

Buying and selling consumer services and goods are regulated by the Consumer Protection Act (38/1978). In general, a party selling the product – whether it is the manufacturer or a retail company – is responsible for the flawless delivery and proper function of a treatment system. This necessitates, however, appropriate installation and use as well as adequate maintenance of the product. The consumer is responsible for notifying the seller within a reasonable time after discovering or ought to have discovered a defect. The same regulation applies to the liability of wastewater treatment designers and construction services. The provisions of the Consumer Protection Act only govern agreements between consumers and entrepreneurs, not the employment relationships. However, the property owner is responsible for defining the order. Conflicts may occur and are sometimes complex; therefore, it is highly essential to prepare a written agreement for the work.

Construction services are responsible for the proper installation of the wastewater treatment system according to the technical plan. This includes the responsibility to perform the agreed work in the time given and to repair any flaws if they occur. Some contractors also provide maintenance services, or these can be provided by separate actors. These services include the maintenance of pumping and wastewater treatment systems, emptying septic tanks, sludge transport, and delivering necessary chemicals. Sludge transport is defined in the Waste Act (646/2011) as the responsibility of the municipality, but it is generally performed by private companies (see also Chapter 3.3.2). Chapter 3.7 provides a more specific description of various service providers in the Finnish parts of the Interreg Nord programme area.

3.6 Governance practices

3.6.1 Authorization

The permits for on-site sanitation systems must be applied for from the municipal building administration. When a wastewater system is to be constructed, or the functioning of an existing system is to be enhanced, a wastewater system plan to that effect must be enclosed with the required application for a building or action permit, or a building notification, filed under the Land Use and Building Act (132/1999).

The main content of the wastewater system plan is defined in the Environmental Protection Act (527/2014). The plan shall include information on the design, structure, and operation, as well as an estimation of the treatment result and the environmental load from the wastewater treatment system. In addition, other information necessary for the construction, operation, and monitoring of the system should be included. Furthermore, the wastewater system plan is defined in more detail in the Government Decree (157/2017). The plan shall take into account the intended and potential use of the property and the life cycle of the buildings and include:

- information on the quantity and quality of the effluent formed,
- information on the sewer system and its sizing,

- information on the location drawing of the sewage system pipes, equipment and treated wastewater discharge point, the location and accessibility of treatment and maintenance sites, buildings affected by the sewage system and sewage, household water wells, and other water abstraction, surface and groundwater,
- where appropriate, an assessment of the operation of the wastewater system at peak and groundwater levels.

Including a wastewater system plan in the permit process provides the building authority the possibility of assessing the suitability of the planned system and also enables better surveillance on behalf of the environmental authority. Municipalities may define that certain simple wastewater treatment systems can be built with a building notification instead of a permit. This procedure may be applied to simple grey water systems for example.

3.6.2 Supervision

The municipal authorities have certain official methods of supervision and enforcing the legislative requirements. These are: the request, the prohibition, and the order. The supervisory authority shall take action to initiate the administrative enforcement proceedings if The Environmental Protection Act (527/2014) is violated. A municipal environmental authority selects adequate methods for supervision. For example, site visits and visual inspections are made but sampling of the treated wastewater is not required in Finland. A municipal authority may inspect a site and conclude the evaluation without taking a sample. However, in some cases, samples are taken from the effluent if there is a need to prove the functionality, for example, for a court case, or if the treatment method has not been in use in Finland before. The influent is never sampled. In addition to site visits, a used method for surveillance is a letter campaign to property owners requiring a copy of the wastewater system report. The report is a mandatory document (defined in the Environmental Protection Act), which every property owner needs to have if he or she hasn't already applied for a permit for the system. Such a report must enable the environmental authority to assess the loading caused by the wastewaters produced at the property and thus the possible need for upgrading the treatment system. However, generally, authorities do not have the resources for systematic site visits, so inspections are typically performed by a risk-based evaluation or as a result of a complaint from a neighbour. Municipalities demand resources from the government, but such an aid is not on the horizon. (Yle uutiset 2019; 2021). Yet, some local supervision campaigns are known to be active, at least in the Keski-Uusimaa, Jyväskylä, Turku and Pori Regions (Keski-Uudenmaan ympäristökeskus 2022; Keski-Suomi 2021; Turun Sanomat 2021; Yle uutiset 2021).

Tarasti (2009) and the on-site sanitation committee established by the Ministry of the Environment (Luonsi 2010) suggested that the supervision should be targeted at those areas sensitive to pollution, such as groundwater and coastal areas. In addition, Tarasti (2009) proposed that the supervision should be regulated by the Government Decree (157/2017) in order to harmonize the supervision in all municipalities, but this recommendation was not realized. In 2014, a thesis made for the Environment Centre of Keski-Uusimaa created a prioritization model for on-site sanitation regulatory control. It defined the priority of the areas for the supervision, based on the risk of environmental pollution and health hazards, in order to allocate the few resources for supervision effectively. The used criteria were surface water and groundwater conservation and health protection. (Autio-Nousiainen 2014)

In practice, the supervision can be a three-step procedure: information sharing, assessment, and supervision. Information sharing includes a letter to the property owners, which clarifies the regulative demands for updating the wastewater treatment systems and possibilities to apply for an exception. In the assessment phase, every property owner has to submit a report of their situation including an account of the current wastewater treatment system, its use, and maintenance. The actual supervision phase consists of a site visit, a request for updating the wastewater treatment system and giving an

order, if necessary. The order can be intensified by imposing a conditional fine. (Autio-Nousiainen 2014)

3.6.3 Guidance

An important part of the implementation of on-site sanitation is direct and indirect communication with stakeholders. Although information does exist, the problem might be finding appropriate information in the case of an individual property owner (e.g., Rinnola 2008). Consequently, during 2011–2019, various organizations provided guidance, funded by the Ministry of the Environment, to the property owners. The aim of such was to enhance wastewater treatment during the transition period of the legislation. The advisors helped the property owners to find relevant information to meet their needs, for example, reliable information on the need for improvements, alternative wastewater systems or a municipality's permit procedure. Furthermore, the guidance aimed at activating the passive property owners and getting them interested in the effects of their wastewaters and the possibilities of improving their systems. The means for the guidance were numerous: the evaluation of the water supply and treatment systems during on-site visits, personal guidance in town centres (e.g., libraries, town hall), general guidance lectures, email- and telephone guidance, websites, and printed material. The responsibility of the implementation and management of guidance was generally given to local environmental associations. On average, there were 15–17 funded organizations annually. The total amounts of guided inhabitants are summarized in Figure 4. (Kallio 2020)

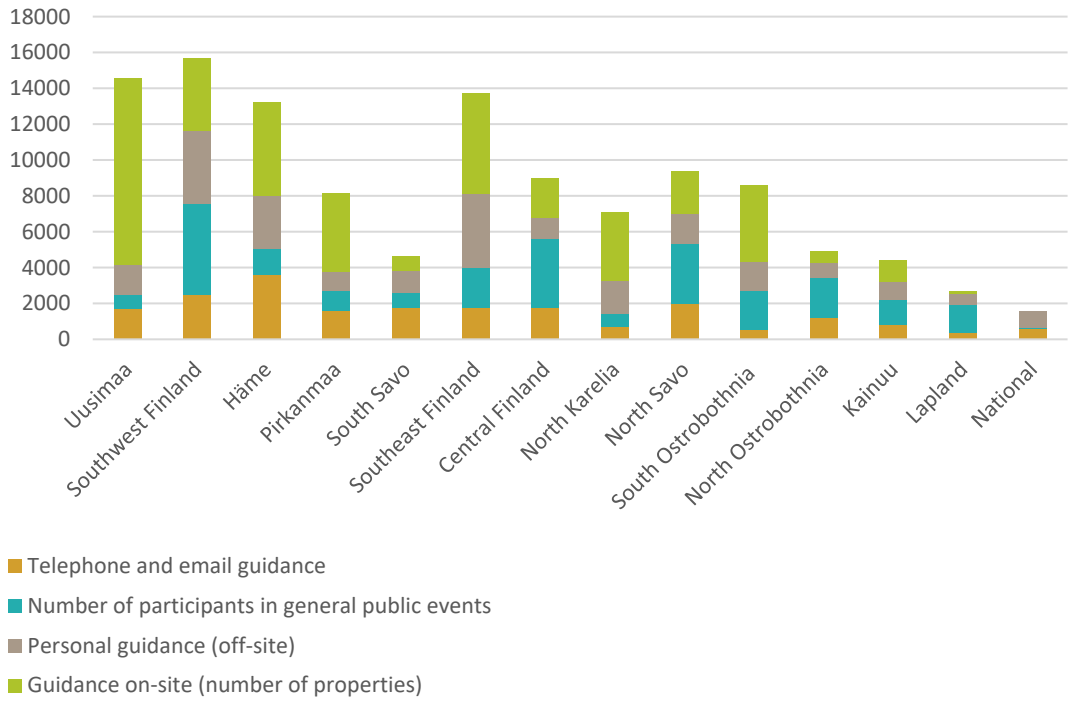

Figure 4. Guidance in 2011–2019 in the regions defined by the ELY centres. Note that Central Ostrobothnia is part of the South Ostrobothnia. (Adapted from Kallio 2020)

The guidance was a significant investment for implementing the legislation related to on-site wastewater treatment. It succeeded in arising property owner interest in the topic and in distributing relevant information; however, the effect on the enhancement activity was limited (Kallio 2020). The enforced guidance ended in October 2019 and will not be continued by governmental funding. Nevertheless,

some municipalities continue to fund guidance organizations in order to have more resources in information services.

3.6.4 Other support mechanisms

In addition to guidance, other communication efforts, such as information-sharing and web-based services have been implemented. Between 2009 and 2017, the Ministry of the Environment has published three detailed guidebooks of the legislation, policies and practices of on-site wastewater sanitation (Kaloinen & Santala 2009; Hallanaro & Kujala-Räty 2011; Kangas 2017), which were intended especially for municipal authorities. In addition, significant numbers of brochures have been published for authorities, practitioners, as well as for citizens.

Since the regulations enforce wastewater treatment in certain geographical areas – groundwater areas or areas closer than 100 metres from the mean water level of a water body – it is essential to provide information about such locations. The spatial information services, provided by the Finnish Environment Institute, include two open access web-based tools (Figure 5). The first illustrates the ground water areas and 100-metre coastal areas through a map-based tool, where the user can type in the address of a property and the map will show whether it is included in those areas or not. The second, a web-tool called *Vesihuoltotulkki*, utilizes the same map-based information and includes specifying questions about the location. After answering those questions, the user receives options for the suitable on-site wastewater treatment systems for the property in question.

Figure 5. Two open access web-based tools provided by the Finnish Environment Institute: ground water areas and 100-metre coastal areas (on the left), and the same information adopted in a customer web-tool called Vesihuoltotulkki (on the right).

In addition to direct and indirect communication, some individual incentives have occurred as well. The way the municipalities supervise the on-site wastewater treatment varies significantly: while some are very active and have fluent permit processes, others just wait passively. Consequently, the interest organization of companies producing plastic products, *Muoviteollisuus ry*, organized a competition for the municipalities: the winner being the municipality, which was the most advanced in the implementation of the legislative requirements. The winner of the 3,000 euros prize was the City of Salo, with the arguments for such a choice being the fluent decision-making process of the City of

Salo's building authority, professional skills of the authorities, and easy-to-use electronic services and webpage. (Muoviteollisuus ry 2021)

3.7 Availability of services in the programme area

The availability of services related to on-site sanitation was evaluated in the Finnish parts of the Interreg Nord programme area: North and Central Ostrobothnia and Lapland. The evaluation included four categories: technical planning, equipment sales, construction, and maintenance services. The number of service providers was calculated mainly through a web search. Several web portals provide geographical information to users to find, for example, the closest planners, contractors or retailers of wastewater treatment systems. Most of these are created and maintained by equipment manufacturers who provide their customers with the possibility of easily searching the closest retailers of their products. Furthermore, a guidance project called *Jätevesihanke* (wastewater project) has created and maintains such a web portal and provides objective information of available services in the whole of Finland.

In addition to the web search, the data was supplemented by contacting regional actors, such as equipment manufacturers, municipal actors, especially in the technical sector, and the third sector (*Koneyrittäjien liitto, Kemijoen vesiensuojeluyhdistys*). Table 4 summarizes the amount of available service providers in the programme area. It is notable that many of these providers offer two or more of these services. Thus, the total amount of service providers is less than the figures presented in the table. Moreover, some actors operate inside several municipalities, so the fifth column of Table 4 presents the total number of actors according to the number of offices, and the sixth column according to the number of enterprises which provide the services in question.

Table 4. A summary of the available service providers in the programme area.

Service	Lapland	North Ostrobothnia	Central Ostrobothnia	Total (number of offices)	Total (number of enterprises)
Technical planning	9	33	4	46	39
Equipment sales	39	68	13	120	87
Construction services	27	48	7	82	80
Maintenance services	9	16	4	29	24

As shown in Table 4, several actors provide **technical planning services**: engineering offices, HPAC-planners, contractors and even some hardware stores including planning services. Some of these actors are specialized in wastewater treatment systems. A national FISE register includes the planners who are certified and educated in the planning of wastewater systems. Two of the 28 FISE certified planners work in the programme area. Altogether, this area included 39 technical planning enterprises who offer planning services of wastewater treatment systems. Two large engineering offices had planners in several municipalities.

Equipment sales is performed by both retailers and manufacturers of the wastewater treatment systems. Some of the retailers are specialized local actors and some are nationwide hardware store chains. The programme area included three hardware store chains, which had altogether 36 stores covering the whole area. In addition, there were 84 local retailers.

Mapping of the available **construction services** was not evident. There are about 12,000 machine contractors in Finland, but there is no official register of those who provide services related to wastewater treatment systems. However, the web portals indicated altogether 80 contractors being actively involved in this area.

Maintenance services include the maintenance of pumping and wastewater treatment systems, emptying septic tanks, and delivering necessary chemicals. Some of the service providers offered only sewage truck service. Altogether, the programme area included 24 actors who offer maintenance services of wastewater treatment systems. Three of them are large service companies (*Lassila & Tikanoja, Delete Group and Eerola-yhtiöt*), which operate in several regions, while the remainder are local service providers.

These figures were quite surprising since the message from the field, particularly from the guidance projects (see Chapter 3.6.3), is that there is a shortage of service providers, especially those of proficient planners (Kallio 2020). A guidance report from Lapland states that gathering a list of proficient planners from the municipalities and from the *HPAC Association of Finland (SuLVI)* resulted in two names only (Kemijoen vesiensuojeluyhdistys 2017). Altogether, this study found nine planners from Lapland. However, in such a region, the distances are long, and the planners are located in seven of the 21 municipalities. In Central Ostrobothnia, there were only two entrepreneurs operating inside four municipalities, but the area is much smaller compared to Lapland. Moreover, it should be noted that the quantity of services does not guarantee quality: the advisors received feedback from incompetent planners, some of whom made plans even without a site visit (Kallio 2020).

3.8 Governance and practical challenges

The regulatory framework clearly defines the requirements for on-site sanitation. In addition, roles and responsibilities of various stakeholders as well as the process for upgrading on-site sanitation systems, including issuing a permit, are clearly defined. However, the issues with non-compliance hinders the implementation of the regulation and still about half of the old properties situated in transition period areas lack proper sanitation fulfilling the legislative requirements. The governance and practical challenges can be divided into three categories: legislation and authorities, resources, and knowledge and competence.

Legislation and authorities

Since the execution of the Government Decree (542/2003) had started slowly, in 2007, the Ministry of the Environment appointed an on-site sanitation committee to enhance the execution as well as assess the related problems and give proposals for action (Luonsi 2010). In 2009, at the final stage of the committee activity, the Ministry called an administrator to assess the current state of the execution of the Government Decree and related problems. The aim was also to find measures to expedite the implementation of the Government Decree (542/2003). Several suggestions were made and implemented as well (Tarasti 2009). In 2011, the Government Decree was amended, and also in 2015 and 2017, and the transition period was postponed.

The key governance challenge in Finland is that the legislation lost its credibility during the numerous changes. According to the inquiry (Rinnola 2008), many property owners wanted to postpone upgrading the wastewater system as long as possible. In Southwest Finland, for example, the implementation of on-site sanitation systems ceased completely after the legislative changes in 2011. During 2007–2010, there were many EU funded projects enhancing the implementation, but after the changes occurred, only two guidance projects funded by the Ministry of the Environment remained. In addition, development, planning and marketing of on-site systems, as well as the willingness of property owners to renovate their systems decreased along with the uncertainty brought by the changes in legislation. (Lammila & Nummelin 2014). Due to the changes and complexity of the issue, citizens are still confused, and some are waiting for more changes to occur (Kallio 2020).

Municipalities vary in terms of interpretation of the legislation. Competition from new inhabitants, especially in net out-migration municipalities, may lead to too vague an interpretation and the granting of permits for on-site treatment systems without adequate grounds. Mattila (2005) stated: “It will be

difficult to make practices stricter in future if management is not taken seriously enough in the first years of implementation". However, proper environmental protection and management practices could be a good advertisement for a municipality as well (Valpasvuo 2002).

In some municipalities, there are challenges due to a lack of cooperation between the municipal building control authority and the environmental protection authority (Luonsi 2010). The latter is more recent, as is the environmental legislation in Finland, and it is often centralized. One environmental authority may operate inside several municipalities; for example, the area of responsibility of the Environment Office of Oulu includes seven municipalities (City of Oulu 2021). However, the building control authority generally exists in every municipality. Thus, the two authorities may be placed in different offices or even in different municipalities, and in the worst cases they do not communicate or even contradict one another. Thus, inconsistencies in the permit procedure and the supervision will lead to administrative challenges. This aspect supports those concerns about multilevel governance structures struggling with coordination problems and the lack of implementation (Sandström et al. 2019).

Resources

A significant obstacle to upgrading the wastewater treatment systems is the cost. The investment costs vary from 500–3,000 euros for a grey water treatment system to 5,000–15,000 euros for a blackwater treatment system. It is important to note, however, that a proper on-site wastewater treatment system will increase the value of the property. Nevertheless, especially in sparsely populated areas, the value of the property might even be lower than the investment cost of the treatment system. It is common for the collateral value of a real-estate not even to cover the required bank loan (SYKE 2019). In such cases the property owners are expected to apply for an exception from the municipality. To mitigate the problem, the Government should develop financial solutions for property owners of limited means (Vienonen 2007). The share of work included in the construction and installation of the on-site treatment systems can be deducted for the tax purposes as a tax credit for domestic help. Tarasti's (2009) proposal to extend the tax credit also to the technical planning of the systems, however, has not been implemented.

Now that the transition period has ended in Finland, municipalities can fully implement the administrative enforcement procedure defined in the Environmental Protection Act (527/2014). It is expected that in some cases only enforcement will make the change. Property owners might be sceptical in terms of supervision, and this decreases the motivation for renovations. There is a significant concern that municipalities do not have sufficient resources for the supervision and enforcement of the legislation. (Kallio 2020.) For example, the City of Oulu, with its 200,000 inhabitants, has only four staff members in the building administration department and three in environmental administration. In practice, these individuals do not have the time for guidance or supervision of on-site sanitation. (Talvitie 2021)

Furthermore, the transport and treatment of septic tank sludge will be problematic in some areas, especially in northern Finland, where distances are long, and the number of service providers is low. While upgrading the on-site systems will increase the amount of sludge, concurrently, the possibility of small municipal wastewater treatment plants to treat septic tank sludge has decreased due to stricter environmental regulations. Long transport distances are not environmentally reasonable, and new alternative treatment solutions should be found (Lammila & Nummelin 2014). As an example, a project in Eastern Lapland, funded by the Ministry of the Environment, investigates the potential of former livestock farms to receive and treat the septic tank sludge in their sludge tanks constructed for livestock manure (Tarkka & Leppänen 2019). Furthermore, a report of the collection and treatment of septic tank sludge in Southwest Finland concludes that water should be removed from the sludge as early as possible: either with special transport equipment or decentralized temporary storages with the possibility of dehydration. The former is has already been tested in some areas in Sweden. (LCA Consulting 2018)

Data, knowledge and competence

In terms of planning and supervising on-site sanitation, one of the most important knowledge-requirements is up-to-date information of the current systems. Thus, a significant problem hindering the work of the municipal authorities is the deficiency in the national database of buildings defined in the Government Decree on Population Information System (128/2010). The database includes many variables of the properties, but the information concerning on-site wastewater systems is not defined in the decree, making it impossible to save this data in the database. Consequently, the municipal authorities have their own Excel-files and other tools to keep up with the current situation. Information is easily lost, and the local databases vary, which makes them incompatible. Lack of data is a general problem all over the country.

Rinnola (2008) estimated that property owners' lack of knowledge was a significant challenge in enhancing on-site wastewater treatment during the early years of the new legislation, which came into force in 2004. Moreover, the on-site sanitation committee stated that enforcing the Government Decree has been hindered by the lack of knowledge concerning the regulations and the environmental effects of wastewaters (Luonsi 2010). This was also noticed, for example, in the City of Oulu: Talvitie (2021) has stated that there is not enough knowledge among the property owners to evaluate the need for upgrading the existing on-site sanitation systems and that the possible benefits are not acknowledged. Over the years, national and regional wastewater guidance and various communication efforts have partly changed the situation. In general, knowhow has increased: for example, it is generally understood that a septic tank system with no secondary treatment is not adequate and treatment systems should be upgraded near a water body. Although information is easily available, people usually do not know whether a property is located in a groundwater area or not. Moreover, a lack of knowledge occurs among the authorities as well, and education would be required. (Kallio 2020)

The problem is not always that the systems are not upgraded or installed, but several factors endanger the functioning of the already installed on-site system. According to Rinnola (2008), 23% of the property owners in Kauhajoki would like to install the system themselves. Although this is not prohibited, it may result in significant operation problems. Sometimes people also choose to take a shortcut and treatment systems are built without permits. Moreover, inadequate maintenance of a wastewater treatment system can cause a lot of problems in the functioning of the system (Viitala 2001; Grebot et al. 2019). During the site visits of the guidance projects, it was found that almost all properties lacked maintenance instructions, and many had deficiencies in maintaining the on-site system (Kallio 2020). Currently, the property owner has the responsibility of the maintenance, but this can be purchased from a service provider. While the majority wants to maintain the system by themselves, there are some indications that the demand for professional services will increase along with more technical systems (Lammila & Nummelin 2014). Professional maintenance and service contracts are recommended for the systems, which are technically demanding, but it can be argued that the role of professional maintenance services should be more considerable or even defined mandatory in legislation (Mattila 2005; Tarasti 2009; Luonsi 2010). In terms of large units, 20-29 PE, Luodeslampi et al. (2019) recommended that in order to guarantee an adequate performance of those units, municipalities should set an obligation to monitor the units and use professional service providers for the monitoring and maintenance.

The reform of the on-site wastewater legislation has generated a growing business around the topic. This has led to some aggressive and misleading marketing, and some property owners have bought systems which are insufficient for their local conditions (Luonsi 2010). In the absence of a comprehensive certification system for service providers, property owners may have difficulties in defining whether, for example, a planner is competent. Though some certificates do exist, they are not encompassing. For example, the number of FISE[3] certified planners in Finland is altogether 28.

[3] FISE is a limited company offering certifications for construction-, HPAC- and real estate professionals.

Moreover, some property owners have complained about incompetent planners (Kallio 2020), which may lead, for example, to an inappropriate choice of an on-site system.

In some areas, the Development Plans do not clearly indicate the extent and timetable for the intended expansion of the municipal sewer network, or the establishment of new wastewater cooperatives is not clear. Thus, the inhabitants are uncertain whether the sewer network will reach their property or not in the future, which may decrease the willingness to upgrade the on-site wastewater treatment systems. (Helminen et al. 2013)

3.9 Conclusions

In accordance with the efforts of decreasing the eutrophication load to water bodies, the Finnish Government started to regulate wastewater treatment in areas of dispersed settlement in 2004. The regulation process was not straightforward but included several changes to the regulation and postponements of the transition period over the years. In 2019, the transition period ended and all properties outside the sewer network should meet the treatment requirements in two categories: 1) properties built after 2004 should meet the requirements automatically, and 2) properties built before 2004 and located either in the groundwater area or closer than 100 metres from the mean water level of a water body had to meet the requirements by 31October 2019. The properties built before 2004, but not situated in the above-mentioned areas, are not obliged to meet the requirements now, but should upgrade the wastewater systems during the next significant construction work. However, an overview of the current state of on-site wastewater treatment shows that various governance challenges are hindering the implementation of the regulation.

The options for improving the wastewater treatment system are either connecting the property to the closest sewer network, improving an existing on-site treatment system, or constructing a new one. Along with the National Sewerage Programme during 2011–2016, almost 20,000 properties were connected to the sewer network (Vasama et al. 2018). However, it is not affordable to spread networks everywhere in such a sparsely populated country as Finland. In addition, after some legislative changes, the willingness of property owners to connect to the network decreased. Currently, about 286,000 permanent residences and about 440,000 leisure homes built before 2004 are not connected to a sewer network (Kallio & Suikkanen 2019). Despite numerous implementation efforts, the figures for upgrading the wastewater treatment system to meet the requirements remain low. According to conservative estimates (Kallio 2014; 2020; Kallio and Suikkanen 2019), there are altogether some 37,000–45,000 permanent residences and about 69,000 leisure homes in the category two, which still have inadequate treatment systems that do not meet the requirements.

The governance framework includes multiple actors, which can be divided into authorities, information providers, and service providers, and they all interact with each other and with property owners. The processes are regulated in detail, for example, the roles and responsibilities of various actors, as well as the permit process and technical planning. However, multilevel governance structures are recognised as having problems in coordination and implementation (e.g., Sandström et al. 2019). While the governance structures are clear, the problem is rather in the governance practices, where several challenges hinder the implementation of the legislative requirements. The governance challenges can be divided into three categories: legislative and authoritative functionality, lack of resources, and lack of knowledge and competence. First, the key problem seems to be that the legislation has lost its credibility during the numerous changes. In addition, a vague interpretation of legislation does occur in some municipalities as well as a lack of cooperation between the municipal authorities. Moreover, the lack of resources in supervision delays the implementation. For a property owner, the risk of having sanctions is insignificant and will easily lead to ignorance of regulations.

From the perspective of property owners, a lack of resources is known to be a significant barrier as well. Upgrading or constructing a new on-site system, or connecting a property to the sewer network,

can be a significant investment compared to the value of old real estates in sparsely populated areas. In addition, a single property owner may lack adequate knowledge. Although the regional guidance efforts initiated by the Ministry of the Environment have improved the general state of knowledge, some property owners may still have inadequate information concerning, for example, the implementation process, treatment techniques or available services. Uncertainty may lead to ignorance of the regulations in general or, in some cases, inadequate installation or maintenance of on-site systems, which can cause considerable problems in the form of system malfunctions. A lack of adequate knowledge among the municipal authorities, as well as incompetent planning have also been reported.

As early as 2005, the study concerning the management of on-site sanitation (Mattila 2005) concluded that "[if] the co-operation between stakeholders in on-site sanitation does not work, new laws and regulations will be just empty words in 10 or 20 years". Previously presented governance challenges partly reflect inadequate collaboration between stakeholders. However, analysing the interaction and collaboration in detail would require in-depth interviews of various stakeholders and a profound reasoning. Such can be recommended for future studies. In addition, a review of good regional and local governance practices in the field of on-site sanitation could be investigated in terms of peer support and -learning for other regions and municipalities.

4 Sweden

In Sweden, about 12% of the population use on-site sanitation systems. The main responsibility for the supervision of on-site wastewater treatment systems lies with the municipality while regional and national authorities have a guiding role. Currently, many malfunctioning on-site systems have been replaced or upgraded but at the same time there are still many systems in need of attention. In addition, the operation and supervision of on-site systems is widely discussed in different forums in Sweden, both by municipalities and other authorities but also by suppliers and other stakeholders.

4.1 State of on-site wastewater treatment systems

In Sweden, about 12% of the population, in other words 965,126 detached houses, are not connected to the municipal sewer network and thus need to manage and operate their own on-site sanitation system (Statistics Sweden 2019a; 2019b). Several different sanitation systems are used, infiltration systems (wastewater drainfields) being the most common option (33%), followed by systems with only a septic tank (27%) and sand filters (16%) (Figure 6) (Olshammar 2018).

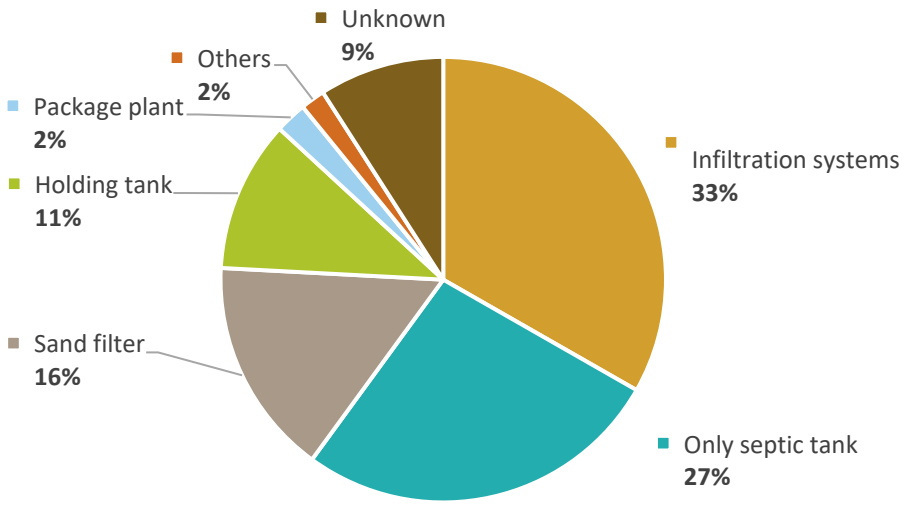

Figure 6. Types of sanitation systems used on properties with detached houses that are not connected to municipal wastewater services. Permanent habitation and leisure homes are included. (Data from Olshammar 2018)

In many cases, the on-site sanitation systems are not well maintained and the treatment efficiency is insufficient. In addition, many systems are old and/or consist of only a septic tank and are thus in need of upgrading. In 2009, there were still 133,000 sites (approx. 20% of all sites) in Sweden that treated wastewater in only septic tanks (Ek et al. 2011). However, in recent years, municipalities have become active and initiated campaigns for systematically identifying on-site treatment systems and improving them. Today, many systems have already been renewed or upgraded. Still, up to 2018, approx. 27% of all on-site systems, consist of only a septic tank with no secondary treatment (Olshammar 2018). The increase in percentage of insufficient treatment systems (only a septic tank) may possibly be explained by the more detailed statistics and higher number of identified systems, for example, up to 2009 probably fewer sites were known to exist.

In 2013, the Swedish Agency for Marine and Water Management (SwAM) published an investigation assigned by the Swedish Government about policy instruments and regulative changes concerning on-site sanitation systems that would be necessary in order to increase the pace of renewing the treatment systems. In this investigation, the Agency suggested the implementation of a tax or fee system to stimulate the renewal pace, which was at that time only 1–2% annually. In addition, the Agency stated that a long-term sustainable annual renewal pace should be at 5%. However, the system was never implemented. (Swedish Agency for Marine and Water Management 2013)

The trade association for Sanitary Engineering (*VVS-Fabrikanterna*) has carried out a yearly survey for Swedish municipalities since 2006, inquiring about the number of permits issued by the municipalities for on-site treatment systems. For 2020, this investigation showed that 18,780 permits were issued (77% of the municipalities had answered the questionnaire and these municipalities covered 83% of all existing on-site systems) (VVS Fabrikanternas Råd 2021). To keep an appropriate pace of upgrading and renewing the on-site systems, it is necessary that 36,000 on-site systems are upgraded/renewed per year (VVS Fabrikanternas Råd 2021). Thus, this investigation suggests that too few on-site systems are renewed per year and that the challenge with poorly functioning on-site treatment system still persists.

4.2 Legislation and regulation

During the 1950s, on-site sanitation systems in Sweden started to develop when septic tanks started to be constructed. In 1998, the Ordinance Concerning Environmentally Hazardous Activities and the Protection of Public Health (SFS 1998:899) was enforced prohibiting the discharge of wastewater that has only been treated by septic tanks with no secondary treatment. This regulation was reinforced by the General Advice on On-site Wastewater Systems for Domestic Wastewater (NFS 2006:7) in 2006, which specifies the limit values for the discharge of BOD (biological oxygen demand), nitrogen, and phosphorus, and establishes the main regulatory framework for on-site sanitation.

Legislation

In Sweden, the management and governance of wastewater systems is regulated in a number of different national laws, the most relevant for on-site systems being The Swedish Environmental Code (SFS 1998:808) and the Ordinance Concerning Environmentally Hazardous Activities and Protection of Public Health (SFS 1998:899). According to the latter, on-site sanitation systems normally require a permit, but if no water from a toilet is present, it is sufficient to have a registration of the facility at the supervising authority (§ 13, SFS 1998:889). The regulation covers wastewater treatment units up to 200 PE. The relevant regulations have been described and summarized in a report by the Swedish Agency of Marine and Water Management (Christensen, 2015).

Other relevant legislation for on-site sanitation systems are the Planning and Building Act (SFS 2010:900) and the Public Water Services Act (SFS 2006:412). The latter states that it is the responsibility of the municipalities to manage wastewater services themselves, rather than having the responsibility with the property owner, if there are any risks for the environment or human health and if the area in question is large (§ 6, SFS 2006:412). These conditions are assessed case by case. Furthermore, the Civil Engineering Act (SFS 1973:1149) regulates associations and their wastewater units. Generally, the Consumer Protection Act (SFS 1990:932) plays a role as it regulates the consumers' rights after buying a package plant, for example.

Based upon the background of poorly-functioning on-site systems, in 2016, the Swedish Agency for Marine and Water Management (SwAM) proposed changes in the Ordinance Concerning Environmentally Hazardous Activities and Protection of Public Health (SFS 1998:899) with the aim of making the municipalities work with the on-site systems more effective (Swedish Agency for Marine

and Water Management 2016a). So far, these changes and additions to the legislation have not been implemented by the government.

National Environmental Quality Standards

In Sweden, there are 16 Environmental Quality Standards, several of which being relevant for on-site wastewater systems. The Standards are a legally binding policy instruments introduced in 1999 to remedy the environmental impact of diffuse pollution sources (Swedish EPA 2020). The Standards that are significant to on-site sanitation systems are Reduced Climate Impact, Natural Acidification Only, A Non-Toxic Environment, Zero Eutrophication, Flourishing Lakes and Streams, Good-Quality Groundwater, A Good Built Environment, A Balanced Marine Environment, and Flourishing Coastal Areas and Archipelagos.

General Advice on On-Site Wastewater Systems for Domestic Wastewater

The most important guidelines concerning on-site sanitation are presented in the General Advice on On-Site Wastewater Systems for Domestic Wastewater (later in the text General Advice) which was first implemented by the Swedish Environmental Protection Agency in 2006 (NFS 2006:7). In 2011, the responsibility for on-site wastewater systems was shifted to SwAM which adopted the guidelines (Swedish Agency for Marine and Water Management 2016b). These guidelines aim at clarifying how the provisions in the Swedish Environmental Code (SFS 1998:808) and the Ordinance Concerning Environmentally Hazardous Activities and Protection of Public Health (SFS 1998:899) should be implemented for cases with up to 25 connected persons (25 PE). The General Advice is not binding legislation but is followed to a great extent by the municipalities.

In general, an on-site treatment system should not be loaded with storm- or drainage water, it should be water-tight and designed in a way that makes supervision and maintenance easy, it should be placed in a way that ensures a good function during its lifetime, it should have attached instructions for operation and maintenance (from the supplier) as well as an alarm (if necessary) and it should be possible to take samples from the system (Swedish Agency for Marine and Water Management 2016b). Furthermore, according to these guidelines, there are two protection levels for protecting the environment and human health: the “standard” and “high” protection levels. The protection level of an area is defined by the municipal authorities. Depending on the protection level, an on-site wastewater treatment facility should remove different percentages of pollutants (Table 5).

Table 5. Minimum percentage removal of BOD, nitrogen and phosphorus (in %) from domestic wastewater in on-site facilities up to 25 PE as stipulated in the General Advice on On-Site Wastewater Systems for Domestic Wastewater. (NFS 2006:7)

Parameter	Protection level – standard (%)	Protection level – high (%)
BOD_7	90	90
Total phosphorus	70	90
Total nitrogen	Not regulated	50

For environmental protection around on-site systems, the water consumption should be decreased by using water-effective appliances, only phosphate-free detergents and household chemicals should be used, the risk of spreading disease to animals should be minimized, and it should be possible to recycle nutrients from wastewater flow-streams or by-products. For the protection of human health, it should be ensured that the discharge of wastewater does not increase the risk of infection or other inconveniences such as odours, and that by-products are managed hygienically. In areas with a high protection level, it can become necessary to take additional measures to protect human health, e.g., the prohibition of

certain discharges, making the discharge point inaccessible, and by increasing the robustness of the treatment system or the addition of a treatment step.

The General Advice (NFS 2006:7) also regulates the placement and location of an on-site treatment unit. The treatment system should be located so that the effect on the receiving waters becomes as minimal as possible. Furthermore, the outer edge of the treatment unit should have a distance of at least ten metres but preferably more than 30 metres from the water body. Furthermore, the septic tanks should have a distance of at least 20 metres to any aquifer used for water extraction (valid for water-tight septic tanks), be placed above the groundwater level, and be accessible to sludge collection trucks. If the wastewater is infiltrated into the ground, the treatment unit should be placed downstream of any water extraction point. The distance from the treatment unit and the groundwater extraction point should correspond to a groundwater transport time of at least two to three months at the maximum water extraction; the distance should never be below 20 metres. The distance between the wastewater infiltration level and the highest groundwater level should be at least one metre.

Importantly, and in accordance with the Swedish Environmental Code, the General Advice states that municipalities should provide pre-conditions that enable the recycling of resources, e.g., by implementing systems for the collection and treatment of wastewater flow-streams and their transfer to farmers.

4.3 Stakeholders and their responsibilities

In Sweden, several organizations and stakeholders are active in the field of on-site wastewater treatment, namely the authorities (on national, regional and municipal levels), the private operators of the on-site treatment facilities, the suppliers and companies providing construction and maintenance services, consultants, research institutions, and universities carrying out research projects. The different stakeholders' roles and involvement in the sector is shown in Figure 7 and further described in the text below.

Authorities

The national authority responsible for on-site wastewater systems is the Swedish Agency for Marine and Water Management (SwAM). The authority's main task is to provide guidance for supervising authorities on on-site wastewater systems up to 200 PE. On a national level, this means that SwAM provides guidance on how on-site wastewater systems should be supervised by the local authorities. The County Administrative Boards provide guidance on supervision at a regional level. The municipalities are the supervising and licensing authorities and are thus responsible for not only issuing permits for on-site wastewater systems but also for supervising them. If a municipality needs guidance on supervision or issuing permits, it should first turn to the regional authority but will also find guidance from SwAM, since SwAM has an extensive web-based guide on supervision and authorization, reports on on-site wastewater systems, legal cases, a newsletter, and workshops. Because of their supervising role, the municipalities are not allowed to guide the operators directly. Some municipalities have, however, created a separate guidance unit which is free from the duty of supervision.

The water authorities' assignment is to implement the EU Water Framework Directive in Sweden. Regarding on-site sanitation system, the water authorities carried out a questionnaire to all municipalities in Sweden in 2020 asking for the number of existing on-site systems and the number of on-site systems that would need to be renewed up to 2027.

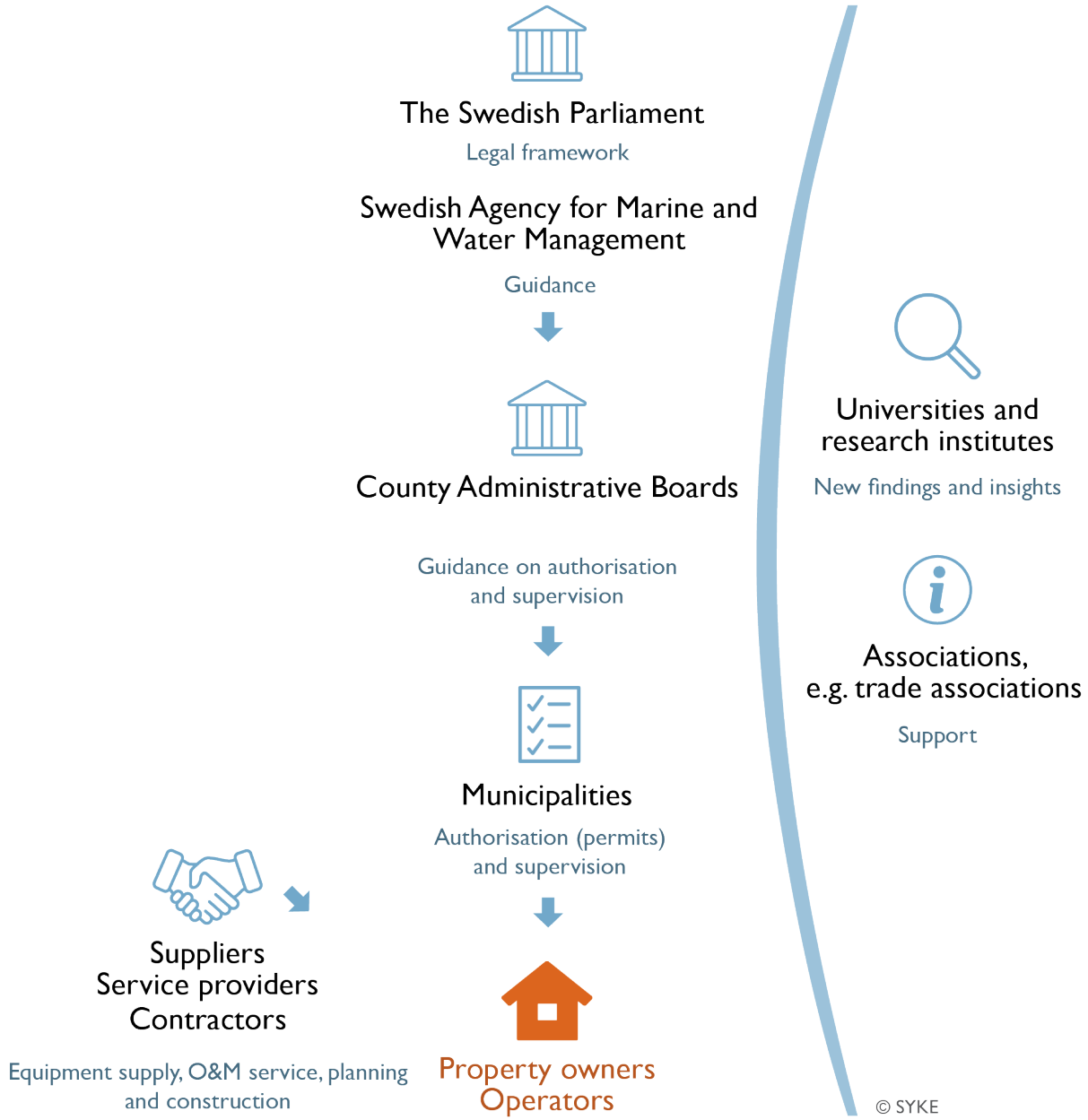

Figure 7. Overview of actors and stakeholders and their roles in on-site wastewater management. O&M: Operation and Maintenance.

Operators

Very often, the operators of on-site wastewater systems are property owners; however, the operators sometimes join forces and form wastewater associations in order to operate an on-site wastewater system together. As on-site wastewater systems are defined as to include all systems up to 200 PE, many municipal wastewater treatment plants (with fewer than 200 connected people) are also defined as on-site systems, but they are operated by water utilities. The operator is responsible for operating and maintaining the wastewater unit as is specified in the permit. Many property owners operate their systems themselves, without prior education. In many cases, operators owning a package plant make a contract with an external service company that helps with the operation and maintenance. Where associations are formed with the aim to install and operate a wastewater system, the platform for wastewater associations (GemVA) provides support by helping with the legal aspects of establishing an association and bringing together the associations with consultants, suppliers, and service providers.

Suppliers and service providers

Several suppliers of package plants, septic tanks, and other pre-fabricated equipment operate on the Swedish market, and are organized in a trade organization (*VVS Fabrikanterna*). Local contractors often help the operators with the design of the facility, permit applications, and technical drawings. Normally, the contractors also install the wastewater facility or construct a wastewater infiltration bed or sand filter. The contractors' organization is *Maskinentreprenörerna* (ME). Furthermore, there are service contractors providing regular maintenance as well as operational support to the operators. In many cases, when package plants are installed, the private operator signs a service contract with a service provider. Although they are not mandatory, service agreements are recommended by many municipalities.

Associations

Various associations are active in the Swedish on-site wastewater treatment sector. Some of these associations have previously been mentioned and for increased clarity are also listed and described below:

- ***VA-guiden*** is an information platform for municipalities, authorities, and private operators that provides independent, comprehensive, and reliable information for the sector. *VA-guiden* is owned by many of the Swedish municipalities and also has other stakeholders as members. In addition, more than 600 companies – entrepreneurs/contractors, suppliers and service providers – present their products on the platform. The platform is visited by 25,000 private operators a month seeking advice on how to renovate or renew their on-site system. (VA-guiden 2021)
- ***VVS-Fabrikanterna*** is a trade association for Sanitary Engineering including the HPAC (heating, plumbing, and air conditioning) and water and sanitary industry. The association has 100 members, which are leading companies on the market, selling products and material on the Swedish and international markets. On their webpage, the association is described as an information platform for members but also for authorities and other stakeholders. For instance, *VVS-Fabrikanterna* does a yearly questionnaire study to investigate the percentage of replaced or upgraded on-site units where the Swedish municipalities are asked to report the number of permits issued during the year.
- ***Maskinentreprenörerna*** **(ME)** is a trade and employers' association which represents and supports entrepreneurs (contractors) that use earth work machines. It works for the development of the sector and has approx. 4,000 members. The main task of the organization is to support and counsel the members. (Maskinentreprenörerna 2020)
- **GemVA** is a platform for wastewater associations and provides support to associations of private operators. GemVA helps with the legal aspects of establishing a wastewater association. It also supports the wastewater association to find consultants, suppliers, and service providers to establish and operate their (private) wastewater unit. (GemVa 2021)

4.4 Governance practices

This chapter describes the governance practices with on-site wastewater systems in Sweden, including the issuing of permits, responsibilities for monitoring, as well as the enforcement of legislation. The responsibilities of the actors and stakeholder are described as well.

Authorization

In Sweden, the environmental department of the municipality acts as the authorizing and supervising authority. When a private person plans to install an on-site wastewater unit, an application with information and plan of the system has to be sent to the municipality that will assess the case and eventually issue the permit. During the process, the General Advice (NFS 2006:7) is an important tool. The routines for authorization vary across municipalities but normally a map with the localization of the unit, a description, and a sketch of the unit have to be attached to the application. The municipality often adds demands to the permit informing the operator on how the unit must be operated and maintained.

It is important to note that Swedish municipalities cannot force an operator to use a certain type of treatment system. For example, when the municipality has established a blackwater collection system, still the operator cannot be forced to have a holding tank and connect to the system. In these cases, strong recommendations by the municipalities help to connect as many households as possible.

Supervision

The environmental departments of the municipalities are also responsible for the supervision of on-site wastewater systems (<200 PE). The supervision varies widely between municipalities and depends, e.g., on the municipality's size: larger municipalities often have more resources for supervision than smaller ones. During recent years, many municipalities have generated an inventory of all on-site systems in their area and started initiating a renewal or renovation of on-site systems that showed an insufficient treatment efficiency and posed a potential risk for the environment or human health. The supervising authorities have several tools to use for pushing the implementation of sufficiently efficient treatment units. For example, the municipality can use injunctions and penalties to make operators change/update their systems. The strongest tool is prohibition or a ban, which prohibits the operator from using the wastewater unit unless it is upgraded. The municipalities have different strategies of using these tools. Some issue a ban directly and other municipalities recommend voluntary measures to the operator as a first step.

According to legislation, each municipality must have a three-year plan on how to carry out the supervision of on-site systems. The regional authorities make sure that these plans exist and are followed. In the plan, it is necessary to prioritize the supervising activities. Often, those areas where bathing water or drinking water quality is at risk are prioritized. It is more difficult to assess where measures need to be taken due to eutrophication problems. To assess the environmental status of different areas, the municipalities use a tool called VISS (Water Information System Sweden 2021), which is a database with information on the status of Sweden's largest water courses, lakes, groundwater, and coastal waters. In Uppsala, for example, the plan for supervision includes a risk-based division of the areas, which are systematically supervised. Altogether, of about the 12,000 properties that have an on-site treatment system, some 400–500 properties are inspected yearly (Kallio & Vienonen 2019).

The on-site visits related to the supervision are paid by the operators as well as by single property owners. This practice makes it expensive for the operator when the supervising authority visits the on-site unit, e.g., for inspection or sampling. It is uncommon, however, that sampling is carried out by the supervising authority. Nevertheless, inspection visits are carried out, even if not regularly in many municipalities. SwAM provides guidance for the municipalities' supervision work, for example, there is a comprehensive guide with practical examples for effective supervision (Swedish Agency for Marine and Water Management 2015).

Supporting efforts

SwAM provides guidance for supervising authorities on on-site wastewater systems up to 200 PE. Extensive material is available on SwAM's webpage, including, e.g., a web-based guide for

authorization (Swedish Agency for Marine and Water Management 2019) and a guide for supervision (Swedish Agency for Marine and Water Management, 2015). In addition, the General Advice (NFS 2006:7) for on-site systems (see Chapter 4.2) is described and clarified for practical use in a handbook provided by the agency (Swedish Agency for Marine and Water Management 2008).

In 2010 and 2011, the Swedish EPA (Environment Protection Agency) carried out a national information campaign ("*Små avlopp – ingen skitsak*") to raise awareness of the many poor on-site systems. The aim was to reach out to a pre-defined number of municipalities and regional authorities and to generate methodologies that would increase the renewal pace in the long term (Swedish Agency for Marine and Water Management 2012). However, the campaign was not generally seen as successful and SwAM does not today recommend such campaigns. In contrast, supervision and enforcement are seen as the most effective methods for renewing and upgrading on-site systems.

4.5 Governance and practical challenges

Although many on-site systems have been renewed or upgraded in recent years, several challenges remain. The renewal pace of the on-site systems is still too low (VVS Fabrikanternas Råd 2021) as described in Chapter 4.1. The supervision and authorization of on-site systems is not always easy for municipalities, one possible reason being the lack of legislative functional requirements for on-site systems, such as discharge limits. The current treatment requirements are presented only in General Advice (NFS 2006:7), which is not binding as an Act would be. Moreover, the governance of on-site systems is not harmonized in Sweden and the practices vary across municipalities. In addition, the supervision of on-site systems brings about difficulties of various kinds. For example, the supervision of soil-based systems such as infiltration systems is challenging since their functioning cannot be measured, mostly a visual inspection is possible. Furthermore, there is a lack of resources, especially in small municipalities. A lack of competence can also sometimes be an issue in small municipalities where only one staff member may be responsible for many topics in addition to the on-site systems, such as school transport, waste management, etc., and it is not possible to be an expert in all different topics.

Another difficulty is the assessment of different units when issuing the permit. Suppliers bring new units on the market, and it is unclear how well they function, and the supervising authority is unsure if a permit should be issued or not. Moreover, the functioning of, e.g., soil-based systems such as sand filters, is unclear. It is not certain if such filters fulfil the requirements for phosphorus (P) reduction stated in the General Advice (70 or 90% depending on the sensitivity level of the area). In several studies, it has been shown that this is not the case (e.g., Eveborn et al. 2012); nevertheless, sand filters are allowed and constructed. For this, a clearer legislation would be required.

In addition to the aforementioned factors, there is also often a lack of knowledge and awareness among property owners. As many have not had a functioning on-site unit for decades, some do not see the necessity of building one now and they do not know about the legislative requirements. Moreover, there are many complaints from the property owners' side on being forced to build an expensive facility, the cost of which sometimes might exceed the value of the property. Such has been pointed out in several newspaper articles in recent years.

4.6 Conclusions

In Sweden, there are 965,126 detached houses that are not connected to the municipal sewage network and thus need to manage and operate their own on-site sanitation systems. These systems are mostly soil-based. Though the legislation regarding these systems is rather complex and manifold, binding regulation for functional requirements is lacking. The on-site systems in Sweden are governed and influenced by a number of different actors and stakeholder where the main role is played by the

supervising authorities, the municipalities, while the national and regional authorities have a guiding role. Although many malfunctioning on-site wastewater systems have been replaced or upgraded in the past years, the renewal pace of the on-site systems is still too low which is one of challenges remaining.

5 Norway

In Norway, around 14.5 % of the population is served by on-site sanitation systems. The governance of decentralized wastewater treatment is well organized through an ample regulatory framework which defines the role of different stakeholders. Municipal authorities bear the responsibility of permit issuing, supervision, inspection, and regulation enforcement.

5.1 **Legislation**

5.1.1 Background for the regulatory framework

In general, wastewater treatment policies in Norway are tailored to the environmental conditions of regional areas. While impacts related to the organic load derived from urban wastewater discharge are low, eutrophication is still considered an important issue causing detrimental effects in the water quality of different water bodies, in particular that of lakes. Therefore, Norwegian legislation regarding wastewater treatment focuses on phosphorus (P) removal (NIVA 2002).

The number of wastewater treatment plants implemented in Norway increased significantly in the 1970s and 1980s after the Water Pollution Control Act (LOV-1970-06-26-75) came into force. The act was the result of a national outcry over the increase in eutrophication and the deteriorating status of water sources. In the early 1980s, more robust legislation regarding wastewater treatment was adopted in the form of the Pollution Control Act (LOV-1981-03-13-6) which is still the main legislation regulating wastewater treatment in the country. In 1991, the EU Urban Waste Water Treatment Directive (UWWTD) (91/271/EEC) was enacted prompting further upgrading of wastewater treatment plants and policies to meet its requirements. Implementation of small-onsite wastewater treatment systems started at the beginning of the 20th century, and infiltration systems began to be used systematically in the 1960s and consisted of very simple units with the main purpose of providing ways to dispose of wastewater.

In Norway, pollution abatement policies generally do not fully follow the recommendation of the UWWTD. Pollutant removal standards are not general for all areas within the country but are adjusted according to receiving water conditions and the sensitivity of the receiving bodies (Källqvist et al. 2002; Berge & Saether 2018). There is more focus on P removal and less on BOD, whereas the full implementation of the UWWTD requires wastewater treatment which targets not only phosphorous removal but also organic matter and other nutrients (Källqvist et al. 2002). The North Sea Declaration and the Convention for the Protection of the Marine Environment of the North-East Atlantic (known as the "OSPAR Convention") have resulted in nitrogen removal requirements for certain treatment plants in the country in addition to supporting requirements for phosphorus removal. Nitrogen removal is only demanded for wastewater treatment plants that discharge into the Inner Oslofjord and the Gramma river, which are sensitive areas. The effluent demands for nitrogen are in accordance with EU guidelines (UWWTD, 91/271/EEC).

5.1.2 Legislation related to on-site sanitation

Specific regulations on the discharge from wastewater treatment systems not connected to a sewer network were first released in 1972 with several amendments or new regulations released between 1975 and 2016. In 1985, through Regulations on Discharges from Separate Sewage Systems (FOR-1985-12-02-2071, into force 1986), the scope of regulation was extended to incorporate the obligation for residential and leisure buildings with running water to apply for a permit. The regulation included some guidance on the construction and operation of infiltration systems. In the 1990s, the recommendation for

the design of ground-based treatment systems was improved and released in government issued reports (soil assessment, design according to load, feeding mode, sand filter design, etc.) to maximize treatment efficiency. Following this, in the early 2000s, Regulations on Discharges from Small Sewage Plants (FOR-2000-04-12-352) provided municipalities with more authority and responsibilities in relation to wastewater management (issuing of permits, supervision, etc.). With the enactment of the Pollution Control Regulations in 2004 (FOR-2004-06-01-931), requirements for the use of dimensioning guidelines and operation procedures, as well as requirements for the use of neutral experts on the assessment of unit type and effectivity were added. The requirement for the use of package plants, whose design, function, and operation were certified, came into force in 2013 for wastewater units serving up to 50 PE. In 2016, the revision of regulations brought about more detailed guidelines for the designing and operation of different types of systems and ground assessment for infiltration units (Norsk Van 2018). Currently, wastewater discharge from households not connected to a sewer network is regulated mainly by the:

- Pollution Control Act (1981)
- Pollution Control Regulations (2004)
- Planning and Building Act (2008).

Pollution Control Act (LOV-1981-03-13-6)

The "Pollution Control Act" of 1981(into force 1983), amended in 2005 (into force in 2007), is the main legislation on protection against pollution and waste. The Act is a law on protection against pollution and concerning waste, and imposes a general ban on pollution emissions though allows businesses and other land use activities to apply to environmental authorities for exemptions or permits. The Act is implemented by the Ministry of Climate and Environment. Chapter 4 of the Act defines the responsibilities and requirements for wastewater treatment facilities.

Pollution Control Regulations (FOR-2004-06-01-931)

Pollution Control Regulations provide detailed rules on pollution while general rules are found in the Pollution Control Act. The Pollution Control Regulations are a long list of regulations (Directives, Acts, etc.), thematically divided into 13 parts. Part 4 applies to wastewater treatment and has rules to protect the environment from the adverse effects of wastewater. Wastewater pollution discharge from on-site sanitation systems is addressed in Part 4, Chapters 11, 12, and 13.

Chapter 11 of the Pollution Control Regulations (General provisions on wastewater discharge) lists definitions, classifications, rules for the allocation of fees, and reporting for service providers, etc. pertinent to wastewater discharge regulations. Below is a classification of areas receiving discharges of wastewater:

- Sensitive areas: i) Natural lakes, other freshwater bodies, estuaries, fjords, and other sea areas that are eutrophic, or that can become eutrophic in a short time if protective measures are not taken; ii) Lakes and rivers that are intended for the abstraction of drinking water and which may have a greater nitrate concentration, if no measures are taken other than those stipulated in the regulations on water supply and drinking water; iii) Areas where it is necessary to carry out further treatment in addition to secondary treatment to satisfy other directives and EU legislations.
- Less sensitive areas: A marine body of water or a marine area is a less sensitive area of discharge of wastewater that does not have harmful effects on the environment due to the area's morphology, hydrology, or special hydraulic conditions. The risk of discharges to adjacent areas where they may have harmful effects on the environment must be considered. The following conditions shall be taken into account in the less sensitive areas: open coves, estuaries, and other sea areas which have good water exchange, and which are not exposed to eutrophication or oxygen loss, or which are not expected to become eutrophic or to be exposed to oxygen loss as a result of discharges of wastewater from urban areas.

- Normal areas: Freshwater deposits in Norway that are not classified as sensitive.

A general classification of areas includes: a) Sensitive areas: The coastal stretch from Sweden's border to Lindesnes with associated catchment area and the Grimstadfjord area (Nordåsvannet, Grimstadfjorden, Mathopen, and Dolviken). Dense settlements with nitrogen removal requirements: Nordre Follo, Oslo, Jessheim, and Lillehammer; b) Normal areas: Freshwater deposits in Norway that are not classified as sensitive; c) Less sensitive areas: Coastal waters and estuaries from Lindesnes to Grense Jakobselv that are not classified as sensitive. (FOR-2004-06-01-931)

Chapter 12 of the Pollution Control Regulations explains the requirements (Table 6) for discharges of sanitary wastewater from residential buildings, cottages, and the like. For activities that only discharge greywater, this chapter only applies if running water has been installed. All new treatment systems or expansion of already existing systems require a permit. Municipalities are the authorities responsible for supervising the application of legislation. Emissions from smaller sewage systems can also lead to odour problems, reduced bathing water quality, and hygienic problems. To take care of such special considerations, the municipality may set special conditions or prohibit the discharge of wastewater in certain areas (Act on municipal health and care services and the Pollution Control Regulations Chapter 12-6). In addition, municipalities can set different requirements in areas where the objectives of the WFD are not met. The requirements in local regulations shall replace the requirements of sections 12-7 to 12-13 of the Pollution Control Regulations. However, when municipalities, based on environmental conditions, consider establishing a local regulation, it will be for setting stricter requirements for emissions than those stated in the regulation. To ensure that the effects of the discharge are minimized on the recipient, the discharge site should be located so that: a) discharges to sea and fresh water are located at least 2 m below the lowest water level; b) discharges to rivers only occur to rivers with year-round water flow; and c) discharges to the ground only occur to local loose materials.

Table 6. Wastewater treatment discharge requirements (FOR-2004-06-01-931)

Systems servicing < 50 pe				
Discharged to areas	**Type of recipient**	**Total P Removal (%)**	**BOD_5 Removal (%)**	**Suspended solids (SS)**
Sensitive Normal	Catchments used for, e.g., water supply	90	90	
	Risk of eutrophication	90	70	
	Neither use for drinking water nor at risk of eutrophication	60	70	
Less sensitive	-	-	-	20% removal or 180 mg/L (annual mean value)

Chapter 13: Requirements for the discharge of municipal wastewater from small agglomerations. This applies to discharges of municipal wastewater from populated areas with a total discharge of more than 50 PE and less than 2,000 PE to freshwater, less than 2,000 PE to estuaries, or less than 10,000 PE to sea. It states that treatment units must be dimensioned, built, operated, and maintained by experts so that it has sufficient performance under all climatic conditions that are normal for the place where it is located. The discharge point for these units shall be located and designed so that the effects of the discharge on the recipient are as minimal as possible and that user conflicts are avoided, including that the discharge does not pose a risk of contamination of drinking water. Variations in the amount of wastewater during the year must be considered when designing the plant. The system shall be designed so that representative samples can be taken off the inflowing wastewater and the treated wastewater. In

addition, it must be possible to make measurements of the amount of wastewater. Moreover, package plants need to be operated and maintained following a written operation and maintenance agreement. In addition, sludge separators must be completely emptied of sludge as required and not less frequently than every other year.

Discharge load (capacity of units) and pollutant removal efficiency for regulation binding and report purposes are normally estimated based on the population or person equivalent load (PE). The PE value is understood to mean the amount of organic matter that is biodegradable and measured via the biochemical oxygen consumption over five days (BOD_5), which is 60 g of oxygen per person per day. Other factors related to emissions per person per day used in calculations are phosphorus (1.8 g/person/day) and nitrogen (12 g/person/day).

Planning and Building Act (LOV-2008-06-27-71)

The Planning and Building Act regulates building construction and planning in the country. According to the Act, on-site wastewater treatment systems are structures large enough to require building permit application. The Act appoints the municipalities as building permit authorities and details the overall and technical requirements for location, ground survey, system design, and implementation. In addition, it details who can submit applications (in the case of on-site systems, the developer/house owner can be the applicant), the requirements for the content and the processing of applications, and the required competencies of the project designer and executer. All tasks related to the implementation of a wastewater treatment system must be performed by professionals, and the companies linked to a project must assume liability for the work performed.

5.2 State of on-site wastewater treatment systems

Approximately 377,000 small sewage plants (<50 PE) operate in Norway (excluding leisure homes) serving just over 792,000 people (Statistics Norway 2021). The majority of the units consist of septic tanks only (>184,500 units) while over fewer than half of the units are using infiltration systems (> 113,000 units) as secondary treatment (Norsk Vann 2018; Statistics Norway 2021) (Figure 8). Small package treatment plants are a combination of mechanical, biological, and chemical treatment in one unit and were introduced in Norway in the 1990s (Norsk Vann 2018). Currently, although package treatment plants are readily available and used, conventional systems (septic tanks and septic tanks followed by soil infiltration systems) are still the most common units in operation (Statistics Norway 2021). According to an ongoing review of on-site wastewater treatment systems in the country, most facilities (50–90%) do not function as designed and require replacement (Norsk Vann 2020). Updating these systems will require significant investments as well as a skilled workforce and provision of services for the design and execution of new systems. The available workforce has been assessed to be limited in all regions across the country (Norsk Vann 2020). In addition to the permanent residences, there are about 440,000 leisure homes in Norway (Statista 2021), most of which are situated outside sewer network areas.

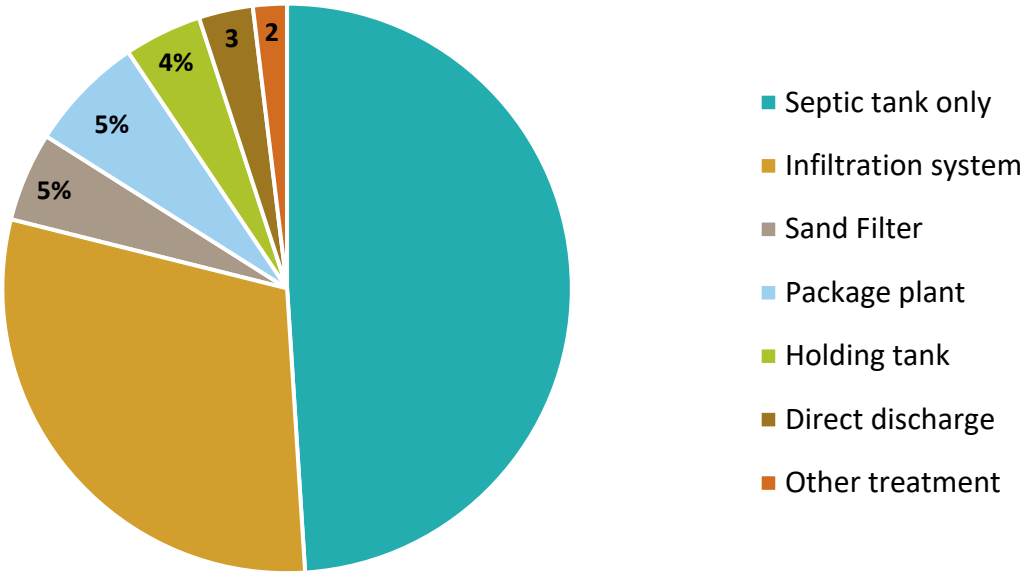

Figure 8. Proportion of inhabitants connected to different treatment systems (serving <50 PE, excluding leisure homes, in year 2019) (Statistics Norway 2021).

5.3 Stakeholders and their responsibilities

In the case of wastewater treatment, the managing governmental authorities are the Ministry of Climate and Environment (ownership, fees, wastewater, sludge, climate change adaptation), and the underlying Norwegian Environment Agency (NEA). At the regional and local level, the County Governors are the pollution control authority for the 400 largest wastewater treatment plants, while the municipalities themselves are the authority for all other wastewater treatment plants. Interaction among authorities and other stakeholders can be seen in Figure 9. Norway consists of 19 counties; each county provides discharge permits to larger municipal wastewater treatment plants. Since 1 January 2001, the municipalities can issue permits for wastewater treatment plants with a capacity of less than 1,000 PE. Before 2001, only county authorities could provide pollution discharge permits. Thus, currently the role of regional authorities is minor in terms of on-site sanitation.

Authorities

Municipalities have two different responsibilities regarding the management of small-scale wastewater treatment systems, pollution control authority (emission applications) and building authority (construction application). The discharge application (pollution) is processed according to the Pollution Control Act and the building application (construction) is processed following the Planning and Building Act. The municipality's role as a pollution authority is significantly different from the municipality's role as a building authority (Norsk Vann 2018). According to the Pollution Control Act, regional (County) environmental authorities have the responsibility to supervise (via audits, etc.) administrative measures of municipalities regarding their role as a pollution control authority in addition to the provision of guidance.

As the pollution control authority, the municipality must assess whether the application is correctly documented and whether the proposed treatment solution is suitable for the relevant location. The municipality must assess the impact of the discharged pollution in a larger and more holistic context. While issuing the discharge permit, the municipality can add additional conditions to prevent

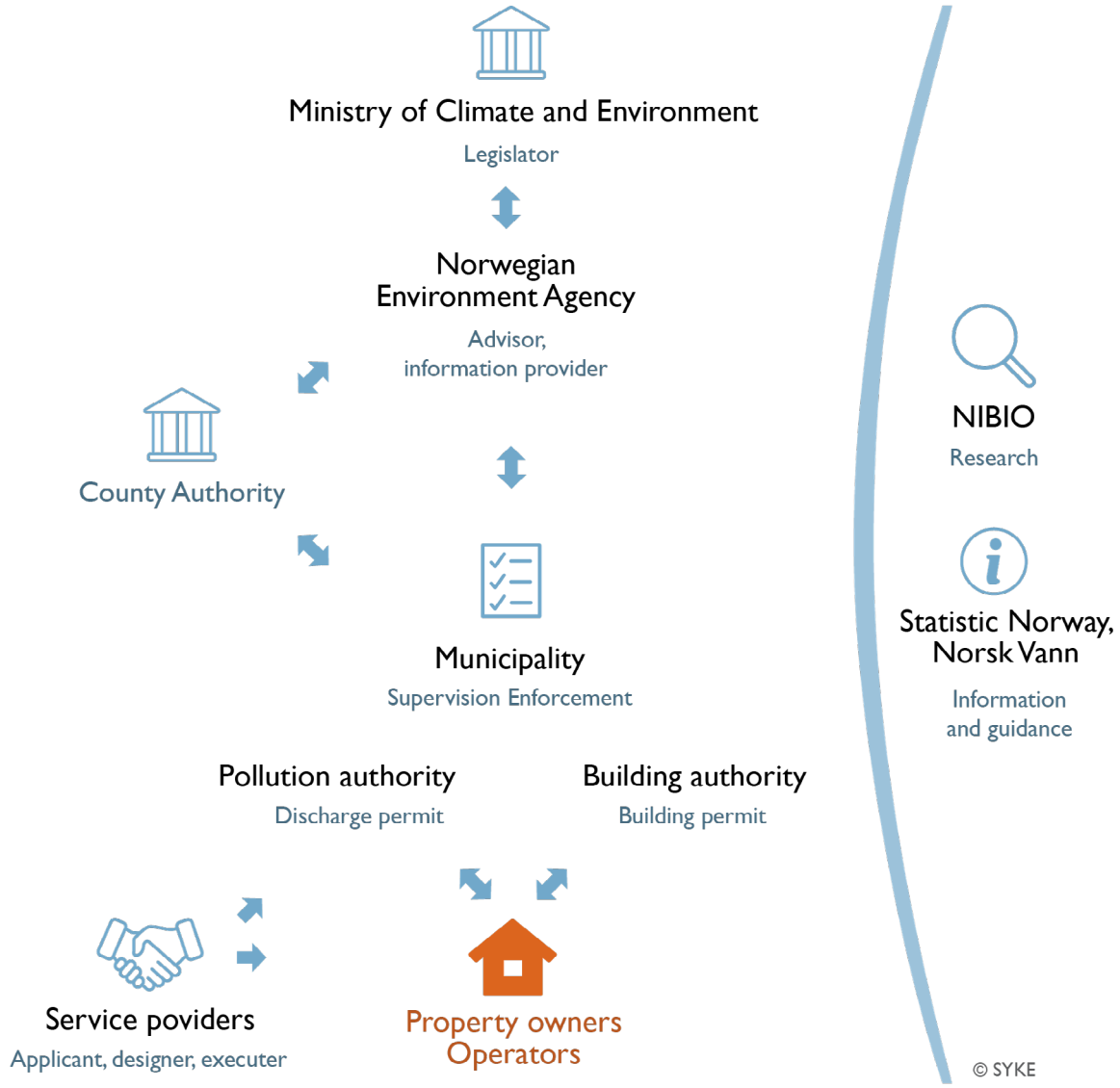

Figure 9. Overview of actors and stakeholder and their roles in on-site wastewater management.

environmental impacts or inconvenience of released pollution. The permit gives the plant owner the right to pollute, something which is otherwise prohibited, and such pollution consists of discharging treated wastewater. Municipalities are also responsible for the supervision of facilities their issue permits for operation. (FOR-2004-06-01-931).

As the building authority, municipalities grant permission for the construction or implementation of a wastewater treatment system. Permission is granted if the proposed facility does not conflict with planning and building legislation, other regulations, or private law agreements. The municipality's role is to ensure that each system is designed, or its soundness is assured by expert enterprises, but otherwise does not interfere in the design. The municipality shall process an application for a building permit for the sewage system and shall grant permission when there is a basis for it. In addition, the municipality must process applications for a certificate of building completion, supervise progress, and possibly impose sanctions if necessary.

Property owners

The homeowner is normally the person who applies for permission to pollute (or contracts a service provider to apply on their behalf) and who becomes responsible for meeting the permit requirements. Therefore, the homeowner is responsible for the discharge after the establishment of the facility, including responsibility for operation and maintenance. Usually, the homeowner is also the developer in the construction case, who also applies and receives permission for the building project. The homeowner signs application documents and must contribute with all the required background information, but is otherwise not responsible for the content of the application. Necessary background information that is requested from the homeowner is, for example: to provide observations regarding water flow in streams and how the streams are used; to report on the notification of neighbours; to provide information about drinking water sources (your own and your neighbours'); to provide registered agreement with a neighbouring property if the facility is not to be located on the homeowner's own property and at communal facilities; to describe personal wishes and needs, especially based on requirements for operation and maintenance of unit; and to provide information on how many people will use the facility. (Norsk Vann 2018)

Service providers

A sewage treatment plant is a major construction, especially when it comes to ground investigations, dimensioning, choice of the correct system, and description of the execution. Such measures require sufficient competence in all stages, something a house owner does not normally have. All tasks in connection with the establishment of the wastewater treatment system must be performed by professional companies which act as the applicant (on behalf of the homeowner), designer, and project executer. The municipality may also require a neutral professional to oversee the tasks carried out by the designer and executer. In addition to the building application, the involved service providers must submit declarations of liability to the municipality before starting the project. At the end of the work, these companies must submit a declaration of conformity that confirms that the tasks have been performed in accordance with all relevant requirements. This must be submitted before a completion certificate can be issued. In addition to the provisions of the Planning and Building Act, the requirements of Chapter 12 of the Pollution Control Regulations must also be met. Even if a company has the competence and can be approved in accordance with the provisions of the Planning and Building Act, the company must also meet the requirements for competence in the pollution regulations. According to the Norsk Van report (2018), the role of the companies acting as the applicant, designer, and executer are as follows:

- The applicant is responsible for ensuring that the permit applications and documentation to be submitted to the municipality are complete. The applicant is the project liaison and contact person with the municipality. The applicant needs to coordinate the various actors in the implementation of the project and forward permits and other information from the municipality to the other responsible parties. The start-up of work must not be initiated until the municipality has given permission. The applicant receives the declarations of conformity from designers and executors at the completion of their work, updates the implementation plan, submits documentation to the owner against receipt, and applies for the completion certificate. During supervision, the applicant must facilitate the work to be done by the municipality and assure the involvement of responsible companies. In cases involving on-site treatment systems, it is quite common for the company that holds the role of the applicant to also hold the role of designer or executor.
- The designer is responsible for ensuring that the project meets all the technical requirements. The designer must, for example, carry out necessary investigations, and prepare drawings, calculations, and documentation that verifies and confirms that the relevant requirements in the construction technology regulations are met. The designer produces the documentation required by the executer;

thus, the designer needs to prepare sufficiently detailed drawings and show how systems must be fitted. In addition, the designer also selects which type of systems should be used or specifies the performance that the system must satisfy. If the designer only indicates the performance, the choice of system is the responsibility of the executing company. According to the Planning and Building Act, there are two types of responsibility: producer responsibility and liability in construction matters, both of which complement each other. The manufacturer of the product/system is responsible for the quality of the product and documentation (e.g., manufacturers of package plants). Companies with construction liability are responsible for selecting a suitable product, for the design, and for executing the project in question. (Norsk Vann 2018)

- The executer is responsible for establishing the wastewater treatment system in accordance with the designer's working drawings and assembly instructions for the product. Investigations on the location of the construction and the facility must be carried out and documented. Documentation regarding the management, operation, and maintenance of the unit must be submitted to the person who has the role of the applicant. Coordinates and map sketches are part of the documentation. (Norsk Vann 2018)

Small-scale treatment systems require operation and maintenance. It is important that the person who is selected as the maintenance provider has sufficient competence. In the case of package plants, there is a requirement in the Pollution Control Regulations for a written service agreement that is not required for other types of systems, but the municipality has the opportunity to set conditions for this in the discharge permit. A standard report form should be used for package plants to service providers to a yearly report on the status of the unit to the municipal authorities. There is no corresponding form for other types of units. (Norsk Vann 2018)

Information providers

The Norwegian Environment Agency (NEA) is the official information provider, and is responsible for providing general guidance to municipalities and service providers on the requirements of legislation, permit procedures, etc. On the NEA website, one can find guidelines and templates of forms required for permit submissions and processing, examples of sewage treatment unit design, etc. The agency also helps to fund research and practical projects aiming at increasing awareness and evaluating systems efficiency, for example.

Statistics Norway provides information on existing treatment systems based on data collected by municipalities. Substantial information is made available by representatives of stakeholder groups (associations, research, and educational institutions, etc.). Among the most active are the Norwegian Water (Norsk Vann) and The Norwegian Institute for Bioeconomics (NIBIO). Norsk Vann is a national association for Norwegian water industry (water utilities, service providers, organizations). It produces extensive reports and guidance materials on several aspects of on-site sanitation systems such as unit design and operations, permit application procedures and assessment, etc., targeting both municipality and unit owners (e.g., Norsk Vann 2018; 2020). The NIBIO is an administrative agency subject to the Ministry of Agriculture and Food. It concentrates on research and information sharing and, in terms of on-site sanitation, it shares a considerable amount of guidance material on its website with detailed documentation on permit procedures, unit selection and design, maintenance, etc.

5.4 Governance practices

In the case of small-scale wastewater treatment systems, two permits are required: one for the discharge of wastewater (permit to pollute) and the other for the building of the facility. Both the permit for the discharge of wastewater and the permit for construction are assessed individually and decisions are made individually. The discharge application (pollution) is processed according to the Pollution Control

Act (LOV-1981-03-13-6) and the building application (the measure) is processed in accordance with the Planning and Building Act (LOV-2008-06-27-71). A permit to pollute is required when:

- a new sewage treatment plant is established,
- there is an increase in the number of people using an existing facility,
- a system replacement or physical changes are required to an existing system,
- additional buildings are connected to an existing sewage treatment plant, without this necessarily causing increased emission.

When wastewater treatment systems are to be rehabilitated or a new system is to be established, mapping and assessment of the area are necessary to clarify what opportunities and limitations exist regarding the recipient environment. Challenges with pollution in general and different user interests must be considered for a larger area. Effluent from several sewage plants that discharge into the same recipient must be considered together so that the total load is evaluated. The result of the mapping and assessment will affect the location, choice of system type, and requirements for documentation to be annexed to the application. Comprehensive mapping and assessment can be partly or completely done in connection with the municipal area and/or zones planning. If comprehensive mapping and assessment have not been fully studied in connection with area plans, it must be conducted in connection with the application processing of individual facilities. Whoever applies for the discharge permit must ensure that a comprehensive survey and assessment is carried out and submitted together with the application. In practice, this is the company that assists the homeowner with the preparation of the application that is responsible for acquiring the necessary documentation. (Norsk Vann 2018)

Municipalities' supervisory duty starts as soon as a discharge permit has been granted. Among other things, the municipality inspects that the facilities are dimensioned, built, operated, and maintained so that sufficient performance will be achieved under all the normal climatic conditions for the place where they are located. Inspections should also be carried out based on the building permit at the same time. In addition, the municipality can supervise existing/older facilities established legally without a permit and facilities that are established illegally. The municipality shall supervise that the provisions and decisions made pursuant to the pollution regulations are complied with. In case of a dispute among the parties on the decisions made by municipal authorities, appeals can be submitted to county authorities for assessment. (FOR-2004-06-01-931; Norsk Vann 2018)

Since the construction of a sewage treatment system is a type of construction activity that is covered by the Planning and Building Act (LOV-2008-06-27-71) and requires permission before commissioning, a building permit is required. As the building authority, the municipality has a duty to coordinate with other authorities in accordance with the Planning and Building Act. This means that the municipality has a duty to obtain any permits, consents, and statements from other authorities affected by the building in question if the applicant has not done this in advance. For example, if the building application is not accompanied by a copy of a permit from the pollution authority, the building authority will coordinate with the pollution authority in the municipality so that a decision in accordance with the pollution legislation is available before the building application is decided (Norsk Vann 2018). The municipality shall process an application for a building permit for the sewage system, possibly with an attached application for dispensation. When there is a basis for it, the municipality shall grant permission. The municipality must also process an application for a certificate of completion, supervise, and possibly impose sanctions if necessary (LOV-2008-06-27-71).

During inspections, the municipality can take a closer look at whether various requirements under the Planning and Building Act have been met. Everything that follows from the planning and building legislation can be subject to the municipality's supervision. Normally, supervision focuses on both the quality and the location of the facility, thus documentation of the fulfilment of technical requirements and the tasks performed by the designer and executor are evaluated. The municipality can evaluate the choice of products and product documentation and the qualifications of the people responsible for the

different tasks. Together, the building supervision and the supervision of the pollution discharge can be combined (Norsk Vann 2018).

5.5 Governance and practical challenges

In Norway, municipalities have the responsibility to supervise, inspect and report on the implementation and status of on-site sanitation systems. Operators of systems serving > 50 PE (mostly municipalities but also private persons and communities) report to the Norwegian Environment Agency (NEA) while operators of systems serving < 50 PE report to the Statistics Norway which produces yearly reports on the gathered data. The extent to which municipalities (and other operators) comply with the reporting requirements varies significantly around the country (Eid 2021; Magnusson 2021). Municipalities partially cover management costs by collecting fees on the issuing of permits and completion of supervision tasks. However, as these do not fully cover all costs, additional funds must be allocated if systematic supervision, inspection, and reporting activities are to be conducted. Municipalities receive funds from the government for the many tasks they must perform, and it is up to the administration to share the funds among different tasks/responsibilities. Based on the available reports and interviews with experts (representatives of stakeholder groups) (Eid 2021; Magnusson 2021), it appears that for a large portion of municipalities (although many exceptions exist) the allocation of funds to the management of on-site sanitation is not seen as a priority. In addition, the way municipalities interpret and use their authority to establish local restrictions varies substantially around the country. According to the expert's opinion (Magnusson 2021), municipalities that prioritize to some extent the management of on-site sanitation in their budgeting and strategies are also those more aware of and more compelled to use their authority to regulate local discharge limits, for example.

In 2019, an audit of the municipalities' implementation of their responsibilities as pollution control authorities in accordance with Chapter 13 of the Pollution Control Act (sanitation systems serving 50>PE<2000) was conducted by the NEA and County Governors. The audit report points out that over 90% of municipalities do not have standardized procedures in place for facility evaluation, and the assessment of efficiency of for updating older permits. In general, municipal departments dealing with environmental pollution control and building permit are understaffed and therefore overloaded with allocated responsibilities. There are no systematic data collection and digitalization tools which could help with the registration of units, supervision of their functionality, as well as for the request of support or for the reporting to regional and national authorities. Another critical issue often raised by local authorities, especially by small municipalities, is the lack of a qualified work force. (Norwegian Environment Agency 2020). Intermunicipal collaboration has been suggested as a possible solution to improve current conditions (Magnusson 2021). However, such collaborations raise other challenges such as overcoming diverging political and social views, and the authors did not find reports of on-going intermunicipal collaboration. When consulted (e.g., NEA 2020), municipalities highlighted the need for more detailed information on several issues (regulation, design and implementation, status of local environment, etc.) as only "general information" can be retrieved from the NEA. However, other information providers, such as Norsk Van and the NIBIO, supply extensive information on legislative, technical and other practical matters. Although resources are not available for a case-by-case guidance (Eid 2021), it appears that the real issue is not the lack of information but the capability of municipalities to transform the available guidance into actions.

The installation and maintenance of on-site treatment systems is expensive. Furthermore, the requirements set for particular areas can be strict thus bringing adverse feedback from voters, i.e., general public and local inhabitants. Consequently, significant political will (which is not always present) is required to press ahead with controversial issues. In general, public awareness regarding on-site sanitation (regulations, units, impacts, etc.) is poor. According to Magnusson (2021), no nationwide campaign has been organized to address this issue and only a small number of municipalities have

embarked on their own campaigns. Although a substantial amount of information can be found online from information providers such as Norsk Vann, the NIBIO and NEA, the focus is on providing guidance to municipalities and to some extent to service providers. There is a clear need for information to be made available targeting the general public. Wider awareness would possibly decrease public unease and frustration towards local authorities and increase pressure on national governments for the better availability of resources. According to Norsk Vann report (2020), of the country's approximately 330,000 smaller wastewater treatment facilities (excluding leisure homes), a large percentage must be replaced. However, the exact percentage is not known; municipalities that are conducting evaluation and reporting on their progress have disclosed that somewhere between 50–90% of all facilities must be replaced (Norsk Vann 2020). Although the investment required per treatment unit varies, an average amount of approx. 10,000 Euros/unit was estimated by Nork Vann. The replacement of 50% of the countries' small-scale facilities requires an investment of over 1.6 billion Euros (Norsk Vann, 2020). Overall, these are large investments, which must be paid for by the homeowners. Before such a financial burden is place on homeowners, a lot needs to be done to increase awareness on the reasons the updates/replacements are required.

According to Norsk Vann (2020) and Magnusson (2021), it is important that possible investments on updates or the replacement of small-scale wastewater treatment systems are made so that treatment requirements set by the environmental authorities are complied with. Thus, it is also important that past errors/deficiencies when establishing systems are avoided. For this to occur, knowledge regarding the effectivity of different treatment units, the most suitable conditions for their implementation (load, discharge restrictions, local geology and topography requirements, etc.) and a skilled work force for their design, implementation, and maintenance must be available. Currently, this is not the case. Very few reports exist on the efficiency of different treatment units and the effect of operational parameters, such as, continues or intermittent load (main household or leisure home) (e.g., Abbas 2017). Furthermore, competence on the design, implementation, and maintenance of on-site sanitation systems has been recognized as being limited across the country (Norsk Vann 2018; 2020). If educational programmes do not become available to produce experts in the field, this situation will not change in the near future.

5.6 Conclusions

In general, governance of on-site sanitation in Norway is well organized. The roles of different actors are well described, and regulations mostly support actions in aid of the environment. However, the situation on the ground seems to differ from that described in regulations and flow charts presented in available documentation. To summarise, governance practices in reality differ across the country and differ significantly from those proposed by authorities and relevant regulations. Overall, it can be stated that pressing obstacles (among others) for bringing changes to current practices on the municipal, regional and national levels are public awareness, political will, a lack of a specialized work force as well as economic and technological resources. A turnaround in practices and strategies requires the full participation of the homeowner as the facility owner as well as national and local authorities (especially municipalities), service providers, and educational institutions.

6 Comparison of the case-studies

Altogether, there are about three million inhabitants living outside the centralized sewer network in Finland, Sweden, and Norway. Governance of on-site sanitation, including regulatory framework as well as management of the whole on-site sanitation chain, is an important aspect in mitigating diffuse pollution. The lessons learned from various governance practices in different countries are valuable in planning future on-site sanitation. This chapter presents a comparison among the three countries, highlighting the key similarities and differences in governance principles and implementation strategies.

6.1 **Study area**

In general, due to high sewer connection rates and efficient municipal wastewater treatment, the overall state of wastewater management is at a high level in the Nordic countries. However, a considerable proportion of the population live in dispersed settlements. In comparison to other parts of Europe, Finland, Sweden, and Norway have a low population density, and their northern regions are even more sparsely populated than the southern areas. Consequently, it is not an economic or environmentally sound option to extend sewer networks to distant villages and single properties all over the country. In total, approximately 3 million inhabitants (12–15% of the population) in Finland, Sweden, and Norway live in areas without a centralized sewer network. In addition, there are close to half a million leisure homes in each country (Statistics Finland 2019; Statistics Sweden 2020; Statista 2021), which are typically located in unsewered areas (Table 7). While sanitation strategies in the three countries prioritize the connection of properties to municipal sewer networks, there are properties where connection is not practical and/or economically viable.

Small-scale sanitation systems may include, for example, septic tanks, holding tanks (storage), sand filters, infiltration fields, package plants, wetlands, and dry toilets. While all of these are utilized in the three countries, the use of wetlands is rather rare and the applicability of willow systems in northern conditions, for example, is questionable (Amofah et al. 2012; Postila & Heiderscheidt 2020). Furthermore, dry toilets are mainly implemented in leisure homes. Sand filters and infiltration fields are common in all three countries, whereas package plants and holding tanks are less common (Table 7). The most widely used system in Finland and Norway, and the second in Sweden, is the septic tank without further (secondary) treatment. The treatment efficiency of septic tanks is not sufficient to meet the requirements (Table 9) where discharge limits apply. In addition, the efficiency of other types of treatment units is also a concern due to reported variations in system efficacy usually caused by construction defects or a lack of adequate maintenance or operation (Heinonen-Tanski & Matikka 2017; Martikainen et al. 2018; Hedin 2018; Vidal et al. 2018). Overall estimates, although sometimes vague, suggest that more than half of the on-site sanitation systems located in areas subject to treatment requirements (Sweden 73%, Finland 55–67%, Norway 50–90%) would not meet them.

Another aspect to consider while evaluating or inspecting on-site units is the possible effect of cold winter conditions. Low sub-freezing temperatures can reduce biological activity and hinder the functioning of on-site sanitation systems (e.g., partially freezing) (Luostarinen et al. 2007; Kauppinen et al. 2014; Kinnunen et al. 2021; Vidal et al. 2021). In Finland, for example, the function of a system and its treatment efficiency is assessed as an annual average, thus the possible drop in efficiency of treatment systems during the winter can be compensated in the summer. In addition to the effects of cold climate conditions, the low population density of northern areas impact on-site sanitation. Maintenance of septic tanks generally requires the removal of sludge once a year. Long distances cause some challenges to sludge transportation, especially during the cold winter months. Moreover, small centralized municipal wastewater treatment plants may restrict the delivery of collected sludge to their

facilities for treatment either due to their limited capacity or tightening environmental regulations. Thus, the sludge often needs to be transported further away to large, centralized wastewater treatment plants.

Table 7. Overview of the study area.

	Finland	Sweden	Norway	References
Population in 2020 (millions)	5.53	10.35	5.38	World Bank 2021a
Average population density (persons/km^2) [a)]	18.1	25.0	14.5	World Bank 2021b
Population living outside sewer network (%)	15	12	14.5	Lapinlampi 2021; Statistics Sweden 2019b; Statistics Norway 2021
Number of properties (permanent habitation) outside sewer network	286,000 [b)]	471,473	377,285 [d)]	Kallio & Suikkanen 2019; Olshammar 2018; Statistics Norway 2021
Number of leisure homes	441,000 [b)]	600,000	440,000	Kallio & Suikkanen 2019; Statistics Sweden 2020; Statista 2021
Proportion of treatment units not fulfilling the treatment requirements (%)	55–67 [c)]	73	50–90	Kallio 2020; Kallio 2014; Olshammar 2018; Norsk Vann 2020
Most used treatment systems (%)	Permanent habitation	Permanent habitation and leisure homes	Permanent habitation	
Septic tanks with no secondary treatment	42	27	49	Olshammar 2018; Statistics Norway 2021
Sand filter	13	16	5	
Infiltration system		33	30	
Package plant	5	2	6	
Holding tank	2	11	4	
Others / not specified	38	11	6	

a) Population density in European Union was 111.7 in 2018 (World Bank 2021b).
b) The number refers to properties built before 2004 and situated outside the sewer network.
c) This percentage is calculated only for permanent habitation situated in transition period areas (67,000 properties) (see Chapter 3.2). The percentage for leisure homes is estimated to be about 20% of the 343,000 leisure homes situated in transition period areas (Kallio & Suikkanen 2019).
d) The number of properties calculated based on data regarding the number of people living outside the sewer network and the average number of persons living in one household in Norway.

6.2 Regulatory framework

The definition of on-site sanitation under the regulatory framework varies between the countries. In general, all single property owners having a wastewater treatment system at the site are considered operators of an on-site sanitation system. However, in the three countries there are also user-owned wastewater associations of varying sizes which can manage the wastewater treatment of several properties or schools, ski resorts, restaurants, etc. Operators of treatment units serving up to 100 PE in Finland and 50 PE in Norway are regulated by legislation concerning on-site sanitation. In Sweden, on-site wastewater systems include systems serving up to 200 PE. Thus, in Sweden small municipal wastewater treatment plants (serving up to 200 people) are also defined as on-site systems, though they are operated by water utilities.

All three countries have introduced a regulatory framework to mitigate diffuse pollution from non-connected dwellings (Table 8). However, in Sweden, the regulations are specified under the "General Advice", therefore they are not as binding as the Finnish and Norwegian regulations, adopted on the basis of the law. A common policy among the three countries is the establishment of treatment requirements, i.e., the treatment efficiency to be achieved (Table 9), whereas in many other European countries, requirements of regulation concern only the system's operation with no specific removal efficiency for target pollutants (Grebot et al. 2019).

Table 8. Legislation and regulation related to on-site sanitation (main regulations are in brown text).

	Legislation	Standards, guidelines and strategies
Finland	• Environmental Protection Act (527/2014) • Government Decree on Treating Domestic Wastewater in Areas Outside Sewer Networks (157/2017) • Water Act (264/1961) • Waste Act (646/2011) • Land Use and Building Act (132/1999)	• Baltic Sea Conservation Programme – Finnish Government decision-in-principle • Water Protection Policy Outlines – Finnish Government decision-in-principle • National Sewerage Programme
Sweden	• Swedish Environmental Code (SFS 1998:808) • Ordinance Concerning Environmentally Hazardous Activities and the Protection of Public Health (SFS 1998:899) • Planning and Building Act (SFS 2010:900)	• National Environmental Quality Standards • General Advice on On-site Wastewater Systems for Domestic Wastewaters (NFS 2006:7)
Norway	• Pollution Control Act (LOV-1981-03-13-06) • Pollution Control Regulations (FOR-2004-06-01-931) • Planning and Building Act (LOV-2008-06-27-71)	

Table 9. Minimum percentage removal of organic matter (BOD_7), total phosphorus (P_{tot}) and total nitrogen (N_{tot}) from domestic wastewater in on-site facilities.

	Level of requirement	BOD_7 [a] (%)	P_{tot} (%)	N_{tot} (%)
Finland	Standard	80	70	30
	High	90	85	40
Sweden	Standard	90	70	not regulated
	High	90	90	50
Norway	Less sensitive [b]	-	-	not regulated
	Normal	70	60	not regulated
	Sensitive [c]	70 / 90	90	regulated according to location [d]

a) In Norway, the removal percentage of organic matter is calculated according to BOD_5.
b) Areas which are classified as less sensitive are not regulated at all concerning BOD_5, Ntot and Ptot, but have a treatment requirement of 20% removal or 180 mg/l of suspended solids (SS).
c) There are two kinds of sensitive areas: BOD_5 needs to be removed 70% in areas sensitive to eutrophication and 90% in catchment areas used for water supply. For Ptot, the requirement for both sensitive areas is 90%.
d) Dense settlements in sensitive areas with nitrogen removal requirements set by local authorities: Nordre Follo, Oslo, Jessheim, and Lillehammer.

Overall, the requirements appear to be quite similar, but some differences occur. In all three countries, compliance with the requirements is assessed based on the standardized loads to the units, not on actual influent wastewater quality measurements. Wastewater pollution is estimated based on the person-equivalent load in gramps per person per day (g/p/day) for BOD_7 or BOD_5, P (tot) and N (tot), and the number of users served by the unit. Efficiency is determined by converting the concentrations of effluent contaminants (sample analysis) into daily loads by multiplying the concentration values by water consumption per person per day. However, there are differences in the defined person-equivalent (PE) load values between the countries; for example, for BOD_7 in grams per person per day, it is set for 50 in Finland, 48 in Sweden, and 60 in Norway. In addition, the average water consumption in Finland is 111 L (Korhonen et al. 2020), in Sweden 136 L (Swedish Water and Wastewater Association 2020), and in Norway 180 L (Statistics Norway 2020). For compliance with standard/normal BOD removal efficiency set in regulations (Finland 80%, Sweden 90%, and Norway 70%), BOD concentration in the effluent, with the reported average water consumption values, must be less than 90 mg/L, 35.3 mg/L, and 100 mg/L in Finland, Sweden, and Norway, respectively. Thus, the difference in required effluent quality, based on average water consumption, and therefore the difference in the required unit performance for standard level regulation compliance can be significant between the countries.

Geographical designation of discharge limits (assessment of environmental sensitivity) and implementation of regulations also differ among the countries. For example, Finland is the only country regulating nitrogen removal for all areas. In Finland, the standard treatment requirements apply to all properties situated either on a groundwater area or closer than 100 metres from the mean water level of a water body. Among other properties, those built before 2004 must meet the requirements when a significant construction work is performed on the premises. Properties constructed after 2004 need to fulfil the requirements automatically, and municipalities may demand stricter treatment requirements in sensitive areas. The possibilities for requesting an exception are described in detail in legislation (Chapter 3.3.2) and the municipal authority makes the decision.

In Sweden, municipalities may decide the level of treatment requirement (standard or high) independently. Municipalities, therefore, have more power than in Finland and Norway, partly because the requirements are not included in legislation but introduced as General Advice. In Norway, treatment requirements (less sensitive, normal, sensitive) are determined on a national basis, but municipalities can impose stricter requirements. An individual municipality may allocate different environmental classifications into different areas inside their jurisdiction, according to the conditions of local water sources; for example, if the water body is used for water supply or is highly polluted. They can also set

specific provisions on leisure homes while elaborating municipal and urban zoning plans. In addition, the classification can be changed if the situation changes. Owners of new properties must therefore contact the municipal authorities and follow the current requirement levels of their location. In less sensitive areas, only the discharge of suspended solids is regulated, and in practice, a septic tank alone achieves this level of requirement. Exceptions for discharge limits to single properties may be granted based on the assessment and judgement of a municipal authority in Sweden and Norway. In all three countries, grey water is also regulated, but if the amount of grey water is negligible, it can be conveyed directly to the ground.

While comparing the governance practices of the three countries, an interesting example is the specific requirements set by municipalities concerning the use of holding tanks. In Finland, for example, in the Oulu region, the use of holding tanks as on-site sanitation system is obligatory in groundwater areas as it reduces the diffuse load from the properties (Oulun seudun ympäristötoimi 2017). Yet, in the municipality of Uppsala, in Sweden, the use of holding tanks in groundwater areas is not recommended, as the environmental impact of sludge transport is expected to increase (Kallio & Vienonen 2019).

6.3 Stakeholders' roles and responsibilities

While the role of local governments in water services varies considerably across Europe, similar practices dominate in the Nordic countries in terms of municipalities owning water and wastewater utilities and being responsible for water services also outside water distribution and sewer networks (Juuti & Katko 2005). Within these types of decentralized governance systems, local and regional governments have primary responsibility for water management. The main stakeholders related to on-site sanitation are presented in Table 10. The structure is rather similar: governmental organizations act as legislators and provide general guidance to regional and local authorities, while regional authorities provide guidance to municipalities regarding the implementation of the regulations. Municipalities have the main responsibility for authorizing the unit's implementation, assuring compliance with regulations, and performing supervision. However, allocation of responsibilities among different stakeholders varies among the three countries and is described in the following sub-sections.

Table 10. The main stakeholders related to on-site sanitation

	Main authorities	**Others**
Finland	• Ministry of the Environment • Regional Centres for Economic Development, Transport and the Environment (ELY) • Municipal building administration • Municipal environmental administration	• Finnish Environment Institute (SYKE) • Local environmental associations and other guidance organizations • Research organizations • Suppliers and service providers • Operators
Sweden	• The Swedish Parliament • Swedish Agency for Marine and Water Management (SwAM) • County Administrative Boards (*Länsstyrelsen*) • Municipalities • Ministry of Climate and Environment	• Associations • Research organizations • Suppliers and service providers • Operators
Norway	• Norwegian Environment Agency (NEA) • County Authority • Municipal pollution authority • Municipal building authority	• Statistics Norway • Norwegian Water (Norsk Vann) • NIBIO • Suppliers and service providers • Operators

Governmental organizations and regional authorities

In Finland and Norway, the ministries are responsible for the regulatory framework of on-site sanitation. In Finland, the Ministry of Environment is also responsible for general guidance, but in Norway the Norwegian Environmental Agency (NEA) is the main organization providing guidance to municipalities. In Sweden, the main actor at the governmental level is the Swedish Agency for Marine and Water Management (SwAM), which has no legislative power but an active guiding role towards regional authorities. SwAM provides general guidance for supervision, organizes seminars and education events, and maintains an online tool for municipal administrators. In Finland and Sweden, the regional authorities are involved in the implementation of the regulations, and they provide guidance to municipalities. However, in Norway, the role of regional authorities is less relevant.

Local authorities

In all three countries, municipalities are responsible for issuing building and environmental permits for on-site sanitation systems, supervising compliance with laws and regulations, as well as monitoring for any illegal activities. Thus, enforcing legislation and supervising the existing systems is mainly the responsibility of the municipalities. In Sweden, every municipality must have a three-year plan for the supervision and its implementation is overseen by regional authorities, which does not occur in Finland or Norway. A commonality in all three countries is that the level and quality of supervision provided by municipalities vary significantly between the municipalities.

Within a municipal government organization, administrative tasks concerning on-site sanitation are in general allocated for two departments: environmental regulation and building control. In Finland, the roles between the two authorities are divided so that the building authority is responsible for the permit process (building permit), and the environmental authority is responsible for the supervision and implementation of environmental legislations as well as granting exceptions. In Sweden, the Environmental Division of the municipality grants the permit and is also responsible for supervision. In Norway, two permits are required: the discharge permit and the building permit. Thus, both authorities are involved in the permit procedure. In addition, they are both responsible for enforcing regulation and supervision. However, in some municipalities, one person can perform both duties, pollution and building authority.

Local authorities are also required to provide guidance to property owners and service providers. In Finland and Sweden, guidance on general questions related to on-site sanitation is provided by municipal authorities, but for more specific questions (e.g., related to the choice of a treatment system) owners are directed to consult a planner or other impartial actor, as the municipality is responsible for handling the permit application. Some regions have an individual unit for guidance to separate it from permitting and supervision. In Norway, municipalities provide general guidance on the permitting procedure and on the discharge requirements of the unit's location. Specific guidance is mostly provided by Norsk Vann (Norwegian Water), the NIBIO, and service providers, as all tasks related to the establishment of the wastewater treatment system must be performed by professional companies. The municipality may also require an impartial professional to oversee the tasks carried out by the designer and executer of the unit implementation.

Costs related to the implementation and operation of on-site systems differ in the three countries. In general, permits are subject to a charge, but in Norway and Sweden the costs related to supervision are also paid by the property owners through supervision fees. In Finland, the costs of the supervision are generally paid by the municipalities, but property owners can be charged for certain tasks (e.g., dealing of applications for exceptions).

Service providers

In Norway, planning and construction companies must prove their liability and competence, which is determined in the Planning and Building Act (LOV-2008-06-27-71) and in the Pollution Control Regulations (FOR-2004-06-01-931). The conditions for issuing a discharge permit may also include requirements for competence. In addition, municipalities do not approve self-build systems if the property owner cannot prove his or her competence. Thus, the requirements for competence are stricter in Norway than in Finland, where, for example, certification for professional on-site sanitation planning is voluntary, and the permit process, including planning, can be conducted by the property owner without professional competence. However, the use of a professional planner is highly recommended in Finland. In Sweden, the use of a professional planner is not mandatory, but in practice, contractors are normally recruited to design the unit and provide the plans and documents required for the permit application. The use of professional services is obligatory in Norway when dealing with package plants: a professional planner and a service agreement for the maintenance of the plant with a professional company. Municipalities can also set requirements for having a service agreement for the maintenance of other types of systems, which is recommended by, e.g., Norsk Vann; however, this does not normally occur. In Finland and in Sweden, both a professional planner and a service agreement, are recommended for the implementation of package plants, but they are voluntary.

In Finland and Norway, the waste collection (sludge from septic tanks or black water from holding tank) is performed mainly by private companies, while in Sweden, the water utilities transport the sludge. According to the representative of stakeholder groups, sludge transport service providers in Norway often act as unofficial inspectors and report to municipal authorities if they have identified any issues while performing sludge removal measures.

Other stakeholders

One significant stakeholder's group in all three countries are associations. In Finland, the national guidance project (see Chapter 3.6.3) was carried out by about 20 local environmental associations. The Finnish Environment Institute (SYKE) coordinated the projects and provided educational modules to the employees of involved associations. SYKE also has the role of general information provider in Finland in the field of on-site sanitation. In Sweden, various associations are active in the water sector and on-site sanitation (see Chapter 4.3). Active information and interaction platform providers are the VA-guiden, the trade associations for service providers (*VVS-Fabrikanterna, Maskinentreprenörerna*), and the platform for wastewater associations (GemVA). In Norway, the most active association concerning on-site sanitation is the national association for Norwegian water industry (Norsk Vann). It produces extensive reports and guidance materials on several aspects of on-site sanitation. Another active stakeholder and information provider in Norway is The Norwegian Institute for Bioeconomics (NIBIO). The NIBIO is an administrative agency subject to Ministry of Agriculture and Food. It concentrates on research and information sharing and, in terms of on-site sanitation, it shares a considerable amount of guidance material on its website with detailed documentation on permit procedure, unit selection and design, maintenance, etc.

Operators

The operator of an on-site sanitation system is most often a single property owner or sometimes two or more property owners operating a common system. In addition, small user-owned wastewater associations operate systems serving several houses, still having the status of on-site sanitation. In Sweden, small wastewater utilities serving up to 200 PE also still operate under the on-site sanitation framework (see Chapter 6.2). The responsibility of an operator is to ensure that the property has an adequate treatment system, which fulfils the minimum treatment requirement defined in legislation (Finland and Norway) or in General Advice (NFS 2006:7) (Sweden). Municipalities, service providers,

and information providers support the operators, and their involvement and responsibilities depend on the case and the country; however, the responsibility of organizing proper on-site wastewater treatment lies with the operator.

6.4 Main issues

Contaminant discharge limits or requirements for on-site sanitation systems are regulated through regulatory frameworks in Finland, Sweden, and Norway. However, issues with non-compliance hinder the implementation of regulations in all three countries. Despite efforts to share information and supporting actions in implementation processes, a significant number of properties still lack an adequate treatment system for domestic wastewater. However, a lack of systematic data collection and sharing complicates status assessment and brings under suspicion available information. Yet, most importantly, this has a direct effect on the supervision work performed by municipalities. The vastly unknown status of on-site sanitation is not only an issue in the studied countries but is also defined as one of the major sanitation challenges on the European level (Grebot et al. 2019; WHO 2021). The saying "we cannot manage well what we don't know" describes the situation in most countries.

Other important challenges to be highlighted in Finland, Sweden, and Norway are the lack of resources and competence. Concerns regarding the lack of economic resources and the lack of a specialized work force were raised throughout the information gathering process for elaboration of this report, e.g., during the webinar organized for the stakeholders of the ON-SITE project in Finland. Municipal authorities do not have enough resources to enhance the implementation or surveillance of on-site sanitation, in particular, site visits are highly labour-intensive and require specialized competences. From the property owner point of view, affordability is an issue faced by many households. Upgrading an on-site sanitation system, building a new one or connecting the property to the sewer network might be too expensive, especially for properties located in sparsely populated areas where the value of the property can be low. Overall, the lack of available resources for surveillance and implementation results in a low probability of sanctions against property owners leading to non-compliance.

Furthermore, non-compliance can also result from a lack of knowledge or awareness of property owners regarding regulations, environmental impacts, etc. Consequently, on-site sanitation is not considered an important topic by authorities and/or decision makers as well as property owners. This culminates in the inaction of all actors, leading to non-compliance of the regulations. In addition, issues concerning management practices along the sanitation service chain transpire in all three countries. As often reported, inappropriate planning, installation, and/or maintenance of on-site units easily lead to operational failures of the treatment systems. These might be a consequence of the previously mentioned lack of knowledge or awareness of property owners or the service providers, and the inexistence of mechanisms for controlling and/or standardizing the quality of services (e.g., certification systems).

Overall, the challenges faced by the three countries regarding on-site sanitation are surprisingly similar. Moreover, similar issues are also reported by other European countries. For example, in a comparative study of five European countries (Finland, Ireland, France, Poland, and Bulgaria), issues leading to non-compliance were highlighted, which correspond to those found in this present study: high costs and a lack of resources, a lack of awareness and difficulties with inspections, as well as insufficient data availability (Grebot et al. 2019).

6.5 Good practices

The national legislations of Finland and Norway enable a clear definition of the roles and responsibilities of various stakeholders and a fluent permit procedure. Although the "General Advice"

strategy used in Sweden is not as binding as the legislations adopted in Finland and Norway, the framework used also enables the development of good practices. Strict contaminant discharge restrictions are in place in the three countries, illustrating the ambition of protecting national and international water resources, and a strategy pushing towards sustainable on-site sanitation.

In addition to the comprehensive regulatory frameworks in the three countries, this section highlights a number of good practices which support the implementation of regulations and national strategies. For example, in Finland, the Ministry of the Environment provided funding for a national guidance project during 2011–2019. Regional environmental non-governmental organizations (NGO) formed a guidance network and they performed general guidance in their regions, made on-site visits, and established targeted advice for property owners. This increased common awareness among the property owners and helped to tackle the gap in knowledge and competence issues (see Chapter 3.6.3). An important aspect of on-site sanitation is the scattered nature of system location, which makes supervision activities time and resource consuming. Sweden has responded to the issue of supervision with a mandatory three-year supervision plan for the municipalities which report to regional authorities. An integrated inspection organized on a national level can help municipalities to implement supervision practices and enhance the implementation of regulations.

The management of the whole on-site sanitation service chain requires an extensive and multifaceted knowledge in technical assessment, implementation and construction of units, environmental impact assessment, supervision of regulatory procedures, etc. Thus, municipal authorities and service providers require a significant amount of information to perform their work. In Norway, extensive guidelines are accessible online and in well-illustrated and practical language reports. These contain information regarding regulations, systems design, implementation, supervision, etc. The reports and online data bases are the result of strong collaboration among stakeholder groups, namely wastewater and water utilities and municipal associations, as well as research and educational institutions. Although the Norwegian government (through NEA) provides funds and is often the proponent of the projects, the strong activity of Norsk Vann and the NIBIO has generated invaluable information.

International supporting tools are also available. An Interreg project “Village Waters” has developed a web-based tool to help property owners to select the most suitable and cost-efficient on-site treatment system for their property. The tool includes six countries that are part of the Helsinki Convention (HELCOM), including Finland and Sweden. (VillageWaters 2021). In addition, a digital compendium of sanitation systems and technologies support the selection of a locally appropriate sanitation system considering environmental aspects, socio-cultural context as well as institutional and maintenance capacities (SSWM 2021).

Despite being ahead in terms of regulation, Finland, Sweden, and Norway can learn from the experiences and good governance and management practices of other European countries. As clearly seen throughout this report, the lack of knowledge regarding the implementation of systems and their status is one of the main challenges in the management of on-site systems. The implementation of systematic registration procedures can help answer some of the most urgent questions, such as how many systems are in operation, where they are located, and what technology they use. Registration for on-site sanitation systems exists in, for example, Latvia, Ireland, and Hungary (Paderi 2021). These systems generate data which is used by authorities for status evaluation and supervision, and by research groups looking into advancing the available knowledge on the unit’s efficiency and environmental impacts. Another challenge faced by the authorities is the resources required for supervision. Organizing surveillance through an independent organization might be one solution. In France, a public service organized by municipalities (SPANC) is responsible for surveillance, but it can also offer maintenance and renovation services. Furthermore, costs are covered by the fees collected from the property owners. Ireland applies a national inspection plan and a risk-based approach in order to prioritize areas which pose the highest risks to the environment and human health. In Austria, surveillance is performed

annually by a professional service provider and the costs are covered by the property owners. Additionally, the property owners can attend a training course on the maintenance and operation of the on-site systems, and if the course is completed, official inspections are performed less frequently. (WHO 2021)

6.6 Concluding remarks

The relevance of on-site sanitation in terms of health and environmental impacts is undeniable. However, it often does not receive the required attention in international and national policy and the regulatory frameworks. Insufficient on-site sanitation causes significant diffuse pollution in Europe, including Finland, Sweden, and Norway. On a European level, the topic is now highlighted under the Protocol on Water and Health (EUR/ICP/EHCO 020205/8Fin), as well as in the process revising the EU's Urban Waste Water Treatment Directive (91/271/EEC).

Despite numerous challenges, Finland, Sweden, and Norway can be seen as pioneers in the governance of on-site sanitation, especially in terms of the regulatory framework. Purification requirements for on-site sanitation systems are regulated through these frameworks and the responsibilities of different stakeholders are well described. In the three countries, governmental organizations act as legislators and provide general guidance to regional and local authorities, while regional authorities provide guidance to municipalities regarding implementation of the regulations. Municipalities have the main responsibility for authorizing the unit's implementation, for assuring compliance with the regulations and performing supervision. However, issues with non-compliance hinders the implementation of the regulation in all three countries. Similar challenges have also been reported by other European countries, such as high costs, a lack of resources and specialized work force, a lack of awareness and difficulties with inspections, as well as insufficient data availability.

This present study provides some common points and lessons learned regarding the governance of on-site sanitation in Finland, Sweden, and Norway, while also considering the perspectives from other case-studies (Kattainen 2012; Grebot et al. 2019), as well as the on-going evaluation on the European level (WHO 2021). Thus, the key recommendations for enhancing the management of on-site wastewater treatment are:

- A coherent **national regulatory framework** is of critical importance as the basis for good governance practices and a well-functioning sanitation service-chain. It harmonizes the overall regulation, enables the definition of the roles and responsibilities of various stakeholders, and gives a mandate for action.
- Implementation of the regulations require **adequate support mechanisms** at all levels of implementation: national, regional, and local. Appropriate support mechanisms vary depending on the country specific regulatory framework, but some general suggestions can be made:
  - A risk-based national inspection plan implemented at a local level could help municipalities to perform surveillance in a systematic manner.
  - A service-oriented approach would support property owners to have professional services for the planning, construction, and maintenance of on-site sanitation systems, but would also support public authorities if the responsibility of surveillance and regular inspections were given to an independent actor.
  - Multichannel communication, information-sharing, and education should be available and formulated considering every target group: municipal authorities, property owners, service providers.
  - Systematic data collection could be enhanced through a national registration of on-site sanitation systems and thus facilitate the supervision and implementation of regulations and better understanding of the whole picture and current state of on-site sanitation.

    - Monetary aid for property owners to support installation and renovation could increase the level of compliance.
- Increasing **public awareness** to strengthen the policy relevance: on-site sanitation should be highlighted on behalf of various actors and considered in strategies concerning, e.g., river basin management as well as public water services.
- Country specific case studies as well as comparative studies are useful in terms of **peer learning** in the governance of on-site sanitation. Nevertheless, the challenge is to implement the lessons learned in practice. Common platforms are required on both a national and international level to present the results of various studies, share good practice, collaborate, and learn from each other.

Lexicon

BOD	Biological oxygen demand
BOD_5	Biological oxygen demand in five days
BOD_7	Biological oxygen demand in seven days
BWD	Bathing Water Directive (76/160/EC)
CE	*Conformité Européenne*
CEN	European Organization for Standardization
CPR	Construction Products Regulation
DoP	Declaration of Performance
EEA	European Economic Area
EFTA	European Free Trade Association
ELY Centre	Finnish Centres for Economic Development, Transport and the Environment
FISE	Limited company offering certifications for construction in Finland
GemVA	Swedish platform for water associations
HPAC	Heating, plumbing and air-conditioning
ME	*Maskinentreprenörerna* – a trade and employers' association for contractors
N	Nitrogen
N_{tot}	Total nitrogen
NANDO	New Approach Notified and Designated Organizations
NEA	Norwegian Environment Agency
NGO	Non-Governmental Organization
NIBIO	Norwegian Institute for Bioeconomics
NMBU	Norwegian University of Life Sciences
P	Phosphorus
P_{tot}	Total phosphorus
PE	Population Equivalent / Population Equivalent
RBMP	River Basin Management Plan
REFIT	Regulatory Fitness and Performance Programme
SS	Suspended solids
SwAM	Swedish Agency for Marine and Water Management (*Havs och Vatten myndigheten*, HaV)
Swedish EPA	Swedish Environment Protection Agency
SYKE	Finnish Environment Institute

UWWTD	Urban Waste Water Treatment Directive (91/271/EEC)
VA-guiden	Swedish information platform for municipalities, authorities and private operators
VSS-Fabrikanterna	Swedish trade association for Sanitary Engineering
WFD	Water Framework Directive (2000/60/EC)

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