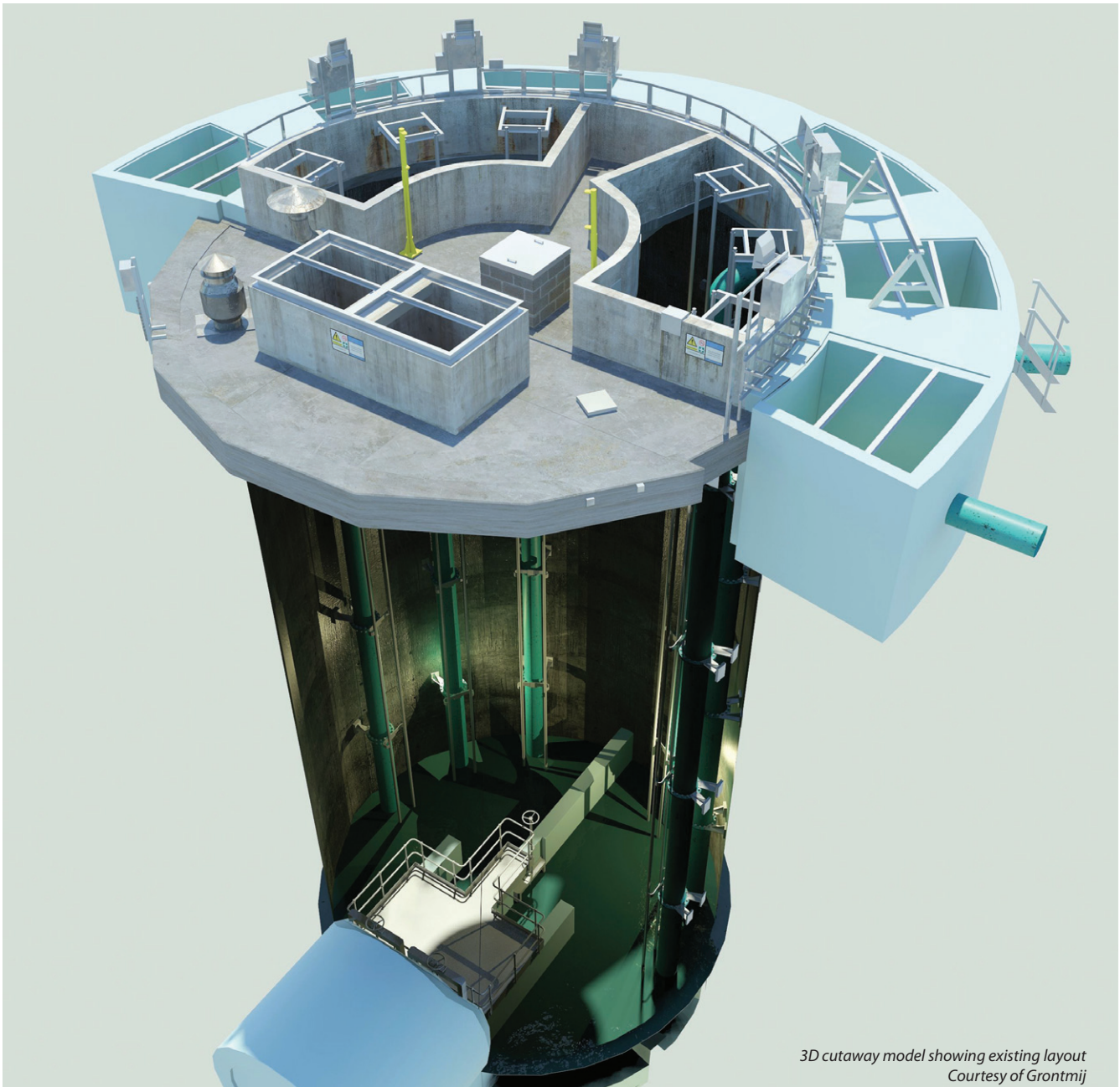


Langdon Road Sewage Pumping Station

Dŵr Cymru Welsh Water refurbishes a critical asset to improve bathing water quality in Swansea Bay

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Langdon Road Sewage Pumping Station is the terminal pumping station serving the city and surrounds of the Swansea Catchment, Wales. The catchment serves an approximate population of 167,000. The pumping station, commissioned in 1998, can pump up to 3,024 litres per second (l/s) to Swansea Bay Wastewater Treatment Works (WwTW), via twin 900mm internal diameter rising mains. The pumps within the pumping station have been found to be problematic, which has resulted in frequent discharges of the combined sewer overflow (CSO) downstream of the River Tawe barrage and within close proximity of the Swansea Bay Bathing Water polygon.



3D cutaway model showing existing layout
Courtesy of Grontmij

Existing Asset

The pumping station is located in the Swansea Docks area, approximately 1,200m west of the WwTW. The pumping station is a 10m internal diameter, 20.6m deep wet well. Flows enter the wet well through a 2km long 3.8m internal diameter sewer and

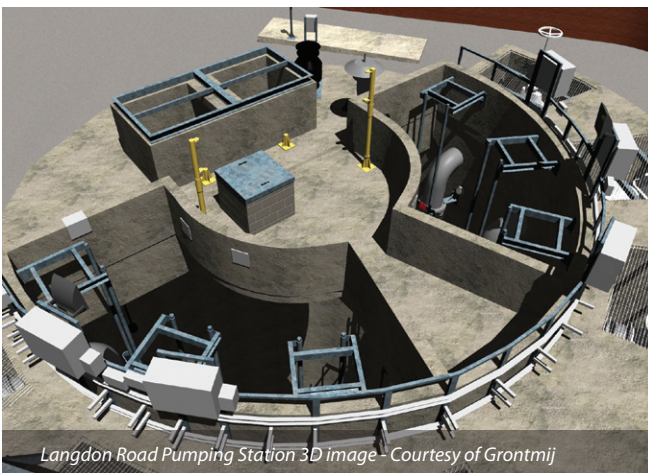
are split into two halves of the sump by a 4m high dividing wall. Two 2m high penstocks can currently be lowered into the mouth of the sewer to separate the sumps for maintenance. However, these penstocks only lift 2m, and cause a restriction when the sewer is at full bore.



Langdon Road Pumping Station 3D image - Courtesy of Grontmij



Pointcloud scan and generated image - Courtesy of Grontmij



Langdon Road Pumping Station 3D image - Courtesy of Grontmij



Pointcloud scan and generated image - Courtesy of Grontmij

The pump station design provides 6 (No.) pumps in total, split evenly between the two sumps and were all originally Bedford submersible sewage pumps, having a capacity of 600l/s. The mode of operation was duty/assist/assist/assist/assist/standby.

The pumps within the pumping station have been found to be problematic, subject to frequent failing, which is considered to be caused by excessive wear due to the hydraulic design of the pumping station sump. The failure to consistently pass the full 3,024l/s forward to Swansea Bay WWTW has caused frequent discharge of the combined sewer overflow (CSO) situated upstream of the tunnel. (Since commissioning, two of the original pumps have been replaced with Flygt variable speed pumps).

This CSO (CSO989) discharges directly downstream of the River Tawe barrage and within close proximity of the Swansea Bay Bathing Water polygon. Swansea Bay Bathing Water was classified as "Poor" under the revised Bathing Water Directive for the 2005-2009 period. Marine modelling undertaken by Intertek-Metoc identified that CSO989 was a significant contributor to the classification. Welsh Water have targeted the Bathing Water to achieve and maintain "Sufficient" quality standard. The improved, consistent performance of Langdon Road has shown enhancement of the water quality model through reduction in spill volume at CSO989.

Design and construction

The key projects participants are:

<i>Client</i>	Dŵr Cymru Welsh Water
<i>Principal Contractor</i>	Morgan Sindall
<i>Technical Consultant</i>	Grontmij
<i>Commercial Consultant</i>	EC Harris
<i>Physical Modelling</i>	BHR Group Ltd
<i>3D laser survey</i>	Hope Draughting Ltd
<i>Precast Supplier</i>	CPM Group
<i>Pump Supplier</i>	Flygt (now Xylem)

Objectives

Principal contractor Morgan Sindall and their designer Grontmij were challenged to achieve the following drivers, which took into account the difficulty of achieving an effective solution within the existing pumping station structure:

- Reduce reactive maintenance due to pump malfunction on the pump station by a minimum of 66% - from an average of 30 incidents per annum to 10, or less;
- Achieve and maintain the duty requirements of the pumps; 3,024l/s pass forward to Swansea Bay WWTW during peak flows to the station.

Physical modelling of the pumping station

In order to achieve the deliverables, Welsh Water commissioned BHR Group Ltd (the Fluid Engineering Centre, Cranfield) in 2007-8 to build a one third scale model of the sump.

The existing sump was tested and alterations made, using submersible pumps from three manufacturers, Flygt, Bedford and Hidrosta.

The report from BHR identified significant underwater vortices and air-entrainment issues with the current benching arrangement. These issues were causing the existing pumps to suffer from significant cavitation problems and were literally rocking themselves apart. The report was used to generate the scope of works and included the following civil works modifications to the sump arrangement, pump configuration and pump selection:

- Replace 6 (No.) existing 320kW foul pumps with variable speed units of the same size.
- Remove existing flow straightening and baffling features in the sump plus inlet channel and concrete infill.
- Move pumps to more suitable positions in sump to avoid vortices combining.
- Construction of new benching towards pumps, baffle wall, flow straightening and vortex elimination features.
- Move access walkway to penstocks out of flow path to pumps and adjust penstocks to fully clear flow path to pumps when open.

Temporary works

The project team had a number of significant challenges to overcome in order to implement the brief: maintaining flows in the station, working at significant depth within a confined space and potentially explosive atmosphere, and agreement with Welsh Water over specifications that were outside normal standards.

Maintaining flows

One of the major challenges that the project team encountered was that flows through the pumping station must be maintained to Swansea Bay WwTW to prevent significant spilling at the upstream CSO. The dividing wall between the two sumps meant that one sump could be isolated at a time. The two rising mains were associated with pumps from each sump, so the capacity of the station would reduce from circa 3,000l/s, to 1,700l/s. However, the dividing wall between the two sumps is only 4m high and hydraulic modelling identified that the wall would be overtopped during peak diurnal dry weather flows.

Modelling predicted that by adding a further 2m temporarily to the wall, the "dry" sump would be protected from overtopping for up to a 1 in 1 month return period design storm. Due to the cantilever effects on the dividing wall, any increase above 2m would require the existing wall to be braced, which would interfere with the demolition and construction works. Additionally, a temporary shield wall was constructed and installed in the incoming sewer. The shield wall covers half of the sewer and prevents flows entering the "dry" sump. It was necessary to be installed in the tunnel, in front of the penstocks, to enable the existing penstocks to be removed and replaced with new penstocks and frames that will lift the penstocks fully out of the tunnel.

Installation of the shield wall in the tunnel required close liaison between Morgan Sindall, the Environment Agency and Welsh Water Operations staff. The only way the shield could be installed was to reduce flows into the pumping station. To do this, during a period

of dry weather, penstocks at the start of the tunnel were closed and the existing upstream storage in the Swansea Interceptor Trunk Sewer utilised, before inducing spills at CSO989. Throughout the installation process, the Environment Agency was made aware of when the penstocks were closed and when the spills began. By working at night and at the turn of the tide, impact of spills was kept to a minimum.

Maximising precasting, minimising risk

Construction risks of working at depth, within a live wet well are significant. To limit the time that we have people working in the wet well, it was decided to design the new benching as precast concrete, or stainless steel elements, which could be lowered into place, before being bolted/fixed into the base of the wet well. To achieve the necessary precision in prefabricating the elements, the design team required to have confidence in the dimensions off the existing wet well.

As the pumping station is 20m deep, man-entry is only available through man-rider baskets, which may not result in sufficiently accurate dimensions. To overcome this challenge, a Point Cloud Survey was undertaken by Hope Draughting Ltd (Widnes, Cheshire) The Survey negated the need for man-entry into the wet well and provided sufficient detail to identify that the central dividing wall was offset by 100mm. This check gave the confidence to design the precast elements.

To ensure that the precast elements could be laid onto a flat surface, the existing benching required to be broken out. To minimise the time in the wet well, the majority of the existing benching will be broken out by remote control breakers.

Construction delivery

Preliminary works began in November 2011, with the removal of the existing cover slab in January 2012. Due to the adverse weather conditions experienced throughout March and April, little work has been possible, as the volume of flows arriving at the works has beaten the remaining three pumps.

Temporary pumps have been installed to increase the flows to Swansea Bay WwTW and with favourable weather conditions throughout the summer of 2012, construction is forecast to be completed by March 2013.

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