THE CONCOURSE STORAGE TANK

David Shepherd BSC(Hons), CEng, MICE(UK) - Watercare Services Ltd.

ABSTRACT

The Concourse storage tank provides 13,000m3 of wastewater storage which reduces overflows from Watercare's Western Pump Station to the level permitted under the Auckland Air, Land and Water Plan.

Procurement of the tank was via a FIDIC design-build contract awarded to Brian Perry Ltd, with Beca as their designer. The design-build approach allowed the contractor to optimise the tank shape, aspect ratio and construction techniques to best suit their resources and capabilities and hence provide the best value for the project. The design-build approach reduced the overall completion time by streamlining the transfer from design to implementation as parts of the work could be approved and implemented earlier in the programme and other elements such as electrical and control system design could be completed during the construction phase.

This paper outlines the technical challenges, the design solutions developed and innovative construction techniques used to construct the tank. The main tank was constructed using 'double-tee' precast concrete sections, whilst the inlet pumping station was constructed as a caisson and sunk into the ground. The tank has an automatic cleaning system that uses a series of Steinhardt flushing gates that are released in sequence to scour the tank floor.

KEYWORDS

Wastewater Storage Tank Design-build

1 INTRODUCTION

The Auckland Regional Council, through the Air, Land and Water Plan set the minimum acceptable level of wastewater overflows at two events per discharge per year with a volume not exceeding 1,000m^3 throughout the region.

Overflows from the Western (DPS044) pump station exceed this standard and were unlikely to be consented without mitigation works. The Concourse storage tank provides 13,000m3 of storage capacity, which results in reduced overflows from the Western pump station to the level permitted under the Air, Land and Water Plan.

2 PROJECT APPROACH

2.1 BACKGROUND

Watercare's Western pump station is situated at the head of the Western Interceptor Sewer, which receives wastewater flows from a large catchment to the west of Auckland. Historically the Western pump station overflowed into Henderson Creek approximately 7 times per year during wet weather events. The frequency and volume of overflow events was forecast to steadily increase as a result of the significant growth planned in the Northern Regional Strategic Growth Area (NORSGA) unless additional trunk sewer capacity or overflow mitigation was provided.

Following a major joint planning initiative with Watercare and Ecowater the Waitakere Wastewater Master Plan was finalised in 2006. This plan identified a storage facility located at The Concourse, Henderson as the optimal option to reduce the occurrence of overflows in the western area network.

Detailed investigation considered seven sub-options for providing a storage facility and concluded that an offline storage tank of 13,000m^3 should be constructed. The design target for the Concourse storage tank, Western pump station and the surrounding network is for less than 10 overflows in 5 years.

2.2 PROCUREMENT

In 2009 a procurement plan for the project was prepared and due to the nature of the project it was assessed that a design-build process had the potential for significant savings to Watercare. As a result, during the process of preparing the 'User Requirements' for the contract, the assumptions made during the planning stage were challenged (i.e. that the tank had to be below ground) and hence both below and above ground tank options were included in the tender documents.

The greater scope there is for alternative designs and construction methodologies leading to innovative solutions and better value for money, the more attractive design-build projects are to Contractors / Consultants and clients. For this project the performance requirements for the storage tank were specified in Watercare's 'User Requirements' but they still left significant room for innovation in the tank design and construction methodologies.

The design-build process allowed each contractor tendering for the project to optimise the tank shape, aspect ratio and construction technique to best suit their company resources and capabilities and thus provide the most economic solution for the project. The design-build approach also reduced the overall completion time by streamlining the transfer from design to implementation. Parts of the work were approved and implemented earlier in the programme whilst other elements such as electrical and control system design were completed during the initial construction phase.

While the design-build approach resulted in higher risks to Watercare associated with the exact detail design of the storage tank these risks were managed through the performance specification and the Notice of 'No Objection' process for all design work. The design-build approach also minimised the risks to Watercare associated with design errors or omissions which could have led to contractual claims and thus ultimately provided the best value for money for Watercare for this project.

2.3 DESIGN

Following a competitive tendering process where a shortlist of three pre-qualified contractors bid for the project, the contract was awarded to Brian Perry Civil in June 2010.

Contract awarded under a FIDIC Yellow Book Design-Build construction contract with Brian Perry Civil using Beca as their design consultants.

The 'User Requirements called for a seismic resistance importance level 3 under AS/NZS 1170:2002 – i.e. equivalent to a return period of 1 in 500 years and a tank water tightness of class 2.

Brian Perry's tender proposal was for an above ground tank with a pumped inflow and gravity outflow. The above ground tank minimized excavation of low-quality material (and expensive disposal), reduced nuisance on site, and meant the only deep excavation on site was for the inlet pumping station which had a relatively small footprint. Storage tank is constructed of precast 'double-tee' sections linked together with in-situ concrete strips. The double-tee sections provide an economic wall section and also introduce an architectural feature along what would otherwise have been blank walls. The ribs, along with the resultant shadow lines help break down the visual mass of the structure.

The tank is approximately 30m wide by 50m long and is split internally into 6 lanes that are each 5m wide. At the head of each lane is a chamber controlled by a Steinhardt flushing gate that receives the first volumes of sewage to enter the tank and stores it ready for flushing. Once the chambers are full, the sewage overflows into the main tank. The lanes have a 2% longitudinal gradient to promote flushing efficiency. At the end of the lanes is a flushing sump, which is sized to take the flushing volume from each lane in turn. When the tank is empty each lane of the floor is flushed sequentially.

Access into the tank for maintenance is provided via a 'submarine' door in the side tank. This provides ground level access which simplifies procedures for tank entry when necessary to maintain the flushing gates.

The inlet pumping station discharges into four fixed-head risers into a high level inlet manifold pipe. This simplifies the pumping regime, removed the need for large diameter reflux and isolation valves, and reduced operational risk.

Value Engineering during the design process resulted in a number of significant project savings. Following value engineering workshops held with Watercare, contractor and designer stakeholders, a number of 'User Requirements' were removed or modified resulting in cost savings. These included the following:

- the requirement for stairway access to the tank roof was removed. This was replaced with a ladder, mid-level platform, fall arrest system etc. The reason for this change was that as a function of the design, infrequent access was required to the roof area to check on level control instrumentation.

- the requirement for a permanent standby generator was removed. This was replaced with the provision of a hardstanding space and a connection point for a mobile generator. Reason for this change was that the frequency of power supply failure in the area was low and the risk of this occurring during the time when the facility was required to fill was considered to be very low and hence acceptable to Operations.

- the requirement for fixed tank ventilation was removed. This was replaced with the facility to install 3 No. temporary fans on tank roof when man access is required for maintenance or inspection. The reason for the change was that infrequent access will be required to the tank (twice per annum) and that existing fans owned by Operations can be lifted onto the roof.

The above changes not only resulted in capital cost savings but will also result in significant savings in operational costs.

Beca's detailed design submissions were reviewed by SKM as the Employers Engineers and were peer reviewed by Babbage Consultants.

2.4 CONSTRUCTION

The overall tank design simplified the construction requirements by minimizing the complexity of the facility. A number of key construction techniques were used to reduce time, cost and risk. Constructing the tank from precast units reduced the overall construction programme and ensured a high quality 'factory' finish.

As the site was underlain by a layer of peat which introduced a significant dewatering risk during excavation, the pump station was constructed as a caisson and sunk into the ground by weighting from above and excavating from within concrete shell. The pump station was 9m x 9m x 10m deep and was constructed in two lifts. The first lift was constructed on a site concrete slab, which was then removed and a small excavator placed on beams inside the structure to allow it to dig out inside – this allowed the caisson to sink. Once it sunk down to ground level the structure was supported whilst the next level of the concrete was poured and the same process repeated.

The main tank was constructed on 164 No. 10m long driven H piles which founded on the residual east coast bays. These works were undertaken off the subgrade platform for the tank. To speed up the overall construction and reduce construction risk, the sump and ground beams were constructed first. On to this the precast panels were installed utilizing the 100t piling crane. The panels were back propped to dead men – this allowed all but two of the panels to be installed prior to the main floor pour.

The stich pours between the precast wall units were bottom poured using self-compacting concrete in a single pour – the key issue related to this was the establishment of adequate restraint of the formwork under the full 10m of hydrostatic pressure. Brian Perry also utilized fiberglass tie bars to reduce the need to plug very tie hole after construction. This reduced the risk and improved the construction programme.

Photograph showing double-tee precast panels partially erected

3 CONCLUSIONS

The design-build procurement process resulted in an end result that provided Watercare with a facility that provides excellent functionality together with minimum capital and operational costs. The opportunity to challenge functionality and design requirements in a constructive atmosphere with the designer and constructor, resulted in cost savings and reduced ongoing operational and maintenance costs.

ACKNOWLEDGEMENTS

Toby Davies – Brian Perry Civil.