Beachbuoy
User & Engagement Expert Review

September 2023

Summary

The User & Engagement Expert review aims to assess the User Experience of the Beachbuoy desktop interface and emphasises on the usability (i.e. easiness of use) of the mapping interface as well as providing insight into users' perceptions with respect to specific interaction aspects. The review is based on the methods of Heuristic Evaluation and Interviews with end users.

This review found that Beachbuoy performed relatively well in terms of usability and that participants involved in this review prefer it over alternatives sources which provide similar data. There are, however, significant trust gaps and therefore space for much improvement to address reliability concerns and maximise the perceived usefulness of the service. A set of key recommendations rated as 'Low', 'Medium' and 'Critical' are presented herein to support improving the service further. These ratings do not take into account the technical complexities of addressing the recommendations, but focus entirely on priorities addressing user concerns as identified during the interviews. Subsequently the ratings in the overarching report have been modified to consider technical complexities in delivering key recommendations.

There is also a clear need to involve a wider end user audience in the engagement process using effective channels which support two-way information communication flows to provide a service tailored to the end user needs and further build a trusting relationship with end customers.

Important Note: This User and Engagement Expert Review Report focuses on communicating users' perceptions about BB as those were reported during the interviews. These are in their majority accurate, but they may include some misconceptions that contradict experts' (i.e. SW employees) opinions. These have been taken into account in the provided recommendations. It is subsequently Southern Water's role to correct any misconceptions

through the provision of accurate and easy to understand information that build an accurate public understanding about BB services, their purpose and supported functionality.

1. Aims and Methodology

Aims

The User & Engagement Expert review aimed to assess the User Experience of the Beachbuoy mapping interface (desktop version only) and provide a set of recommendations to improve BB's functionality based on user needs. User Experience, in the context of this review, involves investigating the usability (i.e. easiness of use) of the mapping interface and users' perceptions with respect to specific interaction aspects and the data provided. This review is guided by the questions outlined in Table 1. Subsequently this review presents the overall findings and recommendations for improving Beachbuoy maps and answers the questions listed in Table 1.

Table 1: Expert Review Questions

Category	Questions for Expert Review
Human and Health Implications	1. Is it a problem for Beachbuoy (BB) users not receiving RED warnings when they should be?
	2. Is it a problem for BB users incorrectly receiving RED warnings whilst there is no real threat?
Review Process and System	3. Propose how BB can be more open and transparent with regards to data being routinely and in some cases being extensively manipulated, deleted and dismissed as false alarms in the release history. How does such misleading information affect BB users?
General Modelling	4. Would both volumetric and duration data be more helpful to BB users?
	5. Are there any missing BB features from the reviewer's perspective.
User Engagement	6. How do the developers know what users want/need. Would independent elicitation of system requirements be helpful over what developers think we need?
	7. Surfers Against Sewage safer seas app is a well trusted app used for many years. It uses just two colours RED and GREEN (Bad/Good) would it be reasonable/helpful for BB to adopt a simpler approach or whether the current approach is appropriate and there is sufficient confidence in the precision of the data.
	8. Is BB reliable? Does it update metronomically every hour? Is this a problem from a user health perspective?
	9. Is BB reliable? Are the software updates seamless, well tested and problem free should users expect properly tested software updates to keep them safe and well informed?
	10. Has BB Stakeholder involvement been effective. Historically this has been dysfunctional; there is very little representation from actual users, and these are often side-lined. How can stakeholder involvement be improved so that user requirements for improvements and enhancements should be openly debated and prioritised in a Beachbuoy Stakeholder user forum to ensure that both functional and non-functional requirements are addressed to optimise benefit for both Southern Water and the user community.

Methodology

To assess the usability of the Beachbuoy desktop interface an externally recognised best practice approach was used. This approach involved a number of different steps and included an expert inspection and user interviews, as explained in detail below, to get a deep understanding of what is working, what users need and where design improvements should focus.

First the method of Heuristic Evaluation was used. Heuristic Evaluation is a popular usability inspection method which is utilised to identify "usability problems in a user interface design so that they can be attended as part of an iterative design process" (Nielsen, n.d.). The heuristics used are from Skarlatidou et al. (2013) and they were previously developed after extensive usability user testing of similar web mapping interfaces for public information provision in the environmental context. Special attention was paid to heuristics which are known to further influence the perceived trustworthiness of the map and the data provided.

Although Heuristic Evaluation is extensively used for the evaluation of interfaces by usability experts and it is extremely popular due to its cost-effectiveness, it also comes with its limitations. The most significant being that, as an expert evaluation method, it might miss some of the actual end user concerns and usability problems they are facing, which are particularly relevant to Beachbuoy. To make sure end users' concerns and usability problems they are facing were taken into consideration and to further answer the expert review questions which refer explicitly to end users' insights, nine interviews were conducted (out of the 15 participants invited to take part in this study). Although this might be considered relative a small number of participants, especially compared to the number of actual and potential Beachbuoy users, participants' opinions and views had many similarities and it can be suggested that a sufficient number of those were successfully captured and discussed here.

All interviews were one hour long and took place online, via Microsoft Teams. Southern Water (SW), under the guidance of the expert reviewer, put together a participation list, which was drawn mainly from the stakeholder working group and their wider end user networks. All participants are actual end users of Beachbuoy and they use the application regularly for different purposes. Due to limited resources and the short duration of this project, interviews were scheduled to run from 14th to 25th of August 2023. All interview data are completely anonymized; this report provides a summary of views and opinions which are presented in a way that individuals cannot be identified.

2. Overview of User & Engagement - Independent Review Findings

Most of England's sewage network carries rain and wastewater within the same pipe network. This is particularly problematic when rainwater volume increases dramatically due to rainfall conditions and clean rainwater and wastewater are pumped directly into the rivers and sea to prevent it from backing up into people's properties or streets. Due to greater public awareness of sewage spills across the country, members of the public have become extremely concerned about health and environmental impacts and the water companies' practices, especially with respect to misreporting illegal sewage releases and their plans to reduce sewage overflows (Niels de Hoog, 2023). This led to suspicion and distrust especially with respect to how regularly sewage is discharged, the duration and volume of these spills and their public health impacts. Within that context public surveys show that people's trust in water companies is at its lowest point since 2011 (Ofwat, 2023); with two-thirds of those surveyed to distrust water companies to prevent sewage from entering rivers or seas (Hayter, 2023).

Public demands for the provision of accurate, timely and trustworthy information are therefore more important than ever before and public's "right to know" is protected by relevant legislation. Water companies across the country provide relevant information to report on environmental performance, which includes information about outfall releases. Southern Water's Beachbuoy service launched in 2018 to communicate openly outfall releases and their impacts to bathing sites across the South-East coast.

2.1 Beachbuoy Overview and Design Strengths

Participants in this study identify that the main purpose that Beachbuoy serves is to ***inform the public about outfall releases***, and therefore ***improve awareness of when it is safe to enter the sea*** and therefore minimise public health risks. Participants - regardless of how reliable and trustworthy they think it currently is, as these views may vary - **unanimously agree that the purpose and function of Beachbuoy is very important.** There are hundreds of people who access water bodies and who actively use Beachbuoy to get informed about outfall releases. Participants mention there are many more people who could benefit from it, but they are not aware that Beachbuoy exists.

As of September 2023, when this review took place, Beachbuoy's graphical interface offers affordances, and its design features and functionality are consistent throughout the different web pages. High quality graphics and appropriate use of satellite imagery are being used to

communicate map background information. All map features stand out from base maps (although on landing page they look cluttered). The structure and organisation of information is successful with meaningful headings and subheadings although a significant amount of additional information needs to be added and therefore a restructuring of the menu is proposed to support users navigate more effectively and directly answer their questions and concerns in the future.

Generally, information is communicated in lay terms on the main Beachbuoy information page, although as more information is added additional examples should be provided together with video tutorials. An important trust cue is the provision of external materials where people can find additional information, through relevant links and documents, which are currently available on the information page. It is not very clear when textual information was last updated and although it seems recent it is recommended to always mention the date of the last update onto relevant web pages. No error messages, broken links or 'not found' pages were detected.

The interface received positive feedback by participants and they do not mention any significant usability barriers. The users who participated in the interviews did not describe any specific difficulties using the interface, although most of them are frequent and advanced users. The only novice user who participated in the interviews was not aware of the pop-up window functionality when clicking on a bathing site and the alerts service. Therefore, the provision of alerts service needs to be better communicated outside the pop-up window, perhaps using a link below the map or on top of the map where 'email notifications' are mentioned. Interviews with a wider population sample of novice users may reveal further limitations.

2.2 Beachbuoy User Experience Issues and Recommendations for Improvement

Findings here are presented in two sections. The first (2.2.1) summarises all the user experience issues that refer to the general interface and the textual information that Beachbuoy provides and the second (2.2.2) summarises all problems found related to Beachbuoy maps.

Identified problems are assigned a 'Low', 'Medium' or 'Critical' rating to emphasise the importance of implementing the relevant re-design recommendations. Ratings are established based on the inspection review findings and also in terms of how many participants during the interviews mention this particular problem.

2.2.1 General Interface Issues

1. Improve Beachbuoy Access (critical): The expert inspection review and interviews found that Beachbuoy is rather difficult to access unless people are aware that it exists and how to find it. Several participants mentioned that there are hundreds of local people who would benefit from Beachbuoy, but who do not know about it. To improve transparency over the service it is recommended that a 'Beachbuoy Map' link appears on the service provider's main home page, ideally listed as one of the company's main services (as shown below).

2. Reorganise and provide additional information (critical): Currently there is a link on top of the map (i.e. 'Beachbuoy information page') which directs the user to a page with relevant textual information. This information targets mainly intermediate users; in other words, it is too basic for advanced users and too little for beginners. A menu should be provided at the top of the Beachbuoy information page to directly take the user to the relevant section they are interested in reading. Usability testing should reveal where to place the menu, and what should be the menu contents for users to easily access the information there are looking for.

This review found that further information should be added with respect to the following:

i. *How to use the Map:* Explain how to use the map, what all symbols mean, how to sign up to receive alerts. Pay particular attention to the white unverified releases symbol and explain why it exists and how it works. Additional interviews would be beneficial to further understand perceptions about the "white" symbol and the information which needs to be provided (see also issue #12).

ii. *Beachbuoy Spatial Data:* Explain all map background data (i.e. bathing sites and outfalls included/non-included on the map); provide information about the spatial accuracy of these features (see also issue #11).

iii. *How Updates work*: How often data are updated on Beachbuoy; the process of automated and manual updates; why and how data are updated on the 'Historical and current releases' Table (here focus on examples where genuine releases change to non-genuine and shorter duration times in the process of manualy updating the data); justify why some longer releases are broken down into multiple releases which are minutes apart.

iv. *Beachbuoy Modelling*: Explain the modelling process to identify impact on bathing sites with examples of how it works for different locations which have different geographic characteristics. Information needs to include more examples in lay terms for people to easily understand technical information.

v. *Background information*: Southern Water provides videos through other pages that Beachbuoy users would find particularly beneficial but which they do not know they exist (e.g. 'The wastewater process'[1]; 'What are storm overflows?'[2]). These should be also provided and be more visible through Beachbuoy. Also, provide information about: what affects water quality; concentration rates of releases; what are genuine and non-genuine releases; an explanation of impact severity for bathing sites.

vi. *Provision of a Frequently Asked Questions section*: see Issue #4 below.

3. Provide videos and appropriate visualisations for users with different competency levels (critical): This review found that users have different perceptions about how Beachbuoy works. Although this is not uncommon, to a certain degree it is the result of the very limited information provided, which does not meet the needs of neither beginners nor advanced users. Following the recommendations above for the provision of additional information it is important to utilise different audio-visuals (videos, graphs, text, pictures etc) and explain information in lay terms for people to build a common understanding of the system characteristics. Information should be evaluated (in usability testing ideally with eye-tracking equipment) to ensure people can easily access it, understand it, and that they are in a position to build rational trust perceptions.

4. Provide a Frequently Asked Questions section to answer user queries (critical): This review found that users contact the service provider with questions about Beachbuoy; e.g., how the system works, especially with respect to updates. These questions should be all collected with relevant responses and shared with end users via a Frequently Asked Questions section.

5. Provide tailored email notifications with sufficient content (critical): This review found that most users sign up for the alerts service. Participants think the service is useful, but not in terms of how it is currently provided. Email notifications need to provide some content to the notification without the expectation that users will manually check Beachbuoy to access this information. For further information see Expert Review *Question #1*.

***6. Provision of brief explanation of manual data updates in 'Historical and current releases' Table (critical)*:** This review found that one of the most controversial features on Beachbuoy is the limited information to justify and explain manual data updates in the 'Historical and current releases' Table. A column should be added to the table to provide end users with a short explanation of relevant manual data updates which result in Beachbuoy data

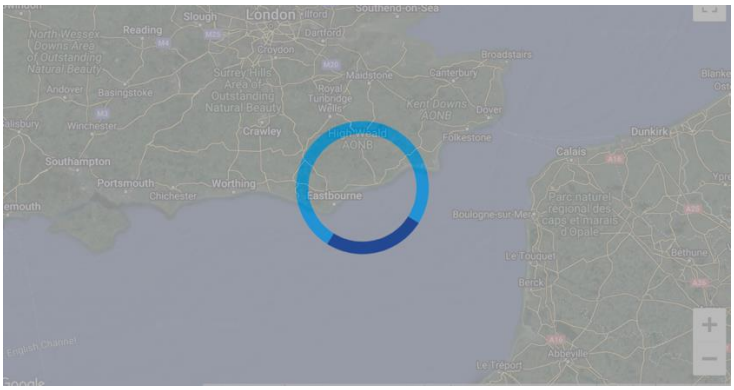
[1] https://www.southernwater.co.uk/help-advice/sewers-and-drains/wastewater-process
[2] https://www.southernwater.co.uk/our-performance/storm-overflows/what-are-storm-overflows

modifications. This needs to focus on the nature of the change (e.g. “Outfall Release duration reduced from 10 to 7 hours for reason ‘X’”) to improve user confidence in the process and in data reliability, rather than providing some abstract justification which will further increase suspicion. For further information see also Expert Review *Question #3*.

7. Provide a Forum for two-way communication with end users to promote transparency and trust (low): This review found that there are many people who are interested in and use regularly Beachbuoy with different competency levels. A forum, provides an online space for people to ask questions, share their experiences, better connect with Southern Water in terms of two-way information communication flows and create a sense of community. Some people have also expressed an interest in participating in specific forum threads which will aim to improve the design and further development of Beachbuoy in an agile way. A forum usually requires moderation and being responsive to people’s queries, so a decision to implement this design feature needs to be considered carefully to ensure that end user expectations are subsequently met.

2.2.2 Mapping Interface

8. Optimise Beachbuoy Map Loading Speeds (critical): The expert inspection review and interviews found that Beachbuoy is slow when users open the web mapping page for the first time. As a general usability principle, the interface should load **in less than 1-2** seconds and that the loading times should equate to the perceived value of the task at hand (Vassilatos and Crawshaw, 2022). If, for example, the task at hand is to quickly view the map to see if there are any recent releases and their impacts to specific bathing sites, which equates to less than one second, loading speed needs to be improve considerably.



9. Reduce the size of the pop-up window (critical): This review found that the size of the pop-up window is very large and that it contains unnecessary white space. Many users complained that they cannot view the data when zooming in as the pop-up window covers significant space on the mapping interface. It is therefore recommended that the size of the pop-up window is reduced considerably.

10. Add all relevant map data or explain why specific background data are not provided to improve transparency and trust (critical): Several participants in this study commented that there are additional bathing sites, which have recently received water designation, but which do not appear on Beachbuoy. Most participants also mention that many outfalls, which they know they exist in their local areas, are not shown on the map or that the outfall names are not representative of their actual location (see issue #11). Background map data (such bathing sites and location of outfalls) is currently missing, and this information can be better communicated with end users to address these concerns.

11. Provide information about spatial data accuracy below the map (critical): Further to issue #10 above, no information is provided about the spatial accuracy of the data. For example, this review found that many users think that the outfalls’ spatial location shown on the map is random and that many outfalls are not shown on the map. (e.g. “*People don’t know*

where outfalls are"; "I can see an outfall a mile out in the sea. No one really knows if this is the true location"; "I know at least of another two CSOs in the area which are not shown on the map"; "Most people would like to know and recognise outfalls by name, but the names are not quite representative of the outfalls exact location" – interview comments). This data according to issue #10 recommendation above, needs to be added and an explanation of the spatial data accuracy should be further provided.

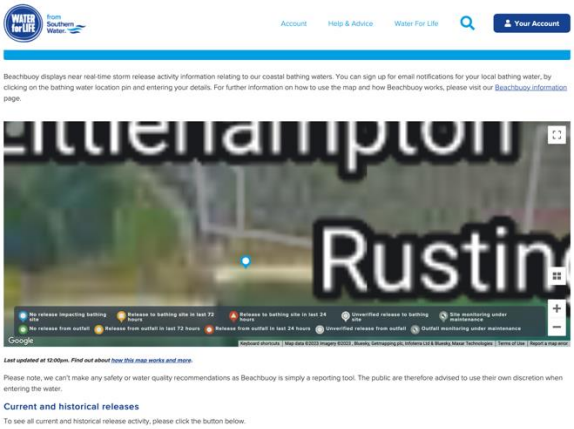
12. Reconsider the use of the white "unverified release" symbol (no recommendations/further testing is required): This review found that many participants do not like and do not trust the white unverified release symbol. Many users treat this feature as a red alert when it is shown on the map until it is fully verified. This process, participants mention, may take several hours or even days which is particularly problematic. For further information see Expert Review *Questions #3 #8 and #9.* Additional interviews and usability user testing would provide further insight into this feature to make specific recommendations.

13. Specify time zones for reporting outfall release duration (critical): Several participants report that they suspect that the start and end times shown on Beachbuoy are in GMT, not BST. Details about the time zone used to communicate this information needs to be clearly visible.

14. Enable viewing impact of releases on bathing sites and releases from outfalls as two separate layers (critical): If we pay closer attention to the map legend, it is easy to recognise that it actually shows two layers of information (i.e., impact from releases on bathing sites at the top and outfall releases at the bottom), whereas the map shows only impacts (top layer). While most users who participated in this study are familiar with Beachbuoy functionality and the fact that a specific bathing site needs to be selected in order to view releases from outfalls in this area (i.e., second layer of information), beginners are not aware of this feature. It is recommended that from the landing page the users are given the option to select which layer they would like to view (i.e., 'outfall releases' only; 'impact on bathing sites' only; or both as in what it is currently provided).

15. Provision of a search bar for a more tailored map navigation based on user's preferences (medium): This review found that users would like to use a search bar to search for a specific location or incorporating a location sharing option so that the map automatically zooms into the area end users are located. A search bar is currently provided by Thames Water EDM Map[3].

16. Improve font size design to match different scales (medium): The API provides a range of different scales, but design aspects such as the font size, are not always appropriate to different zoom in levels (e.g. see screenshot below). This can be easily fixed to improve the usability and aesthetics of Beachbuoy.



17. Improve visibility of selected objects/points on the map (medium): The map contains many overlapping markers showing bathing sites. When a bathing site is selected a pop-up

[3] https://www.thameswater.co.uk/edm-map

window appears. As points are cluttered, users will not be able to confidently know the point to which the pop-up window corresponds, unless they zoom in significantly. Adding a border to the selected object can improve the usability of this feature.

18. Improve interaction with 'Historical and current releases' Table (low): This review found that there are two ways to access the 'Historical and current releases' Table; i.e. either through the pop-up window from a specific bathing site, or through the table below the mapping interface. Most users prefer the first option as they are mainly interested in a specific bathing site which they select immediately after they visit the website. The table contains raw data which users find very useful, nevertheless interaction could be significantly improved through a more intuitive design, such as displaying duration and volumetric data visually on the map for the selected area and relevant outfalls.

19. Comment on Map Colours (no recommendations/further testing required): This review found that users like the blue/amber/red/green colour scheme and they find it easy to use. The number of people involved in the interviews is quite small and might have missed in the sample people with colour blindness as this was not a criterion for participation. With one in 12 men having some form of colour blindness it is recommended that the choice of colours is further evaluated using colorbrewer2.org and usability testing.

2.2.3 Other recommendations

20. Perform a User Experience Evaluation on the mobile version of Beachbuoy (critical): Most participants mention that they prefer to access Beachbuoy through their mobile devices. This means that user and engagement analysis should further take place to capture user experience elements and users' perceptions with respect to the mobile interface and maps.

21. Perform Stakeholder Mapping and engage with a wider user audience to build trust (critical): see *Expert Review Question #10*.

22. Extend Interviews and perform Usability User Testing for different types of users with various competencies (critical): Interviews were extremely beneficial in this review in terms of capturing users' concerns and requirements. It is believed that if the interviews are extended to capture the perceptions of a wider – yet more targeted in terms of competency levels - population sample of end users, will provide the service provider with a much better understanding of specific usability issues which need to be addressed as well as, people's trust concerns and requirements to inform the re-design of subsequent Beachbuoy versions.

2. Expert Review Questions

This section answers the Expert Review Questions and provides further recommendations to address the issues identified during the interviews.

#Q1. Is it a problem for BB users not receiving RED warnings when they should be (false negative)?

From a User & Engagement point of view *Expert Review Questions #1 and #2* were discussed with respect to Beachbuoy data and the alerts that users sign up to receive for specific geographic areas of interest[4]. All, but one, participants have signed up for this service and they are particularly interested in continuing to receive accurate and meaningful information when it is relevant to them. The only participant who has not signed up, ***was not aware of the***

[4] None of the participants mentioned - with respect to *Expert Review Questions #1 and #2* - getting additional alerts derived from other water quality monitoring sources, which show some impact to bathing sites. This at the moment is beyond the scope of Beachbuoy functionality. If additional water quality monitoring data are matched up against Beachbuoy data this may improve transparency and trust, however this feature needs further investigation to understand functional and non-functional requirements (see *Expert Review Question #6*).

service as they are not a regular user and never uses the pop-up window, as they access 'Historical and current releases data' through the table below the map.

The main reason end users sign up for these alerts is ***to get informed quickly and accurately*** about any recent releases that may affect water quality of their local bathing sites. Some may decide to not to get into the sea. Most participants agree that it is ***very problematic*** not to receive a RED warning when they should as this exposes them to health risks. Although not equally ideal, yet they prefer to receive a RED warning, when there is no real threat (*Expert Review Question #2*) rather than not receiving one when there is real threat (*Expert Review Question #1)*.

The first scenario (*Expert Review Question #1)* they describe it as *"dangerous*", *"worrying"* and *"trust-breaking"* (e.g., *"That's very worrying. I lose all faith on Beachbuoy. Why have a system if it doesn't give me correct information? You better off without a system"; "When this happens we are not happy with Southern Water"* (interview comments), while the second scenario (*Expert review Question #2*) as *"annoying" (e.g., "I may have wished to go swimming and didn't go. Not life threatening but it is annoying"* (interview comment).

Participants further expressed their concerns about the usability and design of these alerts. Notifications report a system status change for the geographic area of their interest, but they provide no content about the characteristics of this change (e.g., *"They are useless because I get an email that something changes and then I have to go to Beachbuoy to figure out what's going on. These emails should actually say what changes in my area"* – interview comment). Users, once they receive a notification, they must check Beachbuoy for relevant data, which might not always be possible due to lack of appropriate equipment, Internet access and so on. When this happens users will not be able to see a RED warning and therefore still be affected.

Recommendations

- ✔ Inform users about all (actual or potential) RED warnings (critical).
- ✔ Provide content so that email notifications become more meaningful (critical).

#Q2. Is it a problem for BB users incorrectly receiving RED warnings whilst there is no real threat (false positive)?

As discussed in the *Expert review Question #1* above, this question also refers to current Beachbuoy data and the alerts that users sign up to receive for specific geographic areas of interest. Users find it much more problematic not receiving a RED warning when there is a real threat (8/9 interviewees) rather than receiving a RED warning whilst there is no real threat. As discussed above they simply describe this scenario as *"annoying" (e.g., "I may have wished to go swimming and didn't go. Not life threatening but it is annoying"; "If they send me an alert at 10:03 and was about to go swimming and 11:03 I get a cancellation I'll still be able to go for a swim. It's not a big deal. If I didn't get though a genuine alert when there should be one that could make me ill which is much more bothersome"* – interview comments), but they do not find it *"dangerous"* or suspicious for the data provider to significantly impact their trust into the system (7/9 interviewees). For other stakeholders (2/9 interviewees) though (e.g., local authorities) this scenario *"puts them in an awkward position"* (interview comment), yet those affected are more likely to agree with participants' comments above.

Recommendations

See *Expert Review Question #1* above.

#Q3. Propose how BB can be more open and transparent with regards to data being routinely and in some cases being extensively manipulated, deleted, and dismissed as false alarms in the release history. How does such misleading information affect BB users?

Outfall releases detected by sensors are automatically reported on Beachbuoy. A verification process through manual updates then takes place to identify and correct false triggers/positives and Beachbuoy data are updated accordingly.

Several participants in this study report how data are manipulated to provide different duration times, hours or - in some cases even - days after the actual release, explaining that *"these times always go down, never up"* (interview comment); *"It comes out as Southern Water pays no attention to Beachbuoy updates. There are so many inconsistencies in the data"* (interview comment). Participants also describe how information about genuine releases turn into non-genuine and vice versa. This process has caused a lot of attention, i.e., three interviewees started collecting screenshots of the 'Historical and current releases' Table to capture these changes.

Interviews reveal that this feature ***has a significant negative impact on users' trust perceptions into the system and the perceived usefulness of Beachbuoy***. Although the table feature exists to improve transparency, in fact it has the opposite effect on users' trust perceptions, mainly – as users report - ***due to the lack of a clear explanation of why Beachbuoy data are manipulated during the process of manual updates.*** An important reason for this is that not everyone understands how the automated and manual updates work (e.g., with respect to manual updates participants mention: *"This is not true. I don't think SW goes around every single pump and check it"*; *"I don't think they know that I don't know how this process works"* – interview comments). To address this, ***a clear explanation of how the system works, especially with respect to updates, in lay terms should be provided on the information page***.

One participant explained that they contacted Southern Water and *"they've never been able to tell me the reasons of these changes"* (interview comment). When discussed what information is essential to the users to have at hand to confidently decide whether they trust data updates most participants explain that ***short textual explanations should be added to the table to explain and justify manual data changes when these occur.***

Participants further ***heavily criticise the use of the white 'unverified release' symbol***, explaining that once this is shown on the map ***they treat it as a red alert as they are not willing to undertake any risk and get into the water*** (*"Surfers Against Sewage uses the same data but seems these are not being manipulated in the same way. The white icon of Beachbuoy would be red on Surfers Against Sewage and that works better for me"*- interview comment). All participants explain that the perceived purpose of Beachbuoy is to provide them with accurate and timely information to inform their decisions of accessing the water and that data manipulations as well as releases which are reported as 'unverified' *"defy this purpose"* (interview comment).

Recommendations

✓ Add brief explanation to justify data updates during the manual updates process. This should appear next to the relevant change on the 'Historical and current releases' Table (medium).

✓ Explain in lay terms how Beachbuoy updates work (both automated and manual) (critical).

✓ Explain in lay terms the specifics of the 'unverified overflow release' feature and the reason it exists in the first place (critical).

#Q4. Would both volumetric and duration data be more helpful to BB users?

All participants unanimously agree that it is extremely important to continue having access to duration data, ***and further be informed about the volume of outfall releases***, which is currently not provided.

Participants expressed their concerns about the lack of transparency with respect to: a. the diameter of the pipes and b. details of not only *'how much'* and *'how long'* but also *'what' is* being released (e.g., *"Volumetric data would be only useful if I know the concentration rate"* – interview comment). Provision of such information might be essential to further improve transparency and trust in the data provided. Some participants suggested that volume should be provided in lay terms, for example, using the dimensions of a standard swimming pool as a unit size, for communication purposes.

Recommendations

✓ Add volumetric data (critical).

✓ Improve transparency about concentration rates through Beachbuoy information page (critical).

✓ Ensure there is an explanation of what volumetric data means provided in lay terms (medium).

#Q5. Are there any missing BB features from the reviewer's perspective.

This review apart from usability issues of existing features, also identified missing features that could be provided to address specific user concerns and improve overall interaction. These are discussed in Section 2.2. A summary of key missing features is further provided below:

i. A clear link to access Beachbuoy from the home page of the service provider.
ii. Missing information with respect to the following: How to use the Map; Description of Beachbuoy Spatial Data; How Updates Work; Beachbuoy Modelling; Background and water quality information (see issue #2 in Section 2.2.1).
iii. A Frequently Asked Questions page (see issue #4 in Section 2.2.1)
iv. A Forum to enable two-way communication, promote transparency and trust (see issue 5 in Section 2.2.1).
v. Relevant content to make email notifications more useful (see issue #6 in Section 2.2.1).
vi. Explanation of the nature of each manual update to improve transparency (see issue #7 in Section 2.2.1).
vii. Missing information about map data and spatial accuracy (see issues #10 and #11 in Section 2.2.2).
viii. Specifying time zones for duration times (see issue 13 in Section 2.2.2).
ix. Adding a search bar to navigate the map more easily (see issue #15 in Section 2.2.2).
x. A detailed stakeholder analysis and plan to engage with a broad spectrum of Beachbuoy users with different characteristics to capture and subsequently integrate needs and requirements into the design of future versions (see recommendation #21 and #22 in Section 2.2.3)

#Q6. How do the developers know what users want/need. Would independent elicitation of system requirements be helpful over what developers think we need?

Requirements engineering plays a very important role in the product development lifecycle; it supports not only understanding – and subsequently managing - users' (i.e. a broad range of different types of stakeholders who utilise the system) expectations with respect to how the system should or should not be performing (i.e., what tasks it should or it should not support) and what kind of user experiences it should generate (e.g., be enjoyable to use; informative in terms of educating users about what they want to know; and other hedonic values). This process of consulting the users further helps build a relationship with them, which is particularly important in low trust contexts.

Different methods can be used to help developers identify user needs, functional and non-functional requirements; these mainly include ***"focus groups, use cases, prototyping, observations, interviews, workshops and role-playing"*** (Karshiladze and Luo, 2015). Some of these methods are more effective than others depending on the stage of the product's lifecycle development; e.g., whether existing features are being evaluated, or the system is being redesigned to incorporate new features to address additional user needs. Also, some of these methods are more appropriate than others in terms of understanding users' emotions and feelings evoked by interaction, especially with respect to non-functional requirements (e.g., reliability, trustworthiness, how perceived risk is managed through different features, etc). This is extremely significant for systems like Beachbuoy where trust plays a significant role not only in terms of how people manage risk based on the information provided, but also in terms of their overall trust perceptions towards the service provider.

This review found that although stakeholder involvement informs Beachbuoy development, ***this is limited to key stakeholders*** (see *Expert Review Question #10*) rather than a much broader spectrum of different types of end users who could equally contribute by getting more actively engaged in this process. Participants, members of the stakeholder meeting group that's been formed for this reason, comment ***that product development could benefit from a wider selection and engagement of local users.*** This can be decided following a stakeholder analysis as further discussed in *Expert Review Question #10*.

Although not mentioned in the literature as the most suitable method to support user requirements' elicitation, surveys have been also employed by the service provider to get user feedback and further identify needs and expectations. A major interface design change which was applied in September 2022 - to show on the landing page the impact on bathing sites instead of releases was based on the results of a feedback survey which took place in 2021. Based on this independent expert review's findings, ***several users are not satisfied with this change and they still want to see all releases regardless of how much they impact or not relevant bathing sites.***

Surveys, can be effective as a requirement elicitation technique, but there are several limitations especially when it is the only method used for this purpose when they are used to draw conclusions on low response rates (as it was the case in this example, with a response rate of 10%); and when the results are not based on a well-balanced and targeted participation sample which captures requirements of users with different experience and competency levels (e.g., beginners, intermediate and advanced users). Also, surveys are asking for feedback outside the context of using the application, which may result in various types of bias; they do not necessarily help the service provider build a connection with end users; empathise with them by better understanding their concerns and emotions and; ensure they are being heard building in that way customer rapport and an ethic of care.

For these reasons, this review recommends ***the use of appropriate Human-Computer Interaction methods*** for the elicitation of user requirements, with an emphasis on both functional and non-functional requirements. This review found for example, that Beachbuoy is currently lacking the provision of appropriate information to help users understand how the system works and build rational trust perceptions and such elements can only be explored with appropriate emphasis on non-functional requirements. ***Interviews, usability testing and focus groups*** can support the aims described earlier in this section. Once user requirements are identified within specific contexts-of-use, they can be further evaluated with a wider population sample using surveys, social media or even a forum. These should be applied in the context of both Beachbuoy desktop and mobile interfaces.

Note: Human-Computer Interaction methods may require the use of strict methodological protocols to ensure that these are correctly applied and minimise bias. Human-Computer Interaction experts should check the validity of methodological protocols before such methods are being employed.

Recommendations

✓ Perform additional interviews and usability user testing (observation) to capture functional and non-functional requirements for both desktop and mobile interfaces (critical).

✓ To implement Human-Computer Interaction methods follow appropriate methodological protocols (critical).

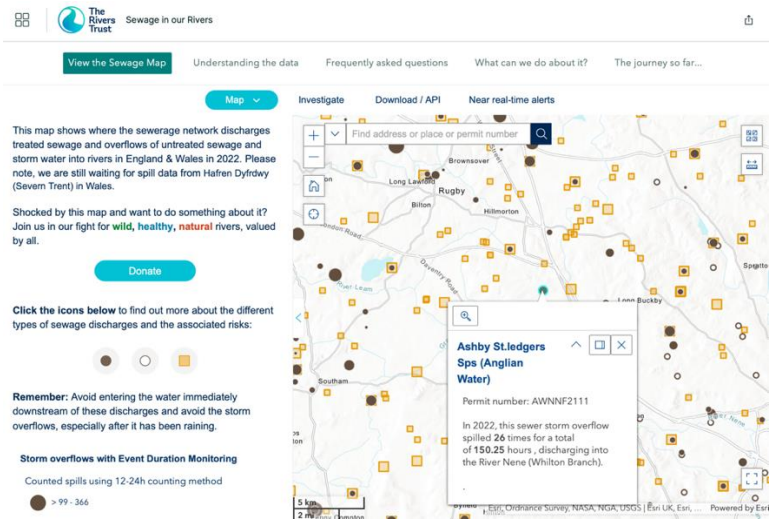
✓ Interviews and usability testing should be used to engage end users (outside the existing stakeholder group) with different competency levels and categorise needs and requirements accordingly (critical).

✓ 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.

#Q7. Surfers Against Sewage safer seas app is a well trusted app used for many years. It uses just two colours RED and GREEN (Bad/Good) would it be reasonable/helpful for BB to adopt a simpler approach or whether the current approach is appropriate and there is sufficient confidence in the precision of the data.

The web mapping interface of the Surfers Against Sewage shows bathing sites across the coast, with one the following symbols on top: a green tick (for no pollution alert), a red exclamation mark (for pollution risk forecast or incident alert), a red ‘x’ symbol (for sewage pollution alert). Some further data provided for poor annual classification (x red symbol), out of season sites (snowflake symbol), maintenance alert (spanner tool). The icons are explained at the bottom of a map rather than using a map legend. Users can interact with each map point by clicking on it and read relevant information on a pop-up window. The pop-up windows are rather heavy in text, which might result in usability barriers. There is no information about the data sources or how forecasts are generated neither below the map nor in the FAQ section on the web-based version (this is a feature that generally violates trust heuristics). The mobile ‘Safer Seas and Rivers Service’ app provides information about data sources, and users can register to receive updates and report sewage pollution and upload relevant pictures. This service and the two-way information flows that enables is believed to be critical in terms of transparency and trust.

A similar colour scheme and symbol choice is also used by the Thames Water sewage release map[5] although, similarly to Surfers Against Sewage, it doesn't show the impact of the releases to water quality. A similar approach – i.e., Red/Green colour scheme with relevant symbols on top - might be beneficial for simplicity purposes especially if the map is used to show both releases and impact to bathing sites at once as separate layers (as described in Section 2.2.2 issue #14) . If a significant number of Beachbuoy users have previously interacted with similar applications, the provision of a similar visualisation, offers a great opportunity to minimise any complexity in the learning curve, which is particularly important for novice users. An alternative way to visualise sewage is used by the Rivers Trust and Unearthed Greenpeace sewage map[6] (different size points to show number and duration of spills as shown on the screenshot below).



This study found that participants prefer Beachbuoy's interface, choice of colours and visualisation with the exception of the white 'unverified release' symbol. Nevertheless, and due to the small number of participants, it is recommended that additional usability user testing experiments or interviews are used to evaluate different visualisation approaches to identify and subsequently implement the most preferred by end users.

This review also found that beginners who interact with both Surfers Against Sewage and Beachbuoy believe that the two maps show the same data. It was clear in the interviews that participants ***do not understand that Surfers Against Sewage shows releases and Beachbuoy the impact of releases on bathing sites on the landing page.*** It is believed that, provision of two layers of information (i.e. view impact, view releases) (as recommended for issue #14 in Section 2.2.2) will solve this problem and address users' concerns of not being able to view all releases instantly.

[5] https://www.thameswater.co.uk/edm-map
[6] https://theriverstrust.org/sewage-map

With respect to trust, this review found that the users who tend to trust Surfers Against Sewage more is either because they are not aware that it uses Beachbuoy data, or they are aware, but they prefer that the map shows outfall releases instead of impact to bathing sites.

Recommendations

✓ 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) (low).

#8. Is BB reliable? Does it update metronomically every hour? Is this a problem from a user health perspective?

It is clearly indicated from the textual information that Beachbuoy data are updated in "near real-time". Below the map it is further shown that automated updates happen every hour. There is no explanation about the manual and automated update processes that it is easy to access, and which improves awareness of this feature.

When frequency of updates was discussed with interview participants, most of them felt confused. This is: i. due to discrepancies in the update timings across automated and manual updates; ii. the fact that manual updates vary in times, i.e. on several occasions, according to participants' feedback, updates timings vary significantly from hours to even days.

As discussed in *Expert Review Question #3* Beachbuoy updates have attracted a lot of attention and negatively impact users' trust perceptions into the system as well as perceived usefulness of Beachbuoy. This is directly relevant to its main purpose of informing people about when it is safe to enter the water, as interviewees identify and describe the purpose of the service. As a result, the reliability of updates is a significant problem from a user's health perspective (e.g., "*It used to be every eight hours, then two and now I think it is one hour. But it is not always working and therefore it is not trustworthy to make decisions about my health and safety"*; *"That's very worrying. I lose all faith on BB. Why have a system if it doesn't give me correct information. You better off without a system"*; *"The problem is that the manual review process will not happen until most likely the discharge is over. By that time the discharge will be yellow or even green. How is this helpful?"* – interview comments).

There is an urgent need to inform Beachbuoy users about updates and most importantly to be consistent with how long manual updates take to appear into the system. The roadmap set internally for manual updates needs to be simplified with the main aim to provide accurate information ***as quickly as possible***. For this reason, a threshold needs to be set for manual updates, to set users' expectations towards the right direction in terms of how long they should wait for manual updates to appear to make an informed decision about accessing the water or not.

Recommendations

✓ Provide clear explanations of how updates work (critical).

✓ Provide clear explanation of Beachbuoy update times (i.e. both manual and automated) (critical).

✓ Set threshold for manual updates (e.g., no less than two hours) to improve reliability and help users efficiently manage health risks (critical).

#Q9. Is BB reliable? Are the software updates seamless, well tested and problem free should users expect properly tested software updates to keep them safe and well informed?

In addition to what already discussed in *Expert Review Questions #3 and #8* above, Beachbuoy data reliability is influenced significant by the following:

i. Unverified releases communicated through the white symbol are also relevant in terms of influencing the system's reliability and having an impact into users' decisions to access the water or not. As explained in *Expert Review Question* #Q3 these are treated by most users as actual releases, in terms of taking relevant action. The way unverified releases are manually checked and the way relevant data are updated are of significant user concern. A decision therefore needs to be made about how unverified releases are communicated in the future and the significance of setting a threshold value for a manual check to confirm the situation, in as close to "near real-time" as possible.
ii. The time zones for the start and end timings in the 'Historical and current releases' Table are not specified. Several users report that most likely these are in GMT, which means that timings are off during summer months, which several users may not realise.
iii. Confusion with respect to the duration of some releases. For example, participants mention that frequently a longer release is broken down into multiple releases: *"Another weird thing that I noticed is that lots of multiple releases may happen almost back to back. A 20 hours release may consist of three releases which actually happen only one or two minutes apart. Why are they presenting data like that?"* (Interview comment).

As further outlined in *Expert Review Questions #6 and #10* this review found that Beachbuoy in its current form it is neither perceived as reliable nor it fully meets the needs and expectations of users with different experience and competency levels. Stakeholder mapping and an approach which enables the engagement of a much broader yet targeted (for end users characteristics) spectrum of stakeholders, with an emphasis on local users, and further analysis to collect user functional/non-functional requirements will potentially improve the service and how people interact with it.

Recommendations

✓ Explain why some longer releases are described as multiple smaller releases even when these are just a few minutes apart (critical).

✓ Specify time zones for start and end release times (critical).

✓ Explain in lay terms on Beachbuoy information page the 'unverified overflow release' feature and the reason it exists in the first place (critical).

✓ Set threshold for manual updates that verify a release (critical).

#Q10. Has BB Stakeholder involvement been effective. Historically this has been dysfunctional; there is very little representation from actual users, and these are often side-lined. How can stakeholder involvement be improved so that user requirements for improvements and enhancements should be openly debated and prioritised in a Beachbuoy Stakeholder user forum to ensure that both functional and non-functional requirements are addressed to optimise benefit for both Southern Water and the user community.

Water companies across the country provide relevant information to report on environmental performance, which includes information about releases. Southern Water's Beachbuoy service launched in 2018 to communicate openly outfall releases and their impacts to bathing sites across the South-East coast. Since then Beachbuoy was updated in May 2021 to cover *"all 83 of our region's designated bathing waters and two non-designated recreation harbours, along with more details about each release"* (Southern Water, 2021). The innovativeness of this service is on the fact that Beachbuoy data are linked to Aspire (i.e. Southern Water's spill reporting system) so data are updated on the map in near real-time. The Beachbuoy stakeholder working group was formed in October 2020, which included stakeholders from different organisations as well as local people from the entire region, who met regularly to provide input which informs the development of Beachbuoy services and visualisation.

Between November 2021 and January 2022, the Customer Insight Team launched the Beachbuoy feedback survey to get further insight into how users use the service, the interface design and other features they like and dislike and their recommendations as for how the service could be improved. Subsequently the website was updated in September 2022; the main change at this stage involved showing on the map an assumed impact of releases on bathing waters, instead of simply showing the location of all releases. Since September 2022 the website is updated on an hourly basis, as opposed to two-hours, before. The collection of user feedback to further improve the service and tailor it more to the user needs is an ongoing effort, which will subsequently inform the launch of a more sophisticated version to accommodate a wider range of user needs and improve user interaction.

This expert review found that the changes that were made in September 2022 generated public suspicion and reduced people's trust in the data provided. Some participants expressed a view that *"Beachbuoy was great before the changes in September 2022…now it shows less releases, which doesn't make sense…we don't know much about the impact models and we don't necessarily trust them"* (interview comment). Videos and textual information to explain how Beachbuoy impact models work in lay terms are essential and should have accompanied the changes which took place in September 2022. Such information needs to be transparent and relevant functionality should provide people with an option to ask questions and get further support when they require it. A forum has been further suggested by several participants for two-way communication; e.g., people can use it to raise an issue or ask a question and get a response, give feedback and so on.

Despite the ongoing efforts of the service provider to engage with a wide range of stakeholders there are still significant gaps especially in terms of reaching out to members of the public and specific groups which use Beachbuoy on a regular or occasional basis. One participant mentioned, "*we know that sewage and storm overflows is the biggest issue for*

local residents" and most people agreed that there is great potential for local people to be involved in this process as *"there are so many who could benefit from Beachbuoy but they are not aware of its existence"* (interview comment). Participants, referred to various swimmers' groups, surfer and sailing clubs, fishing groups, farmers, local business as well as various individuals who access the sea across the South-East coast and who would benefit from being more involved in this process.

Stakeholder engagement, including the involvement of local people, should be ideally supported through different mechanisms for synchronous and asynchronous communication channels, face-to-face but also online methods which support two-way information communication flows. This is to accommodate people's needs more effectively (e.g., time, availability) and be inclusive towards a more diverse population group. Traditional engagement approaches have been criticised for introducing new forms of participation barriers and exclusion, and for not considering people's views and opinions into decision-making processes. For this reason, methods such as surveys, stakeholder roundtables, focus groups and discussion panels should be further combined with other activities such an online forum where people can discuss issues and provide feedback asynchronously.

Although engagement approaches so far have been targeting a diverse range of stakeholders, the stakeholder working group mainly consists of local authorities' representatives, politicians, and environmental organisations and groups (e.g., Environment Agency and Surfers against Sewage). Some local people have been also participating but in very limited numbers. To make stakeholder engagement more efficient a stakeholder analysis and mapping (e.g. see Skarlatidou et al., 2019) should be carried out by the service provider as an instrumental tool to guide decision-making and inform organisational practices with respect to stakeholder and public engagement when it comes to Beachbuoy. This will help raise awareness of Beachbuoy services, get more diverse user feedback and opinions for improving it, identify appropriate communication mechanisms to support and sustain engagement and subsequently maximise Beachbuoy impact so that local communities can fully benefit from it. In this context campaigns to attract a wider audience can be helpful as well as the provision of incentives to compensate people for their time and input in engagement and consultation processes.

Recommendations

✔ Perform stakeholder analysis to map all relevant stakeholder groups across the South-East coast (critical).

✔ Emphasis should be paid on improving awareness about Beachbuoy and engage more actively with members of the public who might benefit from it (medium).

✔ Provide incentives or other mechanisms to encourage participation (medium).

References

- Nielsen, J. (n.d.) How to conduct a Heuristic Evaluation (Online Source: https://www.ingenieriasimple.com/usabilidad/HeuristicEvaluation.pdf)
- Skarlatidou, A., Cheng, T. and Haklay, M. (2013) Guidelines for trust interface design for public engagement Web GIS, International Journal of Geographical Information Science, 27:8, 1668-1687, DOI: 10.1080/13658816.2013.766336
- Ofwat (2023). Trust in Water. Online: https://www.ofwat.gov.uk/trust-in-water/)
- Hayter, L. (2023) Staying afloat: public trust in water providers declines over 2022. Online: https://savanta.com/knowledge-centre/view/staying-afloat-public-trust-in-water-providers-declines-over-2022/
- Vassilatos, F. and Crawshaw, C. (2022) Loading Feadback. Online: https://pencilandpaper.io/articles/ux-pattern-analysis-loading-feedback/
- Karshiladze, I. and Qingju, L. (2015) How Requirements Elicitaion Process Takes User Experience(UX) Into Account. Dissertation Thesis: University of Gothenburg.
Skarlatidou, A, et al. (2019) The Value of Stakeholder Mapping to Enhance Co-Creation in Citizen Science Initiatives. Citizen Science: Theory and Practice, 4(1): 24, pp. 1–10. DOI: https://doi.org/10.5334/cstp.226
- Niels De Hoog (2023) 'Unacceptable': how raw sewage has affected rivers in England and Wales – in maps. Online. https://www.theguardian.com/environment/ng-interactive/2023/sep/12/unacceptable-how-raw-sewage-has-affected-rivers-in-england-and-wales-in-maps

Dr Artemis Skarlatidou

London

8 September 2023