Structured Decision Making: An Approach to ALARA?

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Consider…..

How to make more efficient and cost-effective decisions for radioactive contamination?

And….

Why? (perhaps obvious?)

Why do we make disposal sooo difficult?

- Radioactive waste management tail is currently wagging the nuclear industry dog
  - Nuclear energy or fossil fuel?
  - Nuclear energy or climate change?
- Need to optimize use of ever more scarce resources (GAO?)
- Move beyond simple compliance assessments, and hence make better decisions, use resources more effectively, etc.
- 40 years of practice and changes in technology since regulations were first written on typewriters
  - Time to improve regulations and guidance
- Should future generations still be asking these questions?

Long-term Complex Modeling?

- Modeling into the distant future is fraught with vast unstated uncertainties that increase with time
- Future changes in technology/society/evolution are not accounted for
- Economics of the problem
  - discounting under ALARA should limit future modeling
  - disconnected from PA performance objectives
- Natural catastrophes change environmental systems
  - Why assume that radioactive waste will be important in that context?

Simplify Science Models?…..

- If there is water, or erosion, and people, then there is a potential problem
- If there is no water and no erosion, or no people, then there is not much of a problem

(Ok – maybe an over-simplification!)

Our "go to" tends to be modeling first, when we should be understanding decision structure and hence need for models

Note – US and Western World have different resources than the rest of the world, so different value systems elsewhere

Consider a different approach….

Decision Science:

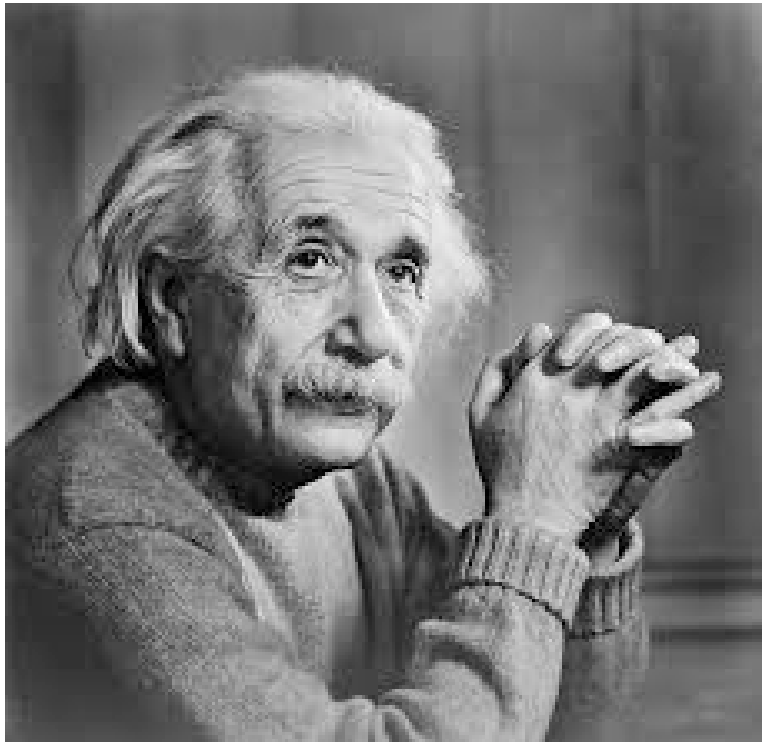
- Structured Decision Making
- Formalized Common Sense
- Value Focused Thinking
  - *The only reason we are making a decision is that we care about something – maybe we should focus on what we care about first*
- Stakeholder Engagement
  - *DAD or EDD?*
    - *Decide, announce, defend*
    - *Engage, deliberate, decide*

Proper planning

- Planning must be deliberative and collaborative
- Then, action can be taken quickly and carefully

Einstein….

- **“If I had an hour** to solve a problem, I'd spend 55 minutes thinking about the problem and five minutes thinking about solutions.”



Separate Values from Science

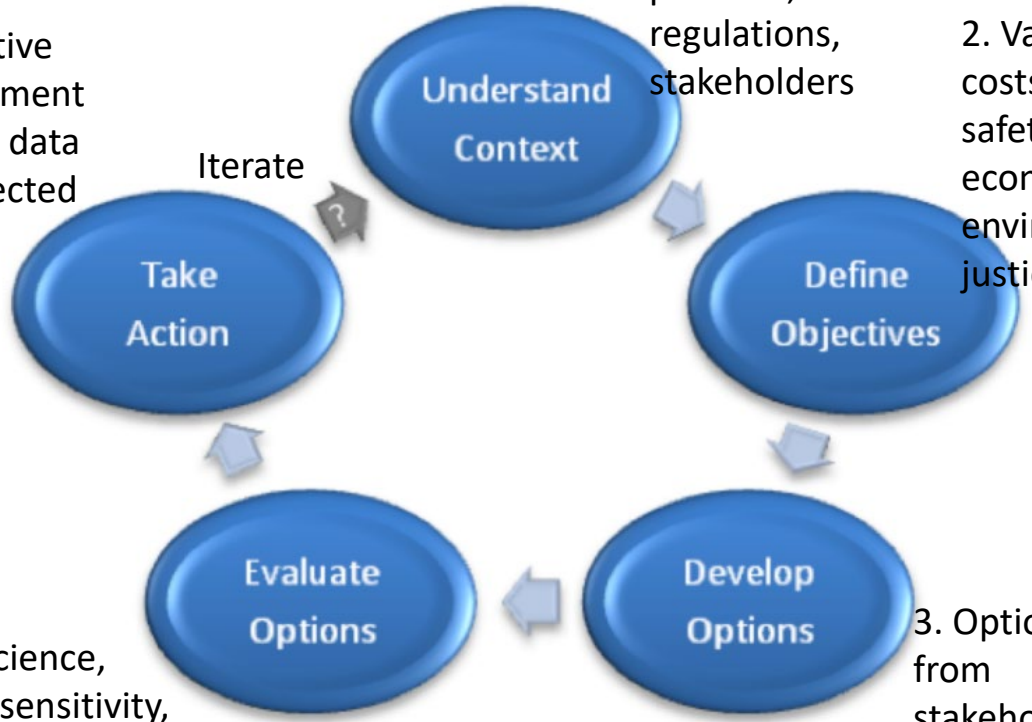
"Unless we make a conscious choice to separate utility and probability, the two inevitably become intertwined in a hopeless melange in which we lose site of, and confuse, the underlying assumptions that drive our perceptions of what we want (utility) and what we'll get (probability)."

Morgan D. Jones – The Thinker's Toolkit

Structured Decision Making

- Formalized common sense
- Current term of art – Structured Decision Making (SDM) – *Gregory et al* (*2012*)
- Values focused thinking (*Keeney, 1992*)
  - "Decisions are made with the purpose of achieving something, which is defined by the **values** for the given decision"
  - "Values are what we fundamentally care about in decision making. Alternatives are simply means to obtain our values"

Stakeholder Engaged – Structured Decision Making



1. Site, problem, regulations, stakeholders

2. Values – costs, risk, safety, economy, jobs, environmental justice

3. Options from stakeholders and SMEs

4. Models, science, uncertainty, sensitivity, value of information

5. Adaptive management as more data are collected

Community involvement

- Describe the problem
- Understand what matters to the community and all other interested parties
- Identify alternatives that best address the concerns of the community and all other stakeholders

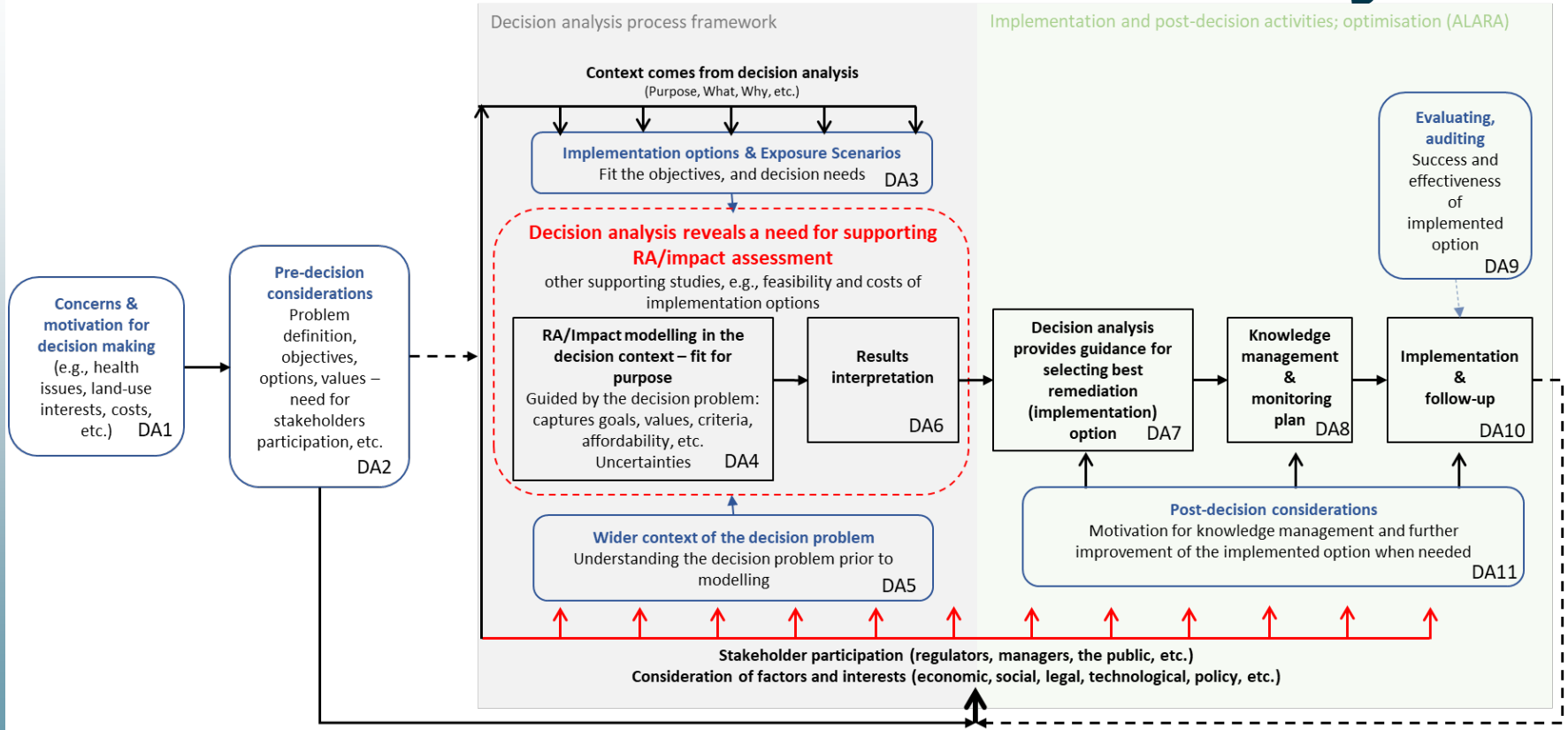
Subject Matter Experts – complete alternatives evaluation

Decision makers – select best alternative

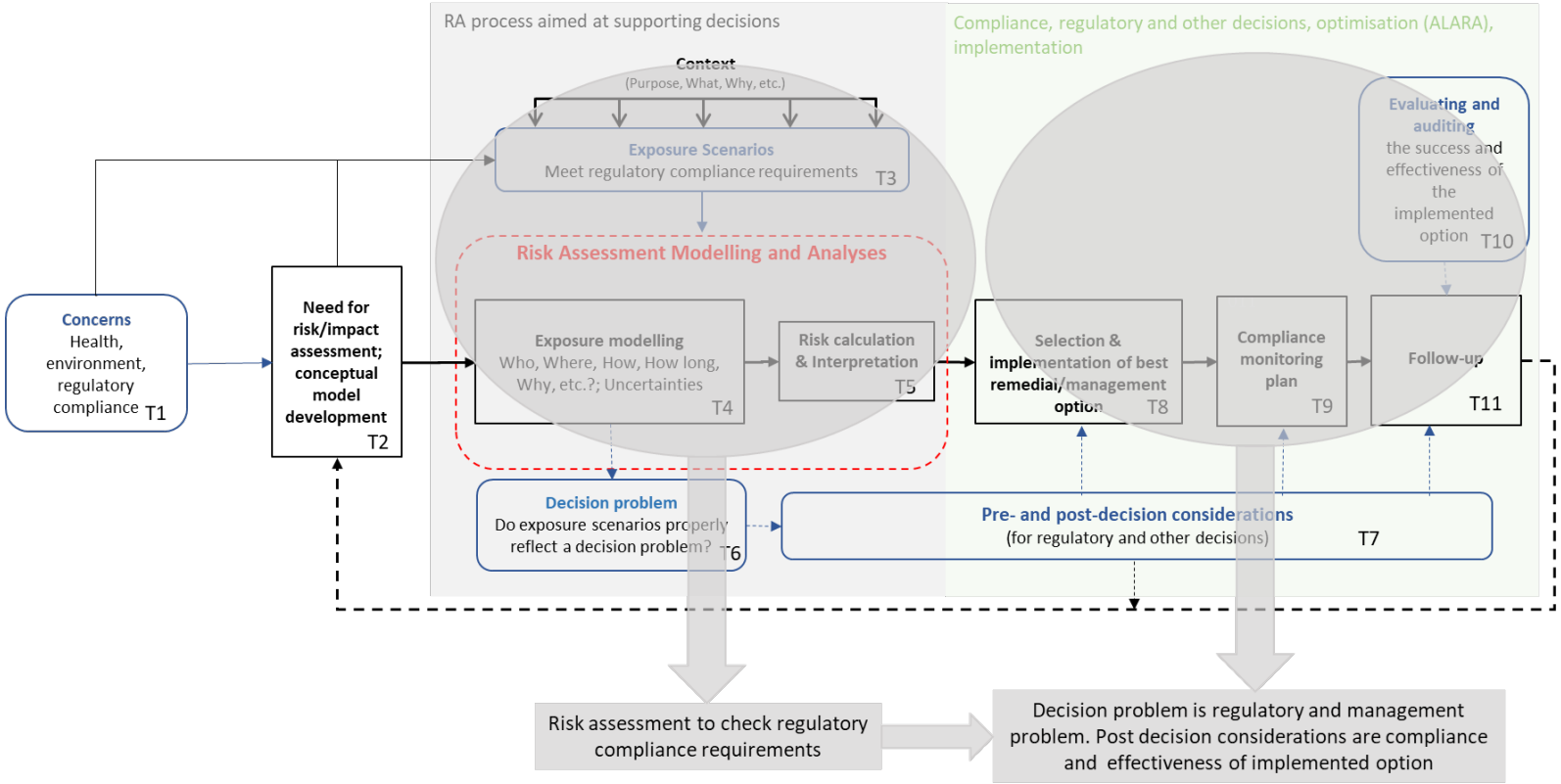
Communication Benefits

- Stakeholder engagement
- Easier to understand
- Easier to communicate and explain
  - Because it represents what we think we know and our uncertainties about that
    - I.e., it's honest
  - Rather than what we know to be wrong, inaccurate, or mis-applied
- Consequently, more difficult to disagree
  - Helps avoid redo, or another rock

IAEA MODARIA – Old Way



IAEA MODARIA – New Way



IAEA MODARIA – Old Way

1. Science (fate and transport modeling focus)
   - Hydrology, hydrogeology, geochemistry, soil science, plants, animals, etc.
2. Risk/dose assessment
   - Human health – risk or dose
   - Ecological risk
3. Statistics and Decision Analysis
   - Bayesian for decision modeling
4. Stakeholder engagement/communication

IAEA MODARIA – New Way

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UK Regulatory Guidance

Home > Decommissioning of nuclear sites and release from regulation

Environment Agency

Guidance

Decommissioning of nuclear sites and release from regulation

Published 24 July 2018

https://www.gov.uk/government/publications/decommissioning-of-nuclear-sites-and-release-from-regulation/decommissioning-of-nuclear-sites-and-release-from-regulation

ALARA

ALARA (acronym for "as low as is reasonably achievable") means making every reasonable effort to maintain exposures to radiation as far below the dose limits in this part as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.

Isn't this basically a description of decision analysis?

Some EPA Examples

- SMARTe – Sustainable Management Approaches and Revitalization Tools – Brownfields Revitalization
- Re-imagining Cleveland – Regional land use planning
- DASEES – Decision Analysis for a Sustainable Environment, Economy, and Society –
  - *Land re-use and watershed management*
  - *Social Network tool for stakeholder involvement*
- Resiliency planning for climate change
- Stream Water Quality
- Coral reef management
- Dairy farmers

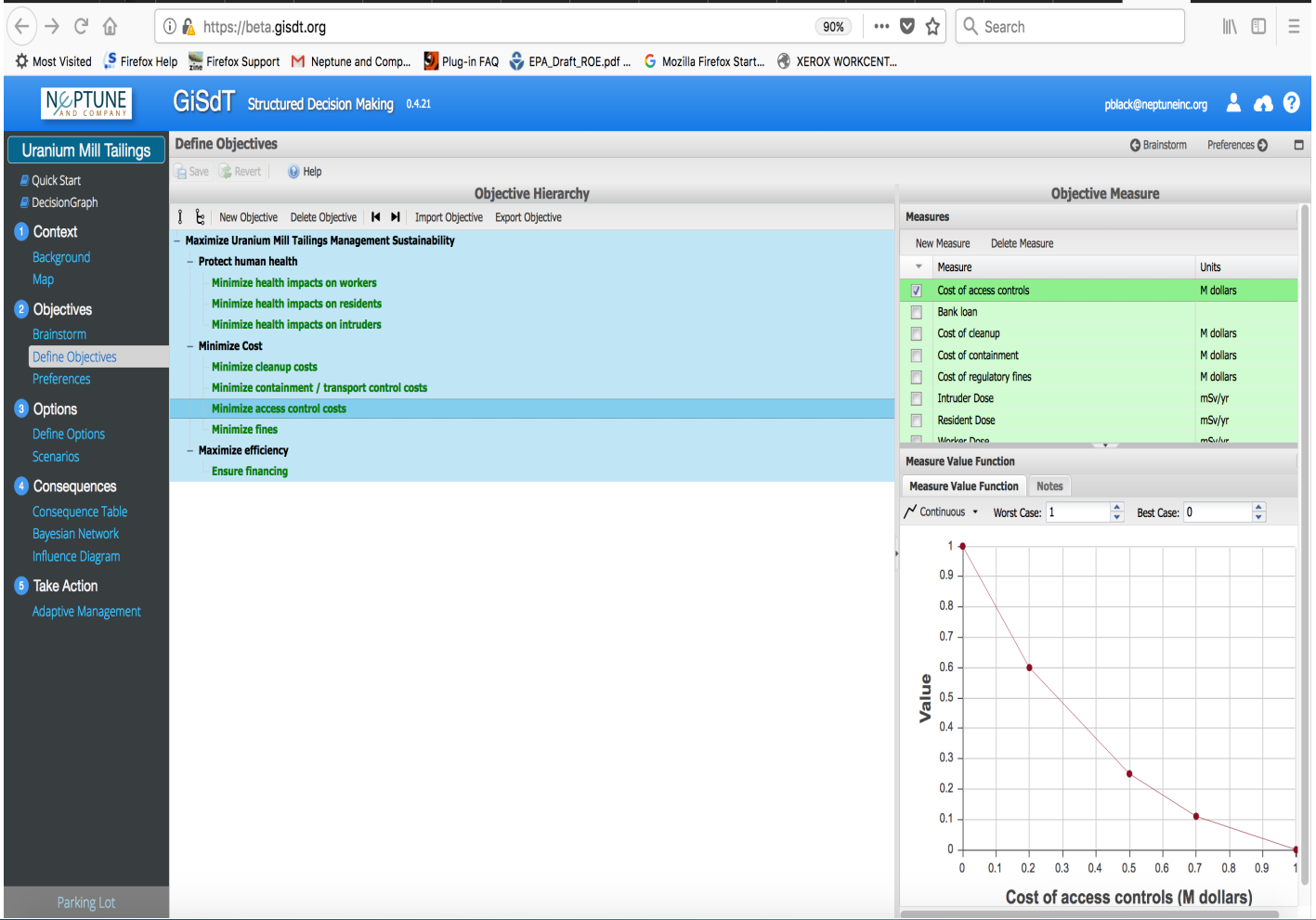
Other Groups

- Nuclear waste industry – disposal, monitoring
- DoD – cleanup chemical warfare agents
- MMRP – characterize and remediate UXO
- FDA – prioritization for mitigating foodborne illnesses
- Risk management, environmental liability issues for commercial industry
- Geothermal energy development
- Facilities management

Tight budgets – need to focus on better solutions, need some optimization

- GAO concerns for DOE's long-term environmental liability

Uranium Mill Tailings example


https://beta.gisdt.org
90%
Search
Most Visited
Firefox Help
Firefox Support
Neptune and Comp...
Plug-in FAQ
EPA_Draft_ROE.pdf ...
Mozilla Firefox Start...
XEROX WORKCENT...
NEPTUNE AND COMPANY
GiSdT Structured Decision Making 0.4.21
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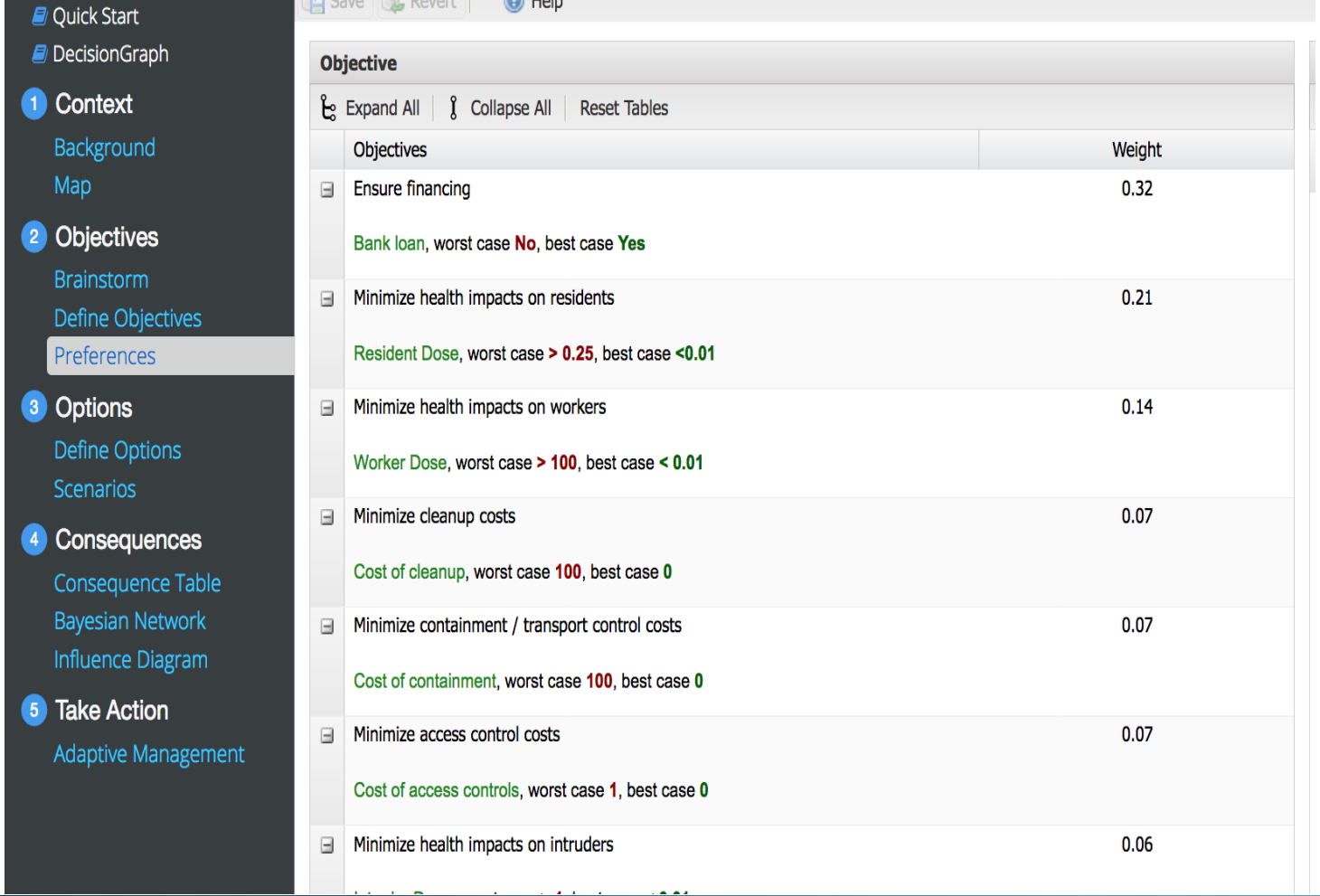
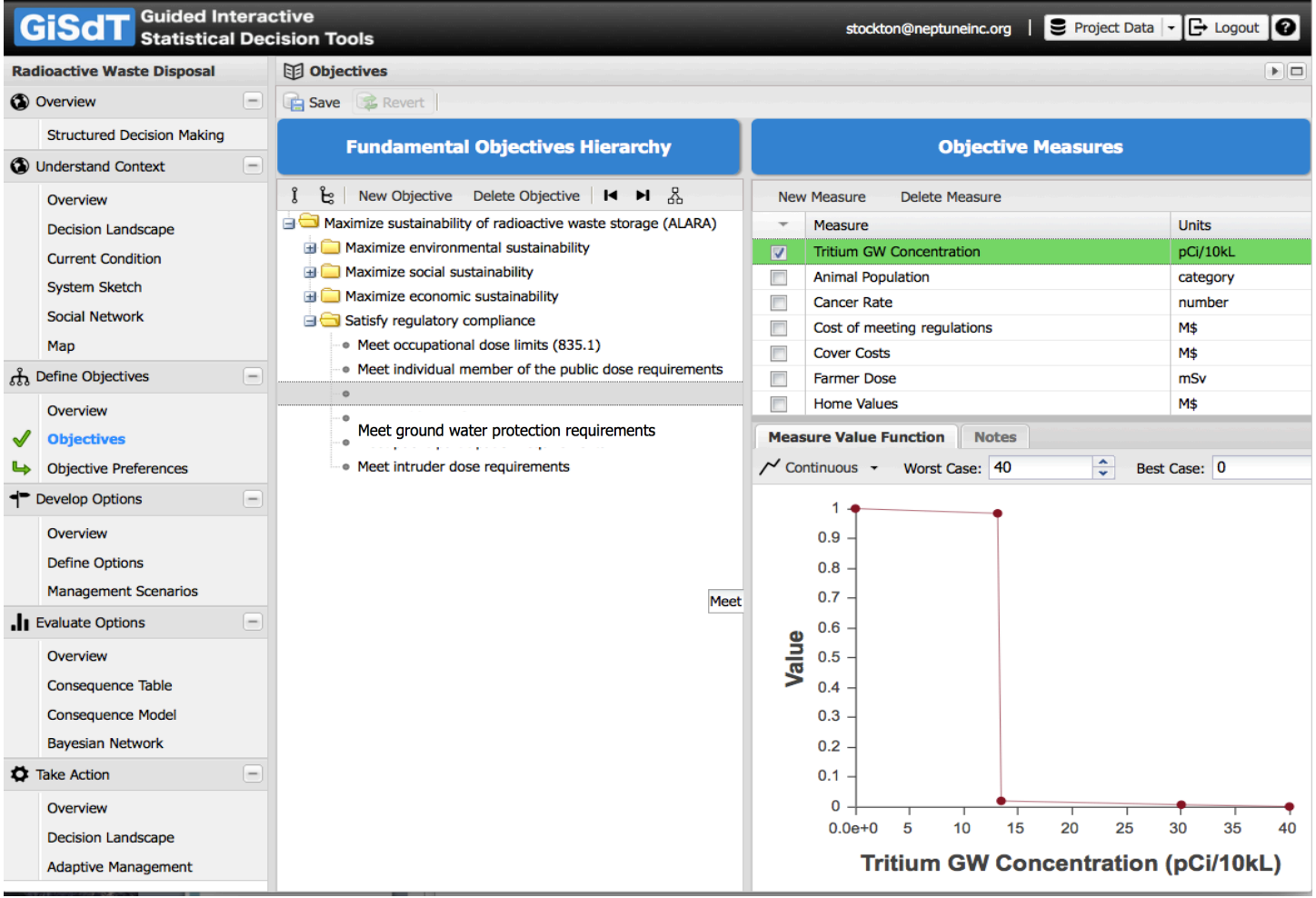
Uranium Mill Tailings
Quick Start
DecisionGraph
1 Context
Background
Map
2 Objectives
Brainstorm
Define Objectives
Preferences
3 Options
Define Options
Scenarios
4 Consequences
Consequence Table
Bayesian Network
Influence Diagram
5 Take Action
Adaptive Management
Parking Lot
Define Objectives
Brainstorm
Preferences
Save
Revert
Help
Objective Hierarchy
New Objective
Delete Objective
Import Objective
Export Objective
Maximize Uranium Mill Tailings Management Sustainability
Protect human health
Minimize health impacts on workers
Minimize health impacts on residents
Minimize health impacts on intruders
Minimize Cost
Minimize cleanup costs
Minimize containment / transport control costs
Minimize access control costs
Minimize fines
Maximize efficiency
Ensure financing
Objective Measure
Measures
New Measure
Delete Measure
Measure
Units
Cost of access controls
M dollars
Bank loan
Cost of cleanup
M dollars
Cost of containment
M dollars
Cost of regulatory fines
M dollars
Intruder Dose
mSv/yr
Resident Dose
mSv/yr
Measure Value Function
Measure Value Function
Notes
Continuous
Worst Case: 1
Best Case: 0
Value
Cost of access controls (M dollars)


Quick Start
DecisionGraph
1 Context
Background
Map
2 Objectives
Brainstorm
Define Objectives
Preferences
3 Options
Define Options
Scenarios
4 Consequences
Consequence Table
Bayesian Network
Influence Diagram
5 Take Action
Adaptive Management
Save
Revert
Help
Objective
Expand All
Collapse All
Reset Tables
Objectives
Weight
Ensure financing
0.32
Bank loan, worst case No, best case Yes
Minimize health impacts on residents
0.21
Resident Dose, worst case > 0.25, best case <0.01
Minimize health impacts on workers
0.14
Worker Dose, worst case > 100, best case < 0.01
Minimize cleanup costs
0.07
Cost of cleanup, worst case 100, best case 0
Minimize containment / transport control costs
0.07
Cost of containment, worst case 100, best case 0
Minimize access control costs
0.07
Cost of access controls, worst case 1, best case 0
Minimize health impacts on intruders
0.06


GiSdT
Guided Interactive
Statistical Decision Tools
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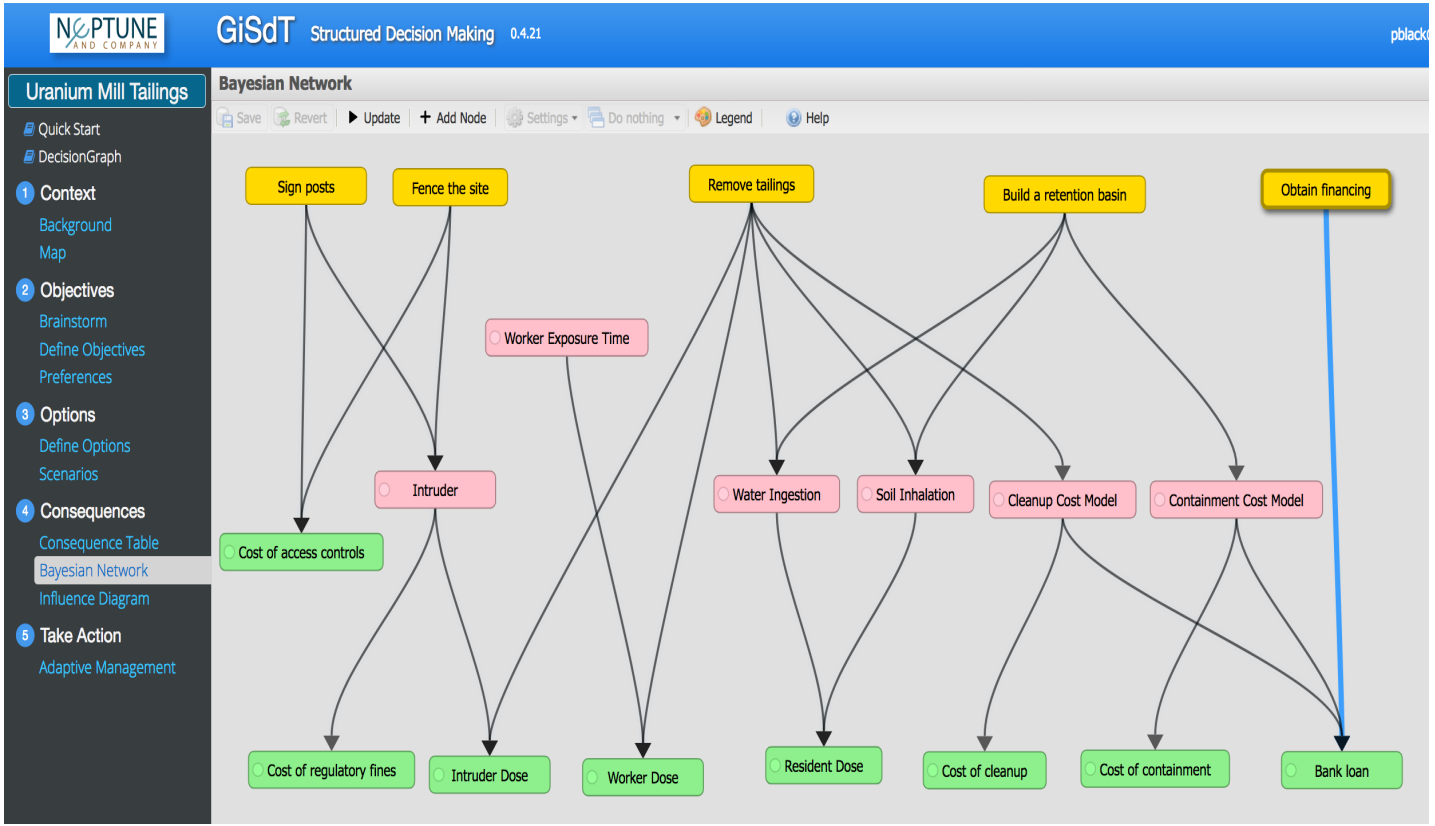
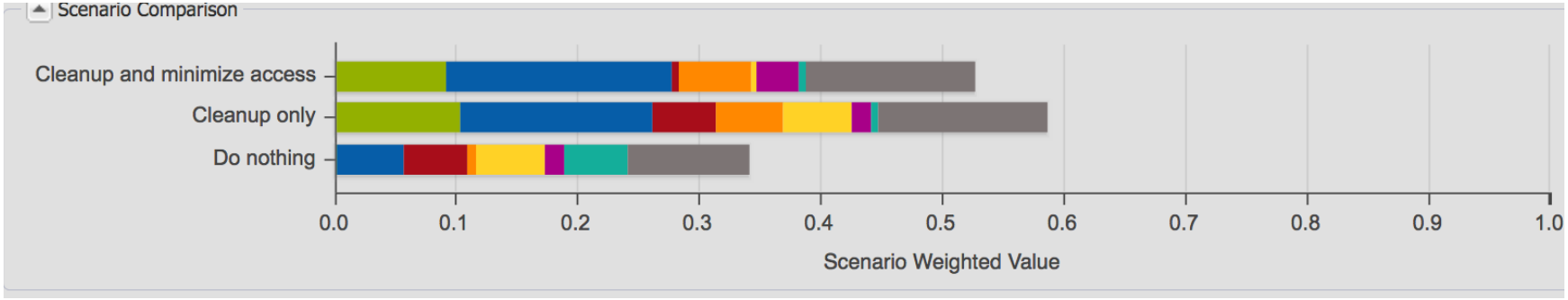
Project Data
Logout
Radioactive Waste Disposal
Overview
Structured Decision Making
Understand Context
Overview
Decision Landscape
Current Condition
System Sketch
Social Network
Map
Define Objectives
Overview
Objectives
Objective Preferences
Develop Options
Overview
Define Options
Management Scenarios
Evaluate Options
Overview
Consequence Table
Consequence Model
Bayesian Network
Take Action
Overview
Decision Landscape
Adaptive Management
Objectives
Save
Revert
Fundamental Objectives Hierarchy
New Objective
Delete Objective
Maximize sustainability of radioactive waste storage (ALARA)
Maximize environmental sustainability
Maximize social sustainability
Maximize economic sustainability
Satisfy regulatory compliance
Meet occupational dose limits (835.1)
Meet individual member of the public dose requirements
Meet ground water protection requirements
Meet intruder dose requirements
Meet
Objective Measures
New Measure
Delete Measure
Measure
Units
Tritium GW Concentration
pCi/10kL
Animal Population
category
Cancer Rate
number
Cost of meeting regulations
M$
Cover Costs
M$
Farmer Dose
mSv
Home Values
M$
Measure Value Function
Notes
Continuous
Worst Case:
40
Best Case:
0
Value
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.0e+0
5
10
15
20
25
30
35
40
Tritium GW Concentration (pCi/10kL)

Options ➔ Models ➔ Objectives



Initial Results



- Ensure financing
- Minimize health impacts on residents
- Minimize containment / transport control costs
- Minimize health impacts on intruders
- Minimize access control costs
- Minimize fines
- Minimize cleanup costs
- Minimize health impacts on workers