# Locative Audio for Educational and Inclusive Cartography: A Case Study in Green Stormwater Infrastructure

Nuzhat T. Nawshin [a,*], Robert E. Roth [a], Annika Anderson [a], Gareth Baldrica-Franklin [a], R. Justin Hougham [c], David A. Hart [b]

[a] Cartography Laboratory, Department of Geography, University of Wisconsin−Madison, nawshin@wisc.edu, reroth@wisc.edu, ajanderson26@wisc.edu, baldricafran@wisc.edu
[b] University of Wisconsin Sea Grant Institute, dhart@aqua.wisc.edu
[c] Division of Extension, University of Wisconsin-Madison, justin.hougham@wisc.edu

* Corresponding author

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**Abstract:**

*Locative audio*, or the strategic placement of sound within the landscape (Behrendt 2015), presents a transformative opportunity in mobile cartography, blending immersive auditory storytelling with geospatial technology to foster engagement and accessibility. Research on locative audio is particularly crucial for inclusive design since audio and multimodal interaction can enhance safety by reducing visual overload and promote accessibility for non-sighted users (Shum et al. 2016; D'Ignazio and Klein 2016). This work-in-progress focuses on evaluating a locative audio mobile application developed to guide users through green stormwater infrastructure practices in Shorewood, Wisconsin. Building on a prior comparative analysis and an iterative design process, this study advances the discourse on locative audio's potential to support geospatial education and inclusive user experiences.

Our previous research involved two significant phases: comparative analysis and expert evaluations. The comparative analysis examined 38 locative audio applications, assessing them for five code categories: app technologies, tour characteristics, visual representations, sonic representations, and interactions (see Roth et al. 2023). This analysis provided a comprehensive understanding of the state-of-the-art in locative audio platforms, highlighting their strengths, weaknesses, and unique features. Through this process, we sought to identify what made these platforms effective, engaging, or challenging, and ultimately to determine the most suitable platforms for developing our tour.

From this analysis, we identified VoiceMap (https://voicemap.me/) and Echoes (https://echoes.xyz/) as the most suitable platforms from the sample as they provided robust functionalities and intuitive user experiences. These apps demonstrated strengths in usability, geofencing functionality, and integration of narrative storytelling. However, to fully meet the specific requirements of our case study, we developed a third custom prototype using Leaflet.js, an open-source JavaScript library.

Building on the insights from the comparative analysis, we proceeded to an expert evaluation phase where seven professionals tested all three prototypes during a case study walking tour of Green Stormwater Infrastructure in Shorewood, Wisconsin. Feedback was collected on the five aforementioned code categories through surveys and focus group discussions. Participants noted several critical incidents (see Figure 1.) including route confusion, unsafe street crossings, and audio playback discrepancies, as well as a need for more engaging and structured storytelling content.

Based on this feedback, we selected Leaflet.js, as it allowed for greater customizability, and implemented a looping route design, structured educational narratives, geofenced audio cues, and user interface refinements, including accessible and responsive design. The app also incorporates visual aids such as images, customized maps and diagrams, and interactive prompts to educate users about the environmental and social impacts of Green Stormwater Infrastructure while promoting accessibility and engagement. The current prototype is available at: *https://ntnawshin.github.io/Shorewood-Walking-Tour/*.

We currently are designing a comprehensive user evaluation to be conducted in the Spring of 2025. The evaluation will follow a user-centered design approach, recruiting 20 participants across diverse demographics to assess the app's usability, educational effectiveness, and engagement.
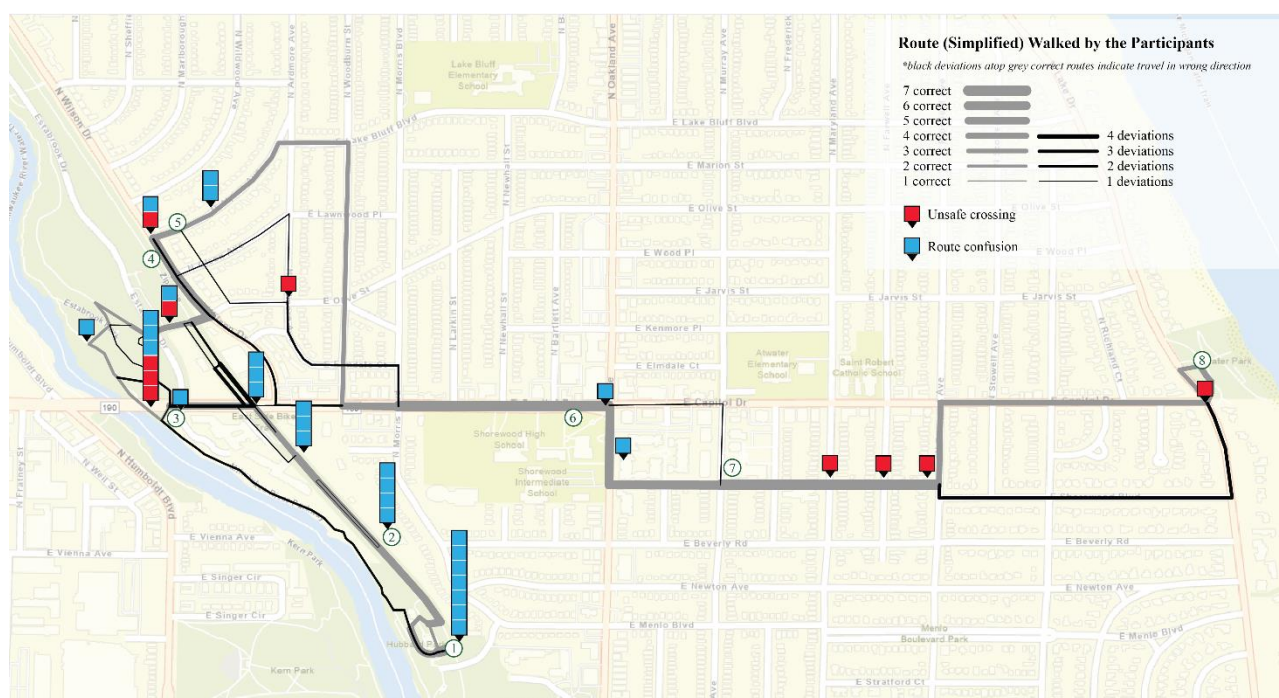
Figure 1. Example figure, placement, caption and numbering: the famous ICA logo.

The evaluation will build upon the methods used during the expert evaluation phase, featuring a two-hour walking tour where participants interact with the app while applying think-aloud and observation methods. Following the tour, participants will complete a mixed-methods questionnaire containing multiple-choice, Likert scale, and free-response questions, mirroring the expert evaluation.

Key evaluation criteria include the five code categories identified during the comparative analysis, expanded to assess the app's utility and user-reported learning outcomes. Retention-focused criteria will assess the tour's effectiveness in fostering engagement, memorability, and knowledge acquisition, while reflection-based questions will explore the app's influence on participants' understanding of green stormwater infrastructure, emphasizing its practical applications and societal benefits. Feedback from this evaluation will inform future iterations of the app, focusing on improving user experience, enhancing educational content, and further optimizing the app's design for inclusiveness.

By presenting the methodology and anticipated outcomes of this evaluation, we aim to contribute to broader discussions on the role of locative audio in fostering educational, and inclusive geospatial experiences. The findings will offer insights into the best practices for integrating audio and visual elements in mobile cartography to support accessibility and promote awareness of environmental and infrastructural topics.

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