Decontamination Strategy and Technology Selection Tool (DeconST)

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Donna Edwards, Tim Sa, Stephen Mueller,
Paula Krauter (retired), Julie Fruetel,
Lynn Yang, Mark Tucker
Sandia National Laboratories

Shawn Ryan, Paul Lemieux,
Leroy Mickelsen, Mario Ierardi
U.S. Environmental Protection Agency

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.

Sandia National Laboratories

Motivation: Decontamination of a complex facility requires many considerations

- **Potential decontamination methods**
  - environmental conditions
  - application requirements
  - site-specific inputs
- **Cleaning and removal of potentially contaminated items or material**
  - off-site treatment
  - source reduction
  - waste management

…**all with associated costs and benefits**

Problem is exacerbated in wide-area incident with potentially hundreds to thousands of contaminated facilities and limited availability of resources.

DeconST: a Decision-Support Tool for Single-Facility Remediation

RESULTS SUMMARY	Decontamination Technologies					
	Volumetric Decontamination			Surface Decontamination		
	Chlorine Dioxide Gas	Methyl Bromide	Vaporous Hydrogen Peroxide®	Aqueous Chlorine Dioxide	Bleach Immersion	Hydrogen Peroxide PAA, Oxonia Active
% of Materials Decontaminated	90%	90%	10%	0%	90%	100%
Total Cost, $M	$5.6	$5.0	$5.6	$8.3	$8.3	$8.2
Material Removal/Replacement Time (person hours)	66,500	53,500	71,200	86,900	86,700	84,000
Total Waste Generated (tons)	300	200	300	400	400	400
least desirable: :most desirable						

Source: WARRP Decontamination Strategy and Technology Selection Tool: User Manual and Report

DeconST: a Decision-Support Tool for Single-Facility Remediation

- **Features**
  - Facility-specific, effective remediation approaches
  - Comparison of decontamination technologies for the facility
  - Flexible, data-rich framework

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least desirable: :most desirable						

- **Intended User**
  - Technical Working Group (TWG) functioning under a Unified Command (UC) providing recommendations to the Incident Commander (IC)

Source: WARRP Decontamination Strategy and Technology Selection Tool: User Manual and Report

Tool Overview

DECONTAMINATION SELECTION TOOL©

Chemical Agent | **Biological Agent** | Radiological Agent

Facility Name: *Medium Office*

Facility Information (* = required inputs, to be set first)

Type	Walled Office	*
Size (qualitative)	Medium	*
Floor Area (ft^2)	80,000	
Volume (ft^3)	800,000	
Ceiling Height (feet)	10	
User Input Area (sqft)	80,000	
Number of Occupants	291	

HVAC Information

System Type	Ducted
Duct Lining	Lined
Accessibility/Complexity	Less-Accessible

Agent Information

Agent Type	Bacillus anthracis

Weather Considerations

	Relative Humidity (%)
Humidity Profile	
HIGH:	50
LOW:	20

	Temperature (°F)
Temperature Profile	
HIGH:	85
LOW:	50

Cost-Scaling Factors

Labor & Materials Scaling Factor	1 (cost multiplier)
Waste-Handling Difficulty	low

Enter new Decontamination Technology | Enter new Facility Material | Generate Report

NOTES:

RESULTS SUMMARY

least desirable:

Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties.

Note: Rounding of numbers can cause totals to not equal the sum of the component parts.

Volumetric Decontamination

HVAC is decontaminated as part of volumetric decontamination

	Chlorine Dioxide Gas (3000 ppmv, 3 hrs, >70% RH, >75 deg F)	Methyl Bromide (…degees C, 75% RH, 18 hour contact time)	Vaporous Hydrogen Peroxide® (225 ppmv, 4 hrs)	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide (3000 ppm, 1 hr contact time, 3 spray applications)
% of Exterior Structural Materials Decontaminated	**0%**	**0%**	**0%**	**0%**	**0%**
% decontaminated and reusable	0%	0%	0%	0%	0%
% decontaminated and destroyed (treated waste)	0%	0%	0%	0%	0%
% of Interior Materials Decontaminated	**90%**	**90%**	**10%**	**0%**	**0%**
% decontaminated and reusable	80%	90%	10%	0%	0%
% decontaminated and destroyed (treated waste)	10%	0%	0%	0%	0%
% of Contents Decontaminated	**50%**	**50%**	**50%**	**40%**	**40%**
% decontaminated and reusable	40%	50%	50%	40%	40%
% decontaminated and destroyed (treated waste)	20%	0%	0%	0%	0%
Total Cost, $M	**$5.6**	**$5.0**	**$5.6**	**$8.2**	**$8.3**
Decon Process Cost, $M	**$3.0**	**$3.3**	**$2.8**	**$4.5**	**$4.5**
Waste Management Cost, $M	**$2.0**	**$1.1**	**$2.2**	**$3.1**	**$3.2**
Material Removal/Replacement Time	**66,500**	**53,500**	**71,200**	**86,900**	**86,900**
Removal Time (person hours)	45,200	33,000	33,900	48,800	48,800
Replacement Time (person hours)	21,300	20,500	37,300	38,100	38,100
Total Waste Generated (tons)	**300**	**200**	**300**	**400**	**400**
Removed for Waste Treatment & Disposal *(Materials & contents removed as waste prior to decontamination)*	200	200	200	200	200
Treated Waste *(Materials & contents decontaminated, but damaged by technology)*	100	0	0	0	0
Potentially Contaminated Waste *(Materials & contents for which decontamination technology fails)*	0	0	200	300	300

User Input: Facility Information

DECONTAMINATION SELECTION TOOL©

Chemical Agent | **Biological Agent** | Radiological Agent

Facility Name: *Medium Office*

Facility Information	* = required inputs, to be set first
Type	Walled Office *
Size (qualitative)	Medium *
Floor Area (ft^2)	80,000
Volume (ft^3)	800,000
Ceiling Height (feet)	10
User Input Area (sqft)	80,000
Number of Occupants	291

HVAC Information	
System Type	Ducted
Duct Lining	Lined
Accessibility/Complexity	Less-Accessible

Agent Information	
Agent Type	Bacillus anthracis

Weather Considerations

Humidity Profile	Relative Humidity (%)
HIGH:	50
LOW:	20

Temperature Profile	Temperature (°F)
HIGH:	85
LOW:	50

Cost-Scaling Factors

Labor & Materials Scaling Factor	1 (cost multiplier)
Waste-Handling Difficulty	low

Enter new Decontamination Technology | Enter new Facility Material | Generate Report

NOTES:

User Instructions

Input Facility Information
- Enter a Name for the facility.
- [REQUIRED INPUTS, TO BE SET FIRST]: Select the facility type and qualitative size in order to populate default quantities of urban materials.
- Update facility parameters, if desired. Note that tool will prompt to confirm new parameters or revert to default.

Input HVAC Information
- Select HVAC system type -- ducted or unducted.
- For ducted systems, select whether ducts are lined or unlined and a description of the accessibility of the system for cleaning, considering location and lengths of ducts.

Input Agent Information
- Select the agent type (*B. anthracis*).

Input Weather Considerations
- Input the high and low relative humidity and outdoor temperatures.

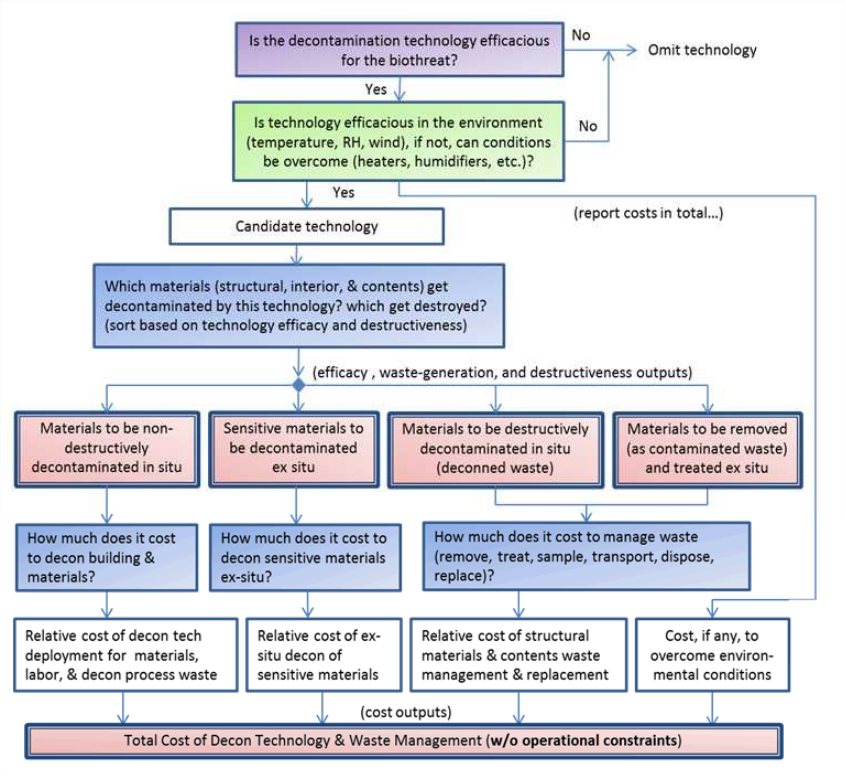
Input Cost-Scaling Factors
- Adjust urban-area premium.
- Select the waste-handling difficulty.

(optional) Add New Decontamination Technology
- Push button to Enter new Decontamination Technology.
- Enter new technology's efficacy and destructiveness on each facility material.
- Enter cost of new technology.
- Push button to add new technology to input, calculations, and results worksheets and charts.

(optional) Add New Facility Material
- Push button to Enter new Facility Material.
- Enter efficacy and destructiveness of each decontamination technology on each facility material; push continue button.
- Enter removal and replacement information; push continue button.
- Enter thickness and density information. Enter quantity of material in this facility. Check boxes to include material in calculations.

Next Steps
- Switch to Materials Inputs worksheet to adjust quantities of and determine actions on materials and to input costs for high-value items decon and contents replacement.
- Switch to Sampling Inputs worksheet to adjust sampling densities.
- Switch to Results worsheets and charts to view results.
- Push Generate Report button to print input and output worksheets and charts.

Tool Logic Diagram:



*Note: The EPA's BOTE experiment is the source for the concept of "waste handling difficulty."

User Input: Materials & Sampling Information

* MATERIALS INPUTS

Facility Materials
(default values populated from I-WASTE Tool)

	Percent	Quantity* Tons	Quantity* Yards³	MATERIAL ACTION: Keep in Place Untreated	Remove for Alternate Decon (e.g., high-value item)	Remove for Waste Treatment & Disposal	Treat in Place (with facility decon technology)	EXCLUDE: Exclude Potentially Contaminated and/or Damaged Material from Waste Stream	per Item COSTS (optional inputs): High-Value Items Cost to Remove, Decon, & Replace, in $	Cost & Labor to Replace, $ (contents that are potentially contaminated or damaged)
Exterior Structural Materials		4,153.6	1,504.5							
Brick		371.9	228.3	●	○	○	○			
Concrete		2,901.4	840.4	●	○	○	○			
Steel		322.4	93.4	●	○	○	○			
Wood		464.9	285.4	●	○	○	○			
Other		93.0	57.1	●	○	○	○			
Interior/Non-Structural Materials	to Defaults									
Total Non-Structural Building Materials										
Floors		25.0	182.3							
Carpet	90%	19.1	166.3	○	○	○	●			
Marble and Ceramic Tiles	0%			○	○	○	●			
Wood Flooring	0%			○	○	○	●			
Other Floor Materials	10%	6.0	16.0	○	○	○	●			
Walls		120.0	345.6							
Curtains and Acoustical Material	0%			○	○	○	●			
Drywall	100%	120.0	345.6	○	○	○	●			
Wood	0%			○	○	○	●			
Other Wall Materials	0%			○	○	○	●			
Ceilings		28.6	309.5							
Ceiling Tiles	100%	28.6	309.5	○	○	○	●			
Other Ceiling Materials	0%			○	○	○	●			
Other Non-Structural Building Materials		23.4	387.5	○	○	○	●			
Art and Music Equipment				○	○	○	●			
Bathroom and Kitchen Materials				○	○	○	●			
Dishware				○	○	○	●			
Electronic Equipment		29.3	223.9	○	●	○	○			
Food				○	○	○	●			
Furniture		202.8	2,110.4							
Porous	30%	60.8	633.1	○	○	○	●			
Non-Porous	70%	142.0	1,477.3	○	○	○	●			
Gym and Sports Equipment				○	○	○	●			
Linens				○	○	○	●			
Medical Supplies				○	○	○	●			
Medical Waste				○	○	○	●			
Paper and Office Supplies		164.4	504.6	○	○	●	○			
Personal Effects				○	○	○	●			
Pharmaceuticals				○	○	○	●			
Other Items and Equipment				○	○	○	●			

SAMPLING REQUIREMENTS

for Decontamination

Sample Densities by Decontamination Technology

		Process Phase: Characterization	Decontamination Verification	Clearance	
Volumetric Decontamination					
Chlorine Dioxide Gas	1 sample per	500	500	50	ft^2
Methyl Bromide	1 sample per	500	500	50	ft^2
Vaporous Hydrogen Peroxide®	1 sample per	500	500	50	ft^2
Surface Decontamination					
Chlorine Dioxide Liquid	1 sample per	500	500	50	ft^2
Aqueous Chlorine Dioxide	1 sample per	500	500	50	ft^2
Bleach Immersion	1 sample per	500	500	50	ft^2
Bleach Spray	1 sample per	500	500	50	ft^2
Bleach Wash	1 sample per	500	500	50	ft^2
Hydrogen Peroxide PAA, Oxonia Active	1 sample per	500	500	50	ft^2
Hydrogen Peroxide PAA, Minncare	1 sample per	500	500	50	ft^2
Hydrogen Peroxide PAA, Spor-klenz RTU	1 sample per	500	500	50	ft^2
Hydrogen Peroxide PAA, Peridox RTU	1 sample per	500	500	50	ft^2

Sample Densities for Structural and Interior Materials and Contents removed as Waste during Decontamination

Type of Waste			
Solid	1 sample per	2000	pounds
Liquid	1 sample per	55	gallons

for Demolition Processes

Sample Densities for Characterization before Demolition

Demolition			
w/ rebuilding	1 sample per	500	ft^2
w/o rebuilding	1 sample per	500	ft^2

Sample Densities for Structural and Interior Materials and Contents Demolished

for Solid Waste	1 sample per	330	pounds

*Facility-specific materials types and quantities are derived from Hazus and I-WASTE tools.

Results Summary

RESULTS SUMMARY	least desirable: :most desirable						
	Volumetric Decontamination			Surface Decontamination			
	HVAC is decontaminated as part of volumetric decontamination			HVAC will be very difficult to access and decontamin			
Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties.	**Chlorine Dioxide Gas** 3000 ppmv, 3 hrs, >70% RH, >75 deg F	**Methyl Bromide** 211 mg/l, 37 degees C, 75% RH, 18 hour contact time	**Vaporous Hydrogen Peroxide®** 225 ppmv, 4 hrs	**Chlorine Dioxide Liquid**	**Aqueous Chlorine Dioxide** 3000 ppm, 1 hr contact time, 3 spray applications	**Bleach Immersion** Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Immersion 30-min. STS neutralized then extracted	**Bleach Spray** Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Spray 60-min contact. STS neutralized at end of contact time.
Note: Rounding of numbers can cause totals to not equal the sum of the component parts.							
% of Exterior Structural Materials Decontaminated	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
% decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%
% decontaminated and destroyed (treated waste)	0%	0%	0%	0%	0%	0%	0%
% of Interior Materials Decontaminated	**90%**	**90%**	**10%**	**0%**	**0%**	**90%**	**90%**
% decontaminated and reusable	80%	90%	10%	0%	0%	0%	0%
% decontaminated and destroyed (treated waste)	10%	0%	0%	0%	0%	90%	90%
% of Contents Decontaminated	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**
% decontaminated and reusable	40%	50%	50%	40%	40%	40%	40%
% decontaminated and destroyed (treated waste)	20%	0%	0%	0%	0%	0%	0%
Total Cost, $M	**$5.6**	**$5.0**	**$5.6**	**$8.2**	**$8.3**	**$8.3**	**$8.3**
Decon Process Cost, $M	**$3.0**	**$3.3**	**$2.8**	**$4.5**	**$4.5**	**$4.5**	**$4.5**
Waste Management Cost, $M	**$2.0**	**$1.1**	**$2.2**	**$3.1**	**$3.2**	**$3.2**	**$3.2**
Material Removal/Replacement Time	**66,500**	**53,500**	**71,200**	**86,900**	**86,900**	**86,700**	**86,700**
Removal Time (person hours)	45,200	33,000	33,900	48,800	48,800	48,700	48,700
Replacement Time (person hours)	21,300	20,500	37,300	38,100	38,100	38,100	38,100
Total Waste Generated (tons)	**300**	**200**	**300**	**400**	**400**	**400**	**400**
Removed for Waste Treatment & Disposal *(Materials & contents removed as waste prior to decontamination)*	200	200	200	200	200	200	200
Treated Waste *(Materials & contents decontaminated, but damaged by technology)*	100	0	0	0	0	200	200
Potentially Contaminated Waste *(Materials & contents for which decontamination technology fails)*	0	0	200	300	300	100	100

Results Summary

RESULTS SUMMARY	least desirable:						:most desirable
	Volumetric Decontamination			Surface Decontamination			
	HVAC is decontaminated as part of volumetric decontamination			HVAC will be very difficult to access and decontamin			
Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties.	Chlorine Dioxide Gas	Methyl Bromide	Vaporous Hydrogen Peroxide®	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide	Bleach Immersion	Bleach Spray
Note: Rounding of numbers can cause totals to not equal the sum of the component parts.						...e to 0.6% NaOCl by ...etic acid to pH (6.8). ...n 30-min. STS ...d then extracted	Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Spray 60-min contact. STS neutralized at end of contact time.
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% decontaminated and reusable						0%	0%
% decontaminated and destroyed (treated v						0%	0%
% of Interior Materials Decontaminated						**90%**	**90%**
% decontaminated and reusable						0%	0%
% decontaminated and destroyed (treated v						90%	90%
% of Contents Decontaminated						**40%**	**40%**
% decontaminated and reusable						40%	40%
% decontaminated and destroyed (treated v						0%	0%
Total Cost, $M						**$8.3**	**$8.3**
Decon Process Cost, $M	$3.0	$3.3	$2.8	$4.5	$4.5	$4.5	$4.5
Waste Management Cost, $M	$2.0	$1.1	$2.2	$3.1	$3.2	$3.2	$3.2
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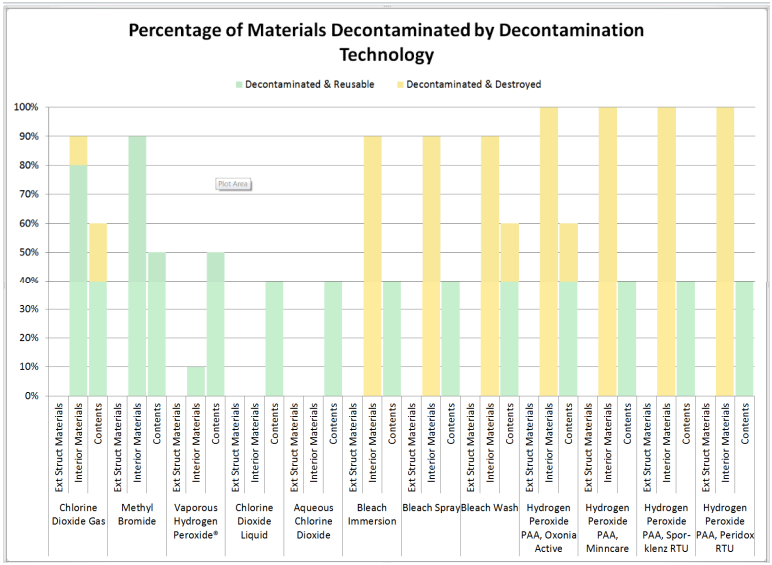
Total Waste Generated (tons)	**300**	**200**	**300**	**400**	**400**	**400**	**400**
Removed for Waste Treatment & Disposal *(Materials & contents removed as waste prior to decontamination)*	200	200	200	200	200	200	200
Treated Waste *(Materials & contents decontaminated, but damaged by technology)*	100	0	0	0	0	200	200
Potentially Contaminated Waste *(Materials & contents for which decontamination technology fails)*	0	0	200	300	300	100	100

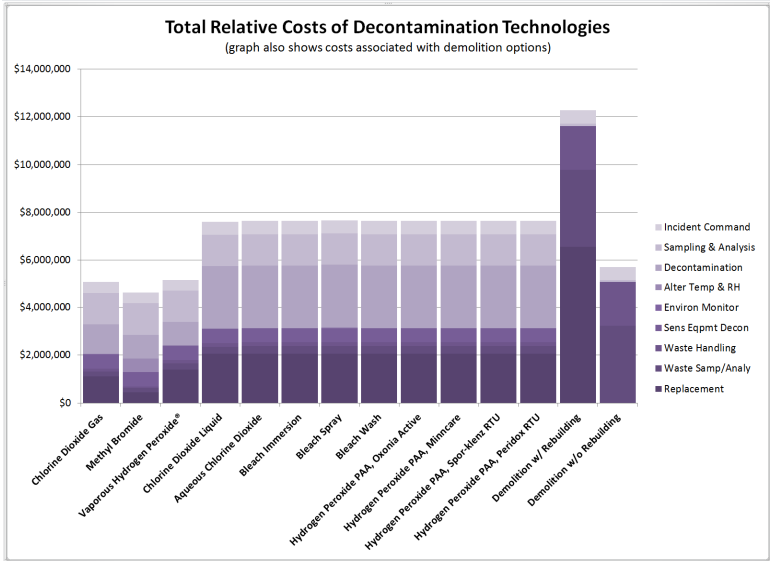
Caveat: Numbers are intended for comparison purposes rather than indicators of actual costs!

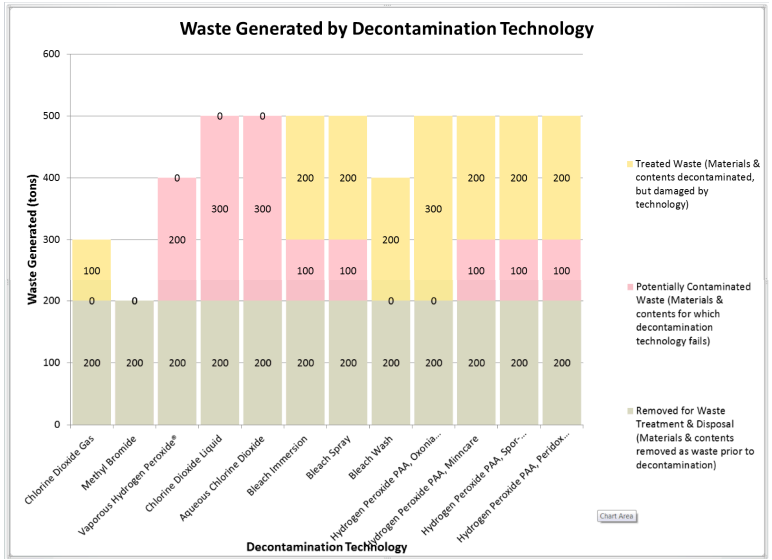
Output Screens

RESULTS - MATERIALS DISPOSITION LIST

		Material Action & Result	Volumetric Decontamination: Chlorine Dioxide Gas — Exterior Structural Materials	Chlorine Dioxide Gas — Interior Materials	Chlorine Dioxide Gas — Contents	Methyl Bromide — Exterior Structural Materials	Methyl Bromide — Interior Materials	Methyl Bromide — Contents
Not Waste		Kept in Place Untreated	Brick, Concrete, Steel, Wood, Other Structural Materials			Brick, Concrete, Steel, Wood, Other Structural Materials		
Not Waste		Removed for Alternate Decon			Electronic Equipment			Electronic Equipment
Not Waste		Treated in Place:						
Not Waste	Included in Decon % Calculations	Decontaminated w/o Damage		Drywall, Ceiling Tiles	Non-Porous Furniture		Carpet, Drywall, Ceiling Tiles	Porous Furniture, Non-Porous Furniture
Waste	Included in Decon % Calculations	Decontaminated but Damaged		Carpet	Porous Furniture			
Waste	Included in Decon % Calculations	Potentially Contaminated but Reusable		Other Non-Structural Building Materials				
Waste	Included in Decon % Calculations	Potentially Contaminated and Damaged		Other Floor Materials			Other Floor Materials, Other Non-Structural Building Materials	
Waste		Removed for Waste Treatment & Disposal			Paper and Office Supplies			Paper and Office Supplies
		Waste excluded from Waste Stream Calculations (Amounts & Costs)						







DeconST: Impact

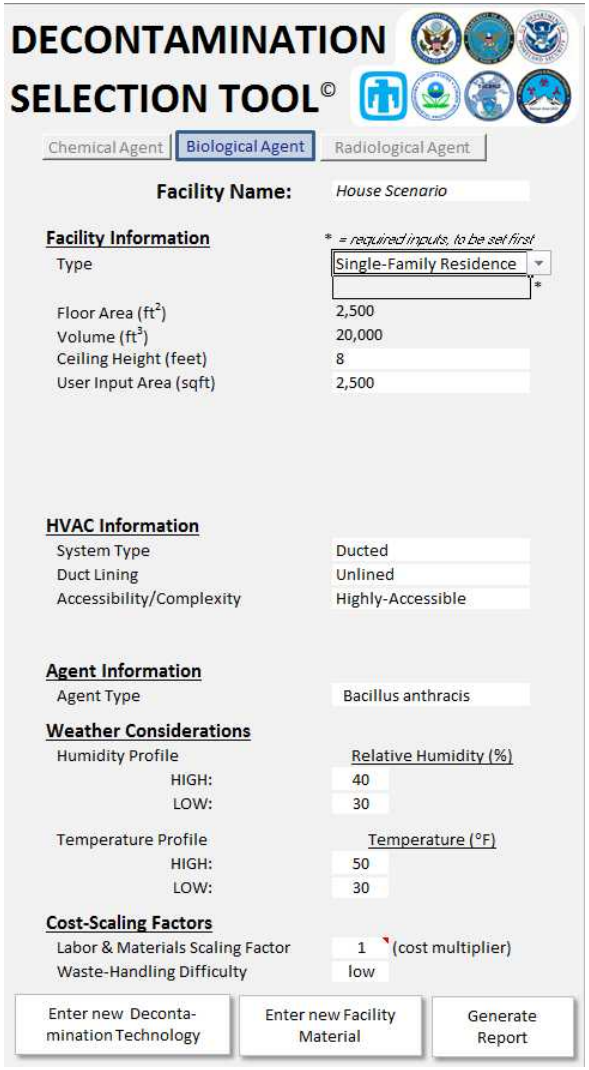
- **EPA's OSC "BioGuide"**
  - Incorporated into Decontamination Technologies Chapter

- **DoD/DTRA's Transatlantic Collaborative Biological Resiliency Demonstration (TaCBRD)**
  - Demonstrated at Technical Demonstration 1
  - Integration into TaCBoaRD tool

Extra slides if needed during Tool Demonstration…

Demonstration Scenario 1: Single-Family Residence

- Floor area is 2,500 square feet
- Ceiling height is 8 feet
- Volume is 20,000 square feet
- HVAC system is ducted, unlined, highly accessible
- Relative humidity ranges from 30 % to 40 %
- Temperature ranges from 30°F to 50°F
- Urban-area premium is 1, and the waste-handling difficulty* is low



*Note: The EPA's BOTE experiment is the source for the concept of "waste handling difficulty."

Demonstration Scenario 1: Single-Family Residence

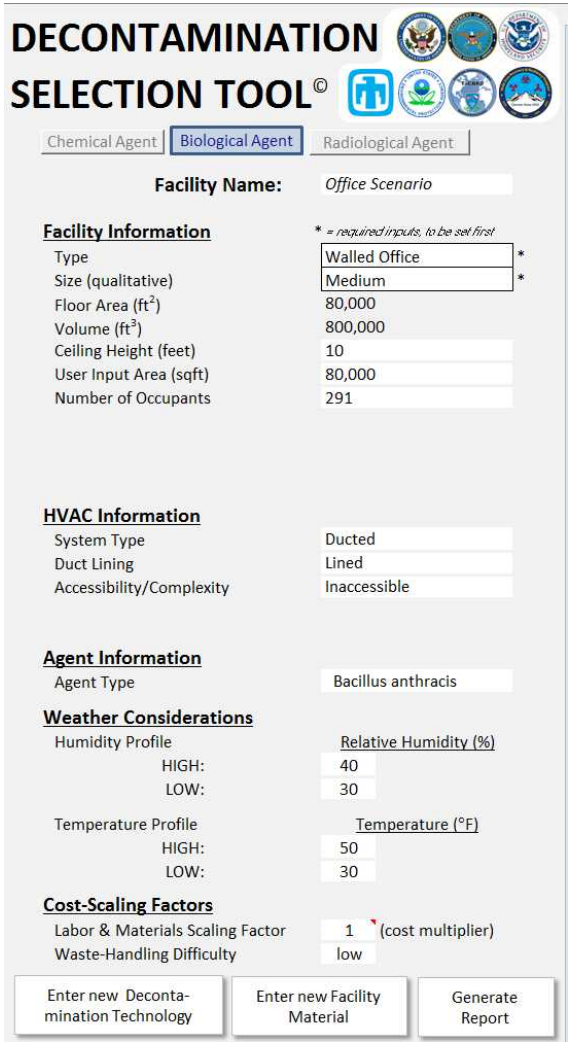
Best Choices — Alternates — Good for Interior Materials

RESULTS SUMMARY (least desirable → most desirable)

	Volumetric Decontamination (HVAC is decontaminated as part of volumetric decontamination)			Surface Decontamination (HVAC will be relatively easy to access and decontaminate using surface decontamination technologies)									Demolition	
	Chlorine Dioxide Gas (3000 ppmv, 3 hrs, >70% RH, >75 deg F)	Methyl Bromide (212 mg/l, 37 degees C, 75% RH, 36 hour contact time)	Vaporous Hydrogen Peroxide® (225 ppmv, 4 hrs)	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide (3000 ppm, 1 hr contact time, 3 spray applications)	Bleach Immersion (NaOCl by weight. Add acetic acid to pH (6.8). Immersion 30-min. STS neutralized then extracted)	Bleach Spray (NaOCl by weight. Add acetic acid to pH (6.8). Spray 60-min contact. STS neutralized at end of contact time.)	Bleach Wash (Dilute 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Spray 10-min contact. Rinse with H2O. STS neutralized at end of contact time. Waste had significant level of spores that must be treated.)	Hydrogen Peroxide PAA, Oxonia Active (27.5% H2O2, 5.8% PAA)	Hydrogen Peroxide PAA, Minncare (22% H2O2, 4.5% PAA)	Hydrogen Peroxide PAA, Spor-klenz RTU (1% H2O2, 0.08% PAA, <10% AA)	Hydrogen Peroxide PAA, Peridox RTU (4% H2O2, 0.22% PAA)	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Structural Materials Decontaminated	90%	90%	0%	0%	0%	90%	50%	90%	50%	50%	80%	50%	n/a	n/a
% decontaminated and reusable	90%	90%	0%	0%	0%	90%	40%	90%	0%	0%	40%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	0%	0%	0%	0%	0%	50%	50%	50%	50%	n/a	n/a
% of Interior Materials Decontaminated	70%	70%	0%	0%	0%	70%	70%	70%	100%	100%	100%	100%	n/a	n/a
% decontaminated and reusable	70%	70%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	0%	0%	70%	70%	70%	100%	100%	100%	100%	n/a	n/a
% of Contents Decontaminated	80%	80%	80%	70%	70%	70%	70%	80%	80%	70%	70%	70%	n/a	n/a
% decontaminated and reusable	30%	80%	60%	30%	30%	50%	50%	50%	30%	30%	30%	30%	n/a	n/a
% decontaminated and destroyed (treated waste)	50%	0%	20%	40%	40%	20%	20%	30%	50%	40%	40%	40%	n/a	n/a
Total Cost, $k	$250.0	$231.0	$394.0	$439.0	$440.0	$325.0	$357.0	$325.0	$438.0	$438.0	$365.0	$438.0	$327.0	$143.0
Decon Process Cost, $k	$132.0	$138.0	$116.0	$141.0	$141.0	$141.0	$141.0	$141.0	$141.0	$141.0	$141.0	$141.0	$20.0	$20.0
Waste Management Cost, $k	$117.0	$93.0	$278.0	$298.0	$299.0	$184.0	$216.0	$184.0	$297.0	$298.0	$224.0	$298.0	$307.0	$123.0
Material Removal/Replacement Time	5,100	4,400	16,300	16,700	16,700	5,900	14,900	5,900	16,000	16,100	14,600	16,100	17,300	6,100
Removal Time (person hours)	1,000	400	5,100	5,500	5,500	800	4,200	800	4,900	4,900	3,900	4,900	6,100	6,100
Replacement Time (person hours)	4,000	4,000	11,100	11,200	11,200	5,100	10,700	5,100	11,200	11,200	10,700	11,200	11,200	0
Total Waste Generated (tons)	10	10	40	40	40	20	30	20	40	40	40	40	50	50
Sent Directly to Waste (*Materials & contents removed as waste prior to decontamination*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (*Materials & contents decontaminated, but damaged by technology*)	0	0	0	0	0	10	10	10	30	30	30	30	0	0
Potentially Contaminated Waste (*Materials & contents for which decontamination technology fails*)	10	10	40	40	40	10	20	10	10	10	10	10	50	50

Demonstration Scenario 2: Medium-Sized Walled Office

- Floor area is 80,000 square feet
- Ceiling height is 10 feet
- Volume is 800,000 square feet
- HVAC system is ducted, lined, inaccessible
- Relative humidity ranges from 30 % to 40 %
- Temperature ranges from 30°F to 50°F
- Urban-area premium is 1, and the waste-handling difficulty is low



DECONTAMINATION SELECTION TOOL©

Chemical Agent | Biological Agent | Radiological Agent

Facility Name: *Office Scenario*

Facility Information * = required inputs, to be set first

Type	Walled Office *
Size (qualitative)	Medium *
Floor Area (ft^2)	80,000
Volume (ft^3)	800,000
Ceiling Height (feet)	10
User Input Area (sqft)	80,000
Number of Occupants	291

HVAC Information

System Type	Ducted
Duct Lining	Lined
Accessibility/Complexity	Inaccessible

Agent Information

Agent Type	Bacillus anthracis

Weather Considerations

Humidity Profile	Relative Humidity (%)
HIGH:	40
LOW:	30
Temperature Profile	Temperature (°F)
HIGH:	50
LOW:	30

Cost-Scaling Factors

Labor & Materials Scaling Factor	1 (cost multiplier)
Waste-Handling Difficulty	low

Enter new Decontamination Technology | Enter new Facility Material | Generate Report

Demonstration Scenario 2: Medium-Sized Walled Office

Best Choices

Alternates

Good for Interior Materials

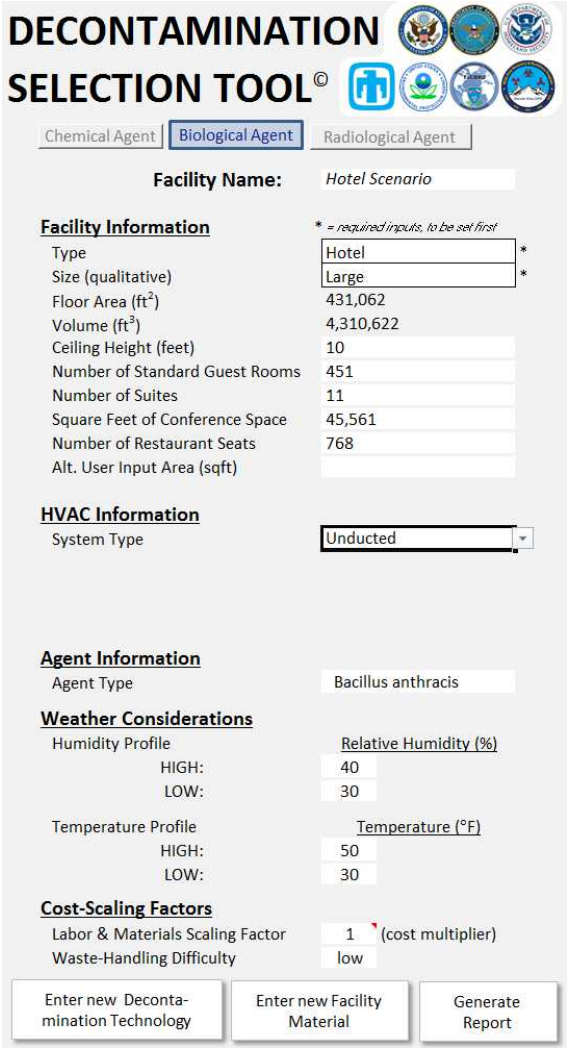
RESULTS SUMMARY

least desirable ... most desirable

	Volumetric Decontamination			Surface Decontamination										Demolition	
	HVAC is decontaminated as part of volumetric decontamination			HVAC will be very difficult to access and decontaminate; costs for this must be considered before using surface decontamination technologies											
	Chlorine Dioxide Gas (1000 ppm v, 5 hrs, >70% RH, >75 deg F)	Methyl Bromide (211 mg/L, 27 degrees C, 75 % RH, 16 hour contact time)	Vaporous Hydrogen Peroxide® (22.5 ppmv, 4 hrs)	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide (5000 ppm, 1 hr contact time, 3 spray applications)	Bleach Immersion (6% NaOCl by weight. Add acetic acid to pH (8.5). Immersion 30-min. STS neutralized then extracted)	Bleach Spray (6% NaOCl By weight. Add acetic acid to pH (8.5). 3 spray 60-min contact. STS neutralized at end of contact time.)	Bleach Wash (Dilute to 0.5% NaOCl by weight. Add acetic acid to pH (8.5). Spray 10-min contact. Rinse with H2O. STS neutralized at end of contact time. Assume had significant level of spores that must be treated.)	Hydrogen Peroxide PAA, Oxonia Active (27.5% H2O2, 5.5% PAA)	Hydrogen Peroxide PAA, Minncare (22% H2O2, 4.5% PAA)	Hydrogen Peroxide PAA, Spor-klenz RTU (1% H2O2, 0.08% PAA, <10% AA)	Hydrogen Peroxide PAA, Peridox RTU (4% H2O2, 0.22% PAA)	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Structural Materials Decontaminated	100%	100%	10%	10%	10%	100%	90%	100%	20%	20%	30%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	10%	0%	0%	90%	80%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	10%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	90%	90%	10%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% decontaminated and reusable	80%	90%	10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% of Contents Decontaminated	60%	60%	60%	50%	50%	50%	50%	60%	60%	50%	50%	50%	n/a	n/a
% decontaminated and reusable	40%	60%	50%	40%	40%	40%	40%	40%	40%	40%	40%	40%	n/a	n/a
% decontaminated and destroyed (treated waste)	20%	0%	10%	10%	10%	10%	10%	20%	20%	10%	10%	10%	n/a	n/a
Total Cost, $M	$8.5	$4.9	$12.0	$17.7	$17.8	$11.1	$11.9	$11.1	$17.7	$17.8	$16.6	$17.8	$14.5	$9.0
Decon Process Cost, $M	$3.1	$3.7	$2.8	$4.5	$4.5	$4.5	$4.5	$4.5	$4.5	$4.5	$4.5	$4.5	$0.7	$0.7
Waste Management Cost, $M	$5.4	$1.3	$9.2	$13.2	$13.3	$6.6	$7.4	$6.5	$13.2	$13.2	$12.1	$13.2	$13.9	$8.3
Material Removal/Replacement Time	81,000	63,000	220,000	233,000	233,000	100,000	200,000	98,000	225,000	226,000	210,000	226,000	275,000	163,000
Removal Time (person hours)	57,000	41,000	110,000	121,000	121,000	60,000	97,000	58,000	113,000	114,000	103,000	114,000	163,000	163,000
Replacement Time (person hours)	24,000	22,000	110,000	112,000	112,000	41,000	102,000	41,000	112,000	112,000	107,000	112,000	112,000	0
Total Waste Generated (tons)	1,000	0	4,000	5,000	5,000	1,000	1,000	1,000	5,000	5,000	4,000	5,000	5,000	5,000
Sent Directly to Waste (*Materials & contents removed as waste prior to decontamination*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (*Materials & contents decontaminated, but damaged by technology*)	0	0	0	0	0	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0	0
Potentially Contaminated Waste (*Materials & contents for which decontamination technology fails*)	0	0	4,000	4,000	4,000	0	1,000	0	4,000	4,000	3,000	4,000	5,000	5,000

Demonstration Scenario 3: Large Hotel

- Floor area is 430,000 square feet
- Ceiling height is 10 feet
- Volume is 4,300,000 square feet
- HVAC system is unducted, unlined, highly accessible
- Relative humidity ranges from 30 % to 40 %
- Temperature ranges from 30°F to 50°F
- Urban-area premium is 1, and the waste-handling difficulty is low



DECONTAMINATION SELECTION TOOL©

Chemical Agent | Biological Agent | Radiological Agent

Facility Name: Hotel Scenario

Facility Information * = required inputs, to be set first

Type	Hotel	*
Size (qualitative)	Large	*
Floor Area (ft^2)	431,062	
Volume (ft^3)	4,310,622	
Ceiling Height (feet)	10	
Number of Standard Guest Rooms	451	
Number of Suites	11	
Square Feet of Conference Space	45,561	
Number of Restaurant Seats	768	
Alt. User Input Area (sqft)		

HVAC Information

System Type: Unducted

Agent Information

Agent Type: Bacillus anthracis

Weather Considerations

Humidity Profile	Relative Humidity (%)
HIGH:	40
LOW:	30

Temperature Profile	Temperature (°F)
HIGH:	50
LOW:	30

Cost-Scaling Factors

Labor & Materials Scaling Factor: 1 (cost multiplier)

Waste-Handling Difficulty: low

Enter new Decontamination Technology | Enter new Facility Material | Generate Report

Demonstration Scenario 3: Large Hotel

Best Choices

Alternates

Good for Interior Materials

RESULTS SUMMARY

least desirable ← → most desirable

	Volumetric Decontamination (HVAC is decontaminated as part of volumetric decontamination)			Surface Decontamination (Unducted HVAC can be decontaminated as part of the facility decontamination process)									Demolition	
	Chlorine Dioxide Gas (3000 ppmv, 3 hrs, >70% RH, >75 deg F)	Methyl Bromide (211 mg/L-37 degrees C, 75% RH, 16 hour contact time)	Vaporous Hydrogen Peroxide® (225 ppmv, 4 hrs)	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide (3000 ppm, 1 hr contact time, 3 spray applications)	Bleach Immersion (NaOCl by weight. Add acetic acid to pH (6.8). Immersion 30-min. STS neutralized then rinsed)	Bleach Spray (NaOCl by weight. Add acetic acid to pH (6.8). Spray 60-min contact. STS neutralized at end of contact time.)	Bleach Wash (Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Spray 10-min contact. Rinse with H2O. STS neutralized at end of contact time. Treats had significant level of spores that must be treated.)	Hydrogen Peroxide PAA, Oxonia Active (27.5% H2O2, 5.5% PAA)	Hydrogen Peroxide PAA, Minncare (22% H2O2, 4.5% PAA)	Hydrogen Peroxide PAA, Spor-klenz RTU (1% H2O2, 0.08% PAA, <10% AA)	Hydrogen Peroxide PAA, Peridox RTU (4% H2O2, 0.32% PAA)	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Structural Materials Decontaminated	100%	100%	10%	10%	10%	100%	80%	100%	20%	20%	30%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	10%	0%	0%	90%	70%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	10%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	80%	80%	10%	10%	10%	80%	80%	80%	100%	100%	100%	100%	n/a	n/a
% decontaminated and reusable	70%	80%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	0%	0%	70%	70%	70%	90%	90%	90%	90%	n/a	n/a
% of Contents Decontaminated	80%	80%	80%	70%	70%	70%	70%	80%	80%	70%	70%	70%	n/a	n/a
% decontaminated and reusable	50%	80%	60%	50%	50%	50%	50%	50%	50%	50%	50%	50%	n/a	n/a
% decontaminated and destroyed (treated waste)	30%	0%	20%	20%	20%	20%	20%	40%	40%	20%	20%	20%	n/a	n/a
Total Cost, $M	$42.5	$25.5	$64.7	$91.7	$91.9	$56.4	$62.1	$56.3	$91.7	$91.8	$83.3	$91.8	$74.6	$42.4
Decon Process Cost, $M	$16.5	$19.6	$14.9	$24.3	$24.3	$24.3	$24.4	$24.3	$24.3	$24.3	$24.3	$24.3	$3.5	$3.5
Waste Management Cost, $M	$26.0	$5.9	$49.9	$67.4	$67.6	$32.1	$37.7	$32.0	$67.5	$67.5	$59.0	$67.5	$71.0	$38.8
Material Removal/Replacement Time	300,000	230,000	1,340,000	1,350,000	1,350,000	410,000	1,140,000	400,000	1,300,000	1,300,000	1,180,000	1,300,000	1,490,000	650,000
Removal Time (person hours)	100,000	40,000	510,000	550,000	550,000	120,000	400,000	110,000	490,000	490,000	410,000	490,000	650,000	650,000
Replacement Time (person hours)	200,000	190,000	830,000	810,000	810,000	290,000	740,000	290,000	810,000	810,000	760,000	810,000	840,000	0
Total Waste Generated (tons)	3,000	1,000	21,000	22,000	22,000	4,000	7,000	4,000	22,000	22,000	20,000	22,000	23,000	23,000
Sent Directly to Waste (Materials & contents removed as waste prior to decontamination)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Materials & contents decontaminated, but damaged by technology)	2,000	0	0	2,000	2,000	3,000	3,000	3,000	6,000	6,000	6,000	6,000	0	0
Potentially Contaminated Waste (Materials & contents for which decontamination technology fails)	1,000	1,000	21,000	21,000	21,000	1,000	4,000	1,000	16,000	16,000	14,000	16,000	23,000	23,000

Assessment Scenario 1

- A large hospital is located in the hot zone after a wide area release of “anthrax” spores. The hospital has no visible structural porous materials on the interior of the facility (i.e., no brick, concrete, or wood). The facility is 500,000 sq. ft. with 200 beds and 10 ft. nominal ceiling heights. The general weather conditions are between 50-70 °F (low-high) and 60 % RH.
- A sampling density of four samples per room (approximately one sample every 50 sq. ft.) has been requested by the State Department of Public Health, with a no growth requirement for all samples, for facility clearance and re-occupancy.
- Present recommendations on decontamination options for this facility to the IC by 1100 hours.

Assessment Scenario 1: Injects

- **Inject #1**: The facility is located in an area with low-high temperature of 10 - 30 °F and 25 % RH.
- **Inject #2**: Based upon the past use of fumigation with chlorine dioxide, the sampling density requirement can be decreased by a factor of ten, to one sample every 500 sq. ft.
- **Inject #3**: OSC Nick Malathion has negotiated that the state will cover the waste cost of interior facility materials (e.g., carpet, ceiling tile) if a local business is used to decontaminate the facility. There are several service professional commercial facility cleaners with capabilities and appropriate H&S requirements to perform surface decontamination of the facility. Also, due to the confidence that the state has in the EPA decontamination experience, the sampling requirement of any recommended option can be reduced by a factor of ten, to one sample every 500 sq.ft.

Assessment Scenario 2

- Two single family residences (one at 2,500 sq. ft. with 8 ft. ceilings and one at 25,000 sq. ft. with 15 ft. ceilings) are located in the confirmed contamination zone after a wide area release of anthrax spores. The weather conditions are 50-70 °F (low-high) with 50 % RH. Sampling requirements have been suggested to be at 50 samples per residence. Present recommendations on decontamination options by 1330 hours.