Summary of Pre-conference Workshop at "Sustainability 2008"
Water Environment Federation Specialty Conference

Global Climate Change Adaptation and Mitigation in the Water Environment
Organized by the American Academy of Environmental Engineers (AAEE)

June 22, 2008

The wastewater industry, like many others, is coming to grips with the challenges posed by climate change. A carbon-constrained future awaits this industry with growing regulatory burdens, pressure to reduce emissions and the challenge of adapting to a changing climate. The scope and pace of climate change issues present challenges categorically different from others previously faced by the wastewater industry as pressure builds to take significant action immediately. Although the topic is drawing more attention, leaders in the field are still grappling with framing the questions posed by the problem, and answers thus far are elusive.

AAEE has created two comprehensive workshops to introduce this topic to wastewater professionals. The first was a pre-conference workshop designed by AAEE as part of the Water Environment Federation's Sustainability 2008 Specialty Conference held in National Harbor, Maryland June 22-25, 2008. This workshop provided an interactive forum for forty attendees and nine presenters to discuss the fundamentals of climate change with emphasis on the impacts on design and operation of facilities. A second pre-conference workshop is associated with WEFTEC 2008 in Chicago covering these same themes.

The workshop was designed to first establish a foundation introducing the participants to climate change fundamentals and regulatory concerns. The discussion then explored potentials in the industry for mitigating and adapting to climate change impacts. Real world examples concluded the workshop's first segment. Throughout, participants were encouraged to compose questions for the next segment, an interactive panel discussion featuring the nine speakers. The workshop concluded with an interactive breakout session designed to provide input to the industry on the issues and questions surrounding climate change and its impacts on the wastewater industry.

The presenters included professionals who currently lead the efforts in the wastewater community in various aspects of this still developing arena. Nine speakers covered climate change fundamentals; federal, regional and state strategies and regulatory frameworks; adaptation and mitigation potentials in wastewater practice; carbon release and energy utilization as design considerations; and research topics related to climate change and the wastewater industry. This venue presented a rare opportunity to assemble these experts in one event.

This summary provides a brief review of the technical presentations and outlines the input received from the workshop attendees. Each of the presenters is credited with the content of their presentation and has been provided an opportunity to review and comment on the brief summaries provided in this report.

Climate Change Background
John Cromwell, Stratus Consulting

Conclusive information now confirms that human activities are increasing the concentrations of greenhouse gases and that temperature rise is accelerating according to the Intergovernmental Panel on Climate Change (IPCC) in its Fourth Assessment Report. The IPCC report, which summarized an arduous consensus process involving scientists from throughout the world and which received a Nobel prize, made the strongest statement yet on the risk of human-induced climate change and the options for adaptation and mitigation. Temperature rise is unequivocal and accelerating, and climate models predict temperature gains of 1.1 to 6.6 degrees C by 2100. Warming increases the pace of the hydrologic cycle resulting in more overall precipitation, intense storms, increased rain versus snow, early spring melting, increased surface runoff, and higher ocean levels. Because of the greater runoff intensity and consequent reduction in infiltration and retention, groundwater and surface water storage will be negatively impacted. With less water stored as ice, sea levels are projected to rise 0.2 to 0.8 meters by 2100.

Predicted impacts on water and wastewater systems include increased irrigation and urban water supply demands, altered treatment plant performance due to higher water temperature, increased overflows of untreated sewage, greater potential for agricultural and urban non-point pollution, and direct damage to facilities due to intense runoff and rising sea levels.

In response to these predicted impacts, water and wastewater utilities should adopt flexible integrated resource planning strategies for adaptation through operational flexibility and carefully planned capital projects. Basin-wide strategies are needed that demand new forms of institutional and stakeholder collaboration and regulatory flexibility. Mitigation in the form of energy conservation should be part of an overall sustainability program that considers both adaptation and mitigation. Comprehensive solutions will require flexibility in cap and trade or other regulatory structures. Adaptation and mitigation are critical priorities in the wastewater industry and should not wait for perfection of climate models; they should begin now.

National Water Program Strategy: Response to Climate Change

Michael Shapiro, Deputy Assistant Administrator, Office of Water, USEPA

According to USEPA's Office of Water, climate change will affect broad areas of EPA's Clean Water Act and Safe Drinking Water Act missions. Warmer water temperatures will reduce assimilative capacities of surface waters and increase the impacts of certain pollutants, leading to more impaired waters and more complex TMDL and permitting challenges. Because of redistribution of precipitation, areas with less rainfall will experience drinking water supply challenges, lower stream flow conditions that will make effluent discharges more difficult, and wildfires that will result in runoff and flood impacts. Areas with greater precipitation will see more sewer overflows, more runoff and nonpoint pollution, and infrastructure overloading. Predicted changes in storm intensity and sea level rise create the need for integrated water, storm water, and wastewater infrastructure planning and greater interagency coordination. With this background, the Office of Water's Draft Climate Strategy has established five major program goals for addressing climate change within its areas of responsibility:

Goal 1: Mitigation of Greenhouse Gases
Goal 2: Adaptation to Climate Change
Goal 3: Climate Change Research Related to Water
Goal 4: Education on Climate Change
Goal 5: Management of Climate Change

Distributed among these goals, 46 specific actions have been outlined. Key among mitigation strategies are improved energy efficiency and conservation at water and wastewater facilities, and by residential and commercial users. In addition, geologic sequestration of carbon dioxide is a leading candidate for reducing greenhouse gas emissions from the combustion of coal, and the Office of Water will play a significant role in regulating these activities. Adaptation strategies under review include evaluating the need for changes in drinking water, clean water, and effluent standards; creating new tools to assist watershed and wetland protection; and enhancing water infrastructure initiatives, which include sustainability guidance, clarification of the use of revolving loan funds, and the development of emergency response planning tools. EPA plans to expand its role in water research planning, improve outreach to stakeholders by creating a water and climate change clearinghouse, and partner with other Federal agencies by establishing a Federal Agency Water/Climate Coordination Group. EPA is preparing for implementation by supporting state and regional efforts, and encouraging integrated adaptation planning through coordination among states.

State and Regional Action on Climate Change

Patrick Hogan, Solutions Fellow, Pew Center on Global Climate Change

Individual states and several regions within the US have developed initiatives aimed at reducing greenhouse gas (GHG) emissions. While these programs are not directed at water and wastewater utilities, they will impact these industries. The Regional

Greenhouse Gas Initiative (RGGI) involves 10 eastern states and represents the nation's first cap-and-trade program. RGGI deals only with power plant CO2 emissions. The goal of RGGI is to stabilize GHG emissions at current levels between 2009-2015 and a 10% reduction by 2019. The Western Climate Initiative (WCI) involves seven states and two Canadian provinces. Others, including Mexican states are involved as observers. The WCI is broader than RGGI in that it has established an economy-wide GHG reduction goal of 15 percent below 2005 levels by 2020. The Midwest GHG Reduction Accord, which involves six states and one Canadian province, is expected to set long-term GHG reduction targets of 60-80% below current levels by mid-century. Among states, California and Florida were the first to establish aggressive GHG emission reduction goals. Fifteen additional states also have GHG emission reduction targets. With the recent failure to pass federal legislation, states are still providing leadership in this area. Each level of government has a role in climate policy.

Global Warming and Water Resources

Nancy Stoner, Natural Resources Defense Council

A mix of strategies is needed to mitigate GHG emissions and to adapt to climate change that will continue to occur even if GHG emissions stop today. Vulnerability analyses by both water/wastewater utilities and environmental/resource agencies need to be performed to assess impacts of climate change. Climate change will cause more intense runoff events, which will impact water quality, and tax flood control systems as well as change the locations of precipitation and available fresh water. Sea level rise will impact groundwater quality in coastal regions and make wastewater facilities often located at low coastal elevations more vulnerable. Higher watercourse temperatures may change species makeup and allow invasive species to flourish.

General Circulation Models (GCMs) have been downscaled to regional levels to predict impacts on precipitation and hydrology. Resulting response strategies developed in a case study of the Seattle region included increased reservoir storage, optimization of groundwater and surface water use, emphasis on conservation, reclaimed water projects and desalination as a last resort. Integrated water resource management, which is watershed-based, cross-agency, and addresses multiple issues such as water supply, quality, stormwater management, and ecosystem protection, will be the key concept in developing response strategies. Partnerships in providing funding and in implementation of strategies, involving energy, land use, stormwater, water supply, and wastewater planning are critical to finding sustainable solutions.

As an example of the impacts of water conservation, reduction in the importation of water from northern California to southern California by 100,000 acre-feet per year could save enough electricity to power 25 percent of San Diego households. Case studies of strategies such as low impact development, green roofs and streets, and wetlands enhancement have shown the benefits of water and energy conservation. Saving water saves substantial amounts of energy. For example, it is estimated that nearly 20 percent of electrical energy consumption in California is related to water supply. Mitigation in the form of water conserving fixtures and appliances can make a significant impact, as can improvements in agricultural irrigation methods. Finally, land use decisions need to consider climate change impacts and potential for flooding.

Greenhouse Gas Production and Mitigation Potentials in Wastewater Treatment

Mike Stenstrom, PhD, Professor, Civil and Environmental Engineering, UCLA

The objective of this work is to develop a model that estimates greenhouse gas production in wastewater treatment and to use the methodology to investigate differences between aerobic and anaerobic treatment. The model applies to a secondary treatment plant employing primary treatment followed by aerobic biological treatment or anaerobic treatment with anaerobic digestion of biosolids, and it differs from previous models by considering the dissolved methane in the effluent. Three cases of aerobic technology were considered: conventional activated sludge (SRT=10 days), extended aeration activated sludge (SRT=30 days), and high-rate activated sludge (SRT=30 days). The anaerobic technology includes one case represented by either an upflow anaerobic sludge blanket or anaerobic filter (SRT=30days). The model includes CO_2 and CH_4 but neglects N_2O. The model predicts that at high influent sewage strength as measured by BOD_u, the anaerobic process produces "negative" net CO_2 because the methane produced can be combusted and used to offset fossil fuels. At lower sewage strengths, aerobic processes produce lower net CO_2. If methane in effluent streams from anaerobic processes could be captured, anaerobic treatment would be more favorable in terms of greenhouse gas emissions than aerobic processes. Additional work is needed to show the comparison between "no treatment" and energy efficient treatment in terms of net GHG emissions. Treatment and sequestration of carbon in biosolids may result in net GHG reductions.

Demonstrating Carbon Benefits of Biosolids Land Application

Chris Peot, Biosolids Manager, District of Columbia Water and Sewer Authority

Biosolids recycling should be portrayed to the public as an activity that recovers valuable nutrients, energy, and carbon. The public is increasingly energy and climate change conscious and needs to hear the message regarding the benefits of biosolids recycling. A large part of the energy benefit accrues from the avoidance of inorganic fertilizer production, which is very energy intensive.

Prior to the industrial revolution, atmospheric carbon was in balance between respiration by animals and consumption of CO_2 in photosynthesis. The carbon from plants and animals is considered biogenic, short cycle carbon. It cycles from atmosphere to sequestration relatively quickly. The atmospheric balance may be disrupted when carbon is released from long-term sequestration sources such as petroleum deposits. Plants cannot take up the CO_2 released from petroleum combustion quickly enough, upsetting the balance. Biogenic sources do not upset the balance because the plant life from which they originate absorbs the CO_2 produced by animals consuming the plants. Recycling biosolids to the land sequesters carbon in soil and plants. Avoidance of inorganic fertilizer use reduces green house gas releases by reducing the use of fossil fuels in manufacture and transportation of the fertilizer, both of which dwarf the release of carbon in transport of biosolids.

In a typical month of operation of the District of Columbia Water and Sanitation Authority Blue Plains treatment plant, approximately 43,000 wet tons of biosolids are recycled producing a net benefit of nearly 3,000 metric tons of CO_2 avoided emissions which is the equivalent of approximately 6,700,000 automobile miles. For all of 2007, Blue Plains biosolids recycling to soil avoided inorganic fertilizer use of over 5,000 metric ton equivalents of CO_2 and approximately 25,000 metric tons of CO_2 were sequestered in the soil. These estimates account for biosolids transportation to the recycle locations. One of the most successful recycling programs involves land reclamation through planting poplar tree forests.

Facility Design Options: Creating New Mitigation Possibilities
Jay Witherspoon, Vice President and Fellow Technologist, CH2M Hill

Design of mitigation strategies for greenhouse gas (GHG) emissions is driven by rising fossil fuel energy costs, carbon footprint neutrality goals, mandatory and/or voluntary GHG reductions, and water availability stresses created by climate change and growing demand. Sustainable design involves balancing social, economic, environmental, and technical performance. Adaptation, which involves designing systems to cope with the impacts of climate change, and mitigation, which involves designing systems to reduce GHG emissions, are both important sustainability concepts and are intertwined in an integrated framework. Urban water management has historically been based on single use approaches but must in the future focus on multiple use systems. Advantages of a multiple use or hybrid system include secure water supplies through water reclamation and reuse, less resource consumption through reduced conveyance and less potable water production, and increased water supply availability through reduced per capita consumption. Models such as the VOYAGE™ model can be used to create system planning scenarios that optimize for climate change.

GHG regulations and carbon trading will present threats and opportunities. In addition to the effects on water supply and sea levels mentioned previously, economic impacts such as rising energy, material, and commodity prices can be expected. Opportunities include renewable energy incentives, carbon trading and increased demand for reclaimed water.

GHG emissions produced by unit processes within a typical wastewater treatment plant include CO_2, CH_4, and N_2O. Primary treatment is not expected to produce significant GHGs. Secondary treatment is anticipated to produce all three gases. Anaerobic digestion and subsequent biosolids dewatering and combustion of digester gas can be expected to produce CO_2 and CH_4. In addition, stationary and mobile sources associated with the wastewater treatment plant operation account for additional GHG emissions.

Planning for the Brightwater Treatment Plant in Seattle offered an opportunity to examine GHG emission potentials of various unit process alternatives. Considering capital cost, energy consumption, operational costs, and GHG footprint, a combination of Actiflo primary treatment and membrane bioreactors was chosen for the facility. Energy costs and associated GHG emissions are projected to be only 75% of those associated with a comparable conventional activated sludge process.

Management of biosolids is another area where designers can put sustainable management ideas into action. Use of fluidized bed reactors for biosolids combustion reduced fuel costs significantly in Minneapolis-St. Paul, Minnesota. Composting is accomplished with low net GHG emissions and produces a soil amendment that sequesters carbon by improving biomass yields.

Carbon and Energy Footprints in Wastewater Treatment

Diego Rosso, PhD, Assistant Professor, Civil and Environmental Engineering, University of California, Irvine

CO_2 emissions originate from activated sludge treatment, anaerobic digestion, and combustion of CH_4 in power generation systems. CH_4, if not captured, may be emitted by anaerobic processes. GHG credits may be created through sequestering carbon in biomass production and in offsetting the combustion of fossil fuels through combustion of biogases.

When wastewater is treated in conventional activated sludge systems and especially with nitrification and denitrification (N/DN), and when energy recovery is included, net greenhouse gas emission reductions can be achieved compared to no treatment. For example, the ratio of energy required to energy offset in conventional activated sludge treatment can be as low as 0.9 when energy recovery is employed and up to 1.6. With N/DN treatment, which can reduce oxygen requirements, the ratio can be as low as 0.8 and range up to 1.9.

Methane emissions from all sources are projected to more than double between 1990 and 2025 with a significant shift from Europe and North America to Asia in terms of dominance in methane emissions. GHG production in Asia is projected to be over three times that produced in North America by 2025 with comparatively very low levels of control. Both North America and Europe are projected to have similar levels of GHG production but with substantial control. Growth in GHG emissions in South America and Africa by 2025 will bring those two continents close to North American and European GHG emission levels but with very low levels of controls anticipated.

In conclusion, well-operated wastewater treatment plants can be energy-neutral, and carbon sequestration can be accomplished. Factors such as digestion temperature, activated sludge process selection and distance to landfill can significantly affect the carbon footprint of a facility and must be carefully considered when designing a wastewater treatment plant.

Wastewater Research in a Climate Change World
Glenn Reinhardt, Executive Director, Water Environment Research Foundation

The Water Environment Research Foundation (WERF) has developed a climate change research focus area designed to answer major questions facing the wastewater profession. Immediate questions facing wastewater utilities include:

1. How will nutrient programs affect carbon footprints?
2. Will consent decrees consider carbon footprints?
3. How will TMDLs and UAAs change?
4. What will this cost?

The research challenges involve (a) identifying, quantifying and reducing GHGs, (b) minimizing impacts, (c) managing risk, (d) managing cost, and (e) improving resource recovery, energy production, and energy efficiency. Clearly there is a relationship between water and energy in terms of GHG production, and much of WERF's ongoing research centers on energy management and sustainability in wastewater treatment.

Climate change questions that begin to define additional research needs include:

1. How can measurement of carbon footprints of wastewater treatment facilities be made consistent given the variety of protocols and accounting organizations?
2. What are the risks and opportunities associated with climate change and how do they vary geographically?
3. How can climate change be incorporated into infrastructure design?
4. How can we educate the public and change their behavior?
5. How will future discharge limits be affected by changes in flow and in receiving water bodies?
6. How will climate change affect the financial stability of wastewater utilities?
7. How can the industry best adapt to climate change?

WERF has established eight key research projects to address climate change.

1. Wastewater focused review of climate change knowledge and research organizations.
2. White paper on climate change impacts on the wastewater industry.
3. Wastewater vulnerability handbook.
4. Case studies of historic extreme events.
5. International toolbox for navigating climate change information.
6. Wastewater industry emissions inventory and verification handbook.
7. Post discharge conversion of NH_3 and NO_3 to GHG species like N_2O and NO.
8. Guidance on carbon trading for wastewater utilities.

Potential future WERF projects include:

1. Demonstration of net sequestration of carbon in biosolids as compost or land application.
2. Impacts of climate change on the designated use of water bodies.
3. Infrastructure planning to adapt cost-effective responses to climate change.
4. Carbon footprint of new infrastructure construction.
5. Climate change impacts on soils and underground assets.
6. Legal/regulatory barriers to climate change adaptation and mitigation.
7. Clearinghouse of information tools and best practices to deal with climate change.

WERF has determined that there is a funding gap of over $4 million to accomplish the top ranked energy optimization and potential future research projects related to climate change. Work on the eight key research projects listed above is starting in the second half of 2008.

Panel Discussion

At the beginning of the workshop, each participant was given a 3”x5” card for the purpose of recording one or more questions during the day to be posed to the panel for discussion. Participants were reminded several times during the day to listen for points made by the presenters that would trigger good panel discussion questions. This helped to keep the audience engaged. Prior to the afternoon break, the cards were collected and reviewed during the break. Questions that were repeated or were of similar theme were given preference and those that would be of broadest appeal to the audience were selected. The panel participated in selecting the questions. The panel was made up of the presenters.

The following is the list of questions provided by the workshop participants (audience). Although the intent was to have the panel discuss the entire slate of questions, the interaction between the audience and the panel (and within the panel members themselves) limited what could be covered in the time permitted. All of the questions provide insight to the issues facing the wastewater industry.

1. The distinction between mitigation and adaptation was mentioned several times. Please expand on how these are different, as well as the approaches and tools required to address each.

2. Mike Shapiro mentioned that the State Revolving Fund could be opened up for adaptation projects. What is the scale of the adaptation needs in terms of dollars, and what is EPA doing to support the fund?

3. Sea level rise will pose a threat to wastewater facilities in coastal areas. Given the data we saw this morning, sea level rise appears to be inevitable. What programs are planned to move or protect these facilities?

4. Given the limited available capital resources and the inevitability of the problem, what is the most cost-effective use of our limited financial resources: mitigation or adaptation?

5. While issues being discussed today are undisputedly important, at what point does the tail begin to wag the dog? Is not our primary mission still protection of public health and the water environment?

6. Should perceptions of dollar and energy costs for clean water change? Should treatment standards be reduced to control the carbon footprints of treatment?

7. Arguably, increasingly stringent effluent limits mean (can mean?) greater energy consumption and GHG emissions. How should utilities, designers and regulators optimize or balance performance objectives – cost? Energy consumption? GHG emission? Are we looking at "climate parameters"? Incorporated in WWTP permit conditions? Guidelines? Benchmarks? Information to help managers decide among alternatives?

8. Mitigation – What are some of the leading options for investment to most cost-effectively mitigate climate change? (worldwide and domestically)

9. Can EPA be an effective leader to address climate change or is it subject to oversight and control of political leaders? How does EPA overcome politics to become a more effective leader in addressing climate change?

10. What is the definition of biogenic? Should it encompass all cycles that would have occurred naturally even if the constituents are not completely recycled? Why are N_2O and CH_4 not considered biogenic?

11. What is EPA doing to keep pharmaceuticals out of wastewater so that it can be more easily reused? What is EPA doing to promote water recycling?

12. Models need improvement and refinement to help justify to ratepayers the many preemptive, expensive infrastructure projects needed for mitigation/adaptation.

13. What are the policy changes that will encourage climate change adaptation and mitigation in the water sector? What steps have been made for interagency coordination of FEMA, EPA, NOAA, etc?

14. Do you think additional grant money will be made available for water efficiency, water conservation, and water reclamation programs?

15. In terms of N_2O emissions, where do you think the research should be focused: pathways for N2O emissions, impacts of DO, SRT, etc., measurement and monitoring, others?

16. How will EPA balance nitrogen reductions being requested by a lawsuit to the increase carbon and GHG footprint? Increases for advanced treatment schemes?

Breakout Session

Workshop participants, including presenters, were asked to break into groups of about 10, and each group selected a recorder and a presenter. Participants chose either a "Mitigation" table or an "Adaptation" table, and two breakout tracks worked simultaneously. The following outline was provided to guide the discussions:

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Breakout Discussion Outline:

a. List the four most important adaptation/mitigation strategies for the wastewater industry
b. List major issues, gaps, or challenges related to these strategies.
c. Needs assessment: what does the industry need in the following areas to effectuate successful adaptation/mitigation
    - Legislation
    - Regulations
    - Research
    - Funding
    - Communication- within industry and with public

Each group spent 50 minutes in table discussion followed by a seven-minute presentation by each group's presenter. Groups 1 and 2 were "adaptation" tables and Groups 3 and 4 were "mitigation" tables. Many of the groups quickly realized that their answers were more general than specific, and that the industry lacks the tools needed to immediately reach mitigation and adaptation goals. Some groups felt that even basic terms like "sustainability" and "biogenic" required defining. The discussion revealed that the industry faces great uncertainty with respect to the impacts of climate change and little clear definition at this point on future directions. The groups understandably found it far easier to identify gaps and needs than solutions. Common themes included: closing gaps in knowledge (measuring emissions, how to mitigate/adapt), gaining public trust (key to approving/funding/permitting new projects), increased funding, defining clear goals, accepting holistic solutions (including breaking down regulatory "silos" and flexibility in permitting), energy efficiency improvements, flexibility in design and promoting resource recovery and reuse. It was clear from the group reports that the audience was intently engaged in the discussion and that participants were not passive observers; they were an integral part of the workshop. The input from each breakout group is outlined below:

Group 1
<u>ADAPTATION</u>

1. Define metrics of "Sustainabilities"
2. Prepare for changes in flows
3. Prepare for changes in sea level, receiving waters, groundwater
4. Public Education – prepare tax - rate payers for new laws, local policies, new taxes & fees
    - Regenerate interest in environmental improvement
5. Integration of regulations & agencies
    - water, wastewater, storm
6. Look at point vs. non-point sources – where to spend to get best overall water quality

ISSUES

1. Lack of unified, focused voice
2. Political will, fragmentation of regulation
3. Fragmentation of responsibility for quantity and quality
4. Funding
    - Government priorities
    - Users' tolerance for fees
5. Analysis paralysis
    - Moving targets
    - Unknowns, uncertainty
6. Need to play catch-up with existing (neglected) infrastructure
7. Need bottom-up, site specific baseline data

NEEDS

1. Integrated system of regulation
2. Tool for integrated engineering, economic, environmental model for planning regulation & policymaking $\geq$ Basin Level for water industry
3. Game-changing technology with respect to water quality
4. Education
5. Solid metrics of sustainability
6. Funding source targeted on environmental quality
7. Research to reduce infrastructure cost

Group 2
ADAPTATION

TOP ADAPTATION STRATEGIES

∞ Hazard Mitigation
  - Response to vulnerability.
  - Flooding
  - Wind
  - Hazard

∞ Land Use Reform
  - Stay away from beach; swamp; flood plains
  - Imperviousness
  - Site design

∞ Flexibility Concern with hard, durable design
  - Build in operational ability to respond to changed conditions
  - "Hedging" incorporated in capital projects

∞ Multi-objective Planning
  - Tearing down the silos

ISSUES

∞ Issues, Gaps, Challenges
  - Funding – scope of cost - benefit analysis
  - Silo – single-issue advocacy and inability to see bigger set of issues
  - Debt capacity
  - Silo policies – driven by legal framework (FEMA example)

∞ Break the traditional decision-making mold
∞ NIMTOO (Not In My Term of Office)
  - Short political horizon
∞ "Owned" Politicians
∞ Brain drain from government at state and local levels
∞ Clouded crystal ball
∞ Public Awareness (not) and concern about rates/costs
∞ Uncertainty – not enough knowledge
∞ Inadequate technology
∞ Lack of sufficient public awareness
∞ Lack of $$$$
∞ Pre-occupation w/ carbon footprint

NEEDS

Communication

- Not talking w/ citizens
- "Vision" of the future
- Not just w/ citizens
- Working w/ industry

Legislation

- Economic Incentives
- "Risk-minimizing innovation"
- De-balkanized institutional structure
- Educational incentives
- Integrated planning, design and permitting process
- Incentive-based grants program for adaptation
- System to recognize ecosystem benefits
- Revolution in land use planning
- Adaptation incentives in Cap & Trade systems

RESEARCH

- Manhattan project to stimulate research
- Change the paradigm to enable innovation
- Flexibility/incentives/… in regulatory drivers

Group 3
MITIGATION

"Revolution vs. Evolution"
Near-Term and Long Term

- Energy Efficiency
- Education
- Urban Development
- Tools

1. Funding
2. Regulatory "Silos"
3. Social Perception
4. "Metrics", how to define and measure sustainability

Legislation

- Mandates to conserve and to reduce GHG emissions
- Funding – Research and Implementation

Regulations

- Same as above

Research

- N_2O
- Legislation to develop a methodology to establish "carbon footprints"
- Resource Recovery

Funding

- Education
- Research
- Evidence Documents
  - Manuals
  - Handbooks
- Zero carbon footprint developments
- Capital vs. O & M funding

Communication

- Define our goals within the industry
- Provide information needed to help the public make decisions – "Speak the people's language"
- "Develop trust"
- Get the message out

Group 4
MITIGATION

A. Collection Systems
- Chemical addition
- CH_4 & N_2O Evolution
- Infiltration/Ex-filtration
- Energy/Pumping
- GHG Analysis/Data

B. Optimizing Plant Operations
- Aeration efficiency.
- Primary treatment
- Decentralized advantages/disadvantages
- Bulletproof → Efficient
- Aerobic/Anaerobic Choice
- Training

- Septage gas & solids issues
- Sub-metering
- GHG Emission Documentation (and Audits)

C. Residuals
  - COGEN and combined heat and power
  - Carbon Sequestration
  - Holistic Assessment
  - Standardizing reporting
  - Definitions (terms)
  - Insitu Testing (off gas/sequestration)

D. Effluent Reuse
  - Locate Plant as needed
  - Indirect potable message/understand
  - Wetlands rehydration
  - Emerging contaminants of concern (ECC) & Endocrine disrupting chemicals (EDC)
  - ECC & EDC Treatment
  - New technology training
  - Public communication
  - CH_4 & N_2O from effluent

Most Important Mitigation Issues

A. Collection System Improvement
B. Optimizing Plant Operations
C. Residuals Management
D. Effluent Reuse