Task B Draft Final Report: Response to Comments

Commenter #1

1. Overall: Outstanding work as usual! Thanks!
2. General: be consistent with serial commas ('a, b, and c' vs. 'a, b and c') revised to consistent format
3. General: can there be any conclusions or recommendations regarding STE to drip? That was one of the RRAC priorities that was to be addressed with this project, and significant field testing was done on this. STE to drip works but requires a more sophisticated headwords/filter system and generally more maintenance than a conventional system.
4. General: will there be any standard particle size recommendations for the ligno media? Is 'chip' vs. 'sawdust' pretty standard in the industry? We cannot provide specific particle size recommendations, as the products available are extremely variable. Unfortunately, there is no standard in the industry. We used both sawdust and wood chips and both worked well, however it is unknown whether there will be a difference long-term between the two, either in performance or life of media. This is why it would be important to monitor the prototype systems over a longer time period.
5. General: what suggestions do you have regarding securing manufacturers for things like the media and liner? The market will drive this, but FDOH must establish a regulatory climate that enables a rational marketplace to emerge for the various technologies, which will then extend to the specific components.
6. General: I see "two stage" and "two-stage" throughout. Be consistent. revised to consistent format
7. 1-1: DOH estimates over 2.7 "million onsite ~~wastewater~~ sewage treatment and disposal systems…" revised
8. 1-1: "A central component of the FOSNRS project was the development, design, and field evaluation of both pilot and full scale onsite wastewater nitrogen reduction technologies ~~at both pilot and full scale~~." revised
9. 1-1: "The goal of Task B of the FOSNRS project…" Perhaps you could quickly outline the four main parts of the project to give a frame of reference to those who don't know what Task B is. added details on the four study areas
10. Figure 3-1: it was not easy to find what DFT stood for without flipping ahead. Could the term be spelled out or put into the Group 2 box on the right? revised to clarify within the Figure
11. Figure 3-4: The "Stage 1 Media: Nitrification" was confusing to me and was different from some of the other similar figures/labels. revised
12. 3-11: "…designs using the media should incorporate a longer HRT than used in the pilot systems." How would we ensure a longer HRT in a stacked drainfield? Flow equalization? Designs for Stage 2 lignocellulosic biofilters should include HRT as a design criteria. HRT is based on the design flowrate and sizing of the treatment components (volume of lignocellulosic

media). For in-ground stacked systems similar to BHS-3 or BHS-7, the volume of lignocellulosic material should be large because it will be difficult to replenish/replace the media when completely spent and this will result in a high HRT in the media. For in-tank stacked systems, it will be more difficult to increase HRT due to tank size, but if the market for nitrogen removal systems is large enough, designs that allow addition of lignocellulosic to the bottom of the tank could develop. It will depend on the market.

13. 3-15: When designing these systems, how would we make the determination if excess sulfate is a concern? I remember a discussion at a RRAC meeting about soils in certain areas of Florida would be more sensitive to some of the reactions that occur due to excess sulfate in the ground. Sulfate is widely distributed in nature, and is one of the major anions occurring in natural waters, ranging from a few to several thousand milligrams per liter. Sulfate has a National Secondary Drinking Water Standard under the Safe Drinking Water Act. The secondary drinking water standards are non-enforceable guidelines regulating contaminants that may cause cosmetic effects or aesthetic effects in drinking water, and are not generally applied to natural waters. The noticeable effects listed by EPA for sulfate levels in drinking water above the secondary MCL of 250 mg/L is salty taste. In recent years, there have been concerns over sulfate in the Everglades leading to increased levels of methylmercury, because sulfate reducing bacteria in sediments can methylate particle bound mercury coming from atmospheric deposition. This was the issue brought up at the RRAC meeting mentioned above. Research is ongoing as to the importance of this effect, and there are currently no regulations governing sulfate in the Everglades and it appears to be one of the few areas where this concern exists.
14. 3-16: The headings for both Group 3 and Group 4 are formatted differently from headings on page 3-13. no change, same as heading on 3-9
15. 3-21: Instead of "A combined lignocellulosic/sulfur Stage 2 biofilter…" maybe "A sequence of lignocellulosic to sulfur for the Stage 2 biofilter…" At first I was thinking there would be a perception these would be mixed. revised Could they be? No, mixing the media would defeat the purpose of using the lignocellulosic to reduce NOx prior to the Sulfur, to reduce sulfate concentrations.
16. 3-24: "The Stage 2 layer can be lignocellulosic media or a mixture of lignocellulosic media and the same sand." What proportions would this mixture be? Revised text
17. Table 4-2: Minor comment: Can anything be done to make it clearer that BHS-4 had two systems? Perhaps column title could say "System(s)". I can see someone less familiar with the project wondering if the 40 needs to have 6 added to it. revised and added a footnote
18. 4-3: Title for section 4-2 should have "Types" capitalized. revised
19. 4-7: Can you explain a bit how the internal recirculation works mechanically? Since this is a fairly common configuration description, it would be good to get an idea of how that works. additional explanation provided on page 4-3
20. Figure 4-8: What are the "?"'s in the liner part of the diagram? revised
21. Table 4-9: Great start for an inspection checklist.
22. Table 4-9: Could a header pipe be used instead of a distribution box? No If the D-box is recommended, could you explain in the report the benefits? added text
23. Table 4-9: The column for "General Maintenance Action" needs to include an action phrase. So, instead of "Water level within the tank", perhaps "Check water level within the tank". The

action item for pump is "Grease", does this mean add a lubricant to the pump or check for clogging from grease? revised

24. Table 4-9: General frequency "1 time every 3-5 years" for the first one. revised
25. 5-1: Section 5.1: Is the correct table referenced in the first sentence? Could it be 3-4 instead of 4-4? revised to clarify reference to table 4-4
26. Table 5-4: Could you add a column at the end for the % reduction? added
27. Figure 5-18: The footnotes are not referenced in the illustration. added
28. Figure 5-18: Footnote 3 doesn't make sense as written. If it was not included because it used no energy, then why is it "not included because energy was used by a small transfer pump". I understand that the pump was not part of the PNRS system. Maybe just say that it was not included because the PNRS system did not use any energy. revised
29. Figure 6-4: Why was BHS-4 SP so different from all the rest? added text
30. 6-9: "However in all prototype PNRS_that employed sulfur, the sulfur media biofilters…" Lots of extra spaces between those words. revised
31. Figure 6-6: The footnote is not referenced in the illustration or the title. revised
32. 6-14: Top of page: "From the calculations ~~indicates~~, it appears that…" revised
33. Table 6-9: Make the last column slightly wider to get "Longevity" on one line. revised
34. Table 6-10: Can another table be created, similar to this one, showing the mean levels for the different parameters? added
35. Figure 6-11: The footnote is not referenced in the illustration or the title. Footnote is above title, when in other places it is below the title. revised
36. 7-1: Where would existing non-passive PBTS nitrogen reducing technology fall? Would they fall in the "Medium" level or would a new level need to be created? Depends on their performance
37. 7-2: "material flaws.~~.~~ The BHS-6 in-tank" Remove the extra period. revised
38. Figure 7-6: Add an outlined box around the PNRS systems. It would help make them stand out a bit. removed this figure, added a table instead
39. Figure 7-7: Add an outlined box around the PNRS systems. The footnotes are not referenced in the illustration. Footnote is above title, when in other places it is below the title. added and revised
40. 8-2: When discussing the need to maintain the 2 foot separation in 8.1, would there be any additional consideration for the alternately wet/dry soil conditions and organic rich soils discussed in Dick Otis's Wekiva report? It would seem that these soils may be more effective in denitrification than others, but this of course would require high levels of nitrification prior to wetting. We have not investigated this in Task B, see results in Task D. We would not recommend compromising the 2 foot separation from wet season water table.
41. 8-2: "Maintaining at least a 2 foot separation between the bottom of the STU and the water table is essential to achieving this level of nitrogen removal from effluent prior to reaching groundwater." Any idea what nitrogen treatment level we should consider for those that are less than 2 feet from the bottom of the drainfield to the water table? When you say "water table" do you mean seasonal high groundwater level, or actual water table? This wording has been revised to make it clear we are referring to a 2 foot separation between the infiltrative surface and the wet season water table. Regarding a less than 2 foot separation, we did not investigate N removal in soils in Task B, but the Task D simple soil tools report has some information from Hydrus runs with 1 foot separation.

42. 8-2: Does the LCCA tool take soil excavation/replacement/addition into consideration? The LCCA includes a factor for soil fill required for a mound system, but does not include the cost of soil excavation (dig out) or replacement. Dig outs should not be conducted in most cases anyway.
43. 8-6: Section 8.2: Would an ATU with recirculation also fall in the "medium level" category? Depends on their performance
44. Table 8-3: previous table (8-1) shows TP. Were these values not available for the studies listed in 8-3? TP has been added if available
45. 8-7: "The medium level option requires a twice per year maintenance inspection under Florida code." What are your thoughts about not doing 2x/yr maintenance inspections or a PBTS operating permit on the medium level systems? Would it depend on whether it is in-ground vs. in-tank? Would these require engineering, or could they be treated similar to what we require for design of an ATU system? Reliable performance requires reliable maintenance. Maintenance requirements are related to system complexity and number of mechanical components subject to failure. Some PNRS designs can achieve high performance with minimal maintenance, and could easily be maintained with 1x/year maintenance. This is a subject that needs further attention, analysis, and regulatory collaboration, but is beyond the scope of the Task B report. Longer term monitoring of the prototype systems would greatly help such an analysis.
46. Table 8-6: previous table (8-1) shows TP. Were these values not available for the studies listed in 8-6? TP has been added if available
47. 9-2: From your perspective as a non-regulator, do you feel innovative permitting is a requirement? What about your recommendation about "further design refinements and testing": anything prescriptive we can do now to get these systems in the ground faster? A permitting process that recognizes the lack of long term data is needed for new or relatively unproven PNRS designs, so that additional data can be gathered and evaluated prior to blanket approval. However, some PNRS component designs could be implemented now. For example, lignocellulosic denitrification (stage 2) biofilters have considerable performance history in the U.S., and the FOSNRS work corroborates that performance. Key to denitrification biofilter performance however is high level nitrification, and off the shelf systems capable of consistent high level nitrification are limited. In our view, attached growth, aerobic, porous media biofiltration is the most proven process for onsite wastewater nitrification, and recommended for passive systems. As we recommend in Section 9.4, several standard PNRS designs could be developed that could be implemented relatively soon, and this was envisioned as part of the complete project.

Commenter #2

1. General: Great work, good summaries of field work and some promising stabs at analysis. thanks
2. General: There appear to be some unknown or not completely characterized factors that influence the performance. I would suggest to flag these as open issues. I think longer term monitoring of these systems would help answer some of these questions.
    a. Some ligno systems do not appear to work for denitrification, hydraulic short-circuiting suspected during PNRSII. HS5 stopped working (page 5-14), HS6 seems to become less effective at end (5-17; 6-6). 20% of NOx are above 10 mg/L (p.6-4). We do not agree

that some lignocellulosic systems do not work. They all worked, but to various levels of denitrification based on operational mode and wastewater quality from Stage 1. The short circuiting suspected in PNRSII appeared to be related to the stage 2 biofilter tankage and media placement, and this was avoided in design of the full scale systems. BHS-5 did not stop working, rather there appeared to be a shift in denitrification due to the operational change to dosing and recirculation. BHS-6 suffered from design and construction issues, had significant hydraulic problems, and had the least volume of ligno and shortest retention time, but still had a high nitrate N removal rate indicating that revisions to the system could improve performance. 80% of NOx values were below 10 mg/L, and the majority of values above 10 mg/L were from BHS-6 and the internal recycle mode of BHS-5, designs we would not recommend. Eliminating those data would greatly change this result. Two things to keep in mind: 1) The lignocellulosic biofilter design for the two-stage in tank systems was meant to reduce NOx prior to the sulfur biofilter in an effort to reduce effluent sulfate, it was not designed to remove all NOx, even though it did for several systems; and 2) it is unknown at this point how long the lignocellulosic media will last, and whether there is a difference between the various lignocellulosic media. Longer term monitoring of these systems would help answer these questions.

   b. some ligno system are not as effective at fecal coliform removal as others (HS4, HS5-SP, HS6 do not meet secondary treatment standards for fecal). Yes, not all systems met secondary treatment standards for fecal, but most applications for these systems will be discharging to a STU, where that will not be a problem. We did not design the PNRS for meeting fecal standards, but it was interesting that significant reduction occurred through the systems.
   c. Sulfur in HS6 appears to stop working at the end (p.5-17). We are not sure what happened on the last sampling event for BHS-6, but we do not believe the sulfur "stopped working". The volume of sulfur in the system could not be expended at this point in time. It is more likely that the final sample was a bad sample or that a hydraulic short circuit developed, as we experienced hydraulic problems in the stage 2 sulfur biofilter several times during the study. Again, the BHS-6 system is not a design we would recommend without significant revisions.

3. General: Section 9 brings up many interesting topics. It seems to shift away from performance-based treatment systems towards more prescriptive designs with no clear responsibility for establishing designs. There is no role for innovative system testing or third-party certification included, two traditional paths of establishing that a system works. More details would be helpful. On the contrary, we believe that the FOSNRS study results demonstrate a level of performance that can be reached consistently, and have produced prototype designs for several of these systems. FDOH could pursue the PNRS technologies evaluated in this project by commissioning detailed standardized designs for several of them to get started. Thus, performance standards could be developed for nitrogen reduction and one could feel confident that there are systems that could meet the standard. If N reduction is required on a widespread basis, then other designs will undoubtedly be developed, so there is also a role for innovative system testing or some similar requirement for proving new system designs prior to blanket statewide approval. Third party testing at some far off controlled test facility is beneficial only

as a guide, the individual systems should be required to meet a defined performance after installation. We firmly believe that performance based standards should be required for nutrient removal systems and that monitoring requirements should be established to prove performance. Section 9 makes these recommendations.

4. p. 3-16: group 3 vs group 4 results; group 3 appeared to do much worse than group 4, any discussion on what the secret ingredient is that makes denitrification in unsaturated woody material possible sometimes? We believe that the "unsaturated" lignocellulosic media in the Group 4 systems is very wet and very close to saturation due to moisture holding potential of the ligno/fine sand mix. Group 4 systems also had much longer hydraulic retention times.
5. p. 3-23: table 3-4, useful to introduce difference between code flow and metered flow into some tables, it appears to be missing from the tables on stage 2 and vertically stacked biofilters. Apparently the difference is more important for some design parameters than for others (different factor for single pass and recycle systems) added to vertically stacked Stage 1
6. p. 4-2: Figure 4-1 Wakulla site is labeled with HS-2, should be HS-6 revised
7. p. 4-2: Table 4-2 code flow for HS-7 is later (table 7-8) given as 200 gpd, why different here? corrected building area which is 2112 ft2; table 7-8 was using the incorrect building area in the LCCA. Revised.
8. p. 4-5: would suggest a note that recirc was extraordinarily high for Aerocell: ""…recycle back to the pump chamber. In order to optimize nitrification the recycle ration was increased to up 10:1 from the usual setting of 4:1. While this …." Revised
9. p. 5-6/6-22 comment only: it appears that the sawdust is releasing more cBOD5 than other ligno materials.
10. p. 5-8: figure 5-6: stage 1 mean line does not appear meaningful, given the difference in operation (could be done similar to recirc tank mean, with different lines for different periods) Revised
11. page 5-11: figure 5-9 comment only: this appears to be system with least effective fecal coliform removal; page 5-13/figure 5-11, HS-5 is not very effective either; HS-6 figure 5-14 has even higher concentrations of fecal coliform from stage 2a or stage 2b
12. p. 5-15 figure 5-13: unclear why afte r switch, stage 2a stops to work. Stage 2a did not "stop working", but denitrification by the lignocellulosic was lower than single pass mode. Not completely clear why, but could be related to impacts from dosing and recirculation to stage 1, such as increased DO to stage 2. Need to keep sampling to see if trend reversed after switching back to single pass operation.
13. p. 5-17 figure 5-15: unclear why sulfur stops working, increasing concentrations in stage 2a for HS-6. Revised discussion. Sulfur did not "stop working", but denitrification decreased after day 350 or so. We suspect short circuiting thru sulfur, due to hydraulic problems and several attempted fixes. Again, the BHS-6 design needs improvements, but it has potential to be a viable system.
14. p. 6-4 "it appears from the limited data that NOx removal rate decreases with retention time" Figure 6-4 is missing the data point for HS-6. Added Could the observation be phrased differently, such as "While….., this may not be the controlling factor."? If there is more than the required minimum retention time (complete removal), the average removal rate (C/HRTprovided) will decrease but this averaged removal rate does say little about reaction rates in the part of the ligno zone that takes part in the reaction. On the other hand, HS5 (R

internal) and HS6 are not achieving complete removal at two of the lowest retention times, but intermediate removal rates. It would seem likely that specific surface area of the medium is a factor that influences reactivity. revised

15. p.6-6 table 6-3 mechanism for low removal fractions of some systems appears unknown. The previous discussions on BHS-5 with internal recycle and BHS-6 mentioned the problems associated with these systems and operational modes, and suspected reasons for reduced performance.
16. p. 6-9 figure 6-4 (see above) HS6 point missing Added
17. p. 7-1 in discussing 30% removal, it would be useful to compare to lookup table values from task D. This section has been revised to clarify. And we agree that there is definitely a need to tie together the four tasks of the FOSNRS project, and this was our intent for completion of the project.
18. p. 7-1 "Stage 1 systems alone…can provide 50-70% total nitrogen removal via pre-denitrification" This gives a different impression than what Damann presented (removal by the time it hits groundwater). If this section is discussing pretreatment effectiveness, then the comparison to BRF data is appropriate. If this section is discussing a total treatment (pretreatment +soil) effectiveness then the BRF-values would likely need to be adjusted. This discussion has been revised to clarify treatment system effectiveness vs. STU

    Assuming 30% reduction of applied nitrogen in the soil, a 50% in tank reduction becomes a 65% reduction overall.

    Fraction remaining N = fraction remaining after pretreatment * fraction remaining after soil treatment 0.35 = 0.5 *.7 . We do not think that type of relationship can be documented, the N reduction from STE applied to soil may be different than the N reduction from NO3 effluent applied to soil. The low, medium and high designations are for planning level analysis, and we are only trying to indicate that additional removal will occur in the soil, so the values assumed are somewhat conservative.

    If this distinction is not made, in-ground systems such as HS7 will look systematically more effective than they are compared to pretreatment systems (treatment comparison should be at the same depth location in the soil). In the context of this study, this precaution only appears to apply the HS7, because HS3 applies the effluent of Stage 2a and 2b to a new drainfield, so the performance of this systems can be compared to other systems. BHS-7 includes a Stage 1 biofilter (unsaturated fine sand) followed by a stage 2 biofilter (ligno liner). It also discharges to the soil after exiting the Stage 2 liner and has >2 ft separation to GW, where additional attenuation will occur. We agree that improvements to the BHS-7 design concept are needed, but the design intent is no different than the other systems in regards to the mechanisms of nitrogen reduction.

19. p. 7-2 "construction material flaws. ~~.~~The BHS-6 tank…" Revised
20. p. 7-2 given the amount of bypassing of the woody layer, is HS-7 only slightly better than conventional and should be classified as low level of treatment? No. The BHS-7 design needs improvement and could yield much better performance with some minor design mods, but based on the perimeter sample results, it achieved an average nitrogen reduction of 65% **PRIOR**

to transport though the surrounding soil to the water table. This is far better than a conventional system at 30% which includes the soil treatment.

21. p. 7-3 one of the assumptions for "uniform basis" is the nitrogen load of 9lbs per bedroom. This should be stated a little clearer because it appears to be an important factor for making HS3's and HS5's cost-effectiveness competitive. Revised to clarify # of bedroom = # of capita * 11.2 g/cap-day
22. Table 7-2: HS1 Energy costs appear different from observations: HS1 used ~ 2.5 kWhr/day, which would come to $90/yr (2.5*265*.1$/kWhr). Annual energy cost used in LCCA is $360/yr. HS3 used .9 kW hr/day, which would come to $33/yr. Annual energy cost used in LCCA is $17.5. HS6 used .5 kW hr/day, which would come to $18.25/yr (.5 *365 days*.1$/kWhr). Annual energy cost in LCCA is $9/year. For system HS1 the increase is a sizeable fraction of the total PV (somewhat over 10%), so understanding the difference in estimated and actual power costs would be very useful. Revised and clarified, but remember that the LCCA is only a planning level tool unless specific system data is entered.
23. Table 7-8 HS7 appears to be missing the pump tank and pump in the LCCA Revised in final LCCA
24. p. 7-17 "present worth per pound of nitrogen removed" appears not based on the observed removal but on estimated nitrogen loads that appears to be higher than observed for systems with higher design flows. Could these be both shown? This has been revised based on the observed removals.
25. Table 7-10/p.7-13. This seemed to bring about some confusion during the RRAC meeting. Perhaps a change in wording for the header or the table caption. this table has been revised.

    Total system costs are already in table 7-9, so could be left out of table 7-10. Change table 7-10 to "summary of estimated and actual construction costs by treatment component". Then have the two current conv./PNRS construction costs as estimated, and add two similar columns for actual. That would give a sense which part of the estimation (conventional/PNRS) is better. HS7 appears to be missing the pump tank in any case (is pump a PNRS component or a conventional?) the BHS-7 LCCA has been updated to include the pump tank

    There seemed to be a need for apple-to-apple comparisons of different approaches (such as all new construction), or where the same components could be reused.

26. p. 7-14 section 7.4.1 an additional comments such as "Figure 7-1 (and before table 7-2 through table 7-9) illustrates that only about half of the present worth of life cycle costs consists of construction costs.

    Perhaps that is already stated someplace, but it seems useful to emphasize. Perhaps section 7.4.3 could be joined with 7.4.1 because they both appear to make the same point. Revised

27. p. 7-20 great idea to introduce a comparison to more active systems. All the active systems are pretreatment systems, as are the passive systems (with the exception of he conventional system), so these numbers are comparable. Removed the conventional system from the discussion
28. Figure 7-6. why is the cost for PNRS in tank stage 1+ R tank here not the same as in table 8-5 ($59.92/lb)? Difference is only slight but confusing. Text has been revised to clarify, difference is because of the actual performance removal used in calculating $/lb N (60.8% see footnote, rather than 60%).

29. p. 7-21. In contrast to the Keys OWNRS study, active systems don't seem to be reaching 70% here. Once the variability bars come around the central tendency, this could become a little more gradual, but what does this suggest for the specification of performance treatment levels (95% seems to be pushing higher than some systems can actually do). Only 1 system in the Keys OWNRS study met 70%. Yes, 95% is higher than active systems can produce, but several PNRS systems consistently met a 95% removal.
30. p. 8-1 by sometimes including soil treatment and sometimes not, the different levels appear to be not completely comparable. For the conventional system, there is only soil. For in tank systems a given reduction by pretreatment is followed by attenuation in the soil. For in ground systems without an additional disposal mechanism there may not be additional attenuation in the soil (system HS-7). The discussion regarding treatment efficiency has been revised. System designs such as BHS-7 have a stage 1 component, a stage 2 component, and still would have to have a 2 foot separation to groundwater from point of disposal so soil attenuation would still occur. We do not see any difference here.
31. p. 8-2. The estimated attenuation in soil could refer to the simple soil tools as another source of support Revised
32. p. 8-3. Comment: the reductions listed in table 8-1 tend to be based on concentration reductions, not on mass load reductions (e.g. the lysimeter study adjusted for chloride concentrations would only estimate about 20% reduction). 30% is then not as low an estimate relative to data. Yes, many studies of this type are concentration based. The USF lysimeter study results are somewhat difficult to interpret because chloride and TDS yielded such different results. Adjusting for average annual rainfall over the study year these results would yield a 40% reduction in TN, and that assumes all rainfall was transported to the water table depth, which is unlikely, and would increase that estimate. We believe that 25 – 35% is a reasonable planning level estimate for a conventional STU in Florida.
33. p. 8-6 Comment: the media filter listed in table 8-3 seem to be on the high side of removing nitrogen. The Keys OWNRS study showed that recirculating sand filters only get 40% reduction (and that active systems can do better), UCF built some that achieved only 20-50% reduction. The RSF in the Keys OWNRS study did not perform well (about 45% reduction) compared to other studies. It consistently achieved complete nitrification, but did not denitrify well. My thoughts are that the ball valve provided poor recirculation control, and that the recirculation tank was too small for the flow under that recirculation scheme. I would never use the ball valve recirculation scheme again. I know nothing about the UCF systems. Many other studies are available that show 50-70% reduction from RSFs.
34. p. 8-8 comment only: table 8-4. It is interesting to compare these estimates to the one from the Keys. The RSF (subtracting SDI) came up then with an estimated of 24k present worth. Using the different interest rate and longer project life in the new estimate, it would have now a present worth of 36k. The new estimate is in between.

    UCF has put out some cost estimates that are much lower. Part of that stems from not including many of the ongoing costs. But they also give the impression that the difference between a conventional system and a recirculating sand filter is only about $2k, which according to the LCCA would not even cover the installation of the additional tanks and pump. We do not think UCF understands everything involved in a recirculating sand filter, there is no way to construct one for $2K, the tank alone is probably going to be that much.

35. p. 8-14. Instead/or in addition of comparing the cost per nitrogen removed of baseline systems, it might be helpful to compare the two treatment levels in terms of cost per additional (relative to baseline) nitrogen removed.
36. This would make the medium option more expensive (e.g. 58.1 ->117 $/lb) and the high option relatively cheaper (44.8 -> 65 $/lb) We have revised the calculations slightly as part of clarifying between treatment system performance and STU additional treatment, so these numbers have changed.
37. p. 9-3. Some elaboration of the equal distribution issue would be helpful. I get the impression that engineering practice has lead in the Keys from drip to a regular gravity distribution pipe as standard design for P-media (assumed to work for conventional drainfields…). This study was successful with some additional designs and a lot of attention to detail. Text revised slightly. We used a gravity distribution pipe for our single pass stage 1 systems successfully as well, but it does require checking the flow distribution occasionally.
38. p. 9-4 Some suggestions on how to assess sizing and life expectancy reductions would be helpful. We have provided preliminary sizing suggestions in the report based on our prototype systems, life expectancy is another matter and continued monitoring of the systems would provide additional data for this. Detailed design criteria still need to be developed.
39. p. 9-5. "medium level…" the recommendation suggests that some medium level treatment systems have enough data to support installation and permitting, or at least more data than high level. Any recommendations on what should constitute "enough data" ? No, but there is a wealth of data in the literature on performance of various systems, and a performance based treatment requirement would put the responsibility for treatment on the designer/contractor/owner. The Keys OWNRS study established 40% for such medium performance systems. We do not agree with this statement, the Keys OWNRS study did not establish treatment levels at all, it just reported on the performance of the various systems studied, which happened to include one poor performing RSF from a denitrification standpoint, because of carbon limitation in the ABF. That RSF provided excellent nitrification and if the ABF was replaced by a PNRS stage 2 biofilter it could have potentially achieved high level treatment. There appear to be some differences in the configuration that may not be obvious but impact performance. NSF 245, acceptance by one or several of the Bay Restoration Fund programs would be potential alternatives to data collection in Florida for the evaluation of at least some treatment trains. But to be successful and know that we are achieving performance, a performance standard is recommended with monitoring to prove performance. Otherwise we end up with what we have now.
40. p. 9-6/7 Several of the suggestions go into the direction of more prescriptive designs rather than letting engineers put something together as PBTS. What should be the qualifications of people designing, installing and inspecting such units for particular construction sites? We are not recommending prescriptive designs for approval, we are recommending detailed design criteria be developed, and perhaps a detailed design or two to speed up PNRS implementation. We have recommended establishment of treatment requirements and monitoring for performance of nitrogen reduction systems.

    Will have passive systems any way to adjust operation when it turns out that they do not work very well? That is up to the designer/contractor/owner. We developed porous media biofiltration systems because they provide the most consistent treatment process for onsite wastewater treatment in our opinion.

41. p. 9-7 the recommendation to pre-approve suppliers suggests the establishment of standards, and an application and review process that would need to be funded by some mechanism. The experience with the wood material in this study suggests that specifiers and installers will want to have leeway to use locally available material. What are ways to improve the accountability of the designers, specifiers and installers? Performance standards are the only way to ensure treatment performance is met.
42. p. 9-8 what are some additional recommendations for designer qualifications? The recommendations include strengthening the Department's technical staff and expertise to be able to review designs for systems for which limited data exist by which to judge their chances of success. On the other hand, experience with wastewater as currently required and supplied by engineers designing onsite systems appears to be a limited predictor of the code compliance of the applications and/or the performance of systems designed by them. As recommended, training should be provided for state and local regulatory personnel, engineers, scientists, and contractors. Biological nitrogen removal is now well understood and has been practiced successfully by municipal wastewater treatment agencies for decades. For onsite applications, the systems need to be simple, thus the focus on porous media biofiltration. We know how to nitrify, we know how to denitrify, and it is just a matter of putting systems together that work for onsite wastewater treatment. If performance is mandated and there is a market, the systems will be developed.
43. 10-2 the Robertson et al (2008) article appeared in *Ground Water Monitoring and Remediation*, not in *Ground Water* Revised

Commenter 3

1. In reference to Section 9.2, PNRS Costs, second bullet. In addressing the prototype system costs, the researchers state that while BHS-7 system's (in-ground) performance was "less than optimal", that with some design revisions it could be the most cost effective. Were design revisions to BHS-7 pursued to improve the design? No Can we at this point revisit this issue? It would be effective to provide options to the "High Level" performing PNRSs that while not "optimal", can result in an increased in N reduction at relatively lower costs. The BHS-7 concept could be refined, but is not part of the study as now defined.

   For example, based on what we know from the prototype and pilot testing data, could a BHS-7 system type be designed to be an augmented N removal version of the prescriptive rule baseline system? At approximately 40 mg/L TN output after 2' of unsaturated soils, or about a 30% N removal, the prescriptive rule baseline treatment system is referred to as a "Low Level" onsite wastewater nitrogen removal system. With the relatively low-cost addition of a Stage 1 biofilter to a new or a retrofit system, the baseline treatment technology could be augmented to provide greater than the 30% reduction; increasing removal efficiencies even if by single or double digit percentages is an improvement. Using a regulatory scheme similar to that of a LPPD, where the drainfield (STU) is less than 1500 Ft^2, and the design can be provided by a Master Septic Tank Contractor. Potentially increasing the N removal efficiency of the baseline system, while reducing costs at all levels. The concept would be to create a non-PBTS system classification of the baseline line system that at a relatively lower cost, increases the ability of a baseline system to reduce N. As a prescriptive system, we would eliminate significant engineering and monitoring costs related to sampling, inspections by maintenance entities, maintenance entity contracts, and operating permits. Our recommended refinements to the BHS-7 design would sort of follow the logic above, but we feel that additional testing would be required to ensure a known performance level. Also, we feel that long term performance and reliability would need to be evaluated prior to widespread implementation.

2. In reference to Section 9.5, Recommendations for PNRS Implementation, fifth bullet.

   Add industry contractors to the list of those who need technology transfer and training. Revised

Commenter 4

1. General: The entire team has done a fantastic job exploring passive nitrogen reducing technology, complements to all contributors present and past. Thank you

   Particularly appreciated are ideas like, "The recommended PNRS systems are organized by technologies that can provide low, medium or high levels of nitrogen removal from onsite wastewater, depending on the nitrogen sensitivity of the receiving waters." Also valued is the idea that other designs will eventually evolve.

   Two questions come to mind. One, can two stage biofiltration be done inside one tank so as to eliminate penetration low on the exterior tank wall? (Long term issues with root intrusion and subsidence leaks are concerns with the low outlet hole.) Yes, this would be possible, but it may not be as simple as it sounds. And two, shouldn't we test these systems to the point of failure by simulating excessive use of water, increasing waste strength, and introducing increased levels of fats, oils, and greases? We remain relatively uninformed about failure. Ideally this would be desirable, and that is why we also recommend longer term monitoring of the systems already installed.

   In conclusion, further study needs to be done; however, the work done so far is a catalyst for future onsite systems. Industry experience and creativity will reduce the cost of the systems over time. We agree!

Commenter 5

1. Implement the use of STUMOD-FL-HPS and PNRS LCCA during County DOH permitting process to ensure the proper selection and costs associated with the OWTS. While STUMOD and LCCA are useful tools for planning level analysis, we are not sure they should be applied to individual OSTDS permits.

2. Have FOWA introduce both STUMOD-FL-HPS and PNRS LCCA in their training and certification process. Good idea
3. Provide online versions of STUMOD-FL-HPS and PNRS LCCA . This would afford monitoring the use/users of the programs. This may be more difficult than it sounds, but it could be looked into.
4. FDOH should continue the monitoring/testing/measuring of the Prototype system installed during the study. Affording owners relief on annual fees during this period. We could not agree more!

Commenter 6

1. I have trouble with the last recommendation where everything must be signed off by a PE with background in Wastewater treatment. I have no problem with boilerplate systems being reviewed and sealed but for onsite systems, it just is cost prohibitive to require each one to be reviewed and signed off by a PE. Over the years I learned that training in engineering curriculums is nil for onsite systems which adds to the confusion. You are correct that onsite wastewater training for engineers is lacking, but as treatment requirements increase, such as for nitrogen removal, more wastewater treatment expertise is required, and it will be especially important for regulators reviewing nitrogen reduction system designs to be knowledgeable in wastewater engineering.

Comments from RRAC meeting 7/28/2015

1. Perhaps add an explanation of limitations on types of establishments that could utilize these PNRS systems. There was a discussion on how commercial strength sewage waste would not work well with these systems, and how domestic strength sewage waste for a commercial facility (i.e. office building) might be a questionable use as well. The FOSNRS study and Task B effort was focused on residential onsite wastewater treatment only. The mechanisms of treatment are similar however, and systems could be designed for higher strength waste or higher flows, but that was not part of this study.
2. What would a prescriptive design look like for these systems? Several system types were studied, some in tank, some in ground, but detailed designs would be refinements of these systems.
3. Where would be places for cost savings that would bring the high performance level to a medium level for some of these systems? The BHS-7 in ground concept should be further explored as a more cost effective option.
4. What work still needs to be done? Any recommended future research areas? Perhaps make this a new section. Continued monitoring of the PNRS already installed to add significantly to our knowledge base. Our recommendations in section 9 include quite a few ideas that will require considerable effort prior to implementation of PNRS.
5. What is your professional opinion on what should be done to address nitrogen from OSTDS? I think the Task B report provides some answers to that question as regards to treatment process, although there is much to be debated about the higher level question of what should be done, and that is beyond the scope of the Task B report.

It is requested that the Task B report on page 5-4 include the comment that

> "the Nitrex system nitrogen removal performance data includes one data point in which there was upset conditions that caused the aerocell unit not to fully nitrify – effluent TKN of ~ 20 mg/l which was the cause of the Nitrex effluent being high. Nitrex effluent averages should be stated with and w/o the upset conditions data point. The precise cause of the aerocell upset is unknown however the high strength septic tank effluent of 93 mg/l TN may have been a factor." Revised.