

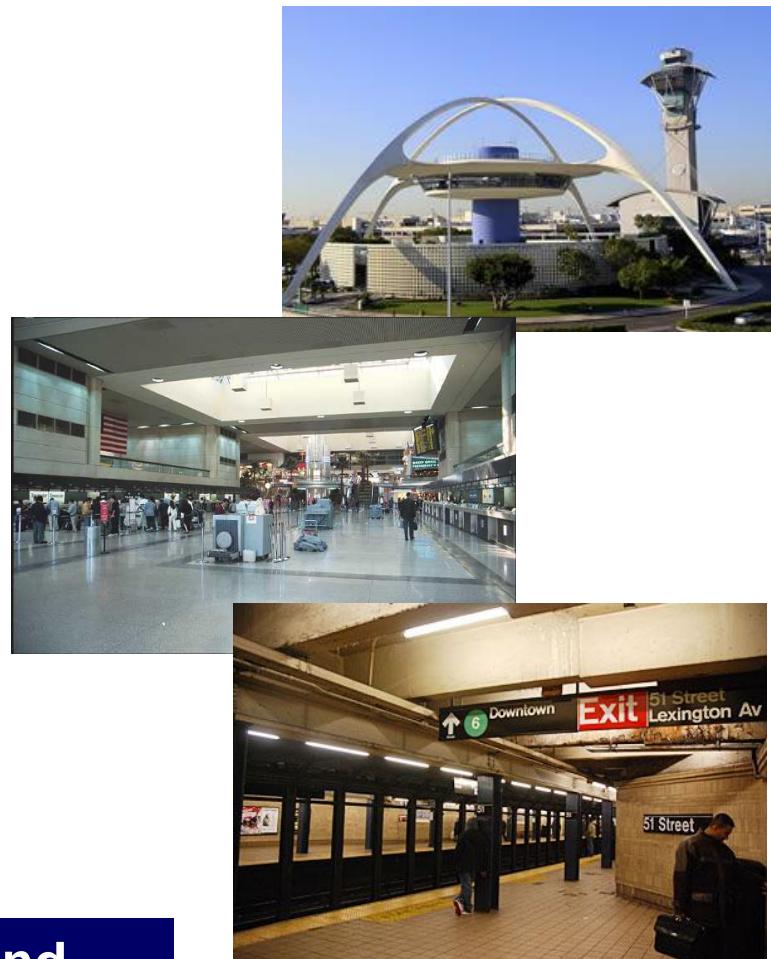


Simulation and Analysis of Facility Remediation: An Overview of the RESTORe Tool

Mark D. Tucker, Ph.D.
Donna M. Edwards, Ph.D.
Sandia National Laboratories
Phone: 505-844-7264
Email: mdtucke@sandia.gov

Presentation Outline

- Background
- Overview of the RESTORe Simulation Tool
- Case Study
- Summary



**RESTORe: Resource Estimation and
Scheduling Tool for Optimized Recover**

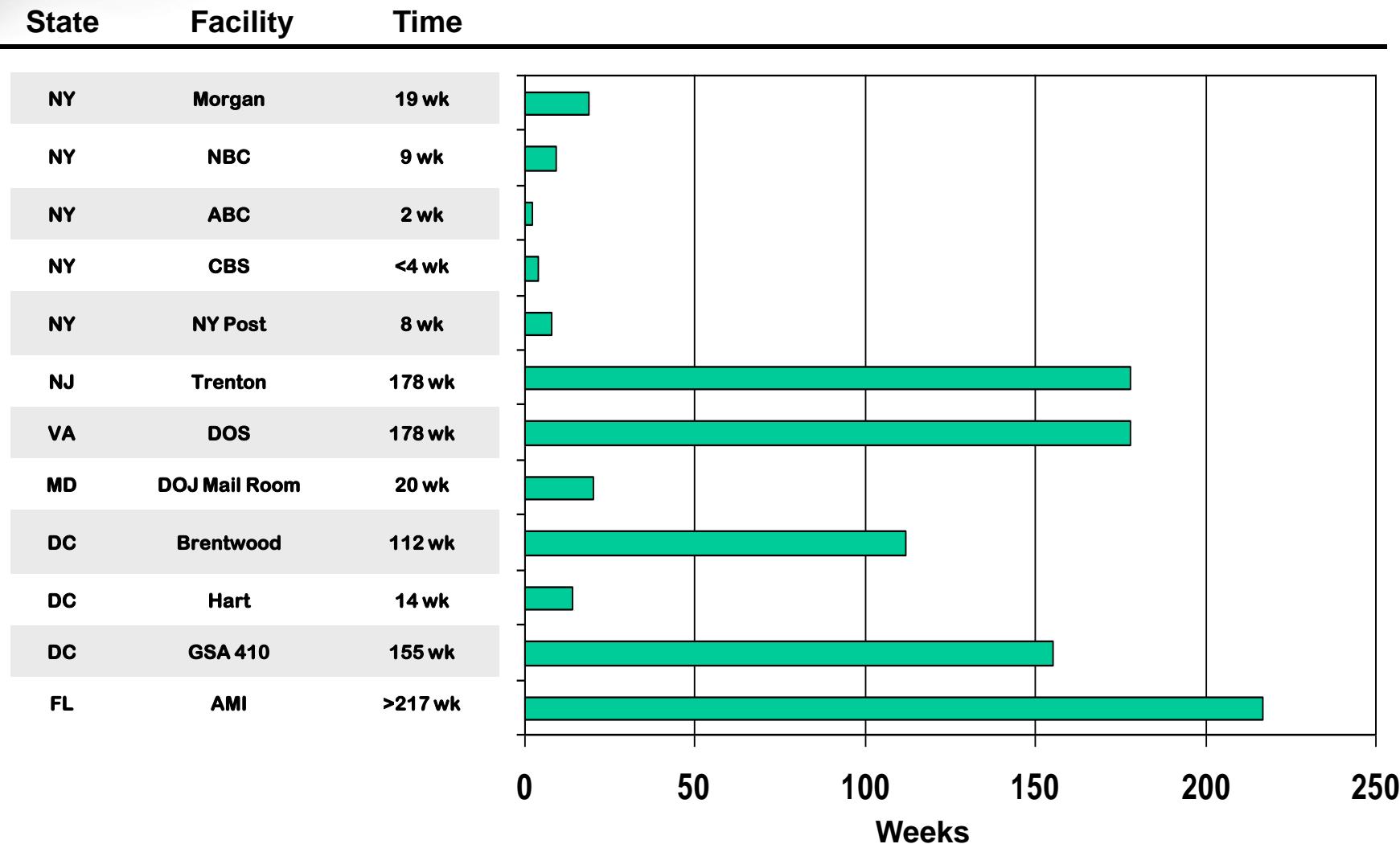
Remediation of a facility following a chemical or biological agent release will be a complex process

- Large open spaces and confined spaces
- Sensitive equipment essential for operations
- Many types of construction materials
- Wide range of decontamination and remediation challenges
- Remediation will include many complex activities
 - Sampling
 - Analysis
 - Decon (fumigation, surface removal, etc.)
 - Waste
 - Refurbishment
- Will involve the coordination and optimal use of many types of resources



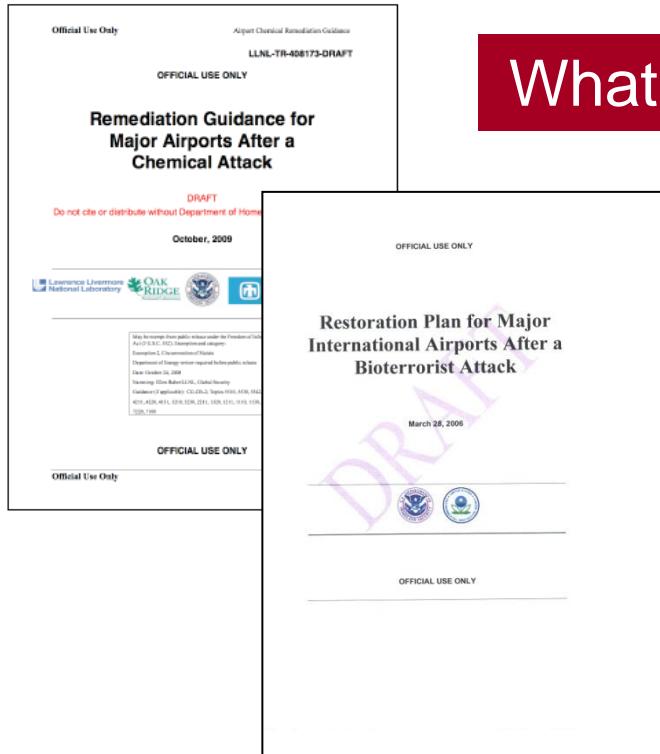
Effective planning for remediation will include both technical issues and more traditional project management issues

Previous recovery activities were very lengthy

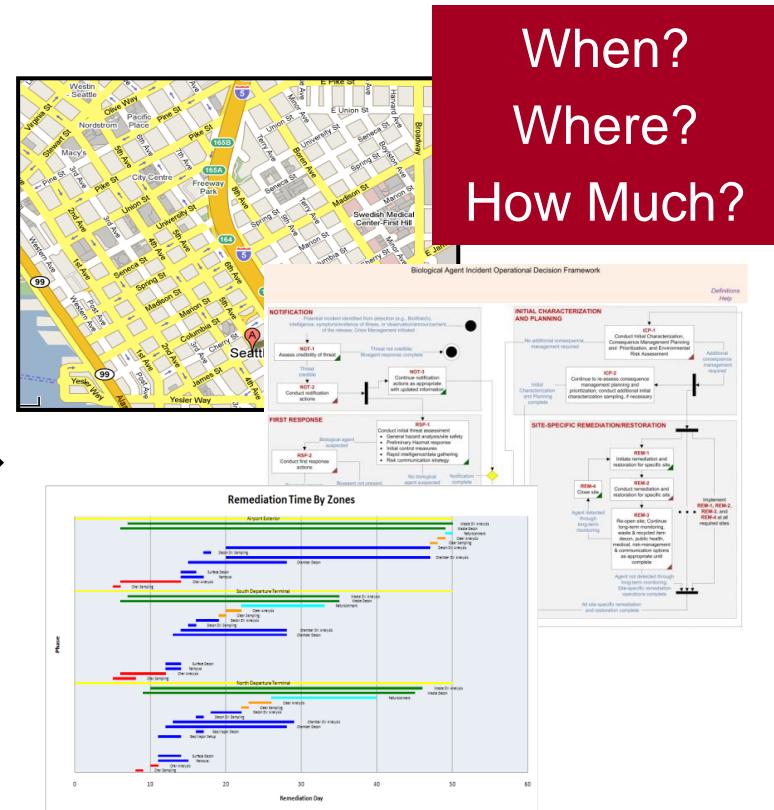


Recovery of facilities following the 2001 anthrax incidents

A method is needed to effectively plan for remediation events in facilities

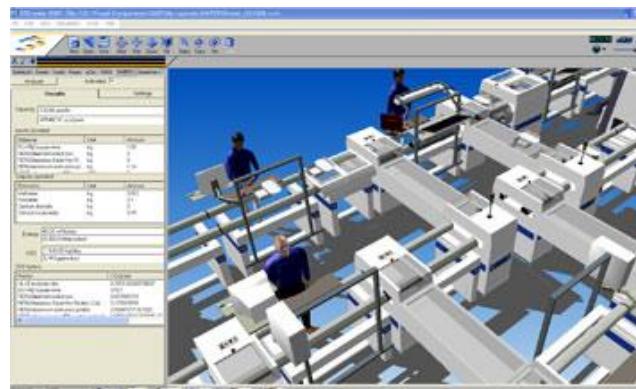


Guidance documents provide general information to plan remediation events

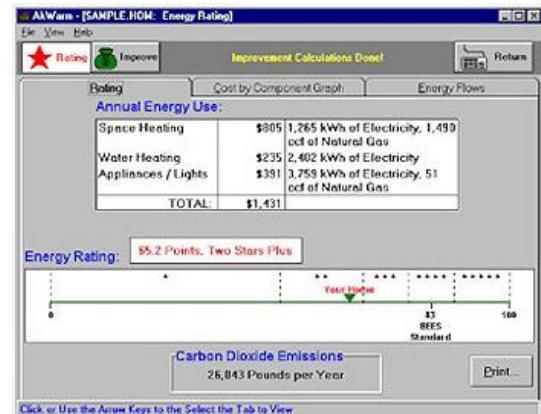


Decision support systems and/or simulation tools can be used for detailed planning for remediation events

Simulation tools are commonly used to better understand and make decisions about complex processes



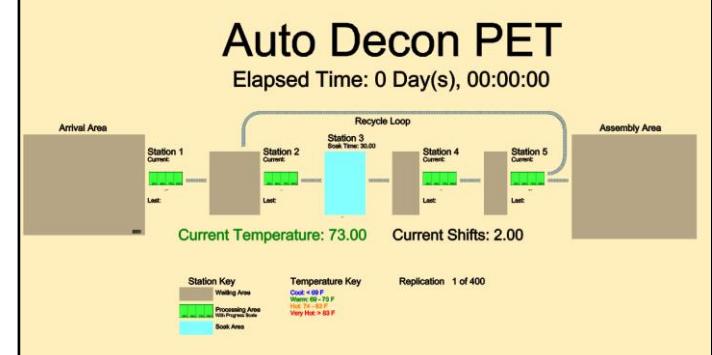
Manufacturing Process Simulation Tools
(NIST)



AKWARM – Building Energy Use (Alaska Housing Finance Corporation)

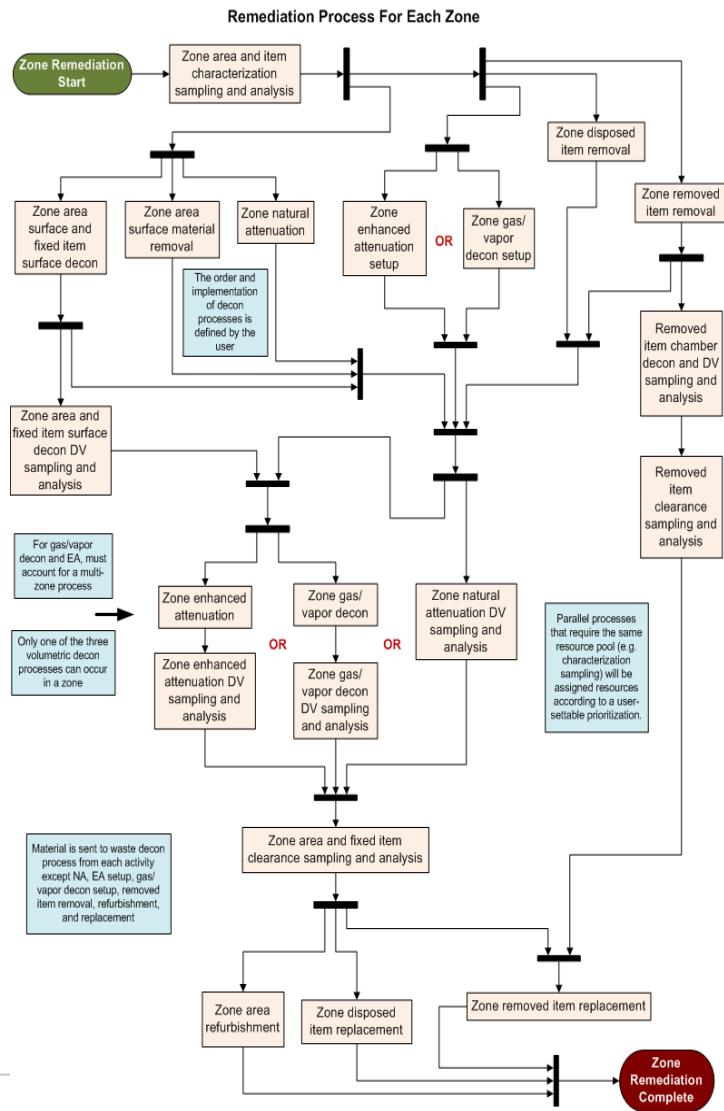


WaterAide – Evaluates water saving opportunities (Energy New England)



PET – Evaluates DoD vehicle decon processes (Sandia National Laboratories)

Facility remediation is also a complex process that can be planned with the assistance of a simulation tool



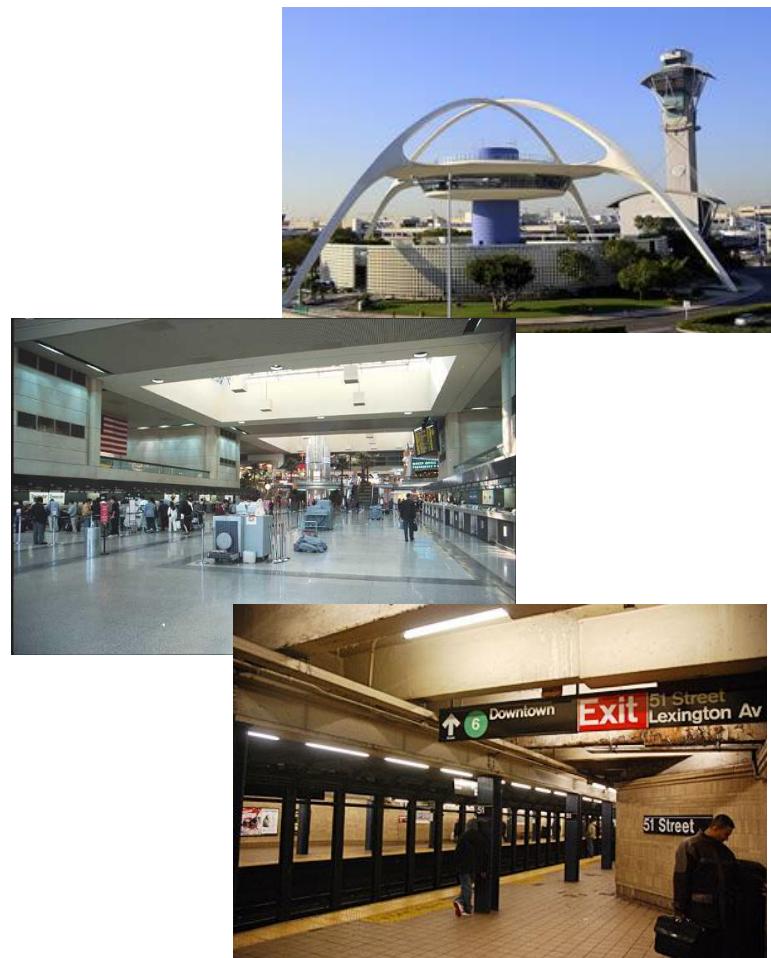
The complex remediation process logic is implemented in RESTORe

The remediation logic is flexible and can be changed (to some degree) by the user

RESTORe was developed as part of the DHS S&T-funded Chemical Restoration OTD project

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Features of the RESTORe Process Simulation Tool

■ Scenario Setup

- Define up to 36 indoor zones and 36 outdoor zones
- Define floor, wall, ceiling areas, zone volume, and number of items
- Addresses both chemical or biological remediation

■ Multiple Remediation Phases

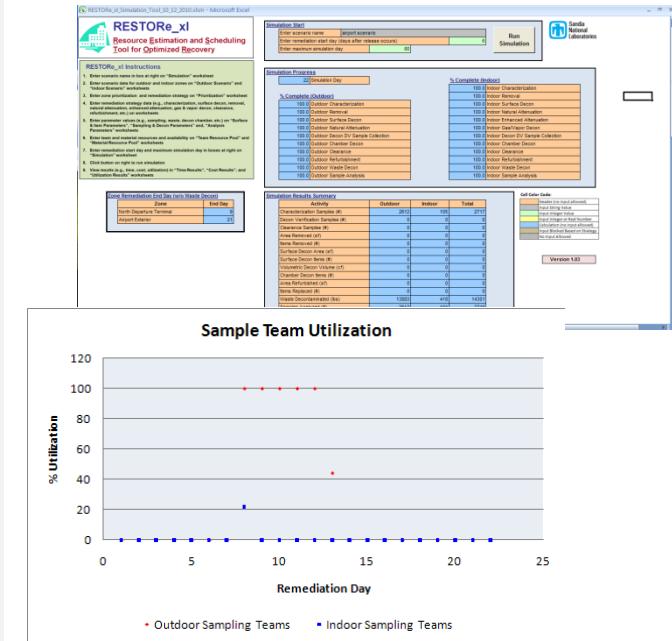
- Characterization
- Decontamination
- Clearance
- Refurbishment
- Waste Handling
- Laboratory Analysis

■ Dynamic Resource Allocation

- Users define availability of resources
- Resources are allocated based on user prioritization of zones and processes

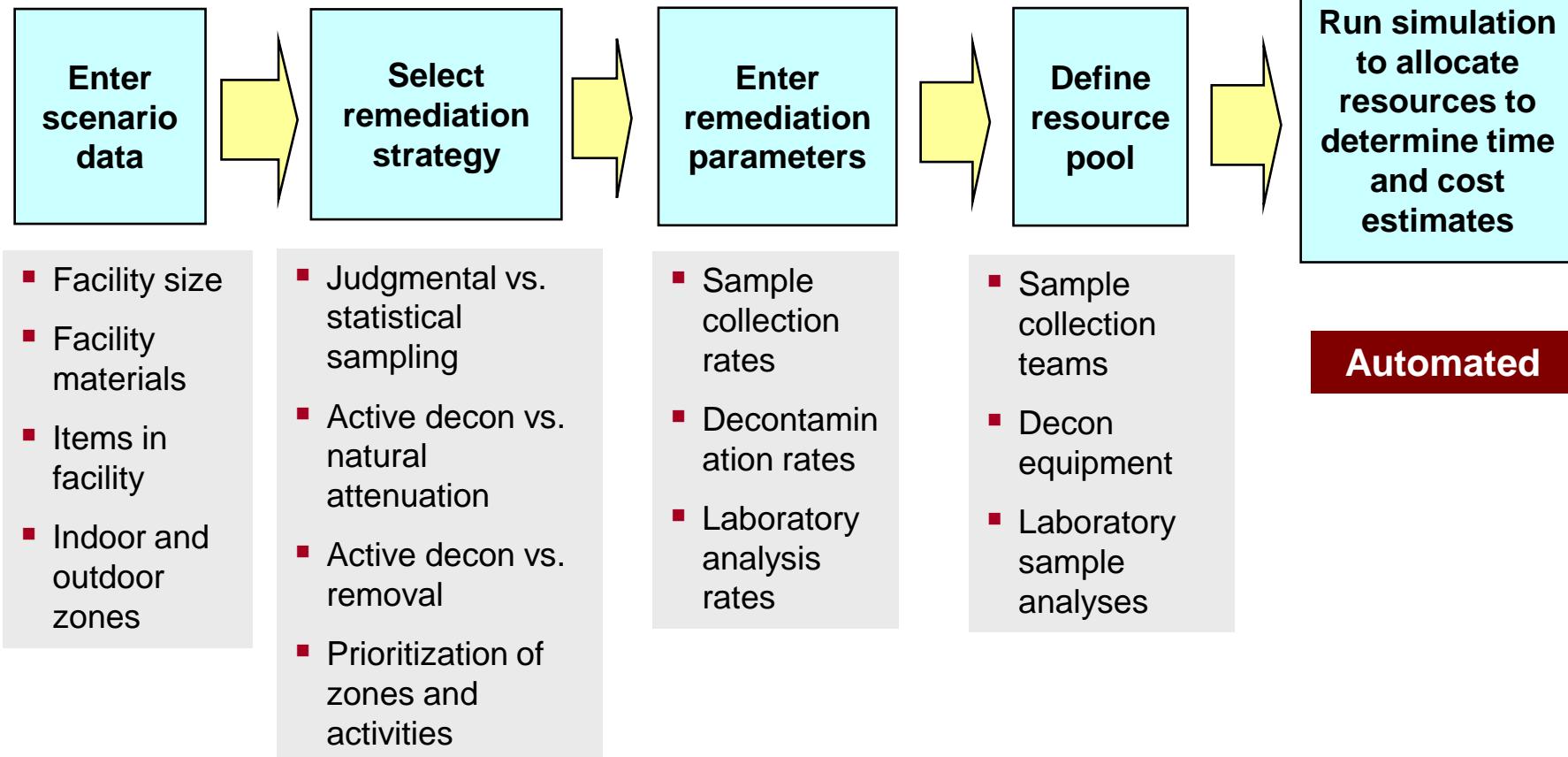
■ Software Overview

- Current version runs in Microsoft Excel 2007
- Process logic was developed using PowerSim™



The objective of RESTORe is to provide information to enable better decision making

Steps to run a RESTORe simulation and analysis



Vary resources, resource allocations, and remediation strategies and to analyze and optimize the recovery process

The first step is to enter scenario data

- Area and volume of the contaminated facility
- Surface coverings in the facility
 - For floors, walls, and ceilings (indoor)
 - Carpet
 - Tile
 - For ground, walls, and roofs (outdoor)
 - Soil
 - Asphalt
- Definition of zones
 - Up to 36 indoor and 36 outdoor zones can be defined



The second step is to define a remediation strategy

- Define remediation processes that will be used
 - Characterization/Clearance
 - Number of samples
 - Types of samples
 - Decontamination
 - Surface decon
 - Removal
 - Natural attenuation
 - Volumetric decon (e.g., gas/vapor)
 - Chamber decon
 - Refurbishment
 - Waste decon
 - Laboratory analysis
- Define the order of decon processes
 - e.g., removal before surface decon, etc.
- Define priority of zones



The next step is to enter remediation parameters

Sampling & Analysis

- Sampling rate (samples/hr/team) for surface, bulk, and real-time samples
- Cost of samples (\$/sample) for surface, bulk, and real-time samples
- Labor rate (\$/hr) for sampling team members
- Laboratory analysis rate (samples/hr) for each sample type

Decontamination

- Surface decon rate (sf/hr/team)
- Cost of decontaminant (\$/gal)
- Removal rate for each material (sf/hr/team)
- Agent decay rates for each material (%/hr)
- Chamber decon rate (lb/hr/chamber)

Refurbishment

- Refurbishment rate for each material (sf/hr/team)
- Labor rate (\$/hr) for refurbishment team members
- Replacement cost of each material (\$/sf)

Several hundred parameters are entered into RESTORe – the accuracy of the analysis depends on the accuracy of the parameters

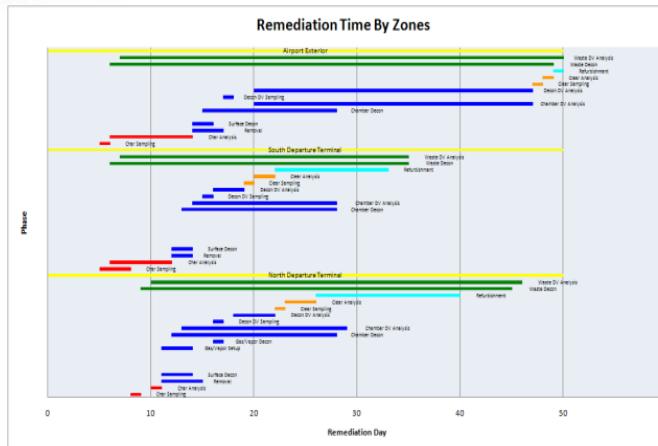
Then, a resource pool is established

- Sampling & Analysis
 - Indoor Sampling Teams
 - Outdoor Sampling Teams
 - Laboratory Analysis
- Decontamination
 - Surface Decon Teams
 - Removal Teams
 - Volumetric Decon Units
 - Decon Chambers
 - Waste Decon Units
- Refurbishment
 - Refurbishment Teams
- The amount and availability of the resources are defined by the user

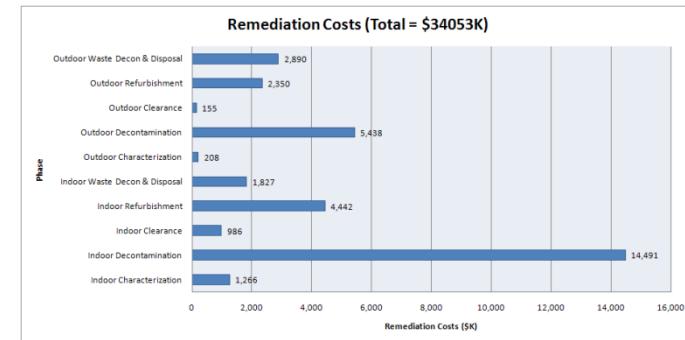


The resource pool includes both human and material resources

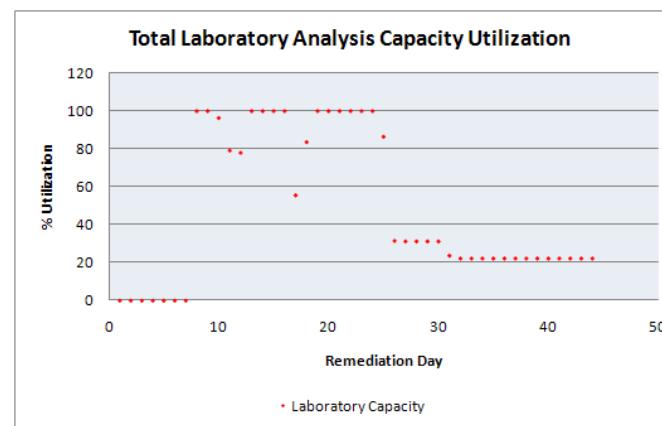
The final step is to run a remediation simulation and generate results



Remediation Timeline Plot



Cost Summary Plot



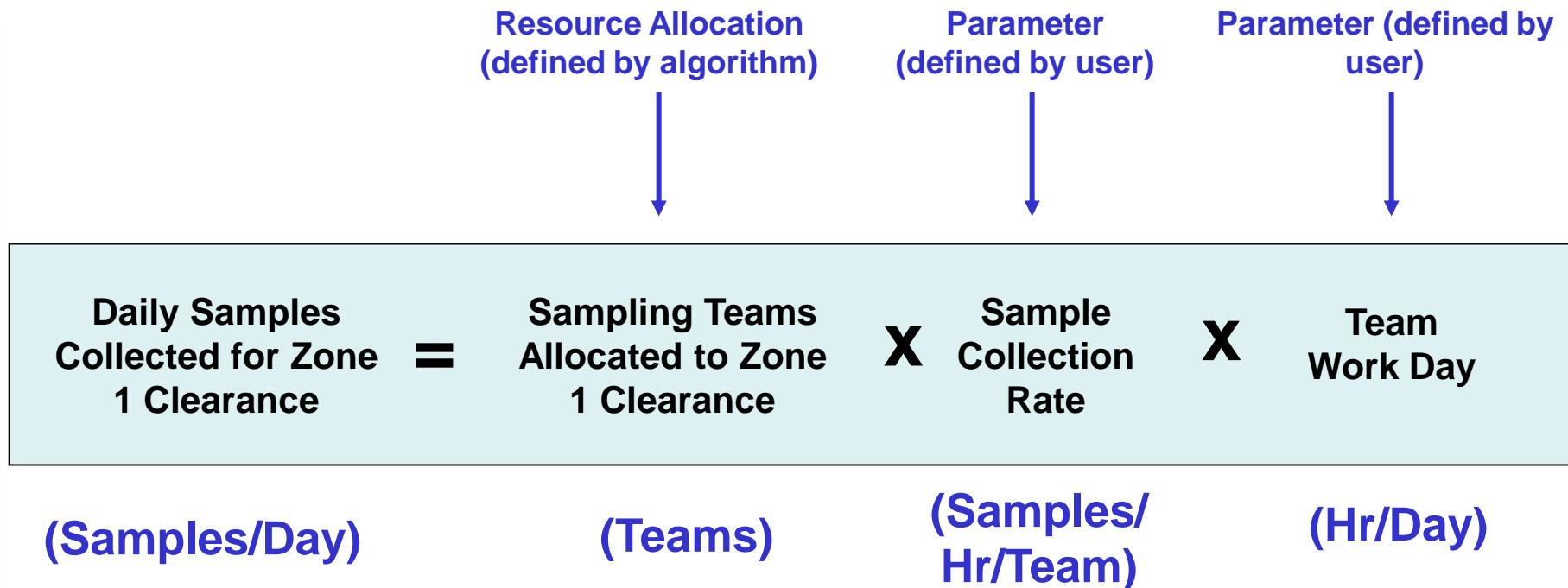
Resource Utilization Plots

Summary Table

Activity	Outdoor	Indoor	Total
Characterization Samples (#)	360	2159	2519
Decon Verification Samples (#)	4976	4878	9854
Clearance Samples (#)	260	1657	1917
Area Removed (sf)	325000	285150	610150
Items Removed (#)	650	4777	5427
Surface Decon Area (sf)	195000	114750	309750
Surface Decon Items (#)	239	1433	1672
Volumetric Decon Volume (cf)	0	2000000	2000000
Chamber Decon Items (#)	400	2388	2788
Area Refurbished (sf)	325000	285149	610149
Items Replaced (#)	650	4777	5427
Waste Decontaminated (lbs)	19535785	10767368	30303153

Summary Tables

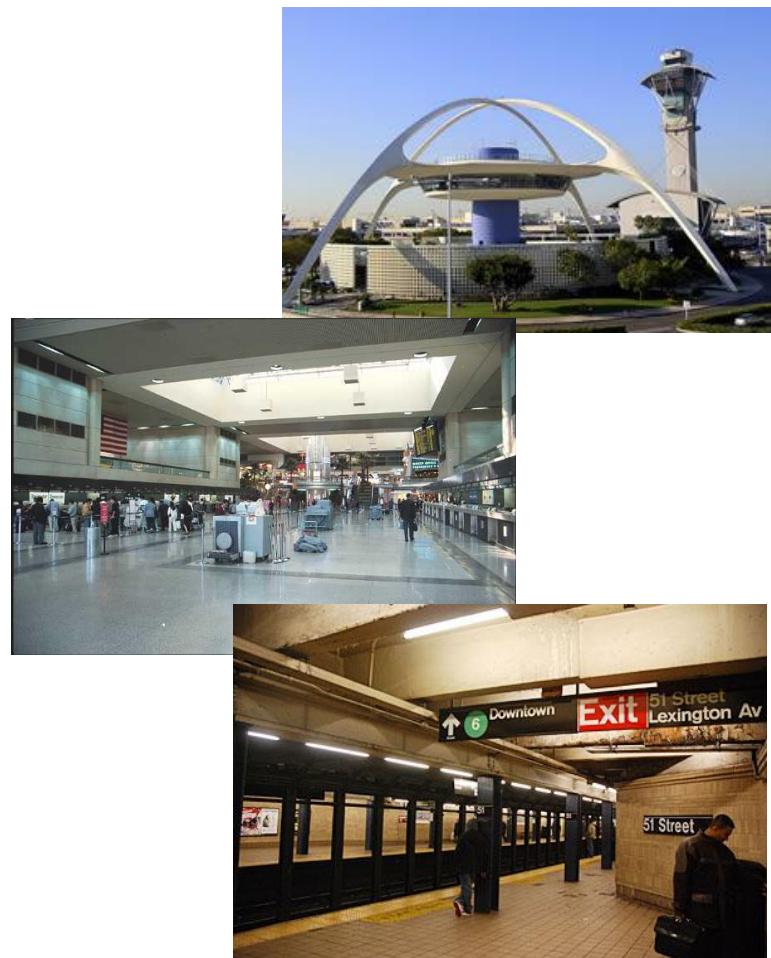
Example remediation calculation in RESTORE



RESTORe makes thousands of simultaneous and inter-related calculations

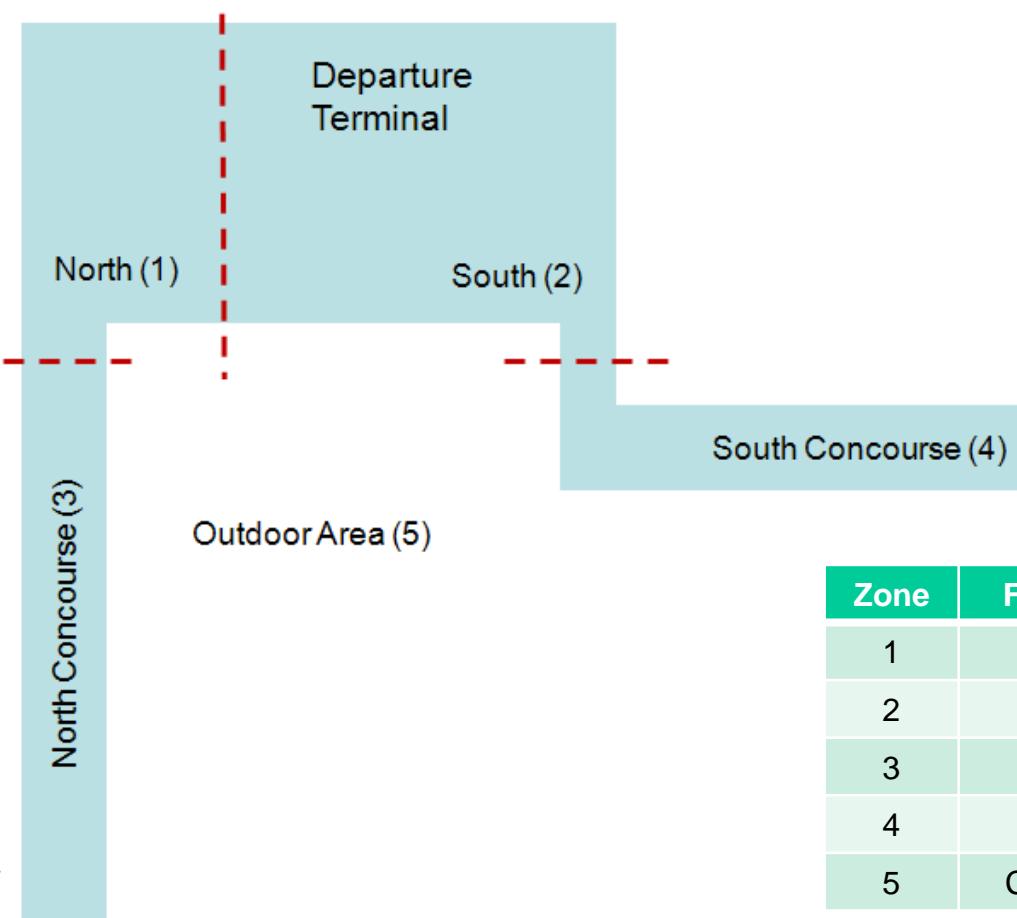
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Airport Scenario Demo (CWA Release)

- Zone 1 – North Departure Terminal
- Zone 2 – South Departure Terminal
- Zone 3 – North Concourse
- Zone 4 – South Concourse
- Zone 5 – Outdoor Area



Scenario involves a release of Sarin on the departure level

Strategy

- Re-open the concourses as rapidly as possible
- Sample for clearance only in South Concourse
- Priority of Zones
 - South Concourse (Priority 1)
 - North Concourse (Priority 1)
 - South Departure Terminal (Priority 2)
 - North Departure Terminal (Priority 2)
 - Outdoor (Priority 3)

Zone	Floor/Ground	Walls	Ceiling
1	Tile	Wallboard, Glass	Ceiling Tile
2	Tile	Wallboard, Glass	Ceiling Tile
3	Tile, Carpet	Wallboard, Glass	Ceiling Tile
4	Tile, Carpet	Wallboard, Glass	Ceiling Tile
5	Concrete, Soil	-	-

Baseline Remediation Strategy

Characterization

	Characterization Sampling (Area)		Characterization Sampling (Items)
	Surface Samples	Bulk Samples	
Zone 1	24	8	138
Zone 2	982	327	221
Zone 3	345	115	120
Zone 4	0	0	0
Outdoor	100	400	160

Clearance

	Clearance Sampling (Area)		Clearance Sampling (Items)	
	Surface Samples	Bulk Samples	Fixed Items	Removed Items
Zone 1	487	162	140	70
Zone 2	196	65	219	113
Zone 3	69	23	122	61
Zone 4	435	145	0	0
Outdoor	65	195	80	40

Decon/Refurbishment

	Decontamination					Refurbishment	
	Surface Decon (Bleach)	Gas Decon (ClO ₂)	Removal of "Difficult to Decon" Surfaces	Removal of Items for Chamber Decon (VHP®)	Removal of Items for Disposal	Replace Surfaces	Replace Items
Zone 1	✓	✓	✓	✓	✓	✓	✓
Zone 2	✓	✓	✓	✓	✓	✓	✓
Zone 3	✓		✓	✓	✓	✓	✓
Zone 4					✓		✓
Outdoor	✓		✓	✓	✓	✓	✓

Lab capacity: 1500 samples per week (GC/MS)

Alternative Remediation Strategy

Decision: Should the US EPA's mobile laboratory (PHILIS) be deployed?

Capability Insertion



PHILIS

Additional lab capacity: 700 samples per week (GC/MS)

Comparison of the baseline and alternative remediation strategies

	Baseline		Alternative (PHILIS)		Difference (Days)
	Start Day of Remediation	End Day of Remediation	Start Day of Remediation	End Day of Remediation	
Zone 1	6	97	6	64	-33
Zone 2	6	97	6	64	-33
Zone 3	5	29	5	20	-9
Zone 4	5	21	5	16	-5
Outdoor	5	99	5	66	-33
Overall	5	99	5	66	-33

Using the alternative strategy, the concourses could be re-opened nine days earlier (~38% timeline reduction) while the entire terminal/area could be re-opened thirty three days earlier (~33% timeline reduction)

Other strategies can also be evaluated using RESTORe including technology insertions (e.g., real-time sampling & and analysis) and resource insertions (e.g., more sampling teams)

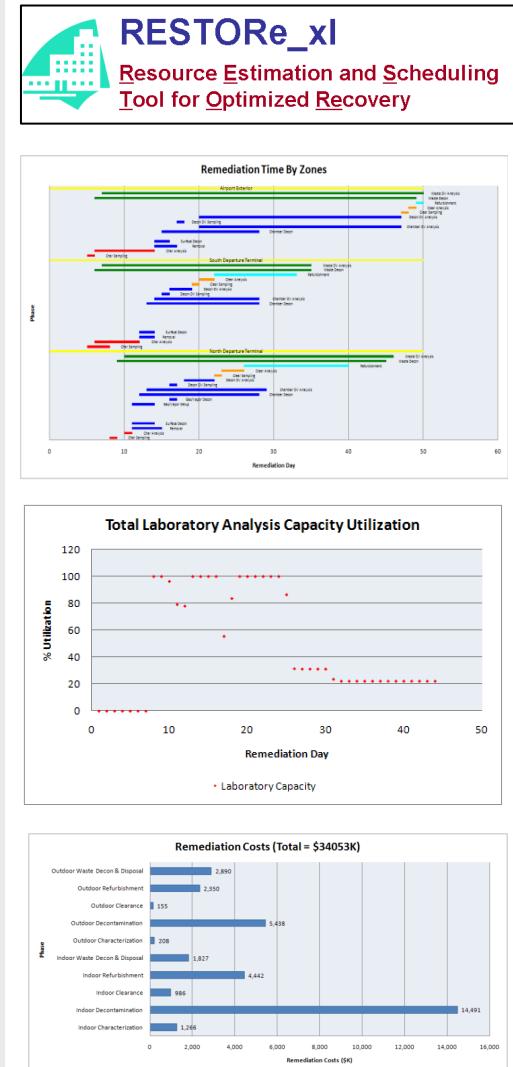
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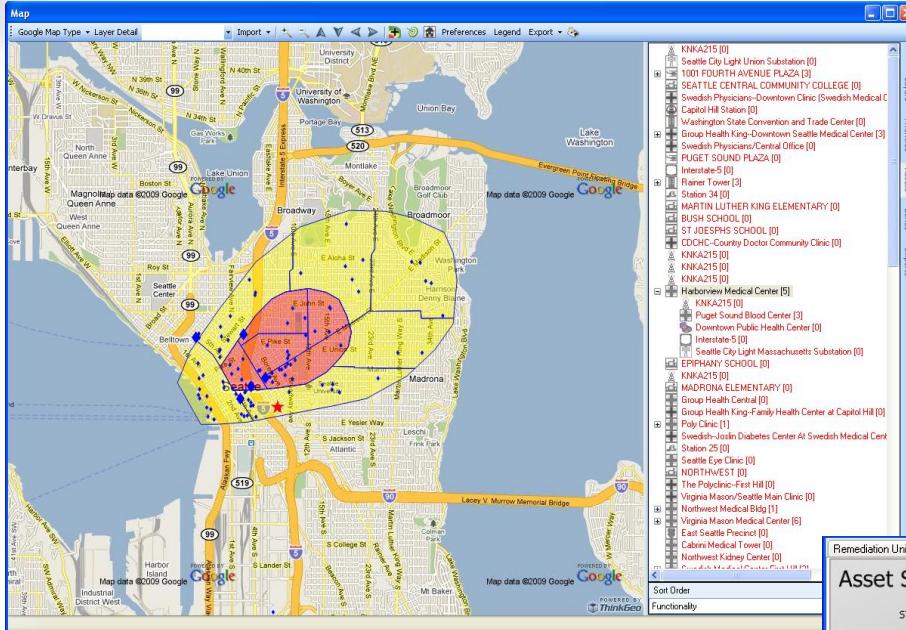


Summary

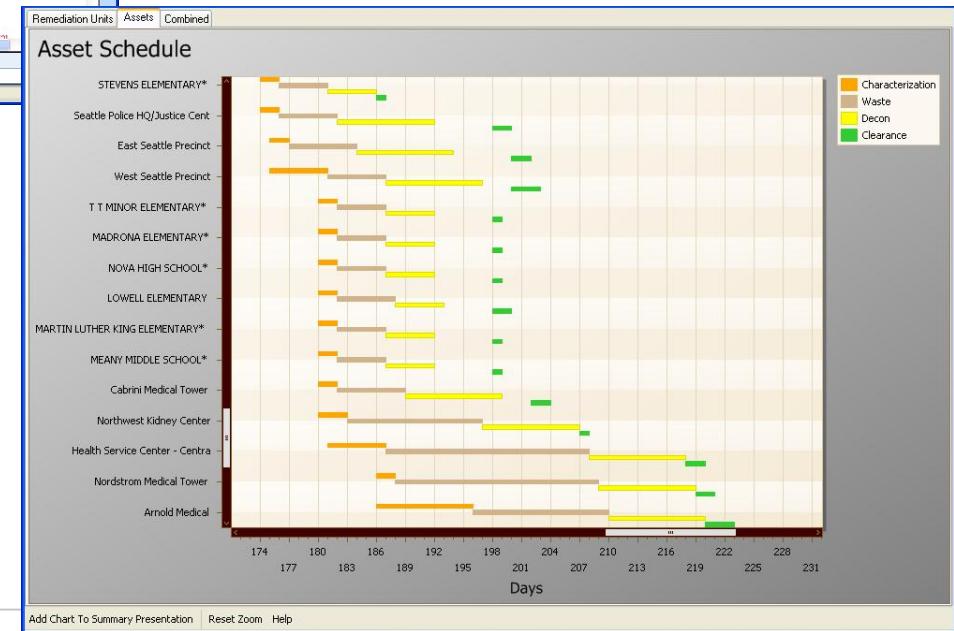
- RESTORe enables detailed analyses of facility remediation
 - Time and cost estimates
 - Resource requirements
 - Analyses of alternative strategies
 - Identification of technology and capability gaps
- RESTORe was developed as part of the DHS S&T Chemical Restoration OTD project
 - Focused on remediation following the release of a chemical warfare agent or toxic industrial chemical
- RESTORe logic has been expanded to include analyses for biological remediation events
 - Potentially applicable to other recovery events (e.g., rad)
 - Addition of optimization algorithms is planned
- Current version runs in Microsoft Excel 2007
 - Excel worksheets are used as the user interface
 - Simulation code runs in the background
 - An enhanced user interface is being developed for a full coded version



What if the release involves many buildings?



The PATH/AWARE tools can be used to estimate remediation timelines and cost for wide area releases



PATH/AWARE was developed for biological agent releases but is being expanded to handle chem/rad releases