Findings and Recommendations
TERRESTRIAL – POPULATED COMPONENT (from Stacey April 10 as revised)

Findings:

- Populated (urban/suburban/developed) land areas provide significant loads of reactive nitrogen (Nr) to the environment, both by generation (e.g., deposition of NOx emissions) and by transfer (e.g., domestic sewage from imported food).
- Categorical sources include sewage treatment plants (STP), industries, subsurface (septic) systems, atmospheric deposition, domestic animal and wildlife waste, and fertilizers used on lawns, gardens and landscapes. Infrastructure (e.g., storm sewers) and landscape conditions (e.g., increased impervious cover) more efficiently move Nr associated with surface runoff to receiving waters and may also inject or infiltrate Nr into ground water.
- Landscape changes, primarily increases in impervious cover, soil disturbance and compaction, and wetland/hydric soil losses, have also reduced the capacity for natural systems to treat Nr inputs by recycling or denitrification.
- Other disruptions in chemical condition (e.g., acidification), biology (e.g., vegetative cover), and physical character (e.g., temperature increase) alter the nitrogen cycle, which may have both negative and positive consequences for Nr amelioration on the populated landscape and in air and water.
- Populated lands are estimated to export as much as 10 times the total nitrogen that was exported under pre-development conditions.

Management:

- Intervention to control Nr can occur in three ways:
    - Prevention or source controls
    - Physical, chemical or biological “dead ending” or storage within landscape compartments where it is rendered less harmful (e.g., long-term storage in soils or vegetation; denitrification; reuse)
    - Treatment using engineered systems such as STPs or best management practices (BMP) for storm water and nonpoint source runoff.
- There are opportunities for combining the three intervention approaches.

Benefits:

- Preventive techniques on land might reduce delivery of Nr to surface and ground waters proportionally to the reduction of inputs, perhaps by 10%[?].
- Preventive techniques for mobile air emissions might reduce deposition by 10%[?].
- Storage is also primarily a preservation technique, reducing nitrogen inputs and enhancing removal and storage features through soil and vegetative management thereby decreasing Nr in the populated compartment by 10%[?].
- STP wastewater or stormwater reuse for industry or for irrigation, which has the added benefit of reducing direct discharge to streams and lakes would eliminate Nr from those sources proportionally to the level of reuse.
- Efficiency of Nr removal from STPs through biological processes can exceed 67%.
- Nonpoint/stormwater Nr removal efficiency is variable and can range quite high in some applications, but Nr removal efficiencies are generally less than 30%.

- Most management practices have coincident benefits of removing other pollutants in addition to Nr and many provide habitat or human use benefits.

Regulation or Voluntary:

- Regulatory approaches work well when large, consolidated sources of Nr are the responsibility of one activity or entity, such as a municipal STP. Management technologies are known, and funding mechanisms are available through federal and state loan and grant programs.
- Other sources of Nr, especially those that are more diffuse such as those related to homeowner activity or from nonpoint sources. Potential approaches include:
    - Tax levies through stormwater utilities as a disincentive to produce storm water and their Nr loads.
    - Promoting local regulations and ordinances that give tax breaks for, or require, use of "green" or "low impact" development techniques that have demonstrated benefits for both runoff volume and pollutant control.
    - Outreach, education and social marketing strategies that promote voluntary changes in lifestyle while supporting environmental management goals as well.

Ancillary Concerns:

- Nr control requires comprehensive evaluation and management of multiple sources in air, land and water media.
- Climate change and energy production from biofuels may exacerbate conditions and undermine the anticipated benefits of Nr controls.
- Nitrogen may not always be the limiting nutrient and other contributing pollutants such as P may need to be managed.

Research and Monitoring Needs:

- To be determined – likely to include research into better management practices to lower cost and improve and quantify removal efficiency for Nr.