Original comments in black, author responses in ***bold italics***.

Thank you for your very thorough comments!

General Comments:

There is an underdeveloped argument made in this paper that the authors' "mechanistic" model, outfitted with parameters derived from a statistical sampling process (Monte Carlo method), are better than: : : regression analyses, other models? If it is better, there needs to be some measure by which the authors can argue it is better.

This is mostly done in the introduction. Many different modeling approaches are described, along with their weaknesses. For example, it is mentioned that many models do not include water price, and our model does use water price. Weaknesses of each modeling strategy are pointed out in the introduction, and our modeling approach is shown to overcome many of these weaknesses (although our approach has weaknesses of its own, which are documented). If all of the referenced models were to be compared by their accuracy, this would constitute a whole paper in itself. We highlight some of the features that make our approach be a better fit to examine water conservation based on physical parameters instead of empirical relationships.

There is an equally underdeveloped argument for the importance or usefulness of the results, who/what models their results agree or disagree with, and what is novel about the findings. There is an argument made that the method itself is novel to household water use and conservation studies, but the methods themselves are not new.

In both the existing conditions and least-cost conservation models, the specific Monte Carlo methods used in each model are not clearly described. For example, in the existing conditions model, I read that parameter distributions are sampled, and each sample/iteration represents a modeled household for which water use is calculated. These samples, in aggregate, characterize a neighborhood's water use. What the authors mean by convergence in reference to this method remains unclear. The authors' application of MC methods in the least-cost model is also unclear.

Responding to your comments and those of other reviewers has helped clear up the description of the application of MC methods in the paper. As mentioned later in this response, the convergence of the MC runs was not tested in a strict way, but rather in a coarse way by resembling total water use. So any references to "convergence" have been removed and replaced with the detail that it was done for 500 houses.

The introduction is difficult to follow. Please provide introductory sentences to each paragraph stating the purpose of mentioning the literature cited, and how those references relate to the authors' study.

Rearranged the introduction to flow better, and put better transitions in. It was somewhat scattershot—hopefully it is a bit smoother now.

It does not become clear until section: 2.1.1 that what the authors have done in – at least with the existing conditions model (and I believe also with the least cost conservation model) - is modify/improve upon an existing model, and then applied and calibrated the model to new data. This should be stated in the Introduction.

The paper was rearranged to give the reader a full picture of the modeling process first, followed by model details. The "basic modeling process" that reviewers found helpful has been moved to the section immediately following the introduction. We would like to save the introduction for the literature review. Since the introduction is somewhat long already with the literature review, elaboration on modeling process and details follow the introduction.

The "basic modeling process" descriptions for both models are very helpful. These should be summarized (or simply just repeated in sentence form) sooner – in the introduction.

This has been mentioned by other reviewers as well. Reference

Was any sensitivity analysis performed on the model? Was it ever demonstrated that the number of parameters estimated for each model is necessary?

No sensitivity analysis as such was performed—but this would be a good idea for future modeling. The number of parameters (69) is high, but not higher than some other studies: Jacobs and Haarhoff used 189 parameters

The authors list two DeOreo et al., 2011 references that are not distinguished when cited in the text (e.g. Page 4872; line 11, 16).

One was just DeOreo 2011, the other was DeOreo et. al 2011, so they are distinguishable when looking at the reference list

I'm not sure why the title references MC methods - there are a variety of methods used in their modeling process.

There are indeed a variety of methods used, but the basic underpinning of all of them is the Monte Carlo loop. Both the "existing conditions" and "least-cost conservation" models are done in Monte Carlo fashion, where no other technique applies to both the models.

Specific Comments:
1. Page 4871; line 12-13: "effective" and "adequacy" are unclear terms; what is the measure of adequacy and effectiveness that the authors refer to?

Rephrased to make it reduce the confusion: now it reads something like "the effectiveness of the economically-driven strategies is linked to the socio-economic conditions"

2. Page 4871; line 20: I don't understand what the authors mean by "data management programs" – this is too vague a description.

We think the description is probably appropriate as it is—it is meaning nothing more than good data storage and accounting

3. Page 4871; line 23,26: What "measured data" is this referring to – household water use data?

Changed to "metered" instead of measured

4. Page 4871; line 24: a model does not "depict" a good fit; a model has a good fit (or not) according to a measure like Rˆ2, AIC, BIC; model predictions/estimates demonstrate a good fit by minimization of a loss function like the RMSE. The language in this section makes it sound like the authors are not familiar with model validation.

Changed the wording to say that the model had good fit, not depicted good fit

5. Page 4872; line 15: "The strength of the regression analysis: : :" Why is this information provided? To what effect? Is this related to the "reasonable" performance mentioned in the next sentence? I can't tell.

It is saying that although the average water use predicted was reasonably close, the individual predictions did not fit the data particularly well (R^2 of .4). We added a few words to make it clear that the regression was on individual home use.

6. Page 4872; line 23-25:

a. Delete this first sentence; the second and third say the same thing. Then, just mention further down in this paragraph that the authors' methods make use of more, newly available measurement data.

Agree that 2nd and 3rd sentences effectively say the same thing: Decided to get rid of the 3rd sentence

b. If this sentence is not deleted – it sounds like the authors are saying that "mechanistic" and "deductive" models are complimentary (or are synonyms); this does not make sense.

The sentence was indeed deleted

7. Page 4873; line 2:

a. Specify what Monte Carlo approach is taken (since this is the first mention made in the paper after the abstract); there are many applications of MC methods.

This is still just an introduction—the M<onte Carlo approach details are spelled out in section 2

b. Please consider if use of the phrase "to include variability" is what the authors meant.

I think it is really what we mean

8. Page 4873, line 6-8: This sentence is confusing:

a. Does the "novel way" that differs from the "more deductive (statistically-based) approaches" mean that the author's model IS deductive, but less so than other models? MC sampling methods ARE a statistically-based approach, but it sounds like the authors are saying that their approach is "novel" because it is more "mechanistic". Please clarify.

Decided to delete this sentence based on your comments and other reviewers' comments

9. Page 4873, line 18: what does it mean that the virtual households are “given” by an MC iteration? Still don’t know what the “iteration” is.

“Given” was an awkward word here, changed it to “generated”

10. Page 4875, line 12: explain what you mean by convergence; what are the convergence criteria?

Very good point. Convergence wasn’t explicitly analyzed, except in a kind of back-of-the-envelope way, so it is misleading to use the word convergence. Changed the phrasing to make it clear that it was truly done for 500 houses, not until convergence.

11. Page 4875, line 16: “are used to capture uncertainty” – this is a weird way to phrase this, consider: “probability distributions capture variability in water use parameters”

Liked the suggestion and changed it

12. Page 4875, line 19:

a. “end use studies” from which parameter distributions are formed: mention that these are the studies previously cited in the introduction, or cite them here if they are different.

Pointed the reader to the previously cited references in the introduction

b. “other literature” needs citation, or reference to where they are already cited.

There is a lot of “other literature”, and it doesn’t seem like the place to list all of the references. This information is fully spelled out in the referenced thesis

c. Are the end use studies and other literature all specific to the study area used here? If not, need to justify how they still represent a relevant distribution for this paper’s study area.

Describing how each and every study applies to the study area would require a large amount of text, and this paper probably isn’t the place for it. Interested readers can see the thesis for the gory details.

d. Re cite to Cahill, 2011 (here and elsewhere): The citations from the thesis should be provided here instead of the thesis.

The revised reference list includes a URL for a version of Cahill 2011.

13. Page 4875, line 23 – Page 4876, line 2: This makes sense, but would be unclear to someone not familiar with MC sampling of model parameter inputs. My understanding is this: this method captures study area water use by way of sampling from the full (empirically-based) distributional range of each parameter; individual realizations from parameter distributions, when plugged into a formula for water use, describe one realization of that water use. Many samples will therefore describe many realizations of individual household water use that when combined, describe a community of water users = a modeled neighborhood based on real neighborhood data.

This is correct. The intended audience should have a loose grip on what MC modeling is.

14. Page 4876, line 2-3: This point needs serious clarification and justification:
    a. Clarify what correlation/covariance exists, between what parameters, and to what potential effect (in the model). It is known that correlation between model input parameters can bias results, and either increase or decrease variability in model output. This needs to be acknowledged, and the disregard of potential or known correlation between input parameters needs to be explicitly stated and justified. When correlation does exist between parameters, there are data transformation and sampling methods that can be applied.
    b. The phrasing of this sentence: 'including covariance' and 'such relations exist' are vague, and makes it sound like the authors do not understand the problem of correlated model input parameters, or how it may be affecting their results.

We added a few more sentences to point that the covariance is quite important, but it wasn't analyzed here. We provide an example of how it could be important (shower length and shower frequency)

15. Page 4876, line 13-15: Need to say why wet/dry seasons are relevant for urban household water use; I'm assuming it's because of the outdoor/landscaping water component, but need to say this if that's the case.

We added a note to say that outdoor use is affected by the seasonality.

16. Page 4878, line 25: Please also state what is sampled in the MC process; presumably this model is "solved" with linear programming methods; what in the model list above (page 4877) is sampled iteratively?

We changed the sentences to make it clear that all 4 steps are performed for each "house" in the Existing Conditions model.

17. Page 4879, line 20 - Page 4880, line 2: Are these methods the authors' own design, or do they stem from another model or method cited previously? If they stem from, or build upon, another model or method, please mention and cite (as was done in the 'existing conditions' model)

These are the author's own design, so no citation is needed

18. Page 4887, line 5-8: Again, did the authors considering conducting a sensitivity analysis of their model to its parameters to see if it's actually necessary to estimate/ sample all parameters?

We did consider it, but we didn't end up doing it. That would be a good extension.

19. Page 4887, line 9: Nice that the authors mention this, it's a really important point.

Thank you. At the end utilities need revenues to maintain operations and healthy finances.

20. Page 4887, line 20: clarify what you mean by robust; robust to what?

Shortened the sentence and got rid of the "robust" mention

21. Page 4887, line 7-8: "more" detailed and "more" mechanistic than what? Again, why is this better, or for what purposes/applications is more detailed and mechanistic better? Need to be explicit about that.

Made it clear that it was more detailed and more mechanistic than traditional regression modeling approaches

Technical Corrections

1. Page 4870; line 4-6: this sentence is awkward, re-phrase; a suggested re-phrasing:
   a) "This study simulates water use in a single-family residential neighborhood using end-water-use parameter probability distributions generated from Monte Carlo sampling."
   b) Monte Carlo methods are "iterative" by nature; remove word "iterative"
   c)

Thanks for the suggestion—that's a lot cleaner

2. Page 4870; line 7: "existing conditions" of/pertaining to what? Define this.

Clarified to mean existing water use conditions in 2010

3. Page 4870; line 22:
   a. What kind of "devices" does this refer to? Specify.

   Made it clear that the devices are "water-consuming"

   b. Remove "quite" – unnecessary.

   Changed it

4. Page 4871; line 3: Add comma after "homes"

Reworded sentence

5. Page 4871; line 5: Remove "etc."

Changed it

6. Page 4871; line 14-17: "Sauri (2003) presents a qualitative approach..." to what?

Made it clear it was to water demand

7. Page 4871; line 21-25: Does the "end-use model" discussed refer to Gumbo et al. (2003) or Blokker et al. (2010)? The two sentences following the citation (Gumbo et al., 2003) on line 21 are unclear as to their reference.

Made the referencing more clear

8. Page 4871; line 26:
   a. does "it" refer to aggregate demand?

Made it more clear

b. “close to”: what does this mean?

It just means that it matched the data well

9. Page 4872; line 1: In reference to “water end use data”: at the beginning of the introduction, define “water end use(s)”, and list a couple specific examples. Then throughout the rest of the text, refer to this term simply as “end use”.

A few examples are presented at the beginning of the introduction, “water end use” is now changed to “end use”

10. Page 4872; line 1: models don’t “attempt” things: : :. Replace “some models have attempted to estimate” with “models estimate”

Changed it

11. Page 4872; line 6-9:

a. replace “has use” with “is useful for”;

Changed it

b. “prediction” of what (the conservation potential)?; “estimation” of what (again, conservation potential)? If not the same thing, specify; if the same thing, just say “longterm, large-scale prediction of X”

Changed it per your suggestion

12. Page 4872; line 6-9:

a. do the authors really mean “much” or “any”?

We do mean much, not any

b. Does “which can cause varying effectiveness: : :” mean “these models therefore result in varying effectiveness [again, what measure of effectiveness]: : :”. Make the “which: : :” statement a new sentence; this sentence is over-long.

Shortened the sentence

13. Page 4872; line 10: add comma after “Still”

In this case, “still” is intended to be used without a comma

14. Page 4872; line 17-19: This sentence is awkwardly phrased and ungrammatical; some suggestions:

a. Replace “have a reasonable performance” with “perform reasonably” or “show reasonable performance”

b. Replace “are useful to estimate” with “useful in estimating”

c. Add “of” after “effectiveness” in line 18.

Changed it

15. Page 4872; line 20: “usually absent: : :” from these models, or from what?
Changed it to reference the models

16. Page 4872; line 20: Use of “However” in this line (after the previous line starting with “However” also) is unclear.

Got rid of a however

17. Page 4873, line 24:
    a. Replace “builds” with “that builds” or “built”

    Changed it

    b. Replace “finding” with “that finds”

    Don’t think this one should be changed

18. Page 4873, line 26: should “of conservation savings” be “on conservation savings”?

Changed it

19. Page 4874, line 3-4: this sentence is awkward, passive voice, and vague with respect to “insights” – say what insights are, or provide an example, in this sentence.

Changed it.

20. Page 4874, line 6: “Both models extend of a models” should be “Both models are extensions of models”

Changed it

21. Page 4874, line 10: Still don’t know what the authors mean by “reasonable”

It was unnecessary, deleted it

22. Page 4874, line 9: I believe these are the same “other” models mentioned before in the introduction; just call them something in the introduction so they can be specifically referred to here and anywhere else in the document.

Deleted the sentence, as it had been said elsewhere in the paper. Since the Blokker study is only mentioned one other time, it is not given a special name

23. Page 4874, line 11: Add comma after “yet”, and just make this a new sentence (starting with “Yet”).

Deleted sentence (see above comment)

24. Page 4874, line 16: Add comma after “CA”

Changed it

25. Page 4874, line 23:
    a. Replace “to the” with “to this”

    Changed it

    b. It is unclear whether or not the “study area” is just this neighborhood, or some area containing this neighborhood (that is larger than the neighborhood).

    Deleted that reference to a study area, as the neighborhood is already mentioned in the sentence

26. Page 4875, line 4-5: “are presented in their assumed market penetration rates”: this is unclear; what does “presented” mean in terms of the model?

Perhaps you may have misread? It is actually “present”, meaning that they exist in their penetration rates

27. Page 4875, line 6-7: re-phrase sentence:
    a. In “it allows”, is “it” the model?

    Changed it to “this simulation model allows”

    b. Change to “: : :specific alternatives’ affect on total water use”

    Changed it

28. Page 4877, line 25: re-phrase “define and solve the optimization equations mixed linear programming”. I don’t understand what this means; did the authors mean “using mixed linear programming methods”?

Changed it to what you interpreted it as
29. Page 4878, line 22-23: please cite the “EBMUD water shortage contingency plant”

Added the citation

30. Page 4879, line 21:
a. Insert “a” between “cutoff” and “proportion”, or re-phrase otherwise

Rephrased

31. Page 4880, line 9-10:
    a. Replace “to” with “that” in line 9

    Changed it

    b. I find the first half of this paragraph (starting with line 9) unclear. The second half is clear.

    I cleaned up the first half a bit to make it more clear

32. Page 4885, line 3: define lphd and gphd.

Defined them

33. Page 4885, line 16: add “of” between “rates” and “most”

Changed it
34. Page 4885, line 28: re-phrase as “These preliminary model results also: : :”

Changed it
35. Page 4886, line 4-5: re-phrase; awkward and ungrammatical.

Rephrased
36. Page 4886, line 23-25: to what affect?

Not sure what you mean here? We’re trying to say that adding this payback period would make the model a bit more realistic
37. Page 4887, line 6: add “it” after the comma following “studies”.

Changed it