Dŵr Cymru Welsh Water

Rhymney Valley & Western Valley Strategic Improvements

Western Valley Tank & CSO

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1 Asset Summary

1.1 Asset Location

Western Valley Trunk Sewer Combined Sewer Overflow (Asset No.71682) is a screened CSO attached to the Western Valley Tank and discharges to the Severn Estuary. The tank (sometimes referred to as LG Tank) and CSO are located within an industrial park south-west of Duffryn, within a car park of the former LG factory on Celtic Way.

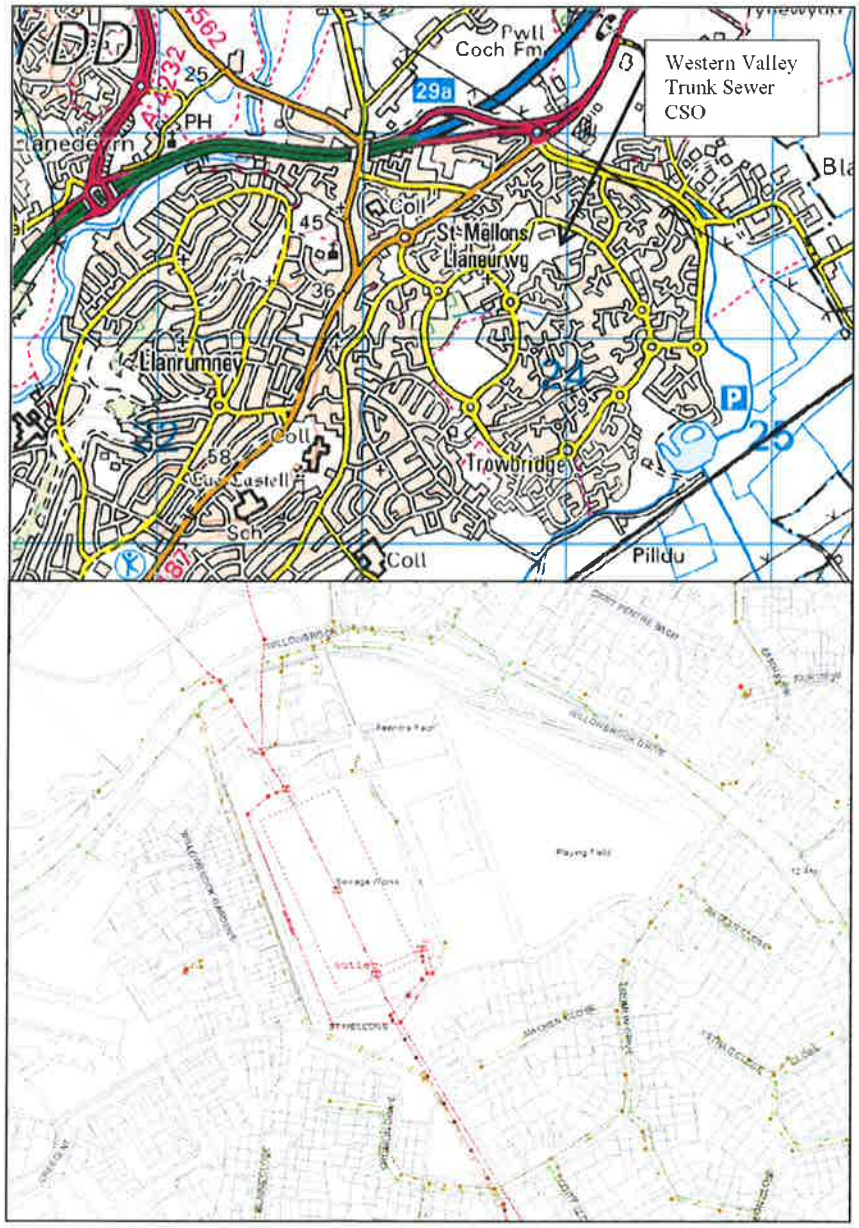


Figure 1: (a) Western Valley Trunk Sewer CSO Location Map, (b) Sewerage Arrangement of Western Valley Tank and Trunk Sewer CSO

1.2 Catchment Strategy

The Western Valley Tanks were constructed in 1965 when the Western Valley Trunk Sewer discharged directly into the Severn Estuary. The tanks were constructed to store flows at high tides when the Western Valley Trunk Sewer outfall was tide-locked.

In 2000, the Cardiff Interceptor Sewer and Cardiff Wastewater Treatment Works (WwTW) were built to intercept and treat the four crude discharges into the Severn Estuary from the catchments of Cardiff Central, Cardiff East, Rhymney Valley and Western Valley. At the same time, the Western Valley Tanks were converted to storm storage tanks and a CSO constructed.

The catchment strategy is outlined in 'The Integrated Waste Water Treatment Works and Sewerage Feeder System Operational Document for Cardiff' (Hyder, 13 February 2002).The main points of the strategy in relation to the Western Valley are described below:

- Flows up to design FFT (6.057m^3/s) will receive preliminary and secondary treatment at Cardiff WwTW.
- Cardiff Eastern, Rhymney Valley and Western Valley flows for treatment are discharged into a common interceptor sewer of some 10km in length, which extends from the Western Valley to the Inlet Pumping Station at Cardiff WwTW.
- The stations at Cardiff Central, Cardiff Eastern, Rhymney and Western Valley receive and manage their respective catchment flows, allowing only the design pass forward flows to pass for treatment at the works, whilst also managing any excess storm flows through a combination of storage, screening and pumping prior to sea discharge.
- The design pass forward values for treatment at Cardiff WwTW are shown below:

Table 1 – Design pass forward flows for treatment at Cardiff WwTW

Cardiff Central	Cardiff Eastern	Rhymney Valley	Western Valley	Total
1,260l/s	2,230l/s	1,109l/s	1,458l/s	6,057l/s

1.3 Asset Description

The Western Valley Tanks are approximately 23,000m^3 in volume. They consist of two rectangular sections, 381.6m long, 6.5m wide and 4.4m high. At a point one meter prior to the discharge point of both tanks an interconnecting automatic penstock (normally open) allows hydraulic balancing between the two tanks (hence they form one tank).

Electrically operated penstocks sized at 1500mm x 1500mm are located on the southern face of both tanks. These penstocks are normally open, with flows from the tanks passing into a common chamber containing one outgoing pipe sized at 1000mm. Immediately downstream of this common chamber a modulating

penstock is automated and powered by an Auma Actuator. This penstock in conjunction with a magnetic flow meter represents the primary flow control device for the system.

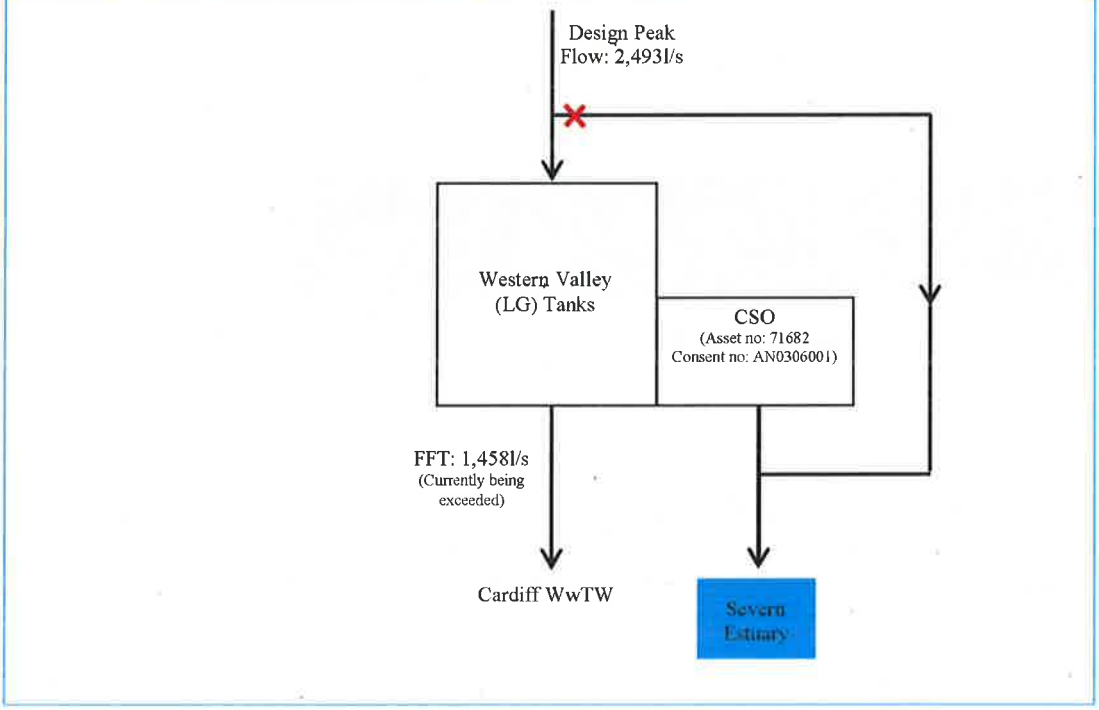
A CSO is attached to the east tank and has a weir level of 14m AOD. This CSO spills through a RoK 1 screen to the Severn Estuary. The screenings are returned to the flow to treatment sewer using a screenings flush penstock which opens for 2 minutes, every 30 minutes, to allow the collected screenings to be discharged into the flow to treatment sewer.

Upstream of the Western Valley Tanks a manhole chamber with manual penstock allows flows to bypass the tanks during maintenance. A 1050mm diameter pipeline links this chamber to the Western Valley Outfall. This bypass is used only in emergencies or during planned maintenance.

1.4 Designed Operation of Asset

When incoming flow is greater that pass forward flow, both tanks fill until the level reaches 14.0m AOD, at which point flows overtop a weir within an adjoining chamber in the eastern corner of the storage tanks. This CSO arrangement spills through a RoK1 screen and discharges to the Severn Estuary via the Western Valley Outfall. The screenings are returned to the flow to treatment sewer using a screenings flush penstock which opens for 2 minutes every 30 minutes to allow the collected screenings to be discharged into the flow to treatment sewer.

Existing Asset Schematic



1.5 Operational Issues

There are a number of operational issues with the Western Valley Tanks:

Sludge

The original method of cleaning the tanks after a storm event was to shut off the outlet to the tanks to allow the flow to build up upstream of the tanks. The outlet is then opened and the retained flow flushed the tanks. However, this mode of operation caused a plug of screenings to arrive at Cardiff WwTW leading to the blinding of the inlet screens. As a result of the blinding of the screens, the tanks have not been cleaned for a considerable period resulting in a build-up of sludge in the tanks. From the surface, it is estimated that the sludge is approximately 1m deep, although it is unclear whether this is simply a scum layer and the sludge extends even further.

Flow controls

At the tank, the magnetic flow meter which controls the actuated outlet penstocks is giving inaccurate and unstable readings causing the penstock to adjust or hunt continually and thus the penstock has been set in a fixed position.

These unstable readings are due to 'plug flow' where air is being entrapped by turbulence and the large air bubbles travelling along the soffit of the pipe in the direction of the flow through the flow meter. As flow meters are designed to operate in a single phase fluid, the plug flow causes the flow meter to give erroneous results.

CSO

The flow controls at the Western Valley Tanks have been altered to pass forward greater than the design pass forward flow of 1,458l/s following the flooding at Western Valley tanks in 2002. The flooding was caused by the CSO weir level being higher than the surrounding ground level and resulted in the car park tarmac above the tank lifting.

The original Micro Drainage model of the Western Valley did not accurately represent the CSO as it did not account for the CSO chamber being raised above ground level as shown in Figure 2.

Figure 2: Photograph of the location of the Western Valley Tanks and CSO

In normal operation, the weir level is very close to ground level and, in the event, that the screen fails, the water level could rise to between 133mm and 533mm above ground level.

On 26 May 2002, flooding occurred at the Western Valley Tanks. The main car park had lifted and water was flowing towards the main LG building. The flooding did not subside until the tank bypass line was opened and the pass forward flow reached over 2,000l/s.

An adapted model has been run with historical flow data during this event. The model shows that the tanks had been surcharged from 02:18 on 24 May 2002 until failure at 16:00 on 26 May 2002 and were under pressure. It is considered likely that the tank failed following prolonged pressurisation due to the weir level being very close to ground level.

In addition, the screen in the CSO chamber is a RoK 1, which was installed in a non-standard arrangement. The screenings are discharged back into the surcharged flow but do not clear properly. Eventually the screenings build up around the discharge arrangement and cause the screen to fail on overload and discharge unscreened storm flows. The 600mm x 600mm screenings flush penstock, which should open for two minutes every 30 minutes to allow the collected screenings to be discharged into the main flow to treatment sewer, also overloads the network causing flooding downstream.

Outfall

The actual capacity of the outfall from Western Valley Tanks is not known. The model shows that under surcharged conditions it can discharge approximately 1,340 l/s (during HAT). The outfall capacity will be reviewed and addressed if necessary as part of any future solution.

2 Consent

The conditions of the discharge consent for the Western Valley Tanks (Consent No: AN0306001) are briefly outlined below:

- Storm Sewage (Schedule No: AN030600101)

The Discharge shall occur when, and only for as long as, the storm sewage facility is fully utilised and the rate of flow at the storm overflow chamber is in excess of 1,458 litres per second due to rainfall and/or snow melt. The storm sewage facility shall be emptied and its contents returned to the pass forward flow as soon as practicable after cessation of the overflow.

A storm sewage facility of at least 13,183 cubic metres design capacity shall be provided and fully utilised prior to discharge being made.

- Sewage in an Emergency (Schedule No: AN030600102)

The discharge shall occur when the inlet pumps at Cardiff Wastewater Treatment Works are inoperative as a result of one or more of the following:

- Electrical power failure;
- Mechanical breakdown of duty and standby pumps;
- Rising main failure;
- Blockage of the downstream sewer.

A storm sewage facility of 13,183 cubic metres design capacity shall be provided and fully utilised prior to discharge being made.

The following standard consent conditions apply to both consents:

- The discharge shall have passed, without prior commination or maceration, through a mechanically raked screening device, having apertures no greater than 6mm in two dimensions.

- The 24 hours response telemetry alarm shall be maintained to provide a notification in the event of the failure of the screen raking mechanism during normal operation.

- A recording system shall be provided and maintained to record the frequency and duration of overflow events.

A copy of the consent is included in Appendix A.

3 Receiving Watercourse

Western Valley Trunk Sewer CSO discharges via a 1050mm diameter concrete pipe into the Severn Estuary at ST29548010.

4 Proposed Solution

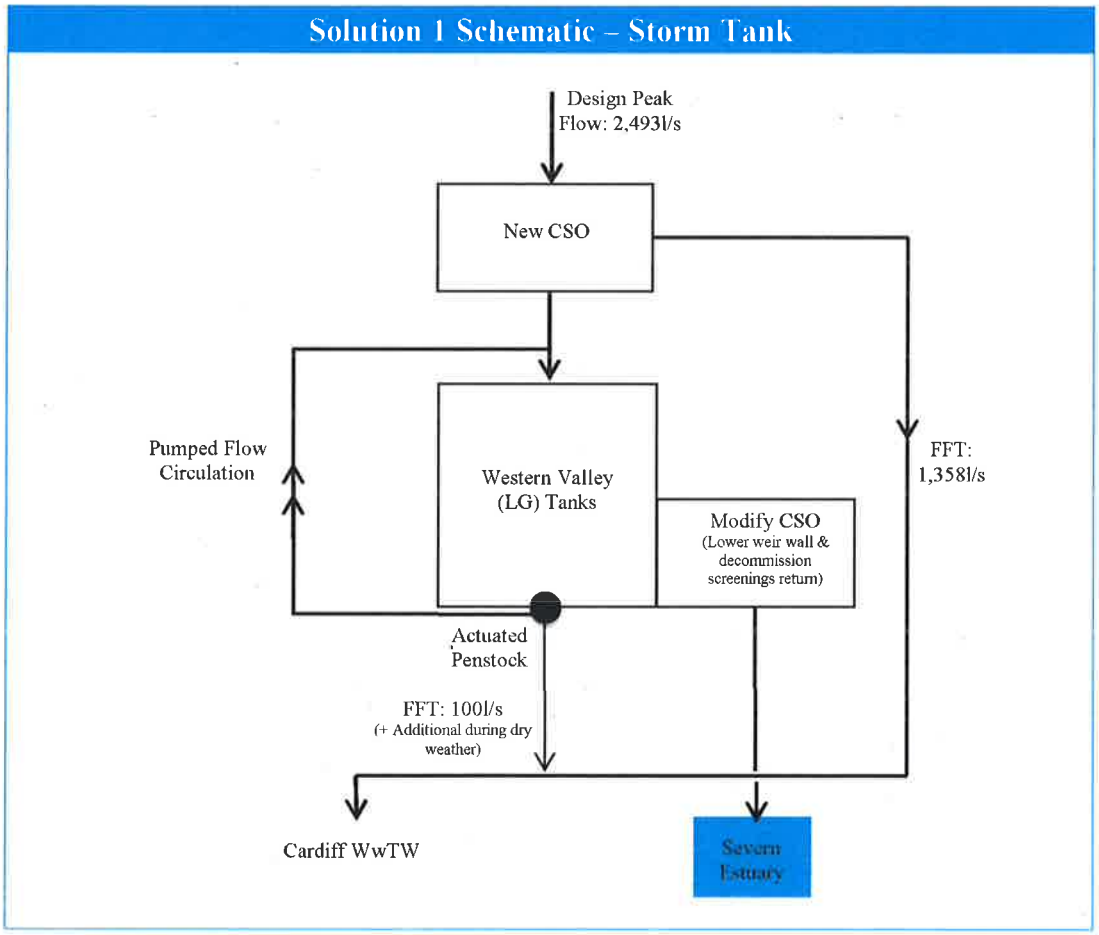
There are two feasible solutions for the Western Valley Tanks to address the operational issues. The first is a consent compliant solution with some drawbacks and the second an alternative solution which would need a variation to the existing consent.

Solution 1 – Storm Tanks (Consent Compliant)

This solution retains the existing storm tanks and comprises a new CSO with a powered RoK1 screen upstream of the tanks and a flow control which limits the pass forward flow to 1,358l/s. A new bypass line will connect the new CSO to the continuation sewer, whilst excess flows spill into the storm tanks. The solution also requires modifications to the existing CSO; including lowering the weir wall, removing the existing CSO screen and decommissioning the existing screenings return. In the event of the tank filling, the flow can spill over the weir and down the outfall into the Severn Estuary or in the case where the capacity of the outfall is beaten (or during a high tide) a level sensor would open the PFF penstock and increase the continuation flow; this is required to prevent flooding at the tanks or from the outfall.

In addition to the above, an actuated penstock will be installed at the downstream end of the tank to utilise the remaining 100l/s of capacity in the continuation sewer whilst draining down the tanks. A level sensor installed within each tank and a magnetic flow meter on the continuation sewer will allow the tanks to empty at higher flow rates during dry weather flow.

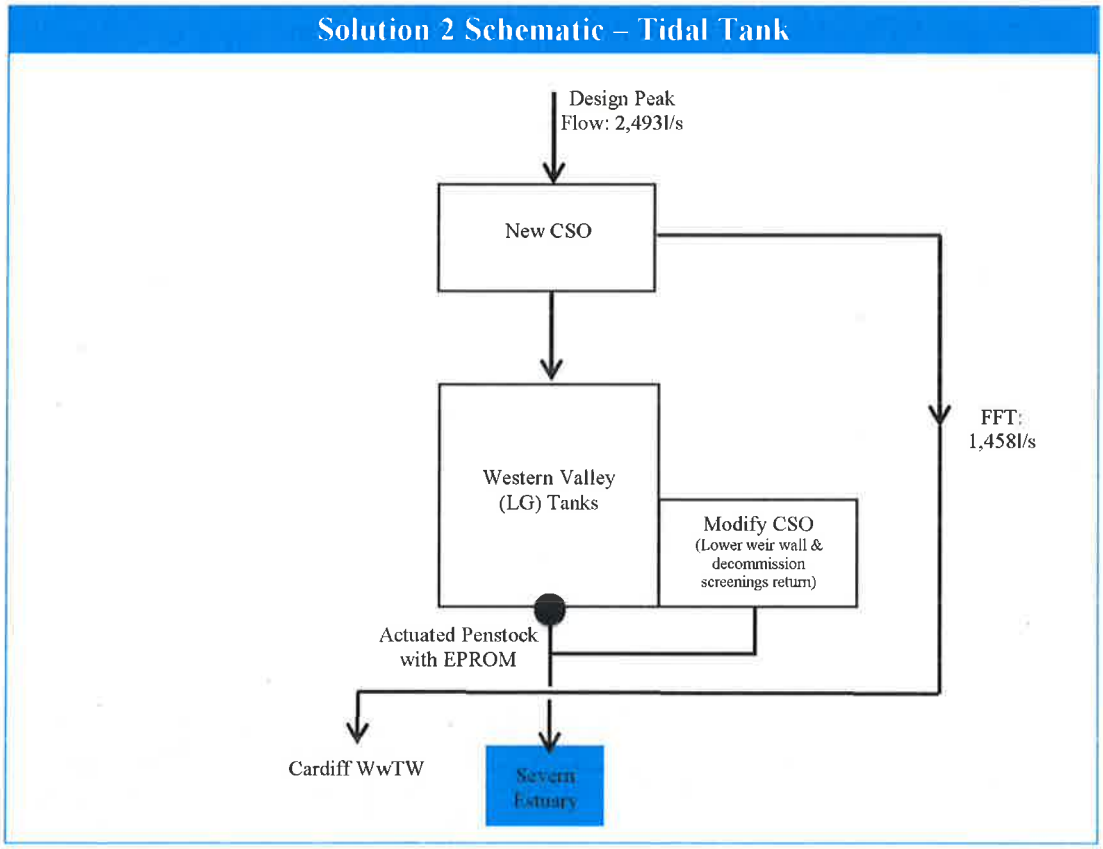
Solution 1 Schematic – Storm Tank



Solution 2 – Tidal Tanks (Variation to Consent)

This solution involves converting the existing storm tanks into tidal tanks (similar to the operation at Rhymney Valley Tanks situated 5km along the coast toward Cardiff) and comprises a new CSO with a powered RoK1 screen upstream of the tank which passes forward 1,458l/s into the bypass sewer around the tanks and spills the remaining flow into the outfall via the tanks. The bypass line will be connected to the continuation sewer. An actuated penstock (controlled by a pre-programmed EPROM) will be installed at the outlet to the tank and will shut during high tides to prevent surcharging of the outfall line and tanks, which could lead to flooding. When the tide drops sufficiently, the penstock will open to allow the stored storm flows to discharge. A new level sensor will be installed in each tank and a new magnetic flow meter will be installed on the continuation sewer to Cardiff WwTW. The actuated penstock, level sensors and magflow will be also linked to the SCADA at the works.

Solution 2 Schematic – Tidal Tank



Spill Comparison

Some analysis has been undertaken in order to compare spills and spill volumes from the Western Valley Tanks CSO and Cardiff Eastern District Pumping Station (Cardiff EDPS) if each option was implemented. These spill rates are based on an existing catchment model which is not verified. This has been used to provide a representation of the impact of both solutions on CSO spills. A single rainfall data set for April 2012 to April 2013 has been applied to the entire catchment. The assessment of additional spills at Cardiff EDPS has been based on

the spill duration at Western Valley CSO, and an assessment of the increase in flow required based on flows and pipe capacities.

The analysis suggests that by converting the tanks back into tidal tanks they will spill approximately 128 times per year from a screened CSO. This equates to a volume of 3,005,000m3 per year; roughly equivalent to the volume currently being passed forward to the interceptor sewer, which is contributing to the spills at Cardiff EDPS by a similar quantum. The additional spills from Cardiff EDPS are due to the capacity downstream of EDPS being taken up by the increased pass forward from Western Valley Tanks. Only a small amount currently spills in extreme rainfall events via the Western Valley Tanks Outfall. Therefore, by converting the tanks to tidal tanks and restricting the pass forward flow to the consented minimum PFF, this solution effectively spills the flow from the Western Valley Tanks outfall rather than Cardiff EDPS. The advantage of this is it reduces the impact on Jackson's Bay Bathing Beaches; Cardiff EDPS has a significant impact on the bathing beaches whereas Western Valley Tanks is approximately 12 km further east and does not have a significant impact on the bathing beaches.

The Storm Tank Option will spill from Western Valley Tanks Outfall fewer times than the Tidal Tank Option; approximately 92 times per year which equates to a volume of 2,233,000m3. However, there remain implications on Cardiff EDPS. Whilst the Storm Tank option spills less at Western Valley Tanks due to the large online storm tank, this tank will take time to drain down and can only drain down when the incoming flows are less than 1,458 l/s. Based on the incoming flows returning to dry weather flow conditions it would take a minimum of almost 10 hours to empty, which means the full tank volume will not always be available for the next rainfall event. This results in a much greater likelihood that the tanks will be full without sufficient capacity to spill the flows down the outfall. In this case additional flows will need to be passed forward to avoid flooding and consequently will end up again spilling at Cardiff EDPS. An estimate of the annual spill volume is 262,465m3.

In addition slow drain down will also result in similar operational problems to what is experienced at the moment including settlement in the tanks and potential high solid loads being passed forward to the works after a storm.

Table 2 - Spill comparison summary.

	Solution 1 Storage Tanks	Solution 2 Tidal Tanks
Spill Count per year	92	128
Spill Volume (m3/yr)	2,233,000	3,005,000
Additional Spill Volume from Cardiff EDPS (m3/yr)	262,465	0

Summary

The benefit of spilling more to sea at Western Valley Tanks via Solution 2 is that it does not contribute to the flow in the interceptor sewer, which itself leads to increased spills at Cardiff EDPS i.e. it spills at a point that is non-significant to the Jackson's Bay Bathing Beaches. In addition by allowing the WV Tanks to drain to sea they are guaranteed to empty and hence be ready for the next rainfall event. Also, as storm tanks, the system will not empty fully between storms, which may lead to the sewage becoming stagnant in the tanks. This may cause a re-occurrence of operational issues at Cardiff WwTW and odour issues within the vicinity of the tanks.

In view of the above, spill frequency from the Western Valley Tanks is not a true reflection of environmental risk as, converting the tanks into tidal tanks will see a reduction in spills from Cardiff EDPS.

Based on a high level assessment, the following can be said:

Storm Tanks:

- It would take approximately 10 hours for the storm tanks to empty into dry weather flow following subsidence of a storm (based on dry weather flow occurring immediately after storm subsidence);
- During this period, PFF from Western Valley Tanks would remain at 1,458 l/s;
- When the tanks are full (up to 92 times per year) there is the potential that flows greater than the minimum PFF will be passed forward to Cardiff EDPS. Resulting in an increase to spill volume from Cardiff EDPS of 262,000 m3 per year.

Tidal Tanks:

- PFF from the tanks would quickly reduce to an approximate dry weather flow following subsidence of a storm, as the tanks do not drain down into the dry weather flow;
- There is no 'lag' period of PFF following a storm;
- PFF will be kept to the minimum during storm events; this is due to the available capacity in the tidal tanks to store the flow for the duration of the storm/tide cycle. Resulting in a reduction to spill volume from Cardiff EDPS.

Recommended Solution

The recommended solution for the Western Valley Tanks is to operate them as tidal tanks as per Option 2 above. This will increase the number of spills and volume of spill from Western Valley Tanks however it will reduce the spill volume from Cardiff EDPS. This also eliminates the risk of the tanks not emptying for long periods of time due to high flows as a result reduces the risk of the tank re-filling with settled sludge. This solution is not consent compliant and will require Natural Resources Wales to vary the consent; however this would bring it in line with Rhymney Valley Tanks which are consented as tidal tanks.