Portsmouth Flood Alleviation Scheme

part of Southern Water's £50m programme of improvements to the sewer network in Portsmouth

by Robert McTaggart BEng CEng CIWEM

Portsmouth (Portsea Island) is the UK's only island city and the most densely populated area outside central London. Currently home to 195,000 people, the population is forecast increase by over 14,500 by 2020. Portsmouth was one of the first cities in the UK to have a dedicated sewage system, with the first pump station at Eastney commissioned in 1865, the same year that Daniel Bazalgette's sewerage system for the south of London was commissioned and three years before central London's system came into operation. Victorian sewerage systems were combined systems (i.e. they combined foul and surface water systems). This system was adequate at the time partially because with less paved areas the flows were lower, but mainly because as all of the flows were discharged into the sea untreated, there was no need to have separate systems.

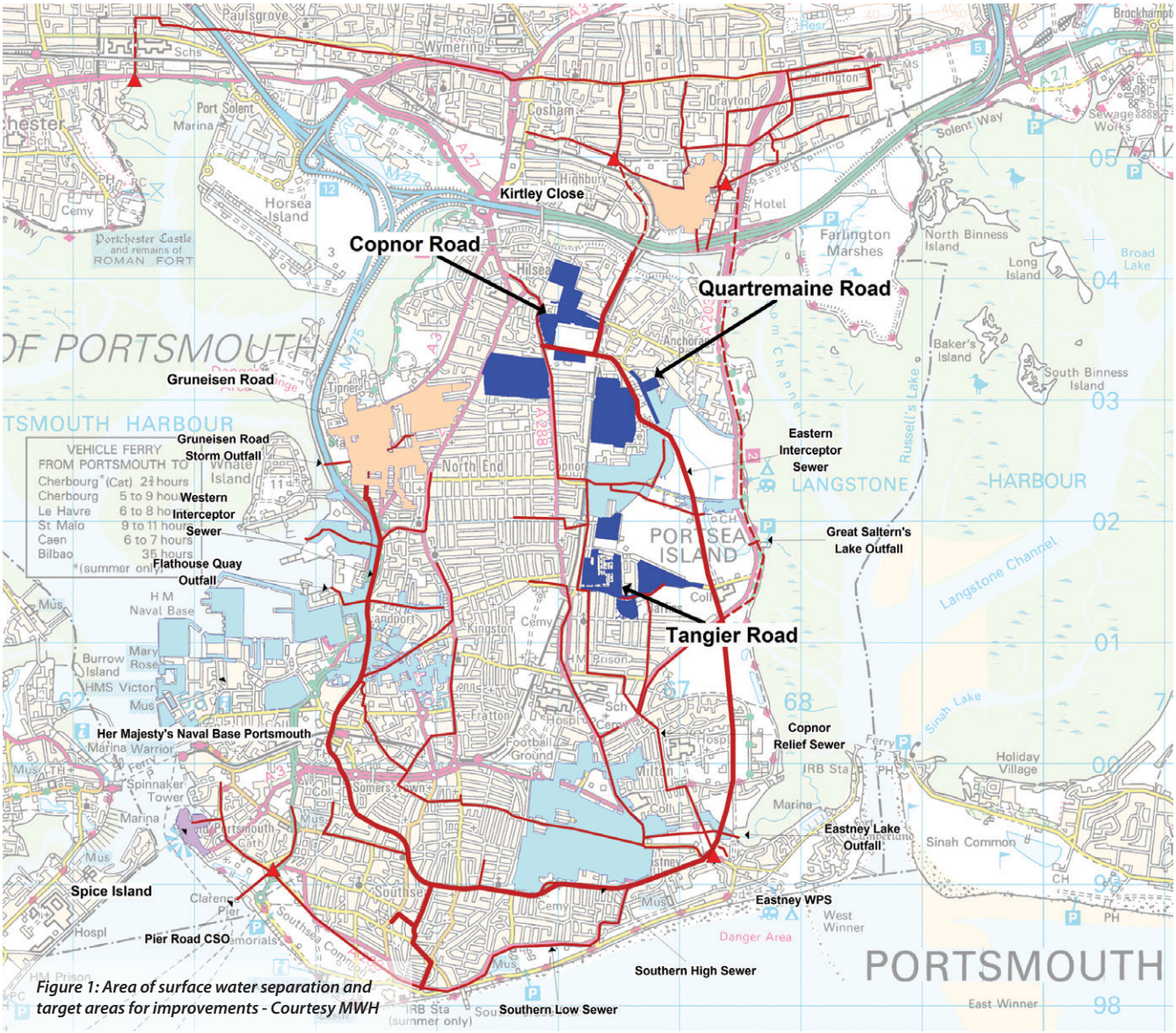

Figure 1: Area of surface water separation and target areas for improvements - Courtesy MWH

Catchment

Over the past 150 years the City of Portsmouth's drainage network has continued to develop but has remained dependant on the use of combined sewers and the Eastney Pumping Station (PS). The city is now served by two interceptor sewers that run north to south on the western and eastern sides of the island. These Interceptor sewers carry the combined sewage flows to Eastney. In dry weather, flows arriving at Eastney are screened and pumped to Budds Farm WwTW for treatment. These flows, together with treated flows from the Havant catchment, then gravitate back to Eastney and are pumped down the long sea outfall.

In storm conditions, the incoming flows exceed the capacity of this system; this excess flow is pumped from Eastney PS to storm tanks

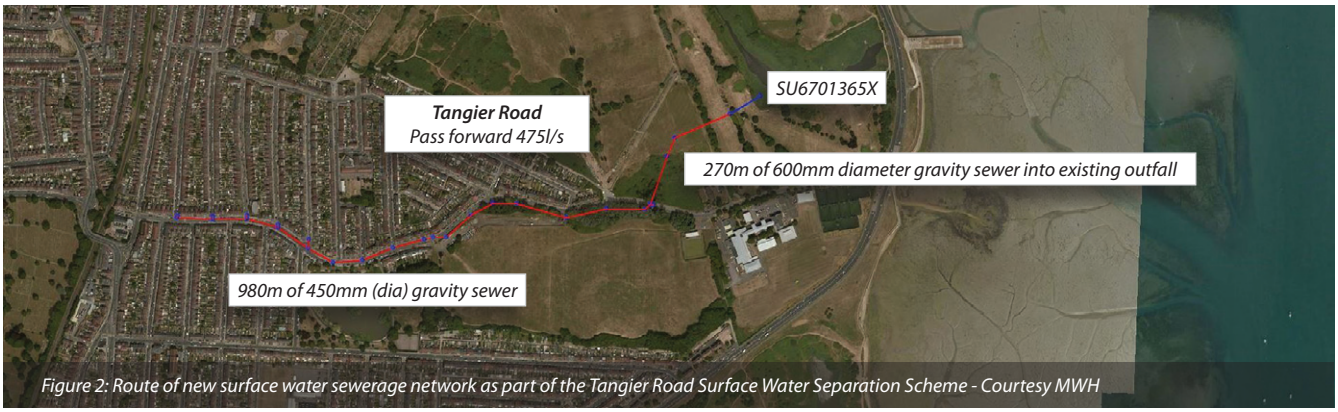

Figure 2: Route of new surface water sewerage network as part of the Tangier Road Surface Water Separation Scheme - Courtesy MWH

at Fort Cumberland. These tanks have a capacity of 40,000m^3 and are filled before any flows are discharged to the sea via the short sea outfall and then emptied back to Eastney PS after the storm has passed. However, due to the quantity of storm water arriving at Eastney, and allowing for filling and emptying the tanks, in a typical year 650,000m^3 of screened wastewater are discharged via the outfall at Fort Cumberland.

Topography

As demonstrated in Figure 3 below, the majority of the island is not only flat but also low lying. The pink and purple areas on Figure 4 detail the surface areas that drain to the Eastney PS. Approximately 60% of the catchment consists of built up areas, 80% of which drain to Eastney PS; this means that nearly half of the entire surface area of Portsmouth drains to Eastney.

These factors combine to produce extremely large flows at Eastney during storm conditions. In dry weather, flows are less than 1,000l/s. However, in storm conditions flows increase to more than 20,000l/s.

Objective of the scheme: Flow reduction

On 15 September 2000 an exceptional severe storm, with a return period of 1 in 108 years, overwhelmed the Eastney PS, causing the pump room to be flooded and stopped the pumps, which resulted in major flooding. Over 750 properties were flooded and it was a full 18 months before the Eastney PS was fully recommissioned.

Considerable investment has subsequently taken place at Eastney PS with the provision of a new standby pump station. However, with half of all rain that falls on the island ending up at Eastney PS there is still a major risk that the capacity of the pump station will be exceeded.

Solution

The majority of the flow in wet weather is surface water. If this could be prevented from entering the combined sewer and diverted to the sea, the quantity of water being transferred by Eastney PS and arriving at Fort Cumberland would be reduced, which would free up capacity in the existing infrastructure, allowing it to be used to provide protection against bigger storms.

The objective of the project was to divert these surface water flows away from the combined sewer networks and discharge them into the harbours around the island.

These areas were selected to minimise impact that the work would have upon the City and would also reduce the risk of flooding in a number of areas identified as flood risk areas within the Portsmouth CC Surface Management Plan.

Three methods of flow reduction were identified which, when taken together, reduced the flow arriving at Eastney PS to the extent that the required flood risk protection level was achieved.

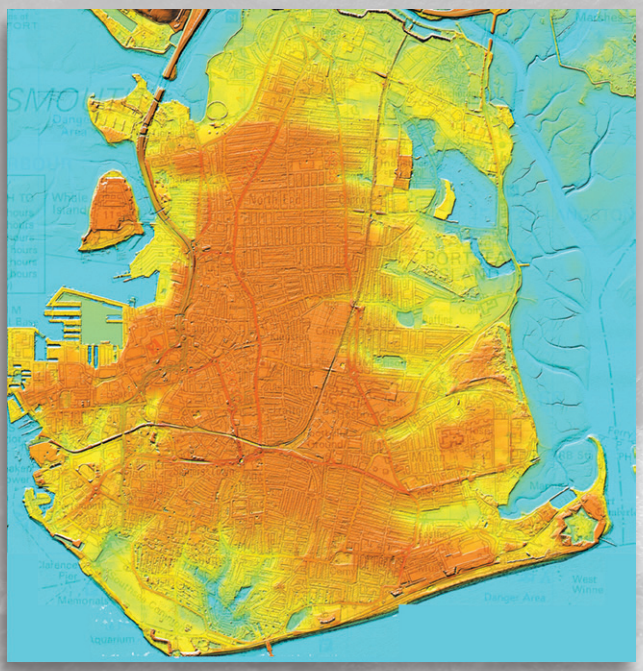

Figure 3: Portsea Island topography
Courtesy MWH

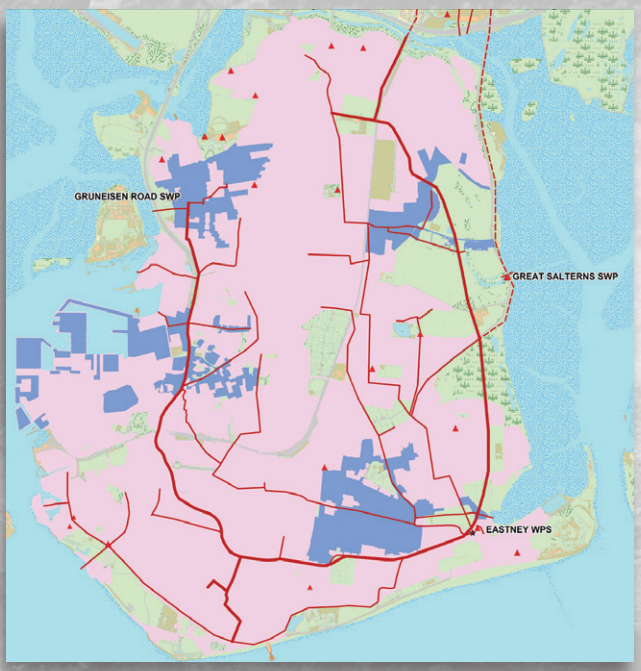

Figure 4: Portsea Island catchment
Courtesy MWH

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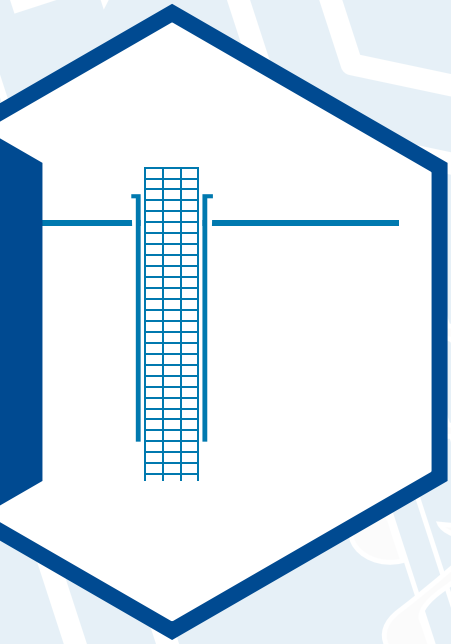

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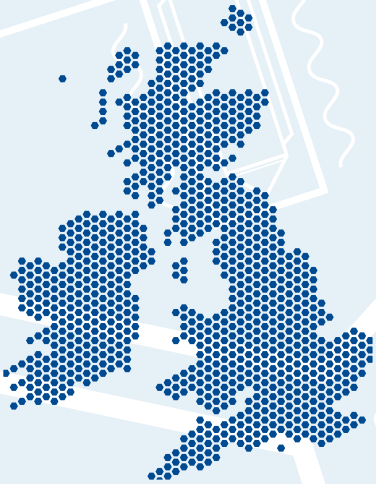

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Nationwide Solutions

(i) Tidal inflow reduction: Spice Island:
4Delivery undertook extensive flow monitoring and data gathering which identified tidal infiltration in the area of the city known as Spice Island in Old Portsmouth. Tidal infiltration from a number of sources of up to 150l/sec was measured against a tide of 2.52m AOD. The volume of unnecessary flows entering the combined system was calculated to be as much as 2,500m^3 per day.

As this area of Portsmouth is a designated conservation area 4Delivery took the decision to remediate sections of the public sewer within Spice Island, where the bulk of this infiltration occurs, as well as preventing tidal infiltration from road gullies on the seaward side of the tide gates in East Street.

(ii) Tidally restricted CSO operation:
Two areas were identified where CSO operation is tidally restricted. 4Delivery proposed to provide the capability to discharge the flows from the sewer network at these locations, at any state of the tide, during storms up to a 1 in 100 year event.

1. Upgrade to Kirtley Road CSO
2. Upgrade to Gruneisen Road Surface Water PS

Surface water separation:
4Delivery proposed to separate surface water from the combined sewer network resulting in a reduction of the flows to Eastney PS. Three areas within the catchment were selected to minimise impact upon the city and to provide synergy with Portsmouth City Councils Surface Water Flood Risk Areas. These are the catchments known as (i) Copnor Road, (ii) Quartremaine Road and (iii) Tangier Road

Copnor Road catchment: Surface water sewers within the Copnor Road Catchment currently discharge flows of up to 2,700l/s into the Eastern Interceptor Sewer.

Surface water was diverted to the Great Salterns Lake via new storage sewers and pumping station discharging to the Quartremaine Road Catchment where infrastructure upgrades were required to allow additional capacities to convey.

Quartremaine Road catchment: Surface water sewers to the East of the Veolia incinerator plant currently discharge flows of up to 1,500l/s into the Eastern Interceptor Sewer. Surface water was diverted into Great Salterns Lake via new surface water pipes and culvert along Quartremaine Road to a new outfall and a new open watercourse channel across the golf course.

Tangier Road catchment: Surface water sewers currently discharge flows of up to 1,600l/s into the Eastern Interceptor Sewer. Surface water was diverted in to the Great Salterns Lake via new surface water pipes along Tangier Road across the golf course and to a new outfall.

Great Salterns Drain and the golf course

A major restriction on the existing surface water drainage system in this area of Portsmouth was the reliance on an existing water course to transfer flows to the outfall pumping station. This watercourse has been designated a major river by the Environment Agency and also forms part of a designated wetland area within the golf course, therefore there was very little that could be done to increase the volume of the channel to transport the increased flows.

Extensive surveys have been made to confirm the extent of the upstream catchment, topographical surveys have been made of the golf course, and rainfall and the flows that this rainfall produces have been measured to produce an accurate computer model of the catchment and how it reacts in storm events. This modelling has shown that the golf course will flood on a regular basis as a result of hydraulic overload of channel section from both land

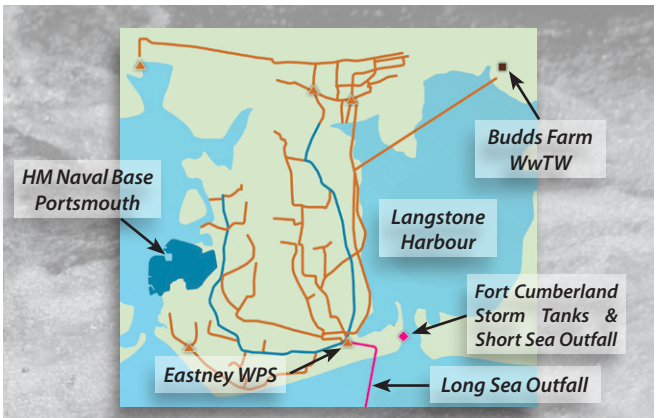

Figure 5 - Portsmouth Sewerage Network Schematic, showing sewers routed to Eastney Wastewater Pumping Station - Courtesy MWH


New Norway Road Surface Water Pumping Station under construction using caisson shaft sinking technique to form wet well - Courtesy MWH


Grassed swale under construction at Great Salterns - Courtesy MWH


Channel formed with Allen Block Walls at Great Salterns - Courtesy MWH

drainage and surface water flows, both of which were addressed as part of this scheme.

The inadequacy of the water course across the golf course

Flows across the golf course will increase by up to 1,700l/s and so additional hydraulic capacity needed to be provided. This took the form of a new open channel that runs parallel to the existing Great Salterns Drain. The existing channel still remains the primary watercourse for first flows, which would ensure that the wetland area within the trees would be maintained.

Surface water was conveyed through the golf course via swales and channels depending on the features of the golf course. A swale is a shallow depression in the ground, with gently sloping sides, that would only fill up when the original watercourse had reached its capacity. The swale is approximately 0.75m deep and the sides would have a 1 in 4 slope. The sides are grassed, which would allow the swale to blend into the course, but it would be much wider than a channel at 6 to 7m wide.

The channel is approximately 0.75m deep and 2.5m wide and faced with patterned-faced concrete Allan Blocks.

There is very little difference between the two flow systems from a hydraulic point of view; so the choice was down to how it would fit into the golf course and the impact that this would have upon the way that the course is structured for players and maintenance.

At the Great Salterns Pump Station, it was proposed to upgrade this asset to provide a robust level of service which required agreement with the Environment Agency. The lake was held at the current level, so in day to day operation, adding bigger pumps would only mean that the pumps would run for a shorter time and modern pumps and motors would be more efficient than the existing pumps.

In periods of high flow, the new, bigger pumps would be better equipped to deal with the flows. Extensive hydraulic modelling and survey has shown that, even in a 1 in 30 year storm event, the lake level would not rise by more than a couple of hundred millimetres, so the flooding that currently occurs frequently around the lake would not happen.

The lake is also large enough for the increased flow to cause a negligible increase in the flow velocities in the lake. The proposed scheme would therefore have a minimal impact upon the ecosystem in and around the lake.

Outcomes

- Achievement 1 in 76 year Level of Service Protection to Eastney WPS.
- Integrated Catchment Solutions.
- Minimising work in areas that would cause disruption to stakeholders and customers in Portsmouth.
- Optimisation of whole life cost.
- Minimisation of Carbon Count.
- Reduction to Impact on the Environment.
- Close cooperation between SW (4D), Portsmouth City Council & the Environment Agency.
- Sustainable solution.
- 67% of the work is off the highway, minimising disruption.
- Costs reduced by reducing the number of schemes and outfalls outlined at outline stages.
- Alignment with PCCís SW Management Plan.

The editor and publishers would like to thank Robert McTaggart, Strategic Technical Manager with 4Delivery (a joint venture between MWH, Veolia Water and Costain), for providing the above article for publication.

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