IAP Response

Ref B2.WSH.LR.A3

Asset Health

1 April 2019

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WSH.LR.A3 Asset Health

Nature of Adjustment (Summarise how you have responded to this action)

The purpose of this document is to demonstrate our approach to the use and application of asset health indicators, working with best practice industry research, to influence our operational decision making. We have included a number of asset health measures within our overall list of measures to be used in monitoring our AMP7 plan. Internally we also collect data showing performance on a number of lower level indicators that provide more granular information relating to the performance of our assets and give early warning of potential impacts on the main service or asset health measures. These indicators play a key role in demonstrating to our Board, executive management, regulators and customers the capability of our assets to deliver service now and in the future.

We are committed to continuing to work with the rest of the water sector and regulators to develop our asset health measures in line with best practice, through the sharing of ideas on possible measures and assessment approaches. These measures and indicators support us in focusing operational decision making on the total expenditure solutions that are in the best interest of our customers. We follow utility industry good practice as outlined in the United Kingdom Water Industry Research (UKWIR) research paper "Serviceability Methodologies" that, originally developed by Ofgem for the UK electricity and gas transmission / distribution companies.

1.1. Our Asset Health Indicator Framework

Our Asset Health Indicator Framework has developed over the last 20 years to focus on the indicators that are most important to our customers. We continue to improve our indicators to respond to external changes driven by regulation, stakeholders and customers. The majority of indicators are developed through collaboration with bodies such as UKWIR, regulators and key stakeholders to reflect the changing needs of the business.

The asset health indicators are fundamental to how we operate the business. This is demonstrated in the way operational teams develop our strategic objectives, investment plans and day-to-day routine maintenance tasks.

Figure 1 below demonstrates that the framework methodology was developed based on a set of principles, tools and practices to provide a self-assessment approach to asset health indicators across the asset base. This allows us to integrate our planning objectives as part of investment planning with the indicators we use for operational performance, monitoring and company assurance.

Our asset health indicators form part of our Service Measure Framework (SMF), which is used to assess risk in our Investment Manager system and is used to prioritise risk investigations and investment.

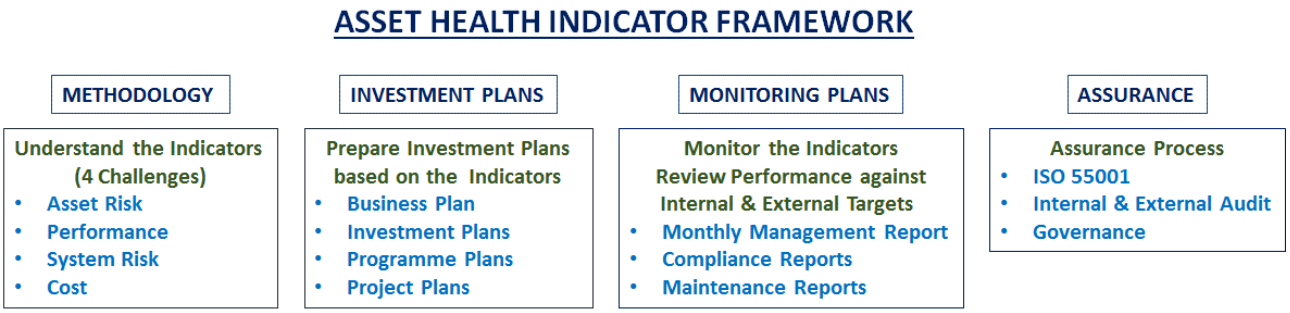


Figure 1 - Asset Health Indicator Framework

1.2. Alignment with industry methodology

Asset Health, as described by CH2M in their report for Ofwat (Targeted Review of Asset Health and Resilience in the Water Industry, September 2017), "needs to consider not only the physical state of the asset but also the importance of the asset in ensuring that service performance targets and customer expectations can be met".

Our approach is founded on four key challenges outlined in the UKWIR paper (Serviceability Methodologies, Reference 12/RG/01/4, p56, 2011)

1.3. How we assess the capability to deliver service

The first challenge in the UKWIR paper requires us to demonstrate that we understand how our capability to deliver service is changing over time and with its impact on cost to the business. Using risk analysis based on the SMF we assess whether service risk is consistent with planned levels forecast in the business plan. The asset health indicators are also used as supporting indicators to provide early warning of emerging problems. For instance, CRI is our key measure of service in relation to water quality but is affected by the performance of a range of different assets. Turbidity compliance is one element of CRI and at a water treatment works has a threshold of 1 NTU, but we also monitor a sub-threshold indicator based on lower thresholds of 0.5 NTU and 0.25 NTU to display an earlier indication of problems before they impact on compliance.

1.4. How we use lag and lead indicators to understand the underlying capability of the asset base (performance and condition indicators)

The second challenge relates to how we use asset condition and loading / capacity factors to understand the capability of our assets. Traditionally the regulators have focused on asset performance indicators such as water mains bursts and sewer blockages to assess the asset base. Nevertheless, assessment of condition through our routine inspection programmes is also a valuable way to assess the capability of assets, for example condition grade of aqueducts, tunnels, critical sewers, structures and reports from reservoir engineers.

Similarly, sub-threshold indicators of loading / capacity are valuable for us to understand trends in capacity to ensure we choose the right intervention based on the supply / demand side balance. Sewerage growth is a good example where we use the distinction between the asset capacity and the system capacity to understand the system availability capacity and the loading asset capacity at the sewage works. Observed and modelled operational data are utilised to develop optimal solutions.

1.5. How we understand the resilience of the system to respond to extreme events (single points of failure, capacity / load indicators)

The third challenge relates to our understanding of system resilience and our capability to cope with extreme events. We have developed, with operational teams, at the catchment and zonal level a tactical view of our systems to identify areas of vulnerability and high consequence highlighting long term stresses such as changes in raw water quality, deterioration in treatment process / capacity and single points of failure.

An example of the operational risk criteria is shown below.

Consider any credible failure mode – even those with no previous incidence; low-likelihood and potentially high cost of mitigation where:-

- The service impact would be significant
- Little or no mitigation is possible based on current capability

Quantifiable information such as population impacted, pollution category, likelihood of failure mode occurring, consequence score, and risk score are used to calculate a monetised risk score, which allows issues to be compared and prioritised on a consistent basis, using the values attributed to the Service Measures Framework.

Whilst operational actions may be taken in the interim to reduce vulnerability of customers to disruption, the scale of intervention ultimately needed is likely to require engagement with customers and regulators.

1.6. How we use the efficiency and effectiveness of totex (cost benefit analysis, operational response times)

The fourth challenge relates to how we prove to our customers and regulators that we deliver value for money in our day-to-day operational activities.

Our Asset Management System (AMS) is designed to help translate our organisational goals into asset management plans for the asset base, maintaining the 'line of sight' and ensuring the optimal balance of cost, risk and performance are delivered for customers and regulators.

This system provides an overview of how decisions flow from the high level objectives to the delivery of work, and represents the building blocks of our asset management and the interfaces across different departments. The AMS has been certified under ISO 55001.

To understand the risk in delivering our services, we use the SMF to consistently score and monetise risks across our asset base. Using a range of methods (e.g. operational observed data and statistical modelling), risks are analysed to determine the impact on service delivery to customers and regulators.

Our investment approach is predicated on the integration of operating and capital expenditure to deliver a total expenditure (totex) approach to investment planning over the whole life of the investment that includes company, customer and societal values. Furthermore, we incorporate non-asset solutions to delivery and include uncertainty and sensitivity analysis to ensure we fully understand our investment decisions. We also ensure an alignment of strategic, tactical and operational planning across the short, medium and

long term. Cost benefit is not the only criteria for decision making but is used as a guiding principle. As important is understanding the interrelationship between operational and capital costs which have determined our total expenditure approach.

1.7. PR19 Metrics – Measures of Success – Influencing factors

We have identified seven asset health measures that we will use to monitor our performance during AMP7:

- Water Mains Bursts
- Water Process Unplanned Outage
- Tap Water Quality Event Risk Index
- Acceptability of Drinking Water
- Sewer Collapses
- Wastewater Treatment works compliance
- Sewer Flooding on customer property (external)

Table 1 shows that there are a range of influencing factors that we need to consider in order to understand and maintain our performance on asset health. The most significant factors, as discussed in the (UKWIR Serviceability Methodologies, 2011) report, impacting on asset health are asset deterioration / maintenance and operational practice. The table shows that we monitor a wide range of indicators to track the various factors that impact on asset health and ensure we deliver on the targets linked to our asset health measures.

Influencing Factors relating to Asset Health					
Asset		**Performance**			
Physical	**Maintenance**	**Assets**	**Split by**	**Service Targets**	**Customer Impact**
Status **Number** **Capacity** **Age** **Condition** **Criticality** **Location**	Reactive - Planned Unplanned Capital – Planned Unplanned	Number of Incidents Number of Failures Number of Breakdowns Number of Blockages Condition Monitoring Power Consumption Leakage Level	Operational Area Operational Teams Supply Zones Catchments Root Cause Third Parties Year / Month / Day	Ofwat DWI NRW EA H&S	Loss of water Water Pressure Flooding Traffic Disruption Billing

Table 1 - Influencing factors relating to asset health

1.8. Governance relating to Asset Health

We track asset health as part of our business as usual performance monitoring activity through the governance processes we operate, which are illustrated below. The data allows us to consider changes to our strategies on a reactive and proactive basis as new trends emerge.

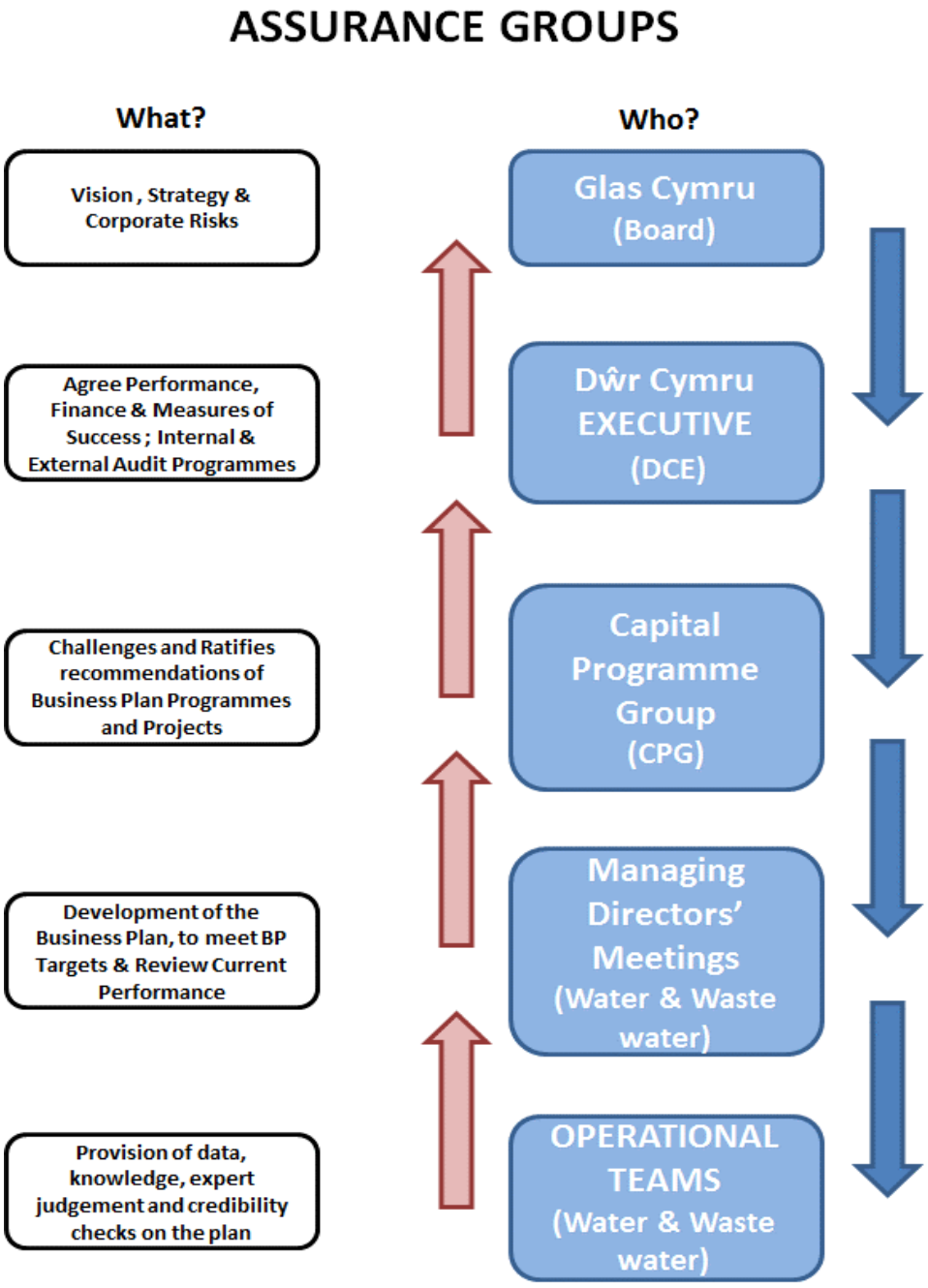


Figure 2 – Assurance Groups

1.9. Monitoring Plans

An essential component of the framework are our Measures of Success (MoSs) and associated performance commitment (PCs) targets. All measures, including asset health, are reported on an annual basis through our Annual Performance Report (APR). We remain open to adding further measures against which performance can be assessed and reported, as best practice evolves within the industry. Wherever there is an opportunity to increase the availability of relevant information about the services we deliver against our targets we find this beneficial.

On a more tactical basis the performance of our asset health measures and indicators are included within the Monthly Management Report (MMR). The MMR monitors all the company level indicators and is used to discuss performance at Board and Executive meetings. Understanding this performance is pivotal in setting lower level operational strategies and plans to develop and deliver organisational targets.

The top line measures and indicators are also reported and discussed in the monthly team meetings of the Managing Directors for Water and Waste services to develop short, medium and long term management strategies.

Extracts from these reports are provided below showing a range of lagging indicators in the MMR (See Figure 3) and leading indicators (See Figure 4 and 5) being actively used to monitor asset health indicators by day / week / month / year and beyond.

Monthly Management Report – January 2019

Waste Water Services

		Compliance YTD	Actual	Target		Last Year		Annual Target
MOS (B2)	c	No. of WwTWs failed numeric consent	**0**	6	✓	0	✓	6
	c	% pe compliance with WwTW permits	**100**	99.90	✓	100	✓	99.90
MOS (B3a)	c	All pollution incidents Category 1, 2 & 3	**12**	9	✗	7	✗	112
	c	Category 1 & 2 pollution incidents	**1**	0	✗	0	✗	0
	c	Self-reporting (%)	**67**	75	✗	43	✓	75
MOS (F1)		Asset serviceability Wastewater infra	**stable**	stable	✓	Stable	✓	stable
MOS (F1)		Asset serviceability Wastewater non-infra	**stable**	stable	✓	Stable	✓	stable
		Customer YTD	**Actual**	**Target**		**Last Year**		**Annual Target**
MOS (D3)		Properties flooded in the year	**211**	196	✗	172	✗	223
		Convergence Internal Flooding	**215**	n/a		n/a		tbc
		External Sewer Flooding	**4,673**	4,569	✗	4,275	✗	5,500
		Convergence External Sewer Flooding	**3,276**	n/a		n/a		tbc
MOS (D1)		SIM Qualitative (out of 5)	**4.59**	4.56	✓	4.51	✓	4.56
MOS (D1)		SIM Quantitative (low is good)*	**22.10**	21.86	✗	22.57	✓	26.21
		Complaints*	**182**	258	✓	223	✓	310
		Compliments	**1,083**	n/a		942	✓	n/a

c = calendar year metric
* Excludes non-household customers (Ofwat SIM measure).

Figure 3 - Waste Water MMR for January 2019 (extract page 10)

Leading Indicator – Water Treatment Works Turbidity

WTW - Turbidity PCV Failures (>1 NTU)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total

WTW - 50% PCV Turbidity (>0.5 NTU)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
CILFOR WTW (NEW) FINAL (PENRHYNDEUDRAETH)			1										1
GLASCOED WTW FINAL (COMBINED)			1										1
ALWEN WTW FINAL					1								1
CWELLYN WTW FINAL						1							1

WTW - 25% PCV Turbidity (>0.25 NTU)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
ALWEN WTW FINAL			2		3	2	1	1	2				11
BRYN COWLYD WTW FINAL	2	1	3	1		7	1		1	3	1	1	21
CEFN DRYSCOED WTW FINAL			1										1
CILFOR WTW (NEW) FINAL (PENRHYNDEUDRAETH)			1										1
CWM DULYN WTW FINAL			5	1									6
GLASCOED WTW FINAL (COMBINED)			1										1
HIRWAUN WTW FINAL	1									1			2
PONTSTICILL WTW FINAL		1											1
Severn Trent Bulk Supply		1											1
CWELLYN WTW FINAL						1							1
Cefni WTW Final (Pentraeth)							1		1				2
FELINDRE WTW FINAL								1					1
COURT FARM (NEW) WTW FINAL								1					1
BOLTON HILL WTW FINAL									1	1			2
CAPEL CURIG WTW FINAL												1	1

Figure 4 – Water Quality Report December 2018
(DCWW Water Quality Report Dec 18.xlsx – WTW Turbidity data extract for 2018)

These data extracts show how we analyse water quality turbidity performance sampling data across our Water Treatment Works estate on a monthly basis. For us to report a compliance failure we would need to exceed a turbidity level >1 NTU. However, to ensure we minimise the risk of failures we monitor the turbidity NTU levels at >0.25 and > 0.5 to give early warning of potential compliance problems before we exceed the compliance threshold of >1 NTU. This is a good example of where we use lead indicators (NTU levels @ 0.25 & 0.5) to influence operational interventions before they impact on a regulatory compliance failure.

Other lead indicators for water are WTW PCV failures for aluminium, manganese and iron.

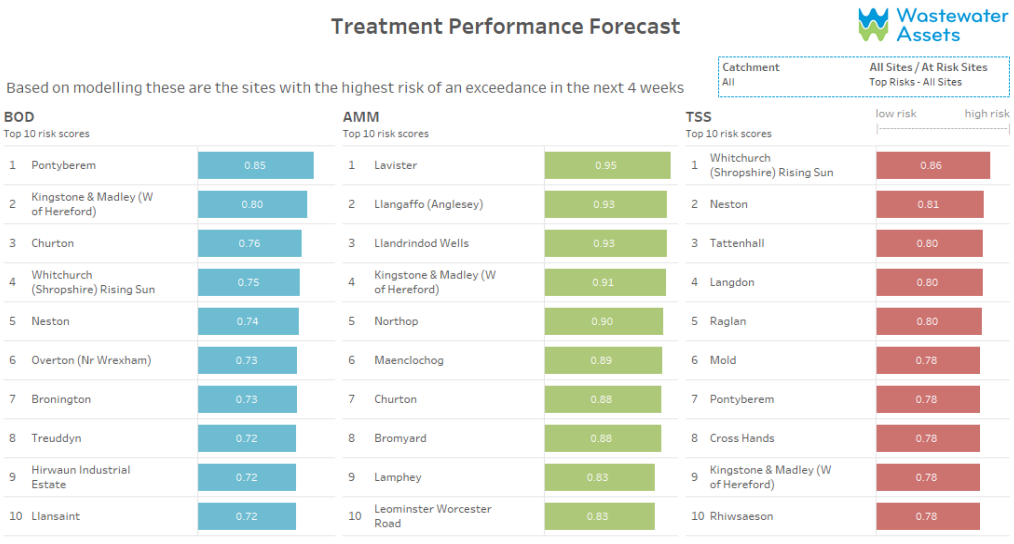


Figure 5 – WWTW Performance Forecast tool – tableau report

Every month we run our Treatment Performance Forecaster tool which highlights the 10 sites on BOD, Amm and TSS that have the highest risk of an exceedance in the following 4 week period. Forecasting is done from a set of models that take into account site characteristics, asset age, effluent performance results, planned and unplanned maintenance, asset size, capacity and rainfall. This information is reviewed by the Head of Wastewater Treatment along with his team every month to ensure any anomalies at the sites are picked up and acted on and any site review by process specialists is undertaken.

Other leading indicators for waste water are WwTW compliance – BOD, SS and NH3 analysis against seek help and check works levels reviewed daily by the operational teams, UV hours lost against annual consent, Iron and Aluminium performance, Phosphorus and Nitrogen annual average performance, predictive below ground models for Flooding, Pollution and Blockages and hotspot analysis.

1.10. Asset health in operational decisions

The following sections show examples of how we use a mix of lag and lead indicators to influence our investment decisions across the business. For the Water Service we have chosen the zonal studies approach, which is being used to target mains burst and acceptability of water performance, and for the Wastewater Service we have chosen WwTW compliance performance.

1.11. Asset Health - Zonal Studies (Water Services)

Zonal Studies are a holistic investigation into the factors influencing performance in a Water Quality Zone. By utilising all mains hydraulic modelling, engineering principles, statistical analysis and the experience and knowledge of local operations, the study identifies the root cause of different aspects of poor performance. The outputs are evidential, auditable and qualitative, allowing for a targeted investment approach, providing the greatest benefit at the lowest cost, driving value for money for our customers. Zonal Studies are a collaborative, integrated business as usual process that act as a streamlining tool through the gateway process and give a joined up strategic approach to investment.

Asset Health - Impact

The Zonal Studies approach uses a mixture of lag and lead indicators to understand current and future risk. It compares the as-is state of a system to a should-be state, based on current network design, and a future state considering 25 years' worth of growth data. Outline solutions are developed based on a root cause analysis process, which use these indicators, and a decision making matrix ensuring consistent and repeatable results.

Asset Health sub-indicator	Lag or Lead indicator	Information provided	Operational Impact
Hydraulic performance standards **Velocity, pressure and water age**	Lag or Lead	Using a hydraulic model to understand the constraints that water experiences as it travels through the network. This enables a very detailed understanding of performance against Welsh Water's hydraulic standards for customer service and calm networks. The inclusion of a 25 year growth assessment gives a view of forward looking requirement and risk. The three named indicators inform the function, optimisation and condition of a system. Velocity (lead / lag) allows for the understanding of sediment settling. Water age (lead / lag) indicates pipe contact time with water with potential corrosion and chlorine decay. Pressure (lag) allows for the understanding of network energy and restrictions, it helps to identify deteriorated mains and underperforming assets.	Do nothing Operational intervention (network optimisation and reconfiguration, mains conditioning and flushing). Capital intervention intrusive mains cleaning, abandonment and replacement (downsizing mains)
Water quality sampling	Lead (thresholds failures) Lag (PCV failures)	To inform WTW performance, mains deterioration and corrosion	
AIM Asset Deterioration Model	Lead	A statistical assessment of asset life, customer impact and natural rate of rise	
Pressure transient logging	Lead	To understand and eliminate transient pressures that can cause mains failures	Do nothing Operational intervention (network optimisation and reconfiguration, servicing of assets). Capital intervention (installation or replacement of network assets and mains replacement).
Asset maintenance records	Lead	To ensure assets, such as air valves, PRVs, WPS, etc. do not malfunction and cause mains failures	
Long section assessment	Lead and lag	This informs risk of air entrapment and location of air valves within the network. This prevents catastrophic mains failures due to compressed air.	

Table 2 – Asset Health sub indicators and operational response

Operational tasks are identified as part of the study such as air valve investigations, pressure management and transient assessment, network optimisation, contingency and other items for further investigations. These tasks must be completed, with the benefits understood, prior to capital investment at these locations.

Solutions that have been identified for capital intervention must undergo site investigation to confirm the condition of assets identified for improvement by using camera surveys and non-destructive testing.

Asset Health sub-indicator	Lag or Lead indicator	Information provided	Operational Impact
Non-destructive testing	Lead	To inform the remaining asset life	Do nothing Operational intervention (network optimisation and reconfiguration, mains conditioning and flushing). Capital intervention (intrusive mains cleaning, abandonment and replacement)
Camera surveys and mains cut outs	Lag	To information the condition grade and sedimentation within a pipe	

Table 3 – Asset Health sub indicators and operational response

The results of the site investigation and previous stages are used to inform an evidence based risk and value exercise for the solution by zone. The condition and remaining asset life, viability of options and cost of the potential solutions will dictate the sliding scale of solutions from do nothing to operationally delivered solutions (flushing) to capital solutions such as intrusive mains cleaning or replacement.

Benefits

In summary the approach ensures that the appropriate solution is developed through an evidence driven methodology to effectively eliminate or mitigate current and future risk at the lowest cost whilst ensuring the longevity of our assets.

1.12. Asset Health – Wastewater Treatment Works Compliance (Waste Water Services)

The Wastewater Treatment Works Compliance measures in AMP6 are made up of a number of sub-performance measures which form part of the permit conditions of the works. These include Sanitary (BOD, Ammonia and TSS), Look-up table (LuT) and Upper Tier (UT) compliance, Non-sanitary LuT and UT compliance, UV annual hours lost and Phosphorus and Nitrogen annual average compliance. Failure under any number of these measures constitute a failure of a works for the year.

Similar to Water Services, a mixture of leading and lagging indicators are used to understand current and future performance risks. These indicators are used by the operational teams to influence short, medium and long term decision making and a number are highlighted in Table 4.

Asset Health Indicator	Indicator description	Indictor level review	Lag or Lead Indicator
Number of LuT sample exceedances	4 year comparison for the number of individual OSM and UWW, sanitary and non-sanitary sample exceedances there are in the year.	Waste Leadership - monthly Head of Wastewater Treatment - monthly Compliance Steering Group – monthly	Lag
Number of WwTW at risk	4 year comparison for the number of sites that are 1 LuT OSM and UWW, sanitary and non-sanitary sample exceedance away from a failed works	Waste Leadership - monthly Head of Wastewater Treatment - monthly Compliance Steering Group - monthly	Lag
Sites with Potential exceedances	Number of sites where internal sampling is picking up potential issues	Waste Leadership - monthly Head of Wastewater Treatment - monthly Compliance Steering Group - monthly	Lag
Iron/ Aluminium Closest to compliance limit	Analysis of in year sample results as a percentage of permit limit	Head of Wastewater Treatment monthly	Lag and Lead
P/N Closest to Annual Limit	Analysis of in year sample results as a percentage of permit limit	Head of Wastewater Treatment - monthly Catchment performance teams – monthly	Lag and Lead
UV Hours lost	Cumulative hours lost in the year	Head of Wastewater Treatment - monthly Catchment performance teams – monthly	Lag and Lead
Performance comparison	Performance comparison information highlights OSM and UWW LuTsites with a +10% change or higher and is at least 75% of a LuT limit	Head of Wastewater Treatment - monthly Catchment performance teams – monthly	Lead
Deteriorating trend analysis	Analysis of the sites where, based on internal sampling trends, have 8 weeks or less until a sample exceedance	Head of Wastewater Treatment - monthly Catchment performance teams – monthly	Lead

Table 4 – WwTW Asset Health indicators

We have a number of reports incorporating the above indicators that are issued, both daily and monthly, using our interactive reporting tool Tableau, which allows various levels within the business to review performance and risk as specified in the table above. There is a decision making hierarchy that reviews the varying levels of reports and actions changes, which include anything from, but not confined to, increasing operational site visits, changing operational and maintenance tasks, increasing levels of telemetry alarms, increasing support

from process specialist teams. Mitigation equipment can be brought in where it is deemed that the issue cannot be resolved in the short term whilst longer term solutions are investigated. Any longer term risks are input into our Investment Manager System for prioritisation for capital investment.

This above approach allows us to increase focus on those WwTW out of our 836 sites which are at greater risk of impacting on our performance. This approach has been in place for a number of years, and the level of data reporting, analysis and lead indicator analysis is increasing year on year. This has allowed us to improve our performance significantly in reducing both the number of failed works and the number of individual sample exceedances we have. Table 5 highlights our improvements over the last 2 AMP periods.

	Number of non-compliant WwTW	LuT Exceedances		
		OSM	UWW	Total
2010	17	144	24	168
2011	26	136	26	162
2012	8	50	4	54
2013	12	103	6	109
2014	5	72	9	81
2015	8	90	5	95
2016	3	66	5	71
2017	10	58	6	64
2018	2	50	1	51

Table 5 – WwTW performance improvement since 2010

1.13. Asset Health in investment plans

The governance of our investment programme also incorporates a consideration of asset health as part of the project approval process.

The Board approves our Investment Programme at the start of each AMP period and each year a rolling five year Business Plan is approved as part of the normal business planning process. This will be adjusted each year if there are emerging concerns about trends in performance for asset health indicators.

After Board approval of the high level programme, sub-programmes and individual projects are approved and released through the investment process at proportionate delegation levels within the company. Each programme or project is supported by a business case which explains in detail the risks to be resolved, performance metrics impacted and the benefit / costs of undertaking the work.

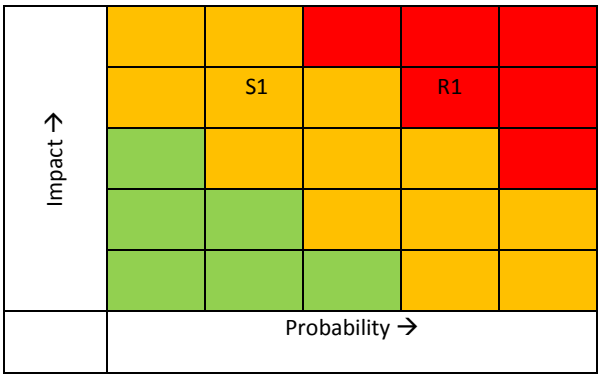
A project level example for Pwll SPS is included below and indicates the level of asset health detail (serviceability and performance outlined in red), backed up with the cost / risk analysis, required to support an investment decision by the Capital Programme Group.

Recommended Solution Upgrading foul pumps to increase pass forward flow (PFF) to 285 l/s and reuse existing wet well.

Solution Overview -

- 3No. PFF pump replacement and associated pipework and valves;
- Baffle plates and vanes in existing wet well;
- Improvements to the existing wet well cover slab and access;
- Replacement of NRVs, penstocks, isolation valves and air valves;
- New MCC and standby generator; and
- Launder feed pumps and associated pipework and valves.

Risk Reduction



Business Impact

CAPEX (LBE)	£2,216,728
Annual OPEX Change	+£34,600
Whole Life Cost (as NPV)	£3,751,828
Whole Life Benefit	£6,607,442
Benefit Cost Ratio	1.761

The solution will reduce the spills in Pwll SPS an annual average of no more than 10, while consistently meeting the consented PFF of 285 l/s.

Contribution to Measures of Success	
Pollution Reduction	Reduction in annual spills from circa 37 to an annual average of no more than 10.
Adapting to climate	The site is currently liable to tidal flooding. New structures, the generator and MCC panel, are located above the 1 in 100 year flood level +climate change allowance + freeboard, providing greater resilience for future climate change.
Asset Serviceability	Asset achieves consented PFF. Significant improvement in asset performance.

Residual Risks

All solutions investigated have been developed assuming infiltration removal works at the Stradey Park Housing Development have been completed. Infiltration issues (from the new housing development) were first noted in 2015 and flows have been estimated to contribute to two additional spills per annum at Pwll SPS i.e. 12 spills per annum not the targeted 10. The cost (on average across Llanelli and Gowerton schemes) per spill removed is approximately £250,000 i.e. a total cost of £500,000. Developer services are following up with the housing developer on removing this infiltration.

Reason for recommendation

The SPS will consistently achieve consented PFF of 285 l/s hence reducing the storm spill number to 10 average per year. The hydraulic modification to the wet well will allow the existing structure to be reused avoiding the need for large civil works at the site. The proposed pumps are uniform size and are variable speed. This will allow the SPS to be operating more consistently (i.e. for duty cycles and PFF) and the pumps to perform at their optimum efficiency.

This solution offers the best balance of long term value and operational safety.

Figure 6 – extract from Capital Governance Paper for project approval

1.14. Conclusion

In conclusion, our asset health indicator framework has been developed using best practice industry guidance to ensure that we provide credible historical and forward looking indicators, which influence our operational decision making to satisfy the needs of our customers and regulators both now, and in the future.

It is clearly not just asset health that determines investment and we need to balance this with service indicators. Notwithstanding this, asset health has been linked to service, theoretically and statistically across the industry. Asset health is about keeping on top of the problem and the investment decision also considers the costs and benefits of restoring health over the whole population of assets.

The paper demonstrates how we actively use and apply asset health indicators to influence our operational decisions through what the industry consider are the most significant factors, asset deterioration / maintenance and operational practices. Furthermore, it expresses how we partake in and apply industry research to develop forward looking asset health metrics to deliver best value service to our customers, and meet targets set by our regulators.