

# Sycamore Rd Storage Shaft Flood Alleviation Scheme

1,100m<sup>3</sup> of offline storage in Farnborough protects 25 properties from hydraulic foul sewer flooding for rainfall events of up to 1 in 30-year return periods

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**R**esidential properties along Sycamore Road, Farnborough, Hampshire have a long history of both internal and external foul sewage flooding. There were 15 properties on the Sewer Flooding History Database (SFHD). The site lies within the Camberley catchment. The area has separate foul and surface water systems. The preceding flooding investigation identified that due to growth in the catchment and changes in the network, the flows to Sycamore Road Sewage Pumping Station (SPS) had increased significantly causing flooding at Sycamore Road.



Construction - 6m Diameter Storage Shaft - Courtesy of MGJV

## Key driver

Flow surveys were undertaken to demonstrate the increase of flows in the Sycamore Road SPS catchment. The results were used for the verification of the existing verified hydraulic model. The model predicted surcharge in the existing 225mm diameter foul sewer in Sycamore Road due to increased flows in the network which were further hindered by the limited pumping rate at Sycamore Road SPS. Some surcharge events were experienced for events even as low as 1 in 2-year return period, demonstrating the high flood risk within the catchment.

Customer questionnaires further confirmed flooding at properties in Sycamore Road as well as flooding of the public highway through manholes. Occasionally overland flows were reported to enter the properties causing property damage and potential health risks.

The driver properties were noted to be lower than the road level, with the gardens at these properties were some 300-400mm lower than the road level. This made them vulnerable to flooding due

to surcharging in the 225mm diameter foul sewer. The urgency of the issue required management of the excessive flows during the rainfall events.

## The recommended solution

The hydraulic modelling indicated that a 1,100m<sup>3</sup> offline storage was required to protect the driver properties from hydraulic foul flooding for a rainfall event of up to 1 in 30 year return period. Initial site investigations suggested that the proposal to construct a 15.5m internal diameter, 20m deep storage shaft on the traffic island between Sycamore Road and Castle Close, would provide the required storage. Thames Water appointed Morrison Galliford Try Joint Venture (MGJV) as principal contractor and Mott MacDonald was appointed the principal designer.

## Site investigations and geotechnical information review

MGJV commissioned Environmental Scientifics Group (ESG) to undertake ground investigations for the project. The ground investigation comprised one cable percussive borehole to 35m





Sycamore Road neighbourhood - Courtesy of Mott MacDonald



Safety on site - Courtesy of Mott MacDonald



Working Close to large existing services - Courtesy of Mott MacDonald



Steel sheet piles wall of deep trench for box culverts  
Courtesy of Mott MacDonald

deep and one trial pit to 3.7m deep at the proposed location of the new storage shaft. An additional three window sample boreholes to 5m deep were drilled together with dynamic probes in the area to facilitate optioneering of the solution including a shallower shaft combined with a storage tunnel.

The result of the ground investigation indicated that the ground condition at the site was predominantly Camberley Sands formation, comprised of layers of sand and gravels. The gravels are present at 2.3-2.8m below ground level (BGL) with the sand comprising the remaining depth of the boreholes (35m BGL). The result also showed that the water table was at 0.5m BGL.

#### The revised solution

Ground investigation information indicated that the construction of a 1,100m<sup>3</sup> offline storage tank, to a depth of 20m deep in poor ground condition, would require a long design and construction timescale, as well as posing a difficult construction environment with significant health and safety risks. In order to mitigate such risks, a 2m diameter 320m long box culvert tunnel was considered. This option considerably reduced the size of the storage shaft.

However, due to the local soil strata and minimum cover required for the construction of a 2m diameter tunnel, this option was discounted. The gravelly formation of the soil, risk of severe ground heave or settlement and the high water table required a much deeper tunnel and subsequently a deeper shaft at the end of the tunnel.

The collaborative approach between the construction team and design team suggested some key variations to the previously discounted solutions. The revised option considered a shallower and smaller shaft with the additional storage volume to be provided by constructing a 320m long, 2.25m wide by 1.50m high box culvert under Sycamore Road. The variation required the following key design:

- A smaller and shallower storage shaft to provide storage volume of approximately 125m<sup>3</sup>. The storage shaft is 6m (internal) in diameter and 7m deep with 2 (No.) pumps rated at 72l/s operating as duty/standby.
- New 320m long, 2.25m wide by 1.50m high box culvert to provide storage volume of 925m<sup>3</sup> to connect the overflow from the 2 (No.) weir manholes to the new offline storage tank. The culvert depth ranges from 2.9m to 4.3m.
- A new 375mm diameter sewer to be laid in parallel with the existing 225mm diameter sewer for approximately 240m.

This above revised option was agreed by all parties before being taken forward to detailed design.

#### Settlement analysis

In order to control groundwater levels during the construction of the new culvert at Sycamore Road, Farnborough, a dewatering system was proposed, using two parallel lines of well points at a depth of 6m. As a result of the drawdown of water, settlement to the nearest property was anticipated.

To assess the potential settlement that could result from the dewatering system, a settlement curve was generated from the edge of the culvert outwards. The curve indicated that the settlement across the individual property located 10m away was approximately 2mm. This was deemed to be acceptable and unlikely to cause damage to the property as the threshold of settlement across one property was not expected to exceed 5mm.

#### Challenges

There were many challenges that had to be overcome in order to deliver the Sycamore Road storage shaft project. These included:



- Careful analysis and assessment of shaft and culverts to ensure that all services were avoided especially the 14" cast iron gas main. Early consultation with the gas company was undertaken to investigate the possible impact on the large gas main.
- Vibration monitoring devices were installed on site to ensure that the vibration levels were maintained at the lowest levels to prevent annoyance to the local residents.
- Due to high ground water level, the new storage shaft was built by caisson method. The ground was excavated uniformly to allow the caisson to sink equally. The concrete plug was constructed under water using a tremie pipe. Once the mass concrete plug was placed, the water was pumped out to provide a dry environment for installing the reinforcement and a final concrete pour to form a water tight concrete shaft base.
- There was very little working space available at the traffic island, which had the added risk of proximity to live traffic. The construction team made every effort to minimise the space requirements for the temporary construction, whilst allowing for a reasonable working area for the construction staff. There were physical barriers to protect local residents and users of the King George Playing Fields, which were kept open to the public throughout the construction stage. This required vigilance and excellent safety plans and procedures from the MGJV site team.
- The shaft was located near to the existing protected trees. The local authority and an arboricultural consultant were consulted regarding the work methods and proposals to ensure the proposed methodologies were appropriate.
- A public consultation was undertaken to incorporate the comments from the local residents into the design. The new ventilation pipe was designed to be as far away as possible from the residential properties and the new kiosk was screened from the main road by an evergreen hedge.

#### Added value

- By close collaboration with all parties, a hybrid solution combining the reduced size of the storage shaft (from 15.5m diameter and 20m deep, to 6m diameter and 7m deep) and a 320m long box culvert was achieved.
- Hydraulic modelling allowed the use of real time controls to optimise the storage volumes required to protect the driver properties from flooding.
- Collating and reviewing extensive underground services data to design out potential services clashes as well as providing continuous technical support to the construction team on site.
- Liaison with MGJV planning consultants to assist with discharge of the planning constraints imposed to facilitate approval from Local Planning Authority.

#### Conclusion

The success of the project has largely been achieved through close collaboration with all parties and a combination of expertise to reduce the risks of working in poor ground conditions with high water table. Despite the difficult construction environment, the project was completed safely which is a great achievement for the promotion of a good safety culture.

The construction of this scheme has ensured that 25 properties in Sycamore Road are protected from hydraulic foul sewer flooding during 1 in 30 year storm events.

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2.25m x 1.5m Box Culverts - Courtesy of Mott MacDonald