IAP Response

Ref B2.12.WSH.CE.A1

Cwm Taf Water Supply Strategy IAP Response

1 April 2019

Contents

1. Cost efficiency challenge

We have carefully reviewed Ofwat's feedback on our cost adjustment claims, and in discussion with the Board and the CCG, considered how best to respond. In the case of the Cwm Taf Water Supply Strategy, we believe that we can provide clarifications and further evidence that substantially addresses the challenges and issues raised by Ofwat. This document provides that additional information, and in view of this, we have concluded that the total size of the original cost claim, £72.963m, is still justified.

The main challenges made in Ofwat's IAP assessment of our Cwm Taf Water Supply Strategy cost adjustment claim [WSH-WN601001] are:

- Lack of justification for treated storage size;
- The DWI enforcement notices do not have any actions that require a closure of the existing facilities or upgrades in the medium to long-term;
- The cost claim is partly (but not fully) covered in modelled base expenditure;
- A customer protection mechanism has not been fully defined.

Sections 2 to 10 considers each challenge in detail and presents the new information relevant to each.

2. Size of storage

2.1 IAP challenge

Extract from Ofwat's Cost adjustment claims feeder model [WSH-WN601001] – Need for investment test:

"The cost benefit analysis for the preferred option is not compelling as the preferred option includes a £42m storage improvement (160 Ml, 24 hours storage) with no justification (experience is that 8 hours storage at WTWs is more normal)."

2.2 Our response

The key point here is that the number of hours of storage depends on the flow rate used. Ofwat's contention that 8 hours is more normal is correct, but based on a lower assumed flow rate.

Storage volume – time equivalence

In the Cwm Taf Water Supply Strategy cost adjustment claim the storage volume of the new water treatment works was presented as 24 hours storage at average flow of 160 Ml/d. However, the maximum flow and usable water volume available during a period of routine maintenance affects the conversion from storage capacity (volume) to the number of hours.

When the storage time is calculated using the maximum flow of 225Ml/d and adjusted for:

- One tank being out of service for maintenance;
- Typical useable tank capacity of 70% of the total storage;
- The top 20% is used for demand variations through the day and the bottom 10% is unusable without impact on water quality and customer service.

The resultant usable, resilient storage volume is 74.2Ml (106Ml x 70%), equivalent to 8 hours at maximum flow 225 Ml/d.

Storage volume benchmarking

We commissioned Black & Veatch to produces an analysis of the appropriateness of the storage capacity proposed in the Cwm Taf Water Supply Strategy see Appendix 1: Black and Veatch - Merthyr WTW - WTW flow rate and treated water storage.

They benchmarked the proposed storage volume against other similarly sized works recently built in the UK and against our own Felindre water treatment works.

	Cwm Taf WTW	Glencorse WTW	Katrine WTW	Mayflower WTW	Felindre
WTW Maximum Flow Ml/d	225	175	240	90	240
Tank Storage volume Ml	160	90	160	20+50*	150
Storage as % of maximum flow	71%	51%	67%	77%	63%

Newly Built UK WTWs and their associated storage volumes

*20Ml is newly built storage (for 10ML/d direct feed) and 50Ml existing strategic storage immediately downstream.

Given the strategic importance of the Cwm Taf WTW within the South East Wales Conjunctive Use System (See Section 6: Resilience), the proposed storage capacity as a % of maximum flow does not appear excessive on a comparative basis.

3. DWI Notice

3.1 IAP challenge

Extract from Ofwat's Cost adjustment claims feeder model [WSH-WN601001] – Need for investment test:

"The 2 DWI enforcement notices do not have any actions that require a closure of the existing facilities or upgrades in the medium-long term."

3.2 Our response

On 27 March 2019, the DWI issued a notice that requires the decommissioning of the three existing works. The notice is provided in Appendix 2.

4. Maintenance adjustment

4.1 IAP challenge

Extract from Ofwat's Cost adjustment claims feeder model [WSH-WN601001 – Need for adjustment test

"The cost claim is partly, but not fully, covered in the modelled baseline."

Extract from Ofwat's Cost adjustment claims feeder model [WSH-WN601001] - Overall assessment result

"We also consider a saving in base maintenance will be achieved which has been calculated by using the proportion of deployable output that the new works capacity provides applied to the proposed average Maintaining the long term capability of the assets - non-infra spend of the company."

4.2 IAP response

We disagree with Ofwat's position that a £29.6m adjustment should be made to the claim for an implicit allowance in base maintenance.

First, we disagree in principle with the claim that a saving in base maintenance will be achieved. In fact, there will be no saving on base maintenance during AMP7. The elements of the two AMP scheme that will be delivered in AMP7 (storage and network connections) will not allow us to save on maintenance of the existing works, the output from which will be required well into AMP8. The cost we have included in the claim reflect the actual cost of delivering the AMP7 elements of the scheme, which will increase resilience as outlined in the investment case, but will not replace the existing works. We have included £10m of maintenance costs on existing works in our base costs for AMP7, to allow for the ongoing maintenance requirements of the existing works. This amount is reflective of the recent maintenance costs during AMP6, which were factored into Ofwat's modelled Botex allowance.

Secondly, should Ofwat be arguing that there should be a reduction in the base allowance during AMP7 to adjust for the future cost savings in AMP8 and beyond (which we do not accept is valid), we do not see how this could be larger than the £10m which is consistent with the quantum of the costs for base maintenance in recent years entered into the modelling (see table below). It doesn't make sense to argue that we will be 'saving' more than we have recently been 'spending'.

Thirdly, the rationale for Ofwat's calculation (the proportion of deployable output that the new works capacity provides applied to the proposed average Maintaining the long term capability of the assets - non-infra spend of the company) has not been explained and, we would argue, is not a valid basis for estimating the appropriate cost saving (if you accept that there is a cost saving, which we don't). Our reason for this is that the cost line 'Maintaining the long term capability of the assets - non-infra spend' includes a range of cost items that is not relevant for this calculation, including costs associated with, for example, pumping stations maintenance costs, and also costs of Business Information Systems/IT, overheads and other cost items not affected by the proposed WTW scheme. The proportion of the

'Maintaining the long term capability of the assets - non-infra spend' actually spent on water treatment works is c.67%. Of this amount approximately 50% is spent on assets with a short life, of less than 10 years, broadly equivalent to the £10m included in our base cost for AMP7.

£29.6m x 67% x 50% = £9.9m

Finally, we would argue that a portion of the future cost saving is captured in Ofwat's ongoing frontier efficiency shift. This is precisely the kind of long-term, multi-benefit and innovative scheme that companies will be required to make in order to 'keep up' with the proposed frontier shift.

The table below shows the total maintenance spend at each of the existing sites over the last five years (2017-18 prices), a total of £11.86m overall.

	Cantref	**Llwynon**	**Pontsticill**	**Total**
	£m	**£m**	**£m**	**£m**
2013-14	0.06	0.35	1.05	1.45
2014-15	1.46	0.37	0.83	2.65
2015-16	0.25	0.13	0.93	1.31
2016-17	0.11	0.60	2.70	3.41
2017-18	0.01	1.66	1.37	3.03
	1.88	3.10	6.88	11.86

The table below shows the split between enhancement and maintenance expenditure over AMP7 and AMP8. We accept that a saving to base maintenance will be achieved during AMP8 as we commission and bring into service the new WTW. For this phase of the project we recognise that around 55% of the total costs would be accounted for within base maintenance, as the expenditure will in part be in lieu of maintaining the long term capability of the assets.

	AMP7	AMP8	Total
Enhancement	£91m	£66m	£157m (64%)
Base	£0m	£89m	£89m (36%)
Pre-Efficiency Total	£91m	£155m	£246m
Post Efficiency Total	£73m	£124m	£197m

Full details of the maintenance costs are set out in Appendix 3 Merthyr Costs Summary spreadsheet.

5. Customer protection

5.1 IAP Challenge

Extract from Ofwat's Cost adjustment claims feeder model [WSH-WN601001] – Customer protection test:

"The project is still in its early phase and as such the risk mitigation and customer protection elements have yet to be fully defined."

5.2 Our response

We are making a change to our Business Plan to include a customer protection outcome delivery incentive (ODI) for the Cwm Taf Water Supply Strategy project. Full details of the measure are included in the revised Performance commitments definitions IAP response. It is intended to return in full to customers any allowed totex for the Cwm Taf Water Supply Strategy that remains unspent at the end of AMP7.

6. Resilience

6.1. IAP challenge

Extract from Ofwat's Cost adjustment claims feeder model [WSH-WN601001] – Need for investment test:

"The company states that the proposed WTW would improve resilience in the SEWCUS area compared to the existing situation due to the improved ability to undertake maintenance and treat deteriorating water quality (improved processes/ability to treat variable raw water quality, additional treatment and storage capacity). Insufficient evidence is provided to demonstrate the magnitude of the improvement hence the stated case for the resilience was weak and inconclusive."

6.2. Our response

<u>Our Resilience Plans for Cwm Taf WTW</u>

As the new treatment works will be replacing three existing sites, our plans have been formulated to ensure that we do not reduce the overall resilience of the SEWCUS system, and indeed strengthen resilience in some important respects. Building Cwm Taf WTW as three streams of treatment will eliminate any risk associated with single points of failure both during normal operation and during maintenance activities, thus replicating the resilience of having three separate sites.

The lack of final water storage at the existing Pontsticill, Llwynon, and Cantref works (4 hours, 2 hours and 1 hour at maximum flows respectively) has meant that maintenance work at these sites is hampered by needing to limiting shutdowns to a maximum of 4 hours. This has significantly impacted performance of the treatment works, increased the overall maintenance costs and contributed to service interruptions suffered by customers.

A three stream approach for the final water tanks at Cwm Taf WTW will allow full maintenance activities including short term cleaning, disinfection, minor repairs and full structural repairs without stored water volume falling below 8 hours of normal supply. This

will result in an improvement in the resilience of the assets and improved service to customers.

SEWCUS Network Resilience Benefits

In addition to the limited storage at the existing WTW sites, 7 downstream service reservoirs have less than 24 hours of storage with some under 12 hours. This makes repairs or maintenance on trunk mains significantly more challenging. The additional storage provided in the Cwm Taf scheme and its location within the network increases the resilience of the network overall and improves our ability to maintain the critical trunk mains.

Strategic Resilience Benefits

The new Cwm Taf WTW will provide significant strategic benefits across South Wales to enable us to mitigate against the risk of low likelihood and high consequence events. Three scenarios are considered below. The scenarios provide context for the resilience improvement achieved by the proposed works, and support the storage capacity selected and specific configuration of the assets. More detail can be seen in Appendix 6 Resilience Report.

Scenario 1 - Loss of Felindre WTW due to a process or pollution incident

The Felindre WTW, to the West of the SEWCUS zone, is the largest capacity site across the Welsh Water area, feeding Swansea and the surrounding area. It is currently a single source of supply for over 130,000 properties and is at risk of short term shutdowns due to a process failure or pollution incident. In the event of a failure, (a pollution incident on the river source for example), this could result in a loss of up to 118 Ml/d at average flow or in excess of 200 Ml/day at maximum flow. The additional storage capacity at Cwm Taf WTW, linked with our Network Resilience project to transfer water between the SEWCUS and Swansea supply systems (East West Transfer), will provide some 30 Ml/d of additional resilience to both areas.

Scenario 2 – Severe weather impact on SEWCUS

During 2018 there were two events which affected water supply across South Wales: the freeze thaw in February/March and the summer drought period between May and August. During these periods the outputs from water treatment works were at maximum volume, using all the available raw water resources to meet demand. Had any one of the WTWs in SEWCUS failed during these periods there would have been insufficient network and water treatment storage to provide resilience to allow the recovery of the failed asset before impacting customers. Although an outage was avoided during the severe weather events in 2018, storage volume did reach extremely low levels. The additional storage provided under the Cwm Taf proposal would create significant additional resilience against this scenario. Further details are included in the Resilience Report Appendix 6.

Scenario 3 - Raw water quality event

The three raw water sources feeding the existing treatment works can experience a variety of different water quality events. Of particular note are the regular landslips that occur at our Cantref and Llwynon reservoirs. Currently, if such an event occurs, the affected works suffers a significant shutdown which causes problems in the wider network. The proposed

new works would rely on the same three sources, but it would allow the network to rely on storage in the short term while the affected water source is isolated or blended with water from the other sources. This would reduce the risk of the raw water events impacting final water quality.

7. Optioneering

7.1 IAP challenge

Extract from Ofwat's Cost adjustment claims feeder model [WSH-WN601001] – Best option for customers test:

> "The company has put forward a limited range of options for the investment case (do nothing, maintain only, replacing 3 or 5 existing WTW, different levels of treatment provision). A further option of replacing 8 WTW was ruled out on cost benefit grounds at an early stage in the assessment."

7.2 Our response

We do not accept that the optioneering process that resulted in the eventual preferred solution of the new Merthyr WTW was limited. As set out in the investment case [5.8E PR19IC: Cwm Taf Water Supply Strategy WSH] we went through an extensive and thorough multi-stage optioneering process. The first stage examined thoroughly the various options for dealing with the principal problem (taste and odour issues) while retaining the existing configuration of WTWs (options 1 to 4 below) versus some alternative scheme (option 5).

The initial assessment hence considered five options:

- Option 1: Do nothing
- Option 2: Alternative supply of water (none available)
- Option 3: Catchment management (only a partial solution)
- Option 4: Maintain and enhance existing sites (multiple possibilities considered, but all with significant drawbacks)
- Option 5: Abandon some or all existing works and build a new works elsewhere

The results of the first round of optioneering concluded that Options 4 and 5 were best placed to deliver the required outcomes, subject to a more detailed review a second stage. Detailed options were then considered for a new WTW (Option 5), which included:

- Consideration of up to 8 alternative processes at a new site;
- Options of replacing 3, 5 or all 8 existing works; and
- 3 alternative site locations

This culminated in a comprehensive review of a total of 76 different options. The most viable of the options generated were then compared against the option to upgrade and maintain the existing sites (Option 4) and the final proposal was selected based on the cost benefit analysis.

8. Robustness and efficiency of costs

8.1. IAP challenge

Extract from Ofwat's Cost adjustment claims feeder model [WSH-WN601001] – Robustness and efficiency of costs test:

"The cost estimates are based on the following:

a. Capex using the company's UCD to extrapolate existing data and as such should be considered as reasonable for a feasibility stage but not sufficiently robust for a decision making stage. It appointed BV in Sept 2017 (to April 2018) to review cost including a challenge of the UCD costs. BV has also used UCD data from its other projects for other Water companies. **There has been a 20% efficiency improvements included in the final costs but there was no evidence of the reasons for this**.

b. The company reports that opex costs have been based on existing data from similar sized WTW. The 40 year opex for the new WTW was calculated using the cost data for existing sites; chemicals, power, sludge and operator costs from Felindre WTW which has a capacity of 240Ml/d and an average output of 150Ml/d. **WSH does not state whether Felindre WTW has similar treatment processes. Also, would be better to have data from more than one site or from a process model for the proposed site**."

8.2 Our response

The majority of the project scope for the Cwm Taf Water Supply Strategy falls outside the range covered by our Unit Cost Database (UCD). In developing our cost estimate we followed a multi-stage process.

1. Initial costs were developed using our in-house unit cost models
2. An external engineering firm (Black & Veatch) were appointed to review the costs
3. The quantity surveying experts within our in-house UCD team undertook a further review of the scope and application to models that had been recommended by Black & Veatch.
4. Costs were benchmarked by Mott MacDonald Bentley (MMB), with comparisons across other companies

This iterative process improved the robustness of the cost estimates for this complex project. Further detail can be found in Appendix 7 Cost Benchmarking report. In respect of the efficiency improvements included in the final costs please see Ref 3.6 PR19 Costs: Efficiency, benchmarking and recovery Section 2.2.

<u>Felindre WTW as a Comparator</u>

Felindre WTW was selected as an Opex comparator because it has almost the same design and daily production capacity to that being proposed for the Merthyr WTW.

	Merthyr WTW	Felindre WTW
Maximum flow	225Ml/d	240 Ml/d
Average flow	118Ml/d	160 Ml/d

The treatment process at Felindre is almost identical to that proposed for the new WTW, including the following treatment stages: coagulation, flocculation, dissolved air flotation, rapid gravity filtration, granular activated carbon (GAC) and disinfection.

Merthyr WTW only differs from Felindre in that it will include an additional rapid gravity filtration stage, for Manganese removal which will allow the GAC stage to address taste and odour issues and will incur additional pumping costs for both raw and treated water.

Adjustments were made to the Felindre WTW base line cost to take account of the differences in processes and additional pumping costs.

Full details of the cost assessment for the project are included in the "Merthyr Costs Summary" (Appendix 3).

9. Clarification of Post Efficiency Value

We have identified an error in table Wn6, which may have caused some confusion in the assessment of our claim. This table showed a total of £74.996m. The correct figure of £72.963m was shown in our table WS2. We have corrected this in our table resubmission.

10. Affordability

9.1 IAP challenge

Extract from Ofwat's Cost adjustment claims feeder model [WSH-WN601001] – Affordability test:

"There was no real impact assessment provided on the affordability of this scheme to either the company or customers.

There is no evidence that it had calculated the impact on customer bills for this project."

9.2 Our response

The replacement of three difficult to maintain WTW with one new WTW with 160Ml of storage will provide long term cost savings compared to the costs of continuing maintenance and upgrades of the existing WTW for a 40 year period. Over the life of the assets this will result in lower customer bills than would otherwise have been the case. Because of this we do not feel it would have been appropriate or meaningful to test the short-term bill impact with customers, especially in the context of bills which were in any case declining significantly in real terms. Our overall PR19 business plan including the Cwm Taf Water Strategy resulted in a £22 reduction in customer bills. Customer acceptability testing of our plan found that 92% of our customers found the plan acceptable and 95% found it affordable.

Appendices

Appendix 1 – Black & Veatch: Merthyr WTW – WTW flow rate and treated water storage

Expertise & Collaboration

MERTHYR WTW

WTW FLOW RATE AND TREATED WATER STORAGE

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Revision	Prepared by	Checked by	Reviewed by	Authorised for issue	Issue date	Issue status
P0.1	P H Davies					

B&V Project No. 122459

Document Title: Merthyr WTW – Flow Rate and Storage Review

Document No. 122459-BVL-ZO-MR……

1 Background

Consideration towards a new treatment works in the Merthyr area commenced in 2013 following a strategic review of the investment needs for the existing water treatment works at Pontsticill, Llwynon and Cantref.

The output from the Black & Veatch review, issued between October 2013 and February 2014, indicated that expenditure on the existing assets over a period of 4 "AMPs", together with potential enforced requirement for taste and odour removal, would be equivalent to the cost of a completely new and comprehensive treatment works.

A limiting factor to further development at each site is the lack of available land to accommodate Granular Activated Carbon (GAC) contactors, for taste and odour reduction. By necessity these treatment stages would have to be constructed remote from the existing site locations, thus increasing the difficulties in control, introducing additional maintenance routines, duplicated plant and equipment, introducing new discharge consents and complicating the network distribution.

Because of land restrictions a subsequent conclusion was reached that indicated a single GAC contactor plant would be more cost effective and the only logical means of providing GAC contactors.

Having assessed the composite future investment requirements for maintaining the existing works and providing a new, remote GAC treatment plant, a logical step followed which was to assess whether there was economic benefit in providing a single new treatment works, with dedicated storage, against a separate and disconnected mix of new and old assets.

Initial and subsequent analysis confirms that a single, new treatment works at a new location was a more cost beneficial undertaking.

2 WTW Design Flowrate

2.1 Initial selection

Outline designs for scope and cost estimations were based on a nominal works production of 225Ml/d. This being the sum of the design capacities for the three main existing works, Llwynon, Cantref and Pontsticill.

Flow: cost sensitivity analyses were also prepared for 3 other flow rates, 200Ml/d, 242Ml/d and 264Ml/d. These flow rates were considered to be the potential production requirements for a new works relative to the potential number of existing assets that could be replaced, 3, 5 or 8. (Pontsticill, Llwynon, Cantref/Nantybwch, Carno/Hirwaun, Maerdy, Tynywaun)

- Studies carried out through 2015 concluded that an 8 works replacement scenario was not economic due to the cost of connecting the raw and treated water distribution systems.
- A 5 works replacement scenario was borderline on cost benefit and would depend on future network investment. This situation would be reviewed throughout the assessment process and into future years).
- A 3 works replacement was economically advantageous.

Design Capacity (Ml/d)	Flow rate source	Cost (WTW Only, CAPEX)
200	Lower sensitivity test. Peak Available capacity for 5 works	£106. 0million
225	Sum of 3 works	£112.5 million
242	Average Annual Licence	£121.5 million
264	Sum of 5 works	£125.0 million

Flow: Cost sensitivity Analysis at varying flow rates – WTW element only.

In the overall Capex/Opex calculations produced during then assessment, the main difference between 3, 5 and 8 works replacement was the additional Capex associated with distribution requirements. A 5-asset replacement would necessitate up to £35 million of additional pumping and trunk mains. An 8-asset replacement programme equated to over £50 million extra for additional pumping and distribution, at that point the 8-asset option was discounted from further assessment.

The flowrate of 225 Ml/d was agreed during previous investigations (October 2014) and is derived from the sum of the maximum design capacities of the three existing water treatment works – Pontsticill, Llwynon and Cantref.

A number of factors were considered when selecting the production requirement:

- Current Design and Abstraction Licences,
- Evidence to support the proposed demand rate of a 3 and 5-asset scenario,
- More efficient treatment costs,
- Centralised control,
- Off-site storage and alternative sources of supply,
- Onsite treated water storage requirements in relation to production,
- Resilience and ability to carry out planned and unplanned maintenance,
- Production turn-down requirements,
- Resilience during unmanageable risks – power, drought, freeze/thaw and transport,
- DCWW 2050 Vision,

The production rate should be sufficient to satisfy diurnal flow patterns and support other areas of the SEWCUS network.

The potential for reducing the 225 Ml/d flowrate was investigated and considered against providing a treatment works with a production rate of 200Ml/d.

In a straightforward Capex comparison, the difference between a 200 Ml/d treatment works and a 225 Ml/d treatment works is £6.5 million.

If however a 200Ml/d treatment plant was constructed and it was later deemed necessary or advantageous to increase the production capacity and/or maximise use of an economic raw water resource then the cost of extending the 200Ml/d treatment works to 225Mld/d is estimated to be in excess of £20million, minimum.

Therefore, constructing the treatment works with a design flowrate of 225Ml/d will be more cost effective than extending at a later date.

Cost was not the only factor considered within the extension option as some elements cannot readily be costed, these would include, for example, un-designing and re-designing the original three-stream concept in order to begin designing the extension which would be an additional process stream. Thereafter further difficulties would be encountered during constructing and commissioning the new assets when working alongside and connecting to an adjacent critical treatment plant.

The numerical advantage of a three stream process conveniently allows each of the process stages to be divided into equal numbers of process cells, giving 3, 6, 9, 12 or 15 interchangeable process units per stage, each based on 75Ml/d. In doing so, the layout and control system will be conceived to provide built-in resilience to failure and accommodate planned maintenance. Adding an extension would upset the very concept of the resilience built into the original three stream design.

Furthermore, if all the ancillary plant and equipment (chemical dosing, storage, wastewater treatment etc.) were originally designed for the lower production rate then all that equipment would need to be upgraded. The net cost of increasing production from 200Ml/d to 225 Ml/d would entail, therefore, not only a mathematically inappropriate addition to the three stream process but would involve

replacing the majority of the peripheral support plant including some of the high lift distribution pumps.

The most logical and economical way of producing a treatment works under these circumstances is to either design the works with two sets of design criteria so that the works can be extended later or to simply design and construct the works to the maximum capacity at the outset. Having double design criteria will lead to additional cost in the initial and subsequent phases and is not considered to be conducive to overall cost efficiency.

2.2 Outline Design Parameters

To test the initial selection of a 225Ml/d WTW capacity, a set of basic design parameters was agreed as follows;

- The ability to meet the maximum output requirements from the existing 3 sites, which is calculated as being 194 Ml/d and to have either
  - the capability to supply an additional 30 Ml/d for transfer from East to West in an emergency situation, or
  - allow a future abandonment of Nantybwch and Carno WTW, which currently have a maximum peak available capacity of 30Ml/d.

2.3 Existing design criteria and abstraction details.

The following table shows the current source, abstraction and design capacities for each works.

Each source would be retained and diverted to the new treatment works.

Works	Reservoir source	Licensed abstraction volume	Maximum design capacity
		Ml/d (annual average)	Ml/d
Pontsticill WTW	Upper Neuadd Lower Neuadd Pontsticill	109.4	105
Llwynon WTW	Beacons Cantref Llwynon	93.4	88
Cantref WTW	Beacons Cantref		32
		202.8	225
Nantybwch WTW	Shon Sheffrey	30	30
Carno WTW	Upper and Lower / Carno	9.1	9
		39.1	39
Totals		241.8	264

This table provides the current works capacities and the annual licence divided by 365 as an indication of the available water resource. There are no daily licence conditions related to the Taff Fawr or Fechan reservoirs so the peak abstraction licences will not constrain the production rate of the new works.

2.3.1 Historical Data:

From historical data, over a 12 month period during 2017, flow records indicate the following:

Ml/d	Pontsticill	Llwynon	Cantref	Total
Max	88	60	26	194
Average	63	48	14.7	126
Min	40	30	10	80

2.3.2 Forecasts:

WRMP figures received in December 2017 indicate:

Ml/d	Pontsticill	Llwynon	Cantref	Nantybwch	Carno	Total
Min	35.0	11.0	0.0	0.0	2.3	84.7
5th %ile	40.0	11.0	0.0	0.0	2.3	103.5
Mean	79.2	44.1	3.3	9.8	2.6	138.9
95th %ile	85.0	55.0	21.0	25.0	5.0	167.5
Max	85.0	55.0	21.0	25.0	5.0	175.7

Five works have been assessed within the WRMP table in order to include within the assessment the suitability of the works to accommodate Nantybwch and Carno, at a later date.

The probability of each treatment works operating at maximum output simultaneously has not been calculated. The possibility cannot however be removed from the assessment. If this situation did occur under circumstances when Nantybwch and Carno were incorporated then the demand could reach 194 + 30 = 224Ml/d.

The design capacity of 225 Ml/d indicates that the new works would operate at approximately 75% maximum capacity, increasing to approximately 86% if the two additional works (Nantybwch and Carno) are introduced. This utilisation is reasonable and would allow for planned and unplanned maintenance activities without increasing risk to water supply. Furthermore, it would be accommodated without the need to provide an extension to the works in future years (see above).

The above data and calculations supports the decision to select 225 Ml/d as the design criteria for the new works. It also supports the selection of a three-stream process (each 75Ml/d) with in-built resilience which can be called upon to support 150Ml/d if one stream were out of service, and the turn-down ratio of 3:1.

The WRMP figures include an uplift of 14% over current demand and it is understood these reflect the maximum deployable output for the supply and distribution system. If restrictions were removed it is also understood that deployable output could be increased. It is with this potential to remove network restrictions that the 225Ml/d figure has been retained at present.

Providing a treatment works with 225 Ml/d output would significantly benefit the network once improvement work has been made to deployment (network storage, pumping and main sizes).

In addition to the forecast design flow rate there are several important issues to consider regarding to sizing the new water treatment works;

- Raw water resource availability and licencing using Taf Fechan and Taf Fawr. There is sufficient water available to treat 225 Ml/d based annual abstraction licences without daily limits but constrained by rule curve.
- Water Treatment capacity that can meet the additional demand of Nantybwch and Carno in future without further extension to the existing treatment process.
- Ability to distribute the water through the strategic network (currently a constraint but is planned for improvement in AMP9 and beyond). Will be party addressed by the construction elevation of the new 160 Ml clear water tank
- Resilience in water supply and storage in north west SEWCUS providing the secondary benefit of enhanced resilience to other parts of SEWCUS network and, following strategic network improvements, to points further afield including Felindre WTW and the area to the West of Cardiff.

- Increasing the resilience of SEWCUS with the ability to supply an additional 50 Ml/d during an incident.
- The multi-streamed design of the new site would allow the ability to optimise operational costs and supply our customers with a resilient treated water supply optimised from least cost sources.
- Resilience will be further enhanced through future network development which could allow increased use of the new WTWs. Demand on the new works is currently constrained by:
    - The ability to distribute treated water past the Tongwynlais SRV;
    - If the network constraint were removed at Tongwynlais SRV this would reduce the need for Sluvad and Court Farm treatment works to supplement the area.
    - To meet any future demand through the potential West-East-West link, a strategy for the development of the strategic network is planned during AMP7 to identify strategic mains links and requirements to increase resilience of the South Wales.
    - The need for resilience against other works outages at any time of the year e.g. the loss of Sluvad or Court Farm. This also relates to the network and the ability to serve the SRVs beyond Tongwynlais.
    - The ability to carry out maintenance on the Taff Valley trunk main system. Treated water storage

2.3.3 Conclusion

The selection of 225 ML/d ahead of any other flow rate satisfies the outline design parameters indicated in 2.2 above.

The three stream approach to the treatment works and the storage tank provides enhanced resilience over a traditional operational approach.

The 225Ml/d figure maximises the availability of raw water source in the area and also allows for future expansion of the network to allow rationalisation of Carno and Nantybwch WTWs.

3 Treated Water Storage Tank Volume

3.1 Outline Design parameters

A number of factors were used to determine the basis for the storage volume that should be incorporated in the scheme:

- The treated water storage tank should support the network for approximates 24 hour storage at 95%ile deployable output from the 5 WTWs (see 2.3.2 above).

- An 8 hour minimum storage figure should be achieved under the following conditions.
    - One compartment of three out of service
    - A minimum operating depth of no less than 10%
    - A typical operating set point band for tank operation to be between 20% and 90% of full operating depth. Tank useable capacity under normal circumstances therefore 70%.

To satisfy these criteria, the calculation initial took the average flow from the combined works of 160Ml/d and applied this as a three compartment, 160Ml storage tank. This satisfied the 24 hour parameter.

A storage of 160Ml with one of three compartments out of serve provides the second requirement of 8 hours storage as shown below?

Tank Volume – 2 compartments of 53Ml	106 Ml
Operating depth	70%
Usable pumped volume	74.2Ml
Flow rate	225 Ml/d
Retention (storage) time	74.2/225 = 0.33 days = 8 hours

Calculation to determine minimum storage time at Max flow under maintenance.

3.2 Network Storage

Network storage was also reviewed to determine the supply characteristic away from the treatment works and storage tank with a view to determining the support that would be provided/required from a 160Ml storage tank and a 225Ml/d treatment works.

Storage within the network supplied by the new works is indicated below.

	Service Reservoir name	SRV Volume m3	Approx Retention hrs	Av draw m3/h	Against Av storage	Against Av Draw	Alternative Supply
Llwynon	Ty Canol	7000	30	233.3	108%	54%	Sluvad
	Tongwynlais	54000	20	2700.0	72%	620%	Sluvad
	Wenallt	67000	60	1116.7	217%	257%	Sluvad
Pontsticill	Pengarnddu	9000	11.5	782.6	42%	180%	None
High Level	Pengarnddu New	100	2	50.0	7%	11%	None
	Senghenydd	6800	22	309.1	79%	71%	Pontsticill Low Level
	Rhymney Bridge	4500	33.5	134.3	121%	31%	None
	Tafarnaubach	13500	34.5	391.3	125%	90%	Nantybwch
	Llwydcoed	7000	18.5	378.4	67%	87%	None
Pontsticill	Penybryn	9000	27	333.3	98%	77%	One tank mothballed
Low level	Abercynon	2045	55	37.2	199%	9%	None
	Gilfach Fargoed	9000	23.5	383.0	85%	88%	None
	Bedwas	9000	31	290.3	112%	67%	None
	Gwernau	9000	44	204.5	159%	47%	None
	Senghenydd	6800	22	309.1	79%	71%	Pontsticill High Level
	Cilfynydd	909	23	39.5	83%	9%	None
	Ty Gwyn	9000	14.5	620.7	52%	143%	None
	Tonteg	1800	12.5	144.0	45%	33%	Llantrisant new connection
	Llanilid	3200	38	84.2	137%	19%	Llantrisant new connection
	Llantrisant	5090	31	164.2	112%	38%	Cefn Hirgoed SR

	Service Reservoir name	SRV Volume m3	Approx Retention hrs	Av draw m3/h	Against Av storage	Against Av Draw	Alternative Supply
Total Volume		233744					
Max Draw/h	m3/h			8705.8			
Max draw / day	m3/d		24	208938.7			

A storage volume of 160Ml at the new works would provide support the entire system volume for 16 hours maximum, when full. When operating under 2/3rds capacity this would be reduce to just 11 hours.

Under emergency conditions, when alternative supplies are necessary, (red highlighted SRVs) the new tank would support the system for approx. 48 hours.

Tongwynlais SRV alone would need 1/3rd of a fully available 160Ml storage and 50% of the storage when one tank is out of service.

3.3 Storage conclusion

Based on the evidence available and provided above, the selection of a three compartment 160Ml storage tank would appear to be the most appropriate in the circumstances.

4 Comparison with other UK WTW built in recent years

	Merthyr WTW	Glencorse WTW	Katrine WTW	Mayflower WTW	Felindre
WTW Maximum Flow Ml/d	225	175	240	90	240
Tank Storage volume Ml	160	90	160	20+50*	150
Storage as % of maximum flow	71%	51%	67%	77%	63%

*20Ml is newly built storage (for 10ML/d direct feed) and 50Ml existing strategic storage immediately downstream.

As can be seen in the table above, the storage provided is broadly in line with a number of these other sites but offers significantly more resilience due to the three stream approach.

Appendix 2 – Draft DWI notice March 2019

guardians of drinking water quality

THE WATER SUPPLY (WATER QUALITY) REGULATIONS (WALES) 2018

NOTICE UNDER REGULATION 28(4)

DWR CYMRU: AMP7 Cwm Taff Water Treatment Works (WTW)

Version Number: V1

T67151: Cantref, T67149: Llwynon and T67034: Pontsticill.
WQZ: Y8120 Pontsticill Low Level

Legal Instrument Database Reference number: LI/DWR/2018/00001

THE WELSH MINISTERS:

1. have on 20 July 2018 received a report from Dwr Cymru (the "**Company"**) dated 30 May 2018 (the "**Report**") which states that there is or has been a significant risk of supplying water from Cantref, Llwynon and Pontsticill WTWs that is likely to be unwholesome and may constitute and danger to human health.

2. **GIVES NOTICE** to the Company under regulation 28(4) of the Water Supply (Water Quality) Regulations (Wales) 2018 that it must satisfy the following requirements:

   For risks associated with:
   - Taste and Odour
   - Raw Water deterioration
   - Resilience of supply
   - Regulation 26(4) - Design & continuously operate an adequate treatment process for the water source

Requirements	**Date until/by which requirements must be maintained/ satisfied (as appropriate)**
(a) to maintain the following measures for the period specified [in each case]	
i. Develop and implement mitigation action plans for raw water deterioration, and the presence of Geosmin and/or MIB above taste & odour thresholds in treated water leaving Cantref, Llwynon and Pontsticill, to include:	Ongoing

- Early initiation of Powdered Activated Carbon (PAC) dosing on reaching pre-defined triggers of concentration of Geosmin and/or MIB
- Use of company designed “critical parameter boards” with defined triggers and escalation processes
- Regular and routine reviews of customer contacts
- Raw water source management including use of alternative reservoir draw offs and technologies to reduce algal blooms and reservoir stratification

ii. Enhanced operational monitoring for taste and odour, for the water leaving Cantref, Llwynon and Pontsticill works, and within the water supply zones covered by this notice.

iii. Optimisation of current treatment processes within the operational limits that have an impact on taste and odour parameters.

iv. Continue water quality monitoring in the water supply zones supplied by Cantref, Llwynon and Pontsticill works.

v. Record, monitor and analyse consumer contacts received within the zones supplied by Cantref, Llwynon and Pontsticill works to examine trends and identify issues and as required for the DWI annual return. React to consumer contacts as appropriate.

vi. Liaison with local and public health authorities following on from any PCV failure, in line with company procedures.

(b) to review, revise and make operational the following measures, by the date specified below:

Short term measures:

i.	Inform an on-going raw water risk assessment by enhanced monitoring for taste and odour causing compounds	Ongoing from date of issue of notice
ii.	Develop a suitable audit strategy	30 April 2021

Long term measures:

iii.	Confirm the design and delivery programme for a single water treatment works (Cwm Taff) to replace the existing three assets (Cantref, Llwynon and Pontsticill).	By 31 March 2025
iv.	Construct and commission Cwm Taff works and complete associated network connectivity to facilitate the decommissioning of Cantref, Llwynon and Pontsticill WTWs	By 31 March 2030

(c) to audit whether the measures have been effective by the following means:

i.	Define and confirm the strategy for auditing the effectiveness of the above measures, to include: • Ensuring the current works are optimised for treatment of taste and odour causing compounds, and continue optimisation until the new works is fully operational. • Develop and initiate a commissioning plan for the new works. • Utilise results from the pilot trial of the new works to inform the outcomes of future decisions made. • Enhanced monitoring of taste and odour causing compounds at the supplying works, relevant downstream service reservoirs and from consumer taps within zones supplied from the works. Complete a monthly review of this data. • Develop and initiate an action plan for use when results from monitoring of works or zones covered by this notice are not within the expected ranges. • Target a reduction in customer contacts reporting taste and odour on supply as a result of the presence of MIB and Geosmin at concentrations above taste and odour thresholds. This will be measured through the annual submission of customer contacts to DWI as well as notification of events as appropriate.	All measures listed in (c)(i) by 30 April 2021
ii.	Improved resilience of supply demonstrated by fewer works outages that result in customer impact of loss of supply.	Demonstrated from 2030
iii.	Implement the audit strategy outlined **until this Notice is revoked.**	Ongoing

(d) to provide the following information in the time and manner specified below to enable monitoring of progress towards the mitigation of the risk of supplying water that may be unwholesome and may constitute a potential danger to human health:

i.	Provide a progress report annually by 31 January and against the following milestones:	Ongoing
ii.	Confirm the design and delivery programme for a single WTW (Cwm Taff) to replace the existing three assets (Cantref, Llwynon and Pontsticill)	30 April 2025
iii.	Construct and commission Cwm Taff WTW and associated network connectivity to facilitate the decommissioning of Cantref, Llwynon and Pontsticill WTWs	Complete each stage from 2025 onwards and complete by 30 April 2030
iv.	Review the risk assessment for Y8120 Pontsticill Low Level as required by Regulation 27(4) and subsequently submit a revised regulation 28 report accompanied by a signed board level declaration.	30 June 2030
v.	Submit a satisfactory completion report	31 May 2031

Failure by the Company to comply with this Notice may result in enforcement proceedings under section 18 of the Act.

Signed by authority of the Secretary of State

Milo Purcell.

Milo Purcell

Deputy Chief Inspector

27 March 2019

DWI ref: LI/DWR/2018/00001

Appendix 3 – Merthyr Costs Summary Spreadsheet

Please see attached excel file .

Appendix 4 – Merthyr WTW Cost Summary Spreadsheet Methodology

Expertise & Collaboration

SEWCUS NORTH WTW REVIEW

Merthyr WTW Business Case

Cost Summary Spreadsheet Methodology

DCWW REF :
B&V DOCUMENT : **122459-BVL-ZO-SS-RP-Z- 00001**

Dŵr Cymru Welsh Water

April 2018

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Merthyr WTW Cost Summary Spreadsheet Methodology

1) Introduction

The objective of the spreadsheet is to review the cost figures developed during the "2015-19-10 DCWW Feasibility Extension Report Final Issue" (Ref 1) and "Extended Study Cost summary v8.2" costing spreadsheet (Ref 2). The review process of the potential solutions to a single new 3 WTW scenario between September 2017 and April 2018 has enabled the original spreadsheet to be simplified to concentrate on the new 3 WTW option whilst maintaining the comparison with the existing 3 WTW scenario. In order to benchmark this solution the two 5 WTW scenarios (new and existing) have been maintained within the spreadsheet. Welsh Water have developed long term high level for their water treatment and strategic network connectivity which have been captured within the South Wales Strategic Pipeline Strategy (Ref 3) and the Strategic Area Investment Plans (Ref 4). The Merthyr WTW project is the first strategic project to be progressed towards the achievement of these plans.

The Cost Summary spreadsheet is made up of a series of worksheets which allow the capital costs for the project to be brought in from separate Solution Pricing Tool spreadsheets. In addition to this the operational costs have been developed using historic information, from separate spreadsheets, to provide a benchmark cost which allow comparison of the whole life costs for the two solutions within the 3 and 5 WTW scenarios. The various worksheets and their linkages have been summarised within Figure 1 below and are described below.

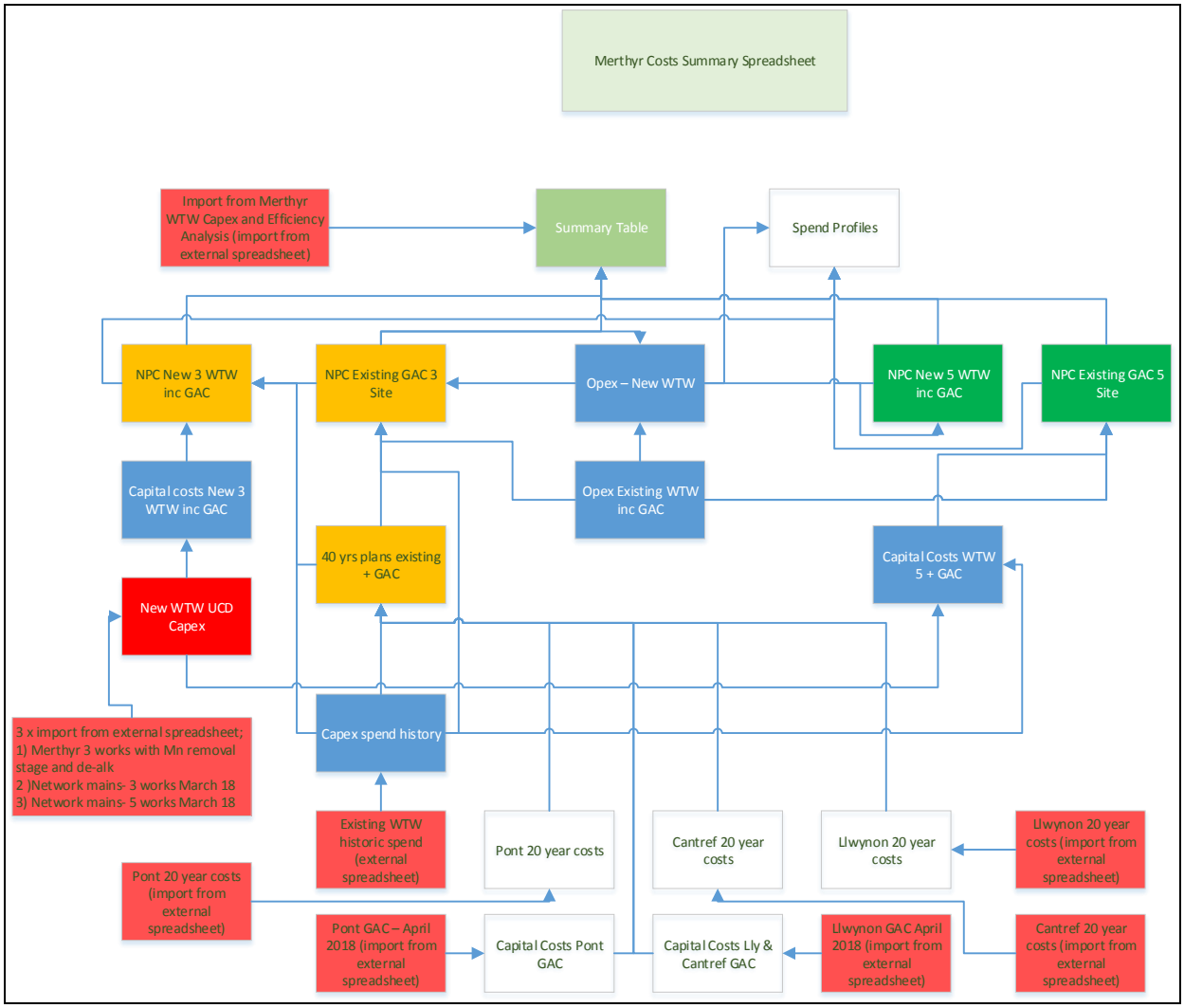


Figure 1 – Overview of the Merthyr WTW Costs Summary Spreadsheet

The main Cost Summary Spreadsheet together with all externally linked spreadsheets or stand-alone spreadsheets are stored in the same folder on DCWW S :\ drive

S:\AssetServices\DCWW\AssetStrategy\Asset_Strategy_AMP7\Water\10 Strategic Area Investment Plans\Merthyr WTW\Cost information\Project Costs\Merthyr Review

Worksheet Index

Name	Content
Summary Tables	Main collection of Capex and Opex costs for all options
Spend Profiles	40 year spend profiles for all options
New 3 WTW UCD CAPEX	Scheme Costs imported from external STP spreadsheets
Capital costs New 3 WTW inc GAC	New 3-works costs – profiled – actual cost
NPC New 3 WTW inc GAC	New 3-works costs – profiled – NPC cost
Opex - New WTW	Opex calculations for New Works
NPC Existing GAC 3 site	Existing 3- Works NPC profiled
Opex - Existing WTW inc GAC	Existing Works Opex costs
NPC New 5 WTW inc GAC	New 5-Works NPC profile
Capital costs WTW 5+GAC	Existing 5-works costs – profiled – actual cost
NPC Existing GAC 5 site	Existing 5-works costs – profiled – NPC
40yrs plans existing + GAC	Capex costs existing 5 works – profiled – actual cost
Capital costs - Pont GAC	Imported STP cost for Pontsticill GAC
Capital Costs - Lly&Cantref GAC	Imported STP cost for combined Llwynon/Cantref GAC
PontGAC onsite direct	Pontsticill WTW maintenance projection - nominal
8yrs plans existing	8 year maintenance projection for existing 3 & 5 works
Forecast risk spend summary	Investment Manager derived risk figures (background info only)
Needs modified	List of Needs as at 2014 (background info only)
Capex spend history	Historical Spend at 5 existing sites – June returns, 14 year period
SW Onsite direct costs	Forecast new Merthyr WTW “super works” future maintenance requirements
Opex - existing works	Existing works Opex derived from historical costs and flows
Ponstic WLC	Spend Profile Pontsticill with GAC (background info only)
Cantref WLC	Spend Profile Cantref with GAC (background info only)
Decom Costs	Decommissioning costs for existing works (no backup) (background info only)

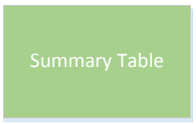
Abbreviations:

STP = Solution Target Pricing tool
NPC = Net Present Cost
UCD = Unit Cost Database

Note: For ease of navigation, where a cell in a worksheet contains a formula linking that cell to another cell/worksheet, the link can be followed by first selecting the cell, then pressing “Ctrl+[“ keys simultaneously.

Comments have been inserted within the worksheets where notes relevant to the content of particular cells have been inserted. Comment locations are depicted by a red triangle in top right corner of a cell.

2) "Summary Tables" Worksheet



The "**Summary Table**" worksheet provides an overview of the various costs associated with the project. Figure 2 below shows three different ways that the costs have been summarise to enable the costs and comparisons between solution cost benefit to be made.

Column two provides the Net Present Cost (NPC) of the project with no delivery efficiency, the NPC has been calculated using a 2.4% discount factor. The costs have been split between Capital and Operational costs which have used the values from the "**NPC New 3 WTW inc GAC**" worksheet.

Column three provides the at cost values for the project with no efficiencies or discount factors. The costs have been split between Capital and Operational costs which have used the values from the "**NPC New 3 WTW inc GAC**" worksheet.

Column four provides the capital cost during AMP7 and AMP8 for the project with no efficiencies or discount factor. These costs have come from Columns C and I rows 20 to 29 of the "**NPC New 3 WTW inc GAC**" worksheet and the addition of the two values.

Column five provides the capital cost with efficiencies applied in AMP7 and AMP8 and the values calculated within a separate spreadsheet the "**Merthyr WTW Capex and Efficiency Analysis**" spreadsheet.

The costs to retain the existing 3 sites provides the same columns but the cost data for this option is sources from the "**NPC Existing GAC 3 site**" worksheet.

The three 3-site options assessed are as follows;

- New Merthyr WTW 3 sites provides the whole of the project cost including the 160 Ml storage tank
- New Merthyr WTW 3 sites 225 Ml/d no additional storage. This includes providing a storage volume of 27 Ml – equal to the current clean water storage volume at the existing three sites. The costs allow a direct comparison with the maintenance of the existing sites
- Retain existing 3 sites and provide GAC treatment. This option is the cost of maintaining and upgrading the existing sites

A similar table is provided on the Cost Summary sheet for the 5 works option, with the exception of column 5. The sources of information for that table are obtained from the "**NPC New 5 WTW inc GAC**" and "**NPC Existing GAC 5 site**" worksheets.

Three Site Options	No Efficiencies	No Efficiencies	No Efficiencies	With Efficiencies
	NPC - 40 Years	Cost over 40 years	AMP7/8 Cost with 160 Ml Storage	AMP7/8 Cost with 160 Ml Storage and efficiencies
New Merthyr WTW 3 sites 225 Ml/d with 160 Ml/d Storage (additional 133Ml)	**Cost (£)**	**Cost (£)**	**Cost (£)**	**Cost (£)**
CAPEX new works	259,679,914	311,126,352	246,078,328	198,925,938
OPEX new works	96,363,042	144,244,569		
Total Cost	**356,042,957**	**455,370,921**	**246,078,328**	**198,925,938**

	NPC - 40 Years	Cost over 40 years	AMP7/8 Cost 27 Ml Storage	AMP7/8 Cost 27 Ml Storage with efficiencies
New Merthyr WTW 3 sites 225 Ml/d No additional storage 27Ml Storage Tank only	**Cost (£)**	**Cost (£)**	**Cost (£)**	**Cost (£)**
CAPEX new works	228,840,397	277,927,901	212,879,877	171,808,356
OPEX new works	96,363,042	144,244,569		
Total Cost	**325,203,439**	**422,172,470**	**212,879,877**	**171,808,356**

	NPC - 40 Years	Cost over 40 years	AMP7/8 Cost	AMP7/8 Cost with efficiencies
Retain existing 3 sites and provide GAC	**Cost (£)**	**Cost (£)**	**Cost (£)**	**Cost (£)**
CAPEX	239,987,913	338,005,505	144,807,285	116,992,264
OPEX	127,013,022	196,680,023		
Total Cost	**367,000,935**	**534,685,527**	**144,807,285**	**116,992,264**

Figure 2 – Snapshot - Summary Cost Tables from the Summary Table worksheet

3) "Spend Profiles" Worksheet

Spend Profiles

The Spend Profile worksheet provides a numerical and graphical representation of spend profiles associated with each of the investment options shown on the summary tables, described in section 2 above.

The profiles are presented as separate Capex and Opex, annually and cumulatively. The Capex and Opex are then similarly shown as Totex, annually and cumulatively.

Costs for both the 3-works and 5-works option are shown, over a 40 year period.

The figures are in two batched rows. Rows 6 to 46 are actual cost, rows 54 to 94 are is Net Present Cost (NPC) figures.

For the purposes of the NPC figures, a discount percentage of 2.4 % has been used.

The figures visible on this worksheet are shown without any efficiency factors. Lower down on the same worksheet (hidden) is a similar array of figures which can be adjusted to reflect a target delivery efficiency. This will allow Asset Strategy to determine potential outcome costs under various efficiency scenarios.

Both the delivery efficiency and the discount percentage for NPC production can be adjusted by entering new figures for each calculation in a single cell. Efficiency can be adjusted in cell F140. Discount percentage is adjusted by entering a new percentage in cell D41 of the "**Summary Tables**" tab.

Graphical representation of the numerical entries are shown beneath the section showing the "cumulative" figures only, (the area of the worksheet containing the graphs begins at cell AI97). Graphs for all for options are presented.

Capex and Opex figures for the basis of the spend profiles are obtained from the following worksheets:

NPC New 3 WTW inc GAC

NPC New 5 WTW inc GAC

NPC Existing GAC 3 site

NPC Existing GAC 5 site

These spreadsheets contains both NPC and Actual costs for each option.

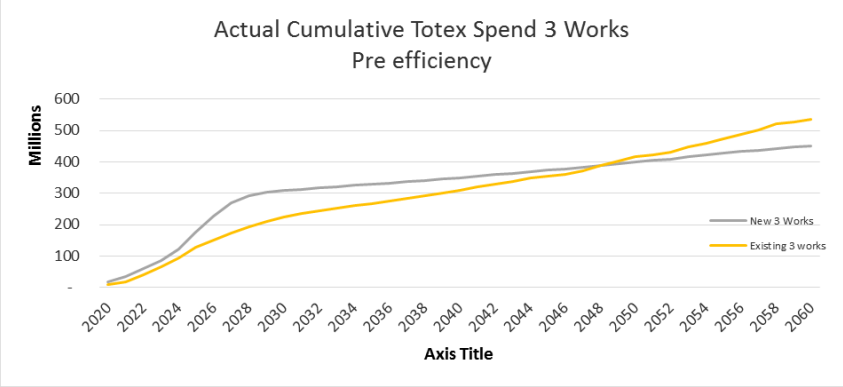
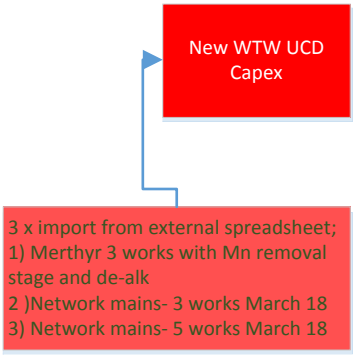


Figure 3 – Snapshot - Example spend profile:

4) Capital Investment Costs, "New 3 WTW UCD Capex" Worksheet



Capital costs for the new 3 works and 5 works options are produced on separate Solution Target Price spreadsheets and imported using hyperlinks into the "**New 3 WTW UCD Capex**" worksheet. This is the primary area where imported costs for the both the 3 and 5 new works are held. All other dependent calculations for the new works costs analysis are linked to these imported figures.

For the review a 225Ml/d water treatment works was deemed to satisfy the propose flowrate for both a 3 works and 5 works WTW replacement option.

The TOTAL Capex for a 3 or 5 works option is distinguishable by the different network / trunk mains costs. The 5 works options has a higher trunk mains costs (columns F and L).

The relevant sections of the worksheet are shown below for the 3-works and 5-work options

March 18 with revised pipe route - 3 works			WTW	Network
COST TYPE			**COST (£)**	**COST (£)**
1	DIRECT COSTS	Direct Costs attributable to a specific process	£ 121,299,257.95	£ 25,485,372.51
2	SITE SPECIFICS	Site-wide costs not attributable to a specific process	£ 6,293,252.78	£ 421,178.87
SUBTOTAL	**(DIRECT COSTS)**		**£ 127,592,510.73**	**£ 25,906,551.38**
3.01	CONSTRUCTION MANAGEMENT GENERAL	Including temporary works, prelims, accomodation, storage	£ 10,588,647.28	£ 2,940,238.14
3.02	CONTRACTORS RISK	Civil & process contractor's risk	£ 4,037,282.22	£ 1,036,909.72
3.03	CONTRACTORS PM / SUPERVISION	Contractor's project management and supervision	£ 14,896,670.52	£ 2,697,302.69
3.04	DESIGN	Contractor's feasibility, outline and detailed design	£ 16,431,098.28	£ 1,840,956.93
SOLUTION TARGET PRICE			**£ 45,953,698.31**	**£ 8,515,407.49**
3.05	CONTRACTORS FEE	Contractor's insurance, overhead & profit	£ 9,518,662.47	£ 1,584,442.77
SUBTOTAL	**(INDIRECT COSTS)**		**£ 9,518,662.47**	**£ 1,584,442.77**
4	DCWW ON COSTS	Including DCWW insurance, land & compensation, ops support	£ 9,385,552.90	£ 3,187,106.64
5	DCWW OVERHEAD	DCWW recharge (overhead)	£ 13,471,529.71	£ 2,743,545.58
SUBTOTAL	**(CLIENT COSTS)**		**£ 22,857,082.61**	**£ 5,930,652.22**
TOTAL COST TO CLIENT			**£ 205,921,954.12**	**£ 41,937,053.85**
				£ 247,859,007.98

Figure 4 – Snapshot - Capital investment cost – 3 works

March 18 with revised pipe route - 5 works			WTW	Network
COST TYPE			**COST (£)**	**COST (£)**
1	DIRECT COSTS	Direct Costs attributable to a specific process	£ 122,486,377.95	£ 46,921,069.22
2	SITE SPECIFICS	Site-wide costs not attributable to a specific process	£ 6,293,252.78	£ 421,178.87
SUBTOTAL (DIRECT COSTS)			**£ 128,779,630.73**	**£ 47,342,248.09**
3.01	CONSTRUCTION MANAGEMENT GENERAL	Including temporary works, prelims, accomodation, storage	£ 10,588,647.28	£ 5,373,061.10
3.02	CONTRACTORS RISK	Civil & process contractor's risk	£ 4,037,282.22	£ 1,894,873.48
3.03	CONTRACTORS PM / SUPERVISION	Contractor's project management and supervision	£ 14,896,670.52	£ 4,929,115.09
3.04	DESIGN	Contractor's feasibility, outline and detailed design	£ 16,431,098.28	£ 3,364,208.48
SOLUTION TARGET PRICE			**£ 45,953,698.31**	**£ 15,561,258.15**
3.05	CONTRACTORS FEE	Contractor's insurance, overhead & profit	£ 9,518,662.47	£ 2,895,448.39
SUBTOTAL (INDIRECT COSTS)			**£ 9,518,662.47**	**£ 2,895,448.39**
4	DCWW ON COSTS	Including DCWW insurance, land & compensation, ops support	£ 9,385,552.90	£ 5,824,194.47
5	DCWW OVERHEAD	DCWW recharge (overhead)	£ 13,471,529.71	£ 5,013,620.44
SUBTOTAL (CLIENT COSTS)			**£ 22,857,082.61**	**£ 10,837,814.91**
TOTAL COST TO CLIENT			**£ 207,109,074.12**	**£ 76,636,769.54**
				£ 283,745,843.67

Figure 5 – Snapshot - Capital investment cost – 5 works

The total Capex for both new works options are shown on this single worksheet.

The Capex for the water treatment works and network / trunk mains are imported from separate DCWW UCD Solution Target Pricing Tool spreadsheets. One spreadsheet has been prepared for the WTW scope and one for each of the network / trunk mains scopes, namely:

Merthyr 3 Works with Mn removal stage and de-alk.

Network mains- 3 works March 18

Network mains- 5 works March 18

Because the STP spreadsheets contain various macros and hidden worksheets and models they have been kept as stand-alone items. Links in the Cost Summary spreadsheet (**NPC Existing GAC 3 site** worksheet) will automatically update to reflect any changes that might be made to the STP sheets, provided all spreadsheets remain in their current folder on the DCWW server or the hyperlink can be traced.

The costs on this worksheet use an efficient factor of "1". Adjustment to delivery factors can be made on the Spend Profile worksheet as indicated in Section 3 above.

5) Capital Cost Distribution – New Works

Capital costs New 3 WTW inc GAC

The Capital Costs identified in section 4 above are transferred for use in the worksheet "**Capital costs New 3 WTW inc GAC**" and "**Capital costs WTW 5+ GAC**".

Capital Costs WTW 5 + GAC

Merthyr Review April 2018

Capital Cost for Superworks using the NEW UCD model+GAC

	3 works	
Summary	**Onsite treatment**	**Raw & treated water mains**
Direct Cost	121,299,258	25,485,373
Site Specifics	6,293,253	421,179
Construction Management	10,588,647	2,940,238
Contractor's Risk	4,037,282	1,036,910
Contractor's PM/supervisio	14,896,671	2,697,303
Design	16,431,098	1,840,957
Contractor Fees	9,518,662	1,584,443
DCWW Oncost	9,385,553	3,187,107
DCWW Recharge	13,471,530	2,743,546
TOTAL	**205,921,954**	**41,937,054**

Figure 6 – Snapshot - Capital cost used in 3-works cost distribution

The costs in this section differ from those shown in Section 4 because they exclude land purchase and decommissioning costs, those costs are shown separately on this particular worksheet.

On these worksheets the capital costs are distributed in a manner which represents the likely construction period for the two options and the expenditure over that period. The distribution includes both the WTW and Trunk Mains costs.

This worksheet begins the task of allocating annual spend and AMP spend which is used within the subsequent NPC calculations worksheets.

The worksheet also includes a proportion of the original investment which had been allocated for refurbishment, at a future point in time. In addition, the costs entered in cells C40:C47 are decommissioning costs for the 3 works.

The costs entered in cells C61:C64 are the projected 25 year refurbishment costs. These particular costs have been reduced from the original calculation indicated in cell H17 because it was felt the scope seemed excessive, this was a review team opinion. The percentages used against the original figure are shown in cells BE61:BE64.

Maintenance/refurbishment requirements have been calculated by applying a percentage against the costed scope of the original STP sheet for the new works. Whilst the scope has changed during this review this element was retained on the basis that the costs indicated appeared reasonable.

6) Net Present Cost – New Works

NPC New 3 WTW inc GAC

NPC New 5 WTW inc GAC

The "**NPC New 3 WTW inc GAC**" or "**NPC New 5 WTW inc GAC**" worksheets, capture the profiled/distributed spend of all the Capital Costs (Capex) and Operational Costs (Opex) and calculates the Net Present Costs (NPC) for each using a 2.4% discount factor. The NPC is calculated from the profiled Capex and Opex spends, the totals for all spends total cost and NPC are captured in row 63 with the total NPC Capex in cell L64 and the NPC Opex in cell V64.

The capital cost distribution identified in Section 5 is transferred into two the worksheets the "**NPC New 3 WTW inc GAC**" or "**NPC New 5 WTW inc GAC**" where maintenance, land purchase, decommissioning, removal of additional storage costs and operating costs are added. All costs are projected over a 40 year period. At the top of each worksheets in rows 4 to 14 are the NPC discount rate % values used and summary 40 year and NPC costs with and without the additional 133 Ml storage included within the new 3 and 5 WTW inc GAC projects, Figures 7 and 8 below show the values from the "**NPC New 3 WTW inc GAC**" worksheet, as an example.

40 year COSTS WITH 160 Ml STORAGE (£000's)	
CAPITAL COSTS	311,126,352
OPERATING COSTS	144,244,569
TOTAL 40 YEAR COST	**455,370,921**
NPC CALCULATION WITH 160 Ml STORAGE (£000's)	
NPC CAPITAL COSTS	259,679,914
NPC OPERATING COSTS	96,363,042
RESIDUAL VALUE NPC	N/A
TOTAL NPC	**356,042,957**

Figure 7 – Screen shot of the total 40 year and NPC costs from the NPC New 3 WTW inc GAC worksheet

40 year COSTS 27 Ml STORAGE (£000's)	
CAPITAL COSTS	277,927,901
OPERATING COSTS	144,244,569
TOTAL 40 YEAR COST	**422,172,470**
NPC CALCULATION 27 Ml STORAGE (£000's)	
NPC CAPITAL COSTS	228,840,397
NPC OPERATING COSTS	96,363,042
RESIDUAL VALUE NPC	N/A
TOTAL NPC	**325,203,439**

Figure 8– Screen shot of the 40 year and NPC costs with additional storage removed from the New 3 WTW inc GAC worksheet

Using the "**NPC New 3 WTW inc GAC**" worksheet as an example the headings for the Capex Costs for the new WTW (columns C & D), asset renewal of the mechanical and electrical assets after 20 years of the project completion (columns E & F), maintenance of the existing sites until completion of the new WTW in 2029 (columns G & H), land purchase and decommissioning costs in year 1 and then 2030 onwards (columns I & J). An additional pair of columns K and L captures the new cost of the additional storage so that it can be removed from the calculations for the values on the summary worksheet. A screen shot of the Capex costs and be seen in Figure 9 below. The capital data is imported from "40yrs

plans existing + GAC" worksheet for the new WTW and M&E replacement costs, the "Capex spend history" worksheet for maintaining the existing sites and decommissioning costs calculated from the "decom costs" worksheet with a factor included to remove the on cost spend included within the new WTW costs.

CAPITAL COSTS										
YEAR	UCD Cost Model capex 3 sites - excluding land and decommissioning		M&E Replacement		Maintain existing works 2028 Transition from old to new 2029 Superworks 2030 onwards		Land Purchase and Decommisioning Costs		cost, net difference in 160 Ml Storage above the existing 27 Ml storage	
	COST	NPC	COST	NPC	COST	NPC	COST	NPC	COST	NPC
0	8,335,583	8,335,583	-	0	4,000,000	4,000,000	593,560	593,560	- 500,000	-500,000
1	8,629,753	8,427,494	-	0	4,000,000	3,906,250	-	0	- 500,000	-488,281

Figure 9 – Screen shot of the Capital costs from the NPC New 3 WTW inc GAC worksheet

Continuing to use the "**NPC New 3 WTW inc GAC**" worksheet as an example the Opex costs, derived from worksheet "**Opex – New Works**" have been split into these categories; PAC Dosing (columns M & N), Chemicals including GAC regeneration (columns O & P), Power (columns Q & R), Operational costs including operators (S & T) and sludge (U & V). A screen shot of the Opex costs can be seen in Figure 10 below.

OPERATING COSTS									
PAC dosing New Works GAC included in Chemicals costs		Chemicals inc GAC regen 2029 onwards		Power		Operational Cost including operators		Sludge	
COST	NPC	COST	NPC	COST	NPC			COST	NPC
200,000	200,000	783,053	783,053	2,074,524	2,074,524	1,378,446	1,378,446	74,822	74,822
200,000	195,313	783,053	764,700	2,074,524	2,025,903	1,378,446	1,346,139	74,822	73,068

Figure 10 – Screen shot of the Capital costs from the NPC New 3 WTW inc GAC worksheet

The Opex calculation contains cost data from the historical operating records of the existing treatment works at Cantref, Llwynon, Pontsticill and Felindre WTW for the 3 WTW option. Felindre WTW has been used to derive the operational costs for the new site because it has a similar capacity to the planned new WTW. The existing cost data has been developed further with the addition of forecast to pumping costs, GAC regeneration and energy recovery. The Opex for the 5 WTW option contains additional information for the WTW of Carno and Nantybwch as well as additional raw and treated water pumping based on the forecast costs. The Opex data for new WTW has been derived from the "Opex - New WTW" and "Opex - Existing WTW inc GAC" worksheets.

7) Capital Cost Distribution – Existing Works

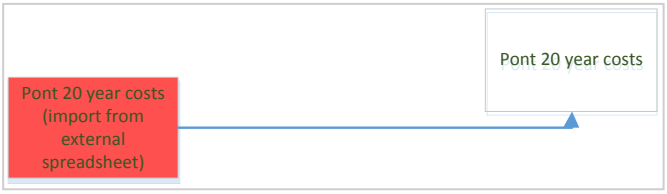
40 yrs plans existing + GAC

Capital Costs for the existing 3 and 5 sites are collected on the "**40yrs plans existing + GAC**" worksheet.

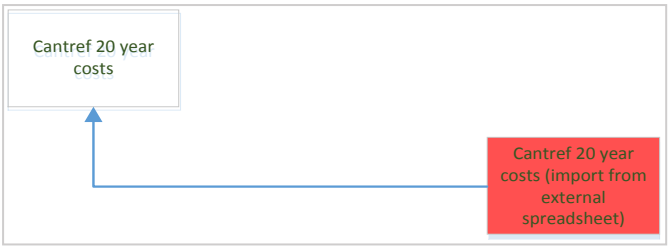
This worksheet begins the task of allocating annual spend and AMP spend which is used within the subsequent NPC calculations worksheets. From this worksheet, NPC values are then calculated for each the 3 and 5 works options - "**NPC Existing GAC 3 site**" and "**NPC Existing GAC 5 site**".

Some costs but not all, shown on this worksheet have been prepared on separate STP worksheets. Links on this worksheet are provided to separate worksheets for the 20 year costs and GAC costs only.

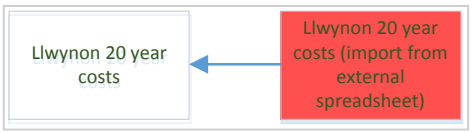
Pontsticill 20 year costs



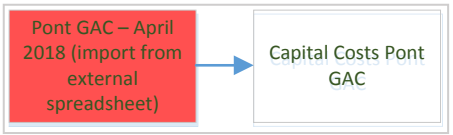
Cantref 20 year costs



Llwynon 20 year costs



Pontsticill GAC - April 2018



Llwynon GAC - April 2018

A single STP sheet, **"Llwynon GAC - April 2018"** is used for a GAC plant at Llwynon, this single GAC plant is sized to cater for both Llwynon and Cantref flows and was envisaged being located at Llwynon.

There are STP spreadsheets for the 10 (8) year costs, but these have not been linked to the "**NPC Existing GAC 3 site**" and "**NPC Existing GAC 5 site**" worksheets.

There are no separate spreadsheets for the 40 year costs. These were not uncovered during the B&V review. The figures on the worksheet have been taken to be correct as entered.

The existing works capital costs are distributed in a manner which represents the likely construction period for the two options (retain 3 works or 5 works) and the expenditure over that period. The distribution includes both the WTW maintenance and proposed GAC plants at Pontsticill, Llwynon and Cantref. The maintenance and enhancement work has been staggered to reflect the likely sequential construction method.

8) Net Present Cost – Existing Works

NPC Existing GAC 3 Site

The worksheets "**NPC Existing GAC 3 site**" and "**NPC Existing GAC 5 site**" collate Capex information from the "**40yrs plans existing + GAC**" worksheet described in Section 7 above and **"Capex spend history"** worksheets described in Section 10 below.

NPC Existing GAC 5 Site

The Opex figures are derived from historical operating records from the existing treatment works complimented with additional data relating to pumping, GAC regeneration and energy recovery that are associated with the enhancements. These costs are held on the "**Opex - Existing WTW inc GAC**" worksheet.

Opex has been calculated by taking the individual, total operating cost for each works over a 12 month period, then applying those costs against average flows for the same period to determine average rates per megalitre. The rates so derived for chemical, energy, sludge and labour are then applied to a flow rate of 160Ml/d for the existing 3 site costs and 184Ml/d for the existing 5 site costs, see Figure 11 below for an overview of these values.

Annual Opex Costs Summary	Average daily flow (Ml/d)	Chemical	Energy	Sludge	Operational Costs	Overall Cost Opex Cost per year existing WTW
TOTAL 5 sites inc GAC	184	£ 1,198,882.34	£ 2,919,458.60	£ 74,821.53	£ 1,992,663.60	**£ 6,185,826.07**
TOTAL 3 sites inc GAC	160	£ 952,413.10	£ 2,403,368.85	£ 74,821.53	£ 1,378,446.40	**£ 4,809,049.89**

Figure 11 – Overview of the Opex Costs for the existing 3 and 5 Sites

Figure 11 – Provides an overview of the Opex Costs for the existing

The flow rate of 160Ml/d has been chosen as the benchmark flowrate for Opex comparisons between the new 3 and existing 3 works. There is a separate paper explaining the rationale behind the selection of this flowrate, "New Merthyr WTWs sizing Final v1" (Ref 5). The flow rate of 184Ml/d for the new 5 and existing 5 works is based on the 3 works values and agreed outputs for the two existing sites of Nantybwch and Carno WTWs of 19.5Ml/d and 4.5 Ml/d respectively.

9) Opex Costs – New and Existing Works

Opex – New WTW

Opex Existing WTW inc GAC

Opex costs for the existing works have been derived from historical cost records for each of the 3 or 5 works, for the period 2014-2015. Costs for chemicals, energy, sludge and, operating expenses have been collated and compared to the average flow for that year. The average cost for each parameter is then used to determine the costs for the future flow rates envisaged during the operation of either option.

The future costs are then transferred to the NPC calculations for each option.

In addition to the historical costs, changes brought about by the proposed enhancements to the exiting works (addition of GAC, increased pumping and the introduction of energy recovery) have been calculated based on the hydraulic conditions envisaged. GAC regeneration costs have been calculated separately based on evidence from other WTWs and applied to the enhanced and new works.

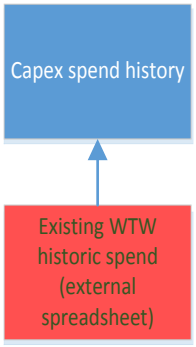
Opex costs for the new works have been based on the Opex costs for the existing works during the construction period. Once the new WTW has been constructed the operational costs for Felindre WTW a similar sized WTW have been used. The Opex costs have been taken from 2015, inflated to allow for an increase in output 160Ml/d, with additional energy /recovery as afforded by the process stages and hydraulic conditions. The chemistry and treatment processes are similar so it has been determined that the costs for these parameters will also be similar. The values can be seen on the "Opex - New WTW" worksheet.

10) Risks, Needs and Historical Spend

The following two worksheets contain information obtained from external sources.

"**Forecast risk spend summary**": Investment Manager derived risk figures imported from
"**Needs**": List of Needs extracted from Investment Manager circa 2014. This information was used to identify the current issues at the existing sites.

These worksheets do not link directly into any other part of the spreadsheet. They do however indicate the level of investment required to mitigate risk at the existing works and set the foundation for considering alternatives, including a replacement works.



"**Capex spend history**": Historical capital spend at the 5 existing WTWs based on average values from the June Returns over a 14 year period from 2000 can be found in Columns A to F rows 6 to 23. This data is imported from spreadsheet "**Existing WTW historic spend**" where the full data from the previous 14 years of June Returns is collated.

Within the "**Capex spend history**" worksheet in columns G to I rows 6 to 17 are maintenance values for interventions at the existing sites which are used for the new WTW options. These values are based on the planned maintenance budgets for AMP7 and AMP8 and take into account the Risks and Needs highlighted above together with the outputs of validation surveys carried out at each asset. The values are not imported from another spreadsheet but based on current pre-efficiency maintenance budgets for water treatment.

11) References

Ref 1 - 2015-19-10 DCWW Feasibility Extension Report Final Issue

Ref 2 - Extended Study Cost summary v8.2

Ref 3- South Wales Strategic Pipeline Strategy

Ref 4 - Strategic Area Investment Plans

Ref 5 - New Merthyr WTWs sizing Final v1

Appendix 5 – Bolton Hill WTW audit assessment letter

Dŵr Cymru
Welsh Water

Mr Daniel Giblin
Drinking Water Inspectorate
Area 1A, 9 Millbank
c/o Nobel House
LONDON
SW1P 3JR

Date:
11th April 2018

Enquiries:
(01633) 373011

Our Ref:
SAE/A120318

Dear Mr Giblin,

Technical Audit of Bolton Hill Works on 22 November 2017

Further to the DWI audit assessment letter received on 12th March 2108 relating to the Technical Audit of Bolton Hill works, please find enclosed the formal response to the recommendations and suggestions set out in your assessment.

Recommendations

> *"2.2- It was reported historically that both raw water pumping stations have been subject to flooding, as such a heavy rainfall event may present a single point of failure and* ***I recommend*** *(Ref: DWR/RN/2018/0127) that 'No Supply' risk assessment scenarios are considered for both [east and west] raw water sources."*

The Canaston Bridge pumping station on the Eastern Cleddau source was designed and constructed with a flood relief channel around the station. The flood relief channel is dredged to remove sediment and debris on a 5-yearly frequency to prevent flow restrictions during flood conditions, ensuring the risk of flooding is minimised.

The Crowhill pumping station on the Western Cleddau has flooded on at least two occasions in the last thirty years.

The Bolton Hill WTW Drinking Water Safety Plan includes the risk of flooding for both water pumping stations. The mitigation in both instances includes the use of the alternative source.

A new risk has been created to reflect the risk of a "no supply" event caused by the flooding of both water pumping stations simultaneously. As the two sources are located approximately 7

miles apart, in separate catchments, and there has been no recorded instance of both sources being subject to flooding during the same event, the likelihood of this event is low and, therefore, the residual risk for this event is also low. The DWSP for Bolton Hill will be amended to include this new risk at the next review meeting on 11th May.

> *"3.3 - There is just one monitor controlling the coagulant and no backup monitor… I* ***recommend*** *(Ref: DWR/RN/2018/0128) a review of all instruments which do not have a backup takes place, to ensure water is adequately treated before it enters supply."*

A UV254 monitor is used to control the coagulant dose at Bolton Hill WTW. This instrument has been selected to replace the previous colour/turbidity monitoring system as it has no moving parts and uses no reagents and is therefore much more reliable and less prone to failure.

The back-up for this instrument is a second UV254 monitor located downstream, on the combined outlet of the DAF process, measuring clarified water quality.

Both instruments are standard within the company and replacement parts and instruments can be sourced through framework suppliers at short notice.

The instrument has been installed according to the company's standard specification with one UV254 instrument at the point of control and a post-clarification monitor as back-up to highlight any water quality issues.

The company standard specification also requires chlorine instrumentation that is used to control the disinfection process and pH monitoring at point of chemical dose control and final water to be monitored with dual-validation instrumentation.

> *"3.6 - Whilst remedial work has sealed the cracks in the exterior [of the Contact Tank roof],* ***I recommend*** *(Ref: DWR/RN/2018/0129) that the company takes appropriate steps to enable the contact tank to be removed from supply for internal inspection, repair, clean and disinfection to be completed."*

A planned overnight shutdown of the treatment works is scheduled to take place to allow the single compartment contact tank to be drained, inspected, repaired, disinfected and returned to service. This planned work is due to be completed by the 30th April 2018.

> *"3.7 - There was no Regulation 27 shut down facility, post sulphur dioxide dosing. I conclude the potential to overdose sulphur dioxide presents an unmitigated risk to the disinfection process and* ***I recommend*** *(Ref: DWR/RN/2018/0130) that the company*

institutes appropriate failsafe shutdown processes or other measures as appropriate to prevent improper disinfection of supplies from Bolton Hill works."

This finding was acknowledged on the day of the audit and an Emergency Shutdown trigger was created at this point in the disinfection process within 2 days of the audit. The ESD functionality has also been tested to ensure that a works shutdown is generated to prevent improperly disinfected water entering supply.

"3.9 - DSF 304 "SRV External Surveillance Form"… noted that seals were peeling from access covers / hatches, and the seals need replacing around ventilator hatches. ***I recommend*** *(Ref: DWR/RN/2018/0131) that the company carry out the remedial work to the potable water reservoir as soon as practicable to prevent contamination of the supply."*

Remedial work had been scheduled to be completed during the week commencing 26th March 2018. However, the adverse weather event in early March has caused a number of delays in carrying out planned work and it has been rescheduled to be completed by the end of April 2018.

"4.2 - In the event that Bolton Hill was unable to supply water… the "Water Company Local Response Plan" would be initiated… To supplement the remaining 16,000 consumers supplied via Bolton Hill works, the company would call on the Mutual Aid system, to supplement its supplies. This information was discussed during the audit, however this level of detail was not within the plan. I conclude that in the event of a loss of supply from Bolton Hill works, there is a risk to wholesomeness of supplies to customers and I recommend (Ref: DWR/RN/2018/0132) that a more detailed, localised plan for alternative supplies is produced, to ensure ease of reference, should it be required in an emergency.

4.3 - Separate, detailed maps are available via the company's GIS mapping system for where the tankers may attach to the network, and supply water via the distribution mains leaving Bolton Hill. As part of the ***recommendation*** *above, these are included in a more localised plan, to ensure ease of reference, should it be required in an emergency."*

The local plan takes the form of a Risk Assessment/Method Statement (company IMS ref: PNF121). This plan has been updated to include the information on Mutual Aid contingency arrangements and now contains hyperlinks to the detailed maps showing bowser and leafleting locations and tankering points. The use of hyperlinks in the document allows up to date information to be accessed via the links in the document. A copy of the revised local plan RAMS document (PNF121) is attached as Appendix 1.

*"5.1- It was noted that the control room is the only place where SCADA is available… **I recommend** (Ref: DWR/RN/2018/0133) that a review of this single point of failure is conducted, and procedures put in place to ensure staff are fully trained and competent to manually operate the works in a safe manner should SCADA be lost."*

The local operations team have started to compile a detailed risk assessment of how the works would be operated in manual mode in a safe manner to maintain satisfactory water quality during an event where the SCADA has been lost for a significant period of time. It is anticipated that this piece of work will be completed by the end of July 2018.

It should be noted that a duplicate of the most recent version of the SCADA software is held remotely in a central library and would be loaded on site (into new hardware as required) to allow restoration of SCADA functionality in a timely fashion, depending on the circumstances.

*"6.1 - Several pieces of uncapped and uncovered pipework, awaiting installation, were observed around the plant. Whilst removed during the audit, **I recommend** (Ref: DWR/RN/2018/0134) that all contaminated pipework is scrapped or disinfected and appropriately stored.*

This issue was raised immediately with the contract partner responsible for delivering the scheme at Bolton Hill WTW. Inspections (see below) have been implemented to ensure that pipework is disinfected before use and unused pipework is stored correctly.

*"6.1 - … I **further recommend** (Ref: DWR/RN/2018/0135) that a review of pipe storage and associated procedures and training of staff is undertaken, to ensure appropriate standards are adhered to."*

A review of training and procedures has established that appropriate measures are in place, however procedures were not adhered to by the contract partners at the time of the audit. Following discussions with the contract partner responsible for delivering the project, regular checks have been implemented by the project management team on-site to ensure adherence to established procedures. A copy of the checklist is included as Appendix 2.

*"6.3 - It was noted that when capital works are being undertaken, this does not feed into the Drinking Water Safety Planning, and the company would not update their Regulation 27 Risk Assessments, to take into account hazards that may be introduced to the plant during periods of capital work. I therefore **recommend** (Ref: DWR/RN/2018/0135) that a plan is put in place by the company for capital works programmes to feed back into the DWSP methodology, so that hazards and risks are suitably captured and mitigated. I*

require *the company to submit new and revised risk assessments to the Inspectorate, in response to this recommendation."*

Two generic risks have been created for all assets (treatment works, service reservoirs and networks/zones) to reflect the risk to (a) water sufficiency and (b) water quality during delivery of capital improvement schemes.

The detail for these risks will be populated for Bolton Hill in April 2018 and will be submitted in the data return to DWI in June 2018 in line with the established reporting process.

For other assets, the new risks will be assessed and populated as part of the regular programme of DWSP review sessions. The detail of these risks will then feed into the monthly data returns to DWI as they are completed.

A copy of the new risk template is included as Appendix 3.

Suggestions

"1.1 - The company provided and overview of its resilience plans for South Wales. A raw water contamination project had been complete, reviewing details of the project were supplied during the audit. I ***suggest*** *this project is put into deliverable terms, so that each standard and each contaminant is quantifiable, and can easily be understood by those that need to use it."*

The raw water contamination project conducted by Arup has now been completed and a report has been submitted outlining potential improvements to raw water monitoring, for example by the use of on-line monitors at abstraction points. The report also concluded that it was not currently feasible with existing technology to monitor for specific contaminants as a result of a deliberate malicious act.

The outputs of this project will now be used to inform future investment decisions on raw water monitoring improvements, however any future investment programme has yet to be finalised.

"1.3 - Whilst investment in a new works is to be welcomed, I conclude that the company may be increasing the risks to water quality resilience by increasing the likelihood of a common failure point for which there would be no alternative supply. I ***suggest*** *that the company reconsider these plans and assures itself that wholesome water supplies could be maintained at all times in the event of a water quality failure from any works, where there is no alternative supply."*

The company's investment plans include a proposal to invest in a new large treatment works in South Wales which will allow the abandonment of a number of ageing assets that are heading towards the end of their operational life. It is recognised that the strategy of reducing the number of water treatment works itself poses an additional resilience risk. However, the company is comfortable that the plans will incorporate sufficient redundancy to ensure that no single points of failure are created and that all risks to the security of supplies to customers are mitigated.

> *"1.4 - The company also provided evidence to show that the wider operational area can be called upon in the event of an incident, to provide support to the site staff should the need arise. I **suggest** that this is incorporated into a formalised, local plan, and that staff responsibilities are clearly defined."*

A restructure of the team is being implemented to increase the competency of the wider team to provide additional support in the operation of the treatment works. This has been formalised in the Personal Development Plans for the operational team members. Training will take the form of an accredited training programme to NVQ Level 3 with formal competency assessments before each team member is deemed competent to operate the works.

> *"1.4 - … I **suggest** that the company reviews the number of competent staff available to operate Bolton Hill works and ensures that there is sufficient operator coverage to maintain wholesome supplies."*

There are currently 4 members of operational staff fully trained and designated as competent to operate Bolton Hill WTW. The operational team is currently undergoing a restructure to increase flexibility and resilience and will result in all members of the team being trained and assessed as competent to operate the treatment works. This change will increase the number of competent operators from 4 to 8.

> *"1.5 - It was noted during the audit, that Bolton Hill has been subject to a number of localised events, which have impacted upon treatment…Whilst there is no evidence of an impact upon the supply to customers, I **suggest** learning from these events is translated into procedures, so events such as this can be rectified and dealt with quickly and efficiently by staff at the plant."*

As part of the Integrated Management System (IMS) procedures, any event resulting in sub-optimal treatment results in an investigation, including a "5-Whys" root cause analysis to determine the underlying cause and remedial actions required to prevent a recurrence. The investigation is completed by the Process Science Team and is circulated and escalated through the Operational Teams to ensure that lessons learned are shared and implemented. A blank copy of the investigation proforma (known as the POF014) is attached as Appendix 4.

*"2.3 - I **suggest** a review of the sampling arrangements for Cryptosporidium takes place, taking into account whether more frequent sampling of the raw water may provide advanced warning that an increased risk is being faced by the works, as opposed to retrospective monitoring after an incident has already occurred."*

Cryptosporidium monitoring is based on the company's Cryptosporidium Strategy. Sampling frequencies for raw, pre-UV and final water are reviewed each year and are adjusted based on the level of risk in the catchment, historic treated water data and other raw water monitoring data such as faecal bacteria indicators. At Bolton Hill, the risk in the catchment is considered to be high, however this is mitigated by raw water storage on site and robust water treatment processes. Consequently, it is believed the current sampling regime is based on a sound methodology, but be revised in the future should new information suggest the level of risk has changed.

*"2.4 - Diesel pumps are available for both pumping stations, should the electrical pumps fail. I **suggest** procedures and documentation are updated to reflect this."*

The Operating Manuals for both pumping stations are currently being re-written to include procedures for the operation of diesel pumps. The amended Operating Manuals are due to be issued by the end of April 2018.

"2.5 - ...all water supplied to the works enters the top raw water reservoir, which cannot be bypassed. Consequently this is a single point of failure. I **suggest** that the risks associated with a water quality contamination of this reservoir and the control measures are considered as part of the companies risk assessment for this works."

It is possible to supply water from the Western Cleddau source, via Crowhill Pumping Station, directly into the treatment works, bypassing the on-site raw water reservoir. This provides mitigation in the event of contamination of the raw water reservoir.

Contamination of the on-site raw water reservoir is not currently included in the risk assessment (DWSP) for Bolton Hill WTW, however this risk will be assessed and added to the DWSP at the next review meeting on 11th May 2018.

*"4.5 - The company reported that there is a long term strategy to improve resilience of supplies in south west Wales via a link main, but this is not likely to be delivered in the next decade. Given the criticality of this works, I **suggest** the company review its plans and*

considers if further mitigation measures are feasible to minimise the likelihood of a loss of supply from Bolton Hill works."

The resilience of supplies from Bolton Hill WTW has been considered as part of the Water Resource Management Planning process and the long term planning for all of our water treatment works is included in the Water 2050 framework.

In the short- to medium-term, the resilience of Bolton Hill is being improved by investing in the existing infrastructure. For example, the DAF clarification stage, rapid gravity filters and chemical dosing plants all currently have capital investment schemes in progress, as demonstrated on the day of the audit.

*"5.1 - …I **suggest** that the company considers alternative solutions to enable the works to be operated remotely in the event of losing the SCADA system."*

There are a number of measures in place to mitigate the risk of losing the SCADA system at Bolton Hill and all other treatment works:

- In the event that the software is lost or corrupted – a library of operating software is maintained and updated to ensure that a copy of the most recent version of the SCADA software is available and is accessible on a 24/7 basis.
- In the event of physical loss of the SCADA system (e.g. failure of PLC) – a stock of critical spares is held to enable repair and recovery of the electronic hardware that runs the control system.
- In the event that the control room cannot be reached (e.g. adverse weather, chemical leak) - There is a rolling programme of SCADA replacement, prioritised on the age/obsolescence of the system and the criticality of the asset. As a consequence of the replacement process, the new generation of SCADA software systems have increased remote operation functionality which allows the operation of assets from the central control room (SmartHub).
- In the event that a catastrophic loss of the control room occurs (e.g. fire in the control room) – The works would be operated in fully manual mode, where possible, by running pumps and other equipment locally until a replacement SCADA could be safely installed. The operations team at Bolton Hill WTW are currently devising a Risk Assessment/Method Statement (RAMS) procedure that would detail how such an operation could be implemented while protecting water quality.
- In the event that catastrophic loss of the control room occurs and manual operation is not possible – the works would not be operable and Total Loss Contingency Plans would be invoked.

"5.2 - I note that the local response plan did not contain instructions on how to verify that the correct consumers had received leaflets [in the event of a boil water situation]. I

suggest *a verification stage is included in the response plan, to ensure the company can satisfy itself, that the correct consumer addresses have received leaflets.*

As part of our response during an incident or event, it is standard practice to call back customers to check that issues have been resolved. This approach has been expanded to include a process for contacting a statistically significant proportion of our customers by telephone to confirm that advice leaflets have been received. This requirement is being added to the Boil Notice and Do Not Drink Notice procedure (IMS ref: EP(3) 12) which is due to be revised, approved and issued by 1st June 2018.

In addition, every incident is subjected to a post-incident review. As part of a review of customer communications, the effectiveness of any leafletting operation is assessed to allow improvements to be identified and implemented.

"5.2 - …The [leaflet] contractor is available on a 24hr basis. I ***suggest*** *the contractor is subjected to audits, from time-to-time, so that the company can satisfy itself that its response is robust and effective in an emergency situation."*

There is no formal contract in place with a third-party supplier of leaflets. However, any future arrangement will include a requirement for Business Assurance audits to be carried out by Dwr Cymru Welsh Water as part of the agreement. It is anticipated that a formal arrangement will be in place within 3 months.

"5.3 - …I ***suggest*** *sampling equipment stockpiles are included in the plan, such as the location and number available, of temporary Cryptosporidium rigs, and other sampling equipment necessary, to ensure staff using the document are aware of equipment available to them."*

As part of the learning from the Franklaw Event, the company has identified the need for additional stocks of portable Cryptosporidium sampling equipment to be deployed in an incident scenario. A process is underway to source equipment and fabricate mobile sampling kits to be held and managed by the Emergency Planning team. This process is due to be completed by June 2018.

"5.4 - A further plan, called "Deployment of Emergency Tanks"… states that hiring of tankers is an option in an emergency situation, and that these tankers could be brought in from outside the organisation. It is not clear from the plan whether the supplier of these tanks had been audited, and whether hygiene standards would be met. I ***suggest*** *that an audit of suppliers is carried out to ensure resources are robust and suitable for the intended purpose."*

Hiring of tankers from a third party supplier would only be used in an emergency scenario and our existing operational procedures do not accommodate the use of tankers from external suppliers.

Consequently, third party sources of tankers would not be authorised until procedures (e.g. a RAMS) had been formalised for their use. Such procedures would require an audit of the third party's internal processes and hygienic practices before allowing the deployment of their tankers as part of our emergency response.

> *"5.5 - The Escalation Procedure states "contact the Silver Manager" if issues cannot be resolved, however it is not clear who the silver managers are, or where to find who they are, should the need arise. I* ***suggest*** *the document makes it clear the roles and responsibilities of specific staff, to ensure a rapid, efficient response, to an escalation event."*

The list of Silver Managers is held centrally in the SmartHub control room in Cardiff. This list is available 24 hours per day and can be accessed via the company Intranet Site or by contacting the SmartHub control room by telephone. This ensures that the correct point of contact is always readily available to all staff.

The role of the Silver Manager and others is clearly defined, in an incident scenario, in the company's Emergency Response Manual which is maintained by the company's Emergency Planning Team.

> *"5.6 - …The date on the MoU document is July 2013, therefore I suggest a review takes place of the document, with the supplier, to ensure contact details and arrangements are still valid."*

The MoU was reviewed at a meeting held with the Red Cross in January 2018 and all contact details and arrangements were confirmed.

> *"5.7 - The company has taken part in "operation Swift"… to test arrangements set out in the MoU. The outcome of the test was successful, however there are a number of post exercise actions outlined in the report, and it is not clear if these have been implemented. I* ***suggest*** *a review of the post exercise actions is completed, with a view to incorporating any learning or improvements into current procedures."*

A review of the Operation Swift actions was held with the Red Cross at the meeting held in January 2018. All outstanding actions have been confirmed as completed by our Emergency Planning Manager.

> *"6.2 - The company has had problems with the supply of Aluminium Sulphate, with pumps and dosing lines blocking… it was found that a change in the manufacturing process may have caused the issue… I acknowledge that some steps have been taken to prevent future problems, such as enhanced cleaning of in-line dosing filters, to prevent blockages, and visual inspections of bulk storage tanks. I **suggest** these measures are formally adopted into standard operating procedures."*

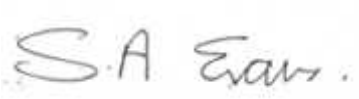
New maintenance tasks have been created in the asset management system (SAP) to complete a fortnightly visual inspection of the bulk storage tanks. These steps will help maintain performance of the existing equipment until the new capital scheme is completed – see comments below.

> *"6.2 - …Whilst the company are now visually inspecting the tanks, evidence of routine inspection and cleaning of the inside of the tanks was not provided. I **suggest** a procedure is put in place, and evidence of routine cleaning and inspections of tanks documented."*

As part of the ongoing capital investment programme, new chemical storage and dosing equipment is currently being installed and is due to be completed and commissioned by the end of December 2018. The ongoing maintenance plans for the new plant include a regime of inspections and cleaning to prevent blocking of dosing equipment. This is due to be recorded in the handover documentation for the new equipment.

I trust this satisfies you that the appropriate actions are being implemented in response to your comments. Should you require any further information or clarification please do not hesitate to contact me directly.

Yours sincerely,



Ms Sharon Evans

Head of Drinking Water Quality

Location:	Bolton Hill WTW, Tiers Cross, Haverfordwest	**SAP Job No:**	N/a
Date / Time of proposed work:	Network reconfiguration to commence at any given time should any unplanned interruption occur lasting greater than 1-2 hours.		
Description of proposed work:	This PNF 121 details a step by step guide to operate the Bolton Hill supply network in the event of the treatment works shutting with only the potable final reservoir available for supply and also in the event of total loss of supply from Bolton Hill WTW.		

Section 1 - Risk Assessment *(the below must use the scoring held in PN (3) 12 – Risk Assessments)*

Likelihood		Consequence	
Water quality	5	**Properties served**	5
Customer complaints	10	**Sensitive customers**	8
Type of job	10	**Severity of problem**	6
Asset condition	6		
Burst Main Data	10		
Total score	**41**	**Total score**	**19**

Total risk score	**779**
Severity of risk	V. low / Low / Medium / High / V. high

Section 2 – Method Statement

1.	**Does the work involve an Alteration/Installation of a Boundary Valve?** (If "No" then go straight to Item 6)	**Yes**
2.	**Date change proposed?**	**N/a**
3.	**Is change Permanent? *(If yes, inform WDMT local leakage reporting analyst)***	**No**
4.	**If Temporary, date to be changed back within 14 days?**	**N/a**
5.	**Details of any network analysis or modelling carried out (for medium, high and very high risk work):**	

Network information

- 27" Flow south to Milton and Orielton 13.00 Mgl/D
- 600mm to Milford Haven Dale 4.50 Mgl/D
- 500mm to H. West/ Plumstone 8.00 Mgl/D
- 12" to Johnston Neyland 1.60 Mgl/D
- 8" Quarry Line off Pot Res. 0.20 Mgl/D

Total Flow 27.3 Mgl/D

Pre-preparation

- All valves to be checked for access and operability prior to work – **TBC**
- Relevant staff informed from customer service / leakage / trunk mains / production
- OCC to be informed of work to update bulletin board & DCWW website
- Notified Water Quality of planned work 3 day in advance of works

The DMA's/WPS'/SRV's affected are:

DMA's – All DMA'S on Bolton Hill WTW, supplies 47,800 props with a population of 90,766

	SRV's (Part 6. – Analysis will include Service Reservoir retention times) **Plumstone** **Narberth Road** **Neyland Tower** **Norchard** **Orielton** **Pentlepoir** **Stephens Green** **Tavernspite** **Templeton** **Wogaston** **<u>Network Modelling</u>** Model available from Claire Keir (Hydraulic modelling engineer) 02920740387 and via the modelling standby team – rota is on the Infozone	
6.	**Is the planned change likely to cause water quality issues?**	Yes – If total loss of supply
	If Yes provide details including possible impact on customers and contingency plans to mitigate risk.	
	Monitor customer contacts through SAP (Silver Centre) Pre flush at boundary valves of the rezones Carry out water quality checks after rezones Mass text to be sent in rezoned areas to inform customers Update Bulletin Board	
	If No, provide evidence as to why not.	

Analysis

1. **Location of works.**

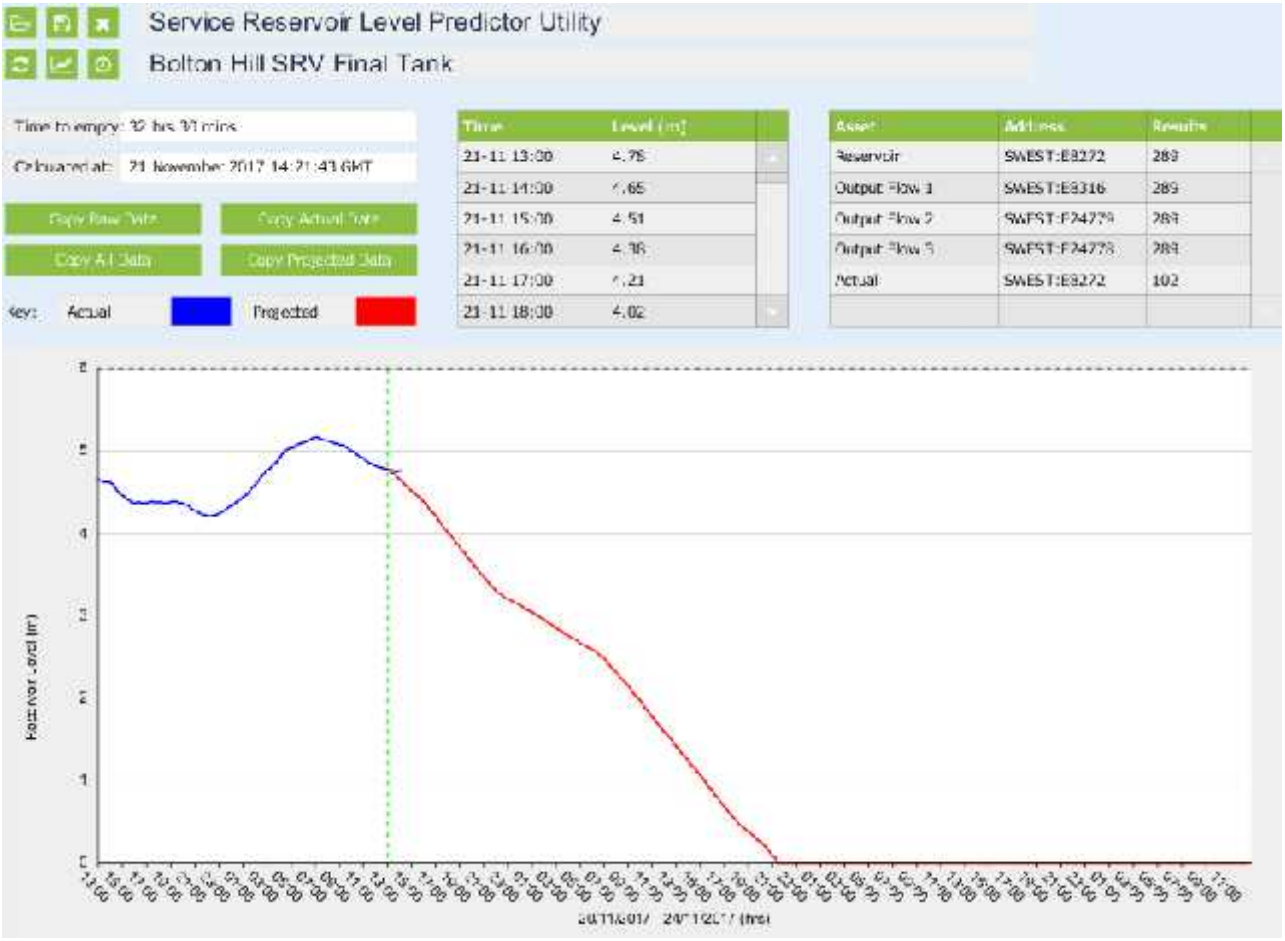
2. **Flow analysis**

Flow details below details Bolton Hill WTW outlets

		Flow (Mld)		Total Demand (Mld)	
Flows	27" Flow south to Milton and Orielton	13.00		27.3	
	600mm to Milford Haven Dale	4.50			
	500mm to H. West/ Plumbstone	8.00			
	12" to Johnston Neyland	1.60			
	8" Quarry Line off Pot Res.	0.20			

3. **SRV storage time and Tanker feasibility**

The attached predictor shows the draw down time for Bolton Hill final potable storage reservoir assuming no flow from treatment and average diurnal flows



SRV		Summer	Winter	Property count	Tanker feasibility	TMA required
Plumstone		23 Hrs	36 Hrs	2476	Rigid	No
Narberth Road		37 Hrs	50 Hrs	2650	Arctic	Yes
Neyland Tower		24 Hrs	24 Hrs	1573	Arctic	Yes
Norchard		45.5 Hrs	67 Hrs	597	Arctic	No
Orielton		96 Hrs	101 Hrs	427	Rigid	No
Pentlepoir		22.5 Hrs	28 Hrs	1183	Rigid	No
Stephens Green		7 Hrs	9 Hrs	1152	Arctic	Yes
Tavernspite		80 Hrs	96 Hrs	525	Rigid	No
Templeton		41 Hrs	45.5 Hrs	1440	NO	N/A
Wogaston		58 Hrs	58 Hrs	274	Arctic	Yes

WPS details

Templeton WPS

Delivery Data

Templeton WPS supplies Templeton village, Church Lane, West Lane, Jubilee Gardens, Tavernspite SR, Castlemehren, Allensbank, Cold Blow and Lampeter Velfrey.

a) Properties supplied directly from Pumping Main 347 (Approx.)

b) Properties supplied by Storage 1685 (Approx.)

Stephens Green WPS

Delivery Data

Stephens Green WPS supplies Norchard SRV and Houghton Lane DMA.

a) Properties supplied directly from Pumping Main 1152.(Approx.)

b) Properties supplied by Storage 1152 (Approx.)

Pentlepoir WPS

Delivery Data

Pentlepoir WPS supplies Templeton SRV, Templeton Village, Ryland Lane, Begelly, Kilgetty/Thomas Chapel and Pentlepoir Village.

a) Properties supplied directly from Pumping Main 3613 (Approx.)

b) Properties supplied by Storage 3613 (Approx.)

Milton WPS

Delivery Data

Milton WPS supplies Pentlepoir SR.

a) Properties supplied directly from Pumping Main None

b) Properties supplied by Storage None

Contingency Planning

1. **Tankering arrangements / preparation;**

   Tankering to Service Reservoirs may be required and would be prioritised and managed by Silver Centre. Tankering is possible into 9 of the 10 SRVs as per the table above. The full fleet of 23 tankers would be available during an emergency. Filling points would be outside the area and most likely off Llechryd WTW
   Tankering and logistics silver team to be put in place to ensure effectiveness of operation
   Water quality to be notified of all SRVs that are supported via tankering in and sampling arranged.

2. **Re-zoning arrangements;**

   Rezoning can be carried out if required as per the plan below.

   Rezone savings

Rezone	Savings off Bolton Hill Ml/d	Properties served by rezone
Extend Preseli to Plumstone and to Bolton Hill 500mm	8.0	12,287
Increase Pressure at Southfields PRV (off Preseli WTW) to increase bleed into Templeton inlet	0.5	
Tavernspite SRV (including inlet main from Templeton WPS) rezoned onto Pendine WTW via EP temporary pump at Three Gates	1.0	1,388
Total	9.50 Mgl/d	

3. **Property information including mass text arrangements and GIS plans;**

Bolton Hill Water quality zone, full list of DMA's and SDMA' can be accessed via the attached link to the shared drive, within the folders on the shared drive are DMA Bowser location plans and site location addresses, also included are DMA plans identifying all properties for leaflet dropping which includes individual property addressed. Example copies have been printed for easy view

\\dcwwlocal\shareddata\Shared Services\DCWW\GIS Bureau\Special Project Work\DCWW713

4. **Contingency fittings**

A very large range of fittings are maintained at Clydach stores, including lengths of pipe and couplings. If the loss of supply is due to a burst a team will be mobilised to undertake a trial excavation to determine exact outside diameter of mains.

Strategic stock for all pipes and fittings are stored at the Central stores Clydach/Swansea. Satellite stores are located at Milton wps, Milton, Pembroke.

5. **Customer acceptability, monitoring & CML**

Water quality will be monitored throughout re-charge to ensure grade 0 (zero) is maintained and introduced back into supply post shutdown.

CML Loggers available on Watercore – L

7.	**Details of work: (NB Health& Safety Performance Method Statement to be attached)**

H&S

- Company PPE to be worn at all times.
- Chapter 8 to be used where required
- Take 5 to be utilised on all tasks.
- Use of TAF forms at all locations of work, valving, and tanker locations etc.
- IMS valving procedure PNL601 to be followed.
- Near Miss Hotline 01443 452800
- Lone working system to be utilised where necessary
- Any issue encountered on site to be escalated immediately to the Silver Centre (Rule of 2).

- Permit to Work (HSF 102) – To be issued daily prior to any work commencing if required;
- Copy of all RAMs to be on site and to be adhered to at all times;
- All RAMs, CTR-H, Permits to Work and COI's HSF119 (if required) to be filed for audit.

Planning check list

- **Environment –** Delete **/** Tick all conditions that apply to this activity, and add any other if required:

Sewage / RAW Water	☐	Deep Water	☐
Dust	☐	Lone worker	☐
Confined Space	☐	Noise	☐
Zoned area	☐	Falls from height	☐
Adjacent Plant	☐	Outdoors	☑
Other…	☐	Other…….	☐

- **Assessments / Certificates –** Delete **/** Tick all conditions that apply to this activity, and add any other if required:

General Risks inc fire:	☑	Manual Handling	☑
COSHH	☑	PTW required?	☐
	☑	COI required?	☐
Other…….	☐	Other…….	☐

Action Plan

Implementation of the Action Plan will be controlled by the duty silver manager. When a silver incident is declared the Silver centre will be opened at the Clydach Depot, Silver Centre room.

Key Contacts

All Management standby rotas are stored and updated on the "Infozone" and can be accessed from the home page. Useful local contacts include:

People / Contractor(s) & Escalation involved in activity

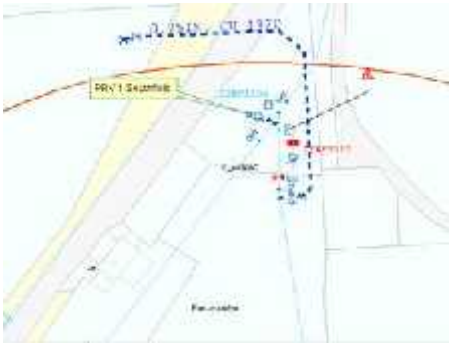
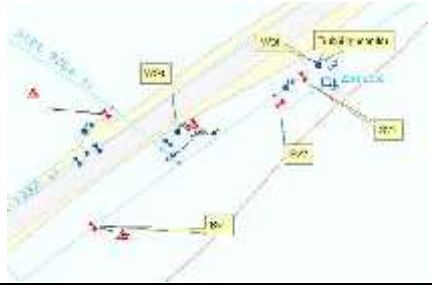
Water Distribution Team	Designation	
Rob Wilson	Distribution Manager (Silver Manager)	07891649842
Martin Cleevely	Network Analyst	07989602086

Chris Woolley	Operations Supervisor	07717 767062
Keith Sharpe	Distribution Technician	07785 346849
Emyr Walters	Distribution Technician	07554 113750
Production Team		
Steve Coaker	Production Manager	07778926252
Phil Jenkins	Production Performance Manager	07785938408
Alan Watkins	Operations Supervisor	07811 262773
Simon Hughes	MEI (Craft) Supervisor	07824529603
Emergency Planning		
Aled Daniel	Emergency Planning Manager	07768230855
Rob Hill	Emergency Logistics Manager	07768336143
Darren Koszalski	Emergency Logistics Supervisor	07824545979
Steve Davies	Emergency Logistics Supervisor	07824545981
Water Quality Scientist		
Sarah Mason	Scientific manager	07796 440733
Dave Webb	Area scientist	07785 326721
Capital Reactive Team		
Wayne Hurley	Capital Manager	07585964514
Dai Roberts	Site coordinator	07557920132
Tom Stevens	Site coordinator	07778812429
Leakage Delivery Team		
Jason Lundregan	Leakage Delivery Manager	07969492619
Andy Williams	Leakage Supervisor	07920786393
David Stevens RPS	RPS Supervisor	07484001697
Repair & Maintenance Team		
Alex Evans	Contracts Delivery Manager	07771674732
Glen Jones	Contract Delivery Technician	07825977126
Jon Williams (Amey)	R&M Manager	07583951845
Derrick Wyke	R&M Manager	07572318999
Tom John	R&M Supervisor	07940404941

No.	Action Plan (Work Schedule)	Responsible Officer	Date / Time	Action Outcome	Signed
8.	**Monitor SRV levels hourly** Plumstone Narberth Road Neyland Tower Norchard Orielton Pentlepoir Stephens Green Tavernspite Templeton Wogaston	**Silver Centre**			

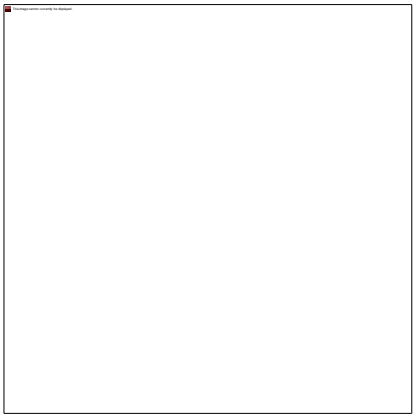
	1 – 4 Hours unplanned interruption to Bolton Hill WTW the following work schedule should be followed.					
1.	Communication from Production Department that an unplanned shutdown of Bolton Hill WTW has occurred. In hours – Distribution team Out of hours – South West Silver standby	**Production Team**				
2.	Shut down Bolton Hill WTW, feed area off "pot" res- final water tank	**Production Team**				
3.	The following Service Reservoir/WPS/Trunk main adjustments carried out at the earliest of opportunities: *Update silver centre after each step is completed*	**Distribution Team**				
4.	Close inlet SV at Orielton SRV Close Inlet to Wogaston SRV	**Distribution Team**				
5.	Turn off pumps at Stephens Green	**Distribution Team**				
6.	Turn off pumps at Milton	**Distribution Team**				
7.	Turn off pumps at Pentlepoir WPS	**Distribution Team**				
8.	Turn off pumps at Templeton WPS to Tavernspite SRV	**Distribution Team**				
9.	Close Inlet to Neyland SRV	**Distribution Team**				
10.	Turn pumps off at Corner Piece WPS to Plumstone SRV	**Distribution Team**				
	4 – 8 Hours unplanned interruption to Bolton Hill WTW the following work schedule should be followed.					

	11.	CML Loggers available to view on Watercore – see attached list of LCAs and Site ID's Here	**Distribution Team**			
	12.	Inform Emergency planning, cancel all other work and mobilise full fleet of tankers to support including North Wales for contingency	**Silver Centre**			
	13.	Carry out flushing operations for possible rezoning Pendine WTW to Templeton SRV rezone Flushing point 221410,210977 Preseli/Plumstone/Haverfordwest rezone Flushing point 198800,219361 Flush mains until grade 0 and take Cl2 readings.	**Distribution Team**			
	14.	**Tankers to be mobilised on 6th hour**	**Silver Centre**			
	8+ Hours unplanned interruption to Bolton Hill WTW the following work schedule should be followed. **Total loss of supply, WTW has failed and no water in Clear water tank at Bolton Hill to supply area**					

	15.	**Carry out rezones** Pendine WTW to Templeton SRV rezone - Open BV at 221410,210977 - This will feed back to Templeton SRV pumps. Preseli/Plumstone/Haverfordwest rezone 1. Turn off Corner Piece WPS  2. Increase outlet pressure at Southfield (PRV1) NGR 204339, 223336 from 64mh to 76mh  3. Close BV1 at Newbridge – this stops the Bolton Hill supply to Plumstrone NGR 198747, 219324 4. Open SV1 and SV2 at Newbridge 	**Distribution Team**			

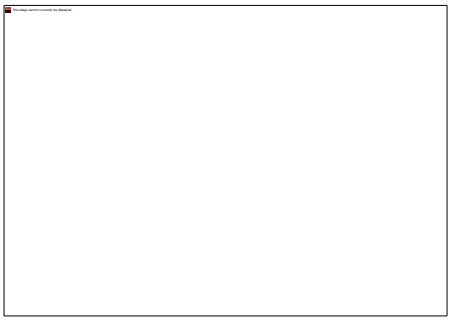
Close SV at Bolton Hill WTW to feed Haverfordwest DMAs from Preseli

5. Flush at WO4 until quality satisfactory



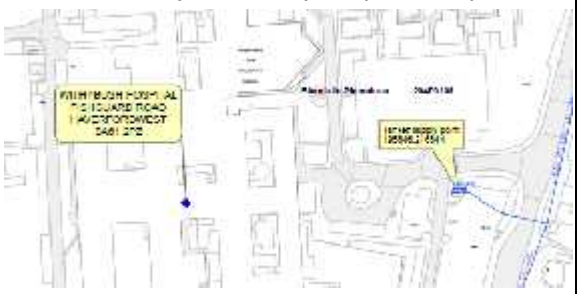
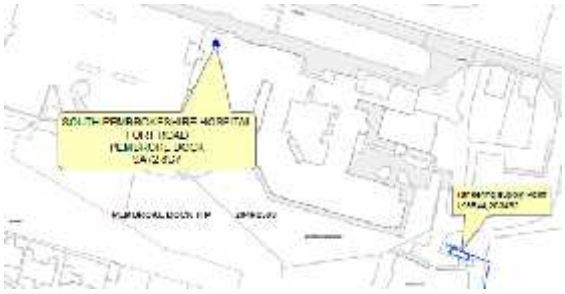
6. Check inlet pressure at Cornerpiece WPS, should be 113mh.

7. Set up SV4 (Control valve at Plumstone SRV) by PRV Technician



8. Visually monitor at WO3 and SRV inlet

		 9. Check PRV2 Rudbaxton NGR 195684, 221730, PRV3 Spittal 195721, 221719 , & PRV4 Poyston Cross NGR 198222, 219770.   				
	16.	Increase Pressure at Southfields PRV (off Preseli WTW) to increase bleed into Templeton inlet	**Pressure Management Team**			

	17.	Tankering Plans actioned from Silver Centre Filling points at Carmarthen show ground, Llechryd wtw and Crosshands Ind estate to be arranged by Siver Centre Plans\12inch Tanker Plan.docx Plans\Plumstone rezone hwest.pdf Plans\Tankering plan for properties fed from then 600mm.docx Plans\Tankering Plan for Area Directly Fed From the 27.docx Plans\27 inch tankers.pdf Plans\12inch tanker plan.pdf Plans\600 out tanker plan.pdf	**Silver Centre & Distribution Team**			
	18.	Inform Water quality team/area scientists of tanker locations	**Silver Centre**			
	19.	Tanker to Withybush Hospital (3 Arctics) 	**Distribution Team**			
	20.	Tanker to South pembs Hospital, Pembroke Dock (2 Rigid) 	**Distribution Team**			

	21.	Water Company Local Resilience Plan will kick in at 24 hrs to meet any deficit through bowser deployment to achieve 10 l/pp/per day statutory requirement After 72hrs will deliver 20l/pp/per day, through bowser and bottled water- may require Mutual aid as per the SEMD protocols Click Here for Bowser plans & Property list	**Gold / Silver Centre**			

9.	**Has the GIS Information been attached?** *A Marked Up Plot Of The Change Must Be Attached To This Form Showing As Applicable: Valves Operated, Location Of Burst, Boundary Valves Etc.* *If Network been permanently changed by this operation a marked GIS Plot & copy of this Form must be passed to GIS Department.*				Yes/No
10.	**Has the boundary valve been altered?** *If yes, please inform GIS to update the system*				Yes/No
11.	**Proposed Signatory**				
12.	**Proposed Signatory** **Authorised Signatory**	**Name**	Chris Woolley	**Date**	
		Post	Operations Supervisor	**Signature**	
13.	**Authorised Signatory**	**Name**		**Date**	
		Post		**Signature**	

Section 3 – Review of Work

	Problems encountered	**Comments**
1.		
2.		
3.		

Other comments

Section 4 – Reviewers Signature

Name		**Signature**	
Post		**Date**	

APPENDIX 2 – SITE CHECKLIST

Health, Safety and Environment Inspection

Project: **Contract No:** **Date:**

Area Inspected:
Enabling works **Start Time:** **End Time:**

Adverse Conditions:

Weather Conditions **None**

✓	Item checked and compliant	x	Item checked and action required	Leave blank if item not checked or not applicable

Ref No.	Item	✓x	Ref No.	Item	✓x
1	Site Welfare		26	Ecology (animals and habitat)	
2	Site Traffic Management		27	Tools and Equipment	
3	Fire, First Aid & Emergency		28	Display Screen Equipment (DSE) and office	
4	Confined Spaces		29	Public Interface	
5	Working at Height		30	Reports, Records and Registers	
6	Lifting Operations & Lifting Equip.		31	Competence	
7	Access Equipment		32	Temporary Works	
8	Excavations		33	Process Safety	
9	Cartridge Tools		34	Other H&S and Environmental issues	
10	Abrasive Wheels		35	Air quality (dust, emissions)	
11	Temporary Electrical Services		36	Archaeology / heritage	
12	Housekeeping		37	Effects on neighbours	
13	Health hazards		38	Protection of trees & vegetation	
14	Fuel and oil storage, handling and refuelling		39	Hazardous waste management	
15	Permit to work		40	Contaminated land	
16	Control of substances hazardous to health (COSHH)		41	Noise and Vibration (Environmental)	
17	Personal protective equipment (PPE)		42	Spill kits	
18	Risk assessment and Method Statements		43	Work near site drainage, watercourses	
19	Demolition		44	Pollution of site drainage, watercourses	
20	Manual handling		45		
21	Storage of materials		46		
22	Waste management		47		
23	Noise, Dust and Vibration control (Health & Safety)		48		
24	Pre-task briefing		49		
25	Site security		50		

Inspection carried out by: _____ Signature: _____ Date: _____

Report closed out by: _____ Signature: _____ Date: _____

A Non Conformance report (NCR) shall be raised and logged for any non-compliance.

Project: **Contract No:** **Date:**

APPENDIX 2 – SITE CHECKLIST

Area inspected _____

No.	Comments	Immediate/Corrective Action Required	Action by	Timescale	Date Closed

Inspection carried out by: _____ Signature: _____ Date: _____

Report closed out by: _____ Signature: _____ Date: _____

A Non Conformance report (NCR) shall be raised and logged for any non-compliance.

APPENDIX 3 – DETAIL OF NEW RISKS RESULTING FROM CAPITAL WORKS

DWSP Section	Reference	DWI Stage	Hazard reference	Hazardous event	Initial likelihood	Initial impact	Initial score	Explanation	Control measure details	Residual likelihood	Residual impact	Residual score	Parameter suite	Comments	DWI Category
040 Site Condition and Management	D103855	Treatment	H063	Potential loss of supply due to third party event during capital activity	4	4	16	During capital work a loss of supply may be experienced due to accidential damage that results in asset shut down	RAMs	2	4	2	PSC000	Schemes ongoing at the moment include:	A - Target risk mitigation received , verified and maintained
040 Site Condition and Management	D103920	Treatment	H062	Potential for contamination of supplies due to third party event during capital activity	4	3	12	During capital work contamination of supply may be experienced due to accidential introduction of potential contaminant	RAMs	2	3	2	PSC062	Schemes ongoing at the moment include:	A - Target risk mitigation received , verified and maintained

APPENDIX 4

Works Abnormal Operation Form
POF 014

On completion of the form, this must be sent to POF014@dwrcymru.com.

Works' Name:		**Date:**	
Reason for Notification:		**RTW? Y/N**	

	Reason for Notification:	
1.	**Which was caused by:**	
2.	**Which was caused by:**	
3.	**Which was caused by:**	
4.	**Which was caused by:**	
5.	**Which was caused by:**	

Action Taken to resolve Problem:

Details of actions taken to protect Customers (E.g. Sampling etc.):

Scientific Signature:		**Date:**	

Post notification 5 day Review:

Root Cause (mark any relevant)

Faulty/Unreliable Plant		Scada/Telemetry Issue	
Power failure		Design Issue/Poor Control	
Failure to identify process/human error		Capital work/maintenance	
Chemical dosing issue		Lack of Instrumentation	
Start-up Issues		Other	

Further Comments/Update:

Agreed Action	Owner	Complete by
Scientific Signature:	**Date:**	

Appendix 6 – Resilience Report

Dŵr Cymru
Welsh Water

Cwm Taf Resilience Benefits and Drivers

Introduction

The raw water resources in the Cwm Taf area are critical to our overall water supply strategy. At peak times they can provide up to 50% of the input to our largest water resources zone, South East Wales Conjunctive Use System (SEWCUS). It is important to maximise the availability and use of these resources in order to meet future demand in a sustainable way.

One of the key benefits required from the Cwm Taf Water Supply Strategy scheme is an improvement to the current levels of resilience in SEWCUS and the three existing water treatment works in the area.

The key resilience benefits of the Cwm Taf Water Supply are summarised in the bullets below and discussed in further detail throughout this report;

- **Strategic Resilience Benefits** – long term resilient site, with multiple raw water sources and improved network connectivity
- **Three stream approach** – resilient WTW with three separate streams, resilient power supply and 160 Ml clear water storage
- **Supply and Access Resilience** - drought / freeze resilience, vehicle access, delivery efficiency
- **Raw Water Resources** – ability to treat water from multiple sources in the event of a pollution or lack of resource
- **Integration and Control Benefits** by having one combined works at the chosen location provides efficiencies for control and operation, central regional control centre, increased flexibility across SEWCUS
- **Improved Network Connectivity;** Improvements to the connectivity from the new site to the water distribution network to improve the connectivity and volume of water that can be delivered into supply
- **Power Resilience;** the improvement of the alternative power supply position when compared with the current sites at the new WTW

Strategic Resilience Benefits

The Cwm Taf Water Supply Strategy will resolve a number of issues including ageing assets, the need to provide capacity for future growth and tightening water quality standards. This document will concentrate on the resilience benefits and drivers that the strategy will address.

In the medium term there is a strategic aim to improve resilience in the North West SEWCUS area which over the last five years has begun to affect our customers. Customer have been affected by interruptions to supply during high demand periods as well as discoloured water due to changes required in the network to maintain the water supply. The cause of this is the condition of the current WTW, their reliability and the limitations of network connectivity that currently exist. In addition to this the current raw water resources position limits the raw water sources available to each Water Treatment Works which can in extreme condition limit or result in a WTW needing to close for several days.

The new Cwm Taf WTW will have the ability to undertake planned maintenance activities on its assets by having a multi-streamed design an additional benefit of this being that any continuation entering the WTW can be isolated to one stream rather than requiring the whole site to shut down. The new site will also have

multiple raw water supplies and enhanced network connectivity further increasing the resilience of supply to our customers.

Three Stream approach

The decision to build the tank in three streams is in response to the resilience agenda driven by both OFWAT and DWI, Appendix 6 - Bolton Hill resilience audit. The new treatment works will be replacing three, (potentially an additional two in the future), existing sites. Due to the criticality of the new WTW we wish to maintain the overall resilience of the SEWCUS system and maintain/increase resilience of our production sites.

By building Cwm Taf WTW in three streams it will eliminate any single points of failure during normal operation, allow isolation of raw water contamination and provide an ability to continue production as normal from two of the streams during lengthy maintenance activities thus replicating the resilience of having three separate sites. The three streams will be from clarification stage through to and including final water tanks, with cross-connections between process stages, see Figure 1 below.

For the final water tanks this will allow full maintenance activities from short term cleaning, disinfection, and minor repairs through to full structural repairs without falling below 8 hours of treated water storage. For the sites that are planned for replacement the lack of final water storage has proven a significant limitation for asset maintenance activities not only for the tanks but also upstream processes, limiting shutdowns to only a few hours only. This has significantly impacted performance of the treatment works and at times impacted the service received by our customers

Each treatment stage will be split into three “virtual” treatment blocks with functionality that allows each “block” to be taken out of service for maintenance without affecting the entire treatment stage. Whilst this improves WTW resilience it also introduces reliability and introduces the ability to carry out planned maintenance on a more cost effective basis, thereby reducing costly reactive maintenance and the implications that plant failures can have on production. In addition to this the ability to return sites into service in a more planned way without the current time constraints will significantly reduce the risk of interruptions to supply or water quality failures.

The three stream approach will also allow streams to be dedicated to a particular raw water source which will mean that should a raw water contamination occur and reach the site the contamination can be isolated and supply continued from the other two streams without affecting customer’s supply.

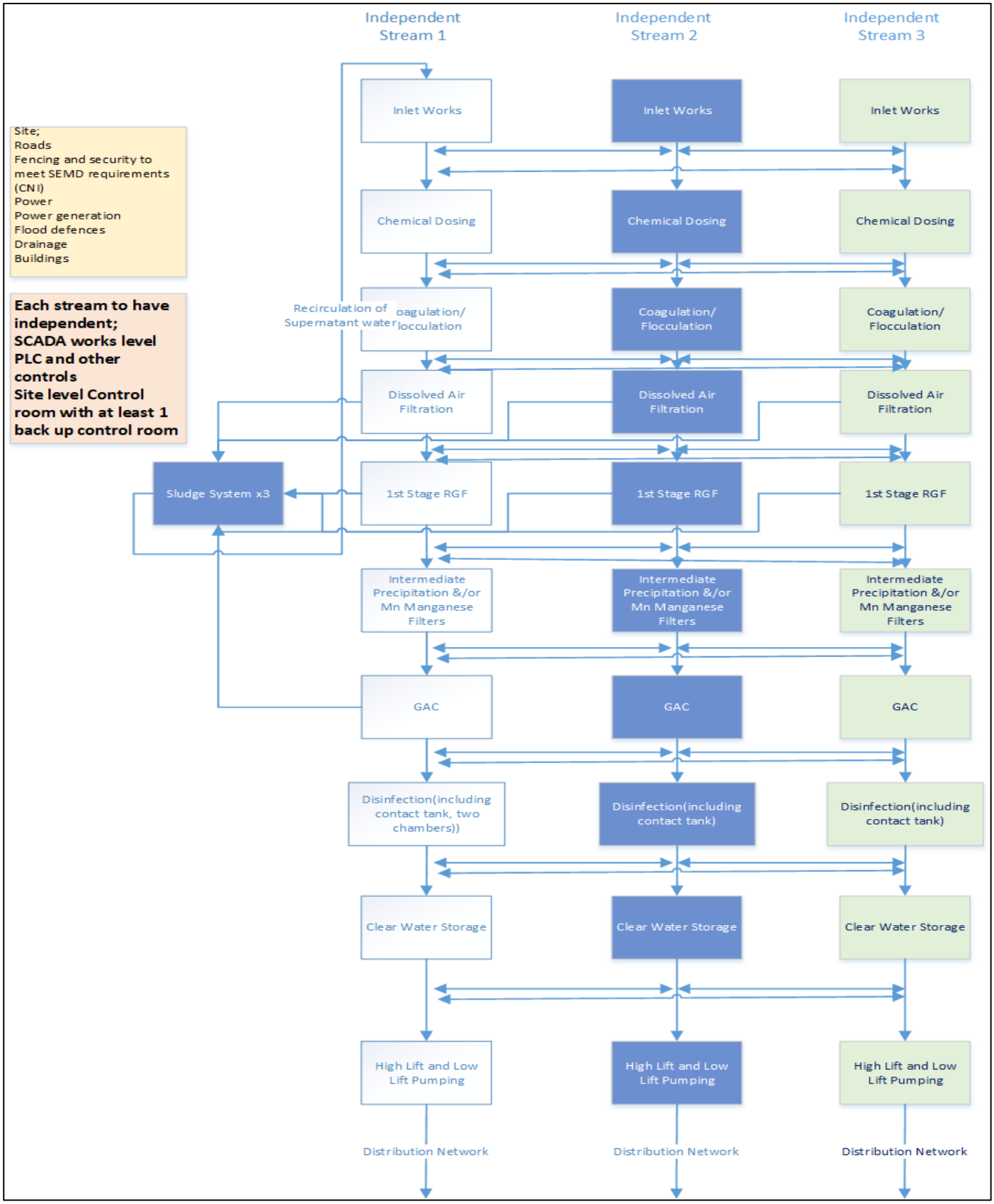


Figure 1 – Three Stream WTW Schematic

Treated water storage

There is a need to have a least 8 hours of usable resilient storage volume to allow for emergency situations to be dealt with even when one of the clear water tanks has been removed from use to allow for cleaning, maintenance and/or inspection. Under planned circumstances with average demand the 160 Ml storage can provide up to 24 hours of storage to enable a WTW shutdown to be resolved or to support other sites.

In the special factors submission the storage volume of the new Cwm Taff WTW was presented as 24 hours storage at average flow of 160 Ml. This was a high level volumetric criteria supported by a pre-planned resilience scenario to have 24 hour storage reserve in the event of an emergency or planned maintenance shutdown. However, when presented in relation to maximum throughput i.e. 225 Ml/d the usable resilient volume is approximately 8 hours, which is discussed in more detail within Appendix 1 – Black and Veatch Merthyr WTW – WTW Flow Rate and Treated Water Storage.

The storage at Cwm Taf WTW in comparison to other recently build UK WTW is broadly in line with a number of these other sites, see Table 1 below, but offers significantly more resilience due to the three stream approach.

Table 1 - Comparison of Storage, Merthyr v other UK recently built WTW

	Cwm Taf WTW	Glencorse WTW	Katrine WTW	Mayflower WTW	Felindre
WTW Maximum Flow Ml/d	225	175	240	90	240
Tank Storage volume ML	160	90	160	20+50	150
Storage as % of maximum flow	71%	51%	67%	77%	63%

*20Ml is newly built storage (for 10ML/d direct feed) and 50Ml existing strategic storage immediately downstream.

Supply and Access Resilience

The low probability high consequence events that can occur due to extreme weather conditions particularly drought / freeze resiliencies has been an issue over the last two years and with climate change predictions this is due to happen at a more regular frequency. Access to the three current water treatment sites has been difficult on occasions in recent years and there are new works will provide a more resilient site than the current three sites with the ability to access the site by two different directions its location at a lower altitude will reduce the risk of road closure and other access issues.

The new site will also have the capability to reliably supply higher volumes of water for longer durations during an emergency with the WTW capacity and on site storage facilitating the ability to do this for both SEWCUS and in the medium term the Tywi conjunctive use system which will support our Felindre WTW in the event of an emergency failure or planned shutdown. Two example scenarios, one for the Felindre WTW failure incident and the other for a failure incident affecting SEWCUS are described below in more detail.

Loss of Felindre due to a process or pollution incident

The Felindre WTW is the largest site across the Welsh Water area and in the event of a failure event for example a pollution on this river source which it could result in a loss of up to an average of 118 Ml per day or peak flow in excess of 200 Ml per day. It is currently a single source of supply for over 130,000 properties and is at risk of short term shutdowns due to a process failure or pollution incident.

An example of the risk can be seen from a pollution event in April/May 2015 resulted in the raw water intake at Nantgaredig raw water pumping station shutting down for around 48 hours impacting both Felindre WTW and Capel Dewi WTW. Should Felindre WTW need to shut down for a 48 hour period up to 130,000 properties, around 70% of the total population served, are at risk of an interruption to supply.

The new clear water tank and Merthyr water treatment works with suitable trunk main connectivity would enable short term support to the Tywi conjunctive use system of approximately 50Ml/day, which equates to

around 40% of the average output, to be supplied from the SEWCUS area in the East into supply from the new WTW. The additional storage would provide a three day buffer to supply this volume of water even during a period of high demand increasing resilience for the whole South Wales area. Without the 160Ml storage the additional demand on the water treatment works particularly at a time of high demand will limit the duration and availability of the support that can be provided. For example 54 Ml of storage would allow 25Ml/day to be supplied for up to two days with minor impact on supplying the existing network.

The availability of treated water links with our strategy for South Wales where we are planning new and improved strategic links between the two areas. The first is planned in AMP7 to provide a link of up to 20 Ml/day that will allow the transfer of water from East to West as well as from West to East and maximising existing assets where possible. The East West/West East project will also scope and cost a future major link, of around 50 Ml/day that is being planned on completion of the Cwm Taf scheme for delivery in AMP9 to increase resilience for our customers across South Wales.

General Resilience Improvement for SEWCUS

During 2018 there have been two events which affected water supply across South Wales, the freeze thaw in February/March and the summer period between May and August. During these periods the water treatment works are maximised to using the available raw water resources to meet demand. Should a failure of any of the Water Treatment works within SEWCUS occur at that stage there is currently an insufficient network and water treatment storage buffer to provide resilience to allow the recovery of a water treatment works following an outage.

To demonstrate the issue Figure 1 below shows the level within the Pontsticill final water tank during an outage period in February 2018 and the associated loss of output from the site for a 24 hour period. A selection of level charts for Service Reservoirs (SRV) supplied by Pontsticill WTW can be seen in figures 2 to 4 below which show a similar fall in storage levels during the site outage. The Pontsticill High Level System, Figure 4 below, can only fed from Pontsticill WTW via Pengarnddu SRV, with the proposed 160 Ml storage tank at Merthyr WTW the likelihood of customer interruption is significantly reduced for this system.

The 160 Ml clear water storage tank at the new Merthyr WTW will provide this buffer as well as enhanced network connectivity enabling the local network and SEWCUS to be supplied from the new tank. During an outage period for any of the nine other WTWs, an issue in the distribution network or a reduced output from the new WTW, particularly during a period of high demand will be supported by the additional storage. Currently this would lead to interruptions to supply or the need to reconfigure the network.

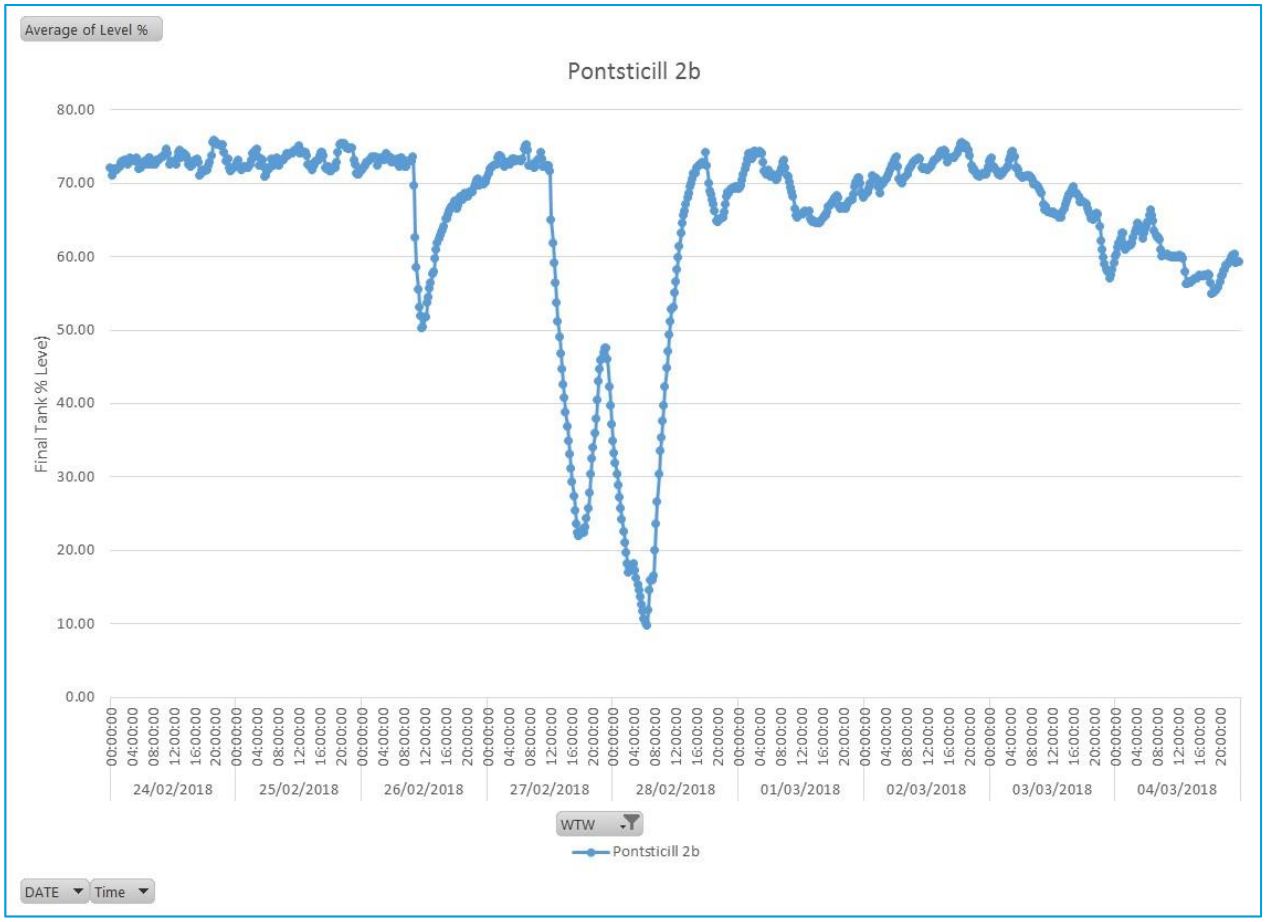


Figure 1 – Pontsticill Final Water Tank Levels during the Freeze Thaw Period in February/March 2018

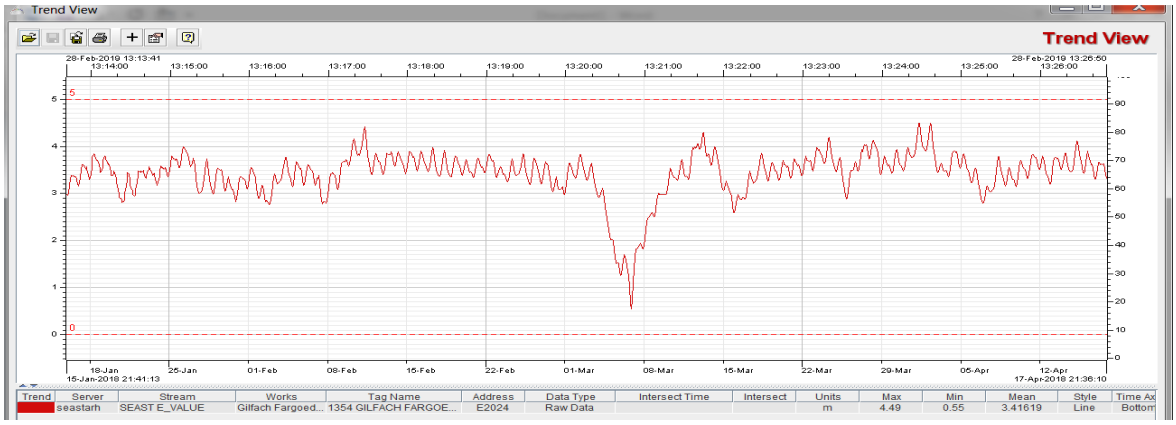


Figure 2 - Gilfach Fargoed SRV Supplied from Pontsticill WTW Properties Served 11,562, March 2018

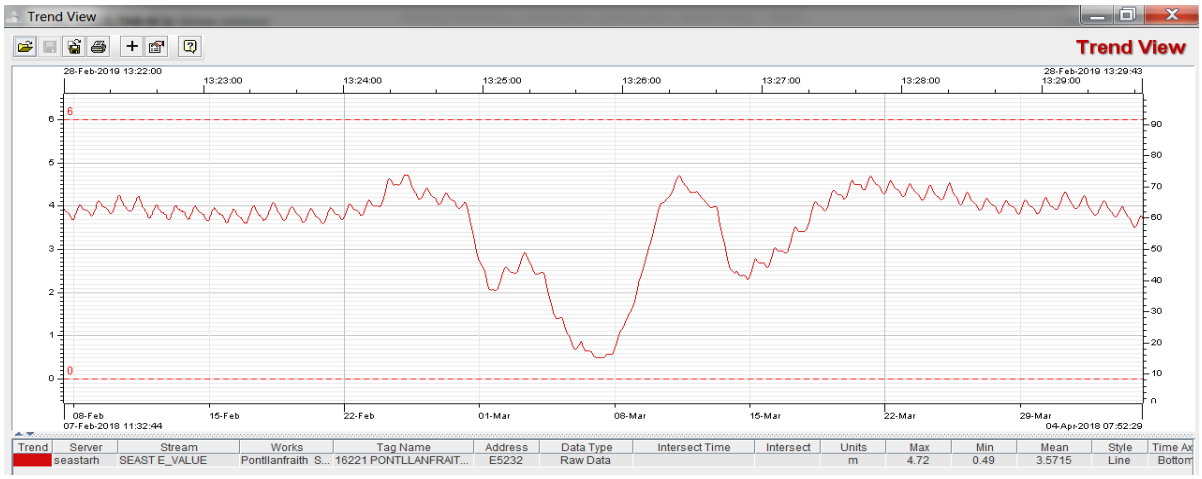


Figure 3 - Pontllanfraith SRV, supplied by Pontsticill WTW, Properties Served 4031, March 2018

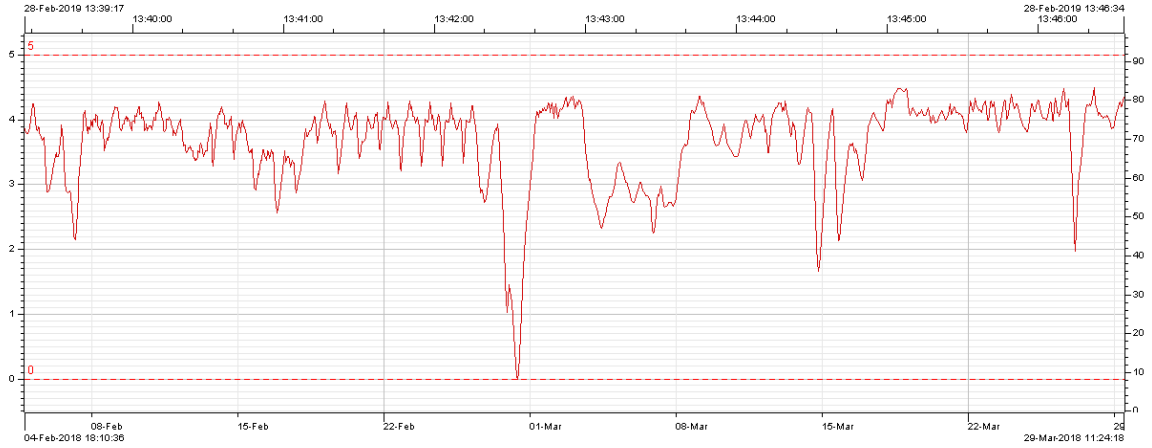


Figure 4 – Pengarnddu SRV fed via the Pontsticill High Level System

Raw Water Resources

The new WTW will have the ability to treat water from multiple raw water sources in the event of a pollution at one of the raw water sources or a lack of resource due to drought conditions production will continue to be able to produce water without the need to close.

The treatment of raw water from more than one raw water resource at the new WTW will further increase resilience. During a pollution, landslip event or raw water pipeline failure affecting one of the raw water sources production will be able to continue to supply water with minimising any impact on customers.

One example of an extreme event are the landslips that affected the Cantref impounding reservoir and resulted in elevated turbidity levels in December 2015 and January 2016. The impact on raw water quality resulted in the raw water at Cantref WTW becoming untreatable for several days whilst the turbidity settled in the body of water in the reservoir to a level where it could be treated. If this were to happen once the new WTW has been built the impact of a loss of raw water from Cantref would only require the isolation of the raw water source and the remaining four impounding reservoirs could supply sufficient raw water.

Before the new WTW has been completed the new clear water reservoir will provide the ability to allow waters from different sources to be blended, improving the acceptability of water for customers. This will allow taste and odour levels to be minimised through blending because algal blooms and the associated elevated MIB and Geosmin levels generally peak at each raw source at different times through the summer.

Integration and Control Benefits

By having one combined works at the chosen location there is an opportunity to provide water to our customers more efficiently by maximising our gravity raw water sources. Currently across our SEWCUS area there is a need to pump water from two main river sources, the Wye and the Usk. This increases the risk of pumping polluted raw water into our pumped storage reservoirs. There is also an additional cost of pumping which with the new WTW in place and our forward programme of network improvements will enable this to be minimised through the development of a centralised system to manage; the source, water treatment works outputs to meet demand across SEWCUS.

An additional benefit of the new WTW is that it provides a location and the opportunity to further develop our remote management of multiple WTW from a centralised site which has improved functionality and enhanced links to our central Smart Hub regional control room. This will result in improved response times to alarms and out of hours issues reducing the risk of water quality failures or interruptions to supply. This will address the control issues highlighted within our resilience scorecard assessment for Pontsticill and Llwynon WTW by providing an alternative way to remotely manage our sites, the ability for automatic shutdown and if required to manually operate sites.

Power Resilience

Currently the three existing sites are not fully resilient to power failures. The new WTW will provide the ability to install power supplies from different substations, the installation of power generation for 100% of the site's power requirements and the installation of uninterruptible power supplies to enable the transfer of operation from the mains supply to generator without impacting WTW operation.

The benefit of this will be a significant improvement to our power failure resilience and will improve our current resilience scorecard assessments for Pontsticill and Llwynon to 100% from 80% and 0% respectively.

Improved Network Connectivity

The new WTW, its clear water storage, its location and connectivity to the water distribution network will provide a more resilient supply to our customers. A number of improvements to the current distribution network will be installed the most significant being the increased level of storage which allows the clean water supply to our customers to become more resilient to longer duration interruptions to supply.

Additional enhancements include; a direct feed from the new WTW to our Llwydcoed Service Reservoir, reducing the volume of water that needs to be pumped to our Pengarnddu reservoir and reducing the age of water and having a higher elevation gravity feed into the distribution network providing the ability to supply a greater volume of water. The additional connectivity and associated improvements to the network will improve the resilience of the water supply in the area.

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Appendix 7 – Cost Benchmarking Report

Dŵr Cymru
Welsh Water

Cwm Taf Water Supply Strategy Cost Benchmarking Summary

Introduction

In developing our cost estimate for the Cwm Taf Water Supply Strategy scheme we have followed a multi-stage process. This is because the majority of the project scope is outside the range of our Unit Cost Database model. Our approach has followed the following process:

1. Initial costs were developed using our in-house unit cost models
2. An external engineering firm (Black & Veatch) were appointed to review the costs developed
3. The QS experts within our in-house UCD team undertook a further review of the scope and application to models that had been recommended by B&V.
4. Costs were benchmarked by Mott MacDonald Bentley (MMB), with comparisons across other companies
5. Additional scope added and updated to new cost model UCDv12

This process was particularly important as the complexity and large scale of the proposed new treatment works is such that we do not have the experience of building this size of asset before, and therefore our unit cost models, on their own, would not be a good benchmark.

1. Initial Cost Development

Once the scope of work was agreed a cost estimate was generated by using the Welsh Water Unit Cost Database (UCD) v11 – 2016/17. The size ranges of many of the new assets associated with the project, for example the 160 Ml storage reservoir, were outside of the data range of the cost curves within the UCD. As a result the costs, developed using the Solution Target Pricing Tool (STPT) within UCD, required further review and adjustment to provide more accurate estimates.

2. Black & Veatch review

Black & Veatch have used their expertise in the delivery of treatment works to derive indicative costs from projects they have previously undertaken across the UK water industry. They reviewed all the cost elements for the projects and highlighted those where the costs did not look representative of a large capacity WTW or the values were outside the range of the UCD cost curves.

For Merthyr Water Treatment Works, as many of the benchmark costs were based on similar, but not identical works, they were considered indicative rather than exact specialist quotes. For example the indicative cost for Lime Dosing is based on Severn Trent's Frankley WTW, which is based on a water treatment capacity of 300-400 Ml/d. The proposed Merthyr WTW will have a capacity of 225 Ml/d and so as a result it would not be appropriate to enter these costs directly as quotes into the Solution Target Pricing Tool (STPT).

A method was developed where the benchmark costs from across the UK water industry were used as the indicative basis for costs and the UCD values were multiplied by an inflation factor to achieve a more realistic value closer to these costs. A summary of the details for the whole project is available in Appendix 1 whilst Table 1 provides an example summary of the adjustments made for the pipelines and the clear water storage tank planned for construction in AMP7. There have been four STPT spreadsheets developed to build up the costs for the new water treatment works and the two associated pipeline and network options.

Water Treatment Process or Network Pipelines	Process and Type of Treatment	Can UCD be used or is an alternative required	Adjustment factor applied	Comments
AMP7 Projects				
Storage	Storage Large capacity clean water storage	No	2	Use x 2 multiplier reflecting benchmark costs
Pipelines	Pipelines of all diameters	Yes		UCD costs have been used

Table 1 – AMP7 Cwm Taf project elements with the inflationary factors used

The impact for the elements of the project associated with AMP7 mean that a multiplier of two has been used for the clean water storage reservoir using Severn Trent's Ambergate service reservoir, £40m for 137Ml of storage as a benchmark cost for the project, where the original cost from UCD without a multiplier was £20.5m for 160Ml.

For the Infrastructure portion of the project, the most appropriate UCD cost models were used without additional inflation. This is because the planned scope of work for this portion of the project was represented in the dataset used to create the existing cost models.

Welsh Water Estimate Adjustment Recommendations

In order to ensure that the estimating methodology was consistent throughout the scope (specifically in relation to the AMP8 project scope), two additional adjustments were recommended by the Welsh Water UCD team:

1) The Pressure Filter model was initially used to represent a GAC process instead of the GAC model. It was recommended that using the appropriate GAC model and increasing the number multiplier to 300% to meet the indicative cost would be more appropriate and ensure a consistent methodology across all items, as no other processes were represented by an alternative model.
2) The estimator recommended that the output cost for Operational Buildings outside of the yardstick range would need to be doubled, but only a 150% multiplier had been applied. The multiplier was changed to 200% for those buildings outside of range to better meet the recommendation.

3. Mott MacDonald Bentley Cost Benchmarking

Following the development of costs by Black and Veatch and the inclusion of the Welsh Water UCD team's recommendations, the completed project estimate was sent to Mott MacDonald Bentley for external benchmarking.

Benchmarking Methodology

The scope used for benchmarking of the water treatment works by MMB included the appropriate processes and yardsticks, but had the costs or any multipliers used to match the indicative costs removed. MMB then returned the scope with industry benchmark costs aligned to the processes. Where comparable industry cost models were available these were used for benchmarking, otherwise a cost estimate was generated for the scope item.
For the Infrastructure portion of the project, the most relevant UCD cost model was benchmarked against the average of seven equivalent industry models as well as against the industry frontier.

Benchmarking Results

The benchmarking exercise assessed the costs for the Water Treatment Works and Infrastructure assets separately. The results generated for the review initially were based on costs generated from the UCD version 11 costs.

The results indicated that for the whole water treatment works the total cost to client adjusted cost estimate, including the multiplication factors, of £181.7m was slightly below the benchmark cost of £188.4m, see Table 2 below. As the adjusted estimate was within 10% of the benchmark value it was deemed acceptable to use.

The trunk mains benchmark cost was 10% less than the industry benchmark but 33% greater than the frontier costs, see Table 3. As a result it was decided that the UCD values should be used without any adjustments for infrastructure assets, totalling £40m total cost to client. The delivery of the infrastructure assets are planned during AMP7.

Initial Benchmark against UCD version 11

Treatment Works Total Project Cost

Original Estimate Total Cost to Client	Adjusted Estimate Total Cost to Client	Benchmark
£167.3m	**£181.7m**	£188.4m
-11%	**-4%**	-

Table 2 – Treatment Works Benchmark Review Results

The adjusted estimate total cost to client was 4% lower than the benchmark

Infrastructure

UCD Model	Average Distance from Industry	Average Distance from Frontier
Open Cut Trunk Mains	-10%	+33%

Table 3 – Infrastructure Benchmark Review Results

4. The Addition of Scope and Finalisation of Cost

Addition of Scope

Prior to the finalisation of costs it was decided by the Welsh Water stakeholder group that there were additional processes and other costs to be added to the scope of the water treatment works. The additional scope included; manganese removal filters, a de-alkalisation plant, land purchase and decommissioning of the three existing water treatment works sites. Other than the land purchase all of these elements are part of the AMP8 project scope.

The total additional costs to the water treatment works were £22.2m, with the main additional cost due to the inclusion of manganese filters at a value of £17.5m. The manganese filters are of similar design to rapid gravity filters and so the benchmarked costs for these has been used. As a result the total cost of the project increased from £181.7m to £203.9m. These costs are based on industry outturn costs for effectively delivered projects. The total cost to client quoted within this document will have efficiencies removed reducing the total project during AMP7 from £91.5m to £73m.

Finalisation of Cost using UCD version 12

During the review process the costs within the UCD were updated to version 12, as part of the annual review cycle, which brought the costs closer to those identified during the benchmarking exercise, reinforcing the approach used to develop the project costs. The original estimate used for benchmarking was completed using v11 UCD models and a financial year 16/17 COPI index. To bring this project in line with financial year 17/18 costs, the estimate was later updated to use v12 UCD models and a 17/18 COPI index.

The inflationary adjustments increased the cost estimated by 1%, increasing the total cost to client for the water treatment works from £203.9m to £205.9m and increasing the total cost to client for the network assets from £40m to £41.9m. The breakdown between AMPs can be seen in Table 4 below.

Project Element	Total Cost	Cost AMP7	Cost AMP8	Decommissioning Cost AMP9
New Water Treatment Works	£205.9m	£49.6m	£154.5m	£1.8m
Network assets associated with the new WTW	£41.9m	£41.9m	£0m	£0m
Total Project Cost	**£247.8m**	**£91.5m**	**£154.5m**	**£1.8m**

Table 4 – Planned spend profile for the Cwm Taf Project

5. Conclusion

The conclusion of the benchmarking exercise was that the costs generated by the B&V review should be used as the project costs because they are within an acceptable range from the benchmark costs.

For the Water Treatment Works a value of £205.9m total cost to client has been generated, which is within 10% of the benchmark cost. This is generated by using UCD v12 models with multiplier adjustments applied to the outputs as defined within this review process. This value is within acceptable variance of the industry benchmark.

The infrastructure benchmark cost review, see Table 3, indicated that the UCD provided costs for the network assets that were lower than industry average by 10% but greater than frontier costs and should be used without further adjustment. A value of £41.9m total cost to client has been allowed for within the project.

The total pre-efficiency spend for the project planned during AMP7 is £91.5m.

Appendices

Appendix 1 - UCD inflationary factor adjustments used following benchmarking

Appendix 1 – UCD inflationary factor adjustments used following benchmarking

Water Treatment Process or Network Pipelines	Process and Type of Treatment	Can UCD be used or is an alternative required	Adjustment factor applied	Comments
AMP7 Projects				
Storage	Storage Large capacity clean water storage	No	2	Use a x 2 multiplier reflecting benchmark costs
Pipelines	Pipelines of all diameters	Yes		UCD costs have been used
AMP8 Projects				
Inlet & Screening	Inlet Process	No	2	Multiplier of 2 used to reflect the three inlets
Chemical Treatment	Chemical Dosing All types	Yes/No	1 & 2	Lime plant and de-alkalisation plant uses x 2 multiplier
Clarification	Flocculation (Ml/d)	No	2	Flocculation tank adjustment due to multiple streams
Clarification	DAF (Ml/d)	No	1.2	Costs for additional assets including dividing walls
Conventional Filtration	Rapid Gravity Filter (Ml/d)	No	1.2 x 2	Includes Rapid Gravity Filter and Manganese removal filter costs
GAC Adsorption	GAC Contactor (Ml/d)	No	3	3 x multiplier to reflect large GAC plant using published figures for Frankley WTW GAC
Disinfection	Contact Tank (Ml) and Chlorine Dosing	Yes/No		Chlorination x 2 to reflect benchmark costs
Advanced Treatment	Orthophosphate Dosing & De-Chlorination	Yes		
Wash water Recovery & Sludge	Sludge Thickening Tank and Wash	No	3 & 2	Sludge thickening x 3 Wash water x 2
Sludge Storage & Dewatering	Sludge Dewatering Centrifuge	No	1.2	
Buildings	Operational Buildings (m3)	No/Yes	2, 1.5 & 1	2 x buildings outside model range 1.5 x chemical storage 1 x sludge & high lift pumping stns
Pumping	High-Lift Pumping (kW)	Yes		
General, All Processes	Whole, Replacement, (l)	Yes		
Inter-process Pipework (Gravity Or Pumped)	Inter-process Pipework (mm diameter)	Yes		
Pumping	High-Lift Pumping (kW)	Yes		
Storage	Storage Standard storage tanks	Yes		
ICA Items	Large SCADA System	Yes		