AtkinsRéalis

Beachbuoy Recommendations Review – Overarching Report

Southern Water

2nd April 2025

BEACHBUOY RECOMMENDATIONS REVIEW

AtkinsRéalis - Baseline

Notice

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1. Introduction

In 2023 Southern Water commissioned an independent review of Beachbuoy, the web-based tool that provides near real-time information about storm release activity near coastal bathing waters in the Southern Water region. Four independent experts covered the four key topic areas of relevance to Beachbuoy:

- Water Quality – Prof. David Kay, Aberystwyth University and the Centre for Research into Environmental Health.
- Oceanographic Modelling – Prof. Roger Falconer, Cardiff University and Roger Falconer Water Consultancy Ltd.
- User and Engagement – Dr Artemis Skarlatidou, University College London.
- Software and Systems – Dr Kevin Holmes, Staff Management Tools.

The key output from each of the reviews was a series of recommendations for Southern Water to implement to improve Beachbuoy. The individual reports, plus an overarching report, are available on the Southern Water website[1].

Since the independent review, Southern Water has been implementing many updates to Beachbuoy, based on the recommendations plus other planned updates in consultation with the Working Group[2]. This has included launching a new web-based tool called Rivers and Seas Watch in November 2024 which has replaced Beachbuoy.

In November 2024 Southern Water commissioned a further piece of work (ongoing) following on from the original review. The original independent reviewers were commissioned to undertake a review of the implementation of their recommendations by Southern Water, to provide Southern Water with an independent view on progress.

A standard approach has been taken by the reviewers to assess the status of the implementation of each recommendation. Each recommendation has been assessed as having been:

- **Fully Addressed**: The recommendation was implemented exactly as intended, meeting all expectations.
- **Partially Addressed**: The recommendation was implemented to some extent but still has room for improvement or is incomplete.
- **Pending**: Implementation of the recommendation is planned, and sufficient evidence has been provided to evidence how the recommendation will be implemented, but it has not yet been carried out.
- **Not Addressed**: The recommendation has not been implemented at all.

AtkinsRéalis was commissioned by Southern Water to coordinate the review of the recommendations by the independent experts, and to provide an overarching report collating the findings of the four reviews, summarising key findings and recommendations.

The report is set out as follows:

- Section 2 – outlines the findings from the recommendations review and the key recommendations going forward.
- Section 3 – provides a summary of the review.

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[1] Rivers and Seas Watch Information

[2] The Rivers and Seas Watch Working Group (run by Southern Water) includes a number of stakeholders and is a forum for feedback on development of Rivers and Seas Watch.

The summary tables from each individual expert review reports are provided in Appendix A and the full reports in Appendix B.

2. Findings from the Recommendations Review

The recommendation review summary tables are provided in Appendix A and the full reports reviewing the implementation of the recommendations are in Appendix B. The key findings from each report are provided here.

2.1 Water Quality (Prof. David Kay)

The initial review of the water quality element of Beachbuoy resulted in five recommendations. The review of the implementation of these recommendations has concluded that all of these recommendations are Fully Addressed or Pending (100%):

- Fully Addressed: 2/5 (40%)
- Partially Addressed: 0/5 (0%)
- Pending: 3/5 (60%)
- Not Addressed: 0/5 (0%)

This aligns with Southern Water's view on their implementation of the recommendations.

The key recommendation going forward to complete implementation of the original recommendations is:

- Maintain close liaison with the UK Water Industry Research (UKWIR) 'Improving Real-Time Public Bathing Water Quality Information (WW/11/N/204)' project team, to ensure that recommendations 3 (acquisition of confirmatory data on Intestinal Enterococci (IE) to compare statistically with model predicted values), 4 (expand the modelling effort to cover the other sources of faecal indicator organisms (FIOs) to the coastal zone from farming, the human population including sewage flows, and wildlife) and 5 (validation of the utility of the modelling and prediction efforts in the Southern Water region need to be reviewed by the environmental and public health communities) are completed as part of the ongoing UKWIR project.

Additionally, the reviewer has provided a new recommendation:

- The model [should] be updated so that only IE and 95%ile values are used as trigger warnings in the model, and E. coli (EC) and maximum values removed, as these define/predict different gastrointestinal attack rates in recreational waters.

2.2 Oceanographic Modelling (Prof. Roger Falconer)

The initial review of the oceanographic modelling element of Beachbuoy resulted in 16 recommendations. The review of the implementation of these recommendations has concluded that the majority of these recommendations are Fully or Partially Addressed (75%), and four are Pending (25%).

- Fully Addressed: 9/16 (56%)
- Partially Addressed: 3/16 (19%)
- Pending: 4/16 (25%)
- Not Addressed: 0/16 (0%)

There are some differences between the reviewers' view of the implementation of the recommendations versus Southern Water's, where Southern Water consider a recommendation has been completed, but the reviewer feels there are some further tasks to be completed. The key recommendations by the reviewer going forward to complete implementation of the original recommendations are:

- To acquire acoustic doppler current profiler (ADCP) current data at a number of key sites across the region for improved model verification (recommendation 3).
- To undertake visual observations of bed characteristics at key beaches, in order to improve justification for nearshore model bed roughness values used in the model (recommendation 6).
- To investigate the impacts of higher wind velocities on flume trajectories (recommendation 7).
- To use dynamic decay rates (recommendation 10).
- To use the collected spot samples to compare to model predictions to refine the diffusion and bed roughness coefficients (recommendation 13).
- To embed the hydro-environmental model data for a wide range of boundary scenarios in an informatics tool to provide continuous real-time predictions of bathing water quality (recommendation 14).

Additionally, the reviewer has provided some new recommendations:

- To undertake some grid independency tests to check that the 70 m grid resolution is sufficiently accurate for current predictions at key bathing water sites (recommendations 1, 4 and 16).
- To provide some graphical comparisons to calibrate the diffusion coefficient and review dispersion-diffusion coefficients (recommendations 9 and 11).

2.3 User and Engagement (Dr Artemis Skarlatidou)

The initial review of the user and engagement element of Beachbuoy resulted in 45 recommendations. The review of the implementation of these recommendations has concluded that the majority of these recommendations are Fully or Partially Addressed (89%) and five are Pending (11%):

- Fully Addressed: 38/45 (85%)
- Partially Addressed: 2/45 (4%)
- Pending: 5/45 (11%)
- Not Addressed: 0/45 (0%)

This broadly aligns with Southern Water's view on their implementation of the recommendations.

The key recommendations going forward to complete implementation of the original recommendations are:

- To explore the technical feasibility of providing volumetric data and related information, along with textual information.
- Volumetric data and related information are critical user requirements for fostering trust and transparency and stakeholder engagement is essential to identify user-friendly solutions to address this requirement, while balancing the technical complexities that this recommendation entails with end user expectations (recommendations 18, 28, 29 and 30).
- To ensure that any future design improvements or new functionalities added to the platform undergo rigorous usability testing to ensure they meet user expectations.
- To ensure the map legend box is visible by default as this will optimise usability for a wider range of users (recommendation 35).

A new recommendation is:

- To explore options such as a left navigation panel (similar to the New Zealand Safeswim app (https://www.safeswim.org.nz)), which could further improve interactivity and engagement.

2.4 Software and Systems (Dr Kevin Holmes)

The initial review of the software and systems element of Beachbuoy resulted in 22 recommendations. The review of the implementation of these recommendations has concluded that the majority of these recommendations are Fully or Partially Addressed (82%) and four are Pending (14%):

- Fully Addressed: 16/22 (72%)
- Partially Addressed: 2/22 (10%)
- Pending: 4/22 (18%)
- Not Addressed: 0/22 (0%)

This broadly aligns with Southern Water's view on their implementation of the recommendations. The key recommendations going forward to complete implementation of the original recommendations are:

- To address the battery powered float sensor event detection, which is still an issue due to required increased sampling rate and battery replacement frequency, with no current non-obsolete options on the market (recommendation 2).
- To progress further: reducing polling and information flow to under 1 hour; the implementation of FME; and, addressing the maintenance cost and maintainability via the FME Low Code development platform (recommendations 4, 6 and 7).
- To further consider the development of a mobile app for Rivers and Seas Watch (recommendation 15).
- To progress further the inclusion of operational decisions/data from the spills team in the data (recommendation 18).

3. Summary

All of the original recommendations from the Beachbuoy review have been reviewed by the same independent experts to provide Southern Water with an update on their implementation. Overall, the vast majority of the recommendations have been Fully Addressed or Partially Addressed (82%), with plans in place to address the remaining recommendations (Pending, 18%). None of the recommendations are assessed as Not Addressed. In addition to the original recommendations, some of the experts have provided new additional recommendations for Southern Water to consider in time.

Generally, the reviewers broadly align with Southern Water's view on the implementation of the recommendations. Each of the reviewers have provided key recommendations for each of the topic areas going forward to ensure that the final tasks can be completed, and all recommendations are fully implemented.

APPENDICES

Appendix A. Recommendation Review Summary Tables

A.1 Water Quality

Table 3-1 – Water Quality recommendations review (as provided by Southern Water and independent reviewer)

Recommendation	Southern Water Action	Reviewer response to implementation
#1 Updating of the modelling to incorporate percentile values from the Bathing Water Directive as triggers for the Beachbuoy warnings.	**Implementation of this recommendation is complete.** Post-processing of the outputs from the modelling has been updated so that both maximum and 95%ile values for both IE and EC are calculated, and the worst of these for both parameters is taken as the trigger for a warning. The inclusion of both maximum and 95%ile values has been in the Beachbuoy live model (released to the public) since early 2024. This approach is the new standard and will be the chosen approach when the new updated model is released and made public.	**Fully Addressed.** However, it should be noted that the World Health Organisation (WHO) Guidelines for Safe Recreational Water Environments (GSRWE, 2003) i.e. published after their (i.e. WHO's) meeting in Annapolis) was the sole basis for the EU Bathing Water Directive (BWD, 2006) which used only IE following the lessons of the UK sea-bathing Randomised Controlled Trials (RCTs) led by David Kay in the UK. The fact that the IE concentrations in the recreational waters used in these RCTs was log10 normally distributed facilitated the use of percentile values of IE to define/predict different gastrointestinal (GI) attack rates in the bather cohort probably associated with Norovirus in the recreational waters (i.e. based on symptomatology) within the bather cohort. Therefore, it is recommended that further updates to the modelling are made to include only 95%ile values for IE as the trigger value for a warning as these define/predict different GI attack rates in recreational waters.

Recommendation	Southern Water Action	Reviewer response to implementation
#2 The model to be updated to include IE in Beachbuoy alongside EC.	**Implementation of this recommendation is complete.** A post-processing method has been adopted which allows the model EC outputs to be converted to IE, allowing both EC and IE outputs for the modelling. The inclusion of IE has been in the Beachbuoy live model (released to the public) since early 2024. This approach is the new standard and will be the chosen approach when the new updated model is released and made public.	**Fully Addressed.** However, I have not seen RCTs which prove that EC will be predictive of illness in the bather cohort. Neither have I seen high quality peer reviewed evidence that EC provides reliable predictive power; i.e. suggesting that EC concentrations can be used to predict health risk amongst the bather cohort in RCT studies. Therefore, it is recommended that further updates to the modelling are made to only include IE as this is the only FIO which has been shown to predict GI illness in recreational waters.
#3 Acquisition of confirmatory data on IE to compare statistically with model predicted values. It is understood that SWS intend to implement this step using the event duration monitors (EDM) to predict IE in the bathing zone(s).	**Implementation of this recommendation is ongoing and will progress as the UKWIR project progresses.** A new UKWIR project 'Improving Real-Time Public Bathing Water Quality Information' has commenced. Southern Water are actively involved in this UKWIR project (Nick Mills is the Programme Lead) and the Sandown Bathing Water model in the Southern Water region is being used as one of the models. Daily IE samples have been collected from November 2023 onwards at Sandown. Some of these samples, from when overflow spills are known to have occurred, will be used to compare to the summary impact tables from the Southern Water model to determine if the IE sample confirms there was or was not an impact on	**Pending.** I doubt that EDM data could be used reliably to predict IE data in the bathing zone. It is more credible accurately to measure IE in the bathing zone. However, this may require multiple (i.e. 3) filtrations at each measure time and location to minimise the errors in FIO organism enumerations but it will enhance accuracy of the FIO enumerations and hence elevate the explained variance of predictive models seeking to elevate the predictive power of models designed to utilise the FIO concentrations to predict illness risk and design water quality criteria to limit health risk to 'acceptable' levels. It is understood that there are plans within the new UKWIR project to analyse the daily IE samples from Sandown and compare them to the summary impact tables.

Recommendation	Southern Water Action	Reviewer response to implementation
	bathing water quality. Additionally, spill details will be used to see how they compare to the sampling data.	
#4 Expand the modelling effort to cover the other sources of faecal indicator organisms (FIOs) to the coastal zone from farming, the human population including sewage flows, and wildlife. If these sources prove trivial SWS need to have the empirical evidence to prove this judgement.	**Implementation of this recommendation will be reassessed as the UKWIR project progresses.** A new UKWIR project 'Improving Real-Time Public Bathing Water Quality Information' has commenced. The aim of this project is to improve coastal bathing water quality forecasting nationally, by producing documentation setting out a consistent, nationally-accepted standard. Although the focus of Phase 1 of this project is on overflows and their impact on bathing water quality, it is acknowledged that there are other inputs to bathing waters which may have an impact on water quality at some sites. Phase 2 of the project will look to develop a statistical machine-learning model for bathing water quality, and the inclusion of other sources of FIOs to bathing waters could be looked at when further developing the scope for this phase.	**Pending.** This, again, is essential, at UK bathing water sites where agricultural sources of FIOs may drive the concentrations in coastal and riverine bathing water sources and therefore this recommendation should look to be implemented as part of the UKWIR project, or some other project with Southern Water.
#5 Validation of the utility of the modelling and prediction efforts in the SWS region need to be reviewed by the environmental and public health communities, the latter within local authorities	**Implementation of this recommendation will be reassessed as the UKWIR project progresses.** The bathing water quality model has been updated following recommendations from the modelling expert review, and these updates	**Pending.** Proper officer's buy-in to the health risk models which are the basis of water quality criteria is essential by senior scientists at CDSC (Colindale) DEFRA, local Department of Public Health and Environmental Health Officer professionals. Hence,

Recommendation	Southern Water Action	Reviewer response to implementation
(LAs) and the National Health Service (NHS), and the former with the Environment Agency (EA).	and the model calibration and performance have been audited by an external modelling expert. We are happy for the calibration/validation report to be reviewed by the EA. The LAs and NHS would also be free to review the calibration and validation report together with other material on the approach taken (including the extensive conservatisms) to provide context to the modelling. We feel it is more appropriate for advice to be taken from the EA who are the public body with expertise in this area. As part of the new UKWIR 'Improving Real-Time Public Bathing Water Quality Information' project which has recently commenced, representatives from the EA are members of the Project Steering Group and as such are able to review and influence the production of documentation setting out a consistent, nationally-accepted standard for coastal bathing water quality forecasting nationally.	they should have opportunity to validate and test the statistical modelling approaches utilised in this data acquisition and health risk design exercise. It is therefore recommended that this recommendation is continually implemented as part of the UKWIR project and opportunities for further implementation where available.

A.2 Oceanographic Modelling

Table 3-2 – Oceanographic Modelling recommendations review (as provided by Southern Water and independent reviewer)

Recommendation	Southern Water Action	Reviewer Response to Implementation
#1 Replace oceanographic and coastal zone modelling suite with newer version.	**Completed.** Latest unstructured grid DHI MIKE 21 and MIKE 3 model acquired by Southern Water and successfully set up to cover the region of the earlier model by Port and Coastal Solutions (PCS)	**Fully Addressed** However, it is recommended that “grid independency” be verified for a 70 m fine grid (see 4. below).
#2 Check to ensure that the Coriolis slope effect is included in grid model.	**Completed** PCS have confirmed that this slope is included in the new model to the writer’s satisfaction	**Fully Addressed**
#3 Field monitoring programme is undertaken to measure the key hydrodynamic parameters for key sites (ADCPs).	**Not completed** PCS have calibrated and verified the new model with limited and/or dated field or recorded data.	**Partially Addressed** PCS have verified their model against existing data which is of limited reliability or dated. To enable more credible model verification then it is recommended that ADCP data are required at about 6 key sites. These data are needed at the earliest opportunity to give more confidence, particularly for the model tidal current predictions. The writer understands that Southern

Recommendation	Southern Water Action	Reviewer Response to Implementation
		Water are looking into scoping and costings for ADCP surveys.
#4 Provide a refined grid cell structure in nearshore areas.	**Completed.** PCS have produced a refined grid structure of 70 m in the nearshore bathing waters. This complies with the original recommended upper bound maximum fine grid size of 75 m. However, with reference being made in the original report by Falconer (2023) advising that the grid size should be reduced to 50 m or a maximum of 75 m, with the latter being an upper limit, it is understood that Southern Water are planning to undertake grid independency tests for a grid resolution down to 50 m in critical sites to confirm that the 70 m resolution is sufficiently accurate in predicting currents along key bathing water sites. If this is not the case, then future simulations may need to be undertaken using an even finer grid (down to 50 m).	**Fully Addressed** Although 75 m was the original upper bound maximum fine grid size recommended, recent similar studies have used fine grid resolutions down to 50 m. Southern Water are aware of this possibility and the writer understands that grid independency tests are being commissioned to check that the 70 m grid resolution is sufficiently accurate for current predictions at key bathing water sites.
#5 Change nested down ratios to ratios of 1:3 or 1:5.	**Completed.** This is no longer relevant as nesting is not necessary with an unstructured grid model - a significant improvement on the earlier model.	**Fully Addressed**
#6 Estimate the approximate bed roughness based on bed data to justify changes in the roughness coefficient.	**Completed.** PCS have undertaken simulations to verify the new model against limited data, using a low	**Partially Addressed** This needs further review as the bed roughness in

Recommendation	Southern Water Action	Reviewer Response to Implementation
	constant roughness value. It is proposed that a site visit and visual reporting of typical ripple and/or dune heights be recorded at key beaches to estimate more precisely a nearshore equivalent roughness coefficient.	nearshore coastal waters generally increases significantly due to ripples and/or dunes. It is therefore suggested that visual observations are made, along with measured typical bedform heights at 2-3 key bathing water sites. This should not involve more than 1-day's work and will give third-parties and lay stakeholders some reassurance that realistic roughness coefficients have been used in the model simulations, rather than just using a roughness value chosen based on giving the closest agreement between predicted and measured field data.
#7 Investigate wind stress effects on the variation in the trajectory and physical characteristics of the discharge plumes in more detail.	**Completed.** PCS have partially covered wind stress impacts through including small winds against drogue data.	**Partially Addressed** Although small winds against drogue data have been included, the impact of larger winds (> 7 m/s) has not yet considered and verified. However, it is understood that Southern Water intend to apply real and forecast wind

Recommendation	Southern Water Action	Reviewer Response to Implementation
		conditions in their future real-time modelling.
#8 Consider implementation of at least a one-equation turbulence model to estimate the turbulent diffusion processes.	**Completed.** PCS have included the Smagorinsky turbulence model in the new model and this is a marked improvement on the earlier model	**Fully Addressed**
#9 Refine solute transport model to include dispersion-diffusion processes related to velocity and depths effects.	**Completed.** PCS are using the particle tracking (PT) model which does not average spatially; hence dispersion effects are minimal except near the bed. New model simulations use constant, rather than varying, diffusion coefficient.	**Fully Addressed** However, it is recommended that the graphical comparisons of predicted v. measured concentrations are identified using a colour key and some x-y plots of concentration v. distance from the release site to calibrate the diffusion coefficient. Also, the dispersion and diffusion values need review and some simulations re-run using revised diffusion coefficients.
#10 Update the model to consider the difference in FIO concentrations based on day and night-time release events.	**Not completed.** The nature of the PT model allows this to be applied as part of post processing of model results. The plan is for FIO decay rates to be included in post processing of simulation results.	**Pending** The writer recommends using dynamic decay rates in bacteria modelling, with at least day- and night-time variations included. The writer does not believe that other rate

Recommendation	Southern Water Action	Reviewer Response to Implementation
		variations can be included in post-processing, other than through dynamic model simulations. Day- and night-time variance should suffice for most conditions.
#11 Use state-of-the-art modelling tools for assessing health risk impacts.	**Completed.** The PCS model is state-of-the-art, and considerable progress has been made in a short time to setup this model.	**Fully Addressed** However, scope remains for refining some coefficients and processes represented in the model, as outlined above.
#12 Additional sampling studies for key bathing sites to understand key source inputs.	**Not completed – will be reassessed as the UKWIR project progresses.** A new UKWIR project 'Improving Real-Time Public Bathing Water Quality Information' has commenced. The aim of this project is to improve coastal bathing water quality forecasting nationally, by producing documentation setting out a consistent, nationally-accepted standard. Although the focus of Phase 1 of this project is on overflows and their impact on bathing water quality, it is acknowledged that there are other inputs to bathing waters which may have an impact on water quality at some sites. Phase 2 of the project will look to develop a statistical machine-learning model for bathing water quality, and the inclusion of other sources of FIOs to	**Pending** The writer is pleased to note that there is a national plan in place address this recommendation.

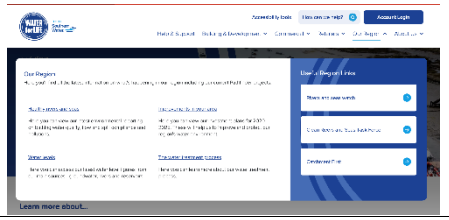
Recommendation	Southern Water Action	Reviewer Response to Implementation
	bathing waters could be looked at when further developing the scope for this phase.	
#13 Additional transect sampling studies for key bathing sites to acquire data for model calibration and validation.	**Not completed – ongoing and will progress as the UKWIR project progresses.** A new UKWIR project 'Improving Real-Time Public Bathing Water Quality Information' has commenced. Southern Water are actively involved in this UKWIR project (Nick Mills is the Programme Lead) and the Sandown Bathing Water model in the Southern Water region is being used as one of the models. Daily IE samples have been collected from November 2023 onwards at Sandown. Some of these samples, from when overflow spills are known to have occurred, will be used to compare to the summary impact tables from the Southern Water model to determine if the IE sample confirms there was or was not an impact on bathing water quality. Additionally, spill details will be used to see how they compare to the sampling data.	**Pending** The writer understands that spot samples have been taken along some bathing beaches and these data need to be compared to model predictions to refine the diffusion and bed roughness coefficients in the nearshore zone to give optimal accuracy for the predicted data inputs to Rivers and Seas Watch.
#14 Embed the coastal modelling data within a hydroinformatics tool to provide real-time input data to Rivers and Seas Watch.	**Not completed.** The writer understands that this task has not yet been undertaken and will be considered further following the implementation of a national plan as referenced in Recommendation 13 above.	**Pending** The writer recommends that informatics tools be used to transfer a range of boundary inputs based on data from many hydro-epidemiological model runs, thereby enabling real-time health risk information to be provided to

Recommendation	Southern Water Action	Reviewer Response to Implementation
		the public and key stakeholders
#15 Run simulations of the effluent release from a typical outfall around mean water level (MWL)	**Completed.** The writer recommends running simulations of effluent discharges from long sea outfalls at MWL, as well as high water (HW) and low water (LW) to establish optimal time of discharging through the tidal cycle.	**Fully Addressed** The writer understands that PCS have undertaken simulations comparing faecal bacteria levels in the region for each long sea outfall, for 1-, 3-, 12- and 25-hour release durations, each starting at HW slack, MWL ebb, LW and MWL flood, for both a spring and neap tide. This range of discharge considerations and release durations was not clear to the writer from the PCS (2024) and is to be welcomed.
#16 Refine Solent and IoW modelling grid to provide finer resolution in the region	**Completed.** PCS have reduced fine grid resolution from 125 to 70 m.	**Fully Addressed** Relative to the upper bound recommendation by Falconer (2023) the modelling has now been undertaken in the nearshore zone using a 70 m grid. However, in the original report by Falconer (2023) it was deemed that it might be desirable to reduce the grid size to 50 m. To ensure that

Recommendation	Southern Water Action	Reviewer Response to Implementation
		the 70 m grid size is sufficiently accurate in predicting the tidal currents in the nearshore zone it is understood that some grid independency tests will be commissioned by Southern Water to compare hydrodynamic predictions between 70 and 50 m resolution in sensitive areas. These tests are to be welcomed and will confirm, or otherwise, that the 70 m grid resolution is sufficiently fine enough to predict accurately the tidal currents in the critical nearshore zones.

A.3 User and Engagement

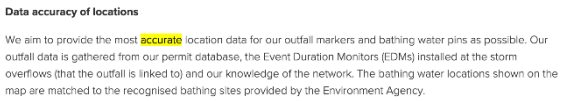
Table 3-3 – User and Engagement recommendations review (as provided by Southern Water and independent reviewer)

Recommendation	Southern Water Actions	Reviewer Response to Implementation
#1 – Improve Beachbuoy access.	**Completed** The Southern Water corporate website we re-built and relaunched in Spring 2024, which introduced a new IA and navigation structure. RSW now appears as a primary service under the 'Our Region' section July 2024 Rivers and Seas Watch now listed as a top link from the "our region" section of site-wide navigation 	**Fully Addressed.**
#2 – Reorganise and provide additional information.	**Completed.** We fully reviewed the informational content provision for Rivers and Seas watch to support the public beta release in June 2024. This review included provision of all the content recommendation's that the expert felt was needed, with a holistic view taken to how this information should be organised for users of the service.	**Fully Addressed.** *Changes in information organisation are notable and achieve intended outcomes. Further testing has shown that the 5-page pdf on tidal modelling should also be available*

Recommendation	Southern Water Actions	Reviewer Response to Implementation
	July 2024 informational content released, including 5-page PDF on tidal modelling https://www.southernwater.co.uk/media/kjxi21bf/beachbuoy-how-we-model-impact.pdf	*from the 'Tidal Modelling' section: https://www.southernwater.co.uk/our-region/clean-rivers-and-seas-task-force/rivers-and-seas-watch/.*
#3 – Provide videos and appropriate visualisations for users with different competency levels.	**Completed** Videos and other interactive (story-telling) elements were provided on the Rivers and Seas Watch landing page that provide users with explanations around the key aspects of RSW (tidal modelling, how RSW works, manual and automated review process) July 2024 Videos available on https://www.southernwater.co.uk/our-region/clean-rivers-and-seas-task-force/rivers-and-seas-watch/	**Fully Addressed.**
#4 –Provide a Frequently Asked Questions section to answer user queries.	**Completed** We completed a review of frequently asked questions from various feedback channels (media team, stakeholders, BB feedback inbox etc.) and provided a comprehensive FAQ's section that addressed the key themes identified via our analysis. July 2024 FAQ available on https://www.southernwater.co.uk/our-region/clean-rivers-and-seas-task-force/rivers-and-seas-watch-faq/	**Fully Addressed.** *Sufficient plans in place to continuously improve FAQ content in line with this recommendation.*
#5 – Provide tailored email notifications with sufficient content.	**Completed** We conducted discovery into the key areas that users felt the email service could be improved – the results highlighted area of improvement could be	**Fully Addressed.**

Recommendation	Southern Water Actions	Reviewer Response to Implementation
	the inclusion of bathing sites and outfall information, start and end times, statuses of releases as well as the ability for users to click-through from email to the relevant position in the RSW web-map within the content of the emails. These changes have been implemented in RSW. Feedback mechanisms are in place to continuously evaluate and monitor the effectiveness of this service, and where opportunities for improvement are identified, these will be evaluated for feasibility and implementation inclusive of user-testing best practices. April 2024 Relish user study includes evaluation of email alerts, which are addressed Nov-Dec 2024 Ongoing further updates to emails based on feedback, including link to feedback form, link to bathing site and minor content changes for clarity	*Additional interviews have shown this to be a strength of the platform and a critical feature.*
#6 – Provision of brief explanation of manual data updates in 'Historical and current releases' Table	**Ongoing** We are currently conducting discovery into how we can feasibly provide for 'reasons' for manual update determination made by spills analysts, with a view of implementing a solution within 2025.	**Partially Addressed**. *Sufficient plans in place to fully address this feature.* *Additional interviews have shown that beginners are not sure what 'genuine' 'under review' and 'not genuine' releases mean when they view the table for the first time; add brief explanation.*

Recommendation	Southern Water Actions	Reviewer Response to Implementation
#7 – Provide a Forum for two-way communication with end users to promote transparency and trust	**Partially complete** A user-forum was used by Relish who implemented the beta program for the development of RSW whilst in private beta, where users could share their experience of RSW whilst it was in development. Longer term, we plan to develop more opportunities to transparently communicate with our users, either by using AI Language models or through moderated forums. Dec 2024 – Jan 2025 Created a dedicated user panel / forum inbox and promoted via stakeholder user group. Further plans to grow the panel Longer term, we plan to develop more opportunities to transparently communicate with our users, either by using AI Language models or through moderated forums.	**Pending**. *Sufficient plans in place to fully address recommendation*
#8 – Optimise Beachbuoy Map Loading Speeds	**Completed.** RSW utilises ESRI's ArcGIS Online, which is a cloud-based GIS platform. The performance / load speed of this interface is greatly increased. July 2024 Loading speeds improved significantly with ESRI.	**Fully Addressed.**
#9 – Reduce the size of the pop-up window	**Completed.** The pop-up size was reduced in RSW	**Fully Addressed.**

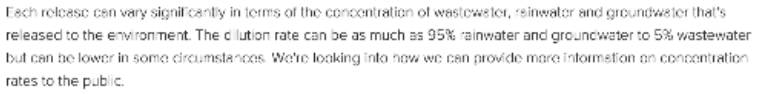
Recommendation	Southern Water Actions	Reviewer Response to Implementation
#10 – Add all relevant map data or explain why specific background data are not provided to improve transparency and trust	**Completed.** All SW CSO outfalls are available on RSW. July 2024	**Fully Addressed.**
#11 – Provide information about spatial data accuracy below the map	**Completed.** We included information in our FAQ section on the spatial accuracy of our outfall assets The FAQ includes information about spatial data  **Data accuracy of locations** We aim to provide the most accurate location data for our outfall markers and bathing water pins as possible. Our outfall data is gathered from our permit database, the Event Duration Monitors (EDMs) installed at the storm overflows (that the outfall is linked to) and our knowledge of the network. The bathing water locations shown on the map are matched to the recognised bathing sites provided by the Environment Agency.	**Fully Addressed.**
#12 – Specify time zones for reporting outfall release duration	**Completed.** We standardised the time-zone format used in RSW so that it will always present information in the current time-zone. We have updated UI to make it clear the time-zone being shown to the user.	**Fully Addressed**.
#13 – Additional interviews and usability user testing to provide further insight	**Completed.** Completed with the working group (9th Nov 2023) decision made to remove white icon. Implemented in Beachbuoy in late 2023 and design decision incorporated in RSW development.	**Fully Addressed.**

Recommendation	Southern Water Actions	Reviewer Response to Implementation
into the white 'unverified release' symbol to make specific recommendations	Additional user testing will be completed as part of the development of mk2 (Beachbuoy 2.0). April 2024 Relish user studies and survey November 2024 – current Continuous discovery and feature-specific user studies (interviews and concept testing)	
#14 – Enable viewing impact of releases on bathing sites and releases from outfalls as two separate layers.	**Completed.** In the development of RSW, we separated outfalls and bathing sites as separate layers, allowing users to transparently inspect the status of these sites without additional interaction e.g. clicking on a bathing site to see outfall information. July 2024 Released to the public as part of the map filter	**Fully Addressed.**
#15 – Provision of a search bar for a more tailored map navigation based on user's preferences	**Completed.** Implemented in the development of RSW	**Fully Addressed.**
#16 – Improve font size design to match different scales	**Completed.** Implemented in the development of RSW	**Fully Addressed.**

Recommendation	Southern Water Actions	Reviewer Response to Implementation
#17 – Improve visibility of selected objects/points on the map	**Completed** Implemented in the development of RSW	**Fully Addressed.**
#18 – Improve interaction with 'Historical and current releases' Table	**Completed.** Implemented in the development of RSW.	**Partially addressed.** *(see recommendation #28 for volumetric Data provision)*
#19 – Choice of colours further evaluated.	**Completed.** We evaluated the use of colour of RSW whilst in testing and found that the RAG statuses to be the preferred colour options to clear indicate levels of alert. Using red and green was evaluated from an accessibility view, and found that the colour contrast ratios were not problematic using accessibility testing tooling	**Fully Addressed.**
#20 – Perform a User Experience Evaluation on the mobile version of Beachbuoy	**Completed.** Our beta testing focused on mobile user experience as a key requirement. Specific features were modified to improve the UX on mobile devices, versus the desktop user experience. For example, the release history table renders as a list of mobile to accommodate a vertical screen orientation, whereas when accessing on a desktop user a prevented with a tradition table as a preferred render of this information	**Fully Addressed.** *Sufficient plans in place to continuously improve User Experience of the Rivers and Seas Watch app.*
#21 – Perform Stakeholder Mapping and engage with a	**Completed.** As part of the private beta program for Beachbuoy 2.0, we are engaging with three segments of external users (separate from our usual stakeholder groups) who represent a cross-section of water-users, alongside existing	**Fully Addressed.**

Recommendation	Southern Water Actions	Reviewer Response to Implementation
wider user audience to build trust	stakeholders (for example, Working Group, Campaign Groups) – which is approximately 50 users.	
#22 – Extend Interviews and perform Usability User Testing for different types of users with various competencies	**Completed.** As above (recommendation #21)	**Fully Addressed.**
#23 – Inform users about all (actual or potential) RED warnings	**Completed.** We re-designed the status hierarchy in BB and RSW so that genuine and unverified releases are communicated to the user with a RED warning.	**Fully Addressed.**
#24 – Provide content so that email notifications become more meaningful	This links to recommendation #5. **Completed.** We conducted discovery into the key areas that users felt the email service could be improved – the results highlighted area of improvement could be the inclusion of bathing sites and outfall information, start and end times, statuses of releases as well as the ability for users to click-through from email to the relevant position in the RSW web-map within the content of the emails. These changes have been implemented in RSW. Feedback mechanisms are in place to continuously evaluate and monitor the effectiveness of this service, and where opportunities for improvement are	**Fully Addressed.** *Sufficient plans in place to fully test the further development of this feature.*

Recommendation	Southern Water Actions	Reviewer Response to Implementation
	identified, these will be evaluated for feasibility and implementation inclusive of user-testing best practices.	
#25 – Add brief explanation to justify data updates during the manual updates process.	**Completed.** We provided informational content on the support RSW webpages that explains and justifies the need for manual reviews for storm overflow releases	**Fully Addressed.** This information (“Manual review” text box) has been now added; does not link to recommendation #6.
#26 – Explain in lay terms how Beachbuoy updates work (both automated and manual)	Links to recommendation #3 & #4 **Completed** We provided informational content on the support RSW webpages that explains how RSW works Completed.	**Fully Addressed.**
#27 – Explain in lay terms the specifics of the ‘unverified overflow release’ feature and the reason it exists in the first place	**Completed** We implemented information content on the support RSW webpages related to unverified storm overflow releases and why it’s important to ensure accurate information to inform the public	**Fully Addressed.**
#28 – Add volumetric data	**Not completed.** We are conducting a discovery project to assess the technical feasibility of different approaches that can be used to provide volumetric data to users for RSW. Part of this study will evaluate the *why* behind this data request, to better understand how volumetric data would add value to users, and whether volumetric data by itself is sufficient to solve the user problems	**Pending.** *Sufficient plans in place to understand based on user feedback what is the best technical way to address this user need.*

Recommendation	Southern Water Actions	Reviewer Response to Implementation
	proposed by displaying volumetric data. We will publish a public report of our findings to discuss the outcomes with our stakeholders and consult on future steps. Dec 2024 Feasibility project brief created and in draft, covering further user research into volumetric data; To be discussed in Q1	
#29 – Improve transparency about concentration rates through Beachbuoy information page	**Completed** We provided informational content that explains concentration rates in our FAQ section  Each release can vary significantly in terms of the concentration of wastewater, rainwater and groundwater that's released to the environment. The dilution rate can be as much as 95% rainwater and groundwater to 5% wastewater but can be lower in some circumstances. We're looking into how we can provide more information on concentration rates to the public.	**Fully Addressed.**
#30 – Ensure there is an explanation of what volumetric data means provided in lay terms	Links to recommendation #3 & #4 **Not completed.** Cannot be addressed until feasibility of volumetric data is addressed. See above. Dec 2024 Feasibility project brief created and in draft, covering further user research into volumetric data; outcomes to be discussed with stakeholder working group upon completion of this study.	**Pending.** *Sufficient plans in place to address this recommendation, which links to recommendation #28.*

Recommendation	Southern Water Actions	Reviewer Response to Implementation
#31 – Perform additional interviews and usability user testing (observation) to capture functional and non-functional requirements for both desktop and mobile interfaces	**Completed** We conducted extensive usability testing during private and public beta, and have recruited a dedicated UX research to ensure this is a BAU part of product development as RSW develops further.	**Fully Addressed.**
#32– To implement Human-Computer Interaction methods follow appropriate methodological protocols	**Completed** We conducted extensive usability testing during private and public beta, and have recruited a dedicated UX research to ensure this is a BAU part of product development as RSW develops further	**Fully Addressed.**
#33 – Interviews and usability testing should be used to engage end users (outside the existing stakeholder group) with different competency levels and categorise needs and requirements accordingly	**Completed** We conducted extensive usability testing during private and public beta, and have recruited a dedicated UX research to ensure this is a BAU part of product development as RSW develops further	**Fully Addressed.** *As new design and functionality features are updated it is essential to continuously evaluate usability and get user feedback.*

Recommendation	Southern Water Actions	Reviewer Response to Implementation
#34 - Methods such as interviews and usability user testing can create a connection/bond with users, build rapport and demonstrate an ethic of care which is necessary to promote and rebuild trust with end users. For this reason, might be best performed by independent experts	**Completed** We conducted extensive usability testing during private and public beta, and have recruited a dedicated UX research to ensure this is a BAU part of product development as RSW develops further.	**Fully Addressed.**
#35 – Run usability testing to evaluate how easy are different visualisations to use by different types of users (i.e., beginners, intermediate and advanced competency levels)	**Completed** We conducted extensive usability testing during private and public beta, which evaluated the information content that support the product. We have recruited a dedicated UX research to ensure this is a BAU part of product development as RSW develops further, which includes content evaluation.	**Fully Addressed**
#36 – Provide clear explanations of how updates work	**Completed** We provided informational content on the support RSW Webpages that details how RSW is updated	**Fully Addressed.**

Recommendation	Southern Water Actions	Reviewer Response to Implementation
#37 – Provide clear explanation of Beachbuoy update times (i.e. both manual and automated)	**Completed** We provided informational content on the support RSW Webpages that details how RSW is updated and timings	**Fully Addressed.**
#38 – Set threshold for manual updates (e.g., no less than two hours) to improve reliability and help users efficiently manage health risks	**Not completed** In order to improve this outcome, we have (and continue) to develop our automated-spills-verification (ASV) tooling, which will reduce the need for manual verification further, allowing our manual spills analyst to reduce the time-taken to review spills.	**Pending.** *Sufficient plans in place to fully address recommendation*
#39 – Explain why some longer releases are described as multiple smaller releases even when these are just a few minutes apart	**Completed** We explained in our RSW informational webpage how large spills are reviewed and adjusted for accuracy – sometimes resulting in multiple small spills being created to accurate reflect what occurred	**Fully Addressed.**
#40 – Specify time zones for start and end release times	**Completed** Time-zones have been added to all user interfaces in RSW	**Fully Addressed.**
#41 – Explain in lay terms on Beachbuoy information page the	**Completed** Links to recommendations #3 & #4	**Fully Addressed.**

Recommendation	Southern Water Actions	Reviewer Response to Implementation
'unverified overflow release' feature and the reason it exists in the first place	July 2024 Change completed and released to the public (Question 3 on https://www.southernwater.co.uk/our-region/clean-rivers-and-seas-task-force/rivers-and-seas-watch-faq/)	
#42 – Set threshold for manual updates that verify a release	**Not completed** In order to improve this outcome, we have (and continue) to develop our automated-spills-verification (ASV) tooling, which will reduce the need for manual verification further, allowing our manual spills analyst to reduce the time-taken to review spills.	**Pending.** *Sufficient plans in place to fully address recommendation*
#43 – Perform stakeholder analysis to map all relevant stakeholder groups across the South-East coast	**Completed** We mapped stakeholders and re-evaluated the stakeholder working group for suitable representation, inviting new members to reflect the geographical areas that we operated in. Our wider User Research strategy ensure that we have targeting and reaching out to a wider community of users that would find value in this service, so that we can engage them further on how to improve the service. February 2024 Work complete Nov 2024 Revised stakeholder analysis completed by incoming user researcher	**Fully Addressed.**

Recommendation	Southern Water Actions	Reviewer Response to Implementation
#44 – Emphasis should be paid on improving awareness about Beachbuoy and engage more actively with members of the public who might benefit from it	**Completed** We actively encourage feedback from the public and promote Rivers and Seas Watch wherever possible as a tool. We will continue with this approach and continuously evaluate how we can do this more effectively via Product Marketing strategies	**Fully Addressed.**
#45 –Provide incentives or other mechanisms to encourage participation	**Completed** Incentivised user study conducted with 85 users via Relish as part of the private beta programme. Further incentivised participation programmes will be run for future product development activities.	**Fully Addressed.**

A.4 Software and Systems

Table 3-4 – Software and Systems recommendations review (as provided by Southern Water and independent reviewer)

Recommendation	Southern Water Implementation of Recommendation	Reviewer Response to Implementation
#1 Retrospective documentation of IT architectures: design of database physical model; documentation of detailed state-change scenarios; collation of business rules.	**Partially complete** Most of this documentation has now been completed and can be evidenced Any gaps vs the recommendation scope intent to be identified	**Fully addressed** (technical architecture in HLD, database structure and Stored Procedures in Low Level Design).
#2 Improvement to restrictions to Telemetry Bandwidth	**Ongoing** Long-term and on-going initiative within SW to improve telemetry and thus drive a reduction in latency and reliability of the EDM data-flow estate	**Pending** for the battery powered sensors as part of a wider ongoing initiative. Battery powered float sensor event detection an issue due to required increased sampling rate and battery replacement frequency, with no current non-obsolete options on the market.
#3 Backup and disaster recovery will be delivered by the new data centre, the timeline for this is unclear.	**Complete** Primary RSW stack now within the data centre w/disaster recovery support. Upstream systems are due migration over time	**Fully addressed** for RSW. Some parts migrated to new data centre, some outstanding with no timeline.
#4 Reduce Polling in BB and information flow to <1hr	**Partially complete** Long-term and on-going initiative within SW to improve telemetry and thus drive a reduction in latency and reliability of the EDM data-flow estate	**Partially addressed** via a number of system wide initiatives along the data flow pipeline (telemetry, event determination in PiAF and the Aspire / RSW interface).

Recommendation	Southern Water Implementation of Recommendation	Reviewer Response to Implementation
#5 The new inflight BB redevelopment will address the extension to inland water via a separate database	**Complete** RSW development included within its scope a separation between the RSW/BB Database and the Aspire Database.	**Fully addressed**
#6 The new BB redevelopment will address integration and workflow issues through the implementation of FME	**Planned** Legacy integration approach (stored procedures) was maintained in the development of RSW [deviation from the HLD] in order to deliver RSW within time-frames required. Stored procedures for integration are considered Tech Debt and will be deprecated (road mapped) and replaced with FME capabilities	See #4 **Partially addressed & pending** The business rule database stored procedures and quartz interface were due to be replaced by FME. Although FME has replaced with ESRI the geospatial front end logic this remains as technical debt. In defence the polling time by Quartz has been reduced from one hour to 15 minutes.
#7 The new BB redevelopment will address the maintenance cost and maintainability via the FME Low Code development platform	**Partially complete** FME is being used for a portion of the processing of data for RSW, reducing some maintainability complexity. Further roll-out of low/no-code FME solution will be deployed in the future.	**Partially addressed** As #4, #6 and #7
#8 Updated project management for the new Beachbuoy redevelopment:	**Partially complete** Many of these artefacts exist. RSW has IT and Business governance via PMO, and executive steer committees. Risk is managed via these channels. A stakeholder working group exists, with representation from external stakeholders across the region. Business Case development exists for a persistent Product Team to support the enduring business needs on transparent environmental	**Fully addressed** on a number of levels, especially with: Separation of RSW and Aspire developments Move of RSW to a BAU Product management lifecycle Move to integrate RSW with corporate strategy and services

Recommendation	Southern Water Implementation of Recommendation	Reviewer Response to Implementation
	reporting. Welcome KH feedback and view on completeness vs recommendation scope intent.	
#9 Formalisation of the Hybrid/Agile IT Standard	**Planned/ on-going** SW is transitioning to a SAFe agile framework, employing transformational contractors to aid transition. RSW Product Team is the first established team, with framework and processes due iteration as the approach is scaled across the business.	**Fully addressed** Especially via the integration of Business Analysis and Data Architecture into the Product enhancement process
#10 Validate releases with external audiences	**Complete** RSW was developed with extensive engagement from a user community (private beta, public beta, full launch) UAT was ran internally over multiple weeks prior to the public beta. This is an approach that will be continued for new RSW Releases	**Fully addressed** on a number of levels: User Voice as part of development The release process with private and public beta UI incorporating a) feedback and b) widening the display to include investment plans
#11 Business Analyst Centre of Excellence	**Complete** This is a wider-IT recommendation. Please see those comments.	**Fully addressed** With hiring professionally BAs
#12 Release Management Improvements	**Complete** RSW was developed with extensive engagement from a user community (see above). Releases are now properly documented and managed within the Atlasian Product suite, in addition to the circulation and public hosting of release notes available via SW RSW pages. Media and comms team were engaged and briefed prior to RSW releases. The above practices will be adhered to into the future.	**Fully addressed** See previous

Recommendation	Southern Water Implementation of Recommendation	Reviewer Response to Implementation
#13 Addressing the one hour on the hour delay to be replaced by something closer to real time updating	**Complete** The polling frequency from Aspire to R&SW has increased from 1 hour to 15 mins	**Fully addressed** The Quartz interface passing data from Aspire to RSW frequency reduced from 1 hour to 15 minutes
#14 Spatial Mapping and Reference Data for site	**Partially complete** I'm keen to review this recommendation based on what we have done in this area. 1) We have associated bathing sites to outfalls, 2) master data held within Aspire from CATalog that maps Outfalls to their associated overflow point within the network. We do intend to show overflow to outfall associating (road mapped), but exposure of more of this information is seen as non-valuable to our users. Documentation about how these associations needs to be centralised with the new Product Confluence pages - and is planned	**Fully addressed** Both fully addressed in parts (extra info on UI including EA sample sites and overflows in reports) and pending (Confluence and work on increasing data re bathing risk – effluent concentration)) Note: the Aspire Detailed Design describes Pi functionality re spill events and addresses reference data interfaces such as CALMS and CATalogue.
#15 Mobile App for BB	**Planned / under consideration** A mobile application version of RSW is under consideration	**Pending** (modifying web interface to fit handheld devices using ESRI capability) and pending (cost/benefit assessment of a fully mobile app).
#16 Formal BB Database Design Documentation	**Complete**	**Fully addressed** (in HLD and Low Level Design)
#17 Formal Aspire Database Design Documentation	**Complete**	**Fully addressed**

Recommendation	Southern Water Implementation of Recommendation	Reviewer Response to Implementation
#18 Include operational decisions / data from the spills team in BB data	**Planned** Short-term Roadmap item - Discovery into how this information is (or is not) captured in Aspire is currently in-flight. Solution design around how to translate this into a user-friendly solution is also in-flight. Once higher confidence in these two areas is reached, implementation will be carried out - target for Q2 2025.	**Pending**
#19 Control / Authorisation for sensitive control data for BB configuration	**Partially complete** BB/RSW Admin has a new authentication protocol utilising SW username and P/W. This is in testing and will be deployed in Q1 2025.	**Fully addressed**
#20 Explain the principle of the check factor limit value to Public in BB	**Complete** We explain the concept of checkfactor via web pages and interactive videos. We do not exposure the checkfactor values, as these are meaningless without technical context of the value. Consideration has been given to translating check factor values into a more meaningful metrics e.g. "confidence; High, Medium, or Low' but this needs further exploration due to concerns around how this could impact trust of the service.	**Fully addressed** in so far as it is possible with a potentially naïve audience
#21 The functionality associated with the map colours needs redesign by a Human Factors expert as part of the BB redevelopment as	**Complete** This was evaluated by our UX designers and during the beta programmes with a RAG colour scheme, based on duration since storm overflow release used as the basis for the colour-coding. Unreviewed	**Fully addressed** but requires evaluation of user feedback over time

Recommendation	Southern Water Implementation of Recommendation	Reviewer Response to Implementation
	releases are considered genuine from a RAG status perspective.	
#22 Document Business Rules	**Partially complete** Business logic has been documented in various forms (Jira issues, process maps, Low Level Design documentation etc.). However, there is no consolidated view of this information at present. Our proposed next steps will be to collate these artefacts within a Product Confluence page(s).	**Fully addressed** Usage of Confluence as the platform is encouraging so long as the overhead to maintain relevance is recognised
NEW - Delays in the manual event (spill) validation process	N/A	**Fully addressed** Improved overflow profiling, use of AI algorithms for event validation and longer term usage of prediction of rainfall.

Appendix B. Recommendation Review Reports

These are provided as separate files

B.1 Water Quality

B.2 Oceanographic Modelling

B.3 User and Engagement

B.4 Software and Systems

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