Southern Water Cost Adjustment Claim

The implications of coastal population on wastewater treatment costs

July 2023

from Southern Water

Cost Adjustment Claim: Coastal Population

What is the claim for?

Serving coastal population requires operating in a coastal environment. This, in turn, has multiple factors that drive up the cost of wastewater treatment. Ofwat consulted on a set of models that does not capture these factors. Southern Water has the largest proportion of coastal population amongst all WASCs and is uniquely impacted by the omission of coastal cost pressures from the models.

This claim proposes an adjustment to Southern Water's cost allowance based on results from robust econometric models that capture the impact of coastal population.

We provide engineering rationale alongside compelling econometric evidence to support our case for a cost adjustment.

Test	Brief summary of evidence to support claim
Need for cost adjustment	Serving coastal populations has unique challenges, which present specific cost pressures to wastewater treatment. Ofwat's econometric models do not take these factors into account, hence the need for a cost adjustment.
Uniqueness	Southern Water has the largest coastal population of all WASCs (41% compared with a sector average of 19%).
Management Control	Having a large coastal population is beyond management control.
Materiality	The claim is material at 2.4% for WWN+ of totex allowances.
Adjustment to allowances	£66m
Cost Efficient	The value of the CAC includes catch-up and frontier shift efficiency challenges.
Need for Investment	Not Applicable
Best option for customers	Not Applicable
Customer Protection	Not Applicable

1. Need for Adjustment

Southern Water's base costs are uniquely affected by exogenous circumstances not captured in the econometric models

Serving coastal population has unique challenges, which present specific cost pressures for wastewater treatment. These cost pressures are not captured in Ofwat's econometric models.[1]

Southern Water has the highest proportion of coastal population compared to other Water and Sewerage Companies (WaSCs). It is therefore uniquely impacted by the failure of the models to capture the cost impact of serving coastal population.

Below we set out all the relevant information to justify the need for an adjustment (which is the key assessment gate for this claim). The relevant information includes:

- Evidence that Southern Water is facing unique circumstances.
- Engineering rationale for the adjustment.
- Econometric evidence for the adjustment.

1.1 Southern Water's unique circumstances

The circumstances underpinning this cost claim are the extent of coastal population in a Southern Water's service area. All else equal, a company with a larger share of coastal population will incur higher efficient costs, mainly in wastewater treatment (the next sub-section explains why).

To understand our sector position on coastal population we used information from the ONS, which provides population statistics for coastal town and cities in England and Wales.[2]

Graphs 1a and 1b summarise our findings from this data. Southern Water has the largest coastal population of all WASCs both in absolute and in percentage terms. At 41.2%, Southern Water's proportion of coastal population is significantly above the sector average of 19.2%.

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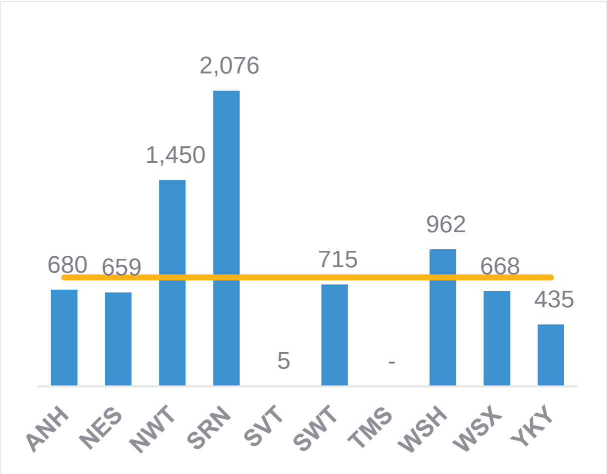
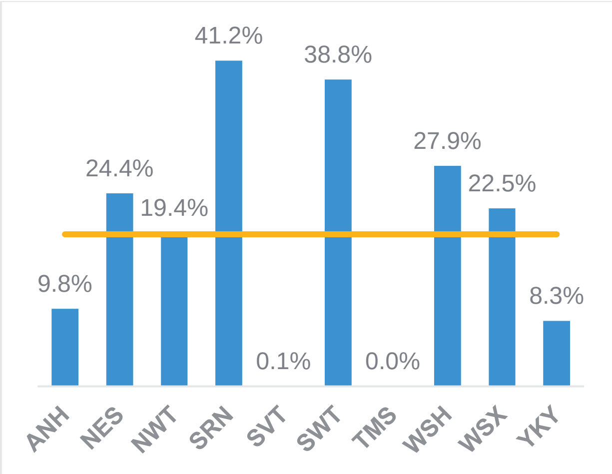
[1] In fact, augmenting the problem, only cost pressures primarily associated with river discharge, rather than sea discharge, are captured in the models.
[2] We provide further detail on the data and method of constructing a company specific metric in appendix 1.

Graph 1a: Coastal population by wastewater company (000s)[1]



Graph 1b: Percent coastal population by wastewater company[1]



[1] based on ONS data of 2021. Findings are similar in other years.

The evidence shows that Southern Water has unique circumstances in terms of exposure to coastal population.

1.2 Engineering rationale for the adjustment

Below we set out several factors that drive additional costs to wastewater treatment in coastal environments.

Requirements on effluent quality

Certain restrictions on wastewater discharge are common in wastewater treatment works (WWTWs) that discharge to inland waters, but not for WWTWs that discharge to coastal waters. This is the case with restrictions on the discharge of ammonia and phosphorous. Other restrictions are more common in WWTWs that discharge to coastal waters, particularly those close to bathing or shellfish waters. These discharge requirements include the need for UV treatment (or other forms of disinfection) and/or Total Nitrogen consents resulting from the impacts of nitrate, nitrite and ammonia.

UV disinfection imparts additional tertiary treatment cost and requires high energy consumption. Nitrogen removal is a tertiary treatment process designed to remove nitrogen-based nutrients in various forms including ammonia, nitrate, nitrite and organic nitrogen. This process requires additional energy costs (for internal recirculation) and chemical costs (for dosing Methanol or similar).

It is important to recognise that UV and Total N-consent cost drivers provide systematic additional cost due to factors beyond management control for coastal companies. Ofwat's PR24 proposed models capture only requirements on discharges to inland waters with a focus on ammonia consents, ignoring the impacts of Total N consents, which exacerbates the issue and creates a bias.

For example, our Peel Common coastal works serving part of the Southampton area and discharging into the sensitive Solent has a Total N consent of 9mg/l (which is below the standard Technical Achievable Limit [TAL] of 10mg/l) and a UV consent of 22.4 mJ/cm^2, but does not have an ammonia consent. Under Ofwat's modelling, the Total Nitrogen consent at Peel Common is not included as the ammonia load allowance, despite the fact the site has methanol dosing to create anoxic conditions to reduce total N loading which includes ammonia. It also has UV disinfection, which requires substantially more energy usage than typical sites without UV, to deliver its consent and which is also not included within the load cost allowance.

Southern Water has eleven sites requiring UV treatment. These require higher than typical maintenance to ensure consent compliance, as there are tight permit conditions on UV operations. Southern Water has 17 WWTW with Total Nitrogen permits, with seven at or below the TAL. This equates to 23% of the population served by Southern Water require Total Nitrogen removal which is not included in Ofwat's load cost allowance. This further demonstrates that treatment works serving coastal populations are complex, require additional costs, and are a significant additional cost driver to Southern Water.

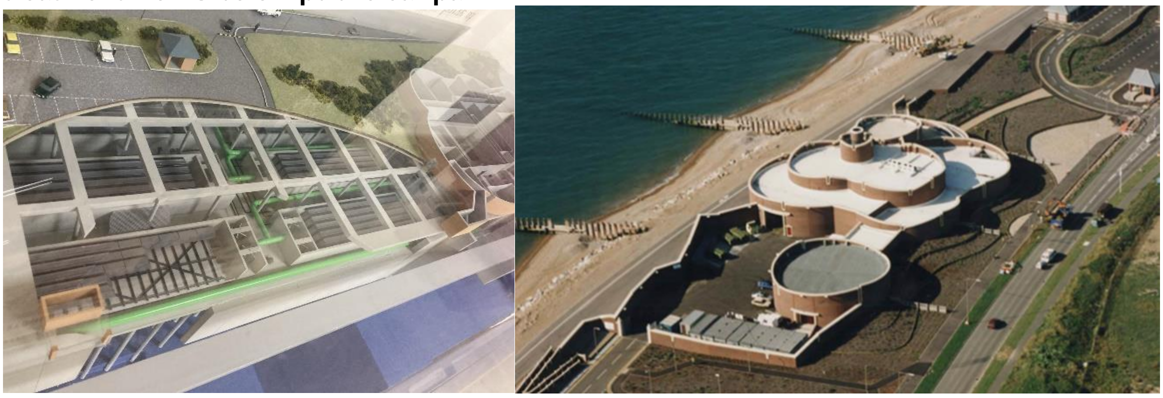
Space constraints and local authority planning restrictions

Much of the Southern Water coastline is heavily populated, with little sparsely occupied land around the population centres, particularly as the urban areas are constrained by the sea on at least one side. This leads to two general WWTW designs – either being located within urban areas using a compact works design or to move the WWTW inland and pump wastewater uphill and a significant distance (see "Double pumping" below). By contrast many inland works are located downstream of a conurbation at a sufficient distance to avoid odour issues and allowing gravity sewers to deliver the wastewater.

In constrained coastal locations we don't have that option and Local Authority planning regulations require the works in urban areas to be covered with advanced odour control systems to prevent odour issues affecting the nearby population. Space constraints therefore lead to additional costs related to odour restrictions, retrofitting works on constrained sites, maintaining covered sites and dealing with additional corrosion from hydrogen sulphide.

Traditionally coastal treatment works only had preliminary or primary treatment before being discharged to sea. In the 1990s, secondary treatment was required before discharge, which required much more space. This was problematic for many of our coastal sites which had a small footprint and were situated in coastal urban areas. One solution (discussed above) was to retrofit a very compact treatment works on the original site and cover or bury it to comply with odour restrictions. Our treatment works at Eastbourne, which is underground at the end of the promenade under a public car park is a good example as shown in Figure 1 below.

Figure 1: Eastbourne wastewater treatment works cross section showing primary and secondary treatment works below public car park

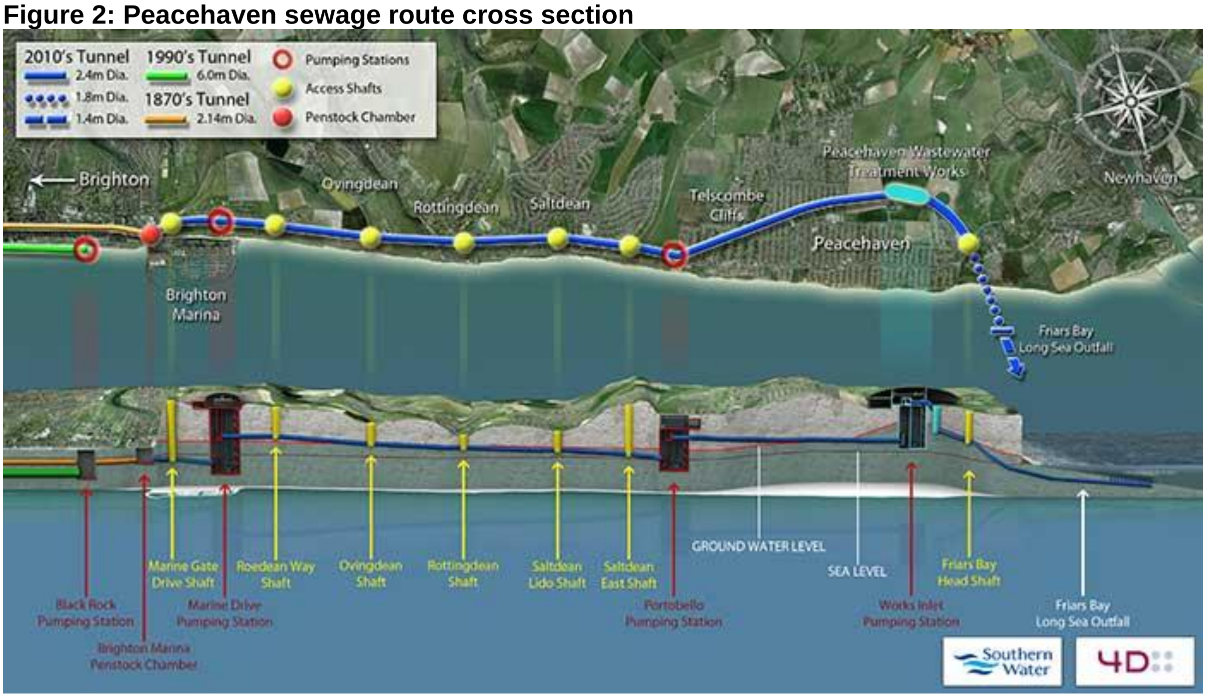


Double pumping

Another solution to the issue of space constraints was to pump the flows inland to a new WWTW site, and then pump back to a seafront location to discharge using sea outfalls. Examples include, Weatherlees Hill (serving Margate, Broadstairs, Ramsgate, Deal, Sandwich); Ford (serving Bognor Regis, Littlehampton); Budds Farm (serving Portsmouth); Broomfield Bank (serving Dover, Folkestone); Peacehaven (serving Brighton and Hove); and West Hythe. These works treat 25% of our flows.

For inland works serving coastal populations, double pumping all flows adds significant power costs compared to conventional treatment works. Sampling 194 of our WWTWs we find that inland coastal WWTWs treating coastal population have power cost per load that are 70% higher than conventional inland WWTWs. A good example is our Peacehaven site, treating Brighton's sewage, located 11 km away from Brighton with 2 large intermediate pumping stations and 7 access shafts along the route, as shown in Figure 2.

Figure 2: Peacehaven sewage route cross section



In total, 40.3% of Southern Water wastewater load (in terms of Population Equivalent) requires Total Nitrogen removal, UV disinfection and/or double-pumping (see Appendix B).

Saline environment

Enhanced corrosion from saline water and salt spray drives higher maintenance costs than comparable inland sites. These costs relate to higher specification valves and mechanical parts to cope with the corrosive environment, more frequent replacement of corroded assets and painting rusting structures. Based on 2020-21 data, our large coastal works on average incur 40% higher repair costs than inland ones (per unit of load).

Saline water contains higher levels of sulphate than non-saline water, leading to higher risk of hydrogen sulphide creation during wastewater treatment. In a poorly ventilated space, this will result in rapid corrosion of not only mechanical, electrical and ICA equipment, but also concrete. To combat this, higher grade materials with better corrosion resistance have to be used, and enhanced ventilation and odour control is needed. Given local planning limits, this enhanced ventilation and odour control is chemical intensive to avoid local air quality issues.

Coastal works also require increased chemical dosing to reduce the production of hydrogen sulphide. This is dosed at pumping stations and the inlet works to reduce the corrosive impact of hydrogen sulphide on the works caused by saline intrusion. For 2020-21 data, chemical costs at our large coastal works were 71% higher, on a per unit of load basis, than at inland works.

Peakiness (i.e., large variation around average load)

Many coastal areas experience extreme summer peak loads due to tourism. WWTWs must be sized based on peak load (structure and treatment asset capacity). Ofwat's models use total load as a cost driver. However, this variable does not capture the effect of peakiness: for two WWTWs with identical total annual load, the one that has higher peak would be of a larger capacity, with higher maintenance and operation costs both at peak and off-peak periods (when small load is treated with an over-sized works).

Outfalls

WWTWs discharging to an inland river tend to have a gravity outfall at the back of the WWTW requiring no mechanical or electrical operation. WWTWs that discharge to seawater tend to have multiple and longer piped outfalls compared to inland works. Sea outfalls are usually over 1km long and incur higher maintenance costs including offshore navigation maintenance requirements. They also require pumping of the full WWTW load during both normal and storm conditions along with requisite backup pumps. For example, our long sea outfall serving Portsmouth (from Eastney WPS) is 3.5km and requires pumping at a maximum rate of 311 Ml/d. It does this through six 750KW sized pumps along with six backup diesel powered pumps capable of pumping 1,555 Ml/d in case of electrical failure or storm conditions.

Spill frequency

WWTWs that discharge to seawaters have stricter spill frequency constraints due to shellfish and bathing water requirements. As a result, more storm tank, storm screening and storm pumping capacity is required with additional pumping to store and then treat the extra flow, resulting in additional maintenance costs over time.

Table 1 shows the difference in spill frequency investigation triggers between fresh and sea water discharge. The constraints on sea water discharge are 4 to 20 times stricter. This leads to a significant increase in the amount of storage capacity required for discharges to sea outfalls serving coastal populations. In turn, this results in higher operating costs for running and maintaining these assets.

Table 1: Spill frequency investigation triggers in fresh and sea water

Receiving water body	Spills per year or bathing season
Fresh waters	
- One year of EDM data	>60
- Two years of EDM data	>50
- Three or more years of EDM data	>40
Sea waters	
- Shellfish Water	10
- Bathing Water	3

Source: Fresh water information from Storm Overflows Assessment Framework, Environment Agency, June 2018. Sea waters information from Water companies: environmental permits for storm overflows and emergency overflows, Environment Agency, September 2018.

Resilience costs

Coastal works have increased risk of sea rise and wave/tidal action, which require specific design specifications. Additional energy resilience is needed for coastal WWTWs given they are often at the end of the electricity distribution network with limited contingency and require additional back-up plant.

1.3 Econometric evidence for the adjustment

To provide econometric evidence for our cost claim we obtained data on coastal population by town and city from the ONS.[3] This allowed us to construct a variable that measures the proportion of coastal population within a company service area:

$$\%\ coastal\ population\ in\ company\ i = \frac{coastal\ population\ in\ company\ i}{total\ population\ in\ company\ i}$$

This variable directly reflects the operating circumstances underlying this claim, namely a company's exposure to a coastal environment (through the customers it serves). This variable encapsulates all the factors we have set out above in the engineering rationale.

Since we expect the coastal effects to be particularly relevant for wastewater treatment costs, we tested the coastal variable in wastewater treatment models.

Table 2 provides estimation results. The results are based on a 'random effects' estimation using panel data from 2011-12 to 2021-22. The table presents the wastewater treatment models included in Ofwat's consultation, with and without the coastal variable.

Table 2: sewage treatment modelling results with the coastline variable

	PR19 specifications			+ coastline variable		
	SWT1	SWT2	SWT3	SWT1	SWT2	SWT3
Load (log)	0.653***	0.723***	0.788***	0.833***	0.892***	0.873***
Load treated in size bands 1-3 (%)	0.029			0.032*		
Load treated in WWTW >100k (%)	0.006***	0.006***	0.006***	0.006***	0.006***	0.006***
WATS (ln)			-0.242***			-0.220***
Load with ammonia consent below 3mg/l (%)	0.004***		0.004***	0.003***		0.004***
Coastline population (%)				0.009**	0.009**	0.006**
Constant	-3.734***	-4.072***	-3.001***	-6.198***	-6.367***	-4.389***
Number of observations	110	110	110	110	110	110
R squared	0.854	0.869	0.911	0.887	0.897	0.922
RESET test (P value)	0.056	0.272	0.849	0	0.25	0.887
Range of efficiency scores	0.684	0.535	0.331	0.437	0.323	0.259

Note: *** indicates 1% significance level; ** indicates 5% significance level; * indicates 10% significance level. Absence of stars indicates a lower level of statistical significance.

The evidence shows that the coastal variable has the expected sign and a plausible magnitude, it is statistically significant and improves the overall quality of the models (e.g., the R-squared appreciably improves and the range of efficiency score narrows for each and every model specification).

[3] We provide further detail on the data and method of constructing a company specific metric in Appendix A.

The impact on the other coefficients in the model is minimal, except for that of load, which significantly increases. The new value of the load coefficient is plausible and is more in line with the expectation that it should be lower but close to one. It is also more consistent with the coefficient estimate of other scale drivers in other water and wastewater models. We consider that the impact on the load coefficient makes the models more credible[4].

We note that the RESET test fails in the first treatment models, where it is marginally significant without the coastal variable.[5] We do not consider this to be a reason for rejecting the new variable given its overall strengths. At PR19 Ofwat said "[a] failure of the RESET test should prompt a search for a more flexible specification, but need not in itself be grounds for dismissing a model"[6], and in fact put forward sewage treatment models that fail the RESET test in its 2018 econometric consultation. Further, in sensitivity analyses we carried out, the RESET test was found statistically significant at 5% level in most model variations.

The econometric evidence provided above is robust and supports an adjustment in respect of our exposure to coastal operating environment. Our coastal variable is intuitive, beyond management control and based on exogenous data from the ONS – a recognised independent source. Our approach satisfies all Ofwat's model selection criteria as follows:

- High quality data ✓
- Engineering rationale ✓
- Exogenous cost driver ✓
- Estimated coefficient is statistically significant ✓
- Estimated coefficient has a stable, plausible magnitude and correct sign ✓
- Robust cost model ✓

1.4 Management Control

The unique circumstances underpinning this cost claim, namely the proportion of coastal population we serve, are outside of our control. This inevitably requires us to deal with the cost pressures identified above.

While management can decide whether a treatment works serving coastal population is located inland or on the coast, each location has its unique cost pressures: inland locations would alleviate cost pressures due to space constraint and saline environment

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[4] The reason for the large impact on the load coefficient is the relatively high negative correlation between the coastal variable and the load variable. This is partly because places with high coastal population tend to have less industrial trade effluent, which can have a large contribution to load.
[5] The RESET test is used to detect a misspecification error (e.g. an omitted variable or the existence of non-linearities).
[6] Cost assessment for PR19: a consultation on econometric cost modelling, Ofwat, March 2018, page 11.

but would require significant additional pumping and sewer length; coastal locations would face the opposite cost pressures. Both locations – inland and coastal – share cost factors related to effluent quality, long sea outfalls, peakiness and spill frequency.

Examples of wastewater treatment works located inland due to planning and costs pressures (avoiding underground sites etc.) include Weatherlees Hill and Peacehaven; and examples of WWTW built at coastal locations with covered or underground sites within small footprints include Eastbourne and Woolston (see Appendix C for further details).

1.5 Materiality

We calculated the value of the claim based on the wastewater treatment models that were included in Ofwat's consultation. Specifically, the value of the claim is the difference between the predictions of the models (after application of catch-up and frontier shift efficiencies) for AMP8 with and without the coastal variable.

Our estimation results in a net value of £66m, which is 2.4% of our forecast wastewater network plus totex of £2,804m. This is above the 1% materiality threshold.

As with most CACs, the final calibration of this claim can only be made once Ofwat make a decision on the final set of models, forecast of cost drivers and efficiency challenges for PR24.

1.6 Adjustment to Allowances

In this section, we set out our econometric modelling approach, results and further explore the interactions with load variables

1.6.1 Modelling approach

To capture the impact of coastal population, in our January 2023 base models submission, we proposed a new variable to Ofwat's PR24 wastewater treatment models to account for the proportion of 'coastal' population in a company area. The variable proposed is exogenous, statistically significant with the right sign and plausible magnitude; improves models' quality and performance; and has a strong engineering rationale.

In the April 2023 consultation document 'Econometric base cost models for PR24', Ofwat stated "that the variable may be capturing a Southern Water specific impact, rather than an overall industry-wide impact of operating in coastal areas." Ofwat indicated that it would not include the coastal variable in the proposed sewage treatment models as the impact was company specific but asked for company views before making a final decision.

We continue to believe that coastal population is a valid cost driver which should be considered within the econometric models. However, in the absence of the final model, we have submitted this company specific cost adjustment claim to account for the unique circumstances and additional costs of operating in a coastal environment that we face.

Our approach of estimating the value of the claim measures the incremental impact of capturing the effect of coastal population in Ofwat's (preliminary) models.

The value of the claim is therefore the net effect of including the variable, and there is no further implicit allowance to deduct.

1.6.2 Symmetrical adjustments

Our approach for calculating the value of the claim readily produces adjustments across the sector. These are presented in Table 3.

Table 3: symmetrical adjustments resulting from incorporating coastal population to Ofwat's models[7]

Company	Adjustment (£m)
Anglian Water	-12
Northumbrian Water	-9
United Utilities	13
Southern Water	66
Severn Trent Water + Hafren Dyfrdwy	-26
South West Water	0
Thames Water	33
Welsh Water	13
Wessex Water	-12
Yorkshire Water	-27
Total	**38**

The overall sector adjustment is positive at +£38m. While this is not strictly a zero-sum game, it is close to it.

If the adjustments were made to predicted costs over the sample period (also known as 'fitted costs'), we may have expected a zero-sum game across the sector (i.e., money inputted to the models = money outputted from the models). However, the proposed adjustments are not to predicted costs, but rather to forecast costs over 2025-30. These, in turn, are shaped by the calibration of each coefficient and the forecast of its respective cost driver. It need not result in a zero-sum game. If a coefficient of a variable that increases fast has gone up, the new model is likely to result in higher future allowances (we note that our approach to forecasting the cost drivers is the same as Ofwat's approach at PR19).

[7] KPMG reviewed the analysis and evidence in this cost claim (however, the views are Southern Water's alone)

1.6.3 Interaction with the Load Variable

At first sight, some of the impacts may seem counter intuitive. For example, Thames Water, which does not have coastal population, receives a positive adjustment, and South West, which has the second highest proportion of coastal population, received no adjustment.

The reason for these "counter-intuitive" results is that the inclusion of the coastal variable has an impact on the coefficients of existing variables. Most noticeably, it has an impact on the load coefficient, which increases in value as shown in Table 2.

To understand why the value of the load coefficient increases, it is useful to understand first why its value is depressed when the coastal variable is omitted from the model: when the coastal variable is omitted from the model, it is in effect relegated to the model's residual. Because the load and coastal variables are negatively correlated, this relegation introduces a (negative) correlation between the load variable and the residual. This is an econometric phenomenon known as 'endogeneity', which results in a bias of the load coefficient. In this case the bias on the load coefficient is downwards because it is capturing not only the effect of load on treatment costs, but also – albeit imperfectly – the effect of coastal population, which, due to the negative correlation, results in an attenuation of the load coefficient. If the coastal variable was included in the model the load coefficient would not have to capture the effect of coastal population – this would be left for the coastal variable to do in a more accurate way – but only the effect of load. That is, this coefficient is left to capture the effect it was intended to capture, and it does so in a more accurate way, without bias.

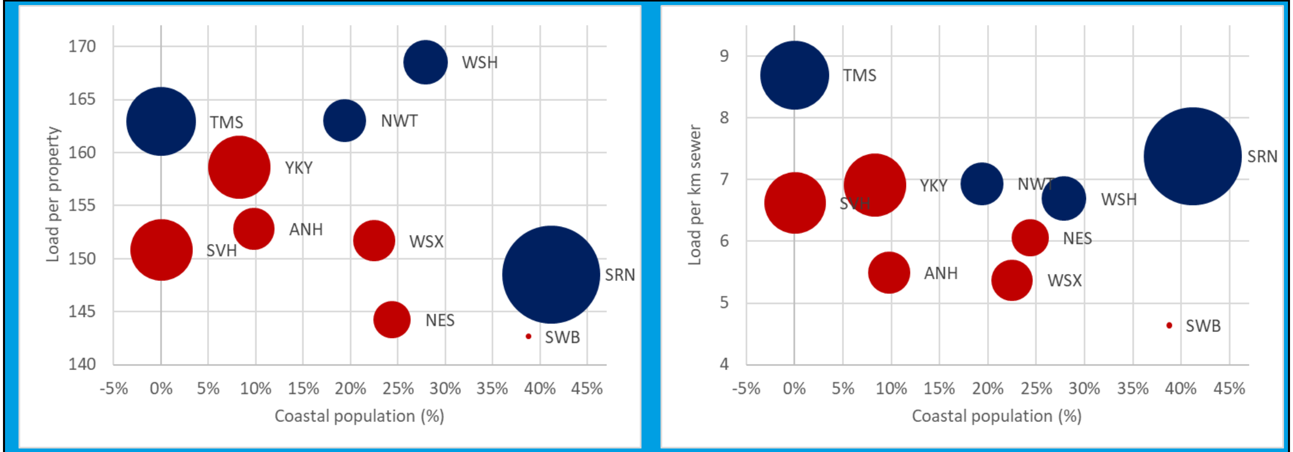
Thus, the inclusion of the coastal variable in the model creates sector adjustments due to two key factors:

- the impact of the new variable (i.e., the proportion of coastal population)
- the impact of the change of the load coefficient.

As a result, companies that have relatively high load may receive an additional allowance with the new model even if they have a low value of the coastal variable. This is the case with Thames Water. On the other hand, South West Water receives no adjustment because the effect of the coastal population (of which SWB has a high value) is being offset by the effect of the load variable (of which SWB has a low value).

Figure 3 demonstrates that companies that have relatively high load may receive an additional allowance with the new model even if they have a low value of the coastal variable. The figure plots the adjustment for each WASC as a function of two values: the share of coastal population in the company's area and its load per property. The figure shows that companies that receive a positive adjustment have a higher share of coastal population and/or a higher load per property or km sewer than companies with a negative adjustment.

Figure 3: adjustment per WASC (due to the inclusion of the coastal variable) as a function of its share of coastal population and its load



[1] Blue circles are positive adjustment. Red circles are negative adjustments. Circle size is proportional to the size of adjustment.

An important question is – how do we know that the impact of the coastal population variable on the coefficient of the load variable is appropriate? We consider that several factors suggest that this impact is appropriate:

1. The model fit (as measured by the adjusted R-squared) appreciably improves.
2. The relatively wide range of efficiency scores narrows. This provides more credibility to the efficiency scores as reflecting relative efficiencies (rather than inaccurate models).
3. The increase in value of the load coefficient makes it more credible. Specifically, the new coefficient is:
   - more aligned to expectations. We typically expect the scale variable to have a coefficient with a value close to 1 (as long as there is a single scale variable). For example, in a report prepared for PR14 CEPA said on the load variable "We would expect a value of above 0.7 and lower than 1.1.".[6] Without the coastal variable one model has a load coefficient of 0.65, which is outside the range above, and the rest are relatively close to the lower end of the range.
   - more consistent with values for the load coefficient that were in place at PR14 and PR19, and more consistent with the coefficient value of other scale variables. Table 4 presents the scale coefficients estimated at PR19 and PR14. They are all close to 1. The load coefficients at PR19 are the lowest, due to the same issue discussed here, namely the lack of accounting for coastal effects in treatment models (but still higher than the load coefficients presented in Ofwat's consultation).

Table 4: coefficients of scale variables estimated at PR14 and PR19

Scale variable	Coefficient
PR19: Connected properties	1.01-1.03
PR19: Length of mains	1.05
PR19: Sewer length	0.84-0.90
PR19: Sludge produced	1.27
PR19: Load	0.77-0.78
PR14: Load	Four models: 0.83, 0.88, 0.88, 0.98

The reason for the low coefficient on load in the absence of the coastal variable, as explained above, is the 'omitted variable bias'. Given that the share of coastal population is negatively correlated with load across the sector, the bias on the load coefficient would be downwards, as observed. The inclusion of the coastal variable removes, or at least mitigates, this bias.

4. Last, it is important to be reminded that economic/engineering rationale for the model should be the main guiding force for its specification. We consider that there is a strong rationale for the coastal variable in the context of Ofwat's wastewater treatment models. As such, the question should perhaps be turned on its head. Namely, rather than asking if the impact on the load coefficient is appropriate when adding the coastal driver, one should ask, is the impact on the load driver appropriate when excluding the coastal driver.

On the interaction between load and coastal population

The cost impacts we report in Table 3 across the sector are affected by the interaction between the load variable and the coastal population variable.

These variables are negatively correlated.

Analysing the data, we found that this negative correlation is driven to some extent by a negative correlation of -0.75 between trade effluent and the proportion of coastal population. That is, companies with a high proportion of coastal population tend to have low trade effluent. Since trade effluent is a material contributor to the load variable (load is a measure of the total volume of wastewater that requires treatment, calculated based on a contribution of 60g BOD5 per head of equivalent population per day), companies with low trade effluent would have low load. The root cause is not clear, but it is likely to relate to the coastal residential conurbations in the South East and the general absence of industry with trade effluent along coastal locations.

2. Cost Efficiency

We consider that the value of the claim is efficient given the strength of models on which it is based, the strong underlying rationale, and that we further applied efficiency challenges to the results of the models.

This is the same way that Ofwat would conclude that any variable included in its models has an appropriate and efficient impact on companies (namely, through the engineering rationale and the statistical performance of the variable/model).

3. Need for Investment (where appropriate)

Not Applicable

4. Best Option for Customers (where appropriate)

Not Applicable

5. Customer Protection (where appropriate)

Not Applicable

Appendix A – Data Sources

Our coastal variable is based on ONS data. We used a number of references:

- Coastal towns in England and Wales datasets, ONS 2020.[8] This publication provides the population as of 2018 for each coastal town in England and Wales but excludes cities with more than 225,000 people.
- In correspondence with the ONS we obtained a list of coastal cities to complement the data on coastal towns above. (available on request from ONS: Subnational@ons.gov.uk)
- In correspondence with ONS we obtained their mapping of coastal town and cities to local authority distributions. available on request from ONS: Subnational@ons.gov.uk

The mapping of population from LADs to wastewater company was done using Ofwat's mapping file

We provide all the data above alongside this cost claim. The data is also available on the ONS website or on request at Subnational@ons.gov.uk.

We also provide a spreadsheet calculating the coastal variable we use in this CAC. The file called "Coastal variable.xlsb".

[8] Coastal towns in England and Wales - Office for National Statistics (ons.gov.uk).

Appendix B – Sites with UV & Total Nitrogen Consents and/or double pumping

Table B1 – Southern Water Coastal Wastewater Treatment Works subject to additional treatment costs

Wastewater Treatment Works	Total N Permit (mg/l)	UV Permit (mJ/cm²)	Double Pumping	PE2022/23
Broomfield Bank WTW			Y	115,003
Eastbourne WTW			Y	114,697
New Romney WTW		42		18,430
Weatherlees Hill A WTW			Y	91,320
Sandown New WTW			Y	135,008
Weatherlees Hill B (Mgate & Bstairs) WTW		31	Y	98,836
Peacehaven WTW			Y	302,183
Newhaven Main WTW			Y	60,510
Swalecliffe WTW		24		35,515
Peel Common WTW	9	22.4		272,946
Milford Road Pennington WTW	9.5	30		55,428
Ford WTW			Y	138,587
Sidlesham WTW	15			25,630
Hythe WTW			Y	20,238
Budds Farm Havant WTW	9.7		Y	382,570
Bosham WTW	10			3,640
Chichester WTW	9	32		48,075
Dymchurch WTW		32	Y	7,008
Thornham WTW	10			21,568
Woolston WTW	15			66,335
Camber WTW		32		1,707
Sub Total				**2,015,233**
Total SRN Population Equivalent				**4,998,543**
				40.3%

Appendix C – Case Studies

Eastbourne WWTW

Key Challenges due to coastal environment

- Planning restrictions and land availability.
- Constrained footprint dictates process choices located underground.
- Consequently, operational, maintenance and access challenges from underground working environment including need for confined entry and breathing apparatus for certain tasks
- Advanced odour control systems
- Extensive corrosion from seawater ingress.
- Limited access for equipment replacements with no option for changing process design or adding process steps

Woolston WWTW

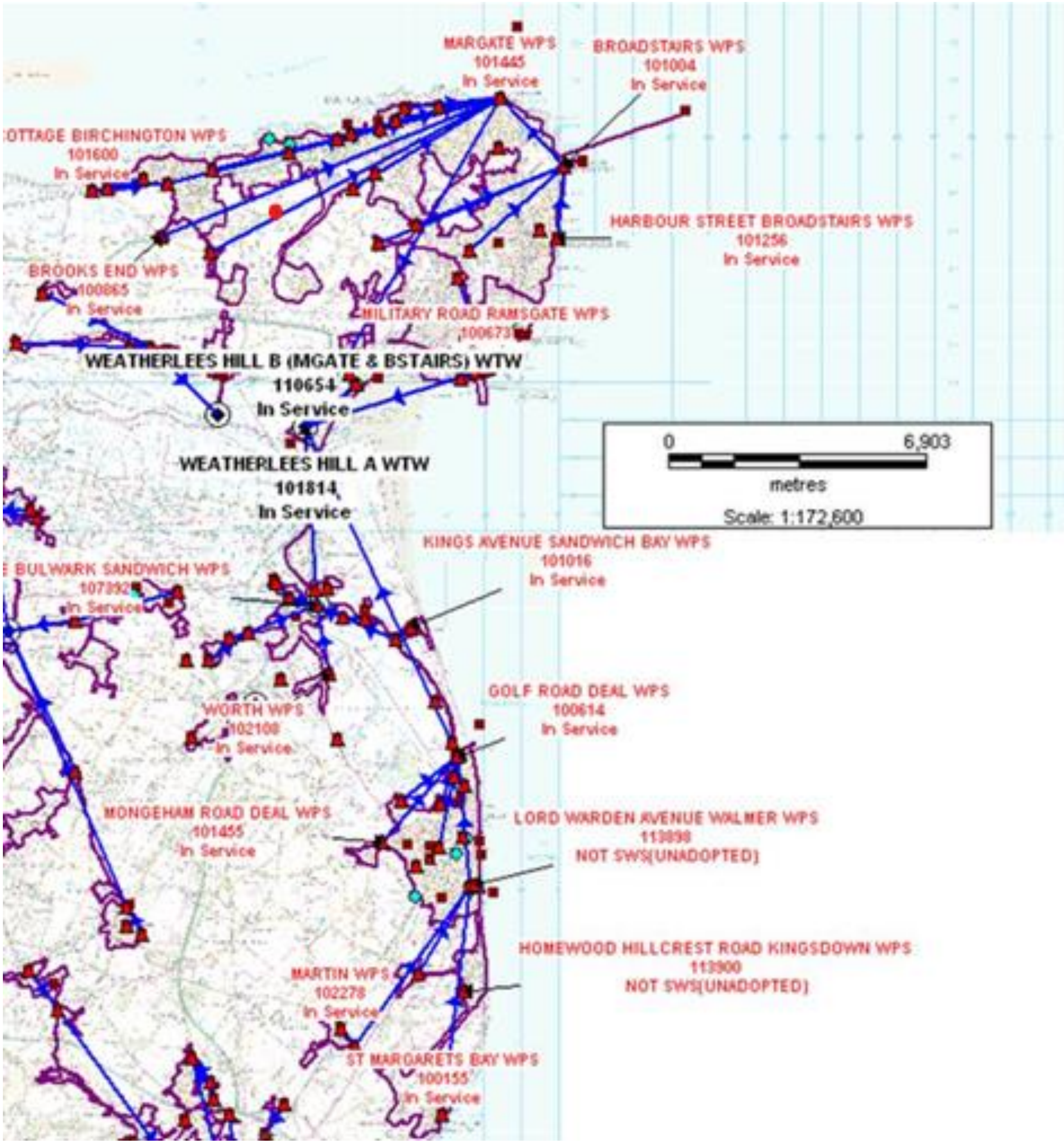
Key Challenges due to coastal environment

- Very constrained site with small footprint in Southampton harbour. Planning and EA permitting process prevented site being located outside the conurbation
- A new luxury waterfront development next to site required new treatment processes that are fully odour-controlled and contained within the building
- Wastewater treated with energy-intensive membrane filtration process to meet new, higher environmental standards due to environmentally sensitive location in Solent
- Treatment process require electrical backup and additional redundancy in equipment to ensure reliability of treatment process
- No room for further expansion on site or adding of process steps

Weatherlees Hill WWTW

Key challenges due to coastal environment

- Due to coastal land availability constraints (arising from the conurbation around the peninsular), the Weatherlees WWTW (serving Broadstairs and Margate) is situated inland.
- This required double pumping uphill to Weatherlees WWTW with the treated effluent pumped back to the Margate pumping station and released via the existing long sea outfall 2km offshore
- Wastewater flows are treated to meet strict bathing water standards, including UV disinfection.



Peacehaven WWTW

Key challenges due to coastal environment

- Lack of suitable sites in the Brighton area.
- Prolonged planning process with judicial reviews.
- Treatment works located 11km from Brighton with several pumping stations.
- 2.5km long sea outfall pipe.
- Situated within South Downs National Park with significant planning constraints requiring most of treatment process to be enclosed underground.