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Opportunities For Circular Economy in the Port of Norrköping

A Preparatory Pilot Report Within the Circular Ports Project

Work Package 1, Activity Number 1.2

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Introduction

The transition toward more resource-efficient and circular port environments has become an increasingly important priority in light of growing environmental pressures, policy ambitions at EU and national levels, and the need to improve the resilience and competitiveness of port-related value chains. Ports play a critical role as nodes where logistics, industry, and material flows intersect, making them well-positioned to enable and accelerate the transition towards a circular economy. Within this context, the Interreg Baltic Sea Region project Circular Ports aims to support ports in developing, testing, and deploying circular economy strategies tailored to port environments.

Circular economy refers to an economic system that aims to maintain the value of products, materials, and resources for as long as possible, while minimising waste generation and negative environmental impacts. According to ISO 59004, circular economy is defined as a systemic approach that enables the recovery, retention, or enhancement of resource value, while contributing to sustainable development goals.

At the European level, circular economy is recognised as a key strategy for reducing resource dependency, mitigating climate impacts, and minimising the release of hazardous substances, while at the same time supporting innovation and competitiveness. Ports represent particularly relevant environments for circular economy implementation, as they function as complex nodes where logistics, industry, energy systems, and material flows intersect.

Achieving meaningful circularity requires more than improved recycling rates; it necessitates a systematic transition up the waste hierarchy, often operationalised through so-called R-strategies. These strategies range from high-value actions such as refuse, rethink, and reduce, to reuse, repair, and recycle, with energy recovery representing the least circular option. Circularity increases as organisations and systems adopt strategies higher up this hierarchy, as these approaches preserve more embedded value and reduce the need for primary resource extraction. In a port context, this may involve preventing waste generation, enabling reuse of materials across port operations or between actors, and developing new circular value chains through industrial symbiosis. In this report, the R-strategy framework is used as an analytical lens to assess the current handling of selected waste streams connected to the Port of Norrköping and to identify opportunities for achieving higher levels of circularity through future pilot activities.

This preparatory report is part of the Circular Ports project and contributes to the implementation of activities led by RISE Research Institutes of Sweden, the Port of Norrköping and the Swedish National Road and Transport Research Institute (VTI). The report focuses on the Swedish pilot in Norrköping, with particular attention to identifying and preparing new waste streams for recycling and other value-retaining circular solutions. The work presented here corresponds to the preparatory phase of pilot activities and provides the analytical foundation for subsequent piloting and testing activities planned within the project.

The primary purpose of this report is to document the preparatory work undertaken together with the Port of Norrköping to support the deployment of circular economy strategies in a port environment. Specifically, the report aims to (i) describe the pilot objectives and scope, (ii) map selected waste and material streams generated from port operations, visiting ships, and port constructional operations (iii) identify existing and potential circular solutions and relevant stakeholders, and (iv) initially assess how the waste streams can be shifted towards higher-

value circular economy strategies. The report thereby contributes to the overall Circular Ports project's objective of supporting ports in moving from linear waste handling practices towards more circular and value-retaining systems.

In addition, the report provides a brief introduction to circular economy principles as applied to port environments, including the use of R-strategies and the waste hierarchy as analytical frameworks. These frameworks are used to assess current practices and to identify opportunities for increasing circularity by prioritising prevention, reuse, refurbishment, and recycling over lower-value recovery options.

The work presented in this report is based on a multi-method approach combining data collection and mapping, document and literature review, and stakeholder dialogue. Inputs have been gathered through collaboration between project partners and relevant actors in the surrounding industrial ecosystem, and insights from previous Circular Ports activities and working groups. Particular attention has been given to ensuring alignment with the project's common methodology and reporting requirements, enabling comparability across pilot ports.

The report is structured as follows. Following this introduction, the next section provides an overview of the Port of Norrköping and the pilot context. This is followed by a description of the pilot objectives and selected waste streams, including their current handling and potential circular pathways. The report then presents an initial mapping of relevant stakeholders and existing circular solutions linked to the pilot. Finally, the report summarises key findings from the preparatory phase, outlines lessons learned, and identifies essential next steps for the continued implementation of circular economy strategies within the Norrköping pilot.

Port of Norrköping

The Port of Norrköping is one of Sweden's largest ports owned and operated by Norrköping Municipality. The port functions as a major logistics hub for central and eastern Sweden. Its geographical location and connectivity are illustrated in Figure 1, showing the port's position in relation to the city of Norrköping, the surrounding region, and the wider Baltic Sea area. The figure highlights the port's strategic proximity to industrial areas and transport corridors, enabling efficient access to both domestic and international markets.



Figure 1. Location of Port of Norrköping in Sweden. Source; Port of Norrköping



The port is not only an infrastructural landlord, but operates several terminals distributed across the harbour area within its own business scope. The port's terminals include the *Pampus terminal*, *Öhmans terminal*, the *Energy Port*, *Ramshäll*, and heavy cargo terminals. Figure 2 provides a detailed overview of the port's internal structure and terminal layout. The figure distinguishes between terminals operated directly by the Port of Norrköping and terminals operated by external parties, illustrating the organisational and operational complexity of the port environment. Cargo handling activities are concentrated around container and intermodal terminals, bulk and break-bulk terminals, liquid bulk facilities, and areas dedicated to project and heavy cargo.



Figure 2. The entire port area and port operations. Source; Port of Norrköping

The port handles approximately 4 million tonnes of cargo annually and manages around 150,000 containers per year. The total quay length amounts to about 2,100 metres, with a maximum water depth of 13.5 metres, enabling the port to accommodate a wide range of vessel types. Around 950 vessels call at the port each year, supported by intermodal connections that include electrified rail access directly into the terminals, with up to 350 truck movements per day. The port operates approximately 63,500 square metres of warehouse space and employs around 160 people. Operational data for the port is summarised in Figure 3, which presents key figures describing the scale and intensity of port activities.

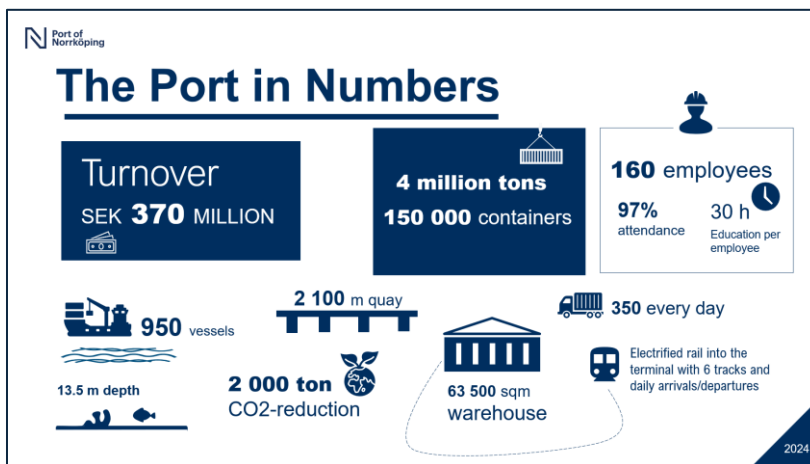


Figure 3. The Port of Norrköping in Numbers. Source; Port of Norrköping



Container and intermodal traffic accounts for the largest share, representing approximately 40 percent of port activity. This is followed by terminal operations at around 19 percent, bulk cargo at 14 percent, liquid bulk at 15 percent, break-bulk at 8 percent, and project and heavy cargo at approximately 4 percent. This diversity of cargo types and operations results in a broad range of material and waste streams, which is a key reason why the Port of Norrköping is well suited as a pilot case for circular economy initiatives.

Environmental work and sustainability initiatives

Environmental management is an integrated part of the Port of Norrköping's operations and is governed by environmental permits under the Swedish Environmental Code. These permits regulate emissions to air and water, noise, waste handling, energy use, and risk management. Compliance is ensured through systematic monitoring, reporting, and regular dialogue with supervisory authorities.

The port's Environmental Report 2024 documents not least structured routines for waste sorting, hazardous waste handling, oil separation, stormwater management, and environmental risk preparedness. The report also highlights gradual improvements in energy efficiency and reduced emissions from port operations and internal transport.

In recognition of its long-term and systematic environmental work, Norrköpings Port was awarded Environmental award of the year 2025. The award acknowledges the port's commitment to sustainability, environmental performance, and innovation, including its work on digital tools for monitoring emissions, improved resource efficiency, and collaboration with industrial and public actors. This recognition further confirms the port's suitability as a pilot environment within the Circular Ports project, where new circular economy solutions are intended to build on an already mature environmental management foundation.

Händelö and current industrial symbiosis

A defining characteristic of the Port of Norrköping is its location within the island called *Händelö*, where large parts of the port's terminals and main industrial activities are situated. The spatial relationship between the port, surrounding industries, and infrastructure is shown in Figure 3 and Figure 4, which together illustrate how port operations are embedded within a dense logistics and industrial landscape.

Händelö hosts the Händelö Eco-Industrial Park (HEIP), an industrial symbiosis bringing together actors such as the Port of Norrköping, a heat and power plant from the energy supplier E.ON., the Norrköping Municipality, Nodra – the municipal water- and waste management company, a Lantmännen Biorefineries plant, the wood- and forestry company Holmen, and the Linköping University. The objective of HEIP is to connect surplus resources from industry and the city into a coordinated system, enabling the reuse of energy, materials, by-products, and infrastructure across organisational boundaries.

With HEIP, several existing industrial symbioses are already in place within the area, including exchanges of energy, bio-based materials, and logistics flows. The concentration of container terminals, bulk handling facilities, liquid bulk operations, and energy-related infrastructure, creates favourable conditions for identifying circular solutions that can utilise port-generated waste streams as inputs for nearby industrial processes.

Pilot area and scope

Within the Circular Ports project, the Port of Norrköping constitutes the defined pilot area for testing circular economy strategies in a real port environment. The main pilot area is defined as the port area within the boundaries of the Port of Norrköping's own operational activities and business operations. This means that the pilot focuses on waste and material flows generated in connection to the port's business operations, including terminals, storage areas, service facilities, port construction activities, and interfaces with visiting ships and industrial activities surrounding the port.

HEIP is considered an important extension of the system boundary. While the port is located within the broader Händelö Eco-Industrial Park and closely connected to its industrial symbiosis, the pilot does not encompass all activities or actors within HEIP. Instead, HEIP is considered part of the surrounding port industries that may support or enable new circular solutions, for example by providing potential receiving actors, complementary material flows, or infrastructure, but it is not itself fully included within the formal pilot boundary.

The scale and diversity of operations underpin the selection of the port as a pilot case. The combination of high cargo volumes, multiple cargo types, and established environmental routines enables a focused yet realistic exploration of circular solutions. Selected waste streams are analysed in terms of origin, volume, composition, current handling practices, and potential pathways for reuse, recycling, or other value-retaining applications.

By clearly defining the pilot area and grounding it in the operational and spatial realities shown in the Figures 1 to 3, the Port of Norrköping provides a concrete and transferable case for the Circular Ports project. The insights generated are intended to support both local implementation and knowledge transfer to other participating ports.

Pilot description

The pilot aim is to explore new circular opportunities by analysing selected waste and materials streams generated within the port's own operations and visiting ships, as well as streams generated from the port's surrounding area for increased industrial symbiosis. The pilot draws on existing knowledge and solutions currently available in the port's surroundings, such as the local industrial symbiosis HEIP and logistical cluster Logistikia.

The goal is to collaborate with existing circular solutions and material flows going to or from the port, and to use them as a base finding solutions and actors for new waste streams for recycling. The project also considers upcoming construction projects within the port and in the local region, to find pilot possibilities exploring how industrial symbiosis and circularity can improve the port's environmental impact as well.

After the preparation phase and analysis of circular possibilities, the upcoming activities for the pilot implementation phase are narrowed down to a few options of CE solutions. The option's arrangement will be further developed and serve as basis for new stakeholder workshops, deeper mapping of potential value chain, calculation of environmental impact, and involvement of current and possible new actors to increase the circularity of the port. As the preparatory phase has shed light on several possible circular flows, the pilot partner group finds it important to keep exploring all the options to enable as optimal increased circularity as possible within the boundaries of the project.

Method of pilot preparation

The method of the pilot preparation activities within the port of Norrköping case has been developed by the research group from RISE and VTI during the first work package of the Circular Ports project. The following list in Table 1 explains the steps within the circularity mapping and analysis work.

Table 1. List of activities in the preparatory phase of the Port of Norrköping pilot.

Basic data gathering
Initial waste stream mapping
Initial stakeholder mapping
Workshops with partner group and closest involved stakeholders
Break down categories for deeper discussion
Literature analysis of circularity pilot options
R-level definition
Regulatory mapping
Assessment of pilot potential
Result of pilot- and regulatory sandbox possibilities for the second project phase

Increased circularity

Literature has identified several manners to reach an increased circularity. These manners can be classified into 10 different R-levels (Potting et al., 2017), see Figure 4. These R-levels form a staircase so by implementing the r-level further up the staircase, thus increases an organization's circularity. R-levels can be utilized to increase circularity across an organization or within one area. This report focuses on the use of R-levels to increase circularity for the identified waste streams of the Port of Norrköping: wood waste, complex materials, landfill, combustible waste, maintenance dredging soil, oil separator waste (from port operations) and oil-based waste (from ships). These identified waste streams are produced from port operations or by ships utilizing the port. After a discussion with the Port of Norrköping, it was determined that maintenance dredging soil, oil separator waste (from port operations) and oil-base waste (from ships) were interesting cases but not chosen as focus wastes for this report and the continuous pilot work, as they already are being placed in a higher R-level than the others identified and described below.

The remainder of this section will discuss the current R-level for each identified waste stream. Additionally, manners to climb up the r-level staircase and increase circularity will be discussed for each waste stream.

Wood waste, mainly in the form of pallets or wooden packaging, have been burned (R9 - recover) after they are no longer able to be used as pallets or packaging. This is the lowest level of circularity according to r-levels. The project group has identified a possibility to Reuse (R3) the wooden pallets and packaging. A different sorting system will need to be realized so that wood could be sorted based on the desires of involved partners. Partners that could take on new ownership of the wood waste produced at the port will need to be identified. From that point, possible solutions can be identified and discussed. Wood waste can be used to be make other types of fibres which can be used in household textiles.

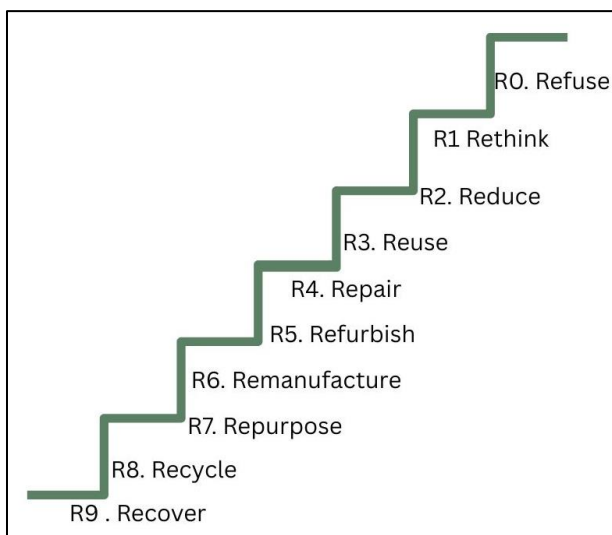


Figure 4. R-levels displayed in a staircase-based framework. Figure inspired by Potting et al (2017).

The second waste flow identified at the Port of Norrköping was complex materials. These materials are a mixture of various materials (i.e. various plastics) making it difficult to sort the different materials so that they may be disposed or reused in appropriate manners. Currently,

the Port of Norrköping burns these complex materials to recover energy (R9). After discussion with the port, the project group determined that recycling (R8) may be achievable. An analysis for determining waste composition would be necessary before reaching out to potential partners to discuss implementation of circular solutions. A similar process could be repeated for combustible waste. Currently combustible waste, mainly coming into the port via ships utilizing the port, is disposed of in efforts to recover some energy (R9). Identification of potential partners, solutions and utilization of a waste composition analysis could help increase the circularity of combustible waste to recycle (R8).

An additional waste flow which has been discussed is excavated rock. Due to the construction of a new railway stretch the East Link, the Port of Norrköping may have the possibility to receive rock and soil that has been excavated and implement it into its circular initiatives. There are some potential problems with the inclusion of this excavated rock which would need to be addressed like nitrogen amounts. Analysis would need to be conducted to determine if transporting excavated rock from the construction site to the port is financially viable. Discussions pertaining to solutions to include excavated rock into the port's circularity will need to be taken with partners.

The pilot will focus on the use of excavated rock from the East Link for the construction of a new berth at Port of Norrköping. While excavated rock will be the focus, the research team is open to the possibility that other waste and material streams could be studied simultaneously.

Regulatory sandbox challenges

Several possible regulatory challenges have been identified during the preparatory phase, particularly those related to environmental permit requirements for a potential future use of excavated tunnel masses in a coming quay construction project. To support the next project phase, a brief overview of the relevant permitting processes has therefore been compiled. This background provides context for regulations that may influence future work with regulatory sandboxes.

The Swedish Environmental Code regulates environmentally hazardous activities and the permit assessment of activities with significant environmental or health impacts. Activities are divided after their severeness into different categories (A, B, or C). A-activities are environmentally significant activities with the highest potential impact on human health or the environment. They require a formal environmental permit granted by a Land and Environment Court before the activity may start. B-activities are environmentally significant but less complex than A-activities. C-activities are lower-risk activities with more limited environmental impact. The distinction between B and C activities, defined in the Environmental Permitting Ordinance (2013:251), determines the applicable legal procedure, responsible authority, level of environmental assessment, and degree of legal certainty for the operator (Naturvårdsverket, 2025).

Through its Environmental Permitting Delegation (MPD), the County Administrative Board acts as the permitting authority for B activities, which are environmentally significant activities requiring a formal permit before commencement. The County Administrative Board also participates in consultations, assesses whether activities may cause significant environmental impact, safeguards national and EU environmental interests, exercises supervisory authority after permits are granted, and acts as a party in court proceedings when decisions are appealed (Naturvårdsverket, 2025).



Municipalities are the local authorities with primary responsibility for C activities, which are lower risk activities subject to prior notification rather than permitting. Municipalities handle local environmental protection, health related nuisance issues, and day-to-day supervision, and they hold a strong mandate in land use planning under the Planning and Building Act (Naturvårdsverket, 2025).

Implementation

The implementation phase builds on the insights and preparatory work conducted during the initial mapping of waste streams and circular opportunities in the port. The following sections describe how the project will start putting ideas into practice and prepare the activities needed for the upcoming pilot work.

Port waste data

The port's environmental report provides a clear overview of the waste and material streams currently handled within the Port of Norrköping. Through the mapping exercise, several key fractions were identified, each varying in volume, composition, and circularity potential. Most of these streams are already managed through established waste handling routines, and while some offer possibilities for some improvements, their relatively small volumes might limit the feasibility of developing new circular solutions within the scope of this project. The systematic review of these flows has therefore served as an important foundation for understanding the port's existing circularity landscape and has highlighted the need to also consider material streams beyond routine operations.

Waste flow mapping

Based on the data from the port's Environmental Report 2024 (Norrköpings Hamn AB, 2024), a structure was developed to gain a deeper understanding of the current situation and to identify potential improvement areas related to recycling and circularity. The set of questions defined for each waste category served as a basis for partner workshops, helping to map the waste activities currently in place and to generate key terms for future discussions on how the port could engage in more circular waste and material flows. The questions are presented in the list below.

- Type of waste (informed in environmental report)
- Weight of waste in metric tonnes (informed in environmental report)
- Origin of waste, ship-based or port generated
- Other notable characteristics of the waste
- Temporary storage of waste in the port
- Handling and storing characteristics
- Transport provider (informed in environmental report)
- Frequency of waste pick up from port
- First receiver of waste after the port site (informed in environmental report)
- Recycling or waste handling activities as the first receiver
- Identified possible second receiver for more waste recycling activities
- End-product after current waste recycling activities
- Potential rest product after current waste recycling activities
- Challenges and/or improvement areas in the waste recycling value chain
- Other comments or discussion points

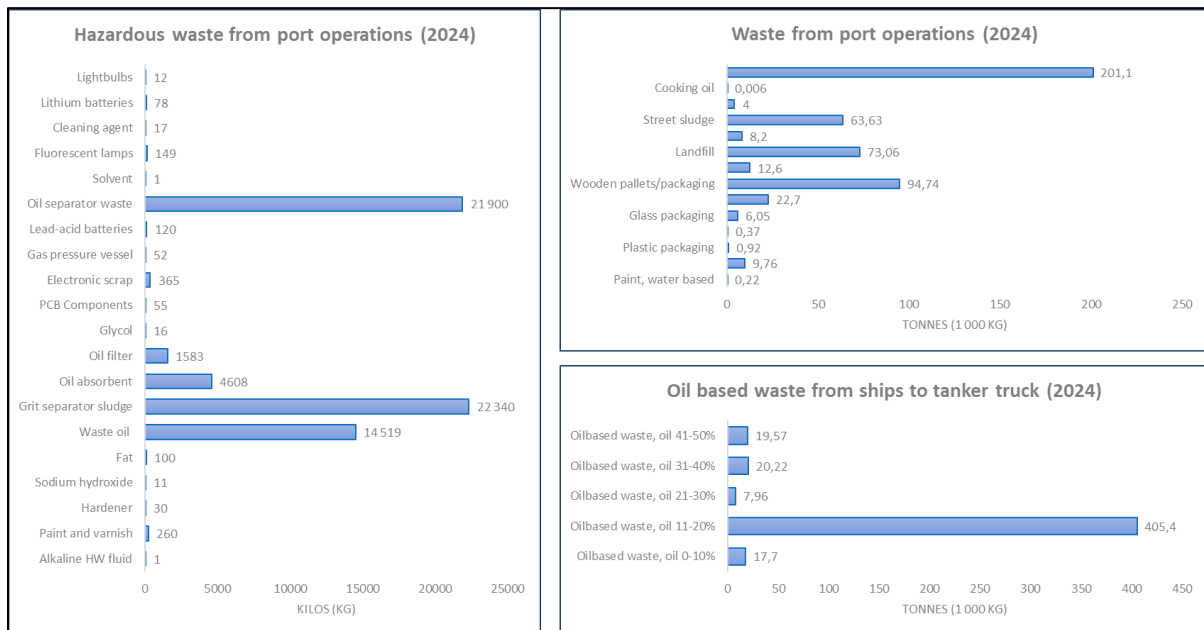


Figure 5. Overview of waste categories generated in the Port of Norrköping 2024. Source: Port of Norrköping

Result of waste flow mapping

Initially, the waste stream mapping done with the structured questionnaire resulted in an identification off the waste streams with most potential for new activities upgrading their R-levels to a CE flow within the port. This identification was based on the amount of waste category volume collected in the port, seeing as a very small amount would not be applicable, and the characteristics off the waste, such as challenges with handling it, understood potential of materials, and what type of actors are involved today or could be involved in a CE solution in the future. The result of this categorisation gave the partner group a list of six waste streams to further discuss and understand on a deeper level to understand the port's potential of circular activities. Those waste streams are illustrated in Figure 5 and explained in the following list. Together, these six waste categories stand for a large amount of the port's total collected waste during 2024.

- Combustible waste,
- Complex materials - Mooring lines and hard plastic bands used for packaging,
- Wood waste - Mostly wooden pieces used to stack goods on top of each other in the port and in containers, but also pallets used in packing and stripping containers with goods.
- Oil-based waste - Oil-based liquids that is collected in the port in smaller amount before collected and transported to oil-separating facility for recycling.
- Hazardous waste - Various hazardous materials and liquids.
- Landfill materials - Sand and gravel swept up from quay side in the port and used for landfill today.



Excavated tunnel masses for port quay expansion

Parallel to the waste related activities originating from the terminal operating side of Port of Norrköping's business area, the pilot partners have discussed what potentials for circular economy there are within the infrastructural business- and maintenance operations of the port as well.

The Port of Norrköping will require a quay expansion within the coming 5–15 years, a development project that demands substantial investment and large volumes of fill material. Already today however, the major regional infrastructure project the East Link is underway. The East Link is a 150–160 km high-speed railway under construction between Järna and Linköping and is planned to open in 2035. The project involves extensive tunnelling and blasting operations, generating significant quantities of excavated rock and surplus material along the route.

The planned expansion of the quay in the Port of Norrköping creates a potential circular opportunity through the use of excavated tunnel masses from the East Link railway project. As the East Link will generate substantial quantities of rock and soil near the port, the material represents a potential substitute for virgin aggregates traditionally required for quay construction. This makes it an interesting case for circularity, both from an environmental and logistical perspective, as local reuse can reduce transport needs, emissions, and the extraction of new resources.

The relevance of this material stream is further strengthened by the short distance between the excavation sites and the port, which may significantly lower handling and transport costs compared to sourcing fill material from more distant suppliers. Importantly, initial dialogues have already taken place with the County Administrative Board, focusing on regulatory conditions for placing excavated rock in a marine environment. A central issue in these discussions has been the nitrogen content of the freshly blasted material, and whether the port could legally use tunnel masses without prior aeration, a factor that would substantially reduce costs and simplify logistics for the quay expansion. These regulatory questions will require continued consultation, detailed environmental assessments, and close coordination with authorities in the next project phase to determine the feasibility of this circular solution.

Summarised assessment of pilot potential

This section summarises results from port waste data mapping and possibilities of a circular port expansion project by including excavated tunnel masses in the planned new quay side. Table 2 is the result of an exercise done in the port of Norrköping partner constellation to understand the best feasibility for a pilot within the Circular Ports project that gives the most value to the port, and that has potential of overcoming challenges such as regulatory obstacles and data sharing difficulties. This analysis naturally leads to the exploration of larger-scale material flows connected to the port's future infrastructural development needs. In particular, the upcoming quay expansion and the simultaneous generation of substantial excavated tunnel masses from the East Link railway project present a more significant opportunity for circularity, both in terms of material volume and potential environmental benefit. The Figure 6 below provides an overview of the selection process towards circular opportunities and particular the case of excavated tunnel masses for quay side construction.

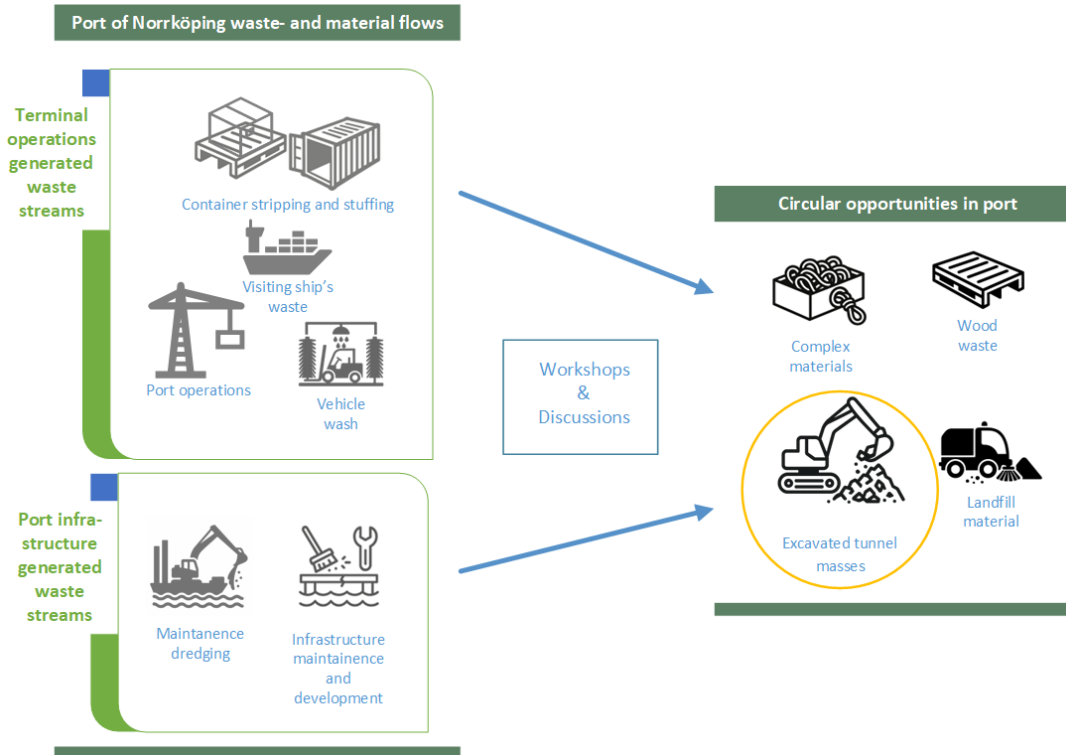


Figure 6. Process summary: From initial waste streams to prioritised circular use of excavated tunnel masses.

Table 2. Assessment matrix for pilot potential.

	Case	Value for the port	Value for other stakeholders	Regulations impacting	Challenges with waste flow	Pilot feasibility
Wood	Assess potential for increased wood waste circularity – identify constraints (regulations, small fractions, competition from energy use).	Deepens the understanding of wood waste utilization and circularity; exploring new pathways, e.g., identify regional industries with similar waste or interest in these fractions.	Highlight the port's role in the circular economy; showcase business opportunities for other actors, e.g., industries/ports generating this waste and industries that could use recycled wood as input material.	Wood recycling during demolition; traceability to ensure wood is not from deforestation; hazardous substances per environmental legislation.	If wood waste is not used for RT chips, alternative material is needed for heat production.	Uncertain case regarding short-term potential for port waste flows; limited interest from the port based on initial discussions with waste service provider.
Complex materials	Ropes and mooring lines currently sent for incineration at a waste facility; potential exists for increased circularity.	Show that the port takes responsibility by exploring pathways toward circularity, even for small and complex materials.	Complex materials are a neglected waste fraction that needs more attention – all ports handle small amounts; can raise awareness among waste and manufacturing companies.	Requirements on the amount of plastic that must be recycled.	Small volumes; increased costs; wide variation in plastic chemical composition, affecting number of fractions/shippments.	Better understanding needed to assess pilot potential.
Landfill	Separate gravel from port side for reuse.	Reuse gravel for sanding quay areas instead of purchasing new material.	Less gravel/sand needs to be produced and transported to the port from elsewhere.	Requires environmental permit for treatment.	Feasible in theory but may yield limited quantities; risk of higher cost per handled volume.	Practically feasible if suitable separation tactic is available.
Excavated tunnel masses	Tunnel masses planned to be excavated from nearby industrial project could be used as fill material for upcoming quay expansion in the port.	Utilise nearby recycled masses to avoid having to use virgin materials.	Excavated rock is reused and does not end up in landfill.	Regulated nitrogen content in material placed in the sea.		Implementation lies in the future; currently only theoretical.

Stakeholders

In the initial phase of the project, key stakeholders connected to the port’s waste and material flows were mapped and grouped into four categories: central internal actors, external commercial actors, public actors and society, and industrial stakeholders. These categories reflect the diverse roles and responsibilities involved in waste handling, logistics, regulation, and circular value-chain development. In this chapter, the most relevant stakeholders from each category are described in more detail, supported by a summarizing figure that provides an overview of their positions and relationships within the system.

Identified

The following figure provides an overview of the identified stakeholder groups and their roles within the port’s waste and material flow system. It serves as a visual summary of the four stakeholder categories and how they relate to the broader circularity context of the pilot.

Table 3. Identified stakeholders within circular opportunities for the Port of Norrköping.

Central internal actor (within Port of Norrköping)
<ul style="list-style-type: none"> • Port authority • Terminal operators • Workshops & service units
External commercial actors
<ul style="list-style-type: none"> • Shipping companies and visiting ship crews • Waste transporters <ul style="list-style-type: none"> • Renall AB • RagnSells AB • Waste & recycling companies <ul style="list-style-type: none"> • Renall AB • RagnSells AB • Nodra • Sortera • Energy and heat provider <ul style="list-style-type: none"> • E.ON • Suppliers of equipment and chemicals
Public actors & society
<ul style="list-style-type: none"> • Norrköping Municipality • Region Östergötland • Östergötland County Administrative Board • Swedish Environmental Protection Agency • Local community & environmental organisations
Industrial Stakeholders (symbiosis)
<ul style="list-style-type: none"> • HEIP • Logistikia • Lantmännen biorefineries • E.ON

Those stakeholders that are most involved in the pilot are the public actors and the industrial stakeholders which are briefly described below.



Public actors

In this category, we find *Norrköping Municipality*, who is the owner of the port. Through their ownership the municipality can steer the ports development to serve both commercial and broader municipal objective ensuring alignment with the city's long-term vision, this could include setting requirements for circularity in procurements and strategies. Apart from this the municipality is further the authority responsible for activities with environmentally lower risk and restricted local impact.

Region Östergötland is a regional authority responsible for health care, regional infrastructure, public transport and regional development. As responsible for regional development they promote sustainable growth, innovation, accessibility and public health, often by coordinating actors and supporting innovation projects.

Östergötland County Administrative Board (Länsstyrelsen i Östergötland) is the state authority at regional level, ensuring compliance of national policy and legislation. Its tasks include environmental protection and supervision, environmental permitting, nature conservation, water management, climate adaptation, cultural heritage protection, and civil protection, as well as coordination of regional development and crisis preparedness.

The Swedish Environmental Protection Agency (Naturvårdsverket) is the national authority for environmental policy and environmental protection. The agency coordinates, develops, and follows up Sweden's environmental efforts, including climate change, biodiversity, air and water quality, chemicals, waste, and nature conservation. It develops regulations, guidance, and knowledge support, administers environmental funding, follows up the national environmental quality objectives, and supports authorities, municipalities, and other actors in implementing environmental legislation and EU environmental policy. As such it provides national instruments for circularity and waste and controls incentives and regulations for recycling.

The Swedish Transport Administration (Trafikverket) is the national agency responsible for the long-term planning, construction, operation, and maintenance of Sweden's transport infrastructure. This includes roads, railways, maritime routes, and aviation infrastructure. The agency works to ensure safe, sustainable, and efficient travel and transport throughout the country, while also coordinating traffic management and promoting environmentally responsible mobility solutions.

Industrial stakeholders

HEIP

As described in the introduction, the Port of Norrköping is located within the Händelö area, which hosts the Händelö Eco-Industrial Park (HEIP). HEIP represents a well-established example of industrial symbiosis in Sweden, where industries, infrastructure providers, public actors, and research organisations collaborate to improve resource efficiency and reduce environmental impact.

The Port of Norrköping is an active participant in HEIP and plays a central role as a logistics node within the symbiosis. While the port's primary function is to provide port, terminal, and cargo handling services, it also serves as an important interface through which circular material and energy flows can pass. Several circular flows within HEIP are already directly or indirectly

connected to the port, for example through the transport of bio-based resources, energy carriers, waste-derived materials, and industrial by-products. In this sense, the port enables circular flows by facilitating the movement and consolidation of materials between different actors rather than being the end user of those materials.

HEIP is closely linked to regional innovation and business networks, including CleanTech Östergötland, which brings together companies, public organisations, and researchers working with environmental technology and sustainable solutions (Händelö Eco-Industrial park, n.d.). CleanTech Östergötland contributes to the HEIP ecosystem by supporting collaboration, knowledge sharing, and the identification of new circular business opportunities. Through this network, the Circular Ports pilot gains access to additional expertise, potential solution providers, and innovation-oriented actors that may support the development and scaling of circular solutions linked to port-related waste and material streams.

Within the Circular Ports project, HEIP plays an enabling and supporting role rather than being part of the formal pilot boundary. As defined earlier, the pilot area is limited to the Port of Norrköping's own operational activities. However, HEIP provides an essential surrounding context that increases the feasibility of circular solutions by offering proximity to relevant industrial, waste management, recycling, and energy actors. The close spatial and organisational connections between the port and HEIP reduce transport distances, lower transaction costs, and facilitate dialogue between stakeholders, all of which are critical factors for implementing circular economy initiatives in practice.

HEIP, through CleanTech Östergötland, contributes to the Circular Port's project in three main ways. First, it connects the port to relevant industrial, waste management, and recycling stakeholders that may act as receivers, processors, or users of port-generated waste and material streams. Second, they support the identification and development of new circular solutions together with the port, building on existing symbioses and exploring opportunities for higher-value resource use. Third, HEIP functions as a platform for knowledge sharing and inspiration, helping to disseminate lessons learned and stimulate broader circular economy thinking beyond the immediate pilot activities. In parallel, a master's thesis is being carried out in collaboration with HEIP in Norrköping, examining residual streams within the industrial symbiosis during the spring.

Renall

Renall AB is one of the port's key waste management partners and plays an important operational role in handling several of the waste streams generated within the Port of Norrköping. As an established and long-term actor in the port area, Renall provides collection, transport, and treatment services for both ship-generated and port-generated waste, giving them deep insight into the practical, logistical, and regulatory aspects of waste handling in a port environment. Their existing presence and technical expertise in waste management, circular solutions, and material logistics make them an important stakeholder for the next phase of the project. Renall's knowledge will support the assessment of circular opportunities related to excavated tunnel masses as well as the continued development of circular practices for other waste streams, particularly when evaluating handling challenges, transport conditions, and potential value-chain configurations.

Logistiska

Logistiska is a regional logistics network and development platform in Östergötland, bringing together companies, public actors, and research environments to strengthen the region's position as a sustainable and efficient logistics hub. The network connects stakeholders across transport, logistics, and infrastructure, and plays an important role in coordinating regional initiatives and facilitating knowledge exchange between industry and academia (Logistiska, n.d.). As the port is a central role in a logistics network, Logistiska serves as a valuable sounding board in the project, helping to contextualise the port's development within the broader transport system of Östergötland and supporting discussions related to logistics, transport planning, and future system implications.

Stakeholder workshops



Figure 7. Two different waste collection locations at the port. (Photos by Anna Skötte).

As part of the Circular Ports project, partners gathered for a two-day study visit and workshop series in the Port of Norrköping to deepen the understanding of local waste streams, identify circular opportunities, and explore collaboration potential with regional stakeholders.

The first day began with an introduction to the port by Port of Norrköping representatives, providing an overview of its operational structure, key industries, and current logistical dynamics. A guided tour through the port area offered participants the opportunity to observe waste flows firsthand, including both port-generated and ship-generated waste, and understand existing handling routines and challenges. This site visit laid the foundation for later discussions around circularity and R-level potential.

Representative of HEIP presented the history and ongoing development of the local industrial symbiosis network. HEIP's experience with circular flows, such as turning forestry by-products into soil, sparked valuable reflections on how similar synergies might be applied within port-related waste streams.

The second day focused on a structured workshop facilitated by RISE. Based on insights gained during the port tour, participants jointly assessed the port's main waste streams, exploring each flow's current management, circularity challenges, and potential for moving up the R-ladder. Additional discussions introduced the broader Circular Ports project framework and insights from the recent partner meeting in Aalborg, ensuring all stakeholders shared a common understanding of the project's objectives and progress. Logistiska contributed perspectives on the port's strategic role within wider material and transport systems, highlighting the importance of integrating logistics considerations into circular solution development.

Lessons learnt

The preparatory phase of the project has highlighted several important lessons regarding both the opportunities and limitations of circular economy implementation in the port environment. Most of the waste streams currently handled in the port are already being recycled, including oil-based waste, which is managed through well-established systems. The availability of detailed waste data was particularly valuable, as it enabled a structured mapping of material flows and provided a solid basis for identifying potential circular pathways. Furthermore, the strong collaboration between actors across the value chain, including waste contractors, industrial stakeholders, and partners within HEIP emerged as a key enabler. The involvement of the port's environmental manager throughout the preparatory phase has also been a significant asset, ensuring that practical challenges, regulatory considerations, and opportunities for piloting could be assessed early and realistically.

At the same time, several challenges have become apparent. Many of the identified waste streams generated within port operations are relatively small in volume, which limits the economic feasibility of developing new circular value chains without additional aggregation or external partners. In several cases, the current treatment methods already function efficiently, leaving limited incentives for actors to invest in alternative solutions. The port's geographical close distance to existing waste management and recycling facilities, while operationally convenient, also reduces the need to develop new local solutions, as current systems already provide effective handling at reasonable cost.

The preparatory work further showed that even when potentially interesting waste streams were identified, with good chances of being lifted in the R-hierarchy scale, such as wood waste or landfill materials, the combination of small volumes and economic or operational barriers made it difficult to at this stage identify a suitable pilot within the scope of the Circular Ports project. To identify a pilot requires that collaborative partners (e.g. an entrepreneur of circular products) are on board, and the small volumes limits the possibilities of the business case. Although the dialogues around how to increase circularity of these materials will continue (e.g. with the waste management partner Renall), it will not be the main focus of the further work in the Circular Ports project. Instead, it was identified that the potential future use of excavated tunnel masses as fill material in the port's upcoming quay expansion includes several relevant questions for the project to look further into as a pilot, especially in relation to how the regulations limit the circularity of the system.

A key challenge moving forward with the pilot of excavated tunnel masses will relate to the involvement of regulatory authorities and the permitting landscape associated with this selected pilot case. While stakeholder engagement within the local industrial ecosystem has so far been strong, the authorities most relevant for the forthcoming construction project, particularly those responsible for environmental permitting and oversight of materials placed in marine environments, have not yet been part of the project constellation. As the work transitions into the implementation phase of the Circular Ports project, close coordination with these actors will be essential to clarify regulatory requirements, assess environmental constraints such as limits on nitrogen content, and understand procedural implications for using excavated rock as quay fill material. These regulatory and administrative aspects are therefore expected to become a central challenge in the next phase, influencing both the feasibility and timeline of the pilot.



Next steps

The next phase will focus on developing the work related to the circular use of excavated tunnel masses from the East Link project for the Norrköping port's planned quay expansion. The upcoming work will include collecting relevant reference cases and best practices from similar initiatives and research, including insights from circular aggregate handling studies such as VTI's recent work on recycled materials (Eriksson et al. 2025). These references will help guide the technical direction of the pilot and identify proven methods for assessing material suitability.

To support this development, the project team will initiate meetings with key stakeholders, primarily the regulatory bodies (the county administrative board of Östergötland), the waste management company (Renall), and representatives from the East Link project (Swedish Transport Administration). These dialogues aim to clarify material characteristics, logistical conditions, handling requirements, and potential constraints that must be addressed when evaluating the feasibility of reusing excavated rock.

The next steps will also centre around a review of the regulatory frameworks governing the use of excavated materials in port construction. This involves mapping relevant permit requirements and understanding environmental criteria that may influence the quay expansion project design. In parallel, an exploration on whether a regulatory sandbox approach could support early testing and dialogue with authorities will be done, creating a structured environment for evaluating circular use of tunnel masses before full permit processes are initiated. This will help ensure that the quay expansion project is both feasible and aligned with regulatory expectations as it moves into its implementation phase.

Further, key performance indicators (KPIs) will be identified that will form the basis for evaluating environmental and economic outcomes of transport alternatives between the tunnel construction site and the port. As a comparison, the transport chain of alternative virgin material from other locations will be compared to this local solution. The team will establish appropriate calculation methods, tools, and system boundaries needed for assessing the different scenarios. This includes identifying specific cases to analyse, determining potential challenges, and developing the necessary input data for environmental and economic calculations. The consideration of additional environmental benefits, such as reduced use of virgin material may be important for communicating the pilot's value to decision-makers.

Complementary work will continue as well through a master's thesis in collaboration with Chalmers University of Technology and RISE, focusing on circular strategies for complex material flows. Insights from this work will feed into the broader methodology development and strengthen the project's capacity to evaluate waste streams beyond the main pilot case. As this thesis runs alongside the previously presented HEIP-related work, the two efforts are expected to complement each other and contribute mutually relevant knowledge to the project.

References

Eriksson, L., Fredriksson, A., Janné, M., Lundberg, K., Ivanetti, K., Sjöstrand, H., Kjellsdotter Ivert, L. (2025). What is circular aggregate handling? : A report on the functions and actors of the aggregate handling system, as well as problems and opportunities for more circular use of aggregates. Swedish National Road and Transport Research Institute, VTI report 1242. Online: <https://vti.diva-portal.org/smash/get/diva2:2003289/FULLTEXT01.pdf>

Händelö Eco-Industrial Park. (n.d.). *Händelö Eco-Industrial Park – English version*. Retrieved from <https://heip.se/en/>

Logistikia. (n.d.). *Logistikia – Östergötland's logistics cluster*. Retrived from <https://www.logistikia.se/>

Naturvårdsverket (2025) [Anmälning- och tillståndsplikt enligt miljöprövningsförordningen](https://www.naturvardsverket.se/vagledning-och-stod/miljobalken/anmalnings--och-tillstandsplikt-enligt-miljoprovningsforordningen/)

Norrköpings Hamn AB (2024). *Environmental Report 2024*. Retrieved from https://www.norrkopingshamn.se/wp-content/uploads/Miljorapport_2024-NHAB.pdf

Potting, J., Hekkert, M. P., Worrell, E., & Hanemaaijer, A. (2017). *Circular Economy: Measuring Innovation in the Product Chain*. (Planbureau voor de Leefomgeving; No. 2544). PBL Publishers. <http://www.pbl.nl/sites/default/files/cms/publicaties/pbl-2016-circular-economy-measuring-innovation-in-product-chains-2544.pdf>