EXECUTIVE OFFICE OF THE PRESIDENT
PRESIDENT'S COUNCIL OF ADVISORS ON SCIENCE AND TECHNOLOGY
WASHINGTON, D.C. 20502

September 5, 2002

President George W. Bush
The White House
Washington, D.C. 20502

Dear Mr. President:

Your Council of Advisors on Science and Technology (PCAST) prepared the enclosed report in response to your initiative to establish a new federal Department of Homeland Security (DHS). The DHS is a bold proposal that PCAST heartily endorses. The proper creation and functioning of this new Department is vital to the security of our nation, and to the preservation of the freedoms that are fundamental to the American way of life.

The PCAST report expresses the expert views of its members on how to maximize the contribution of science and technology to the DHS mission. Our terrorist enemies are technically savvy, and continued technological progress is required to better defend the homeland and "stay one step ahead" of their technical capabilities. American science and technology leadership can and will help the nation counter and respond to the terrorist threats we are confronting. Our optimism is bolstered by the fact that many companies and academic institutions have already come forward offering to apply their know-how, technology, or products in support of the homeland security mission. Moreover, our experience has shown the nation's students are also anxious to find ways to help the country address the new threat we are confronting.

This report originated from the PCAST panel on combating terrorism, chaired by Norman Augustine. It was discussed and approved by the full PCAST in a public teleconference. It presents ideas on how to organize and operate the research and development enterprise within the new DHS. The universally supportive reaction to your basic DHS concept strongly suggests that the new Department will soon be enacted into law. Consequently, PCAST accelerated its schedule to ensure a timely document that could inform the current discussion as the new Department organizes to accomplish its science and technology mission.

We, and the members of PCAST, are available to answer questions about the report.

Sincerely,

John H. Marburger, III
Co-Chair

E. Floyd Kvamme
Co-Chair

Enclosure

The President's Council of Advisors on Science and Technology

REPORT ON MAXIMIZING THE CONTRIBUTION OF SCIENCE AND TECHNOLOGY WITHIN THE NEW DEPARTMENT OF HOMELAND SECURITY

Introduction

Science and technology have created a fundamental change in society during the past half-century. For the first time in history, individuals or small groups can threaten the lives and livelihood of very large groups. This gives leverage to individuals who can "live among us" and wield terrorism as a weapon—even against a nation with near dominance in conventional conflicts on the land, at sea, in the air and in space.

Today's terrorists exploit technology, whether it be for their weaponry (*e.g.,* explosives, chemicals, biological agents, radiological devices, nuclear weapons) or for managing their clandestine affairs (*e.g.,* the Internet, cell phones, computers). Moreover, the terrorists' likely targets often possess a high technological content (*e.g.,* information networks, chemical plants, energy generation facilities, major structures, and aircraft).

At the same time, science and technology (S&T) can be an even stronger weapon for countering terrorism—supporting such functions as sensing the presence of weapons, data mining, identifying individuals, communicating information, and the development of vaccines, to name but a few. Most people familiar with these functions assume the scientific community will continue to produce enhancements and maintain American leadership in antiterrorism.

We caution, however, that our S&T leadership is not automatic. We therefore urge the Administration, Congress, and leading officials within the new Department of Homeland Security (DHS), once formed, to give careful attention to the research and development (R&D) and technological deployment functions of the new Department. Decisions made now will affect the nation's long term technological leadership in the antiterrorism effort.

This report focuses on the organization, content and operation of the DHS R&D enterprise, as Congress is now considering these important issues. The PCAST is working toward submitting a report on how DHS operations will relate to business needs and competitiveness, along with other issues, later this year.

I. The Need for Flexibility

Management flexibility is of paramount importance in the initial organization of R&D programs within DHS -- in terms of organization, personnel and budget. Especially in this initial formative stage, and given that DHS must successfully merge existing programs and cultures, flexibility in organizing an overall structure and establishing operational programs will be vitally important. The management of technical programs is best conducted in an environment where requirements are clearly specified for the broad goals and objectives, but specific mandates and prohibitions regarding how to achieve these objectives are avoided.

In establishing the R&D function, a long-term perspective must be maintained. Every decision need not, and indeed *should not*, be made immediately upon formation of the Department.

As discussed at the end of this report, it is vitally important that DHS be an adaptive, highly flexible organization. Charged with defending the homeland from terrorist attacks, DHS will be a civilian agency operating in a demanding environment. Operations from existing agencies, which had very different missions, cannot govern the functioning of DHS. The Department must be allowed to establish a work ethic and culture that is new and different, and that remains fast-paced, responsive and current (especially in the R&D arena). The importance of allowing creativity to flourish cannot be overstated.

In that regard, terrorism is developing in a manner that cannot be approached entirely through devices, substances and information technology. The terrorist threat involves human behavior, culture, religion and differing world views, as well as behavior and motivations largely unfamiliar to most Americans. It can disrupt us by playing havoc with our economy, transportation, supply chains, legal system, and our psychology. Elements of DHS R&D should therefore involve social scientists, humanists, and "out of the box" thinkers from a wide variety of backgrounds. Highly unusual interdisciplinary work will be required. The R&D functions of DHS should operate so as to promote such non-conventional scientific collaboration.

II. A Proposed R&D Structure for the Department of Homeland Security

While the federal R&D enterprise as a whole is quite large, R&D efforts aimed at combating terrorism exist only in a limited and fragmented fashion within those agencies that will likely comprise the new DHS. Moreover, organizations that will not likely be part of the new DHS, but will have important contributory roles in the antiterrorism mission, also have fragmentary R&D programs related to homeland security.

This absence of a uniform tradition of antiterrorism R&D is a potential asset for the new Department. Experience on what programs or efforts have worked well – and poorly – in other departments and agencies can be applied. Given the importance of the mission of this Department, its substantial budget and its dependence upon technology, it seems clear that DHS should have an integrated, full-spectrum R&D capability, from research through deployment. At the same time, this capability should not duplicate work conducted outside the Department and should draw heavily on the considerable capabilities that reside in academia and industry.

Some of the agencies transferred into the new Department will have a need to conduct R&D pertaining to missions that are unrelated, or only weakly related, to combating terrorism. One example is the search and rescue responsibility of the Coast Guard. This and other examples imply that it will be necessary to build an R&D capability for DHS that will be stronger than the Department's constituent entities in terms of funding, organizational structure, and management.

One possible organizational model is presented below. This organization is shown on the chart attached as Appendix 1, with the numbers of the following sections keyed to the numbers shown on the chart.

1. Under Secretary for Science and Technology

We strongly recommend that a single individual be imbued with the responsibility, authority, and accountability for managing R&D within the Department of Homeland Security, and that this individual be placed at a high level within the Department. Everyone seems to agree that successful homeland security operations depend upon R&D in the long run, but R&D needs high level visibility in the Department for another reason. It is likely that many – or most – of the senior managers in the Department will not have scientific or technical backgrounds, and technical know-how needs to be represented at the strategic level.

We therefore propose that the position of Under Secretary for Science and Technology be established reporting directly to the Secretary of Homeland Security. This person should have a strong S&T background, and be responsible for the entire DHS R&D enterprise, including control over the budget for all DHS R&D programs as well as acquisitions.

The Under Secretary for S&T should conduct a disciplined system engineering and acquisitions activity that performs R&D and conducts demonstrations, operational tests, pilot deployments, and operational installations of newly developed items. The position should further assure that the Department's R&D efforts are responsive to national needs by reaching out to federal, state and local levels, and by assuring that systems requirements are based on sound assumptions and analyses. This Under Secretary should assure that the acquisitions process is orderly, with risks identified and retired on realistic schedules, and that appropriated dollars are spent in an efficient manner.

The Under Secretary for S&T should perform all the functions of the Under Secretary for Chemical, Biological, Radiological and Nuclear Countermeasures, as proposed in the President's legislation, as well as cyber security (which cross-cuts all areas and physical assets) and expanded responsibilities in regard to the management of R&D throughout the Department. This Under Secretary should establish strong intra-department coordination for determining the R&D needs and performance of the various DHS divisions. In particular, the Under Secretary should be included in the chain of acquisition authority throughout the Department, in order to ensure consistency throughout all intra-departmental R&D activities.

2. Homeland Security Research and Development Coordinating Councils

Because the government outside of DHS conducts important homeland security R&D, it is essential that coordination be maintained with other relevant government organizations. These

include, but are not limited to: the Departments of Agriculture, Defense, Commerce, Energy, Health and Human Service, Justice, State, Transportation and Treasury, as well as the Environmental Protection Agency (EPA), the Intelligence Community, the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), and numerous others. While duplicative R&D can on occasion be constructive if limited to high-risk, high payoff areas, it should be undertaken consciously and not because of a lack of coordination. The interagency coordinating function is best accomplished through a Coordinating Council under the auspices of the Office of Homeland Security (OHS) and the Office of Science and Technology Policy (OSTP), with strong DHS participation through the Under Secretary for S&T.

The role of the Under Secretary for S&T as a key agent in helping to coordinate the R&D efforts of both the Department and that of other federal agencies cannot be overstated. To be effective, however, the Under Secretary will have to appreciate the need for a collaborative approach, not one driven by a command structure. To do otherwise would be counter-productive. While the Under Secretary's coordinating role is strongly needed, it cannot be performed in a manner that threatens the work of other federal agencies.

A Coordinating Council for state and local governmental operations should also be considered. As the National Strategy makes clear, state and local governments must play a critical role in homeland security. A mechanism is required for receiving input from, and relaying information to, pertinent state and local officials regarding needed programs or technologies. State and local users of DHS R&D should also be actively engaged, in pilot programs or otherwise, to discuss needs and other issues (see also item 7 below).

3. Industry, Academia and Other Government Research and Development Organizations

Just as most of America's critical infrastructure is privately owned (85%), the majority of research and technology capacity resides in the private sector, *i.e.*, in business, academia or not-for-profits. Capturing this capacity for homeland security R&D presents challenges.

We believe that homeland security R&D should focus on setting requirements, establishing budgets, determining priorities, awarding and managing grants and contracts, testing and evaluating products, and other related functions. Most "hands-on" R&D work can best be done in academia, industry and national laboratories, with a very few important exceptions, which will be noted.

As with much of the Department of Defense's R&D activity, there may be no civilian commercial demand which would motivate the private sector to pursue homeland security R&D, absent government incentives. That is, just as there is no civilian demand for submarines, there is, at least at this point, little or no civilian demand to support the development of vaccines against new biological threat agents. The government's actions in this regard can take many forms—including the creation of standards (*e.g.,* those affecting the insurance industry) and the awarding of contracts and grants, and others that would require legislative action, such as the provision of liability protections or tax incentives.

We also cannot expect civilians to generate the demand that will activate the free market and its industrial R&D on their behalf, unless they are informed both that a significant threat to

their well being exists, and that they can do much to improve their chances of survival. Therefore DHS should be active in informing the public about what they can do for themselves. Every indication exists that this can be done in ways that will empower rather than frighten, and that will result in rapid responses that could greatly reduce the areas in which tax incentives and regulation are needed. As alluded to in Section I above, how best to present threat information to maximize consumer response may be an area for social or behavioral research.

4. Homeland Security FFRDC

The government needs access to timely, independent, highly competent advice relating to homeland security. One proven method of obtaining services of this type is through federally funded R&D centers (FFRDCs) or other similar mechanisms. Whatever type of organization is chosen should be free of burdensome government contracting constraints, personnel policies, and excessive oversight, and should permit a more streamlined management approach than employed in much of the government's past R&D activity.

This organization would perform three functions: systems analysis, support of systems engineering, and "red teaming." The systems analysis function would support assessment of terrorism threat and countermeasures from a systems perspective, identifying vulnerabilities, means of strengthening the target structure, etc. The purpose of the systems engineering effort would be to support the R&D organization in creating new concepts (from a systems standpoint) for dealing with threats which have been identified -- as opposed to performing design or development work.

Finally, red teaming (*i.e.,* the use of innovative individuals who emulate terrorists in selecting targets and planning attacks, based on simulation and controlled table-top and field exercises and tests), would play an extremely important role. Individuals with appropriate qualifications would be provided an environment to think as terrorists might think and to identify vulnerabilities that well-informed terrorists might identify. The red teaming function should report directly to the Secretary, because its activities will cut across the whole Department. Properly executed, its activities will expose not just national vulnerabilities but flaws in DHS programs themselves, so the potential for conflicts of interest (both financial and cultural) should be avoided to the extent possible.

5. Internal Homeland Security Research & Development

Internal HS R&D will encompass several functions -- from research, to testing and evaluation, to deployment -- that should be operated in an integrated and flexible manner. A structure that establishes "stovepipe" offices or operations should be avoided, and one that allows for cross-pollination among functions should be promoted -- but, above all, responsibilities should be clear.

5A. Homeland Security National Laboratory

Internal corporate research would be conducted by a Department of Homeland Security Laboratory (and other federal laboratories), and as such should be focused principally on extremely high payoff but often high risk, long-term pursuits. Frequently, this effort will be of a

highly classified nature and, in general, will focus on applications rather than on the creation of new science. This organization would be encouraged to seek breakthroughs that are difficult to realize in industrial organizations operating under the pressures of the marketplace. It would not be a "management" agency, but would be available for rapid response assistance to operational managers in times of crisis**.** We would note that these activities could likely be performed by focusing the missions of one or more of the existing national labs, rather than establishing a new one.

5B. Operational Test and Evaluation

The purpose of the Operational Test and Evaluation function is to conduct the assessments needed to validate the performance of newly developed systems -- and thereby provide independent input to the Under Secretary for Science and Technology as to the readiness of such systems for utilization. The organization would not be involved in development testing *(i.e.*, testing inherent to the initial creation of the product in question) but would closely coordinate its activities with the line development organizations having responsibility for the latter, and with the operating elements of the Department which will utilize the newly developed items.

5C. Homeland Security Development Organization

A Development Organization would be the principle line management organization reporting to the Under Secretary for S&T, and would have responsibility for managing R&D projects in support of the antiterrorism mission. This function would be the primary acquisition arm for the DHS insofar as technological projects are concerned. It would have full budget authority and line management authority over all DHS R&D and procurement projects except those organizations otherwise mentioned herein and, possibly, those which have no significant homeland security applications (for example, special purpose search and rescue equipment for the Coast Guard). Some R&D under the auspices of the Homeland Security Development Organization might be executed within residual R&D organizations, if any are retained in the entities transferred to the DHS.

5D. Specialized Development Functions

Several options exist for organizing the next layer of functions under the Development Organization. These include organizing on the basis of:

1. Broad missions – such as prevention, alleviation, response and recovery;
2. Narrower missions – such as securing borders, protecting against biological attacks, securing the air transport system, etc.;
3. Specific threats – such as conventional explosives, nuclear weapons, biological weapons, etc.;
4. Constituent entities making up DHS, such as the Immigration and Naturalization Service, Federal Emergency Management Agency, etc.; or
5. Technology – such as sensors, information management, biomedicine, etc.

All things considered, the fifth option, organizing according to technology, seems to make the most sense for an R&D organization. More deliberation will certainly be required before the specific components of such a structure can be proposed, but it should include cyber-terrorism.

5E. Rapid Prototyping Cell

A small rapid prototyping cell or group should be established to conduct "fast track development" of promising new capabilities. This function should be free, to the maximum extent possible, from traditional oversight requirements, contracting restrictions, and reporting demands. There is a degree of risk entailed in granting such freedom. However, history has shown that for very high priority projects there is even greater risk entailed in not providing such freedom. It appears preferable to operate a single rapid prototyping cell that supports all technical missions. This will aid in producing integrated prototype systems.

6. External R&D -- Homeland Security Advanced Research Agency

A large portion of homeland security R&D can and will be conducted external to DHS. Many of these efforts can be marshaled through a homeland security advanced research projects agency (HS-ARPA). This organization would be patterned after the Defense Department's Advanced Research Projects Agency (DARPA). It would be a small organization, involving frequent turnover of its staff, and performing little or no R&D internally. It would principally be a funding conduit to industry and academia to support promising ideas. This provides entrepreneurs and inventors possessing radical ideas, which may upset the internal DHS status quo, an alternative path to resources. The HS-ARPA would thus conduct its work principally through contracts and grants to others.

Another potentially promising avenue of assessing R&D, when that R&D is already in development for the commercial market, is through a venture capital entity that would provide entrée to the large body of work being pursued by small, often start-up, firms. Such an entity would have equity investments available to it as a mechanism for acquiring R&D in addition to the more conventional process used by other components of the homeland security R&D organization, namely grants and contracts. The benefits of a venture capital entity should be studied, and such an entity should be implemented if the review so indicates.

7. Procurement and Deployment of Developed Items

Once scientific discoveries are transformed through the development process into new capabilities, producing and fielding the resultant products or systems remains one of the most challenging aspects of the acquisition process. A difficult transition problem exists between the products' developers and end-use operators, which is exacerbated because of the differing skill sets required of developers, producers (including installers) and operators. Many sound arguments exist in support of various points at which this transition could be made to occur. This proposal takes the view that an item is not "developed" until it can at least be routinely produced and, in most cases, routinely used. Anticipating that many of the DHS user organizations will not possess inherent capabilities for overseeing production or installation activities, it may well be desirable to designate these, too, as responsibilities of the Under Secretary for Science and Technology -- at

least in selected cases where the user organization has limited procurement, installation or test capability.

Thus, to facilitate the transition of new products from the lab to the operator, the Under Secretary for S&T should have responsibility from idea generation through the preparation of a proven data package and, in selected cases, through deployment and check-out in the field. Throughout this process, the end-users should have a primary role in establishing the operational needs and specific requirements, operationally evaluating the product, budgeting for procurement, training personnel, and operating and maintaining the eventual system. By encouraging collaboration throughout the life of the program, the transitional challenges should be ameliorated.

Finally, as noted in the National Strategy, the Under Secretary for S&T should also be responsible for establishing a mechanism for setting standards or identifying "best practices" and certifying products to assist end users that do not have the independent wherewithal or technical capability to judge the merits of various items. State and local government (and business) purchasers need assistance in verifying that important homeland security products will in fact perform as represented. Whether this would best be conducted internally, or in collaboration with the National Institutes of Standards and Technology, should be considered, and perhaps the avenue will differ depending on the type of product or capability involved.

III. R&D Content and Operational Considerations

The Administration and Congress will make decisions, based on a variety of factors, on which R&D agencies, offices and programs to transfer to the DHS. Two important considerations are what R&D is needed and what programs in support of those needs are currently available. These two considerations, and some additional issues, are discussed below.

1. Determining Needs and Priorities

The needs and priorities of homeland security should govern which R&D programs are pursued, as well as drive the best mechanism to pursue them. The OHS has recently published the *National Strategy for Homeland Security*, which lists 11 basic S&T initiatives. These priorities are sound, and should inform future discussions. Moreover, OSTP and OHS are coordinating an interagency task force to further define homeland security R&D needs and priorities. DHS officials should link into this process and not only obtain current insights, but also ensure the needs and priorities are continually re-evaluated, updated, and acted upon.

2. Determining What is (and is not) Available

The DHS legislation proposed by the President would transfer several agencies and offices into four DHS divisions. The proposed movements are sound and comprise evident choices. Federal R&D occurs through many avenues, however, and no one has identified every R&D program that may be pertinent to homeland security.

OSTP, in conjunction with the Office of Management and Budget (OMB), OHS, and DHS should undertake a joint effort to identify each federal R&D program that has relevance to homeland security. Many agencies have independently developed listings of homeland security-

related R&D activities, but the various lists should be consolidated into one manageable inventory or database, and expanded to include all relevant agency programs.

Appendix II presents a list of numerous R&D programs that, at present, have not been considered for inclusion in the new Department. The brief discussion accompanying each program explains why the program could potentially be included within DHS. Many more such programs likely exist, and the Administration and Congress should be aware of their existence to make informed decisions on the R&D makeup of DHS.

Once a complete inventory of current R&D programs relevant to homeland security is developed, these programs should be compared to the DHS' R&D needs and priorities. Inevitably, because the government was not previously oriented to a homeland security mission, there will be needs and priorities for which no programs exist. Such R&D gaps must be identified, and a decision made on how best to fill them.

3. Transfer Criteria

Several decision-making criteria are suggested below for the Administration and Congress to consider when determining which agencies, office or programs to move into DHS. These criteria cannot be applied through a straight mathematical formula, and human subjective judgments must be made. The suggested criteria can hopefully serve to prompt thought and discussion on the issues involved.

1. Subject Area – Whether the existing agency, office or program's subject area constitutes a core R&D function for the DHS mission;
2. Priority Mission – Whether the R&D program constitutes a DHS priority, even if it may be a small component of its present agency;
3. Model Advantage – Whether the form of R&D support needed is best conducted internally within DHS, or better conducted externally;
4. Consistency/Overlap – Whether consistency demands DHS conduct the program to avoid program overlap or fragmentation of R&D programs pertinent to DHS' mission (in some key areas, however, overlap may be desirable);
5. Effect on Current Home – Whether a move would cause disruptive effects on the program's current home or the program itself that would outweigh the benefit that would inure to DHS; and
6. Withering Effect – Whether, given the creation of DHS, the program will lose its support or no longer thrive in its current agency.

Whether an R&D program or entity is transferred directly into the DHS, or research is pursued externally, a strong basis of scientific merit, as well as relevance, should always underpin the selection.

Another overriding consideration must be the ability to engage (and retain) world-class scientists and engineers. The tone set within the new DHS including the level of emphasis placed on S&T from the highest levels will factor into how "the best and brightest" individuals will view transferring into the new Department. Other considerations will include where they will have high quality colleagues, good working conditions, and maximum opportunity to have a positive impact

upon their nation and world, as well as the resources base, the nature of the tasks, and the stature of their leaders.

4. Strong Oversight of External R&D Programs

Not all R&D programs relevant to homeland security will be moved into DHS. Indeed, a strength of U.S. research is its diversity and the opportunity for American scientists to seek support from one agency or another. Accordingly, as noted in Section II (2), DHS will need to effectively manage, or at least coordinate, homeland security R&D conducted at other agencies. While a Coordinating Council, perhaps run through OHS and OSTP, was suggested, strong operational procedures should be designed and implemented. As a matter of human and bureaucratic nature, if a program is not within DHS, then homeland security will not be the governing agency's most important priority.

5. Organizing to Maintain Edge Against the Adaptive Threat

The adaptive nature of the terrorist threat – that our terrorist enemies are technologically savvy, and study and exploit our own systemic weaknesses – means that the new DHS must be an extremely adaptive agency as well. The systems it creates, the workforce it employs, and the R&D priorities it pursues must all be highly flexible and interactive with the outside world. Simply put, DHS cannot become a Washington bureaucracy.

The implications of this for Congress were discussed at the outset. Insofar as DHS R&D operations are concerned, the Under Secretary for S&T should design the Department's R&D systems, programs and employment policies with the adaptive nature of the threat foremost in mind. Some examples of what this would entail include the following:

- The establishment of employment programs that continually bring "new blood" into the Department. In the R&D sector, this would include fellowship programs (from universities), scholarship programs (for students), and inter-governmental details (for other federal workers). Consideration should also be given to how rigid conflict of interest procedures and paperwork discourage industry personnel from working with government. These programs would help ensure that new employees with new perspectives are attracted to DHS, and that DHS staff transition into relevant communities with a DHS background and DHS contacts. The most favorable length of stay cannot be precisely defined, but too rapid turnover would not be optimal. Such visitors should probably be encouraged to stay three to four years.

- The establishment of procurement policies that do not "freeze" technology or engender "stovepipe" operability. The protective systems that DHS designs and implements (the border protection system, for example) must have flexibility ingrained within them, so that the latest technological developments can be swiftly integrated. The various systems deployed must be designed to ensure interoperability; pertinent information must flow with relative ease between DHS and other federal agencies.

- The development of policies for technology transfer (cooperative research and development agreements (CRADAs), intellectual property licenses, etc.) that provide

the maximal flexibility and adaptability allowable by law. Streamlined policies that enable quick establishment of CRADAs or licensing agreements should be pursued so that DHS personnel can access one-of-a-kind industrial facilities, data, instruments, and processes -- and vice-versa -- without delay.

- The establishment of flexible contracting authority that encourages participation by innovative companies that otherwise avoid government contracts. Such flexibility should be modeled after the Department of Defense's "Other Transaction Authority" that provides for negotiated intellectual property rights and relief from many regulatory requirements including mandatory cost principles or accounting standards. This authority was included in the President's proposal to create the new Department.

6. Risk Assessment and Management

In addition to identifying and developing technology for homeland security, researching the development of a logical and quantifiable method of determining how to expend the available resources in the most efficient and effective manner should be considered. Four questions must be answered before the risk can be assessed:

1. What can go wrong?
2. What is the probability that it will go wrong?
3. What are the consequences?, and
4. What does it cost to change these factors?

Risk management must be based upon risk assessment, and risk assessment must be included in the budgeting process, as well as in the R&D programs used to determine infrastructure interaction models. The results of the risk assessment evaluations can be used to inform decisions on which projects should be funded and what changes should be made to existing physical and virtual infrastructures, design and building codes, and regulations.

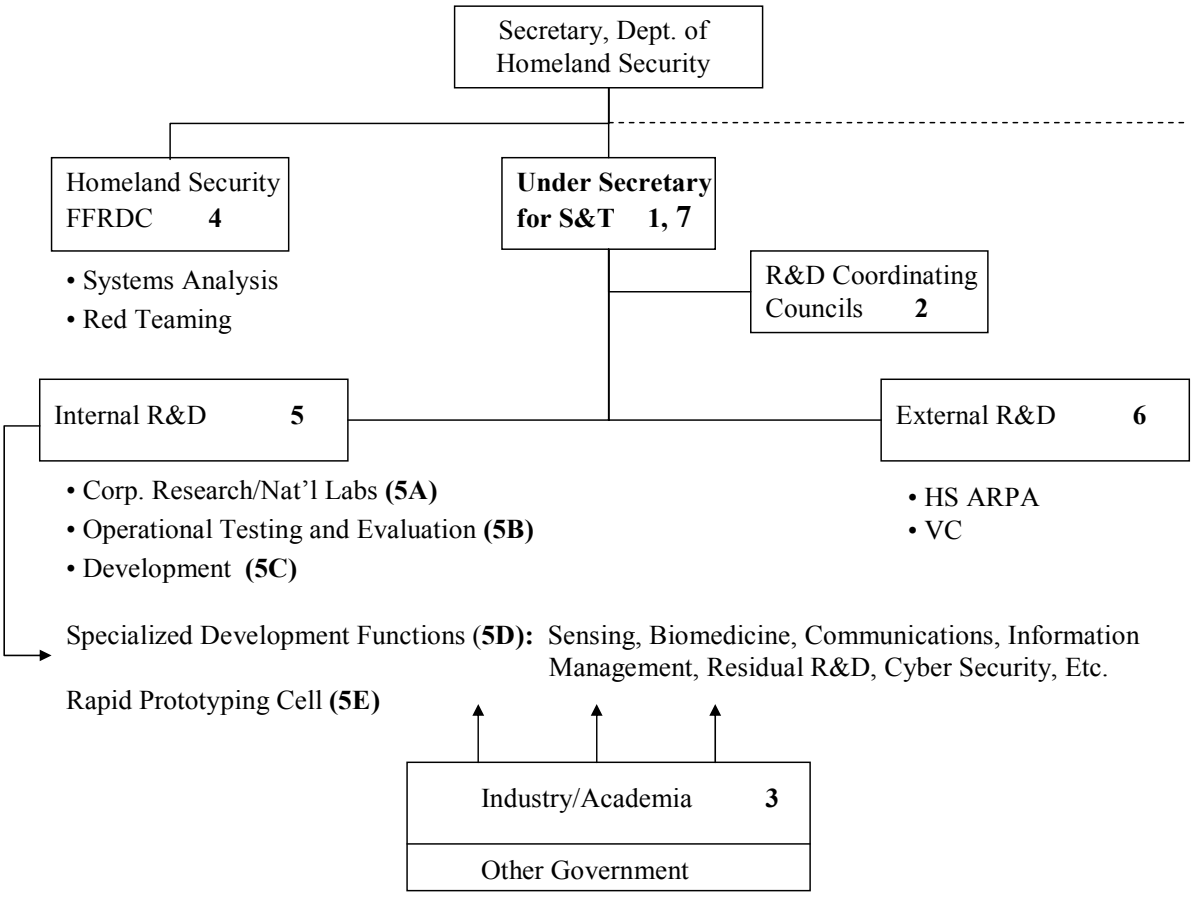
Conclusion

This report presents a suggested avenue to structurally organize the new research and development enterprise within the new Department of Homeland Security, and to fill that structure with the most appropriate R&D programs.

The nation's science and technology leadership can and will help preserve our national advantage against our terrorist enemies. The suggestions in this report can hopefully contribute to that leadership being swiftly deployed, faithfully maintained, and continually improved.

Appendix I

An R&D Management Concept: Homeland Security



Appendix II

The programs described below comprise a partial listing of research and development (R&D) entities or activities that are relevant to a homeland security mission.

It is not suggested that each of these programs should be transferred from their present home agencies to the new Department of Homeland Security, although some of them perhaps should be transferred according to the decision-making criteria suggested in Section III(3) of the report.

In any case, the new Department of Homeland Security should certainly be aware of these R&D entities and activities and have a strong means of coordinating with them.

Department of Agriculture (USDA)

- **National Veterinary Services Laboratories:** These labs are responsible for diagnosis for domestic and foreign animal diseases, diagnostic support for disease control and eradication programs, import and export testing of animals, and laboratory certification for selected diseases. Many of the diseases they diagnose at the facilities are listed as select agents by both the Centers for Disease Control and Prevention (CDC) and USDA. This laboratory was the main diagnostic lab used during the anthrax outbreak. These labs contain the other biosafety level 3 lab (in addition to Plum Island).

- **The Food Safety and Inspection Service (FSIS):** FSIS serves as the front line for detection of diseases and health risks in domestic meat, poultry, seafood and eggs. FSIS tests for microbiological, chemical, and other types of contamination and conducts epidemiological investigations in cooperation with the CDC based on reports of foodborne health hazards and disease outbreaks. Food safety did not appear to be considered as a priority for homeland defense.

- **FoodNET:** Run by CDC's Emerging Infections Program, and similar to PulseNET, FoodNET monitors food disease outbreaks and works collaboratively with USDA, the Food and Drug Administration (FDA) and several states.

- **USDA ARS and CSREES:** Intra- and extramural research programs which support research on food safety, microbes and pathogens that can be used in bio- and ag-terrorism.

Department of Commerce

- **National Institute of Standards and Technology (NIST):**

  - **Building and Fire Research Laboratory:** This lab studies building materials; computer-integrated construction practices; fire science and fire safety engineering; and structural, mechanical, and environmental engineering. Products

of the laboratory's research include measurements and test methods, performance criteria, and technical data that supports innovations by industry and are incorporated into building and fire standards and codes.

- **Structures Division:** This division promotes construction productivity and structural safety by providing measurements and standards to support the design, construction, and serviceability of constructed facilities. The Division performs and supports laboratory, field, and analytical research in the areas of structural evaluation and standards, structural systems and design, construction metrology and automation, and earthquake hazards reduction.

  NIST has legislative authorities to initiate and conduct structural and fire investigations to provide technical analysis of the causes of fire or structural failure. A team of NIST-led experts is currently investigating the technical causes for the collapse of the World Trade Centers, for example. The funding for the NIST-led technical investigation of the WTC collapses will is provided through the Federal Emergency Management Agency (FEMA).

- **Indoor Air Quality and Ventilation Group:** This group develops computer simulation programs and measurement procedures to better understand air and contaminant transport phenomena in buildings. The results of this research are providing valuable methods to evaluate ventilation characteristics and indoor pollutant concentrations in buildings.

  Expertise in ventilation systems developed a sophisticated computer model to understand different ways in which air flow may have transported anthrax spores in the Hart Senate Office Building. The results of the modeling were used in planning sampling within the building and in developing decontamination strategies. NIST's expertise could be applied to the anthrax spore problem quickly because it has long worked to improve indoor air quality by developing computer-modeling programs to show how pollutants, smoke, and contaminants are transported through indoor air.

Department of Defense (DOD)

- **Components of the Defense Advanced Research Projects Agency (DARPA):** DARPA's charter is to prevent technological surprise from harming U.S. national security by sponsoring revolutionary and innovative high-payoff research. Examples of this mission relevant to homeland security are:

  - **Medical Surveillance Program:** The Air Force's Lightweight Epidemiology Advanced Detection and Emergency Response System (LEADERS) uses key components of DARPA's Enhanced Consequence Management Planning and Support System. A commercialized version of the DARPA bio-surveillance program, LEADERS, provided medical surveillance for signs and symptoms of a biological attack for the state of New York within 24 hours of the attack on the

World Trade Center. The CDC also used LEADERS to monitor for specified syndromes from hospitals within in the New York City area and report them back in real-time to the CDC in Atlanta via the Internet.

- **BioSensors Program:** To detect the presence of a threat agent, DARPA is investing in the development of advanced Biosensor Defense Systems that are robust, autonomous, fast, and sensitive to any known bacterial or viral organism, as well as to novel natural or engineered biowarfare agents. Two example systems are the TIGER and BioTOF sensor systems.

- **Medical Diagnostics and Countermeasures Program:** In the event of a biological attack, the U.S. will need to identify those who have been exposed to a biological warfare agent and to distinguish them from the "worried well," as well as from those with natural diseases that might require different treatment. Therefore, identifying disease markers that can serve as rapid indicators of exposure is one of the focus areas of the Advanced Medical Diagnostics Program**.**

- **The Unconventional Pathogen Countermeasures (UPC) Program:** Broad-spectrum countermeasures for threat pathogens are being developed, including anti-viral and antibiotic drug discovery and development, as well as new approaches to vaccinations. Three UPC projects have shown promise in initial evaluations and are transitioning to the U.S. Army Medical Research Institute for Infectious Diseases (USAMRIID) for further development: a drug designed to attack the DNA of bacteria, viruses and malaria; a family of drugs that target a common and critical enzyme in anthrax and other bacteria; and a protein fragment that blocks the effects of toxins released by bacteria

- **Genetic Sequencing of Biological Warfare Agents Program:** The validated threat agent organisms whose sequences had not yet been characterized were sequenced and analyzed via modern, high-throughput sequencing technologies. The organisms we sequenced and analyzed are: *Coxiella burnetti* (Q fever), *Rickettsia typhi* (typhus), *Burkholderia mallei* (glanders), Brucella suis (brucellosis), *Clostridium perfringens* (gas gangrene), and *Franciscella tularensis* (tularemia). Additionally, several more strains and variants of orthopoxviruses related to smallpox are being sequenced, and an orthopoxvirus database was established in collaboration with the CDC and USAMRIID.

- **Immune Building Program:** The goal of this program is to make military buildings far less attractive targets for attack by chemical or biological warfare agents by reducing the effectiveness of such attacks via active and passive response of heating, ventilation, and air conditioning systems, and other building infrastructure (e.g., neutralization and filtration).

- **Information Assurance and Survivability Programs:** This suite of programs was created to raise strong barriers to cyber attack and provide commanders with technology to see, counter, tolerate, and survive sophisticated cyber attacks.

- **Armed Forces Radiobiology Research Institute (AFRRI):** The DOD's principal and only organizational element charged with prosecuting the mandates of the Medical Radiological Defense Research Program (MRDRP); medical nuclear/radiological defense. The current program is highly focused on developmental and applied research in four areas that include prevention and treatment of radiation injuries, biological dosimetry, medical effects of combined exposure to radiation and chemical or infectious agents, and medical effects of chronic exposure to depleted uranium (DU). The second mandate of AFRRI is the training of DoD medical personnel in the management and treatment of radiation injuries; Medical Effects of Ionizing Radiation Course. The third mandate of AFRRI is its medical nuclear response team; Medical Radiobiology Advisory Team. The fourth mandate is consultation to the Office of the Secretary of Defense, Joint Chiefs of Staff and the Commanders-in-Chief of the regions of the world.

  The program's combined personnel and physical elements constitute a nationally unique resource capable of conducting a wide variety of studies into the biological effects of ionizing radiation and development of effective medical countermeasures.

- **Components of the Defense Threat Reduction Agency (DTRA):** DTRA's mission is to safeguard the United States and its friends from weapons of mass destruction (chemical, biological, radiological, nuclear and high explosives) by reducing the present threat and preparing for the future threat.

  - **Chemical and Biological Defense Program (CBDP):** The objective of the CBDP is to enable our forces to survive, fight and win in a chemically or biologically contaminated warfare environment. The CBDP provides for the procurement and development of systems to enhance the ability of personeel to deter and defend against CB agents. The CBDP's six major areas cross cut all military/civilian applications for defense against CB attacks: (1) individual protection; (2) collective protection; (3) medical defense; (4) modeling and simulation; (5) contamination avoidance; (6) decontamination. The Program supports and manages program testing (at the Dugway Proving Ground).

  - **Biological Warfare Defense Program (BW):** The BW conducts research and development of novel technologies against a broad application of many different threat agents. Examples of projects with civilian applications in the detection systems program: Portal Shield ACTD biological and chemical detection network, Long range Bio Stand-off Detector, Joint Biological Remote Early Warning System, Joint Chemical Agent Detector.

  - **Joint Service Technology Panel for Chemical and Biological Defense (JSTPCBD):** This panel makes sure that efforts between DARPA's CBW programs are coordinated with those of the National Institutes of Health and other interested researchers.

- **Technical Support Working Groups (TSWG); Technology Development Division:** By accelerating state-of-the-art technologies that improve force application/protection modeling capabilities, provide enhanced weapons and sensors for defeat of WMD-related facilities, and optimize capabilities for use by Special Operations Forces, DTRA enhances the survivability and operability of U.S. military equities. The agency evaluates the lethality of conventional, biological, chemical, and other advanced weapons against a broad spectrum of target types in warfighting and terrorist scenarios.

- **US Army Medical Research Institute of Infectious Diseases (USAMRIID):** The USAMRIID conducts research to develop strategies, products, information, procedures, and training programs for medical defense against biological warfare threats and naturally occurring infectious diseases that require special containment. USAMRIID, an organization of the U.S. Army Medical Research and Materiel Command (USAMRMC), is the lead medical research laboratory for the U.S. Biological Defense Research Program. The Institute plays a key role in national defense and in infectious disease research as the largest biological containment laboratory in the DOD for the study of hazardous diseases. Medical products developed to protect personnel against biological attack include drugs, vaccines, diagnostic capabilities, and various medical management procedures.

- **Components of the Naval Medical Research Center (NMRC):**

  - **Biological Defense Research Directorate:** This directorate's investigator staff are recognized leaders in the rapid and confirmatory diagnosis of infectious diseases through analysis of a wide variety of clinical materials. The directorate explores basic and applied microbiological, immunological and related scientific research methodologies for the development of medical diagnostics to bioweapons. Research personnel have designed, developed, and tested a broad variety of methodologies which have allowed for swift and accurate disease diagnosis essential for substantive medical protection. In addition, researchers have been instrumental in the advancement and refinement of confirmatory diagnostic methods utilizing polymerase chain reaction (PCR) methodologies in tandem with innovative, state of the art biosensor technologies.

  - **Infectious Disease Directorate (IDD):** The overarching research goal in IDD is to minimize the impact of infectious diseases by preventing infection; and in most cases, the best approach to achieve that goal is through the development of efficacious vaccines. IDD departments have the unique research capability of developing a new vaccine from the conceptual stage through construction, "test tube" evaluation, animal model testing, human safety and immunogenicity testing, to final field trials in a large number of volunteers for efficacy evaluation. NMRC-IDD also serves as the organizational umbrella under which the Navy's participation in the **Department of Defense Global Emerging Infection Systems (DoD-GEIS)** initiative is coordinated. Along with other DoD agencies, Navy researchers participate in efforts for the GEIS Program objectives:

- *Detection and Monitoring*: Detect and monitor emerging pathogens, the diseases they cause, and the factors influencing their emergence to protect military readiness, the health of DoD beneficiary populations and other national interests.

- *Response:* Enhance the prompt implementation of all prevention and control strategies for emerging infections to include improving communication of information about emerging agents.

- *Training and Capacity Building*: Leverage DoD and international public health infrastructures to support surveillance, assessment, response, and prevention of emerging agents through training, networking, and other forms of assistance.

- *Systems Research, Development and Integration*: Integrate public health practices and improve capabilities in clinical medicine, military medicine, laboratory science, epidemiology, public health, and military medical research to facilitate rapid identification and response to emerging infections.

Department of Energy (DOE)

- **Pacific Northwest National Laboratory National Security Division:** Pacific Northwest's mission in national security supports the U.S. government's objectives against the proliferation of nuclear, chemical and biological weapons of mass destruction and associated delivery systems. The lab conducts work in national security programs for the DOE, DOD, and most other federal agencies. The Remote Sensing and Electro-Optics Technical Group provides synergistic capabilities in image analysis, optical and electro-optical system analysis and development, and data fusion/integration, analysis, and visualization.

- **Remote Sensing Test and Evaluation Center:** This Center includes the Remote Sensing Laboratory, the HAZMAT Spill Center, and the Special Technologies Laboratory. The Remote Sensing Laboratory provides integration and flight services for unique research sensors that require airborne testing and data collections to further scientific understanding. The HAZMAT Spill Center on the Nevada Test Site supports field testing of effluent detection sensors for the nonproliferation and Verification R&D program. In addition, Bechtel Nevada provides for facility maintenance, equipment upgrades needed to support sensor testing, and system calibration.

- **New Brunswick Laboratory (NBL):** A center of excellence in the measurement science of nuclear materials, NBL is the U. S. Government's Nuclear Materials Measurements and Reference Materials Laboratory and the National Certifying Authority for nuclear reference materials and measurement calibration standards. As an internationally recognized Federal laboratory, NBL provides reference materials,

measurement and interlaboratory measurement evaluation services, and technical expertise for evaluating measurement methods and safeguards measures in use at other facilities for a variety of Federal program sponsors and customers.

- **DoE Office of Security: The Nonproliferation and National Security Institute:** This Institute**,** located along with Sandia National Laboratory on Kirtland Air Force Base, trains protective-force personnel in the skills required to protect against terrorist threats directed at U.S. nuclear facilities. Its curriculum includes more than 100 courses in five major topical areas: information security, materials control and accountability, personnel security, program and planning management (including curriculum development and instructional techniques), and protection program operations. The Institute encompasses a number of new academies and training centers: Emergency Operations Training Academy (EOTA), Counterintelligence Training Academy (CITA), and Foreign Interaction Training Academy (FITA).

- **Fossil Energy and Energy Supply:** Program elements within these DOE programs could be reoriented to focus on research priorities identified in the NRC report, *Making the Nation Safer: The Role of Science and Technology in Counter-terrorism*.

- **Fossil Energy R&D, Central Systems, Advanced Systems:** Currently the Advanced Systems program supports demonstration projects for integrated gasification combined cycle, pressurized fluidized beds, and turbines. The program ould be focused on the physical and cyber security of the electric transmission system, with a particular emphasis on supervisory control and data acquisition (SCADA) systems, as well as developing integrated multi-sensor warning systems (MWS) and other tools for the real-time monitoring for reliable detection of an attack.

Department of Health and Human Services (DHHS)

- **Components of the Centers for Disease Control and Prevention (CDC):** The CDC's responsibility, on behalf of the DHHS, is to provide national leadership in the public health and medical communities in a concerted effort to detect, diagnose, respond to, and prevent illnesses, including those that could occur as a result of bioterrorism or any other deliberate attempt to harm the health of our citizens.

    - **Epidemic Intelligence Service (EIS):** EIS trains personnel to respond to naturally occurring and bioterror outbreaks and other disaster situations to aid state and local officials in the identification of potential causes and implement appropriate solutions. EIS was established during the Cold War in response to the threat of biological warfare.

    - **Public Health Prevention Service (PHPS):** This Service provides specialists who can provide on-site programmatic support to extend the manpower of state and local public health staff in responding to naturally occurring and bioterror events.

- **Metropolitan Medical Response System (MMRS):** MMRS helps communities prepare for coordinated response of medical, epidemiological and public health experts in response to an attack or disaster. So far, 97 cities nationwide have received assistance.

- **Epidemiological and Laboratory Capacity (ELC); Laboratory Response Network (LRN):** The LRN is a network of governmental (local, state and federal) laboratories that have been trained by the CDC to process samples by well-established and validated procedures. These laboratories must adhere to the LRN standard protocols for testing and must successfully complete periodic proficiency testing challenges sent from CDC. The LRN was formed as a self-organized group through the efforts of the CDC and the Association of Public Health Laboratories (APHL).

- **Surveillance Programs for Foodborne Pathogens: PulseNet and eLEXNET:** The CDC's Food Safety Office mission is to prevent illness, disability and death due to domestic and imported foodborne diseases, whether they occur naturally or as acts of terror. They collaborate with and support other CDC organizations with focus on attainment of food safety program plans, goals and objectives. They work in partnership with the FDA, EPA, USDA, state and local health departments, and other public and private organizations to strengthen regulations and policies for prevention of foodborne diseases.

- **Human Health Surveillance Programs: Emerging Infections Program (EIP) – Health Alert Network (HAN):** CDC has helped establish sentinel disease detection systems that involve local networks of clinicians and other health care providers. To ensure rapid communication and access to critical health information, CDC is implementing the national HAN, in partnership with the National Association of County and City Health Officials (NACCHO), the Association of State and Territorial Health Officials (ASTHO), and other health organizations. The HAN will establish communications, information, distance-learning, and organizational infrastructure for a new level of defense against bioterrorism and other health threats, linking all public health agencies at the local, state, and Federal levels via: (1) continuous, high-speed connection to the Internet, (2) broadcast communications, and (3) satellite- and Web-based distance-learning.

- **National Pharmaceutical Stockpile (NPSP):** Once the cause of a terrorist-sponsored outbreak was determined, specific drugs, vaccines, and antitoxins might be needed to treat the victims and to prevent further spread. CDC has developed of a stockpile of pharmaceuticals to be able to reach victims of an incident anywhere in the continental U.S. within 12 hours. This system was proven for the first time when tons of medical supplies reached New York City within seven hours of deployment following the attack on the World Trade Center.

DHHS/Food and Drug Administration

- **Center for Drug Evaluation and Research (CDER):** CDER is working with other federal agencies to make sure adequate supplies of medicine and vaccines are available to the American public. They are working to provide the most current information on drug preparedness and response to the public in response to a bioterror attack through: drug information; vaccine information; and information of prescribing and buying medicine.

- **Center for Biologics Evaluation and Research (CBER):** CBER plays an integral role in the expeditious development and licensing of products to diagnose, treat or prevent outbreaks from exposure to the pathogens that have been identified as bioterrorist agents. These products must be reviewed and approved prior to the large-scale productions necessary to create and maintain a stockpile. Staff must guide the products through the regulatory process, including the manufacturing process, pre-clinical testing, clinical trials, and the licensing and approval process.

- **Center for Food Safety and Applied Nutrition (CFSAN):** CFSAN is responsible for regulating the foods that are not under the jurisdiction of USDA for human consumption safety.

Department of Justice (DOJ)

- **Border Research and Technology Center (BRTC):** A program within the National Institute of Justice, The Border Research and Technology Center (BRTC), operated by Sandia National Laboratories, is located in San Diego, California. BRTC works with the Immigration and Naturalization Service, the U.S. Border Patrol, the U.S. Customs Service, the Office of National Drug Control Policy, the U.S. Attorney offices, and law enforcement agencies to strengthen technology capabilities and awareness on the Nation's borders.

  One of its most recognized assistance activities has been the implementation of SENTRI (the Secured Electronic Network for Travelers' Rapid Inspection). BRTC also works on joint ventures to identify technologies that will stop fleeing vehicles and is currently participating in a project to detect heartbeats of people concealed in vehicles or other containers. BRTC's technology partners include Sandia, and the Space and Naval Warfare Systems Center–San Diego (SSC-SD).

- **Office of Law Enforcement Technology Commercialization (OLETC):** A program within the National Institute of Justice, this program is designed to develop and deploy an active, broad based national program to assist in the commercialization of innovative technology for use by the law enforcement and corrections community. OLETC's primary objective is to bring research and private industry together to put affordable, market-driven technologies into the hands of law enforcement and corrections personnel.

- **Office of Law Enforcement Standards (OLES) (DOJ funded activity at NIST):** The mission of OLES is to serve as the principal agent for standards development for the criminal justice and public safety communities. OLES has been instrumental in the development of numerous standards and the issuance of various technical reports that have had significant impact on both of these communities. Through its programs, OLES helps criminal justice and public safety agencies acquire the high quality resources they need to do their jobs. To accomplish this task, OLES:
  - Develops methods for testing equipment performance;
  - Develops methods for examining evidentiary materials;
  - Develops standards for equipment and operating procedures;
  - Develops users' guides;
  - Develops standard reference materials; and
  - Performs other scientific and engineering research as required by the criminal justice and public safety communities.

National Science Foundation (NSF)

The NSF supports research related to terrorism and homeland security objectives. It's revised mission statement after Fall 2001 reflects the use of federal funds for research in areas such as detection and decontamination of biological or chemical warfare agents, cybersecurity, and continuing social responses to anti-terrorism. Examples of grants recently funded include:

- **Chemical and Biological Terrorism**
  - will use gas chromatography and polymer sensors ("electronic noses") to identify chemical warfare agents.
  - will explore the use of activated hydrogen peroxide to destroy chemical and biological warfare agents on contaminated surfaces.
  - will develop guidelines to use ozone as an alternative to toxic chemicals to decontaminate spaces contaminated with anthrax.
  - will examine disinfectants such as ultraviolet and gamma irradiation for decontaminating anthrax from objects in closed spaces.
  - will attempt to find inhibitors of "anthrax lethal factor" (a lethal toxin produced by anthrax bacteria and responsible for inhalational anthrax fatalities), which can help develop novel anthrax drugs.
  - will investigate the environmental impact of 9/11 by studying the chemistry and mineralogy of sediments of New York Harbor.

- **Cyber Security**
  - will review trends in cyber security research and identify problems that need to be addressed in the national cyber security research agenda.