

***Interactive comment on* “Stream restoration and sanitary infrastructure alter sources and fluxes of water, carbon, and nutrients in urban watersheds” by M. J. Pennino et al.**

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To the Editor of HESS:

We would like to thank the editor and reviewers for all of their comments and suggestion. We have compiled the editor’s and both of the reviewer’s comments below and we have thoroughly addressed and responded to each comment. Please note that all

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of our responses are in red.

Thank you, Michael Pennino

Response to Referee 1 Comments for HESSD

A general comment is that is difficult to refer to the different sections, as there are not page numbers and the line numbers re-start at every page. The revised manuscript now has page numbers.

Another general and worrying issue is on the use of terminology and concepts, as I have the feeling the authors use them not in the best possible manner. We have gone through the reviewer's suggestions to the abstract and applied these same suggestions to the whole manuscript (see details below).

Finally, I also think that everything in the paper is too case-specific, as the authors were not looking for a broad picture that can be interesting for readers from elsewhere. We included three new sentences to the introduction to show how this work relates to similar studies globally: 1) the first sentence of the second introductory paragraph now states: "The potential for increasing urbanization and climate change to alter hydrology and nutrient fluxes is a problem for cities globally (Julian and Gardner, 2014; Kaushal et al., 2014b; Old et al., 2006; Smith and Smith, 2015; Walsh et al., 2005b)." 2) We added another new sentence in the second paragraph of the introduction, which puts our work within the context of a recent global review and synthesis of stream restoration: "A recent global review and synthesis suggests that certain forms of stream restoration have potential to retain watershed nutrient exports particularly during baseflow, but further evaluation across streamflow is necessary (Newcomer-Johnson et al., 2016). Most of the restoration studies in that paper have focused on baseflow but this study spans streamflow variability. 3) A third new sentence discusses how sewer leaks is a water quality problem globally: "These techniques and others have been used globally to detect the influence of leaky sewer infrastructure on water quality (Ekklesia et al., 2015; Hall et al., 2016; Risch et al., 2015; Tran et al., 2014; Wolf et al., 2012) and it

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has been shown that sewer leaks have impacts during baseflow and stormflow (Divers et al., 2013; Phillips and Chalmers, 2009; Rose, 2007).”

Title: I suggest to change ‘sanitary infrastructure’ to ‘sewer network’ or “sewage system” in the title. In the Title we changed ‘sanitary infrastructure’ to ‘sewers.’

Title: I’m also not so happy with the use of ‘alter’, as it has a negative meaning. To restore a river will influence, or shape, but not really alter. Keep in mind that the two forces you mention are probably pushing the system in opposite directions: restoration and chemical pollution from the sewage system. In the title we changed the word ‘alter’ to ‘impact.’

Abstract: Some general issues in the abstract are that it lacks structure, and that is too long. Authors should try to follow the universal rule of the 5 parts in the abstract: Global why, specific why, how, what, and what it means! We have now made some minor edits to the abstract and removed some text in the abstract to improve flow and clarity.

Abstract, P1, L22: What does it mean unrestored here? I suggest using a different term. Unrestored means not restored, but a pristine river is also an unrestored river. If these 3 rivers are degraded, or altered, or canalized, or use that term. We have changed the abstract and the entire manuscript to use the terminology “urban restored stream” or just “restored stream” for the stream with restoration and “urban degraded” for the other three streams. We are no longer using the term “unrestored” in the manuscript.

Abstract, P1, L23: What do you mean with draining a stormwater management? Stormwater management is not a place, is an action. We added the word ‘upland’ before ‘stormwater management’ and the word ‘systems’ after ‘stormwater management.’

Abstract, P2, L1: How can it be that the peak discharge decreases because of a stream

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restoration? Stream restoration means to improve the conditions within the stream channel. Modifications in the stream channel can influence the hydraulics of the system (depth-velocity relationships), but not the peak discharge, which depends on the basin conditions. We have added some additional text and supporting references to the introduction to explain why we expect stream restoration to impact peak discharge:

“We predict that the stream restoration which reconnects the stream with its floodplain has the potential to impact peak discharge and attenuate flashy flows, due to the peak-flow water overflowing onto the floodplain and infiltrating into the floodplain soil. In fact, flood plain reconnection is an a priori objective in restored streams in Baltimore (Duerksen and Snyder 2005; Greenman-Pedersen Inc. 2003).”

Duerksen C, Snyder C. 2005. Nature-Friendly Communities: Habitat Protection and Land Use Planning. Washington, D.C.: Island Press. 421 pp.

Greenman-Pedersen Inc (2003) Minebank Run II stream restoration design report and 100-year floodplain impact analysis. Appendices, Laurel, p 10

Abstract, P2, L 2-5. These comparisons cannot be done if the basins are different. You should compare it with equal basins, or with the same basin before the restoration. If you would like to assess the restoration effects, you should follow a BACI or a similar design. Furthermore, and in line with the previous comment, an in-stream restoration cannot affect the specific discharge (L/m<sup>2</sup>/d). The objective of this study was to show the impact of urban stream restoration and sewer infrastructure on the sources and exports of water, carbon, and nutrients in urban streams. To make this more clear, to the second objective listed in the last introductory paragraph we added at the end of this sentence “. . .to assess the role of stream restoration and potential pollutant sources, such as leaky sanitary sewers.”

To address the first objective of this study we conducted a before and after analysis for the effect of stream restoration on hydrology.

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To address the second objective of this study we compared the sources and exports among the four watersheds in this study, but due to the small sample size and the differences between watersheds, this paper never asserts that specific management strategies are the cause of the differences in sources or exports. Causality is difficult to attribute with full certainty in some management studies. However, we show how the four streams statistically differ and suggest the influence of leaky sewer infrastructure and stream restoration. We agree with the reviewer that in order to unequivocally demonstrate there is a significant effect of management when comparing sites, it is necessary to have a larger sample size and to control for other factors by having similar basins. However, our results provide new information regarding sources and exports of water, carbon, and nitrogen in urban restored and degraded streams, which is currently scarce in the literature.

Abstract, P2, L5. Streams are not more or less developed. The basin might be more or less developed, but in any case, you must specify in which sense the basin is developed. We changed 'less developed stream' to 'a stream in a less developed watershed'

Abstract, P2, L6. Again, stormwater management is an action, not a place. We added the word 'systems' after 'stormwater management' or 'SWM' when appropriate, throughout the abstract and manuscript.

Abstract, P2, L9-12. The units you provide (kg/ha/y) refer to the basin, not to the stream. When describing exports from streams we changed it to exports from the watershed / catchment where appropriate, throughout the abstract and manuscript.

Abstract, P2, L15. This time, I believe that it's the way round. I bet that here you mean a synoptic survey along the stream, or the mainstem, but not the watershed (or basin). Correct, we changed the word 'watersheds' to 'streams.'

Abstract, P2, L21. To minimize watershed nutrient export? Is this the goal of management, or to reduce the chemical concentrations of some pollutants in the river, that is, to improve the water quality? Chemical concentrations are important to regulate,

but it is also important to reduce nutrient export from watershed to protect downstream ecosystems from eutrophication and hypoxia. For example, there are regulations for total maximum daily loads (TMDLs) by the Clean Water Act in the USA.

Abstract, P2, L23. Why should the repair of the sewer network involve channel modifications? This might be only in some cases, but is case-specific and not a general issue. In general, most of the text is written with a narrow focus, and might not be of interest for a broader audience. Stream restoration involves channel modification, and if the sewers are degraded, then they should be repaired at the same time, otherwise the stream restoration may not show the expected nutrient benefits.

Also, sewer and water infrastructure very often follows the stream channel to capitalize on slope and therefore, channels are redesigned during restoration to protect infrastructure from damage and further erosion (see Mayer et al. 2010 JEQ). This sewer construction approach is repeated in virtually all metropolitan areas so the issue is of general interest.

Mayer, P. M., Groffman, P. M., Striz, E. A., Kaushal, S. S. 2010. Nitrogen Dynamics at the Groundwater-Surface Water Interface of a Degraded Urban Stream. *Journal of Environmental Quality* 39(3): 810-823.

We have modified the last four sentences of the abstract to by cutting out any duplicate material/sentences and by moving some sentences around for clarity. We have also added some of the above text and the citation to the conclusion section to help make this of more interest to a broader audience.

Abstract, P3, L 1-5. The authors jump here to somewhere, aiming to something that has not been discussed before. The last section of the abstract might have general implications, but always based on the submitted work. There are two sentences in the abstract prior to this that describes the how the results of this study suggest the influence of groundwater sources. But we further revised the abstract, P3, L 1-5, to make it clear that this groundwater influence is from the leaky sewer infrastructure

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discussed above and supported by the results of this study.

These are just comments on the abstract and title, which is just a small part of the manuscript, but the most important one. Authors should carefully review the entire manuscript having all the above mentioned issues in mind, and ask for assistance from other colleagues for an internal review before resubmitting their work. Throughout the manuscript, we made sure that it was clear in how we described watersheds as developed and not streams as developed. Using the phrasing a ‘stream in a less developed watershed,’ instead of ‘a less developed stream.’

Throughout the whole manuscript, when describing exports from streams we changed it to exports from the watershed / catchment (when appropriate).

We made sure to change the use of the terms Load (mass) or Export (mass/area/time) in the manuscript was used consistently and appropriately.

Also, when the acronym for stormwater management, ‘SWM’ was used we made sure to add ‘systems’ after or ‘watershed’ before, depending on the context.

Please also note the supplement to this comment:

<http://www.hydrol-earth-syst-sci-discuss.net/12/C7065/2016/hessd-12-C7065-2016-supplement.pdf>

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 13149, 2015.

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