Radiological Emergency Response Planning and Exercise

July 2008

Co-Authors:
Steve Homann
John Nasstrom

Brooke Buddemeier
Certified Health Physicist

Lawrence Livermore National Laboratory, P. O. Box 808, Livermore, CA 94551

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344

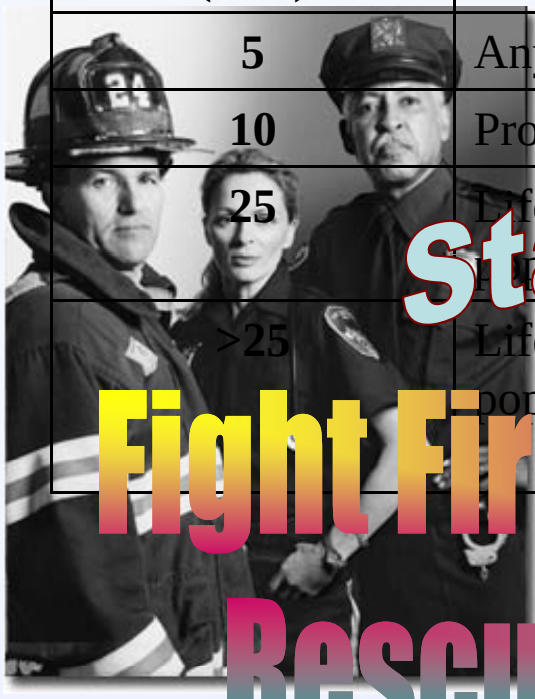
LLNL-PRES-404937

First Responder Considerations

Some Federal Guidelines Do Exist…

But what does it mean to these guys?

Dose Limit (rem)	Activity being performed	Limitations or conditions
5	Any	None
10	Protecting valuable property	None
25	Life saving or protection of large populations	None
>25	Life saving or protection of large populations	Personnel fully aware of the risks involved, and assume limited only on a voluntary basis.



Stay Times?

Turn Back Dose?

Fight Fires…

Decontaminate?

Rescue Victims…

…or wait for the Experts?

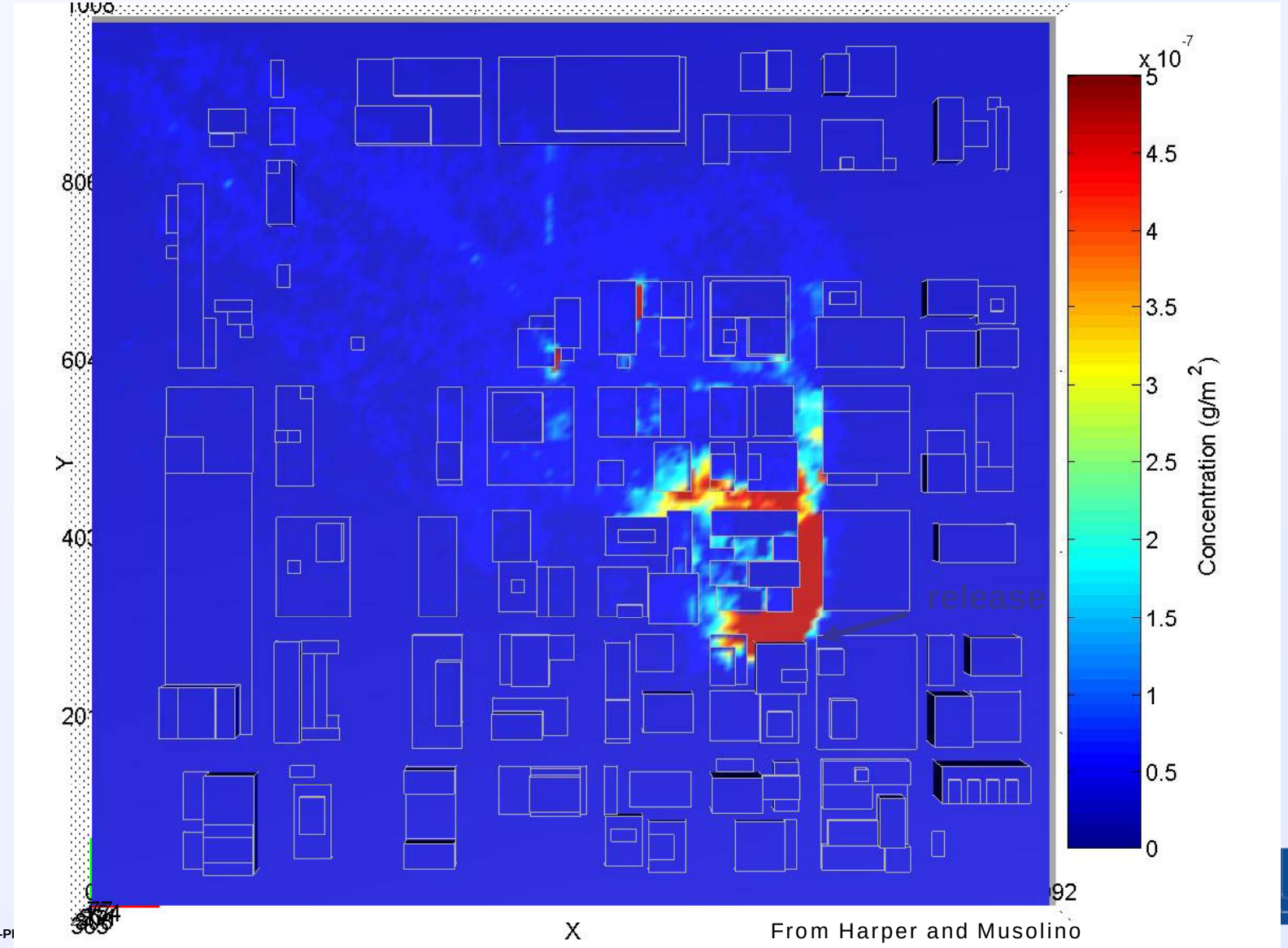
*Taken from Table 2-2 of EPA 400-R-92-001 *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents.*

...and Hard to Implement.

Turn-Back dose rate (lifesaving)	**200 R/hr**
Turn-Back dose	**10 rem**
Personnel Decontamination trigger level (beta, gamma β,γ)	**2 times background**
Personnel Decontamination trigger level (alpha α)	**Any constant, continuous clicks**
Personnel Equipment reuse contamination level (beta, gamma β,γ)	**1 mR/hr on contact (above this decontaminate the equipment prior to reuse.)**

Gamma Ray Dose Rate			Stay Time to Receive This Dose					
Rate / hr	Rate / min	Rate / sec	1 rem	5 rem	10 rem	25 rem	100 rem	500 rem
5 mR/hr	83 μR/min	1.4 μR/min	200 hrs	6 weeks	12 weeks	30 weeks	2 years	
00 mR/hr	1.7 mR/min	27 μR/sec	10 hrs	50 hrs	100 hrs	250 hrs	6 weeks	30 weeks
1R/hr	17 mR/min	270 μR/sec	1 hr	5 hrs	10 hrs	25 hrs	100 hrs	500 hrs
10 R/hr	170 mR/min	2.7 mR/sec	6 minutes	30 minutes	1 hr	2.5 hrs	10 hrs	50 hrs
100 R/hr	1.7 R/min	27 mR/sec	36 seconds	3 minutes	6 minutes	15 minutes	1 hrs	5 hrs
500 R/hr	8.3 R/min	140 mR/sec	7 seconds	36 seconds	72 seconds	3 minutes	12 minutes	1 hrs

How Do We Define “Onsite”?



From Harper and Musolino

Who's Got the Right PPE?

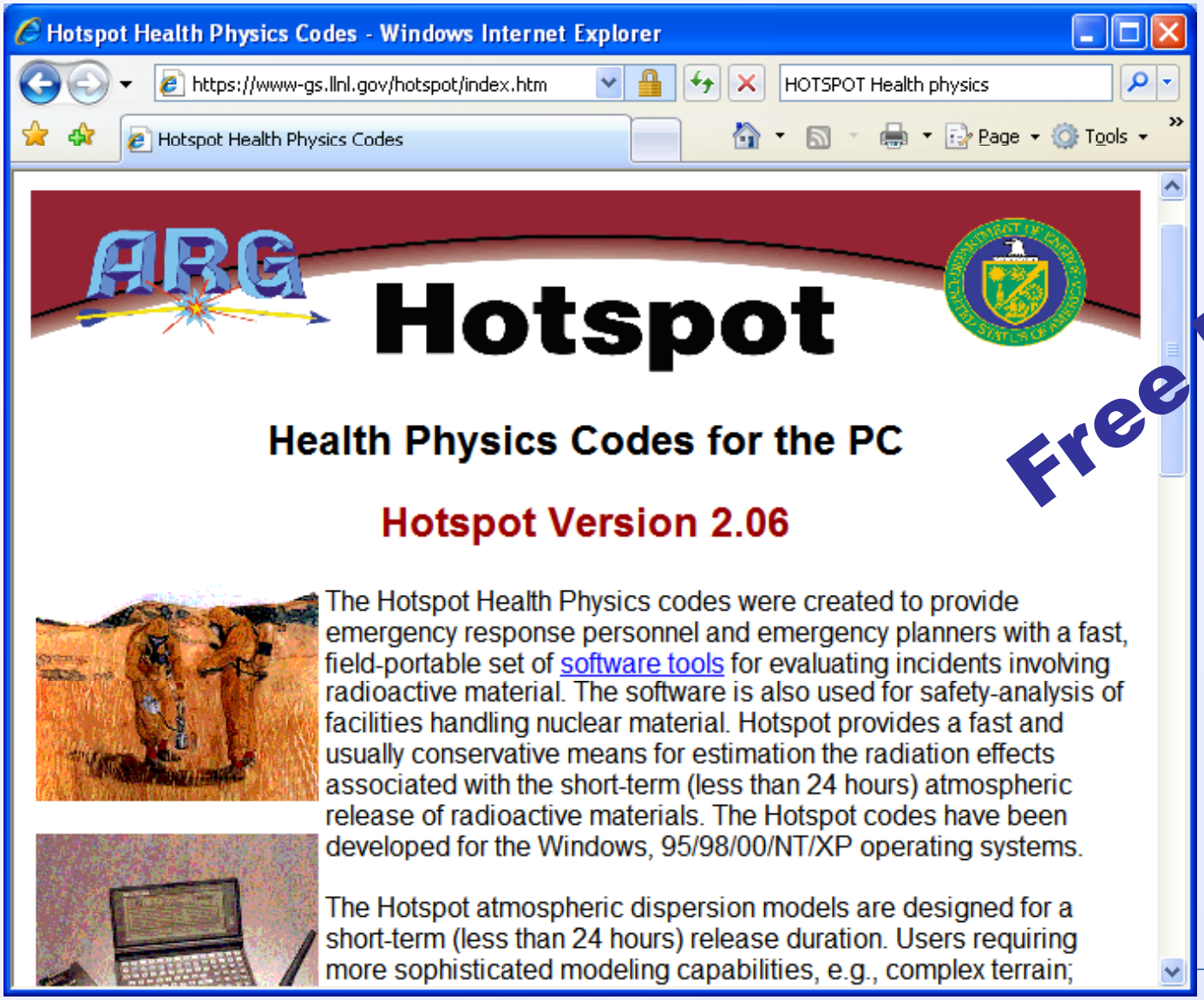
What is the Appropriate DECON?

How Do You Handle the Injured?

And the Answer Is…. It Depends”

- Every community balances the “risk / benefit” equation differently and has different needs.
- Most important to have a **scaleable approach.**
- Planning is often more important than the plan itself.
- A sound scientific basis is important

Using HOTSPOT to Help Communities Understand the Issues



Free Download!

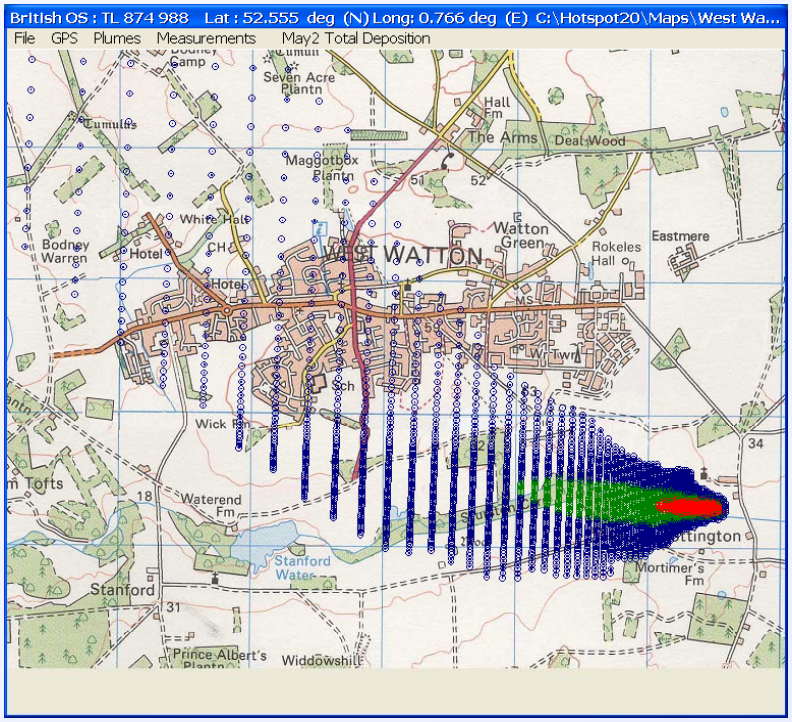
Hotspot Exercise/Demo Support Capabilities

- Import NARAC modeling predictions
  - Plutonium ground deposition (Ci/m2)
  - Time-integrated air concentration ([Ci-sec]/m3)

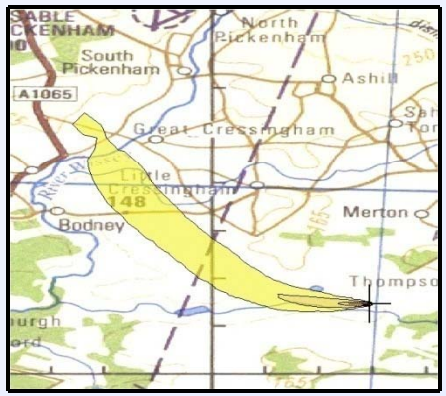
- Accurate (meters), bi-directional geographical coordinate conversion between Latitude/Longitude and other coordinate systems

- Support all US/UK radiation detection/measurement capabilities
  - Ground survey instrumentation
  - Contamination (swipes/smears) measurements
  - Air filters (gross and radon corrected)
  - Miscellaneous (user's can add custom capabilities as needed)
    - Lung deposition
    - Bioassay
    - Etc.

Can Importing Sophisticated NARAC Model Runs

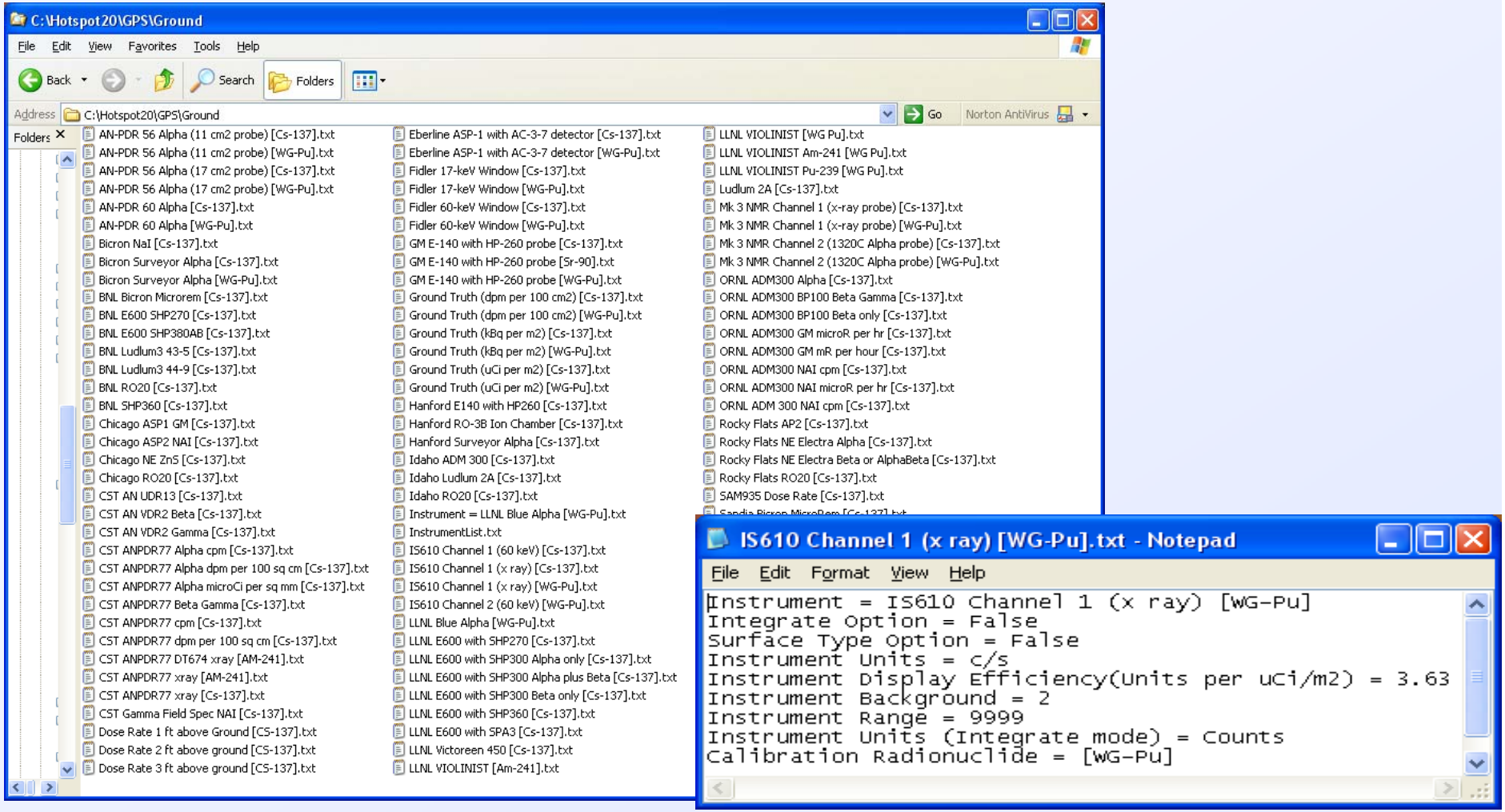


Hotspot geo-positioned map



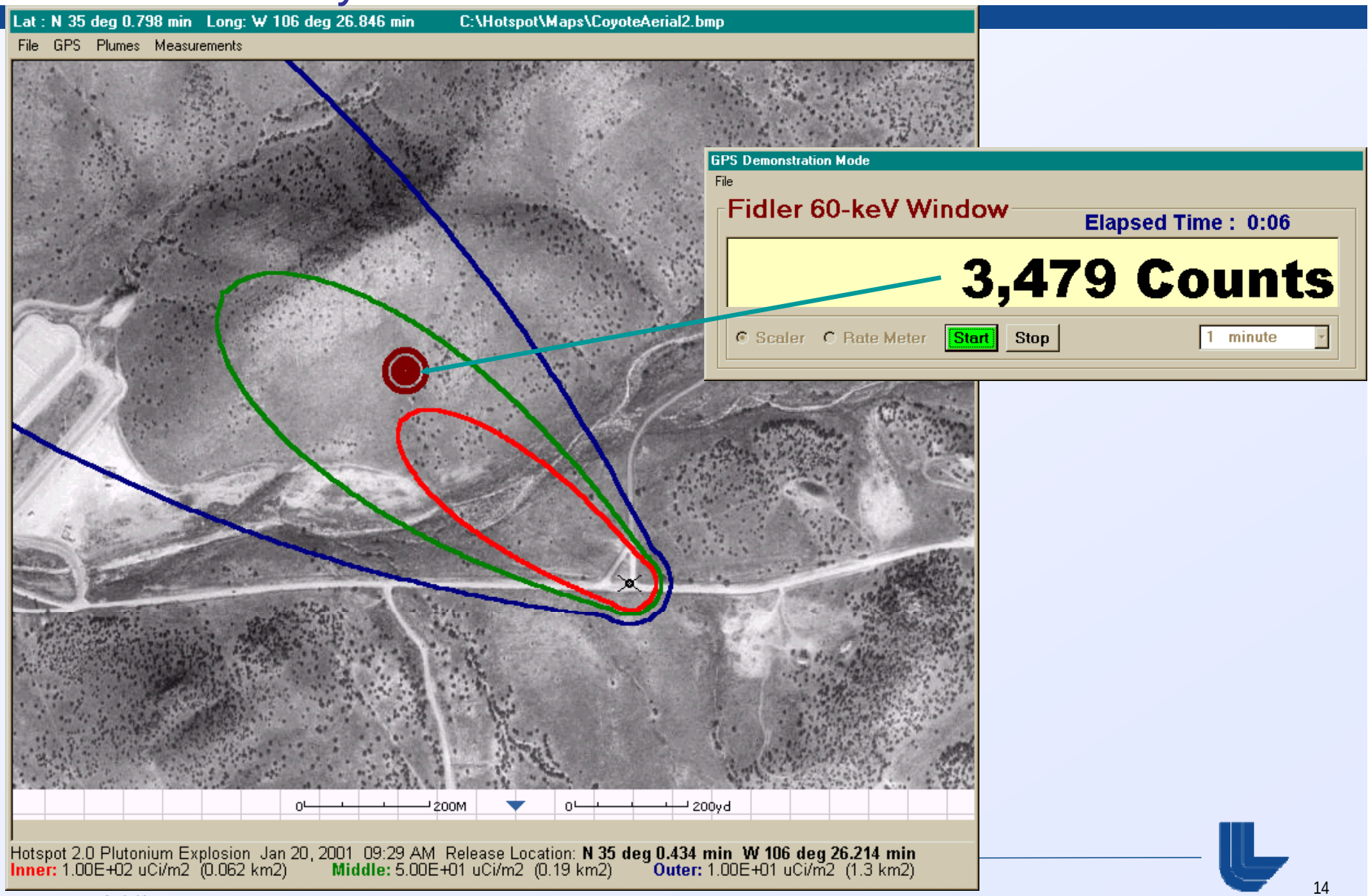
NARAC

Current Hotspot Library contains over 100 radiation survey instruments

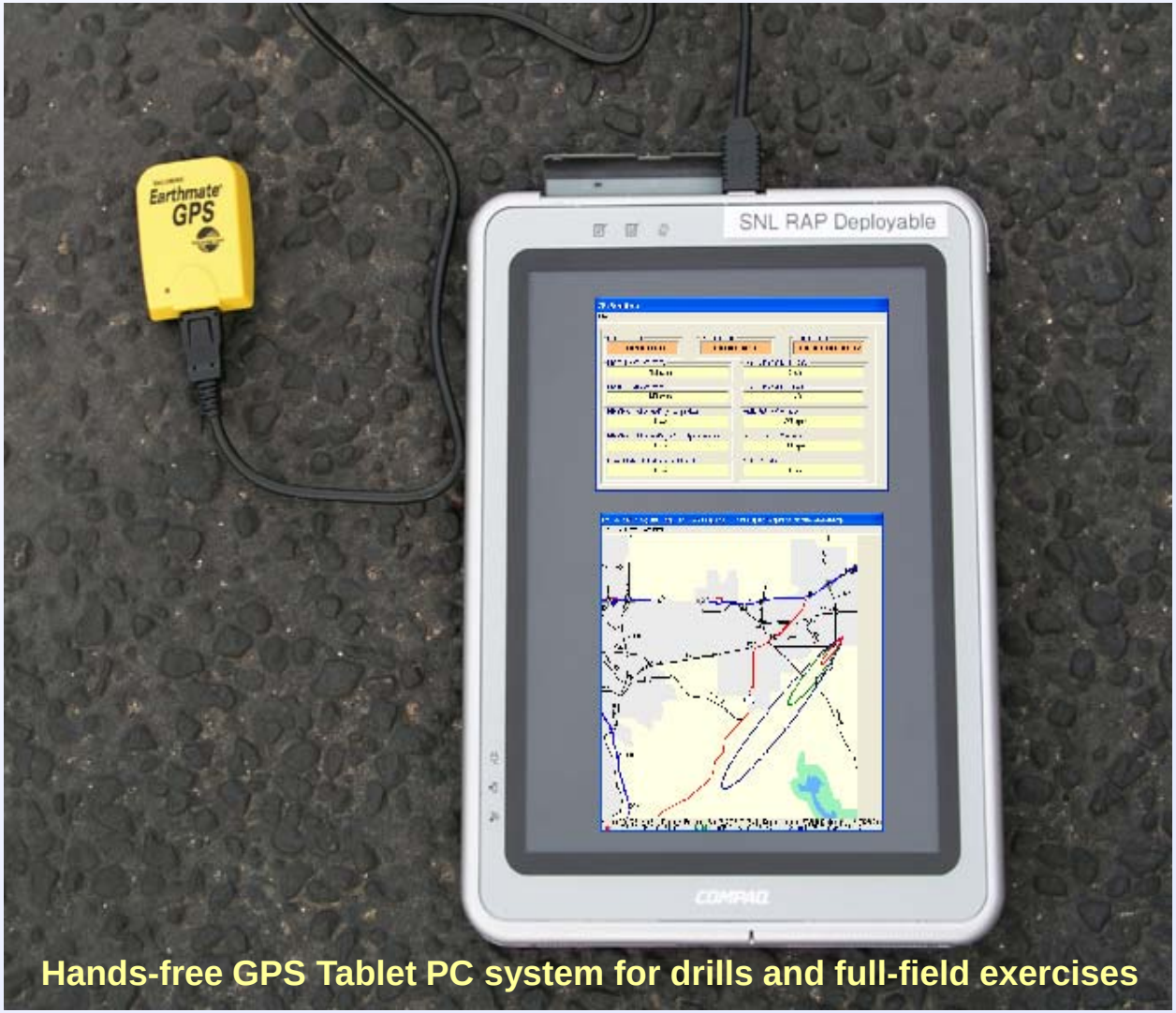


- **Users can easily add their own instruments to the library**

HotSpot GPS Virtual Plume
Real-time Survey Instrumentation Simulation



Hotspot GPS Capability Used by Exercise Controller to Simulate Real-time Data



Hands-free GPS Tablet PC system for drills and full-field exercises

The simulated output of up to 10 radiation survey instruments, along with ground truth, can be displayed in real time

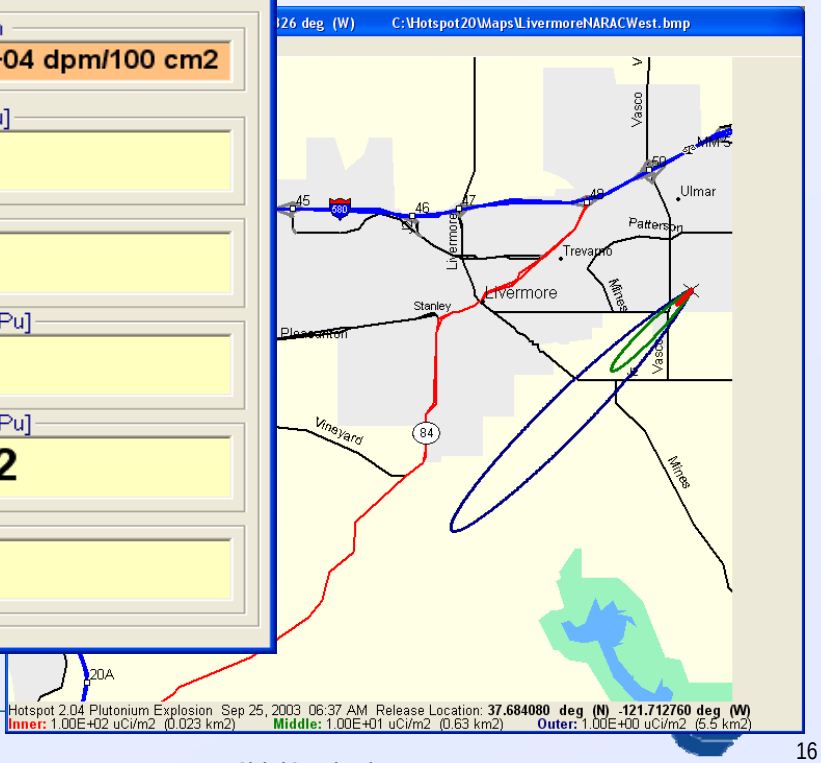
- Display options
  - Instruments, map and plume
  - Instruments and map
  - Instruments only

GPS Real-time Mode

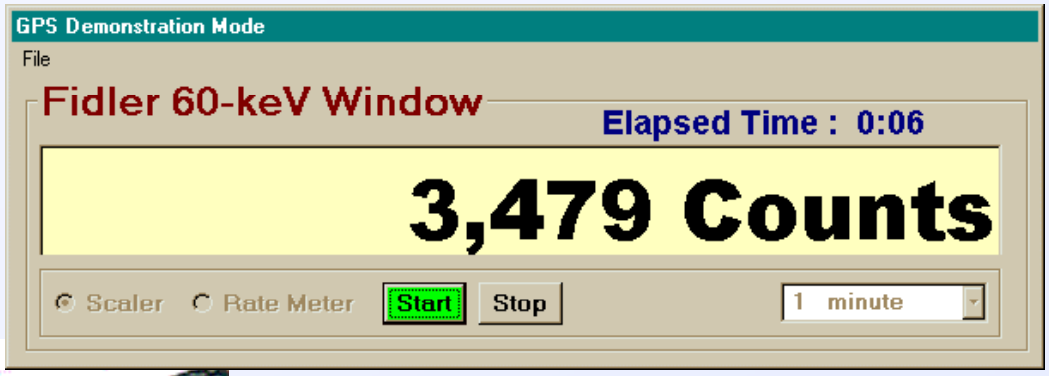
File

Ground Truth	Ground Truth	Ground Truth
3.10E+00 uCi/m2	1.15E+02 kBq/m2	6.88E+04 dpm/100 cm2

FIDLER 60-keV Window [WG-Pu]	IS610 Channel 2 (60 keV) [WG-Pu]
2,200 cpm	19 c/s
FIDLER 17-keV Window [WG-Pu]	IS610 Channel 1 (x ray) [WG-Pu]
2,200 cpm	12 c/s
Mk 3 NMR Channel 1 (x-ray probe) [WG-Pu]	VIOLINIST 60-keV Window [WG-Pu]
10 c/s	37 cps
Mk 3 NMR Channel 2 (1320C Alpha probe) [WG-Pu]	VIOLINIST 17-keV Window [WG-Pu]
60 c/s	40 uCi/m2
Solid State Alpha Monitor (SSAM) [WG-Pu]	AN-PDR 60 Alpha [WG-Pu]
140 c/s	6,500 cpm



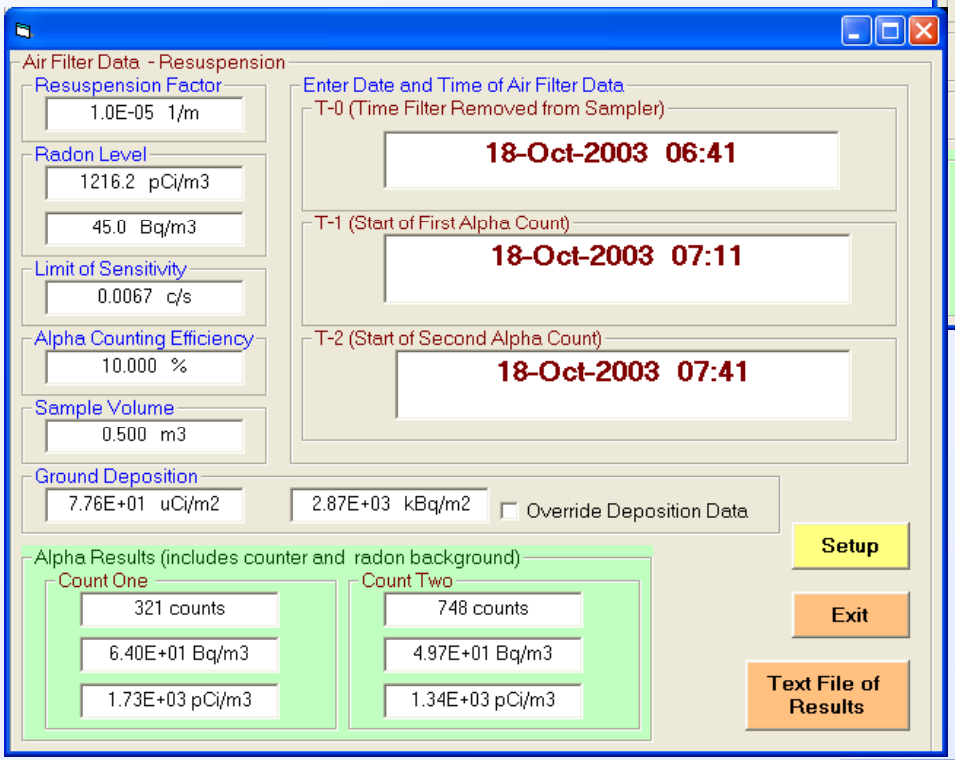
The display can consist of a single instrument, effectively turning a tablet PC into a virtual instrument

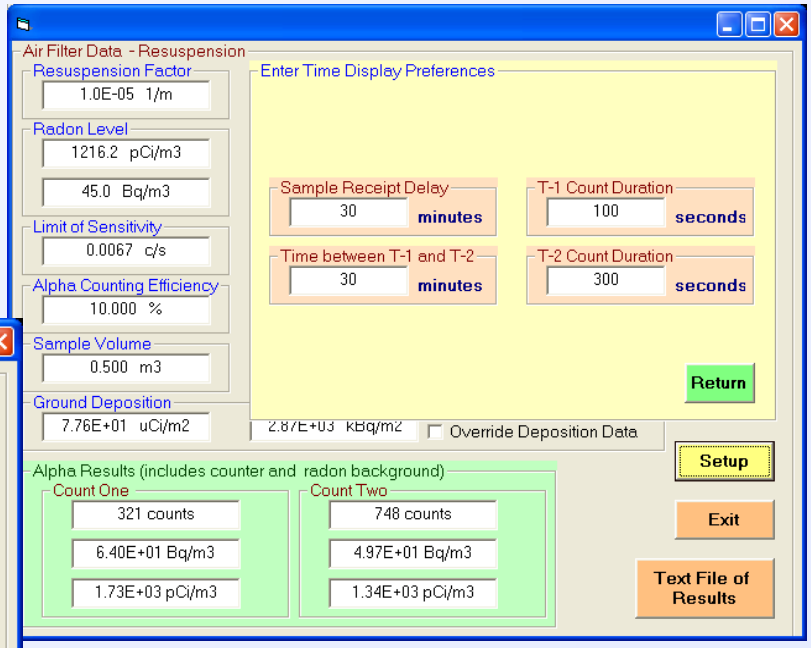


LLNL FIDLER as an example

Hotspot can also simulate air filter sample data

- Hotspot provided counting data to realistically test the assessment of Alpha air concentration in the presence of natural radon background.





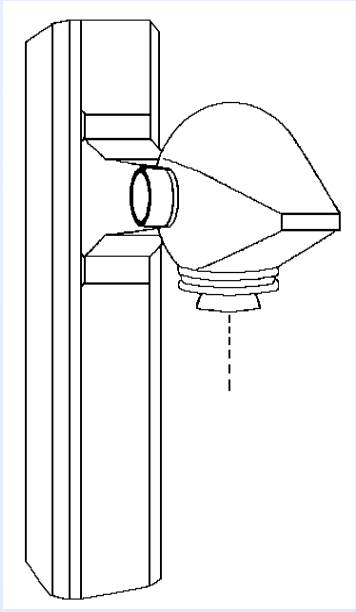
$$K = SA_{T1} - \left[\left(\frac{SA_{T1} - SA_{T2}}{e^{-0.0173(T1-T0)} - e^{-0.0173(T2-T0)}} \right) \times e^{-0.0173(T1-T0)} \right]$$

K = the count rate due to plutonium
SA_{T1} = 1st count rate made at time $T1$
SA_{T2} = 2nd count rate made at time $T2$

$T0$ = time that the air sample stopped being taken

A Case Study: Goiania, Brazil 1987

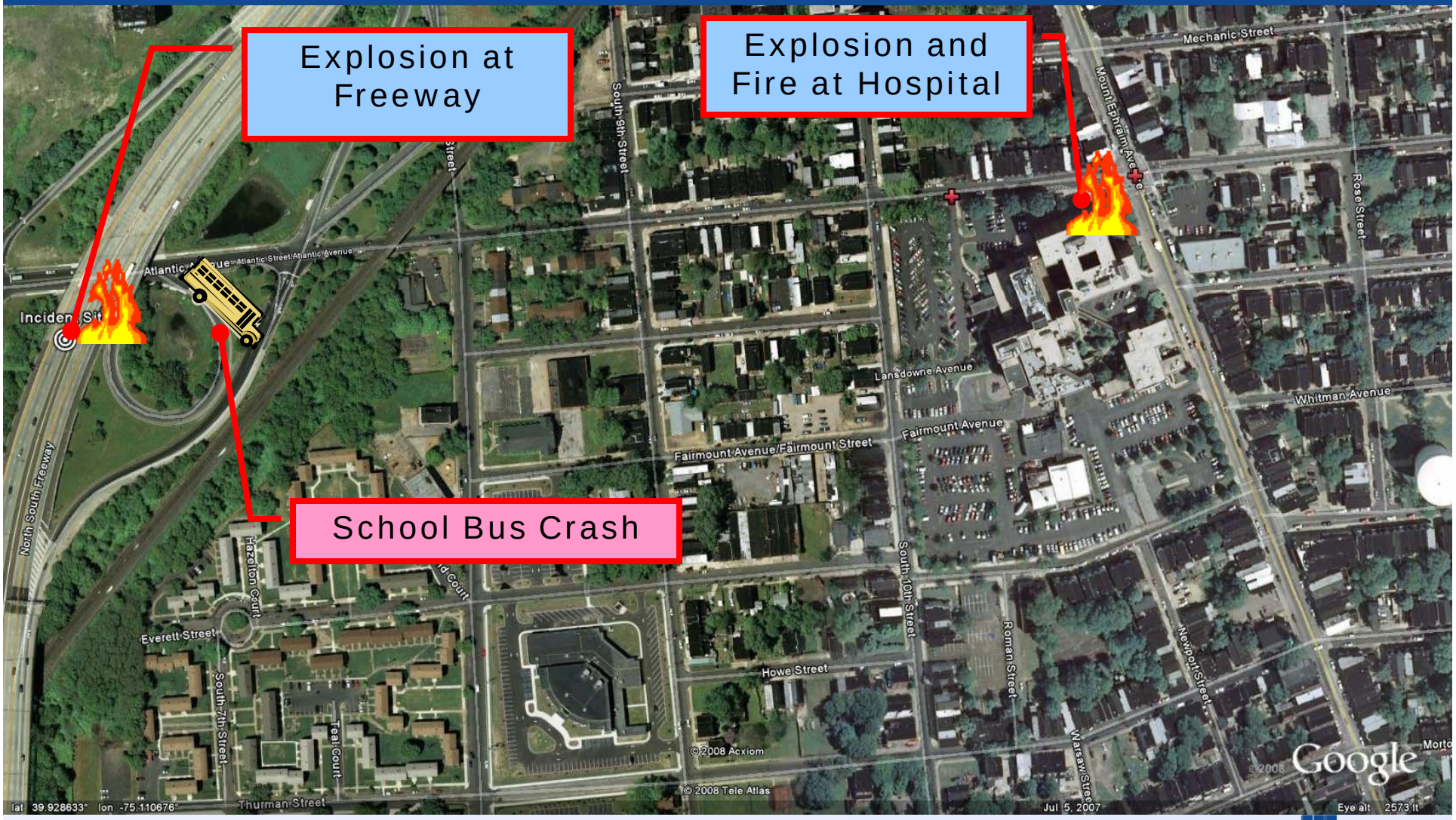
- **When a hospital changed locations, a radiation therapy unit was temporarily left behind.**
- **Scrap metal hunters found the unit and dismantled it for scrap metal (~ Sept 18th).**
- **The 1.4 kiloCi (1,400 Ci) Cs-137 source containment was breached during the process.**
- **Pieces of source distributed to family and friends.**
- **Everyone was impressed by "the glowing blue stones." Children & adults played with them.**
- **Serious radiological accident recognized on Sept 29th when Acute Radiation Syndrome symptoms where recognized by hospital staff.**



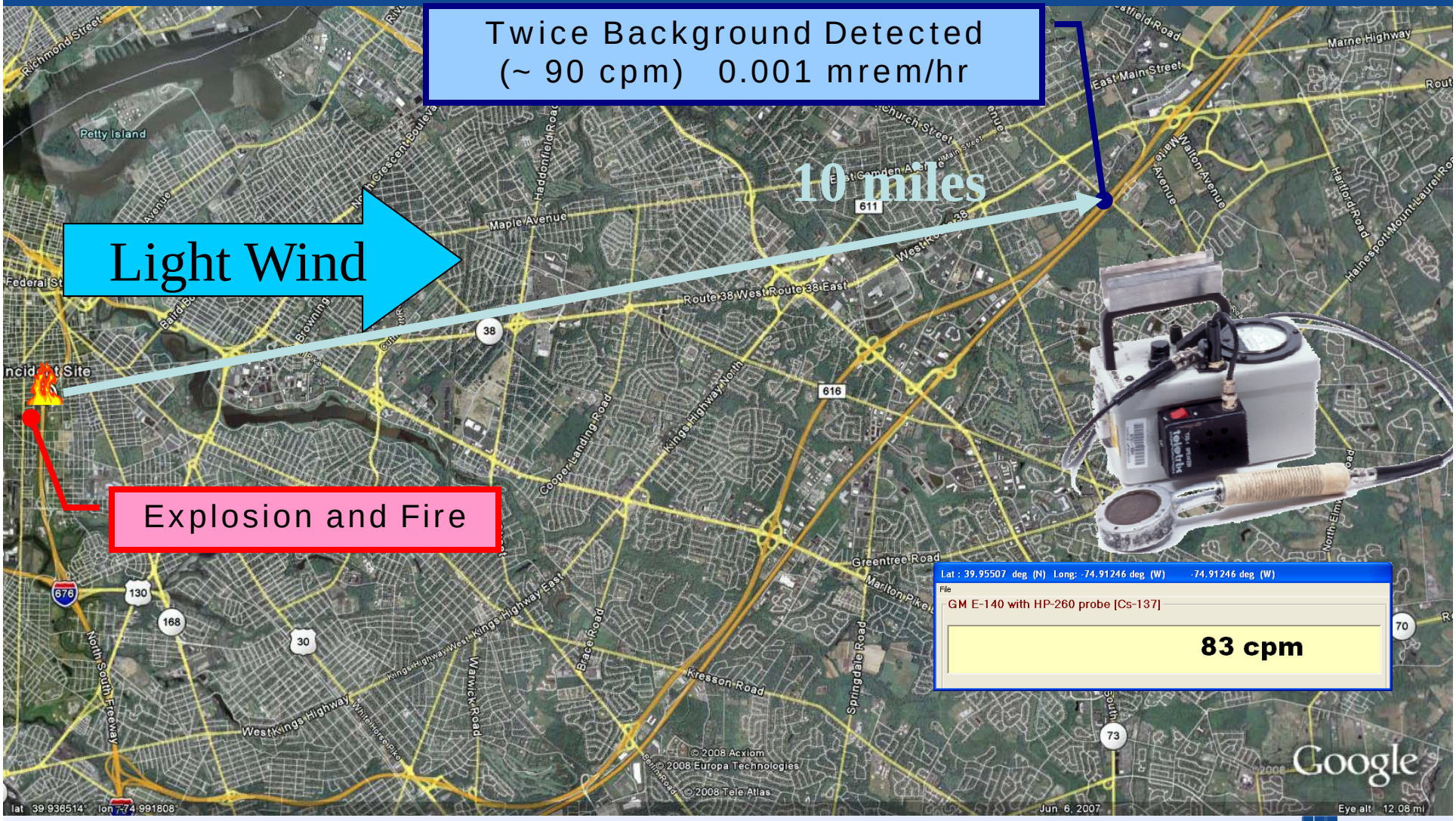
Example: Brazil's 1.37 kCi (1,370 Ci) Cs-137 Source Made Into a "Dirty Bomb"

- Using Fictional "North Pointe" as an Example
- This model assumes "worse case" in that:
  - The source was 100% aerosolized (unrealistic)
  - Small explosive (~ 1 stick of dynamite)
  - Presumes exposed populations "stood outside" during the exposure period.
  - Effects dependent on weather

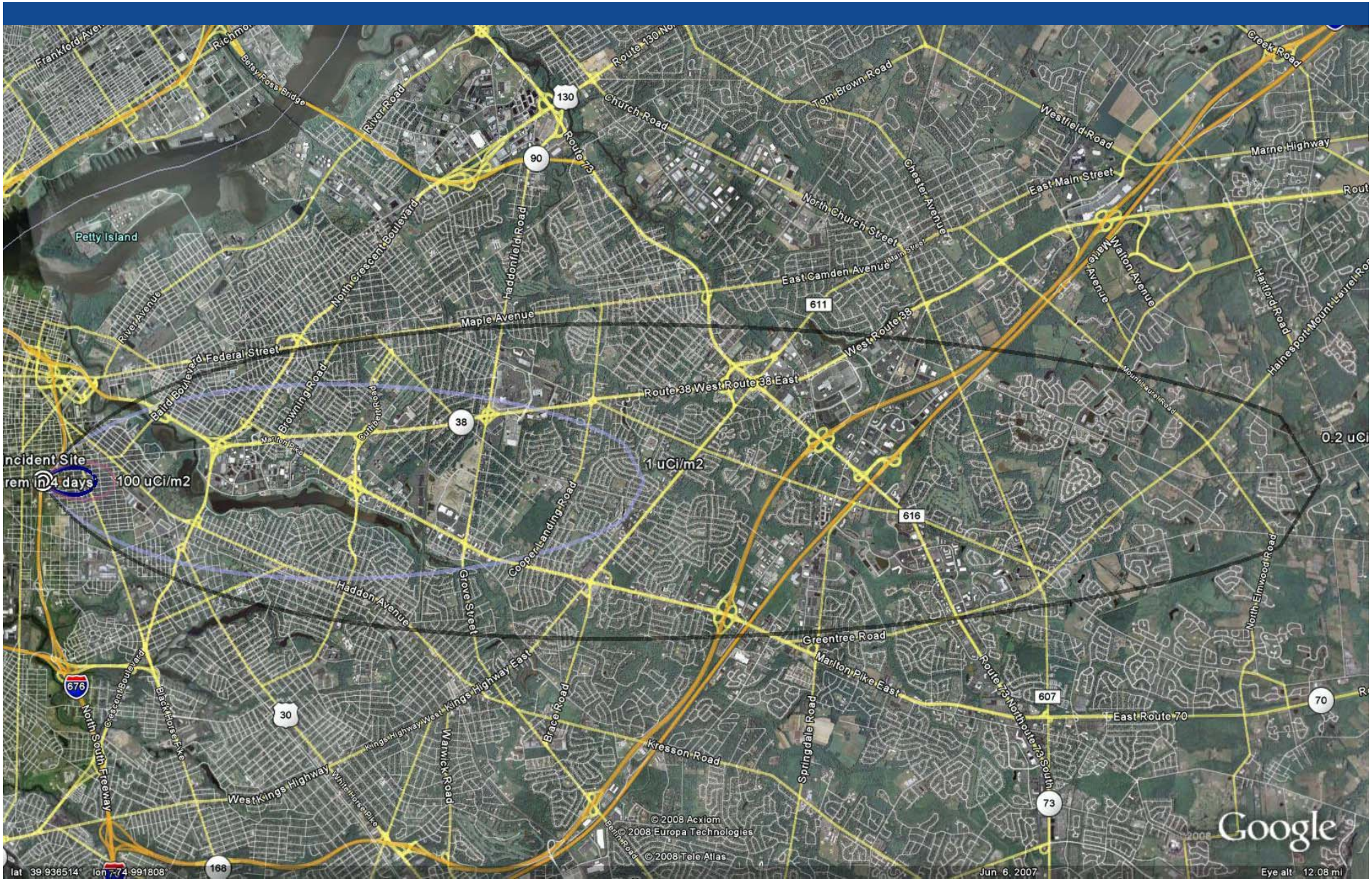
Trouble In North Pointe…

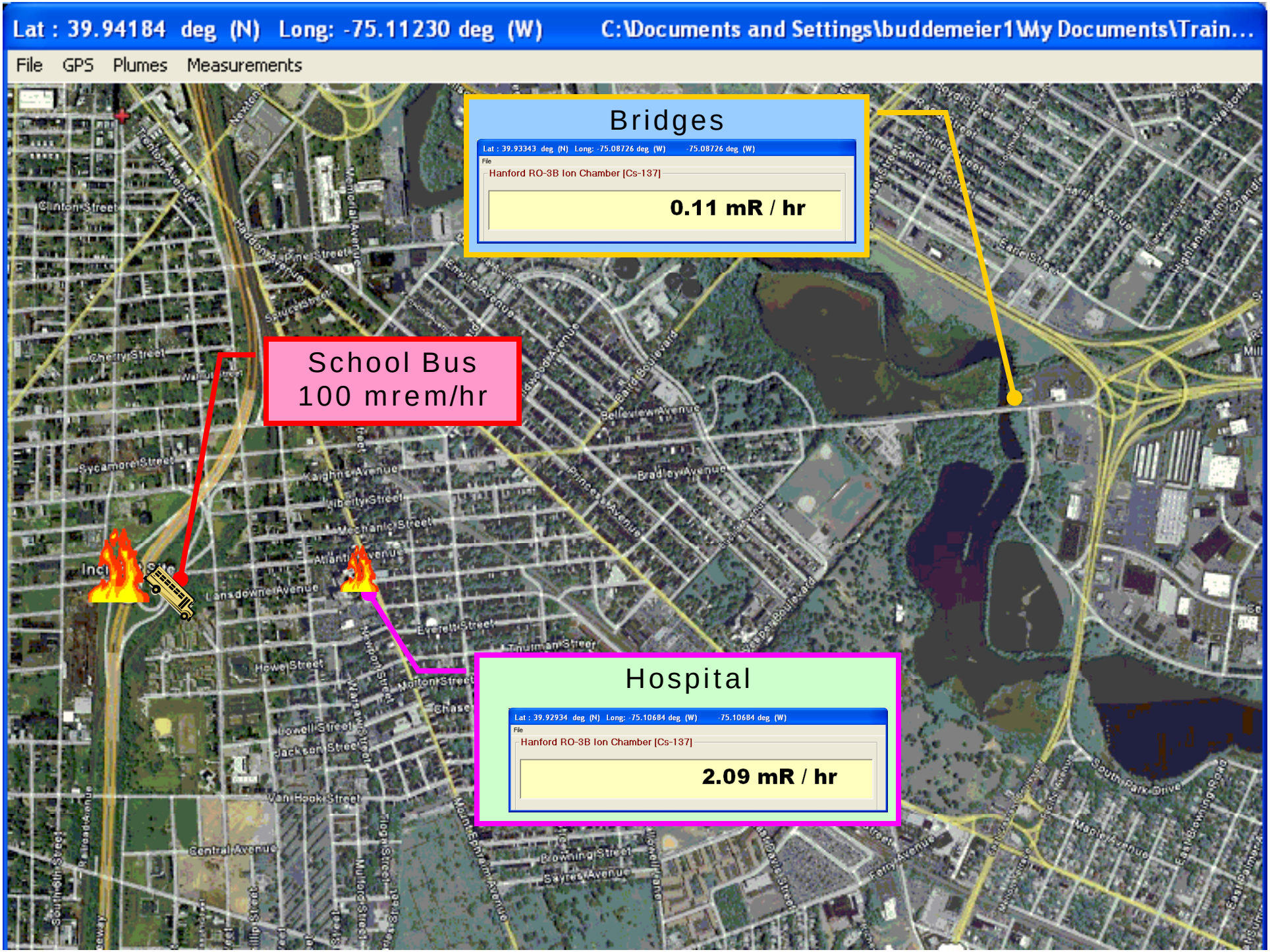


Detectable Ground Contamination Can Be Found Miles Downwind

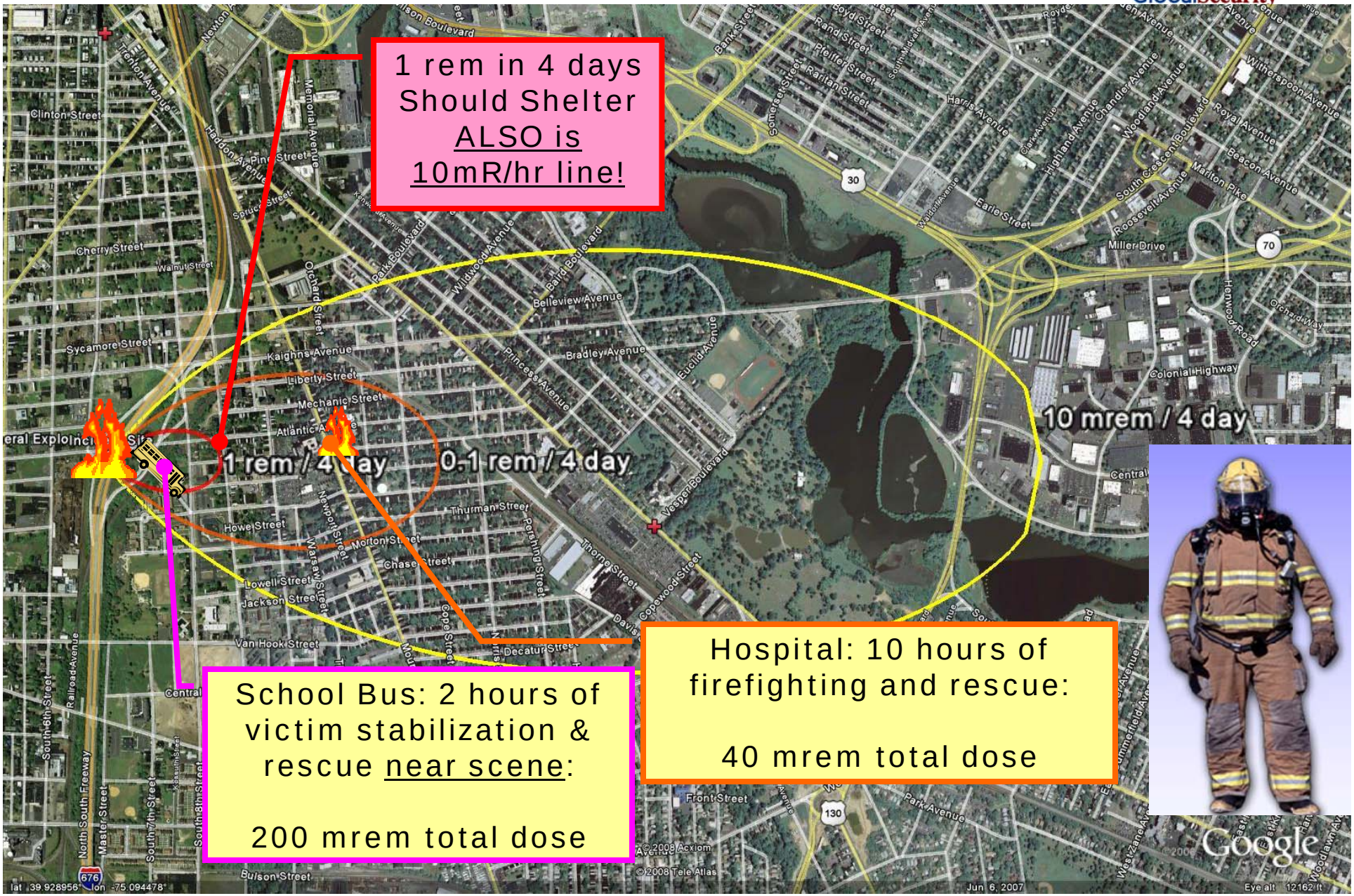


GlobalSecurity
Anticipate • Innovate • Deliver




Lat : 39.94184 deg (N) Long: -75.11230 deg (W)
C:\Documents and Settings\buddemeier1\My Documents\Train...
File GPS Plumes Measurements
Bridges
Lat : 39.93343 deg (N) Long: -75.08726 deg (W) -75.08726 deg (W)
File
Hanford RO-3B Ion Chamber [Cs-137]
0.11 mR / hr
School Bus
100 mrem/hr
Hospital
Lat : 39.92934 deg (N) Long: -75.10684 deg (W) -75.10684 deg (W)
File
Hanford RO-3B Ion Chamber [Cs-137]
2.09 mR / hr
Clinton Street
Cherry Street
Sycamore Street
Lansdowne Avenue
Bellevue Avenue
Bradley Avenue
Howe Street
Jackson Street
Van Hook Street
Central Avenue
Browning Street
Sayres Avenue
Maple Avenue
South Park Drive

Useful Points of Reference



Putting It in Perspective

- **Although easily measured for miles,**
- **Shelter area may only be a few blocks, and**
- **Responders unlikely to get high exposures**

HotSpot Valuable Demonstration Tool

- HOTSPOT is a valuable demonstration and training aid for the community preparedness and emergency response planning, identifying ***operationally valid*** response guidelines

- HotSpot can help demonstrate that;
  - Acute health effects from radiation dose are unlikely for responders.
  - Contamination readily detectable at long distances.
  - Medical emergencies take precedent over radiological monitoring,
  - Used correctly, their instruments and protocols ensure their safety, and
  - The difference between contamination and radiation.

The overall objective when training first responders is to increase their confidence and lower their anxiety about effective radiological emergency response

What would you do?

http://trainex.org/web_courses/air_plume/

References

Transportation Emergency Preparedness Program (TEPP)
http://www.em.doe.gov/otem/program.html

Predictive Modeling Provided By

HotSpot Health Physics Code v2.0, Steve Homann LLNL

National Release Advisory Center, LLNL (http:/narac.llnl.gov/)

Gioania References Provided By

IAEA-TECDOC-1009, “Dosimetric and medical aspects of the radiological accident in Goiania in 1987,” June 1998, International Atomic Energy Agency.

Radiation Emergency Assistance Services (SAER) from the Institute for Radiation Protection & Dosimetry (IRD), BRAZIL, Raul dos Santos.

Dr. Henry B. Spitz, Professor of Nuclear and Radiological Engineering, Department of Mechanical, Industrial & Nuclear Engineering, University of Cincinnati

Dr. Jose Julio Rozental

Bernardo Dantas, Instituto de Radioprotecao Dosimetria, Brasil