



PATH/AWARE: **Prioritization Analysis Tool for All-Hazards/ Analyzer for Wide Area Restoration Effectiveness**

**A Toolset for Prioritizing Critical Infrastructure and
Allocating Resources for Wide Area Restoration**

Presenter: Lynn Yang

Developers: Bob Knowlton Dave Franco
Mark Tucker Lynn Yang
Wayne Einfeld Karim Mahrous
Brad Melton Kim Grommes

Sandia National Laboratories

Following a wide-area incident, to develop a Recovery Strategy, decision-makers need:

- **Information/Situational Awareness**
- Structure (e.g., Incident Command System)
- **Process**
- Relationships

PATH/AWARE tool provides **information** and an **analysis-based process** for recovery planning.

Interagency Biological Restoration Demonstration (IBRD) for Wide-Area Biological Incident

IBRD project objectives:

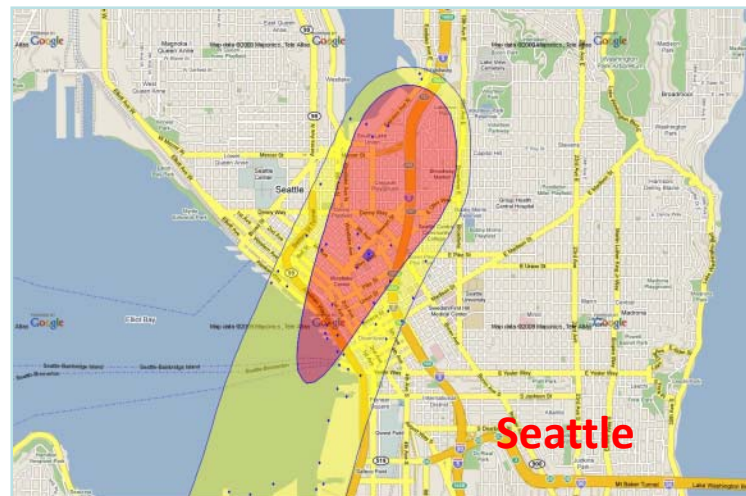
- Develop comprehensive guidance for restoration and recovery following a National Planning Scenario 2 attack, considering civilian/military cooperation
- Evaluate the technology gaps that exist today
- Develop technology, where appropriate, to fill these gaps, with an emphasis on saving time and money in the restoration process

IBRD Program Managers:

- **Chris Russell, DHS-S&T**
- **Ryan Madden, DoD-DTRA**

National Laboratory Participants:

- **Sandia National Laboratories**
- **Lawrence Livermore National Laboratory**
- **Pacific Northwest National Laboratory**
- **Los Alamos National Laboratory**



Project funded by:
Department of Homeland Security -
Science & Technology, and
Department of Defense –
Defense Threat Reduction Agency



As part of IBRD, Seattle OEM, Pierce County DEM, King County OEM have provided critical feedback and ideas in the development of PATH/AWARE.

In a wide area incident, development of an effective Restoration Strategy will be complex

Following a wide-area incident:

- Loss of functionality across many systems
- Limited restoration resources
- Lengthy restoration time, possibly years
- High visibility

Decision makers will want to know:

- Which assets and functions have been impacted?
- How long will the cleanup take? When will critical functions be restored?
- What are the dependencies? How will these be factored into the restoration strategy?
- How much money and resources can the federal government provide? Where do those resources get applied?
- If additional resources were available, could the restoration be done in less time? What are the chokepoints in the process?

Laboratory Analysis



Environmental Sampling



Decontamination

PATH/AWARE helps answer these questions

PATH/AWARE supports the development of a Restoration Strategy based off of prioritized Recovery Objectives

The toolset helps decision-makers:

- identify critical infrastructure in damage area;
- assess impacts on critical functions and services;
- assess and analyze critical infrastructure dependencies;
- develop an integrated, unified prioritization strategy;
- determine resource requirements for restoration operations;
- identify chokepoints in the process; and
- allocate and manage resources effectively

} Gain situational awareness

} Prioritize

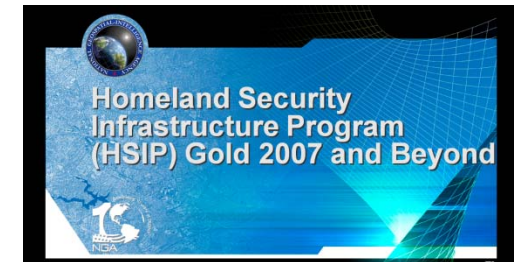
} Allocate resources

... during planning and operational phases.

PATH/AWARE utilizes multiple asset and facility datasets

- **King/Pierce County GIS (as a specific urban example...)**
 - Virtually all county-wide buildings and structures
 - Additional useful attributes (use description, assessed value, plot sizes, building footprints)
 - We have access to these databases -- similar access expected for other urban areas
- **DHS Homeland Security Infrastructure Program (HSIP)**
 - Geo-located critical assets and infrastructures
 - Gold and Freedom levels, restrictions on Gold level use
- **FEMA HAZUS-MH**
 - Residential and non-residential geo-located building inventories
 - Nationwide coverage
 - Transportation infrastructure is also included
- **Emporis**
 - US and Canadian cities
 - Major buildings (>5 floors) in database
 - Many key attributes (size, age, type of HVAC, use, floor space etc.)

KCGIS Center



Front end GIS provides situational awareness including regional service and asset status, properties, and dependencies

The screenshot displays a GIS application interface with a map of Seattle. The map shows various infrastructure assets represented by colored polygons and symbols. A legend window is open, showing infrastructure categories and building types. A list of assets is visible on the right side of the map, including water storage, wastewater treatment, and medical services. A detailed asset information window is open for 'Hospital 55851', showing its name, category, outdoor area, functionality, and priority values.

Legend

Infrastructure Categories: Building

- Depends upon the Selected Asset
- Enables the Selected Asset
- Selected Asset

Asset List

- [12] Water storage
- [52] Water treatment
- [53] Wastewater collection and transmission
- [54] Wastewater treatment
- [55] Wastewater storage and discharge
- [17] General Medical Care
- [19] Psychiatric and substance abuse care
- [4] Kidney dialysis
- [18] Surgical care
- [56] Extended care
- [15] Health practitioner
- [5] Medical and diagnostic laboratory services
- [6] Blood, organ and tissue services
- [2] Hospital 55851
- [57] Pharmacy services
- [14] End of life services
- [58] Hazardous chemical storage
- [59] Hazardous chemical transport
- [60] Hazardous chemical regulation and oversight

Asset: Hospital 55851

General Buildings Building Attributes Dependencies

Name: Hospital 55851

Category: Hospital

Outdoor Area: 100 m²

Functionality: 25 %

Restoration Milestone

Enable Milestone

Milestone Day: 21

Priority Values

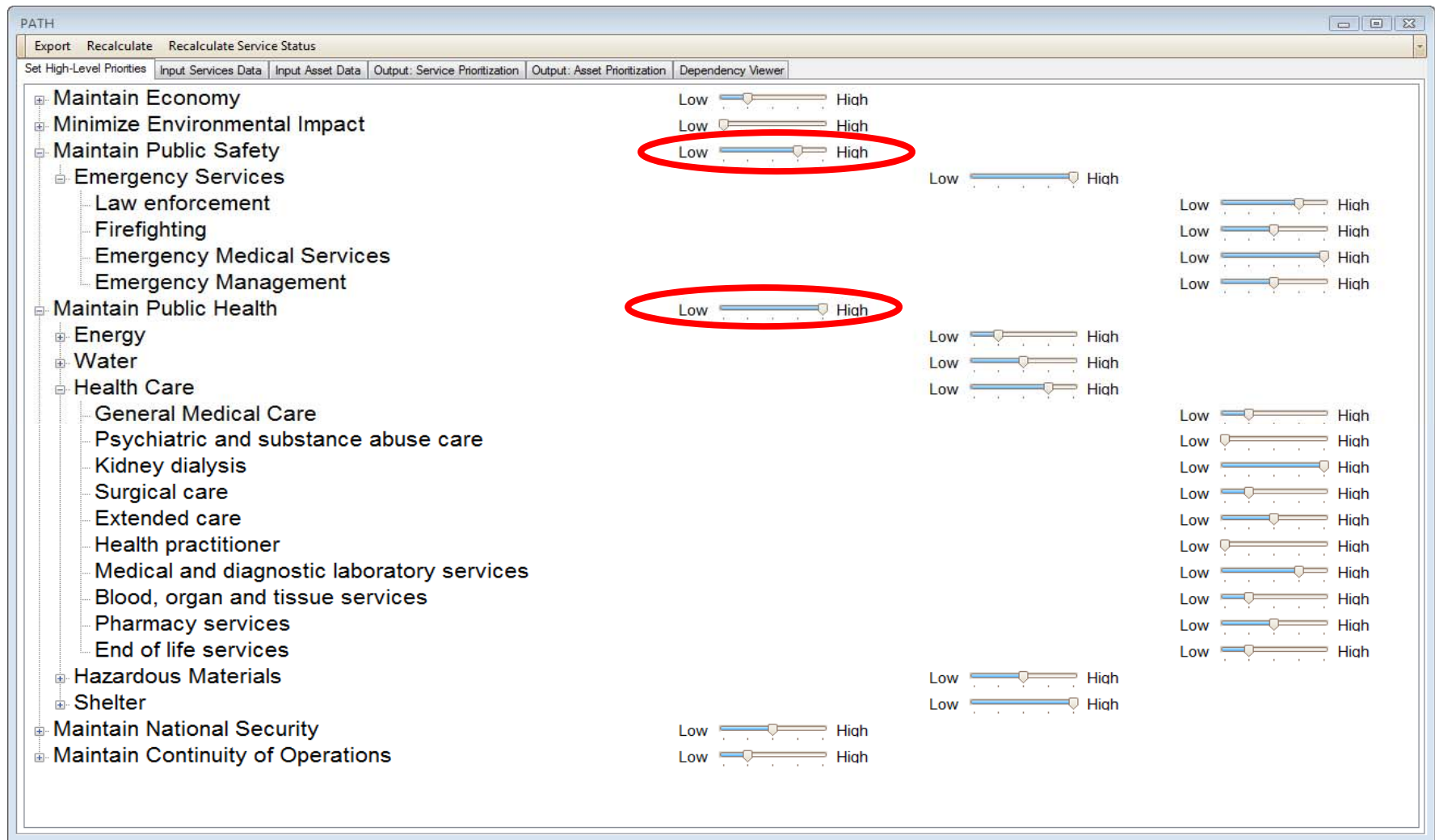
Overall Priority: 2

Asset Priority: 2 (Set in PATH)

Dependency: 0.143 (Set in PATH)

OK Cancel

User inputs weightings on recovery objectives, key functions, and services



Maintain Public Health and Public Safety are weighted high priority objectives. Within these objectives, Water and Health Care are weighted high priority functions.

PATH/AWARE outputs an objective, analysis-based prioritized list of services optimized to meet multiple objectives and account for functional complexities

PATH (Beta-Release -- Not for public distribution)

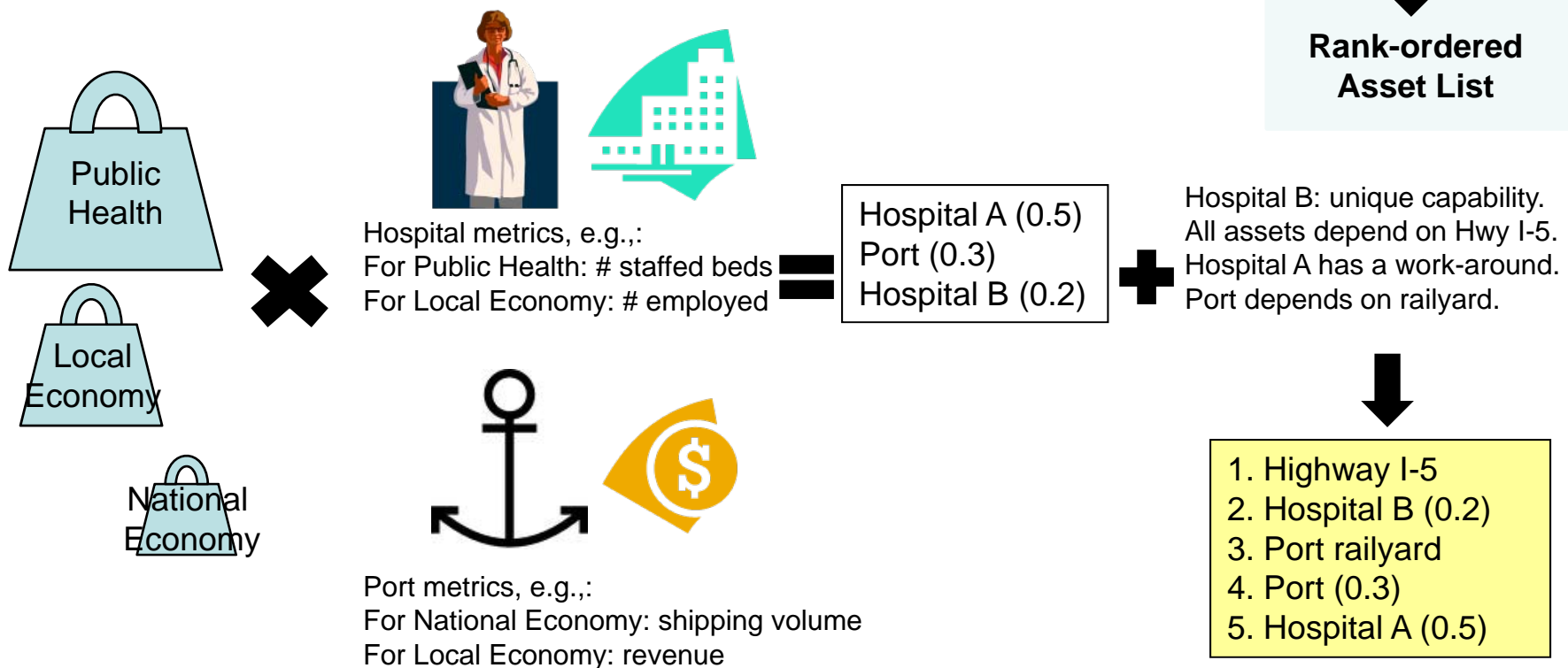
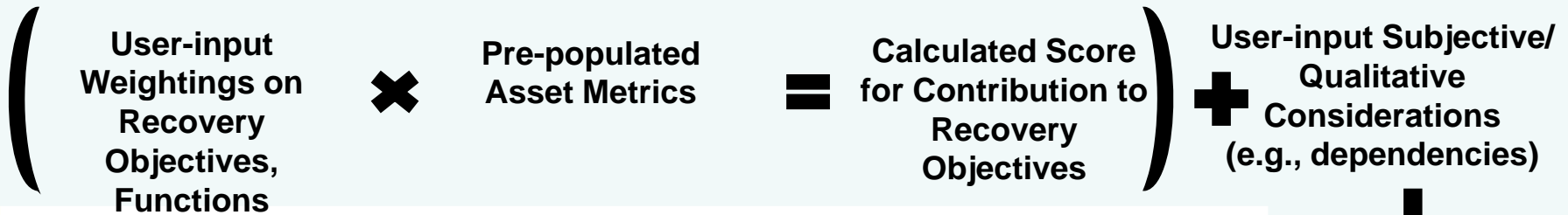
Export Recalculate

Set High-Level Priorities | Input Services Data | Input Asset Data | Output: Service Prioritization | Output: Asset Prioritization | Dependency Viewer

	Service Name	Function Name	Reason
1	Public road transport	Transportation	Enabling Service
2	Water treatment	Water	Enabling Service
3	General Medical Care	Health Care	Contribution To Priorities
4	Psychiatric and substance abuse care	Health Care	Contribution To Priorities
5	Medical and diagnostic laboratory services	Health Care	Contribution To Priorities
6	Kidney dialysis	Health	
7	Water storage	Water	
8	Water transmission	Water	
9	Fossil fuel electric power generation	Energy	
10	Retail services	Comm	
11	Wireless telecommunications	Teleco	
12	Air traffic control	Transp	
13	Firefighting	Emerg	
14	Higher education	Educat	
15	K-12	Educat	

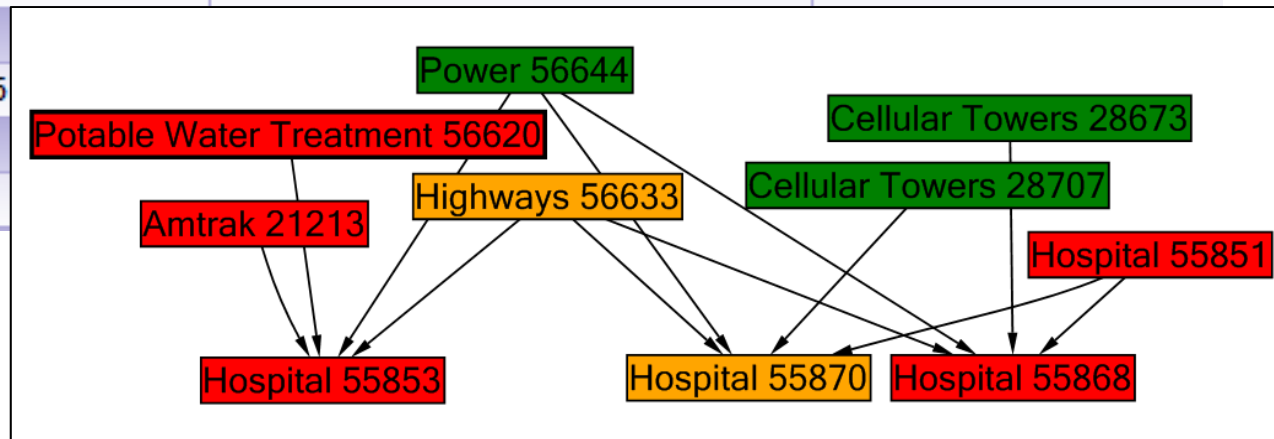
A logical, transparent priority service list provides a starting point for prioritization planning; dependencies analysis informs the prioritization output.

Prioritization algorithm generates a rank-ordered list of assets by applying user-weighted Recovery Objectives and Functions to asset metrics



Based on the previous algorithm, PATH/AWARE outputs an objective, analysis-based prioritized list of assets for operations and planning

Pri...	Asset Name	Infrastructure Category Name	Reason
+	1 Highways 56633	Highways	Enabling Asset
+	2 Hospital 55851	Hospital	Enabling Asset
+	3 Fire 55729	Fire	Enabling Asset
+	4 Public Health 55980	Public Health	Enabling Asset
+	5 Hospital 55870	Hospital	Contribution To Prio
+	6 Primary Care Clinic 116610	Primary Care Clinic	Enabling Asset
+	7 Highways 56635	Highways	Enabling Asset
+	8 Hospital 55852	Hospital	Enabling Asset
+	9 Hospital 55868	Hospital	Contribution To Prio
+	10 Amtrak 21213	Amtrak	Enabling Asset
+	11 Potable Water Treatment 56620	Potable Water Treatment	Enabling Asset
+	12 Hospital 55853		
+	13 Misc Care Facility 117716		
+	14 Transit Link 117194		
+	15 Commercial 56636		



The outputted priority asset list provides the operational detail (e.g., identifies assets needed to restore critical services)

For PATH/AWARE to calculate recovery timelines, the user enters remediation strategies (e.g., characterization and decontamination approaches), resource availability and throughput

The screenshot displays the PATH/AWARE software interface, which is used for calculating recovery timelines. The interface is divided into several sections:

- General:** Includes Scenario, Zones, and Building Infiltration.
- Resources:** Includes Sampling (highlighted), Lab, Screening, Outdoor, and Indoor.
- Characterization:** Includes Outdoor and Indoor.
- Decon:** Includes Outdoor, Thresholds, Indoor Surface Treatment, Indoor Fumigation, and Indoor Self.
- Clearance:** Includes Outdoor, Indoor Surface Treatment, and Indoor Fumigation.

The **Sampling** section is currently active, showing the following parameters:

- Team size: 3 persons per team
- Working day length: 8.0 hours
- Labor rate: 50.00 \$/hr per person
- Number of teams: 30 teams
- Sampling labor cost: 36,000 dollars per team
- Each team collects: 10 samples per team
- Total sampling rate: 2,400 samples per team
- Phase weighting: Characterization 70.0%

The **Outdoor** section is also visible, showing the following parameters:

- Judgmental sampling:
- Red Zone: Area: 24,001,984 sq meters; One sample per: 10,000 sq meters; 2,400 samples
- Yellow Zone: Area: 0 sq meters; One sample per: 1,000 sq meters; 0 samples
- Statistical sampling:
- 95% confidence that 95% of the area has been sampled will require 0 samples.

Decision-makers can vary parameters to reflect different scenarios (e.g., additional resources and alternate sampling strategies)

PATH/AWARE outputs restoration timelines for the prioritized assets and overall area, enabling decision makers to identify when critical services will be restored



Enables what-if analyses on prioritization and remediation strategies

PATH/AWARE automatically generates summary slides of the situation, assumptions, strategy and timelines

For Exercise Purposes Only

**PATH/AWARE
Summary Sheet**

IBRD Preparation Exercises
Day 1: 9/8/2009
Day 2: 9/9/2009

For Exercise Purposes Only

Situation: Map display of Northern Hot Zone and Contaminated CI Assets

Multi-jurisdictional prioritization team was assembled 15 days after the release and produced the prioritization strategy presented in this briefing.

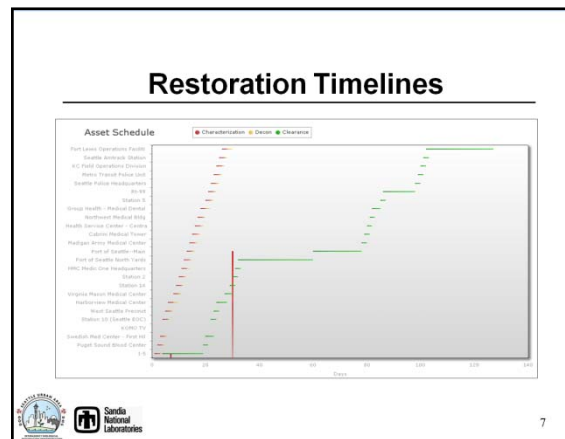
For Exercise Purposes Only

Day 1: Example Assumptions and Inputs to Prioritization Strategy

Recovery Objectives and Weightings		Functions with Temporary Workarounds
Objective	Weight	Function Name
Maintain Economy	2	Energy
Minimize Environmental Impact	2	Food/Water
Maintain Public Safety	5	Shelter
Maintain Public Health	5	Communications (civilian)
Maintain National Security	2	Military training
		Military mobilization
		Military deployment
		Waste-water

**Day 10 Prioritization Strategy for Restoration
(Top 15 assets)**

Priority	Asset	Justification	Restore Day
1	Interstate 66	High Objective Score	94
2	Washington Blvd	High Objective Score	30
3	Clarendon Blvd	High Objective Score	32
4	Fairfax Drive	High Objective Score	34
5	Rosslyn Metro Station	Enabling Asset	34
6	Water mains	Enabling Asset	35
7	Transformer-Wilson	High Objective Score	35
8	Highway 50	High Objective Score	37
9	Courthouse Complex	High Objective Score	107
10	State Hwy 237	High Objective Score	146
11	Wilson Blvd	High Objective Score	84
12	Glebe Road	High Objective Score	75
13	FDIC	High Objective Score	112
14	Ballston Common Mall	High Objective Score	139
15	Clarendon Metro Station	Enabling Asset	88



Summary slides can be used to quickly present decisions to Executives and Commanding Officers

PATH/AWARE Summary

- Provides INFORMATION and a PROCESS
- Replaces paper-based planning
- Enables recovery planners to use data that sectors already have
- Provides situational awareness data on local infrastructure to support long-term recovery decisions
- Gives a basis for more efficient response and recovery (e.g., reducing cost and time)
- Helps recovery planners respond to political pressure to restore everything quickly, by showing trade-offs and timelines for recovery
- Can lead to policy changes

A transition path for PATH/AWARE is being defined and will begin in 2011.