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Peer Review File

Assessing Rain Garden Placement through Hydrological Modeling in the Puget Sound Region

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University of Florida

Loulou Dickey[1,2]
Iowa Stormwater Education Partnership

[1]Round 1
[2]Round 2

Round 1

Associate Editor Summary: Andrea Ludwig, University of Tennessee

Manuscript Summary
This is a modeling study that utilizes established indexing methods that describe spatial distribution of parameters affecting runoff generation and storage to determine optimal placement of green stormwater infrastructure (GSI), specifically rain gardens, in an ecologically-sensitive watershed in Washington. The objectives of this study were to "(i) identify optimum locations for GSI practices, specifically rain gardens, in the Lower Puyallup River Watershed, based on the Hydrologic Sensitivity Index method and (ii) assess the adequacy of the method through hydrological modeling using the WEPP model."

Review Summary
Overall, reviewers found the research to be interesting and valuable for siting GSI. However, considerable work is needed to improve the clarity of the paper, put the findings into context of previous work, and tie this body of work to the design community, which is a major goal of this journal. These are the major concerns highlighted by multiple reviewers:

- The need to **link this work more closely with ecological outcomes and implications for design**. One reviewer questioned the suitability of the paper being published in JEED because it does not make clear connections to implications of this work for the design community.
- The need to **clearly outline knowledge gaps** which make this methodology needed. Reviewers suggested shortening the introduction content related to general GSI and enhancing the specific applications of siting rain gardens to help readers/designers understand the implications of the work.
- The need for **more explanation and clarification in the methods** section. Reviewers noted several areas where more explanation or justification is needed for assumptions or processes. Multiple reviewers also referenced the similarities to the work published in Mahat et al. 2023 (https://onlinelibrary.wiley.com/doi/epdf/10.1111/1752-1688.13219?saml_referrer) and encouraged the authors to discuss how this body of work builds on (or differs from) the body of work in that paper.
- The need to shorten the introduction and **expand the discussion.** Reviewers again wanted more reference to previous work and how this study builds on it or fills gaps and more discussion to put the findings in context of the literature. The research questions are interesting, but reviewers needed more clarity on how your findings answer those questions.

- The need to **clarify conclusion statements**. Reviewers stated they were left confused about the overall take aways from the study and needing more direct answers to the research questions outlined.

In general, reviewers indicated that while there is significant work to be done on this manuscript, it also contains valuable and interesting information worthy of publication. By addressing the major concerns and comments provided here, the paper will be improved for readability and journal context.

Reviewer: Loulou Dickey, Iowa Stormwater Education Partnership

This paper presents a method for identifying optimal rain garden sites without using costly modeling software or time-intensive studies. However, several important details are overlooked. First, the treatment of impervious areas and their runoff in the analysis isn't easily understood, and further explanation is needed, particularly regarding the assumption of runoff captured by storm sewer drains. Second, the recommendations for rain garden siting based on λHSI values may not fully consider the potential of areas with low λHSI to receive additional water. These issues require clarifications of the methodology and conclusions to improve the overall findings and applicability.

Line 100 – Consider whether "cost-effectively" is appropriate here, as the study doesn't include a cost analysis. "Effectively" might be more suitable unless cost assumptions are explicitly stated.

Lines 101-129 – The "Placement of GSI" section is lengthy and reads like a literature review. Consider synthesizing and shortening this section by focusing on the contrast between time-consuming, complex process models (SWMM, HEC-HMS) and the λHSI calculation. The paragraph beginning at line 119 could be shortened, and you could make a stronger argument for why the WEPP model helps validate hillslope runoff.

Lines 130-189 – The background on λHSI calculations is important, but this section could be streamlined by reducing the literature review elements.

Lines 190-191 – The concept of cost-effectiveness could be clarified. Does it refer to the functionality of the practice (as in, effectiveness of the rain garden to infiltrate/treat water)? Or to the site selection analysis (cost of software, time used to do analysis)? Or both? How will cost be considered in the study?

Line 220 – Consider writing out the acronym "a.m.s.l." as "above mean sea level."

Line 234 – A discussion on the accuracy and reliability of Soil Survey data in the discussion section may be beneficial.

Line 242 – There appears to be a typo between "λHSI" and "ArcGIS."

Line 255 – It would be helpful to explain why parks are considered unsuitable for rain gardens.

Lines 273-278 – Clarify if the assumption is that all flow from impervious areas would be captured by storm sewer drains. How accurate is this assumption – does the area have full coverage by storm sewer drains?
Also, it seems that any runoff from impervious areas would be important to capture and treat in a GSI practice before it goes to the storm drain (rather than considering the storm drains as a "solution" to runoff).

Line 291 – Consider providing a stronger argument earlier in the paper for using WEPP to validate the association between λHSI and runoff. This could be set up as one of the study objectives in the introduction.

Lines 316-317 – These two scenarios should be clearly linked to their effect on runoff and GSI siting later in the paper.

Line 347 – A brief explanation of the W statistic (assumed to be the Shapiro-Wilk test statistic) may be helpful. How did the value of this statistic influence the interpretation of results and classification of the λHSI values?

Figure 8 – A brief explanation of how to interpret the violin plot might be helpful for those less familiar with this type of plot. (Width corresponds to the frequency of the data points at that combination of values)

Section 3.4 and Figure 9 – The adjustment procedure and its results could be clarified. It seems that flow from impervious surfaces might be important to intercept before it enters the storm sewer drains.
Also, how much do areas with large λHSI differences (>4) overlap with areas identified as good candidates for rain garden siting in Figure 14? What about areas with moderate differences (32% of the watershed)? Would these moderately different areas matter more if they pushed the λHSI value into a different classification?

Line 390 – Adding "Subsurface" before "Lateral flow" would help to clarify what you are referencing.

Figures 10 and 11 – Consider whether these figures add value; the trends shown seem apparent and could be explained in the text.

Sections 3.5.1 and 3.5.2 – It's unclear how these results are incorporated in the λHSI analysis or whether they inform conclusions for rain garden siting. Again, treating runoff from impervious areas (before it goes into the storm sewer) seems important.

Line 426 – "Runoff decreased" might be clearer if phrased as "runoff was xx% lower."

Lines 433-439 – Why wouldn't areas with low λHSI be good candidates for rain gardens since they have the potential to accept more water than they're already receiving? Could water from roof drains, sump pumps, and other impervious surfaces be redirected to these areas for effective treatment?

Line 437 – "Cost effectiveness" might not be the correct term, as cost was not considered in the analysis. "Effectiveness" might be more suitable.

Line 439+ - A brief discussion of the limitations of using Soil Survey data for these calculations might be beneficial.

Lines 468-469 – The recommendation to limit rain garden implementation to such a small percentage of the watershed seems overly restrictive for a GSI practice meant to be widely dispersed in residential areas. Rain gardens are relatively low-cost (compared to other GSI practices) and often implemented and paid for by residents. Is it necessary to limit their use so drastically?

Lines 513-516 – Isn't the water captured in the drains a good candidate for redirecting into a GSI treatment practice? Are you implying that the drains are a "solution" to runoff?

Lines 516-518 – See my earlier comments about low λHSI areas.

Reviewer: Eben Bean, University of Florida

Thank you for the opportunity to review this interesting research manuscript. Overall there is valuable information included here, that is worthy of publication. The writing was easy to read and follow, and it was generally well structured and organized. This type of spatial analysis approach is helpful to advancing how we cite GSI.

However, the manuscript seems somewhat immature in transitioning from a dissertation chapter and requires some attention to a few areas.

The results, discussion, and conclusions do not put the results of this study in context with literature, particularly those cited in the introduction. Without this, the relevance of this work is undefined.

There seems to be some formatting issues with the document: line numbering restarting, variable notation duplication, referenced figure or table number vs. actual number.

It would help readers unfamiliar with WEPP to discuss and summarize results in hydrologic terms, rather than using the variable/parameter symbology and ranges. What do these values mean hydrologically? This will make it easier for readers to understand the significance of results and relate them to other studies/contexts.

Line	Comment
56	Capitalize Coho Salmon
58	Consider revising as “The Puget Sound region in the US Pacific Northwest…”
59	Consider adding “…metropolitan areas, ‘along with’ forest-, ….”
62	Capitalize Coho Salmon?
71-74	This seems extraneous and could be left out.
86	Consider replacing “going into” with “entering”
94	Consider “contact” time instead of “retention” time.
	Consider noting that these soils produce relatively less runoff.
97-8	Include a reference for this statement. Otherwise, regional stormwater treatment and management can arguably be a better solution for some implementations.
97-101	Consider revising to optimize an outcome. As is, these sentences may come across as noble endeavors rather than mofivations.
120-30	This section seems to be a summary of a reference without integrating it with other background information and literature to setup the research objectives and approach. Consider revising or removing.
120	Flanagan et al. 1995 - not included in references.
121	LIDs – while different terms have been used to refer to stormwater control measures, try to be consistent in your terminology throughout the manuscript.
164?	Define variables: I, Ks, Dm. What are the units?

***Page 7 – Line numbering restarts

4	“methods…. for siting GSI practices”: are these software, approaches, or something else?
5	Spatial resolution is the only limitation stated that affects the accuracy of the “method”.

16	It would help to state explicitly that part or all of the watershed is the study area. Figure 1?
17	Replace "measures" with "is"
19-24	Much of this is conveyed by Figure 1 and does not need to be explicitly stated.
31	Figure caption should include the type of data presented. Consider adding location and land use land cover, or similar.
36-8	Consider cutting from " and with the lowest…." to "…and central regions", since it is conveyed by the figure.
41-5	Where were these data sourced from? A citation should be included.
48	Should the reference be to Table 1?
49	Be consistent with units presentation; use metric with US units in parentheses.
52-3	What are the criteria with respect to available data referenced here? These should be clearly stated before stating it/they were used to exclude sites.
54	Stick with convention of either ft or m with the counterpart in parentheses, throughout the manuscript.
57	Leave the lambda symbol out of the heading.
58	Define the parameter in the text. "We computed the Hydrologic Sensitivity Index, λHSI, in ArcGIS…"
61-2	D-infinity algorithm: is this in ArcGIS or something outside?
63	Define λTWI here.
67	Should "Pandas" library be capitalized?
77-80	Was the maximum area determined by the authors or deferred to engineering guidelines? If guidelines, then state that the guidelines were used as the upper limit of the rain garden area.
92	(i) flow was not: Seems like this needs more text, even if it is "disrupted by impervious area"
119-20	Typically, the station ID and or the lat & long are cited.
120-4	What were these data used for?
125-6	Include citation for soil survey reference.
126-9	As the manuscript is primarily not written in first person ("we"), consider changing where first person is used to third person, for consistency.
133	Citation not included in references.
146-50	What does this mean in relation to the overall objective? This could use a sentence or two of discussion. Later on, the HSI is discussed based on suitability/need of GSI. It would likely help the reader to follow if TWI was framed as a metric for relatively how much water is contributed to an area, while SWSC could be framed as retention capacity of an area, or something similar.
147	Should the reference be specifically Figure 5'a'?
150	Recommend including reference to Figure 5b.
154-5	Add (a) and (b) to caption as the figures are labeled as such.

167	Add space between "distribution" and "for".
188-93	It is not clear that these are necessary since they seem to merely plot the distributions and algebraic relationships of parameters. It is also not clear why soil depths < 0.90 only have one conductivity shown in b.
196	It is not clear what was done here (adjusting the effect of impervious areas). It would help the reader to state more explicitly what was involved in adjusting the effect of impervious area and relating back to methods or equations used.
218-21	ET and Deep percolation do not seem necessary to plot since they are nearly constant across slope steepness and length.
222-6	Similarly, ET and deep percolation do not seem critical to plot her as they are constant across K and soil depth, except for deep percolation for 0.5 m soil depth. Consider consolidating Figures 10 and 11.
231	"necessitating treatment": consider rephrasing as an opportunity for GSI to manage stormwater (flow control, flood management, water quality treatment).
270-3	More of an observation, but if HIS was rainfall, this relationship would look similar to the relationship using Curve Number method.
279-87	It would help to provide some context for the physical representativeness of these classes and their limits. Do the breaks between classes 2, 3, and 4 have physical significance or are they merely artifacts of binning the HSI values?
283-4	What are "these areas"? Is this the area of Class 3? If so, it would help to use consistent terminology in Figure 14 and maybe include Class numbers in the legend.
301	Throughout really, review symbols to remove duplication. It could be the result of some translation process in submission.
310	Remove space after "drain".
316-9	How would this range translate to other regions if applied?
320-1	Would this generally be expected in other urbanized areas?
327-30	If an area is paved, that would seem to drive the runoff production. The lack of water retention available for ET would actually be an effect of increased runoff.
331-3	Can you offer an example of what this might look like in application?
334	Consider adding the range of values in parentheses to define what moderate values are.
337-9	It looks like in figure 14 that you might have 20-30% of the area that is deemed suitable in one way or another though. It would be useful to quantify the abundance of opportunities rather than limiting to only 1% of areas.

Reviewer: Anonymous

Overall the study has well defined objectives and a really interesting research question to tackle. However, I feel the questions were not answered and the conclusions left me confused as what the results mean. The discussion is lacking and therefore most of the results are left to interpretation by the reader, especially since the methods seem rather complex. I think the discussion needs to lengthened substantially while the introduction can be substantially reduced and more focused on the objectives of the study rather than GSI as a whole.

1. lines 12-13: please make sure this is the proper format of highlights for this new journal. I have never seen highlights presented like this before... usually it is 3-5 bullet points with character count limitations
2. Page numbers stop after the abstract... hard to specify where issues are now.

3. Introduction- a little early to bring in a specific region, especially when readers may not know where this is without a map or figure.

4. Introduction paragraph 2- this is all methods or site descriptions. Not introduction. What is material that makes this applicable everywhere. Not just a case study?

5. Having sub headings in an introduction is very uncommon for a typical IMRAD paper. Here I find it distracting, especially the GSI section because you have 3 paragraphs about GSI that are not related to what you are trying to accomplish in your study. Overall, it makes it lengthy and confusing to what your study is actually about. Suggest condensing to main points in 1-2 sentences.

6. Introduction- placement of GSI - It seems like this type of study has been done many times before according to your literature review. Where are the data gaps, why is this study still needed? To me this is missing and thus is makes the paper not necessary to publish.

7. Eqns 1-4. Is this a common way to write this eqn. I am unfamiliar with it so I may not be the best to critique it, but I look at this equation and it looks uninterpretable, especially with the text font and size switching as well as the mix of symbols and variables.

8. Introduction - HSA. Most of this seems like methods. Certainly does not belong in an introduction

9. Introduction - Objectives. This is great. This is what needs to be tied in when you introduce placement of GSI and relate it to the studies that already exist. Explain there limitations.

10. Section 2.1. You state figure 1 as figure 3. Please add a scale bar to both graphics in figure 1.

11. can you reword the phrase with two cases in section 2.5. Reads confusing to me, not quite sure the meaning.

12. Sections 3.1 - 3.4- there is no or minimal discussion in these sections. What do these values mean, what are practical applications, how to interpret figures? Most of this is left up to the reader which is pretty difficult due to the complexity of the equations and models.

Concluding points 1-5,8: these are already known and just a recap of your results. They're not really concluding points as they do not tell me the implications of the work.

Concluding point 6: How would this be an ideal location for rain gardens considering areas with large runoff volumes are where GSI are needed!?!

Concluding point 7: I would guess treating 1% of watershed area is not sufficient enough to make a difference in watershed health/quality, esp for salmon reproduction. Where do you recommend GSI implementation?

Conclusions in general: I feel like they do not recap the main takeaways from the study, not answer your research objective. What I get out of reading the conclusions is that there really isn't any best place to implement GSI and more work is needed.

Reviewer: Anonymous

The authors present a GIS-based approach for siting rain gardens for stormwater management though a case study in the Lower Puyallup River Watershed in western Washington, US. The authors clearly link the need for stormwater treatment through practices such as rain gardens to aquatic ecosystem health, particularly for salmon species that use waters in the area for spawning. This study appears to build on previous work by this group to develop and apply a hydrologic sensitivity index for siting raingardens by validating the method with a physically-based hillslope process model. Overall, the study demonstrates a relatively simple approach using readily available spatial data layers for prioritizing rain garden placement at a watershed scale.

In general, the manuscript can be improved by more clearly describing how this study builds upon the previous work by Mehat et al. (2023). This previous study appears to be a critical foundation for the current manuscript; however the discussion lacks comparisons to the previous study to indicate how the method has been improved, etc. In addition, there are aspects of the methodology and results that require clarification. Finally, it is suggested that the authors also consider opportunities to enhance the ecological relevance of hydrologic index methods such as presented here in future work. A more detailed account of comments and suggestions follows.

The line numbers in the manuscript did not appear to extend past the first page, so I have used page number, section heading and/or figure/table number as a reference.

The research objectives are stated clearly. However, there is opportunity to more clearly connect the objectives of this research to the gap/needs of the design community (that is, the need for effective and user-friendly decision support tools for rain garden placement), particularly following the work of Mahat et al. (2023). This could be addressed by expanding on the last sentence before the objectives statement, in which the Mahat et al. study is first cited, to describe the gaps remaining / improvements needed in Mahat et al.'s approach so that so that it is clear to the reader how these research objectives are advancing efforts to meet the stated need for "cost-effective decision support" for siting raingardens.

Methodology: please consider the following comments to improve the clarity with which you present the research methods.

- Page 3, second paragraph: "Vacant areas" are mentioned specifically as a type of urban area in which GSI can be installed; however, GSI is also appropriate in commercial, residential, and other non-vacant properties. Consider re-phrasing this sentence to avoid implying that GSI is limited to vacant areas or only ideally implemented in such areas.

- Page 3, 3rd paragraph. In addition to reviewing rain garden performance with respect to ammonia and total nitrogen, it would be worthwhile to review removal of additional pollutants, particularly those linked to toxicity in salmon (e.g., PAHs as in work by McIntyre et al.) given the ecological context of this study.

- Page 6, Eqn 3b. Equation 3b describes an adjustment to the soil depth as D*Impervious area. As formulated, higher impervious area would increase soil depth and, hence, the resulting soil water storage capacity index would also increase. The Martin-Mikle et al. reference cited gives the impervious adjustment to D as: Dm = D – D*impervious area. Please check the equation used and, if you did calculate the impervious adjustment to soil depth as stated in Equation 3d, provide explanation for doing so as it is counterintuitive.

- Page 10 – surface slope is often treated as a design constraint for raingardens. Did you take surface slope into account when identifying areas suitable for rain gardens? If not, can you confirm that raingardens were not sited for high slope areas (e.g., upper end of slopes shown in Figure 2a) or justify why slope was not considered?

- Page 10, Section 2.5. Please clarify the spatial aggregation method used to convert the grid-scale raster to the lot-scale. For example, did you use mean value, median, or some other statistic?

- Page 12, last paragraph. Please describe and justify the underdrain scenario in terms of what this represents in an urban headwater. I initially presumed that the underdrain was intended to represent runoff transport via subsurface storm drains or potentially a drainage tile that intercepts shallow groundwater and transports to the outlet (more akin to a shallow interflow process). However, from the results presented in Section 3.5.2 and Figure 12, it appears that water entering subsurface drains was allowed to percolate through the soil profile to become deep percolation. I may just not be familiar with the type of system that would have this effect on hydrologic process. Please provide additional description in the methods for the physical system and associated hydrological processes that were represented by the underdrains in the drainage infrastructure scenario.

- Table 2. Were these characteristics applied to all OFEs or just to OFE 2? Please clarify.

Results and discussion

- Figure 10: For the WEPP results presented in Figure 10 and onward, should there be a time scale associated with the modeled water depth on the y-axis? For example, do the presented water depths represent an annual average over the 10-year simulation period in WEPP? If results are presented as annual averages, please check to ensure they make sense in the context of the annual water balance. For example, in Figure 11, runoff, ET, lateral flow, and deep percolation components appear to exceed the annual average precipitation in some cases.

- Page 22, first paragraph. Since you have a physically-based simulation of runoff depths from WEPP, can you confirm that the range of “moderate” HSI-index values you identified as appropriate for raingarden implementation are within a range that could be effectively treated by raingardens? I understand that this may be an estimate assuming the runoff depths provided by WEPP are considered on an annual timescale, but it would be useful to lend some objectivity to the range of HSI-values recommended for raingardens.

- Page 23, last paragraph – the presentation of watershed areas categorized as “most suitable”, “preferred”, and “suitable” is a little confusing. Can you clarify which HSI-index value classes these descriptors correspond to (e.g., “most suitable” is intuitively Class 3 but are “preferred” areas Class 2 or 4? And what is “suitable”?). Similarly, it would be helpful to connect the description of suitable areas given in Figure 14 to the HSI-index values so that it is more clear how the actual analysis was translated to recommendations.

- Since you analyzed the same watershed as Mehat et al. (2023), some discussion of how and why the suitable areas identified through this study are different is warranted. Do you feel more confident in the mapping produced here since you have some form of validation with the physically-based model? No model is perfect though; are your results still in line with ground-truthing by Mehat et al.?

- Please consider at some point in your discussion or conclusions opportunities to enhance the ecological relevance of an HSI-based index method in future iterations of this rain garden siting method. For example, in this study you have clearly connected the motivation for rain gardens to treat runoff before it enters salmon habitat. In addition to considering seasonal timing of soil saturation (which you have suggested as a final conclusion), could you also consider seasonal timing of "ecologically-sensitive" periods, such as spawning or other developmentally sensitive periods in the salmon life cycle, or hydrological connectivity index to prioritize placement of rain gardens or other GIS to intercept runoff from source areas most likely to enter aquatic habitats?

Organization and writing style: the manuscript is generally well-organized and written, though a few grammatical corrections are needed. For example:

- Page 5, 1st paragraph: Making LID plural as "LIDs" in this context is not grammatically correct. Replace with "LID practices" or similar descriptor.

- Page 7 – it seems "Figure 3" should be "Figure 1"

- Page 15, Figure 6 – need space between "distribution" and "for"

Round 1 Author Response

Responses to the Review Comments
We appreciate the constructive comments from the reviewers towards enhancing the manuscript quality. We have addressed all the comments and incorporated the editorial changes.

In the following, we include the original comments from reviewers in italics, followed by our responses and answers. The line numbers in reviewers' comments refer to those in the first revised manuscript, while the line numbers in our response refer to those in the revised manuscript. Since the introduction was shortened many of the formatting suggestions are redundant—those that were accepted are marked as **Done** in the same line.

Editor Comments
The need to ***link this work more closely with ecological outcomes and implications for design****. One reviewer questioned the suitability of the paper being published in JEED because it does not make clear connections to implications of this work for the design community.*

This paper was submitted for a special collection associated with the AEES meeting in 2023, where the work was presented. We were encouraged to submit it based on both the abstract and the presentation. We were somewhat surprised by the question about the paper's fit at this stage, particularly as only one reviewer expressed this concern. Regardless, we have heeded the review comments and clarified that rain gardens are designed to function as mini ecosystems, and ecological engineering principles apply to their design, installation, and maintenance (Lines 140–144). Therefore, a decision-support tool that optimally locates these ecologically engineered systems on the landscape, is highly relevant to JEED that aims to support the practice of ecological engineering.

The need to ***clearly outline knowledge gaps*** *which make this methodology needed. Reviewers suggested shortening the introduction content related to general GSI and enhancing the specific applications of siting rain gardens to help readers/designers understand the implications of the work.*

We have shortened the introduction by about 500 words. The knowledge gap and implication of the work is now clearly outlined from Lines 132–145.

The need for ***more explanation and clarification in the methods*** *section. Reviewers noted several areas where more explanation or justification is needed for assumptions or processes. Multiple reviewers also referenced the similarities to the work published in Mahat et al. 2023 (https://onlinelibrary.wiley.com/doi/epdf/10.1111/1752-1688.13219?saml_referrer) and encouraged the authors to discuss how this body of work builds on (or differs from) the body of work in that paper.*

The methodology is now explained in more detailed (e.g. Lines 240–248; 280–285) and distinction with Mahat et al. 2023 is made on Lines 135–144.

The need to shorten the introduction and ***expand the discussion.*** *Reviewers again wanted more reference to previous work and how this study builds on it or fills gaps and more discussion to put the findings in context of the literature. The research questions are interesting, but reviewers needed more clarity on how your findings answer those questions.*

The introduction is shortened, and discussion section is significantly expanded Lines 298–304, 328–332, 342–366, 395–403, and 456–460 answering how the findings answer broader questions about the relationship between runoff generation and this indexing approach.

The need to ***clarify conclusion statements****. Reviewers stated they were left confused about the overall takeaways from the study and needing more direct answers to the research questions outlined.*

The main takeaways are added Lines 361–366 and 456–460 in the discussion, and again in conclusion Lines 515–522.

Reviewer #1

There seems to be some formatting issues with the document: line numbering restarting, variable notation duplication, referenced figure or table number vs. actual number. It would help readers unfamiliar with WEPP to discuss and summarize results in hydrologic terms, rather than using the variable/parameter symbology and ranges. What do these values mean hydrologically? This will make it easier for readers to understand the significance of results and relate them to other studies/contexts.

56: Capitalize Coho Salmon **Done**

71-74: This seems extraneous and could be left out. **Done**

94: Consider "contact" time instead of "retention" time. **Done**

97-8 Include a reference for this statement. Otherwise, regional stormwater treatment and management can arguably be a better solution for some implementations.

This line was changed so that we are not assertive about the impact of GSI implementation.

97-101 Consider revising to optimize an outcome. As is, these sentences may come across as noble endeavors rather than motivations. **Done.**

120-30 This section seems to be a summary of a reference without integrating it with other background information and literature to setup the research objectives and approach. Consider revising or removing.

These studies were meant to show how others have approached the problem of GSI placement through hydrological modeling. We have shortened these studies and added their relations with the out study (Lines 99–103).

120 Flanagan et al. 1995 - not included in references. **Done.**

121 LIDs – while different terms have been used to refer to stormwater control measures, try to be consistent in your terminology throughout the manuscript. **Done.**

164. Define variables: I, Ks, Dm. What are the units?

The equations are moved to section 2.3.

****Page 7 – Line numbering restarts*

4: "methods…. for siting GSI practices": are these software, approaches, or something else?

They were meant to be "approaches". This is now corrected.

16: It would help to state explicitly that part or all of the watershed is the study area.

Study area is stated in Line 153 and figure 1.

19-24: Much of this is conveyed by Figure 1 and does not need to be explicitly stated.

We have shortened the statement Line 158–163.

31: Figure caption should include the type of data presented. Consider adding location and land use land cover, or similar.

Figure Caption is modified.

41-5: Where were these data sourced from? A citation should be included.

Data sources are included in Table 1.

49: Be consistent with units presentation; use metric with US units in parentheses. **Done**.

52-3: What are the criteria with respect to available data referenced here? These should be clearly stated before stating it/they were used to exclude sites.

Added the reference and also referred to Table 1.

54: Stick with convention of either ft or m with the counterpart in parentheses, throughout the manuscript. **Done.**

57: Leave the lambda symbol out of the heading. **Done.**

58: Define the parameter in the text. "We computed the Hydrologic Sensitivity Index, λ_{HSI}, in ArcGIS…" **Done.**

61-2: D-infinity algorithm: is this in ArcGIS or something outside?

It is within ArcGIS. This information is now added (Line 199).

63: Define λ_{TWI} here. **Done.**

67 Should "Pandas" library be capitalized? **Done.**

77-80 Was the maximum area determined by the authors or deferred to engineering guidelines? If guidelines, then state that the guidelines were used as the upper limit of the rain garden area.

The maximum area was determined by us after consulting with professional engineers. This is now stated more clearly (Line 223).

92 (i) flow was not: Seems like this needs more text, even if it is "disrupted by impervious area" **Done.**

119-20 Typically, the station ID and or the lat & long are cited. **Done.**

120-4 What were these data used for?

These are necessary climate inputs for WEPP simulation.

125-6 Include citation for soil survey reference. **Done.**

126-9 As the manuscript is primarily not written in first person ("we"), consider changing where first person is used to third person, for consistency.

We have changed to third person in most places but have kept some of the sentences in first person to emphasize agency and our unique perspective.

133 Citation not included in references. **Done.**

146-50 What does this mean in relation to the overall objective? This could use a sentence or two of discussion. Later on, the HSI is discussed based on suitability/need of GSI. It would likely help the reader to follow if TWI was framed as a metric for relatively how much water is contributed to an area, while SWSC could be framed as retention capacity of an area, or something similar.

Discussion added from Line 298–304.

147 Should the reference be specifically Figure 5'a'? **Done.**

150 Recommend including reference to Figure 5b. **Done.**

154-5 Add (a) and (b) to caption as the figures are labeled as such. **Done.**

167 Add space between "distribution" and "for". **Done.**

188-93: It is not clear that these are necessary since they seem to merely plot the distributions and algebraic relationships of parameters. It is also not clear why soil depths < 0.90 only have one conductivity shown in b.

Figure 7 clearly demonstrates the distribution of HSI values and how they are affected by various factors in the study area. There is only one hydraulic conductivity value for each soil classes with a depth < 0.90 m based on the SSURGO database.

196: It is not clear what was done here (adjusting the effect of impervious areas). It would help the reader to state more explicitly what was involved in adjusting the effect of impervious area and relating back to methods or equations used.

This is now explained in more detail in Methodology Line 238–248 and in Result and Discussion Line 346–366.

218-21: ET and Deep percolation do not seem necessary to plot since they are nearly constant across slope steepness and length.

ET and deep percolation are important water balance components. Graphing these components effectively shows that they are not affected substantially by slope steepness and length.

222-6: Similarly, ET and deep percolation do not seem critical to plot here as they are constant across K and soil depth, except for deep percolation for 0.5 m soil depth. Consider consolidating Figures 10 and 11.

ET and deep percolation are important water balance components. Graphing these components effectively shows that they are not affected substantially by slope steepness and length.

231: "necessitating treatment": consider rephrasing as an opportunity for GSI to manage stormwater (flow control, flood management, water quality treatment). **Done.**

279-87: It would help to provide some context for the physical representativeness of these classes and their limits. Do the breaks between classes 2, 3, and 4 have physical significance or are they merely artifacts of binning the HSI values?

The equal-interval was one way of systematically bining and relating the HSI values to suitability of rain garden. The breaks between classes 2, 3, and 4 is a "fine tuning" approach. Class 3 represents areas where hydrological and environmental conditions most favorable for rain gardens as explained in section 3.5. Classes 2 and 4 denote those areas with less optimal conditions for rain gardens. The discussion is now expanded to provide more context (Line 447–553).

283-4: What are "these areas"? Is this the area of Class 3? If so, it would help to use consistent terminology in Figure 14 and maybe include Class numbers in the legend.

We were referring to the most suitable area—now corrected (Line 454).

301: Throughout really, review symbols to remove duplication. It could be the result of some translation process in submission.

There indeed was some problem in document translation during submission. The symbols are corrected in the revised version.

310: Remove space after "drain". **Done.**

316-9: How would this range translate to other regions if applied?

The range would either broaden or narrow based on the topographic and soil characteristics of the watershed.

320-1: Would this generally be expected in other urbanized areas?

As discussed in Line 346–366, it would depend on level of development in the area.

327-30: If an area is paved, that would seem to drive the runoff production. The lack of water retention available for ET would actually be an effect of increased runoff.

We have made the correction (Line 392–396 and Line 508–512).

331-3: Can you offer an example of what this might look like in application?

If there is new development in the upstream of the watershed and they were to set up a drainage system by catching the runoff, it should decrease the runoff downstream. This is also elaborated in discussion (Line 395–403).

334: Consider adding the range of values in parentheses to define what moderate values are.
Done.

337-9 It looks like in figure 14 that you might have 20-30% of the area that is deemed suitable in one way or another though. It would be useful to quantify the abundance of opportunities rather than limiting to only 1% of areas.

We wanted to stress that when the resource is limited, resource managers could prioritize these 1% areas for GSI placement (Line 458–461). We have added the suggestion in the discussion and conclusion.

Reviewer #2
Overall the study has well defined objectives and a really interesting research question to tackle. However, I feel the questions were not answered and the conclusions left me confused as what the results mean. The discussion is lacking and therefore most of the results are left to interpretation by the reader, especially since the methods seem rather complex. I think the discussion needs to lengthened substantially while the introduction can be substantially reduced and more focused on the objectives of the study rather than GSI as a whole.

We have improved the discussion to elaborate on how the result answer critical question of relating Hydrological Sensitivity Index with runoff generation and how this could translate to the placement of GSI (298–304, 328–332, 342–366, 395–403, and 456–460).

1. lines 12-13: please make sure this is the proper format of highlights for this new journal. I have never seen highlights presented like this before... usually it is 3-5 bullet points with character count limitations

The format of highlight is consistent with the journal.

2. Page numbers stop after the abstract... hard to specify where issues are now.

There indeed was some problem in document translation during submission. The version we worked on have proper symbols, page numbers and line numbers. Hopefully, the errors wont repeat in the revised version.

3. Introduction- a little early to bring in a specific region, especially when readers may not know where this is without a map or figure. 4. Introduction paragraph 2- this is all methods or site descriptions. Not introduction. What is material that makes this applicable everywhere. Not just a case study?

We have moved the study area specification to the methodology section.

5. Having sub headings in an introduction is very uncommon for a typical IMRAD paper. Here I find it distracting, especially the GSI section because you have 3 paragraphs about GSI that are not related to what you are trying to accomplish in your study. Overall, it makes it lengthy and confusing to what your study is actually about. Suggest condensing to main points in 1-2 sentences.

We have condensed the introduction section substantially. We thought having subheadings helped provide structure to the introduction section, supported the flow and improved readability.

6. Introduction- placement of GSI - It seems like this type of study has been done many times before according to your literature review. Where are the data gaps, why is this study still needed? To me this is missing and thus is makes the paper not necessary to publish.

Previous studies highlight how hydrological modeling could be used to relate HSI to runoff generation. In this study, we assessed the Hydrological Sensitivity Index approach of GSI placement through hydrological modeling. We have expanded this discussion (Line 133–145).

7. Eqns 1-4. Is this a common way to write this eqn. I am unfamiliar with it so I may not be the best to critique it, but I look at this equation and it looks uninterpretable, especially with the text font and size switching as well as the mix of symbols and variables.

There indeed was some problem in document translation during submission. Nevertheless, we have shifted the equation to the methodology section.

8. Introduction - HSA. Most of this seems like methods. Certainly does not belong in an introduction

We have moved this to method section.

9. Introduction - Objectives. This is great. This is what needs to be tied in when you introduce placement of GSI and relate it to the studies that already exist. Explain there limitations.

We have improved this in the introduction section (Line 99–103; Line 133–145).

10. Section 2.1. You state figure 1 as figure 3. Please add a scale bar to both graphics in figure1.
Done.

11. can you reword the phrase with two cases in section 2.5. Reads confusing to me, not quite sure the meaning.

This section is elaborated (Lines 240–248).

12. Sections 3.1 - 3.4- there is no or minimal discussion in these sections. What do these values mean, what are practical applications, how to interpret figures? Most of this is left up to the reader which is pretty difficult due to the complexity of the equations and models.

We have improved the discussion of result section (Lines 342–366, 395–403, and 456–460).

Concluding points 1-5,8: these are already known and just a recap of your results. They're not really concluding points as they do not tell me the implications of the work.

In the conclusion section we want to revisit the key results, but we have now expanded upon some key implications.

Concluding point 6: How would this be an ideal location for rain gardens considering areas with large runoff volumes are where GSI are needed!?!

Rain gardens are small-scale structures and not suitable for intercepting large volume runoff. City planners with limited resources should prioritize the strongly recommended areas when constructing rain gardens.

Concluding point 7: I would guess treating 1% of watershed area is not sufficient enough to make a difference in watershed health/quality, esp for salmon reproduction. Where do you recommend GSI implementation?

Treating only 1% of the area would not be enough to reduce urban storm runoff. Other larger-scale GSI facilities should also be used to decrease the overall runoff footprint of the watershed. This study serves as a guide to prioritize placement of small-scale GSI such as rain gardens. We have elaborated on this (Line 444–461).

Reviewer #3
In general, the manuscript can be improved by more clearly describing how this study builds upon the previous work by Mahat et al. (2023). This previous study appears to be a critical foundation for the current manuscript; however the discussion lacks comparisons to the previous study to indicate how the method has been improved, etc. In addition, there are aspects of the methodology and results that require clarification. Finally, it is suggested that the authors also consider opportunities to enhance the ecological relevance of hydrologic index methods such as presented here in future work. A more detailed account of comments and suggestions follows.

We have improved how this work builds from the work done by Mahat et al. (2023) and added clarification in the methodology and significant amount of discussion to explain the implication of this study.

The line numbers in the manuscript did not appear to extend past the first page, so I have used page number, section heading and/or figure/table number as a reference.

There indeed was some problem in document translation during submission. Nevertheless, we have shifted the equation to the methodology section.

The research objectives are stated clearly. However, there is opportunity to more clearly connect the objectives of this research to the gap/needs of the design community (that is, the need for effective and user-friendly decision support tools for rain garden placement), particularly following the work of Mahat et al. (2023). This could be addressed by expanding on the last sentence before the objectives statement, in which the Mahat et al. study is first cited, to describe the gaps remaining / improvements needed in Mahat et al.'s approach so that so that it is clear to the reader how these research objectives are advancing efforts to meet the stated need for "cost-effective decision support" for siting raingardens.

We have improved the writings to elaborate how this study improves on Mahat et al. (2023) (Lines 133–145).

*Page 6, Eqn 3b. Equation 3b describes an adjustment to the soil depth as D*Impervious area. As formulated, higher impervious area would increase soil depth and, hence, the resulting soil water storage capacity index would also increase. The Martin-Mikle et al. reference cited gives the impervious adjustment to D as: Dm = D – D*impervious area. Please check the equation used and, if you did calculate the impervious adjustment to soil depth as stated in Equation 3d, provide explanation for doing so as it is counterintuitive.*

The impervious layer was a binary raster of 0 (Impervious) and 1 (Pervious). When the area was impervious, the depth would become 0 and when the area was pervious the depth would remain the same as provided by the SSURGO database.

Page 10 – surface slope is often treated as a design constraint for raingardens. Did you take surface slope into account when identifying areas suitable for rain gardens? If not, can you confirm that raingardens were not sited for high slope areas (e.g., upper end of slopes shown in Figure 2a) or justify why slope was not considered?

Slope was not treated as a constraining factor because rain gardens (distinct from bioretention systems) are much smaller structures that do not have stringent construction requirements, especially in western Washington. Besides, steep-slope areas would automatically be filtered out by their low TWI values and thus low HSI values.

Page 10, Section 2.5. Please clarify the spatial aggregation method used to convert the grid-scale raster to the lot-scale. For example, did you use mean value, median, or some other statistic?

We used Mean and this is now elaborated (Line 226–229)

Page 12, last paragraph. Please describe and justify the underdrain scenario in terms of what this represents in an urban headwater. I initially presumed that the underdrain was intended to *represent runoff transport via subsurface storm drains or potentially a drainage tile that intercepts shallow groundwater and transports to the outlet (more akin to a shallow interflow process). However, from the results presented in Section 3.5.2 and Figure 12, it appears that water entering subsurface drains was allowed to percolate through the soil profile to become deep percolation. I may just not be familiar with the type of system that would have this effect on hydrologic process. Please provide additional description in the methods for the physical system and associated hydrological processes that were represented by the underdrains in the drainage infrastructure scenario.*

This was not meant to represent a drainage system that intercepts groundwater. Instead, it represents the scenario where the development would have it's own flow management system thattakes away water from the hillslope. This is now elaborated (Lines 280–285).

Table 2. Were these characteristics applied to all OFEs or just to OFE 2? Please clarify.

These applied to all OFEs.

Figure 10: For the WEPP results presented in Figure 10 and onward, should there be a time scale associated with the modeled water depth on the y-axis? For example, do the presented water depths represent an annual average over the 10-year simulation period in WEPP? If results are presented as annual averages, please check to ensure they make sense in the context of the annual water balance. For example, in Figure 11, runoff, ET, lateral flow, and deep percolation components appear to exceed the annual average precipitation in some cases.

The precipitation annual average was computed using long-term data, while the WEPP simulation utilized the last 10 years of precipitation data. Additionally, the water balance for each year may not perfectly align with the annual precipitation because water stored in the soil profile can carry over from one year to the next. As a result, components like runoff, evapotranspiration, lateral flow, and deep percolation may exceed annual precipitation in some years.

Page 22, first paragraph. Since you have a physically-based simulation of runoff depths from WEPP, can you confirm that the range of "moderate" HSI-index values you identified as appropriate for raingarden implementation are within a range that could be effectively treated by raingardens? I understand that this may be an estimate assuming the runoff depths provided by WEPP are considered on an annual timescale, but it would be useful to lend some objectivity to the range of HSI-values recommended for rain gardens.

This is a valuable suggestion. Modeling a design hillslope in our study is the first step towards modeling real rain gardens. Detailed rain garden simulations are beyond the scope of this study. We intend to carry out the simulations in future studies. Parameterization of rain gardens for the Puget Sound region will require adequate understanding of typical native plant species used for rain gardens. Vegetation grown in rain gardens are not harvested (cut) and essentially produce more biomass, leading to higher ET and infiltration, and lower runoff.

Page 23, last paragraph – the presentation of watershed areas categorized as "most suitable", "preferred", and "suitable" is a little confusing. Can you clarify which HSI-index value classes these descriptors correspond to (e.g., "most suitable" is intuitively Class 3 but are "preferred" areas Class 2 or 4? And what is "suitable"?). Similarly, it would be helpful to connect the description of suitable areas given in Figure 14 to the HSI-index values so that it is more clear how the actual analysis was translated to recommendations.

We have improved this by revising section 3.6 (Line 443–457).

Since you analyzed the same watershed as Mahat et al. (2023), some discussion of how and why the suitable areas identified through this study are different is warranted. Do you feel more confident in the mapping produced here since you have some form of validation with the physically-based model? No model is perfect though; are your results still in line with ground-truthing by Mahat et al.?

The study of Mahat et al. (2023) focused on identifying suitable areas for bioretention system using this approach and verified the HSI framework through ground truthing. In this study we aim at identifying suitable locations for smaller-scale GSI, specifically rain gardens.

Please consider at some point in your discussion or conclusions opportunities to enhance the ecological relevance of an HSI-based index method in future iterations of this rain garden siting method. For example, in this study you have clearly connected the motivation for rain gardens to treat runoff before it enters salmon habitat. In addition to considering seasonal timing of soil saturation (which you have suggested as a final conclusion), could you also consider seasonal timing of "ecologically-sensitive" periods, such as spawning or other developmentally sensitive periods in the salmon life cycle, or hydrological connectivity index to prioritize placement of rain gardens or other GIS to intercept runoff from source areas most likely to enter aquatic habitats?

Thank you for your thoughtful suggestion. The focus of this study is on hydrologic assessment. Incorporating ecologically sensitive periods, such as salmon spawning, into prioritization for rain gardens should be part of future efforts. Integrating ecological considerations into the hydrological framework could provide further insights. We have added this as a suggestion for future work (Line 528–529).

Reviewer #4

This paper presents a method for identifying optimal rain garden sites without using costly modeling software or time-intensive studies. However, several important details are overlooked. First, the treatment of impervious areas and their runoff in the analysis isn't easily understood, *and further explanation is needed, particularly regarding the assumption of runoff captured by storm sewer drains. Second, the recommendations for rain garden siting based on λHSI values may not fully consider the potential of areas with low λHSI to receive additional water. These issues require clarifications of the methodology and conclusions to improve the overall findings and applicability.*

Line 100 – Consider whether "cost-effectively" is appropriate here, as the study doesn't include a cost analysis. "Effectively" might be more suitable unless cost assumptions are explicitly stated. **Done.**

Lines 101-129 – The "Placement of GSI" section is lengthy and reads like a literature review. Consider synthesizing and shortening this section by focusing on the contrast between time-consuming, complex process models (SWMM, HEC-HMS) and the λHSI calculation. The paragraph beginning at line 119 could be shortened, and you could make a stronger argument for why the WEPP model helps validate hillslope runoff. **Done.**

Lines 130-189 – The background on λHSI calculations is important, but this section could be streamlined by reducing the literature review elements. **Done.**

Lines 190-191 – The concept of cost-effectiveness could be clarified. Does it refer to the functionality of the practice (as in, effectiveness of the rain garden to infiltrate/treat water)? Or to the site selection analysis (cost of software, time used to do analysis)? Or both? How will cost be considered in the study?

Benefit cost analysis was beyond the scope of this study, hence we have removed the statement implying this.

Line 220 – Consider writing out the acronym "a.m.s.l." as "above mean sea level." **Done.**

Line 234 – A discussion on the accuracy and reliability of Soil Survey data in the discussion section may be beneficial.

We have added this in conclusion Line 497–502.

Line 242 – There appears to be a typo between " λ_{HSI}*" and "ArcGIS."* **Done.**

Line 255 – It would be helpful to explain why parks are considered unsuitable for rain gardens.

State ordinances mandate these areas not to be used for rain gardens.

Lines 273-278 – Clarify if the assumption is that all flow from impervious areas would be captured by storm sewer drains. How accurate is this assumption – does the area have full *coverage by storm sewer drains? Also, it seems that any runoff from impervious areas would be important to capture and treat in a GSI practice before it goes to the storm drain (rather than considering the storm drains as a "solution" to runoff).*

With the two scenarios, we are looking to capture two extreme cases: i) where all impervious areas disrupt the flow path and flow is captured by sewer drains and ii) where the impervious areas do not disrupt the flow path at all. The reality will be somewhere in between. We explain this in more detail in Line 251–257.

Line 291 – Consider providing a stronger argument earlier in the paper for using WEPP to validate the association between λ_{HSI} and runoff. This could be set up as one of the study objectives in the introduction.

From lines 254–260 we outline the strengths of the WEPP model and its ability to model hillslope hydrological processes.

Line 347 – A brief explanation of the W statistic (assumed to be the Shapiro-Wilk test statistic) may be helpful. How did the value of this statistic influence the interpretation of results and classification of the λHSI values?

In this study, the W statistic confirmed that the λ_{HSI} values were not normally distributed. This result supports the classification approach of using non-parametric methods, such as equal-interval classification, instead of assuming a normal distribution. The skewed distribution with a heavier right tail implies that higher λ_{HSI} values are relatively rare. The classification, therefore, reflects this asymmetry, with more frequent lower values (as seen in Class 2) and fewer occurrences of higher values (Class 5).

Figure 8 – A brief explanation of how to interpret the violin plot might be helpful for those less familiar with this type of plot. (Width corresponds to the frequency of the data points at that combination of values)

We have added the suggestion to the figure caption.

Section 3.4 and Figure 9 – The adjustment procedure and its results could be clarified. It seems that flow from impervious surfaces might be important to intercept before it enters the storm sewer drains.

We have added the clarification in both methodology (240–248) and results section (346–366)

Also, how much do areas with large λHSI differences (>4) overlap with areas identified as good candidates for rain garden siting in Figure 14? What about areas with moderate differences

(32% of the watershed)? Would these moderately different areas matter more if they pushed the λHSI value into a different classification?

There were no discernable differences in the suitability map developed with or without consideration of flow accumulation. This could be because many of the areas not suitable for rain gardens (per state ordinances and engineering criteria) were excluded. The areas with moderate differences could indeed matter more in case a difference may push the λ_{HSI} value into a different classification, e.g., a location originally in Class 3 could shift to Class 4 or vice versa leading to unmerited priority for rain garden placement. We discuss the implication of the λ_{HSI} *differences* (Lines 346–366)

Line 390 – Adding "Subsurface" before "Lateral flow" would help to clarify what you are referencing. **Done.**

Sections 3.5.1 and 3.5.2 – It's unclear how these results are incorporated in the λHSI analysis or whether they inform conclusions for rain garden siting. Again, treating runoff from impervious areas (before it goes into the storm sewer) seems important.

This highlights the area that needs to be targeted for GSI siting. We have discussed this on Lines 395–403.

Line 426 – "Runoff decreased" might be clearer if phrased as "runoff was xx% lower." **Done.**

Lines 433-439 – Why wouldn't areas with low λHSI be good candidates for rain gardens since they have the potential to accept more water than they're already receiving? Could water from roof drains, sump pumps, and other impervious surfaces be redirected to these areas for effective treatment?

We approached the analysis from the perspective of practitioners with limited resources, focusing on optimizing the placement of rain gardens. Areas with low λ_{HSI} generally have smaller potential for runoff generation, adequate infiltration capacity, and large soil water storage, which makes them less critical for managing stormwater. While these areas may be able to accept additional water (such as from roof drains, sump pumps, or impervious surfaces), they do not pose a significant risk for severe runoff, flooding, or water quality degradation. Hence, from a planning standpoint, these areas are not a priority for GSI placement. On the other hand, areas with moderate λ_{HSI} are more likely to experience runoff but still have adequate capacity for effective water infiltration and treatment. Prioritizing these areas allows city planners and land managers to maximize the impact of rain gardens by addressing both runoff management and stormwater treatment a small-scale GSI, such as rain gardens, can achieve. Therefore, placing rain gardens in areas with moderate λ_{HSI} offers a better balance between suitability for rain gardens and the efficient use of limited resources.

Line 437 – "Cost effectiveness" might not be the correct term, as cost was not considered in the analysis. "Effectiveness" might be more suitable. **Done.**

Lines 468-469 – The recommendation to limit rain garden implementation to such a small percentage of the watershed seems overly restrictive for a GSI practice meant to be widely dispersed in residential areas. Rain gardens are relatively low-cost (compared to other GSI practices) and often implemented and paid for by residents. Is it necessary to limit their use so drastically?

Our recommendation to prioritize rain garden implementation in a small percentage of the watershed is based on the perspective of city planners working at the watershed scale, where the goal is to maximize the effectiveness of GSI with limited resources. The areas identified as most suitable for rain gardens were selected due to their balance of runoff potential and soil infiltration capacity, making them the highest priority for public investment and GSI placement. We agree that rain gardens are relatively low-cost compared to other GSI practices and can be effectively implemented in residential areas. Our recommendation is not intended to limit or discourage residents from building rain gardens on their properties, particularly in areas outside of the highest priority zones. In fact, widespread rain garden implementation at the residential level can complement the more targeted efforts by city planners and contribute to overall watershed health. While the study identifies key areas for prioritizing public rain garden investments, we recognize that rain gardens can be valuable throughout the watershed, especially when implemented and maintained by individual homeowners. We have added a sentence expressing this in discussion and conclusion Lines (443–444; 458–461; 516–523).

Lines 513-516 – Isn't the water captured in the drains a good candidate for redirecting into a GSI treatment practice? Are you implying that the drains are a "solution" to runoff?

In our model scenario with drainage at the hilltop, we observed that when a drainage system diverts water away from the natural flow path, the runoff in downstream areas decreases (as shown in Figure 11). This suggests that development with its own drainage system can reduce some of the runoff that would otherwise flow downslope. The water diverted by the drainage system can be redirected and treated using GSI practices. We did not mean this scenario to be a "solution" but a real-world case, where the runoff is diverted away from the hillslope.

Round 2

Associate Editor Summary: Andrea Ludwig, University of Tennessee

The revised manuscript was reviewed by two of the original reviewers. Both reviewers indicated that the authors had adequately addressed the comments and concerns that arose from the first round of reviews. The notable changes included adding context on how this work expands on Mahat et al. (2024), clarified methodologies, enhanced the discussion, and refined the implications of the study to emphasize how it contributes to the field of ecological engineering design. The reviewers identified some outstanding grammatical errors as well as one area that needs further attention regarding equation 2a and how the variables are explained in the text. Based on these two second reviews, I recommend that we request the authors to address the grammatical errors identified as well as the equation 2a concerns, then assuming that is completed, move towards production and publishing.

Reviewer: Loulou Dickey, Iowa Stormwater Education Partnership

I recommend this paper for publication, pending correction of minor typographical errors on lines 229, 245, 354, and 361.

The revisions have significantly improved the manuscript, addressing the key points raised. I am satisfied with the changes made and recommend that the paper move forward to publication. However, I noticed a few minor typographical errors that should be addressed before final publication:

Line 229: "varying" is misspelled
Line 245: "implement" should be changed to "implemented"
Line 354: There is a double occurrence of "the"
Line 361: "impervious" is spelled incorrectly

Reviewer: Anonymous

The authors have provided thoughtful responses to review comments, and their revisions to the manuscript have provided clarity in methodologies, results, and the broader context of previous research and practice in which their work is situated. I have one additional comment related to the presentation and description of equations in the methods section.

The equation presented for soil depth is labeled as equation 2a in the text but 2b in the list of equations. Following the authors' response to a previous review comments regarding the soil depth determination, I recommend the following revisions to the text to clarify this calculation for the reader:

- ensure that the equation is appropriately labeled and matches the text reference
- Include the abbreviation Dm in the text to clearly define as the soil depth
- define the variable I (I believe this is the binary impervious indicator from the authors response but I did not see this this variable defined in the text)
- describe the binary nature of the impervious variable in the text. This point was clarified in the author responses and it now makes sense to me. I believe it should also be described in the text to ensure readers also understand

Finally, there were a few misspellings in the added text but this should be easy to correct.

Round 2 Author Response

Responses to the Review Comments
We appreciate the comments from the reviewers towards enhancing the manuscript quality. We have addressed all the comments and incorporated the editorial changes.

In the following, we include the original comments from reviewers in italics, followed by our responses and answers. The line numbers in reviewers' comments refer to those in the original manuscript, while the line numbers in our response refer to those in the revised manuscript. Accepted suggestions are marked as **Done.**

Editor Comments
Following careful assessment of your submission, our editorial team and a group of expert reviewers have determined that minor revisions are needed and we would like to invite you to revise the paper according to the comments and suggestions provided.

Thank you. We have made the revisions suggested by the reviewers.

Reviewer #1
I noticed a few minor typographical errors that should be addressed before final publication.

Line 229: *"varying" is misspelled* **Done**

Line 245: *"implement" should be changed to "implemented"* **Done**

Line 354: *There is a double occurrence of "the"* **Done**

Line 361: *"impervious" is spelled incorrectly* **Done**

Reviewer #2

The equation presented for soil depth is labeled as equation 2a in the text but 2b in the list of equations. **Corrected.**

Following the authors' response to previous review comments regarding the soil depth determination, I recommend the following regions to the text to clarify this calculation for the reader:

- *ensure that the equation is appropriately labeled and matches the text reference.* **Done.**
- *Include the abbreviation Dm in the text to clearly define as the soil depth.* **Done.**
- *define the variable I (I believe this is the binary impervious indicator from the authors response but I did not see this variable defined in the text).* **Done.**
- *describe the binary nature of the impervious variable in the text. This point was clarified in the author responses and it now makes sense to me. I believe it should also be described in the text to ensure readers also understand.* **Done (Line 202–205)**.

Finally, there were a few misspellings in the added text but this should be easy to correct.

We have corrected all the misspellings as pointed out. Thank you for your thorough review.