Chemical and Biological Agent Response and Decontamination for Civilian Facilities

Ellen Raber
Department Head, Environmental Protection Department
Lawrence Livermore National Laboratory

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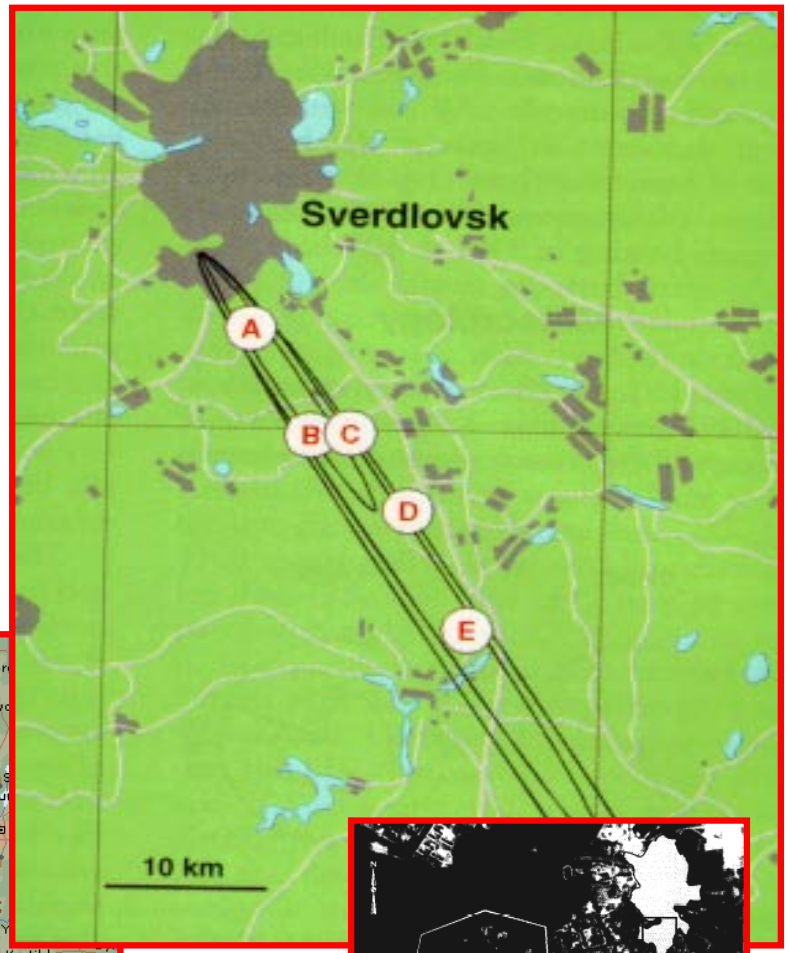
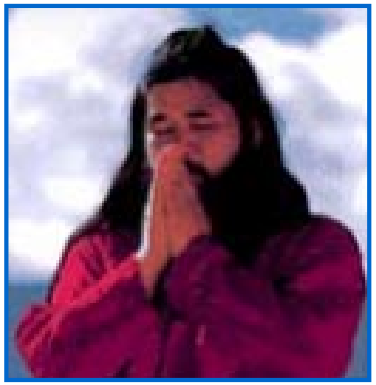


Sverdlovsk Anthrax Incident 1979

Between 120 and 400 persons sick
At least 75 died
Initial report blamed contaminated meat
Later linked to release from bio-weapons facility

Aum Shinri Kyo Anthrax Attack 1993



Aum leader Chizuo Matsumoto
aka Shoko Asahara

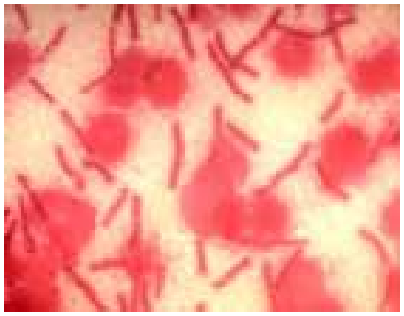
Japan 1995: Aum Shinri Kyo Incident

- Tokyo subway
- Sarin nerve gas
- 12 killed
- 6,000 ill

USA 2001: Florida, New York City, Washington, DC

Two Workers Die and Two are ill at Capitol's Postal Center Inhaled Anthrax Indicated

New York Times, October 23, 2001

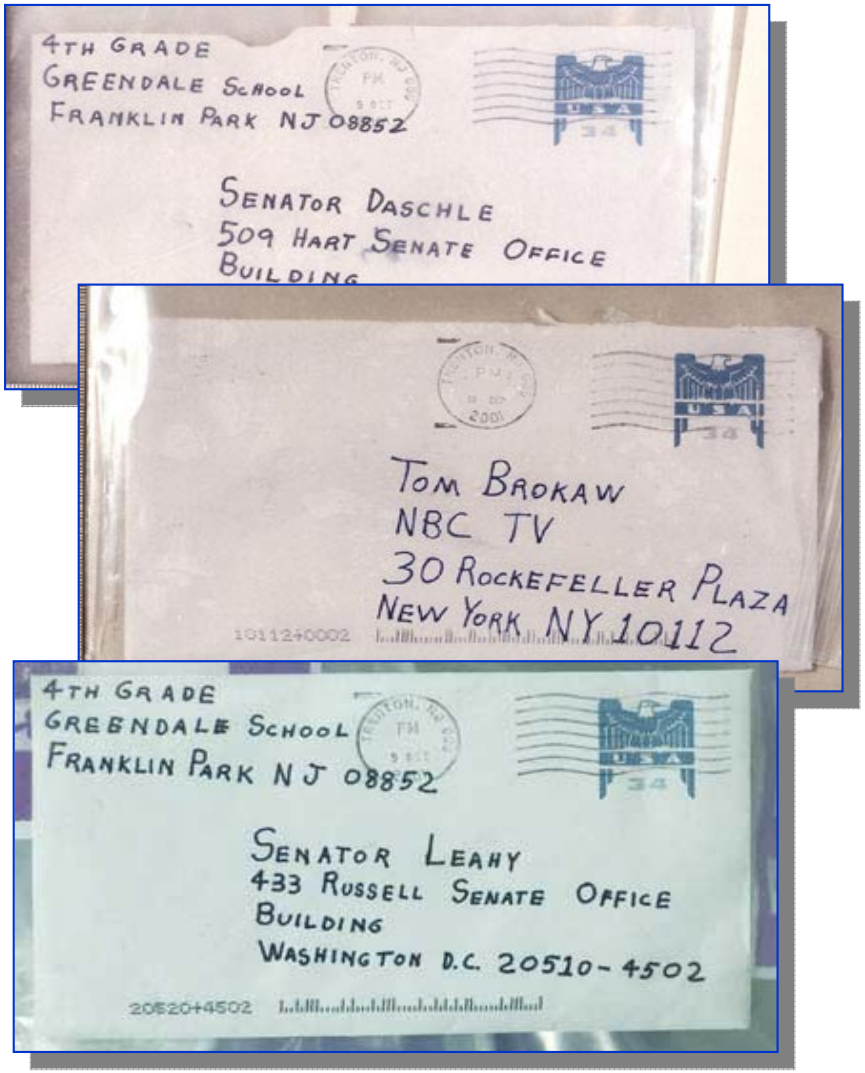


Anthrax Scare Closes High Court
Washington Post, October 27, 2001

Anthrax Cleanup Fraught with Messy Uncertainties
Chicago Tribune, November 24, 2001

Effective response and decontamination for civilian chem-bio incidents is a <u>real</u> need

Bio-remediation projects caused by the 2001 Amerithrax letters took years to complete



- US Post Office mail sorting centers (DC and NJ)
  - Estimated cost of remediation ~$200 M
- Department of State mail facility
  - Building completely gutted
  - 400,000 lb of material treated as hazardous waste
- AMI building in Florida has now become a test facility
- Attacks have raised questions on infectious dose estimates and levels

A deliberate bioterrorist attack against public transportation could have far-reaching economic impact

- Closure of a few nodes could cause widespread disruption
- Attacks are easy, even with new security measures
- Decon and recovery challenges are complex and time consuming
- Little realistic planning has been done to date
- DHS has initiated some projects to address preparedness and restoration

Decontamination and restoration issues are site-specific

Scenario 1

Outdoor (Stadium, Mall)

- Many environmental variables must be considered
- Dilution/natural attenuation may be the solution

Scenario 2

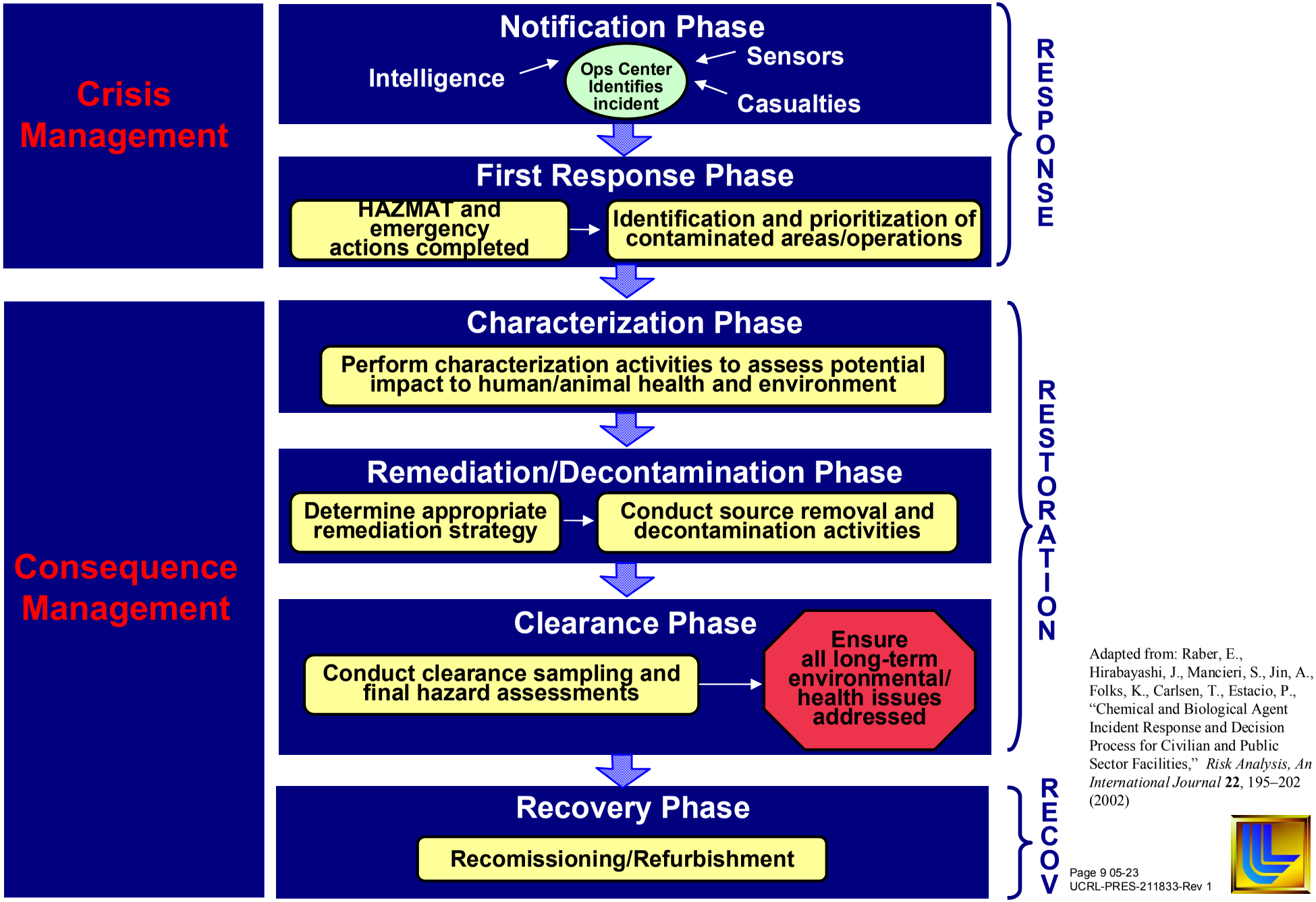
Semi-enclosed (Airport, Subway)

Scenario 3

Enclosed (Office, Hotel)

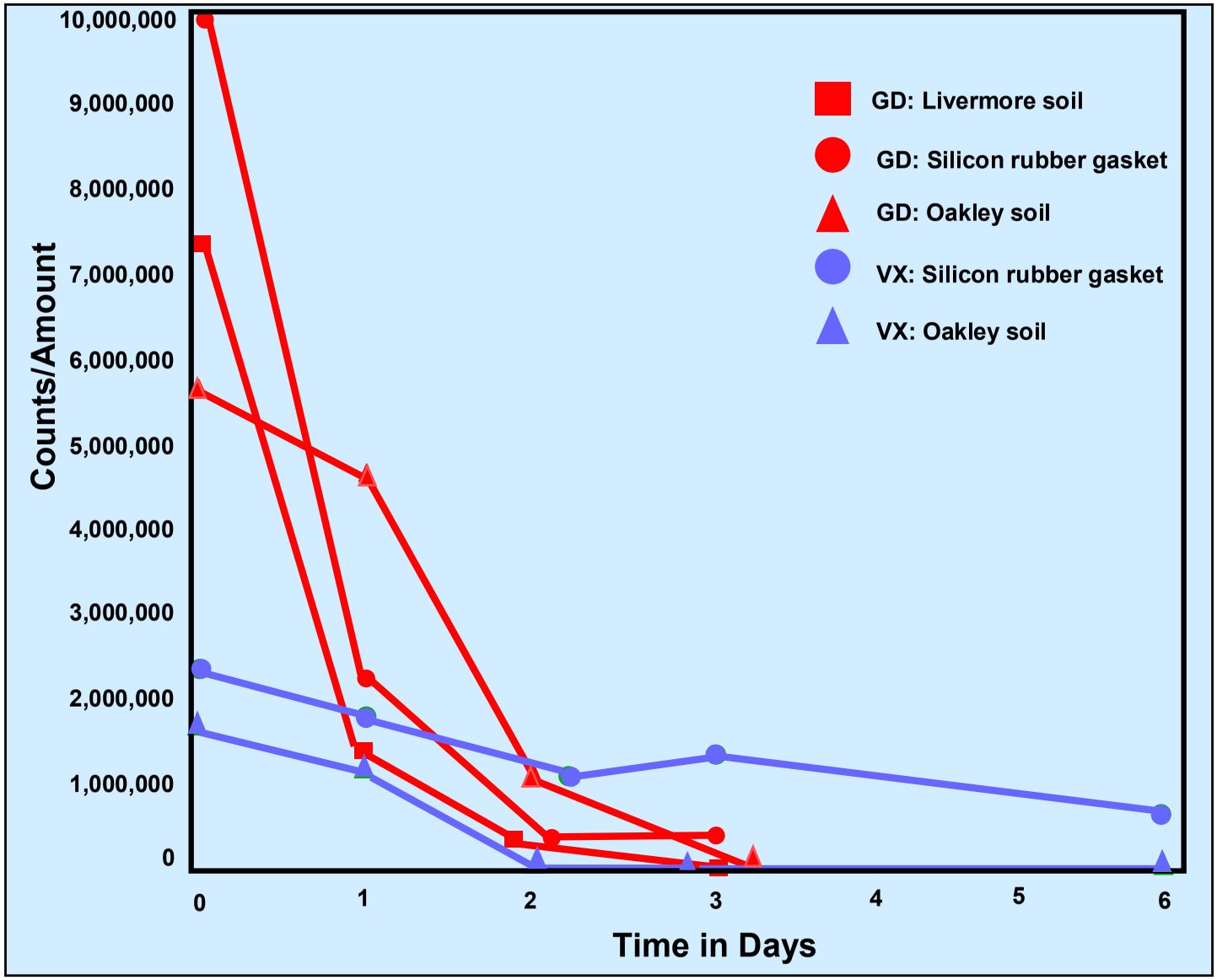
- Public perception issues are key
- More amenable to ventilation interventions

CBW risk-informed response decisions can be addressed in six key phases



Adapted from: Raber, E., Hirabayashi, J., Mancieri, S., Jin, A., Folks, K., Carlsen, T., Estacio, P., "Chemical and Biological Agent Incident Response and Decision Process for Civilian and Public Sector Facilities," *Risk Analysis, An International Journal* **22**, 195–202 (2002)

Natural degradation/attenuation of CW agents may be effective for outdoor cleanup scenarios



- Tests conducted at Porton Downs
- Data from McGuire et al., UCRL-ID-114107, LLNL (1993)

Natural attenuation potential exists for BW agents

- Some literature exists on general spore and bacterial /vegetative cell survival in outdoor environments
- Most research focused on longevity of *Bacillus anthracis* spores in outdoor, ambient environmental settings
  - 90% of spores in soil die within 50 years
  - Remaining spores have ability to germinate and grow
  - Surviving spores can remain viable for 300 years (Sneath, 1962)
  - Calcium and pH dependency probable

- Nonsporulating vegetative cells require substantial water activity, but they are capable of surviving in dormant state

It is important to understand the conditions required for viability (germination, growth, and sporulation) in indoor environments

Decontamination requirements for the civilian sector are very demanding

- Single method effective against all chemical and biological agents
- Relatively noncorrosive
- Nonhazardous and/or environmentally acceptable residues
- Short decontamination times (hours)
- Maximum contact on walls and ceilings
- Relatively inexpensive and available
- Formulation is stable with a long shelf life (>1 year)
- Easy deployment/application by various methods; minimal training

Current standard for surface decontamination is household bleach (5% NaOH)

The leading fumigants are vaporous hydrogen peroxide (VHP) and chlorine dioxide (ClO_2)

- **VHP Advantages**
  - —Less corrosive to almost all materials
  - —Much less destruction of electronic equipment
  - —Minimal waste materials
  - —Lower toxicity reduces hazard to people in the vicinity

- **ClO_2 Advantages**
  - —Easier to generate in large quantities
  - —Easier to reach sporicidal concentrations because of less rapid breakdown
  - —Used for more facilities, and better track record to date

Fumigation requires extensive building preparation and equipment assembly, and labor-intensive monitoring

Brentwood Fumigation Operation

Major decontamination technology gaps exist for public sector needs

- Environmentally acceptable methods need to be further developed

Noncorrosive, nontoxic gases/aerosols for buildings

- Develop/modify technologies for quicker, large-scale decontamination of ventilation systems and buildings with conventional gases (VHP, ClO_2)
- Methods to neutralize toxic gases in large building (i.e., paraformaldehyde)
- Specialized reactive materials (i.e., paints/coatings) that adhere to high vertical places and do not require cleanup
- Methods to decon sensitive electronics and other high-value items
- Radiation sources for BW protection/decon should be further evaluated
- Faster methods to determine agent-specific viability need to be developed

Next generation decontamination technologies need to be developed

Cleanup/decontamination decisions must address stakeholders concerns

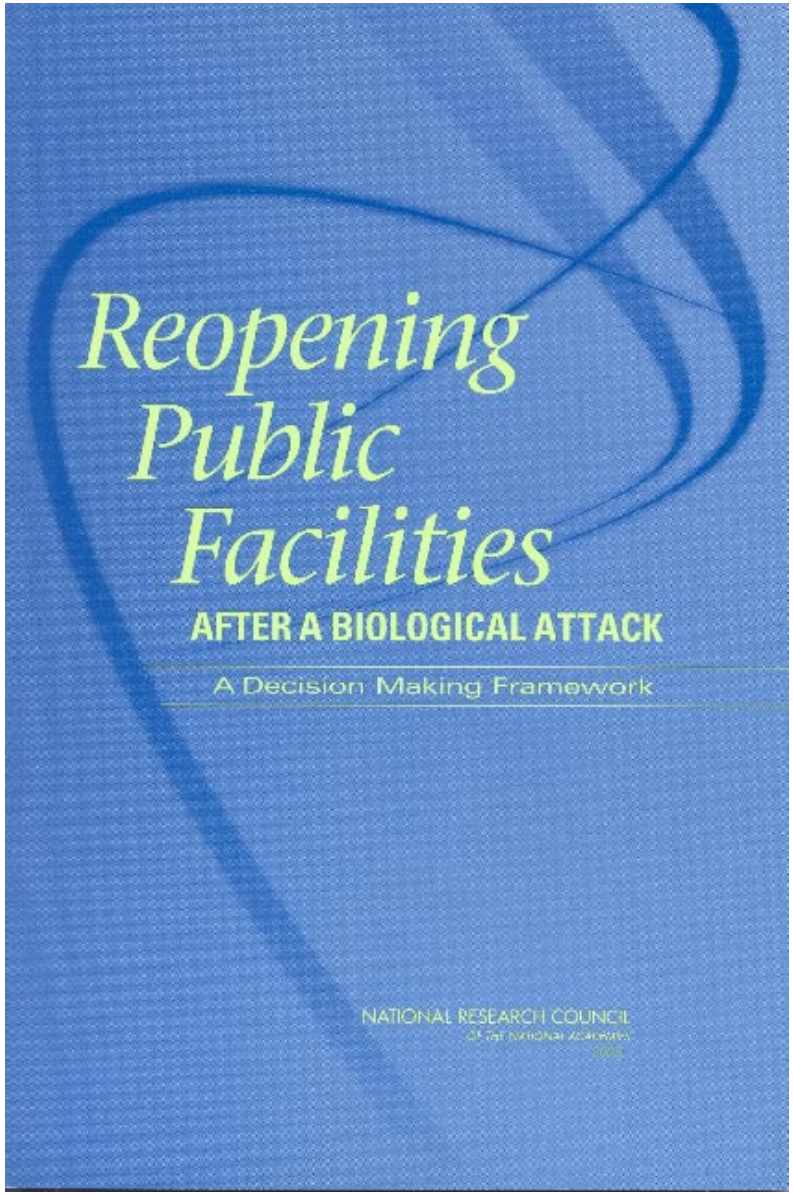
- Likelihood of effect on exposed population(s) as consequence of event:
  - — Relevant exposure (e.g., inhalation, dermal, secondary ingestion) routes
  - — Mobility, fate and multimedia transport of contaminants
- Damage to land, water, property, equipment, and associated costs
- Cost and availability of decontamination options with time constraints
- Potential secondary contamination issues
- Confidence in decontamination methods, including sampling/verification
- Aesthetic and other relevant site-specific factors
- Potential over reaction that may cause increased panic or chaos

Effective risk communication strategies will play an important role with respect to stakeholder acceptance

How Clean is Clean Enough?
How Clean is Safe?

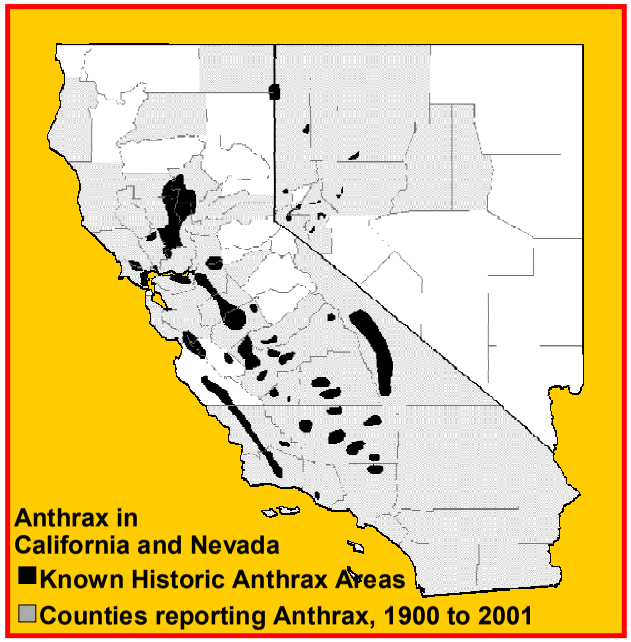
Raber E., Carlsen, T., Folks, K., Kirvel, R., Daniels, J., Bogen, K., "How clean is clean enough? Recent developments in response to threats posed by chemical and biological warfare agents," *International Journal of Environmental Health Research* **14,** 31–41(2004)

Raber E., Jin, A., Noonan, K., McGuire, R., Kirvel, R., "Decontamination issue for chemical and biological warfare agents: how clean is clean enough?" *International Journal of Environmental Health Research* **11,** 128–148 (2001)



Recent NAS study addressing "How Clean is Safe?" for biological agents—included four major elements

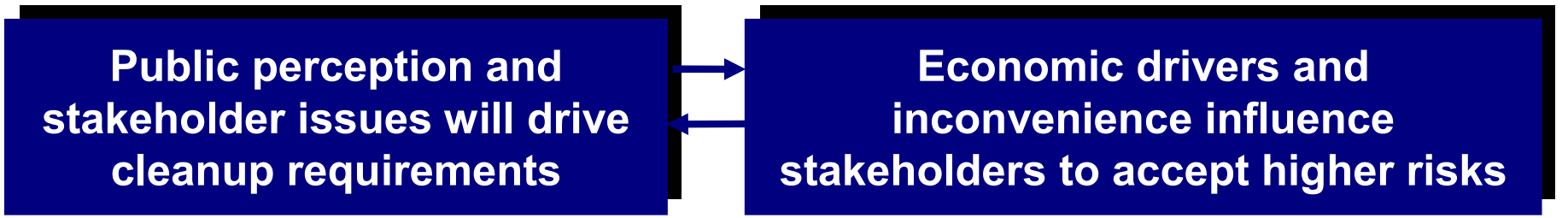
- Re-evaluation of infectious dose for key bio-agents
- Determine appropriate quantitative risk assessment framework/models
- Review dose from natural and residual contamination levels
  - — Natural degradation in various environments
  - — Potential effects on surrounding population
- Review past cleanup efforts to more completely understand implications of exposure/dose to infectivity and immunity



Key bio-agents were evaluated including anthrax, smallpox, and plague

What level of cleanup will be required to meet both regulatory and stakeholder needs?

- Potential for acute and long-term chronic impacts on key populations
  - Low-dose, long-term, chronic CW toxicity data not adequate
  - Infectious dose levels for many BW agents incomplete or inconsistent
  - Inhalation models and risk-assessment data and protocols limited
- Existing/applicable regulatory standards need to be further validated
  - CW agent newly published values can be applied for cleanup and re-entry
  - Public acceptance of some biological risk efforts
- Site-specific parameters and usage are key
- Monitoring systems ensuring concentrations are below “safe” level necessary



Cleanup criteria for biological agents are more problematic

- **Current biosafety practices may be adapted for public sector use**
  - American Industrial Hygiene Assoc: *Biosafety Reference Manual*
  - CDC: Biosafety in Microbiological & Biomedical Laboratories
- **Biological cleanup criteria strongly driven by stakeholder issues**
  - Public may demand zero live organisms for any enclosed structures
  - Economic drivers will influence stakeholders to accept higher risks
- **Existing public decontamination standards may serve as useful guidelines for public acceptance of some risks**
  - Public acceptance of hospital disinfectant methods (<15 CFU/m^3)
  - Requirements for public swimming pools / nonpotable water (<200 CFU/ml)
- **Understanding indigenous levels of some organisms (i.e., anthrax) helpful**

Current EPA de facto cleanup level is zero growth from any environmental sample collected and analyzed

In summary, approaches are needed to rapidly restore critical infrastructure

- National consensus on cleanup standards for chem/bio-terrorism agents
- Improved decontamination methods and procedures
- Better understanding of decision processes and lines of authority
- Large-scale tests and demonstrations of rapid remediation operations/options