Pipeline Development – Strategies and Tools to Minimize Landscape Impacts

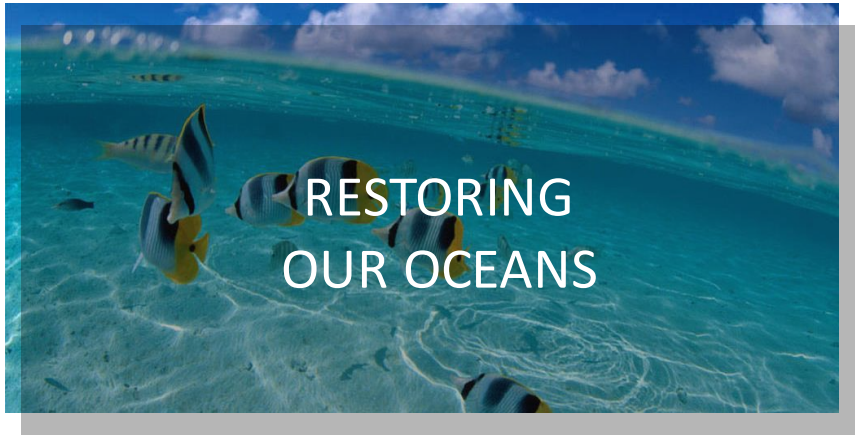
Pennsylvania Pipeline Task Force

September 23, 2015

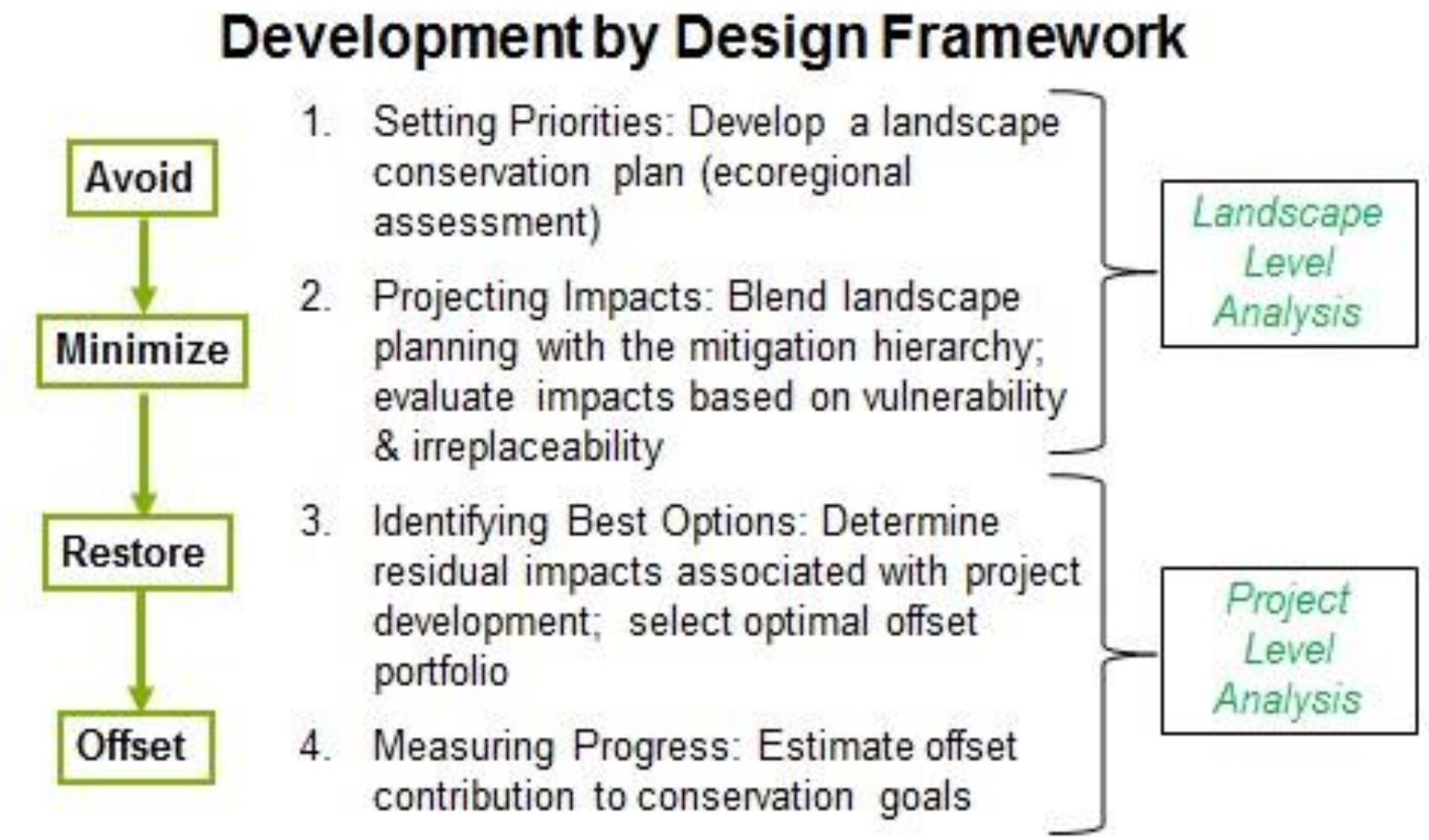
Nels Johnson

THE NATURE CONSERVANCY

SAVING THE LANDS AND WATER ON WHICH ALL LIFE DEPENDS



DEVELOPMENT BY DESIGN



Pipeline Development – Minimizing Landscape Impacts

- Scale and Nature of Impacts
- Strategies and Tools for Reducing Landscape Impacts

Most People Focus on This…

But Most of the Impacts Come From This

Scale and Nature of Impacts

Scope and Scale of Energy Development Unprecedented in North America

Energy sprawl is (by far) biggest driver of habitat loss in the United States

Energy development is expanding into many areas that previously were not at risk

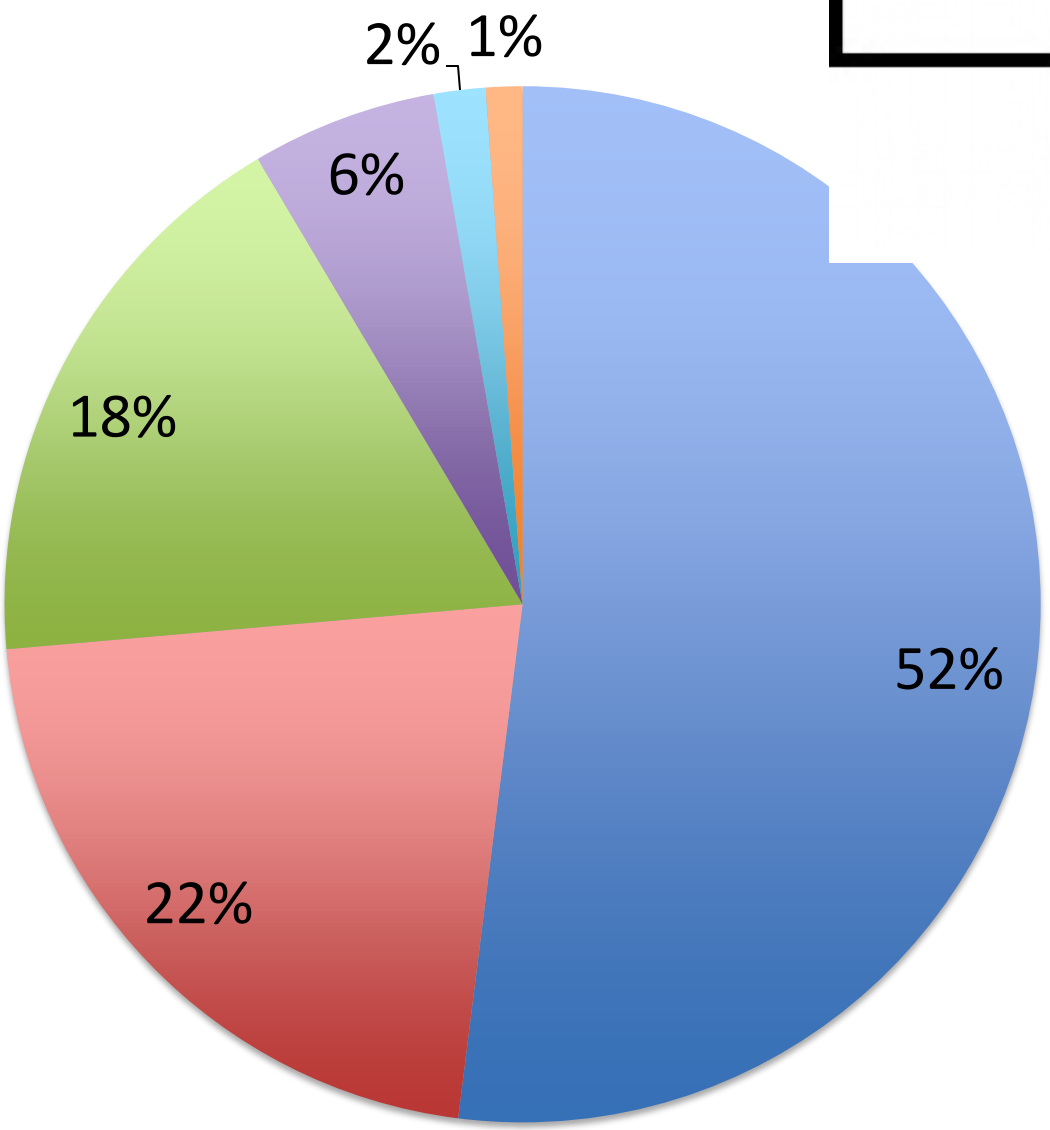
Significant opportunities for improved siting and mitigation

Source: Fargione et al (*in press*)

Direct vs. Landscape impact

Direct vs. Landscape impact

Direct Impact



51M acres

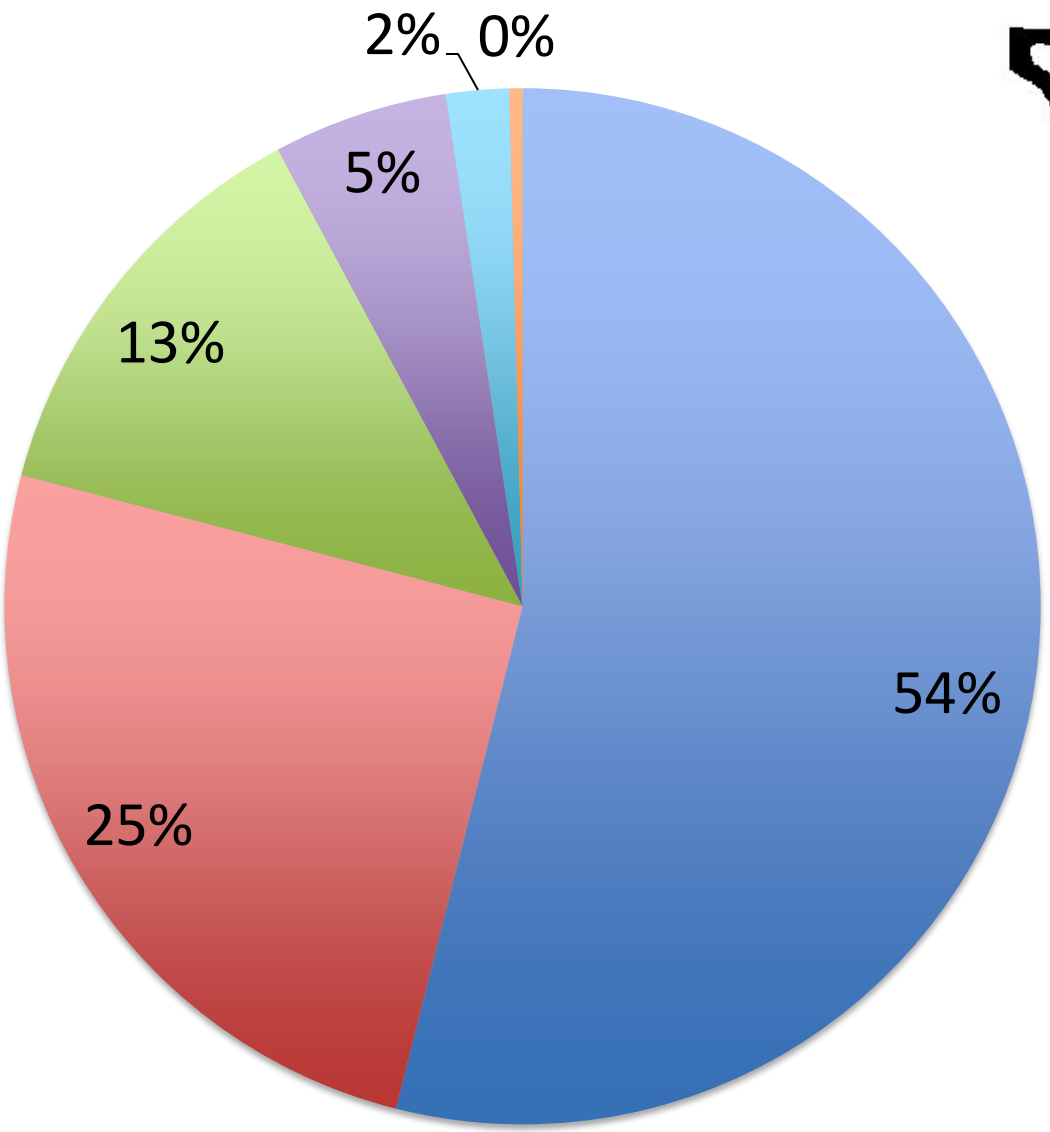
(Nebraska)

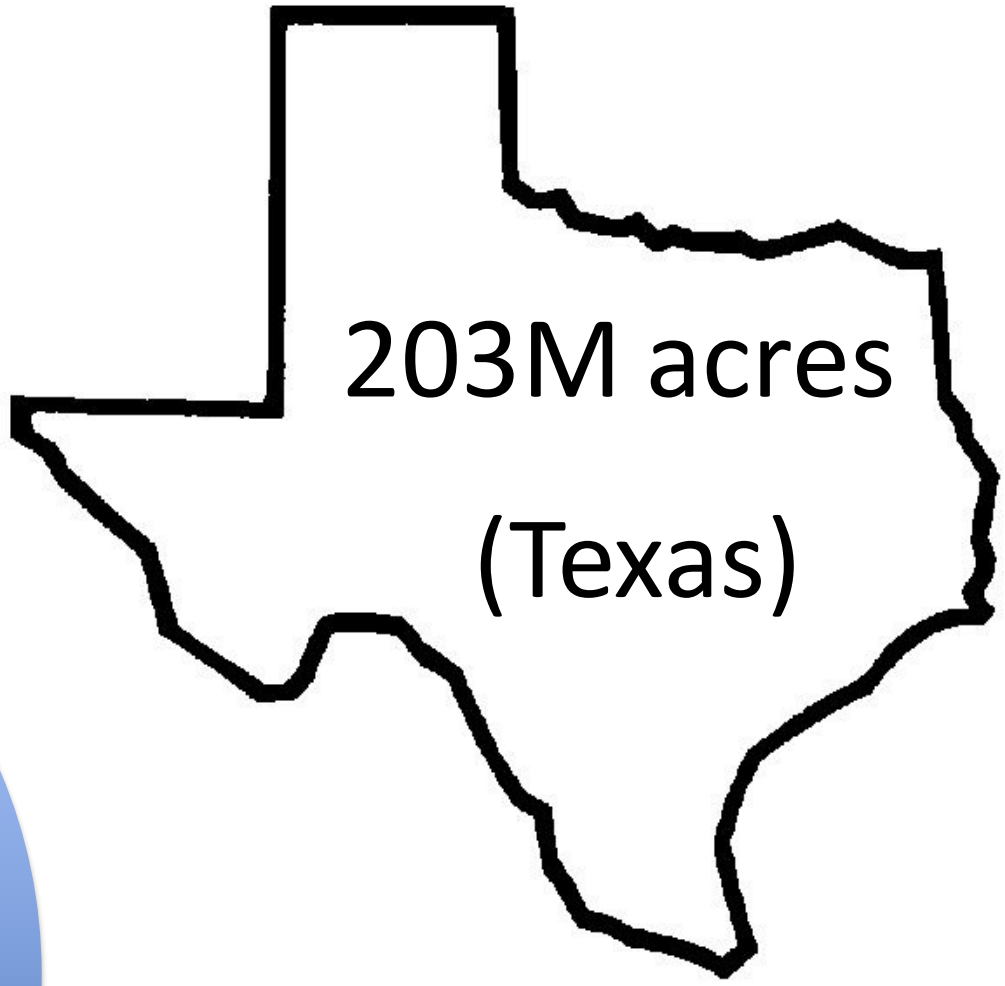
- coal
- biofuels
- gas
- oil
- nuclear
- renewables

10 million acres

Source: Fargione et al (*in press*)

Indirect Impact

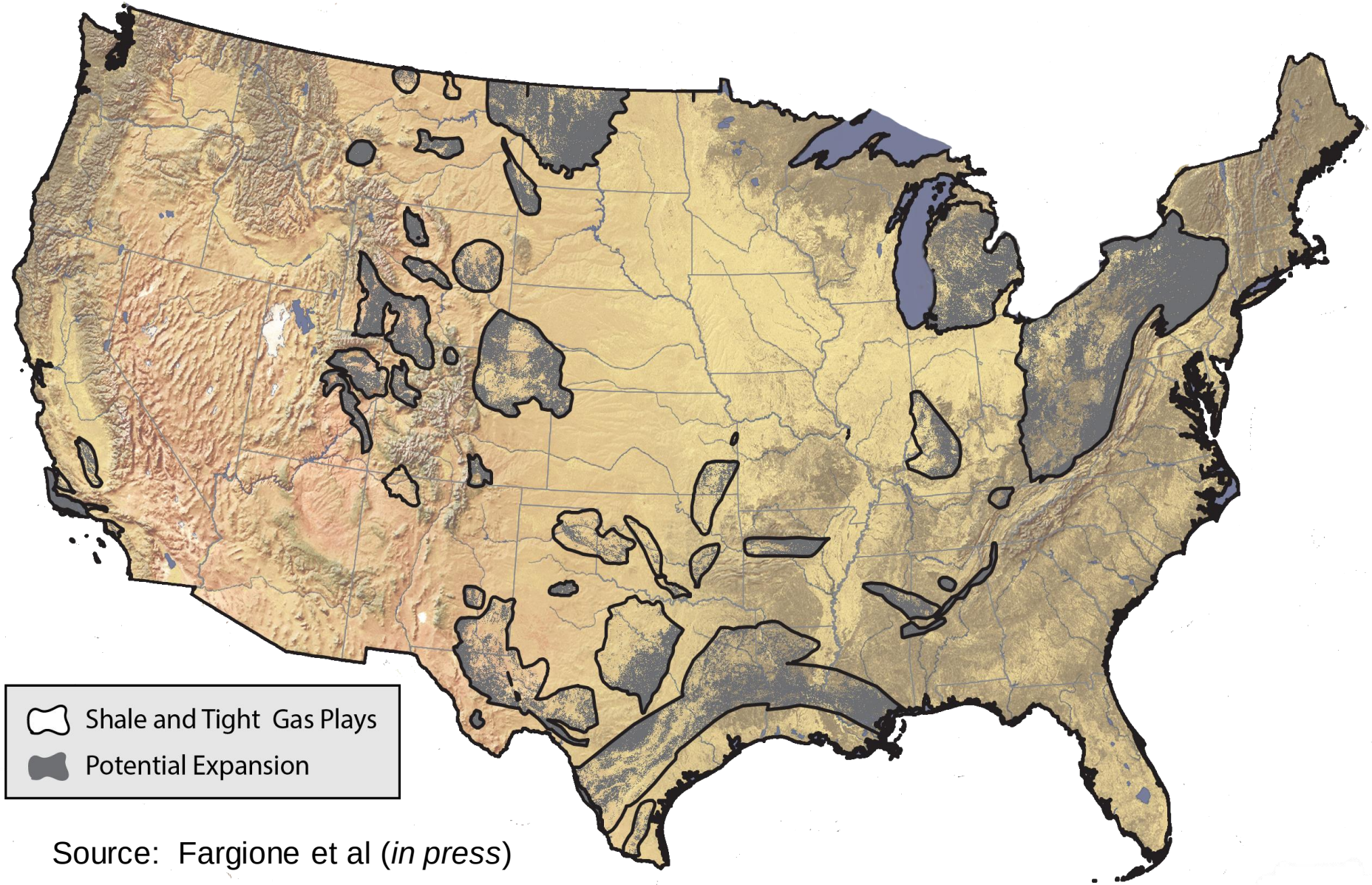




gas 110 million acres
oil
coal
biofuels
renewables
nuclear

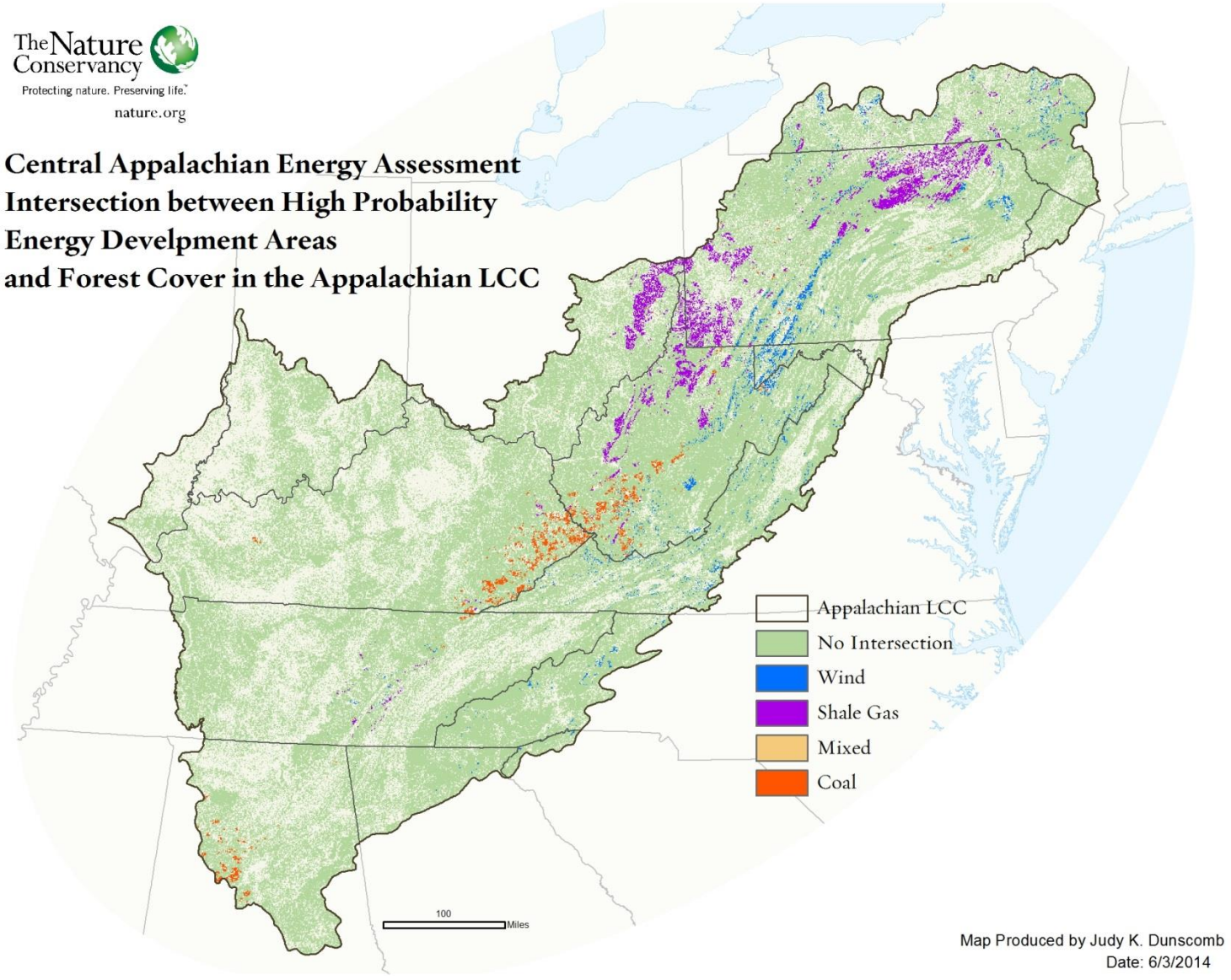
Source: Fargione et al (*in press*)

New Energy Landscapes: Fracking
321M acres at risk
up to 141M acres developed



Source: Fargione et al (*in press*)

Appalachian Energy Projections – Forest Risk



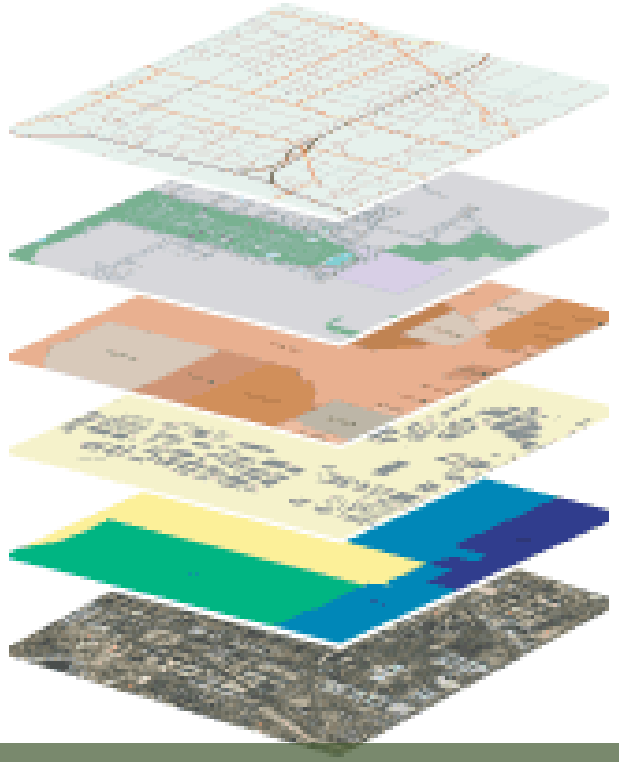
Geographic Projections for Marcellus Development

Modeled the relationship between:

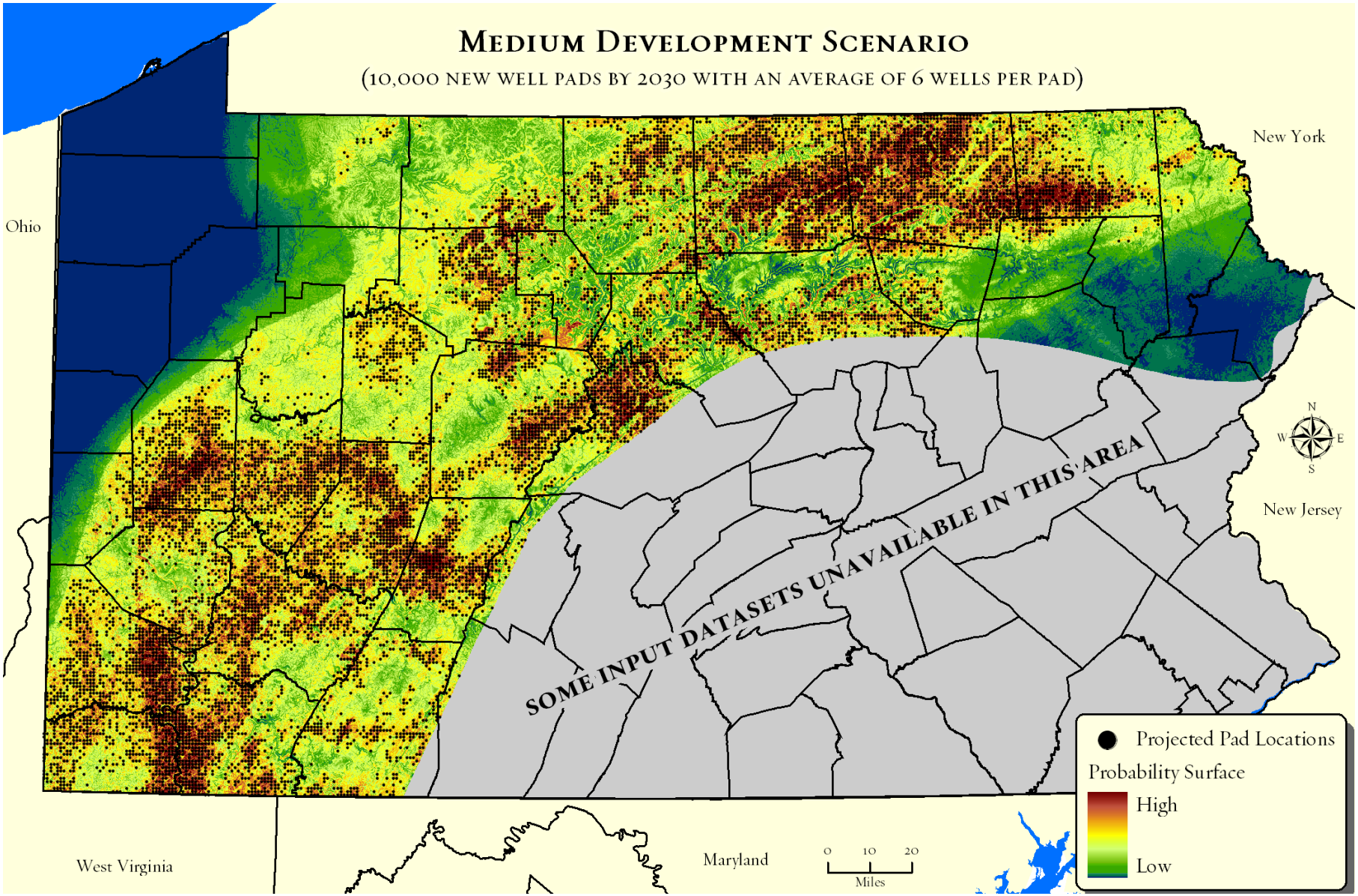
- Drilled and permitted Marcellus wells (from PA-DEP data)

- Spatial variables related to geology and infrastructure:

  - Thermal Maturity
  - Shale Depth
  - Shale Thickness
  - Percent Slope
  - Distance to Roads
  - Distance to Pipelines



Geographic Projections for Marcellus Development



How Many New Gas Pipelines in U.S?

- 298,000 miles of large diameter natural gas transmission pipelines in U.S.
- 160,000 miles of hazardous liquid pipelines (oil, gasoline, butane, etc.)
- Pipeline industry estimates >5,000 miles of large diameter natural gas transmission pipelines are being built annually.

How Many New Gas Pipelines in PA?

- PA has >12,000 miles of large diameter oil/gas pipelines
- Pipeline mileage in PA will at least quadruple by 2030
- The gathering pipeline footprint alone is larger than the cumulative area impacted by all other Marcellus gas infrastructure combined
- Total direct land impact could exceed 300,000 acres (1% of PA land area)

Water Quality – Sediment and Nutrients

Photo: Patrick Drohan – Penn State

Photo: Josh Parrish – TNC

Land Use – Habitat Loss

Land Use – Habitat Fragmentation

Oil/Gas Transmission Pipelines (12 acres/mile)

Edge Effects on Forest Interior Species

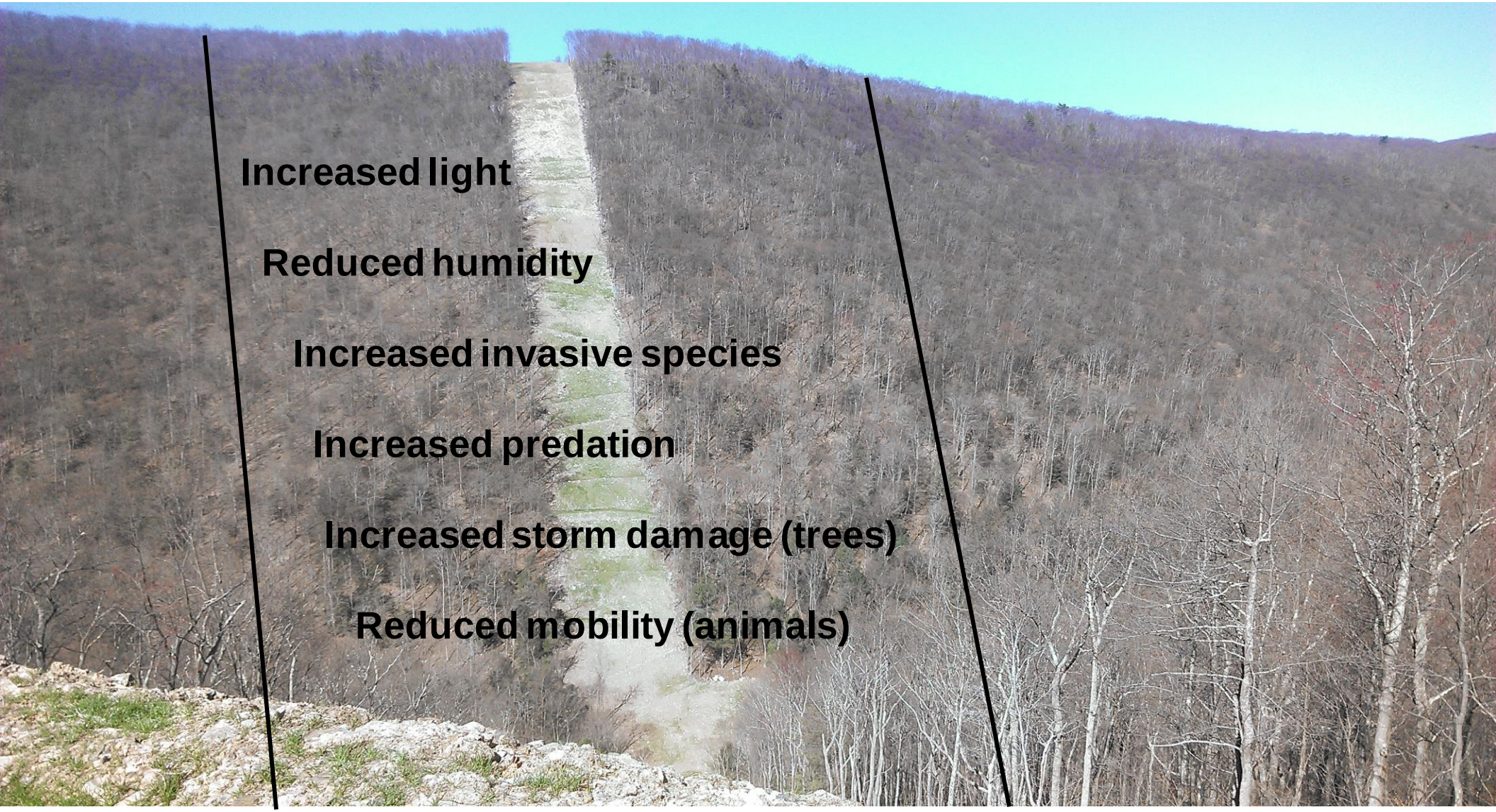


Photo: Josh Parrish – TNC

Environmental Impacts of Pipeline ROWs

Physical Impacts

Soil disturbance/erosion

Noise (electrostatic)

Noise (compressor stations)

VOC and methane emissions (natural gas)

Light (large electric lines)

Chemical use/spills

Mowing/cutting vegetation

Ecological Impacts of Transmission ROWs

- Habitat fragmentation
- Increased predation
- Vectors for invasive species
- Animal travel corridors
- Favorable sites for early successional/grassland species

Strategies and Tools to Reduce Ecological Impacts

Strategies to Minimize Pipeline Impacts

1) **Demonstrate Need/Share Capacity**

2) **Regional/Landscape Planning**
   - ***EnSitu* Landscape Tool**
   - **Regional Pipeline Siting Tool**

3) **Impact or Mitigation Fees**

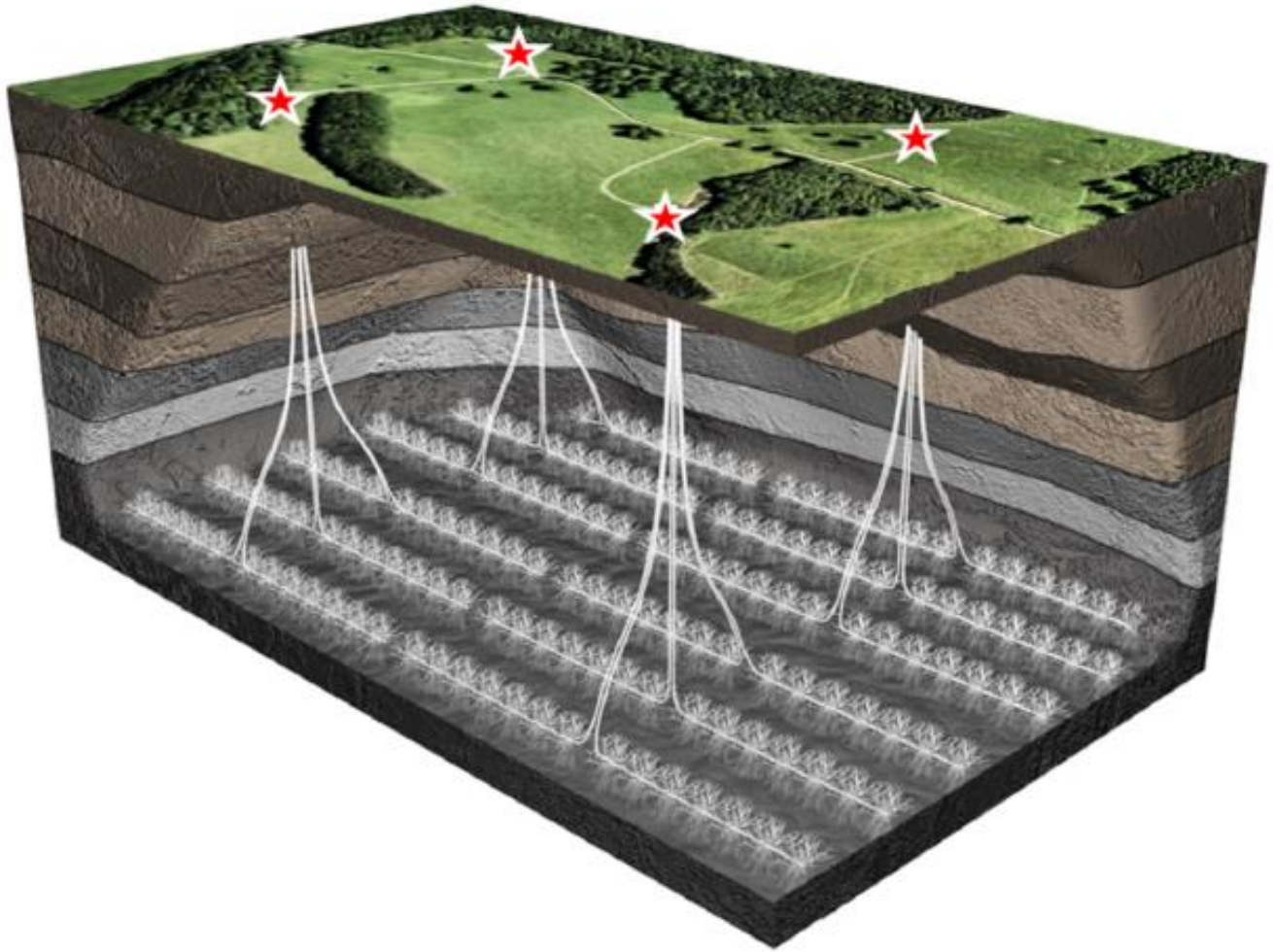
4) **Co-Locate Pipelines With Other Right-of-Ways**

5) **Narrow Right-of-Ways**

1) **Right-of-Way Management**
   - ***TNC Recommended Conservation Practices***

Tools to Reduce Impacts: *EnSitu*

Flexibility in Siting at the Surface



Tools to Reduce Impacts: *EnSitu*

THE UNIVERSITY of TENNESSEE KNOXVILLE

Richard King Mellon Foundation

Colcom Foundation

CADMUS

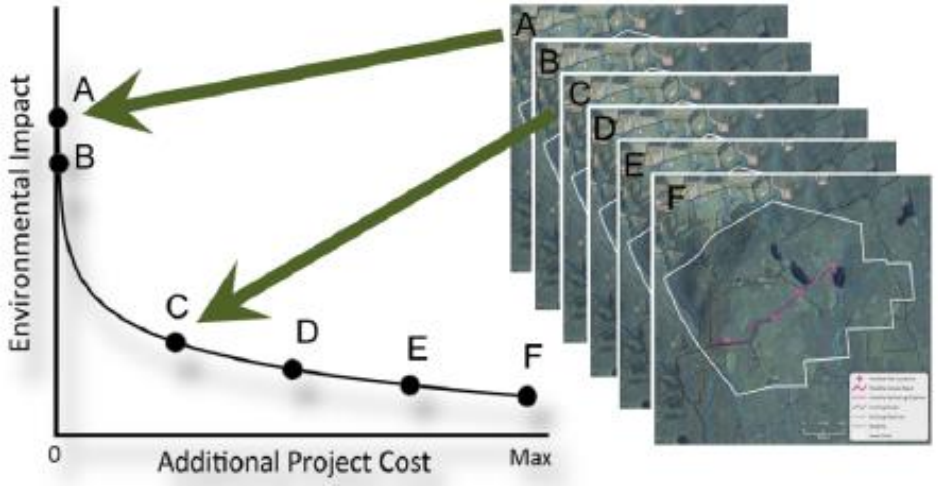
J.P. Morgan

Industry Advisors

Tools to Reduce Impacts: *EnSitu*

The ArcGIS-Based Shale Siting Tool:

- Generates shale oil/gas surface infrastructure scenarios that avoid and reduce environmental impacts and risks
- Incorporates existing environmental regulations and encourages exclusions and setbacks beyond regulatory minimums
- Assesses trade-offs between environmental impacts and infrastructure development costs



Tools to Reduce Impacts: *EnSitu*

Tool Applications

- Reduce habitat impacts and minimize risks by going beyond regulatory compliance
- Identify optimized infrastructure layouts for many well pads at the same time
- Compare individual layouts in terms of environmental impacts and financial costs
- Site only linear infrastructure (with known pad locations)

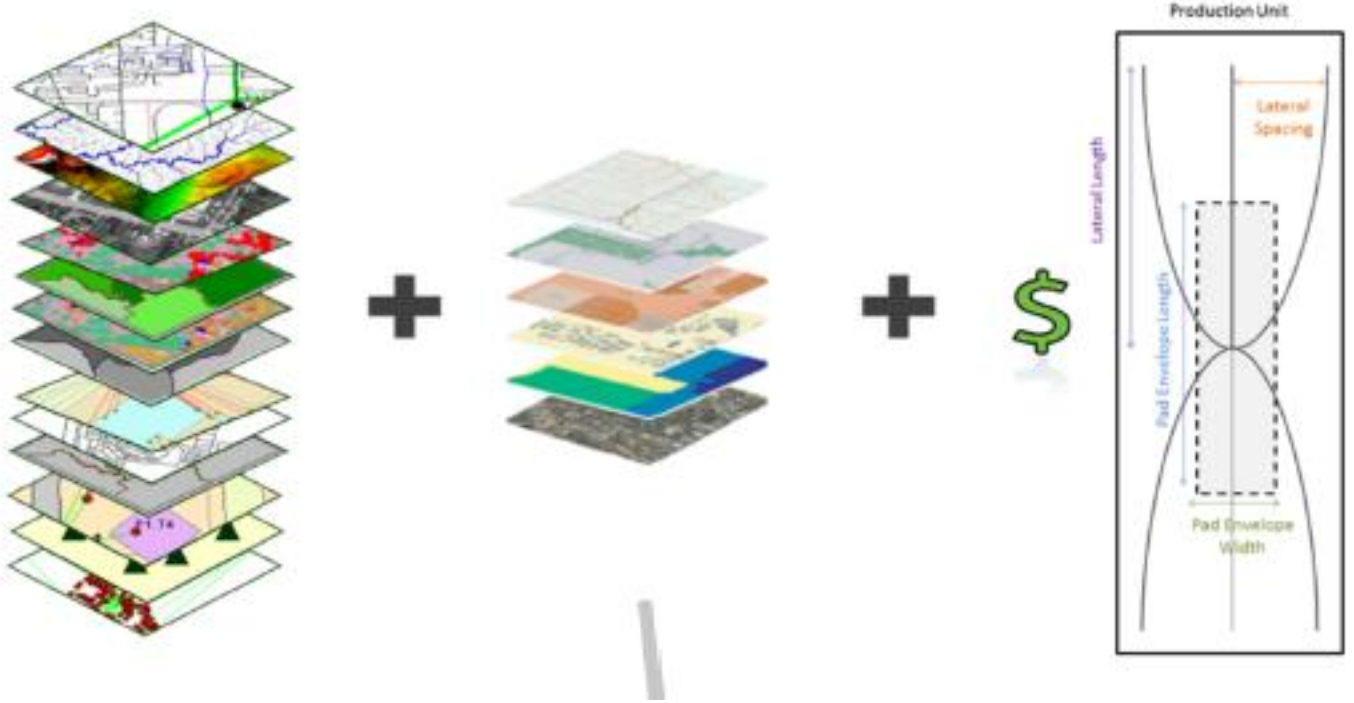
Tools to Reduce Impacts: *EnSitu*

Tool Inputs

Base Data Layers

User-Provided Data Layers

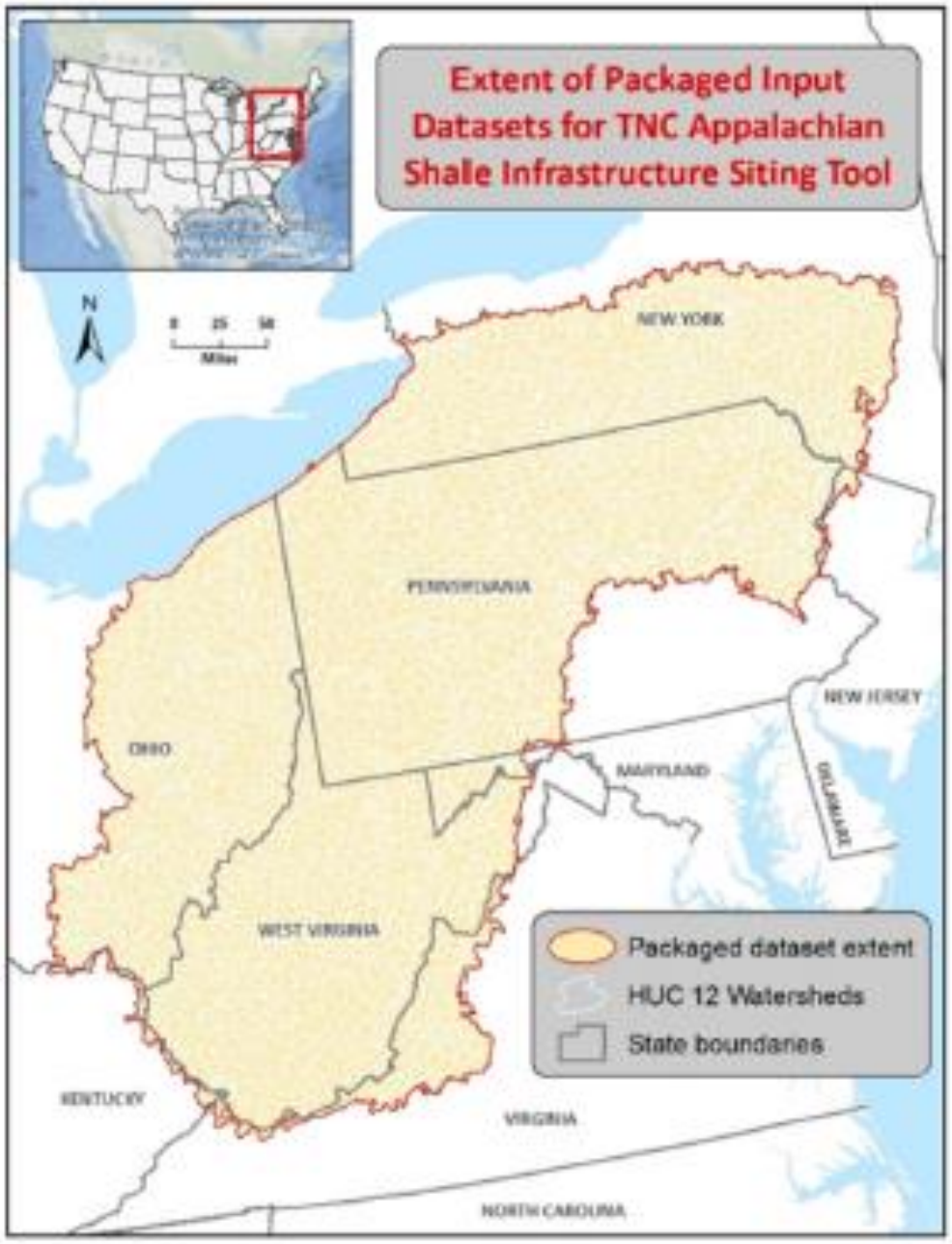
Customized Settings *(Optional)*



Tools to Reduce Impacts: *EnSitu*

- Target Audiences:
  - Oil and gas operators
  - Oil and gas consultants
  - Large land owners and managers
  - Regulators

Tools to Reduce Impacts: *EnSitu*

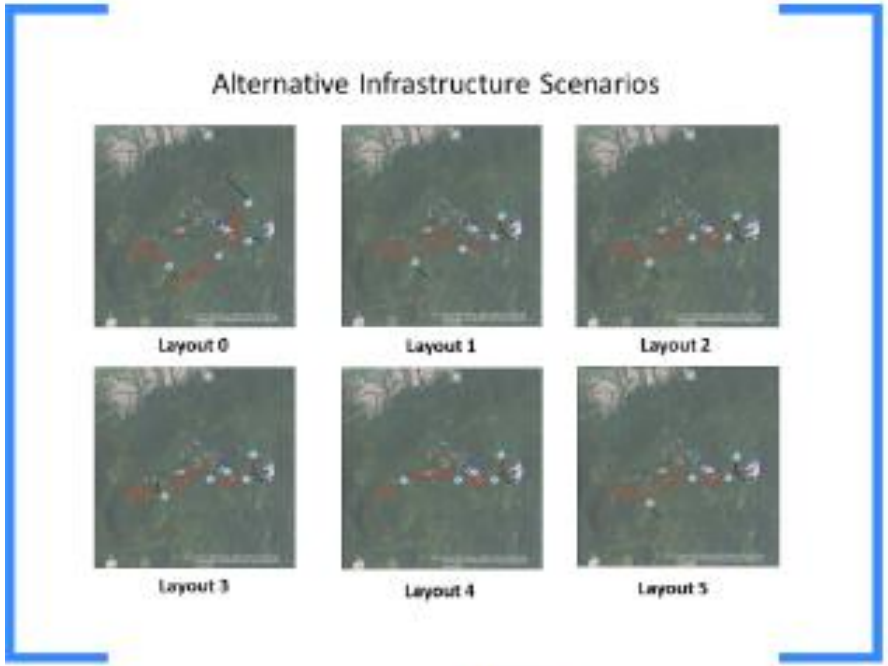


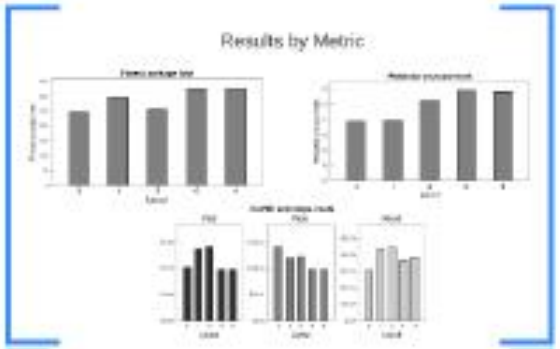
Tools to Reduce Impacts: *EnSitu*

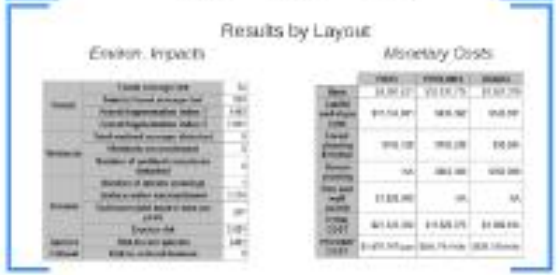
Basic Processing Steps (highly simplified)

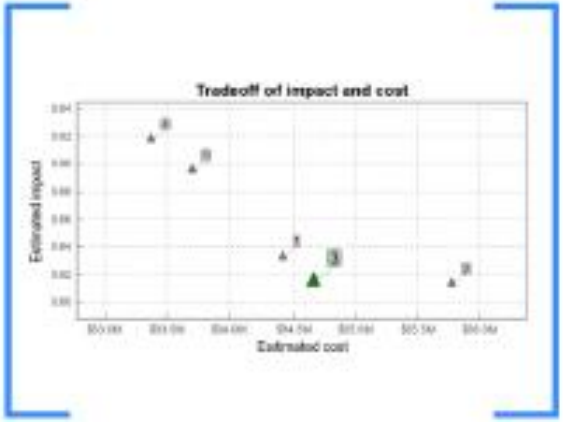
Tools to Reduce Impacts: *EnSitu*

Tool Outputs



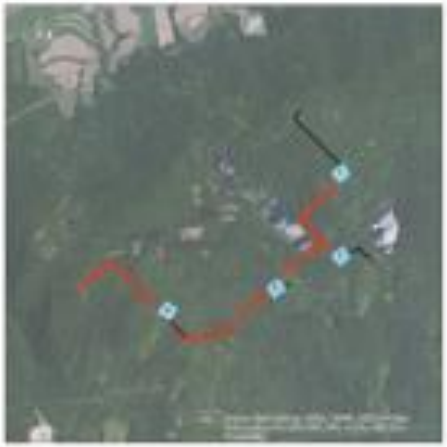




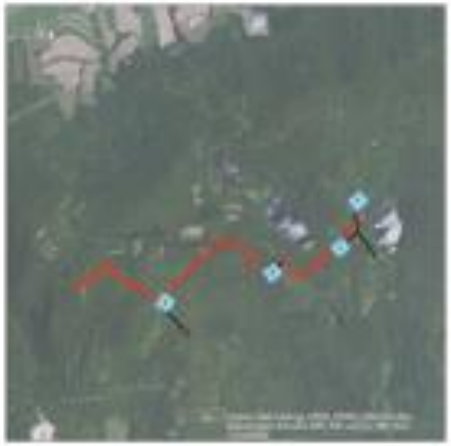


Tools to Reduce Impacts: *EnSitu*

Alternative Infrastructure Scenarios

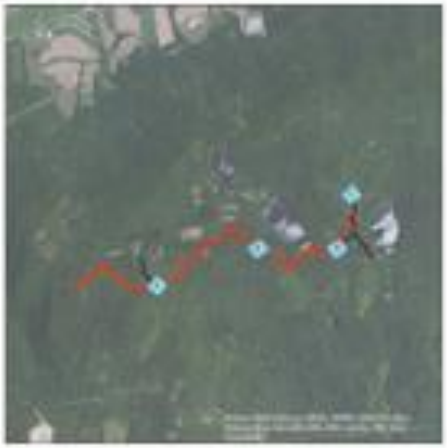


Layout 0

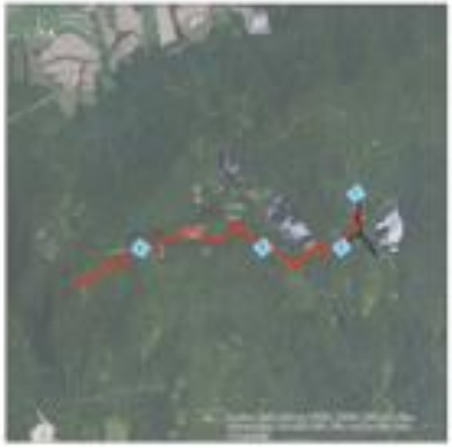


Layout 1

Layout 2



Layout 3

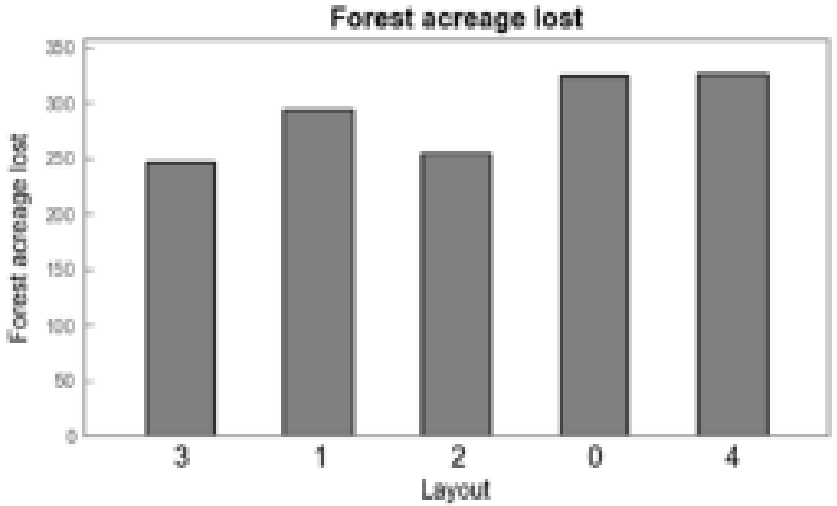


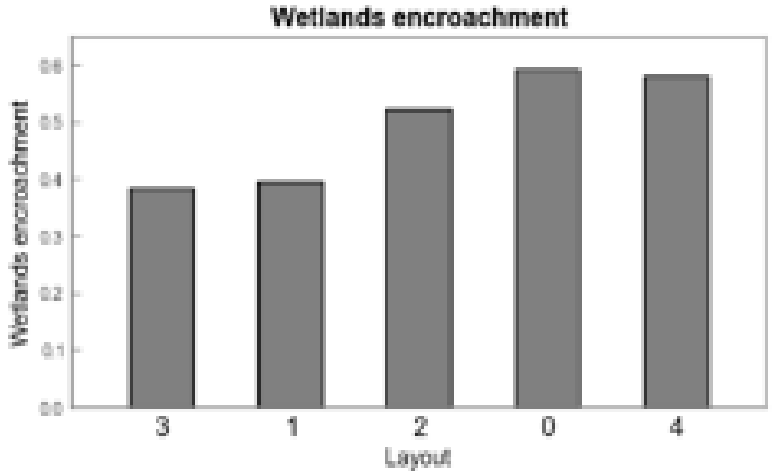
Layout 4

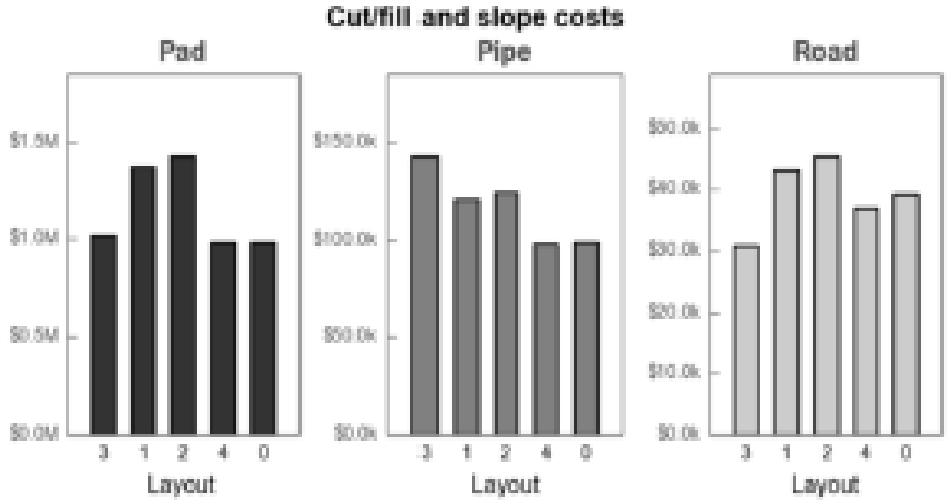
Layout 5

Tools to Reduce Impacts: *EnSitu*

Results by Metric







Tools to Reduce Impacts: *EnSitu*

Results by Layout

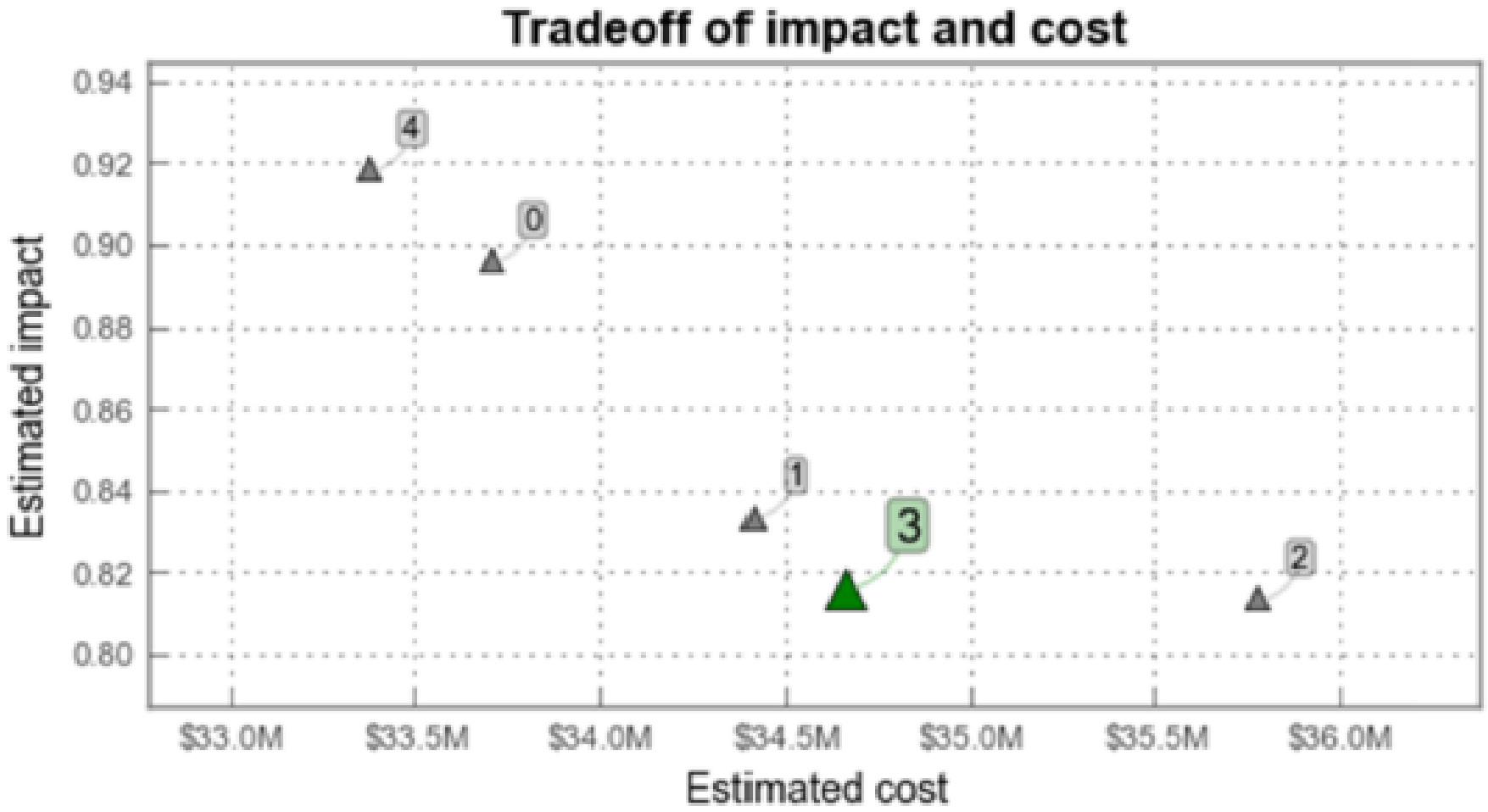
Environ. Impacts

Forest	Forest acreage lost	54
	Interior forest acreage lost	224
	Forest fragmentation index 1	4463
	Forest fragmentation index 2	0.001
Wetlands	Total wetland acreage disturbed	0
	Wetlands encroachment	0
	Number of wetland complexes disturbed	0
Streams	Number of stream crossings	1
	Surface water encroachment	0.274
	Sediment yield (metric tons per year)	207
	Erosion risk	0.001
Species	Risk to rare species	2481
Cultural	Risk to cultural features	0

Monetary Costs

	PADS	PIPELINES	ROADS
Base	$8,387,421	$10,137,775	$1,257,379
Cut/fill and slope costs	$11,154,801	$435,062	$142,931
Forest clearing & timber	$165,128	$105,238	$30,504
Stream crossing	NA	$850,000	$150,000
Pad and well permit	$1,828,000	NA	NA
TOTAL COST	$21,535,350	$11,528,075	$1,580,814
PER UNIT COST	$1,076,767/pad	$924,761/mile	$525,013/mile

Tools to Reduce Impacts: *EnSitu*



Tools to Reduce Impacts: *EnSitu*

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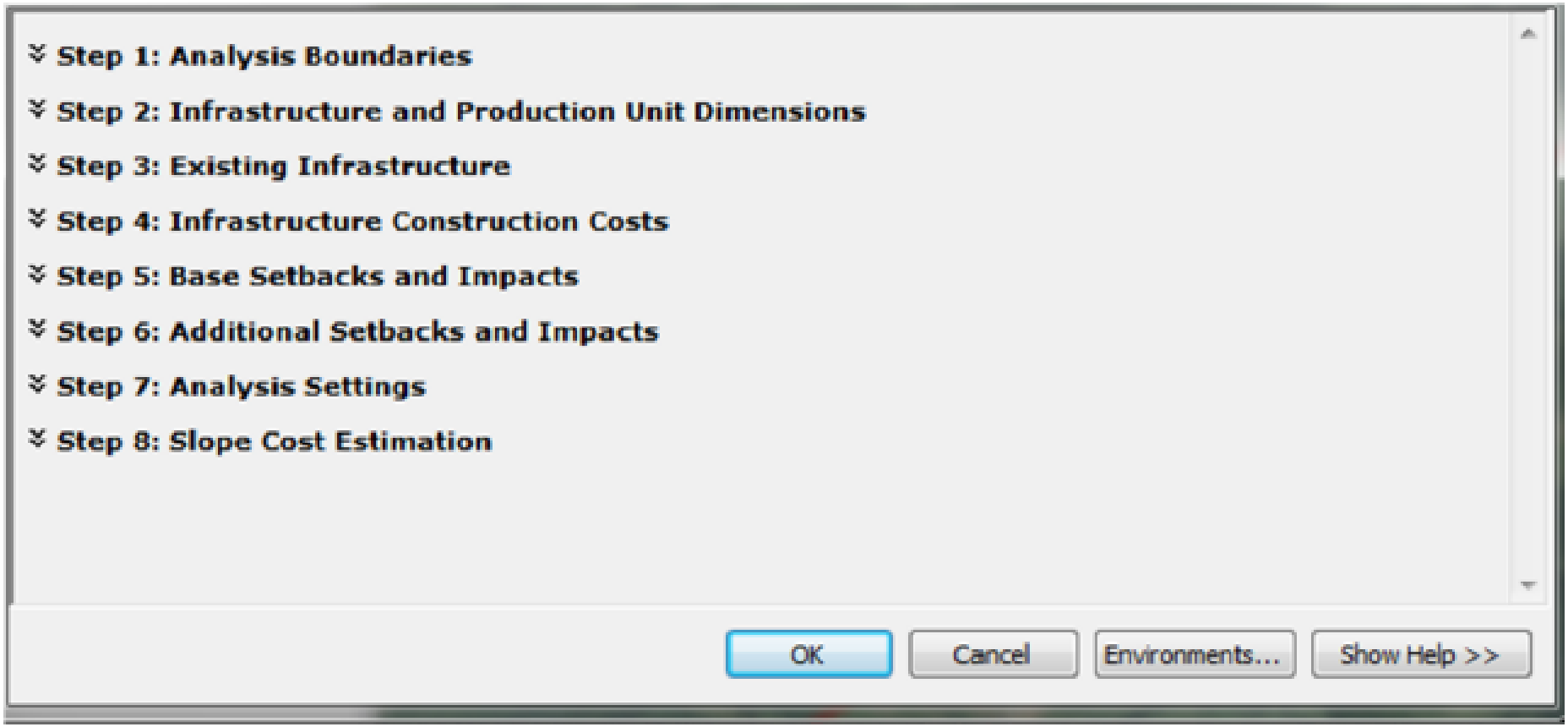
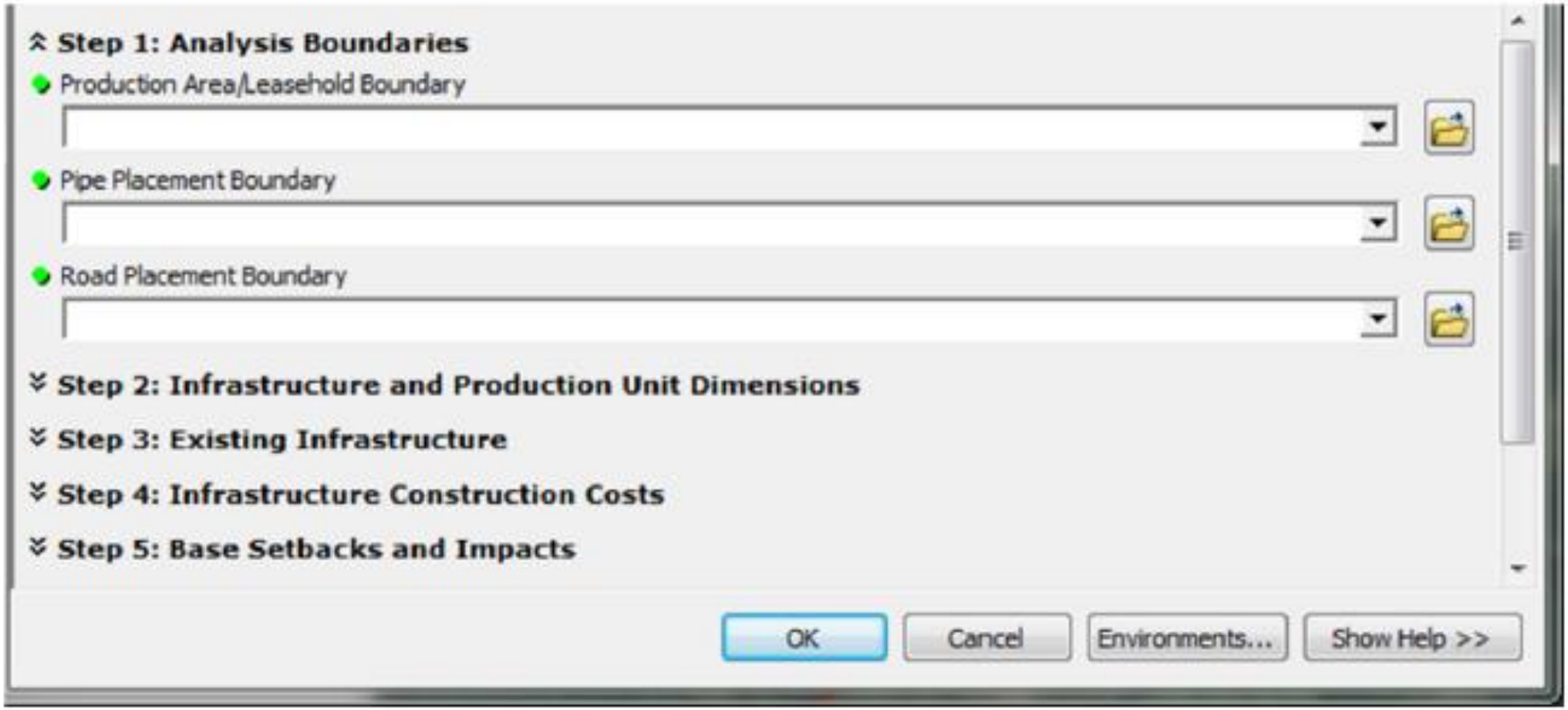
Step-wise Menu



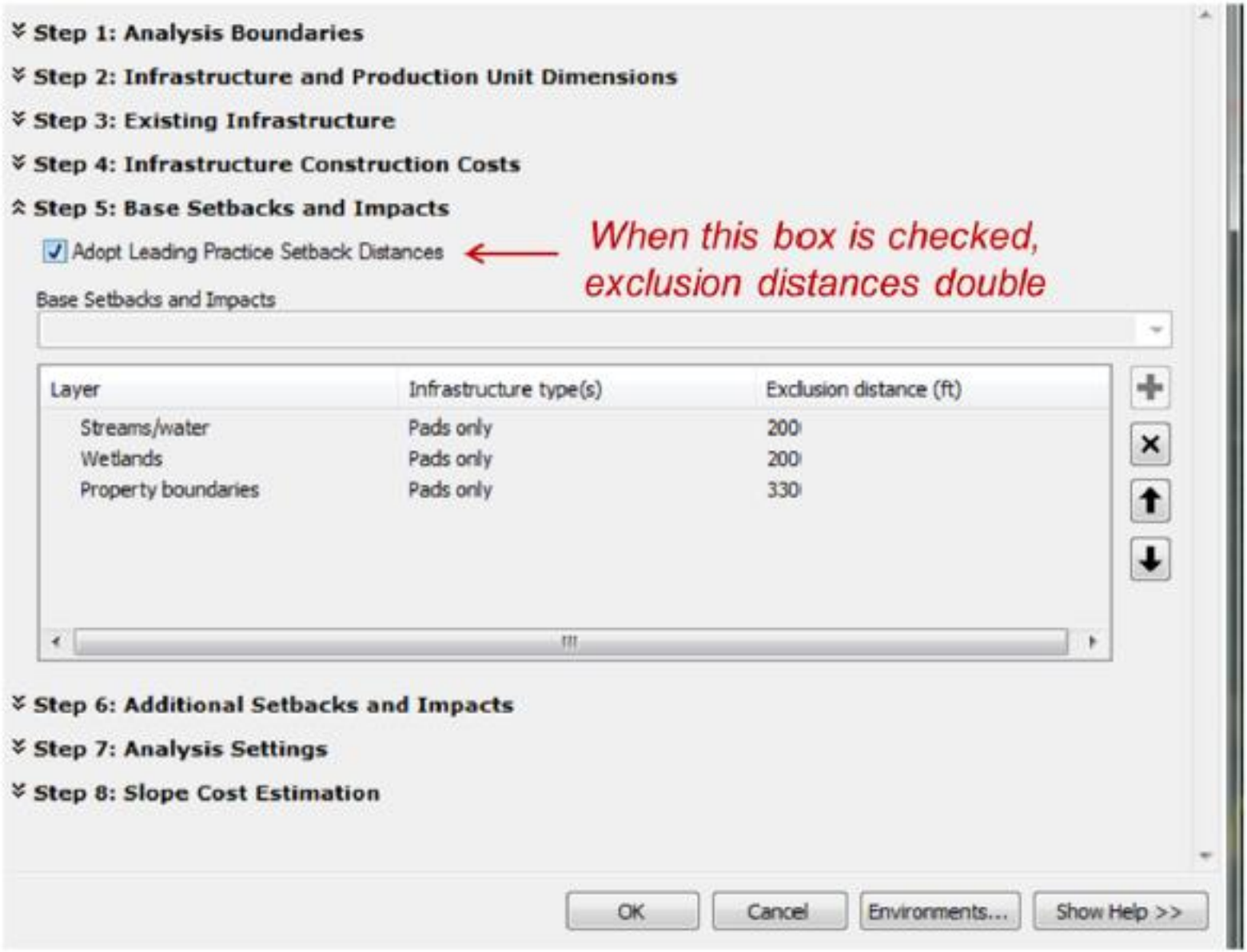
Tools to Reduce Impacts: *EnSitu*

User-Defined Inputs



Tools to Reduce Impacts: ***EnSitu***

Regulatory or Recommended Practice Setbacks



Tools to Reduce Impacts: *EnSitu*

User Guide and Documentation

EROSION RISK

Why is this metric important?

Effects of erosion can degrade ecosystems both at the site of development and downstream. Reducing the risk of erosion is a major factor to consider when developing infrastructure. Erosion can lead to increased levels of sedimentation and turbidity in aquatic habitats, affecting wildlife and water quality.

What does this metric tell me?

Percent of infrastructure area on steep slopes. Add some description of low (good) values vs higher (poor) values.

How is this metric calculated?

% of infrastructure area on steep slopes. Average slope was a coarse proxy for erosion potential; this revised metric is a better measure of erosion risk and a better compliment to the sediment yield metric. steep slope threshold to be determined by TNC freshwater scientists (perhaps based on thresholds in sediment yield tool). Total_slope

SEDIMENT YIELD

Why is this metric important?

Effects of sedimentation include changes to stream characteristics, water quality, and the behavior, physiology, abundance, and diversity of aquatic and semi-aquatic species. Impacts to streams can cascade into other parts of the stream ecosystem.

What does this metric tell me?

Sediment yield, in metric tons per year. Add some description of low (good) values vs higher (poor) values.

How is this metric calculated?

Sediment yield, in metric tons per year. QUESTION FOR AUSTIN: Is this a sum of the sediment yield values for all infrastructure pixels? No name listed for metric.

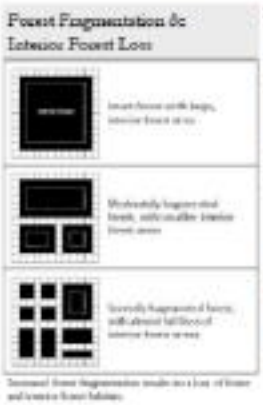
FOREST FRAGMENTATION

Why is this metric important?

Forest fragmentation—the direct loss of forest habitat and the division of forest habitat into smaller pieces—is one impact of gas development. Increased levels of fragmentation can impact biodiversity and wildlife populations in the Appalachian region.

The effects of fragmentation include habitat loss, reduction in habitat quality, loss of interior forest area, increase in edge habitat, barriers to wildlife movement, and the spread of invasive species. Generalist species (species that can thrive in a variety of environments) can benefit from the effects of fragmentation. However, of greater concern are forest-interior species and habitat specialists that are negatively impacted by forest fragmentation.

Beyond the size of individual forest patches, forest cover and configuration within the landscape are also indicators of the overall health of an ecosystem.



INDEX 1

What does this metric tell me?

Add some description of low (good) values vs higher (poor) values.

How is this metric calculated?

Reduction in effective mesh size (m^2); includes edge effects. Forest_meff

INDEX 2

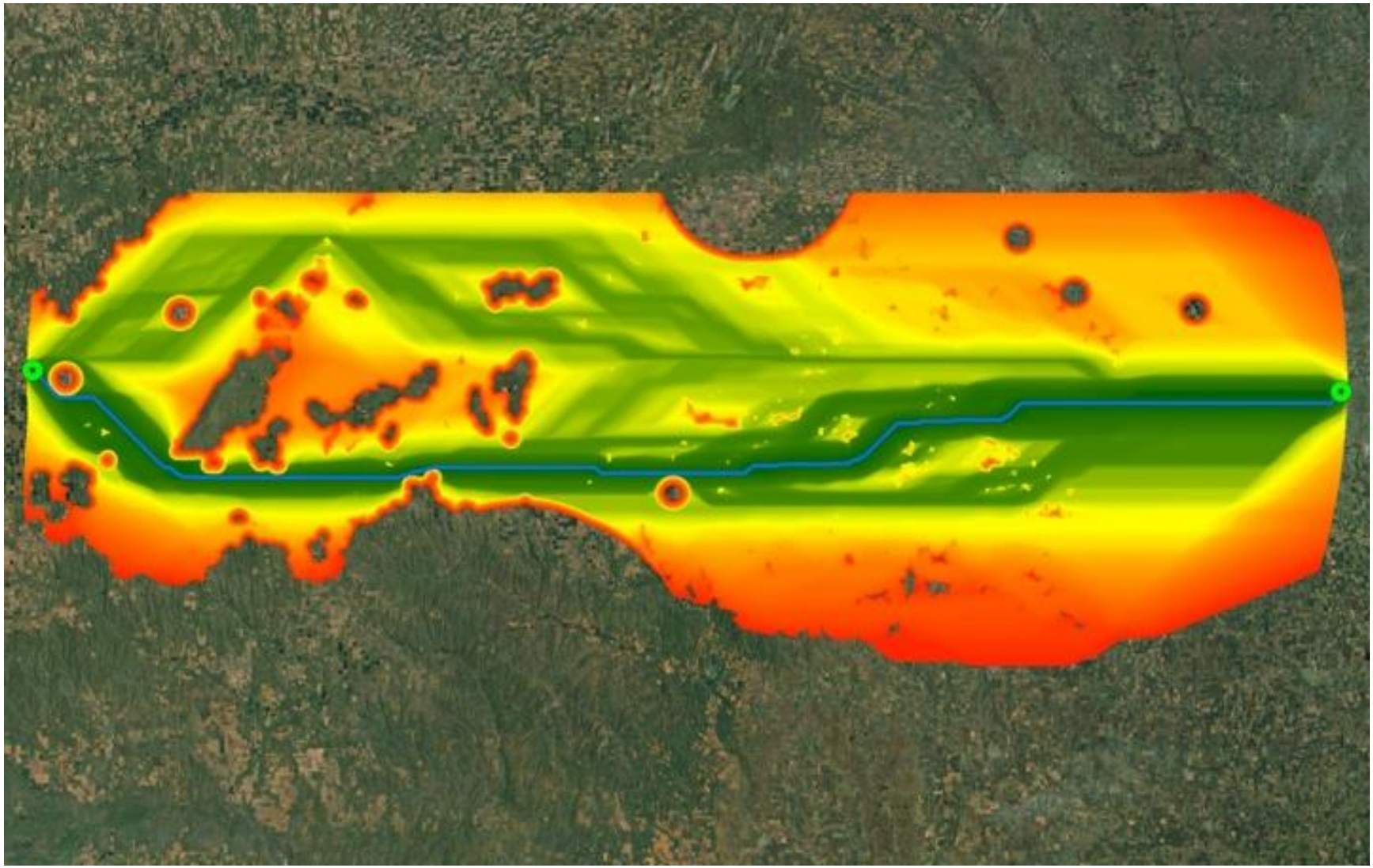
What does this metric tell me?

Add some description of low (good) values vs higher (poor) values.

How is this metric calculated?

Perimeter to area ratio (m/m^2) (weighted by forest value). Forest_p2a

Tools to Reduce Impacts: Regional Pipeline Siting Tool



Tools to Reduce Impacts: Regional Pipeline Siting Tool

- Considers costs of pipeline (can account for above and belowground, other factors affecting costs)
- Considers avoidance areas
- Considers mitigation costs (e.g. wetlands, endangered species)
- User can specify costs
- Identifies least cost paths

Summary Conservation Practices Documents

Summary Documents by Major Topic

- Inform a broad audience about habitat and wildlife impacts
- Synthesize existing practices that help avoid/lessen impacts
- Promote TNC's science–based recommended practices

Will be released in September 2015

Tools to Reduce Impacts: Recommended Conservation Practices

- **State of the research** – characterizes existing body of literature
- **Evidence of impact** – summarizes impacts documented in scientific literature
- **Existing conservation practices and scientific support** – summarizes existing practices and support from the literature
- **TNC Recommended Conservation Practices** – science based recommendations to reduce impacts during construction and operation of oil/gas infrastructure

Tools to Reduce Impacts: Recommended Conservation Practices

Topics Covered

- Landscape-scale Planning
- Ecological Buffers
- Road Development
- Stream Crossings
- Water Withdrawals
- Timing of Activities
- Noise
- Artificial Lighting

Topics In Development

- Pipeline Development
- Invasive Plants

Topics Not Covered

- Air Quality
- Reclamation
- Risks of Spills
- Public Health and Safety

Questions?

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elizabeth johnson@tnc.org

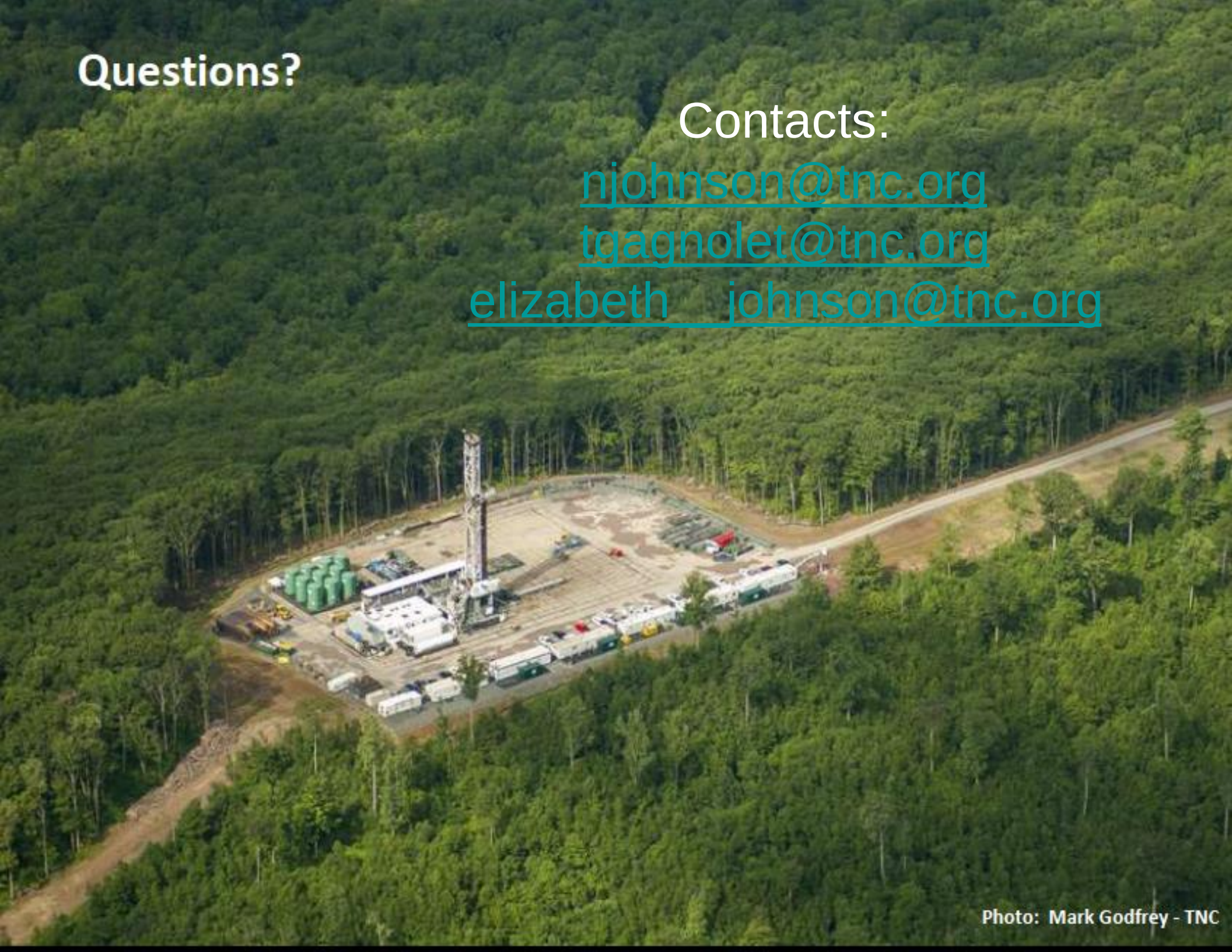

Photo: Mark Godfrey - TNC