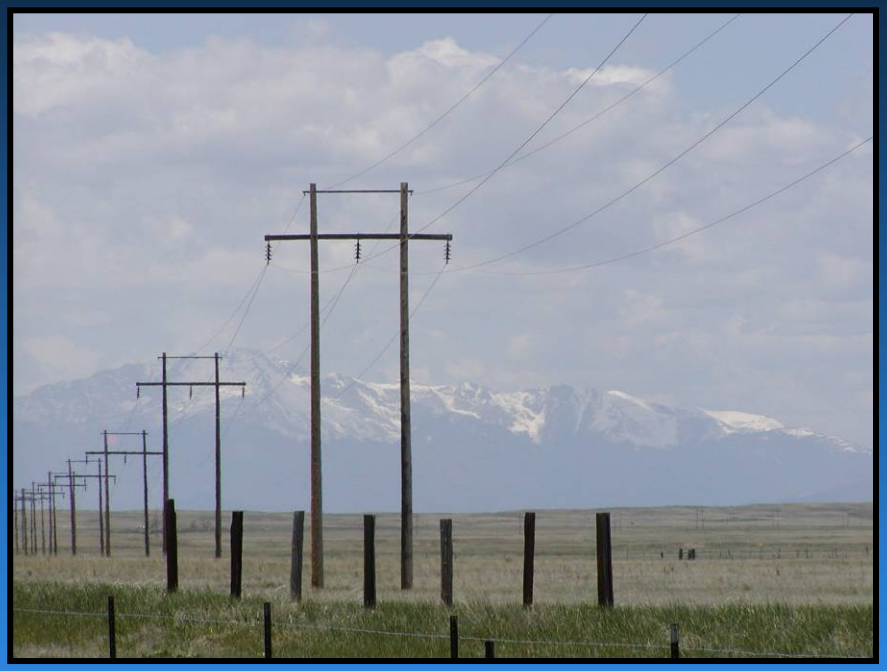
Transmission Line Routing



Special Session on Line Routing
IEEE
Towers, Poles, and Conductors Subcommittee
Tampa, Florida
June 25, 2007

Lori Nielsen
EDM International, Inc.
4001 Automation Way
Fort Collins, CO 80525
(970) 204-4001
lnielsen@edmlink.com

Session Format and Content

- Evolving Hurdles
- Current Trends
- Communication Strategies
- Know Your Issues
- Regulatory Process
- Know Your Audience
- Key Takeaway Points
- Available Tools to Help
- Case Study
- Informal Dialog and Questions

Session Format and Content

Tutorial = Information Exchange

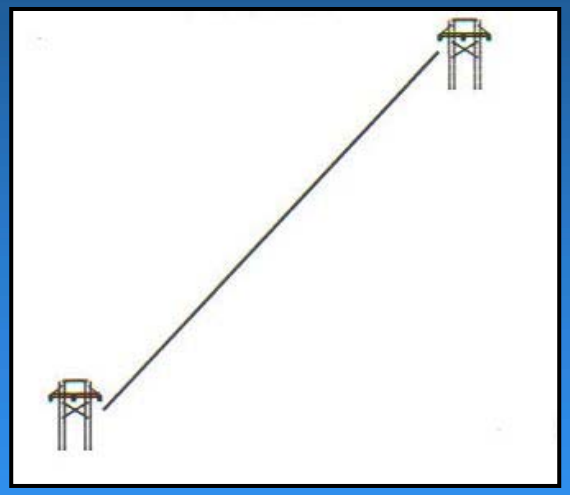
Questions = Answers

Correct Answers = Be Alert!

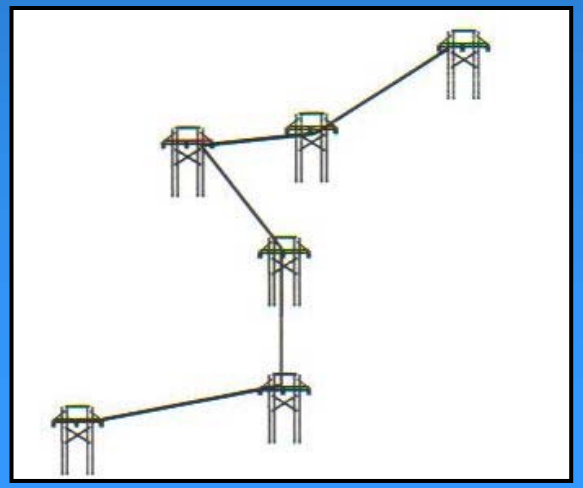
....Stay Alert

Then and Now

Power Line: 1950s

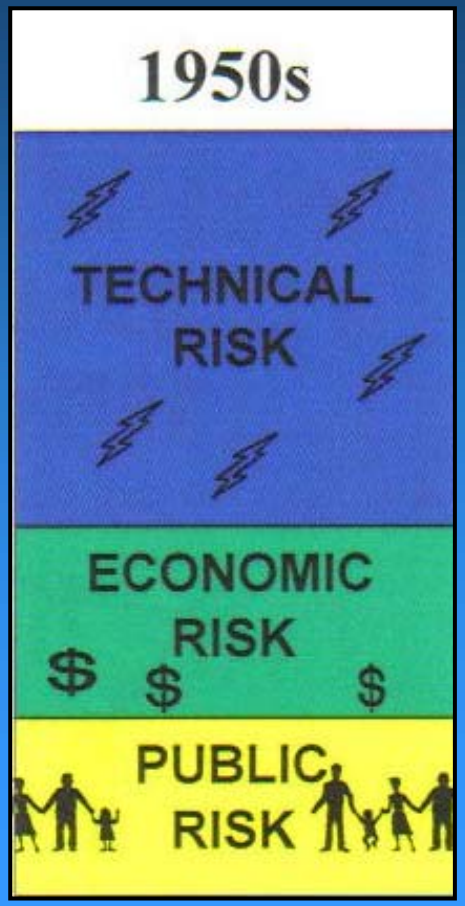


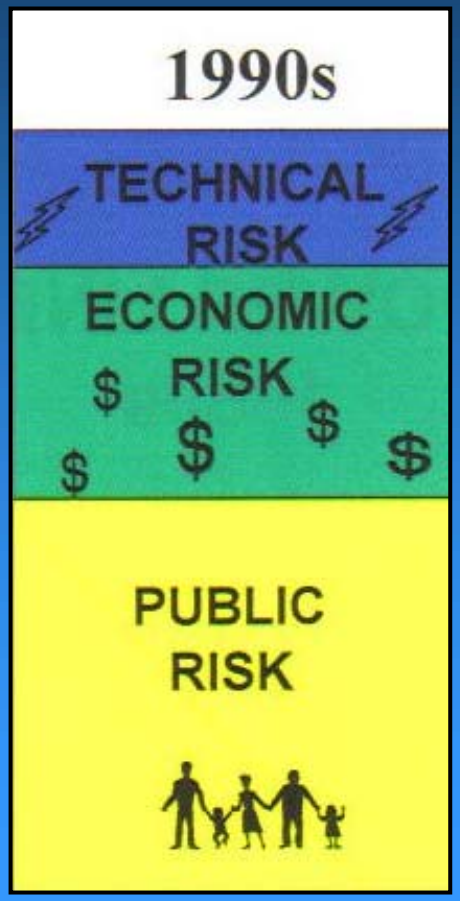
Power Line: 1990s



Source: EPRI 2001

Then and Now





Source: EPRI 2001

Routing Constraints

- Geographical and Cultural Differences
- Examples of Those That Often Differ
  - Vegetative Cover
  - Land Uses
  - Existing Rights-of-Way

Routing Constraints

- **Examples of Those Typically Do Not**
  - **Wetlands**
  - **Threatened and Endangered Species**
  - **Cultural Resources (Archaeological & Historical)**
  - **Visual Resources (Aesthetics)**

Current Trends

- Environmental permitting is increasingly the "CRITICAL PATH" for project siting
- With increasing needs for electric capacity there is a corresponding increase in environmental scrutiny
- Utilities are at the "vortex" of balancing:
  - Capacity
  - Reliability
  - Demand
  - Environmental and Regulatory Requirements

Foresight and planning can be critical for both immediate and long-term effects.

Planning

- Education
- Communication
- Preparation

Planning

- **Education**
  - Knowledge of process
  - Outlining “fatal flaw” analysis
- **Communications**
  - Collaborative effort
- **Preparation**
  - Strategic planning

Problem Example

Michigan Nature Association Intervention:

- Utility's failure to recognize a sensitive area along a planned corridor for two parallel, double-circuit 345-kV transmission lines. This required rerouting after line design, resulting in increased costs for eight additional corner structures.

Success Example

- **California State Wildlife Restrictions:**
  - **Utility's early efforts to identify constraints and opportunities for 115-kV transmission line delineated State Wildlife Area restrictions. Initial line opposition.**
  - **Proactive communications and flexibility.**
  - **Required re-alignment and during the planning stage, but prior to line design or engineering.**
  - **Increased line length with associated costs.**
  - **However, reduced overall costs of the project avoiding project delay and/or litigation.**
  - **Win-Win Scenario!**

Expectations and Communications

- Expectations and communications for routing a new transmission line project
  - Internal
  - External
  - Contractor
- Realistic or unrealistic?

Internal Communications

Management, Engineering, ROW, Environmental

- One of the First Task Items!
- Each Department has Critical Requirements
- Including Applicable Players will Dictate and Streamline Process

External Communications

Agencies, Public, Other Utilities, Environmental Interest Groups

- One of the second task items!
- Sometimes project success greatly depends on the level of public involvement.
- Public communications too often not treated as strategic activity, but more as an afterthought.
- Level of sophistication understanding environmental issues has greatly increased.
- Key = Proactive vs. Reactive

“Inter-Entity” Communications

A role responsible for facilitating communications for all involved!

Internal (Management, Engineering, Environmental, ROW)

+

External (Agencies, Public, Other Utilities, Special Interest Groups)

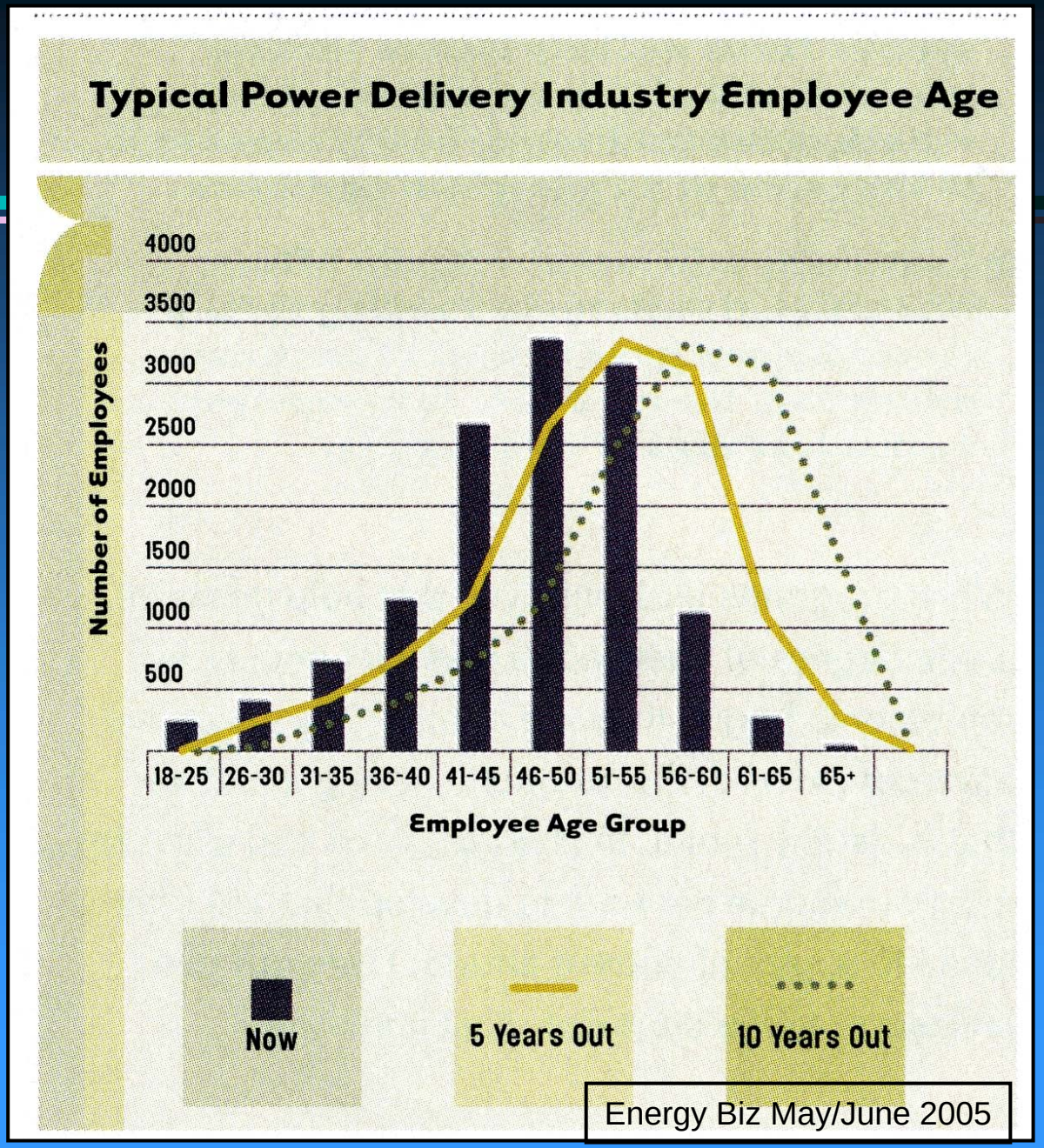
+

Contractor (Environmental, Lands, Public Facilitator)

“Brain Drain” or Loss of Corporate Memory

- Aging workforce
- Challenge to attract new talent

45% of our workforce will become eligible for retirement in the next 6-7 years



Energy Biz May/June 2005

Public and Political Climates

- Under the current political climate and public involvement, the process goes far beyond line design, routing, and engineering.
- How to plan for the following scenarios with decreasing staff availability.

Know Your Project-Specific Issues

- How?
  - Communication with Applicable Players
- When?
  - Early in the Process
- Why?
  - Budget
  - Schedule
  - Gray Hair

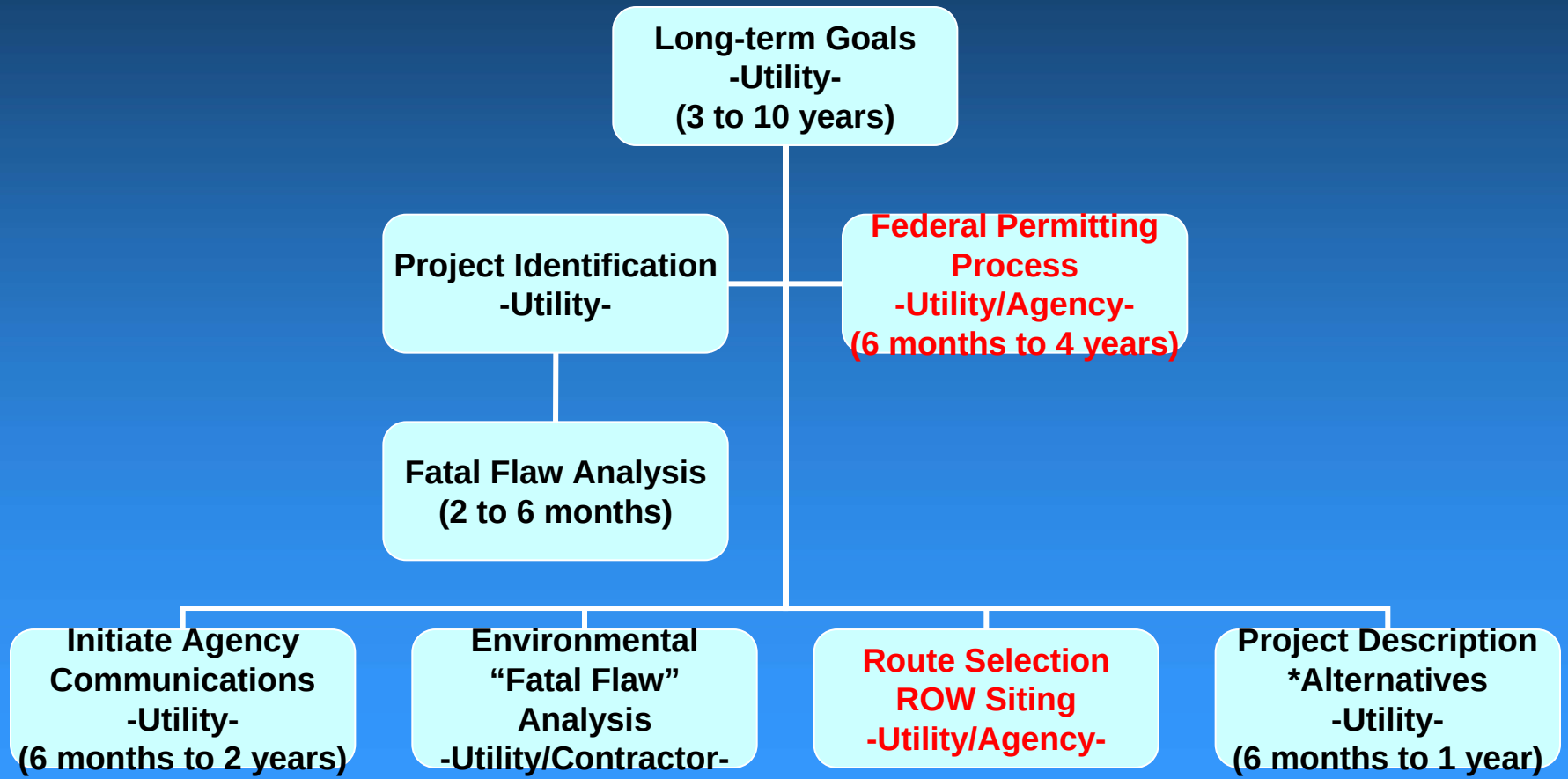
Ducks in a Row

- **Integral to Understand for the Project:**
  - Goals
  - Project Alternatives
  - Schedule
  - Budget
  - Communication Process
  - Stakeholders Involved
  - Resource and/or Public Issues
  - Permitting Process and Associated Legislation
  - How a project can be challenged

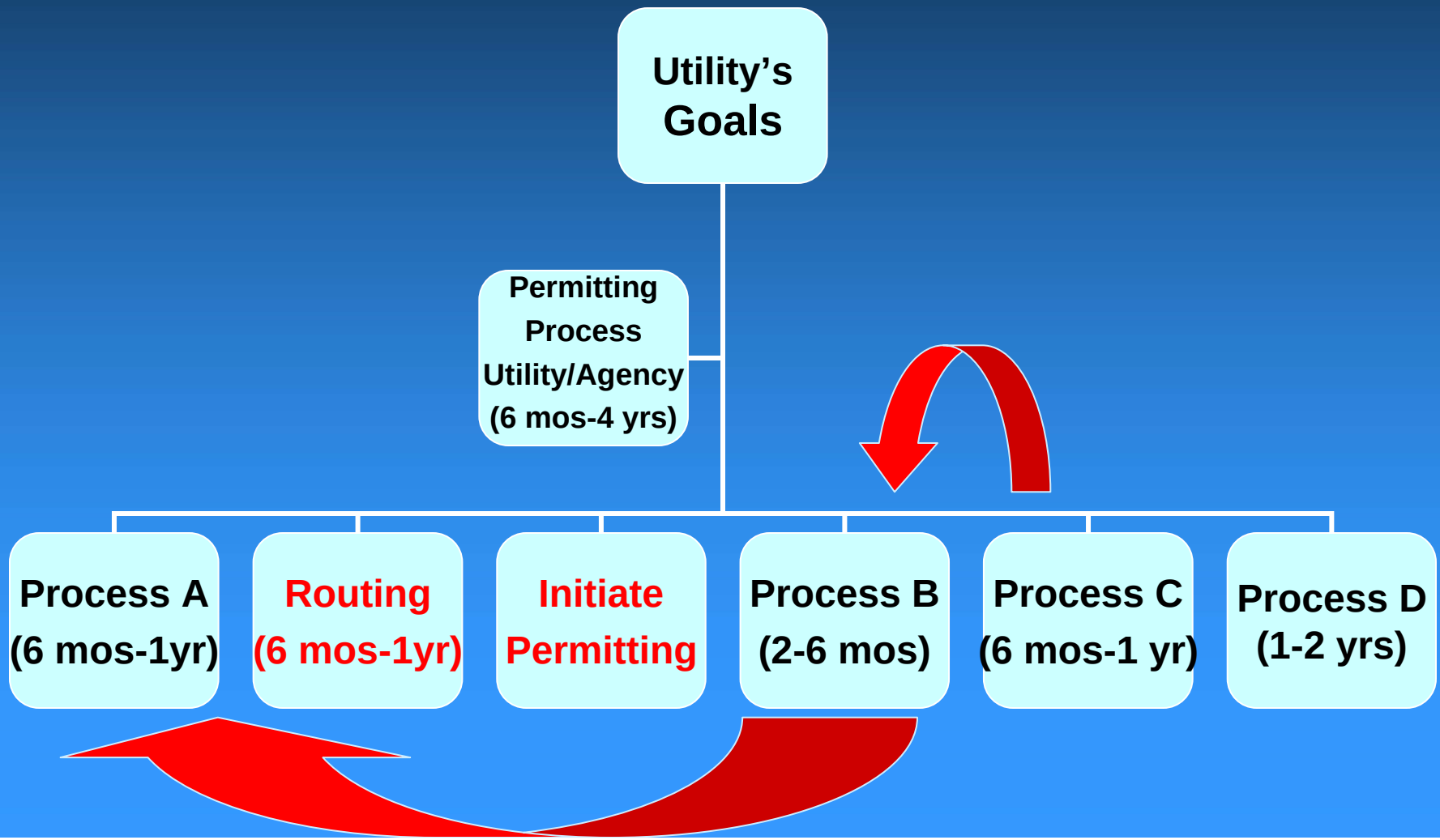
Evolving Challenges and Ducks

- Environmental Permitting = a project must be defensible!
- Understanding how a project can be challenged
  - Examples:
    - Need
    - Reliability
    - Property Values
    - Future Land Uses
    - EMF
    - Avian collision
    - Threatened or Endangered Species
    - Aesthetics

Regulatory Process



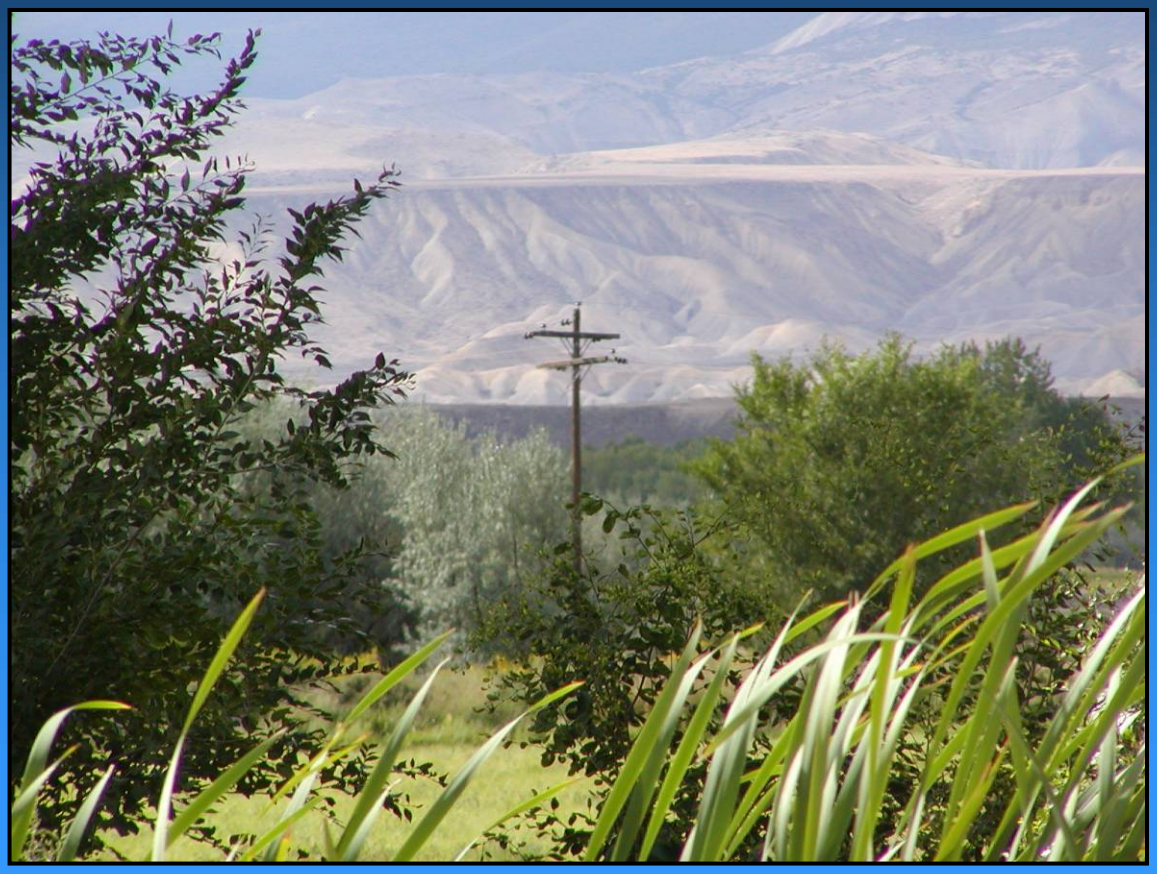
What Can Go Wrong…



Factors to Consider

- Environmental Issues
- Human Resource Issues
- Construction Feasibility and Costs
  - Including equipment access
- Landowner Concerns and Public Perception
- *You Want It When???*
- The Importance of **Environmental Permitting** for New Transmission Line Projects

Wetlands – Clean Water Act



- Delineation Surveys
- Permits

Federally Listed Species – Presence Endangered Species Act

- Presence Surveys
- Avoidance
- “Take” Permit
- Stop Work

Cultural Resources – National Historic Preservation Act

- Pedestrian Surveys
- Reporting
- Avoidance
- Site Mitigation / Data Recovery
- Stop Work

Avian Collision – Flyways Migratory Bird Treaty Act

- Presence
- Avoidance
- Marking

Permitting Considerations – Siting Public Lands Policy

- Presence
- ROW Siting
- Perch Deterrents
- Line Design
- Line Maintenance

Land Uses – Public Lands

- ROWs Corridors
- Environmental Review

Land Use – Private Lands

Land Uses – National Monuments

- Public Involvement
- Rerouting
- Engineering Specs

Access Routes

ROW and Access Routes

Aesthetics – Public Perception

Authorizing Agencies

- Understanding the difference between: federal regulatory, land management, power administration, state, local agencies.
- Open dialog is important…particularly with
- …loss of “Institutional Memory”…a major problem

Loss of Institutional Memory

Remember the Loss of Corporate Memory?

Loss of Institutional Memory

- How does one proactively plan for insufficient agency staff availability and changes in agency personnel?
  - Establishing communication mechanisms EARLY to achieve goals in spite of barriers (e.g., documentation).
  - Anticipate utility staff will be working with agency personnel with limited understanding of transmission lines and their unique challenges for design, construction, and operation.
    - Example: transmission vs. distribution voltages
  - Plan accordingly project schedule and budgets.

Available Tools

- Communication Strategies
  - Internal and External
- Route Comparisons
- GIS-based Programs
  - Viewshed Analyses
  - EPRI-Georgia Power
  - CEC-PIER and SCE
  - EPRI Public Communication Guide
  - Digital Routing Selection

Communication Strategies and Tools

- **Develop communication network to facilitate information transfer, using core team approach.**
  - **Example Tools:**
    - **Weekly Conference Calls**
    - **Interactive FTP Site**
    - **Action Item List**

Action Item List – To Do List

Project Name
Action Item List

Distributed: Date

EXAMPLE

Target Date	Status	Date Completed	Category	Task Item	Roles and Responsibility	Comments	Entered By Date
02/18/08	Initiated		Water	Wetlands Delineation Surveys	Contractor/ Environmental	Pending authorization	LAN 6/1/07

Action Item List – Tasks Completed

Project Name
Action Item List

Distributed: Date

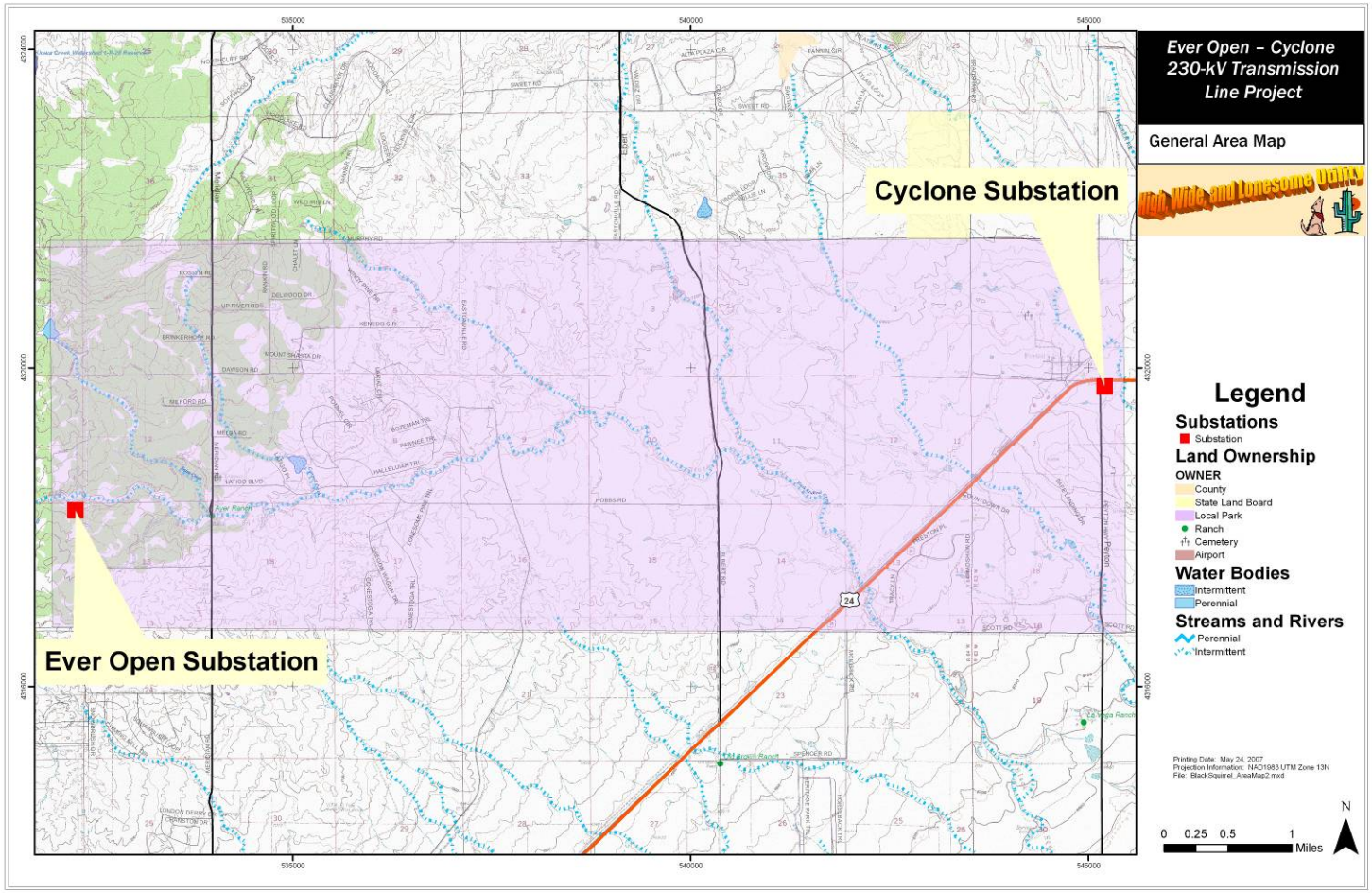
EXAMPLE

Target Date	Status	Date Completed	Category	Task Item	Roles and Responsibility	Comments	Entered By Date
02/18/08	Completed	02/28/08	Water	Wetlands Delineation Surveys	Contractor/ Environmental	Regulatory delay	LAN 02/28/08

Route Comparison Tool

- Developed in the 1970s
- Based on Land Suitability Techniques
- Comparing Areas of Opportunities and Constraints

Route Comparison



Corridor Selection Process

- Examples of Resources and Relative Sensitivity
  - Existing and Proposed Land Uses
  - Land Ownership and Management
  - Sensitive Environmental Resources
  - Sensitive Human Resources
  - Engineering Constraints
    - Cost
    - Reliability

(Note: parallel to “factors that can be challenged”)

Route Comparison

Resource Sensitivity	Routing Objectives
Opportunity or Low Sensitivity	Maximum % of Corridors
Moderate Sensitivity	Minimum % of Corridors
High Sensitivity	Avoid

Environmental Inventory

- **Examples of Opportunities and Constraints and Sensitivity Levels:**
  - Total miles of line (moderate)
  - Miles parallel to existing ROW (opportunity)
  - Miles of new ROW (moderate)
  - Residential crossed (high)
  - Number of sensitive wildlife areas within 0.25 mile (moderate to high)
  - Number of archaeological sites disturbed (high)
  - Etc……

Route Comparison

- Some utilities assign weights to environmental, engineering, and ROW factors…

  Example of What Does NOT Typically Work:

  1 mile wetland = 2 miles irrigated cropland =

  4 miles dry cropland = 6 miles upland rangeland

- Difficult to achieve agreement on assigned weights (i.e., stakeholder input and acceptance)

Route Comparison

- Sometimes better to establish criteria to minimize and maximize, ranking alternative routes on how well these criteria are achieved

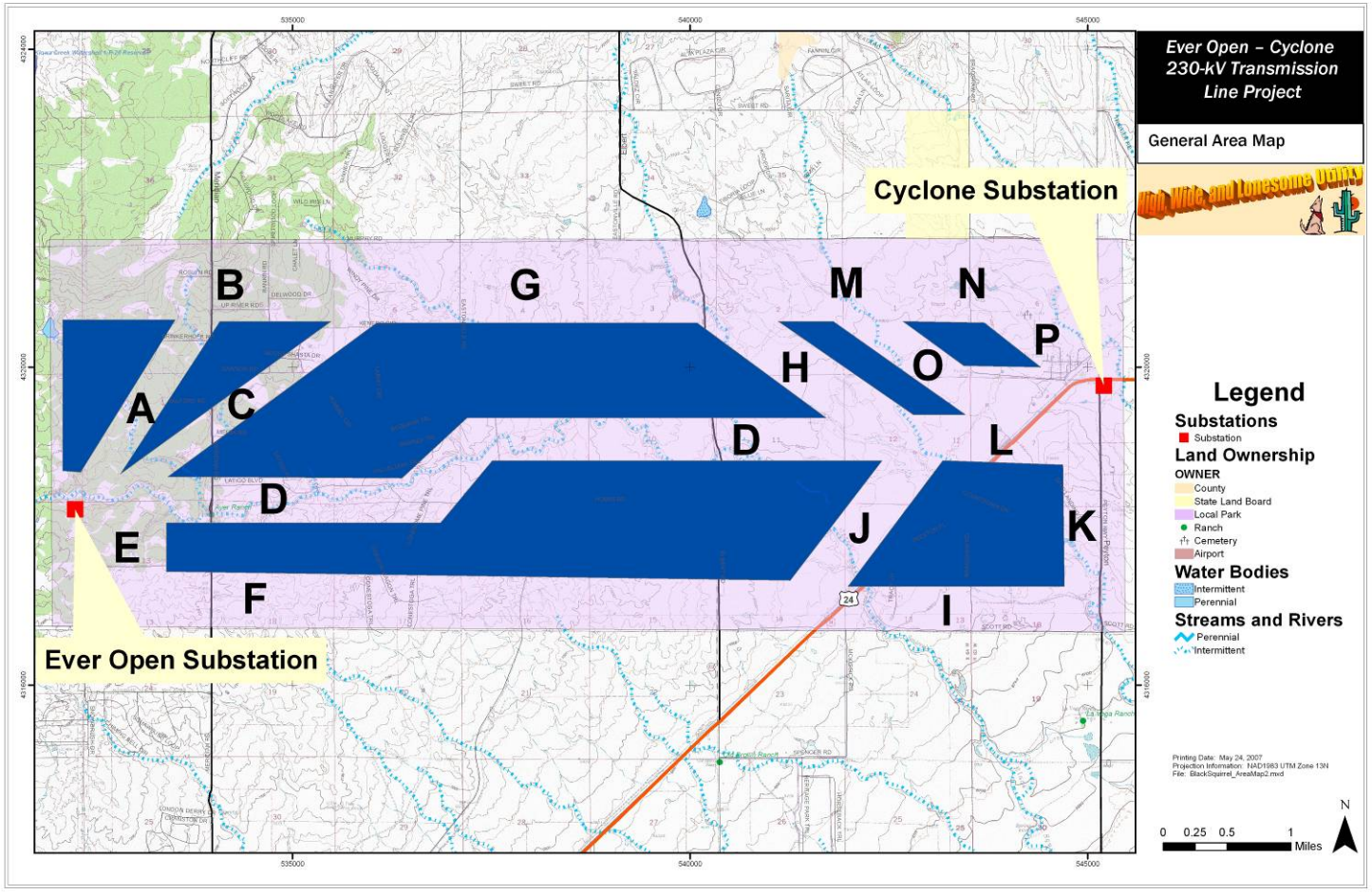
  (GIS can be used for this quantification)

- Ranking where 1 always assigned the highest consistency of a criteria or objective

  (e.g., lowest number of miles of line = 1)

- Corridor with lowest sum = final rank of 1

Routing Links or Segments



Summary of Environmental Inventory Factors by Route

Route (miles)	Total Link Length (miles)	Parallel to Existing Line (miles)	New Row Required (miles)	Residential (miles)	Cultural Sites Crossed (number)	Sensitive Wildlife Species Habitat (miles)	Riparian/Wetland Areas Crossed (miles)	Erosive Soils Crossed (miles)
Route A	49.30	43.10	6.20	9.20	3.00	49.10	0.10	1.80
Route B	50.00	33.10	16.90	3.62	3.00	44.30	1.00	2.20
Route C	50.80	38.60	12.20	9.20	2.00	50.60	0.10	1.80
Route D	51.50	28.60	22.90	3.62	2.00	45.80	1.00	2.20
Route E	48.80	25.10	23.70	2.30	2.00	42.90	0.10	2.70
Route F	50.20	41.50	8.70	9.20	2.00	50.20	0.10	1.00
Route G	50.90	31.50	19.40	3.62	2.00	45.40	1.00	1.40

Preliminary Rank Ordering of Environmental Inventory Factors by Route

Route (miles)	Total Link Length (miles)	Parallel to Existing Line (miles)	New Row Required (miles)	Residential (miles)	Cultural Sites Crossed (number)	Sensitive Wildlife Species Habitat (miles)	Riparian/Wetland Areas Crossed (miles)	Erosive Soils Crossed (miles)
Route A	(2) 49.30	(1) 43.10	(1) 6.20	**(3) 9.20**	(2) 3.00	(5) 49.10	(1) 0.10	(3) 1.80
Route B	(3) 50.00	(4) 33.10	(4) 16.90	(2) 3.62	(2) 3.00	(2) 44.30	(2) 1.00	(4) 2.20
Route C	(5) 50.80	(3) 38.60	(3) 12.20	**(3) 9.20**	**(1) 2.00**	(7) 50.60	(1) 0.10	(3) 1.80
Route D	(7) 51.50	(6) 28.60	(6) 22.90	(2) 3.62	**(1) 2.00**	(4) 45.80	(2) 1.00	(4) 2.20
Route E	(1) 48.80	(7) 25.10	(7) 23.70	(1) 2.30	**(1) 2.00**	(1) 42.90	(1) 0.10	(5) 2.70
Route F	(4) 50.20	(2) 41.50	(2) 8.70	**(3) 9.20**	**(1) 2.00**	(6) 50.20	(1) 0.10	(1) 1.00
Route G	(6) 50.90	(5) 31.50	(5) 19.40	(2) 3.62	**(1) 2.00**	(3) 45.40	(2) 1.00	(2) 1.40

Route Comparison

- Preferred Route Based on Segment Sums
- Ability to Mitigate is Key
- Residual Impacts
  - After Mitigation
  - Alternatives can be Compared
- Viable Alternatives Retained
- Take Preferred and Viable Alternative Routes through Permitting Review
  - National Environmental Policy Act (NEPA)
  - County

Available Tools

Sampling

GIS-Based Tools

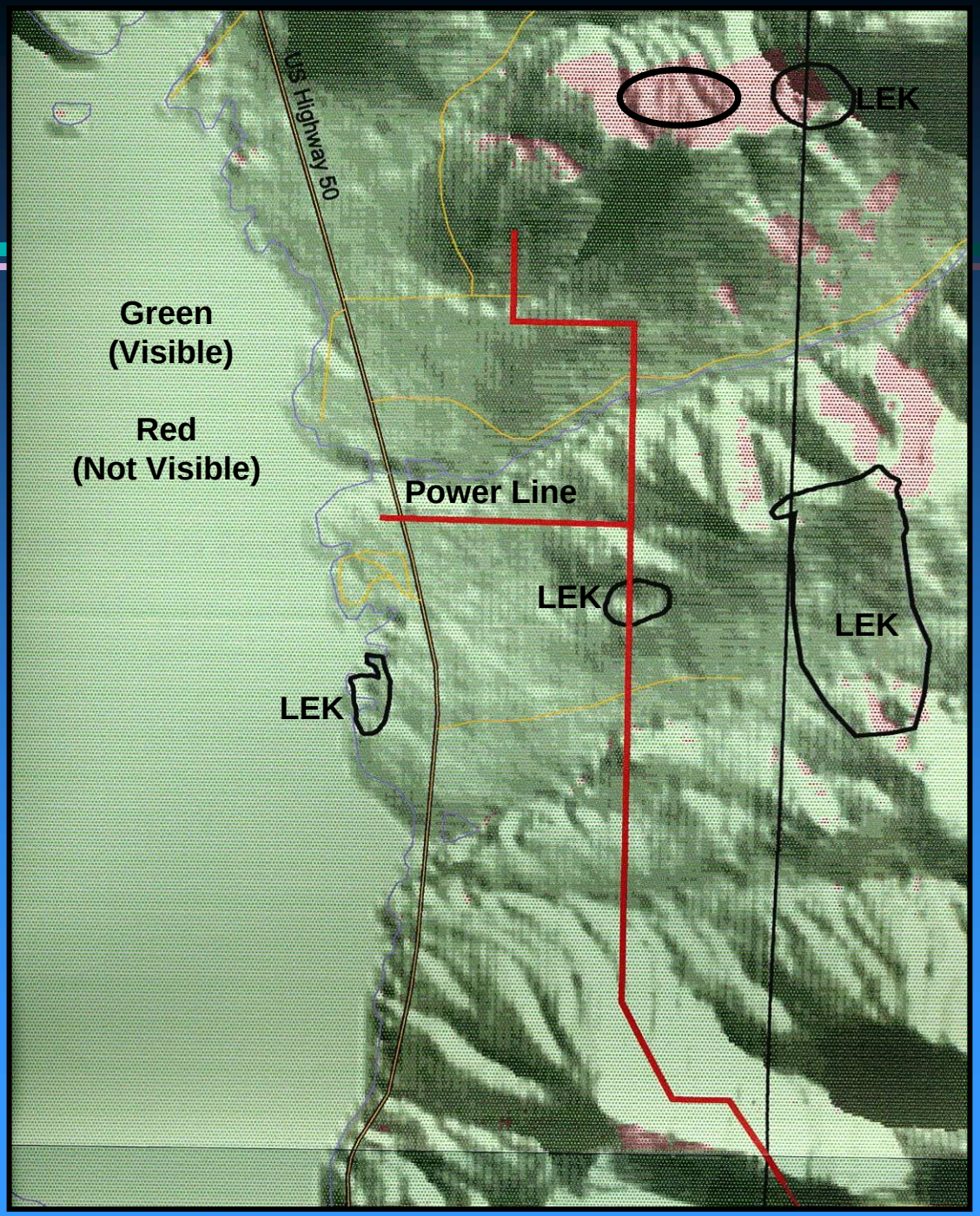
GIS as a Tool

- Route selection is not just a mapping exercise.
- GIS is a powerful tool for quantifying differences among alternate routes…

  ….but nothing substitutes for eyes on the ground
- The last thing you want to do is stand up in a public meeting and try to explain how a computer program selected your preferred route.
- If your audience can not understand your methodology, they are not likely to agree with your conclusion.

Viewshed Analysis

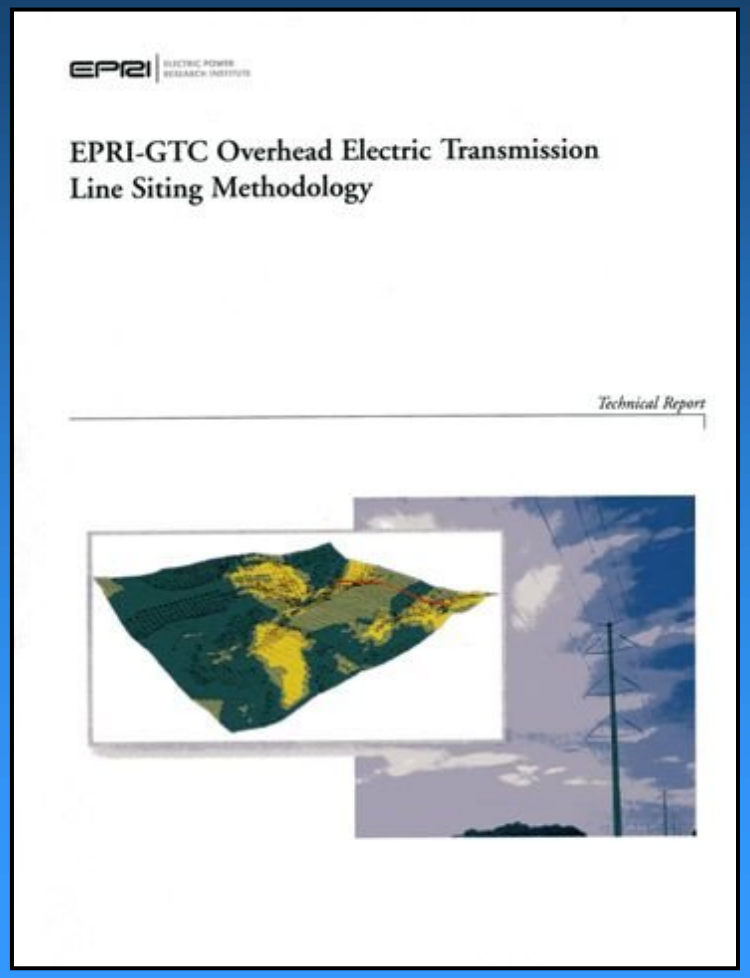
Greater Sage-grouse vs. Golden Eagle Predation



EPRI – GTC

- Siting Decisions = More
  - Quantifiable
  - Consistent
  - Defensible
- GTC's Existing Siting Process = Incorporated
  - GIS
  - Statistical Evaluation
  - Stakeholder Collaboration (>400)

http://www.gatrans.com/gtcsite/pages/gtc_epri_siting_study_main.htm



EPRI – GTC

- Macro Corridor Development
- Alternative Corridor Development
- Alternative Route Analysis
  - Identified Avoidance Areas
  - Used Weighted Values 1-9 (but achieved stakeholder input)
  - Data Layers Grouped
    - Built Environment (public involvement)
    - Natural Environment (minimal effects to)
    - Engineering Requirements (lines, slopes, agricultural)
    - Combined
  - Lower Sum = Highest Suitability

EPRI – GTC

- **Summary**
  - **Two Most Successful Aspects**
    1. Integrating GIS Technology with a New Methodology
    2. Obtaining Stakeholders' Input on Outcome
  - **Unexpected Advantages**
    1. Cost Savings in Data Collection
    2. GIS Siting Model Produced Reports that Supported GTC's Environmental Reporting Process
  - **Four Future Improvements**
    1. Incorporating ROWs Access into Methodology
    2. Incorporating Visual Impacts
    3. Refining GIS Siting Model
    4. Future Testing

http://www.gatrans.com/gtcsite/pages/gtc_epri_siting_study_main.htm

CEC and SCE

- PIER Energy-Related Environmental Research
- Development of a Web-Based Decision Making Tool for Planning Alternative Corridors for Transmission Lines

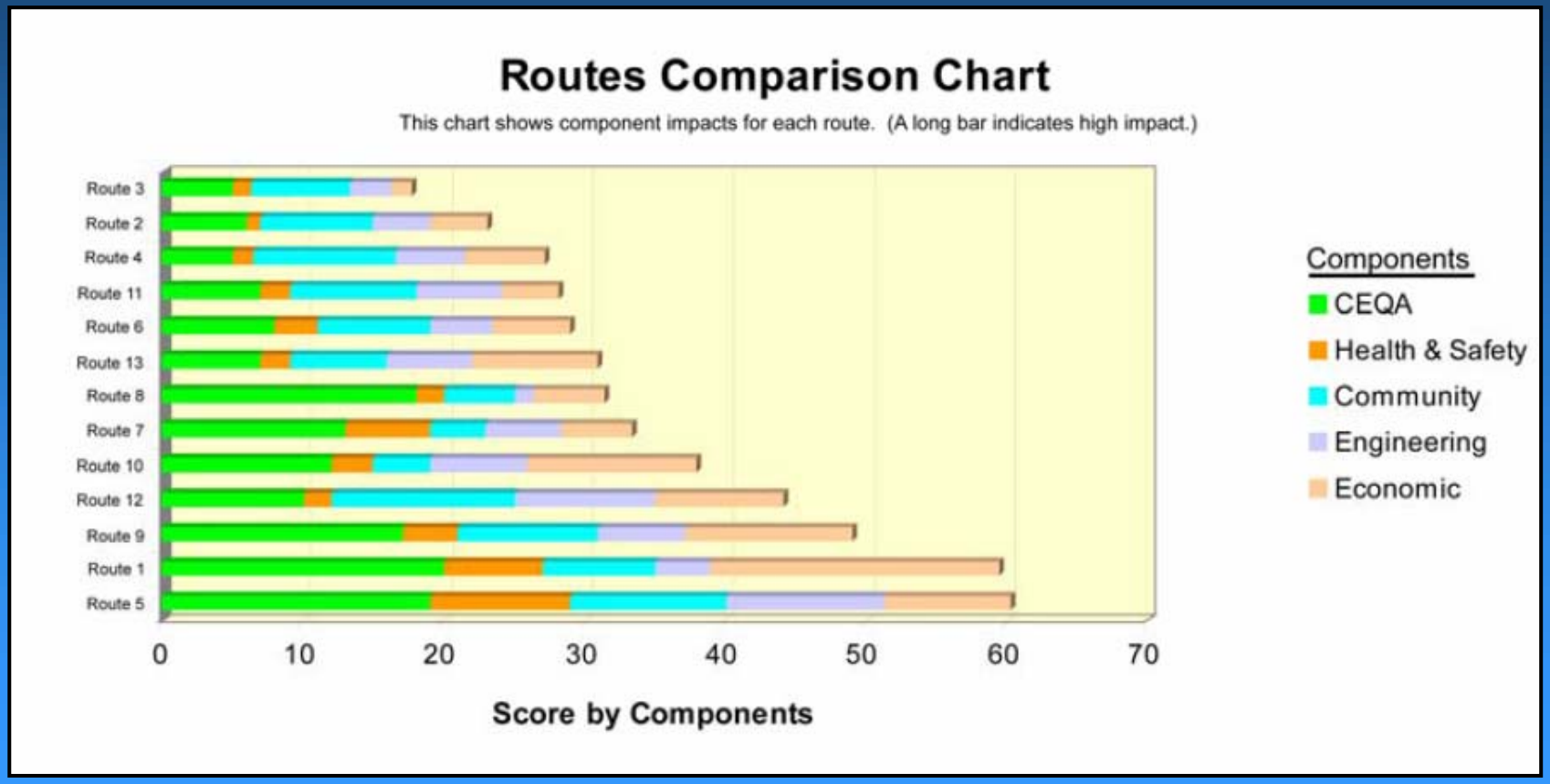
http://www.energy.ca.gov/pier/environmental/project_summaries/PS_500-04-029_DEMING.PDF

http://www.energy.ca.gov/2005_energypolicy/documents/2005-05-19_workshop/LEE_SUSAN_ASPEN.PDF

CEC and SCE

- Needed Tool that Clearly Communicates Differences Among Alternatives
- Multiple Stakeholders
- Target for Meeting the State's Renewable Energy Portfolio by 2017
- Based on analyses that are:
  - Objective
  - Comprehensive
  - Consistent
  - Transparent

CEC and SCE


Routes Comparison Chart
This chart shows component impacts for each route. (A long bar indicates high impact.)
Route 3
Route 2
Route 4
Route 11
Route 6
Route 13
Route 8
Route 7
Route 10
Route 12
Route 9
Route 1
Route 5
0
10
20
30
40
50
60
70
Score by Components
Components
CEQA
Health & Safety
Community
Engineering
Economic

EPRI – GTC

Summary

- **Tested in a Narrow Context for Internal Site Screening…Still in Development**
- **More Comprehensive Testing Needed**
- **Expand Model's Capabilities**
- **Goal: Easy, User-Friendly, and Efficient**

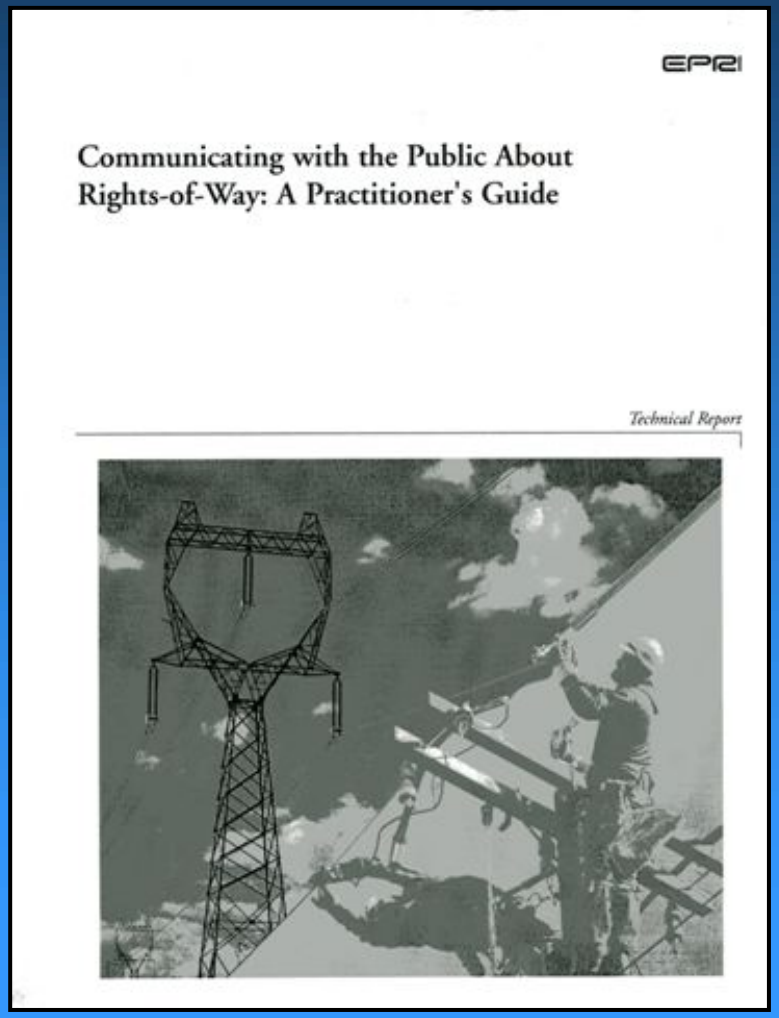
http://www.energy.ca.gov/pier/environmental/project_summaries/PS_500-04-029_DEMING.PDF

http://www.energy.ca.gov/2005_energypolicy/documents/2005-05-19_workshop/LEE_SUSAN_ASPEN.PDF

EPRI – Technical Report

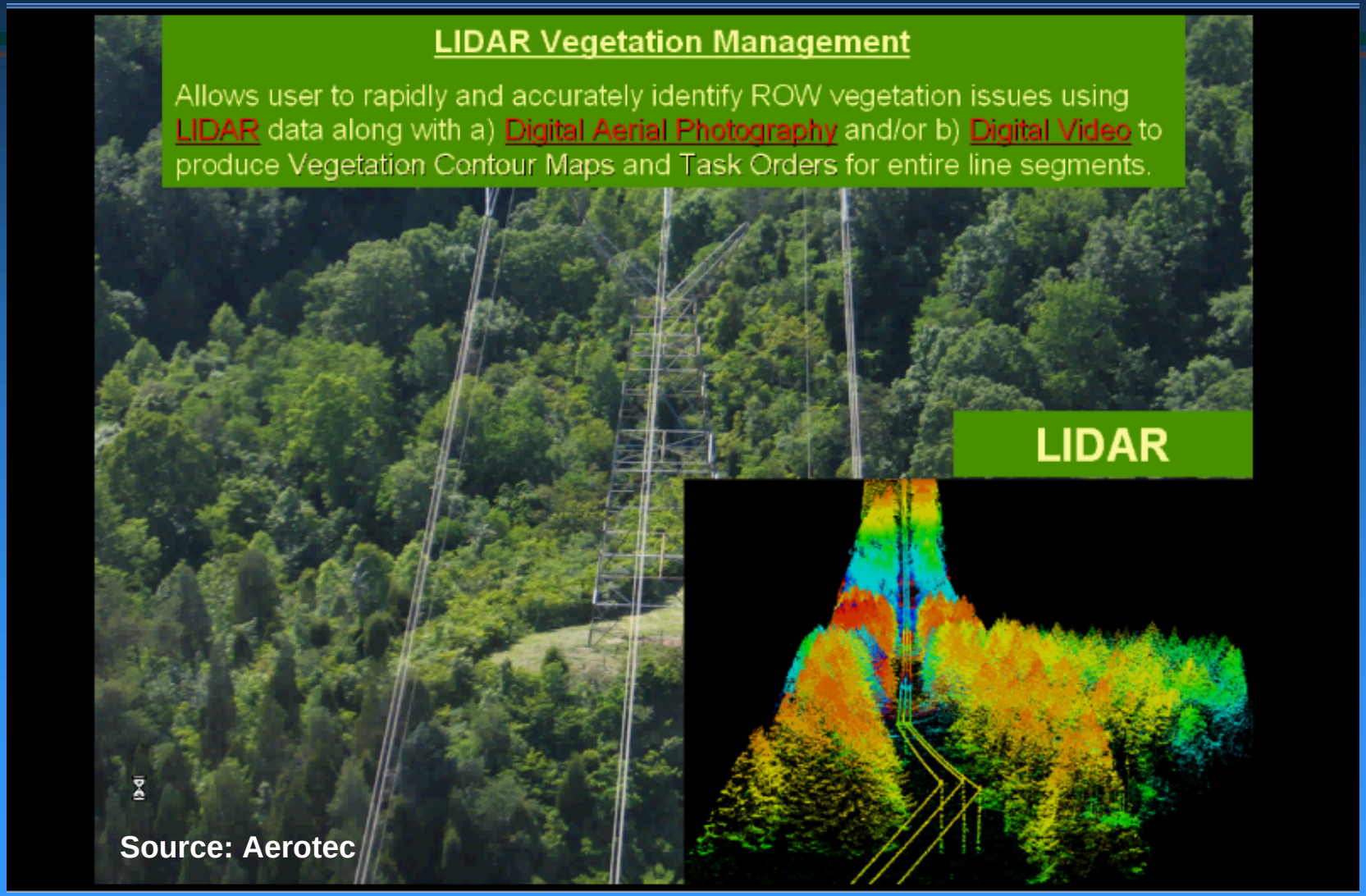
Communicating with the Public About Rights-of-Way A Practitioner's Guide

Product Number: 1005189
9/27/2001



Digital Routing Selection

Digital Routing Selection



Take Home Message

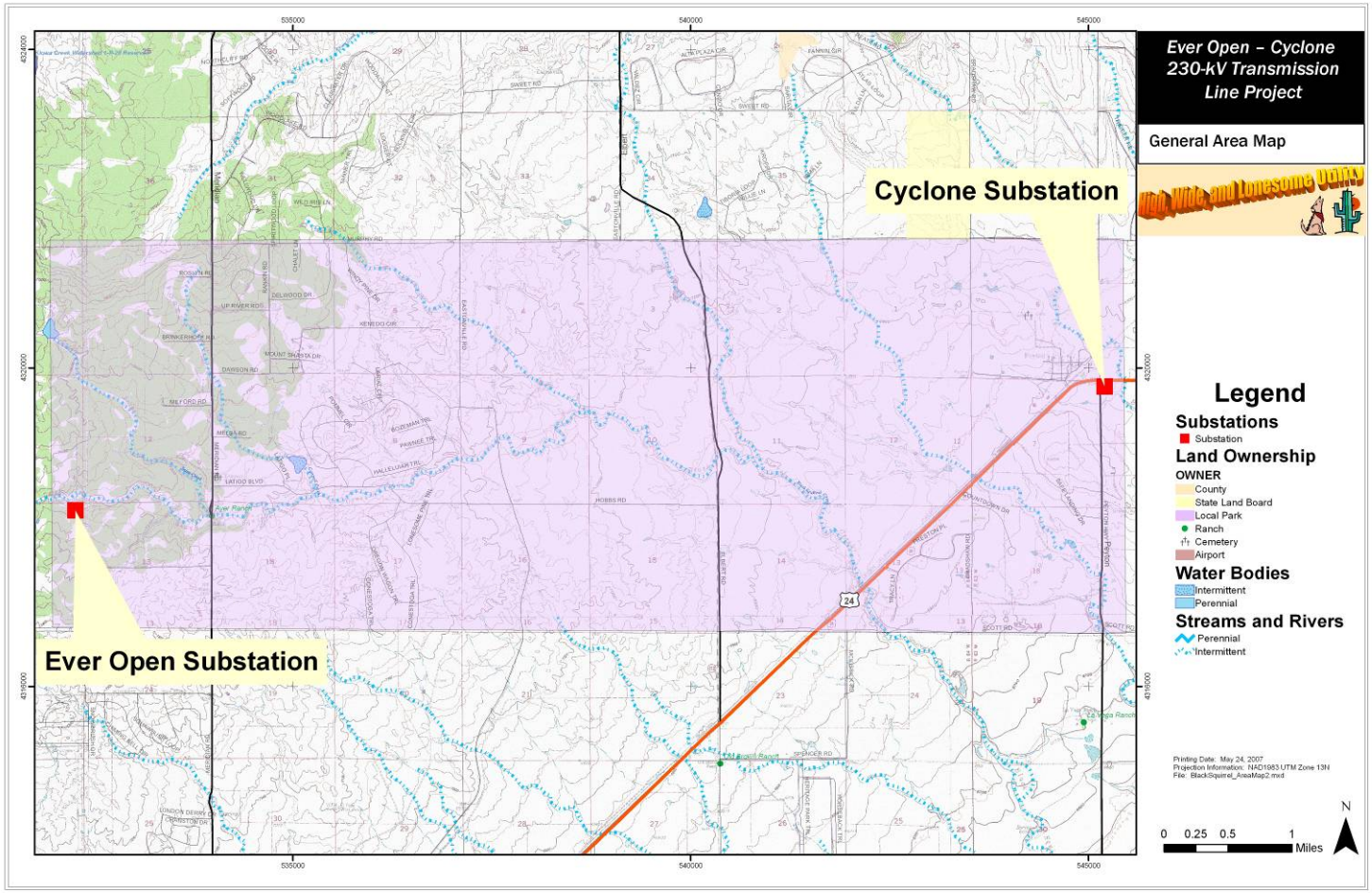
- Projects May (Will) Still have Opposition
- Whatever Tool Used Should:
  - Help Demonstrate Objective Process
  - Ensure Transparency for Public Review
  - Provide Opportunity for Involvement
  - Illustrate Benefits, Costs, Mitigation, etc.
  - Reduce Opposition Levels through Education

Are you still with me?

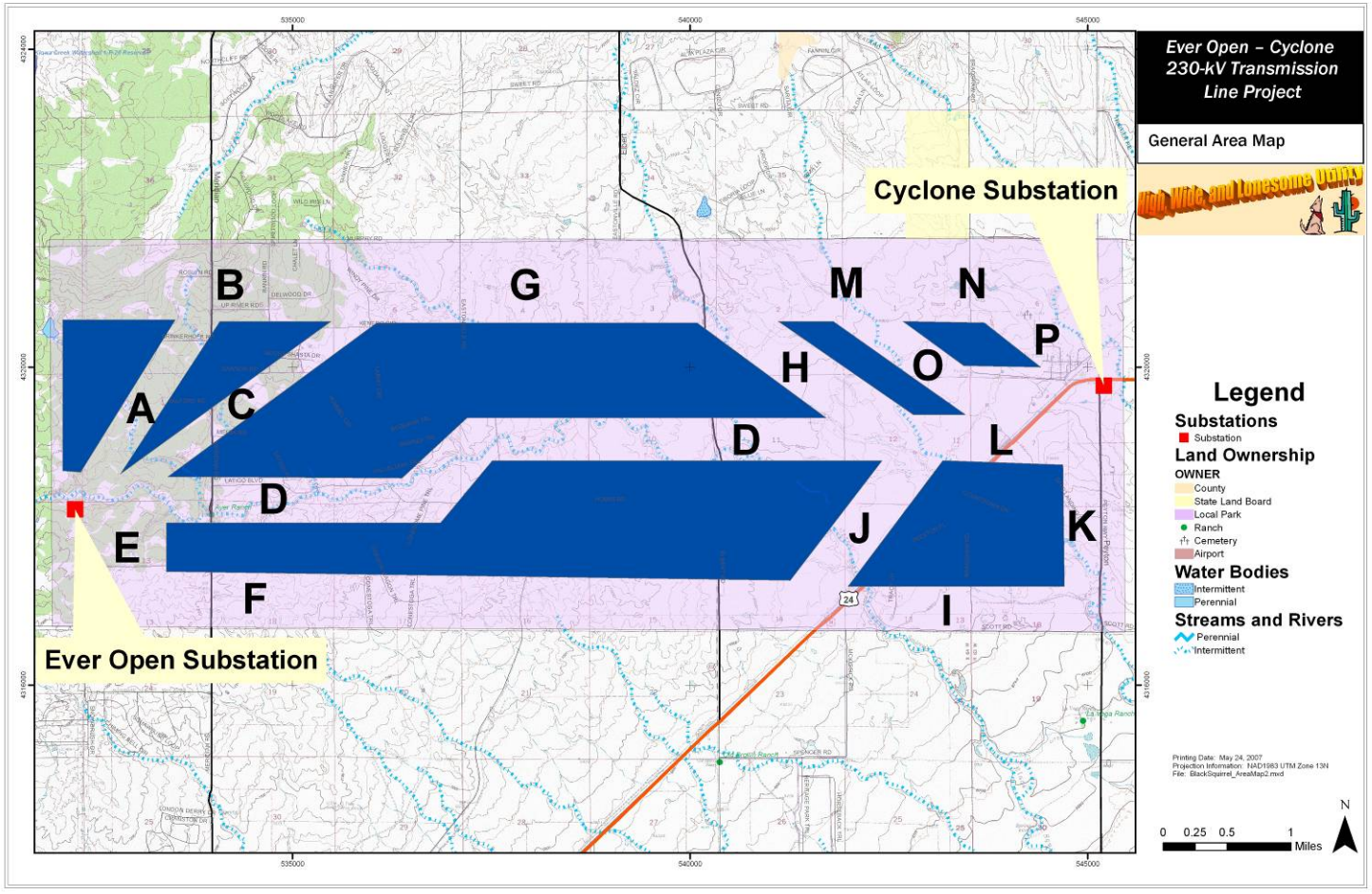
Case Study

- New 30-Mile 230-kV Transmission Line
  - Colorado
  - High, Wide, and Lonesome Utility
  - Ever Open Power Plant in the Lost Forest
  - To the Cyclone Substation of the eastern prairie

Study Area


Ever Open – Cyclone 230-kV Transmission Line Project
General Area Map
Cyclone Substation
Ever Open Substation
Legend
Substations
Substation
Land Ownership
OWNER
County
State Land Board
Local Park
Ranch
Cemetery
Airport
Water Bodies
Intermittent
Perennial
Streams and Rivers
Perennial
Intermittent
Printing Date: May 24, 2007
Projection Information: NAD1983 UTM Zone 13N
File: BlackSquirrel_AreaMap2.mxd
N
0 0.25 0.5 1
Miles

Route Comparison



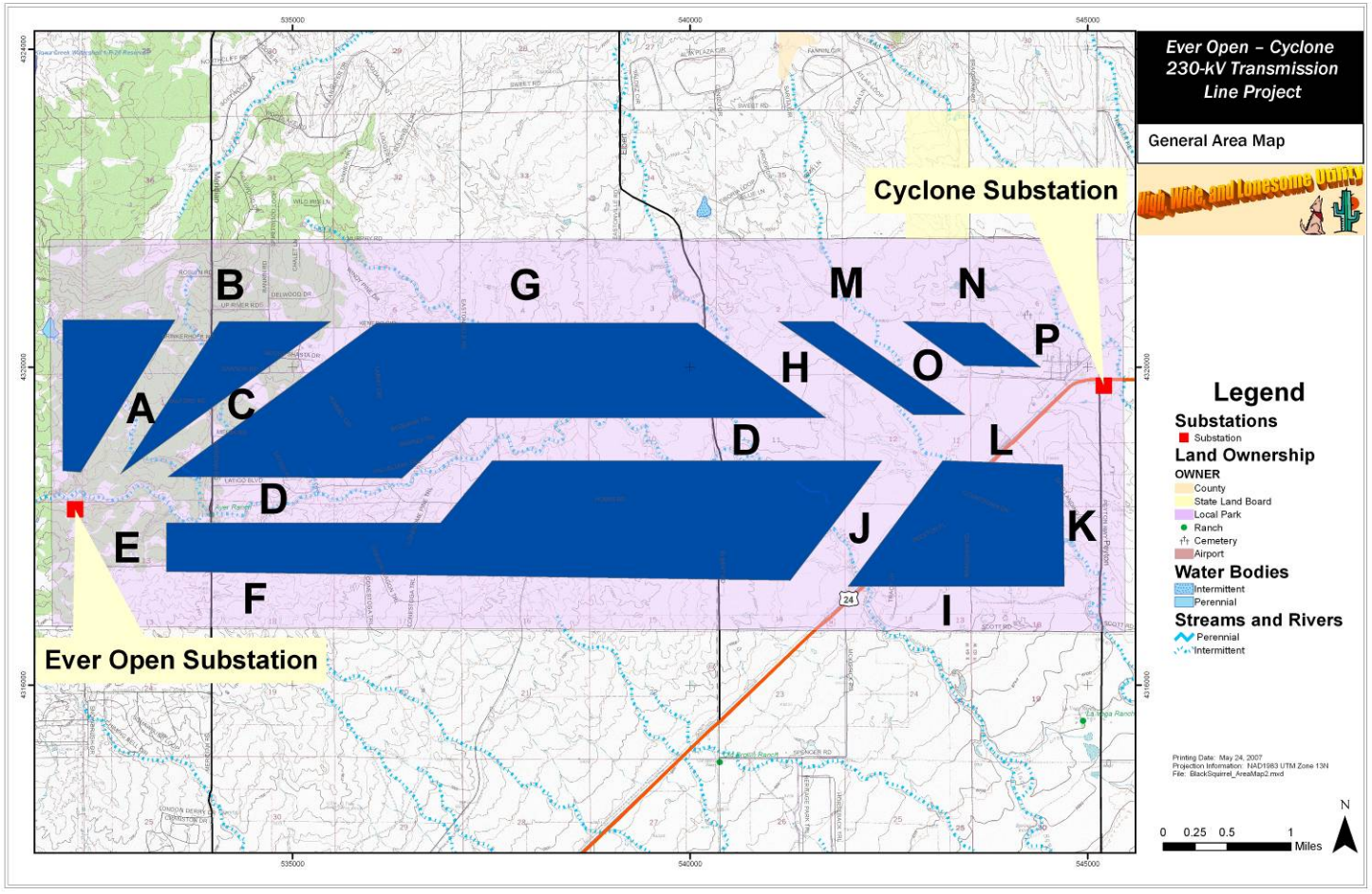
Case Study Questions

- **Identify:**
  - **Who is the primary authorizing agency?**
  - **What are the important environmental, human resource, and engineering issues?**
  - **What are the key regulatory and land management agencies that need to be involved and contacted?**
  - **What type of resource specialists (either internal or external) do you need to get involved early in the process? Will you need field studies completed?**

Case Study Questions

- **Identify:**
  - **Is there a need or requirement for public meetings?**
  - **What are some important elements about developing the appropriate communication process?**
  - **What type of project objectives could be established that would facilitate the selection and ranking of alternative routes for use with this routing problem?**

Route Comparison



Case Study Questions

- **Identify:**
  - **Who is the primary authorizing agency?**
  - **What are the important environmental, human resource, and engineering issues?**
  - **What are the key regulatory and land management agencies that need to be involved and contacted early?**
  - **What type of resource specialists (either internal and external) do you need to get involved early in the process? Will you need early field studies completed?**

Case Study Questions

- **Identify:**
  - **Is there a need or requirement for public meetings?**
  - **What are some important elements about developing the appropriate communication process?**
  - **What type of project objectives could be established that would facilitate the selection and ranking of alternative routes for use with this routing problem?**
    - **Hint:**
      - **Minimize miles of lines**
      - **Maximize co-location of linear facilities**
      - **Minimize # acres of irrigated cropland crossed**

Summary

- No “cookbook” approach to routing methodologies.
- Need to establish a plan or strategy for the applicable siting approach and permitting standards.
- A number of tools are available.
- Planning is Key = Emphasizing
  - Education
  - Communication
  - Preparation

Thank You!!

“Well…what did you think would happen if you spent the whole day banging your head on a power transformer?”