CASE STUDY
UTILIZING WASTE TO CREATE NEW PORT LAND

L Astner, Port Authority Manager, Gävle Hamn AB; A Carpenter, Visiting Researcher, University of Leeds and External Consultant to Port of Gävle and University of Gävle; R Lozano, Professor, University of Gävle; K Sammalisto, Associate Professor, University of Gävle; Sweden

The Port of Gävle is located on the Baltic east coast of Sweden in the Gulf of Bothnia, which is circa 200km to the north of Stockholm. It is the largest container port on the east coast of Sweden and the third largest in Sweden. The Port of Gävle has eight terminals, serving chiefly the wood and steel industries, but also having bulk container and bulk liquid operations. There are around 1,000 ship dockings every year along 2,300 metres of quay, and the port handles nearly 6 million tonnes of freight annually.

This paper presents the most recent port expansion and the major dredging and land creation project that has been undertaken in the Port of Gävle since 2007. This project has seen the deepening and widening of the fairway to accommodate larger vessels, as well as the construction of a new cargo terminal area due to open in late 2019. This land creation work has been undertaken using contaminated sediments dredged from deepening the shipping channel.

LAND CREATION AND DEVELOPMENT COSTS

The port expansion project has, since 2006, created 390,000 metres squared (m2) of new land in three main areas. Two areas were created using stabilised contaminated sediments: the extended Fredriksskans area (60,000m2) and the extended Granudden area (94,000m2). These areas were created using the process of stabilisation and solidification. The third area was created using non-contaminated sediments and reused soils (236,000m2). It has been developed over a much longer period of time and is shallower, and not able to take the weight of large cranes.

A total of US$125 million was invested in the port between 2010 and 2015. The cost of dredging was $43 million, while the cost of material stabilisation for land creation was $17 million. Other activities relating to the port expansion included the creation of a new energy pier ($25 million), the building of stone walls, and improving road connections to the port. Between 2018 and 2019, $83.2 million of investment has been allocated for further port developments.

PORT EXPANSION PHASES

The initial phase of the expansion involved participation in a study, part-funded by the EU, into a process for stabilising contaminated dredged sediments. That study, Sustainable Management of Contaminated Sediments, took place between 2007 and 2013. A 2010 field test in the Port of Gävle created land behind 100m of new quay walls in the Granudden area of the port.

In order to create the new land, sediments were transported to shore, and then mixed in a machine to produce the material to fill in the area behind the new quay walls through the use of castings (pouring the material into a mould). Equipment was put in place on the new land to monitor water quality for heavy metal leakage, and to measure the solidity of the material.

Subsequently, during the field test, 250m2 of new quay was created at Grannuden using contaminated muds, together with binding substances, which were stabilised and solidified within the quay line. Taking into account work undertaken by a Swedish-Norwegian Consortium on the stabilisation and solidification of contaminated sediments the port developed a blend of binding substances including a combination of cement, fly ash from a local energy producer, and Merit 5000 (slag from a local steelworks; also known as MEROX) which created solid land capable of supporting port operations, containers and other machinery, while also containing any contaminants so that they are not leached into the marine environment. Preparatory work took place between 2010 and 2012, with 400,000 million tonnes of stone and gravel used for the quay walls at Fredriksskans, sourced from an undeveloped land area adjacent to the port.

The full-scale expansion project took place between 2012 and 2014. The Port Authority calculated that around 4 million m3 of dredged sediments would need to be removed within the dredging area of which approximately one quarter was expected to be contaminated with substances including heavy metals and polyaromatic hydrocarbons (PAHs) at levels above standards accepted by the Swedish Environmental Protection Agency.

These polluted sediments were located mainly within the top 0.5m layer which consisted mostly of loosely compacted materials and clays, with a water content of around 85-90%. Ultimately, 4.2 million m3 of dredged sediments were removed from around 8-10 km of the fairway- 600,000 m3 of which were contaminated sediments. The remaining material (around 3.6 million m3 of material from below the 0.5m sediment boundary) was disposed of in an area north of Holmudden, a tipping area well away from the main shipping channel.

CONTAMINATED SEDIMENT AS A RESOURCE

Dredged material has been used for building new land in a number of cases (e.g. the expansion of Harwich Haven); however, in the majority of cases the dredged material has been non-contaminated. In the case of

the Port of Gävle, to dispose of a million m3 of contaminated sediments would have required transportation to a distant handling facility with high environmental impact and exorbitant transport costs.

RESULTS OF THE EXPANSION PROJECT

As a result of the full-scale project more than 390,000m2 of new land was created overall. Of this, more than 154,000m2 was created using process stabilization, making it one of the largest stabilisation and solidification projects using binders other than concrete. The method of process stabilisation, using a mixing machine (hence process) rather than mass stabilisation (with excavators combining binders into a basin of sediments) was also new and innovative. Once created, the land was left to settle for two years before it could accommodate heavy machinery.

A new container terminal is being constructed in the Fredriksskans area of the port, expanding that area and doubling its capacity to 600,000 TEU. That new container terminal area will be open for vessel traffic toward late 2019 and the ground was created using stabilised and solidified materials and measures 60,000m2. The contiguous area was created using non-contaminated sediments and reused soil, and measures 236,000 m2.

The Granudden terminal within the port is also being developed on new land and is similar in size to the new container terminal. The quay length has been doubled from the original 350m to 700m in total. The total length of future new quays that will be constructed alongside the two areas created using stabilized sediments will be approximately 800m.

The terminal areas are now accessible to much larger vessels than was previously possible. Prior to dredging, the fairway had a depth of 10.8m and was, at its narrowest point, approximately 60m wide. The new fairway depth is 13.5m and is 126m at its narrowest point. Prior to dredging the fairway could accommodate vessels measuring 220m length, 30m wide (beam) and 10.1m depth (draught). The dimensions post-dredging are 24m x 45m x 12.2m, respectively.

ENVIRONMENTAL BENEFITS

The Port of Gävle has reduced the requirement for new materials. If constructed in a more traditional way, the new land areas would have needed large quantities of rock and gravel. Combining dredged contaminated sediments with waste from other industrial processes (fly ash from an energy company and merit from a local steel company) has created a new resource from waste. Contaminated material from the marine environment was rendered non-hazardous through the stabilisation and solidification process. Additionally, the project minimized the requirement for transportation associated with the expansion works.

The reduction of emissions from road transport, a reduction in the use of new materials, and the use (reuse) of waste materials from other industrial sectors (energy and steel) can foster the sustainable expansion of ports.