The idea of a modern maritime access route from the Baltic Sea to the Port of Szczecin in Poland was already born towards the end of 20th century. Quay walls in the neighbouring Port of Police, built in the 80s, were already constructed to accommodate a depth of 12.5 metres and initial modernisation works commenced in the early 90s. On 28 September 2018 the “Modernisation of the Świnoujście – Szczecin Fairway to a depth of 12.5 m” became a reality with the signing of the design and build contract between the Maritime Office Szczecin and the DIVO consortium (Dredging International NV and Van Oord).

The fairway connects the two Polish ports of Szczecin and Świnoujście with the Baltic Sea. With its new dimension to a depth of 12.5 metres, it enables an effective marine transport of all types of goods from and to both cities and further, via well-established hinterland connections to the western part of Poland, Czech Republic and Slovakia.

The entire project area had been the location of intense fighting and bombing during the Second World War, which on its own, in order to guarantee the safe execution of the dredging works, proved to be a vast undertaking. However, despite this anticipated challenge as well as some exceptional events, such as working during a pandemic (COVID-19) and a difficult period of cold and ice, the ambitious project was completed on time and was handed over to the Maritime Office in Szczecin in the spring of 2022.

Design and engineering

The project was executed in a design and construct format, encompassing a wide array of design tasks, such as the fairway dredge design, two artificial islands with jetties, rock revetments, sheet piling, cable alterations, navigational aids and the implementation of a hydrometeo and Real Time Kinematic (RTK) system.

Design work in Poland is strictly regulated, permitting only certified designers to endorse design documentation. To handle the diverse range of design tasks and adhere to Polish design regulations, a consortium of Polish and Belgium design consultants was engaged. The design consortium together with designers of both dredging contractors worked closely to complete the design.

The fairway remained open for other vessels during the marine works. This required special attention to ensure safe dredging operations, taking into account the dredging fleet deployed without posing an obstruction to vessels calling at port. Nautical studies were performed, creating a framework of safe passing manoeuvres for other vessels during different dredging operations (dredging, sailing loaded and sailing empty). The nautical study along with clear communication with Vessel Traffic Services (VTS) and local pilots ensured safe vessel procedures and minimised delays in the dredging operations.
The dredged material was used to create two artificial islands, with diameters of approximately 1.25 kilometres and 1.8 kilometres respectively. In the north is a nature island with no infrastructure other than a jetty required to access the island for inspections. The southern ‘doughnut-shaped’ island will serve as a reclamation area for future maintenance dredging on the fairway. Both artificial islands are located within the Szczecin Lagoon. The original level at the island locations was about -5 to -6 metres. Soil investigation campaigns revealed soft soil layers greatly influenced the design and construction of the artificial islands. A rubble mound embankment varied based on the local subsoil conditions. The presence of these soft soil layers greatly influenced the design and construction of the artificial islands. A rubble mound embankment proved to be unstable. Therefore, the design was adopted to ensure geotechnical stability of the works and optimise the volume of rock required for construction. The first step in the island construction was the installation of the sand foundation. The elevation of the foundation layer varies from -2 to -3 metres, depending on the hydraulic loading by waves after the island’s completion. The foundation layers were installed by means of a spreader pontoon and followed by a consolidation period. The duration of the consolidation period varied based on the local subsoil conditions. During the second construction step, a sand bund was created reaching above water. Once dryland was formed, Cone Penetration Tests (CPT’s) were performed. Over a hundred CPT’s were conducted on both artificial islands to confirm soil models used for calculating consolidation periods and to determine the degree of consolidation of the soft soil layers. Based on the CPT data, a second consolidation period was determined for every location along the island to ensure sufficient consolidation of the soft soil layer and increase the strength, enabling a safe rising of the reclamation levels to the design levels, up to +5 metres.

The construction sequencing of both islands determined the geotechnical stability and associated consolidation periods, is visualised with four satellite images shown in Figures 1A-D. Figure 1A, taken in October 2020, shows the submerged sand foundation layer at both islands. On the southern island, the western sector of the island was constructed above water first, since this part of the island required the longest consolidation period between the first and second above water reclamation step. At the northern island, the above water operations commenced. Figure 1B, dated February 2021, shows the first step of the above water reclamation works performed along the entire perimeter in the north. The status of the southern island remained unchanged compared to the first step. The picture shows ice covering the entire lagoon, which resulted in short interruption of the reclamation works. Figure 1C, April 2021, shows the progress on the above water works in the south. And the fourth image (Figure 1D) shows the artificial islands at the time of hand-over to the client in May 2022.

The newly designed fairway with its increased dimensions, resulted in interfaces with the existing shoreline at a number of locations. At most locations no infrastructure was present, enabling the design of a small land cut with natural slopes. In the southern, more built-up area of the project, a number of interfaces with existing structures occurred. At four locations, the distance to existing quay walls was too limited to apply unprotected slopes, since these would affect the stability of the existing quay walls. At two locations, the fairway slope was reinforced with a revetment and at the other two locations, a combination of underwater sheet piles and a revetment was required to ensure the stability of the existing structures without reducing the navigational depth at the quay. Furthermore, the project’s impact on the flow of water from Przekop Mielenski into Lake Dąbie needed to be minimised in order to preserve unchanged environmental conditions in Lake Dąbie. The lake entrance is a narrow section of the fairway, thereby eliminating the possibility for natural slopes since these would widen the lake entrance. Both headlands adjacent to the lake entrance needed to be secured. At the southern headland a revetment solution was designed. Since the width of the northern headland was too small to apply a revetment solution, a sheet pile structure was designed as a combination of a sheet pile with ground anchors and a cofferdam. The fairway modernisation also included an upgrade of the navigational aids, requiring the need to design buoys, navigation lights on structures on land and the banks of the fairway. In total, six monopile structures were designed within the fairway banks to support navigation lights, taking into account that winter periods with ice cover are common in the fairway. A design ice thickness of 0.35 to 0.8 metres depending on the location on the fairway proved to be the normative design load for these structures. Therefore, monopiles with a diameter of 1.0 to 1.4 metres were designed at the various locations.

Preparation works
The existing Świnnjście – Szczecin Fairway was subject to various aerial bombings, artillery mining and other war related activities during the Second World War. Therefore, prior to the deepening and widening of the existing fairway an extensive UXO investigation and removal campaign was executed to enable safe dredging and reclamation activities. This scope of works turned out to be a project itself within the project.

UXO investigation and removal campaign
Before actual commencement of the dredging and reclamation works, the working area had to be cleansed from hazardous objects to enable safe execution of dredging and all other marine related activities of the project. UXO presence along the existing fairway was considered a potential threat to:
- the workforce employed on board the various vessels and on the reclamation areas;
- main dredging equipment and auxiliary vessels to perform the dredging and reclamation works; and
- the marine construction works to be executed as part of the contracted project scope (i.e. cable removal and installation works, sheet and jetty piles and rock installation works).

UXO History working area
Based on historical research of the intensive war activities, the project area (with a total length over 60 kilometres) between Świnnjście and Szczecin was divided into three specific “UXO areas”:
- Świnnjście area
- During the period between 1942 and 1945 the northern section of the existing fairway was...
subject to various bombing and air defence of Świnoujście and British aerial mining of the waterways. Moreover, on 16 April 1945 the Royal Air Force executed an aerial attack on the German battleship “Lützow”, stationed near Kasibor.

Within the northern part of the fairway, the UXO investigation and removal campaign focussed on the following expectations:

- High Explosive Fragmentation bombs up to 12,000 lbs;
- ground mines;
- artillery up to 300 mm; and
- munitions dumping.

Police area

Expected UXO’s with the middle section of the existing fairway mainly had to do with the presence of a synthetic fuel factory, which became a target of the aerial raids. Between 1944 and 1945, repeated aerial bombing by the 8th United States Army Air Forces (USAAF) took place. Along with the bombing activities, this resulted in various planes being lost on 7 October 1944. These aerial bombing raids triggered an defence of the aforementioned factory, meaning there was potentially another source of UXO’s within the project area.

Furthermore, throughout the period between 1942 and 1945 British forces executed aerial mining operations of the Polish waterways. Therefore, within this section of the fairway the campaign focussed on the following UXO’s to be expected:

- High Explosive Fragmentation bombs up to 2,000 lbs;
- artillery shells up to 155mm calibre; and
- ground mines.

Szczecin area

Similar to the aforementioned sections, between 1942 and 1945, the southern section of the fairway around the city of Szczecin experienced mining performed by the British Army and aerial bombing. Furthermore, artillery barrages, tactical bombing by the Soviets and amphibious assaults by the Soviet forces over the Odra river (the German and Polish name for the existing fairway) were recorded.

For the southern section of the fairway, the campaign focussed on the expectation of the following UXO’s:

- bombs up to (1,000 kg);
- U.K. and German (aluminium) ground mines; and
- artillery up to 203 mm.

Specific challenges

The historical research concerned the main ‘foundation’ for the investigation and removal campaign. Second “pillar” concerned the requirements and parameters under the main contract. Especially in the Szczecin region where various shipyards do exist and extensive port activities take place, clustered areas of ferrous objects could be expected on the fairway bottom. All in all this resulted in an extensive campaign within an active fairway.

UXO approach

As part of the preparations of the investigation and removal works the following approach was taken:

1. Research of historic events to identify expected UXO’s in areas.

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2. Project specific UXO Risk Assessment (LPA)
   - Evaluate risk to crew and equipment per activity and assess the impact.
   - Trailer suction hopper dredger/cutter suction dredger/backhoe dredger.
   - Cable removal and installation works/sheep and jetty piles installation/offshore installation.
3. Evaluate site conditions (water depth, soils morphology) to determine penetration depths.
4. Define threshold values.
5. Produce Master Target List (MTL)

The Master Target List(s) concerned the main output of the investigation campaign and the starting point for the clearance works.

Investigation and preparation
To obtain the required Master Target List (MTL) as part of the UXO investigation works, a large-scale survey campaign took place. This campaign covered the full footprint of the existing fairway between Świnoujście and Szczecin, with ferrous objects tackled in a two-phase approach. After approaching and removal of the initial number of targets on the Master Target List, a second survey by means of magnetometer was performed and the remainder of ferrous objects removed.

Overall, an astonishing 1,800 unexploded ordnances and war-related objects were removed as part of the removal campaign.

Mitigation measures during dredging

Upon completion of the clearance works a third-party UXO clearance certificate for the various fairway sections was obtained. To cater for any potential threat, which would have been undiscovered by the extensive clearance campaign, some further additional mitigation measures were implemented throughout the deepening and widening of the fairway.

Among others, this included:
- UXO awareness training for both staff and crew directly involved in the dredging campaign;
- a bomb grid in the drag head of each trailing suction hopper dredger employed;
- 24/7 third-party EOD presence and supervision on board of the main dredging equipment; and
- UXO storage containers on board of the main dredging equipment to store any UXO’s encountered.

One of the third-party UXO experts described the campaign as “likely the most comprehensive and largest UXO clearance project ever realised in inland waterways”. It can be concluded that the dredging and reclamation activities and other related works scopes have been executed in an environment without any potential UXO threat to the workforce and equipment employed.

Dredging and reclamation

The dredging works within the project area were spread over a channel length of approximately 62 kilometres and took place over a period of two years (Q2 2020 to Q2 2022).

TSHD Scheldt River, Meuse River and Vox Amalia, as well as CSD Amazone and Spreader barge HAM 1208 were among other auxiliaries deployed to dredge and reclaim approximately 24.5 million m³. All of the dredged material was reclaimed with two artificial islands in the middle of the Szczecin Lagoon and most of the material was pumped hydraulically from the fairway to the islands by use of pipelines.

At the island of Ostrow Gabrowski in the Port of Szczecin, a new turning circle to accommodate the larger vessels was also envisioned. This involved the removal and capital dredging of the existing headland by grab, bucket and backhoe dredger. All material was transported with barges and dumped inside of one of the islands.

Challenges

Although the dredging and reclamation scope within the project might have seemed straightforward, there were several challenging elements to overcome. COVID-19 pandemic: The COVID-19 pandemic that began in March 2020 couldn’t have come at a worse time since the pandemic on operations was limited.
- Active fairway: Although it was known during the preparation phase that the fairway would remain active during the entire dredging campaign, the coordination including daily PCR testing, no visitors on board the vessels, crew traveling in “bubbles”, etc. As a result, the impact of the pandemic on operations was limited.

24/7 third-party EOD presence and supervision on board of the main dredging equipment; and
- UXO storage containers on board of the main dredging equipment to store any UXO’s encountered.

FIGURE 15

Combined overview magnetometer results.

FIGURE 16

Master area showing the extensive amount of objects in the city of Szczecin.

FIGURE 17

Impression of UXO findings in fairway removal campaign.

FIGURE 18


FIGURE 19

Impression of UXO findings in fairway removal campaign.

FIGURE 20

Impression of UXO findings in fairway removal campaign.
New habit for flora and fauna on the northern island.

The entire dredging volume was used for the establishment of two artificial islands, which represents a very sustainable and environmentally advantageous concept. This solution was developed by the initiators of the fairway project from the start.

Additionally, in striving to go a step beyond the formal requirements, the joint venture looked for possibilities to do better, promoting ‘green initiatives’ focusing on using sustainable resources to limit the impact of the works as much as possible. Some of the implemented measures included:

- Greenery design: on the island envisioned as a bird habitat, a greenery design was made as nature compensation (planting of tree, shrubs, etc.), including the creation of an inland lake. Even during the works, the island already proved very attractive as a bird habitat, to the extent that part of the works had to be replanned or scheduled to fence off areas where birds had started to nest.

- Logistics hub: the small port and marina of Trzebież was used as a site office and as a bird habitat, a greenery design was made as nature compensation (planting of tree, shrubs, etc.), including the creation of an inland lake. Even during the works, the island already proved very attractive as a bird habitat, to the extent that part of the works had to be replanned or scheduled to fence off areas where birds had started to nest.

- Use of LNG as fuel: TSHD Scheldt River is an innovative dual fuel tugging suction hopper dredger that executed a large part of the documentation works in cooperation with the Maritime Office in Szczecin. The first LNG burning of a dredging vessel in Polish waters was completed in Port of Szczecin 2020.

- Bunkering within the lagoon: to avoid the mobilisation of CSD Amazone from the dredging area in the centre of the Szczecin Lagoon to the nearest port, a procedure was developed that allowed bunkering next to the fairway.

- Fish spawning and water quality monitoring: an ichthyologist was hired by the project to monitor the fish spawning in the lagoon and river. Continuous sampling was done to monitor the situation.

- Spreader HAM120B: during the under water bund construction of both islands, a dedicated spreader pontoon was used by both CSDs and TSHDs to limit any sludge plume within the lagoon.

- Reclamation equipment: hybrid Caterpillar D6 bulldozers were deployed to reduce the fuel consumption of the dry earth moving equipment.

- Water usage: instead of laying potable water from the shore to both islands for the reclamation crew, pumps and filters were installed so the water from the lagoon could be used for sanitary purposes.

Other construction works

In addition to the above mentioned works, there were many other auxiliary scopes that were executed under the contract. Although proportionally smaller in size, they were at times very complicated and thus created their own challenges which, with the help of local subcontractors who shared their local know how and expertise, had to be addressed.

Cables installation and removal

As part of the full project scope of works, at various locations along the fairway inactive cables crossing the fairway near Szczecin harbour had to be removed.

Furthermore, due to the deepening and widening of the fairway, the existing Vessel Traffic Services (VTS) cable had to be partly removed and reinstated, all while maintaining this important communication method for active shipping traffic. One of the installation techniques used alongside Danab Island was HDD – Horizontal Directional Drilling. Table 1 shows the exemplary lengths of VTS cables used for the works.

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Sheet piling

As mentioned under the design, in order to protect existing structures from the deepening works, sheet pile walls had to be installed along the fairway near the city of Szczecin at the berths of Bon, Zeglarzkie, and Radzin. At Bon and Zeglarzkie, sheet piles were driven into the bottom of the fairway and backfilling works behind the new sheet pile wall were executed to provide protection. At Radzin (in protection of the fairway section) sheet piles were driven into the bottom of the fairway.

Navigational aids

Various navigational aids related works were part of the full project scope of works. This included:

- removal of an existing beacon and supply and installation of a new beacon at the Ostrow Gabrowski peninsula;
- removal of existing dolphins and installation of new dolphins as a result of the widening of the fairway at some locations;
- supply and installation of shore lights along the fairway at Radzin and Wałka Hapa islands;
- supply and installation of navigational aids at the jetty structures on the artificial islands;
- supply of buoys for the widening of the fairway at the Szczecin lagoon and around the artificial islands; and
- renovation of the power supply at Gate IV of the fairway.

Conclusions

The dredging and reclamation scope of the project was one of the biggest capital dredging projects within Europe over the past 20 years.
The combination of the largest UXO investigation and removal campaign, the creation of two islands (approx. 3 kilometres and approx. 8 kilometres from the nearest shore), the onset of COVID-19 and a harsh winter created exceptional challenges that the project team had to overcome.

The joint venture succeeded in building the two islands within Szczecin lagoon and deepen the fairway between Świnoujście and Szczecin to -12.5 metres within three years. This was accomplished by great teamwork between DEME and Van Oord and an excellent cooperation with the client – the Maritime Office in Szczecin.

The modernisation of the fairway from Świnoujście to Szczecin takes the project team had to overcome. The deepening of the Świnoujście - Szczecin Fairway project for DIVO. Currently Benny is working as Programme Manager for the Darsena Europa port expansion project in Livorno, Italy.

The idea of the founders of this groundbreaking project therefore became reality in two senses, being both a win for the economy and a win for nature. The deepening of the Świnoujście - Szczecin Fairways one of the most important dredging projects in Poland’s history. Providing access from the Baltic Sea, the fairway runs between the city of Świnoujście and the Port of Szczecin.

The modernisation of the fairway from Świnoujście to Szczecin takes the performance of this waterway to the next level and ensures environmentally friendly, effective transport of goods to the hinterland of Western Pomerania and further south for years to come. With the reuse of the dredged soil as building material for the two artificial islands in the Szczecin lagoon, the gentle and careful integration of the existing bank structures into the new infrastructure and the cleaning of the canal from polluting residues from the last century, the principles of sustainability were followed in an exemplary manner and excellent ecological accounts set.

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Summary

The deepening of the Świnoujście - Szczecin Fairways one of the most important dredging projects in Poland’s history. Providing access from the Baltic Sea, the fairway runs between the city of Świnoujście and the Port of Szczecin. With more approximately 24 million m³ of material dredged, the channel was deepened by 2 metres to -12.5 metres, enabling the port of Szczecin to handle the next generation of vessels. Despite exceptional challenges, including carrying out most of the work during the pandemic and the presence of large amounts of unexploded ordnance, as well as thick ice in winter, the ambitious project was completed on time, highlighting the tremendous efforts of the JV team, and was handed over to the Maritime Office in Szczecin in the spring of 2022.

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