Biosolids Management Optimization and Alternative Analysis Based on Greenhouse Gas Emissions

OWEA Annual Conference

June 16, 2010

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Learning Objectives

- Eco-Flow™ basics
- Computing Greenhouse Gas (GHG) emissions for biosolids processes
- Alternative analysis methodologies

2009 Solids Treatment and Utilization Master Plan

- Detailed investigation of the solids system at Jackson Pike WWTP, Southerly WWTP, and the Compost Facility for the City of Columbus
  - Cost
  - Energy consumption
  - Greenhouse gas emissions

City’s Goals

- Broad look at all technologies
- Utilize modeling tools to help analyze the options
- Create realistic recommendations for future solids handling processes

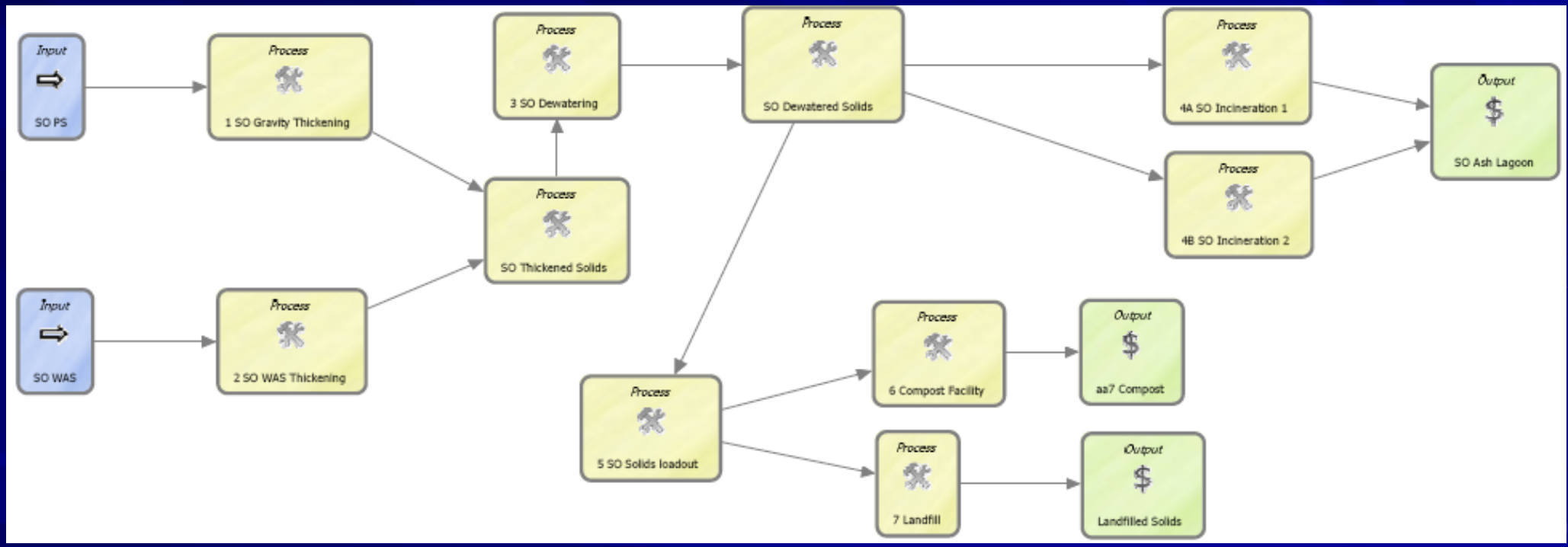
Center for Resilience

- The Ohio State University
- Interdisciplinary research center dedicated to improving the resilience of industrial systems and the environments in which they operate

Eco-Flow™

- Eco-Flow™ is a material flow optimization model
- Analyzes complicated networks to optimize material flow through the network

Southerly Baseline Eco-Flow™ Network



Eco-Flow™ Input

- Energy per dry ton of biosolids processed (MJ/dt)
- GHG emissions per dry ton processed (MT CO_2 e/dt)
- Operation and maintenance costs

Energy Analysis

- Detailed investigation into biosolids processes
- Determined rated horsepower for equipment
- Gathered run time for equipment

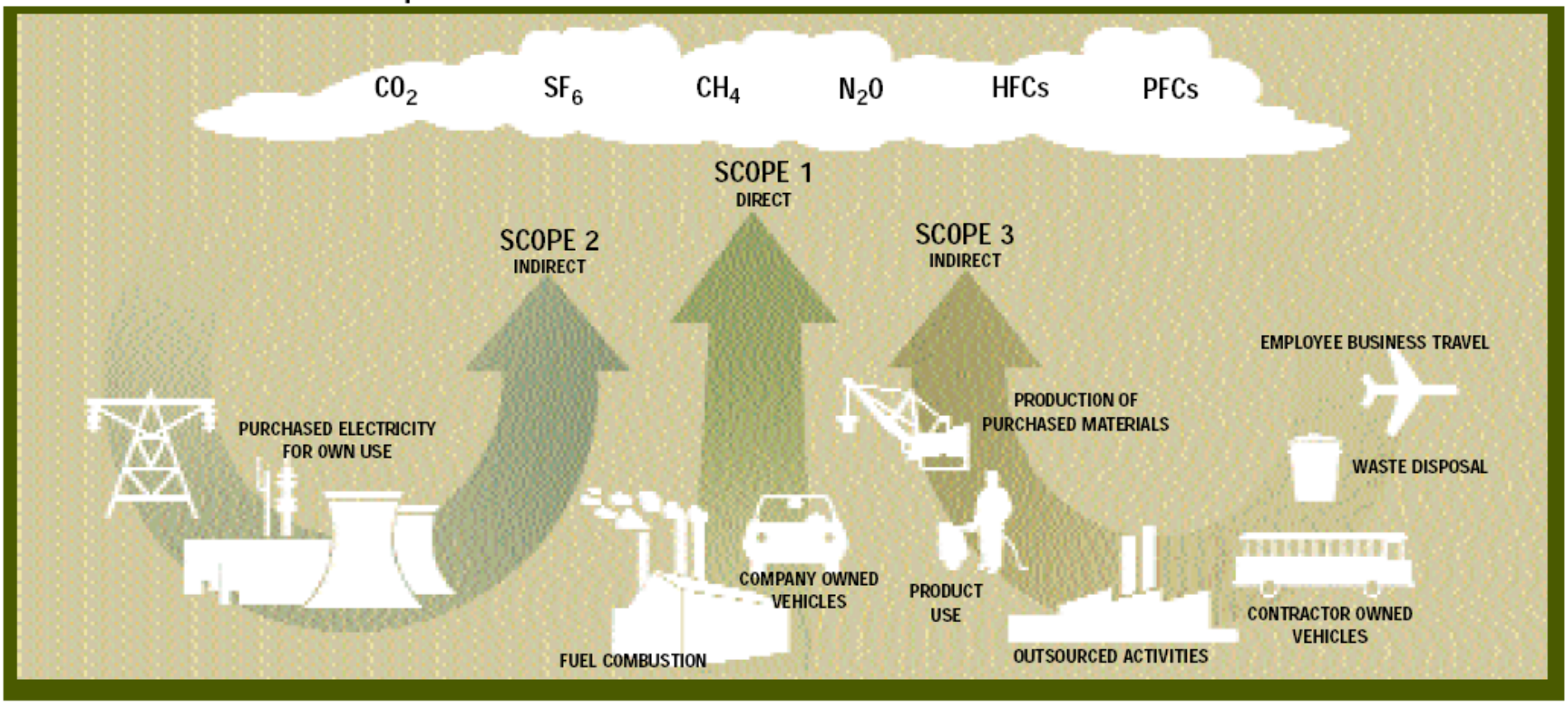
Energy Analysis

Total Energy Expended Related to Solids Produced

Process	Average Daily Energy [kW-hrs/day]	Average Daily Solids [DT]	Average Southerly [kW-hr/DT]	Average JP [kW-hr/DT]
Gravity Thickening	900 kW-hrs/day	41.5 dtpd	22	25
WAS Thickening	19,800 kW-hrs/day	38.4 dtpd	510	495
Sludge Dewatering (old)	23,700 kW-hrs/day	72.2 dtpd	330	NA
Sludge Dewatering (new)	22,200 kW-hrs/day	73.4 dtpd	302	318
Incineration	19,600 kW-hrs/day	44.5 dtpd	440	376

Carbon Emissions

FIGURE 3. Overview of scopes and emissions across a value chain



Adopted from NZBCSD, 2002

Carbon Emissions

- Biogenic carbon
  - Detailed literature search
  - Determined rates of emission based on processing of biogenic biosolids
- Fossil fuel based carbon
  - Gathered nationally published factors
  - Most emissions are from the use of natural gas or electricity

Carbon Emissions

Table 4.1.2 Biogenic GHG Emissions Factors for City of Columbus Biosolids Handling Operations		
Compost	Value	Units
Composting Process	0.40	MT eCO_2/dry ton of biosolids
Decomposition	0.80	MT eCO_2/dry ton of biosolids
Sequestration	0.20	MT eCO_2/dry ton of biosolids
Fertilizer Avoidance	0.05	MT eCO_2/dry ton of biosolids

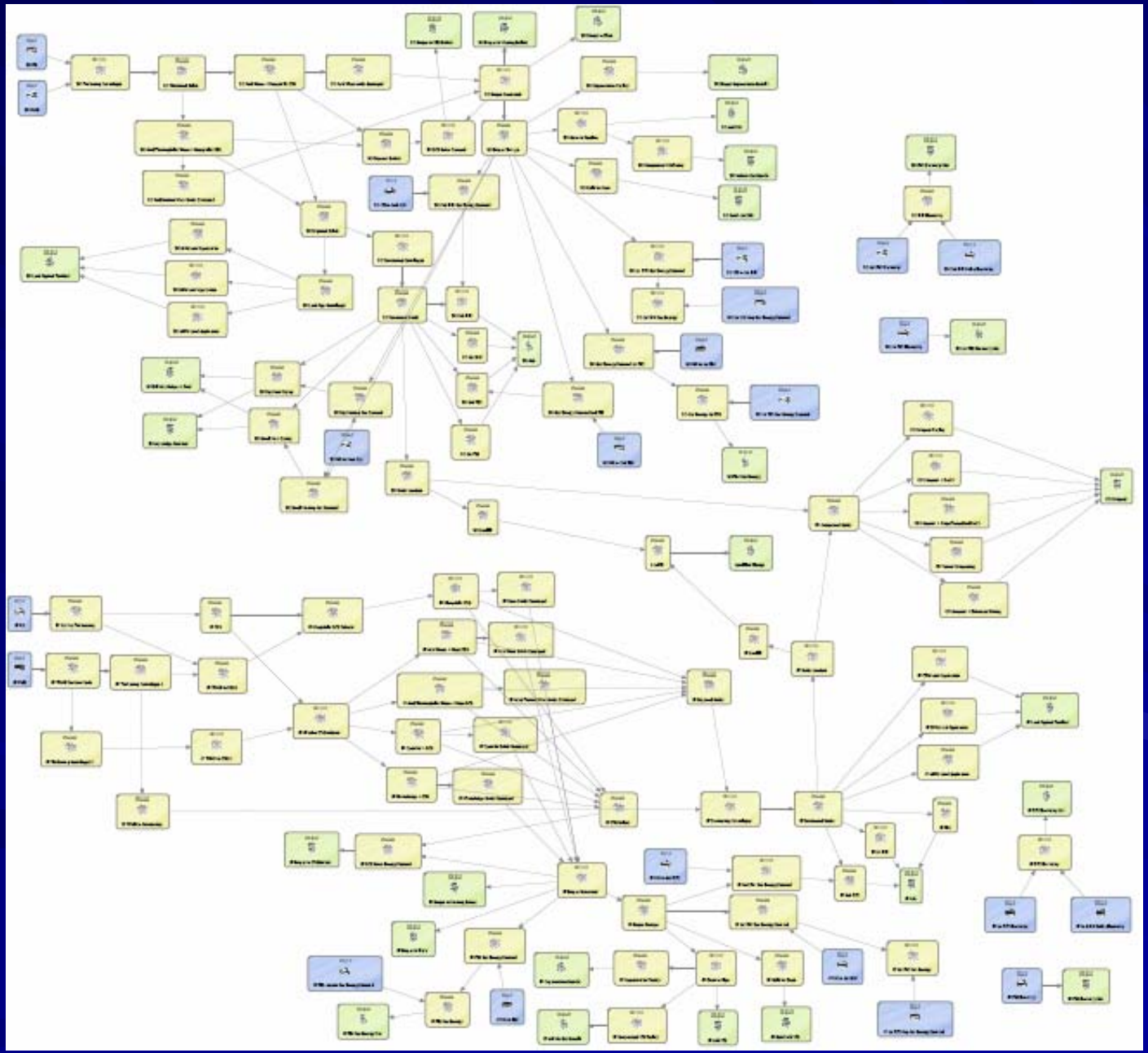
Carbon Emissions

Table 4.1.1 GHG Emission Factors for Anthropogenic Sources			
Source	**Unit**	**Emission Factor ($MTeCO_2$/unit)**	**Documentation**
Electricity	kWh	0.000817	Updated State-level Greenhouse Gas Emission Coefficients for Electricity Generation 1998-2000. Energy Information Administration, Office of Integrated Analysis and Forecasting, Energy Information Administration, U.S. Department of Energy, April 2002
Natural Gas	MMBtu	0.052973	Natural Gas Content for Utilities, EIA SEIT Spreadsheet
Gasoline	Gallon	0.008782	(1) World Resource Institute CO_2 Inventory Report for 2004 & 2005 (2) Transportation Fuel: Gasoline, EIA SEIT Spreadsheet
Diesel	Gallon	0.010047	Transportation Fuel: Diesel, EIA SEIT Spreadsheet

Operation and Maintenance Cost

- Fixed costs were developed, independent of biosolids processed
  - Labor
- Variable costs based on amount of biosolids processed
  - Fuel for incineration

Final Model Network



Biosolids Scenarios Considered

- Investigated a wide variety of scenarios for biosolids treatment and utilization using the Center for Resilience Eco-Flow™ model
  - Extreme scenarios (i.e. only a single disposal option)
  - Diverse scenarios
  - Model chosen pathways
- Over 25 options at each plant

Triple Bottom Line

- Analyzed social, environmental, technical and economic concerns
- Performed on all Eco-Flow™ scenarios
  - Best options included:
    - Utilization by a third party
    - Landfilling
    - Combinations of land application and composting
  - Poor options included:
    - Incineration
    - No digestion

Four-Step Selection Methodology

Step 1: Analyzed Eco-Flow™ modeling and selected the best scenario from among scenarios with similar results

Step 2: Evaluated the selected scenarios with respect to GHG emissions and annualized costs

Step 3: Analyzed the shortlisted scenarios with respect to TBL scores

Step 4: Considered applicability to current operations and City goals to make recommendation

Four-Step Selection Methodology

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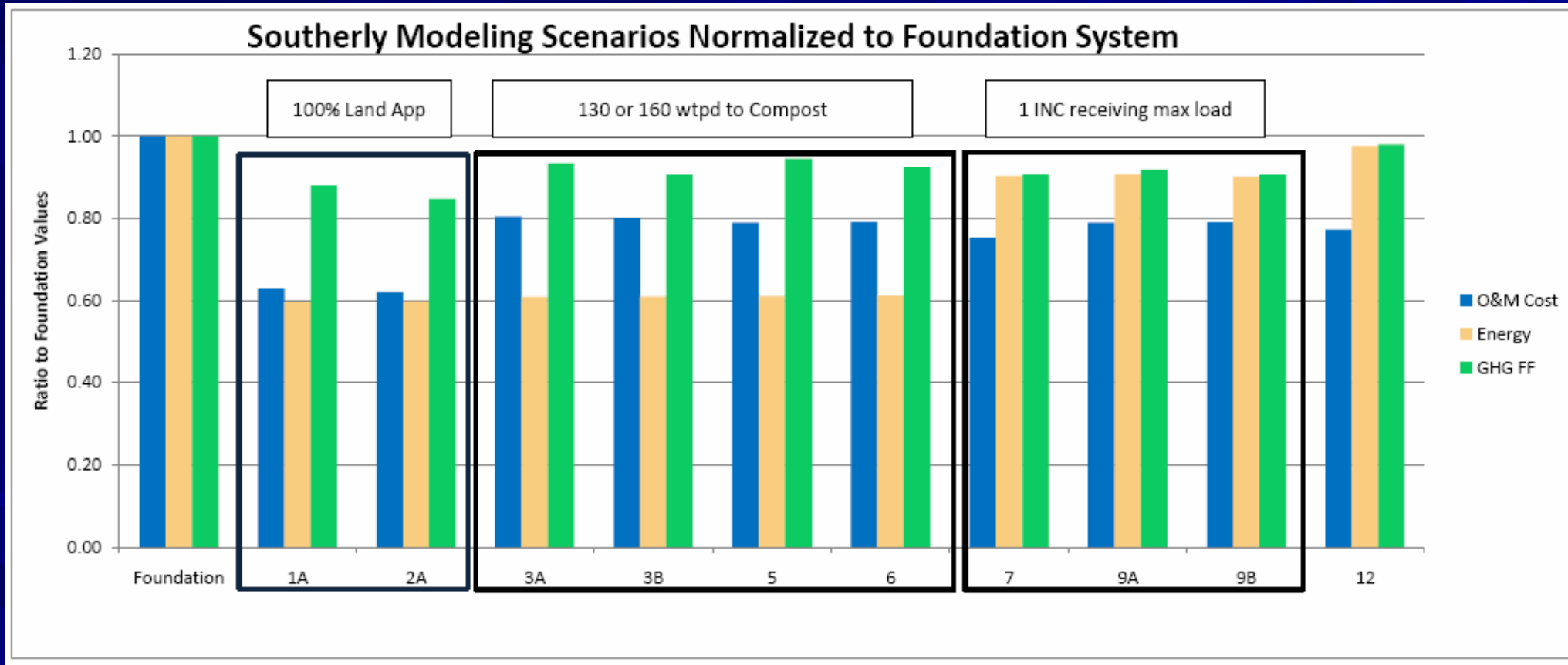
Grouping of Similar Eco-Flow™ O&M Cost, Energy, and GHG Outcomes



Step 1

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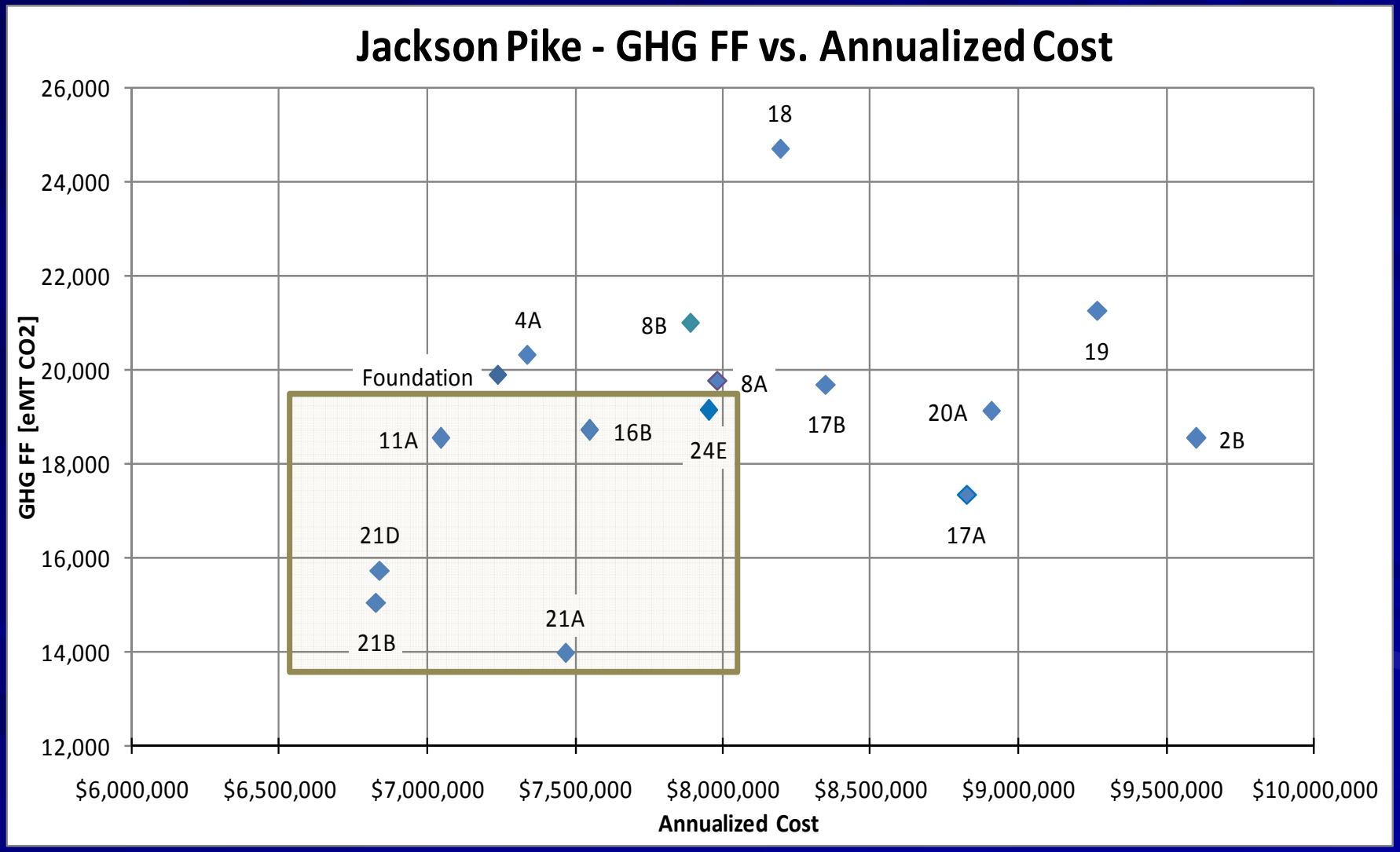
Selected Scenarios with Best GHG Performance per Dollar



Step 2

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Further Screening of Scenarios Using TBL

- Each short listed scenario was evaluated based on:
  - Total TBL
  - Social/Environmental/Technical TBL

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Draft Plan's Recommended Scenario

- JPWWTP: 70% land application, 30% compost, digestion pretreatment, sell pipeline biogas
- SWWTP: 50% land application, 50% compost, acid-methane digestion, sell pipeline biogas
- Compost Facility: additional pad for curing, grinder, and bridge

Current Status

- Further development of TBL analysis to generate risk costs
- Revision in late 2010

Thank you

Rob VanEvra, City of Columbus
Eric Auerbach, Cosmo Bertino, and Dan Gernant, MPI