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U.S. DEPARTMENT OF ENERGY | Fossil Energy

Sandia National Laboratories

# Tool for Assessing the Economic, Societal and Environmental Tradeoffs in Oil & Gas Produced Water Management and Reuse


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NM Produced Water Consortium

NM STATE

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MindsEye Computing, LLC
Visualizing the Future

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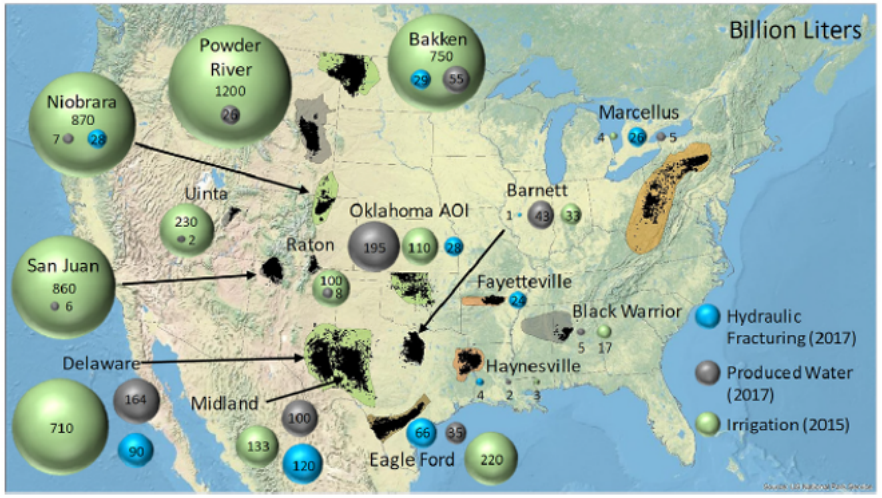
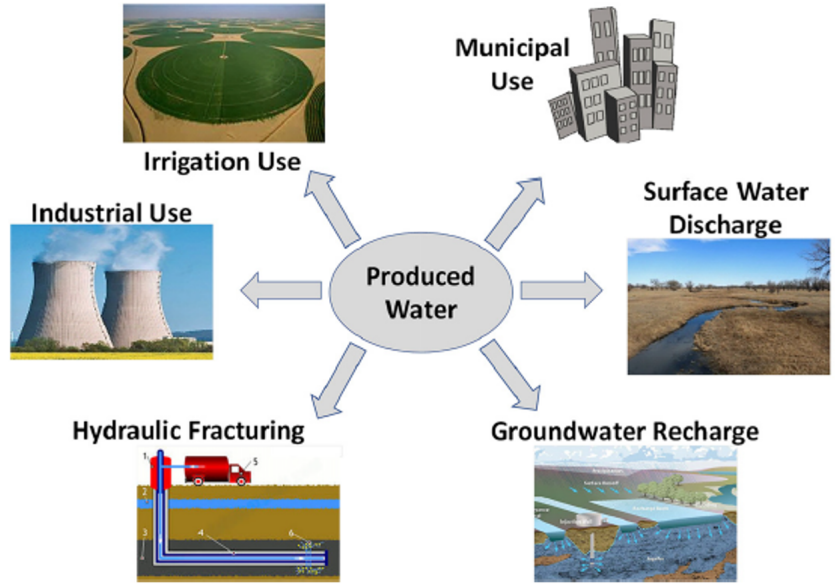
# Tool for Assessing the Economic, Societal and Environmental Tradeoffs in Oil & Gas Produced Water Management and Reuse

**Goal:** Develop an integrated model for assessing the economic, societal and environmental tradeoffs associated with alternative produced water management and fit-for-purpose treatment and reuse.

**Problem:** While many oil producers are considering qualitative Environmental, Social, and Governance (ESG) strategies to assess the general cost and benefits of the reuse of produced water, there is no comprehensive tool for **quantitatively** assessing the full costs and benefits of alternative produced water management and reuse strategies

Oil and Gas Water Management



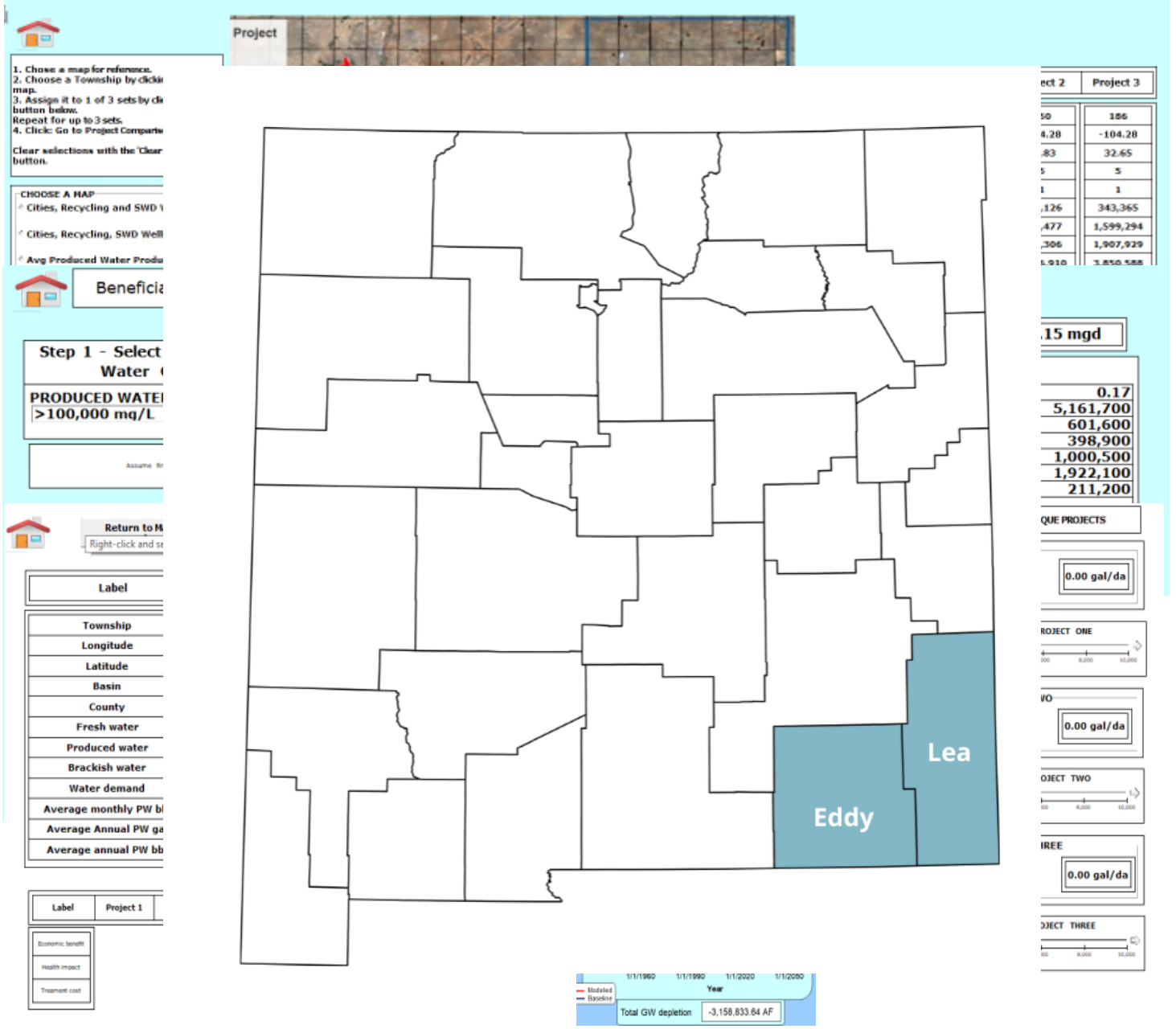




Source: Scanlon et al. 2020

# Overview

***Produced Water-Economic, Socio Environmental Simulation Model (PW -ESESim)***

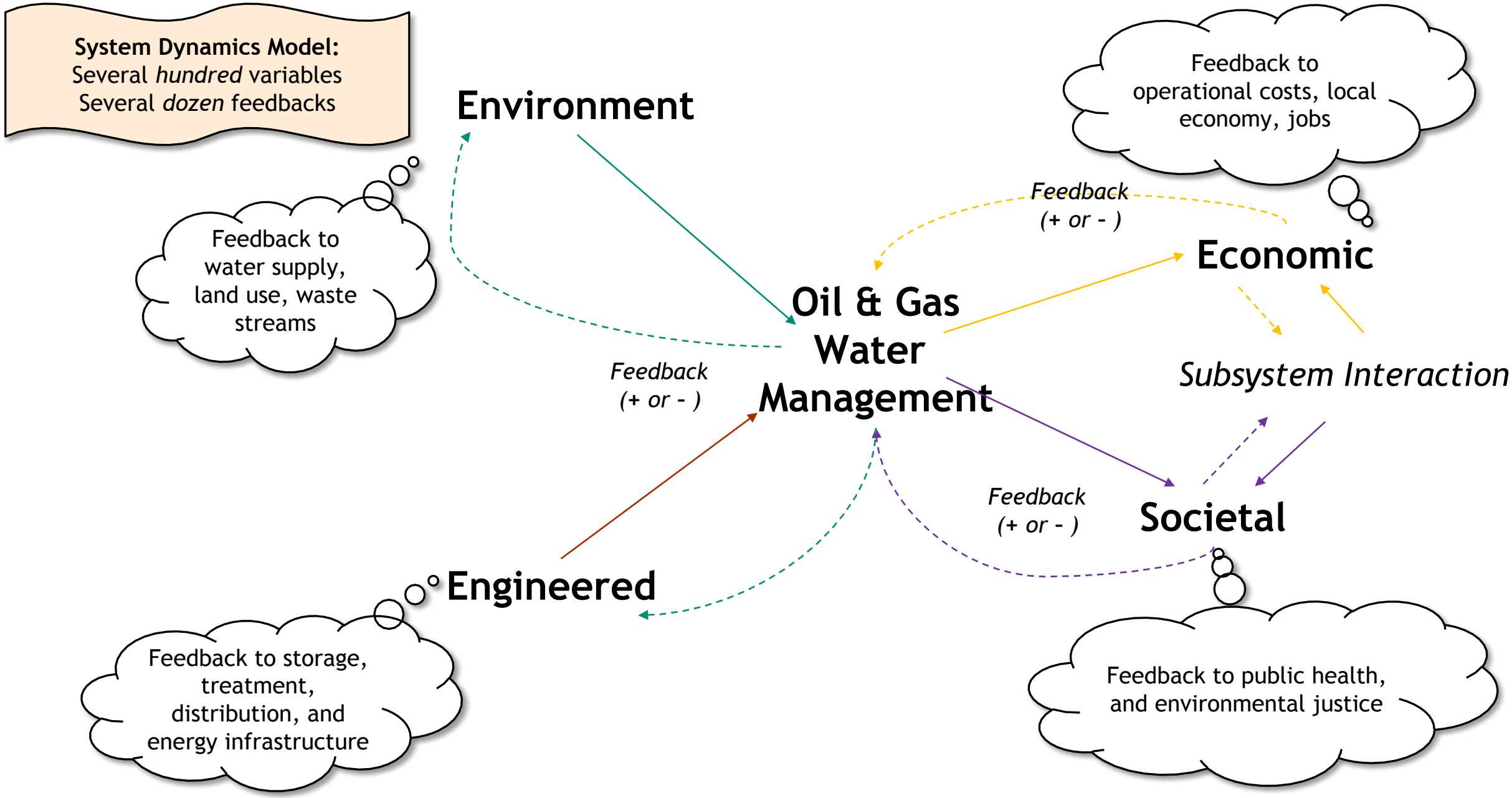
- Assess tradeoffs in ESE for alternative water management strategies
- Publicly available
- Easy to Use
  - GUI controls selection scenario design
    - Source water selection,
    - Produced water disposition,
    - Treatment and other system criteria.
  - GUI renders results for analysis and comparison
- Model resolution
  - Township/Range-scale over Lea and Eddy Counties in SE New



# System Dynamics



**System Dynamics Model:**
Several *hundred* variables
Several *dozen* feedbacks



# Stakeholder Engagement

***Leverage New Mexico Produced Water Research Consortium network of industry, regulators and developers***

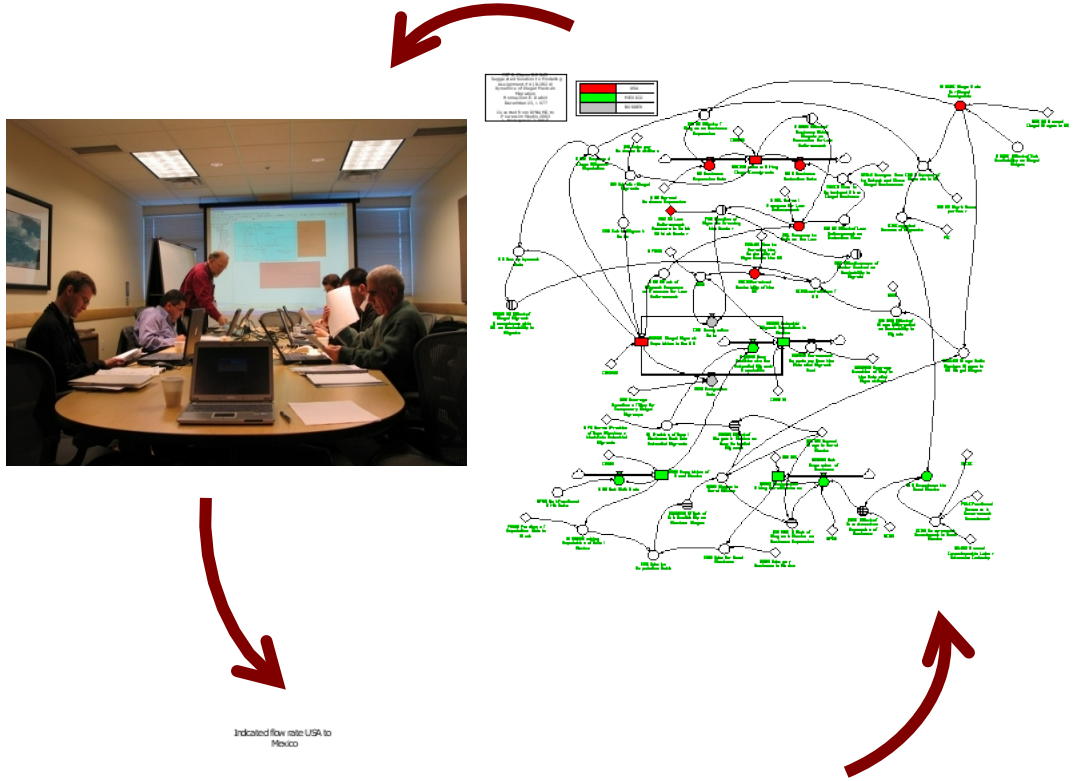
Process of engaging decision-makers and stakeholders in:

- Model development, and
- Decision analysis.

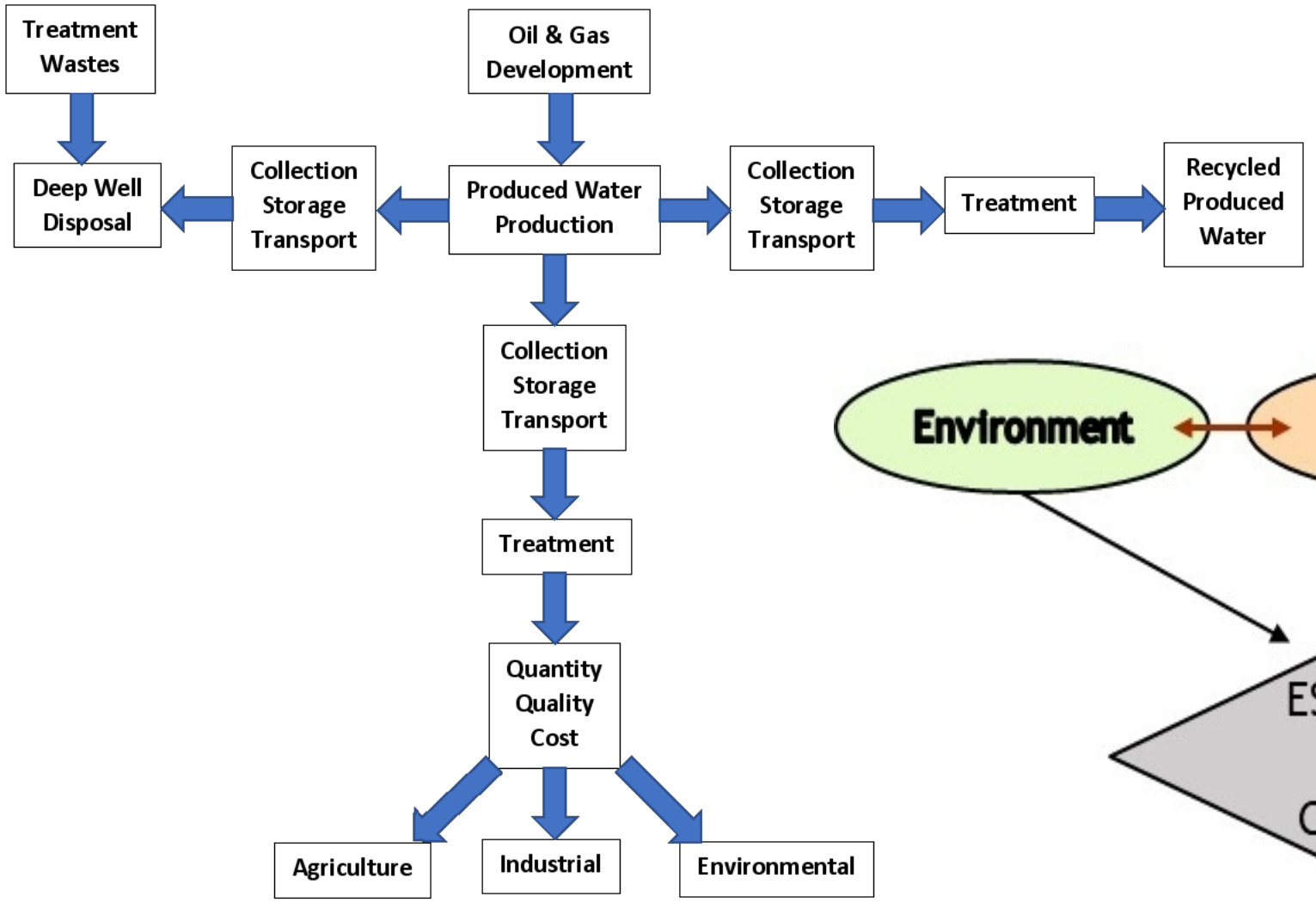
Conducted events on the following topics:

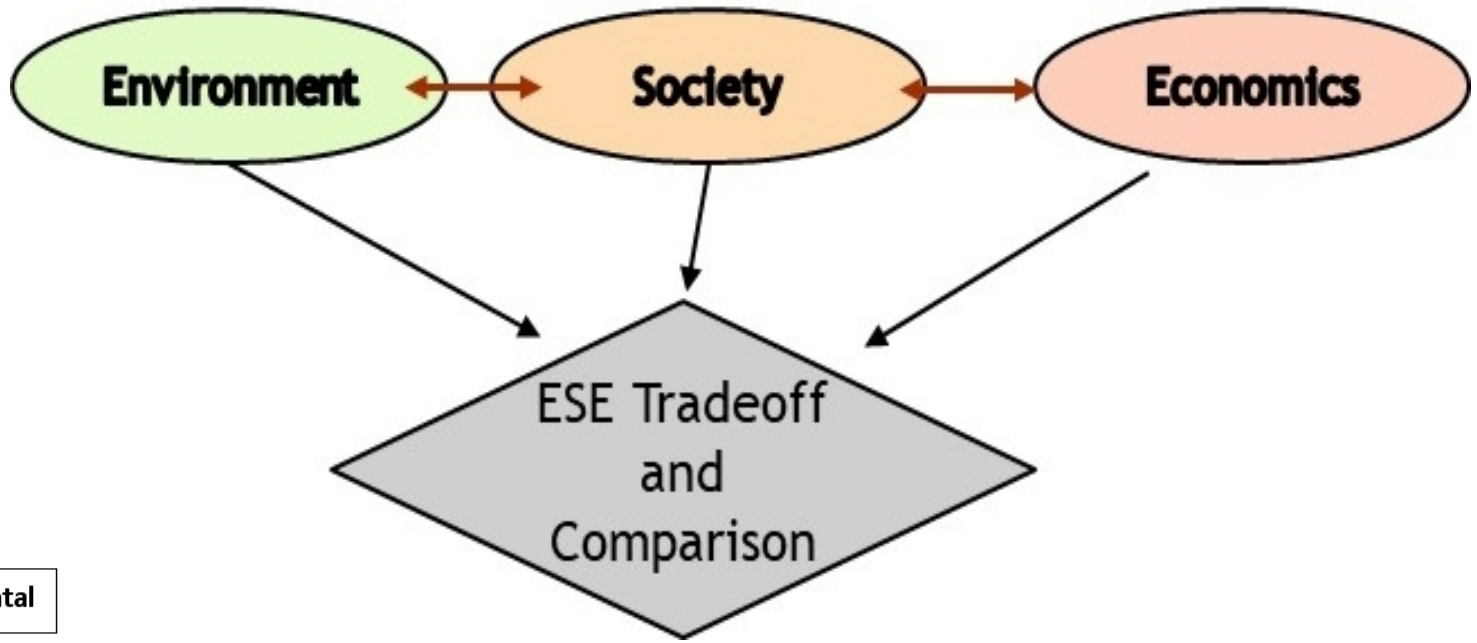
- Data resources,
- Overarching model structure,
- Oil & gas water disposal,
- Oil & gas production, transport and storage (3),
- Southeast NM water resources,
- Economic impacts and water use, and
- Public health effects (2).

Bi-weekly meetings with NMPWRC social-economic working group



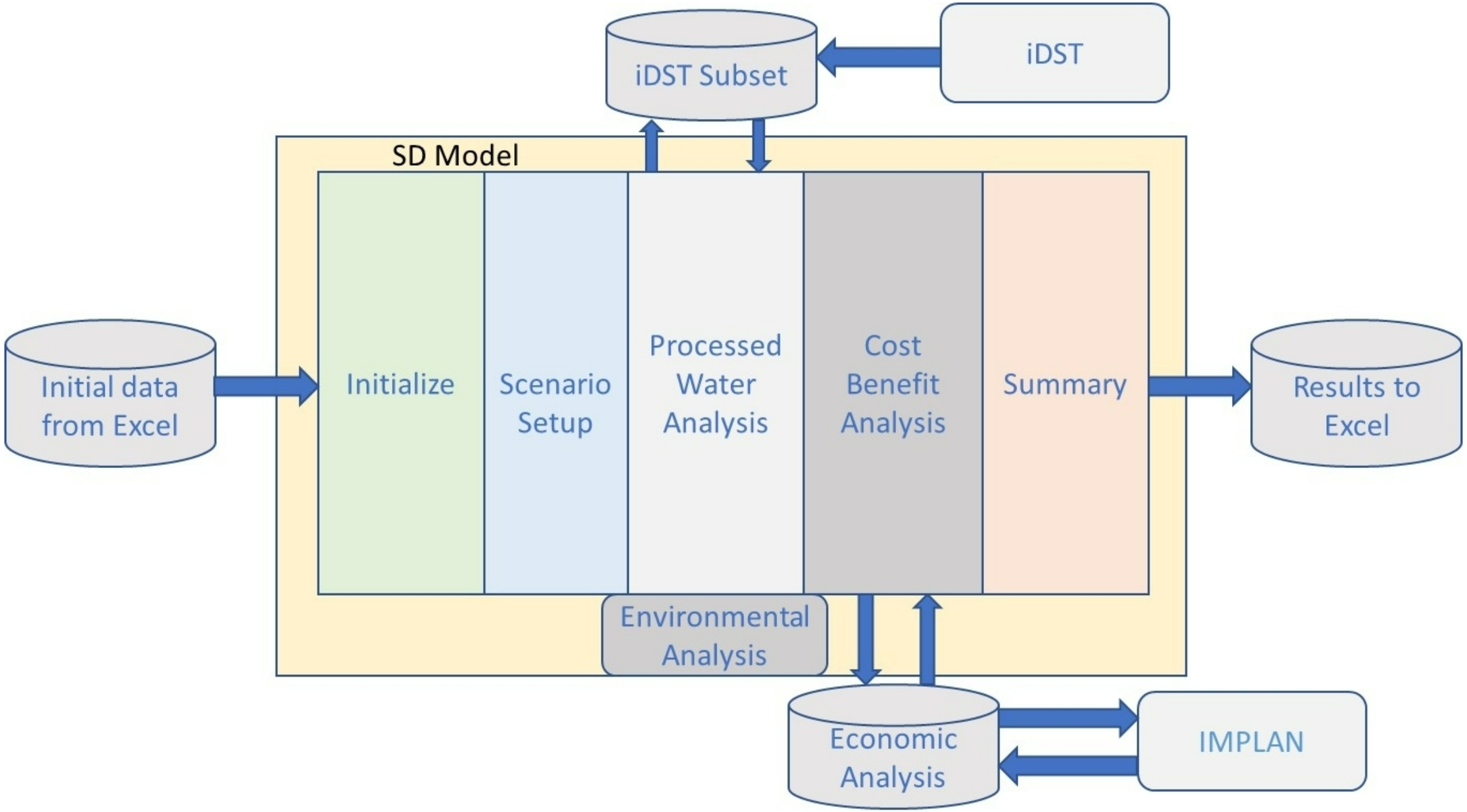
## PW-ESESim Conceptual Model



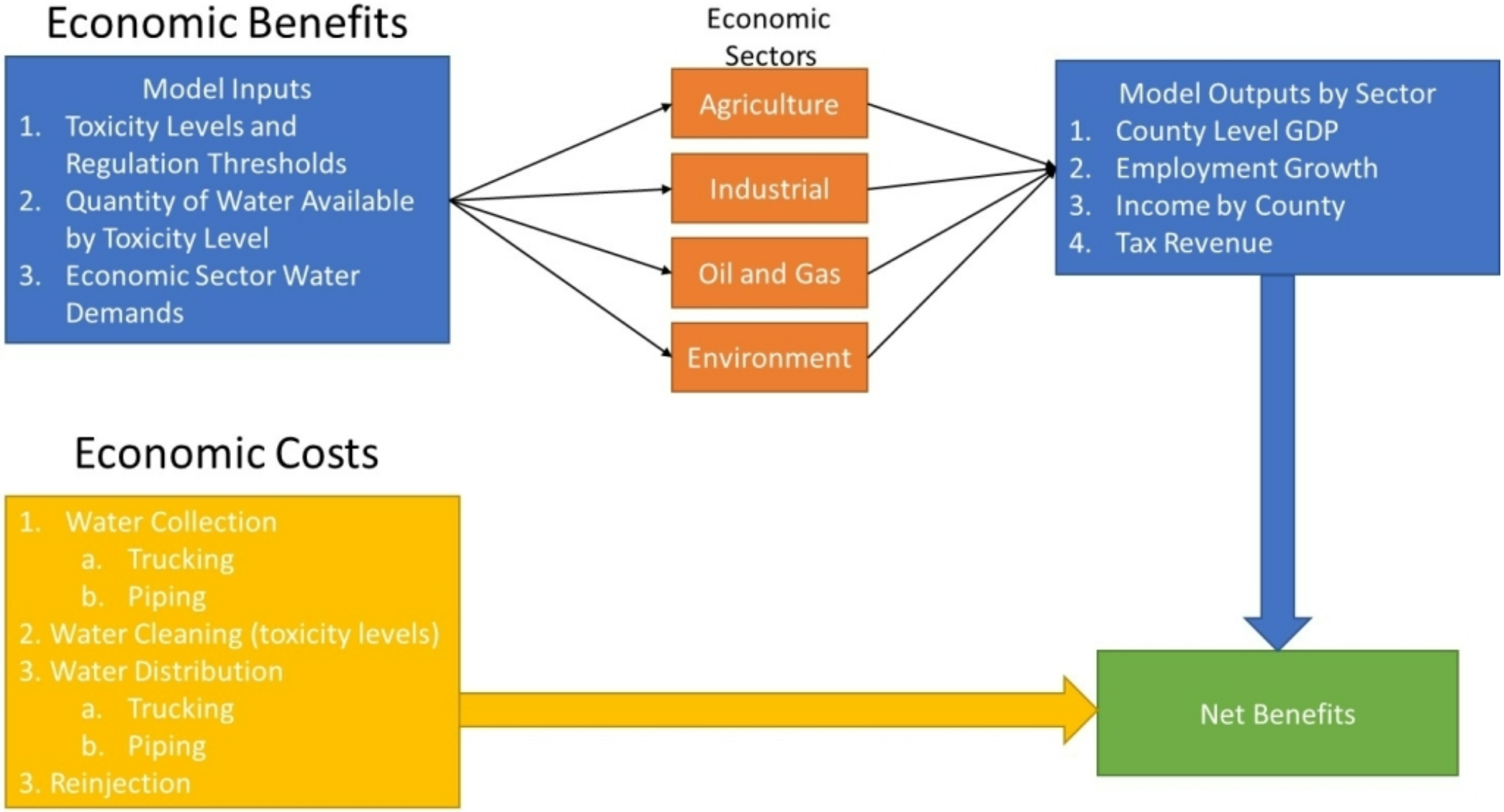



# PW-ESESim




iDST Subset
iDST
SD Model
Initial data from Excel
Initialize
Scenario Setup
Processed Water Analysis
Cost Benefit Analysis
Summary
Results to Excel
Environmental Analysis
Economic Analysis
IMPLAN

# Economics


Economic Benefits
Model Inputs
1. Toxicity Levels and Regulation Thresholds
2. Quantity of Water Available by Toxicity Level
3. Economic Sector Water Demands
Economic Sectors
Agriculture
Industrial
Oil and Gas
Environment
Model Outputs by Sector
1. County Level GDP
2. Employment Growth
3. Income by County
4. Tax Revenue
Economic Costs
1. Water Collection
a. Trucking
b. Piping
2. Water Cleaning (toxicity levels)
3. Water Distribution
a. Trucking
b. Piping
3. Reinjection
Net Benefits

# PW-ESESim

| Baseline 2019 | | |
|---|---|---|
| | Lea | Eddy |
| Year | 2019 | 2019 |
| Population | 71,070 | 58460 |
| Employment | 42,931 | 42,370 |
| Households | 24,870 | 22,274 |
| Number of Industries | 219 | 224 |
| **Output** | **$ 11,371,733,109.45** | **$ 13,255,494,023.61** |
| Petroleum refineries (154) | $ 1,701,018,709.52 | $ 2,031,646,600.35 |
| Oil and gas extraction (20) | $ 1,485,051,628.79 | $ 2,843,265,088.37 |
| Support oil and gas (36) | $ 1,472,959,279.30 | $ 1,553,607,229.90 |
| Drilling oil and gas (35) | $ 808,963,799.61 | $ 199,653,274.53 |
| Truck Transportation (417) | $ 378,795,634.15 | $ 249,368,960.42 |
| Dairy Cattle and milk (12) | $ 135,590,690.21 | $ 36,494,504.57 |
| Beef Cattle ranching (11) | $ 64,361,679.78 | $ 26,361,063.63 |
| Hospitals (490) | $ 127,892,636.10 | $ 171,821,432.72 |
| Construction of highways and streets (54) | $ 52,382,836.20 | $ 53,024,065.51 |
| Construction of new manufacturing (51) | $ 27,956,647.13 | $ 27,414,251.43 |
| Power and transmission (47) | $ 156,428,560.27 | $ 219,700,566.88 |
| **Value Added (GDP)** | **$ 5,988,885,717.74** | **$ 7,593,747,168.19** |
| Employee Compensation | $ 2,522,451,767.30 | $ 2,825,860,351.46 |
| Propieter Income | $ 363,961,674.85 | $ 184,401,716.23 |
| Other Property Income | $ 2,447,875,785.99 | $ 3,852,781,464.56 |
| Taxes on Production and Imports | $ 654,596,489.61 | $ 730,703,635.93 |

## *Benefitted Sectors*

- Agriculture
  - Non-food crops
  - Carbon Sequestration
  - Tree-nuts
  - Livestock
- Industry
  - Potash
  - Data Centers
  - Oil & Gas Equipment
- Environmental
  - Stream Augmentation


# Environment

- Water Resources
  - Source waters
    - Fresh groundwater
    - Pecos river
    - Brackish water
    - Wastewater
    - Produced water
  - Water use sectors:
    - Agriculture/Livestock,
    - Municipal,
    - Oil & gas,
    - Industrial/Mining/Power
- Pollution
  - Waste disposal volumes
  - Aquatic impacts
  - Soil degradation

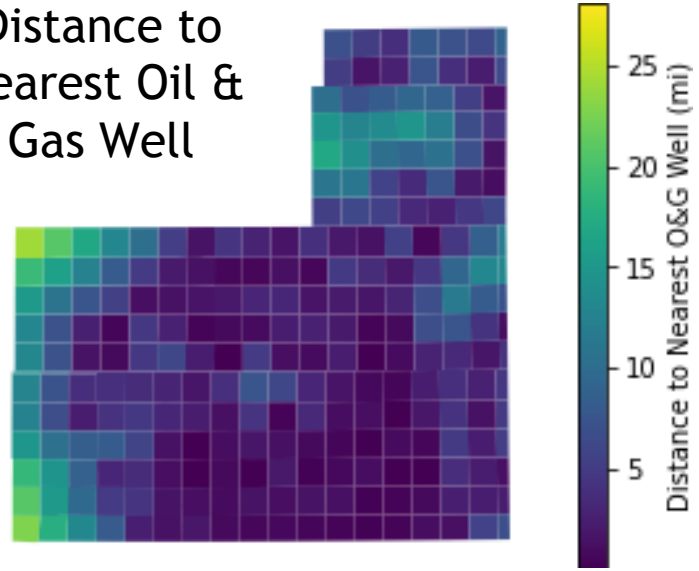
# Social: Human Health

- Based on EPA's Exposure and Fate Assessment Screening Tool (E-FAST)
- Determine change in dose rate for both acute and chronic exposure:
  - Pecos River (incidental contact)
  - Fish Ingestion
  - Groundwater contamination
  - Inhalation (spray irrigation)
- Compare to exposure with current water quality.
- Index to Concentration of

# Social: Environmental Justice

- Metrics adapted from:
  - California Environmental Protection Agency's Environmental Justice Screening Tool (CalEnviroScreen 4.0), and
  - Washington State Department of Health's (WaDOH) Environmental Health Disparities tool

Distance to Nearest Oil & Gas Well




Metrics and State

| Aa Indicators | Variable Type | Status |
|---|---|---|
| Proximity to oil and gas activity | Environmental Exposure | Static |
| Proximity to PW disposal | Environmental Exposure | Static |
| Proximity to heavy traffic | Environmental Exposure | Static |
| Decreased air quality due to traffic | Environmental Exposure | Dynamic |
| Decreased water quantity | Environmental Exposure | Dynamic |
| Impaired waters | Environmental Exposure | Dynamic |
| Poverty rate | Socioeconomic | Dynamic |
| Unemployment rate | Socioeconomic | Dynamic |
| Household affordability | Socioeconomic | Static |
| Historic cultural sites | Cultural | Static |