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Decontamination Strategy and Technology Selection Tool for Decontamination of Facilities Contaminated with Biological or Chemical Agents User Manual

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U.S. Environmental Protection Agency
Office of Research and Development
National Homeland Security Research Center
Research Triangle Park, NC 27711

Disclaimer

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Foreword

The Decontamination Strategy and Technology Selection Tool (DeconST) is a tool that provides decision support to an Incident Commander for cost-benefit analysis of facility remediation options after contamination by chemical or biological agents. A first prototype of the biological agent version of the tool was developed under the Department of Homeland Security's (DHS's) Interagency Biological Restoration Demonstration (IBRD) (Kelley and Tucker 2011). This prototype was extended under the DHS Wide Area Recovery and Resiliency Program (WARRP) (Edwards, Krauter et al. 2012) to couple to materials information in the EPA's I-WASTE tool (U.S. EPA 2013). The tool and accompanying user manual were transitioned under the "Decontamination Strategy and Technology Selection Tool (DeconST): Combination & Optimization of Existing Capabilities" transition agreement established between DHS Science and Technology Directorate and the U.S. Environmental Protection Agency, May, 2012.

The current document results from efforts under the FY16-17 Interagency Agreement #DW08992454601 between US EPA and Sandia National Laboratories. This effort enhanced the existing DeconST (Edwards, Fruetel et al. 2013) (that encompassed only biological incidents) to encompass chemical contamination incidents (e.g., with a chemical warfare agent) and associated decontamination processes.

This content represents the best efforts of the participants based on the information available at the time of publication but is not intended to convey formal guidance or policy of the federal government or other participating agencies. The views and opinions expressed herein do not necessarily state or reflect those of their respective organizations or the U.S. Government.

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1

Introduction and Purpose

Successful decontamination of a complex facility may be achieved through one or more of several potential decontamination methods, based upon the environmental conditions, application requirements, and site-specific inputs. Remediation with each potential technology may involve different levels of cleaning and removal (and possibly off-site treatment) of potentially contaminated items or materials (source reduction), and additional management of items and materials (waste removal), all with associated costs and benefits.

The Decontamination Strategy and Technology Selection Tool (DeconST) provides a comprehensive, data-rich framework for considering decontamination options and facilitating the development of facility-specific, efficient, and effective remediation approaches following attack or contamination with *Bacillus anthracis* (*B.a.*) or a chemical agent such as the blister agent sulfur mustard (HD) or the nerve agent VX. The comparison includes for each decontamination technology the required operational conditions, source reduction, materials compatibility, waste management, and costs to the facility. The DeconST uses published experiment-based data on the decontamination technologies and has the flexibility to incorporate updates to those data as well as new decontamination strategies and technologies and new facility structural and nonstructural materials and contents.

The DeconST is intended to be used by a technical working group (TWG) functioning under a Unified Command (UC) to provide recommendations to the Incident Commander (IC) on decontamination technologies appropriate to a given building. The DeconST is not an expert system, meaning that it does not tell the IC/UC what technology to use, but rather it presents a series of options and recommendations, with color-coded estimates of likelihood of success, cost implications, and waste estimates. The DeconST outputs, including tables of waste composition, cost distribution charts, and other information that would justify recommendations, are provided as detailed reports suitable for inclusion in the records of the IC/UC.

Chapter

2

Quick-Start Guide

This Quick-Start Guide enables the user to rapidly use the DeconST to assess the decontamination strategy and technology options for a facility, comparing the options based on their relative effectiveness, costs, destructiveness, and waste generated. For more comprehensive instructions, consult the remaining portions of the User Manual.

Version

There are currently three versions of the tool: DeconST-bioBa for *B. anthracis*, DeconST-chemHD for sulfur mustard, and DeconST-chemVX for VX. It is important that the user ensure the correct version is being used.

Inputs

There are three worksheets of input: the User Input worksheet, the Materials Inputs worksheet, and the Sampling Inputs worksheet.

User Input Worksheet

The User Input worksheet collects information on the facility, any structure contamination considerations, the HVAC system, agent, weather, and any cost-scaling factors.

Facility Information

Enter a Name for the facility in the Facility Name box. Select the facility type and qualitative size to populate default quantities of urban materials. For instructions on how to handle a facility type not in the drop-down menu, see the Advanced Features section. Update the facility parameters, if desired. Note that the tool will prompt to confirm new parameters or revert to default.

Facility Structure Contamination Considerations

Select True or False from the drop-down menus to indicate if the facility structure may be contaminated or might contain asbestos or lead paint.

HVAC Information

Select the 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.

Agent Information

The user should verify that this box lists the correct biological or chemical agent, and if not, the user should switch to the correct version of the tool: DeconST-bioBa for *B. anthracis*, DeconST-chemHD for sulfur mustard, or DeconST-chemVX for VX. For chemical agents, the user can input the Decontamination Efficacy Threshold from the dropdown menu or by typing a number in the box.

Weather Conditions

Input the daily high and low relative humidity and high and low outdoor temperatures. These considerations enter into cost calculations to achieve appropriate decontamination conditions inside the building.

Cost-Scaling Factors

Adjust urban-area premium, which is a multiplicative factor for all labor and materials costs. Select the waste-handling difficulty (high, moderate, low). Costs are based on assuming decontamination would be performed on one building only and do not reflect economies of scale.

Generate Report

The Generate Report button runs a "Print Preview" on the main input and output pages, from which the user may print a report. Note that the preview of the report is not in color unless a color printer is chosen and that color is used to help convey the results comparison. Also note that if the page layout for some of the charts cuts off the edges, exit the print preview, go to the chart, adjust the page layout margins to narrow (even if they are already narrow), and press the Generate Report button again. The preview may show only the first page but printing to a .pdf will include all report pages.

Next Step

Switch to the Materials Inputs worksheet.

Materials Inputs Worksheet

The Materials Inputs worksheet shows default quantities of structural and interior nonstructural building materials and contents for the facility type selected on the User Input worksheet. These quantities were auto-populated from the EPA's I-WASTE tool based on the facility type that is identified on the User Input Tab. The user may customize the quantities on this page, select appropriate actions for each material, and input per item costs as necessary.

Materials Quantities

Adjust the quantities of the structural and interior materials and contents by typing in white cells for areas, percentages, tons, and/or quantities. Note that the quantities must be positive numerical values and that the total percentages must not exceed 100%. To adjust the floor area, return to the User Input worksheet.

Material Action

For each material or item, use radio buttons to select the appropriate action:

- Keep in Place Untreated

- Remove for Alternate Decontamination (e.g., for high-value items)
- Send Directly to Waste
- Treat in Place (with Facility Decontamination Technology)

Exclusion

For any materials to be excluded from the waste stream calculations (amounts and costs) (e.g., structural materials), check the corresponding box. Note that the checkboxes do not apply to materials successfully decontaminated by the technology, since these materials would not be sent to waste in any case.

Per Item Costs

The required entries are shown as open white cells in the per Item COSTS columns. For each high-value material or item to be removed for alternate decontamination, enter the cost to remove, decontaminate, and replace the material or item. For other items, input the costs and labor to remove and replace the item, if the item is sent directly to waste or if the item is treated by a facility decontamination method but remains potentially contaminated or becomes damaged. Leaving blank entries in the white cells assumes zero costs.

Next Step

Switch to the Sampling Inputs Worksheet.

Sampling Inputs Worksheet

The Sampling Inputs worksheet shows the sampling densities for the process phases and waste generated from both decontamination and demolition processes. Sampling considerations are included in cost calculations.

For Decontamination Processes

Set the sampling densities for each process phase (characterization, decontamination verification, and clearance) for each decontamination technology. Set the sampling densities for waste materials (structural and interior materials and contents removed as waste) and for the liquid waste generated during decontamination processes.

For Demolition Processes

Set the sampling densities for characterization sampling before demolition. Set the sampling density for waste materials demolished during the demolition process (structural and interior materials and contents demolished and removed).

Next Steps

Switch to the Results Summary worksheet to view summary results.

Results Summary

The Results Summary worksheet shows a comparison across the different decontamination strategies and technologies (one for each column) of the high-level decision considerations: the Percentages of Materials Decontaminated, the Total Cost, the Material Removal and Replacement Time, and the Total Waste Generated.

Decontamination Strategies and Technologies

The first rows of the summary table show the default types of decontamination strategies and technologies, the HVAC considerations, and the decontamination technology conditions.

Default Strategies

The default decontamination strategies considered in the tool are the following:

- Natural Attenuation (chem versions only)
- Volumetric Decontamination
- Surface Decontamination
- Demolition: with and without rebuilding (equivalent to "restricted use" and "unrestricted use" in Superfund terminology)

Other technologies (including hybrid technologies) can be added by the user. See the Advanced Features section of the User Manual for instructions.

HVAC Considerations

The first row under the Strategy Categories shows the HVAC Considerations. For Volumetric Decontamination processes, the HVAC system is decontaminated as part of the volumetric decontamination process. For Surface Decontamination processes, decontamination of the HVAC system may present a separate and difficult challenge. Decontamination of less-accessible ducted HVAC systems may require significant efforts that are not explicitly incorporated into the cost calculations in the DeconST.

Decontamination Technology Conditions

The first row under the name of each decontamination technology shows the conditions under which that technology was tested in the laboratory.

Decision Considerations

The decision considerations are the rows of the table, including the Percentages of Materials Decontaminated, the Total Cost, the Material Removal and Replacement Time, and the Total Waste Generated. Note that the color coding is a gradation from red to green, with red being the less-desirable and green being the more-desirable outcome; the user may alter the color scheme to an absolute scale by changing the color thresholds in the rightmost columns of the worksheets.

Decontamination Percentages

The Percentages of Materials Decontaminated show the total percent of each type of material (structural materials, interior nonstructural materials, and contents) that is successfully decontaminated by each technology, as well as the percentages of those that are reusable versus destroyed. (Note that the percentages are by mass for the structural materials and contents and by area for the interior materials.) The same information is presented graphically on the % of Materials Decontaminated by Decontamination Technology plot (the Materials Decon % Plot chart). Details on the disposition of each material type can be found on the Results Materials Lists worksheets (with and without the quantities of materials listed) and on the Results Materials Disposition worksheet.

Total Cost

Cost estimation approaches were largely based on the approaches and results from the Bioresponse Operational Testing and Evaluation (BOTE) program (U.S. EPA 2013). The Total Cost rows show the sum and the components of the Decontamination Process Cost (including incident command, characterization and clearance sampling and analysis, temperature and humidity adjustment, decontamination, and long-term monitoring) and the Waste Management Cost (including the costs for removing, decontaminating, disposing of, and replacing all materials and contents damaged and/or not decontaminated by the technology). The cost information is presented graphically in the Total Relative Costs of Decontamination Technologies plots (on the Costs Plot and Costs Plot wDemo charts) and in detail in the Results Costs worksheet. Remember that the HVAC decontamination is not included and may incur considerable costs; see the HVAC considerations row for this facility. Note that the costs of the decontamination strategies and technologies are provided as relative costs for purposes of strategy and technology comparison. The true total cost would need to consider the cost of facility downtime, which for many facilities would likely overwhelm the cost of the remediation.

Material Removal/Replacement Time

The Material Removal and Replacement Time rows show the total *labor hours* required for the Removal and Replacement. Note that these times are provided as relative labor requirement times for purposes of strategy and technology comparison. The actual facility downtime would need to take into consideration resource availability.

Total Waste Generated

The Total Waste Generated rows show the total and component quantities of waste in three categories:

- **Sent Directly to Waste** the materials and contents removed as waste prior to decontamination (note that these materials may still go through some sort of decontamination or treatment process prior to disposal);
- **Treated Waste** the materials and contents decontaminated but damaged by the decontamination technology; and
- **Potentially Contaminated Waste** the materials and contents for which the decontamination technology fails

The information is shown graphically on the Waste Generated by Decontamination Technology plots (on the Waste Generated Plot wDemo and woDemo charts). Details on the disposition of each material type can be found on the Results Materials Lists worksheets (with and without the quantities of materials listed) and on the Results Materials Disposition worksheet.

Chapter

3

User Manual

This user manual explains the basic functionality of the DeconST to assess the decontamination strategy and technology options for a facility, comparing the options based on their relative effectiveness, costs, destructiveness, and waste generated.

Version

There are currently three versions of the tool: DeconST-bioBa for *B. anthracis*, DeconST-chemHD for sulfur mustard, and DeconST-chemVX for VX. It is important that the user ensure the correct version is being used.

Decision Logic

The following diagram shows the logic implemented in the DeconST. The logic is implemented for each decontamination technology evaluated against one facility, with user-supplied information on the facility type, size, materials, environmental conditions, etc. The first step considers only those decontamination technologies that are efficacious against the threat agent. The second step considers the environmental conditions required for the use of that decontamination technology, making note of those conditions and including any required use of heaters/coolers and humidifiers/dehumidifiers in the cost of that decontamination technology. The third step sorts the building structural materials, interior nonstructural materials, and contents into four categories: those effectively decontaminated by the technology, those removed for alternate decontamination (e.g., high-value items), those effectively decontaminated but destroyed, and those potentially still contaminated (whether salvageable or destroyed). (Note that the user has two other options: to exclude materials from the decontamination process and to exclude materials from the waste stream.) The output of the tool is shown in the red boxes (the disposition of each material in the facility and the total cost, including the costs of the decontamination process itself (including incident command, characterization and clearance sampling and analysis, temperature and humidity adjustment, decontamination, and long-term monitoring) plus the costs of waste generated by the effects of the technologies on the structural and interior materials and contents of the facility (including the costs for removing, decontaminating, disposing of, and replacing all materials and contents damaged and/or not decontaminated by the technology). It must be emphasized that other unanticipated operational constraints may impact the decision process.

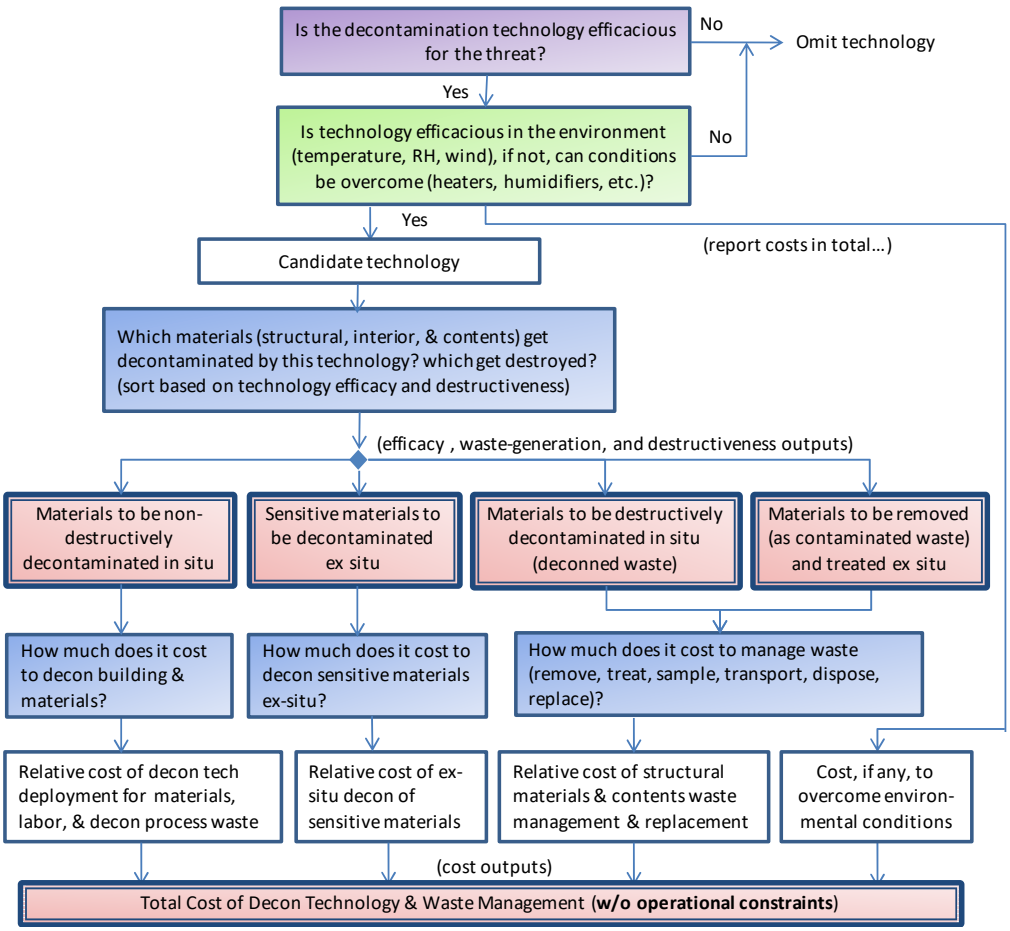


Figure 1. Selection Process Implemented in DeconST

Inputs

There are three worksheets of input: the User Input worksheet, the Materials Inputs worksheet, and the Sampling Inputs worksheet.

User Input Worksheet

The User Input worksheet, shown in Figure 2, collects information from the User on the facility, any structure contamination considerations, the HVAC system, agent, weather, and any cost-scaling factors.

Facility Information

Enter a Name for the facility in the Facility Name box. Use the drop-down boxes to select the facility type and qualitative size to populate default quantities of urban materials. Update the facility parameters, if desired. Note that the tool will prompt to confirm new parameters or revert to defaults.

DECONTAMINATION SELECTION TOOL©

Chemical Agent | Biological Agent | Radiological Agent

Facility Name: *Medium Office*

Facility Information

* = required inputs, to be set first

Type	Office	*
Size (qualitative)	Medium	*
Floor Area (ft^2)	80,000	
Volume (ft^3)	800,000	
Ceiling Height (feet)	10	
Walled Offices Floor Area (sqft)	20,000	
Walled Offices # of Occupants	32	
Cube Offices Floor Area (sqft)	60,000	
Cube Offices # of Occupants	115	

Facility Structure Contamination Considerations

Structure may be contaminated	FALSE
Facility might contain asbestos	TRUE
Facility might contain lead paint	TRUE

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:	40
LOW:	20

	Temperature (°F)
Temperature Profile	
HIGH:	50
LOW:	-20

Cost-Scaling Factors

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

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

Disable pop-up boxes: *"x" = disable pop-ups* *" " = enable pop-ups*

Figure 2. User Input Worksheet (DeconST-bioBa)

Facility Structure Contamination Considerations

Select True or False from the drop-down menus to indicate if the facility structure may be contaminated or might contain asbestos or lead paint.

HVAC Information

Use the drop-down boxes to select the HVAC system type – ducted or unducted. For ducted systems, use the drop-down boxes to select whether ducts are lined or unlined and a description of the accessibility of the system for cleaning, considering location and lengths of ducts.

Agent Information

The user should verify that this box lists the correct biological or chemical agent, and if not, the user should switch to the correct version of the tool: DeconST-bioBa for *B. anthracis*, DeconST-chemHD for sulfur mustard, or DeconST-chemVX for VX. For chemical agents, the user can input the Decontamination Efficacy Threshold from the dropdown menu or by typing a number in the box.

Weather Considerations

Input the daily high and low relative humidity and high and low outdoor temperatures.

Cost-Scaling Factors

Adjust urban-area premium, which is a multiplicative factor for all labor and materials costs. Select the waste-handling difficulty (high, moderate, low).

Enter New Decontamination Technology

The Enter New Decontamination Technology button runs a series of macros that enables the user to enter new volumetric, surface, natural attenuation (for DeconST-chem only), or hybrid decontamination technologies. See the Advanced Features section for instructions.

Enter New Facility Material

The Enter New Facility Material button runs a series of macros that enables the user to enter new structural materials, interior non-structural materials, or contents. See the Advanced Features section for instructions.

Generate Report

The Generate Report button runs a “Print Preview” on the main input and output worksheets and charts, from which the user may print a report. Note that the preview of the report is not in color unless a color printer is chosen, and that color is used to help convey the comparison of results. Also note that if the page layout for some of the charts cuts off the edges, exit the print preview, go to the chart, adjust the page layout margins to narrow (even if they are already narrow), and press the Generate Report button again. The preview may only show the first page, but printing to a .pdf will include all report pages. The report is to be suitable for use to document the decision-making process that the Incident Commander (IC) uses to develop decontamination approaches.

Excel Implementation

The DeconST is implemented in Excel with macros to facilitate transparency and flexibility. Zooming and freezing/unfreezing panes can aid visibility on screens of various sizes. All values, formulas, and

macros can be viewed and altered. Most cells are protected to prevent inadvertent alteration. However, if the user wants to change cell contents, the first step is to unprotect the worksheet. To unprotect any worksheet, use the "Unprotect Sheet" command on the "Review" menu. No password is required. All worksheets and charts can be altered. The user should remember to save an original copy of the tool for recovery from any changes or alterations.

Next Step

Switch to the Materials Inputs worksheet.

Materials Inputs Worksheet

The Materials Inputs worksheet, shown in Figure 3, shows default quantities of structural and interior nonstructural building materials and contents for the facility type selected on the User Input worksheet. These quantities were auto-populated from the EPA's I-WASTE tool based on the facility type that is identified on the User Input worksheet. The user may customize the quantities on this worksheet, select appropriate actions for each material, and input per item costs as necessary.

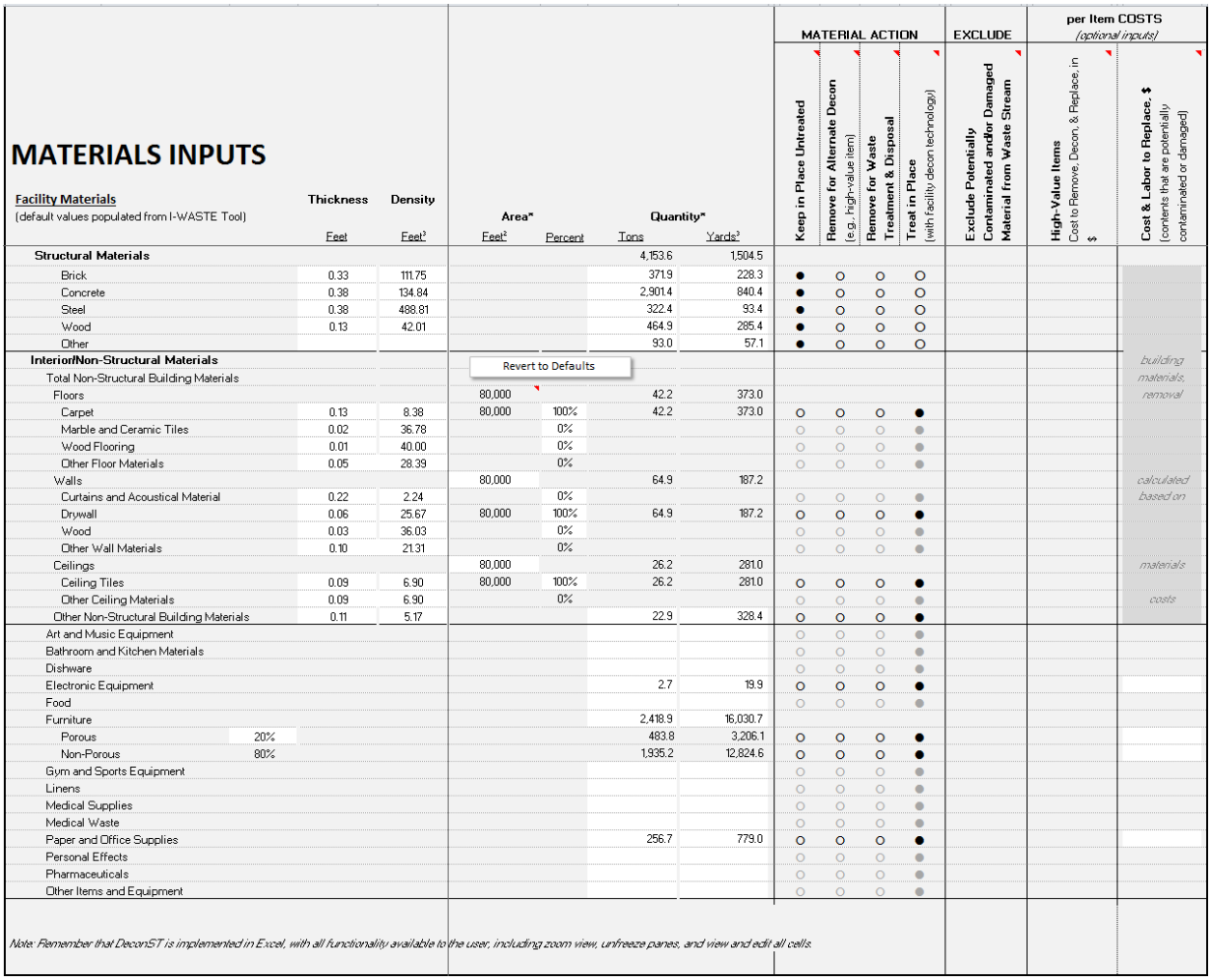
Materials Quantities

Adjust the quantities of the structural and interior materials and contents by typing in white cells for areas, percentages, tons, and/or quantities. Note that the quantities must be positive numerical values and that the total percentages must not exceed 100%. To adjust the floor area, return to the User Input worksheet.

Material Action

For each material or item, use radio buttons to select the appropriate action:

- Keep in Place Untreated these materials will be excluded from the percentage materials decontaminated calculations;
- Remove for Alternate Decontamination these materials, e.g., high-value items such as electronic equipment, will be excluded from the percentage materials decontaminated calculations, and the user should input the cost to remove, decontaminate, and replace the items;
- Send Directly to Waste these materials e.g., food or medical waste, will be excluded from the percentage materials decontaminated calculations, and for facility contents, the user should input the cost to remove and replace the items;
- Treat in Place (with Facility Decontamination Technology) these materials will be treated by the facility decontamination technology and therefore included in the percentage materials decontaminated calculations. For facility contents, the user should input the cost to remove and replace those items that may remain potentially contaminated or be destroyed by the facility decontamination technology.



MATERIALS INPUTS

Facility Materials (default values populated from I-WASTE Tool)		Thickness (Feet)	Density (Feet³)	Area* (Feet²)	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)
Structural Materials						4,153.6	1,504.5							
Brick		0.33	111.75			371.9	228.3	●	○	○	○			
Concrete		0.38	134.84			2,901.4	840.4	●	○	○	○			
Steel		0.38	488.81			322.4	93.4	●	○	○	○			
Wood		0.13	42.01			464.9	285.4	●	○	○	○			
Other						93.0	57.1	●	○	○	○			
Interior/Non-Structural Materials				Revert to Defaults										building materials removal
Total Non-Structural Building Materials														
Floors				80,000		42.2	373.0							
Carpet		0.13	8.38	80,000	100%	42.2	373.0	○	○	○	●			
Marble and Ceramic Tiles		0.02	36.78		0%			○	○	○	●			
Wood Flooring		0.01	40.00		0%			○	○	○	●			
Other Floor Materials		0.05	28.39		0%			○	○	○	●			
Walls				80,000		64.9	187.2							calculated based on
Curtains and Acoustical Material		0.22	2.24		0%			○	○	○	●			
Drywall		0.06	25.67	80,000	100%	64.9	187.2	○	○	○	●			
Wood		0.03	36.03		0%			○	○	○	●			
Other Wall Materials		0.10	21.31		0%			○	○	○	●			
Ceilings				80,000		26.2	281.0							materials
Ceiling Tiles		0.09	6.90	80,000	100%	26.2	281.0	○	○	○	●			
Other Ceiling Materials		0.09	6.90		0%			○	○	○	●			costs
Other Non-Structural Building Materials		0.11	5.17			22.9	328.4	○	○	○	●			
Art and Music Equipment								○	○	○	●			
Bathroom and Kitchen Materials								○	○	○	●			
Dishware								○	○	○	●			
Electronic Equipment						2.7	19.9	○	○	○	●			
Food								○	○	○	●			
Furniture						2,418.9	16,030.7							
Porous	20%					483.8	3,206.1	○	○	○	●			
Non-Porous	80%					1,935.2	12,824.6	○	○	○	●			
Gym and Sports Equipment								○	○	○	●			
Linens								○	○	○	●			
Medical Supplies								○	○	○	●			
Medical Waste								○	○	○	●			
Paper and Office Supplies						256.7	779.0	○	○	○	●			
Personal Effects								○	○	○	●			
Pharmaceuticals								○	○	○	●			
Other Items and Equipment								○	○	○	●			

Note: Remember that DeconST is implemented in Excel, with all functionality available to the user, including zoom view, unfreeze panes, and view and edit all cells.

Figure 3. Materials Inputs Worksheet

Exclusion

For any materials to be excluded from the waste stream calculations (amounts and costs) (e.g., supposing the city decides to handle some portion of the waste), check the corresponding box. Note that the checkboxes do not apply to materials successfully decontaminated by the technology, since these materials would not be sent to waste in any case.

Per Item Costs

The required entries are shown as open white cells in the per Item COSTS columns. For each high-value material or item to be removed for alternate decontamination, enter the cost to remove, decontaminate, and replace the material or item. For other items, input the costs and labor to remove and replace the item, if the item is sent directly to waste or if the item is treated by facility decontamination method but remains potentially contaminated or becomes damaged. Leaving blank entries in the white cells assumes zero costs.

Excel Implementation

The DeconST is implemented in Excel with macros to facilitate transparency and flexibility. All values, formulas, and macros can be viewed and altered. Most cells are protected to prevent inadvertent alteration. However, if the user wants to change cell contents, the first step is to unprotect the worksheet. To unprotect any worksheet, use the "Unprotect Sheet" command on the "Review" menu. No password is required. All worksheets and charts can be altered. The user should remember to save an original copy of the tool for recovery from any changes or alterations.

Next Step

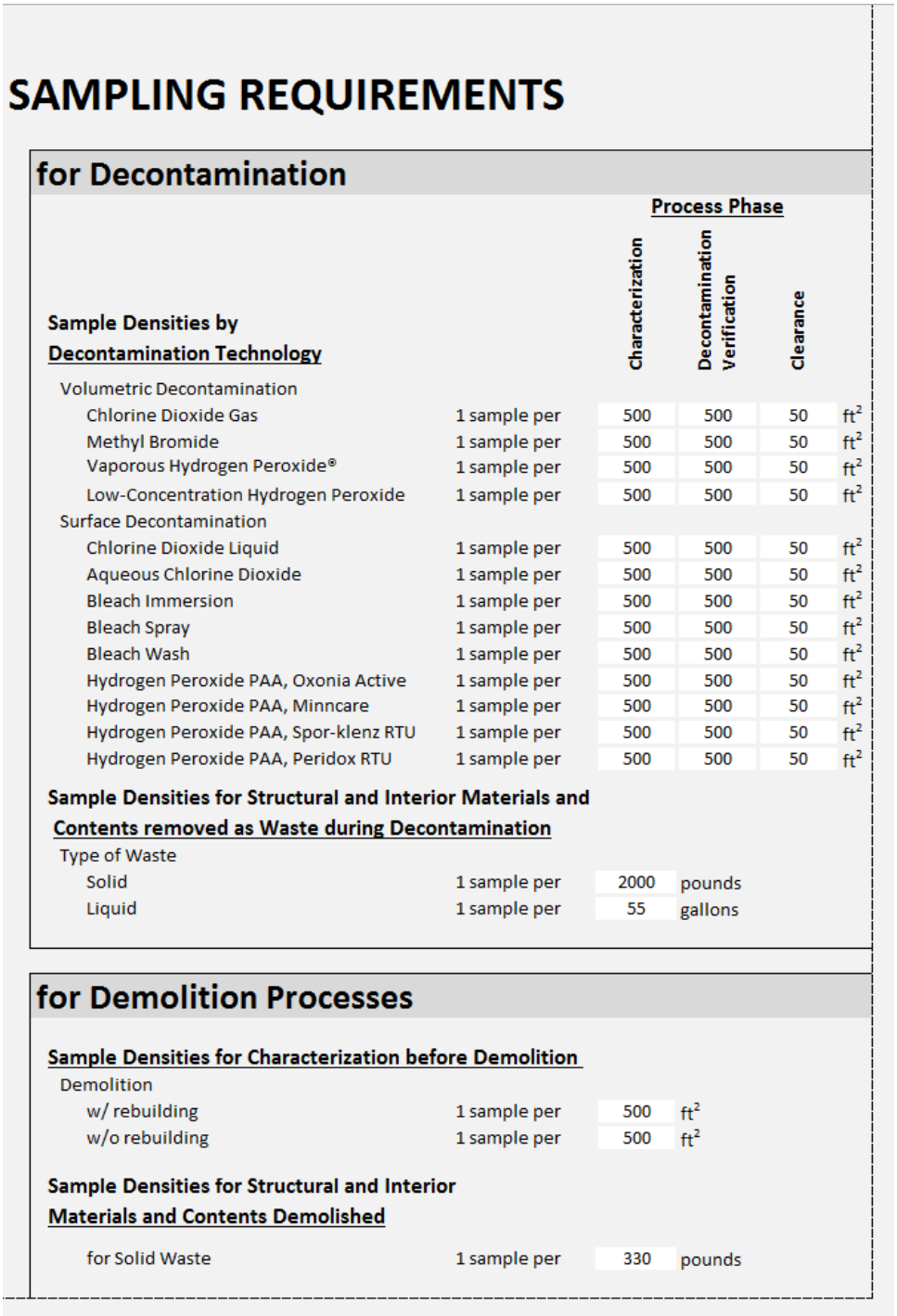
Switch to the Sampling Inputs worksheet.

Sampling Inputs Worksheet

The Sampling Inputs worksheet, shown in Figure 4, shows the sampling densities for the process phases and waste generated from both decontamination and demolition processes.

For Decontamination Processes

Set the sampling densities for each process phase (characterization, decontamination verification, and clearance) for each decontamination technology. Set the sampling densities for waste materials (structural and interior materials and contents removed as waste) and for the liquid waste generated during decontamination processes.



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
Low-Concentration 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

Figure 4. Sampling Inputs Worksheet (DeconST-bioBa)

For Demolition Processes

Set the sampling densities for characterization sampling before demolition. Set the sampling density for waste materials demolished during the demolition process (structural and interior materials and contents demolished and removed).

Next Steps

Switch to the Results Summary worksheet to view summary results.

Results Summary

The Results Summary worksheet, condensed and shown in Figure 6, shows a comparison across the different decontamination strategies and technologies (one for each column) of the high-level decision considerations: the Percentages of Materials Decontaminated, the Total Cost, the Material Removal and Replacement Time, and the Total Waste Generated.

Decontamination Strategies and Technologies

The first rows of the summary table show the default types of decontamination strategies and technologies, the HVAC considerations, and the decontamination technology conditions.

Default Types

For DeconST-bio, the default decontamination strategies and technologies considered in the DeconST are the following:

- **Volumetric Decontamination:** Chlorine Dioxide Gas, Methyl Bromide, Vaporous Hydrogen Peroxide®, and Low-Concentration Hydrogen Peroxide
- **Surface Decontamination:** Aqueous Chlorine Dioxide, Bleach Immersion, Bleach Spray, Bleach Wash, and Hydrogen Peroxide PAA (including Oxonia Active, Minncare, Spor-Klenz RTU, and Peridox RTU)
- **Demolition:** with and without rebuilding (equivalent to "restricted use" and "unrestricted use" in Superfund terminology)

For DeconST-chem (all versions), the default decontamination strategies and technologies considered in the tool are the following:

- **Natural Attenuation:** Natural Attenuation (25 ºC/24 h); VX version also includes (25 ºC/1 week) and (25 ºC/2 weeks) applications
- **Surface Decontamination:** 10x diluted Bleach 60 minutes, 10x diluted Bleach 24 hours, Full strength Bleach 60 minutes, 3% H_2O_2 solution 30 minutes, Easy Decon DF200 60 minutes, Easy Decon DF200 24 hours, DeconGel 1108, and Decon Green; VX version also includes OxyClean, ZEP Industrial Cleaner Full Strength, and ZEP Industrial Cleaner 25% solution
- **Volumetric Decontamination:** Chlorine Dioxide Gas, modified Vaporous Hydrogen Peroxide®, and Steam
- **Demolition:** with and without rebuilding (equivalent to "restricted" and "unrestricted" use in Superfund terminology)

Additional technologies (including hybrid technologies) can be added by the user through the Enter New Decontamination Technology button on the User Input worksheet. See the Advanced Features section for instructions.

RESULTS SUMMARY

least desirable

	Volumetric Decontamination						
	HVAC is decontaminated as part of volumetric decontamination				HVAC will be ven		
	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	**Low-Concentration Hydrogen Peroxide** 3000 ppmv, 3 hrs, >70% RH, >75 deg F	**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
% by Mass of Structural Materials Decontaminated	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
% by mass decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%
% by mass decontaminated and destroyed (treated waste)	0%	0%	0%	0%	0%	0%	0%
% by Area of Interior Materials Decontaminated	**100%**	**100%**	**30%**	**0%**	**0%**	**0%**	**100%**
% by area decontaminated and reusable	70%	100%	30%	0%	0%	0%	0%
% by area decontaminated and destroyed (treated waste)	30%	0%	0%	0%	0%	0%	100%
% by Mass of Contents Decontaminated	**90%**	**90%**	**90%**	**0%**	**70%**	**70%**	**70%**
% by mass decontaminated and reusable	70%	90%	90%	0%	70%	70%	70%
% by mass decontaminated and destroyed (treated waste)	20%	0%	0%	0%	0%	0%	0%
Total Cost, $M	**$6.6**	**$5.3**	**$4.9**	**$18.6**	**$8.8**	**$8.8**	**$8.8**
Decon Process Cost, $M	**$3.1**	**$3.8**	**$2.8**	**$6.9**	**$4.5**	**$4.5**	**$4.5**
Waste Management Cost, $M	**$3.5**	**$1.5**	**$2.1**	**$11.7**	**$4.3**	**$4.3**	**$4.3**
Material Removal/Replacement Time, k person hours	**171.0**	**71.0**	**88.0**	**674.0**	**207.0**	**207.0**	**205.0**
Removal Time, thousand person hours	165.0	66.0	78.0	664.0	196.0	196.0	194.0
Replacement Time, thousand person hours	6.0	5.0	10.0	11.0	11.0	11.0	11.0
Total Waste Generated, kilo Tons	**1.0**	**0.0**	**0.0**	**3.0**	**1.0**	**1.0**	**1.0**
Removed for Waste Treatment & Disposal *(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)*	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Potentially Contaminated Waste *(Materials & contents for which decontamination technology fails)*	0.0	0.0	0.0	3.0	1.0	1.0	1.0

Notes:

1. *Decontaminated = Met or exceeded Decontamination Efficacy Threshold Log Reduction of:* 6 *orders of magnitude*
2. *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.*
3. *Rounding of numbers can cause totals to not equal the sum of the component parts.*
4. *The presence of asbestos and lead paint are additional considerations for waste handling and demolition.*

Figure 5a. Results Summary Worksheet Part 1 (DeconST-bioBa)

:most desirable							
Surface Decontamination						**Demolition**	
y difficult to access and decontaminate; costs for this must be considered before using surface decontamination technologies							
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.	**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. Rinsate 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** (equivalent to "Unrestricted Use" in Superfund terminology)	**Demolition w/o Rebuilding** (equivalent to "Restricted Use" in Superfund terminology)
0%	**0%**	**0%**	**0%**	**0%**	**0%**	All facility materials are demolished and removed, and then decontaminated through the waste handling process.	All facility materials are demolished and removed, and then decontaminated through the waste handling process.
0%	0%	0%	0%	0%	0%		
0%	0%	0%	0%	0%	0%		
100%	**100%**	**100%**	**100%**	**100%**	**100%**		
0%	0%	0%	0%	0%	0%		
100%	100%	100%	100%	100%	100%		
70%	**90%**	**90%**	**70%**	**70%**	**70%**		
70%	70%	70%	70%	70%	70%		
0%	20%	20%	0%	0%	0%		
$8.8	**$8.6**	**$8.6**	**$8.8**	**$8.8**	**$8.8**	**$20.4**	**$18.2**
$4.5	**$4.5**	**$4.5**	**$4.5**	**$4.5**	**$4.5**	**$0.7**	**$0.7**
$4.3	**$4.1**	**$4.1**	**$4.3**	**$4.3**	**$4.3**	**$19.7**	**$17.6**
205.0	**185.0**	**184.0**	**204.0**	**204.0**	**204.0**	**722.0**	**693.0**
194.0	174.0	173.0	193.0	193.0	193.0	693.0	693.0
11.0	11.0	11.0	11.0	11.0	11.0	29.0	0.0
1.0	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**7.0**	**7.0**
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0
1.0	0.0	0.0	1.0	1.0	1.0	7.0	7.0

Figure 6b. Results Summary Worksheet Part 2 (DeconST-bioBa)

HVAC Considerations

The first row under the Strategy Categories shows the HVAC Considerations. For Volumetric Decontamination processes, the HVAC system is decontaminated as part of the volumetric decontamination process. For Surface Decontamination processes, decontamination of the HVAC system may present a separate and difficult challenge. Decontamination of less-accessible ducted HVAC systems may require significant efforts that are not explicitly incorporated into the cost calculations in the DeconST.

Decontamination Technology Conditions

The first row under the name of each decontamination technology shows the conditions under which that technology must be applied.

Decision Considerations

The decision considerations are the rows of the table, including the Percentages of Materials Decontaminated, the Total Cost, the Material Removal and Replacement Time, and the Total Waste Generated. Note that the color coding is a gradation from red to green, with red being the less-

desirable and green being the more-desirable outcome; the user may alter the color scheme to an absolute scale by changing the color thresholds in the rightmost columns of the worksheets.

Decontamination Percentages

The Percentages of Materials Decontaminated (detail shown in Figure 7) shows the total percent (by weight or surface area) of each type of material (structural materials, interior nonstructural materials, and contents) that is successfully decontaminated by each technology, as well as the percentages of those that are reusable versus destroyed. (Note that the percentages are by mass for the structural materials and contents and by area for the interior materials.) The same information is presented graphically on the % of Materials Decontaminated by Decontamination Technology plot (the Materials Decon % Plot chart). Details on the disposition of each material type can be found on the Results Materials Lists worksheets (with and without the quantities of materials listed) and on the Results Materials Disposition worksheet.

% by Mass of Structural Materials Decontaminated	**0%**	**0%**	**0%**	**0%**
% by mass decontaminated and reusable	0%	0%	0%	0%
% by mass decontaminated and destroyed (treated waste)	0%	0%	0%	0%
% by Area of Interior Materials Decontaminated	**100%**	**100%**	**30%**	**0%**
% by area decontaminated and reusable	70%	100%	30%	0%
% by area decontaminated and destroyed (treated waste)	30%	0%	0%	0%
% by Mass of Contents Decontaminated	**90%**	**90%**	**90%**	**0%**
% by mass decontaminated and reusable	70%	90%	90%	0%
% by mass decontaminated and destroyed (treated waste)	20%	0%	0%	0%

Figure 7. Results Summary Worksheet - Percentage of Materials Decontaminated Detail

Total Cost, $M	**$6.6**	**$5.3**	**$4.9**	**$18.6**
Decon Process Cost, $M	**$3.1**	**$3.8**	**$2.8**	**$6.9**
Waste Management Cost, $M	**$3.5**	**$1.5**	**$2.1**	**$11.7**

Figure 8. Results Summary Worksheet - Total Cost Detail

Total Cost

The Total Cost rows (detail shown in Figure 8) show the sum and the components of the Decontamination Process Cost (including incident command, characterization and clearance sampling and analysis, temperature and humidity adjustment, decontamination, and long-term monitoring) and the Waste Management Cost (including the costs for removing, decontaminating, disposing of, and replacing all materials and contents damaged and/or not decontaminated by the technology). The cost information is presented graphically in the Total Relative Costs of Decontamination Technologies plots (on the Costs Plot and Costs Plot wDemo charts) and in detail on the Results Costs worksheet. Remember that the HVAC decontamination is not included and may incur considerable costs; see the HVAC considerations row for this facility. Note that the costs of the decontamination strategies and technologies are provided as relative costs for purposes of strategy

and technology comparison. The true total cost would need to consider the cost of facility downtime, which for many facilities would likely overwhelm the cost of the remediation.

Material Removal/Replacement Time

The Material Removal and Replacement Time rows (detail shown in Figure 9) show the total *labor hours* required for the Removal and Replacement. Note that these times are provided as relative labor requirement times for purposes of strategy and technology comparison. The total facility downtime would need to take into consideration resource availability.

Material Removal/Replacement Time, k person hours	171.0	71.0	88.0	674.0
Removal Time, thousand person hours	165.0	66.0	78.0	664.0
Replacement Time, thousand person hours	6.0	5.0	10.0	11.0

Figure 9. Results Summary Worksheet - Material Removal/Replacement Time Detail

Total Waste Generated, kilo Tons	1.0	0.0	0.0	3.0
Removed for Waste Treatment & Disposal *(Materials & contents removed as waste prior to decontamination)*	0.0	0.0	0.0	0.0
Treated Waste *(Materials & contents decontaminated, but damaged by technology)*	1.0	0.0	0.0	0.0
Potentially Contaminated Waste *(Materials & contents for which decontamination technology fails)*	0.0	0.0	0.0	3.0

Figure 10. Results Summary Worksheet - Total Waste Generated Detail

Total Waste Generated

The Total Waste Generated rows (detail shown in Figure 10) show the total and component quantities of waste in three categories:

- **Sent Directly to Waste** the materials and contents removed as waste prior to decontamination,
- **Treated Waste** the materials and contents decontaminated, but damaged by the decontamination technology
- **Potentially Contaminated Waste** the materials and contents for which the decontamination technology fails

The information is shown graphically on the Waste Generated by Decontamination Technology plots (on the Waste Generated Plot wDemo and woDemo charts). Details on the disposition of each material type can be found on the Results Materials Lists worksheets (with and without the quantities of materials listed) and on the Results Materials Disposition worksheet.

Notes

The following notes are included at the bottom of the page as reminders to the user:

1. Decontaminated = Met or exceeded Decontamination Efficacy Threshold Log Reduction of: 6 orders of magnitude (or 80% for chem versions)

2. 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.
3. Rounding of numbers can cause totals not to equal the sum of the component parts.
4. The presence of asbestos and lead paint are additional considerations for waste handling and demolition. (This statement shows up in different forms, depending on the contamination considerations selected on the User Input page.)

Excel Implementation

The DeconST is implemented in Excel with macros to facilitate transparency and flexibility. All values, formulas, and macros can be viewed and altered. Most cells are protected to prevent inadvertent alteration. However, if the user wants to change cell contents, the first step is to unprotect the worksheet. To unprotect any worksheet, use the "Unprotect Sheet" command on the "Review" menu. No password is required. All worksheets and charts can be altered. The user should remember to save an original copy of the tool for recovery from any changes or alterations.

Next Steps

Switch to any of the more detailed results worksheets or plots, as indicated in the previous text.

- Results - Materials Disposition List (with or without amounts) (on the Results Materials Lists worksheet or Results Materials Lists wAmts worksheet, and in Figure 11) shows details on the disposition of each material type under each decontamination technology.
- Waste Generated by Decontamination Technology (with or without demolition options) (on the Waste Generated Plot wDemo and woDemo charts, and in Figure 12) show the breakdown of waste disposition for each decontamination technology. Note that not all the possible colors are shown in Figure 11 because the example scenario did not result in the type of waste with the green color coding.
- Total Relative Costs of Decontamination Technologies plots (on the Costs Plot and Costs Plot wDemo charts, and in Figure 13) show the sum and the components of the decontamination process and waste management costs. Note that not all the possible colors are shown in Figure 12 because the example scenario did not result in the type of cost elements with all possible colors.
- Results – Relative Costs table (on the Results Costs worksheet, and in Figure 14) shows the numerical breakdown of the components of the decontamination process and waste management costs for each decontamination technology.
- Percentage of Materials Decontaminated by Decontamination Technology plot (on the Materials Decon % Plot chart, and in Figure 15) shows graphically the total percent of each type of material (structural materials, interior non-structural materials, and contents) that is successfully decontaminated by each technology, as well as the percentages of those that are reusable versus destroyed.
- Results Materials Disposition table (on the Results Materials Disposition worksheet) shows the details on the disposition of each material type.

RESULTS - MATERIALS DISPOSITION LIST

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

Figure 11. Results Materials Disposition List (DeconST-bioBa)

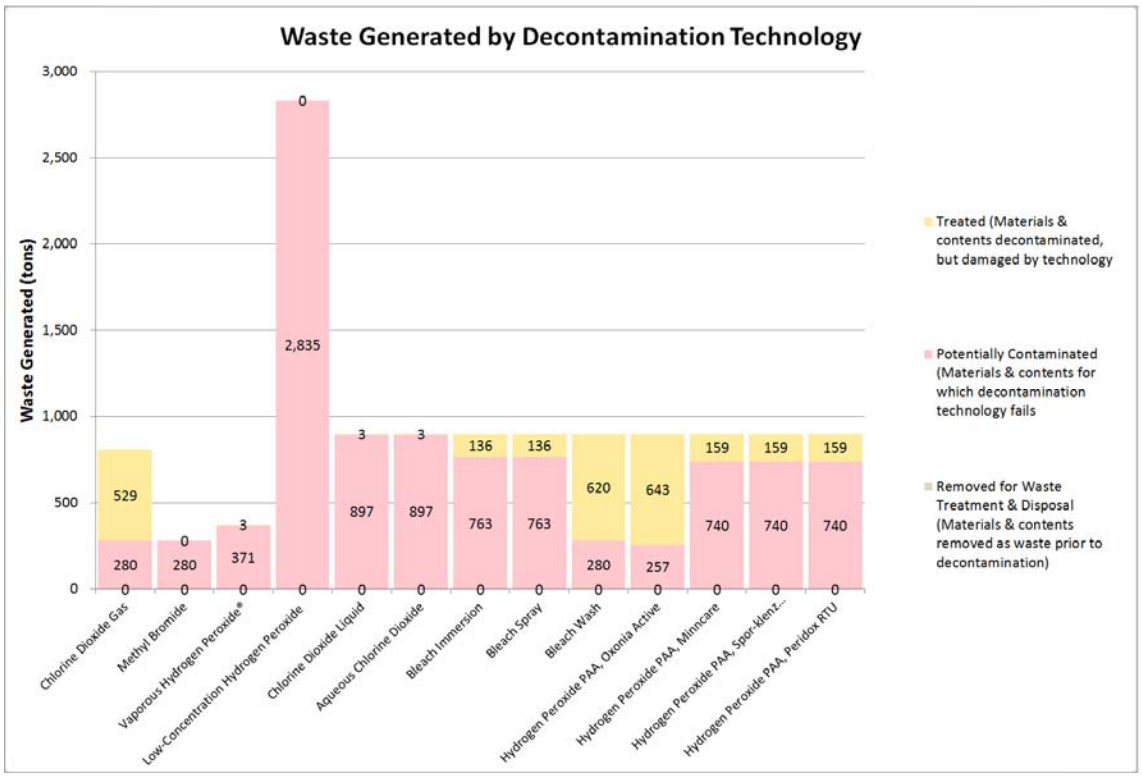


Figure 12. Waste Generated by Decontamination Technologies (DeconST-bioBa)

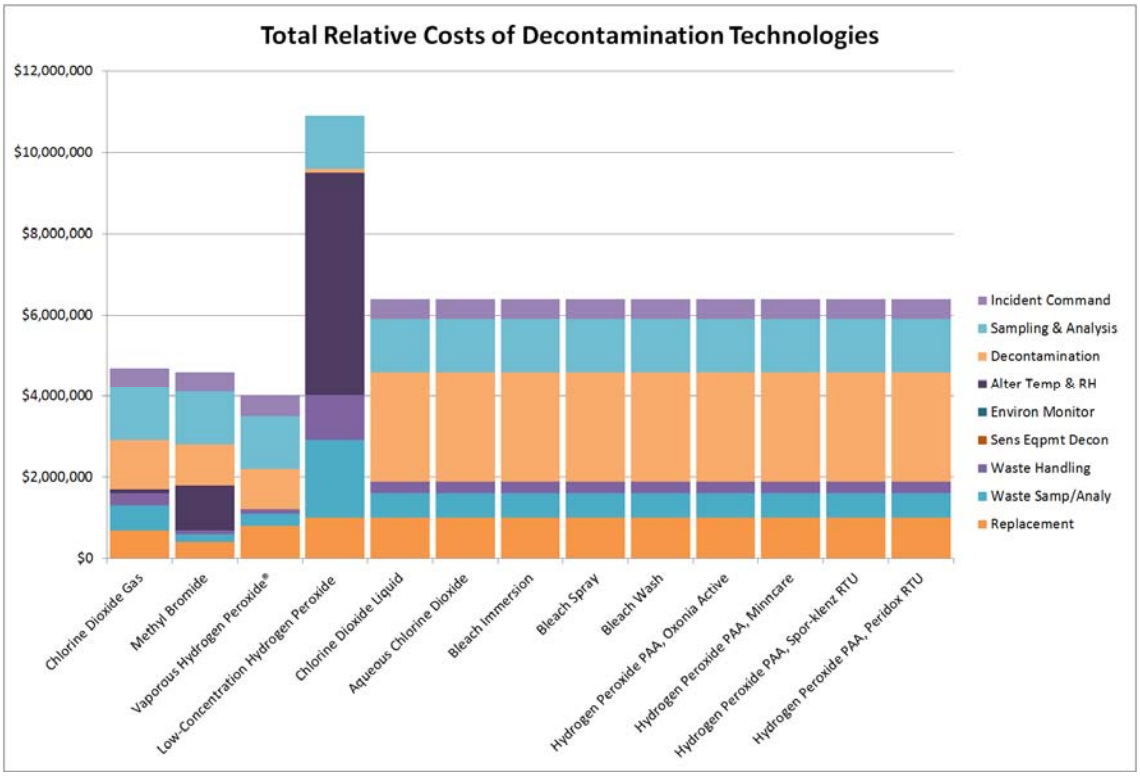


Figure 13. Total Relative Costs of Decontamination Technologies (DeconST-bioBa)

RESULTS - RELATIVE COSTS

	Volumetric Decontamination				
	HVAC is decontaminated as part of volumetric decontamination				
	Chlorine Dioxide Gas	Methyl Bromide	Vaporous Hydrogen Peroxide®	Low-Concentration Hydrogen Peroxide	Chlorine Dioxide Liquid
Total Cost = Waste + Decontamination Process:	**$6,600,000**	**$5,300,000**	**$4,900,000**	**$18,600,000**	**$8,800,000**
Material Removed as Waste:					
Total Quantity (tons)	**1000**	**0**	**0**	**3000**	**1000**
Removed for Waste Treatment & Disposal (Materials & contents removed as waste p	0	0	0	0	0
Treated (Materials & contents decontaminated, but damaged by technology	1000	0	0	0	0
Potentially Contaminated (Materials & contents for which decontamination technolo	0	0	0	3000	1000
Waste Cost ($)	**$3,500,000**	**$1,500,000**	**$2,100,000**	**$11,700,000**	**$4,300,000**
Removal Labor	$1,700,000	$700,000	$700,000	$6,600,000	$1,900,000
Decontaminated Waste Materials	$1,000,000	$0	$0	$0	$0
Potentially Contaminated Waste Materials	$700,000	$700,000	$700,000	$6,600,000	$1,900,000
Waste Handling	$1,200,000	$400,000	$600,000	$4,000,000	$1,300,000
Sampling Collection and Analysis	$600,000	$200,000	$300,000	$1,900,000	$600,000
Fixed Cost	$100,000	$0	$0	$300,000	$100,000
Transportation	$100,000	$0	$100,000	$400,000	$100,000
Handling	$300,000	$100,000	$100,000	$1,100,000	$300,000
Disposal	$100,000	$0	$0	$300,000	$100,000
Replacement	$700,000	$400,000	$800,000	$1,000,000	$1,000,000
Sensitive Item Decon:					
Cost ($)	$0	$0	$0	$0	$0
Quantity (tons)	0	0	0	0	0
Decontamination Process Relative Cost:	**$3,100,000**	**$3,800,000**	**$2,800,000**	**$6,900,000**	**$4,500,000**
IC Cost	$500,000	$500,000	$500,000	$0	$500,000
Sampling & Analysis Cost	$1,300,000	$1,300,000	$1,300,000	$1,300,000	$1,300,000
Characterization	$100,000	$100,000	$100,000	$100,000	$100,000
Decontamination Verification	$100,000	$100,000	$100,000	$100,000	$100,000
Clearance	$1,100,000	$1,100,000	$1,100,000	$1,100,000	$1,100,000
Decontamination Costs	$1,200,000	$1,000,000	$1,000,000	$100,000	$2,700,000
Costs to Alter Facility Temperature & RH	$100,000	$1,100,000	$0	$5,500,000	$0
Environmental Monitoring Costs	$0	$0	$0	$0	$0

Figure 14. Results - Relative Costs Breakdown (DeconST-bioBa)

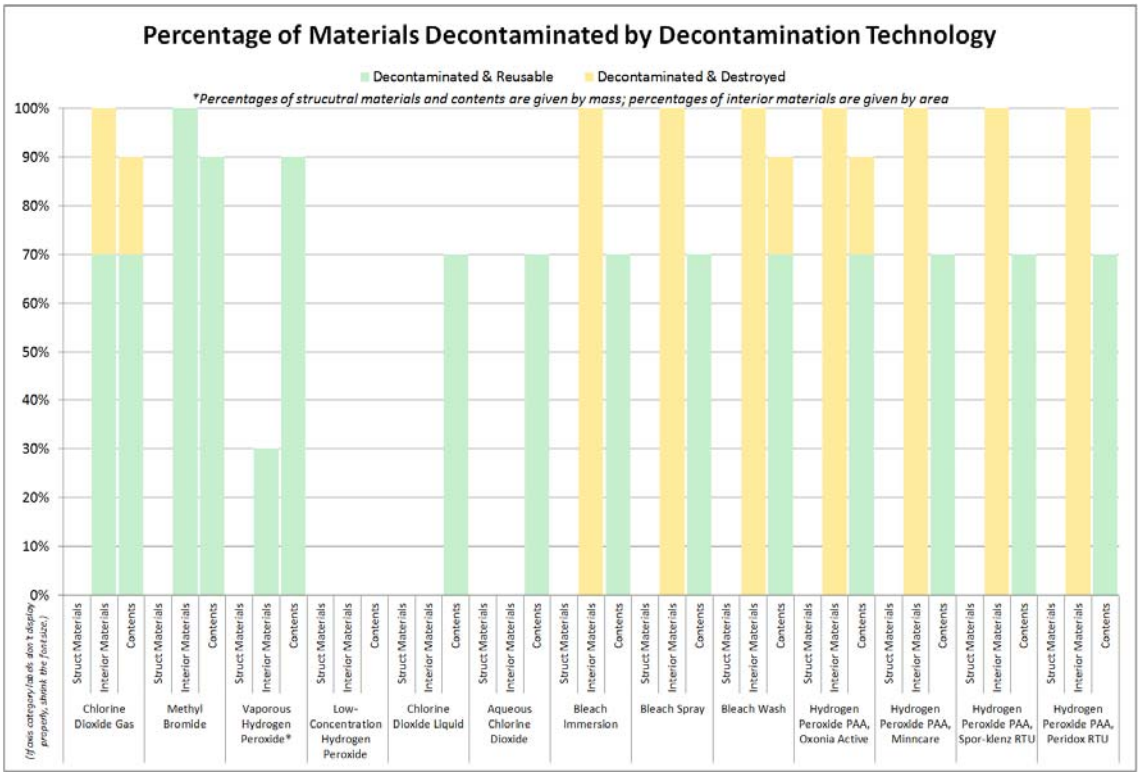


Figure 15. Results - Percentage of Materials Decontaminated by Decontamination Technology (DeconST-bioBa)

Advanced Features

Three primary advanced features are accessible on the User Input worksheet: the ability to accommodate a facility type not in the drop-down menu, the ability to add a new decontamination technology, and the ability to add a new facility material or item. These features allow the tool to evolve and accommodate changing user needs.

Other Structure Types

The DeconST uses the default facility types built in to the USEPA's Incident Waste Decision Support Tool (I-WASTE DST): Walled Office, Cubicle Office, Hospital, Hotel, Movie Theater, School, Shopping Mall, and Single-Family Residence (U.S. EPA 2013). To accommodate other facility types, the user may select the choice "Other Structure Types" for the Facility Type on the User Input worksheet. A pop-up box then gives the user the choice to run the I-WASTE DST tool to generate materials quantities for that structure or to enter the materials quantities manually.

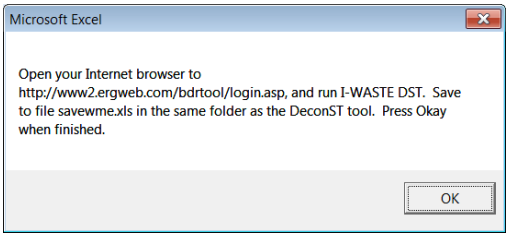


Figure 16. Instructions for using I-WASTE Tool to Determine Materials Quantities

Running I-WASTE DST

If the user chooses to run the I-WASTE DST tool, the instructions shown in Figure 15 appear.

Navigate an Internet browser to http://www2.ergweb.com/bdrtool/wme.asp (Figure 17) and run the I-WASTE DST tool (user account required). Run the Waste Materials Estimator according to suggestions found under the Modeling Other Structure Types button, including possibly selecting a multiple of the default facility types and modifying the default parameters for each of those default facility types. When finished, push the Generate Estimate button and then the Save to File button. Save the file to the default suggested name, waste_est.xls, and be sure to place it in or move it to the same folder as the DeconST tool. View, confirm, and adjust the materials values on the Materials Inputs worksheet, which has been updated to reflect the values found in the waste_est.xls file. Switch back to the User Input worksheet and enter the Ceiling Height and User Input Area. Consult the waste_est.xls file or the savewme worksheet to find the floor areas used by the I-WASTE tool.

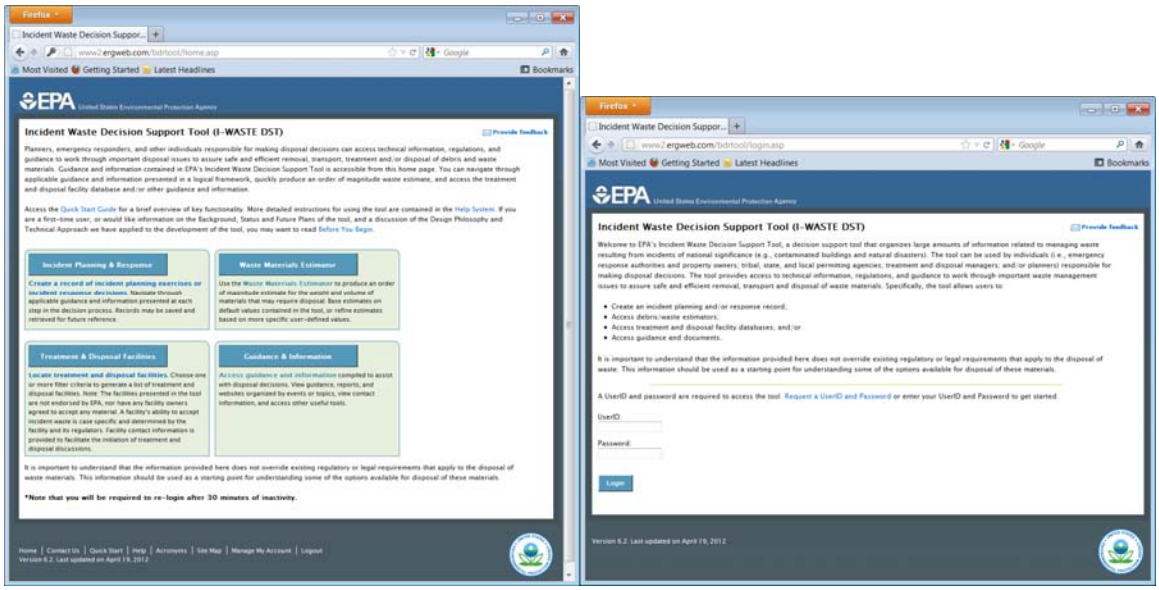


Figure 17. USEPA I-WASTE DST Login and Home Worksheets

Entering Materials Information Manually

If you choose not to run the I-WASTE tool, then you are given the option to enter the materials information manually. In this case, the materials quantities are cleared from the Materials Inputs worksheet. Enter the quantity for each material in the appropriate place. Switch back to the User Input worksheet and enter the Ceiling Height and User Input Area.

Adding a New Decontamination Technology

The DeconST-bio was created with the following default decontamination strategies and technologies:

- **Volumetric Decontamination:** Chlorine Dioxide Gas, Methyl Bromide, Vaporous Hydrogen Peroxide®, and Low-Concentration Hydrogen Peroxide
- **Surface Decontamination:** Chlorine Dioxide Liquid, Aqueous Chlorine Dioxide, Bleach Immersion, Bleach Spray, Bleach Wash, and Hydrogen Peroxide PAA (including Oxonia Active, Minncare, Spor-Klenz RTU, and Peridox RTU)
- **Demolition:** with and without rebuilding (equivalent to "restricted use" and "unrestricted use" in Superfund terminology)

DeconST-chem (all versions) was created with the following default decontamination strategies and technologies:

- **Natural Attenuation:** Natural Attenuation (25 ºC/24 h); VX version also includes (25 ºC/1 week) and (25 ºC/2 weeks) applications
- **Surface Decontamination:** 10x diluted Bleach 60 minutes, 10x diluted Bleach 24 hours, Full strength Bleach 60 minutes, 3% H_2O_2 solution 30 minutes, Easy Decon DF200 60 minutes, Easy Decon DF200 24 hours, DeconGel 1108, and Decon Green; VX version also includes OxyClean, ZEP Industrial Cleaner Full Strength, and ZEP Industrial Cleaner 25% solution

- **Volumetric Decontamination:** Chlorine Dioxide Gas, modified Vaporous Hydrogen Peroxide®, and Steam
- **Demolition:** with and without rebuilding (equivalent to "restricted" and "unrestricted" use in Superfund terminology)

If you would like to add another decontamination technology, gather the technical information about that technology and follow the two steps below. Be sure to save the DeconST as a separate file name so that you can recover from any error.

Note: For a new decontamination technology that is a hybrid of a volumetric and a surface decontamination method, you have two options: (1) if the facility will be divided into zones and each zone treated with different decontamination strategies, then the DeconST can be run multiple times, once for each decontamination zone; (2) if the multiple decontamination technologies will be applied within a single physical zone in the facility, then use the method below, with the following caveat: if the cost of the decontamination method is based on the facility volume, then enter the method as a new volumetric decontamination method; if the cost is based on the facility floor area, then enter the method as a new surface decontamination method.

Step 1: Enter the new decontamination technology onto the Decon Technology Data worksheet

Push the "Enter new Decontamination Technology" button on the User Input worksheet. Answer the questions to tell the DeconST whether the new technology is a Volumetric, Surface, or Natural Attenuation (for DeconST-chem only) Decontamination method.

Macros will run to insert new columns on the Decon Technology Data worksheet in the appropriate place in the table. Following the examples of the previous columns, enter the name of the new technology. Enter the efficacy and destructiveness of the new decontamination technology on each of the materials listed. If a value is unknown, then leave that cell blank. Include reference information about the data. Be sure to enter the environmental conditions, both a text description and values for required temperature and relative humidity conditions, as well as the required application time. The wind speed is not currently used by the DeconST. Input a one-word nickname for the new decontamination technology; note that the format for this nickname must be consistent with Excel standards for worksheet names and variable names (nickname must begin with a letter or underscore, nickname may not contain spaces or invalid characters, nickname may not conflict with an Excel built-in name or the name of another object in the workbook, nickname must be no more than 21 characters). Finally, add the decontamination costs, the liquid waste generation rate, and the environmental monitoring costs for the new decontamination technology.

Step 2: Run macros that add the new decontamination technology into the rest of the DeconST

When you have finished adding the information to the Decon Technology Data worksheet, scroll back to the top of the page and press the Add New Decon Technology to Results Worksheets button. A pop-up window prompts for the type of the new decontamination technology – volumetric, surface, or natural attenuation. Be sure to answer consistently with the technology you added. Macros will run to insert the new decontamination technology into the DeconST, adding it to the Decon Technology Data Rollup worksheet, creating a new calculations worksheet (called Calcs for

Nickname), adding it to the Results worksheet, the Results Materials Disposition worksheet, the Results Costs worksheet, the Costs plots, the Waste Generated plots, the Percent Materials Decontaminated plot, the Results Summary worksheet, the waste disposition calculations, and the Results Materials Lists worksheets. In the lower left corner of Excel, the Application Status Bar will display messages indicating the status of the macros, since this process may take several minutes to run, depending on the speed of your machine.

When the new decontamination technology has been successfully added to the DeconST, you will be taken to the Results Summary worksheet to view the results for the new technology in context of the other technologies. If you made a mistake, the easiest way to recover is to close this instance of the DeconST without saving and open a back-up version.

Adding a Facility Material or Item

The DeconST was created with the following default materials and contents:

- **Structural Materials:** Brick, Concrete, Steel, Wood, Other;
- Interior Non-Structural Materials:
    - Floors: Carpet, Marble and Ceramic Tiles, Wood Flooring, Other Floor Materials;
    - Walls: Curtains and Acoustical Material, Drywall, Wood, Other Wall Materials;
    - Ceilings: Ceiling Tiles, Other Ceiling Materials, Other Non-Structural Building Materials;
- **Contents:** Art and Music Equipment, Bathroom and Kitchen Materials, Dishware, Electronic Equipment, Food, Furniture (Porous and Non-Porous), Gym and Sports Equipment, Linens, Medical Supplies, Medical Waste, Paper and Office Supplies, Personal Effects, Pharmaceuticals, Other Items and Equipment

If you would like to add another material or contents not in this list, gather the technical information about that material (about the decontamination technologies on that material and about the costs for removing and replacing that new material or contents) and follow the two steps below. Be sure to save the DeconST as a separate file name so that you can recover from any error.

Step 1: Enter the new material onto the Decon Technology Data worksheet

Push the "Enter new Facility Material" button on the User Input worksheet. You will be taken to the Decon Technology Data worksheet. Find the appropriate place to insert the new material (alphabetically by category) and insert a row in the table. In that new row, put the name of the new material in the first column and, working across the columns, put the efficacy and destructiveness data for each decontamination technology on this material. When you have finished inputting the information, select the entire row containing the new material, scroll to the top left corner of the page, and push the "Continue adding data for New Material" button.

Step 2: Run macros that add the new material or contents into the rest of the DeconST

Macros run that add the new material to the Decontamination Technology Rollup worksheet, to the Costs-Waste Handling worksheet, to the Materials Inputs worksheet, to each of the calculations worksheets for each decontamination technology (the Calcs for NickName worksheets), to the Results worksheet, to the Materials Disposition worksheet, and to the Waste Disposition Calculations worksheet.

Step 3: Input labor costs for the new material or contents

After the macros have added the new material to the entire DeconST, you are taken to the "Costs - Waste Handling" sheet and prompted to insert values for costs. For a new structural or interior nonstructural material, enter the removal thickness, the removal labor and equipment cost, and the replacement cost. For new contents, enter the removal labor costs, and the replacement costs. When you have finished, scroll to the top of the page then push the "Continue adding data for New Material" button.

Step 4: Input amount and action for the new material or contents

You will next be taken to the Materials Inputs worksheet. For a new structural or interior nonstructural material, add thickness and density information. For the new material or contents, add the amount of the new material that is present in the facility. Set radio buttons to choose the appropriate action for the new material, set the checkbox if the material should be excluded from waste stream calculations, and enter per-item costs as necessary. When you have finished, the new material has been added to all worksheets, charts, and calculations in the DeconST.

Chapter

4

Example Scenarios

This section shows two example scenarios, their inputs and outputs, and a discussion of each. The two scenarios are a chemical agent released in a medium-sized office building and a biological agent released in an elementary school. Note that the use of the term "medium-sized" is used as a purely qualitative assessment of the size of the facility. The DeconST populates the estimated square footage and occupants for the facilities, which are then modifiable by the user.

Scenario 1: Chemical Agent in an Office Building

Scenario 1 involves a medium-sized office building with 25,000 ft^2 of walled offices (12 occupants) and 55,000 ft^2 of cubicle offices (100 occupants) contaminated with sulfur mustard sprayed into an HVAC duct. Characterization sampling has determined that the facility structure is likely not contaminated. The age of the facility indicates that asbestos and lead paint might be present. The HVAC system is ducted, unlined, highly accessible. The temperature of the building ranges between 60 and 80 °F, and the relative humidity ranges from 45-50%. The urban-area premium is 1, and the waste-handling difficulty is low. The User Input worksheet is shown in Figure 18.

The Materials Input worksheet is shown in Figure 19. The materials quantities are the values calculated from the I-WASTE worksheets for an office building of these specifications. The base scenario considers treating all interior/nonstructural materials and contents in place and does not include costs for replacing contents damaged by the decontamination process.

The Results Summary worksheet is shown in Figure 20. The best choice of decontamination strategy is volumetric decontamination with modified Vaporous Hydrogen Peroxide® or steam. An alternate decontamination strategy is surface decontamination using full strength bleach for 60 minutes. The percentage of materials decontaminated ranges from 90% for the best choice decontamination technologies to 0% for the poorest decontamination technologies. The decontamination costs including waste handling range from $4.6 million to $9.8 million to $21.1 million for the best, alternate, and poorest decontamination technologies, respectively. The amount of waste generated ranges from 0 to 1 to 4 kilotons for the best, alternate, and poorest decontamination technologies, respectively. Note that demolition costs $23 million to $25 million and is on the same order of magnitude as decontamination with some of the poorest technologies. The HVAC system will be decontaminated as part of any volumetric decontamination, and for any of the surface decontamination technologies, will be relatively easy to access and decontaminate.

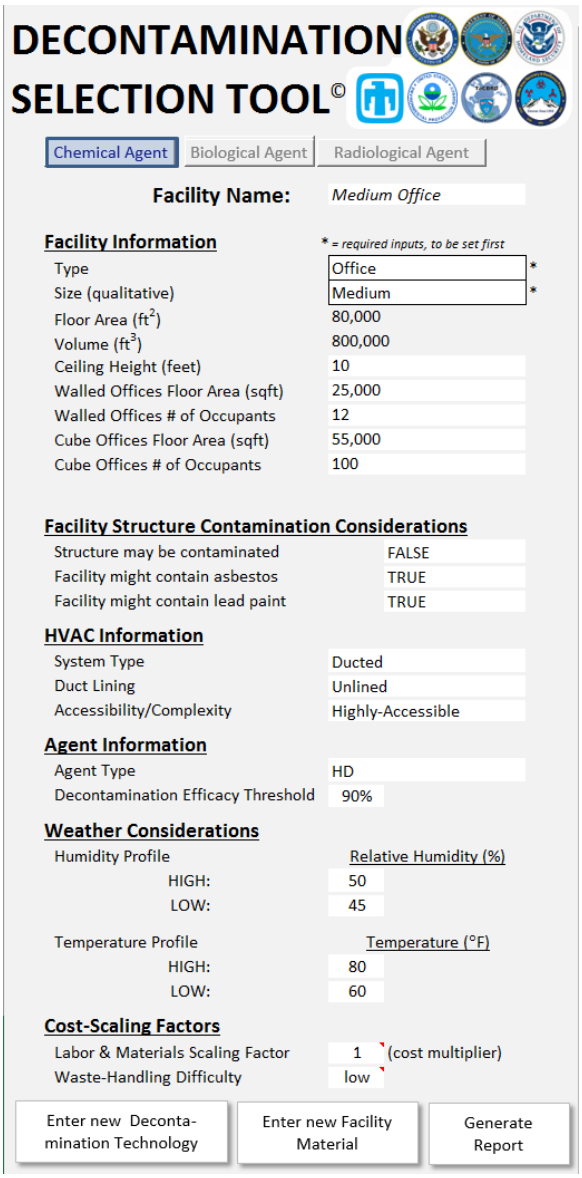
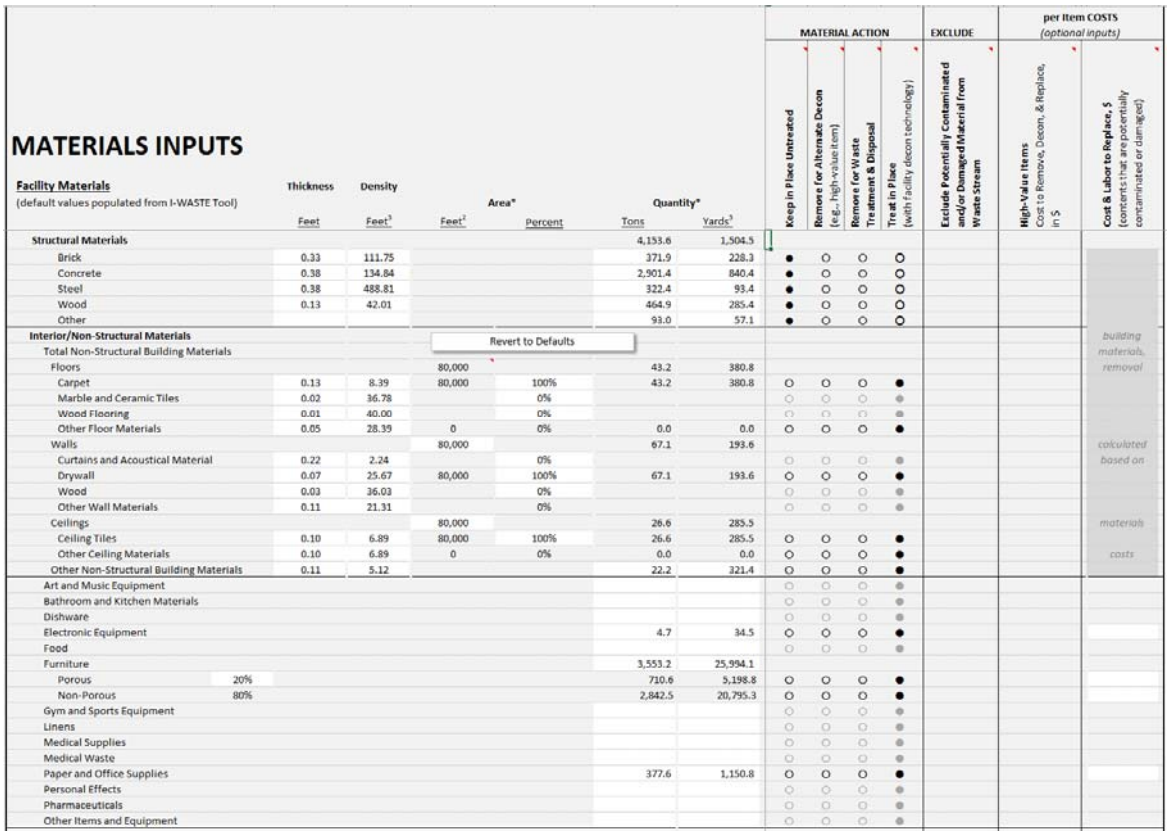


Figure 18. Chemical Agent in Office Building Scenario User Input Worksheet



MATERIALS INPUTS

Facility Materials (default values populated from I-WASTE Tool)	Thickness	Density	Area*		Quantity*		MATERIAL ACTION				EXCLUDE	per Item COSTS (optional inputs)	
	Feet	Feet^3	Feet^2	Percent	Tons	Yards^3	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 Potentially Contaminated and/or Damaged Material from Waste Stream	High-Value Items Cost to Remove, Decon, & Replace, in $	Cost & Labor to Replace, $ (contents that are potentially contaminated or damaged)
Structural Materials					4,153.6	1,504.5							
Brick	0.33	111.75			371.9	228.3	●	○	○	○			
Concrete	0.38	134.84			2,901.4	840.4	●	○	○	○			
Steel	0.38	488.81			322.4	93.4	●	○	○	○			
Wood	0.13	42.01			464.9	285.4	●	○	○	○			
Other					93.0	57.1	●	○	○	○			
Interior/Non-Structural Materials			Revert to Defaults										building materials removal
Total Non-Structural Building Materials													
Floors			80,000		43.2	380.8							
Carpet	0.13	8.39	80,000	100%	43.2	380.8	○	○	○	●			
Marble and Ceramic Tiles	0.02	36.78		0%			○	○	○	●			
Wood Flooring	0.01	40.00		0%			○	○	○	●			
Other Floor Materials	0.05	28.39	0	0%	0.0	0.0	○	○	○	●			
Walls			80,000		67.1	193.6							calculated based on
Curtains and Acoustical Material	0.22	2.24		0%			○	○	○	●			
Drywall	0.07	25.67	80,000	100%	67.1	193.6	○	○	○	●			
Wood	0.03	36.03		0%			○	○	○	●			
Other Wall Materials	0.11	21.31		0%			○	○	○	●			
Ceilings			80,000		26.6	285.5							materials
Ceiling Tiles	0.10	6.89	80,000	100%	26.6	285.5	○	○	○	●			
Other Ceiling Materials	0.10	6.89	0	0%	0.0	0.0	○	○	○	●			costs
Other Non-Structural Building Materials	0.11	5.12			22.2	321.4	○	○	○	●			
Art and Music Equipment							○	○	○	●			
Bathroom and Kitchen Materials							○	○	○	●			
Dishware							○	○	○	●			
Electronic Equipment					4.7	34.5	○	○	○	●			
Food							○	○	○	●			
Furniture					3,553.2	25,994.1							
Porous 20%					710.6	5,198.8	○	○	○	●			
Non-Porous 80%					2,842.5	20,795.3	○	○	○	●			
Gym and Sports Equipment							○	○	○	●			
Linens							○	○	○	●			
Medical Supplies							○	○	○	●			
Medical Waste							○	○	○	●			
Paper and Office Supplies					377.6	1,150.8	○	○	○	●			
Personal Effects							○	○	○	●			
Pharmaceuticals							○	○	○	●			
Other Items and Equipment							○	○	○	●			

Figure 19. Chemical Agent in Office Building Scenario Materials Inputs Worksheet

RESULTS SUMMARY	Natural Attenuation	Surface Decontamination									Volumetric Decontamination			Demolition	
	Decontamination of HVAC is unknown.	HVAC will be relatively easy to access and decontaminate using surface decontamination technologies									HVAC is decontaminated as part of volumetric decontamination				
	Natural Attenuation (25C / 24 hr)	10x diluted Bleach 60 min	10x diluted Bleach 24 h	Full strength Bleach 60 min	3% H2O2 solution; 30 min contact time	Easy Decon DF200 60 min	Easy Decon DF200 24 h	DeconGel 1108	Decon Green	Chlorine Dioxide Gas	modified Vaporous Hydrogen Peroxide®	Steam	Demolition w/ Rebuilding	Demolition w/o Rebuilding
	77F; 11% RH; 24 hrs	Bleach: Dilute to 0.6% NaOCl by weight. Spray 60-min contact. STS neutralized at end of contact time.	Bleach: Dilute to 0.6% NaOCl by weight. Spray 24 hour contact. STS neutralized at end of contact time.	Bleach: Full strength bleach. Spray 60-min contact. STS neutralized at end of contact time.	3% H2O2; 30 min contact time	DF200; 60 minute contact time	DF200; 24 hour contact time	DeconGel 1108; ? Hour contact time	Decon Green; 24 hour contact time	3000 ppmv, 7 hrs, >70% RH, >75 deg F	220 ppmv, 3 hrs	60 min steam rate 1.5 kg/hr	(equivalent to "Unrestricted Use" in Superfund terminology)	(equivalent to "Restricted Use" in Superfund terminology)
% by Mass of Structural Materials Decontaminated	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	All facility materials are demolished and removed, and then decontaminated through the waste handling process.	All facility materials are demolished and removed, and then decontaminated through the waste handling process.
% by mass decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		
% by mass decontaminated and destroyed (treated waste)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		
% by Area of Interior Materials Decontaminated	0%	0%	30%	30%	0%	0%	0%	0%	30%	0%	70%	70%		
% by area decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	70%	70%		
% by area decontaminated and destroyed (treated waste)	0%	0%	30%	30%	0%	0%	0%	0%	30%	0%	0%	0%		
% by Mass of Contents Decontaminated	0%	0%	0%	90%	0%	0%	0%	0%	0%	0%	90%	90%		
% by mass decontaminated and reusable	0%	0%	0%	70%	0%	0%	0%	0%	0%	0%	90%	90%		
% by mass decontaminated and destroyed (treated waste)	0%	0%	0%	20%	0%	0%	0%	0%	0%	0%	0%	0%		
Total Cost, $M	$18.4	$21.1	$21.1	$9.8	$21.1	$21.1	$21.1	$21.1	$21.1	$19.7	$4.6	$4.6	$25.3	$23.1
Decon Process Cost, $M	$1.9	$4.5	$4.5	$4.5	$4.5	$4.5	$4.5	$4.5	$4.5	$3.1	$2.8	$2.8	$0.7	$0.7
Waste Management Cost, $M	$16.6	$16.6	$16.6	$5.3	$16.6	$16.6	$16.6	$16.6	$16.6	$16.6	$1.8	$1.8	$24.6	$22.4
Material Removal/Replacement Time, M person hours	1.0	1.0	1.0	0.3	1.0	1.0	1.0	1.0	1.0	1.0	0.1	0.1	1.0	1.0
Removal Time, million person hours	1.0	1.0	1.0	0.3	1.0	1.0	1.0	1.0	1.0	1.0	0.1	0.1	1.0	1.0
Replacement Time, million person hours	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Waste Generated, kilo Tons	4.0	4.0	4.0	1.0	4.0	4.0	4.0	4.0	4.0	4.0	0.0	0.0	8.0	8.0
Removed for Waste Treatment & Disposal *(Materials & contents removed as waste prior to decontamination)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Potentially Contaminated Waste *(Materials & contents for which decontamination technology fails)*	4.0	4.0	4.0	0.0	4.0	4.0	4.0	4.0	4.0	4.0	0.0	0.0	8.0	8.0

Figure 20. Chemical Agent in Office Building Scenario Results Summary Worksheet

Scenario 2: *Bacillus anthracis* in an Elementary School

In Scenario 2, a terrorist releases *Bacillus anthracis* spores into an elementary school. The school has 200 students and 30,000 ft^2 of surface area. Characterization sampling has determined that the facility structure is likely not contaminated. The age of the facility indicates that asbestos and lead paint might be present. The HVAC system is ducted, unlined, highly accessible. The temperature of the building ranges between 60 and 80 °F and the relative humidity ranges from 45-50%. The urban-area premium is 1, and the waste-handling difficulty is low.

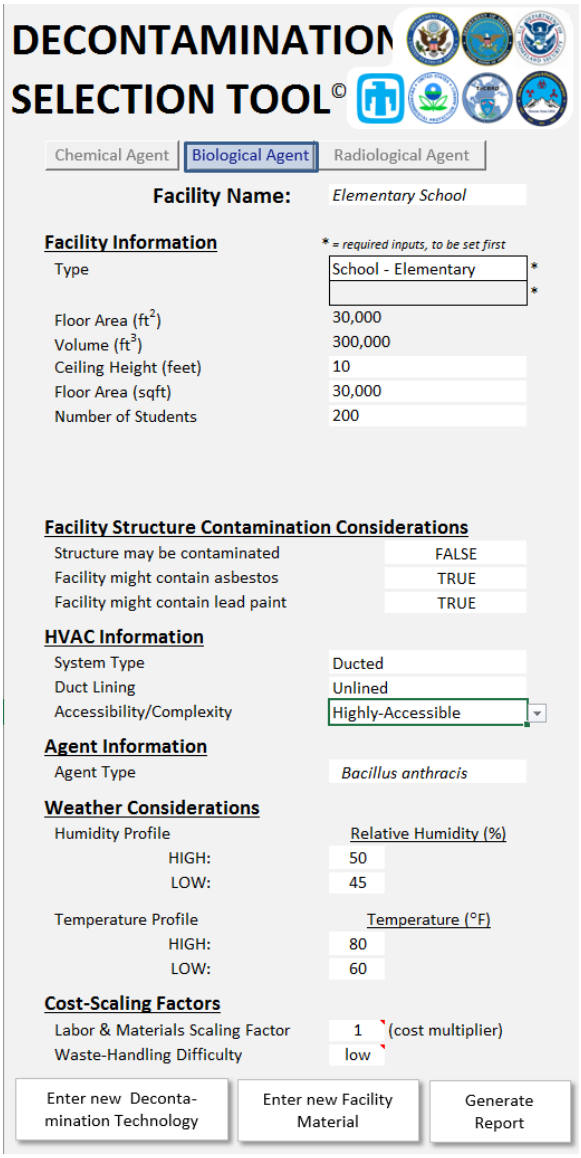


Figure 21. Biological Agent in an Elementary School Scenario User Input Worksheet

The Materials Input worksheet is shown in Figure 22. The materials quantities are the values calculated from the I-WASTE worksheets for an elementary school building of these specifications.

The base scenario considers treating all materials in place and does not include costs for replacing contents damaged by the decontamination process.

The Results Summary worksheet is shown in Figure 23. It is notable that there are many good decontamination choices, including both volumetric and surface decontamination strategies. The best choice decontamination strategy is volumetric decontamination with chlorine dioxide gas or methyl bromide. Alternate decontamination strategies include volumetric decontamination with Vaporous Hydrogen Peroxide® or surface decontamination using any of the bleach or hydrogen peroxide formulations. The percentage of materials decontaminated ranges from 90% for the best choice decontamination technologies to 0% for the poorest decontamination technologies. The decontamination costs including waste handling range from $1.6 million to $2.3 million for the best and poorest decontamination technologies, respectively. The amount of waste generated ranges from 0 to 1,000 tons for the best and poorest decontamination technologies, respectively. Note that demolition costs $3.8 million to $4.6 million, significantly more than the decontamination options. The HVAC system will be decontaminated as part of any volumetric decontamination; however, for any of the surface decontamination technologies, the HVAC system may not be easy to access and decontaminate.

MATERIALS INPUTS

Facility Materials (default values populated from I-WASTE Tool)	Thickness	Density	Area*		Quantity*		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)
	Feet	Feet³	Feet²	Percent	Tons	Yards³							
Steel	0.38	488.81			139.1	38.8	●	○	○	○			
Wood	0.13	42.01			223.9	133.5	●	○	○	○			
Other					44.8	26.7	●	○	○	○			
Interior/Non-Structural Materials			Revert to Defaults										*building materials, removal*
Total Non-Structural Building Materials													
Floors			30,000		5.2	37.9							
Carpet	0.04	8.44	25,461	85%	3.9	34.4	○	○	○	●			
Marble and Ceramic Tiles	0.02	36.78		0%			○	○	○	●			
Wood Flooring	0.01	40.00		0%			○	○	○	●			
Other Floor Materials	0.02	28.41	4,539	15%	1.3	3.4	○	○	○	●			
Walls			2,020		2.8	8.1							*calculated based on*
Curtains and Acoustical Material	0.22	2.24		0%			○	○	○	●			
Drywall	0.11	25.64	2,020	100%	2.8	8.1	○	○	○	●			
Wood	0.03	36.03		0%			○	○	○	●			
Other Wall Materials	0.12	21.30		0%			○	○	○	●			
Ceilings			35,301		10.1	108.3							*materials*
Ceiling Tiles	0.08	6.92	35,301	100%	10.1	108.3	○	○	○	●			
Other Ceiling Materials	0.08	6.92		0%			○	○	○	●			*costs*
Other Non-Structural Building Materials	0.19	4.84			9.7	148.8	○	○	○	●			
Art and Music Equipment					1.2	15.4	○	○	○	●			
Bathroom and Kitchen Materials							○	○	○	●			
Dishware							○	○	○	●			
Electronic Equipment					10.7	93.8	○	○	○	●			
Food							○	○	○	●			
Furniture					57.0	630.4							
Porous	20%				11.4	126.1	○	○	○	●			
Non-Porous	80%				45.6	504.3	○	○	○	●			
Gym and Sports Equipment					1.6	30.7	○	○	○	●			
Linens							○	○	○	●			
Medical Supplies							○	○	○	●			
Medical Waste							○	○	○	●			
Paper and Office Supplies					33.0	274.7	○	○	○	●			
Personal Effects							○	○	○	●			
Pharmaceuticals							○	○	○	●			
Other Items and Equipment							○	○	○	●			

Figure 22. Biological Agent in an Elementary School Scenario Materials Inputs Worksheet

RESULTS SUMMARY	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 3000 ppmv, 3 hrs, >70% RH, >75 deg F	Methyl Bromide 212 mg/l, 37 degrees C, 75% RH, 18 hour contact time	Vaporous Hydrogen Peroxide® 225 ppmv, 4 hrs	Low-Concentration Hydrogen Peroxide 3000 ppmv, 3 hrs, 70%RH, >75 deg F	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.	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. Rinsate has 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, 0.23% PAA	Demolition w/ Rebuilding (equivalent to "Unrestricted Use" in Superfund terminology)	Demolition w/o Rebuilding (equivalent to "Restricted Use" in Superfund terminology)
% by Mass of Structural Materials Decontaminated	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**		
% by mass decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	All facility materials are demolished and removed, and then decontaminated through the waste handling process.	All facility materials are demolished and removed, and then decontaminated through the waste handling process.
% by mass decontaminated and destroyed (treated waste)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		
% by Area of Interior Materials Decontaminated	**90%**	**90%**	**40%**	**0%**	**0%**	**0%**	**90%**	**90%**	**90%**	**90%**	**90%**	**90%**	**90%**		
% by area decontaminated and reusable	60%	90%	40%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		
% by area decontaminated and destroyed (treated waste)	40%	0%	0%	0%	0%	0%	90%	90%	90%	90%	90%	90%	90%		
% by Mass of Contents Decontaminated	**70%**	**70%**	**70%**	**0%**	**50%**	**50%**	**60%**	**60%**	**70%**	**70%**	**60%**	**60%**	**60%**		
% by mass decontaminated and reusable	40%	70%	60%	0%	40%	40%	40%	50%	50%	40%	40%	40%	40%		
% by mass decontaminated and destroyed (treated waste)	20%	0%	10%	0%	10%	10%	10%	10%	20%	20%	10%	10%	10%		
Total Cost, $M	**$1.7**	**$1.6**	**$1.6**	**$1.4**	**$2.3**	**$2.3**	**$2.3**	**$2.3**	**$2.3**	**$2.3**	**$2.3**	**$2.3**	**$2.3**	**$4.6**	**$3.8**
Decon Process Cost, $M	$1.2	$1.2	$1.1	$0.6	$1.7	$1.7	$1.7	$1.7	$1.7	$1.7	$1.7	$1.7	$1.7	$0.3	$0.3
Waste Management Cost, $M	$0.5	$0.3	$0.5	$0.8	$0.6	$0.6	$0.6	$0.6	$0.6	$0.6	$0.6	$0.6	$0.6	$4.3	$3.5
Material Removal/Replacement Time, k person hours	**16.8**	**11.4**	**14.7**	**30.1**	**18.6**	**18.6**	**18.3**	**18.0**	**17.5**	**17.7**	**18.2**	**18.2**	**18.2**	**50.7**	**40.2**
Removal Time, thousand person hours	14.6	9.5	12.4	27.5	16.0	16.0	15.7	15.4	14.9	15.1	15.5	15.5	15.5	40.2	40.2
Replacement Time, thousand person hours	2.2	1.9	2.3	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	10.5	0.0
Total Waste Generated, kilo Tons	**0.1**	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**2.0**	**2.0**
Removed for Waste Treatment & Disposal *(Materials & contents removed as waste prior to decontamination)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Potentially Contaminated Waste *(Materials & contents for which decontamination technology fails)*	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	2.0	2.0

Figure 23. Biological Agent in an Elementary School Scenario Results Summary Worksheet

Chapter

5

Upgrades since 2012 Version of Tool

DeconST was initially developed in 2012 as a tool to examine decontamination options for facilities contaminated with the biological agent *Bacillus anthracis*. The 2016-2017 effort updated that tool and adapted it into new versions for chemical agents mustard (HD) and VX. This chapter lists the primary upgrades and bug fixes in the tool.

Upgrades

- Incorporates new I-WASTE multiplication factors.
    - Consolidates cubicle and walled offices into a single office building type.
- Handles importing I-WASTE output file (with new filename).
- Incorporates new materials and labor costs from:
    - Craftsman 2017 National Heavy Construction Estimator.
    - Craftsman 2017 National Construction Estimator.
    - Craftsman 2017 National Repair and Remodeling Estimator.
- Incorporates new HAZMAT premium from Bureau of Labor and Statistics 2015 report.
- Includes Low Concentration Hydrogen Peroxide as another volumetric decontamination technology for bio.
- Chem versions for HD and VX available.
- Removed "user defined functions" (UDFs) and replaced with simple unit conversion factors.

Major Bug Fixes

Structural Materials

- Steel structural materials - 1000x mistake in replacement materials cost (units mistake) – caused ~$3M error on costs for Medium Office building for all but Methyl Bromide and Vaporous Hydrogen Peroxide).
- Brick structural materials – 76% reduction in removal labor hours and costs (units mistake).

All Interior/Non-structural Materials

- All – 27x increase in labor time and costs for removal (missing unit conversion).
- Floor tiles – 38% reduction in replacement materials cost (difference in NCE estimates).
- Ceiling tiles – 50-75% reduction in materials and labor costs (used different section in NCE).

Minor Bug Fixes

- Added missing equipment costs in interior/non-structural materials removal and replacement costs.

- Added missing HAZMAT premium costs on materials sent directly to waste.
- Corrected handling of materials "excluded from waste stream".

Changes by Page

General

- Added note to many pages: *Remember that DeconST is implemented in Excel, with all functionality available to the user, including zoom view, unfreeze panes, and view and edit all cells.*

Macros

- Enter New Facility Material - Upgraded to allow new interior/non-structural materials to be placed at top and bottom positions within each category.

User Input Page

- Facility Information:
  - added a default qualitative size for each facility type.
  - changed the words "Alt. User Input Area" to "Floor Area".
- Added Facility Structure Contamination Conditions:
  - true/false input for potential contamination of structure – changes radio buttons for structural materials on Materials Inputs page.
  - true/false inputs for potential presence of asbestos and lead paint – changes note at bottom of Results Summary and Results Materials Lists pages.
- Added minimum efficacy percentage user input for chem tool.
- Weather considerations: Added checks that high values are greater than low.
- Urban Area Premium: added note for clarification.
- Cost-Scaling Factors: waste-handling difficulty: added note to reference Municipal Solid Waste.
- Added Disable pop-ups box to disable pop-ups in basic tool operation.

Materials Inputs Page

- Renamed Exterior Structural Materials to Structural Materials.
- Limited floor area from sum of floor materials (calculated from material volume divided by material density) to be no larger than facility floor area (from User Input page).
- Limited ceiling area to be no larger than floor area.
- Corrected calculations of "other" floor, wall, and ceiling areas to use indirect addressing to allow proper inclusion of new materials added by macros.
- Implemented functionality of radio buttons to reflect user input regarding potential contamination of structure.
- Changed thicknesses to use calculated facility-specific values (derived from I-WASTE, rather than Internet, calculated on new Materials Thicknesses page).

- User sees differences in
  - surface areas for interior non-structural materials (due to new use of I-WASTE-derived facility-specific thicknesses, rather than Internet-derived).
  - total floor area and ceiling area limited to facility floor area set on User Inputs page.

Sampling Inputs Detail Page:

- Spelled out acronyms PCR and BI, Polymerase Chain Reaction and Biological Indicator.

Results Summary Page

- % of … Materials Decontaminated: changed these to:
  - % by Mass for Structural and Contents; and
  - % by Area for Interior Materials.
- Color shading: added user controls for endpoints and midpoints of color ranges.
- Demolition Columns:
  - Added notes about Superfund terminology.
  - Replaced materials decontaminated % n/a placeholders with text "All facility materials are demolished and removed, and then decontaminated through the waste handling process."
- Material Removal/Replacement Time:
  - Display results as k- and M-person hours, as appropriate.
- Total Waste Generated:
  - Display results as kilo- and Mega-Tons, as appropriate.
  - Changed text "Sent Directly to Waste" to "Removed for Waste Treatment and Disposal".
- Added notes at bottom of page:
  - Note that Decontaminated = met the minimum efficacy % put on User Input sheet.
  - Note that responds as appropriate to potential presence of asbestos or lead paint.

Waste Generated Plots:

- Removed rounding in source data.

- User sees actual numbers now.

Costs Plots:

- Changed color schemes.
- Removed rounding in source data.

- User sees overall lower costs – due to error fixed in replacement cost of steel (mistake added $3M to all but VHP and Methyl Bromide).

Results Costs/Results Materials Disposition/Results Pages:

- Color shading: added user controls for endpoints and midpoints of color ranges.

- User sees higher replacement costs.

Materials Decon % Costs Plot:

- Source data calculates % of interior non-structural materials decontaminated by area rather than mass.
- Added note under title: Percentages of structural materials and contents are given by mass; percentages of interior materials are given by area.

- Added note next to origin: If axis category labels don't display properly, shrink the font size.

- User sees greater % of interior non-structural materials decontaminated.

Results Page:

- Source data calculates % of interior non-structural materials decontaminated by area rather than mass.
- Changes in material removal and replacement costs for interior non-structural due to use of new thicknesses (derived from I-WASTE, rather than Internet, calculated on new Materials Thicknesses page); also differences due to updated removal and replacement costs; biggest difference in steel replacement cost for materials.
- Added coloring for materials disposition outcomes of Keep Untreated and Send Directly to Waste (could do this on Materials Disposition page, too!).

- User sees:
    - greater % of interior non-structural materials decontaminated.
    - differences in waste-management cost, material removal/replacement time, total waste generated - dominated by replacement cost of steel (mistake added $3M to all but VHP and Methyl Bromide).

Costs – Waste Handling Page:

- Changed materials thicknesses from internet-derived values to facility-specific I-WASTE values calculated on Materials Thicknesses page.

CostRefs - Replace Structural/CostRefs - Remove Interior/CostRefs - Replace Interior/ HazMAT / Reference Pages.

- Updated all materials removal and replacement numbers and labor rates consistent with updated references (on References page).

Calcs. for (Decon Technology) Pages (all):

- Added columns to calculate areas of materials under Decontaminated Successfully (green) and Decontaminated Waste (yellow) columns.
- Added columns to calculate quantities of waste excluded from calculations and then to exclude them.
- Added calculations of percentage by area for interior/non-structural materials.
- Changed all totals and % calculations to use indirect references to include any new materials added with Add New Materials Macros.
- Moved heating/cooling and humidifying/dehumidifying calculations to location not affected by the addition of any new materials added with Add New Materials Macros.

I-WASTE Pages (all):

- Updated to be consistent with new I-WASTE workbook provided by EPA.

Materials Thicknesses – added page:

- Calculates facility-specific materials densities determined from I-WASTE.

Chapter

6

Technical Reference Guide

The Technical Reference Guide is intended for the advanced user who wants to change parameters not part of the user input worksheets or for the developer who wants to change calculations or functions. This Guide begins with an Overview of the Worksheets, Charts, and Macro Subroutines, then provides descriptions of the Worksheets and Charts and of the Macro Subroutine and Functions, and includes a description of the primary parameters that are not accessible on the User Input or I-WASTE tabs.

To make changes to any worksheet, the first step is to unprotect the worksheet. To unprotect any worksheet, use the "Unprotect Sheet" command on the "Review" menu. No password is required. All worksheets and charts can be altered. The user should remember to save an original copy of the tool for recovery from any changes or alterations.

Overview of Worksheets, Charts, and Macros

The DeconST consists of over fifty Microsoft Excel worksheets and charts and over thirty macro subroutines and functions. Further subsections in this Technical Reference Guide provide summaries of each (see subsections on Worksheets and Charts, and on Macro Subroutines and Functions, respectively), but before that this subsection gives an overview of the organization and relationships among them. The first subsection and figure show an overview of the worksheets, charts, and the macro subroutines together with their general organization. The next two subsections and figures show the effects of the Add New Decon Technology macro and the Add New Material macro, respectively.

Overview and Organization of the Worksheet and Charts and Subroutines

Figure 24 shows an overview of the worksheet and charts and macro subroutines together with their general organization, grouped by associations shown in the orange-outlined frames. The component worksheet and charts are shown as blue rectangles, the data connections between them as blue arrows, and data connections through macro subroutines as green arrows.

The User Input Worksheets grouping includes the worksheets and macro subroutines that collect the user input on the facility and environmental conditions, display the associated default types and quantities of the default values and designate special handling for the materials, and allow the user to input sampling densities and certain costs.

The Facility Worksheets grouping contains the USEPA I-WASTE worksheets, which generate materials type and quantity estimates based on facility type and relevant parameters; these materials types and quantities are collected in the Facility Data worksheet and sent to the Materials Input worksheet in the User Input Worksheets collection. The Facility Worksheets grouping also includes the savewme worksheet, which is where data are collected from external execution of the I-WASTE tool directly.

The Data Worksheets grouping contains data that are used by the DeconST and that in general would not be modified by the casual user, including the Decon Technology Data worksheets, which include decontamination technology effectiveness, application conditions, environmental factors, and material compatibility; the Parameters worksheets, which include threshold values and certain lists; the Sampling and Waste Cost Data worksheets, which include the costs for processing samples, the cost of sampling and transporting waste, and the cost of waste handling, including removal and replacement; the Heater/Cooler Costs worksheets, which include the costs to rent heaters, air-conditioners, humidifiers, and/or dehumidifiers to alter the interior operational conditions; and the HVAC Worksheet, which provides a qualitative translation of the HVAC parameters into HVAC decontamination advice.

The Calculations Worksheets grouping combines the information from the User Input Worksheets grouping with the information from the Data Worksheets grouping to perform the calculations, one worksheet for each decontamination technology. These calculations are sent to the Results worksheet, which is part of the Intermediate Output Worksheets grouping that also includes some parsing of the results into the Intermediate Results Worksheets and the Results Worksheets for Plots.

The final grouping is the Outputs to User grouping, which takes the Intermediate Output Worksheets and produces the Results Tables and Plots that are displayed to the User.

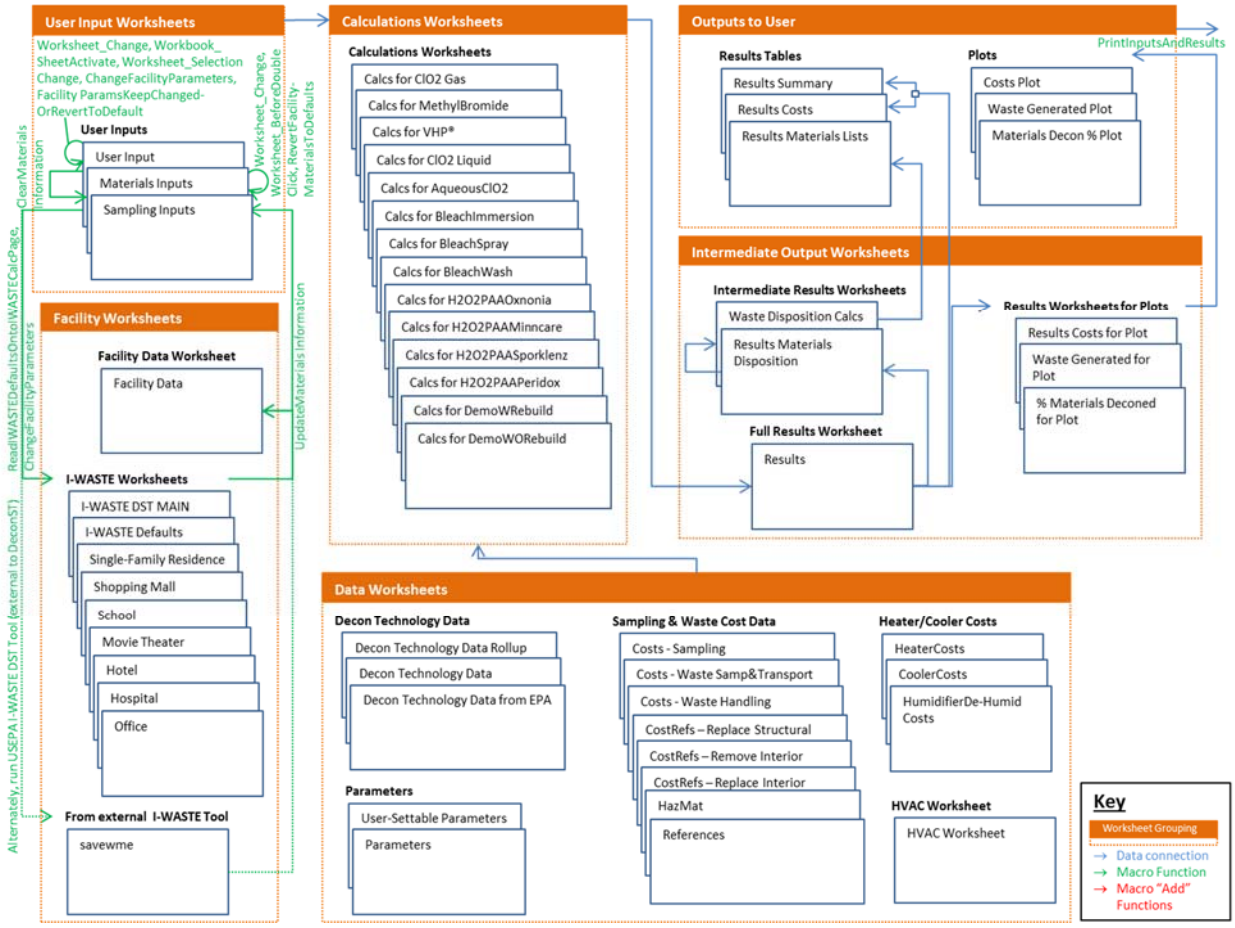


Figure 24. Workbook Tabs and Macro Subroutines - Basic

Effect of Adding a New Decontamination Technology on the Worksheets and Charts

Figure 25 expands Figure 24 to show the effect on the worksheets and charts of adding a new decontamination technology through the Add New Decon Technology macro. As in Figure 24, Figure 25 shows the general organization through the groupings in orange-outlined frames, the component worksheet and charts as blue rectangles, the data connections as blue arrows, and the macro connections as green arrows. To add a new decontamination technology, the user pushes the "Enter a new Decontamination Technology" button on the User Input worksheet and thereby launches the Add New Decon Technology macro. The macro inserts columns on the Decon Technology Data worksheet for the user to enter the appropriate technology information. The user pushes the Add New Decon Technology to Results Worksheets button to launch the next macro subroutine (AddNewDeconMethodToAllPages); this macro then runs multiple macros (shown in red text) that add the new decontamination technology to each of the affected worksheets and charts (indicated by pale red coloring).

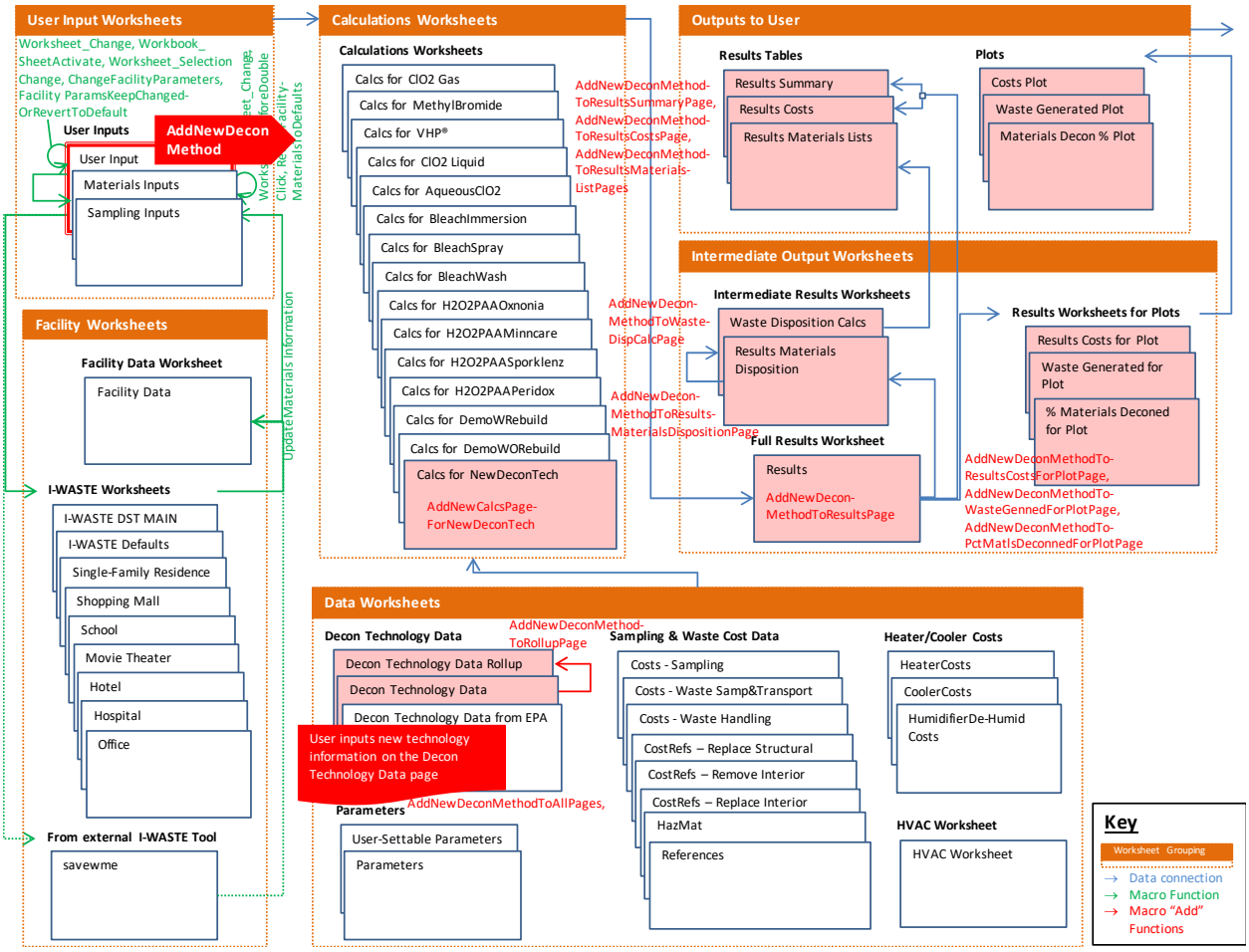


Figure 25. Workbook Tabs and Macro Subroutines - Add New Decontamination Technology

Effect of Adding a New Material on the Worksheets and Charts

Figure 26 similarly expands Figure 24, this time to show the effect on the worksheet and charts of adding a new structural or non-structural interior material or item through the Add New Decon Material macro. As in Figures Figure 24 and Figure 25, Figure 26 shows the general organization through the groupings in orange-outlined frames, the component worksheet and charts as blue rectangles, the data connections as blue arrows, and the macro connections as green arrows. To add a new material, the user pushes the "Enter a new Facility Material" button on the User Input worksheet and thereby launches the Add New Material To Materials Input Page macro. The macro inserts a row on the Decon Technology Data worksheet for the user to enter the appropriate material information – the efficacy and compatibility of each decontamination technology on that material. The user pushes the "Continue adding data for New Material" button to launch the next macro subroutine (AddNewMaterialFrom-DeconTechDataPage). This macro runs multiple macros (shown in red text) that add the new material to each of the affected worksheets and charts (indicated by pale red coloring) and then takes the user to the "Costs – Waste Handling" worksheet, where the user can input the costs for removal and replacement of the new material. When the user pushes the "Continue adding data for New Material" button" at the top of this page, the user is

taken to the Materials Inputs worksheet to complete the process by adding the amount of new material in the facility and choosing the appropriate action for the new material.

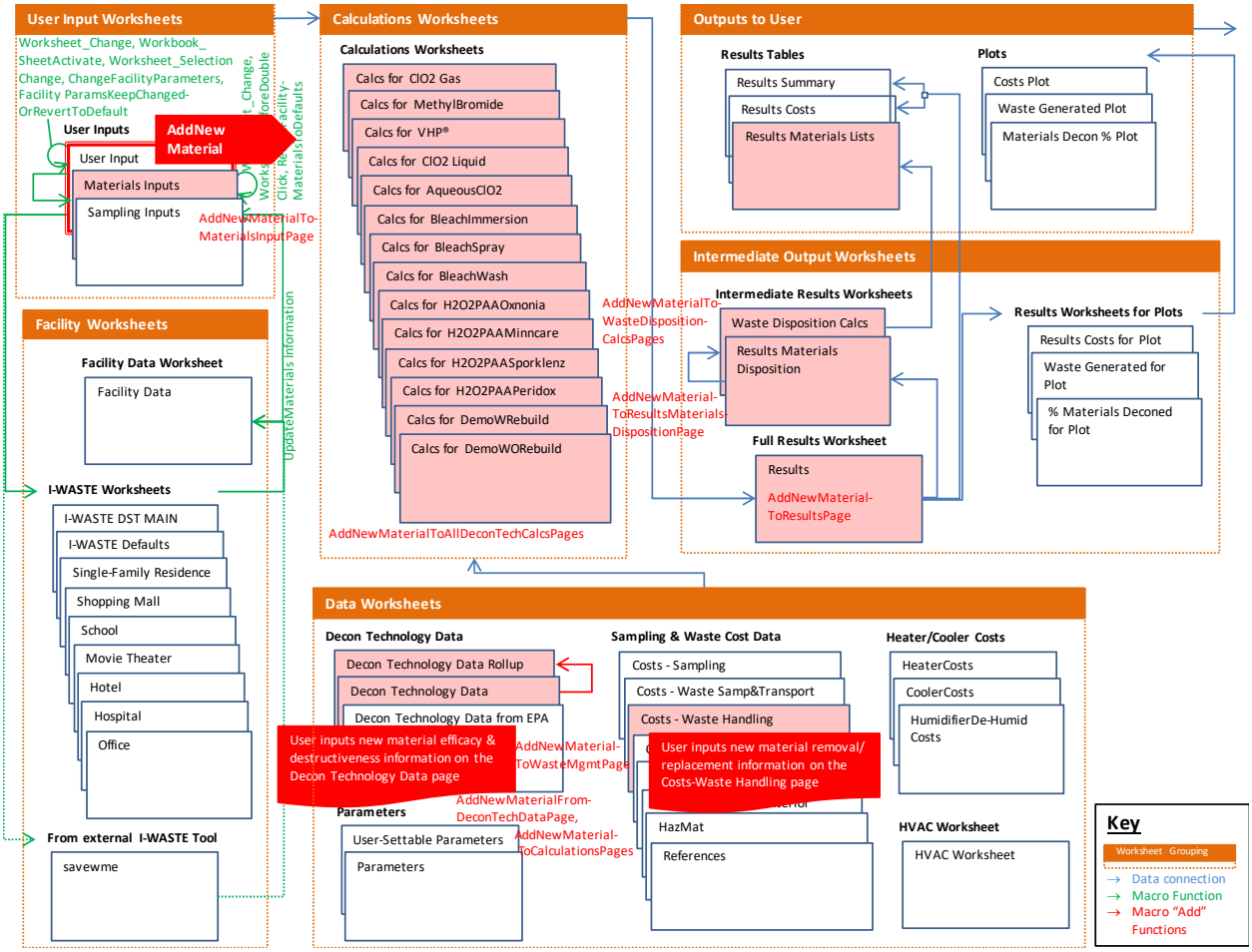


Figure 26. Worksheets and Charts and Macro Subroutines - Add New Material

Worksheets and Charts

As illustrated in Figure 24-Figure 26 in the preceding subsection, there are six groupings of worksheets and charts: user input worksheets, outputs to the user, intermediate output worksheets, data worksheets, calculations worksheets, and facility worksheets. In addition, some front matter worksheets include some of the information from this User Manual and Report. Table 1-Table 7 list the worksheets and charts according to those groupings. Below the tables, each worksheet or chart is described further.

Table 1. Front Matter Worksheets

Front Matter Worksheets
Foreword
Introduction and Purpose
Quick Start Guide

Table 2. User Input Worksheets

User Input Worksheets

User Input
Materials Inputs
Sampling Inputs
Sampling Inputs – detail[1]

Table 3. Outputs to User

Outputs to User Worksheets and Charts

Results Tables
Results Summary
Results Materials Lists
Results Materials Lists wAmts[1]
Results Costs

Charts
Waste Generated Plot woDemo
Waste Generated Plot wDemo[1]
Costs Plot
Costs Plot wDemo[1]
Materials Decon % Plot

[1] Worksheet not shown on Figure 24-Figure 26.

Table 4. Intermediate Outputs Worksheets

Intermediate Outputs Worksheets
Full Results Worksheet
Results
Intermediate Results Worksheets
Waste Disposition Calcs
Waste Disposition Calcs wAmts[1]
Results Materials Disposition
Results Worksheets for Plots
Results Costs for Plot
Waste Generated for Plot
% Materials Deconed for Plot

Table 5. Data Worksheets

Data Worksheets
Decon Technology Data
Efficacy Against Biothreat[2]
Decon Technology Data Rollup
Decon Technology Data
Decon Technology Data from EPA
Parameters
User-Settable Parameters
Parameters
Sampling and Waste Cost Data
Costs - Sampling
Costs - Waste Samp&Transport
Costs - Waste Handling
Costs - in situ Decon[2]
CostRefs - Replace Structural
CostRefs - Remove Interior
CostRefs - Replace Interior
HazMat
References
Heater/Cooler Costs
HeaterCosts
CoolerCosts
Humidified-Humid Costs
HVAC Worksheet
HVAC Worksheet

[2] Worksheet not shown on Figure 24-Figure 26.

Table 6. Calculations Worksheets (DeconST-bioBa)

Calculations Worksheets
Calcs for ClO2 Gas
Calcs for MethylBromide
Calcs for VHP®
Calcs for LCHP4Days[3]
Calcs for ClO2 Liquid
Calcs for AqueousClO2
Calcs for BleachImmersion
Calcs for BleachSpray
Calcs for BleachWash
Calcs for H2O2PAAOxonia
Calcs for H2O2PAAMinncare
Calcs for H2O2PAASporklenz
Calcs for H2O2PAAPeridox
Calcs for DemoWRebuild
Calcs for DemoWORebuild

Table 7. Facility Worksheets

Facility Worksheets
Facility Data
I-WASTE DST MAIN
I-WASTE Defaults
Open Space
Single-Family Residence
Shopping Mall
School (1 each for Elementary, Middle, High)
Movie Theater
Hotel
Hospital
Office
Materials Densities*[4]
Materials Thicknesses[4]
savewme

Front Matter Worksheets

The Front Matter Worksheets contain up front information copied directly from the User Manual and Report, including the Forward, the Introduction and Purpose, and the Quick Start Guide.

[3] Worksheet not shown on Figure 24-Figure 26.

[4] Worksheet not shown on Figure 24-Figure 26.

Foreword

The Foreword discusses the funding and development of the DeconST, acknowledges contributions of the participants in the Operational Assessment, and lists the creators of the DeconST tool.

Introduction and Purpose

The Introduction and Purpose explains the motivation for the development, provides a brief description, and discusses the user community for the DeconST.

Quick Start Guide

The Quick Start Guide enables the user to rapidly use the DeconST to assess the decontamination strategy and technology options for a facility, comparing the options based on their relative effectiveness, costs, destructiveness, and waste generated.

User Input Worksheets

The User Input Worksheets, described in detail in the Inputs section of the User Manual, include the User Input worksheet, the Materials Inputs worksheet, and the Sampling Inputs and Sampling Inputs - detail worksheets.

User Input Worksheet

The User Input worksheet collects information from the User on the facility, the facility structure contamination considerations, the HVAC system, agent, weather, and any cost-scaling factors.

Materials Inputs worksheet

The Materials Inputs worksheet shows default quantities of structural and interior non-structural building materials and contents for the facility type selected on the User Input worksheet. These quantities were auto-populated from the EPA's I-WASTE tool based on the facility type that is identified on the User Input worksheet. The user may customize the quantities on this worksheet, select appropriate actions for each material, and input per item costs as necessary.

Sampling Inputs and Sampling Inputs - detail Worksheets

The Sampling Inputs worksheet shows the sampling densities for the process phases and waste generated from both decontamination and demolition processes. The Sampling Inputs – detail worksheet allows the user to specify for each sample type the type of analysis technology: polymerase chain reaction (PCR), biological indicator (BI), or culture. This specification will be important after data become available on the differing costs for these different analysis technologies but is not important at this point.

Outputs to User Worksheets and Charts

The Outputs to User Worksheets and Charts include the following:

- Results Tables: Results Summary, Results Materials Lists (wo and wAmts), Results Costs, and
- Charts: Waste Generated Plot (woDemo and wDemo), Costs Plot (wo and wDemo), Materials Decon % Plot.

Results Tables

Results Summary

The Summary worksheet, discussed in detail in the Results Summary section of the User Manual, shows a comparison across the different decontamination strategies and technologies (one for each column) of the high-level decision considerations: the Percentages of Materials Decontaminated, the Total Cost, the Material Removal and Replacement Time, and the Total Waste Generated.

Results Materials Lists (wo and wAmts)

The Results Materials Lists and Results Materials Lists wAmts worksheets show details on the disposition of each material type (and the quantities of each) under each decontamination technology. The sheets show for each material the associated action (Kept in Place Untreated, Removed for Alternate Decon, Treated in Place, or Sent directly to Waste), as well as which waste materials would be excluded from the waste stream calculations. The row headings indicate which of the Treated in Place categories become waste (Decontaminated but Damaged, Potentially Contaminated but Reusable, and Potentially Contaminated and Damaged).

Results Costs

The Results Costs worksheet shows the numerical breakdown of the components of the decontamination process and waste management costs.

The decontamination process relative costs include costs for the following:

- Incident command,
- Sampling and analysis (including characterization, decontamination verification, and clearance),
- Decontamination process,
- Altering the facility temperature and relative humidity, and
- Environmental monitoring costs.

The Cost for Sensitive Item Decontamination is shown as well.

The Waste Costs include:

- Removal Labor (including the removal labor for both Decontaminated Waste Materials and Potentially Contaminated Waste Materials);
- Waste Handling (including costs for waste sampling collection and analysis; fixed waste-handling costs; costs for waste transportation, handling, and disposal; and costs for replacement of the materials or items); and
- Replacement of any materials or items removed as waste.

Charts

Waste Generated Plot (woDemo and wDemo)

The Waste Generated Plots wDemo and woDemo charts show for each decontamination technology the total quantity of waste generated as well as the breakdown of waste disposition – quantities of treated waste (materials and contents decontaminated but damaged by the technology), potentially contaminated waste (materials and contents for which the decontamination technology fails), and

materials sent directly to waste (those removed prior to decontamination). This chart is shown in two versions, with and without the waste generated by the demolition processes; in cases for which the quantity of waste generated by demolition is of the same order of magnitude as the decontamination technologies, the former chart is appropriate, but in cases for which the quantity of waste generated by demolition is of a higher order of magnitude than the decontamination technologies, the latter chart allows the user to see more readily the differentiation across the decontamination technologies.

Costs Plot (wo and wDemo)

The Costs Plot and Costs Plot wDemo charts show the sum and the components of the decontamination process and waste management costs for each decontamination technology. The two plots differ in both if the demolition options are shown for the same order-of-magnitude considerations discussed for the Waste Generated Plots. Note that although the differentiation in the color gradations may be difficult to interpret, the cost component can be found by hovering the mouse over any element of the bar chart. Also note that the user is free to edit the chart using the power of Excel to create the desired outcome.

Materials Decon % Plot

The Materials Decon % Plot chart shows graphically the total percent of each type of material (structural materials, interior non-structural materials, and contents) that is successfully decontaminated by each technology, as well as the percentages of those that are reusable versus destroyed. Note that any material left in place untreated or removed for alternate decontamination or sent directly to waste, does not appear on this chart.

Intermediate Outputs Worksheets

The Intermediate Outputs Worksheets include seven worksheets organized into three categories as follows:

- Full Results Worksheet: Results;
- Intermediate Results Worksheets: Waste Disposition Calcs (wo and wAmts) and Results Materials Disposition; and
- Results Worksheets for Plots: Results Costs for Plot, Waste Generated for Plot, and % Materials Deconed for Plot.

Full Results Worksheet

Results

The Results worksheet contains all the results from all the calculations pages for each decontamination technology pulled into one worksheet. This worksheet is the foundation for the output worksheets and plots that are shown to the user. The top rows of the worksheet are hidden from the user and are used to determine rounding factors for each of the high-level results of interest, which are shown in the top rows visible to the user and duplicated to form the view provided by the output Results Summary worksheet. Below the summary rows are listed the facility materials and the user-defined materials actions, which are brought in from the Materials Inputs worksheet. To the right is a large table that shows for each structural and interior material or item

the efficacy and destructiveness of each decontamination technology as well as the disposition of that material or item under the user-selected material action combined with that decontamination technology. This portion of the table together with the results summary is duplicated to form the view provided as the Results Materials Disposition worksheet. Below the materials disposition portion of the worksheet is the results costs portion, which shows the numerical breakdown of the components of the decontamination process and waste management costs, and which is duplicated to form the view provided by the Results Costs output worksheet. Below the costs portion is a table that was intended to capture notes about each of the decontamination technologies but is not used in the current version of the DeconST.

Intermediate Results Worksheets

Waste Disposition Calcs (wo and wAmts)

The Waste Disposition Calcs (wo and wAmts) worksheets perform the operations required to produce the output Results Materials Lists and Results Materials Lists wAmts worksheets. This worksheet is a series of tables going down the sheet, one table for each material action and/or disposition: Kept Untreated, Removed for Alternate Decon, Successfully Deconed, Treated Waste, Potentially Contaminated Reusable, Potentially Contaminated Destroyed, Sent Directly to Waste, and Waste Excluded from Waste Calculations. The information is pulled from the Results Materials Disposition worksheet and binned into the appropriate tables in the "material disposition" column under each decontamination technology. The comma-separated lists shown in the Results Materials Lists output worksheets are produced using count and concatenate operations hidden from the user's view in two columns on the right and left edges of each decontamination technology column; to view the operations, the user must color the text and widen those columns.

Results Materials Disposition

The Results Materials Disposition worksheet provides a more comprehensive view of the materials disposition than is presented in the output Results Materials Lists and Results Materials Lists wAmts worksheets, but shows less information than is contained in the full Results worksheet. The Results Materials Disposition worksheet shows just the output Results Summary plus the portion of the Results worksheet showing the materials dispositions. Below the Results Summary portion, on the left are listed the facility materials and the user-defined materials actions, which are brought in from the Materials Inputs worksheet. To the right is a large table that shows for each structural and interior material or item the efficacy and destructiveness of each decontamination technology as well as the disposition of that material or item under the user-selected material action combined with that decontamination technology. This information is used by the Waste Disposition Calcs worksheets to produce the output Results Materials Lists and Results Materials Lists wAmts worksheets

Results Worksheets for Plots

Results Costs for Plot

The Results Costs for Plot worksheet exists simply to transform the cost information from the Results worksheet into a form that supports the creation of the bar charts that are the output Costs Plot and Costs Plot wDemo charts.

Waste Generated for Plot

Similarly, the Waste Generated for Plot worksheet exists simply to transform the cost information from the Results worksheet into a form that supports the creation of the bar charts that are the output Waste Generated Plots wDemo and woDemo charts.

% Materials Deconed for Plot

The % Materials Deconed for Plot worksheet exists simply to transform the cost information from the Results worksheet into a form that supports the creation of the bar charts that are the output Materials Decon % Plot chart.

Data Worksheets

The Data Worksheets include nineteen worksheets organized into five categories as follows:

- Decon Technology Data: Efficacy Against Biothreat, Decon Technology Data Rollup, Decon Technology Data, Decon Technology Data from EPA;
- Parameters: User-Settable Parameters, Parameters;
- Sampling & Waste Cost Data: Costs - Sampling, Costs - Waste Samp&Transport, Costs - Waste Handling, Costs - in situ Decon, CostRefs - Replace Structural, CostRefs - Remove Interior, CostRefs - Replace Interior, HazMat, References;
- Heater/Cooler Costs: HeaterCosts, CoolerCosts, HumidifierDe-Humid Costs; and
- HVAC Worksheet: HVAC Worksheet.

Decon Technology Data Worksheets

Efficacy Against Biothreat

The Efficacy Against Biothreat worksheet is a placeholder for future expansion of the tool to address recovery from contamination with any one of many possible chemical, biological, or radiological agents; this worksheet would show the efficacy of each decontamination technology against each of the possible contamination agents.

Decon Technology Data Rollup

The Decon Technology Data Rollup worksheet shows the efficacy (pass/fail/unknown) and destructiveness information, as well as the resulting materials disposition for treatment in place, for each decontamination technology on each structural or interior material or item. The materials disposition information on this worksheet is carried through to all results worksheets. The efficacy pass/fail information is obtained by comparing the efficacy numbers for each technology on each material (from the Decon Technology Data worksheet) against the efficacy threshold required for decontamination (set on the Parameters worksheet). That efficacy information is combined with the destructiveness information compared to the Destructiveness level to send to Waste on the Parameters worksheet to determine the disposition of each material or item.

Decon Technology Data

The Decon Technology Data worksheet contains the relevant information (including references) for each decontamination technology, including the numerical efficacy (log reduction) and destructiveness information on each structural or interior material or item, the operational and

environmental conditions required for effective application of the technology, the fixed and size-based costs for incident command and decontamination, the liquid-waste generation rate, and any environmental monitoring costs. On this worksheet, the user would input the relevant data on any new decontamination technology or material to be added to the DeconST (after being brought here by either the Enter New Decontamination Technology or Enter New Facility Material button on the User Input worksheet). Note that the efficacy information is translated into pass/fail information on the Decon Technology Data Rollup worksheet before being used to determine the materials dispositions for the results pages.

Decon Technology Data from EPA

The Decon Technology Data from the EPA worksheet contains the numerical efficacy (log reduction) and destructiveness information on each structural or interior material or item as obtained from and vetted with our EPA colleagues. This information was translated onto the Decon Technology Data worksheet; the worksheet is kept for reference but is not required for the functionality of the DeconST.

Parameters

User-Settable Parameters

The User-Settable Parameters worksheet contains the percentage breakdown of the HAZUS structural materials categories:

- Brick, Wood, and Other Structural Building Materials; and
- Reinforced Concrete and Steel.

The casual user may not want to change the component percentages, but this page provides a mechanism for the more expert user to do so.

Parameters

The Parameters worksheet contains several items that the more expert user may want to access and change.

Default Parameters

The Default Thresholds for Bio Agents shows suggested Log Reduction values for various decontamination objectives – reuse, risk reduction, demolition – which were considered for inclusion in an earlier version of the DeconST, but were removed after the Operational Assessment, and thus are no longer used. The Thresholds section shows two parameters:

- the Efficacy Threshold, used to determine at what log-reduction value a decontamination method is said to be effective (pass) versus not effective (fail), and thus used as the comparison factor that translates the log reduction values on the Decon Technology Data worksheet into the pass/fail values on the Decon Technology Data Rollup worksheet; and
- the Destructiveness level to send to Waste, used to determine whether at what level a technology is considered to destroy a material.

These two parameters together determine the resulting materials disposition for each material that is treated in place by each decontamination technology.

List Elements

The List Elements table contains the elements of each drop-down list required by the DeconST, including high-moderate-low (used for the Waste-Handling Difficulty on the User Input worksheet), log increments (used for the Urban-Area Premium on the User Input worksheet), check mark toggle (used on the Materials Input worksheet to exclude potentially contaminated and/or damaged material from the waste stream), Sampling Areas (used in the Sampling Inputs and Sampling Inputs - detail worksheets), and the HVAC Type, Duct Type, and Accessibility (used for the HVAC Information on the User Input worksheet).

List of Bacterial Agent Types

The List of Bacterial Agent Types is not used by the current version of the DeconST but would be used to populate the Agent Information on the User Input worksheet when a future version of the DeconST could be adapted to address contamination with those other types of agents.

Other

The Waste-Handling Difficulty is used to translate difficulties of high, medium, and low into numerical cost multipliers for the waste-handling costs. The Sampling Requirements Factors are used to translate the sampling requirements data from the BOTE experiment into high, medium, and low sampling density requirements.

Sampling and Waste Cost Data

Costs - Sampling

The Costs - Sampling worksheet contains data from the BOTE experiment, including the sample data and some building dimensions, which are not used directly by the DeconST but were used to determine the per sample cost for collection and analysis labor and materials. The worksheet has placeholders for differentiation of the sample costs by sample type (polymerase chain reaction, biological indicator, or culture), which can be used separately in the DeconST in conjunction with the different sample types designated on the Sampling Inputs - details worksheet, but now the DeconST uses the average sample cost over all sample types obtained from the BOTE experiment. These numbers are used by the Calcs for DeconTechnology worksheets to calculate the Sampling and Analysis cost components for each decontamination technology.

Costs - Waste Samp&Transport

The Costs - Waste Samp&Transport worksheet contains data from the BOTE experiment: the fixed costs per cubic foot, the transportation costs (including mileage, truck capacity, and distance to landfill), the waste handling costs (including the waste processing rate and the waste handling team cost), and the waste acceptance fees. These numbers are used by the Calcs for DeconTechnology worksheets to calculate the Waste Handling cost components for each decontamination technology.

Costs - Waste Handling

The Costs - Waste Handling worksheet contains material-specific removal and replacement labor rates and costs that are used by the Calcs for DeconTechnology worksheets to calculate the total labor time and costs required for removal and replacement of each material or item of contents in each category of waste disposition for the facility.

Specifically, the Costs - Waste Handling worksheet shows the removal rate and cost as well as the replacement rate and cost (including materials, labor, and equipment) for each structural and interior material. The values in this table come from two primary sources (the National Construction Estimator and the National Repair and Remodeling Estimator), referenced on the References worksheet.

This worksheet also contains removal rate and costs for each item of contents, although these rates and costs are guesstimates based on a quick internet search of moving costs. The replacement costs for items of contents are handled by user input on the Materials Inputs worksheet.

The table includes a removal labor premium for contaminated materials and items of contents, which is determined by the PREMIUM_for_HazMAT_Removal defined on the HazMat worksheet.

Costs - in situ Decon

The Costs - in situ Decon worksheet originally contained the costs for the phases of decontamination for each decontamination technology, but those were moved to the Decon Technology Data worksheet. What remains on the Costs - in situ Decon worksheet is a percentage cost distribution for splitting the BOTE experiment decontamination costs between fixed costs and size-based costs. This percentage is used on the Decon Technology Data worksheet to calculate the fixed and size-based costs for decontamination for each decontamination technology.

CostRefs - Replace Structural

The CostRefs - Replace Structural worksheet contains snapshots of the National Construction Estimator that were used to derive the replacement rate and cost (including materials, labor, and equipment) for each structural material in the Costs - Waste Handling worksheet.

CostRefs - Remove Interior

The CostRefs - Remove Interior worksheet contains snapshots of the National Repair & Remodeling Estimator that were used to derive the removal rate and cost (both labor and equipment) for each interior material for the Costs - Waste Handling worksheet.

CostRefs - Replace Interior

The CostRefs - Replace Interior worksheet contains snapshots of the National Construction Estimator that were used to derive the replacement rate and cost (including materials, labor, and equipment) for each interior material for the Costs - Waste Handling worksheet.

HazMat

The HazMat worksheet contains references to the Occupational Employment Statistics, Occupational Employment and Wages from the Bureau of Labor Statistics to calculate the pay differential between hazardous materials removal workers and construction laborers. This pay differential is called the PREMIUM_for_HazMAT_Removal and is used by the DeconST to represent the removal labor premium for potentially contaminated materials on the Costs - Waste Handling worksheet.

References

The References worksheet provides website links for the National Construction Estimator, the National Repair and Remodeling Estimator, and the Bureau of Labor Statistics documents that

provide parameters to the CostRefs - Replace Structural, CostRefs - Remove Interior, CostRefs - Replace Interior, and HazMat worksheets that feed into the Costs - Waste Handling worksheet.

Heater/Cooler Costs

HeaterCosts, CoolerCosts, and HumidifierDe-Humid Costs

The HeaterCosts, CoolerCosts, and HumidifierDe-Humid Costs worksheets contain the operating and rental costs for heating, air-conditioning, humidifying, and de-humidifying units, respectively. These are used by the Calcs for DeconTechnology worksheets to calculate any heating, cooling, and humidifying/de-humidifying costs required to obtain the proper operational environment for that decontamination technology.

HVAC Worksheet

HVAC Worksheet

The HVAC Worksheet provides the mechanism for translating the HVAC information provided by the User on the User Input worksheet into the resulting message about HVAC decontamination displayed on the Results, Results - Summary, and Results Costs worksheets.

Calculations for Decontamination Technology Worksheets

This subsection pertains to all the Calculations for Decontamination Technologies worksheets, including the following:

for Volumetric Decontamination Technologies

- Calcs for ClO_2 Gas
- Calcs for MethylBromide
- Calcs for VHP®
- Calcs for LHCP4Days
- Calcs for any new volumetric decontamination technologies added by the User

for Surface Decontamination Technologies

- Calcs for ClO_2 Liquid
- Calcs for AqueousClO_2
- Calcs for BleachImmersion
- Calcs for BleachSpray
- Calcs for BleachWash
- Calcs for H2O2PAAOxonia
- Calcs for H2O2PAAMinncare
- Calcs for H2O2PAASporklenz
- Calcs for H2O2PAAPeridox
- Calcs for any new surface decontamination technologies added by the User

for Demolition Processes

- Calcs for DemoWRebuild
- Calcs for DemoWORebuild

The Calculations for Decontamination Technology worksheets, one for each decontamination technology or process, are the heart of the DeconST calculations. The structure of these is the same for each technology or process, with some minor variations between those for volumetric versus surface decontamination methods versus demolition processes.

The large table of materials and dispositions starting in the upper left side of the worksheet combines the facility-specific materials and quantities and the user-selected materials actions together with the material- and technology- specific decontamination efficacy and destructiveness to calculate the types and quantities of materials that are binned into each of the materials actions/disposition categories: kept in place untreated, removed for alternate decontamination, sent to waste, successfully decontaminated, decontaminated but destroyed, potentially contaminated (either salvageable or destroyed). The removal labor time and cost are calculated for each material in each of these categories. The far-right columns of the table calculate the replacement costs for those materials that are sent to waste and the total quantities of waste excluded from the calculations. All the various quantities in these columns are totaled in the lower rows to determine the totals and percentages of structural and interior materials and contents in each action/disposition category. These percentages are then consolidated below as the

- % by mass of Structural Materials Decontaminated
- % by area of Interior Materials Decontaminated
- % by mass of Contents Decontaminated,

each broken down between the % decontaminated and salvageable and the % decontaminated and destroyed (treated waste).

Below these % Decontaminated calculations are the Total Costs (including the decontamination process plus waste handling costs), and the total amounts of waste generated in each of four categories:

Solid Waste (tons)

- Sent Directly to Waste (Materials and contents removed as waste prior to decon (tons));
- Treated (Materials and contents decontaminated, but damaged by technology);
- Contaminated (Materials and contents for which decontamination technology fails; and
- Liquid Waste Generated (gallons).

Below these summaries are the cost components that make up the total costs and that were described for the Results Costs output worksheet. These cost components (repeated here) are the following:

Decontamination process relative costs:

- Incident command;
- Sampling and analysis (including characterization, decontamination verification, and clearance);
- Decontamination process;
- Altering the facility temperature and relative humidity; and
- Environmental monitoring costs.

Waste Costs:

- Removal Labor (including the removal labor for both Decontaminated Waste Materials and Potentially Contaminated Waste Materials);
- Waste Handling (including costs for waste sampling collection and analysis; fixed waste-handling costs; costs for waste transportation, handling, and disposal; and costs for replacement of the materials or items);
- Replacement of any materials or items removed; and
- Cost for Sensitive Item Decontamination.

The costs to alter the facility environmental conditions (heating, cooling, humidifying, and dehumidifying) require the calculation of the numbers of hours the units are required to operate. Those calculations are made on these worksheets as well – below the large table of materials and dispositions.

The difference between the Calculations worksheets for Volumetric versus Surface decontamination methods is for only one calculation – the size-based decontamination cost. For volumetric decontamination methods, the size-based decontamination cost depends on the building volume, whereas for surface decontamination methods, the size-based decontamination cost depends on the building floor area.

The Calculations worksheets for Demolition have two other differences. First, the user-directed materials actions are not applied; in the case of demolition, all structural and interior materials and contents are sent to waste as potentially contaminated, destroyed materials. Second, for Demolition without Rebuilding, no materials replacement costs are calculated.

Facility Worksheets

The Facility Worksheets include the Facility Data worksheet, the USEPA I-WASTE worksheets, the Materials Densities Worksheet, and the savewme worksheet.

Facility Data Worksheet

The Facility Data worksheet collects the materials types and quantities calculated in the I-WASTE worksheets (based on the User Input parameters); the Facility Data worksheet is then referenced to update the information on the Materials Input worksheet.

I-WASTE Worksheets

The USEPA I-WASTE worksheets generate materials type and quantity estimates based on facility type and relevant parameters given on the User Input worksheet and provide the values to the Facility Data worksheet. The I-WASTE worksheets include the following:

- I-WASTE DST MAIN;
- I-WASTE Defaults;
- Open Space (used only for the densities of certain materials);
- Single-Family Residence;
- Shopping Mall;
- School – Elementary;
- School – Middle;

- School – High;
- Movie Theater;
- Hotel;
- Hospital; and
- Office.

According to I-WASTE Technical Contact Colin Hayes (Eastern Research Group, Inc.),

[The I-WASTE worksheets are] the master compilation of factors and equations currently used in the I-WASTE Waste Materials Estimator (WME). Also available are calculation templates for each structure type that are modeled after the actual WME input screens. The model calculations for each structure type generate the WME estimates based on the actual equations and factors for each WME waste category.

Materials Densities Worksheet

The materials densities worksheet calculates the facility-specific densities for each of the structural and interior materials and contents from information provided in the I-WASTE worksheets. The facility-specific materials densities from this worksheet are inserted into the density column in the Materials Inputs worksheet, which uses them to determine the quantity in tons of a material for which the user has entered the amount by specifying the percent area covered by that material. (Note that the 2012 version of the DeconST used average densities across all facility types, but that sometimes resulted in nonsensical results.)

Materials Thicknesses Worksheet

The materials thicknesses worksheet calculates the facility-specific thicknesses for each of the structural and interior materials and contents from the information provided in the I-WASTE worksheets. The facility-specific materials thicknesses from this worksheet are inserted into the thickness column in the Materials Inputs worksheet, which uses them to determine the surface area of each material from the volume. (Note that the 2012 version of the DeconST used average materials thicknesses derived from internet searches, but that sometimes resulted in nonsensical results.)

savewme Worksheet

The savewme worksheet holds data read from an external savewme.asp file, generated by an external execution of the I-WASTE tool. The materials quantities are used to update the types and quantities on the Materials Inputs worksheet when the Facility Type selected is “Other Structure Types.”

Macro Subroutines and Functions

As illustrated in Figure 24-Figure 26 in a preceding subsection, there are three types of macro subroutines: those associated with basic DeconST operations, those associated with adding a new decontamination method, and those associated with adding a new material. In addition, there are several functions that perform smaller roles. Table 8-

Table 11 list the macro subroutines and functions according to those classifications. Below the tables, each subroutine is described further with its name, its required inputs (and outputs for functions), a brief description of its operations, and listings of the calling operation/routine and the functions/subroutines it calls.

Table 8. Basic Subroutines

Basic Subroutines
Workbook: Workbook_SheetActivate
User Input: Worksheet_SelectionChange
User Input: Worksheet Change
Materials Inputs: Worksheet Change
Materials Inputs: Worksheet_BeforeDoubleClick
FacilityParamsKeepChangedOrRevertToDefault
ClearMaterialsInformation
ReadIWASTEDefaultsOntoIWASTECalcPage
UpdateMaterialsInformation
ChangeFacilityParameters
RevertFacilityMaterialsToDefaults
PrintInputsAndResults

Table 9. Subroutines for Adding a New Decontamination Method

Routines for Adding a New Decontamination Method
AddNewDeconMethod
AddNewDeconMethodToAllPages
Function AddNewDeconMethodToRollupPage
AddNewCalcsPageForNewDeconTech
AddNewDeconMethodToResultsPage
AddNewDeconMethodToResultsMaterialsDispositionPage
AddNewDeconMethodToResultsCostsPage
AddNewDeconMethodToResultsCostsForPlotPage
AddNewDeconMethodToWasteGennedForPlotPage
AddNewDeconMethodToPctMatlsDeconnedForPlotPage
AddNewDeconMethodToResultsSummaryPage
AddNewDeconMethodToWasteDispCalcPage
AddNewDeconMethodToResultsMaterialsListPages
CalcsForNewTechMakeNamesGlobal
Make Global

Table 10. Subroutines for Adding a New Material

Subroutines for Adding a New Material
Add New Material
AddNewMaterialFrom-DeconTechDataPage
AddNewMaterialToCalculationsPages
AddNewMaterialToWasteMgmtPage
AddNewMaterialToMaterialsInputPage
AddNewMaterialToAllDeconTechCalcsPages
AddNewMaterialToResultsPage
AddNewMaterialToResultsMaterialsDispositionPage
AddNewMaterialToWasteDispositionCalcsPages

Table 11. Functions

Functions
ConvertToLetter
myGetOpenFileName
RemoveLeadingSpacesFromString

Basic Subroutines

Workbook Private Sub Workbook_SheetActivate

Inputs: this Sheet (Object)

Description: This private subroutine is associated with the entire workbook. If the user tries to activate any sheet, this routine checks the UserInputUserIsChangingFacilityParams parameter on the User Input worksheet to see whether the user has touched any of the facility parameters on the User Input worksheet. If this parameter indicates the user has changed the facility parameters, the routine re-activates the User Input worksheet and selects the Facility Type cell, which in turn activates the private User Input worksheet's private subroutine Worksheet_SelectionChange.

Calls: Indirectly calls User Input worksheet's private subroutine Worksheet_SelectionChange.

Called by: User activating any sheet.

User Input Private Sub Worksheet_SelectionChange

Inputs: Target (Excel Range)

Description: This is a private subroutine associated with the User Input worksheet. If the user touches any of the facility parameters, then this routine makes a note of that (by setting the UserInputUserIsChangingFacilityParams parameter on the User Input worksheet) so that when the user has finished changing the facility parameters, the user is prompted on whether to keep the changes or revert to defaults through the routine FacilityParamsKeepChangedOrRevertToDefault.

Calls: FacilityParamsKeepChangedOrRevertToDefault.

Called by: User selecting cells on the User Input worksheet.

User Input Private Sub Worksheet Change

Inputs: Target (Excel Range)

Description: This is a private subroutine associated with the User Input worksheet. If the user changes the value in a cell on the User Input worksheet, this routine checks whether it is one of three types of cells:

If the user changes any of the facility parameters, then, like the Worksheet_SelectionChange subroutine, this routine makes a note of that (by setting the UserInputUserIsChangingFacilityParams parameter on the User Input worksheet). The new value(s) will be updated when the user selects a different cell (through Worksheet_SelectionChange) or changes to a new worksheet (through the workbook Subroutine Workbook_SheetActivate).

If the user has changed the Facility Type, then this routine resets the size choices to match those appropriate for this facility type, clears the facility-specific parameters, and clears the materials values from the Materials Inputs worksheet (through ClearMaterialsInformation). If the facility type is one that doesn't have size choices (Movie Theater or Single-Family Residence), then this routine runs ReadIWASTEDefaultsOntoIWASTECalcPage to update the facility-specific parameters on the User Input page and then runs UpdateMaterialsInformation to update the materials information on the Materials Inputs worksheet. If the facility type is "Other Structure Types," then this routine provides instructions on how to run the I-WASTE Decision Support Tool to get the materials information, or gives the user the option of entering the materials information manually on the Materials Inputs page.

If the user has changed the Qualitative Size of the facility, then this routine clears the materials values from the Materials Inputs worksheet (through ClearMaterialsInformation), updates the facility-specific parameters on the User Input page (through ReadIWASTEDefaultsOntoIWASTECalcPage), and then updates the materials information on the Materials Inputs worksheet (through UpdateMaterialsInformation).

Calls: ClearMaterialsInformation, ReadIWASTEDefaultsOntoIWASTECalcPage. UpdateMaterialsInformation, myGetOpenFileName.

Called by: User changing values in cells on the User Input worksheet.

Materials Inputs Private Sub Worksheet_Change

Inputs: Target (Excel Range)

Description: This is a private subroutine associated with the Materials Inputs worksheet. If the user changes the value in a cell on the Materials Inputs worksheet, this routine does one of two things, depending on which cell the user has changed.

For structural and interior non-structural materials, if the user changed the area (either the value or the percentage) covered by that material, this routine replaces the values in the Quantity columns (tons and cubic yards) with formulas that calculate the quantities based on the new area and on the thickness and density of the material (from hidden columns to the left of the Area columns).

Alternately, if the user has changed a radio button or checkbox, this routine implements that functionality, blanking out the other radio buttons, and enabling checkboxes and removing values from costs columns as appropriate.

Calls: None.

Called by: User changing values in cells on the Materials Inputs worksheet.

Materials Inputs Private Sub Worksheet_BeforeDoubleClick

Inputs: Target (Excel Range).

Description: This is a private subroutine associated with the Materials Inputs that acts after a double-click of either a radio button or a checkbox.

If the user double-clicks a radio button, this routine selects that radio button and deselects the others. The change in value then causes the private subroutine Worksheet_Change to run, which enables/disables checkboxes and removes values from costs columns as appropriate.

If the user double-clicks a checkbox in the exclude column, this routine toggles that checkbox between checked and blank.

Calls: Indirectly calls Materials Inputs worksheet private subroutine Worksheet_Change.

Called by: User double-clicking cells on the Materials Inputs worksheet.

Subroutine FacilityParamsKeepChangedOrRevertToDefault

Inputs: None.

Description: This routine notifies the user that the facility parameters may have been modified, asks the user whether to keep the new parameters or revert to default values, and calls the appropriate routines to carry out the selection (ChangeFacilityParameters for keeping the new parameters or ReadIWASTEDefaultsOntoIWASTECalcPage and UpdateMaterialsInformation for reverting to the default values). In addition, the routine resets the User Input worksheet parameter UserInputUserIsChangingFacilityParams to FALSE, indicating that the user has made no additional changes to the Facility Parameters on the User Inputs worksheet that would require an update to the materials values on the Materials Inputs worksheet.

Calls: ChangeFacilityParameters, ReadIWASTEDefaultsOntoIWASTECalcPage, UpdateMaterialsInformation.

Called by: User Input Private Sub Worksheet_SelectionChange, AddNewDeconMethod, AddNewMaterial, PrintInputsAndResults.

Subroutine ClearMaterialsInformation

Inputs: None.

Description: This routine clears the information on the Materials Inputs worksheet, removing the areas, percentages, and/or quantities of each structural and interior non-structural material and item. It also resets the radio buttons and check boxes and removes any values in the per Item Costs Cells. On the User Input worksheet, this routine removes the facility-specific parameters.

Calls: None.

Called by: User Input Private Sub Worksheet_Change.

Subroutine ReadIWASTEDefaultsOntoIWASTECalcPage

Inputs: thisBldgType (String), thisBldgQualSize (String)

Description: This routine uses the building type and qualitative size to read the appropriate I-WASTE default values (from the I-WASTE Defaults worksheet), insert them into the corresponding facility-specific I-WASTE worksheet, then put the facility-specific parameters and their default values onto the User Input worksheet.

Calls: None.

Called by: User Input Private Sub Worksheet_Change.
FacilityParamsKeepChangedOrRevertToDefault.

Subroutine UpdateMaterialsInformation

Inputs: thisBldgType (String), thisBldgQualSize (String)

Description: This routine copies the materials quantities information from the Facility Data worksheet or the savewme worksheet (for "Other Structure Types") to the appropriate place on the Materials Inputs worksheet.

Calls: None.

Called by: User Input Private Sub Worksheet_Change.
FacilityParamsKeepChangedOrRevertToDefault, ChangeFacilityParameters.

Subroutine ChangeFacilityParameters

Inputs: None.

Description: If the user has changed any of the facility-specific parameters on the User Input page away from the default value(s), this routine transfers the new parameter value(s) onto the facility-specific I-WASTE worksheet, which provides an updated building floor area (if not specified directly by the user), and which updates the facility-specific materials values on the Facility Data worksheet. The routine then calls UpdateMaterialsInformation to transfer those new materials values from the Facility Data worksheet to the Materials Inputs worksheet. If the user provided a new floor area (and floor area is not an I-WASTE parameter for this facility type), this routine then scales the structural and interior non-structural materials proportionately. In addition, this routine reminds the user to save the file often.

Calls: UpdateMaterialsInformation.

Called by: FacilityParamsKeepChangedOrRevertToDefault.

Subroutine RevertFacilityMaterialsToDefaults

Inputs: None.

Description: This routine reverts the materials quantities on the Materials Inputs worksheet to their default values by simply resetting the Facility Type and Qualitative Size on the User Inputs

worksheet, which then activates the associated private Worksheet_Change subroutine. In addition, this routine reminds the user to save the file often.

Calls: (indirectly) User Inputs private Worksheet_Change subroutine.

Called by: User pressing Revert to Defaults button on Materials Inputs worksheet.

Subroutine PrintInputsAndResults

Inputs: None.

Description: This routine provides the ability to format and print a report of the most important of the workbook input and output worksheets and charts: User Input, Materials Inputs, Sampling Inputs, Sampling Inputs – detail, Results Summary, Results Materials Lists, Results Materials Lists wAmts, Results Costs, Results Materials Disposition. Prior to printing the report, the routine checks whether the user has changed any of the facility parameters on the User Input worksheet and handles that, prompts the user to remember to save the file often, reminds the user that to view the color-based information, the computer's default printer must be set to print in color, creates footers for each page to be printed, and then executes Excel's print preview routine on the set of worksheets and charts.

Calls: FacilityParamsKeepChangedOrRevertToDefault.

Called by: User pressing the Generate Report button on the User Input worksheet.

Subroutines for Adding a New Decontamination Method

Subroutine AddNewDeconMethod

Inputs: None.

Description: The routine first checks whether the user has changed any of the facility parameters on the User Input worksheet and handles that and prompts the user to remember to save the file often. Then, the routine asks the user whether the new method is a volumetric or surface decontamination method, creates new columns for the technology information on the Decon Technology Data worksheet, and prompts the user to enter that information.

Calls: FacilityParamsKeepChangedOrRevertToDefault.

Called by: User pressing Enter New Decontamination Technology button on the User Input worksheet.

Subroutine AddNewDeconMethodToAllPages

Inputs: None.

Description: This routine calls a series of routines to first add the new volumetric decontamination technology to the Decon Technology Data Rollup worksheet, next to add a new calculations worksheet for the technology, and finally to add the new technology to all the appropriate worksheets and charts in the workbook. (This routine is the same as AddNewDeconMethodToAllPages, except that this routine passes a Boolean that tells the called subroutines that the new technology is for volumetric decontamination.)

Calls: AddNewDeconMethodToRollupPage,

AddNewCalcsPageForNewDeconTech,

AddNewDeconMethodToResultsPage, AddNewDeconMethodToResultsMaterialsDispositionPage, AddNewDeconMethodToResultsCostsPage, AddNewDeconMethodToResultsCostsForPlotPage, AddNewDeconMethodToWasteGennedForPlotPage, AddNewDeconMethodToPctMatlsDeconnedForPlotPage, AddNewDeconMethodToResultsSummaryPage, AddNewDeconMethodToWasteDispCalcPage, AddNewDeconMethodToResultsMaterialsListsPages

Called by: User pushing the Add Volumetric Decon Technology to Results Pages

button on the Decon Technology Data worksheet.

Function AddNewDeconMethodToRollupPage

Inputs: Boolean telling whether new decontamination technology is for volumetric or surface decontamination.

Outputs: Nickname (as String) of the new decontamination technology.

Description: This function takes the decontamination technology newly-added to the Decon Technology Data worksheet and inserts it into the Decon Technology Data Rollup worksheet, with the important step of comparing the efficacy numbers for the new technology on each material against the efficacy threshold required for decontamination and thus translating the efficacies into pass/fail values.

Calls: none.

Called by: AddNewDeconMethodToAllPages.

Subroutine AddNewCalcsPageForNewDeconTech

Inputs: isVolDeconMethod As Boolean, nickName As String

Description: This routine creates a new calculations page for the new decontamination technology by copying the "Calcs for ClO2 Gas" worksheet if the new technology is a volumetric decontamination method or the "Calcs for ClO2 Liquid" worksheet if the new technology is a surface decontamination method. The routine then adds the technology nickname to the defined names used on that worksheet and makes the names global to apply to the entire workbook. The routine updates certain formulas to make them refer to the column associated with the new decontamination technology on the Decon Technology Data Rollup worksheet. Finally, the routine adds the technology to the Sampling Inputs and Sampling Inputs – detail worksheets.

Calls: CalcsForNewTechMakeNamesGlobal, ConvertToLetter.

Called by: AddNewDeconMethodToAllPages.

Subroutine AddNewDeconMethodToResultsPage

Inputs: isVolDeconMethod As Boolean, nickName As String

Description: This routine adds the new decontamination technology to the Results worksheet. It copies the existing results columns for Chlorine Dioxide Gas if the new technology is a volumetric decontamination method, or for Chlorine Dioxide Liquid if the new technology is a surface

decontamination method. The routine updates formulas to reflect the nickname of the new technology, and fixes the formatting of the table.

Calls: none.

Called by: AddNewDeconMethodToAllPages.

Subroutines AddNewDeconMethodToResultsMaterialsDispositionPage

- AddNewDeconMethodToResultsCostsPage
- AddNewDeconMethodToResultsCostsForPlotPage
- AddNewDeconMethodToWasteGennedForPlotPage
- AddNewDeconMethodToPctMatlsDeconnedForPlotPage
- AddNewDeconMethodToResultsSummaryPage
- AddNewDeconMethodToWasteDispCalcPage
- AddNewDeconMethodToResultsMaterialsListPages

Inputs: isVolDeconMethod As Boolean, nickName As String

Description: These routines perform basically the same task – adding the new decontamination technology to the corresponding results worksheet. Each routine copies the existing results columns for Chlorine Dioxide Gas if the new technology is a volumetric decontamination method, or for Chlorine Dioxide Liquid if the new technology is a surface decontamination method. The routine updates formulas to reflect the nickname of the new technology, and fixes the formatting of the table.

Calls: none.

Called by: AddNewDeconMethodToAllPages.

Subroutine CalcsForNewTechMakeNamesGlobal

Inputs: nickName As String, varName As String

Description: This routine feeds new variable names associated with the new calculations worksheet for the new decontamination technology into the MakeGlobal subroutine, which transforms the variables into global variables that function in the entire workbook.

Calls: MakeGlobal.

Called by: AddNewCalcsPageForNewDeconTech.

Subroutine MakeGlobal

Inputs: theName As Name, theWorksheet As Worksheet

Description: This routine removes a local name associated with a worksheet and recreates it as a global name that functions in the entire workbook. This routine is used particularly for names associated with the new calculations worksheet for the new decontamination technology.

Calls: none.

Called by: CalcsForNewTechMakeNamesGlobal.

Subroutines for Adding a New Material

Subroutine AddNewMaterial

Inputs: none

Description: This routine takes the user to the Decon Technology Data page, then prompts user to insert a row for the new material in the appropriate place and to input the efficacy and destructiveness data for each decontamination technology on this material.

Calls: None, but prompts user to highlight the new material row, then push the "Continue Adding Data for New Material" button at the top of the Decon Technology Data worksheet.

Called by: User pushing Enter New Facility Material button on User Input worksheet

Subroutine AddNewMaterialFromDeconTechDataPage

Inputs: None, but the new material row must be highlighted on the Decon Technology Data worksheet

Description: This routine adds the new material to the following pages: Decon Technology Data Rollup, Costs - Waste Handling, Materials Inputs.

Calls: AddNewMaterialToCalculationsPages(to prow),

AddNewMaterialToWasteMgmtPage(newMaterialType).

Called by: User pushing the "Continue Adding Data for New Material" button at the top of the Decon Technology Data worksheet after highlighting the new material row.

Subroutine AddNewMaterialToCalculationsPages

Inputs: text

Description: This routine adds the new material to all decontamination technology calculations pages and to the results worksheet, the materials disposition worksheet, and the waste disposition calculations worksheet.

Calls: AddNewMaterialToAllDeconTechCalcsPages(topRow),

AddNewMaterialToResultsPage(topRow),
AddNewMaterialToResultsMaterialsDispositionPage(topRow),
AddNewMaterialToWasteDispositionCalcsPages(topRow).

Called by: AddNewMaterialFromDeconTechDataPage.

Subroutine AddNewMaterialToWasteMgmtPage

Inputs: NewMaterialType As String

Description: Activates the Costs - Waste Handling worksheet and prompts the user to enter values for costs -- removal thickness, removal labor and equipment costs, and replacement costs for a structural or interior material, or for removal labor costs and replacement costs for an item.

Calls: None, but prompts user to push the "Continue adding data for New Material" button at top of the Costs - Waste Handling worksheet.

Called by: AddNewMaterialFromDeconTechDataPage.

Subroutine AddNewMaterialToMaterialsInputPage

Inputs: None

Description: This routine activates the Materials Inputs worksheet, prompts user to add thickness and density (for new building materials) and amount of new material in facility, and reminds user to set radio buttons to choose material action. The routine then tells user that when finished, the new material has been added to all workbook pages.

Calls: None

Called by: User pushing the "Continue adding data for New Material" button at top of the Costs - Waste Handling worksheet.

Subroutine AddNewMaterialToAllDeconTechCalcsPages

Inputs: topRow is a Boolean that tells whether the new material is at the top of the list in its category.

Description: This routine adds the new material to every decontamination technology calculations worksheet, starting from "Calcs for ClO2 Gas," looping through each worksheet, ending with "Calcs for DemoWORebuild," and including any worksheet added for any new decontamination technology.

Calls: None.

Called by: AddNewMaterialToCalculationsPages.

Subroutine AddNewMaterialToResultsPage

Inputs: topRow is a Boolean that tells whether the new material is at the top of the list in its category.

Description: This routine adds the new material to the "Results" worksheet.

Calls: None.

Called by: AddNewMaterialToCalculationsPages.

Subroutine AddNewMaterialToResultsMaterialsDispositionPage

Inputs: topRow is a Boolean that tells whether the new material is at the top of the list in its category.

Description: This routine adds the new material to the "Results Materials Disposition" worksheet.

Calls: None.

Called by: AddNewMaterialToCalculationsPages.

Subroutine AddNewMaterialToWasteDispositionCalcsPages

Inputs: topRow is a Boolean that tells whether the new material is at the top of the list in its category.

Description: This routine adds the new material to the "Waste Disposition Calcs" and the "Waste Disposition Calcs wAmts" worksheets, updating text manipulation formulas for each decontamination technology.

Calls: None.

Called by: AddNewMaterialToCalculationsPages.

Functions

Function ConvertToLetter

Inputs: column number i as an Integer

Outputs: the corresponding alphabetic column letter

Description: This function finds the alphabetic column letter corresponding to the i^{th} column of an Excel worksheet.

Calls: none.

Called by: Materials Inputs worksheet Private Sub Worksheet_Change,

ClearMaterialsInformation, AddNewDeconMethodToRollupPage, AddNewCalcsPageForNewDeconTech, AddNewDeconMethodToResultsCostsForPlotPage, AddNewDeconMethodToWasteGennedForPlotPage, AddNewDeconMethodToPctMatlsDeconnedForPlotPage, AddNewMaterialToWasteDispositionCalcsPages.

Function myGetOpenFileName

Inputs: none

Outputs: the file name

Description: Displays the standard Open dialog box and gets a file name from the user without opening any files. (The initial purpose of this function was to get the file name differently for Mac vs. windows PC, but DeconST is not currently implemented for Mac.)

Calls: built-in method Application.GetOpenFilename.

Called by: User Input Worksheet Private Sub Worksheet_Change.

Function RemoveLeadingSpacesFromString

Inputs: thisStringWSpaces As String

Outputs: the same string with the leading spaces removed

Description: This function removes the leading nonbreaking/CHAR(160) spaces from the input string.

Calls: None.

Called by: UpdateMaterialsInformation.

Parameters

This section contains a listing of the primary parameters that are not accessible on the User Input worksheets, are not part of the I-WASTE Worksheets, and are those that in general would not be modified by the casual user. The table entries are grouped by topic as discussed in the Overview and Organization of the Worksheet and Charts and Subroutines section:

- Decon Technology Data, which includes decontamination technology effectiveness, application conditions, environmental factors, and material compatibility;
- Parameters, which includes threshold values and certain lists;
- Sampling and Waste Cost Data, which includes the costs for processing samples, the cost of sampling and transporting waste, and the cost of waste handling, including removal and replacement;
- Heater/Cooler Costs, which includes the costs to rent heaters, air conditioners, humidifiers, and/or dehumidifiers to alter the interior operational conditions;
- HVAC Worksheet, which provides a qualitative translation of the HVAC parameters into HVAC decontamination advice.

According to this grouping, each table shows a descriptive name of the parameter, the Excel name (if any), and the default value. In this way, the user can quickly view the default values of these parameters and find the location of the parameter in case any modification is required.

Table 12. Data Worksheets Parameters

Name	*Excel Name*	Default Value
Decon Technology Data		
Decon Technology Data and Decon Technology Data Rollup (Reference on Decon Technology Data from EPA worksheet) Materials Compatibility Data For each Decontamination Technology on each Material		
Efficacy	Depends on technology and material; these are numerical values on Decon Technology Data worksheet and threshold values on Decon Technology Data Rollup worksheet	
Destructiveness	Depends on technology and material	
Conditions Required for Effective Application of Technology		
Application Conditions	Depends on technology	
Environmental Conditions		
Low Temperature	*TemperatureLowNickname*	Depends on technology
High Temperature	*TemperatureHighNickname*	Depends on technology
Low Relative Humidity	*RelativeHumidityLowNickname*	Depends on technology

High Relative Humidity	*RelativeHumidityHighNickname*	Depends on technology
Application Time	*ApplicationTimeNickname*	Depends on technology
Decontamination Costs		
Fixed Costs for Decontamination	*DeconFixedCostNickname*	Depends on technology
Incident Command Costs for Decontamination	*DeconICCostPerSfNickname*	Depends on technology
Decontamination Costs for Volumetric Decontamination	*DeconDeconProcessCostPerCfNickname*	Depends on technology
Decontamination Costs for Surface Decontamination	*DeconDeconProcessCostPerCfNickname*	Depends on technology
Liquid Waste Generation Rate		
Size-based rate	*LiquidWasteGenerationPerSfNickname*	Depends on technology
Environmental Monitoring Costs		
Fixed	*EnvironmentalMonitoringFixedCostsNickname*	Depends on technology
Size-based	*EnvironmentalMonitoringCostsPerSfNickname*	Depends on technology

Parameters

User-Settable

Breakdown of Structural Materials

Brick, Wood, and Other Structural Building Materials

Brick	*BrickCompositePctBrick*	40%
Wood	*BrickCompositePctWood*	50%
Other	*BrickCompositePctOther*	10%

Reinforced Concrete and Steel

Concrete	*ConcreteCompositePctConcrete*	90%
Steel	*ConcreteCompositePctSteel*	10%

Parameters

Thresholds		
Efficacy Threshold	*efficacy Threshold*	6
Destructiveness level to send to Waste	*destructiveness Threshold*	Moderate
Cost-Scaling Factors		
Waste-Handling Difficulty	*Waste_Handling_Difficulty_HighFactor, Waste_Handling_Difficulty_ModerateFactor, Waste_Handling_Difficulty_LowFactor*	100, 10, 1
Sampling and Waste Cost Data		
Costs - Sampling		
Sampling and Analysis Costs per Sample		
PCR	*CollectionAndAnalysisCostPerSamplePCR*	$681
BI	*CollectionAndAnalysisCostPerSampleBI*	$681
Culture	*CollectionAndAnalysisCostPerSampleCulture*	$681
Costs – Waste Sampling and Transportation		
Fixed Costs		
Fixed Costs	-	$5/ft^3
Waste Transportation Costs		
Mileage Costs	-	$5/mile
Truck Capacity	-	7 tons
Distance to Landfill (Decon-terminated Solids)		200 miles
Waste Handling Costs		
Solid Waste Processing Rate	-	2000 lb/hour
Waste Handling Team Cost	-	$384/hour
Waste Acceptance Fee		
Solids	*WasteAcceptanceFeePerTonSolids*	$100/ton
Costs – Waste Handling		
For Materials		
Removal Thickness		
Removal Thickness	-	Depends on material
Decontaminated Waste		
(References on CostRefs - Remove Interior)		
Removal Labor Time	-	Depends on material

Removal Labor Cost	-	Depends on material
Equipment Cost	-	Depends on material
Potentially Contaminated Waste Removal Labor Premium	*PREMIUM_for_HazMAT_Removal* (Reference on HazMAT worksheet)	122%

Replacement Cost
(References on CostRefs - Replace Structural and CostRefs - Replace Interior worksheets)

Materials	-	Depends on material
Labor	-	Depends on material
Equipment	-	Depends on material

For Items

Decontaminated Waste Removal Labor Time	-	0.10 hours/lb
Removal Labor Cost	-	$1/lb
Potentially Contaminated Waste Removal Labor Premium	*PREMIUM_for_HazMAT_Removal*	122%
Replacement Cost Replacement Cost	Handled by User Input on Materials Input worksheet	

Heater/Cooler Costs

Heater Costs

Operating Cost	HeaterBTUperHrPerCfperDegF	0.625 BTU/h/ft^3/degF
Rental Cost	HeaterRentalCostPerDayPer20kBTU	$20 per day/20k BTU

Cooler Costs

Operating Cost	CoolerBTUperHrPerCfperDegF	0.625 BTU/h/ft^3/degF
Rental Cost	CoolerRentalCostPerDayPer20kBTU	$20 per day/20k BTU

Humidifier/De-Humid Costs

Humidifiers:

Operating Cost	HumidifierBTUperHrPerCfperPct	0.625 BTU/hr/ft^3/%RH
Rental Cost	HumidifierRentalCostPerDayPer20kBTU	$20 per day/20k BTU

Dehumidifiers:

Operating Cost	DehumidifierBTUperHrPerCfperPct	0.625 BTU/hr/ft^3/%RH
Rental Cost	DehumidifierRentalCostPerDayPer20kBTU	$20 per day/20k BTU

Heating, Ventilating, and Cooling (HVAC) Worksheet

Difficulty Level by ducting and duct	
Unducted	1
Unlined	
Highly -Accessible	2
Moderately Accessible	3
Less Accessible	4
Inaccessible	5
Lined	
Highly Accessible	3
Moderately Accessible	4
Less Accessible	5
Inaccessible	5

HVAC Message Level:

0	HVAC is decontaminated as part of volumetric decontamination
1	Unducted HVAC can be decontaminated as part of the facility decontamination process
2	HVAC will be relatively easy to access and decontaminate using surface decontamination technologies
3	HVAC may be difficult to access and decontaminate; costs for this must be considered before using surface decontamination technologies
4	HVAC will be relatively difficult to access and decontaminate; costs for this must be considered before using surface decontamination technologies
5	HVAC will be very difficult to access and decontaminate; costs for this must be considered before using surface decontamination technologies

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Appendix

A

Appendix A: Training and Tabletop Exercise

The half-day Training and Tabletop Exercise (TTX) on September 7, 2017, at Research Triangle Park, NC, exposed a broader USEPA audience to all three versions of the DeconST. The training session conveyed to participants a working knowledge of how to use the user-friendly software to develop recommendations for an Incident Commander. In the TTX that followed, participants used the DeconST to work through two scenarios to identify bugs and recommend improvements to make prior to the September 30, 2017, release of the tool, as well as to develop training materials and user guides to accompany the release of the tool.

The Training & Tabletop Exercise began with background and training on the basics of DeconST. Then, two exercise groups were formed, each being given a copy of the tool and instructed to walk through three given scenarios. Comments and suggestions were collected throughout.

This chapter discusses the Agenda, Participants and Roles, Training of DeconST Basics, DeconST Tabletop Exercise, Bugs and Tool Suggestions, Epiphanies, Action Items, and Parking Lot Issues. Appendix A contains the invitation letter and copies of the slides.

Agenda

TIME	**TOPIC**
8:30 AM – 8:45 AM	Welcome and Introductions
8:45 AM – 10:15 AM	Training of DeconST Basics
10:15 AM – 10:30 AM	Break
10:30 AM - 12:00 PM	DeconST Tabletop Exercise

Participants and Roles

Designer/Facilitators

U.S. Environmental Protection Agency

- Paul Lemieux, Ph.D., Associate Division Director, Decontamination and Consequence Management Division, National Homeland Security Research Center

Sandia National Laboratories

- Donna Edwards, Ph.D., Homeland Security Systems Analyst, Systems Research & Analysis Department
- Charles John, M.S., M.C.R.T., M.H.A., M.B.A., Ph.D., Homeland Security Systems Analyst, Systems Research & Analysis Department

Testing and Design Enhancement Groups

Group 1 (in person)
Donna Edwards (Sandia)
Chuck John (Sandia)
Alden Adrion (NHSRC)
Tim Boe (NHSRC)
Michael Pirhalla (NHSRC)
Lukas Oudejans (NHSRC)
Katherine Ratliff (NHSRC)
Joe Wood (NHSRC)

Group 2 (online)
Paul Lemieux (NHSRC)
Mario Ierardi USEPA (ORCR)
Christine Langlois-Miller (ORCR)
Amelia McCall (NHSRC)
Kathy Nickel (NHSRC)l
Kelly Smith (NHSRC)

Potential Official ORD Reviewers of User Guide, Tutorial, Tool

- Joe Wood, Mario Ierardi

Training in DeconST Basics

The goal of the user training was for participants to demonstrate an understanding of the fundamental user, materials, and sampling data inputs to generate results that support facility-specific decontamination strategies. Specific training objectives included:

- To provide user-level training to access and utilize the DeconST tool to generate facility-specific decontamination strategies
- To provide user-level training focused on understanding the different data inputs and interpretation and application of DeconST results to communicate facility-specific decontamination strategies

Training in the DeconST basics followed the Quick Start Guide, which is replicated in the front of this report, in the front matter worksheet tabs in the DeconST tool, and in the slides contained in Appendix A. A video version is also available.

Discussion from the participants included the following notes:

- Note that the waste from demolition would be assumed to be contaminated with the bio or chem agent only and not impacted by asbestos, lead, etc. (Lukas)
- Maybe the wording of “Natural Attenuation” should change to “No decon for X h” (Lukas)

- The selected %efficacy on the input page should be visible on the main result page; it drives the % decontaminated materials. (Lukas)
- Result page: The use of green for values that are just, say, 8% suggests that it is the best option [relative scaling], which it is, but 8% is marginal. Maybe an absolute scaling would be better plus a message that all numbers need to be placed into context by looking at the materials that drive the results. (Lukas)
- Need some disclaimer that the tool does not address clearance goals, and best decon options that roll out from this tool do not guarantee that application of such technology will reach surface concentrations at or below clearance levels. (Lukas)
- Possible caveats to include on Results Page: Critical Infrastructure may have priority when selecting between options for multiple buildings; tenting may not be feasible for some structures which may impact ability to use volumetric decon. (Paul)
- Results from characterization may have profound impact on decontamination selection options (e.g., if structure is not contaminated, then structure can be removed from consideration). This will affect messaging. (Paul)
- Noted that the waste quantities don't add up when comparing results on the materials distribution slide versus the material distribution graph. This only appeared when structural materials were excluded from decontamination considerations on the materials input slide. (Paul)
- Discussion about importance of translating tool output to something that supports IC decision-making. (several people)
- Discussion about applicability of tool to wide-area scenario. (Mario)
- Run multiple scenarios to develop rules of thumb. (Tim)
- Batch file capability. (Tim)
- Please define all acronyms in the tool. It would be nice if they were defined in a pop up message box, rather than having to refer to the user's guide. (Kathy)
- I was never successful in generating the report, even when I tried to save it to a pdf. (Kathy)
- The cost bar charts were done in varying shades of purple. I found it hard to differentiate the various cost components because the colors were so similar. I suggest using contrasting colors for ease of distinguishing the various categories. (Kathy)

DeconST Tabletop Exercise

The goal of the Tabletop Exercise was for participants to demonstrate an understanding of the different data inputs to generate DeconST results and appropriately apply the results in support of facility-specific decontamination strategies. Specific exercise objectives included:

- Participants will be able to apply the DeconST training principles to input scenario data, generate and apply results, and discuss facility-specific decontamination strategies.
- Participants will be able to develop a technical briefing of the facility-specific decontamination strategies for an Incident Commander.
- Participants will be able to develop a public information strategy and press briefing for building decontamination operations.

The group was divided into two groups for the exercise (in-person and online) as noted above, and two scenarios were exercised:

- Chemical agent Sulfur Mustard (HD) released in an office building.
- Biological agent *Bacillus anthracis* released in a school building and tracked to a hospital and a single-family residence.

The next sections describe the scenarios, participant tasks, results, and discussion.

Scenario 1: Chemical Agent (Basic)

A medium sized office building with 25,000 ft^2 of walled offices (12 occupants) and 55,000 ft^2 of cubicle offices (100 occupants) is contaminated with sulfur mustard sprayed into an HVAC duct. The temperature of the building ranges between 60 and 80 °F, and the relative humidity ranges from 45-50%. What is the best option(s) for decontaminating the office building? Is demolition a viable option?

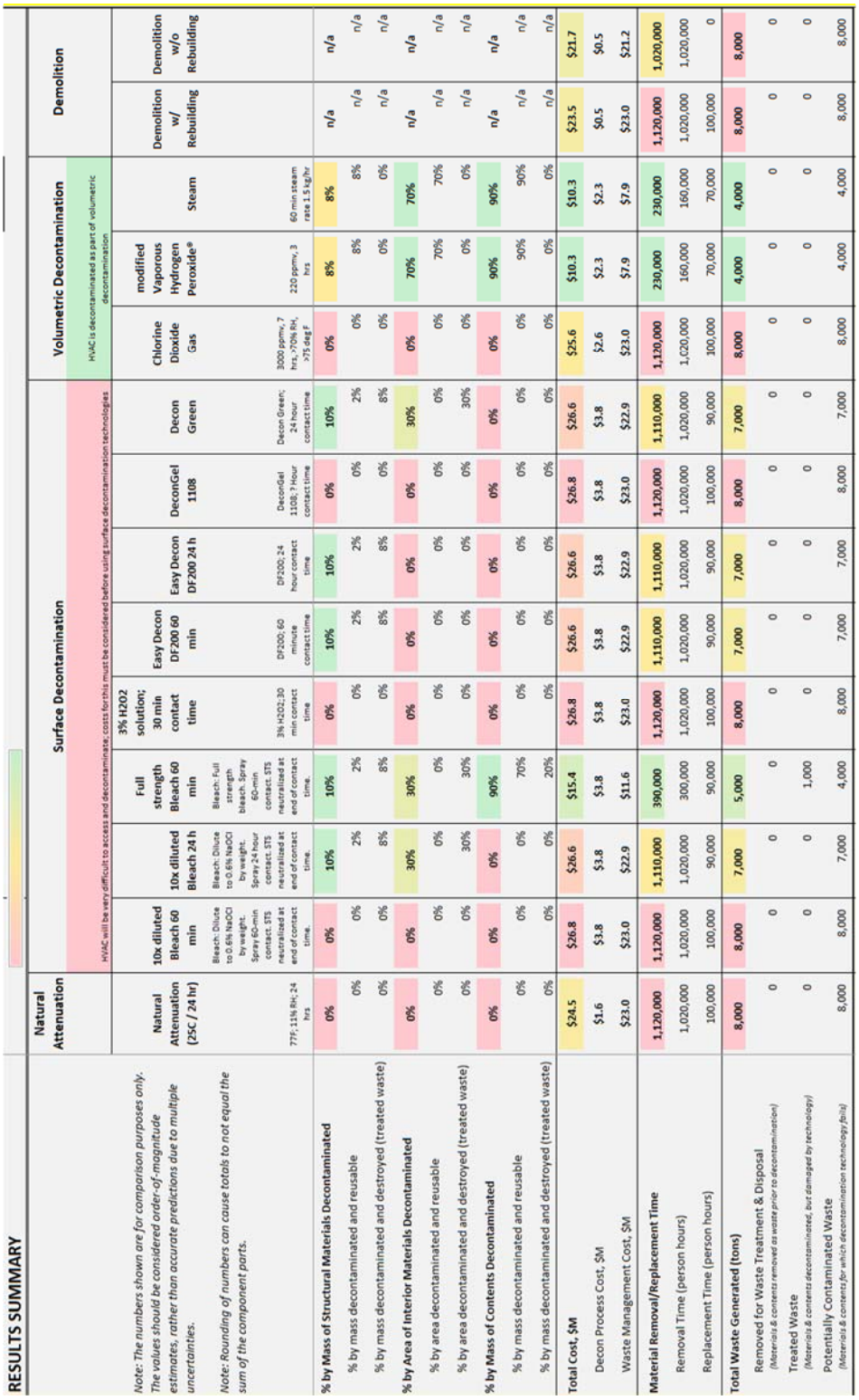
Scenario: Medium Sized Office Building	
Contaminant	Sulfur mustard sprayed into an HVAC duct
Offices (Walled)	25,000 ft^2 of walled offices (12 occupants)
Offices (Cubicle)	55,000 ft^2 of cubicle offices (100 occupants)
Temperature (F)	Building temperature ranges between 60 and 80 °F
Relative Humidity (%)	Building relative humidity ranges from 45-50%

Participant Tasks

- Identify and discuss the data inputs for the User Input Worksheet and the Materials Input Worksheet.
- Produce the Scenario Results Summary Worksheet.
- Interpret the results data needed to develop decontamination strategies.
- Discuss the decontamination strategy options.
- What is the best option(s) for decontaminating the office building?
    - What resources are needed to execute the recommended decontamination strategy?
    - How long will it take for the decontamination team to be assembled and arrive on-scene?
    - Is demolition a viable option?
- Highlight the information and the technical detail that should be included in a technical briefing to the Incident Commander.
- What is the public information strategy? What information will be included in a press briefing? What are the challenges in developing this press briefing? How will a "one voice, one message" concept be maintained?

Results

The results are shown in the following figure:



RESULTS SUMMARY	Natural Attenuation	Surface Decontamination								Volumetric Decontamination			Demolition	
		HVAC will be very difficult to access and decontaminate; costs for this must be considered before using surface decontamination technologies								HVAC is decontaminated as part of volumetric decontamination				
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.	Natural Attenuation (25C / 24 hr)	10x diluted Bleach 60 min	10x diluted Bleach 24 h	Full strength Bleach 60 min	3% H2O2 solution; 30 min contact time	Easy Decon DF200 60 min	Easy Decon DF200 24 h	DeconGel 1108	Decon Green	Chlorine Dioxide Gas	modified Vaporous Hydrogen Peroxide®	Steam	Demolition w/ Rebuilding	Demolition w/o Rebuilding
Note: Rounding of numbers can cause totals to not equal the sum of the component parts.	77F; 11% RH; 24 hrs	Bleach: Dilute to 0.6% NaOCl by weight. Spray 60-min contact. STS neutralized at end of contact time.	Bleach: Dilute to 0.6% NaOCl by weight. Spray 24 hour contact. STS neutralized at end of contact time.	Bleach: Full strength. Spray 60-min contact. STS neutralized at end of contact time.	3% H2O2; 30 min contact time	DF200; 60 minute contact time	DF200; 24 hour contact time	DeconGel 1108; ? Hour contact time	Decon Green; 24 hour contact time	3000 ppmv, 7 hrs, >70% RH, >75 deg F	220 ppmv, 3 hrs	60 min steam rate 1.5 kg/hr		
% by Mass of Structural Materials Decontaminated	0%	0%	10%	10%	0%	10%	10%	0%	10%	0%	8%	8%	n/a	n/a
% by mass decontaminated and reusable	0%	0%	2%	2%	0%	2%	2%	0%	2%	0%	8%	8%	n/a	n/a
% by mass decontaminated and destroyed (treated waste)	0%	0%	8%	8%	0%	8%	8%	0%	8%	0%	0%	0%	n/a	n/a
% by Area of Interior Materials Decontaminated	0%	0%	30%	30%	0%	0%	0%	0%	30%	0%	70%	70%	n/a	n/a
% by area decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	70%	70%	n/a	n/a
% by area decontaminated and destroyed (treated waste)	0%	0%	30%	30%	0%	0%	0%	0%	30%	0%	0%	0%	n/a	n/a
% by Mass of Contents Decontaminated	0%	0%	0%	90%	0%	0%	0%	0%	0%	0%	90%	90%	n/a	n/a
% by mass decontaminated and reusable	0%	0%	0%	70%	0%	0%	0%	0%	0%	0%	90%	90%	n/a	n/a
% by mass decontaminated and destroyed (treated waste)	0%	0%	0%	20%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
Total Cost, $M	$24.5	$26.8	$26.6	$15.4	$26.8	$26.6	$26.6	$26.8	$26.6	$25.6	$10.3	$10.3	$23.5	$21.7
Decon Process Cost, $M	$1.6	$3.8	$3.8	$3.8	$3.8	$3.8	$3.8	$3.8	$3.8	$2.6	$2.3	$2.3	$0.5	$0.5
Waste Management Cost, $M	$23.0	$23.0	$22.9	$11.6	$23.0	$22.9	$22.9	$23.0	$22.9	$23.0	$7.9	$7.9	$23.0	$21.2
Material Removal/Replacement Time	1,120,000	1,120,000	1,110,000	390,000	1,120,000	1,110,000	1,110,000	1,120,000	1,110,000	1,120,000	230,000	230,000	1,120,000	1,020,000
Removal Time (person hours)	1,020,000	1,020,000	1,020,000	300,000	1,020,000	1,020,000	1,020,000	1,020,000	1,020,000	1,020,000	160,000	160,000	1,020,000	1,020,000
Replacement Time (person hours)	100,000	100,000	90,000	90,000	100,000	90,000	90,000	100,000	90,000	100,000	70,000	70,000	100,000	0
Total Waste Generated (tons)	8,000	8,000	7,000	5,000	8,000	7,000	7,000	8,000	7,000	8,000	4,000	4,000	8,000	8,000
Removed for Waste Treatment & Disposal *(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	1,000	0	0	0	0	0	0	0	0	0	0
Potentially Contaminated Waste *(Materials & contents for which decontamination technology fails)*	8,000	8,000	7,000	4,000	8,000	7,000	7,000	8,000	7,000	8,000	4,000	4,000	8,000	8,000

Figure A-1. Scenario 1 Results: Office Building

Discussion

- Structural materials – the part that is not contaminated becomes waste; but that makes no sense for 82% of structure – how can that be waste? It is demolition then.
- And what does that mean for interior materials and contents? If the building is demolished, you can't do the rest.
- Decon Tech Data Rollup – check rollup results; fix demolition numbers.
- Tech briefing.
- Limited tech data to support.
- Unknown handled as doesn't work.
- With VHP - 92% of structural materials become waste.
- With VHP or steam, keep steel frame, and cheaper than demolition.
- Noticed the profound impact of structural materials.
- Realize that after facility characterization, you would have more information.
- Can possibly change how to handle the individual materials based on this information.
- This insight opens the tool to a new use – the optimization of characterization.
- Is the facility structure contaminated or not?
- Which materials are critical to the remediation decisions?
- Communications/Public Messaging
- Initial thought was that messaging is not informed by tool.
- Mario points out the IC has four basic questions.
  - Is it safe?
  - What options do we have?
  - What will it take (in terms of resources)?
  - How long?
- Mario also suggests we consult the RCRA 9 questions about protecting human health and the environment; he will send an email with these suggestions

Scenario 2: *Biological Agent (more complex)*

A terrorist releases *Bacillus anthracis* spores into an elementary school. The school has 200 students and 30,000 ft^2 of surface area. Although the school authorities were alerted to the presence of the terrorist who released the material, and the students were contained and sent to the local hospital (20 beds) for observation, one student who didn't feel well left the school and went home immediately after the release but before anyone knew what had happened (ignore the mode of transportation for the student/students and possible secondary contamination thereof). Because of this, the child contaminated his home (a 2500 ft^2 private residence) with *B.a.* spores. Now there are three structures needing decontamination: the school, the house, and the hospital. You have at your disposal one set of equipment each to generate and contain chlorine dioxide and methyl bromide, and bleach and sprayers are available at Home Depot. What would be your recommendation to decontaminate these three facilities? Would that recommendation change if time were of the essence?

Scenario: Elementary School	
Agent	*B. anthracis* spores
Student Population	200 students elementary school age
Floor Area	30,000 ft^2
Additional Scenario Information	School authorities were alerted to the presence of the terrorist who released the material. Students were contained and sent to the local hospital (20 beds) for observation. BUT 1 student who did not feel well left the school and went home immediately after the release but before anyone knew what had happened. The child contaminated his home (a 2500 ft^2 private residence) with *B.a.* spores. Note: Ignore the mode of transportation for the student/students and possible secondary contamination.
Structures Needing Decon	School House Hospital
Available Assets	1 set of equipment EACH to generate and contain chlorine dioxide and methyl bromide Bleach and sprayers are available at Home Depot.

Participant Tasks

- Prioritize the approaches based on what is available.
- Discuss the options available based on the DeconST results.
- What would be your recommendation to decontaminate these three facilities?
- Would your recommendation change if time were of the essence?
- Develop the technical briefing for the incident commander for each of the three facilities.
- Highlight the information and the technical detail that should be included in a technical briefing to the Incident Commander.
- Discuss the challenges of developing a technical briefing for a chemical event versus a biological event.
- What is the public information strategy?
- What information will be included in a press briefing?

Results

The results for the school, hospital and single-family residence are shown in the following:

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** 211 mg/l, 37 degees C, 75% RH, 18 hour contact time	**Vaporous Hydrogen Peroxide*** 225 ppmv, 4 hrs	**Low-Concentration Hydrogen Peroxide** 3000 ppmv, 3 hrs, >70% RH, >75 deg F	**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
% by Mass of Structural Materials Decontaminated	**100%**	**100%**	**10%**	**0%**	**10%**	**10%**	**100%**
% by mass decontaminated and reusable	90%	100%	10%	0%	0%	0%	90%
% by mass decontaminated and destroyed (treated waste)	10%	0%	0%	0%	10%	10%	10%
% by Area of Interior Materials Decontaminated	**90%**	**90%**	**40%**	**0%**	**0%**	**0%**	**90%**
% by area decontaminated and reusable	60%	90%	40%	0%	0%	0%	0%
% by area decontaminated and destroyed (treated waste)	40%	0%	0%	0%	0%	0%	90%
% by Mass of Contents Decontaminated	**70%**	**70%**	**70%**	**0%**	**50%**	**50%**	**60%**
% by mass decontaminated and reusable	40%	70%	60%	0%	40%	40%	40%
% by mass decontaminated and destroyed (treated waste)	20%	0%	10%	0%	10%	10%	10%
Total Cost, $M	**$2.9**	**$2.4**	**$7.1**	**$7.1**	**$8.6**	**$8.6**	**$3.8**
Decon Process Cost, $M	$1.7	$1.9	$1.6	$0.9	$2.5	$2.5	$2.5
Waste Management Cost, $M	$1.1	$0.6	$5.5	$6.2	$6.1	$6.1	$1.3
Material Removal/Replacement Time	**38,000**	**29,000**	**127,000**	**147,000**	**135,000**	**135,000**	**41,000**
Removal Time (person hours)	20,000	13,000	58,000	76,000	64,000	64,000	22,000
Replacement Time (person hours)	18,000	16,000	69,000	71,000	71,000	71,000	19,000
Total Waste Generated (tons)	**400**	**100**	**2,600**	**2,900**	**2,900**	**2,900**	**400**
Removed for Waste Treatment & Disposal *(Materials & contents removed as waste prior to decontamination)*	0	0	0	0	0	0	0
Treated Waste *(Materials & contents decontaminated, but damaged by technology)*	200	0	0	0	200	200	200
Potentially Contaminated Waste *(Materials & contents for which decontamination technology fails)*	100	100	2,600	2,900	2,600	2,600	100

most desirable

	Surface Decontamination HVAC will be relatively easy to access and decontaminate using surface decontamination technologies						Demolition	
	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.	**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. Rinsate 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**
	90%	**100%**	**20%**	**20%**	**30%**	**20%**	**n/a**	**n/a**
	80%	90%	0%	0%	10%	0%	n/a	n/a
	10%	10%	20%	20%	20%	20%	n/a	n/a
	90%	**90%**	**90%**	**90%**	**90%**	**90%**	**n/a**	**n/a**
	0%	0%	0%	0%	0%	0%	n/a	n/a
	90%	90%	90%	90%	90%	90%	n/a	n/a
	60%	**70%**	**70%**	**60%**	**60%**	**60%**	**n/a**	**n/a**
	50%	50%	40%	40%	40%	40%	n/a	n/a
	10%	20%	20%	10%	10%	10%	n/a	n/a
	$4.4	**$3.8**	**$8.6**	**$8.6**	**$7.9**	**$8.6**	**$6.6**	**$5.4**
	$2.6	**$2.5**	**$2.5**	**$2.5**	**$2.5**	**$2.5**	**$0.4**	**$0.4**
	$1.9	**$1.3**	**$6.0**	**$6.0**	**$5.4**	**$6.0**	**$6.2**	**$5.1**
	110,000	**40,000**	**129,000**	**130,000**	**124,000**	**130,000**	**147,000**	**76,000**
	48,000	21,000	59,000	59,000	57,000	59,000	76,000	76,000
	62,000	19,000	71,000	71,000	67,000	71,000	71,000	0
	700	**400**	**2,900**	**2,900**	**2,600**	**2,900**	**2,900**	**2,900**
	0	0	0	0	0	0	0	0
	200	300	600	600	600	600	0	0
	500	100	2,300	2,300	2,000	2,300	2,900	2,900

Figure A-2. Scenario 2 Results: School

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** 211 mg/l, 37 degees C, 75% RH, 18 hour contact time	**Vaporous Hydrogen Peroxide®** 225 ppmv, 4 hrs	**Low-Concentration Hydrogen Peroxide** 3000 ppmv, 3 hrs, >70% RH, >75 deg F	**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
% by Mass of Structural Materials Decontaminated	0%	0%	0%	0%	0%	0%	0%
% by mass decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%
% by mass decontaminated and destroyed (treated waste)	0%	0%	0%	0%	0%	0%	0%
% by Area of Interior Materials Decontaminated	100%	100%	30%	0%	0%	0%	100%
% by area decontaminated and reusable	70%	100%	30%	0%	0%	0%	0%
% by area decontaminated and destroyed (treated waste)	30%	0%	0%	0%	0%	0%	100%
% by Mass of Contents Decontaminated	80%	80%	80%	0%	70%	70%	70%
% by mass decontaminated and reusable	40%	80%	50%	0%	40%	40%	40%
% by mass decontaminated and destroyed (treated waste)	40%	0%	30%	0%	30%	30%	30%
Total Cost, $M	$2.2	$2.1	$2.2	$1.8	$3.3	$3.3	$3.2
Decon Process Cost, $M	$1.6	$1.7	$1.5	$0.8	$2.4	$2.4	$2.4
Waste Management Cost, $M	$0.6	$0.3	$0.7	$1.0	$0.9	$0.9	$0.9
Material Removal/Replacement Time	24,000	17,000	29,000	39,000	32,000	32,000	31,000
Removal Time (person hours)	12,000	6,000	15,000	25,000	18,000	18,000	17,000
Replacement Time (person hours)	12,000	12,000	14,000	15,000	15,000	15,000	15,000
Total Waste Generated (tons)	100	0	100	100	100	100	100
Removed for Waste Treatment & Disposal *(Materials & contents removed as waste prior to decontamination)*	0	0	0	0	0	0	0
Treated Waste *(Materials & contents decontaminated, but damaged by technology)*	0	0	0	0	0	0	100
Potentially Contaminated Waste *(Materials & contents for which decontamination technology fails)*	0	0	100	100	100	100	0

most desirable

	Surface Decontamination						Demolition	
	HVAC will be relatively easy to access and decontaminate using surface decontamination technologies							
	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.	**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. Rinsate 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**
% by Mass of Structural Materials Decontaminated	0%	0%	0%	0%	0%	0%	n/a	n/a
% by mass decontaminated and reusable	0%	0%	0%	0%	0%	0%	n/a	n/a
% by mass decontaminated and destroyed (treated waste)	0%	0%	0%	0%	0%	0%	n/a	n/a
% by Area of Interior Materials Decontaminated	100%	100%	100%	100%	100%	100%	n/a	n/a
% by area decontaminated and reusable	0%	0%	0%	0%	0%	0%	n/a	n/a
% by area decontaminated and destroyed (treated waste)	100%	100%	100%	100%	100%	100%	n/a	n/a
% by Mass of Contents Decontaminated	70%	80%	80%	70%	70%	70%	n/a	n/a
% by mass decontaminated and reusable	40%	40%	40%	40%	40%	40%	n/a	n/a
% by mass decontaminated and destroyed (treated waste)	30%	40%	40%	30%	30%	30%	n/a	n/a
Total Cost, $M	$3.3	$3.2	$3.2	$3.2	$3.2	$3.2	$6.6	$5.4
Decon Process Cost, $M	$2.4	$2.4	$2.4	$2.4	$2.4	$2.4	$0.3	$0.3
Waste Management Cost, $M	$0.9	$0.9	$0.9	$0.9	$0.9	$0.9	$6.2	$5.0
Material Removal/Replacement Time	31,000	31,000	31,000	31,000	31,000	31,000	115,000	63,000
Removal Time (person hours)	17,000	16,000	16,000	16,000	16,000	16,000	63,000	63,000
Replacement Time (person hours)	15,000	15,000	15,000	15,000	15,000	15,000	52,000	0
Total Waste Generated (tons)	100	100	100	100	100	100	2,900	2,900
Removed for Waste Treatment & Disposal *(Materials & contents removed as waste prior to decontamination)*	0	0	0	0	0	0	0	0
Treated Waste *(Materials & contents decontaminated, but damaged by technology)*	100	100	100	100	100	100	0	0
Potentially Contaminated Waste *(Materials & contents for which decontamination technology fails)*	0	0	0	0	0	0	2,900	2,900

Figure A-3. Scenario 2 Results: Hospital

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 211 mg/l, 37 degees C, 75% RH, 18 hour contact time	Vaporous Hydrogen Peroxide® 225 ppmv, 4 hrs	Low-Concentration Hydrogen Peroxide 3000 ppmv, 3 hrs, >70% RH, >75 deg F	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
% by Mass of Structural Materials Decontaminated	0%	0%	0%	0%	0%	0%	0%
% by mass decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%
% by mass decontaminated and destroyed (treated waste)	0%	0%	0%	0%	0%	0%	0%
% by Area of Interior Materials Decontaminated	70%	70%	30%	0%	0%	0%	70%
% by area decontaminated and reusable	50%	70%	30%	0%	0%	0%	20%
% by area decontaminated and destroyed (treated waste)	30%	0%	0%	0%	0%	0%	50%
% by Mass of Contents Decontaminated	80%	80%	80%	0%	70%	70%	70%
% by mass decontaminated and reusable	30%	80%	60%	0%	30%	30%	50%
% by mass decontaminated and destroyed (treated waste)	50%	0%	20%	0%	40%	40%	20%
Total Cost, $k	$186.0	$164.0	$185.0	$142.0	$227.0	$227.0	$216.0
Decon Process Cost, $k	$131.0	$128.0	$116.0	$48.0	$141.0	$141.0	$141.0
Waste Management Cost, $k	$56.0	$36.0	$70.0	$94.0	$86.0	$86.0	$75.0
Material Removal/Replacement Time	1,800	1,100	3,800	4,800	4,200	4,200	2,000
Removal Time (person hours)	1,100	500	1,200	2,200	1,700	1,700	1,100
Replacement Time (person hours)	700	700	2,500	2,600	2,600	2,600	900
Total Waste Generated (tons)	10	10	20	30	20	20	20
Removed for Waste Treatment & Disposal *(Materials & contents removed as waste prior to decontamination)*	0	0	0	0	0	0	0
Treated Waste *(Materials & contents decontaminated, but damaged by technology)*	0	0	0	0	0	0	10
Potentially Contaminated Waste *(Materials & contents for which decontamination technology fails)*	10	10	20	30	20	20	10

most desirable

Surface Decontamination						Demolition	
HVAC will be relatively easy to access and decontaminate using surface decontamination technologies							
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.	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. Rinsate 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
0%	0%	0%	0%	0%	0%	n/a	n/a
0%	0%	0%	0%	0%	0%	n/a	n/a
0%	0%	0%	0%	0%	0%	n/a	n/a
50%	70%	50%	50%	50%	50%	n/a	n/a
0%	20%	0%	0%	0%	0%	n/a	n/a
50%	50%	50%	50%	50%	50%	n/a	n/a
70%	80%	80%	70%	70%	70%	n/a	n/a
50%	50%	30%	30%	30%	30%	n/a	n/a
20%	30%	50%	40%	40%	40%	n/a	n/a
$222.0	$216.0	$226.0	$226.0	$226.0	$226.0	$211.0	$130.0
$142.0	$141.0	$141.0	$141.0	$141.0	$141.0	$20.0	$20.0
$81.0	$75.0	$85.0	$86.0	$86.0	$86.0	$191.0	$110.0
3,900	1,900	4,100	4,100	4,100	4,100	15,800	6,300
1,300	1,100	1,600	1,600	1,600	1,600	6,300	6,300
2,600	900	2,600	2,600	2,600	2,600	9,500	0
20	20	20	20	20	20	50	50
0	0	0	0	0	0	0	0
10	10	20	20	20	20	0	0
10	10	0	0	0	0	50	50

Figure A-4. Scenario 2 Results: Single-Family Residence

Discussion

- For all facilities, Methyl Bromide, ClO_2 and Bleach Wash are all good choices.
- Prioritize hospital for methyl bromide because it is critical infrastructure.
- Flip argument is that hospital knew kids were coming and may have taken precautions about contamination.
- School is something lower – "essential" infrastructure – use ClO_2.
- Flip argument is that school HVAC system was location of attack.
- Home is not critical – hotel, etc. – use bleach.
- Bleach produces most waste and is highest cost – this is of less consequence on the smaller building.

Bugs and Tool Suggestions

- Add default facility sizes (rather than blanks).
- Fix color coding across costs.
- Too many characters per cell sometimes -- when in $K instead of $M, bio for sure, maybe chem.
- Double-click to open – tool sometimes crashes.
- Need explanation of differences between chem and bio tool.
- Foreward vs. Forward – two spellings.
- User Input.
- Remove freeze panes – maybe add messages about this on several pages.
- Office – change "IW" to walled-office.
- Remove "user input" words on areas.
- Cost-scaling factors – add pop-up to say, "national average"; add suggestions, e.g., 2x for NYC? Remember price-gouging for times of disaster.
- Waste-handling – popup that says like municipal solid waste; LMH from BOTE.
- Print Report – add instructions about quirks.
- Check highs > lows.
- Add a place to input if the building structure is contaminated.
- Materials Inputs sheet.
- Remove red total numbers.
- Sampling Inputs.
- Fix wrap/underline on Contents removed as waste.
- Need to add caveats on demolition – as popups and in User Guide.
    - Waste acceptance criteria.
    - Many other issues that come into play – e.g., asbestos
- Why would sampling density be different if the building is being rebuilt or not? – Cathy
    - We're not saying it would be different, just allowing for that possibility.
    - Suggest using terminology from Superfund – "Unrestricted" vs. "Restricted" use.
- Results Summary.
- HVAC considerations need to be added to Natural Attenuation columns.
- Fix column widths to remove ###s and text wrapping, check page breaks after.

- Add note that Decontaminated = met the minimum efficacy % put on User Input sheet.
  - Add display of minimum efficacy % on this worksheet.
- Consider whether red/green should be absolute or relative; or make these user-settable thresholds?
- Consider whether to remove n/as for demolition – replace with 0%; at least put more explanation.
- Can we identify or create a template for info to go to IC or PIO?
- Age of the building is not considered – add a comment.
- Asbestos, lead paint – add caveats?
- Level of contamination in facility – add a comment.
- Check for math problems with the waste quantity graphs.
- If you remove the structural materials, you see zeroes in the waste generated plots for steam and VHP.

Epiphanies

- Characterization sampling must determine whether the structure of the facility is contaminated or only the interior.
- Understanding the extent and level of contamination in the facility may be essential to determining the most appropriate decon method (but we knew that before, right?)
- DeconST (or at least the information encoded in it) can be used to point to which materials are most important to characterize (those that would drive different decon decisions).

Action Items

- TTX notes – Paul will merge input from everyone who sends notes.
- Analysis work – Donna will send findings of summer student analysis to Tim (cc Paul).
- User Manual.
- Modify to reflect changes in the tool – Donna.
- Add merged TTX materials and notes – Donna? Or Chuck?
- Add list of known bugs and suggested improvements – Donna.
- Formatting and review – Paul.
- Tool updates.
- Create list of updates to Bio tool to inform group – Donna.
- Organize and categorize tool suggestions – Donna.
  - Fixes and checks.
  - Suggestions:
    - Easy to do.
    - Ideas to save (include list in user manual).
- Video Tutorial.
- Create draft – Paul.
- Redo voicing as required – Chuck with Paul's recorder.
- Share draft – Donna will send FTP invitation to Paul for transfer.
- Review draft – Chuck and Donna.

Parking Lot Issues

- Gaps in efficacy data impact the robustness of this tool (Mario).
- Can we develop a classified version for a “non-traditional” threat agent? (Mario) (This is a trend Mario is noticing; OHS is pushing people to get clearances; To be prepared for this, we need to be thinking).
- Mario’s interest in an NTA version of the tool is noted. However, imagine there are no decon options or decon cannot be implemented, it would all become waste and then the tool can already function by simply having zero decon options... bit of a misuse of the word “selection” in DeconST but at least the demolishing cost is calculated; I-WASTE can do that too. (Lukas)

Appendix

B

Appendix B: Training and Tabletop Exercise Invitation and Slides

Invitation Letter

The text of the invitation letter is included below.

> Greetings:
> The U.S. Environmental Protection Agency's (EPA's) National Homeland Security Research Center (NHSRC) invites you to attend a half-day training/table top exercise (TTX) **on Thursday September 7, 2017,** to learn about and test the new version of the "Decontamination Selection Tool" (DeconST). **PLEASE SAVE THE DATE**.
>
> DeconST was initially developed by Sandia National Laboratories supported by EPA for the 2012 Wide Area Recovery and Resiliency Program (WARRP) with funding from the U.S. Department of Homeland Security. DeconST was developed as an MS Excel spreadsheet-based tool that focused on aiding a technical working group or other advisors to provide recommendations to an incident commander to decide upon what decontamination technology to use to decontaminate a building contaminated with *Bacillus anthracis* (anthrax). It does not require any special software to run beyond MS Excel 2016.
>
> The new version of DeconST improves upon the biological agent decontamination technology selections that were included in the original version of the tool by adding data from recently completed research on biodecontamination and now adds similar functionality selecting approaches to decontaminate buildings affected by a chemical contamination incident.
>
> It is expected that DeconST might be used by an On-Scene Coordinator, Removal Manager, Technical Working Group, or other Subject Matter Experts (e.g., Special Teams, NHSRC) to provide recommendations to an Incident Commander regarding selection of the most effective means to decontaminate a building following a chemical/biological contamination incident and includes considerations such as

decontamination effectiveness, material destruction, waste generation, relative cost, and uncertainties of the DeconST assessments of response options.

The half-day training/TTX will take place (morning or afternoon session TBD) on Thursday September 7, 2017, in Room E-310A at the EPA's Facilities in Research Triangle Park, NC. It will also include the ability to connect via webinar/teleconference to minimize the impact on our travel budgets at the end of the fiscal year. We will distribute copies of the beta version of the DeconST prior to the training/TTX session.

During the training session, you will be presented with the necessary functionality of DeconST so that you can gain a working knowledge of how to use the user-friendly software to develop recommendations for an Incident Commander. The training session will be followed up by a TTX that will involve using DeconST to work through two scenarios defined by the hosts of the TTX.

The results from the TTX will be used to identify bugs to fix and improvements to make in DeconST prior to its September 30, 2017 release, as well as to develop training materials and user guides to accompany the release of the tool.

Please acknowledge your willingness to attend this activity via email to Lemieux.paul@epa.gov and indicate your preference for attending a morning or afternoon session and whether you will attend in person or online.

Thank you.

Paul M. Lemieux, Ph.D. US EPA Office of Research and Development
National Homeland Security Research Center
Associate Division Director NHSRC/DCMD
919-541-0962 919-541-0496 fax 513-300-9958 cell lemieux.paul@epa.gov
www.epa.gov/nhsrc

Slides

The slides used for the Training and Tabletop Exercise are included in the following pages.

Exceptional service in the national interest

Sandia National Laboratories




DeconST Quick Start User Training & TTX

07-Sept-17

Quick Start Training Agenda

Sandia National Laboratories

TIME	TOPIC
8:30 AM – 8:45 AM	Welcome & Introductions
8:45 AM – 10:15 AM	Training of DeconST Basics
10:15 AM – 10:30 AM	Break
10:30 AM - 12:00 PM	DeconST Tabletop Exercise
12:00 PM	Adjourn

Training Scope & Objectives

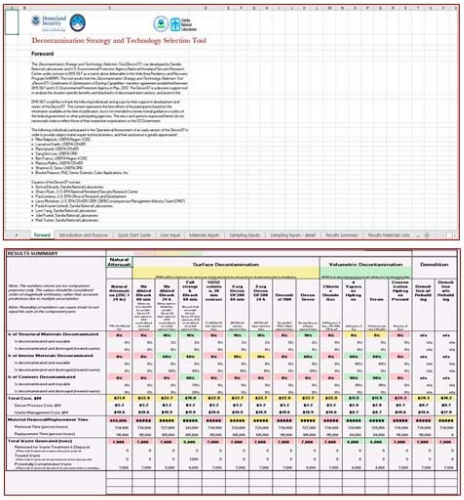
GOAL: The goal of the EPA DeconST User Training is for participants to demonstrate an understanding of the fundamental user, materials, and sampling data inputs to generate results that support facility-specific decontamination strategies.

Training Objectives	
Objective 1	*To provide user-level training to access and utilize the DeconST tool in order to generate facility-specific decontamination strategies.*
Objective 2	*To provide user-level training focused on understanding the different data inputs and interpretation and application of DeconST results to communicate facility-specific decontamination strategies.*

3

DeconST at a Glance

- The DeconST goal is to provide information so that a Technical Working Group can assess potential decontamination strategies and technology options for a particular facility, comparing the options on the basis of their relative effectiveness, costs, destructiveness, and waste generated.
- DeconST presents a series of options and recommendations, with color-coded estimates of likelihood of success, cost implications, and waste estimates of decontamination technologies appropriate to a given building.
- DeconST provides outputs, including tables of waste composition, cost distribution charts, and other information that would justify the recommendations given to an Incident Commander.



4

Key Stakeholder Messages

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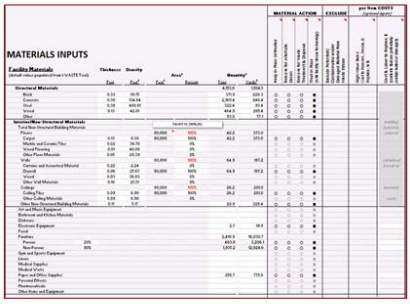
DeconST provides a comprehensive, data-rich framework for considering decontamination options and facilitating the development of facility-specific, efficient, and effective remediation approaches following attack or contamination with Bacillus anthracis (B.a.) or a chemical agent.

Stakeholders can….

- Assess the decontamination strategy and technology options for a particular facility, comparing the options on the basis of their relative effectiveness, costs, destructiveness, and waste generated.
- Identify and recommend a decontamination strategy to the incident commander so that remediation operations can be planned, approved, and implemented more quickly.

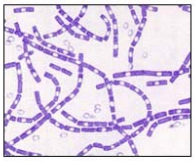


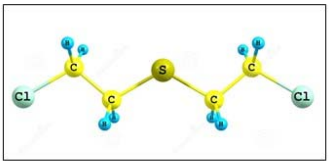
5

DeconST Initial StartUp

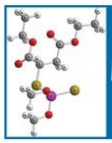
Sandia National Laboratories

- Using DeconST
  - Locate the appropriate version of DeconST
    - *B. anthracis:* DeconST-bioBa
    - Sulfur Mustard: DeconST-chemHD for
    - VX: DeconST-chemVX
    - Malathion: DeconST-chemMalathion
  - Download the DeconST tool to your personal Windows computer (DeconST does **NOT** run on a Mac)
  - Open the DeconST executable Microsoft Excel file
  - Enable Macros when prompted
  - Begin using the tool





VX



MALATHION

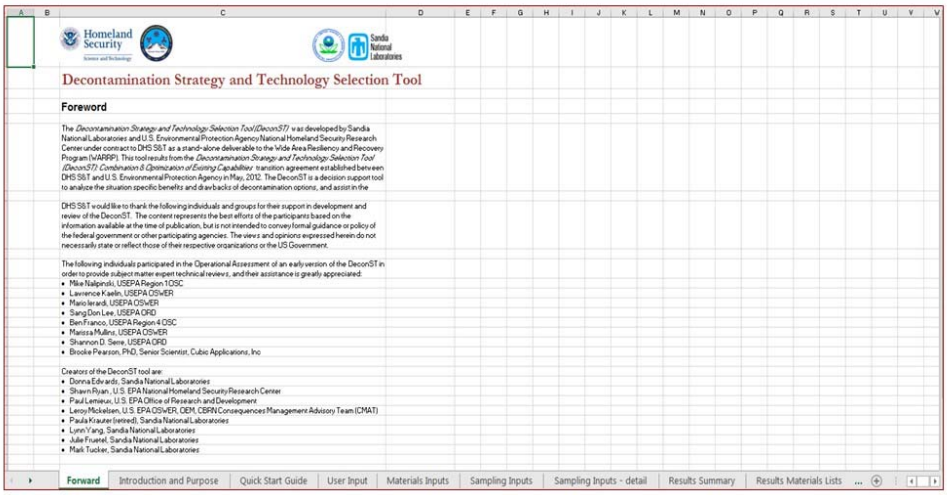
Microsoft

6

DeconST Fundamentals

LET'S GET STARTED!

DeconST Main Screen



Key Messages

- The first 3 Excel Worksheets contain the pertinent content in the Quick Start Guide as a reference if needed during operation.
- Data are entered into the tool beginning with the User Input Worksheet.

User Input Worksheets

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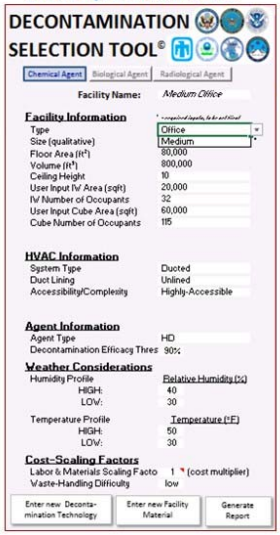
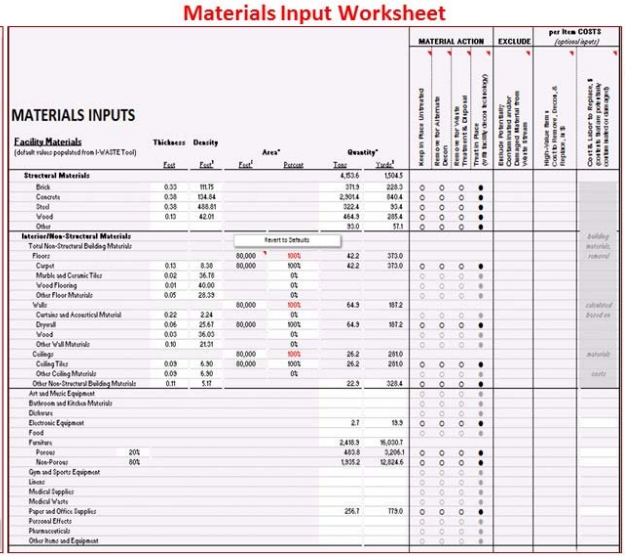
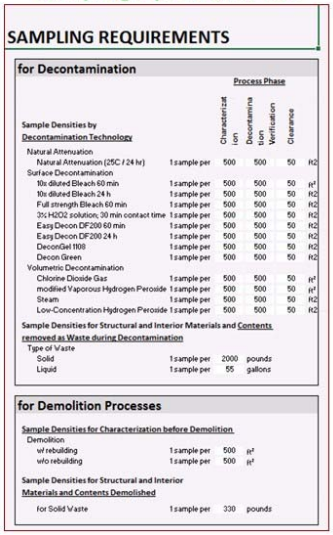
User Input Worksheet



Materials Input Worksheet



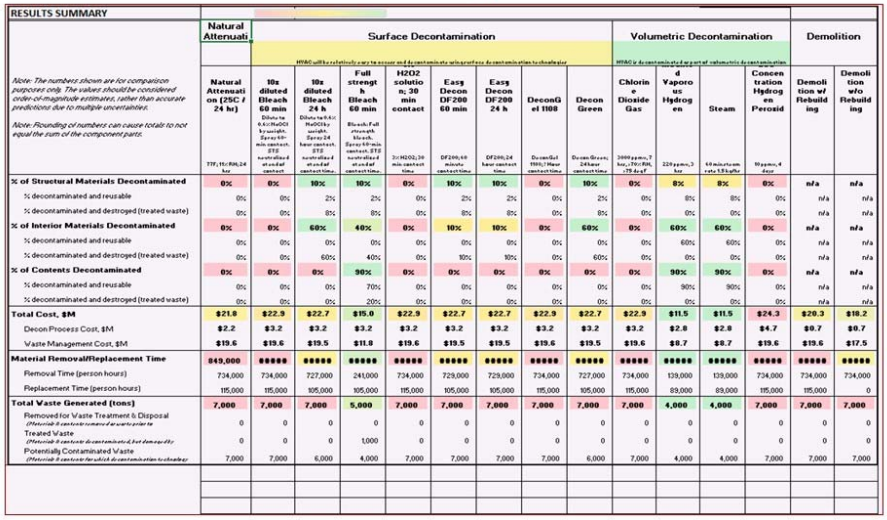
Sampling Input Worksheet



Results Summary

Sandia National Laboratories

Results Summary Worksheet



RESULTS SUMMARY

	Natural Attenuation	Surface Decontamination								Volumetric Decontamination			Demolition	
	Natural Attenuation (25C / 24 hr)	10x diluted Bleach 60 min	10x diluted Bleach 24 h	Full strength Bleach 60 min	H2O2 solution; 30 min contact	Easy Decon DF200 60 min	Easy Decon DF200 24 h	DeconGel 1108	Decon Green	Chlorine Dioxide Gas	d Vaporous Hydrogen	Steam	Concentration Hydrogen Peroxid	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Structural Materials Decontaminated	0%	0%	10%	10%	0%	10%	10%	0%	10%	0%	0%	0%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	2%	2%	0%	2%	2%	0%	2%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	8%	8%	0%	8%	8%	0%	8%	0%	0%	0%	0%	n/a	n/a
% of Interior Materials Decontaminated	0%	0%	60%	60%	0%	10%	10%	0%	60%	0%	60%	60%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	60%	60%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	0%	0%	0%	n/a	n/a
% of Contents Decontaminated	0%	0%	0%	90%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	70%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
Total Cost, $M	$21.8	$22.9	$22.7	$15.0	$22.9	$22.7	$22.7	$22.9	$22.7	$22.9	$11.5	$11.5	$24.3	$20.3	$18.2
Decon Process Cost, $M	$2.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$2.8	$2.8	$4.7	$0.7	$0.7
Waste Management Cost, $M	$19.6	$19.6	$19.5	$11.8	$19.6	$19.5	$19.5	$19.6	$19.5	$19.6	$8.7	$8.7	$19.6	$19.6	$17.5
Material Removal/Replacement Time	849,000	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####
Removal Time (person hours)	734,000	734,000	727,000	241,000	734,000	729,000	729,000	734,000	727,000	734,000	139,000	139,000	734,000	734,000	734,000
Replacement Time (person hours)	115,000	115,000	105,000	105,000	115,000	105,000	105,000	115,000	105,000	115,000	89,000	89,000	115,000	115,000	0
Total Waste Generated (tons)	7,000	7,000	7,000	5,000	7,000	7,000	7,000	7,000	7,000	7,000	4,000	4,000	7,000	7,000	7,000
Removed for Waste Treatment & Disposal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste	0	0	0	1,000	0	0	0	0	0	0	0	0	0	0	0
Potentially Contaminated Waste	7,000	7,000	6,000	4,000	7,000	7,000	7,000	7,000	6,000	7,000	4,000	4,000	7,000	7,000	7,000

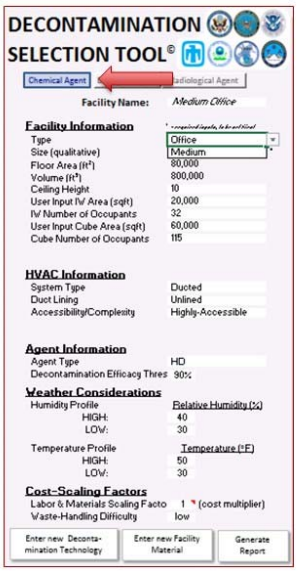
10

User Input Worksheets: Facility

Sandia National Laboratories

Instructions

1. Once again, verify you are using the correct version of the tool.



DeconST Screenshot Interpretation

- The User Input Worksheet collects the information about the:
  - Facility
  - HVAC system
  - Agent or chemical
  - Weather
  - Cost-scaling factors if there are any

Key Messages

- DeconST requires minimal user input to get initial data results
- Customizable assessments can be done based on a variety of different building types.

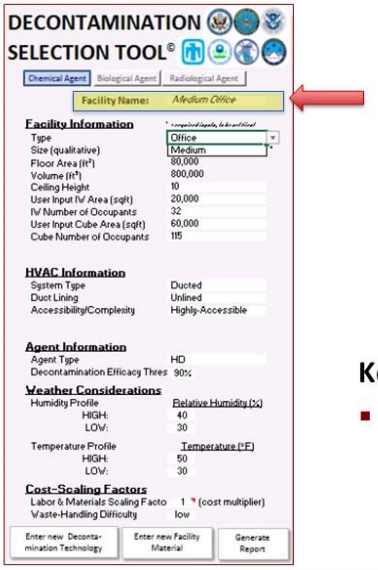
11

User Input Worksheets: Facility

Sandia National Laboratories

Instructions

1. Once again, verify you are using the correct version of the tool.
2. Name the building. Enter a Name for the facility in the Facility Name box.



Key Messages

- Use easily recognizable nomenclature when naming the facility.

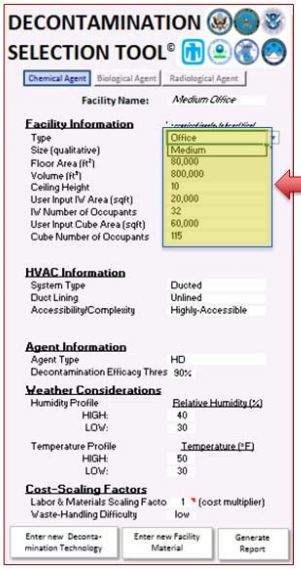
12

User Input Worksheets: Facility

Sandia National Laboratories

Instructions

1. Once again, verify you are using the correct version of the tool.
2. Name the building. Enter a Name for the facility in the Facility Name box.
3. Verify or change the facility information. Select the facility type and qualitative size from the drop down menus in order to populate default parameters.



Key Messages

- If a facility type is NOT in the drop-down menu, refer to the Advanced Features section of the User Guide for instructions.
- When the Size (qualitative) is selected from the drop down menu, the Floor Area and Volume data fields are auto-populated to reflect the size.
- Other facility specific parameters also auto-populate.

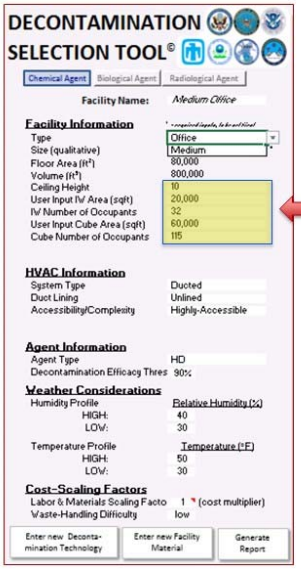
13

User Input Worksheets: Facility

Sandia National Laboratories

Instructions

1. Once again, verify you are using the correct version of the tool.
2. Name the building. Enter a Name for the facility in the Facility Name box.
3. Verify or change the facility information. Select the facility type and qualitative size from the drop down menus in order to populate default parameters.
4. If desired, update the facility parameters. In the case of an office building, these are:
   a) Ceiling Height
   b) User Input Individual-Walled Office Area
   c) Individual-Walled Office Number of Occupants
   d) User Input Cube Area
   e) Cube Number of Occupants



Key Messages

- There are default values supplied for all input parameters
- Users can adjust these values as needed

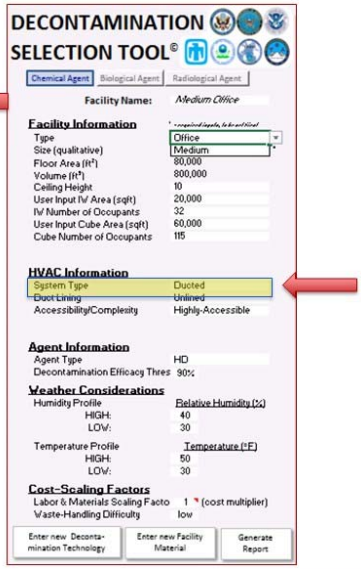
14

User Input Worksheets: HVAC

Sandia National Laboratories

Instructions

1. Now, enter the building HVAC information.
2. Select the HVAC system type – ducted or unducted.

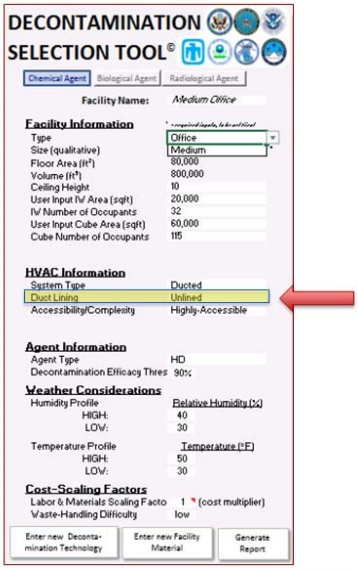


User Input Worksheets: HVAC

Sandia National Laboratories

Instructions

1. Enter the building HVAC information. Select the HVAC system type – ducted or unducted.
2. For ducted systems, select whether ducts are lined or unlined.

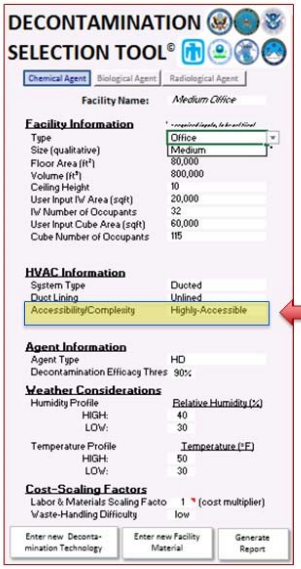


User Input Worksheets: HVAC

Sandia National Laboratories

Instructions

1. Enter the building HVAC information. Select the HVAC system type – ducted or unducted.
2. For ducted systems, select whether ducts are lined or unlined.
3. Select the best descriptor of the accessibility of the system for cleaning, considering location and lengths of ducts.



DeconST Screenshot Interpretation

- Duct work does not change the waste and the efficacy
- Decontamination for duct work may be different than the decontamination for the rest of the building
- Pay attention to the implications of the duct work for using a particular decontamination strategy

Key Messages

- Due to complexities of decontamination of HVAC, DeconST recommendations for HVAC are given as caveats to the overall assessment of different technologies.

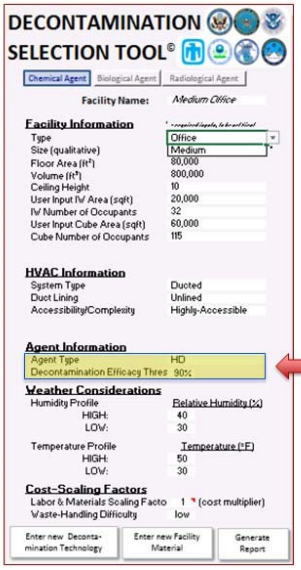
17

User Input Worksheets: Agent

Sandia National Laboratories

Instructions

1. Next, verify the agent information.
2. Verify that this box lists the correct chemical agent (or biological agent).



DeconST Screenshot Interpretation

- If the correct agent is NOT listed, switch to the correct version of the tool:
  - *B. anthracis* – DeconST-bioBa
  - Sulfur Mustard – DeconST-chemHD
  - VX – DeconSTVX
  - Malathion - DeconST-chemMalathion
- In this example, Sulfur Mustard is the chemical agent (Agent Type = HD).
- For chemical agents, the desired minimum Decontamination Efficacy may be found in the dropdown menu OR can be typed in the box.

Key Messages

- Double check the contaminant again to ensure the correct version of DeconST is being used.

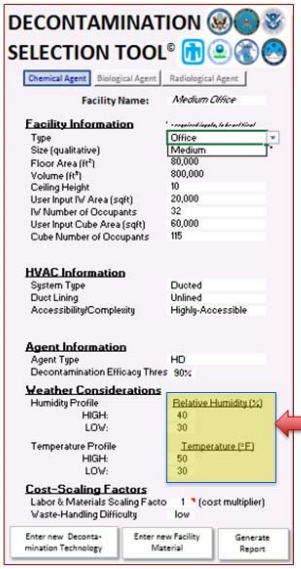
18

User Input Worksheets: Weather Conditions

Sandia National Laboratories

Instructions

1. Information about the weather considerations is next.
2. Input the daily high and low relative humidity and high and low outdoor temperatures.



DeconST Screenshot Interpretation

- Values are required for both the High and the Low.

Key Messages

- There are default values supplied for all input parameters.
- Users can adjust these values as needed.

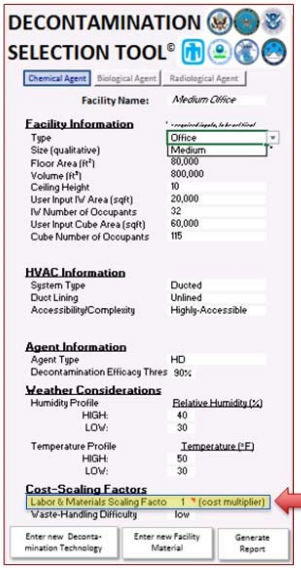
19

User Input Worksheets: Cost-Scaling

Sandia National Laboratories

Instructions

1. Adjust urban-area premium, which is a multiplicative factor for all labor and materials costs.



DeconST Screenshot Interpretation

- There may be cost multipliers due to location or incident that may be needed to be applied to correct cost estimates.
- Often cost multipliers are not needed.

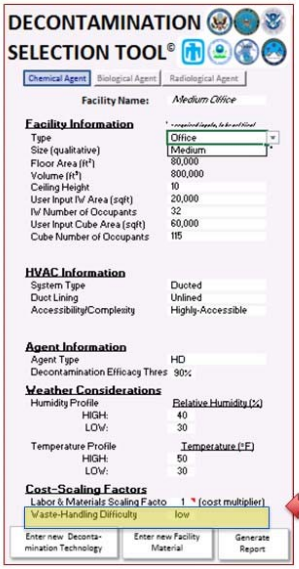
20

User Input Worksheets: Cost-Scaling

Sandia National Laboratories

Instructions

1. Adjust urban-area premium, which is a multiplicative factor for all labor and materials costs.
2. Select the waste-handling difficulty (high, moderate, low).



DeconST Screenshot Interpretation

- Depending on the location, waste may be more or less difficult to handle.
- Low indicates similar to municipal solid waste.
- Medium is more difficult
- High is very difficult.

Key Messages

- Waste handling (Low, Medium, High) will impact the cost estimates.

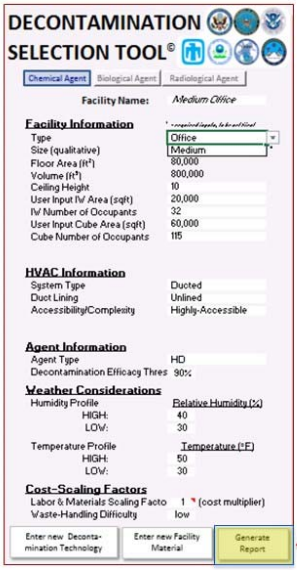
21

User Input Worksheets: Generate Report

Sandia National Laboratories

Instructions

1. The Generate Report button runs a "Print Preview" on the main input and output pages, from which the user may print a report.



DeconST Screenshot Interpretation

1. Note that the preview of the report is not in color unless a color printer is chosen.
2. Color is used to help convey the results comparison.

Key Messages

1. A full report will be available that can be used to develop the key content sections of the technical briefing provided to the incident commander.

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SWITCH TO THE MATERIALS INPUT WORKSHEET

Materials Input Worksheet

MATERIALS INPUTS

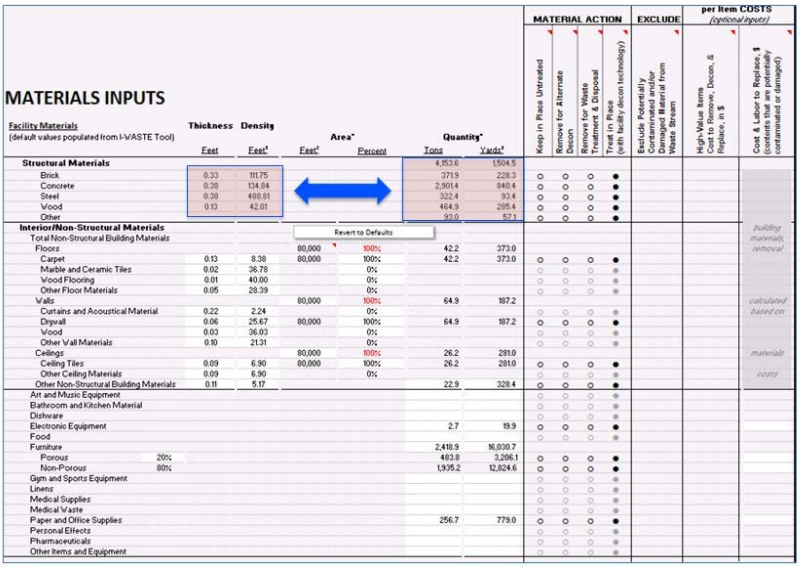
Facility Materials (default values populated from I-WASTE Tool)	Thickness Feet	Density Feet³	Area* Feet²	Area* Percent	Quantity* Tons	Quantity* Yards³	MATERIAL ACTION: Keep in Place Untreated	MATERIAL ACTION: Remove for Alternate Disposal	MATERIAL ACTION: Remove for Waste Treatment & Disposal	MATERIAL ACTION: 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 Segment, Decon, & Replace, in $	per Item COSTS (optional inputs): Cost & Labor to Replace, $ (only if materials potentially contaminated or damaged)
Structural Materials					4,153.6	1,504.5							
Brick	0.33	111.75			371.9	228.3	○	○	○	●			
Concrete	0.38	134.84			2,901.4	840.4	○	○	○	●			
Steel	0.38	488.81			322.4	93.4	○	○	○	●			
Wood	0.13	42.01			464.9	285.4	○	○	○	●			
Other					93.0	57.1	○	○	○	●			
Interior/Non-Structural Materials			Revert to Defaults										building materials removal
Total Non-Structural Building Materials													
Floors			80,000	100%	42.2	373.0							
Carpet	0.13	8.38	80,000	100%	42.2	373.0	○	○	○	●			
Marble and Ceramic Tiles	0.02	36.78		0%			○	○	○	●			
Wood Flooring	0.01	40.00		0%			○	○	○	●			
Other Floor Materials	0.05	28.39		0%			○	○	○	●			
Walls			80,000	100%	64.9	187.2							calculated based on
Curtains and Acoustical Material	0.22	2.24		0%			○	○	○	●			
Drywall	0.06	25.67	80,000	100%	64.9	187.2	○	○	○	●			
Wood	0.03	36.03		0%			○	○	○	●			
Other Wall Materials	0.10	21.31		0%			○	○	○	●			
Ceilings			80,000	100%	26.2	281.0							materials costs
Ceiling Tiles	0.09	6.90	80,000	100%	26.2	281.0	○	○	○	●			
Other Ceiling Materials	0.09	6.90		0%			○	○	○	●			
Other Non-Structural Building Materials	0.11	5.17			22.9	328.4	○	○	○	●			
Art and Music Equipment							○	○	○	●			
Bathroom and Kitchen Material							○	○	○	●			
Dishware							○	○	○	●			
Electronic Equipment					2.7	19.9	○	○	○	●			
Food							○	○	○	●			
Furniture					2,418.9	16,030.7							
Porous	20%				483.8	3,206.1	○	○	○	●			
Non-Porous	80%				1,935.2	12,824.6	○	○	○	●			
Gym and Sports Equipment							○	○	○	●			
Linens							○	○	○	●			
Medical Supplies							○	○	○	●			
Medical Waste							○	○	○	●			
Paper and Office Supplies					256.7	779.0	○	○	○	●			
Personal Effects							○	○	○	●			
Pharmaceuticals							○	○	○	●			
Other Items and Equipment							○	○	○	●			

Key Messages

- The Materials Input Worksheet shows default quantities of structural ( ) and interior non-structural ( ) building materials and contents for the particular facility type ( )selected on the User Input worksheet.
- These quantities were auto-populated from the EPA's I-WASTE tool based on the facility type that is identified on the User Input Tab.
- The user may customize the quantities on this page, select appropriate actions for each material, and input per item costs as necessary.

Materials Input Worksheet: Quantities

Sandia National Laboratories



MATERIALS INPUTS

Facility Materials (default values populated from I-WASTE Tool)	Thickness Feet	Density Feet³	Area* Feet²	Area* Percent	Quantity* Tons	Quantity* Yards³	MATERIAL ACTION: Keep in Place Untreated	Remove for Alternate Disposal	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 Salvage, Decon, & Replace, in $	Cost & Labor to Replace, $ (contaminated or damaged)
Structural Materials					4,153.6	1,504.5							
Brick	0.33	111.75			371.9	228.3	○	○	○	●			
Concrete	0.38	134.84			2,901.4	840.4	○	○	○	●			
Steel	0.38	488.81			322.4	93.4	○	○	○	●			
Wood	0.13	42.01			464.9	285.4	○	○	○	●			
Other					93.0	57.1	○	○	○	●			
Interior/Non-Structural Materials													
Total Non-Structural Building Materials													
Floors			80,000	100%	42.2	373.0							
Carpet	0.13	8.38	80,000	100%	42.2	373.0	○	○	○	●			
Marble and Ceramic Tiles	0.02	36.78		0%			○	○	○	●			
Wood Flooring	0.01	40.00		0%			○	○	○	●			
Other Floor Materials	0.05	28.39		0%			○	○	○	●			
Walls			80,000	100%	64.9	187.2							
Curtains and Acoustical Material	0.22	2.24		0%			○	○	○	●			
Drywall	0.06	25.67	80,000	100%	64.9	187.2	○	○	○	●			
Wood	0.03	36.03		0%			○	○	○	●			
Other Wall Materials	0.10	21.31		0%			○	○	○	●			
Ceilings			80,000	100%	26.2	281.0							
Ceiling Tiles	0.09	6.90	80,000	100%	26.2	281.0	○	○	○	●			
Other Ceiling Materials	0.09	6.90		0%			○	○	○	●			
Other Non-Structural Building Materials	0.11	5.17			22.9	328.4	○	○	○	●			
Art and Music Equipment							○	○	○	●			
Bathroom and Kitchen Material							○	○	○	●			
Dishware							○	○	○	●			
Electronic Equipment					2.7	19.9	○	○	○	●			
Food							○	○	○	●			
Furniture					2,418.9	16,030.7							
Porous 20%					483.8	3,206.1	○	○	○	●			
Non-Porous 80%					1,935.2	12,824.6	○	○	○	●			
Gym and Sports Equipment							○	○	○	●			
Linens							○	○	○	●			
Medical Supplies							○	○	○	●			
Medical Waste							○	○	○	●			
Paper and Office Supplies					256.7	779.0	○	○	○	●			
Personal Effects							○	○	○	●			
Pharmaceuticals							○	○	○	●			
Other Items and Equipment							○	○	○	●			

Revert to Defaults

Instructions

1. Adjust the quantities of the structural materials for Thickness (feet), Density (feet³), and Quantity (Tons and Yards³).

DeconST Screenshot Interpretation

- Default quantities are based on Hazus and I-WASTE for the building type selected on initial page.
- Often these quantities do not need editing.

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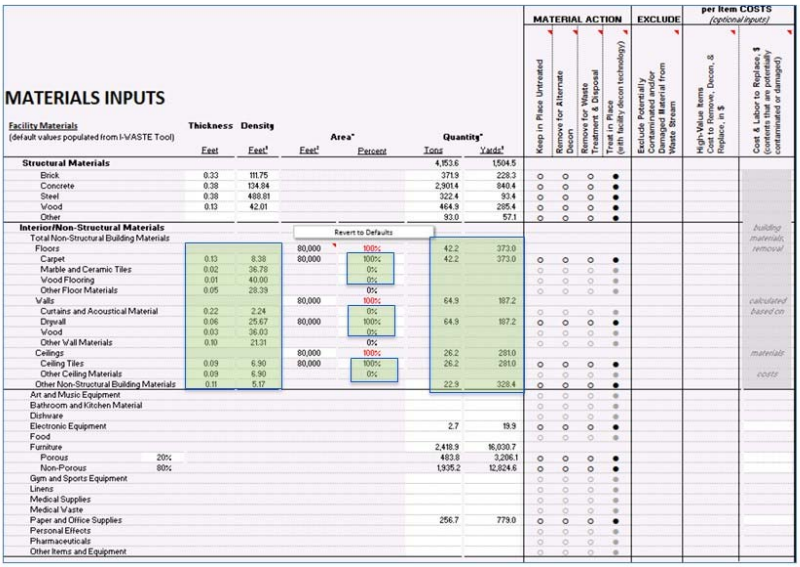
Materials Input Worksheet: Quantities

Sandia National Laboratories



MATERIALS INPUTS

Facility Materials (default values populated from I-WASTE Tool)	Thickness Feet	Density Feet³	Area* Feet²	Area* Percent	Quantity* Tons	Quantity* Yards³	MATERIAL ACTION: Keep in Place Untreated	Remove for Alternate Disposal	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 Salvage, Decon, & Replace, in $	Cost & Labor to Replace, $ (contaminated or damaged)
Structural Materials					4,153.6	1,504.5							
Brick	0.33	111.75			371.9	228.3	○	○	○	●			
Concrete	0.38	134.84			2,901.4	840.4	○	○	○	●			
Steel	0.38	488.81			322.4	93.4	○	○	○	●			
Wood	0.13	42.01			464.9	285.4	○	○	○	●			
Other					93.0	57.1	○	○	○	●			
Interior/Non-Structural Materials													
Total Non-Structural Building Materials													
Floors			80,000	100%	42.2	373.0							
Carpet	0.13	8.38	80,000	100%	42.2	373.0	○	○	○	●			
Marble and Ceramic Tiles	0.02	36.78		0%			○	○	○	●			
Wood Flooring	0.01	40.00		0%			○	○	○	●			
Other Floor Materials	0.05	28.39		0%			○	○	○	●			
Walls			80,000	100%	64.9	187.2							
Curtains and Acoustical Material	0.22	2.24		0%			○	○	○	●			
Drywall	0.06	25.67	80,000	100%	64.9	187.2	○	○	○	●			
Wood	0.03	36.03		0%			○	○	○	●			
Other Wall Materials	0.10	21.31		0%			○	○	○	●			
Ceilings			80,000	100%	26.2	281.0							
Ceiling Tiles	0.09	6.90	80,000	100%	26.2	281.0	○	○	○	●			
Other Ceiling Materials	0.09	6.90		0%			○	○	○	●			
Other Non-Structural Building Materials	0.11	5.17			22.9	328.4	○	○	○	●			
Art and Music Equipment							○	○	○	●			
Bathroom and Kitchen Material							○	○	○	●			
Dishware							○	○	○	●			
Electronic Equipment					2.7	19.9	○	○	○	●			
Food							○	○	○	●			
Furniture					2,418.9	16,030.7							
Porous 20%					483.8	3,206.1	○	○	○	●			
Non-Porous 80%					1,935.2	12,824.6	○	○	○	●			
Gym and Sports Equipment							○	○	○	●			
Linens							○	○	○	●			
Medical Supplies							○	○	○	●			
Medical Waste							○	○	○	●			
Paper and Office Supplies					256.7	779.0	○	○	○	●			
Personal Effects							○	○	○	●			
Pharmaceuticals							○	○	○	●			
Other Items and Equipment							○	○	○	●			

Revert to Defaults

Instructions

1. Adjust the quantities of the structural materials for Thickness (feet), Density (feet³), and Quantity (Tons and Yards³).
2. Adjust the quantities of the interior materials by typing in the white cells for Thickness (feet), Density (feet³), and Quantity (Tons and Yards³).

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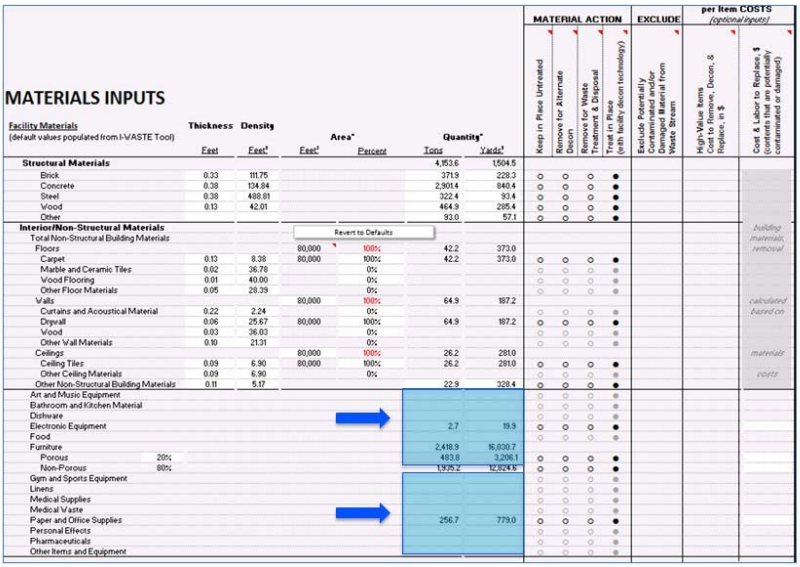
Materials Input Worksheet: Quantities



MATERIALS INPUTS

Facility Materials (default values populated from I-WASTE Tool)	Thickness Feet	Density Feet³	Area* Feet²	Area* Percent	Quantity* Tons	Quantity* Yards³	MATERIAL ACTION: Keep in Place Untreated	Remove for Alternate Decon	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 Segment, Decon, & Replace, in $	Cost & Labor to Replace, $ (cost to remove potentially contaminated or damaged)
Structural Materials					4,153.6	1,504.5							
Brick	0.33	111.75			371.9	228.3	○	○	○	●			
Concrete	0.38	134.84			2,901.4	840.4	○	○	○	●			
Steel	0.38	488.81			322.4	93.4	○	○	○	●			
Wood	0.13	42.01			464.9	285.4	○	○	○	●			
Other					93.0	57.1	○	○	○	●			
Interior/Non-Structural Materials			Revert to Defaults										
Total Non-Structural Building Materials													building materials removal
Floors			80,000	100%	42.2	373.0							
Carpet	0.13	8.38	80,000	100%	42.2	373.0	○	○	○	●			
Marble and Ceramic Tiles	0.02	36.78		0%			○	○	○	●			
Wood Flooring	0.01	40.00		0%			○	○	○	●			
Other Floor Materials	0.05	28.39		0%			○	○	○	●			
Walls			80,000	100%	64.9	187.2							calculated based on
Curtains and Acoustical Material	0.22	2.24		0%			○	○	○	●			
Drywall	0.06	25.67	80,000	100%	64.9	187.2	○	○	○	●			
Wood	0.03	36.03		0%			○	○	○	●			
Other Wall Materials	0.10	21.31		0%			○	○	○	●			
Ceilings			80,000	100%	26.2	281.0							materials
Ceiling Tiles	0.09	6.90	80,000	100%	26.2	281.0	○	○	○	●			
Other Ceiling Materials	0.09	6.90		0%			○	○	○	●			costs
Other Non-Structural Building Materials	0.11	5.17			22.9	328.4	○	○	○	●			
Art and Music Equipment							○	○	○	●			
Bathroom and Kitchen Material							○	○	○	●			
Dishware							○	○	○	●			
Electronic Equipment					2.7	19.9	○	○	○	●			
Food							○	○	○	●			
Furniture					2,418.9	16,030.7							
Porous 20%					483.8	3,206.1	○	○	○	●			
Non-Porous 80%					1,935.2	12,824.6	○	○	○	●			
Gym and Sports Equipment							○	○	○	●			
Linens							○	○	○	●			
Medical Supplies							○	○	○	●			
Medical Waste							○	○	○	●			
Paper and Office Supplies					256.7	779.0	○	○	○	●			
Personal Effects							○	○	○	●			
Pharmaceuticals							○	○	○	●			
Other Items and Equipment							○	○	○	●			

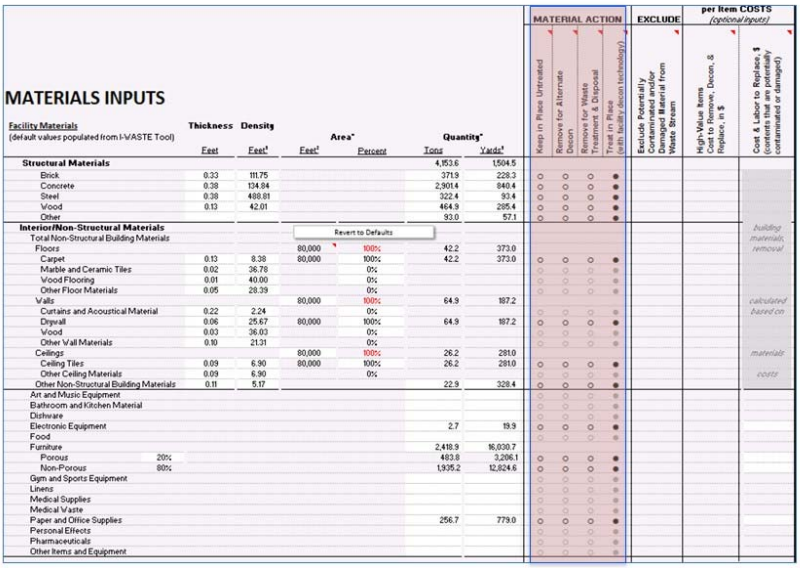
Instructions

1. Adjust the quantities of the structural materials for Thickness (feet), Density (feet^3), and Quantity (Tons and Yards^3).
2. Adjust the quantities of the interior materials by typing in the white cells for Thickness (feet), Density (feet^3), and Quantity (Tons and Yards^3).
3. Adjust the quantities of the contents by typing in the white cells for Quantity (Tons and Yards^3).

Key Messages

1. Note that the quantities must be positive numeric values and that the total percentages must not exceed 100%.
2. To adjust the floor area, return to the User Input worksheet .

Materials Input Worksheet: Material Action



MATERIALS INPUTS

Facility Materials (default values populated from I-WASTE Tool)	Thickness Feet	Density Feet³	Area* Feet²	Area* Percent	Quantity* Tons	Quantity* Yards³	MATERIAL ACTION: Keep in Place Untreated	Remove for Alternate Decon	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 Segment, Decon, & Replace, in $	Cost & Labor to Replace, $ (cost to remove potentially contaminated or damaged)
Structural Materials					4,153.6	1,504.5							
Brick	0.33	111.75			371.9	228.3	○	○	○	●			
Concrete	0.38	134.84			2,901.4	840.4	○	○	○	●			
Steel	0.38	488.81			322.4	93.4	○	○	○	●			
Wood	0.13	42.01			464.9	285.4	○	○	○	●			
Other					93.0	57.1	○	○	○	●			
Interior/Non-Structural Materials			Revert to Defaults										
Total Non-Structural Building Materials													building materials removal
Floors			80,000	100%	42.2	373.0							
Carpet	0.13	8.38	80,000	100%	42.2	373.0	○	○	○	●			
Marble and Ceramic Tiles	0.02	36.78		0%			○	○	○	●			
Wood Flooring	0.01	40.00		0%			○	○	○	●			
Other Floor Materials	0.05	28.39		0%			○	○	○	●			
Walls			80,000	100%	64.9	187.2							calculated based on
Curtains and Acoustical Material	0.22	2.24		0%			○	○	○	●			
Drywall	0.06	25.67	80,000	100%	64.9	187.2	○	○	○	●			
Wood	0.03	36.03		0%			○	○	○	●			
Other Wall Materials	0.10	21.31		0%			○	○	○	●			
Ceilings			80,000	100%	26.2	281.0							materials
Ceiling Tiles	0.09	6.90	80,000	100%	26.2	281.0	○	○	○	●			
Other Ceiling Materials	0.09	6.90		0%			○	○	○	●			costs
Other Non-Structural Building Materials	0.11	5.17			22.9	328.4	○	○	○	●			
Art and Music Equipment							○	○	○	●			
Bathroom and Kitchen Material							○	○	○	●			
Dishware							○	○	○	●			
Electronic Equipment					2.7	19.9	○	○	○	●			
Food							○	○	○	●			
Furniture					2,418.9	16,030.7							
Porous 20%					483.8	3,206.1	○	○	○	●			
Non-Porous 80%					1,935.2	12,824.6	○	○	○	●			
Gym and Sports Equipment							○	○	○	●			
Linens							○	○	○	●			
Medical Supplies							○	○	○	●			
Medical Waste							○	○	○	●			
Paper and Office Supplies					256.7	779.0	○	○	○	●			
Personal Effects							○	○	○	●			
Pharmaceuticals							○	○	○	●			
Other Items and Equipment							○	○	○	●			

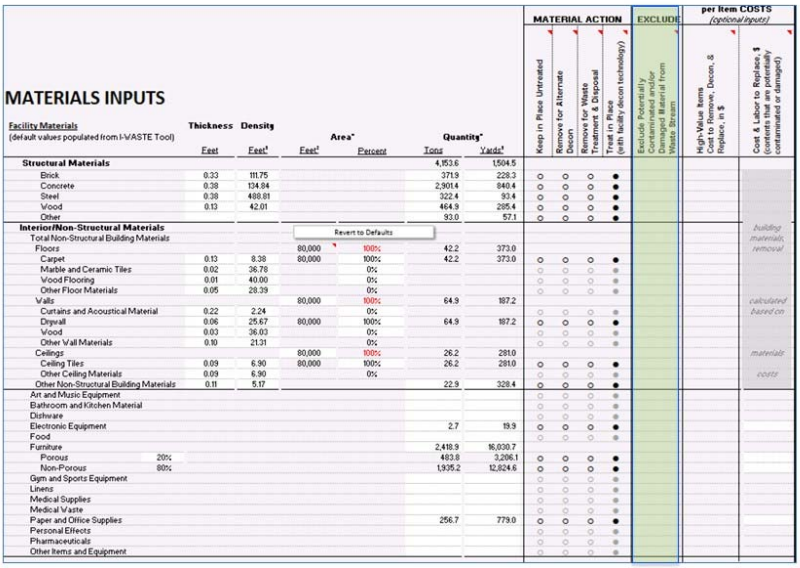
Instructions

1. For each material or item, use radio buttons to select the appropriate action:
   a) Keep in Place Untreated
   b) Remove for Alternate Decontamination (e.g., for high-value items)
   c) Send Directly to Waste
   d) Treat in Place (with Facility Decontamination Technology)

DeconST Screenshot Interpretation

- The user can assign different types of decon/waste management for each of the different materials
- The default is to treat all of the materials in place.

Materials Input Worksheet: Exclusion



MATERIALS INPUTS

Facility Materials (default values populated from I-WASTE Tool)	Thickness Feet	Density Feet³	Area* Feet²	Area* Percent	Quantity* Tons	Quantity* Yards³	Keep in Place Untreated	Remove for Alternate Decon	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 $	per Item COSTS (optional inputs): Cost & Labor to Replace, $ (per item sent to waste directly contaminated or damaged)
Structural Materials					4,153.6	1,504.5							
Brick	0.33	111.75			371.9	228.3	○	○	○	●			
Concrete	0.38	134.84			2,901.4	840.4	○	○	○	●			
Steel	0.38	488.81			322.4	93.4	○	○	○	●			
Wood	0.13	42.01			464.9	295.4	○	○	○	●			
Other					93.0	57.1	○	○	○	●			
Interior/Non-Structural Materials			Revert to Defaults										
Total Non-Structural Building Materials													building materials removal
Floors			80,000	100%	42.2	373.0							
Carpet	0.13	8.38	80,000	100%	42.2	373.0	○	○	○	●			
Marble and Ceramic Tiles	0.02	36.78		0%			○	○	○	●			
Wood Flooring	0.01	40.00		0%			○	○	○	●			
Other Floor Materials	0.05	28.39		0%			○	○	○	●			
Walls			80,000	100%	64.9	187.2							calculated based on
Curtains and Acoustical Material	0.22	2.24		0%			○	○	○	●			
Drywall	0.06	25.67	80,000	100%	64.9	187.2	○	○	○	●			
Wood	0.03	36.03		0%			○	○	○	●			
Other Wall Materials	0.10	21.31		0%			○	○	○	●			
Ceilings			80,000	100%	26.2	281.0							materials
Ceiling Tiles	0.09	6.90	80,000	100%	26.2	281.0	○	○	○	●			
Other Ceiling Materials	0.09	6.90		0%			○	○	○	●			costs
Other Non-Structural Building Materials	0.11	5.17			22.9	328.4	○	○	○	●			
Art and Music Equipment							○	○	○	●			
Bathroom and Kitchen Material							○	○	○	●			
Dishware							○	○	○	●			
Electronic Equipment					2.7	19.9	○	○	○	●			
Food							○	○	○	●			
Furniture					2,418.9	16,030.7							
Porous	20%				483.8	3,206.1	○	○	○	●			
Non-Porous	80%				1,935.2	12,824.6	○	○	○	●			
Gym and Sports Equipment							○	○	○	●			
Linens							○	○	○	●			
Medical Supplies							○	○	○	●			
Medical Waste							○	○	○	●			
Paper and Office Supplies					256.7	779.0	○	○	○	●			
Personal Effects							○	○	○	●			
Pharmaceuticals							○	○	○	●			
Other Items and Equipment							○	○	○	●			

Instructions

1. For any materials to be excluded from the waste stream calculations, for example structural materials, check the corresponding box in the Exclude Column.

Key Messages

1. Note that the checkboxes do not apply to materials successfully decontaminated by the technology, since these materials would not be sent to waste in any case.

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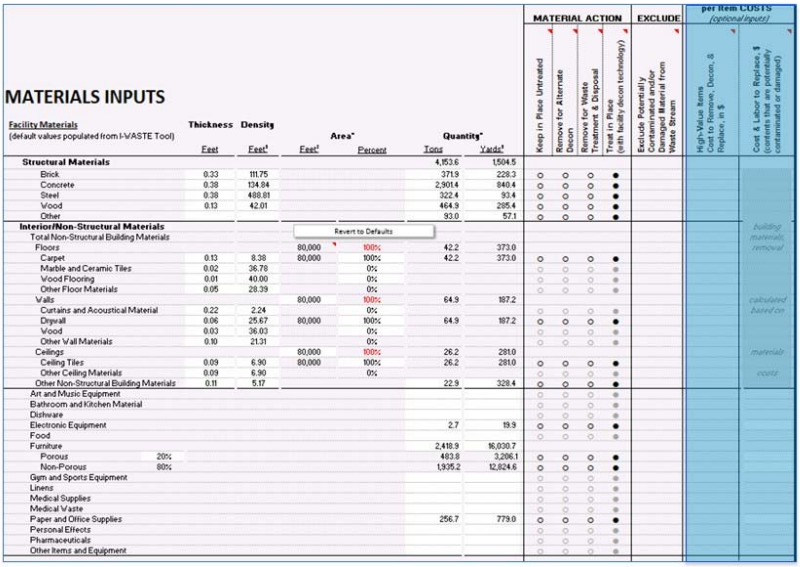
Materials Input Worksheet: Per Item Cost



MATERIALS INPUTS

Facility Materials (default values populated from I-WASTE Tool)	Thickness Feet	Density Feet³	Area* Feet²	Area* Percent	Quantity* Tons	Quantity* Yards³	Keep in Place Untreated	Remove for Alternate Decon	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 $	per Item COSTS (optional inputs): Cost & Labor to Replace, $ (per item sent to waste directly contaminated or damaged)
Structural Materials					4,153.6	1,504.5							
Brick	0.33	111.75			371.9	228.3	○	○	○	●			
Concrete	0.38	134.84			2,901.4	840.4	○	○	○	●			
Steel	0.38	488.81			322.4	93.4	○	○	○	●			
Wood	0.13	42.01			464.9	295.4	○	○	○	●			
Other					93.0	57.1	○	○	○	●			
Interior/Non-Structural Materials			Revert to Defaults										
Total Non-Structural Building Materials													building materials removal
Floors			80,000	100%	42.2	373.0							
Carpet	0.13	8.38	80,000	100%	42.2	373.0	○	○	○	●			
Marble and Ceramic Tiles	0.02	36.78		0%			○	○	○	●			
Wood Flooring	0.01	40.00		0%			○	○	○	●			
Other Floor Materials	0.05	28.39		0%			○	○	○	●			
Walls			80,000	100%	64.9	187.2							calculated based on
Curtains and Acoustical Material	0.22	2.24		0%			○	○	○	●			
Drywall	0.06	25.67	80,000	100%	64.9	187.2	○	○	○	●			
Wood	0.03	36.03		0%			○	○	○	●			
Other Wall Materials	0.10	21.31		0%			○	○	○	●			
Ceilings			80,000	100%	26.2	281.0							materials
Ceiling Tiles	0.09	6.90	80,000	100%	26.2	281.0	○	○	○	●			
Other Ceiling Materials	0.09	6.90		0%			○	○	○	●			costs
Other Non-Structural Building Materials	0.11	5.17			22.9	328.4	○	○	○	●			
Art and Music Equipment							○	○	○	●			
Bathroom and Kitchen Material							○	○	○	●			
Dishware							○	○	○	●			
Electronic Equipment					2.7	19.9	○	○	○	●			
Food							○	○	○	●			
Furniture					2,418.9	16,030.7							
Porous	20%				483.8	3,206.1	○	○	○	●			
Non-Porous	80%				1,935.2	12,824.6	○	○	○	●			
Gym and Sports Equipment							○	○	○	●			
Linens							○	○	○	●			
Medical Supplies							○	○	○	●			
Medical Waste							○	○	○	●			
Paper and Office Supplies					256.7	779.0	○	○	○	●			
Personal Effects							○	○	○	●			
Pharmaceuticals							○	○	○	●			
Other Items and Equipment							○	○	○	●			

Instructions

1. For each high-value material or item to be removed for alternate decontamination, enter the cost to remove, decontaminate, and replace the material or item.
2. For other facility contents, input the costs and labor to remove and replace a given item, in the event that the item is sent directly to waste or in the event that the given item is treated by facility decontamination method but remains potentially contaminated or becomes damaged.

Key Messages

1. Note that leaving blank entries in the white cells assumes zero costs.

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SWITCH TO SAMPLING INPUTS WORKSHEET

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Sampling Input Worksheet

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SAMPLING REQUIREMENTS

for Decontamination

Sample Densities by Decontamination Technology		Process Phase: Characterization	Decontamination Verification	Clearance	
Natural Attenuation					
Natural Attenuation (25C / 24 hr)	1 sample per	500	500	50	ft2
Surface Decontamination					
10x diluted Bleach 60 min	1 sample per	500	500	50	ft2
10x diluted Bleach 24 h	1 sample per	500	500	50	ft2
Full strength Bleach 60 min	1 sample per	500	500	50	ft2
3% H2O2 solution; 30 min contact tir	1 sample per	500	500	50	ft2
Easy Decon DF200 60 min	1 sample per	500	500	50	ft2
Easy Decon DF200 24 h	1 sample per	500	500	50	ft2
DeconGel 1108	1 sample per	500	500	50	ft2
Decon Green	1 sample per	500	500	50	ft2
Volumetric Decontamination					
Chlorine Dioxide Gas	1 sample per	500	500	50	ft2
modified Vaporous Hydrogen Peroxi	1 sample per	500	500	50	ft2
Steam	1 sample per	500	500	50	ft2
Low-Concentration Hydrogen Peroxi	1 sample per	500	500	50	ft2

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	ft2
w/o rebuilding	1 sample per	500	ft2

Sample Densities for Structural and Interior Materials and Contents Demolished			
for Solid Waste	1 sample per	330	pounds

Key Messages

- The Sampling Inputs worksheet shows the sampling densities for the process phases and waste generated from both decontamination and demolition processes.

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Sampling Input Worksheets: Decon Processes

Sandia National Laboratories

Instructions

1. For each Decontamination Technology, set the sampling density for each of the three Process Phases.
   a) Characterization
   b) Decontamination Verification
   c) Clearance

SAMPLING REQUIREMENTS

for Decontamination

Sample Densities by Decontamination Technology		Process Phase: Characterization	Decontamination Verification	Clearance	
Natural Attenuation					
Natural Attenuation (25C / 24 hr)	1 sample per	500	500	50	ft2
Surface Decontamination					
10x diluted Bleach 60 min	1 sample per	500	500	50	ft2
10x diluted Bleach 24 h	1 sample per	500	500	50	ft2
Full strength Bleach 60 min	1 sample per	500	500	50	ft2
3% H2O2 solution; 30 min contact tir	1 sample per	500	500	50	ft2
Easy Decon DF200 60 min	1 sample per	500	500	50	ft2
Easy Decon DF200 24 h	1 sample per	500	500	50	ft2
DeconGel 1108	1 sample per	500	500	50	ft2
Decon Green	1 sample per	500	500	50	ft2
Volumetric Decontamination					
Chlorine Dioxide Gas	1 sample per	500	500	50	ft2
modified Vaporous Hydrogen Peroxi	1 sample per	500	500	50	ft2
Steam	1 sample per	500	500	50	ft2
Low-Concentration Hydrogen Peroxi	1 sample per	500	500	50	ft2

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	ft2
w/o rebuilding	1 sample per	500	ft2

Sample Densities for Structural and Interior Materials and Contents Demolished			
for Solid Waste	1 sample per	330	pounds

DeconST Screenshot Interpretation

- Very simple input of sampling requirements can be adjusted based on visual sampling plan (known as VSP) or other tools, but the input must be in terms of samples per unit area.

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Sampling Input Worksheets: Decon Processes

Sandia National Laboratories

Instructions

1. Set the sampling densities for the solid waste and the liquid waste generated during decontamination processes.

SAMPLING REQUIREMENTS

for Decontamination

Sample Densities by Decontamination Technology		Process Phase: Characterization	Decontamination Verification	Clearance	
Natural Attenuation					
Natural Attenuation (25C / 24 hr)	1 sample per	500	500	50	ft2
Surface Decontamination					
10x diluted Bleach 60 min	1 sample per	500	500	50	ft2
10x diluted Bleach 24 h	1 sample per	500	500	50	ft2
Full strength Bleach 60 min	1 sample per	500	500	50	ft2
3% H2O2 solution; 30 min contact tir	1 sample per	500	500	50	ft2
Easy Decon DF200 60 min	1 sample per	500	500	50	ft2
Easy Decon DF200 24 h	1 sample per	500	500	50	ft2
DeconGel 1108	1 sample per	500	500	50	ft2
Decon Green	1 sample per	500	500	50	ft2
Volumetric Decontamination					
Chlorine Dioxide Gas	1 sample per	500	500	50	ft2
modified Vaporous Hydrogen Peroxi	1 sample per	500	500	50	ft2
Steam	1 sample per	500	500	50	ft2
Low-Concentration Hydrogen Peroxi	1 sample per	500	500	50	ft2

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	ft2
w/o rebuilding	1 sample per	500	ft2

Sample Densities for Structural and Interior Materials and Contents Demolished			
for Solid Waste	1 sample per	330	pounds

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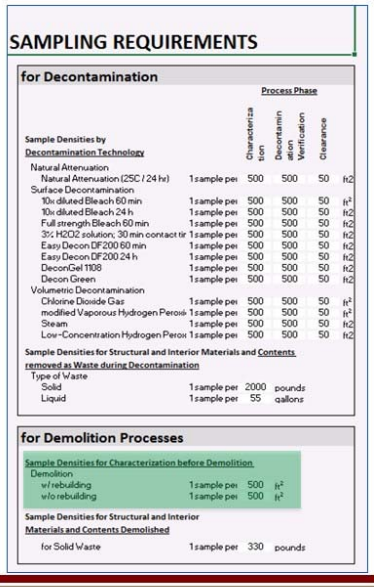
Sampling Input Worksheets: Demo Processes

Sandia National Laboratories

Instructions

1. Set the Sample Densities for Characterization for Demolition.



SAMPLING REQUIREMENTS

for Decontamination

Sample Densities by Decontamination Technology		Process Phase: Characterization	Decontamination Verification	Clearance	
Natural Attenuation					
Natural Attenuation (2SC / 24 hr)	1 sample per	500	500	50	ft2
Surface Decontamination					
10x diluted Bleach 60 min	1 sample per	500	500	50	ft2
10x diluted Bleach 24 h	1 sample per	500	500	50	ft2
Full strength Bleach 60 min	1 sample per	500	500	50	ft2
3% H2O2 solution; 30 min contact tir	1 sample per	500	500	50	ft2
Easy Decon DF200 60 min	1 sample per	500	500	50	ft2
Easy Decon DF200 24 h	1 sample per	500	500	50	ft2
DeconGel 1108	1 sample per	500	500	50	ft2
Decon Green	1 sample per	500	500	50	ft2
Volumetric Decontamination					
Chlorine Dioxide Gas	1 sample per	500	500	50	ft2
modified Vaporous Hydrogen Peroxi	1 sample per	500	500	50	ft2
Steam	1 sample per	500	500	50	ft2
Low-Concentration Hydrogen Peroxi	1 sample per	500	500	50	ft2

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	ft²
w/o rebuilding	1 sample per	500	ft²

Sample Densities for Structural and Interior Materials and Contents Demolished

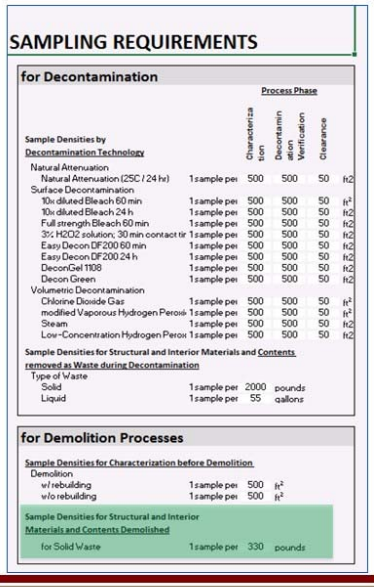
for Solid Waste	1 sample per	330	pounds

Sampling Input Worksheets: Demo Processes

Sandia National Laboratories

Instructions

1. Set the Sample Densities for Structural and Interior Materials and Contents Demolished.



SAMPLING REQUIREMENTS

for Decontamination

Sample Densities by Decontamination Technology		Process Phase: Characterization	Decontamination Verification	Clearance	
Natural Attenuation					
Natural Attenuation (2SC / 24 hr)	1 sample per	500	500	50	ft2
Surface Decontamination					
10x diluted Bleach 60 min	1 sample per	500	500	50	ft2
10x diluted Bleach 24 h	1 sample per	500	500	50	ft2
Full strength Bleach 60 min	1 sample per	500	500	50	ft2
3% H2O2 solution; 30 min contact tir	1 sample per	500	500	50	ft2
Easy Decon DF200 60 min	1 sample per	500	500	50	ft2
Easy Decon DF200 24 h	1 sample per	500	500	50	ft2
DeconGel 1108	1 sample per	500	500	50	ft2
Decon Green	1 sample per	500	500	50	ft2
Volumetric Decontamination					
Chlorine Dioxide Gas	1 sample per	500	500	50	ft2
modified Vaporous Hydrogen Peroxi	1 sample per	500	500	50	ft2
Steam	1 sample per	500	500	50	ft2
Low-Concentration Hydrogen Peroxi	1 sample per	500	500	50	ft2

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

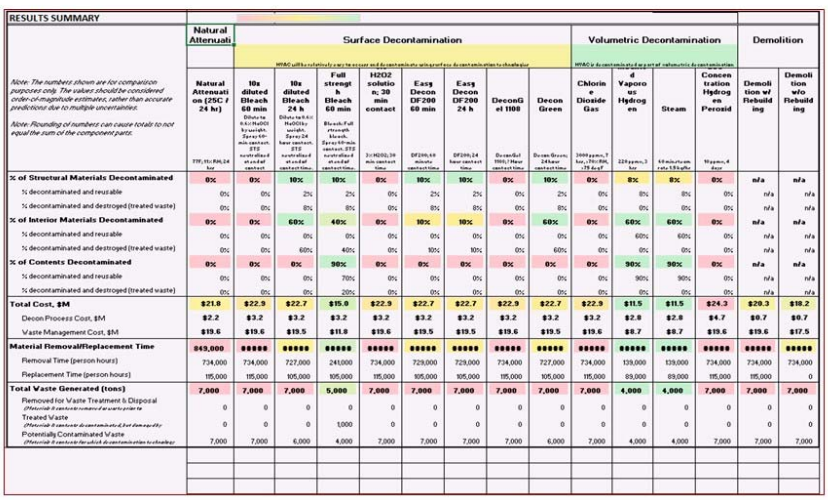
Demolition			
w/ rebuilding	1 sample per	500	ft²
w/o rebuilding	1 sample per	500	ft²

Sample Densities for Structural and Interior Materials and Contents Demolished

for Solid Waste	1 sample per	330	pounds

SWITCH TO RESULTS SUMMARY

Results Summary Worksheet



RESULTS SUMMARY	Natural Attenuation	Surface Decontamination								Volumetric Decontamination				Demolition	
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.*	Natural Attenuation (25C / 24 hr)	10x diluted Bleach 60 min	10x diluted Bleach 24 h	Full strength Bleach 60 min	H2O2 solution; 30 min contact	Easy Decon DF200 60 min	Easy Decon DF200 24 h	DeconGel 1108	Decon Green	Chlorine Dioxide Gas	Vaporous Hydrogen	Steam	Concentration Hydrogen Peroxid	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Structural Materials Decontaminated	0%	0%	10%	10%	0%	10%	10%	0%	10%	0%	8%	8%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	2%	2%	0%	2%	2%	0%	2%	0%	8%	8%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	8%	8%	0%	8%	8%	0%	8%	0%	0%	0%	0%	n/a	n/a
% of Interior Materials Decontaminated	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	60%	60%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	60%	60%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	0%	0%	0%	n/a	n/a
% of Contents Decontaminated	0%	0%	0%	90%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	70%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
Total Cost, $M	$21.8	$22.9	$22.7	$15.0	$22.9	$22.7	$22.7	$22.9	$22.7	$22.9	$11.5	$11.5	$24.3	$20.3	$18.2
Decon Process Cost, $M	$2.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$2.8	$2.8	$4.7	$0.7	$0.7
Waste Management Cost, $M	$19.6	$19.6	$19.5	$11.8	$19.6	$19.5	$19.5	$19.6	$19.5	$19.6	$8.7	$8.7	$19.6	$19.6	$17.5
Material Removal/Replacement Time	849,000	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####
Removal Time (person hours)	734,000	734,000	727,000	241,000	734,000	729,000	729,000	734,000	727,000	734,000	139,000	139,000	734,000	734,000	734,000
Replacement Time (person hours)	115,000	115,000	105,000	105,000	115,000	105,000	105,000	115,000	105,000	115,000	89,000	89,000	115,000	115,000	0
Total Waste Generated (tons)	7,000	7,000	7,000	5,000	7,000	7,000	7,000	7,000	7,000	7,000	4,000	4,000	7,000	7,000	7,000
Removed for Waste Treatment & Disposal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste	0	0	0	1,000	0	0	0	0	0	0	0	0	0	0	0
Potentially Contaminated Waste	7,000	7,000	6,000	4,000	7,000	7,000	7,000	7,000	6,000	7,000	4,000	4,000	7,000	7,000	7,000

DeconST Screenshot Interpretation

- The Results Summary worksheet shows a comparison across the different decontamination strategies and technologies (one for each column) of the high-level decision considerations:
  - Percentages of Materials Decontaminated
  - Total Cost
  - Material Removal and Replacement Time
  - Total Waste Generated
- The first rows of the summary table show the default types of decontamination strategies and technologies, the HVAC considerations, and the decontamination technology conditions.
- The default decontamination strategies considered in the tool are the following:
  - Natural Attenuation (chem only)
  - Volumetric Decontamination
  - Surface Decontamination
  - Demolition: with and without rebuilding
  - Other technologies (including hybrid technologies) can be added by the user

Decon Strategies & Technologies: HVAC

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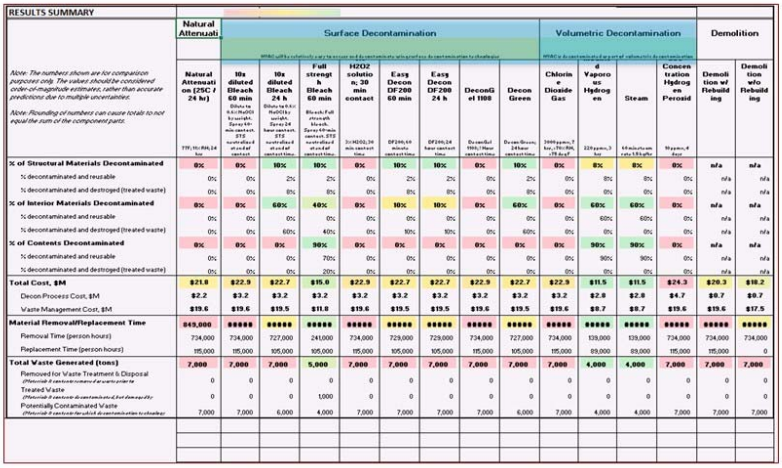

RESULTS SUMMARY

	Natural Attenuation	Surface Decontamination								Volumetric Decontamination				Demolition	
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.*	Natural Attenuation (25C / 24 hr)	10x diluted Bleach 60 min	10x diluted Bleach 24 h	Full strength Bleach 60 min	H2O2 solution; 30 min contact	Easy Decon DF200 60 min	Easy Decon DF200 24 h	DeconGel 1108	Decon Green	Chlorine Dioxide Gas	d Vaporous Hydrogen	Steam	Concentration Hydrogen Peroxid	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Structural Materials Decontaminated	0%	0%	10%	10%	0%	10%	10%	0%	10%	0%	0%	0%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	2%	2%	0%	2%	2%	0%	2%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	8%	8%	0%	8%	8%	0%	8%	0%	0%	0%	0%	n/a	n/a
% of Interior Materials Decontaminated	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	60%	60%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	60%	60%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	0%	0%	0%	n/a	n/a
% of Contents Decontaminated	0%	0%	0%	90%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	70%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
Total Cost, $M	$21.8	$22.9	$22.7	$15.0	$22.9	$22.7	$22.7	$22.9	$22.7	$22.9	$11.5	$11.5	$24.3	$20.3	$18.2
Decon Process Cost, $M	$2.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$2.8	$2.8	$4.7	$0.7	$0.7
Waste Management Cost, $M	$19.6	$19.6	$19.5	$11.8	$19.6	$19.5	$19.5	$19.6	$19.5	$19.6	$8.7	$8.7	$19.6	$19.6	$17.5
Material Removal/Replacement Time	843,000	######	######	######	######	######	######	######	######	######	######	######	######	######	######
Removal Time (person hours)	734,000	734,000	727,000	241,000	734,000	729,000	729,000	734,000	727,000	734,000	139,000	139,000	734,000	734,000	734,000
Replacement Time (person hours)	115,000	115,000	105,000	105,000	115,000	105,000	105,000	115,000	105,000	115,000	89,000	89,000	115,000	115,000	0
Total Waste Generated (tons)	7,000	7,000	7,000	5,000	7,000	7,000	7,000	7,000	7,000	7,000	4,000	4,000	7,000	7,000	7,000
Removed for Waste Treatment & Disposal *(Material if contamination can be removed)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste *(Material if contamination destroyed, but low quality)*	0	0	0	1,000	0	0	0	0	0	0	0	0	0	0	0
Potentially Contaminated Waste *(Material if contamination could not be removed or destroyed)*	7,000	7,000	6,000	4,000	7,000	7,000	7,000	7,000	6,000	7,000	4,000	4,000	7,000	7,000	7,000

DeconST Screenshot Interpretation

- The first row under the Strategy Categories shows the HVAC Considerations.

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Decon Strategies & Technologies: HVAC

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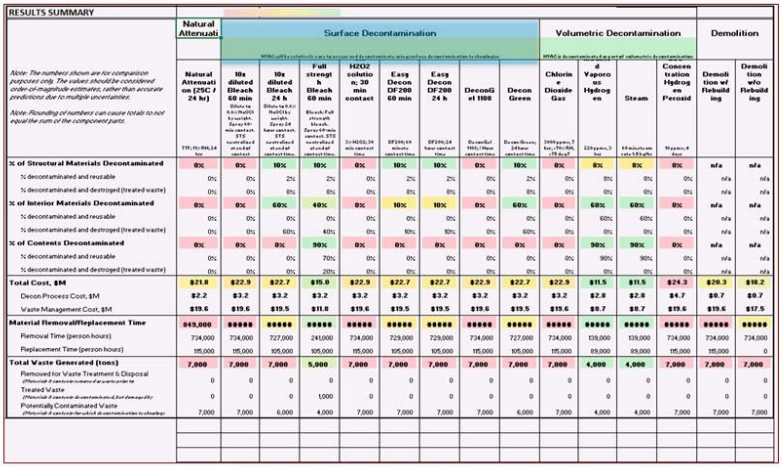

RESULTS SUMMARY

	Natural Attenuation	Surface Decontamination								Volumetric Decontamination				Demolition	
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.*	Natural Attenuation (25C / 24 hr)	10x diluted Bleach 60 min	10x diluted Bleach 24 h	Full strength Bleach 60 min	H2O2 solution; 30 min contact	Easy Decon DF200 60 min	Easy Decon DF200 24 h	DeconGel 1108	Decon Green	Chlorine Dioxide Gas	d Vaporous Hydrogen	Steam	Concentration Hydrogen Peroxid	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Structural Materials Decontaminated	0%	0%	10%	10%	0%	10%	10%	0%	10%	0%	0%	0%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	2%	2%	0%	2%	2%	0%	2%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	8%	8%	0%	8%	8%	0%	8%	0%	0%	0%	0%	n/a	n/a
% of Interior Materials Decontaminated	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	60%	60%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	60%	60%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	0%	0%	0%	n/a	n/a
% of Contents Decontaminated	0%	0%	0%	90%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	70%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
Total Cost, $M	$21.8	$22.9	$22.7	$15.0	$22.9	$22.7	$22.7	$22.9	$22.7	$22.9	$11.5	$11.5	$24.3	$20.3	$18.2
Decon Process Cost, $M	$2.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$2.8	$2.8	$4.7	$0.7	$0.7
Waste Management Cost, $M	$19.6	$19.6	$19.5	$11.8	$19.6	$19.5	$19.5	$19.6	$19.5	$19.6	$8.7	$8.7	$19.6	$19.6	$17.5
Material Removal/Replacement Time	843,000	######	######	######	######	######	######	######	######	######	######	######	######	######	######
Removal Time (person hours)	734,000	734,000	727,000	241,000	734,000	729,000	729,000	734,000	727,000	734,000	139,000	139,000	734,000	734,000	734,000
Replacement Time (person hours)	115,000	115,000	105,000	105,000	115,000	105,000	105,000	115,000	105,000	115,000	89,000	89,000	115,000	115,000	0
Total Waste Generated (tons)	7,000	7,000	7,000	5,000	7,000	7,000	7,000	7,000	7,000	7,000	4,000	4,000	7,000	7,000	7,000
Removed for Waste Treatment & Disposal *(Material if contamination can be removed)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste *(Material if contamination destroyed, but low quality)*	0	0	0	1,000	0	0	0	0	0	0	0	0	0	0	0
Potentially Contaminated Waste *(Material if contamination could not be removed or destroyed)*	7,000	7,000	6,000	4,000	7,000	7,000	7,000	7,000	6,000	7,000	4,000	4,000	7,000	7,000	7,000

DeconST Screenshot Interpretation

1. The first row under the Strategy Categories shows the HVAC Considerations.

2. For Surface Decontamination processes, decontamination of the HVAC system may present a separate and difficult challenge.

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Decon Strategies & Technologies: HVAC

Sandia National Laboratories

RESULTS SUMMARY	Natural Attenuati	Surface Decontamination								Volumetric Decontamination				Demolition	
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.	Natural Attenuation (25C / 24 hr)	10x diluted Bleach 60 min	10x diluted Bleach 24 h	Full strength Bleach 60 min	H2O2 solution; 30 min contact	Easy Decon DF200 60 min	Easy Decon DF200 24 h	DeconGel 1108	Decon Green	Chlorine Dioxide Gas	Vaporous Hydrogen	Steam	Concentration Hydrogen Peroxid	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Structural Materials Decontaminated	0%	0%	10%	10%	0%	10%	10%	0%	10%	0%	8%	8%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	2%	2%	0%	2%	2%	0%	2%	0%	8%	8%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	8%	8%	0%	8%	8%	0%	8%	0%	0%	0%	0%	n/a	n/a
% of Interior Materials Decontaminated	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	60%	60%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	60%	60%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	0%	0%	0%	n/a	n/a
% of Contents Decontaminated	0%	0%	0%	90%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	70%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
Total Cost, $M	$21.8	$22.9	$22.7	$15.0	$22.9	$22.7	$22.7	$22.9	$22.7	$22.9	$11.5	$11.5	$24.3	$20.3	$18.2
Decon Process Cost, $M	$2.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$2.8	$2.8	$4.7	$0.7	$0.7
Waste Management Cost, $M	$19.6	$19.6	$19.5	$11.8	$19.6	$19.5	$19.5	$19.6	$19.5	$19.6	$8.7	$8.7	$19.6	$19.6	$17.5
Material Removal/Replacement Time	849,000	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####
Removal Time (person hours)	734,000	734,000	727,000	241,000	734,000	729,000	729,000	734,000	727,000	734,000	139,000	139,000	734,000	734,000	734,000
Replacement Time (person hours)	115,000	115,000	105,000	105,000	115,000	105,000	105,000	115,000	105,000	115,000	89,000	89,000	115,000	115,000	0
Total Waste Generated (tons)	7,000	7,000	7,000	5,000	7,000	7,000	7,000	7,000	7,000	7,000	4,000	4,000	7,000	7,000	7,000
Removed for Waste Treatment & Disposal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste	0	0	0	1,000	0	0	0	0	0	0	0	0	0	0	0
Potentially Contaminated Waste	7,000	7,000	6,000	4,000	7,000	7,000	7,000	7,000	6,000	7,000	4,000	4,000	7,000	7,000	7,000

DeconST Screenshot Interpretation

1. The first row under the Strategy Categories shows the HVAC Considerations.
2. For Surface Decontamination processes, decontamination of the HVAC system may present a separate and difficult challenge.
3. For Volumetric Decontamination processes, the HVAC system is decontaminated as part of the volumetric decontamination process.

Key Messages

1. In particular, decontamination of less-accessible ducted HVAC systems may require significant efforts that are not explicitly incorporated into the cost calculations in the DeconST.

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Decon Strategies & Technologies: Conditions

Sandia National Laboratories

RESULTS SUMMARY	Natural Attenuati	Surface Decontamination								Volumetric Decontamination				Demolition	
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.	Natural Attenuation (25C / 24 hr)	10x diluted Bleach 60 min	10x diluted Bleach 24 h	Full strength Bleach 60 min	H2O2 solution; 30 min contact	Easy Decon DF200 60 min	Easy Decon DF200 24 h	DeconGel 1108	Decon Green	Chlorine Dioxide Gas	Vaporous Hydrogen	Steam	Concentration Hydrogen Peroxid	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Structural Materials Decontaminated	0%	0%	10%	10%	0%	10%	10%	0%	10%	0%	8%	8%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	2%	2%	0%	2%	2%	0%	2%	0%	8%	8%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	8%	8%	0%	8%	8%	0%	8%	0%	0%	0%	0%	n/a	n/a
% of Interior Materials Decontaminated	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	60%	60%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	60%	60%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	0%	0%	0%	n/a	n/a
% of Contents Decontaminated	0%	0%	0%	90%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	70%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
Total Cost, $M	$21.8	$22.9	$22.7	$15.0	$22.9	$22.7	$22.7	$22.9	$22.7	$22.9	$11.5	$11.5	$24.3	$20.3	$18.2
Decon Process Cost, $M	$2.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$2.8	$2.8	$4.7	$0.7	$0.7
Waste Management Cost, $M	$19.6	$19.6	$19.5	$11.8	$19.6	$19.5	$19.5	$19.6	$19.5	$19.6	$8.7	$8.7	$19.6	$19.6	$17.5
Material Removal/Replacement Time	849,000	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####
Removal Time (person hours)	734,000	734,000	727,000	241,000	734,000	729,000	729,000	734,000	727,000	734,000	139,000	139,000	734,000	734,000	734,000
Replacement Time (person hours)	115,000	115,000	105,000	105,000	115,000	105,000	105,000	115,000	105,000	115,000	89,000	89,000	115,000	115,000	0
Total Waste Generated (tons)	7,000	7,000	7,000	5,000	7,000	7,000	7,000	7,000	7,000	7,000	4,000	4,000	7,000	7,000	7,000
Removed for Waste Treatment & Disposal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste	0	0	0	1,000	0	0	0	0	0	0	0	0	0	0	0
Potentially Contaminated Waste	7,000	7,000	6,000	4,000	7,000	7,000	7,000	7,000	6,000	7,000	4,000	4,000	7,000	7,000	7,000

DeconST Screenshot Interpretation

1. The first row under the name of each decontamination technology shows the conditions under which that technology must be applied.

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Decon Strategies & Technologies: Decisions

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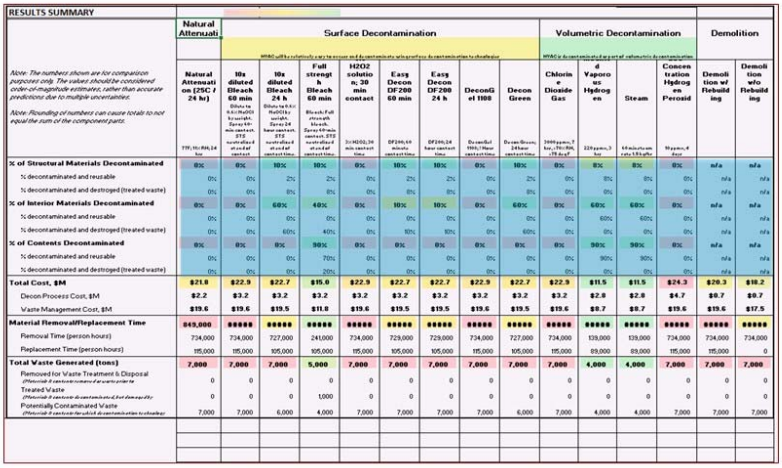

RESULTS SUMMARY

	Natural Attenuation	Surface Decontamination								Volumetric Decontamination				Demolition	
	Natural Attenuation (25C / 24 hr)	10x diluted Bleach 60 min	10x diluted Bleach 24 h	Full strength Bleach 60 min	H2O2 solution; 30 min contact	Easy Decon DF200 60 min	Easy Decon DF200 24 h	DeconGel 1108	Decon Green	Chlorine Dioxide Gas	d Vaporous Hydrogen	Steam	Concentration Hydrogen Peroxid	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Structural Materials Decontaminated	0%	0%	10%	10%	0%	10%	10%	0%	10%	0%	0%	0%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	2%	2%	0%	2%	2%	0%	2%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	8%	8%	0%	8%	8%	0%	8%	0%	0%	0%	0%	n/a	n/a
% of Interior Materials Decontaminated	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	60%	60%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	60%	60%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	0%	0%	0%	n/a	n/a
% of Contents Decontaminated	0%	0%	0%	90%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	70%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
Total Cost, $M	$21.8	$22.9	$22.7	$15.0	$22.9	$22.7	$22.7	$22.9	$22.7	$22.9	$11.5	$11.5	$24.3	$20.3	$18.2
Decon Process Cost, $M	$2.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$2.8	$2.8	$4.7	$0.7	$0.7
Waste Management Cost, $M	$19.6	$19.6	$19.5	$11.8	$19.6	$19.5	$19.5	$19.6	$19.5	$19.6	$8.7	$8.7	$19.6	$19.6	$17.5
Material Removal/Replacement Time	849,000	######	######	######	######	######	######	######	######	######	######	######	######	######	######
Removal Time (person hours)	734,000	734,000	727,000	241,000	734,000	729,000	729,000	734,000	727,000	734,000	139,000	139,000	734,000	734,000	734,000
Replacement Time (person hours)	115,000	115,000	105,000	105,000	115,000	105,000	105,000	115,000	105,000	115,000	89,000	89,000	115,000	115,000	0
Total Waste Generated (tons)	7,000	7,000	7,000	5,000	7,000	7,000	7,000	7,000	7,000	7,000	4,000	4,000	7,000	7,000	7,000
Removed for Waste Treatment & Disposal (Potential if contamination can't be corrected)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Potential if contamination can't be corrected)	0	0	0	1,000	0	0	0	0	0	0	0	0	0	0	0
Potentially Contaminated Waste (Potential if contamination can't be corrected)	7,000	7,000	6,000	4,000	7,000	7,000	7,000	7,000	6,000	7,000	4,000	4,000	7,000	7,000	7,000

DeconST Screenshot Interpretation

1. The decision considerations are the rows of the table, including the:
   a) Percentages of Materials Decontaminated
   b) Total Cost
   c) Material Removal and Replacement Time
   d) Total Waste Generated

Decon Strategies & Technologies: Percentages

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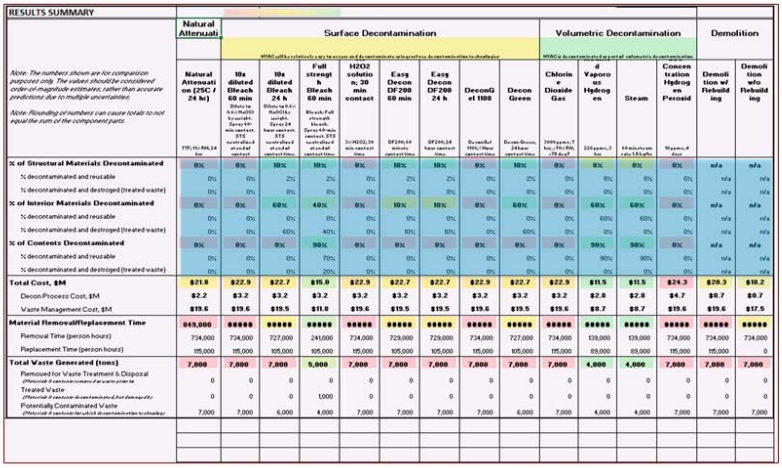

RESULTS SUMMARY

	Natural Attenuation	Surface Decontamination								Volumetric Decontamination				Demolition	
	Natural Attenuation (25C / 24 hr)	10x diluted Bleach 60 min	10x diluted Bleach 24 h	Full strength Bleach 60 min	H2O2 solution; 30 min contact	Easy Decon DF200 60 min	Easy Decon DF200 24 h	DeconGel 1108	Decon Green	Chlorine Dioxide Gas	d Vaporous Hydrogen	Steam	Concentration Hydrogen Peroxid	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Structural Materials Decontaminated	0%	0%	10%	10%	0%	10%	10%	0%	10%	0%	0%	0%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	2%	2%	0%	2%	2%	0%	2%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	8%	8%	0%	8%	8%	0%	8%	0%	0%	0%	0%	n/a	n/a
% of Interior Materials Decontaminated	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	60%	60%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	60%	60%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	0%	0%	0%	n/a	n/a
% of Contents Decontaminated	0%	0%	0%	90%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	70%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
Total Cost, $M	$21.8	$22.9	$22.7	$15.0	$22.9	$22.7	$22.7	$22.9	$22.7	$22.9	$11.5	$11.5	$24.3	$20.3	$18.2
Decon Process Cost, $M	$2.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$2.8	$2.8	$4.7	$0.7	$0.7
Waste Management Cost, $M	$19.6	$19.6	$19.5	$11.8	$19.6	$19.5	$19.5	$19.6	$19.5	$19.6	$8.7	$8.7	$19.6	$19.6	$17.5
Material Removal/Replacement Time	849,000	######	######	######	######	######	######	######	######	######	######	######	######	######	######
Removal Time (person hours)	734,000	734,000	727,000	241,000	734,000	729,000	729,000	734,000	727,000	734,000	139,000	139,000	734,000	734,000	734,000
Replacement Time (person hours)	115,000	115,000	105,000	105,000	115,000	105,000	105,000	115,000	105,000	115,000	89,000	89,000	115,000	115,000	0
Total Waste Generated (tons)	7,000	7,000	7,000	5,000	7,000	7,000	7,000	7,000	7,000	7,000	4,000	4,000	7,000	7,000	7,000
Removed for Waste Treatment & Disposal (Potential if contamination can't be corrected)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Potential if contamination can't be corrected)	0	0	0	1,000	0	0	0	0	0	0	0	0	0	0	0
Potentially Contaminated Waste (Potential if contamination can't be corrected)	7,000	7,000	6,000	4,000	7,000	7,000	7,000	7,000	6,000	7,000	4,000	4,000	7,000	7,000	7,000

Key Messages

1. Note that the color coding is a gradation from red to green, with red being the less-desirable and green being the more-desirable outcome.

DeconST Screenshot Interpretation

- The Percentages of Materials Decontaminated show: the total percent of each type of material (structural materials, interior non-structural materials, and contents) that is successfully decontaminated by each technology, as well as the percentages of those that are reusable versus destroyed.
- The same information is presented graphically on the % of Materials Decontaminated by Decontamination Technology plot (the Materials Decon % Plot chart).
- Details on the disposition of each material type can be found on the Results Materials Lists worksheets (with and without the quantities of materials listed) and on the Results Materials Disposition worksheet

Decon Strategies & Technologies: Total Cost

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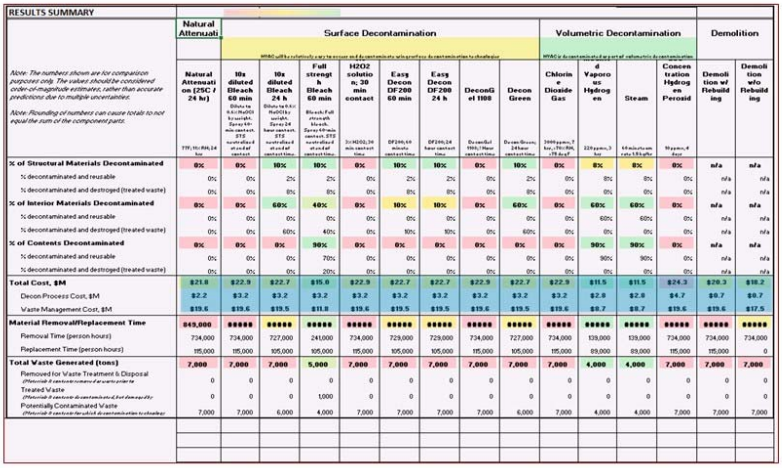

RESULTS SUMMARY																
	Natural Attenuati	Surface Decontamination									Volumetric Decontamination				Demolition	
	Natural Attenuation (25C / 24 hr)	10x diluted Bleach 60 min	10x diluted Bleach 24 h	Full strength Bleach 60 min	H2O2 solution; 30 min contact	Easy Decon DF200 60 min	Easy Decon DF200 24 h	DeconGel 1108	Decon Green	Chlorine Dioxide Gas	d Vaporous Hydrogen	Steam	Concentration Hydrogen Peroxid	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Structural Materials Decontaminated	0%	0%	10%	10%	0%	10%	10%	0%	10%	0%	0%	0%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	2%	2%	0%	2%	2%	0%	2%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	8%	8%	0%	8%	8%	0%	8%	0%	0%	0%	0%	n/a	n/a
% of Interior Materials Decontaminated	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	60%	60%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	60%	60%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	0%	0%	0%	n/a	n/a
% of Contents Decontaminated	0%	0%	0%	90%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	70%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
Total Cost, $M	$21.8	$22.9	$22.7	$15.0	$22.9	$22.7	$22.7	$22.9	$22.7	$22.9	$11.5	$11.5	$24.3	$20.3	$19.2
Decon Process Cost, $M	$2.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$2.8	$2.8	$4.7	$0.7	$0.7
Waste Management Cost, $M	$19.6	$19.6	$19.5	$11.8	$19.6	$19.5	$19.5	$19.6	$19.5	$19.6	$8.7	$8.7	$19.6	$19.6	$17.5
Material Removal/Replacement Time	849,000	######	######	######	######	######	######	######	######	######	######	######	######	######	######
Removal Time (person hours)	734,000	734,000	727,000	241,000	734,000	729,000	729,000	734,000	727,000	734,000	139,000	139,000	734,000	734,000	734,000
Replacement Time (person hours)	115,000	115,000	105,000	105,000	115,000	105,000	105,000	115,000	105,000	115,000	89,000	89,000	115,000	115,000	0
Total Waste Generated (tons)	7,000	7,000	7,000	5,000	7,000	7,000	7,000	7,000	7,000	7,000	4,000	4,000	7,000	7,000	7,000
Removed for Waste Treatment & Disposal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste	0	0	0	1,000	0	0	0	0	0	0	0	0	0	0	0
Potentially Contaminated Waste	7,000	7,000	6,000	4,000	7,000	7,000	7,000	7,000	6,000	7,000	4,000	4,000	7,000	7,000	7,000

Key Messages

1. Remember that the HVAC decontamination is not included and may incur considerable costs; see the HVAC considerations row for this particular facility.
2. Note that the costs of the decontamination strategies and technologies are provided as relative costs for purposes of strategy and technology comparison.

DeconST Screenshot Interpretation

- The Total Cost rows show the sum and the components of the Decontamination Process Cost (including incident command, characterization and clearance sampling and analysis, temperature and humidity adjustment, decontamination, and long-term monitoring) and the Waste Management Cost (including the costs for removing, decontaminating, disposing of, and replacing all materials and contents damaged and/or not decontaminated by the technology).
- The cost information is presented graphically in the Total Relative Costs of Decontamination Technologies plots (on the Costs Plot and Costs Plot wDemo charts) and in detail on the Results Costs worksheet.
- The true total cost would need to consider the cost of facility downtime, which for many facilities would likely overwhelm the cost of the remediation.

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Material Removal/Replacement Time

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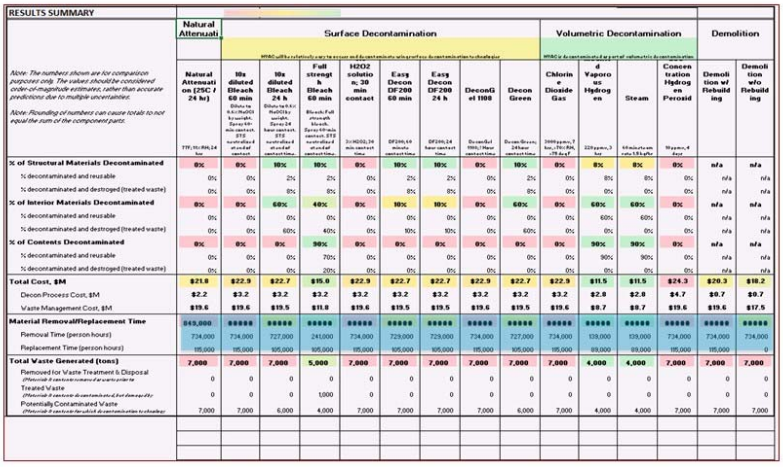

RESULTS SUMMARY																
	Natural Attenuati	Surface Decontamination									Volumetric Decontamination				Demolition	
	Natural Attenuation (25C / 24 hr)	10x diluted Bleach 60 min	10x diluted Bleach 24 h	Full strength Bleach 60 min	H2O2 solution; 30 min contact	Easy Decon DF200 60 min	Easy Decon DF200 24 h	DeconGel 1108	Decon Green	Chlorine Dioxide Gas	d Vaporous Hydrogen	Steam	Concentration Hydrogen Peroxid	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Structural Materials Decontaminated	0%	0%	10%	10%	0%	10%	10%	0%	10%	0%	0%	0%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	2%	2%	0%	2%	2%	0%	2%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	8%	8%	0%	8%	8%	0%	8%	0%	0%	0%	0%	n/a	n/a
% of Interior Materials Decontaminated	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	60%	60%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	60%	60%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	0%	0%	0%	n/a	n/a
% of Contents Decontaminated	0%	0%	0%	90%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	70%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
Total Cost, $M	$21.8	$22.9	$22.7	$15.0	$22.9	$22.7	$22.7	$22.9	$22.7	$22.9	$11.5	$11.5	$24.3	$20.3	$19.2
Decon Process Cost, $M	$2.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$2.8	$2.8	$4.7	$0.7	$0.7
Waste Management Cost, $M	$19.6	$19.6	$19.5	$11.8	$19.6	$19.5	$19.5	$19.6	$19.5	$19.6	$8.7	$8.7	$19.6	$19.6	$17.5
Material Removal/Replacement Time	849,000	######	######	######	######	######	######	######	######	######	######	######	######	######	######
Removal Time (person hours)	734,000	734,000	727,000	241,000	734,000	729,000	729,000	734,000	727,000	734,000	139,000	139,000	734,000	734,000	734,000
Replacement Time (person hours)	115,000	115,000	105,000	105,000	115,000	105,000	105,000	115,000	105,000	115,000	89,000	89,000	115,000	115,000	0
Total Waste Generated (tons)	7,000	7,000	7,000	5,000	7,000	7,000	7,000	7,000	7,000	7,000	4,000	4,000	7,000	7,000	7,000
Removed for Waste Treatment & Disposal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste	0	0	0	1,000	0	0	0	0	0	0	0	0	0	0	0
Potentially Contaminated Waste	7,000	7,000	6,000	4,000	7,000	7,000	7,000	7,000	6,000	7,000	4,000	4,000	7,000	7,000	7,000

DeconST Screenshot Interpretation

- The Material Removal and Replacement Time rows show the total *labor hours* required for the Removal and Replacement.
- Note that these times are provided as relative labor requirement times for purposes of strategy and technology comparison.
- The actual facility downtime would need to take into consideration resource availability.

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Decon Strategies & Technologies: Waste

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RESULTS SUMMARY															
	Natural Attenuati	Surface Decontamination								Volumetric Decontamination				Demolition	
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.	Natural Attenuation (25C / 24 hr)	10x diluted Bleach 60 min	10x diluted Bleach 24 h	Full strength Bleach 60 min	H2O2 solution; 30 min contact	Easy Decon DF200 60 min	Easy Decon DF200 24 h	DeconGel 1108	Decon Green	Chlorine Dioxide Gas	d Vaporous Hydrogen	Steam	Concentration Hydrogen Peroxid	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Structural Materials Decontaminated	0%	0%	10%	10%	0%	10%	10%	0%	10%	0%	0%	0%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	2%	2%	0%	2%	2%	0%	2%	0%	8%	8%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	8%	8%	0%	8%	8%	0%	8%	0%	0%	0%	0%	n/a	n/a
% of Interior Materials Decontaminated	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	60%	60%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	60%	60%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	60%	40%	0%	10%	10%	0%	60%	0%	0%	0%	0%	n/a	n/a
% of Contents Decontaminated	0%	0%	0%	90%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and reusable	0%	0%	0%	70%	0%	0%	0%	0%	0%	0%	90%	90%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
Total Cost, $M	$21.8	$22.9	$22.7	$15.0	$22.9	$22.7	$22.7	$22.9	$22.7	$22.9	$11.5	$11.5	$24.3	$20.3	$18.2
Decon Process Cost, $M	$2.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2	$2.8	$2.8	$4.7	$0.7	$0.7
Waste Management Cost, $M	$19.6	$19.6	$19.5	$11.8	$19.6	$19.5	$19.5	$19.6	$19.5	$19.6	$8.7	$8.7	$19.6	$19.6	$17.5
Material Removal/Replacement Time	849,000	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####
Removal Time (person hours)	734,000	734,000	727,000	241,000	734,000	729,000	729,000	734,000	727,000	734,000	139,000	139,000	734,000	734,000	734,000
Replacement Time (person hours)	115,000	115,000	105,000	105,000	115,000	105,000	105,000	115,000	105,000	115,000	89,000	89,000	115,000	115,000	0
Total Waste Generated (tons)	7,000	7,000	7,000	5,000	7,000	7,000	7,000	7,000	7,000	7,000	4,000	4,000	7,000	7,000	7,000
Removed for Waste Treatment & Disposal (Potential if contamination of an item prior to	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Potential if contents decontaminated, but damaged by	0	0	0	1,000	0	0	0	0	0	0	0	0	0	0	0
Potentially Contaminated Waste (Potential if contents/solid decontamination technology	7,000	7,000	6,000	4,000	7,000	7,000	7,000	7,000	6,000	7,000	4,000	4,000	7,000	7,000	7,000

Key Messages

1. Details on the disposition of each material type can be found on the Results Materials Lists worksheets (with and without the quantities of materials listed) and on the Results Materials Disposition worksheet..

DeconST Screenshot Interpretation

- The Total Waste Generated rows show the total and component quantities of waste in three categories:
  - **Sent Directly to Waste**: the materials and contents removed as waste prior to decontamination
  - **Treated Waste**: the materials and contents decontaminated, but damaged by the decontamination technology
  - **Potentially Contaminated Waste**: the materials and contents for which the decontamination technology fails
- The information is shown graphically on the Waste Generated by Decontamination Technology plots (on the Waste Generated Plot wDemo and woDemo charts).

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Application of DeconST Results

DECONST TABLETOP EXERCISE

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Exercise Scope & Objectives

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<u>Goal:</u> The goal of the EPA DeconST tabletop exercise is for participants to demonstrate an understanding of the different data inputs to generate DeconST results and appropriately apply the results in support of facility-specific decontamination strategies.

Exercise Objectives	
Objective 1	*Participants will be able to apply the DeconST training principles to input scenario data, generate and apply results, and discuss facility-specific decontamination strategies.*
Objective 2	*Participants will be able to develop a technical briefing of the facility-specific decontamination strategies for an Incident Commander.*
Objective 3	*Participants will be able to develop a public information strategy and press briefing for building decontamination operations.*

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Participant Breakout Groups

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<u>Group 1: Online</u>

- All those online are in 1 group
- Stay on the line and we are moving into another room for the scenario discussions

<u>Group 2: In Person</u>

- Remain in this room

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Scenario: Chemical Agent

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Scenario: Medium Sized Office Building	
Contaminant	**Sulfur mustard sprayed into an HVAC duct**
Offices (Walled)	25,000 ft^2 of walled offices (12 occupants)
Offices (Cubicle)	55,000 ft^2 of cubicle offices (100 occupants)
Temperature (F)	Building temperature ranges between 60 and 80°F
Relative Humidity (%)	Building relative humidity ranges from 45-50%

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Scenario: Chemical Agent

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Participant Tasks

- Identify and discuss the data inputs for the User Input Worksheet and the Materials Input Worksheet
- Produce the Scenario Results Summary Worksheet.
- Interpret the results data needed to develop decontamination strategies.
- Discuss the decontamination strategy options.
- What is the best option(s) for decontaminating the office building?
  - What resources are needed to execute the recommended decontamination strategy?
  - How long will it take for the decontamination team to be assembled and arrive on-scene?
  - Is demolition a viable option?
- Highlight the information and the technical detail that should be included in a technical briefing to the Incident Commander.
- What is the general public information strategy? What information will be included in a press briefing? What are the challenges in developing this press briefing? How will a "one voice, one message" concept be maintained?

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Scenario: *B. Anthracis*

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Scenario: Elementary School	
Agent	*B. Anthracis spores*
Student Population	200 students elementary school age
Surface Area	30,000 ft^2
Additional Scenario Information	• School authorities were alerted to the presence of the terrorist who released the material • Students were contained and sent to the local hospital (20 beds) for observation. • **BUT** 1 student who did not feel well left the school and went home immediately after the release but before anyone knew what had happened. • The child contaminated his home (a 2500 ft^2 private residence) with *B.a.* spores. • **Note**: Ignore the mode of transportation for the student/students and possible secondary contamination.
Structures Needing Decon	• School • House • Hospital
Available Assets	• 1 set of equipment EACH to generate and contain chlorine dioxide and methyl bromide • Bleach and sprayers are available at Home Depot.

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Scenario: *B. Anthracis*

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Participant Tasks

- Prioritize the approaches based on what is available.
- Discuss the options available based on the DeconST results.
- What would be your recommendation to decontaminate these 3 facilities?
- Would your recommendation change if time were of the essence?
- Develop the technical briefing for the incident commander for each of the 3 facilities
- Highlight the information and the technical detail that should be included in a technical briefing to the Incident Commander.
- Discuss the challenges of developing a technical briefing for a chemical event versus a biological event.
- What is the general public information strategy?
- What information will be included in a press briefing?

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HOT WASH

Appendix

C

Appendix C: Paths for Additional Development

Since the time of the initial development of DeconST, additional work through the DOD's Transatlantic Collaborative Biological Resiliency Demonstration (TaCBRD) program updated and created a web version of the tool, other paths for future development remain, particularly for connections to other tools, namely, the Department of Homeland Security (DHS) and the Department of Defense's (DOD) Prioritization Analysis Tool for All-Hazards (PATH) and Analyzer for Wide-Area Restoration Effectiveness (AWARE) (Einfeld, Knowlton et al. 2009) and the DHS's Resource Estimation and Scheduling Tool for Optimized Recovery (RESTORe) (Tucker and Edwards 2011).

The development of DeconST for TaCBRD created a web-based version of the tool and integrated it into the TaCBoard, an integrated, web-based system of biological-incident response decision-making tools (Ginley 2014). Connecting the DeconST to PATH/AWARE would place the problem of single-facility decontamination in the context of a wide-area recovery problem, allowing refinement of the PATH/AWARE wide-area calculations, and include prioritization and resource availability considerations at the single-facility level in DeconST. Connecting the DeconST to the RESTORe tool would couple the decontamination strategy and technology information and the waste considerations in DeconST with the ability in RESTORe to break a facility into zones and to consider resource availability and make detailed time calculations. These paths are discussed in the sections below.

Integrated System: TaCBRD's TaCBoaRD

The U.S. Department of Defense -- Defense Threat Reduction Agency's (DoD-DTRA's) Transatlantic Collaborative Biological Resiliency Demonstration (TaCBRD) program developed and demonstrated a capability for resilience in countering a wide-area biological incident that impacts U.S. and Partner Nation civilian and military personnel and key infrastructure. TaCBRD aimed to enhance the ability of allies and partners to effectively respond to an incident to maintain and restore essential services, and to manage and mitigate problems resulting from a biological incident. As part of TaCBRD, a system suite of decision-making tools, known as the TaCBoaRD, was developed to provide real or near real-time biological surveillance, information sharing, data aggregation decision-support tools to enable bio-incident planners and responders to best prepare, select, and execute bio-mitigation strategies specific to a situation based on the information that may be available.

To function as part of this integrated system, the DeconST was adapted to work with the Java-based software architecture of the TaCBoaRD. Since the DeconST is built in Microsoft Excel with Visual Basic, the integration does not happen automatically. Two options for accomplishing the integration were considered: (1) converting the DeconST to Java, and (2) wrapping the DeconST in an application programming interface that establishes communication between the Excel-based DeconST and the Java-based TaCBoaRD. The two options are discussed below. The decision was made to wrap the DeconST for the integration.

Converting the DeconST to Java (not done)

Converting the DeconST to Java would have required building the user interface (both input tables as well as output tables and graphs), converting the Excel-based macros that support the user interface (including those that allow the user to add new decontamination technologies and additional facility materials and contents), and building the algorithms and logic that support the calculations.

Pros

The advantage of converting the DeconST to Java would have been that it then could integrate seamlessly with other Java applications, particularly with the TaCBRD's TaCBoaRD.

Cons

The primary disadvantage of converting the DeconST to Java was that Java is not preferred for USEPA, the Technology Transition Agreement partner and the organization responsible for maintenance and updating of the tool after transition. Sustainment under a Java implementation would have required contractor-based computer programming skills beyond those required by an Excel implementation. The advantages incurred by the Excel implementation factored highly in engaging USEPA support and involvement in the development of the DeconST.

Wrapping the Excel-based DeconST to Interface with the Java-based TaCBoaRD (selected option)

Wrapping the DeconST in an application programming interface that establishes communication between the Excel-based DeconST and the Java-based TaCBoaRD required building user-interface components to:

- collect inputs from the user and hand them to the Excel-based DeconST, and
- display the Excel-based DeconST output tables and graphs.

Much of the Excel-based content was adapted and encapsulated, including the algorithms and logic that support the calculations and the Excel-based macros that support the user interface.

Pros

The primary advantage of wrapping the DeconST is that the DeconST remains implemented in Microsoft Excel, the preferred platform for the USEPA, the Technology Transition Agreement partner and the organization responsible for maintenance and updating of the tool after transition. The Excel implementation allows transparency of the data, calculations, and code to a much wider audience of users and developers. A developer could replace a data value or a calculation, while keeping the connection to the wrapper intact.

Cons

The primary disadvantage of wrapping the DeconST is that the advanced features implemented in Macros are not included. To add a decontamination technology or new material, the user would have to run those macros in the Excel version and then integrate that new version into the web version.

Wide-Area Recovery Tool: PATH/AWARE

Funded jointly through the DHS Science and Technology Directorate (DHS/S&T) and the DOD Defense Threat Reduction Agency (DOD DTRA) through the four-year collaborative program named the Interagency Biological Restoration Demonstration (IBRD), the Analyzer for Wide-Area Restoration Effectiveness (AWARE) is a planning tool that addresses restoration activities following a wide-area chemical, biological, or radiological attack on civilian or military infrastructures. This tool enables planners to specify an attack scenario and then evaluate various options for both outdoor and indoor restoration, estimating both time and cost requirements for the various phases of a restoration. Similarly funded through IBRD, the Prioritization Analysis Tool for All-Hazards (PATH) is an analysis and decision support module for decision makers to prioritize critical infrastructure for restoration in preparation for and/or during wide area recovery following natural or man-made disasters, including wide area biological contamination. PATH interfaces with the analysis tool, AWARE, to provide recovery timelines, enabling critical path analysis and the optimization of resource allocation and management according to restoration priorities.

Connecting the DeconST to PATH/AWARE would place the problem of single-facility decontamination in the context of a wide-area recovery problem, allowing refinement of the PATH/AWARE wide-area calculations, and including prioritization and resource availability considerations at the single-facility level in DeconST. Five options for this integration have been identified, and are discussed here in order of lowest to highest level of integration.

Option 1: Waste and Cost Data from DeconST Coded into PATH/AWARE

This option incorporates into PATH/AWARE the new knowledge gained from the execution of the DeconST (e.g., waste and cost) on specific generic facility types. By gaining cost and waste data, the PATH/AWARE time and cost calculations would become more accurate. In this option, the integration is of the data, not between the tools. This option requires modifications to existing algorithms and the development of new output user interfaces, as well as the addition of generic facility types to PATH/AWARE, and would require approximately five to six person-months of effort.

Option 2: Recommended Decontamination Strategies from DeconST Coded into PATH/AWARE

This option hard-codes into PATH/AWARE the DeconST output for recommended decontamination strategies for generic building types. The higher-resolution, higher-fidelity decontamination data would build additional accuracy into the PATH/AWARE timelines. As in the previous option, this option integrates data, not the tools. This option could be combined with Option #1 and Option #4 or #5 for the “rest of the buildings” not in the prioritized list and would require building out the database for additional building types. PATH/AWARE Building Utility can be used to generate square

footage for specific buildings, and the user could input material composition and other assumptions (or these could be default values that come from I-WASTE). In addition, this option requires the incorporation of multiple decontamination strategies into PATH/AWARE and would require approximately six to nine person-months of effort.

Option 3: All Decontamination Strategies from DeconST Exported into PATH/AWARE

Export multiple (maybe all) decontamination strategies for each building type from DeconST to PATH/AWARE. This approach would allow PATH/AWARE to look at a chosen subset of decontamination strategies for all building types and would include the ability to apply a certain decontamination strategy to a subset of infrastructure based on availability of resources, etc. It would enable a limited type of sensitivity analysis to be done in PATH/AWARE without having to tightly couple all the calculations. The more effort that is spent in setting up and exporting scenarios in DeconST would give more information for PATH/AWARE to use. Examples would be exporting multiple decontamination techniques, multiple sampling densities, etc. For this option, tool integration is not necessary, but PATH/AWARE would need either a new input mechanism for the user to manually input and select strategies for each building type or a linkage between DeconST and PATH/AWARE to automatically import strategies from DeconST into PATH/AWARE. This option could be combined with Option #1 and Option #4 or #5 for the "rest of the buildings" not in the prioritized list. This option requires user interface development to assign strategies in PATH/AWARE and would require approximately six to nine person-months of effort for the manual linkage or nine to twelve person-months of effort for the automatic linkage.

Option 4: Higher Resolution Analysis of Critical Infrastructure (one way: PATH/AWARE to DeconST)

In this option, PATH/AWARE is used to generate the prioritized list of facilities, the square footage of each facility, and the number of days of delay before each facility can be decontaminated. The user runs DeconST to analyze each facility with greater resolution. The combined information would enable broad, lower-resolution wide-area restoration planning followed by detailed, higher-resolution decontamination planning for specific facilities. For example, the user could perform detailed cost, waste, and time estimates for the ten highest priority facilities. These calculations could be performed separately and manually (with no tool integration) or from PATH/AWARE initiating the DeconST calculations. Integration of the tools for this option could include making the prioritized list interactive so that the user could click on the timeline for a facility to launch the DeconST for that facility. The manual version of this option would require some development to the DeconST to incorporate the facility square footage and the number of days of delay and would require approximately five to six person-months of effort. Linking the tools so that PATH/AWARE could launch the DeconST would require development to both tools, with approximately six to nine person-months of effort.

Option 5: Higher Resolution Analysis of Critical Infrastructure (two way: PATH/AWARE to DeconST)

Option #5 builds on Option #4 by adding a loop back from DeconST to PATH/AWARE. As in Option #4, PATH/AWARE is used to generate the prioritized list of facilities, the square footage of each facility, and the number of days of delay before each facility can be decontaminated. The user runs DeconST to analyze each facility with greater resolution. The higher-resolution, facility-specific information from the DeconST is then returned to PATH/AWARE to refine the remediation timelines to help the user iteratively refine the broader wide area restoration strategy. As for Option #4, integration of the tools could include making the prioritized list interactive so that the user could click on the timeline for a facility to launch the DeconST for that facility, use the DeconST to refine the decontamination strategy, and then return to PATH/AWARE and have the DeconST strategy for that facility auto-populated into PATH/AWARE. Linking the tools in this manner would require development to both tools, with approximately nine to twelve person-months of effort total.

Time and Resources Tool: RESTORe

Motivation

The DeconST provides a comparison table of decon approaches, showing the environmental considerations, the materials management decisions, and the costs of each. The materials management decisions include the separation of materials (structural, interior, and contents) into those to be decontaminated in situ and ex situ and those to be removed as either contaminated or decontaminated waste, based on the efficacy and destructiveness of each decontamination technology on each material. The current cost calculation is partial, calculating only the costs of the decontamination technology implementation – including costs for characterization, decontamination, verification, clearance, monitoring, and waste management – but excluding consideration of the costs of facility downtime. The disadvantage of the partial cost calculation is that the direct costs are only one component of the costs and are likely to be overwhelmed by the cost of the facility downtime. An important next step in the evolution of the DeconST is to incorporate the cost of facility downtime to provide a more complete cost-benefit analysis of the remediation approaches.

Approach

A separate tool, the Resource Estimation and Scheduling Tool for Optimized Recovery (RESTORe), developed under DHS/S&T's Chemical Restoration and Operational Technology Development (Chem Restoration OTD) Project, calculates the time required to remediate a facility based on the process parameters and the availability of resources. With the development of an interface between the two tools, the DeconST would be able to utilize RESTORe to calculate the time required for each decontamination technology. The coupling of these tools is shown in Figure , below, and requires the following steps:

- Costs Database – Adapt DeconST and RESTORe to use a single costs database;
- Time Database – Develop referenced database of time requirements for each process component (e.g., sample collection rates, decon rates, laboratory analysis rates);

- Materials Information – Adapt materials quantities information in IWMPRT and DeconST to be input to RESTORe;
- Contents – Adapt DeconST and RESTORe to treat contents/items consistently;
- User Interface – Adapt DeconST user interface to collect additional information (resource availability and cost per day of facility downtime) and to report new results (total time required and total cost of facility downtime for each decontamination technology); and
- Tools Coupling – Develop coupling between tools to run RESTORe once for each decontamination technology.

This additional development should be undertaken in conjunction with the USEPA to continue the established collaboration for guidance and review of product.

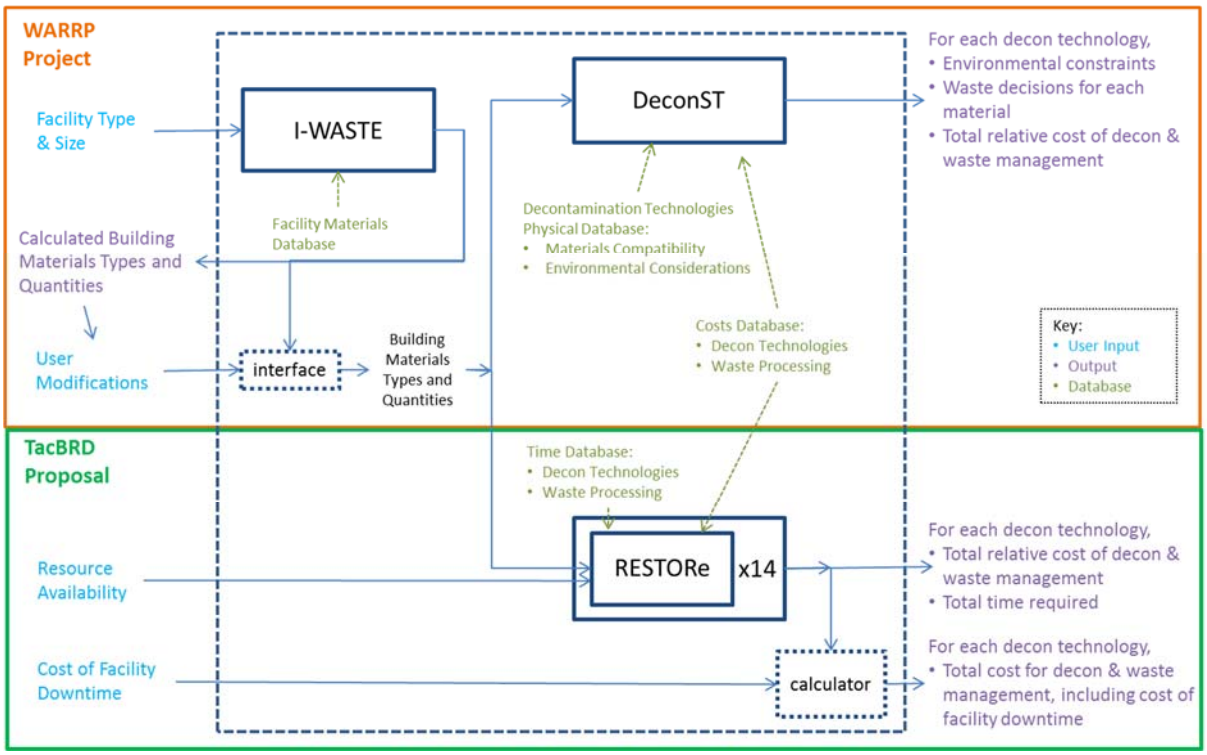

Figure C-1. Coupling of DeconST and RESTORe Tools

Schedule and Budget

The development steps can be executed in parallel over the course of nine months with the following approximate budget:

- Costs Database – $50k;
- Time Database – $50k;
- Materials Information – $50k;
- Contents – $50k;
- User Interface – $50k;
- Tools Coupling – $50k.

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