CASE STUDY

Transformation of Wastewater Impoundment into Yingcheng Reservoir at Sino-Singapore Tianjin Eco-City

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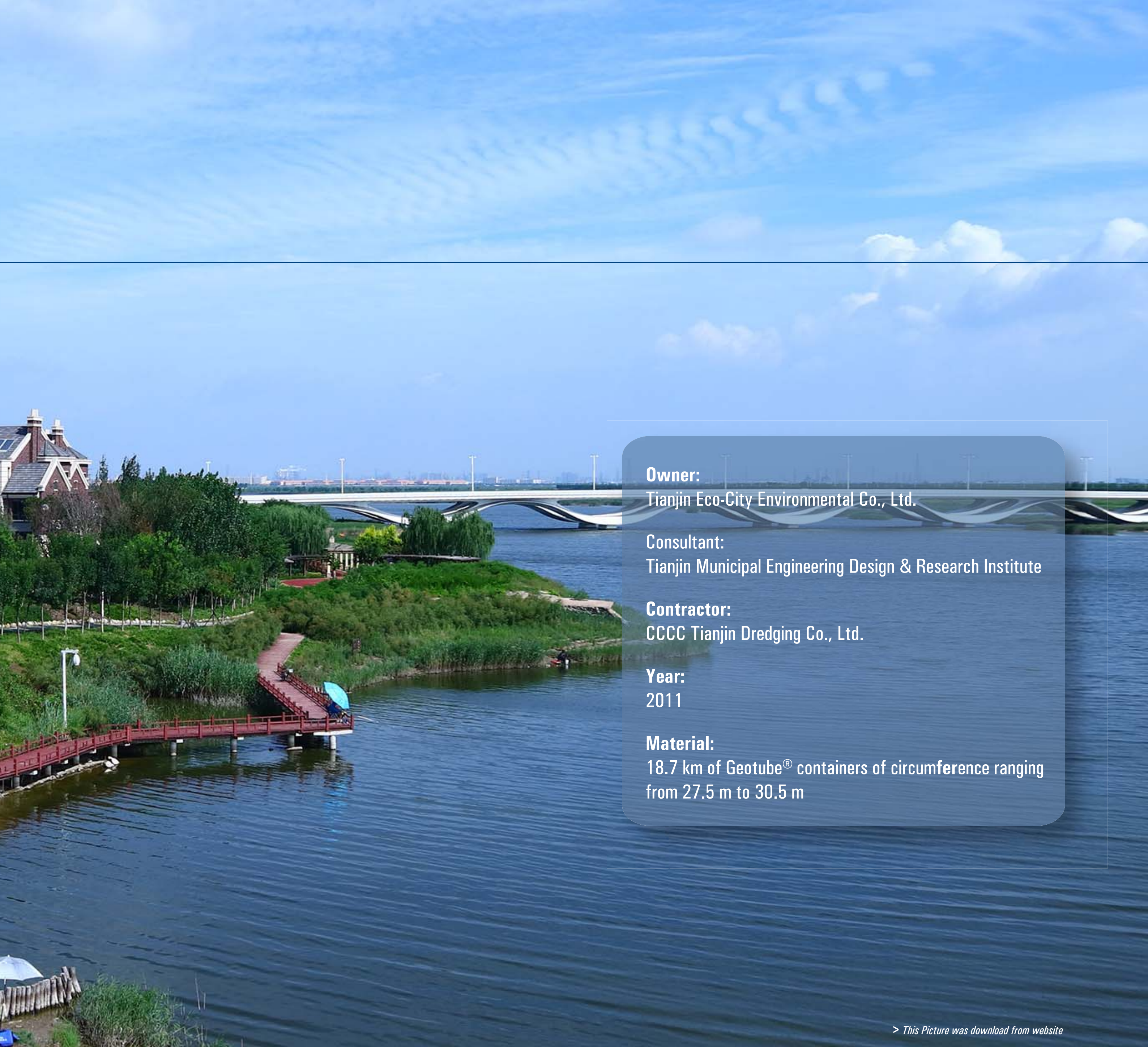
Catching World Attention

This project caught world attention in 2011. The New York Times (Sept. 28, 2011) article on “China’s City of the Future Rises on a Wasteland” quoted as follows: “Three years ago, this coastal area fit perfectly into the dictionary definition for wasteland. Its soil was too salty to grow crops. It was polluted enough to scare away potential residents. Sometimes the few fishermen who lived here saw investors driving in, but quickly turned around and left, leaving nothing behind except dust. But then some people showed up to buy a piece of this land. It is about half the size of Manhattan. They restored the soil, cleaned up water pollution and began preparing the once-deserted place for a city that will host green businesses and some 350,000 residents by 2020.”



Project Background

Tianjin Eco-City in China is a 30-square-kilometer modern township project under joint development by the governments of Singapore and China. Located 40 km from Tianjin, 150 km Southeast of Beijing in Northeast China, the project is scheduled to build 100,000 sustainable homes for 350,000 residents by the time the entire project is completed around 2020.

Tianjin Eco-City will use sustainable technologies, such as solar and wind power, plus innovative wastewater treatment and ecologically friendly with existing wetlands and biodiversity preserved or improved. Tianjin Eco-City's vision is to be a thriving city which is socially harmonious, environmentally-friendly and resource efficient. The development aims to improve the living environment and to build an eco-culture that will serve as a role model for future developments in China.

The Wastewater Impoundment and Cleanup Plan

In early 1976 the Hangu District Council converted a low lying area into a wastewater impoundment lake. The wastewater lake was created by the construction of a m³ high perimeter earth dyke. The lake covers an area of about 3.0 km² with an impoundment capacity of 5.6 million m³. From mid-1976 this wastewater impoundment lake began receiving untreated domestic and industrial wastewater from Hangu District, pumped in through underground pipes. The water and sediments are contaminated with mercury, arsenic, copper, cadmium, hexachlorobenzene and DDT along with high levels of raw sewage.

Integral to the development of Tianjin Eco-City is the plan to remediate the wastewater impoundment lake. The project to turn the wastewater impoundment area into an ecologically friendly reservoir lake was projected to cost USD 230 million. A total of about 5 million m³ of contaminated sediments required to be dredged and disposed of as part of the lake remediation programme. The contaminated water would be treated at the proposed water treatment plant for Tianjin Eco-City to be built beside the impoundment lake.

The Geotube® Dewatering and Containment Solution

Geotube® dewatering containers were used to contain the dredged slurry and dewater the material to a consistency similar to compacted borrowed material to form a mound on a reclaimed area along the shoreline. This was deemed the most attractive solution as the dredged contaminated sediments are put to beneficial use. Figure 1 shows the Geotube® filling, dewatering and consolidation processes.

> Figure 1. The Geotube® Dewatering Process.

Trials to Validate the Geotube® Solution

A series of tests were performed to determine the ideal choice of dewatering fabric and chemical accelerant. This was followed with a full-scale prototype test to fully assess the performance of the dewatering tube system and to arrive at accurate design parameters. The full-scale prototype test confirmed the effectiveness of the Geotube® dewatering technology and its ability to manage huge quantity of dredged contaminated sediments within a short period of time.

The Geotube® Dewatering Operations

Three dredges with a combined pumping capacity of 3,000 m^3/h were deployed for the supply of sediment slurry to the dewatering platform. Effectively the pumping averaged between 1,500 and 2,000 m^3/h. The sediment slurry was supplied by a floating pipeline across the surface of the impoundment lake that was then connected into an onshore pipeline network. Tap off steel pipe outlets of 160 mm diameter with gate control valves were positioned in sets of six at convenient locations along the onshore incoming slurry pipelines. Generally, at any time six tubes were filled simultaneously, keeping the filling rate at between 250 and 300 m^3/h.

When these tubes were filled to the control height, the control valves were shut while sediment slurry was diverted to the adjacent battery of six tubes laid out ahead of time. When the filled tubes had dewatered for some time and reduced in height, they were filled again to the control height. This repeated filling and dewatering was controlled by the adjustment of the manifold valve system until the target solids concentration of 50% in the tube was achieved. Once this was achieved, the next layer of tubes was then deployed(see Figure 2).

The process was then repeated until completion of dewatering. Geotube® dewatering works began in May 2010 and was completed by end October 2010.

The Geotube® Dewatering Platform

The dewatering tube facility for the treatment of the contaminated sediments was located on a site reclaimed from the Western side of the impoundment lake. The reclaimed area approximates 120,000 m^2 with a maximum length about 760 m and a maximum width about 230 m. The

> Figure 2. The Geotube® Dewatering Platform .

dewatering facility was designed according to the principles of a landfill; having a geomembrane liner for liquid isolation and a drainage system above this liner for drainage, collection, and removal of the effluent water. Earthfill was placed above the top geotextile reinforcement layer and compacted to form the base for the laying of the HDPE geomembrane liner. Above the geomembrane liner a nonwoven geotextile cushion layer was laid before drainage aggregate was placed on top. The Geotube® dewatering platform was constructed in early 2010.

Effluent and Lake Water Treatment

Five water pump units, each with pumping capacity of 350m³/h, situated at five sump locations, were used to pump the effluent water discharged from the dewatering tubes back into the impoundment. The water in the impoundment area was extracted and treated at the new water treatment plant.

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The Eco-Transformation Works

> Figure 3. The Geotube® mound eventually turned into recreational parkland.

Once the tubes had dewatered, general soil fill was used to cover over the geotextile tubes and form a smooth, graded surface for the mound core. The final capping consisted of a HDPE geomembrane liner laid over the prepared soil surface with a soil cover placed on top of the geomembrane liner. The capping layer for the Geotube® containers was placed around mid-2011. When the impoundment area was pumped fully dry, earthworks were carried out to reshape the lake. Following that, the new lake was re-impounded with clean water. The Geotube® mound would eventually be landscaped and turned into recreational parkland (see Figure 3).

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