Anonymous Referee #1
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The article by Lee et al tackles an interesting topic in the field of green infrastructure. The research approaches the paper investigated are meaningful for GI under smaller storm events. Some of the assumptions used in the paper need to be better explained and argued. The conclusions are not attended yet due to insufficient description of their methods, model settings, estimation of key parameters, in particular the part 2.2-2.4. Nonetheless, I think that the article had good potential for being published, provided that the following comments are adequately addressed.

General response to Reviewer 1:
Generally, it seems that this reviewer had little issue with the approach, the performance evaluation of the approach, or the demonstration of the effectiveness of the approach at evaluating GI, all of which were the main points to be covered in the MS. Rather, He/She was more interested in understanding how to implement the approach given what seems to be familiarity lack of familiarity with ArcGIS or SWMM software. We will provide clarifying text where appropriate as noted below in the direct responses. We will direct such readers to our Report that addresses this matter to a certain extent as the details apply specifically to the implementation of the approach. But many of the Reviewer's points of confusion and questions can be addressed through consult of existing tutorials and user guides of the software used to develop and conduct this study. We will make attempts to clarify this aspect as noted above (i.e., that this MS is not meant to serve as a tutorial for GIS and SWMM software) in the revision while making sure to cite relevant references where such information exists.

General comments:
1. The research approach replies on a highly resolved spatial database of urban land cover, stormwater drainage feature and topography, what about its potential application in a general context? Most of urban areas may not have such detailed dataset or require extensive surveying and modeling efforts.

- ⇨ *Indeed, highly resolved spatial databases are not always available for many urban areas. This is because these GIS databases can be expensive to develop and maintain; and/or may not be required for conventional stormwater management purposes. However, in our experience more and more municipalities in the U.S., at least, are developing and improving their spatial databases of stormwater infrastructure. To address this comment we would add the following content to section 2.2.1: "Existing databases that include the* details for the stormwater infrastructure in this watershed *are not always readily available to the modeler. In these cases, to adopt the subsequently described approach to GI scenario modeling in SWMM could require considerable ground-truthing and site surveying. In lieu of onsite visits, and as will become apparent from the descriptions below, what would be most important is determining the spatial location of storm sewer inlets. These are often visible from readily available aerial photographs. When elevation data for the storm sewer network is unavailable, much can be inferred using surface elevation data and assuming local construction codes for stormwater infrastructures, such as catch basin depths, and conveyance pipe diameters and slopes were applied. Such approximations would suffice for GI scenario analysis considerations, where storm sewer design is not the primary focus."*
- ⇨ *Also, the reviewer includes land cover and topographic information in his/her assessment on data availability. For land cover, the availability is somewhat irrelevant, as our approach requires land cover analysis and detailed digitization to do the subarea parameterization in SWMM that we describe in the manuscript (MS). This land cover and subsequent Subarea categorization is described in fairly specific detail in section 2.2.2. We struggled with how detailed the descriptions needed to be during the preparation of earlier drafts. Two internal reviewers, prior to submission to HESS, suggested the detail was too much and that the MS was too long. To address this issue we have prepared a companion report that will be published as a USEPA, Office of Research and*

Development contribution, that will be freely available to anyone interested. We will reference this report in the final version of the HESS MS, should it be accepted for publication.

2. Relevant references are needed to support statements in the text, see specific comments for details. The key definitions (e.g., DCIA, ICIA, SPA, BPA) are given, but a conceptual model characterizing these key processes in a watershed and their spatial connections should be provided.

- ⇨ *We will add a new figure that will depict a conceptual schematic that provides context to the DCIA, ICIA, SPA, and BPA categorization. This can be in the form of a side view of a home situated along a street with storm sewer infrastructure depicted.*
- ⇨ *It is important to note, however, that these areas are defined within a subcatchment for SWMM modeling, not at the watershed scale. A watershed in SWMM consists of a number of subcatchments, which interact based on the existing storm collection system.*

3. The land cover characterization in GIS is an essential step to provide inputs for hydrological evaluation in SWMM. Very limited information is given to understand how it is done in GIS analysis. Also readers need more details on how the four types of subareas are subsequently modeled in SWMM (e.g. parameter settings), e.g., how to parameterize BPA, ICIA, SPA for subcatchments.

- ⇨ *As noted under 1. above, we struggled with the level of details to provide. Our intent for the MS was to focus on evaluating the performance of the approach to modeling GI in SWMM. For readers that want specific guidance on implementing the approach the USEPA report is being prepared. This can be referenced in the final version of the MS. It includes details on how to process clip, intersect, union, and manipulating attribute data in ArcGIS. Much of this will be familiar to users of ArcGIS, so we tried to strike a balance in the MS. If the Editor prefers a different tact to providing this information we could try to include as a supplemental section or appendix.*

4. A better description of model calibration process is recommended, e.g., summary of parameters, inputs and outputs, criteria of performance.

- ⇨ *We disagree with this comment. We provide quite a bit of detail on our approach to calibration in section 2.5 and show results of sensitivity analysis in Figure 10; a standard approach to model calibration, as well as giving initial and calibrated values of the sensitive input parameters in Table 1. What we failed to include was the initial and calibrated value for the width of BPA. This will be added to Table 1 in the final version of the MS. The output of calibration, along with performance statistics (i.e., NSE and R^2) is provided in Figure 11. So, we believe the level of detail is sufficient and actually contrary to what the reviewer suggests.*

Specific comments:

1. P1, L21-24: it is confusing to mention the dimension and details of calibration parameters in the abstract before the relevant descriptions are provided.

- ⇨ *This text in the abstract is not meant to note dimension and details of specific calibration parameters, rather to note a significant aspect about the approach to SWMM set-up that is presented in this study. What the text indicates in the abstract is that adopting the approach reduces the number of parameters that might be considered during calibration. However, while Reviewer 1 likely misunderstood the context for the description, Reviewer 2 correctly points out some inaccuracies in this statement (see general responses above and specific responses below) so we will eliminate it from the abstract*

2. P2, L13-15: there are conflicting conclusions about the cost-effectiveness of GI, please provide references for your statements. In particular, the detention pond can be costly in terms of the construction and maintenance costs.

⇨ *That is why we put the word "may" in the sentence on L12. We will add the following to the sentence at L13: "…., like detention ponds, especially in cases where land is not available or very expensive."*

3. P2, L27-30: how the upstream area is discretized and the subcatchment are parameterized matter both in the modeling and calibration. Typical way to discretize subcatchments replies on GIS-based hydrological and landuse analyses to achieve reasonable characterization of natural drainage divisions. Any references to support your statements?

⇨ *Seems like these comments are related to P3 (not P2), L27-30. We will try to include the presented criteria by the reviewer with relevant references, e.g., SWMM Application Manual (Gironás et al., 2009).*

4. P3, L32: please define "a unit-area based analysis"

⇨ *The term unit-area is a relatively common term in the field of stormwater modeling that refers to normalizing model output by using a common spatial dimension, e.g., in our case, 1 acre. We don't think it is warranted to define this relatively standard term in the introduction. Furthermore, in addition to the spatial dimension we define the land cover characteristics of the unit-area specifically for this study beginning on P10, L22. and at P11, L4. We will add to this sentence the word 'unit' to "hypothetical area" to help clarify.*

5. Figure 1: No legend for background landuse

⇨ *Good catch. A relevant legend for the drainage system and the land use categorization will be added to the map.*

6. P4, L15-20: A sketch of mentioned drainage system (manholes, pipes) is missing. Can author provide more information about the current drainage in the area? How many pipelines and manholes ? what is the current service level of the system?

⇨ *The existing drainage system is presented in Figure 5. A legend will be added to the figure to help define it. We don't see how statistics on number of pipes and manholes or 'current service level' of the system is relevant.*

7. Section 2.2.2: Details are needed to understand the spatial analysis used in the study. what are the inputs and resolution? What types of GIS tools and processes are used to identify and digitize the 16 land covers? how do you estimate the future potential for GI implementation (e.g., to evaluate the potential of downspout disconnection for a main building) and which parameters are used?

⇨ *We used 0.76 m LiDAR as noted in P6, L18. We felt the level of detail called for by the reviewer unwarranted for the specific purpose of this MS, which is to highlight the specific aspects and provide results of the analysis of performance of the approach developed for GI Analysis in SWMM. And as mentioned earlier, details on GIS analysis are included in the USEPA report that will be referenced in the final version of the MS, or if this is deemed insufficient, we can try to cut and paste relevant sections for addition to supplementary materials section or appendix. The referenced report includes how to process clip, intersect, union, and manipulating attribute data.*

⇨ *For the third question; a systematic approach to 'estimate the future potential for GI implementation' would be quite difficult given uniqueness of place considerations, and is beyond the scope of this research.*

8. P6, L1-L10: Though Figure 3 depicts the different boundaries of BPA, I still don't understand how to set the BPA in SWMM and which parameter do you use to represent BPA? how did you choose the buffer widths in this study? Can author provide more information on how to use the "intersect" tool for estimating the BPA and SPA?

⇨ *The description of how to set-up the BPA in SWMM starts on P8, L31. We note that the original widths of the BPA are arbitrarily determined and explain why this has to be the case on P6. To provide more details on using the intersect and other functions in ArcGIS would require a step-by-step approach to using ArcGIS software. We, in fact, provide this detail in the USEPA report that is undergoing internal review and will be referenced in the MS, but we feel it is inappropriate for this MS to call for a tutorial on how to use certain functions in ArcGIS. An interested reader can find this information searching the help menu and user guides of the ArcGIS software.*

9. P7, L15-16: Authors considered DS-IA and DS_PA in subcatchments, could authors show how the two parameters are obtained? Is it a simple characterization of the dry ponds and detention areas in subcatchment?

⇨ *DS stands for depression storage, as noted in the list of abbreviations. DS is a standard term used in urban hydrology that denotes the depth of water that can collect on urban surfaces. The initial value assigned to DS per land cover type was assigned based on recommendations or defaults described in the SWMM User's manual, as noted on P8, L19. DS has nothing to do with dry ponds or other built detention areas.*

10. P7, L16-20: How did you choose the values for Scut and IMD? Can you provide more details on the division of IA into areas with or without DS? Also you mentioned several ways to route the internal flows, how do you model it in SWMM?

⇨ *We assign these values, in particular, using recommendations from the SWMM user manuals as noted on P8, L2: We will make note of this for the infiltration parameters earlier in this same section to help clarify. As for the other questions posed here, these can be answered for interested readers by consulting the SWMM user's manual documentations already referenced. We don't think addressing these questions with new additions to the text is warranted. It becomes more apparent with each comment that this reviewer has little experience using SWMM, we feel it is only necessary to go into the details of how to model urban hydrology using SWMM as they pertain to the described approach to GI scenario analysis. It is not our job to provide a tutorial on how to use SWMM. These are available at the SWMM download site, which will be referenced in the revision*

11. Section 2.4.2: (a) vegetation swale (VS) seems an appropriate option to represent BPA, how the authors determined the parameters for VS, e.g., berm height, vegetation volume fraction? (b) how the authors determined the values of initial saturation and % of subcatchment imperviousness draining to the BPA from the geoprocessing steps? (c) I am confused about the way to model BPA, is it modeled as a VS (LID competent), or an individual catchment, or changes in subcatchment imperviousness and width? Why set the width (60 feet) for BPA?

⇨ *We will try to clarify further in the revision, but generally we already state that parameter values are set based on guidance from the SWMM user manuals or from our experience working in urban areas. All of these details will be added to help clarify, including, berm height (0.1-in or 2.54-mm to minimize any storage effect within the berm, which is the case for real BPA), vegetation volume fraction (0, this is assumed to be negligible.), % imperviousness draining to the BPA (ICIA / TIA, where TIA = DCIA+ICIA). BPA is modeled as a VS (SWMM LID option) within a subcatchment, not as an individual subcatchment. We further acknowledge that many aspects of the BPA are unverifiable, and rationalize why this is not relevant to the integrity of the approach in section 2.3.2.*

12. L9, L18-19: can authors give an detailed example on the evaluation of the groundwater flow in the study region? Is it calculated using Eq. 3 (then how the authors incorporated the equation in SWMM for groundwater simulation?) or just the difference between individual subcatchment surface and its nearest stream bottom?

⇨ *No, we cannot provide more detail on groundwater flow. As mentioned in the manuscript, there was no observational data on groundwater flow. This is typically the case in urban modeling applications using SWMM. We will clarify that groundwater modeling parameters were defined using the SWMM Reference Manual and users' group knowledge base (e.g., https://www.openswmm.org/Topic/1465/groundwater-parameters; https://www.openswmm.org/Topic/4840/groundwater-values). The remaining questions in this response are irrelevant to our study.*

13. Figure 5: what is the difference between Figure 4 and 5? it seems that both figures mainly give the depiction of the subcatchments. Adding regional drainage network (manholes, pipelines) are recommended.

⇨ *Figure 4 is map of the watershed with relevant land cover and subcatchment delineation. Figure 5 is the conceptual representation of the area being model in the SWMM software, which includes the configuration of the storm sewer drainage network. As mentioned earlier, we will add a relevant legend to Figure 5, to help clarify.*

14. P10,L26- 28: Conceptual illustrations of the 6 options are well presented in Figure 6, but I find it difficult to understand how the 6 options are modeled in SWMM in details? for example, which subcatchment parameters are used to represent the different subareas (e.g. ICIA, TIA) and how to control the flow or routing directions?

⇨ *As shown in the legend, each rectangular represents a subcatchment in SWMM, and the dotted line divides subareas within the subcatchment. A rectangle without a dotted line means the subcatchment consists of a single (homogeneous) subarea, either 100% impervious or pervious. The arrows represent flow routing directions. We will add these clarifications. The legend in the figure will be updated.*

15. P11, L20-24: any reference to support your assumptions on the lengths for overland flows and surface slopes?

⇨ *Length of overland flow means the flow length where the flow is maintained as overland flow (or sheet flow). It doesn't mean the physical length of a drainage area. This has long been a point of confusion in SWMM modeling. We will attempt to clarify in the revision. Surface slopes of typical urban drainage features are based on construction code or are inferred based on the GIS. The relevant references will be added.*

16. P12, L2: A brief explaining of the method is recommend.

⇨ *The following brief description will be added: "The 95th percentile rainfall event is defined as the measured precipitation depth accumulated over a 24-hour period for the period of record that ranks as the 95th percentile rainfall depth based on the range of all daily event occurrences during this period."*

17. P12, L7-10: one way to represent the GI can be the decrease of DCIA, which impacts the subcatchment imperviousness directly. That is one side of the problem, another is to attenuate the surface flow and slow down the speed. Is there any measure to model this aspect in your approach?

⇨ *The effect of GI scenarios on the temporal dynamics of runoff is considered by comparing storm hydrographs before and after GI addition to the model. To address this comment we will add a note on the temporal changes to the storm hydrographs shown in Figure 13 to the results. Namely something like this: "It is interesting to note from Figure 13 that the peak flow for the event depicted in the figure is slightly higher in the GI Scenario, but that the duration of flows slightly smaller than this peak is longer in the baseline scenario."*

18. P13, Eq. 5-9: how to calculate the different Q values in SWMM? which result files are used to obtain these values?

- ⇨ *This seems to be another question about SWMM modeling basics, to include the details of which are not appropriate for this MS. The reviewers question can be answered by consulting the SWMM user's documentation. If this question is based on the hydrograph separation procedure the calculations for the individual Q values are explained in the manuscript. Further action related to this comment is unwarranted.*

19. P14, L16-18: I don't understand, if in option 4 where rainfall onto PA is completely captured by DS or infiltrated into soil, how come the simulated flow rates are much higher than the ones from the rest options?

- ⇨ *The following description will be added to help explain the results observed for option 4: "Hydrologic connectivity is very important. In Option 4, the one-acre area is modeled as a single subcatchment with two subareas: IA and PA. Because this setup ignores the difference between DCIA and ICIA, the entire impervious area (subarea IA) is actually modeled the same as DCIA, which means all of the runoff is discharged to the storm drainage system directly with no abatement. Under a small storm (like <1-month storm), runoff occurs only from impervious area, more specifically only from DCIA. For small storms, runoff from ICIA is completely controlled by BPA (if ICIA exists), but no ICIA is modeled under Option 4. Because of this, modeled runoff from this option is higher than any of the other options.*

20. P17, L1-2: without field measurement for valuation, how do you interpret the results? Given the clay type soil, 48% is much higher than expected.

- ⇨ *We think this comment is based on a mis-understanding of the term interflow. We validated the total flow at the outlet of the watershed for the baseline condition using observed flow data. By applying artificial modeling conditions (e.g., DCIA only, or excluding the groundwater component as described in the manuscript), we tried to show how to develop more effective GI implementation scenarios. These conditions are contemplative and do not actually exist, so they cannot be validated with measured data. The 48% interflow doesn't mean all the 48% flow discharges through the entire soil layer as groundwater. There would be considerable amount of very shallow subsurface flow that discharges through a shallow layer near the surface with a relatively high porosity. We will try to clarify in the revision.*

21. P17, L15: can you provide some explanations on the increasing peak flow resulting from the GI scenario?

- ⇨ *Definitely. We will add the following explanation: Overall the flow volume is reduced from the GI scenario. However, when the peak occurred around 15:30 (shown in Figure 13 the capacity of the GI for controlling stormwater was already exceeded because of controlling runoff during the previous rainfall that occurred between 7:00 and 14:00. Under this saturated condition, even the direct rainfall to the GI area will be discharged with minimum abatement. If there is no GI (as in the baseline condition), the same area receives only direct rainfall, there is no additional runon from impervious area, and that rainfall is controlled by still available surface depression storage and not-saturated infiltration capacity.*