
DŴR CYMRU WELSH WATER

Developer Impact Assessment
August 2015

Gresford WwTW
396 house development impact

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EXECUTIVE SUMMARY

A study has been conducted to assess the impact of a new housing development on the Dŵr Cymru Welsh Water (DCWW) Gresford wastewater treatment works (WwTW) in Wrexham. The proposal is for a development of 396 houses.

There is sufficient capacity in all process units to handle the future flows and loads with the exception of the storm tank. (Table 1), however this requirement is not attributed to the development. The WwTW can accommodate the development without a developer contribution.

Table 1 Process upgrades required to meet design guidelines for the current shortfall and developer impact

	Additional capacity required		
	Currently required	Developer impact	Total
Primary settlement	0 m ³ 0 m ²	0 m ³ 0 m ²	0 m ³ 0 m ²
Biological filtration	0 m ³ 0 m ²	0 m ³ 0 m ²	0 m ³ 0 m ²
Humus settlement	0 m ³ 0 m ²	0 m ³ 0 m ²	0 m ³ 0 m ²
Activated sludge plant	0 m ³ 0 m ²	0 m ³ 0 m ²	0 m ³ 0 m ²
Final settlement	0 m ³ 0 m ²	0 m ³ 0 m ²	0 m ³ 0 m ²
Storm Tank	589 m ³	0 m ³	589 m ³

The assessment has found that:

1. There is headroom in the primary settlement tank (PST) capacity. No capital investment recommended
2. There is headroom in the biological trickling filter capacity. No capital investment recommended
3. There is headroom in the humus settlement capacity. No capital investment recommended.
4. There is headroom in the oxidation ditch Activated sludge plant (ASP) capacity. No capital investment recommended.
5. There is headroom in the final settlement capacity. No capital investment recommended.
6. Sludge production will increase slightly, however the current pumping and thickening equipment can be operated for a slightly longer duration to meet future requirements. No investment recommended.

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1 INTRODUCTION

Grontmij has been commissioned by Dŵr Cymru Welsh Water (DCWW) to undertake a Development Impact Assessment (DIA) to determine the potential impact of a new housing development of 396 properties on Gresford wastewater treatment works (WwTW).

An assessment of the WwTW performance at the existing flows and loads was conducted, and the required process capacity to perform within DCWW design guidelines presented. The development impact was then assessed.

This report covers the findings from the DIA and recommends the process upgrades required to meet DCWW design guidelines.

2 BACKGROUND

2.1 Gresford WwTW

The works is gravity fed to an inlet pumping station, where flow is lifted to an elevated inlet works. Storm and site returns are also pumped to the inlet chamber. This combined flow gravitates through a storm separation chamber with overflow weir (to the onsite storm tank), and then gravitates through two duty escalator screens. Screenings are removed through the screenings handling systems. Screened crude sewage is then split, 70 % to the activated sludge plant (ASP) stream and 30 % to a trickling filter stream, in a flow distribution chamber (FDC). Ferric sulphate is dosed into the FDC to remove phosphorus in the ASP and filter stream primary settlement tanks (PSTs).

Screened crude sewage gravitates directly to 2nr oxidation ditch ASPs. ASP effluent is clarified in 2nr radial flow final settlement tanks (FST's) with half bridge scrapers.

Screened crude sewage also gravitates through 2nr radial flow PSTs with half bridge scrapers. Settled sewage then gravitates to the filter dosing chamber and is split between 4nr rectangular biological trickling filters with mechanical distribution drives. Filter effluent passes to a FDC splitting the flow between 2nr radial flow humus settlement tanks (HSTs) with half bridge scrapers. ASP and filter plant effluent is blended in the final effluent chamber, and passes through an MCERTS flow meter before discharge to the River Alyn.

The existing process unit sizes are set out in Table 1. Process unit volumes were provided by DCWW and dimensions gleaned during a site survey.

Table 1 Process unit sizes for Gresford WwTW

	Quantity	Total Volume, m ³	Total Surface area, m ²	Comments
Parkwood screen	2	-	-	Screen and screenings handling system
Radial flow primary settlement tank	2	497	190	Auto de-sludge to 3 % dry solids.
Rectangular Biological trickling filter	4	2,808	5,079	51.8 m long, 13.6 m wide, 1.8 m deep and mechanically driven.
Radial flow humus settlement tank	2	442	176	Auto de-sludge at 0.6 % dry solids to humus sludge pumping station.
Oxidation ditch	2	3,000	-	Oxidation ditch with operating MLSS of 3,500 mg/l
Sludge buffer tank	1	-	-	An old digester run-off tank will be converted to a sludge buffer tank in August 2015.
Drum thickener	1	-	-	To be installed in August 2015. Throughput is unknown.
Thickened sludge holding tank	1	-	-	An old sludge holding tank will be converted to a thickened sludge holding tank in August 2015
Storm tank	1	612	-	-

Installation of a duty drum thickener is planned for August 2015 and will be operational when the development begins discharging. Hence, this sludge treatment stream has been included in this assessment. Humus sludge, surplus activated sludge (SAS) and primary sludge will be automatically removed by de-sludge valves, and fed to a sludge buffer tank upstream of a single duty drum thickener. Sludge thickened to 6% dry solids will be fed to a thickened sludge storage tank. The capacity of the sludge tanks and throughput of the thickener are unknown, so the requirements have been defined in this assessment. Thickening liquors will flow to the site returns pumping station, and returned to the inlet chamber.

2.2 Current flows, loads and consents

Flow data from the MCERTS flow meter was made available for the period 1st June 2014 to 1st June 2015 (Figure 1). This data was used to derive the true flows to treatment for the catchment.

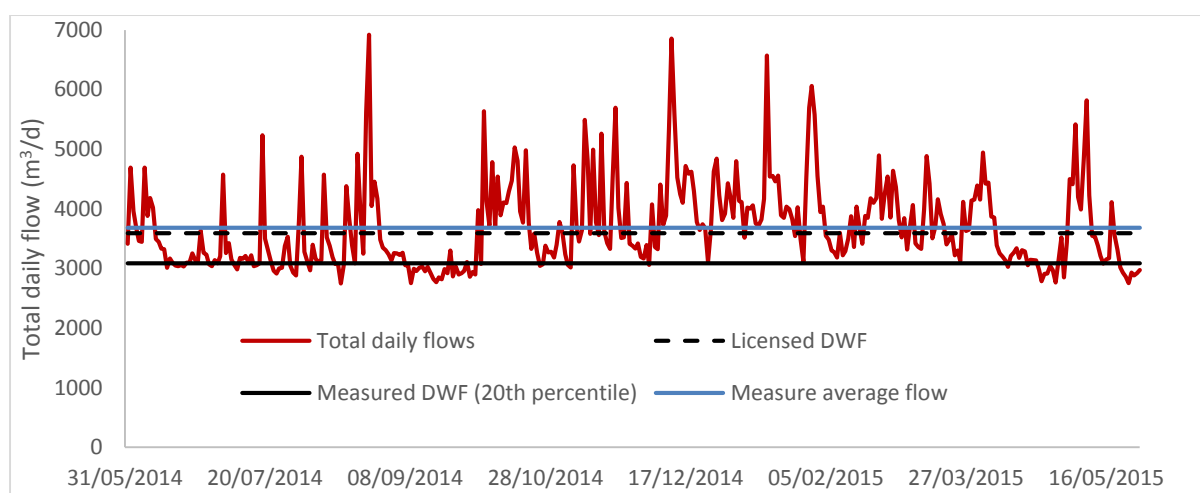


Figure 1 Final effluent daily flow data from June 2014 to June 2015

Gresford WwTW is covered by Consent No. CM0040601 dated 17th May 1988 reviewed under Schedule No. CM0040601 01/F dated 31st December 2005, permitting discharge to the River Alyn (Natural Resources Wales, 2005). In determining compliance, the 20th percentile flow of 12 months has been taken as DWF. Over the 12 month period, DWF did not exceed the licenced DWF (Table 2; Figure 1).

Table 2 Consented flows and loads for final effluent at Gresford WwTW and measured final effluent quality from operator self monitoring regulatory samples

	Regulatory consent	Current Performance
Population equivalent	-	17,661
DWF, m ³ /d	3,590	3,087
Average flow, m ³ /d	-	3,683
Infiltration, m ³ /d	-	318
FFT, m ³ /d	9,677	9,418
Biochemical oxygen demand (BOD), mg/l	30	11.0*
Total suspended solids (TSS), mg/l	45	26.5*
Ammoniacal nitrogen (AmmN), mg/l	7	5.9*
Total Phosphorus (TP)	1	1
Aluminium (Al)	1	0.12

Iron (Fe)	5	2.6
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*based on 95 percentile concentrations

The current crude sewage loads to the works are set out in Table 3.

Table 3 Current loads to Gresford WwTW based on population equivalent and trade effluent load

	Crude sewage loads
BOD, kg/d	1,425
TSS, kg/d	1,376
AmmN, kg/d	137
P, kg/d	44

Final effluent quality data has been obtained for the period June 2014 to May 2015. Over the 12 month period, the process has performed within consent based on operator self-monitoring (OSM) regulatory samples (Figure 2;

Table 4).

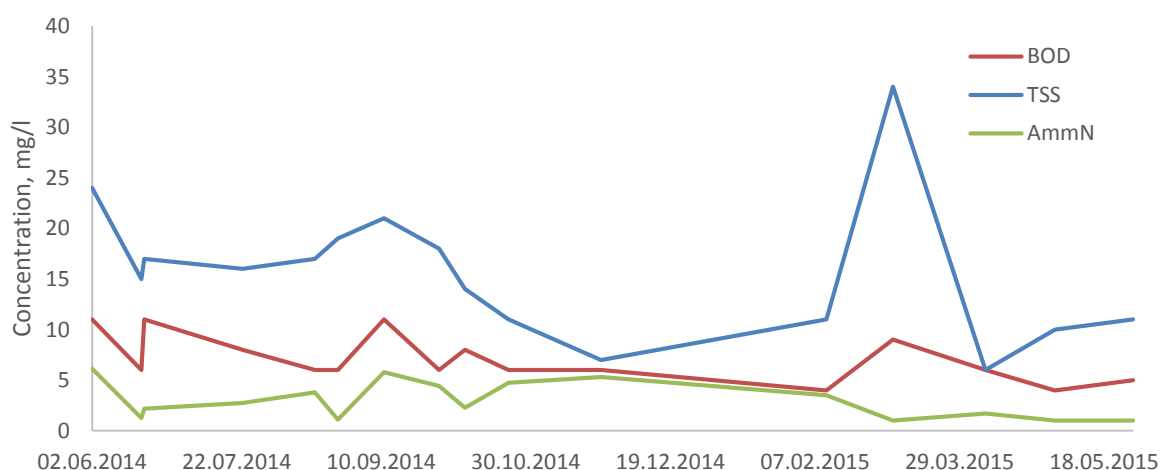


Figure 2 Operator self-monitoring (OSM) regulatory sample data for period June 2014 to May 2015

Table 4 Summary of final effluent OSM data

Parameter	Average mg/l	95th percentile mg/l	No. consent failures	No. samples
BOD	7.1	11.0	0	16
TSS	15.7	26.5	0	16
AmmN	3.0	5.9	0	16

2.2 Process unit headroom assessment

The existing process units were assessed against current flows and loads to determine if there is any available headroom. At current peak flow to treatment (PFT), defined as consented FFT plus the site returns, there is capacity in all process units with the exception of the storm tank (Table 5).

The thickener throughput and sludge storage volumes are unknown so have been defined in this assessment based on current flow and load requirements (Table 5). A 20 % uplift was added to the required throughput to calculate the design throughput as per design guidelines. If the installed thickener meets the required throughput, it will be capable of processing the sludge within 6.7 hours per day.

Table 5 Assessment of current primary and secondary treatment process units at peak flow to treatment (PFT).

Parameter	Design Standard	Actual	Compliant
<u>PST</u>			
Design hydraulic loading rate (HLR_{design}), m/h	1.50 (DCWW, 2014)	0.65	Y
Minimum hydraulic retention time (HRT_{min}), h	2.00 (DCWW, 2014)	3.77	Y
Process volume, m ³	248	467	Y
Process area, m ²	83	190	Y
<u>Trickling filter</u>			
Design organic loading rate (OLR_{design}), kg-BOD/m ³ .d	0.07 (DCWW, 2013a)	0.04	Y
Process volume, m ³	3,085	5,079	Y
Process area, m ²	1,705	2,808	Y
<u>Humus tank</u>			
HLR_{design} m/h	1.20 (DCWW, 2013a)	0.70	Y
HRT_{min} h	2.00 (DCWW, 2013a)	3.59	Y
Process volume, m ³	246	442	Y
Process area, m ²	103	176	Y
<u>Oxidation ditch</u>			
F:M, kg-BOD/kg-MLSS/d	0.10 (DCWW, 2011)	0.10	Y
Sludge age, d	10 (DCWW, 2011)	8.5	N
Aeration volume, m ³	2,928	3,000	Y
<u>Final settlement tank</u>			
HLR_{design} , m/h	1.20 (DCWW, 2011)	0.46	Y
Process area, m ²	352	628	Y
MLSS capacity, mg/l	4,655	3,500	Y
<u>Drum thickener and sludge storage</u>			
Sludge buffer tank volume, m ³	761	-	-

Drum thickener throughput, m ³ /h	30.1	25.1	-
Thickened sludge storage volume, m ³	131	-	-
<u>Storm storage</u>			
Storm tank volume	1,201	612	N

Storm storage was calculated based on a per capita provision of 68 l/hd/d. the existing storm tank at Gresford does not meet the minimum requirements.

2.3 Future flows, loads and consents

Future flows and loads were derived assuming a per capita water consumption of 180 l/hd/d and per capita loads of 60 g-BOD/hd/d, 8 g-AmmN/hd/d and 75 g-TSS/hd/d (DCWW, 2011a). Additionally, a future infiltration factor of 10% was applied (DCWW, 2011a). This was conducted for the respective population derived from the assumption of an occupancy rate of 2.4 inhabitants per property (Table 6). The new developments are assumed to have separate foul and storm sewerage, and hence a 1.3 factor for misconnections and infiltration was applied. Future development DWF and FFT was assumed to be:

$$\begin{aligned}\text{Future development DWF} &= PG + I + E \\ \text{Development FFT} &= 1.3 \times \text{development DWF} \\ \text{Future Total FFT} &= \text{Current consented FFT}\end{aligned}$$

Where, P = population
G = Per capita domestic water consumption = 0.18 m³/head/d
I = Infiltration as a percentage of PG = 10 %
E = Trade effluent (not applicable to the catchment)

Table 6 Flows and loads from planned development

Number of domestic connections	Population equivalent	Development flows and loads (DCWW, 2011a)					
		DWF m ³ /d	FFT m ³ /d	BOD kg/d	TSS kg/d	AmmN kg/d	P, kg/d
396	950	188.2	239.5	57.0	66.5	7.1	2.4

The derived future flow and load increases (Table 6) were then applied to the current DWF and FFT conditions at Gresford WwTW (Table 7). Generally, if there is an increase in DWF of more than 8 % over consent then the regulator may review the effluent quality consent standards, to ensure there is no increase in load under the “no deterioration principal”. In this case consented DWF is not predicted to be exceeded in the future (Table 7), hence a tighter consent is not likely to be imposed.

The required drum thickener throughput is within the theoretical design uplifted throughput of 30.1 m³/h. Hence, the thickener should be capable of processing the future sludge volume within 5.7 hours per day, well within the 8 hour design operating duration. It is assumed that the thickening liquors will be return to the head of the works via the site drainage pumping station. At present, this returns to the inlet chamber, upstream of the storm overflow. To prevent thickening liquors being passed to the storm tank the return point should be relocated downstream of the storm separation.

Table 7 Breakdown of future flow derivation for future flow to existing process capacity at Gresford WwTW. The crude sewage loads and loading rates to existing process units at PFT are included

Future flows	
Total future DWF, m ³ /d	3,275
Total future average flow, m ³ /d	3,908
Total future FFT, m ³ /d	9,677
Total future PFT, m ³ /d	9,873
Future crude sewage loads	
BOD, kg/d	1,482
TSS, kg/d	1,443
AmmN, kg/d	144
P, kg/d	47
Future loading rates at PFT for existing process unit sizes	
PST HLR _{actual} m/h	0.65
PST HRT, h	3.77
Filter bed OLR _{actual} kg-BOD/m ³ .d	0.04
Humus tank HLR _{actual} m/h	0.70
Humus tank HRT, h	3.59
ASP F:M, kg-BOD/kg-MLSS/d	0.08
ASP Sludge age, d	10.1
FST HLR _{actual} , m/h	0.46
FST MLSS capacity, mg/l	4,660
Drum thickener throughput, m ³ /h	21.4
Predicted future consent	
BOD, mg/l	30
TSS, mg/l	45
AmmN, mg/l	7

2.4 ASP nutrient check

Currently, the phosphorus load to the ASP is 2.5 kg/d accounting for removal by ferric sulphate dosing. Based on the BOD:N:P ratio of 100:5:1, the ASP requires 10.4 kg/d of phosphorus for BOD and AmmN removal and this will rise to 10.7 kg/d in the future. The required ferric sulphate dose is calculated based on the final effluent phosphorus load to meet the consented average of 1 mg/l, and the proportion of ferric sulphate dosed to each stream is directly related to the influent flow to each stream. The ASP nutrient requirements are not taken into account, and as such there is insufficient phosphorus in the ASP feed.

An alternative method is to firstly calculate the phosphorus requirements for treatment in the ASP and tailor the ferric dose to each stream accordingly. Using this method for the future load, the ASP requires a ferric sulphate dose of 232 kg/d and the PST requires 368 kg/d. Modifications to the ferric sulphate dosing arrangement are recommended so that each stream has its own dosing point. With these modifications and tailoring the phosphorus removal in each stream, there will be no requirement to dose additional phosphorus to the ASP.

2.5 Mixed liquor suspended solids and aeration requirements

To meet the design sludge age of 10 days and F:M of 0.1 kg-BOD/kg-MLSS/d the MLSS in the ASP should be raised to 4,300 mg/l. This is within the solids handling capacity of 4,660 mg/l for the FST's.

There is one duty and one standby blower installed onsite meeting the current peak airflow requirement of 4,899 m³/h. The development accounts for a 7.5 % increase in peak air requirements and hence is unlikely to have a significant impact on the blower requirements.

3 FUTURE REQUIREMENTS

The required additional process capacity to meet the design guidelines (Table 5) is set out in Table 8.

Table 8 Process upgrades required to meet design guidelines for the current shortfall and developer impact

	Additional capacity required		
	Currently required	Developer impact	Total
Primary settlement	0 m ³ 0 m ²	0 m ³ 0 m ²	0 m ³ 0 m ²
Biological filtration	0 m ³ 0 m ²	0 m ³ 0 m ²	0 m ³ 0 m ²
Humus settlement	0 m ³ 0 m ²	0 m ³ 0 m ²	0 m ³ 0 m ²
Activated sludge plant	0 m ³ 0 m ²	0 m ³ 0 m ²	0 m ³ 0 m ²
Final settlement	0 m ³ 0 m ²	0 m ³ 0 m ²	0 m ³ 0 m ²
Storm Tank	589 m ³	0 m ³	589 m ³

All process units are adequately sized for future flows and loads, with the exception of the storm tank. Therefore, the assessment has established the following:

1. As the future flow is within FFT consent, the existing inlet screen will be adequate for future flows and loads. No capital investment required.
2. The storm tank is inadequate for future flows. An additional 589 m³ is required in the future. As the development is assumed to have a separate sewer system, it has no impact on the storm storage requirement,
3. There is headroom in the primary settlement capacity. No capital investment recommended
4. There is headroom in the biological trickling filter capacity. No capital investment recommended
5. There is headroom in the humus settlement capacity. No capital investment recommended.
6. There is headroom in the oxidation ditch ASP capacity. No capital investment recommended.
7. To meet the DCWW design standard sludge age of 10 days, the operating MLSS should be raised from 3,500 mg/l to 4,300 mg/l.
8. There is headroom in the final settlement capacity. No capital investment recommended.
9. Sludge production will increase slightly, however proposed pumping and thickening equipment can be operated for a slightly longer duration to meet future requirements. No investment recommended.

10. The future impact on the humus return pumps will be minimal. Return flows are expected to increase from 20.2 m³/d to 21.0 m³/d. Hence, the current pumps can be utilised, and operated for a slightly longer duration to meet future requirements.
11. There will be no future impact to the return activated sludge pumps as DWF is within consent.
12. The ferric sulphate dosing arrangements should be modified such that 232 kg/d is dosed into the ASP and 368 kg/d is dosed into the PST. This will ensure compliance with the 1 mg/l phosphorus consent and satisfy the nutrient requirements in the ASP.
13. Based on asset design specification, the drum thickener should be capable of 30.1 m³/h throughput. There is sufficient headroom in this to accommodate the actual future throughput of 21.4 m³/h, and process the daily sludge volume within 5.7 hours.

4 CONCLUSIONS AND RECOMMENDATIONS

The existing PSTs, trickling filters, oxidation ditches and FSTs are all adequately sized for the future flows and loads, hence no capital investment is required. The drum thickener will also be capable of processing the sludge so long as it meets the required throughput of 21.4 m³/h.

Additional storm capacity is required, however as the development is assumed to have a separate sewer system, it has no impact on the additional future requirement. Additionally, the ferric dosing arrangement should be altered such that each stream has its own dosing points, and dosing load reduced to satisfy the nutrient requirements of the ASP. At present, a surplus of 564 kg/d ferric sulphate is being dosed, and is leading to a phosphorus shortage in the ASP and excess chemical sludge.

With the recommended upgrades, the works will be capable of meeting the current consent of 30 BOD : 45 TSS : 7 AmmN : 1 P.

The Waste Water Treatment Works can accommodate the development and no developer contribution is required.

REFERENCES

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DCWW, 2011a. Process specification - General requirements for wastewater treatment. PS201 version 5.

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