Full Field Decision Support

FIELD PLANNING AND DEVELOPMENT FOR UNCONVENTIONAL RESOURCES

Company Background

- Company founded in 2002
- Established as an Engineering Company
- Specializing in Geographic Information Systems
- Three core offices: Houston, Calgary, and St. John's
- Staff of Engineers, Geologists, Geographers, and Computer Scientists
- Esri Business Partner (Silver Tier International)

Context

Full Field development for unconventional resources:

- Companies faced with aggressive schedules and production expectations
- Limited lead time for planning which focuses efforts on near term
- Pace and uncertainty limits ability to address broader field lifecycle
- Unexpected incremental investments diminish potential prize

Conscientious companies are concerned about costs and conservation.

Establishing estimates and controlling costs through Full Field planning provides a path to extracting more value.

Quality of decisions and completeness of plans can differentiate between businesses being wildly successful and barely sustainable.

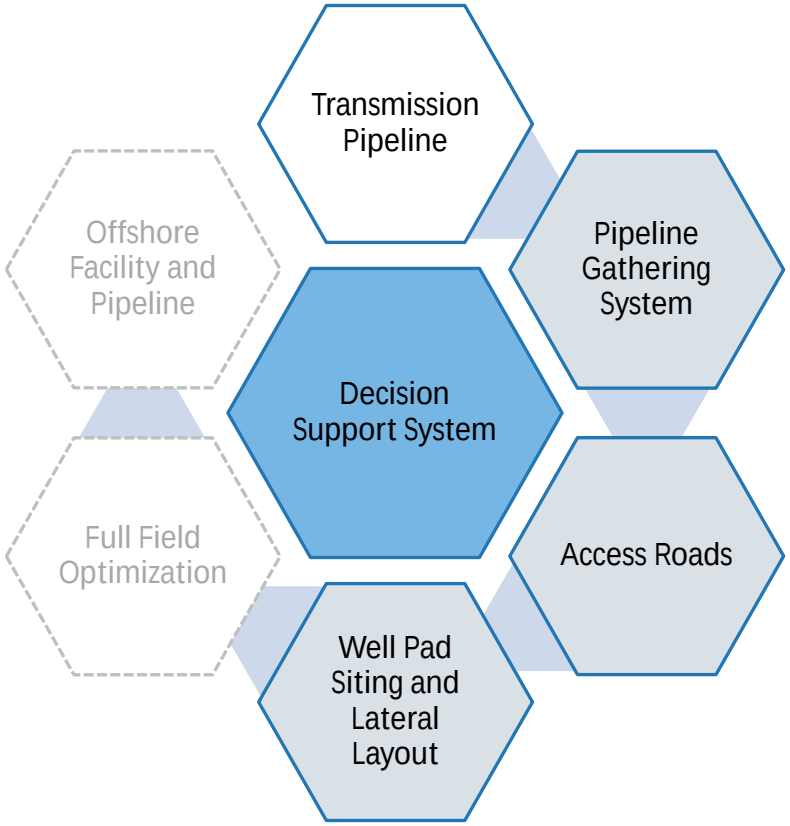
Goals for Full Field Planning

1. Generate results that reduce impact and investment
2. Establish baseline for impact and investment
3. Generate multiple options in place of single solutions
4. Reduce effort needed to evaluate options
5. Provide a means of performing what-if scenarios
6. Keep pace with (or ahead of) planning process
7. Increase lead times, broader view for planning and execution
8. Produce reliable and repeatable results
9. Increase consistency in the planning process
10. Improve documentation of siting choice rationale

Components to Support Full Field Planning

Decision support system must:

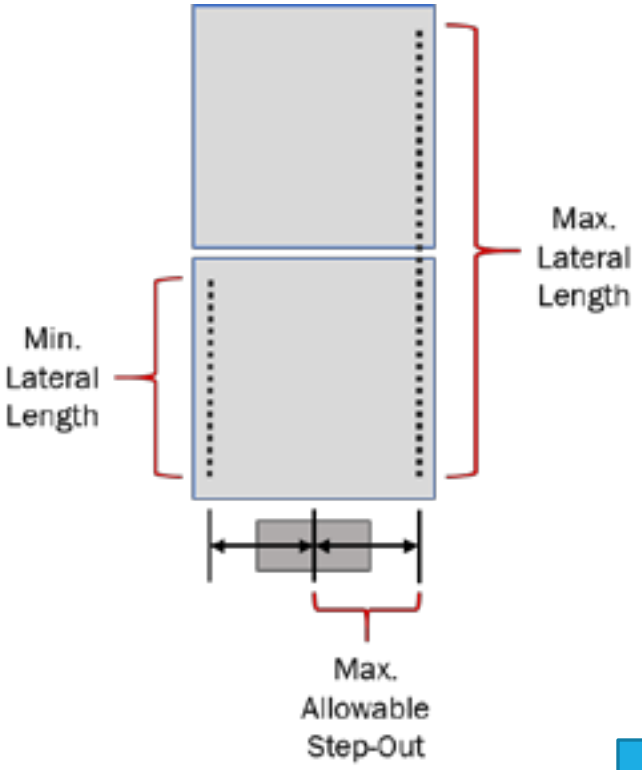
- Consider uniqueness of each **Asset Type** with respect to modeling
- Allow for inputs in terms of **Constraints and Constructability**
- Produce **Realistic Results**
- Incorporate input from and expertise of **Discipline Experts**
- Include specialized **Spatial Data Management** processes and **Analysis Techniques** (GA, NN, LP)
- **Retain Results** and **Analysis Artifacts** for re-use
- Flex to changing business needs

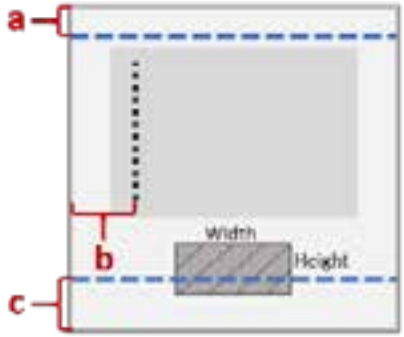


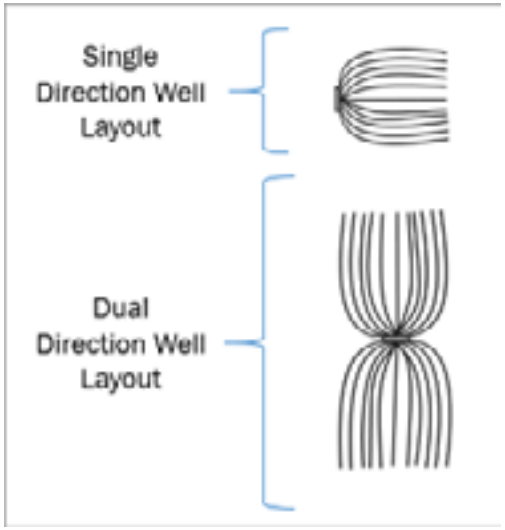
Constraints and Constructability

DEFINING THE SOLUTION IN TERMS OF AFFINITY, AVOIDANCE, AND ABSOLUTE BARRIERS

Geologic and Drilling Constraints







- Structure Depth
- Lateral Spacing
- Lateral Orientation
- Dog-leg Severity
- Wells per pad
- Cut and Fill
- Lease Location
- Set-backs

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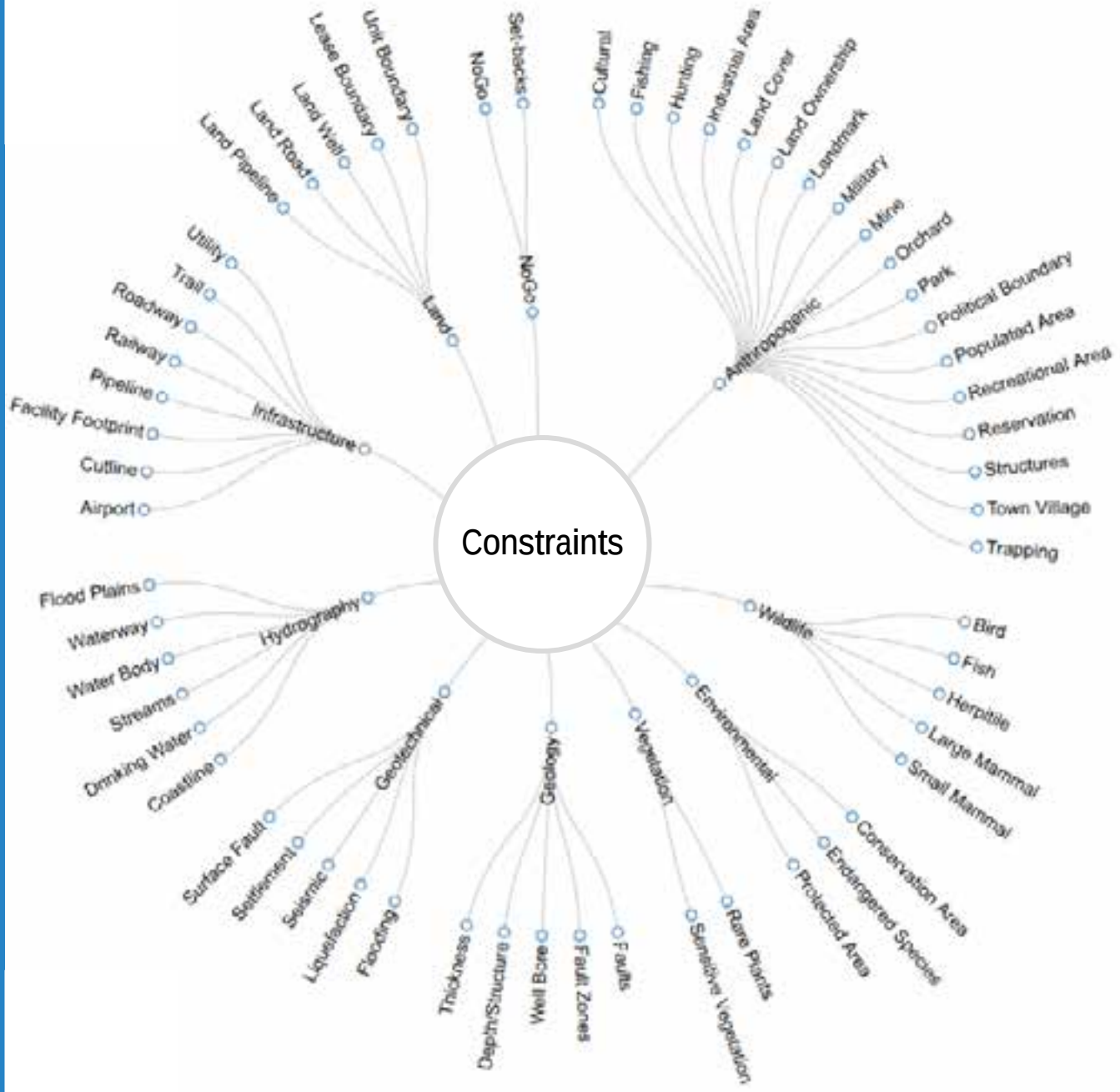
Constraints: Construction, Logistic, and Regulatory

- Anthropogenic
- Environmental
- Geology
- Geotechnical
- Hydrography
- Infrastructure
- Land
- NoGo
- Vegetation
- Wildlife



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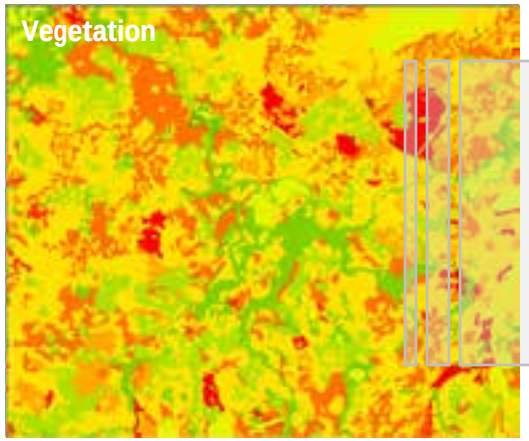
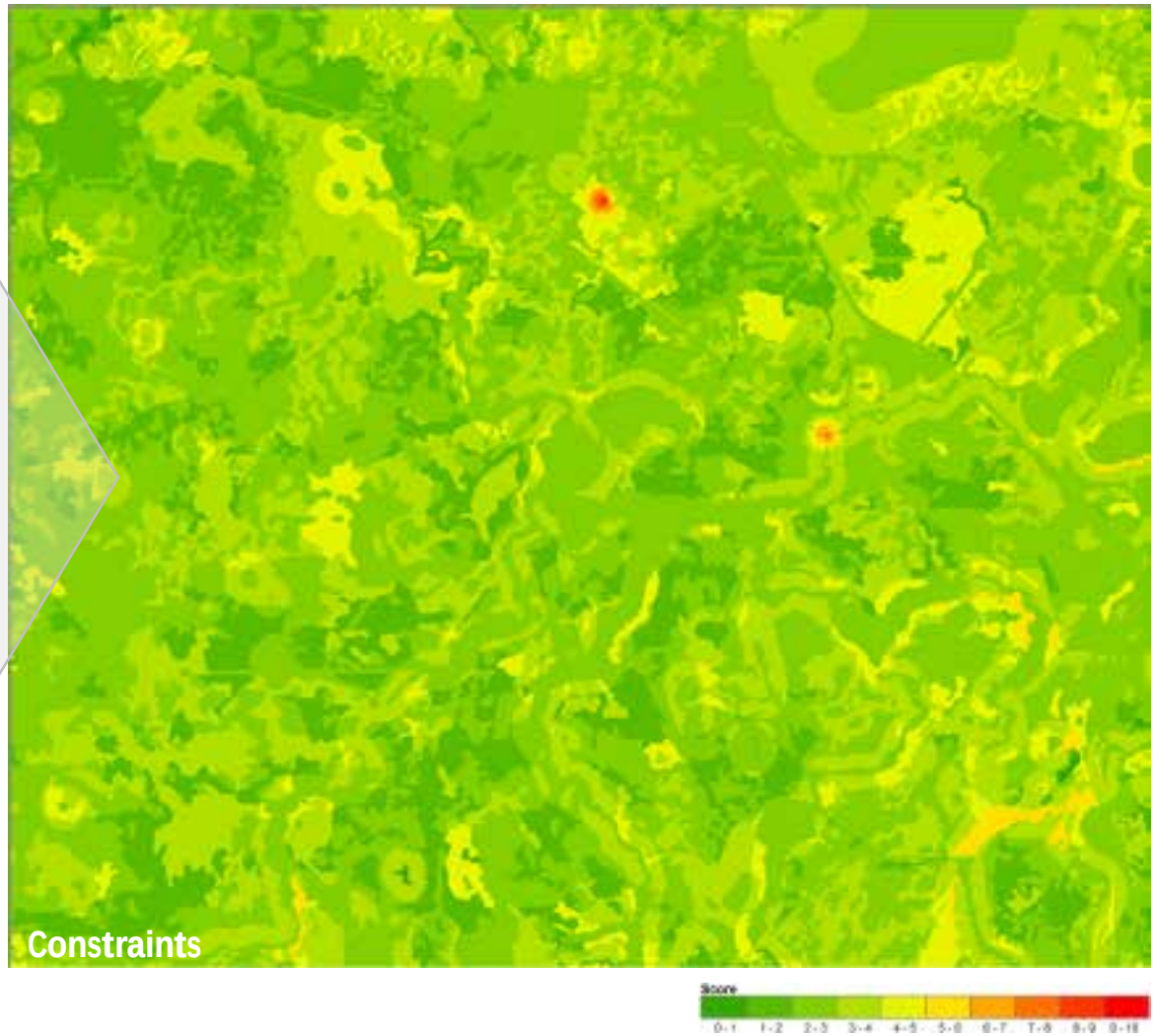
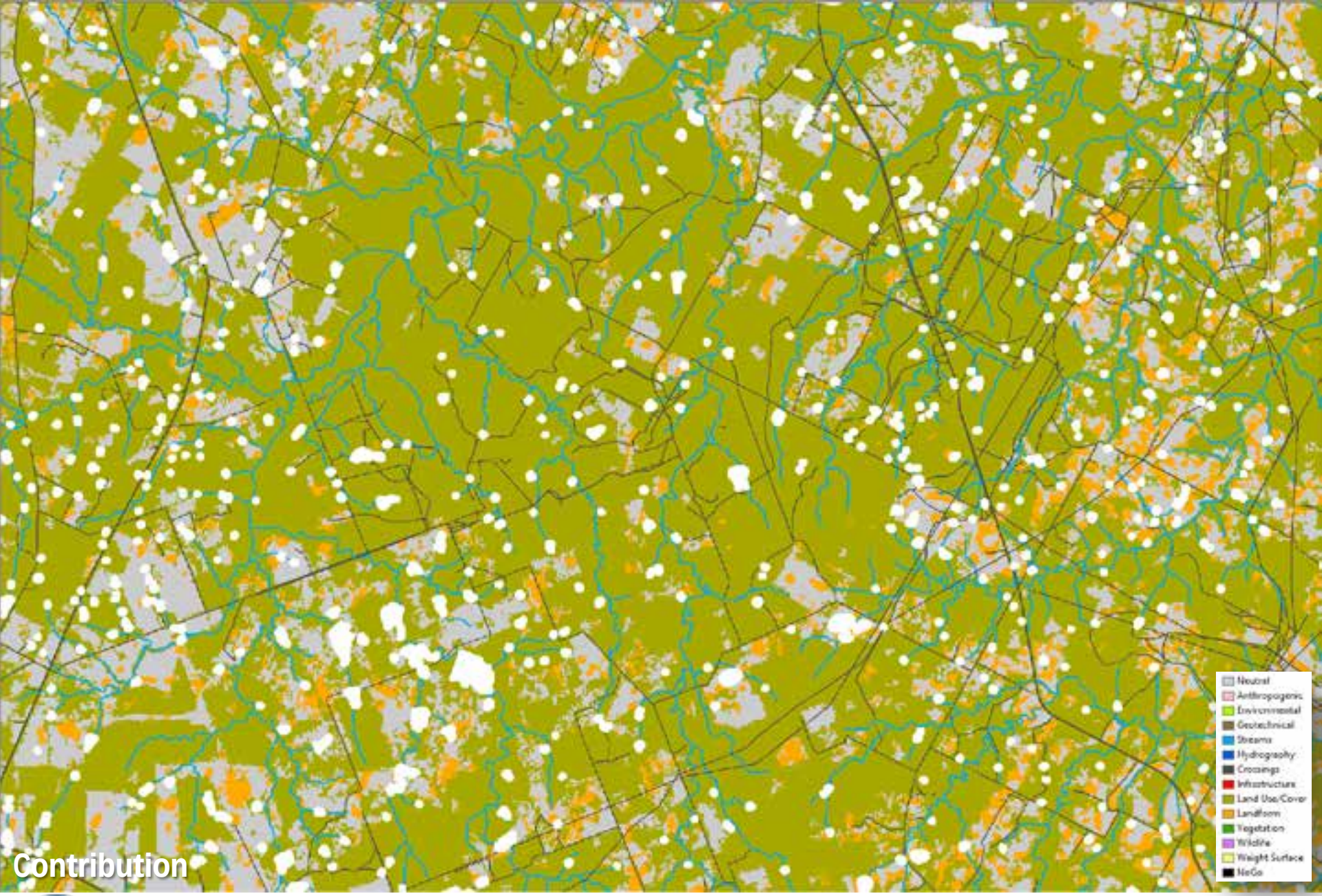
Archeology


Vegetation


Land Use and Disturbances


Constraints
Score
0-1 1-2 2-3 3-4 4-5 5-6 6-7 7-8 8-9 9-10



Contribution

Realistic Results

GENERATING OPTIONS AND OUTCOMES

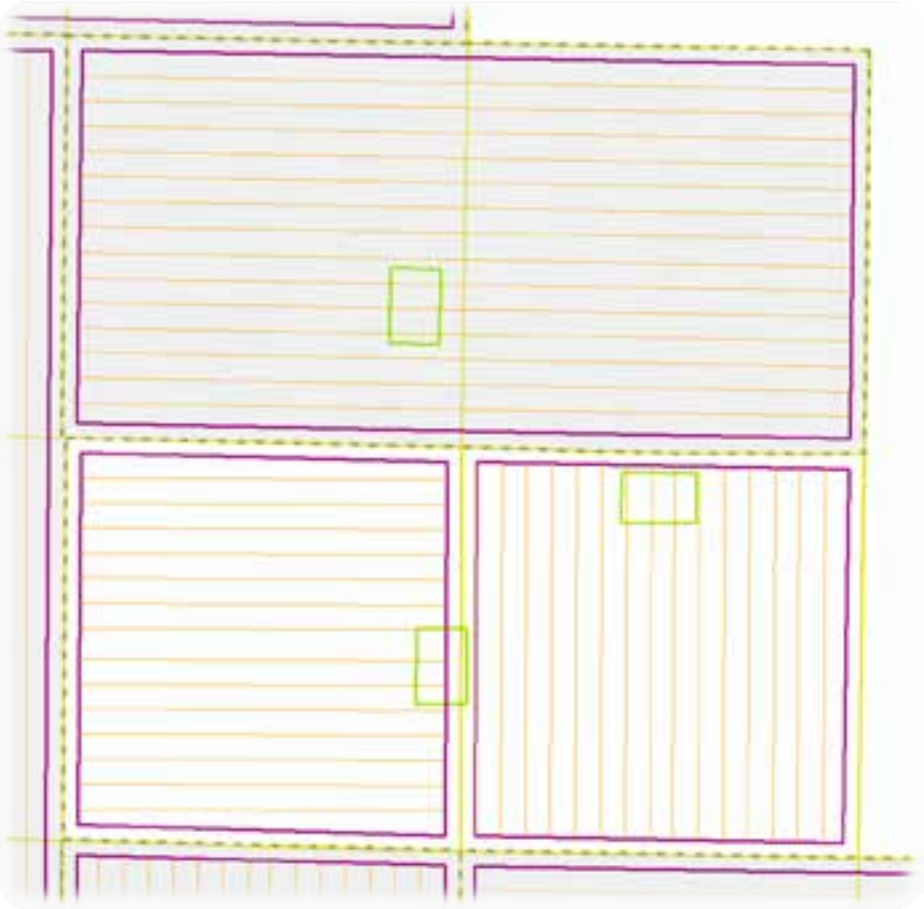
Well Siting

Well Siting analyses produce:

- Well Pad Locations
- Completable Areas
- Well Laterals
- Land Collectives

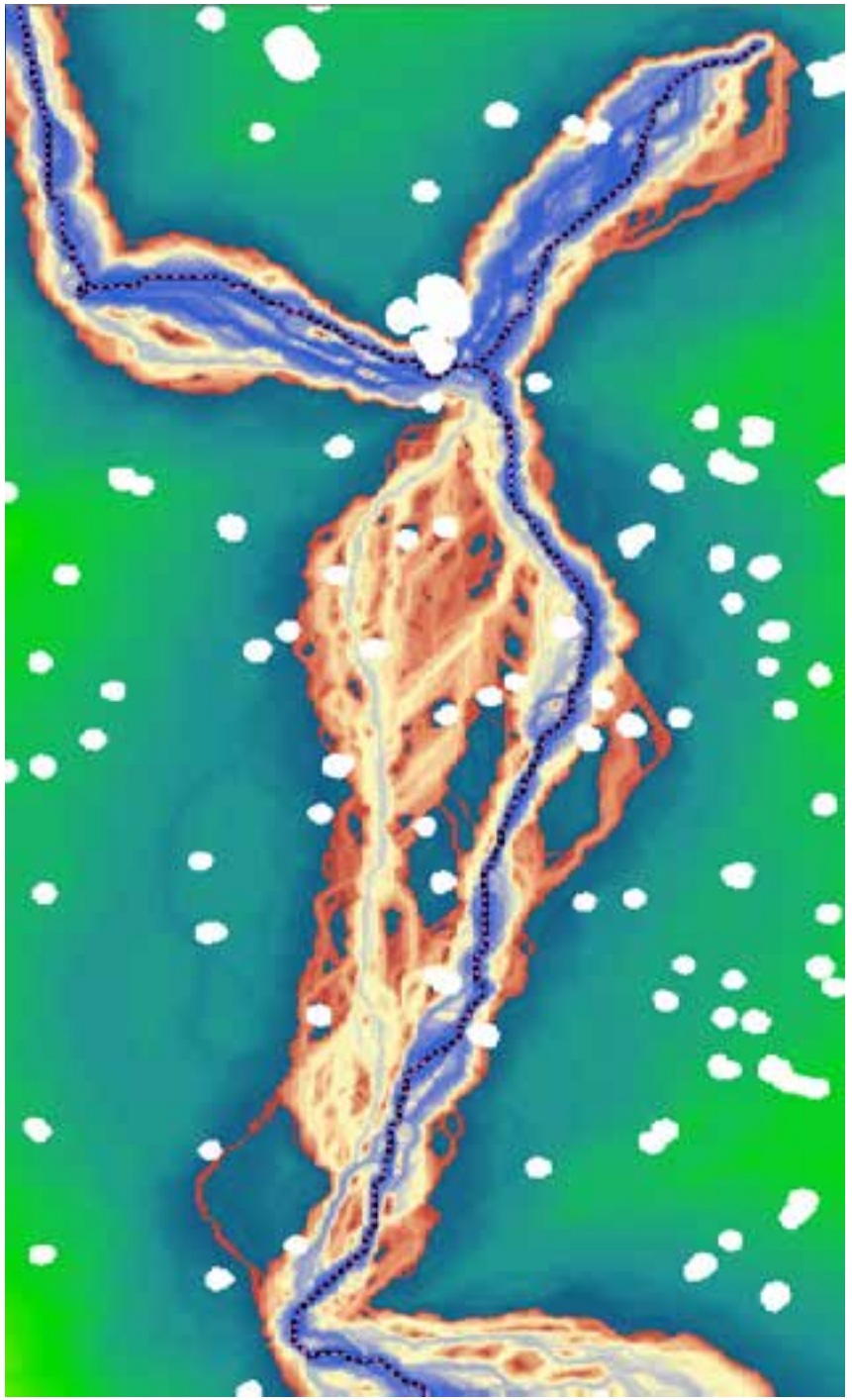
Land Collectives produce:

- Well Pad Locations
- Completable Areas
- Well Laterals



Road and Pipeline Solutions

- Continuous Solution
- Corridor Solution
- Centerline Solution



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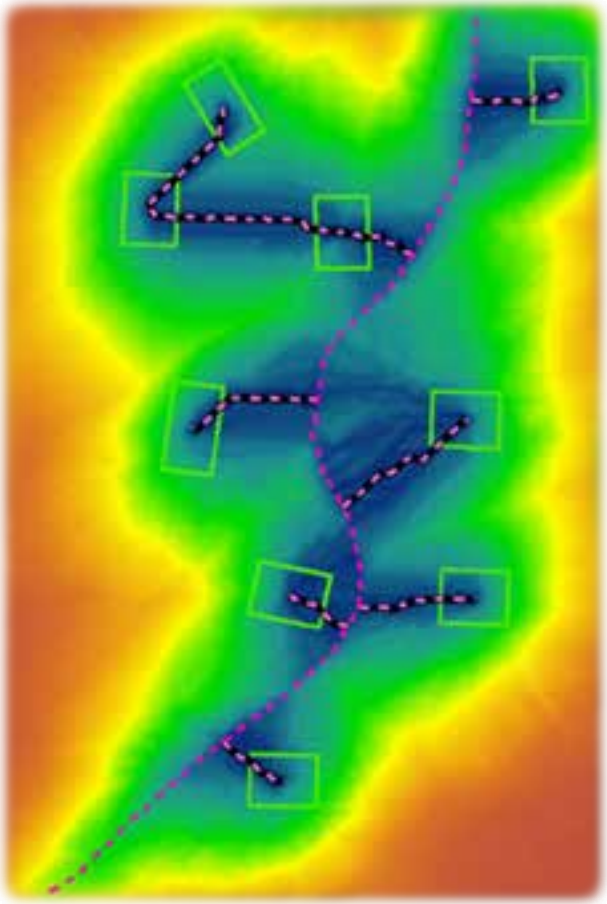
Connectivity

Layout for gathering systems and access roads have additional considerations such as:

- Minimizing overall length
- Varying diameters
- Varying traffic requirements
- Existing infrastructure

Building gathering systems and access roads must be able to account for:

- Existing infrastructure (ignore)
- Existing infrastructure (include)
- Proximity of facilities and Existing Infrastructure



Expert System

ENCAPSULATING EXPERT KNOWLEDGE FOR DECISION SUPPORT

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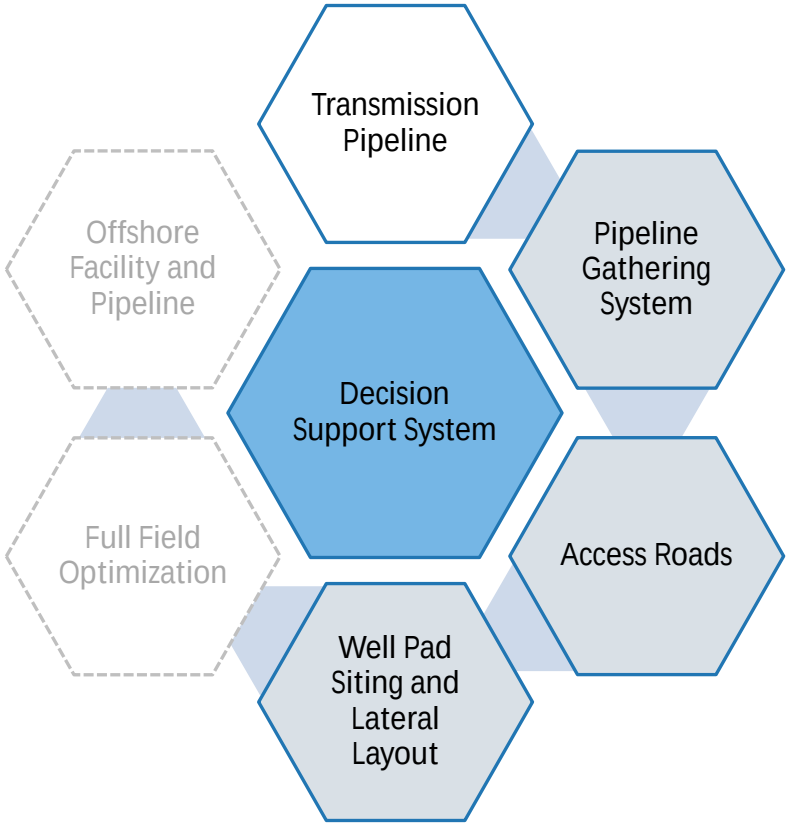
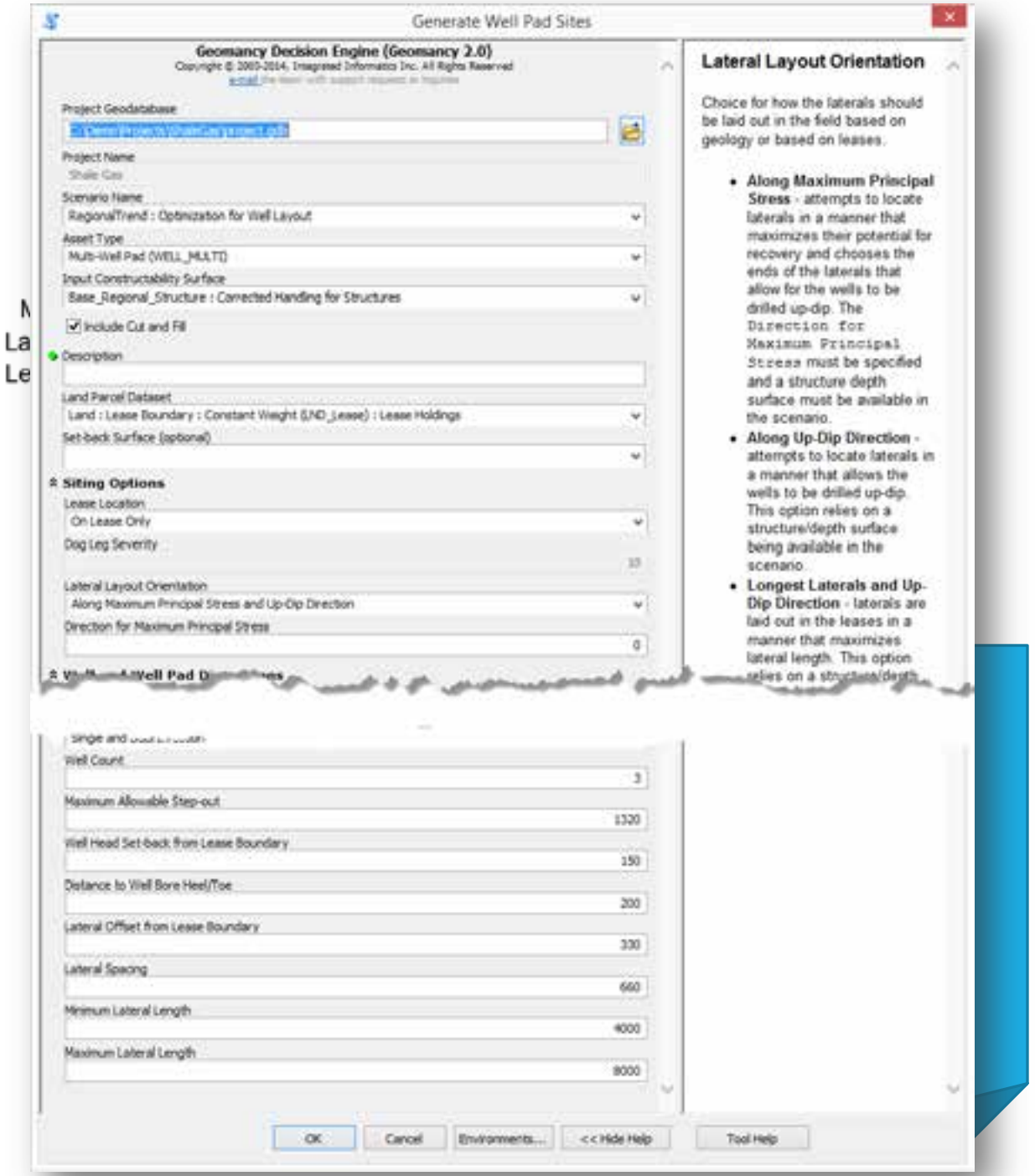


ArcGIS Platform

- Common tool in Energy companies
  - Used across multiple disciplines (e.g. environmental, engineering, geosciences, etc.)
- Ability to model complex Business and Spatial concepts
  - Some additional smarts needed to make ArcGIS Energy-industry-centric
- Core spatial analyses missing some context and specialization
  - Extensible to include high-end analyses techniques like GA, LP, NN
- Data management capabilities great for managing large amounts of data
  - Additional capabilities needed for managing multi-criteria, constraints, settings, parameters, etc.
- Numerous options for extending and deploying
  - Services, Extensions, Toolboxes, Add-ins
- Natural choice as a platform for Full Field decision support systems
- ArcGIS allows for Simplified, Streamlined, and Specialized workflows

Simplified

- Familiarity
- Usability
- Terminology
- Validation
- Documentation



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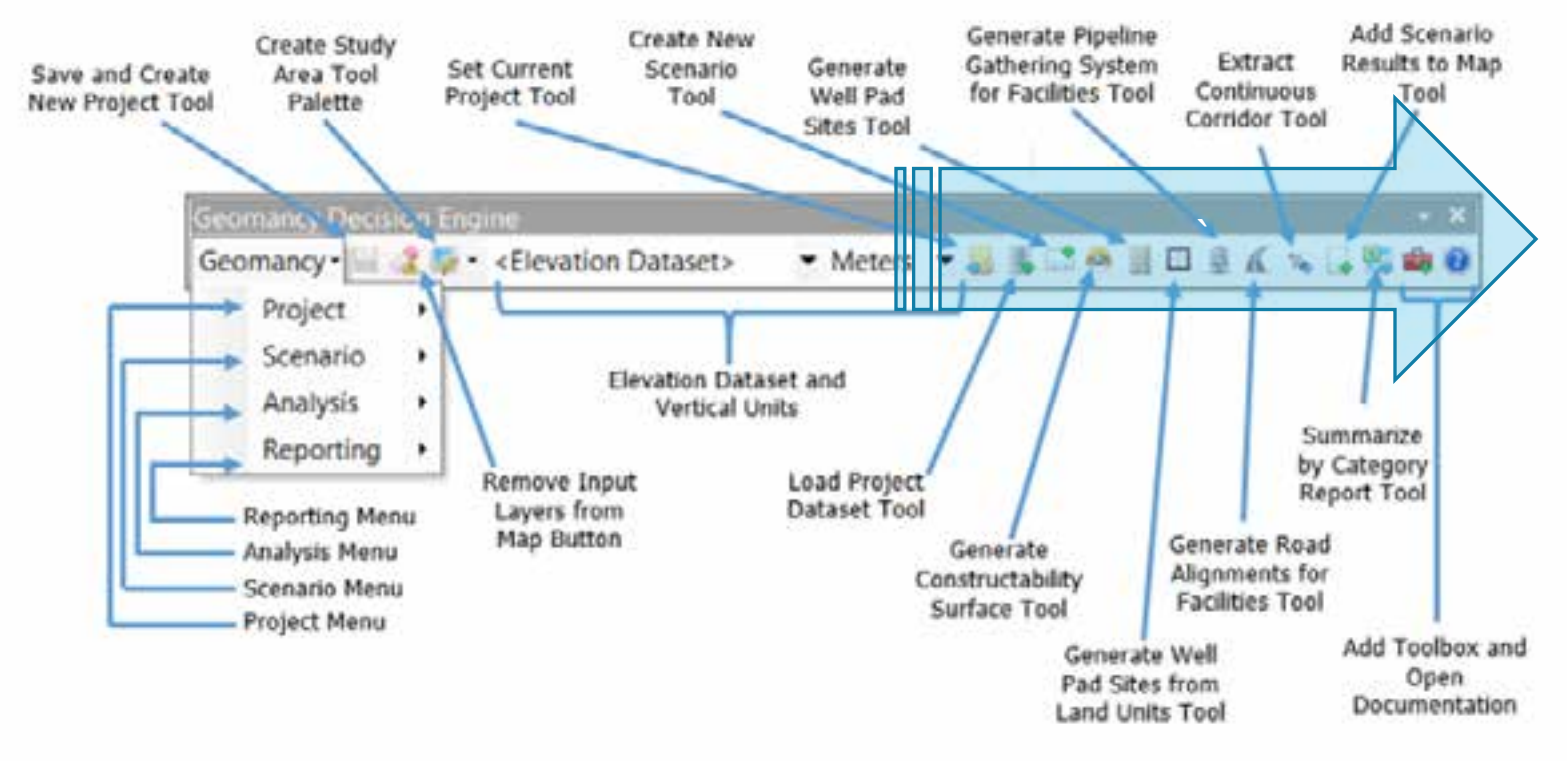
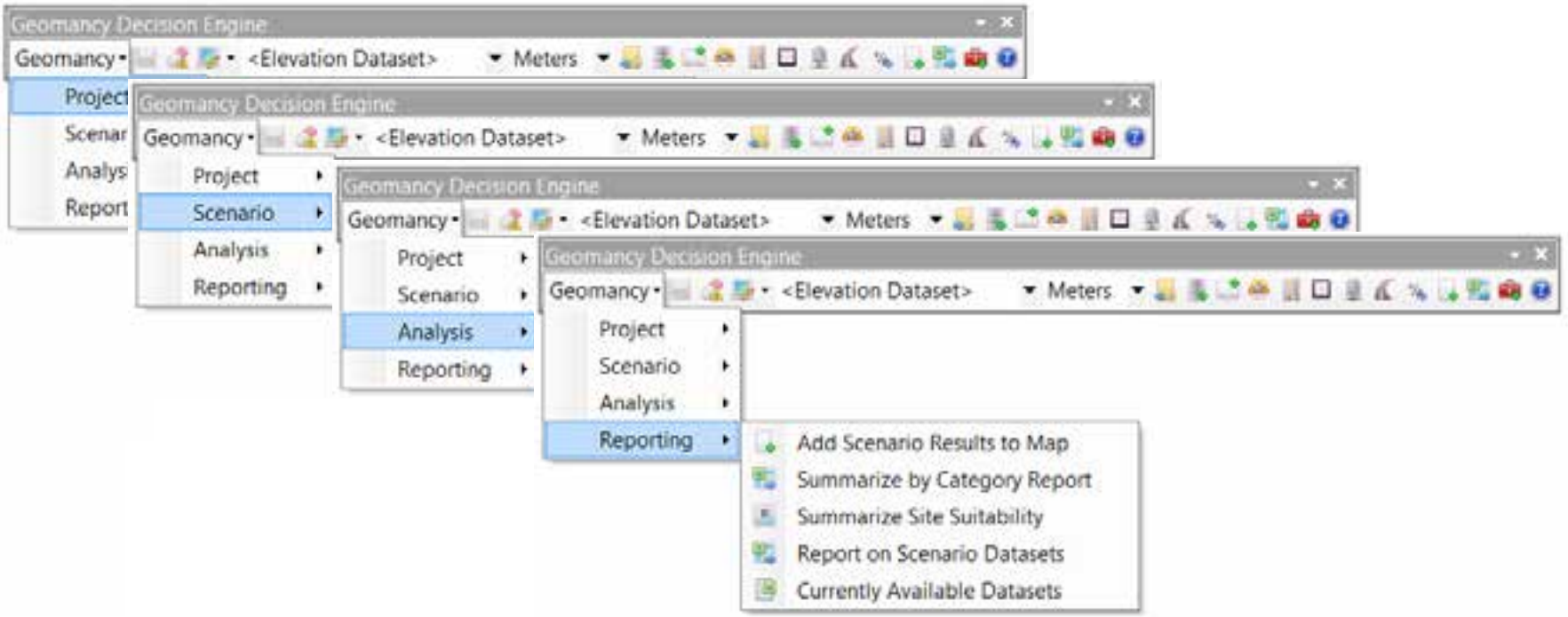
Streamlined



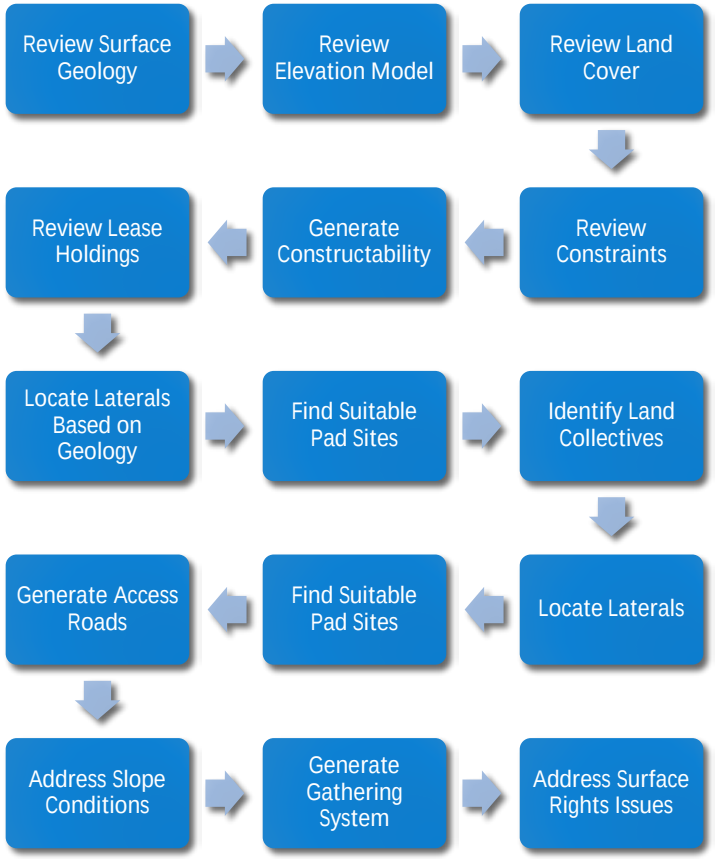
Specialized



Shale-Gas in Developed Area

FIELD DEVELOPMENT IN RURAL AREA WITH SIGNIFICANT POPULATION AND INFRASTRUCTURE

Shale Gas in Developed Area



- Geologic/Production parameters:
  - Drilling in the Up-Dip Direction
  - Minimum length 3600 ft (economic)
  - Lateral spacing is 330 ft
- Drilling parameters:
  - Max dog-leg severity of 10 degrees / 100ft
  - Maximum length 7500 ft (technical)
  - Drill dual direction from pads
  - Step-out is 900 ft (maximum)
- Well Pad parameters
  - 200 ft x 300 ft well pad
  - Locate 'On or Off Lease'
  - 3 wells per pad (single) 6 wells (dual)
- Field rules for the region:
  - 165 ft offset from lease line to well head
  - 165 ft offset from lease line to well heel
  - 165 ft offset from lease line to lateral

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