Northumberland Avenue SPS, Bynea SPS & Llanelli STW Operating Technique

Introduction

The three assets (Northumberland Avenue, Bynea and Llanelli) will operate under a joint control philosophy using a Smart Telemetry Link to ensure cohesion across the three sites. The Smart Telemetry Link plays a critical part in achieving the environment outcomes required. Further information on the Smart Telemetry Link and additional works on each asset can be found in the Natural Resource Wales (NRW) Solution Documents: *Dŵr Cymru Welsh Water Llanelli WwTW and Northumberland Avenue SPS, including Bynea SPS, Halfway SPS and St Michael's Church CSO Solution Document* and *Dŵr Cymru Welsh Water Gowerton WwTW Solution Document.*

Please note the operating technique should be read in conjunction with the accompanying schematic A1.

Smart Link Telemetry

Northumberland Avenue SPS

Flow arrives at Northumberland Avenue SPS from four catchments. Northumberland and Dafen via gravity and Cambrian and Pwll via rising mains (N1). These flows are pumped to Llanelli WwTW by 8 No. foul pumps composed of 4 No. 37 kW small pumps and 4 No. 250 kW large pumps (N2) which will have a max pass forward flow (PFF) capacity of 1,100 l/s.

The operating philosophy of the foul pumps will be as follows:

Each small foul pump has a discharge rating of between 50l/s and 125l/s. The small pumps will be operated on a duty/assist basis in each half of the wet well. Under normal operation, either two or four foul pumps will operate simultaneously at any given time. During small foul pump operation, the large foul pumps will remain in standby mode.

The first pair of small pumps will activate when the level in the wet well reaches the initial start point and operate at low speed. As the level in the well increases, the speed of the pumps will ramp up.

If the level continues to rise, above the working range of the first 2 No. small pumps, an additional 2 No. small pumps will start to operate (giving a total of 4 No. small pumps operating in the wet well). These will all operate at low speed initially, and as the level continues to increase, the speed of all 4 pumps will increase to a maximum. The maximum output from 4 No. small pumps will be 400l/s.

If the level in the wet well continues to rise, this will trigger the start of 2 No. large pumps, and simultaneously allow the 4 No. small pumps to ramp down and stop operating. Each large pump has a discharge rating between 225l/s and 475l/s. If the level in the well continues to rise beyond the 'small to large pump' transition, an additional 2 No. large pumps will start up, giving a total of 4 No. Large pumps operating in the well.

These will initially operate at low speed and ramp up as the level in the well increases. At the max foul operation level, the 4 No. large pumps will be passing forward the maximum flow of 1,100/ls. In the event of unplanned outage or maintenance of a single pump, the remaining three can pump at 1,100 l/s, thereby providing a standby provision.

In storm events when the foul pumps are unable to facilitate the increased inflow to the SPS, the level in the wet well rises and triggers Northumberland Avenue's storm pumps. The 6 No. 130 kW storm pumps are operated as two sets of duty/assist/standby and have a max storm pumping capacity of 3,370 l/s. The storm pumps direct flow to 4,800m3 of storage (2,800 m3 existing and 2,000 m3 new) via a screening chamber (N3).

The operating philosophy of the storm pumps will be as follows:

As the level in the well continues to increase past large foul pump operation range, the storm pumps will begin to operate. These will pass flows in excess of 1,100l/s to the storm tanks. The 4No. large pumps will continue to operate, with their discharge rate limited to 1,100l/s.

The storm pumps will operate on a duty/assist/standby basis in each half of the well, giving a total of 4 No. operating storm pumps. The pumps will deliver a fixed speed rate of 842.5l/s each, and hence a total storm discharge rate of between 842.5 and 3,370l/s will be attainable. With the combined flow of the large foul pumps, this gives a peak station discharge rate of 4,470l/s. The lead duty storm pump will be initiated at the start storm pump level. Subsequent pump starts will be initiated sequentially, based on level until 4 No. storm pumps are in operation.

Storm sewage will be returned from the storage tanks to pass forward flow as soon as practical after cessation of overflow. The 2 No. duty/standby storm return pumps, each with a maximum capacity of 170 l/s, will be controlled with a real time control (RTC) linked to the foul pump's PFF. The duty storm return pump will commence pumping at 50 l/s when the PFF from foul pumps fall below 1,050 l/s. The variable speed storm pump will then ramp up to 170 l/s as the PFF from foul pumps falls from 1,050 l/s to 930 l/s (N4).

When the 4,800 m3 storm storage is full and inflow continues to exceed the 1,100 l/s PFF, storm flow will be directed to the long sea outfall and spill to the Loughor Estuary. In high tide, the long sea outfall can be relieved by an overflow to the Dafen Cut

In the event that due to mechanical/electrical failure, the foul and storm pumps within the wet well cease to operate, a high level screened emergency overflow operates from the pumping station and discharges to the Loughor Estuary (or Dafen Cut Lake if sea outfall is locked).

Bynea SPS

Flow arrives at Bynea SPS from Halfway and Bynea catchments to the North West. These flows are pumped to Llanelli WwTW by 4 No. 55 kW foul pumps with a max pass forward flow capacity of 501 l/s (B1).

In Storm events when the foul pumps are unable to facilitate the increased inflow to the SPS, the storm pumps are activated and direct flow to Bynea's 1,800 m3 of storm storage (B2).

Storm sewage is returned to pass forward flow as soon as practical after cessation of the storm event. Flow is returned via gravity to the wet well once the storm pumps have ceased to operate and the foul pumps have fallen below their max operational PFF (B3).

In the event that the 1,800 m3 storm storage is full and Bynea's inflow continues to exceed its max operational PFF, Bynea's storm pumps will continue to pump to storm tanks causing each tank to overflow to an outfall located in the Loughor Estuary (B4). During high tide conditions when the sea outfall is locked, a secondary storm overflow operates and spills to an un-named tidal pill which is a tributary to the Loughor Estuary (B5).

This secondary storm overflow also acts as an additional emergency overflow which operates in the event of mechanical or electrical pump failure.

Northumberland Bynea Link

Whilst Northumberland Avenue's max PFF is 1,100 l/s and Bynea's 501 l/s, neither station will be allowed to pump their max PFF in unison. The max combined PFF from both stations will be limited to 1,401 l/s. This will ensure the max inflow at Llanelli WwTW's inlet remains at or less than 1,401 l/s (T1). This will be achieved via the following Smart Link Control Philosophy. The real time pass forward flow of each asset will be displayed visually at each asset for operatives.

Control 1

Default operation – (T2).

When required, Northumberland Avenue will pump a max PFF of 1,100 l/s. Bynea will pump a max PFF of 301 l/s.

If Northumberland Avenue's PFF falls below 1,100 l/s, due to the level in the wet well reducing, Bynea's PFF will be allowed to ramp up from 301 l/s by an equal amount.

If Northumberland Avenue's PFF increases, due to the level in the wet well increasing, Bynea's PFF will ramp down accordingly. If this continues, both pumping stations will eventually arrive back at the 1,100 l/s and 301 l/s arrangement.

Providing Control 1 is activated, this relationship will be maintained by a telemetry link between the two stations to ensure combined PFF to Llanelli WwTW never exceeds 1,401 l/s.

Bynea's foul pump's max capacity is 501 l/s, therefore if Northumberland Avenue's PFF falls below 900 l/s (from its max capacity of 1,100 l/s), Bynea will not ramp up beyond 501 l/s. Instead the combined PFF from both stations will reduce accordingly from the max of 1,401 l/s.

Control 2

Emergency operation – (T3).

Control 2 will be activated if flood risk in Bynea is realised. Bynea's foul pumps will increase to 501 l/s to alleviate the risk and Northumberland Avenue's foul pumps ramp down to 900 l/s, ensuring the max inflow to Llanelli remains at 1,401 l/s.

Control 2 will be activated locally from Bynea SPS. An ultra-sonic level sensor situated in Bynea's secondary storm overflow will trigger an alarm should the water level rise above Bynea's flood risk threshold (T4). The alarm will activate Control 2 and Telemetry Smart Link will be used to relay command to Northumberland SPS.

In addition, two other float switches in Bynea will be used in case of mechanical/electrical failure of the primary ultra-sonic used to trigger Control 2 (T5).

Llanelli WwTW

Flow arrives at Llanelli WwTW from Northumberland Avenue and Bynea SPS. The maximum inflow will be 1,401 l/s due to the Telemetry Smart Link between them (L1).

The first 599 l/s of flow continues, as per the current arrangement, to primary, secondary (biological) and tertiary (ultra-violet UV) treatment (L2). Flows in excess of 599 l/s up to 1,249 l/s are directed to Peak Flow Equivalent Treatment (PFET), followed by UV (L3). Flow from both flow to full treatment (FFT) and PFET are then blended prior to sampling and discharging to the Loughor by a long sea outfall. In the event of high tides coinciding with high flows, the discharge shall be via a tidal pumping station (L4).

The PFET treatment is maintained to facilitate 650 l/s however when each unit operates in backwash (to adequately clean the system), the remaining PFET units ramp up to ensure 650 l/s treatment capacity is retained (L5), whilst the backwash effluent discharges to the main FFT treatment stream.

To prevent excessive start/stopping of the PFET system, a 400 m3 balancing tank will be installed prior to PFET treatment. The tank will ensure PFET units are only activated when required and not triggered prematurely for small excesses of 599 l/s FFT. If the 400 m3 tank fills partly but PFET is not required (as inflow to works has fallen below 599 l/s FFT within 20 minutes of exceeding FFT), the PFET backwash pumps are used to empty the tank (L6).

In the event that both the 599 l/s FFT and 650 l/s PFET capacity are fully utilised, flows in excess of 1,249 l/s entering the works spill to Llanelli's WwTW existing 3,500 m3 storm storage. The storm storage will be emptied and returned to the inlet works as soon as practical after cessation of overflow. Storm return pumps empty the tanks at 50 l/s when the inflow to the works falls below 550 l/s to ensure settled storm sewage is treated by FFT rather than PFET (L7).

In the event that the 3,500 m3 storm storage is full and the inflow to Llanelli WwTW remains in excess of the site's treatment capacity (1,249 l/s), the storm discharges to the Loughor sea outfall. The maximum storm discharge rate is 152 l/s during normal operation (L8).

EDM Monthly Data Checks and Interventions

As part of our commitment to gain an improved understanding our assets, we are installing event duration monitors (EDM) at all of the Dŵr Cymru Welsh Water owned and operated intermittent storm discharge assets. This will support our understanding of the impact of our network of assets on the local environment.

Measuring the performance of these assets is a challenge due to the location, complexity and configurations of many of the assets. In order to check that the data that we collect is as correct as possible we check for quality in two respects.

The first is the quality of the data provided, which is represented by data consistency. The second is the performance of the asset, which is represented by spill numbers. These elements are monitored on at least a monthly basis.

Data quality is monitored daily, with periods of missing data leading to a site investigation. Furthermore, monthly reports display the quality of data for the month and the year, with the intention to ensure at least 90% complete data for the regulatory reports. The first stage of analysis is in terms of the amount, duration, and pattern of missing data. Sites with low data quality are identified by either a large proportion of missing data (more than 10% of the reporting period), a consistent recurrence of missing data, a recent deterioration of otherwise good data quality, or frequent small patches of missing data. Any of these issues can lead to investigation and potential change in telemetry setup including retroactive update of data from other sources.

The next data check is concerned with the comparison of spills with rainfall. This involves analysis of spill change month on month with rainfall change month on month as well as overall correlation between spills and rainfall. Sites can be identified as having issues if they have an established relationship between spills and rainfall but have recently had spills that are not in line with this relationship. This can trigger an investigation into whether the spills are genuine and, if they are, whether there is an external cause for the spills, such as a recently developed blockage.

Site investigations are also triggered by spill numbers, with 20 spills being the maximum number of spills any site is allowed before an investigation is triggered. A number of sites (172 in 2017) also have more limited trigger points that can be either 14 spills in the year or 5 spills between May 15th and the end of September. The site investigations following spill numbers are more comprehensive than those for poor data, not only investigating the telemetry at the site but also the operation of the site as a whole. These investigations will take all variables into account to identify the underlying cause of the spill numbers, which can be anything from simply more rainfall than the asset can handle to a blockage further along in the network. These investigations will then lead to a programme to fix the identified issues, with priority given to those with the limited triggers and the results of investigations and intended work for these being provided to NRW.

The above checks represent those that are used frequently. As data is collected throughout the year and for the purpose of regulatory reporting, other checks are also completed including the pattern and consistency of the spill numbers. This highlights sites that are performing inconsistently with historical performance, for example sites that have a history of spills that are showing readings of 0 for extended periods of time. These checks are completed less frequently in order to gather enough data to identify valid patterns to compare against.

Monitoring

Monitoring the effectiveness of the assets will be achieved in two principal ways. Firstly the intermittent will have storm discharge event duration and monitoring (EDM) installed to complement the existing remote monitoring already in place.

This monitoring will record the duration and number of CSO discharges in line with their EDM permit conditions as well as the agreed methodology for calculating the number of CSO operations. DCWW will report the data to NRW at the end of February each year or in response to specific requests. In addition to this requirement, DCWW will also carry out an annual comparison between the number of CSO discharges predicted by the hydraulic models for both catchments for the amount of rain recorded at the Penclacwydd rain gauge (or other mutually agreed source if the Penclacwydd rain gauge is not available) and the actual number logged and report the results of this analysis each year to NRW. The need for this latter monitoring requirement will be reviewed after 3 years by NRW who will confirm if it is still necessary.