S&T Laboratory Infrastructure Requirements Assessment

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Fiscal Year 2021 Report to Congress

Homeland Security

Science and Technology Directorate

Executive Summary

The Department of Homeland Security's (DHS) Science and Technology Directorate (S&T) focuses on providing the tools, technologies, and knowledge products for the Nation's Homeland Security Enterprise (HSE) as the research, development, test, and evaluation (RDT&E) arm of the Department. The S&T Office of National Laboratories provides S&T's centralized laboratory RDT&E function for DHS and consists of five laboratories serving the HSE as critical performers on multiple S&T priority programs:

- S&T Chemical Security Analysis Center (CSAC) – CSAC is the Nation's only federal studies, analysis, and knowledge management center for assessing threats and hazards associated with large-scale chemical events or chemical terrorism events in the United States.
- S&T National Biodefense Analysis and Countermeasures Center (NBACC) – To support America's defense against biological threats, NBACC provides intelligence assessments, preparedness planning, response activities, emerging biological threat characterization, and bioforensic analyses in maximum biocontainment with response capability 24 hours per day, 7 days per week. NBACC has been a crucial resource in supporting the Nation during the Coronavirus Disease 2019 pandemic, including understanding the virus' transmissibility and survivability.
- S&T National Urban Security Technology Laboratory (NUSTL) – NUSTL provides RDT&E products and services to help state and local first responders and emergency managers prevent, protect against, respond to, and recover from homeland security threats and hazards.
- S&T Plum Island Animal Disease Center (PIADC) – PIADC protects against the accidental or intentional introduction of transboundary animal diseases that threaten livestock industries, food security, and the U.S. economy. Because the PIADC mission will be transferred to the newly constructed National Bio and Agro-Defense Facility once it is fully operational, PIADC is not included within this analysis. Additionally, funding requirements for closing PIADC are requested separately through the Plum Island Closure Support program and are not included within this analysis.
- S&T Transportation Security Laboratory (TSL) – TSL is the lead federal laboratory for detection science offering applied research, test and evaluation, and certification of transportation security systems to detect and mitigate the threat of explosives, weapons, contraband, and other threats to transportation and commerce. TSL consists of a main facility at the Atlantic City Airport in New Jersey and satellite facilities at Tyndall Air Force Base east of Panama City, Florida (the Tyndall Reactive Materials Group), and Redstone Arsenal in Huntsville, Alabama (the Detection Technology Center, or DTC).

Over the last 11 years, DHS S&T has not been able to adequately invest into its laboratory infrastructure to keep pace with technological advancements and evolving homeland security mission requirements, which has made it difficult to maintain the infrastructure and core capabilities of S&T's labs. S&T has begun planning for these requirements and is providing a notional, prioritized schedule for repairs subject to the annual budget process and appropriations.

Necessary investments include replacing outdated and substandard facilities, completing basic facility maintenance and repair, replacing outdated laboratory equipment, and investing in capital improvements to meet evolving mission requirements.

To modernize the S&T laboratory infrastructure now and into the future, the S&T laboratories need the following:

1. Resources to sustain existing laboratory capabilities by completing facility maintenance and repair and by replacing laboratory equipment, on the basis of expected service lifecycles in accordance with property depreciation and equipment obsolescence;
2. Nonpay inflation increases; and
3. A funding investment over 3 years to address the backlog of capital improvement projects that could not be addressed with previous funding levels, prioritized as follows:

Table 1: Schedule of Funding Investment for Backlog of Capital Improvement Projects

Priority Level	Requirement	Lab	Year 1	Year 2	Year 3
1	Detection Sciences Testing and Applied Research Center	TSL	✓		
	Facility Maintenance and Repair Backlog	NBACC	✓		
	Facility Maintenance and Repair Backlog	TSL	✓		
	Electron Microscope Replacement	NBACC	✓		
	Facility Scoping Study	NBACC	✓		
	Information Technology (IT) Modernization – Mission-Critical	All	✓		
2	Homemade Explosive Characterization Equipment for the DTC	TSL		✓	
	Mass Spectrometry within Biosafety Level 3 Lab Space	NBACC		✓	
3	IT Modernization – Mission Enhancement	All			✓

S&T plans to allocate funding to address ongoing facility maintenance and repair requirements through the DHS resource allocation planning process based on available resources.

S&T Laboratory Infrastructure Requirements Assessment

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I. Legislative Language

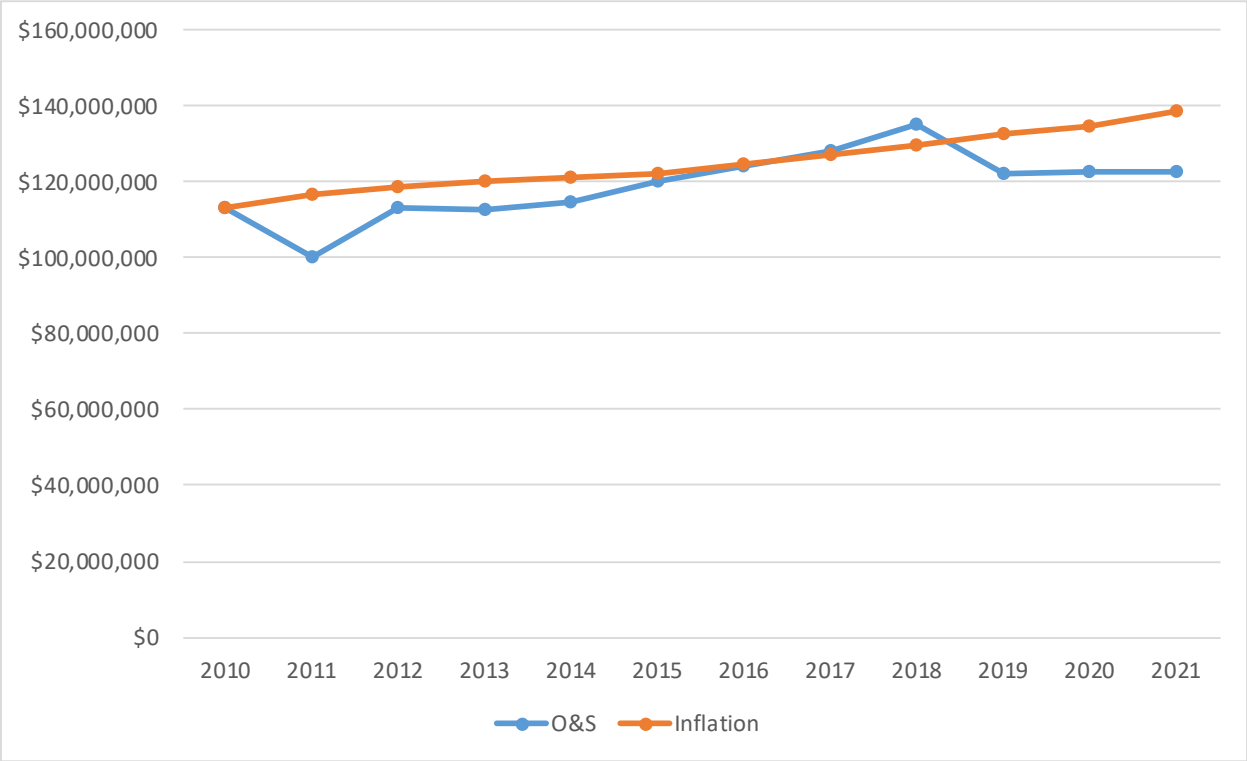
House Report 116-458, which accompanies the Fiscal Year (FY) 2021 Department of Homeland Security (DHS) Appropriations Act (P.L. 116-260), includes the following language:

> *Laboratory Facilities*–As the Department is called upon to research threats such as COVID–19, it is imperative that our nation's labs are equipped to respond in a timely and effective manner. The Committee is aware of infrastructure requirements for several S&T labs and directs S&T to complete an assessment of unmet requirements to be submitted in conjunction with the President's fiscal year 2022 budget request. This assessment shall include a prioritized list of maintenance and repair requirements; an inventory of equipment and systems that require routine replacement or upgrades; an inventory and assessment of facility capacity and additional space requirements; and a prioritized schedule for the replacement of and/or upgrades to equipment and systems.

II. Background

Over the past 11 years, DHS Science and Technology Directorate (S&T) funding for its lab facilities eroded in purchasing power to approximately $14.5 million below what was appropriated in 2010. Lab facility funding has not kept pace with inflation, creating a growing gap between supporting lab operations, including all pertinent compliance requirements, salaries, facility maintenance and repair, equipment replacement, and the amount appropriated to S&T. This gap is shown in the graph below, with cumulative inflation growing from 2010 to 2021.

Figure 1: S&T Lab Facilities' Operations and Support Appropriations vs. Inflation*



** Operations and Support funding does not include appropriations for the National Bio and Agro-Defense Facility (NBAF)*

This has resulted in an increasing number of facility maintenance and repair projects and equipment replacements that either have remained unfunded or, out of necessity, have leveraged operations funding that was reserved for other needs. Both situations are unfavorable because either funding reserved for unforeseen issues is depleted, or a known and planned operational task critical to mission success underperforms. This situation diminishes S&T's ability to perform to its mandate, and it will continue to worsen as operational costs continue to increase annually on the basis of inflation and other factors. As a result of both inflationary pressures and unexpected pricing changes, the following are examples of recent cost increases at S&T labs:

- Garrison prices for the National Biological Analysis and Countermeasures Center (NBACC) cost roughly $8-10 million per year and have increased 2.7 percent annually since 2015 while Garrison's scope of work either has stagnated or decreased.
- Mission-critical laboratory consumables like liquid nitrogen have increased in price by 19 percent.
- There is increased regulatory burden on S&T's biological laboratories due to expanding compliance complexity and rigor of oversight requirements. This results in increased effort and labor costs to remain compliant. For example, there are increased reporting requirements associated with Middle East Respiratory Syndrome, avian influenza, and dual use research of concern that collectively add to the labor costs of running S&T's biological labs, including NBACC and the Plum Island Animal Disease Center (PIADC).
- Much of S&T's laboratory infrastructure is not owned outright and, therefore, is subject to increasing market rates for use and lease agreements. These include the National Urban Security Technology Laboratory's (NUSTL) use of General Services Administration facilities, as well as property use agreements with the Department of Defense and the Federal Aviation Administration at other labs.
- S&T laboratories are highly dependent upon specialized contract labor for safety and security and Federal Protective Services costs for protective security services. Although federal laboratory staff have received regular cost of living adjustments, contract labor rates have risen annually.
- There are emerging requirements for increased secure program space. Sensitive compartmented information facilities (SCIF), critical to protecting sensitive intelligence, have been added to individual S&T labs, thereby increasing operating costs for additional security infrastructure and labor.

These are a representative sample of the general cost increases that have been absorbed annually into the flat operating budget of the S&T labs. An annual nonpay inflation increase of 2.5 percent for laboratory facilities allows funding levels to maintain pace with anticipated operation cost increases.

Beyond an annual increase in operations funding, technological innovation and future-focused research cannot be sustained without a long-term source of funding for facility improvements and equipment replacement. S&T plans to allocate funding to address ongoing laboratory infrastructure facility maintenance and repair requirements and improvements through the DHS resource allocation planning process.

III. Summary of Findings

A. Annual Funding Requirements

To sustain S&T's labs, funding must cover depreciation of the laboratory buildings and assets. An annual investment of approximately $10 million will support a capital investment program that enables S&T labs to meet regulatory requirements, to maintain modern technological standards, and to perform end-of-life replacements for mission-critical equipment.

Using publication 946 from the Internal Revenue Service for property recovery periods, the S&T labs' physical infrastructure (i.e., real property) is depreciating at a rate of $5.92 million per year. The S&T labs' critical operating systems, scientific equipment, and information technology (IT) infrastructure are experiencing obsolescence at an annual rate of $3.81 million based on their expected service lives. An analysis of the replacement lifecycles and depreciation costs of infrastructure across multiple labs and systems is featured in the tables below and summarizes the annual investment of approximately $10 million to maintain the current functionality of facilities, systems, and equipment and to prevent them from degrading to a state of dysfunction.

Table 2: S&T Laboratory Asset Values

Asset Value ($ in millions)						
	Property	**Building**	**Non-Tech**	**High-Tech**	**Lab Equipment**	**Total**
Labs	**NBACC**	$203.01*	$4.20	$1.90	$21.4	$230.51
	Transportation Security Laboratory (TSL)	$24.06**	$0.37	$1.34	$3.30	$29.07
	Chemical Security Analysis Center (CSAC)	$3.49	$0.05	$0.49	$0.37	$4.40
	NUSTL	$6.49	$0.19	$0.40	$0.74	$7.82

* *Based on replacement value*

** *Based on replacement values of TSL and the Tyndall Reactive Materials Group; does not include the Detection Technology Center (DTC), which is not owned by DHS*

Table 3: Annual Requirements based on Asset Value/Depreciation

Annual Requirements ($ in millions)						
	Property	**Building**	**Non-Tech**	**High Tech**	**Lab Equipment**	**Total**
	NBACC	$5.08	$0.35	$0.38	$2.14	$7.95
Labs	**TSL**	$0.59	$0.03	$0.27	$0.33	$1.22
	CSAC	$0.09	$0.01	$0.10	$0.03	$0.23
	NUSTL	$0.16	$0.02	$0.08	$0.07	$0.33
					Total Annual Funding Requirements	**$9.73**

The following list provides a few select examples where the inability to invest properly in needed capital improvements affected the S&T labs' ability to meet mission requirements:

- A trailer being used as a makeshift lab space for homemade explosive (HME) synthesis suffered a pipe burst, resulting in major electrical failure and mold growth. The only alternative was to use a hardened lab as a replacement, which reduced testing throughput by 20 percent. Appropriate lab space is necessary to be established to complete the full breadth of HME synthesis activities at TSL.
- TSL experienced additional throughput impacts when 10 of its 12 fume hoods became nonfunctional as result of this equipment operating well beyond its designed service life.
- In 2016, NBACC experienced a series of roof leaks that would have been avoidable with the availability of sustained funding, but instead led DHS to spend $1.2 million to replace its roof.
- A severe reduction of lab functionality and operations at PIADC persisted for 18 months because of drainage issues that arose from using cheaper, temporary fixes for various facility repairs. Animal holding was not available during this time, which severely affected the lab's ability to complete critical research activities.

The maintenance and upkeep of these aging assets should be accounted for so that each laboratory can meet critical mission requirements. As funding permits, S&T plans to allocate funding to address ongoing facility maintenance and repair requirements and equipment replacement.

Appendices 1 through 4 provide more detailed information about each S&T laboratory and its specific annual facility and equipment investment requirements. Because the PIADC mission will be transferred to NBAF once it is fully operational, PIADC infrastructure needs are not included within this analysis. Additionally, funding requirements for closing PIADC are requested separately through the Plum Island Closure Support program and are not included within this analysis.

B. One-Time Funding Requirements

Investments are needed in the near term to ensure that the S&T laboratory infrastructure can make the necessary leap forward to address these deficiencies and to address substantial capacity shortcomings to meet evolving mission requirements. S&T identified capital improvements, facility maintenance and repair, and equipment replacement priorities to enable the S&T labs to meet mission requirements effectively. Although this section provides a summary for the need of each of the these required investments, Appendices 1 through 5 provide additional details.

C. Facility Maintenance and Repair Requirements

NBACC Facility Maintenance and Backlog

NBACC requires funding to perform repairs in order to meet regulatory and contractual requirements and to maintain 100 percent 24-hours-per-day/7-days-per-week operation and research capability. A recent facility condition assessment has identified several repairs and

modifications necessary to maintain regulatory compliance and full facility functionality. A nonexhaustive list of projects that need completion for NBACC to remain mission-capable includes:

- Repairing and recertifying the building lightning protection system, which is required to meet inspection and certification requirements;
- Replacing the Biosafety Level (BSL)-3 dunk tanks, which are showing corrosion; catastrophic failure will shut down the suite;
- Replacing autoclave bioseals, which are pitting; and.
- Upgrading the Effluent Decontamination System control system to provide better monitoring and response capability while also enhancing safety compliance.

TSL Facility Maintenance and Repair Backlog

TSL requires funding to perform repairs in order to meet regulatory and contractual requirements. In 2017, a facility condition assessment identified recommended actions to address these building conditions over 10 years. The main buildings are all older than 20 years with many of the components at or beyond their estimated design life. Some examples of diminished productivity resulting from failing facilities include:

- The need to relocate an HME synthesis lab from a trailer that suffered a pipe burst, resulting in major electrical failure and mold growth;
- The need to provide employees with plug-in electrical heaters because of failed heating, ventilation, and air conditioning (HVAC) components; and
- The need to evacuate TSL because of spurious fire alarms caused by poorly ventilated spaces and an aging fire detection system, resulting in the loss of approximately 50 manhours per evacuation.

D. Inventory of Equipment and Systems that Require Routine Replacement or Upgrades

NBACC Electron Microscopes

NBACC confirmed funding requirements for electron microscopes that rapidly are approaching the end of their service life. Replacing this equipment is required to keep research for both the National Bioforensic Analysis Center and the National Biological Threat Characterization Center on the cutting edge. Without these microscopes, the Federal Bureau of Investigation (FBI) and S&T will be unable to satisfy fully their responsibilities to support the HSE to prepare for and respond to biological threats to the homeland. These strategic responsibilities have been set forth in both presidential directives and national strategies for biodefense.

Figure 2. Field Electron and Ion Company (now Thermo Fisher Scientific) Apreo VS scanning electron microscope

IT Modernization across the S&T Laboratories

Lab mission requirements must keep pace with modern technological advancements in order to remain effective, but the S&T labs are handicapped by existing IT infrastructure. Currently, S&T provides IT resources at six site locations and many other satellite locations affecting more than 650 federal staff and contractors. If the IT infrastructure on which the mission relies does not keep pace with technological improvements, this becomes a hindrance.

As with most IT systems, S&T's systems for its labs were developed and implemented over many years and do not meet the current needs of programs and facilities that they support. The lab IT infrastructure is antiquated and needs the following improvements to remain mission-capable:

- **Network Improvements:** Many labs are challenged with inadequate network capacity and data transfer speeds. In some cases, researchers have had to leave the facility to access the Internet through Wi-Fi hotspots in order to retrieve online resources. A network overhaul is required, including initial study, design, new equipment, upgrading leased circuits, configuration, and testing.
- **Infrastructure Upgrades:** Some equipment currently used in IT operations is either insufficient to meet the growing data requirements of the labs or is approaching the end of service life. The inventory of equipment also varies greatly, which increases the burden to manage configurations, updates, and troubleshooting. In combination with cloud migration, equipment upgrades are still necessary, such as replacing HVAC systems, replacing ductwork, upgrading power supplies, and building out new IT closets and server rooms specifically designed and equipped to house specialized IT equipment.
- **File Sharing:** The S&T labs frequently need to share large amounts of data both with both internal and external partners, including vendors and other government

organizations. Some of the information shared is classified. Temporary solutions have significant limitations. For example, data often must be saved to an encrypted external hard drive and physically mailed. Different file-sharing platforms and tools could be utilized to mitigate these restrictions, and bandwidth could be upgraded to reduce transfer times. This solution will be dependent on an overall network plan that determines which services are migrated to the cloud. To ensure security of these data and the rest of the network, additional hardware would be required to facilitate the external connections to the equipment.

- **IT Service Support:** Currently, IT services are administered by both local lab IT staff and S&T IT staff. The ticketing systems, change management policies, and configuration control are not aligned or are administered through different systems. For example, if a lab staff member submits a service request, it is processed by local lab IT personnel; however, escalating issues that are beyond the capabilities of local IT require submitting a new ticket through a different system, which lacks visibility to the end user. An analysis of alternatives should be performed to recommend solutions and tools on the basis of S&T lab needs. These solutions may include consolidation of lab service desks and service request tools.

There are additional IT investment requirements to enhance the S&T labs' ability to support mission execution records and knowledge management, machine learning and artificial intelligence, workflow management, and licensing. More specific details regarding the IT investment requirements are available in Appendix 5, "Information Technology."

E. Inventory and Assessment of Facility Capacity, Additional Space Requirements, and New Capabilities

Detection Sciences Testing and Applied Research (DSTAR) Center

This new, state-of-the-art facility will enable TSL to assist the Transportation Security Administration (TSA) and other customers with more efficiency and effectiveness in testing and with evaluating threat screening devices.

- Much of TSL's work currently is done in makeshift facilities that require increasing maintenance and repair. Currently, many TSL staff work in office trailers and temporary buildings that have water penetration resulting in mold issues, and that are beyond their useful life.
- The DSTAR Center's design features automated, state-of-the-art laboratories to provide for the safe and effective validation of explosive screening devices. It also will include sterile areas for test and evaluation of trace detection devices and modern computational

Figure 3. Rendering of the DSTAR Center

infrastructure for analyzing and archiving threat images from computed tomography and millimeter wave threat screening devices. The DSTAR Center also will have areas for HME assembly and will provide the means to synthesize hazardous and benign test articles. These areas are vital because of terrorists' increasing preference for HME, which has made the test and evaluation of explosive screening devices much more complex and time-consuming.

- This project is consistent with S&T's congressionally mandated Infrastructure Master Plan for the TSL from 2010 through present day. Initial design documentation and environmental planning is complete.

HME Characterization Equipment for the Detection Technology Center

In 2011, S&T, TSA, and the FBI agreed jointly to fund and create DTC at the FBI Terrorist Explosive Device Analytical Center (TEDAC) in Huntsville, Alabama. A micro-computed tomography (MicroCT) device at TEDAC would be beneficial to the overall conduct of HME research. The MicroCT is the preferred means of identifying and validating detection characteristics of emerging explosive threats and would allow for a more rapid response to emerging threats. With several hundred HMEs awaiting characterization, the DTC facility would contribute significantly to efficiency of characterization of these threats and the subsequent validation of technologies to detect them.

NBACC Facility Scoping Study

NBACC is DHS's primary facility employed to help DHS and its HSE partners, including the law enforcement community, characterize biological pathogens and toxins and to determine the threat that they pose to Americans in the event of an intentional or unintentional release. An investment will be used to perform a scoping study to understand the funding needs required for secure BSL-2 and SCIF space for classified biological characterization and bioforensics and laboratory computing center to support the transfer, analysis, and storage of the large data sets associated with recent advancements in biotechnology. This facility scoping study will include updating the mission need statement and developing an analysis of alternatives, operational requirements, and a conceptual design package.

NBACC Mass Spectrometry within BSL-3 Lab Space

Since the 2001 Amerithrax attack, there has been an increasing need to develop "methods"-based approaches to analyzing biological samples. Mass spectrometry (MS) enables the evaluation of a variety of biochemical molecules without a prior knowledge of what those molecules are. This highly sensitive method enables analysis of small molecule toxins and can be used to identify biological signals of pathogenesis and biomarkers of disease from novel threats. Toxinology MS capabilities were established in the BSL-2 lab space beginning in 2015. The replication of MS and other analytical chemistry instrumentation in additional BSL-3 lab spaces will support testing at higher containment for samples that require handling at this level. Being able to conduct these analyses at BSL-3 is critical to both the FBI and S&T in effectively accomplishing their respective missions. Currently, there are no suitable third-party laboratories that offer a BSL-3 MS capability for bioforensic analysis. The only viable solution for NBACC is to dedicate part of the BSL-3 lab space to MS capability and to procure the appropriate MS and analytic chemistry instrumentation.

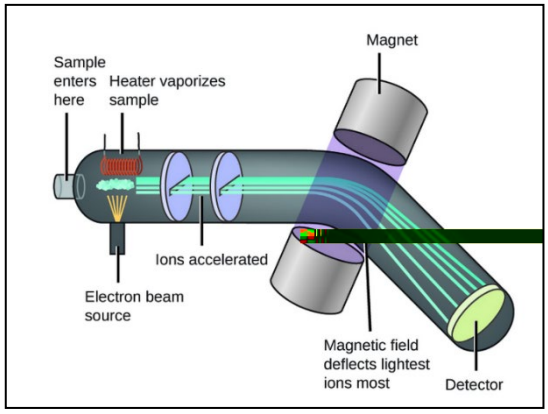


Figure 4. Mass spectrometry diagram

IV. Prioritized Schedule

Sections III and IV of this document provided a summary of requirements for S&T labs, and prioritizes those funding requirements as follows:

A. Priority Level 1

- New construction, facility maintenance and repair, or other capital improvements that would have safety, security, or laboratory readiness impacts if not implemented.
- Facility maintenance/repairs or equipment replacement that are necessary to execute mission requirements.

B. Priority Level 2

- New capabilities that are critical to meeting mission requirements and that require additional facility capacity, space requirements, or specialized equipment.

C. Priority Level 3

- New capabilities that are not critical to meeting mission requirements.
- Although these capabilities would enhance the lab's ability to support mission execution, they would not be considered necessary to do so.

Table 4 summarizes how the facility maintenance and repair, equipment replacement or upgrades, and new capabilities and space requirements described in Sections III of this document were prioritized. S&T plans to allocate funding for these requirements through the DHS resource allocation planning process.

Table 4: Prioritized Schedule of S&T Lab Investment Requirements

Priority Level	Requirement	S&T Lab	Year 1	Year 2	Year 3	Out-years
Annual Requirements						
1	Facility Maintenance and Repair	All	✓	✓	✓	✓
1	Equipment Replacement or Upgrades	All	✓	✓	✓	✓
One-Time Requirements						
1	DSTAR Center	TSL	✓			
1	Facility Maintenance and Repair Backlog	TSL	✓			
1	Facility Maintenance and Repair Backlog	NBACC	✓			
1	Electron Microscope Replacement	NBACC	✓			
1	Facility Scoping Study	NBACC	✓			
1	IT Modernization – Mission Critical	All	✓			
2	HME Characterization Equipment for the DTC	TSL		✓		
2	Mass Spectrometry within BSL-3 Lab Space	NBACC		✓		
3	IT Modernization – Mission Enhancement	All			✓	

V. Appendices

A. National Biodefense and Countermeasures Center

B. Transportation Security Laboratory

C. Chemical Security Analysis Center

D. National Urban Technology Security Laboratory

E. Information Technology

F. Abbreviations

S&T Lab Infrastructure Requirements Assessment - Appendix A: National Biodefense Analysis and Countermeasures Center

1.0 Introduction

A biological attack on American soil may go undetected for hours, days, or weeks without direct involvement and quick intervention from the scientific community. Department of Homeland Security (DHS) Components and federal law enforcement must understand the threat posed by deadly biological pathogens and how they can take hold in an operational setting or can be used by bad actors to harm innocent people. The Science and Technology Directorate (S&T) National Biodefense Analysis and Countermeasures Center (NBACC)—located on Fort Detrick in Frederick, Maryland—is the only purpose-built maximum biocontainment laboratory in the country dedicated to providing threat characterization and forensic analysis on biological agents, while focusing on homeland security mission needs. NBACC is operated as a federally funded research and development center by Battelle National Biodefense Institute (BNBI).

NBACC is one of just 13 biosafety level (BSL)-4 laboratory facilities in the country, able to work on the deadly pathogens for which there is no cure. NBACC provides capabilities to conduct sensitive experiments that address operational needs and knowledge gaps in America's biodefense. The lab is equipped with unique aerobiology containers used to assess biological agents like Ebola and SARS-CoV-2 (the virus that causes Coronavirus Disease 2019 (COVID-19)) and understands their survivability across multiple environments. Novel use of the lab's research capabilities has proven indispensable in assisting the Countering Weapons of Mass Destruction Office and the Federal Emergency Management Agency with applied research during the COVID-19 pandemic response. NBACC offers the sole high-containment biodefense capability providing bioforensic laboratory support to the Federal Bureau of Investigation (FBI) 24 hours per day/7 days per week (24/7).

Figure 1-1. NBACC entrance

Since its inception, NBACC and its staff of more than 240 dedicated BNBI contract employees have filled critical shortfalls in its scientific knowledge of biological agents needed to defend the public from acts of terrorism. NBACC's 223,973 square-foot facility and 51,927 square feet of lab space include two centers: the National Bioforensic Analysis Center (NBFAC), which conducts technical analyses in support of federal law enforcement investigations, and the National Biological Threat Characterization Center (NBTCC), which conducts experiments and studies to understand biological vulnerabilities and hazards better. Together these centers offer a national resource for understanding the risks posed by the malicious use of biological agents and the operational

capability to support the investigation, prosecution, and prevention of biocrimes and bioterrorism by achieving the below strategic objectives.

Strategic Objectives

- Develop equipment, protocols, and training procedures for response to and recovery from biological attacks.
- Enhance the technical capabilities of the DHS operational elements and other federal, state, local, and tribal agencies in order to allow them to fulfill their homeland security-related missions.
- Develop methods and capabilities to test and assess threats and vulnerabilities and to anticipate emerging threats.
- Support leadership in science and technology.

NBACC Operations and Support

- Provides safe and compliant operations for more than 50,000 square feet of BSL-2, -3, and -4 laboratories, including continuous operational support to law enforcement.
- Maintains Centers for Disease Control and Prevention (CDC) and the U.S. Department of Agriculture (USDA) Biological Select Agent and Toxin Program-compliant biosafety laboratories, including CDC/USDA inspections. Also maintains Association for Assessment and Accreditation of Laboratory Animal Care accreditation.

Figure 1-2. Protective lab suits

- Conducts a "Work for Others" program that makes the NBACC national security biocontainment capabilities more broadly available to other federal agencies.
- Maintains Defense Security Service compliance.

NBFAC

- NBFAC operates at the direction of the FBI's Laboratory Division (FBI-LD) and conducts 24/7 technical analyses for sensitive federal law enforcement investigations with custom-built bioforensic casework laboratories and dedicated technical staff.
- NBFAC identifies and characterizes biological agents in evidentiary samples with simultaneous analyses using agent-based assays, which include bacterial and viral culture, polymerase chain reaction, and immunoassays as well as methods-based capabilities that include genomics (whole genome sequencing and bioinformatics analysis), electron microscopy, and mass spectrometry (MS).

- NBFAC has built strong technical core capabilities with International Organization for Standardization (ISO) 17025-accredited, agent-based methods and assays in bacteriology, virology, toxinology, and molecular biology. None of these capabilities existed prior to the Amerithrax attacks of 2001.

NBTCC

- NBTCC establishes the scientific basis for the threat posed by traditional and nontraditional biological agents and life science-related technologies to support and inform the Homeland Security Enterprise (HSE) biodefense preparedness, response, and recovery decisions.

NBTCC is a critical component of the S&T Probabilistic Analysis of National Threats Hazards and Risks mission to provide accurate, useful, and defensible knowledge and tools to stakeholders in time to enable risk-informed decision-making for defense against weapons of mass destruction threats to the Homeland.

- NBTCC conducts real-time research during response to characterize emerging biothreat agents and develops tools to improve response, recovery, and future preparedness.
- NBTCC conducts research to understand the persistence and potential for secondary transmission of biological contaminants in a variety of environments and the ability of various disinfection technologies to inactivate or remove biological contaminants.
- NBTCC evaluates how a variety of adversarial actors could develop and deploy biological weapons against American targets to inform consequence and risk assessments.

Memorandum of Agreement (MOA) between S&T and FBI-LD

In September of 2018, the most recent MOA was signed between S&T and FBI-LD. This MOA sets forth the terms by which S&T and FBI-LD will collaborate on the management of NBACC. Prior to this MOA, S&T and FBI-LD had collaborated to formulate and initiate integrated forensics programs for chemical and biological threats. The activities that support said programs have been, and continue to be, executed in coordination between S&T and FBI-LD.

Along with the joint oversight of NBACC, S&T and FBI-LD also share the financial responsibilities regarding the lab. The MOA sets forth that FBI-LD is responsible for 40 percent of the costs to operate the facility, which include:

- Three NBACC contract line items:
  - NBFAC support,
  - Core support, and
  - Analytic tasks associated with NBFAC and core support for the long-term lifecycle costs of the facility.
- Services provided by the U.S. Army Garrison Fort Detrick and other NBACC services that support the NBACC facility.

Notable Accomplishments

- In 2020, NBTCC scientists greatly improved the understanding of SARS-CoV-2 (the virus causing COVID-19) and methods to prevent its spread. NBTCC produced a formula that predicts how the virus persists while suspended in the air and on surfaces, increasing scientific understanding of the virus's behavior under real-world conditions.
- In 2020, S&T released an online predictive modeling tool to estimate natural decay of SARS-CoV-2 under a range of environmental factors that affect its stability. Leveraging the results of research conducted by NBACC, the tool assists operators in the field by estimating environmental persistence of the virus under certain combinations of temperatures and humidity. (https://www.dhs.gov/science-and-technology/sars-calculator)

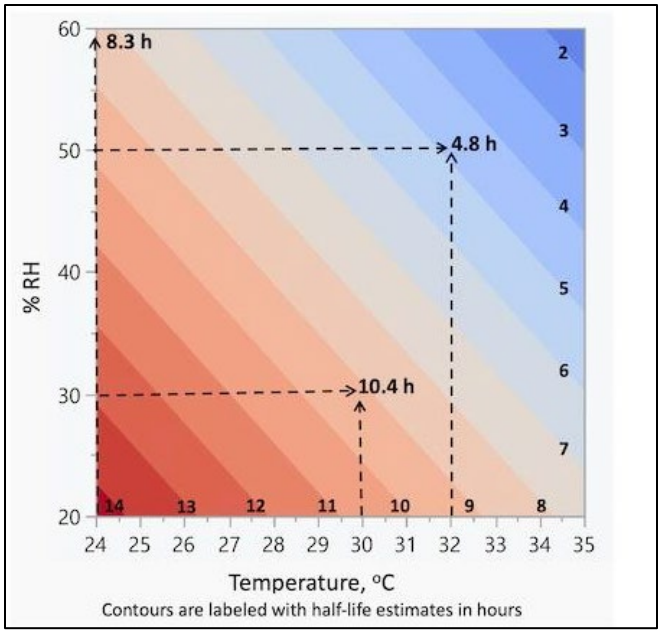


Figure 1-3. Applying Surface Stability Model to estimate SARS-CoV-2 stability on indoor surfaces

- In 2020, NBFAC conducted nearly 300,000 individual analyses in support of 45 separate cases for the FBI. The number of cases handled per year by NBFAC has risen steadily over the past 5 years, and NBFAC also is working with multiple other federal agencies as well as the United Nations in analyzing biological materials for both law enforcement and intelligence investigations.
- From Fiscal Year (FY) 2011 through FY 2019, NBTCC has transitioned products that address 92 traditional agent knowledge gaps, providing timely and high-quality data on the characteristics of biological threat agents and dual-use technologies. This has led to improved assessments of the risk of a biological attack and the preparedness and response capabilities required to mitigate the consequences of such an attack. In response to new threats identified by DHS, NBTCC determined the potential hazard to inform threat assessments.
- In response to the largest Ebola outbreak recorded and importation of cases to the United States, NBTCC conducted Ebola virus stability and disinfection research to understand the risk of virus transmission through contaminated surfaces. Results were used to inform decontamination methods, waste disposal practices, and risk assessments for DHS Components, law enforcement, and first responders.

NBACC Investment Requirements Summary

- **Facility Maintenance and Repair**
  An annual investment is required for continuous maintenance and repair based on Internal Revenue Service (IRS) published rates of depreciation for various classes of assets.

- **Equipment Replacement**
  Large quantities of equipment will be reaching their end of life over the coming years. As this equipment degrades, there is a risk that equipment failure could occur and that the labs will become inoperable.

- **Facility Maintenance and Repair Backlog**
  In 2019, a facility condition assessment (FCA) was conducted at NBACC. On the basis of this assessment, an investment is required to address deficiencies that have accumulated over the past several years. These one-time investments will address several maintenance needs and will ensure that NBACC can maintain safety and compliance with federal regulations.

- **Electron Microscope Replacement**
  In addition to normal equipment refresh, two electron microscopes must be replaced as they have reached end-of-life status. Without these microscopes, the FBI and S&T will be unable to satisfy their responsibilities fully to enable the HSE to prepare for and respond to biological threats to the homeland.

- **NBACC Facility Scoping Study**
  NBACC is DHS's primary facility employed to help DHS and its HSE partners, including the law enforcement community, to characterize biological pathogens and toxins. Currently, NBACC is encountering capacity and capability gaps due to the increasing demand for analyses. An investment will be used to perform a scoping study to determine any needs associated with the NBACC facility.

- **MS within BSL-3 Lab Space**
  Since the 2001 Amerithrax attack, there has been an increasing need to develop methods-based approaches to analyzing biological samples. MS enables the evaluation of a variety of biochemical molecules without a prior knowledge of what those molecules are. Toxinology MS capabilities were established in the BSL-2 lab space beginning in 2015. The replication of MS and other analytical chemistry instrumentation in additional BSL-3 laboratory spaces will support testing at higher containment for samples that require handling at this level. Being able to conduct these analyses in BSL-3 labs is critical to both the FBI and S&T in accomplishing their respective missions effectively.

2.0 Facility Maintenance and Repair Requirements

2.1. Sustained Requirements

According to the NBACC FCA issued in September 2019, NBACC is a $203 million asset. For tax purposes, the IRS has published estimated rates of depreciation for various classes of assets. These rates provide a reasonable basis to estimate the cost of maintaining lab

infrastructure annually. When these depreciation rates are applied, S&T estimates that it would be responsible for approximately $5.08 million of facility repairs at NBACC annually based on its $203 million estimated value. S&T plans to address ongoing facility maintenance and repair requirements based on available resources.

2.2. Requirement Backlog

NBACC is a limited-access BSL facility requiring compliance with DHS, CDC, USDA, the Nuclear Regulatory Commission, and other federal regulations. NBACC is one of the mission-critical facilities of S&T that must be sustained properly, restored, and kept modernized for use according to Homeland Security Presidential Directive 10 and to maintain capabilities to support the DHS Strategic Framework for Countering Terrorism and Targeted Violence.

S&T is working constantly to address NBACC's backlog of issues and deficiencies. The system condition assessment in the 2019 FCA identified high-priority repairs and modifications necessary to maintain regulatory compliance and full facility functionality. NBACC has created a short-term plan to make sure that the necessary repairs are made and that necessary equipment is purchased to maintain its regulatory compliance and facility functionality while also increasing efficiency and safety.

This short-term plan includes the repairs and/or replacement of several high-priority systems and pieces of equipment (shown in Table 2-1). This includes addressing water intrusion and excessive condensation within the facility, repairing the building lightning rods, replacing variable frequency drives, etc.

Table 2-1. 3-Year Maintenance Action Plan

System	Priority	Asset ID	System Description	Deficiency
BSL-4	1	BLD-EXCRTWL	Aluminum frame, curtain wall	Engineering study of repair needs to address water intrusion through storefronts and excessive condensation
BSL-4	2	ELC-LHTPROT	Facility lightning protection system	Missing lightning rods, installation was not done per UL code and needs correcting
Admin	2	CUB-PRT	Cubicle partitions and office space	Replacement and refurbishment of lifecycle fixed furnishings
BSL-4	3	LDT-PT	Laboratory dunk tank/ passthrough boxes	Replacement of corroded and failing dunk tanks
Admin	3	EXT-GRD	-	Soil erosion around manhole
BSL-4	4	BLD-EXBRCK	Brick veneer with concrete masonry unit backup	Application of sealant and repointing of brick
BSL-4	4	BLD-EXOVRHD	Door, overhead, commercial steel, 12' x 12'	Replace damaged rollup dock door hardware and opener
Admin	4	BLD-CLPNL	24" x 48" tile, 3/4" rigid fiberglass board with fabric	Replacement of ceiling damaged by water intrusion

Table 2-1. 3-Year Maintenance Action Plan

System	Priority	Asset ID	System Description	Deficiency
Admin	4	BLD-CRPT	Carpet tile, nylon, fusion bonded, 18" x 18" or 24" x 24", 42 oz.	Replacement of worn carpeting throughout offices and common spaces
BSL-4	4	PLM-EDS	Effluent decontamination system (EDS)	Replacement of EDS components at or approaching end of design life
BSL-3	4	PLM-LFT	Pneumatic lift station	Replacement of lift station components at or approaching end of design life
BSL-4	4	ELC-VFD	Variable frequency drives	Replacement of variable frequency drives at or approaching end of design life, replacement of half of units to maintain redundancy
BSL-4	4	BAS-SRV	Building automation system including servers, control panels, device level controls, sensors, power supplies and other associated devices	Building automation system: replacement of end-of-life controllers, sensors, and actuators
BSL-4	4	COM-TEL	Information Technology (IT) infrastructure includes virtual desktop infrastructure (VDI) and servers	IT VDI system lifecycle system replacement
BSL-4	4	SEC-SRV	Facility security system including servers, badge readers, physical access control devices, and associated components	NBACC Security Management System lifecycle component replacement
BSL-4	4	1-410	Laboratory autoclaves	Bioseal replacement. Autoclave seals have some pits; seal gaps would be a CDC finding.
Admin	4	EXT-GRD	-	Investigate drainage issues around loading dock areas and rain leader connection
Admin	4	EXT-PRK	Parking lot, 2" asphalt binder, 1" topping on 9" crushed stone, painted stripe, concrete parking barrier	Seal coat and repainting of parking lot

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3.0 Inventory of Equipment and Systems that Require Routine Replacement or Upgrades

3.1. Sustained Requirements

Large quantities of equipment will be reaching their end of life over the coming years. The costs, grouped by equipment capability, is shown in Table 3-1. The equipment was purchased from multiple different vendors, and at different times—thus, hardware lifetimes and associated service and maintenance contracts will expire at different times for different equipment. As this equipment degrades, the labs will become inoperable, and there is a risk that equipment failure could occur. Over time, this could lead to S&T being unable to satisfy its various responsibilities fully.

Table 3-1. NBACC 2019 Equipment Replacement Summary Tables

Capabilities	2022	2023	2024	2025	2026	2027	2028
Aerobiology	$337,000	$226,000	$98,500	$242,000	$153,000	$300,000	$53,000
Bacteriology	$177,600	$184,920	$215,160	$307,400	$311,300	$363,400	$383,300
Comparative Medicine	$121,000	$126,500	$138,000	$385,000	$790,500	$160,000	$678,000
Electron Microscopy	$50,000	$54,388	$50,000	$50,000	$59,900	$55,000	$0
Genomics IT	$164,000	$163,000	$330,000	$720,000	$545,000	$216,000	$147,000
Molecular	$48,000	$114,000	$52,600	$25,000	$102,000	$0	$31,000
Toxinology	$301,500	$487,213	$608,000	$544,630	$853,687	$800,000	$0
Virology	$53,000	$0	$0	$53,000	$86,000	$687,000	$0
General Lab Equipment	$177,600	$184,920	$215,160	$307,400	$311,300	$363,400	$383,300
Facility & Infrastructure	$327,950	$228,800	$218,600	$320,500	$346,600	$341,180	$319,000
NBACC (Uninflated) Total	**$1,757,650**	**$1,769,741**	**$1,926,020**	**$2,954,930**	**$3,559,287**	**$3,285,980**	**$1,994,600**
Inflation Rate (2.5%)	1.077	1.104	1.131	1.160	1.189	1.218	1.249
NBACC (Inflated) Total	**$1,892,989**	**$1,953,794**	**$2,178,329**	**$3,427,719**	**$4,231,992**	**$4,002,324**	**$2,491,255**

Current outyear replacement dates are estimates based on the manufacturer's predicted life. In practice, S&T uses that date as a starting point but may adjust actual replacement on the basis of factors such as usage, mission criticality, and evolving technological advances. Although the year-to-year cost can fluctuate, S&T will normalize the costs using the above-mentioned date-selection methodology. S&T plans to allocate funding to address ongoing facility maintenance and repair requirements through the DHS resource allocation planning process based on available resources.

3.2. Electron Microscope Replacement

Two of NBACC's electron microscopes no longer will be serviced as of 2025: the Field Electron and Ion Company (FEI, now Thermo Fisher Scientific) Quanta 200 Scanning Electron Microscope (SEM) and the FEI Tecnai BioTWIN T12 Transmission Electron Microscope (TEM). The SEM is required for the morphological analysis of bioforensic casework samples and for the elemental analysis of casework samples. The TEM is required for the morphological analysis of bioforensic casework samples.

Figure 3.1. FEI Talos L120C G2 (TEM) electron microscope

Without these microscopes, the FBI and S&T will be unable to satisfy fully their responsibilities to enable the HSE in preparing for and responding to biological threats to the homeland. These strategic responsibilities have been set forth in both presidential directives and national strategies for biodefense.

4.0 Inventory and Assessment of Facility Capacity, Additional Space Requirements, and New Capabilities

4.1. NBACC Facility Scoping Study

Mission Need

The first goal of the DHS Strategic Framework for Countering Terrorism and Targeted Violence is the ability to understand the evolving terrorism and targeted violence threat environment, and to support partners in the HSE through this specialized knowledge. One key area of concern is the increasing vulnerability that the United States faces not only from the standpoint of direct attack and violence against persons and communities from a range of threats, but the ever-expanding potential for threat to our economy and way of life as we see expansion in the bioeconomy of the United States.

Biotechnology is driving massive change in the economies of the future, and biothreats of the future will be an outgrowth of these technology advances. The U.S. Government must stay at the forefront but is lagging in some key areas of strategic capability investments required to offset these threats.

BSL-2 spaces that are accredited and could be operated from unclassified up to Top Secret/Sensitive Compartmented Information would be ideal for NBTCC mission execution. There are instances where work has been performed in higher level containment spaces because of sensitivity of the work. This results in limiting the amount of work that can be done in higher containment laboratories.

Sensitive Compartmented Information Facility (SCIF) space is vital at facilities like NBACC that regularly process and discuss sensitive information. Recently, there has been insufficient SCIF space to support NBACC's ability to work on secret and top secret projects, such as those pertaining to national security threats. The oversubscription of the SCIF has increased in frequency over time as NBACC has seen an increase in classified work for both threat and forensic programs. Over the past year, multiple users needing to use the same space and capacity excess has occurred multiple times per week.

The NBACC facility was designed and constructed more than 10 years ago, and since that time, biotechnologies that result in the generation of large data sets have exploded. The current infrastructure at NBACC is no longer sufficient to support the transfer, analysis, and storage of such large data sets. In addition, due to the unique national security mission of NBACC, the current needs for generation and analyses of data sets that are classified are greater than the current capacity can accommodate while demand signals for such information is increasing. For example, just a single set of experiments now taking place using Systems Biology approaches is generating 50 gigabytes (GB) of data, which is comparable to the amount of data accumulated over the course of a whole year previously in NBTCC. NBTCC will be performing at least 10 more iterations of data gathering and analysis for just one task, thus generating more than 500GB of raw data. In particular, NBTCC does not have redundantly backed up data storage or server solutions for these large next generation data sets.

Solution

NBACC is planning to perform a scoping study, to include the following, in order to understand the funding needs required for the NBACC facility:

- Updated mission needs statement;
- Analysis of alternatives;
- Operational requirements; and
- Conceptual design package.

Addressing these capability gaps directly supports goals 1 (understand and adapt to the threat environment) and 4 (emphasize locally based solutions) of the DHS Strategic Framework for Countering Terrorism and Targeted Violence.

4.2. Capability Expansion – Mass Spectrometry within BSL-3 Lab Space

Mission Need

Since the 2001 Amerithrax attack, there has been an increasing need to develop methods-based approaches to analyzing biological samples. MS is an analytical technique that measures the charge-to-mass ratio of ions. The results typically are presented as a mass spectrum—a plot of intensity as a function of mass-to-charge ratio. MS enables the evaluation of a variety of biochemical molecules without prior knowledge of what those molecules are. This highly sensitive method enables analysis of small molecule toxins such as saxitoxin and tetrodotoxin. It also can be used to identify biological signals of pathogenesis and biomarkers of disease from novel threats. Being able to conduct these analyses at BSL-3 is critical to both the FBI and S&T in accomplishing their respective missions effectively.

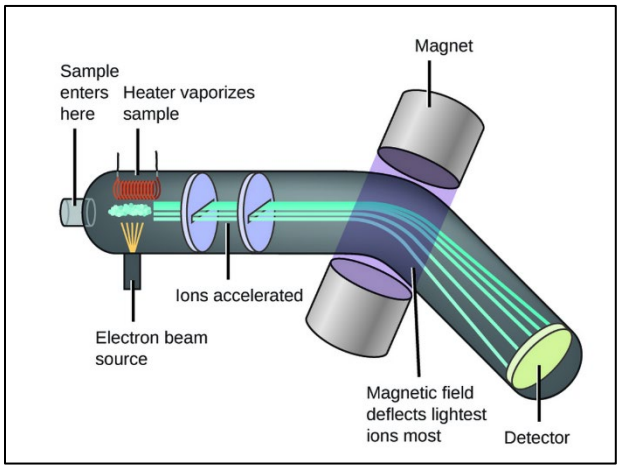

Figure 4-1. Mass spectrometry diagram

In a typical MS procedure, a sample is bombarded with electrons. This may cause some of the sample's molecules to break into charged fragments or simply to become charged without fragmenting. These ions then are separated according to their mass-to-charge ratio, for example, by accelerating them and subjecting them to an electric or magnetic field; ions of the same mass-to-charge ratio will undergo the same amount of deflection. The ions are detected by a mechanism capable of detecting charged particles, such as an electron multiplier. Results are displayed as spectra of the signal intensity of detected ions as a function of the mass-to-charge ratio. The atoms or molecules in the sample can be identified by correlating known masses (e.g., an entire molecule) to the identified masses or through a characteristic fragmentation pattern.

Toxinology MS capabilities were established in the BSL-2 lab space beginning in 2015 and since have included the ISO 17025 validation of two methods-based analytical processes used for the identification and characterization of protein toxins.

Over the past 4 years, MS capability expansion efforts have required the completion of ISO 17025 validations for additional toxins using these analytical processes, and the ISO 17025 validation of an MS-based method for botulinum neurotoxin activity. Additionally, MS capability expansion will continue with ISO 17025 validations of low molecular weight toxin identification and characterization methods.

The replication of MS and other analytical chemistry instrumentation in additional BSL-3 laboratory spaces will support testing at higher containment for samples that require handling at this level.

Solution

The expansion of MS capabilities into higher containment will enhance the current BSL-2 MS methodologies by providing instrument redundancy and by allowing for the establishment of new analytical processes for targets that are not permissible at BSL-2 for supporting FBI investigations.

Currently, no suitable third-party laboratories offer a BSL-3 MS capability for bioforensic analysis. The only viable solution for NBACC is to dedicate part of the BSL-3 space to MS and to procure the appropriate MS and analytic chemistry instrumentation.

5.0 Prioritized Schedule for Replacement of and/or Upgrades to Equipment and Systems

In order to continue to meet current mission requirements successfully and to support HSE customers, NBACC requires funding for facility maintenance and repairs, equipment replacement or upgrades, and new capabilities and space requirements, prioritized as follows:

Priory Level 1

- New construction, facility maintenance and repairs, or other capital improvements that would have safety, security, or laboratory readiness impacts if not implemented.
- Facility maintenance/repairs or equipment replacement that are necessary to execute mission requirements.

Priority Level 2

- New capabilities that are critical to meeting mission requirements and that require additional facility capacity, space requirements, or specialized equipment.

Priority Level 3

- New capabilities that are not critical to meeting mission requirements.
- Although these capabilities would enhance the lab's ability to support mission execution, they would not be considered necessary to do so.
- NBACC does not have any requirements identified in this category.

Table 5-1. NBACC Infrastructure Requirements Ordered by Priority

Priority Level	Requirement	Year 1	Year 2	Year 3	Out - years
Annual Requirements					
1	Facility Maintenance and Repair	✓	✓	✓	✓
1	Equipment Replacement or Upgrades	✓	✓	✓	✓
One-Time Requirements					
1	Facility Maintenance and Repair Backlog	✓			
1	Electron Microscope Replacement	✓			
1	Facility Scoping Study	✓			
2	Mass Spectrometry within BSL-3 Lab Space		✓		

S&T plans to address ongoing facility maintenance and repair requirements based on available resources.

6.0 Horizon Investments

This section includes investments 5-10 years in the future. It is prudent to plan ahead because of the time that it takes for new science to be established.

6.1. Systems Biology (SysBio)

Mission Need

The biological threat landscape is dynamic, and technologies and proliferation of biological materials have continued to expand since the inception of NBACC. Consequently, there exists a potential for an adversary to create novel agents that evade our existing medical and nonmedical countermeasures. To maintain biological threat awareness and characterization objectives and to avoid technological surprise, it is critical that NBACC capabilities keep pace with existing technology in anticipation of new threats.

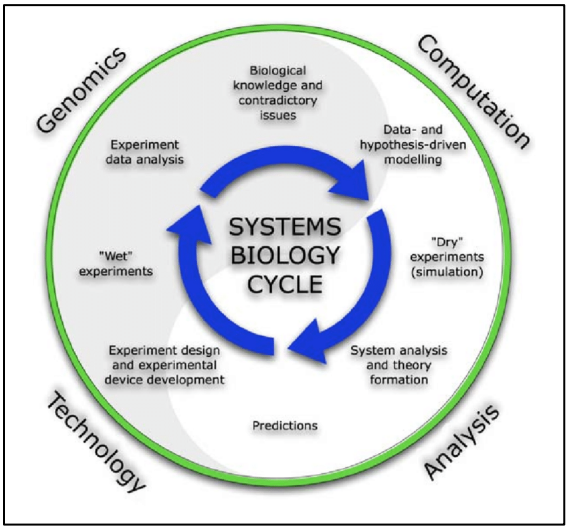

Figure 6-1. SysBio cycle diagram

It is not feasible to investigate all possible biological threat scenarios for the finite number of traditional threat agents that currently exist, and responding to bioincidents *post hoc* will not yield timely and actionable data for decision makers. Additionally, the number of potential threat agents enabled by biotechnology is so vast that more agent-agnostic characterization methods are required. By defining the high-density interaction networks ("interactome") that underpin how biological systems dynamically interact and result in changes in the host or pathogen in the context of model threat scenarios, it will be possible to extrapolate these data into predictive modeling tools to assess novel and emerging threats.

Solution

To meet this need, the NBTCC at NBACC needs to expand capabilities to include state-of-the-art technologies in SysBio. This expansion will establish dedicated capabilities in three areas: nucleic acid sequencing, protein expression profiling, and the computational methods required to analyze such data sets. Genomic sequencing capabilities for threat characterization initially will be established by leveraging and expanding the existing NBFAC processes for next-generation sequencing technologies for viral and bacterial genomics. Expansion of sequencing for applications such as pathogen and host transcriptomics, establishment of host protein profiling, single cell and spatial multi-omics, and integration of the resulting data sets through computational biology will require instrumentation specifically to perform SysBio research in these areas.

Establishing these capabilities at NBACC maintains and expands the breadth of its technical expertise while enabling timely analysis of biological agents up to the highest level of biological containment within a secure envelope up to the Top-Secret level.

The proposed NBTCC SysBio capability will establish the required subject matter expertise, laboratory, and computational resources needed to achieve system-level understanding of interactions among biological threat agents, the environment, and hosts in which they could cause disease. These capabilities will be established incrementally and span four subdisciplines:

- **Genomics:** The ability to sequence the genomes of pathogens and to relate these data to threat characteristics will enable development of future analytic and predictive risk assessment tools that can be applied to newly identified agents when only sequence data are available.
- **Transcriptomics:** Broadly and agnostically profiling pathogen and host gene activity in response to external stimuli and/or infection will yield patterns of gene expression that can be used to understand and predict threat properties and virulence.
- **Protein Profiling:** Detection of protein effectors of specific host biological pathways and/or secreted pathogen virulence factors, along with the ability to isolate specific cell types based on their expressed proteins, will enable and complement genomic and transcriptomic data sets.
- **Computational Biology:** Dedicated bioinformatics expertise and computing resources for threat assessment are required for data integration, analysis, and predictive modeling.

This capability expansion involves augmentation of the current NBTCC program research portfolio through additional laboratory equipment and information systems. Existing NBFAC genomics resources that align with NBTCC SysBio objectives will be leveraged and expanded in the short term to maximize success of this component. Durable laboratory equipment includes: next-generation sequencers (NGS) and NGS library preparation equipment; instrumentation to enable spatially oriented gene and protein expression profiling for targeted multi-omics profiling in tissue specimens; a flow cytometric cell sorter and instruments needed for single-cell transcriptomics; and a highly multiplexable immunoassay platform. Required bioinformatics equipment include three workstations, bioinformatics software, portable data storage devices, and high-performance computing capabilities that will build upon the infrastructure established to support NBFAC. Lifecycle costs associated with maintaining the capability include the labor, service contracts for instrumentation, and reagents for maintaining the instrumentation.

The following is a list of potential milestones for a potential SysBio capability expansion by subdiscipline:

- **Genomics**
    1. Demonstrate capability to utilize genomic analysis to demonstrate how external stimuli (e.g., environmental conditions, physical stresses, host immune responses) confer a selective advantage to particular threat agent genotypes in a mixed population.
    2. Demonstrate capability to leverage synthetic biology tools to validate the fitness of specific threat agent genotypes under specific selective pressures.

- **Transcriptomics**
    3. Perform whole transcriptome analysis of the host and pathogen after pathogen exposure, and identify signatures that correlate with the disease outcome.
    4. Demonstrate capability to perform single cell transcriptomics of prokaryotic cells that vary in their response to external stimuli.
    5. Demonstrate capability to perform single cell transcriptomics of eukaryotic cells to profile the response of diverse cell types to pathogen exposure.
    6. Demonstrate capability to perform spatial gene expression profiling in animal tissue sections after pathogen exposure.
- **Protein Profiling**
    7. Demonstrate capability to perform targeted host protein profiling, and correlate protein profiles with pathogen virulence and/or disease outcome.
    8. Demonstrate capability to perform flow cytometric cell sorting for single cell transcriptomics.
    9. Demonstrate capability to perform spatial protein expression profiling in animal tissue sections after pathogen exposure.
- **Computational Biology**
    10. Establish the computational infrastructure needed to support systems biology projects.
    11. Implement data analysis pipelines and tools to integrate systems biology data sets.
    12. Demonstrate predictive value of computational modeling tools that integrate systems biology data sets.

S&T Lab Infrastructure Requirements Assessment - Appendix B: Transportation Security Laboratory

1.0 Introduction

Each day, the Federal Government screens more than 2.2 million passengers, 1.4 million checked items, and 5.5 million carry-on items for explosives and other dangerous contraband. It's a colossal undertaking for the men and women of the Transportation Security Administration (TSA), who are aided by cutting-edge detection technology to help to ensure a safe and seamless passenger experience. The Science and Technology Directorate (S&T) Transportation Security Laboratory (TSL) is a leader domestically in development of standards, protocols, and test articles necessary for detection technology assessments. Nearly all explosives detection and screening equipment in use at checkpoints in U.S. airports has gone through rigorous testing at TSL.

The lab investigates properties of explosives and other contraband to design test articles for screening systems. Its scientists have received several patents on test articles for X-ray and millimeter wave-based systems, and quality control methods for explosive trace detectors. The lab's work has advanced beyond the standard areas of explosives and contraband detection to include detection of illicit substances such as opioids. TSL experts currently are evaluating artificial intelligence and machine learning capabilities that have the potential to improve the Department of Homeland Security (DHS) Components' ability to improve security in our transportation systems.

Figure 1-1. Transportation Security Laboratory in Atlantic City, New Jersey

For more than 25 years, TSL has remained focused on its enduring mission and long-term vision:

- **Mission**: To enhance homeland security by performing test and evaluation of technologies to detect and mitigate the threat of improvised explosive devices, weapons, and other threats to transportation and commerce.
- **Vision:** Through continuous improvement to its test and evaluation (T&E) services, TSL will remain the preeminent organization for assisting the homeland security enterprise (HSE) in identifying, developing, validating, and deploying threat-detection screening technologies.

Working closely with security equipment manufacturers and DHS component acquisition managers, TSL ensures that operational components of the HSE acquire detection and mitigation solutions that meet their respective operational requirements, with a primary customer focus on TSA's explosives screening needs.

Currently, TSL manages four test facility locations to understand the growing threats and to evaluate the performance and suitability of explosive threat-detection equipment. Each of these facility locations has unique capabilities and a unique mission mandate from DHS:

- **S&T TSL, Atlantic City, New Jersey**: An S&T government-operated laboratory dedicated to the T&E of screening technology threat-detection performance. TSL provides developmental testing from early prototype assessment through certification. TSL conducts testing across all presently deployed technology areas: Explosive Detection Systems, Advanced Technology, Advanced Imaging Technology (AIT), Bottle Liquid Screening, and Explosive Trace Detection. TSL serves as the only laboratory authorized to conduct certification testing on TSA's behalf.
- **S&T Tyndall Reactive Materials Group (TRMG) at Tyndall Air Force Base, Panama City, Florida**: TRMG is a contractor-staffed facility that supports S&T by collecting homemade explosive (HME) data on materials that TSL does not have the equipment, resources, or facilities to handle. TRMG synthesizes bulk quantities of marginally stable and sensitive explosive compounds. TRMG personnel work under the oversight of S&T to meet TSA's needs.
- **S&T Detection Technology Center (DTC) at TEDAC Improvised Explosive Device Synthesis Center (TIEDS), Huntsville, Alabama**: S&T has partnered with the Federal Bureau of Investigation (FBI) to augment the TIEDS capability located in Huntsville, Alabama, with a DHS-supported DTC. The DTC located in TIEDS conducts explosives characterization and testing and performs fundamental research into the behavior and detection characteristics of full threat weight and sensitive emerging explosive threats. TIEDS has the capability to characterize emerging threats fully, to assess their blast performance, and to evaluate the detection performance of representative transportation security equipment against these threats. TIEDS focuses on emerging nonconventional explosives (i.e., HME and derivatives of conventional explosives).
- **S&T Aberdeen Test Center (ATC) at Aberdeen Proving Grounds, Maryland:** Aberdeen has two live fire test ranges dedicated to the DHS Commercial Aircraft Vulnerability and Mitigation Program. ATC supports these facilities with test technicians and explosive specialists who help TSL engineers to perform pressurized and unpressurized vulnerability

tests of aluminum and composite aircraft. Other testing at ATC includes commercial aircraft blast mitigation tests, commercial aircraft least risk bomb location tests, and blast performance measurement and characterization tests with existing and emerging explosive threats.

TSL Investment Requirements Summary

TSL's aging scientific equipment and outdated infrastructure limits the ability of the lab to meet its mission fully. Additionally, investments in new capabilities and infrastructure will allow TSL to fulfill its mission better and ensure its lasting impact in the future.

- **Annual Facility Maintenance and Repair**
  An annual investment is required for continuous maintenance and repair based on Internal Revenue Service (IRS)-published rates of depreciation for various classes of assets.

- **Annual Equipment Replacement**
  Execution of the TSL mission requires state-of-the-art scientific and laboratory equipment which must be replaced periodically to ensure that TSL can execute its mission successfully.

- **Facility Maintenance Repair Backlog**
  In 2017, an independent facility condition assessment (FCA) of TSL's main campus in Atlantic City, New Jersey, concluded that structural, electrical, mechanical, and roofing components of the buildings/structures were in need of extensive repair.

- **Detection Sciences Testing and Applied Research (DSTAR) Center**
  Much of TSL's work currently is done in makeshift facilities not suited to sustained occupancy and not optimal for research and development requiring precisely controlled conditions. Moreover, many of these spaces are beyond their useful life and require extraordinary measures to maintain their viability. Leaking roofs, mold growth, other contamination, poor ventilation, fluctuating temperatures, and cramped working conditions are just some of the problems associated with these facilities. The DSTAR Center would address these problems by providing state-of-the-art laboratories to provide for research and development supporting the safe and effective validation of explosive screening devices. This investment is critical to ensure that TSL maintains its ability to conduct research, development, test, and evaluation of explosive and threat screening devices.

- **HME Characterization Equipment for the DTC**
  Equipment such as a high-resolution X-ray computed tomography (CT) is the preferred means of characterizing the detection properties of explosive threats. With a MicroCT at the DTC, the timeline to identify and develop countermeasures to emerging threats could be reduced significantly. With several hundred HMEs awaiting characterization, the DTC would contribute significantly to efficiency of characterization of these threats and the subsequent validation of technologies to detect them.

2.0 Facility Maintenance and Repair Requirements

2.1. *Sustained Requirements*

TSL is an aging and degrading facility in need of repairs and refurbishments. According to the TSL FCA issued in May 2017, TSL is a $23.6 million asset. S&T estimates that the replacement value of TRMG is $490,000. Without sustained funding for continuous maintenance and repair, these mission-critical facilities may be unable to provide their research, development, test, and evaluation capabilities to DHS.

For tax purposes, the IRS has published estimated rates of depreciation for various classes of assets. These rates provide a reasonable basis to estimate the cost of maintaining lab infrastructure annually. When these depreciation rates are applied, S&T estimates that it would be responsible for approximately $0.59 million of facility repairs at TSL and TRMG annually on the basis of their estimated values. S&T plans to address ongoing facility maintenance and repair requirements based on available resources.

2.2. *Requirements Backlog*

The 2017 FCA involved a thorough visual inspection of all civil, architectural, structural, electrical, mechanical, and roofing components of the buildings/structures to ensure compliance with current codes and standards. The assessment recommended actions to address these building conditions for the next 10 years.

The main buildings are all more than 20 years old with many of the components at or beyond their estimated design life. The ability of most of the components to continue operating effectively at this point is only made possible by unsustainable high levels of maintenance, repair, and modification. Continuing to defer maintenance and equipment replacements will increase operating and maintenance costs and increase the risk of equipment and system failures.

Although some repairs already have been performed, approximately $3.0 million is required to address the remainder of the deficiencies identified in the 2017 FCA. Figure 2-1 provides an overview of the types of repairs that will be made with the $3.0 million. Figures 2-2, 2-3, and 2-4 highlight examples of aging infrastructure and the need for immediate repairs. Examples of diminished productivity resulting from failing facilities include:

- The need to relocate an HME synthesis lab from a trailer that suffered a pipe burst, resulting in major electrical failure and mold growth.
- The need to provide employees with plug-in electrical heaters because of failed heating, ventilation, and air conditioning (HVAC) components (air flow valves in the interior ductwork).
- The need to evacuate TSL because of spurious fire alarms caused by poorly ventilated spaces and an aging fire detection system (each evacuation costing the government roughly 50 labor hours).

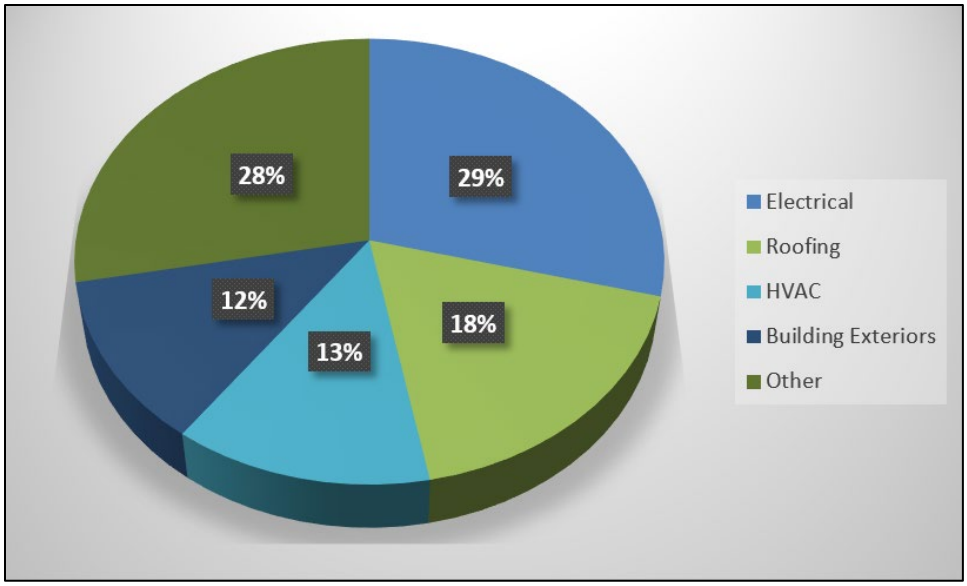

Figure 2-1. Overview of types of facility improvements needed

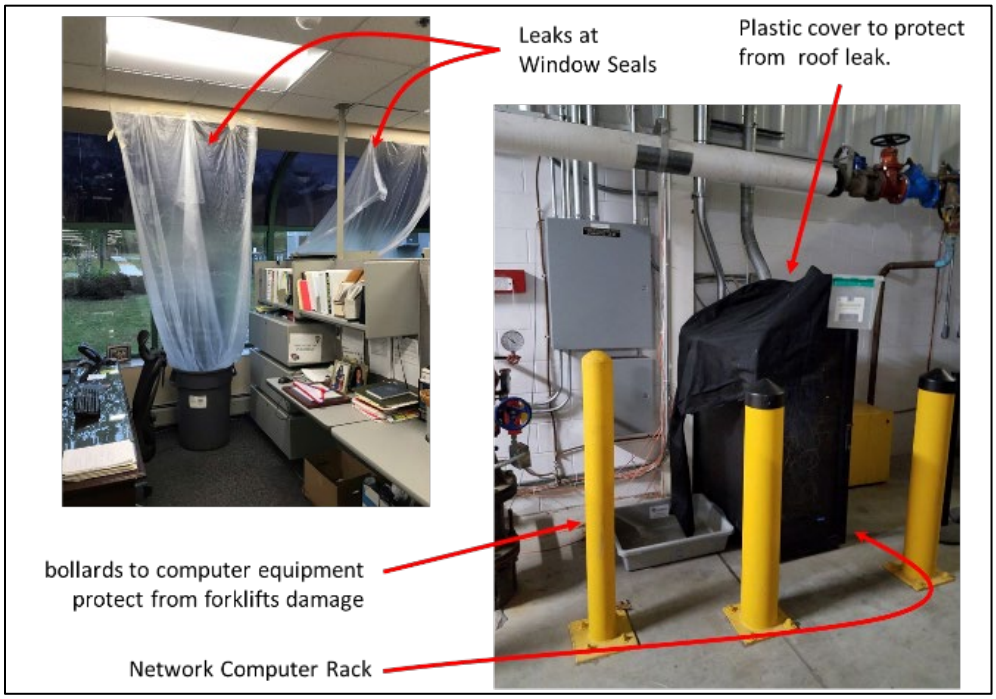

Figure 2-2. Office building and converted warehouses are experiencing frequent roof leaks

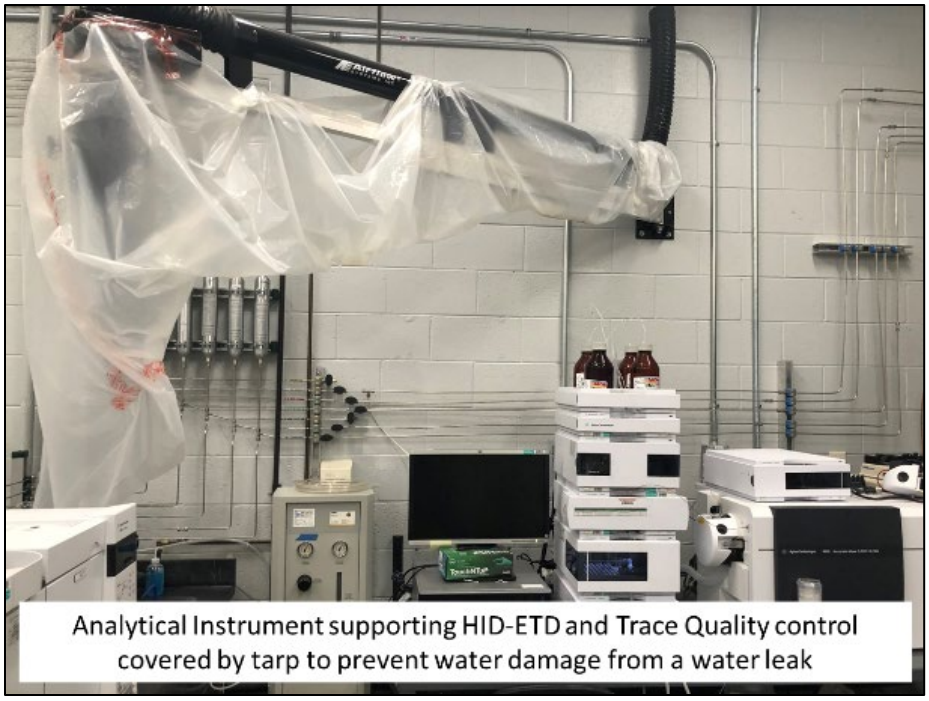

Figure 2-3. Laboratories also are experiencing roof leaks, sometimes directly above expensive equipment.

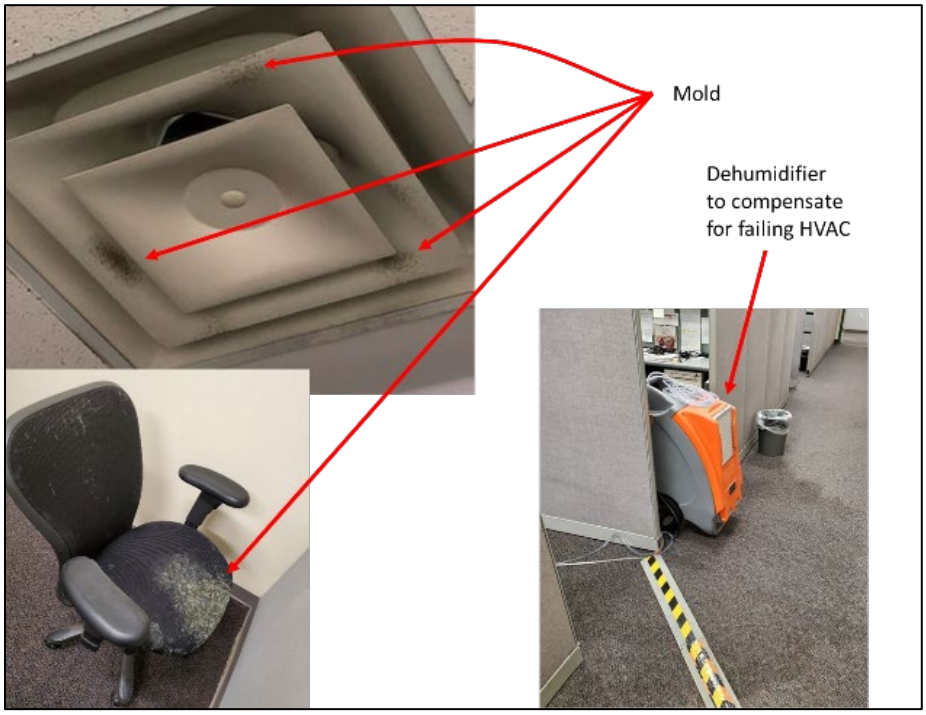

Figure 2-4. Failing HVAC systems and overcrowded areas have resulted in mold growth in the office area.

3.0 Inventory of Equipment and Systems that Require Replacement or Upgrades

Execution of the TSL mission requires state-of-the-art scientific and laboratory equipment to ensure that test articles are representative of actual threats and are reproducible in a manner that ensures that system developers are not chasing a moving target. This equipment must be replaced periodically to ensure that TSL can execute its mission successfully and cost effectively. This equipment includes everything from relatively simple pipettes to spectrograph equipment costing hundreds of thousands of dollars.

The total asset value of the equipment is shown in Table 3-1 based on detailed information from the S&T asset management system. As this equipment begins malfunctioning, the labs will either fail to validate test results or waste time and money producing flawed results.

Table 3-1. Current TSL Equipment Asset Values

Equipment Category	Estimated Total Acquisition Cost ($ millions)
Computer/IT	$1.344
Facility Equipment	$0.373
Scientific Equipment	$3.295
Total	**$5.012**

Laboratory equipment costing hundreds of thousands of dollars and essential to conducting tests and evaluations is degrading quickly and, in some cases, is inoperative. Figure 3-1 illustrates the impact of failing equipment in laboratories.

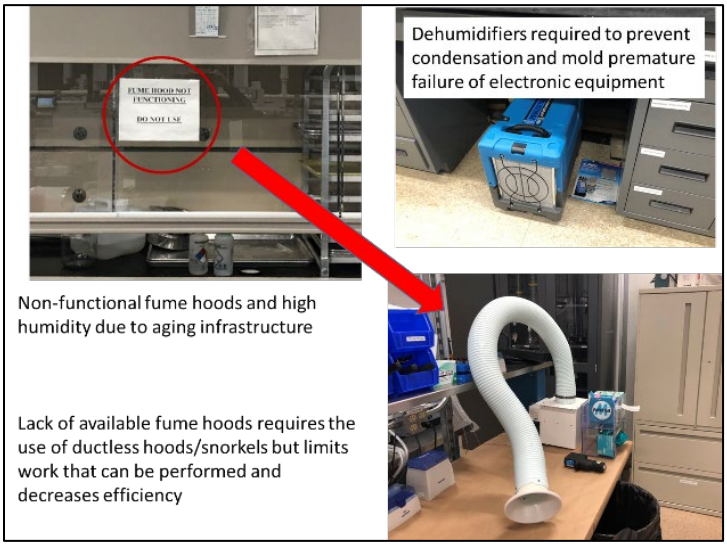

Figure 3-1. Failing laboratory equipment and system has an impact on productivity.

TSL must continue to invest in the replacement of scientific equipment to maintain the current capabilities of the lab. Table 3-2 summarizes the value of TSL assets and estimates the annual replacement cost to maintain this level of capability over time.

Table 3-2. Current TSL Equipment Asset Values ($ in millions)

Type of Asset	Value in Asset Management System	Estimated Lifespan	Estimate Annual Replacement Cost
Non-Tech	$0.37	12	$0.03
High Technology and PCs	$1.34	5	$0.27
Scientific Equipment	$3.30	10	$0.33
Total	**$5.01**		**$0.63**

The values for the different types of equipment were obtained from the S&T asset management system. The estimated annual cost of replacing this equipment is $0.63 million annually based on the IRS-published depreciation rates for the given type of equipment.

To sustain the lab, funding must offset depreciation of the scientific and other equipment. Without this sustained annual investment, the risk of equipment failure will continue to rise and the ability for TSL to execute its mission will decline. This investment will allow the lab to meet regulatory requirements, to maintain modern technological standards, and to perform end-of-life replacements for mission-critical equipment. The purchase of new equipment also will offer cost savings associated with new, more capable equipment offering faster test results and greater automation.

4.0 Inventory and Assessment of Facility Capacity, Additional Space Requirements, and New Capabilities

4.1. DSTAR Center and Other TSL Master Plan Capital Improvements

Mission Need

In the past, technologies were evaluated against a small number of commercial and military explosives historically employed in terrorist plots. The current suite of possible threats continues to expand and now includes marginally stable and highly sensitive HME with many variations. These new threats create an additional testing burden on TSL and corresponding safety and disposal concerns. In addition, TSL often is asked to test technology solutions for an expanded network of transportation systems and potential targets such as government facilities, ports, and event venues (e.g., sports stadiums).

As in every other technology sector, substantial advances have been made in the development and application of explosives and weapons detection and mitigation technologies. TSL must keep pace with the next generation of equipment and the certifications required for deployment. TSL originally was designed to conduct T&E on a small number of detection systems focused on conventional explosives. This required T&E space and explosive storage bunkers, but not much in the way of scientific laboratories. Now many more systems and new threat types must be synthesized and characterized in scientific laboratories. This resulted in the need for additional T&E space and purpose-built scientific laboratories.

In 2015, TSL updated a master plan for capital improvements to address ongoing operations and maintenance issues. The first two phases of the plan have been completed. The following capability gaps were identified in the master plan and have not been resolved:

1. The need for applied research laboratories;
2. The need for a dedicated HME synthesis/preparation facility;
3. The need for an explosives safety testing laboratory;
4. The need for flexible laboratory space for testing of explosive detection technologies; and
5. The need for new office space to replace temporary structures.

Examples of the *ad hoc* nature of current labs are shown in Figure 4-1. Figures 4-2, 4-3, and 4-4 show other effects of overcrowded and deteriorating facilities.

Figure 4-1. *Ad hoc* laboratory space constructed in Building 319 has resulted in overcrowded storage conditions in other parts of the building

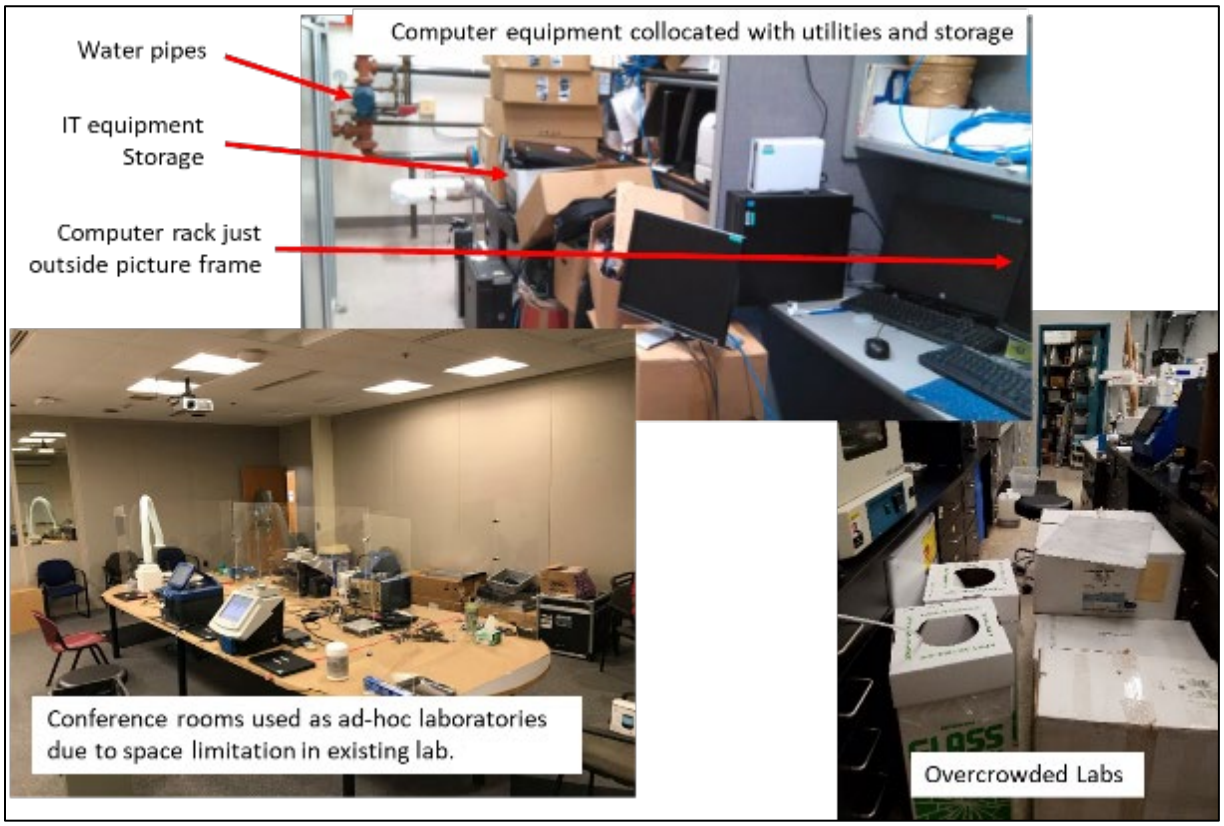

Figure 4-2. Overcrowded facilities have forced staff to use sub-optimal spaces and to improvise testing.

Figure 4-3. Temporary buildings have exceeded their useful life and are experiencing structural failure.

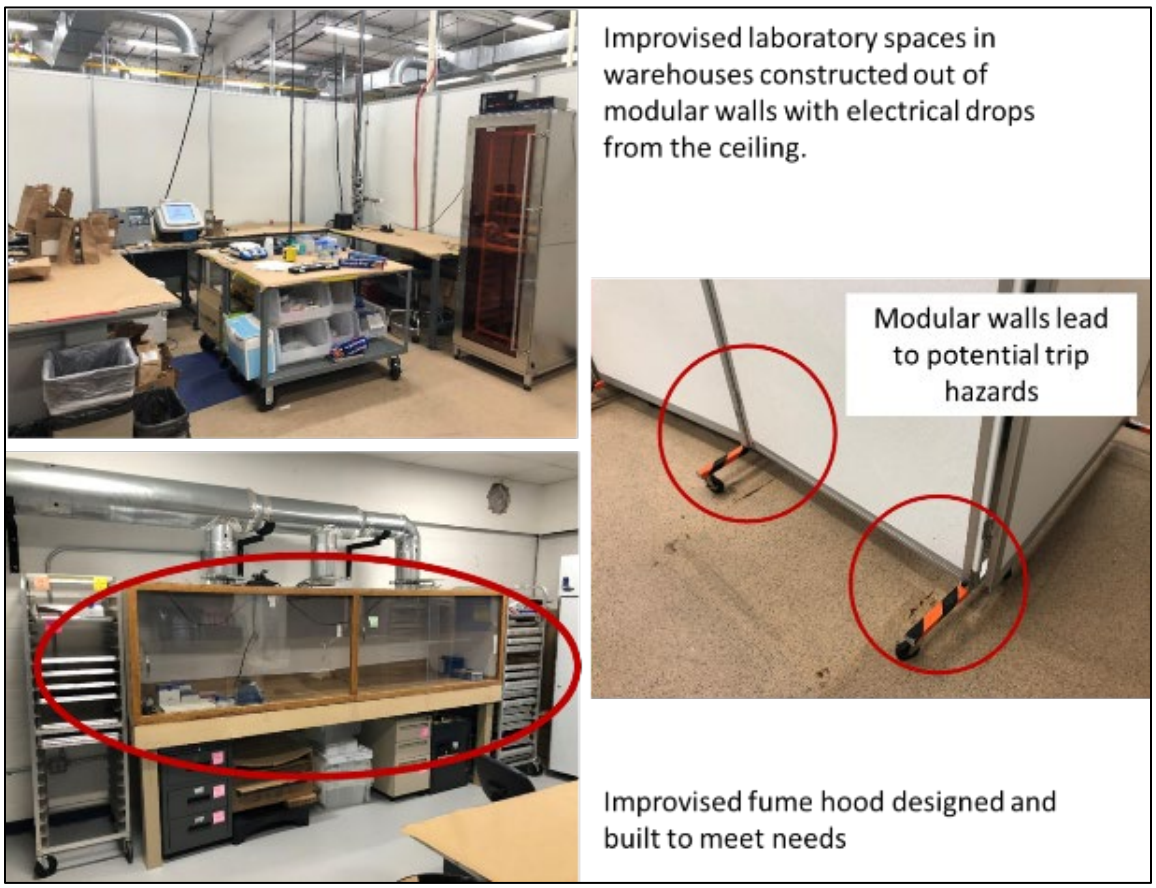

Figure 4-4. Improvised laboratory spaces are inefficient and can be hazardous.

Solution

TSL's Master Plan for capital improvements addresses ongoing operations and maintenance issues. The majority of the costs for Phase III, the remaining phase, are for the DSTAR Center that is described in detail on the following page. Additional components of Phase III include the Facility for Energetic Material Research (FEMR), other site improvements/demolition, and renovation of B318 and B319 for storage purposes after lab functions are relocated to DSTAR Center.

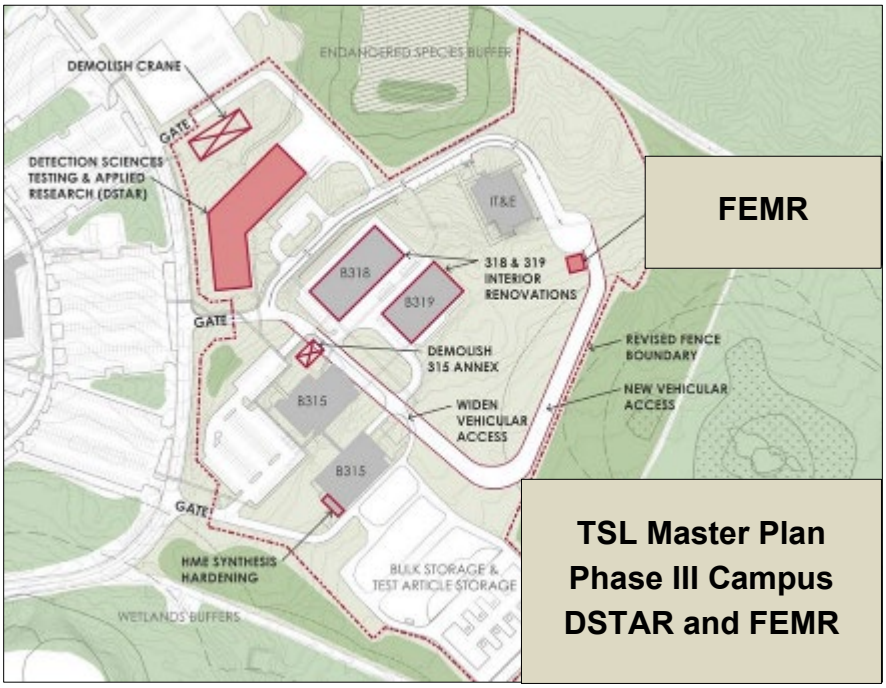

Figure 4-5. TSL Campus Layout with DSTAR Center and FEMR locations

Figure 4-6. Rendering of the DSTAR Center

- **DSTAR Center**

  The following functional areas comprise the DSTAR Center:

  - **Trace T&E Laboratories –** The labs include both the developmental test and evaluation (DT&E) and independent test and evaluation (IT&E) testing areas and a third shared space for storage and rapid testing of TSL's inventory of commercial off-the-shelf and gold standard trace detection devices. DT&E and IT&E laboratory spaces will be configured in a manner that allows up to three simultaneous T&E activities to be performed with visual and acoustic isolation from each other.
  - **Trace Research Laboratories –** These labs develop and evaluate techniques for T&E of trace explosive detection technologies, including systems developed for screening of persons, luggage, packages, cargo, and vehicles. The trace team improves sampling methods, creates new test articles and procedures, and optimizes existing technologies, while simultaneously providing tools and standards to both domestic and international security agencies.
  - **Bulk Detection Laboratories –** These labs include materials characterization, the development of testing methodologies, tools for detection technology, and applied research of next-generation bulk screening technologies. Specialized equipment in this facility is used for measurements of relevant chemical, mechanical, elemental, and X-ray properties of materials that contribute to threat detection requirements and to development of X-ray simulants for technologies such as checkpoint projection X-ray, checked-bag CT X-ray, AIT systems, and next-generation X-ray screening technologies.
  - **Applied Research –** The Applied Research Laboratory functional area activities range from materials characterization to the development and testing/assessment of methodologies for detection technology. Specialized and state-of-the-art instrumentation included in the facility supports work for TSA (air cargo vapor trace program). With minimal additional investment, TSL could also support specialized assessments and testing for other government agencies.
  - **Electromagnetic Effects Laboratory –** The Electromagnetic Signatures of Explosives Laboratory functional area activities range from materials characterization to the development and testing methodologies for detection technology covering the range of the electromagnetic spectrum from DC to ultraviolet. This includes research and development toward the creation of millimeter wave simulants for AIT systems, fundamental chemical and physical measurements of explosives, including HMEs, to support programs for handheld detection systems for passenger screening.
  - **Administrative –** The administrative area will support the laboratory functions and will include four separate areas with different levels of access: a public area where persons visiting TSL may circulate without escort, an access controlled employee work area, an access controlled area for working with materials classified at the Secret level, and an access controlled area for working with materials at the Top Secret/Secret Compartmented Information level. The

Emulator lab also will be located within the administrative area and serves to test automatic target recognition software and houses the emulators for all TSA transportation security equipment, including X-ray and AIT technologies.

- **FEMR**

  Three laboratories and a custom-built detonation chamber comprise FEMR:

  - **Energetics Materials Research Laboratory** – The Energetics Materials Research Laboratory functional area performs safety testing on subgram and larger quantities of explosives. The safety testing consists of impact (drop) testing, friction testing, electrostatic discharge testing, and thermal testing.
  - **Energetic Material Synthesis Laboratory** – The Energetic Material Synthesis Laboratory functional area activities range from the hands-on synthesis/preparation of small quantities of explosives up to the fully remote preparation of up to two kilograms of highly sensitive HMEs.
  - **Shock/Thermal Testing Laboratory (STT) –** The Shock/Thermal Testing Laboratory functional area activities include shock testing, thermal testing, and disposal of up to two kilograms of explosives. The Shock/Thermal Testing Laboratory will house a detonation chamber, which will be a hardened structure designed to absorb the impact of intentional detonations within the chamber.

- **Site Improvements/Demolition**

  - Proposed site infrastructure improvements include new perimeter fencing, parking for the DSTAR Center, pedestrian access to FEMR, a new loop road, and an additional entry gate.
  - The existing crane will be demolished to provide additional parking.
  - The existing temporary office structure will be demolished to make way for the new loop road connection to existing roadway.
  - Approximately 13 parking spaces will be provided adjacent to the facility drop-off, and additional spaces may be created with the demolition of the crane.

- **Building 318/319**

  - Renovate B318 and B319 for storage purposes after lab functions are relocated to the DSTAR Center.

4.2. *HME Characterization Equipment for DTC Facility*

Mission Need

In 2011 S&T, TSA and the FBI agreed to fund and create the DTC jointly at the FBI TIEDS in Huntsville, Alabama. This joint approach to funding created a unique facility that has the capability to synthesize explosive compounds used by terrorists safely and accurately and then to screen full threat-weight explosive devices using TSA explosive detection equipment currently deployed in US airports. The component missing from this near full-service capability is the ability to characterize the detection properties of emerging HMEs. Without this capability,

TIEDS must rely on data from TSL, TRMG, or Lawrence Livermore National Labs, which may not be immediately available.

To characterize the X-ray detection properties of most HMEs accurately, especially those with texture, the DTC needs the ability to perform high-resolution CT imaging of materials. Additionally, to characterize the trace detection features of HMEs adequately, the DTC needs highly accurate mass spectroscopy equipment collocated with its trace detection test laboratories.

Solution

Installation of MicroCT and mass spectrometry (MS) equipment will increase S&T's capacity to characterize HMEs and to address one of the threats favored by terrorists. MicroCT is the only approved means of identifying and validating X-ray detection characteristics of emerging explosive threats. Having MicroCT at the DTC would reduce the timeline significantly to respond to emerging threats. MicroCT is also required to validate results and to ensure that what is synthesized at the DTC is comparable with efforts at TRMG or TRMG.

MS equipment to support the DTC emerging trace detection testing lab is another important tool for the validation of trace detection system performance. Installation of MS equipment would improve the capabilities of the DTC and would allow greater responsiveness to emerging threats.

5.0 Prioritized Schedule for Replacement of and/or Upgrades to Equipment and Systems

In order to continue to meet current mission requirements successfully and to support HSE customers, TSL facility maintenance and repairs, equipment replacement or upgrades, and new capabilities and space requirements are prioritized as follows:

Priory Level 1

- New construction, facility maintenance and repairs, or other capital improvements that would have safety, security, or laboratory readiness impacts if not implemented.
- Facility maintenance/repairs or equipment replacement that are necessary to execute mission requirements.

Priority Level 2

- New capabilities that are critical to meeting evolving mission requirements and require additional facility capacity, space requirements, or specialized equipment.

Priority Level 3

- New capabilities that are not critical to meeting mission requirements.
- While these capabilities would enhance the lab's ability to support mission execution, they would not be considered necessary to do so.

Table 5-1. TSL Infrastructure Requirements Ordered by Priority

Priority Level	Requirement	Year 1	Year 2	Year 3	Out - years
Annual Requirements					
1	Facility Maintenance and Repair	✓	✓	✓	✓
1	Equipment Replacement or Upgrades	✓	✓	✓	✓
One-Time Requirements					
1	DSTAR Center	✓			
1	Facility Maintenance and Repair Backlog	✓			
2	HME Characterization Equipment for the DTC		✓		

6.0 Horizon Investments

To support DHS program needs, S&T's Office of National Laboratories (ONL) has a responsibility to invest in capabilities to support the current authorized lab missions and project horizon investment opportunities for tangential growth and expansion. Making appropriate investments in laboratory infrastructure can be challenging due to the rapidly changing nature of the science, the growing threat to our Nation, and the fiscal restrictions imposed by government funding. ONL would be unable to meet DHS program needs without up-to-date infrastructure and equipment.

Provided below are three likely growth areas for TSL. In some cases, such as contraband and opioid detection, these are areas of tangential growth – areas that while not currently in the TSL mission space, they are so closely aligned in terms of science, infrastructure, or DHS mission that they are natural areas of expansion. In other cases, such as artificial intelligence, they represent an expansion of scientific capabilities to the current state-of-the-art within the existing mission space.

Although all the areas below represent likely future investment needs, because of a lack of certainty on the benefits of the technology or the lack of certainty on the future mission of TSL, ONL is not ready to make a formal request for dedicated funding. However, over the next few years, it is highly likely that TSL will need funding to support one or more of these capabilities.

6.1. *DHS Detection Sciences*

TSL's strategic vision is to expand the capabilities of TSL to be the source of validated threat and contraband screening technology for all DHS components. Future screening detection at the Department level will include a DHS capability both to develop and validate screening technologies for interdiction of pharmaceuticals, currency, and counterfeit goods, as well as energetic materials and weapons. This long-term strategy for TSL to serve as a full-service screening lab supporting the development and deployment of both transportation and infrastructure security systems may drive new requirements for additional or reconfigured laboratory spaces and equipment.

6.2. *Artificial Intelligence and Machine Learning*

As TSA's threat detection requirements become more comprehensive and more difficult for equipment vendors to meet, system developers are turning to machine learning algorithms whose performance already exceeds the performance of even the most sophisticated rules-based algorithms. While these algorithms hold the promise of greater detection, fewer false alarms, and faster throughput, there are issues associated with consistency of performance and latent vulnerabilities. A robust test infrastructure will help researchers to discover early in the development cycle those circumstances that might present a challenge to these sophisticated but inscrutable algorithms. Test automation, robust simulant design, and synthetic data will be key elements in developing a test regime for these data-hungry algorithms.

6.3. *Gas Forming Reactions*

Gas Forming Reactants (GFR) are materials that, when mixed with common substances (e.g., water), can form toxic gasses and are a recognized threat for enclosed spaces with limited opportunity for egress. It is particularly important to TSA to prevent terrorists from smuggling GFRs onto aircraft. It is likely that screening devices commonly used by TSA could undergo modifications followed by rigorous testing such that they could be reconfigured to detect GFRs. However, in order to test these modified systems, TSL needs to have the capability to synthesize and handle GFRs safely. Purpose-built chemistry labs in the DSTAR Center or FEMR building would allow TSL to synthesize, characterize, test, and handle these materials safely.

S&T Lab Infrastructure Requirements Assessment - Appendix C: Chemical Security Analysis Center

1.0 Introduction

At a moment's notice, actionable information about chemical threats or hazards readily must be accessible to emergency planners and responders. It can mean the difference between life and death for hundreds, if not thousands, of people in communities across the country where residential areas meet industrial processes and chemical transport by truck and rail. The Science and Technology Directorate (S&T) Chemical Security Analysis Center (CSAC) is the Nation's only federal studies, analysis, and knowledge management center for assessing threats and hazards associated with large-scale chemical incidents or acts of terrorism. CSAC is located at the Aberdeen Proving Ground in Maryland.

Figure 1-1. CSAC facility

Department of Homeland Security (DHS) Components rely on the data, modeling, simulation, and guidance produced by CSAC to inform their plans and response operations. For example, CSAC operates the world's largest nontraditional agent library, featuring 7,000 data points related to the synthesis and properties of toxic chemicals. CSAC also has been instrumental in compiling and synthesizing information on chemical facilities in the track of major hurricanes by providing actionable information to the Federal Emergency Management Agency, the Defense Threat Reduction Agency, and others. CSAC is a partner to the chemical industry providing scientific guidance to ensure safety, and the lab spearheads the Jack Rabbit program, which has resulted in rich data and a growing body of knowledge about the impact of large-scale chemical releases. The lab's expertise also includes opioid surveillance and detection, and modeling for gas-forming reactions (GFR) on aircraft.

CSAC needs to broaden its capabilities by providing an experimental space capable of analyzing "wet" chemicals to experiment on hazardous substances. A Chemical Security Laboratory (CSL) capability will enable CSAC to identify and validate chemical characteristics in emerging domestic threats, allowing DHS and the Department of Defense (DOD) to protect Americans against a domestic chemical attack. CSAC's mission is affected because CSAC and its partner labs currently are unable to perform the more specific chemical characterization at the empirical level required. Implementing the CSL will require continual investments in new capabilities and infrastructure to fulfill better its mission to ensure CSAC support in protecting the Homeland.

CSAC Mission

CSAC's mission is to assess and address chemical threats to the Homeland. CSAC accomplishes its mission by:

- Collecting, consolidating, curating, storing, and sharing chemical data;
- Generating meaningful assessments, recommendations, and forecasts based on vetted data;
- Identifying, prioritizing, and addressing data gaps through high-quality chemical research, development, test, and evaluation (RDT&E); and
- Performing modeling and simulation of chemical threats and complex environments.

CSAC Capabilities

CSAC provides an enduring, science-based threat and hazard analysis capability, with a core focus on six areas of expertise:

- **Risk and Consequence Modeling**: CSAC risk analysis subject matter experts developed the Chemical Consequence and Threat Tool, part of a comprehensive and integrated platform to analyze all hazards, on the premise that users need a single place to assess all types of threats comparatively. Subject matter experts provide timely hazard analysis, such as the potential consequences from vulnerable chemical facilities within a hurricane's impact zones or possible risks to the food supply chain, using the Chemical Consequence and Threat Tool as well as other modeling programs such as Hazard Predication and Assessment Capability and Quick Urban and Industrial Complex.
- **Chemical Sensors and Detection:** CSAC chemical detection experts conduct analysis and assessment of chemical warfare agents and toxic industrial chemicals for development and deployment of chemical detection and surveillance capabilities. They have assisted U.S. Customs and Border Protection with its detection and interdiction efforts, assessments of current opioid detection technologies, and instrumentation. They assess technology solutions for potential as an existing, modifiable, or developmental solution. CSAC's experts, in collaboration with other government agencies, develop new and advanced approaches for chemical detection.

- **Analytical Chemistry:** Seasoned chemists developed and utilize a Synthetic Opioid Data Repository for fentanyl and 200 synthetic analogs. Their world-renowned expertise and experience are leveraged to observe trends over time to anticipate changes in the threat landscape and to prepare proactively to address them.

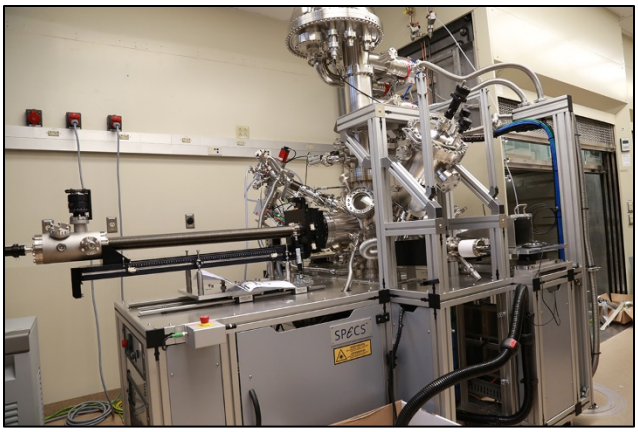

Figure 1-2. X-ray photoelectron spectroscopy can be used for profiling elemental composition.

- **Chemical Toxicology:** Toxicology subject matter experts investigate, analyze, and determine toxicity parameters used to characterize short-term and long-term health effects from acute lethal and sublethal exposures to toxic chemicals, including chemical warfare agents, toxic industrial chemicals, pharmaceutical-based agents, and emerging threats. CSAC partners with the U.S. Army, American College of Toxicology, Centers for Disease Control and Prevention (CDC), National Institute for Occupational Safety and Health, and industry in these efforts.

Figure 1-3. Lab technician performing chemical analysis

- **Synthetic Chemistry and Reaction Characterization:** CSAC developed the Chemical Agent Reactions Database (CARD), containing extensive data sets related to toxic chemical synthesis and properties, including emerging threat compounds. Featuring more than 2,000 chemical reactions, the CARD provides accurate, comprehensive, and actionable data for chemical threat forensics and attribution.
- **Nontraditional Agents and Emerging Chemical Threats:** CSAC maintains and operates the U.S. Government's largest nontraditional agents library, featuring 7,000 data points related to the toxicity, properties, and countermeasures for these toxic chemicals. This library informs CSAC products and capabilities, including the Countermeasure Assessment and Planning Tool, the Chemical Consequence and Threat Tool, CARD, 24/7 technical assistance program, and chemical release studies.

- **24/7 Technical Assistance:** CSAC maintains a continuous on-call technical assistance capability that leverages all tools and expertise outlined above to provide timely and accurate responses to validated questions and requests for analysis.

Notable Accomplishments

- CSAC served as the technical lead in analyzing chemical detection methods to screen packages for fentanyl and other opioids at U.S. Customs and Border Protection's international mail facilities through the S&T Synthetic Opioid Detection at Speed program.
- CSAC played a vital role in the DHS response to Hurricane Dorian as well as the 2020 hurricane season. The lab provided critical chemical facility information and analysis of toxic chemical hazards and risks for more than 2,000 chemical facilities in the Southeast United States, Puerto Rico, and Bahamas. CSAC continues to provide critical chemical facility information for current hurricane threats on the basis of expected landfall location and directional pathway.
- CSAC is working with the United Kingdom Centre for the Protection of National Infrastructure, the United Kingdom Department for Transport, the Transportation Security Administration, and the Combatting Terrorism Technical Support Office to model the transmission of SARS CoV-2 (the virus that causes the Coronavirus Disease 2019 pandemic) in aircraft to evaluate potential mitigation measures. This work was based on previous efforts that modeled the GFR threat to aircraft.
- Each year, hundreds of millions of tons of toxic industrial chemicals like chlorine and ammonia are transported through U.S. towns and cities. Although these chemicals are essential, they pose a risk to the public through the potential for an accidental release or an act of terrorism. To understand and address this risk better, CSAC conducted the Jack Rabbit program to execute multiple large-scale chlorine and ammonia-release experiments that never before had been tested at volumes representative of rail cars, tanker trucks, barges, or bulk storage tanks. Jack Rabbit filled crucial knowledge and data gaps to improve hazard prediction modeling, emergency planning and response, industrial safety and security, and national resilience against chemical release incidents.

Figure 1-4. Jack Rabbit 1 field test with chlorine release

2.0 Facility Maintenance and Repair Requirements

DHS leases space at the Aberdeen Proving Ground in Buildings E3401 and E3330 from the U.S. Army Combat Capabilities Development Command (CCDC) Chemical Biological Center (CBC). CSAC has approximately 50 percent of its staff in each building. DOD plans to renovate Building E3330, including gutting the entire building and leaving only the exterior walls and then rebuilding the interior. DHS has not identified temporary spaces yet that will be required for the staff during the construction period, but is working with DOD to identify temporary space. If DOD cannot find a suitable location to use as a temporary office space, CSAC may need to use DHS funds to secure rented trailers during the construction. This renovation is expected to take 3 years at a minimum. Although DHS will not be responsible for any renovation costs, CSAC will incur additional costs to move into, configure, and equip the necessary temporary spaces.

Beyond Building E3330 renovations, there are no other significant facility maintenance and repairs to note. S&T has focused on completion of facility condition assessments for laboratory facilities that are owned by S&T. S&T, therefore. has not completed a facility condition assessment for CSAC, to date, because it is in leased space from CCDC CBC. DHS is responsible for the facility modifications and upgrades that it requires within its leased space (e.g., sensitive compartmented information facility (SCIF) updates) and other shared facility maintenance and repairs with CCDC CBC. For any upgrades or renovations, CSAC coordinates with the Garrison's Directorate of Public Works, as necessary. A few examples of recent facility renovations and repairs include roof improvements to repair leaks and replacement of CSAC's SCIF vault door.

The estimated value of CSAC is $3.49 million. The Internal Revenue Service (IRS) depreciation rates applied at CSAC equates to approximately $0.09 million of facility repairs at CSAC annually. S&T plans to address ongoing facility maintenance and repair requirements based on available resources.

3.0 Inventory of Equipment and Systems that Require Routine Replacement or Upgrades

There are no immediate needs to replace or upgrade laboratory equipment at CSAC. The following is a summarized list of CSAC equipment that would require replacement over time in accordance with the expected service life for each equipment type:

Table 3-1. CSAC Equipment Summary Table

Equipment Category	Equipment Type	Estimated Total Acquisition Cost
Computer/Information Technology (IT)	Computer Desktop/Microtower	$102,900
	Computer Laptop	$103,900
	Computer Server	$87,400
	Computer Switch Network	$109,800
	Console	$2,800
	Firewall	$7,200
	Network Appliance	$5,200
	Router	$20,900
	Server Blade	$15,500
	Server Network	$12,200
	System Video Teleconference	$14,900
	Wireless Tester	$2,500
	Total Computer/IT	**$485,200**
Facility Equipment	Defibrillator	$3,000
	Printer/Copier/Scanner/Fax	$36,400
	Projector	$400
	Safe (General)	$8,700
	Scanner	$200
	Scanner (Handheld)	$3,100
	Security Appliance	$800
	Shredder	$2,000
	Total Facility Equipment	**$54,600**
Scientific Equipment	Planned Lab Equipment at CSL*	$374,000
	Total Scientific Equipment	**$374,000**
	Total Estimated Value of Equipment at CSAC	**$913,800**

** A list of planned lab equipment at CSL is included in Section 4.0.*

Based on the estimated value of CSAC equipment and the applicable Internal Revenue Service-published estimated rates of depreciation for these assets, S&T estimates that it would be responsible for replacing or upgrading approximately $0.14 million of equipment at CSAC annually.

4.0 Inventory and Assessment of Facility Capacity, Additional Space Requirements, and New Capabilities

4.1. Chemical Security Lab Capability

Mission Need

CSAC has identified a need for a CSL capability on the CCDC CBC campus. This is based on the long-term strategic imperative that CSAC must have and maintain the capability to fill critical data gaps for nonsurety chemical threats rapidly and to validate chemical and physical properties to characterize new and emerging threats. This effort is supported by Homeland Security Presidential Directive-22 Domestic Chemical Defense and is based on CSAC's directive to provide critical chemical threat information to senior leaders and operational decision makers related to chemical threats.

CSL will serve to provide an essential RDT&E capability to enable CSAC to address rapidly, flexibly, and agilely the increasing chemical terrorism threats that often require specific experimental characterization at an empirical level. CSL will strengthen chemical defense by filling time-critical data gaps from new and emerging threats, which may not be rapidly available or attainable through contracting with federal, state, or private laboratories. CSL will address key knowledge and data gaps found in scientific literature and will provide needed data to characterize, evaluate, and prioritize the hazardous effects due to exposure to chemical threats.

CSL will support the fundamental mission of DHS to protect the Homeland by serving as a vital addition to CSAC core capabilities. The CSL will set and validate data for CSAC's risk and consequence models and will contribute essential data to current projects, including the Probabilistic Analysis of National Threats, Hazards, and Risks S&T strategic program, Jack Rabbit, and GFRs, as well as future projects as they arise. Additionally, numerous benefits will be gained from CSL, including:

- Establishing an in-house RDT&E capability that will enable CSAC to investigate novel approaches, to develop innovative solutions, and to secure patents that address the Nation's most pressing and complex chemical threats;
- Providing hands-on experience to the DHS enterprise for chemical threat characterization activities to support operational needs;
- Training other agencies and personnel, utilizing expertise within CSAC;
- Supporting research that improves the quality of collected chemical threat data;
- Expanding CSAC's capabilities in support of long-term mission requirements; and
- Enhancing CSAC's support to its S&T sister laboratories.

Solution

CSAC will select the optimal space to lease and establish the proposed CSL capability and will not replicate other unique laboratory capabilities available at CCDC CBC. CSL will establish a tailored laboratory capability to validate, enhance, and support collection of data on chemical threats. CSL will not be utilized to conduct surety work or work with material requiring certifications (e.g., Drug Enforcement Agency-listed chemicals). The scope and type of testing

will be guided by the mission space of CSL and the scope of information required for CSAC projects and related activities. Staffing and instrumentation will be CSAC's responsibility.

CSAC plans to lease space either from CCDC CBC (Building E3330) or from the U.S. Army Medical Research Institute of Chemical Defense for CSL. As noted in Section 2.1, there are plans to renovate E3330 beginning in Fiscal Year (FY) 2021. CSL will be completed as a part of the Building E3330 renovations, and CSAC still is awaiting a cost estimate from CCDC CBC for establishing the CSL space.

The planned dimensions of CSL range between 12 feet to 16 feet in width and 24 feet to 32 feet in length. The space as leased will be equipped with electric utility lines and outlets, service closets, certified fume hoods, countertops, and storage space for chemicals and instruments. CSL will contain essential instrumentation capable of measuring physical and chemical properties for various chemical threats of interest to DHS. It will not require capital investment in large equipment costing more than $500,000 with burdensome annual service maintenance contracts. The following table summarizes the laboratory equipment to outfit CSL initially:

Table 4-1. CSL Equipment Cost Estimate

Laboratory Equipment	Estimated Acquisition Cost
Gas Chromatograph Mass Spectrometer	$190,000
Multi-Automatic Reactor	$22,000
Handheld pH/Ion/Conductivity Meter Field Kit	$3,000
Analytical Balance	$4,500
Three-Dimensional Printing Capabilities (for mockup environment and modeling validation)	$38,000
Handheld Raman Spectroscope	$3,500
Spectrophotometer/Fluorometer	$18,300
Handheld Fourier-Transform Infrared Spectrometer	$17,200
Glove Box	$12,500
Bench Top Scanning Electron Microscope	$65,000
Total Estimated Cost to Acquire Equipment for the CSL	**$374,000**

S&T plans to fund the initial purchase of CSL scientific equipment and instrumentation in FY 2021 from its existing budget. Beyond outfitting costs for CSL, CSAC estimates increasing annual leasing costs. The estimated leasing cost for CSL is based on leasing lab space at existing nearby federally owned facilities and would include any space fit-out costs, though none are anticipated.

5.0 Prioritized Schedule for Replacement of and/or Upgrades to Equipment and Systems

In order to continue to meet current mission requirements successfully and to support Homeland Security Enterprise customers, CSAC has facility maintenance and repairs and equipment replacement or upgrades, prioritized as follows:

Priory Level 1

- New construction, facility maintenance and repairs, or other capital improvements that would have safety, security, or laboratory readiness impacts if not implemented.
- Facility maintenance/repairs or equipment replacement that are necessary to execute mission requirements.

Priority Level 2

- New capabilities that are critical to meeting evolving mission requirements and that require additional facility capacity, space requirements, or specialized equipment.
- Although this would include CSL, it does not have any initial fit-out or equipment costs. Therefore, CSAC does not have any requirements identified in this category.

Priority Level 3

- New capabilities that are not critical to meeting mission requirements.
- Although these capabilities would enhance the lab's ability to support mission execution, they would not be considered necessary to do so.
- CSAC does not have any requirements identified in this category.

Table 5-1. CSAC Infrastructure Requirements Ordered by Priority

Priority Level	Requirement	Year 1	Year 2	Year 3	Out-years
Annual Requirements					
1	Facility Maintenance and Repair	✓	✓	✓	✓
1	Equipment Replacement or Upgrades	✓	✓	✓	✓
One-Time Requirements					
None					

S&T plans to address ongoing facility maintenance and repair requirements based on available resources.

6.0 Horizon Investments

This section includes investments 5 to 10 years in the future. It is prudent to plan these investments because of the time that it takes for new science to be established.

6.1. Chemical Threat Landscape

Numerous emerging and evolving chemical threats may affect CSAC laboratory infrastructure requirements needed to characterize those threats. Although we currently do not have programmatic needs to invest in laboratory capabilities to address the following threats, we continue to monitor investment needs to meet emergent requirements.

Synthetic Opioids and Other Synthetic Drugs
The availability and diversity of potent synthetic drugs will increase, posing new challenges to detection, interdiction, and public health.

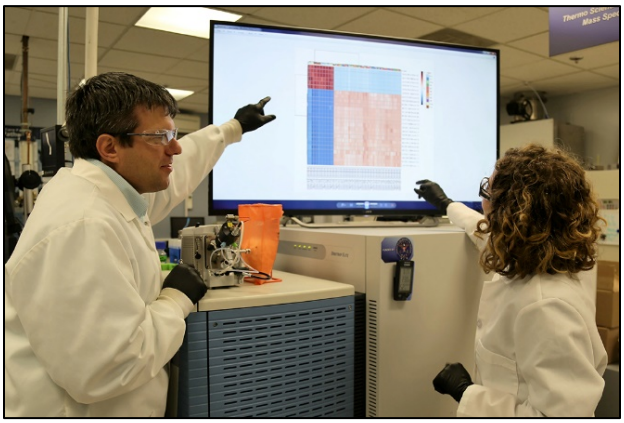

Figure 6-1. Scientists analyze data from a test of biomarkers to determine opioid exposure.

Domestic Synthesis/Illicit Laboratories
The proliferation of knowledge of synthetic routes and recipes for toxic chemicals and other dangerous compounds likely will lead to greater numbers of illicit labs.

Nontraditional Agents
The illicit use of Novachok agents and pharmaceutical-based agents necessitates an understanding of the effectiveness of current protective equipment and decontamination procedures.

Theft and Diversion
Toxic industrial chemicals can be stolen or diverted from legitimate streams of commerce to be used directly in an attack, or as precursors to be used to generate a toxic material, such as GFRs. Characterization of the stability, reactivity, dissemination, toxicity, and persistence of these materials is critical to providing a comprehensive evaluation of the chemical threat to the Homeland.

Unmanned Aerial Systems
With the increasing sophistication, payload capacity, and flight time/distances, unmanned aerial systems represent a new delivery mechanism, increasing the risk of chemical attack scenarios. Characterization of dissemination efficiency, droplet, and aerosol size distribution from these devices is important in understanding the threat posed by these relatively inexpensive and ubiquitous delivery devices.

3-D Printing
Increased sophistication and availability of three-dimensional printing may enable adversaries to acquire previously inaccessible parts and equipment for illicit activities, such as dissemination devices and illicit lab equipment.

S&T Lab Infrastructure Requirements Assessment - Appendix D: National Urban Security Technology Laboratory

1.0 Introduction

Roughly 81 percent of America's population is urban. These operating environments present unique dangers and complex operational challenges to our first responders. Whether it's saving people and property from the heinous acts of violent extremists, maintaining operations during chaotic events and civil unrest, or responding to a catastrophic hazard, first responders rely on sound science and technology to keep them out of harm's way. Police, firefighters, and other emergency responders should not have to guess about whether a piece of tech does what it is supposed to. That's where the Science and Technology Directorate (S&T) National Urban Security Technology Laboratory (NUSTL) and its trusted partnership with the national first responder community prove indispensable.

Strategically located in New York City, NUSTL works closely with interagency partners to test and evaluate first-responder technologies in and around the city's representative urban test bed. NUSTL conducts test and evaluation (T&E) activities that assess the capabilities and limitations of technology and equipment to be used in first responder operations. The results can be used to improve performance of systems under development, as well as to optimize system use and sustainment in operations. Frequently, NUSTL conducts T&E to inform first responder agencies' decisions to purchase and deploy systems and equipment. NUSTL's Radiological/Nuclear Response and Recovery portfolio executes research and development (R&D) activities that deliver technical support, tools, and actionable guidance so that state and local agencies can initiate an effective response in the first minutes and hours following a radiological or nuclear event. As new threats emerge, the NUSTL team is agile in addressing first responders' most pressing needs. For example, in response to the growing threat of drones, NUSTL quickly developed in-house subject matter expertise in and assembled an in-house team for the T&E of counter-unmanned aerial systems. NUSTL leverages its laboratory facilities in partnership with local first responder agencies for more efficient T&E, while providing its meeting spaces for Department of Homeland Security (DHS) coordination with interagency partners and multinational stakeholders.

Figure 1-1. NUSTL entrance

NUSTL Mission

NUSTL provides a full spectrum of research, development, test, and evaluation products and services in support of the first responder community, DHS Components and programs, and the broader Homeland Security Enterprise (HSE). NUSTL's core mission includes:

- Conducting independent T&E of emerging and commercially available technologies for first responders;
- Executing R&D in support of radiological and nuclear response and recovery; and
- Serving as trusted advisors for the first responder community and HSE.

NUSTL Capabilities

NUSTL requires dedicated resources to maintain modern capabilities and strategic investment in its infrastructure to support dynamic DHS and first-responder missions. NUSTL's infrastructure and subject matter experts serve the broader HSE by:

- Leading operational T&E with end-users and private industry manufacturers for both homeland security and first-responder missions;
- Providing a full range of T&E services, including test planning and execution, market research, focus group facilitation, data collection/analysis, technology demonstrations, and operational experimentations;
- Enabling the transition and delivery of user-centered technologies and tools;
- Supporting the operational integration and sustainment of technology into first responder operations;
- Producing technical reports and other knowledge products to educate and inform technology acquisition and deployment decisions;
- Bridging knowledge gaps between technology developers and first responder end-users; and
- Working closely with technology developers and end-users to validate technologies to meet operator needs and requirements.

Radiological/Nuclear Response and Recovery Research and Development

NUSTL's R&D program develops technical resources, tools, modeling, and guidance to help state and local agencies initiate a response in the first minutes and hours following a radiological/nuclear incident. The program works to improve radiological response capabilities at the federal, state, local, tribal, and territorial (FSLTT) levels. R&D activities successfully transition capabilities to first responders and the federal response assets that support them to save lives, to protect responders, and to minimize impact to the community and economy.

A recent highlight of the program is the development of *Radiological Dispersal Device Response Guidance: Planning for the First 100 Minutes*. A radiological dispersal device, or "dirty bomb," detonation in a local jurisdiction will have significant consequences for public safety, responder health, and critical infrastructure operations. NUSTL's animated videos of operationally focused missions and tactics help first responders to implement best practices and response activities during a radiological emergency.

Figure 1-2. Radiological Dispersal Device radioactive ballistic fragments into the surrounding environment

Technology T&E

With services addressing a diverse range of threats, hazards, and capabilities across the homeland security domain, NUSTL equips first responders with information to select and use key technologies and tools effectively in protecting our Nation's cities. NUSTL's test activities range from tests of personal protective equipment for first responders to far more complex evaluations of unmanned aircraft systems and their countermeasures. The results of the lab's T&E activities help first responder agencies to prepare for and respond to homeland security challenges and threats better, as well as to inform their technology and equipment acquisition and deployment decisions.

One of the highlights of NUSTL's T&E portfolio is its System Assessment and Validation for Emergency Responders (SAVER) program. NUSTL's SAVER program performs assessments on commercial technologies that fall under the approved list of equipment for the Federal Emergency Management Agency grant programs. SAVER T&E activities culminate with knowledge products, which are used to inform technology and equipment procurement decisions by FSLTT partners. These knowledge products have been described as "Consumer Reports" for first responder technologies and equipment because they investigate what equipment is available in the market, and how that equipment performs. SAVER products are shared nationally with the responder community, providing a life- and cost-saving value proposition to DHS and first responders. More than 1,000 reports are posted in the SAVER Library and more than 2,000 responders have participated in SAVER assessments and focus groups.

Urban Test Environment

In its current physical location, NUSTL is a hub for DHS in leveraging and maintaining key partner relationships in New York City, representative of a broader first responder community. This history and proximity to key players in its mission space has assisted NUSTL in establishing trusted partnerships and efficient two-way access to primary customers like the New York Police Department (NYPD), the New York City Fire Department (FDNY), and others. Over time, this strategic proximity to key stakeholders has enabled NUSTL to function as a focal point for national first responder T&E support.

NUSTL's location enables S&T to engage key partners and first responder customers rapidly and to leverage New York City efficiently as an "urban testbed" to demonstrate and test technologies. NUSTL's Manhattan facility enables quick deployment of critical emerging technologies into the hands of first responders. NUSTL can evaluate first-responder technology applications most effectively when doing so alongside its core customer base. When put into practice, these advantages provide benefits that support direct customers and the broader DHS preparedness and response mission.

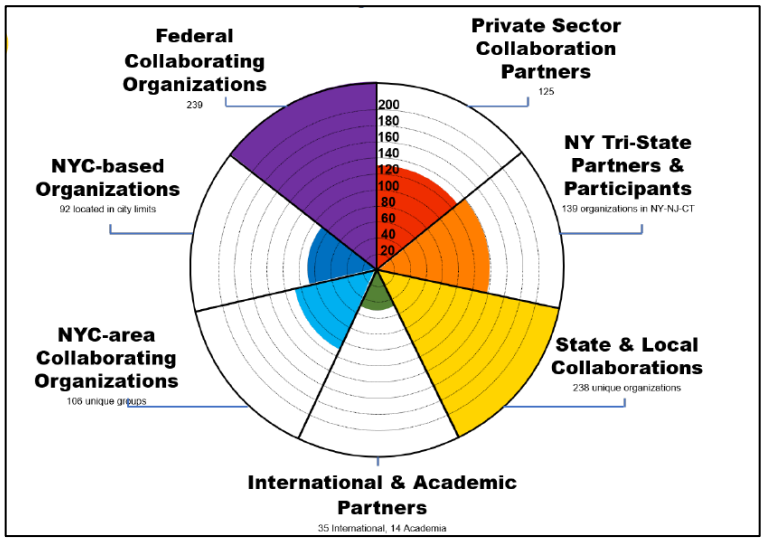

Figure 1-3. NUSTL Affiliations

NUSTL's location enables DHS to participate frequently in high-profile events in New York City with little advance notice because NUSTL easily can conduct local site visits and provide rapid, on-the-ground coordination with local stakeholders. For example, as a result of its longstanding relationships with local New York City agencies, NUSTL was able to secure the Grand Central Terminal as a DHS test venue at no cost to the agency for a realistic, urban, large-scale active shooter exercise in partnership with first responders. As part of this exercise, at the request of the participating New York City agencies—including the NYPD, FDNY, and the Metropolitan Transportation Authority (MTA)—NUSTL conducted technology insertion and evaluation of a variety of technologies to assess their potential for improving first responders' active-shooter preparedness and response. An after-action report summarized detailed technology performance, as well as documented lessons learned and recommendations on where and how the technologies could be most useful in improving active-shooter response. In addition to NUSTL's technology insertion

Figure 1-4. October 29, 2017, Incident training at Grand Central Terminal, New York City. S&T Chief of Staff Kathryn Coulter, NYPD Counterterrorism Division Lieutenant, S&T Under Secretary (Acting) William Bryan, MTA Chief of Police Owen Monaghan, and MTA Board Chairman Joseph Lhota.

and evaluation, S&T programs were able to use this exercise as an opportunity to insert their technologies and to assess their effectiveness in an active shooter scenario response, again at no cost to the government. More than 200 first responders and government representatives participated in NUSTL's critical incident exercise and technology assessment at Grand Central Terminal, with simulated activities occurring on parked trains, track platforms, and other indoor and outdoor spaces in and around the terminal.

2.0 Facility Maintenance and Repair Requirements

NUSTL is leased within a General Services Administration (GSA)-managed building in Manhattan. Although the majority of NUSTL's space is standard office space, there is also an array of specialized facility spaces, including:

- **Labs:** NUSTL's state-of-the-art facility is equipped with several rooms that are dedicated to hands-on technical work. These labs include a gamma room, neutron lab, ready room, and two test labs. Activities in these labs primarily involve tests of radiation detection equipment for New York City-area responders, radioactivity measurement and analysis, construction of hardware and peripherals for test activities, and tests of various first responder tools and technologies.

- **Radiation Source Storage:** NUSTL's Nuclear Regulatory Commission license is maintained for radiation sources, which are handled safely by specialized staff during trainings and exercises conducted by FSLTT and first responder agencies. NUSTL's training and exercise program is designed to support major metropolitan areas against the use of illicit radioactive materials.

- **Rooftop Lab:** NUSTL utilizes its rooftop lab area for T&E mission activities. For example, NUSTL installed a rooftop detector for air monitoring to characterize low-level wind profiles in an urban area for improving an urban dispersion model. In collaboration with scientists from Stony Brook University and the Department of Energy's (DOE) Brookhaven National Laboratory, a Portable Doppler Lidar and a Lightweight Micro-Rain Radar Pro instrument were installed on NUSTL's rooftop space.

- **Sensitive Compartmented Information Facility (SCIF):** The SCIF, accredited in 2020, provides a venue to share and discuss classified information and is utilized by S&T and other DHS agencies, including the Cybersecurity and Infrastructure Security Agency and the Office of Intelligence and Analysis, which share space with NUSTL.

Several active facility projects are funded through operations and support:

- NUSTL is optimizing its floor plan by converting single offices to double and by converting a conference room into hoteling space.
- DHS is releasing legacy facility space related to the prior DOE mission that no longer is required, including basement space and associated exhaust duct work and 5th floor drainpipes. GSA and DHS are evaluating the infrastructure for any residual contamination to determine what remediation is required to decommission the space. S&T already absorbed more than $500,000 of lab operations funding for studies and testing and anticipates absorbing an additional $1.5 million for remediation activities.
- The roof space is being renovated to ensure regulatory compliance and availability for mission requirements. The duct work in a shaft leading to the roof and the associated air handlers need to be decontaminated prior to the build-out.
- NUSTL will upgrade the existing limited area to a SCIF, which will include secure video teleconference equipment and C-Lan network access to allow for briefings up to the Top Secret/Sensitive Compartmented Information level.

Beyond these projects, there are no other significant facility maintenance and repairs to note currently. S&T has focused completion of facility condition assessments on laboratory facilities that are owned by S&T. S&T, therefore, has not completed a facility condition assessment for NUSTL, to date, because it is in leased space from GSA.

Although there are leasing costs for NUSTL within GSA space, its location in New York City offers an urban test bed with an unmatched number and variety of test sites that NUSTL can utilize without incurring additional leasing or maintenance costs. DHS is responsible for facility modifications and upgrades that it requires within its leased space, including space modifications and fit-outs to meet mission and operational requirements. For any upgrades or renovations, S&Ts NUSTL coordinates with GSA as required by the lease conditions. One example of recent facility renovations and repairs includes an updated floorplan and office space renovation completed in 2021.

The estimated value of NUSTL is $6.49 million. For tax purposes, the Internal Revenue Service has published estimated rates of depreciation for various classes of assets. These rates provide a reasonable basis to estimate the cost of maintaining lab infrastructure annually. When these depreciation rates are applied, S&T estimates that it would be responsible for approximately $0.16 million of facility repairs at NUSTL annually. S&T plans to address ongoing facility maintenance and repair requirements based on available resources.

3.0 Inventory of Equipment and Systems that Require Routine Replacement or Upgrades

There are no immediate needs to replace or upgrade laboratory equipment at NUSTL. The following is a summarized list of NUSTL equipment that would require replacement over time in accordance with the expected service life for each equipment type.

Table 3-1. NUSTL Equipment Summary Table

Equipment Category	Equipment Type	Estimated Total Acquisition Cost
Computer/Information Technology (IT)	Switch Network, Firewall	$17,063
	Analyzer (network, multichannel)	$127,263
	Cameras and Camcorders	$33,237
	Computer (mobile, pocket tablet)	$14,703
	Computer Desktop	$45,349
	Computer Gaming	$16,081
	Computer Laptop	$82,884
	Controller (wireless LAN, system)	$5,848
	Server Network	$55,657
	Virtual Reality	$3,000
	Total Computer/IT	**$401,085**
Facility Equipment	Forklift	$16,186
	Generator	$10,326
	Printer/Copier/Scanner/Fax	$36,060
	Projector	$5,854
	Safe (media)	$5,000
	Security	$14,607
	Shed Storage	$19,000
	Vehicles	$80,000
	Total Facility Equipment	**$187,033**
Scientific Equipment	Alpha/Beta Scaler	$12,283
	Amplifier	$10,000
	Detectors, Various types	$307,740
	Disk Array	$14,570
	Drone	$58,301
	Meters	$34,607
	Miscellaneous Lab Equipment	$25,038
	Monitor Portal	$12,543
	Oscilloscope	$16,302
	Radio Portable	$56,885
	Radon Monitor Alpha Guard	$8,100

Equipment Category	Equipment Type	Estimated Total Acquisition Cost
	Repeater Station with VHF	$12,500
	Scintillator, Various types	$144,454
	Shield Geli with roll top	$12,100
	Triathler	$9,970
	Total Scientific Equipment	**$735,393**
	Total Estimated Value of Equipment at NUSTL	**$1,323,511**

On the basis of the estimated value of NUSTL equipment and the applicable Internal Revenue Service-published estimated rates of depreciation for these assets, S&T estimates that it would be responsible for replacing or upgrading approximately $0.17 million of equipment at NUSTL annually. S&T plans to address ongoing facility maintenance and repair requirements based on available resources.

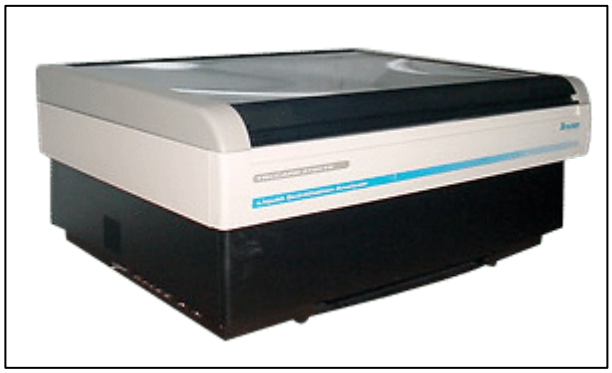

Figure 3-1. The liquid scintillation counter is used to measure radioactivity of a sample material by mixing the active material with a liquid scintillator and counting the resultant photon emissions.

4.0 Inventory and Assessment of Facility Capacity, Additional Space Requirements, and New Capabilities

The existing NUSTL facility footprint meets existing staffing and laboratory mission requirements. There are no significant facility capacity issues or additional space or equipment requirements that have been identified for NUSTL at this time.

As noted in Section 1.0, NUSTL's location positions it to act as a trusted advisor to local agencies. New York City first responder agencies specifically ask NUSTL to participate in local meetings and S&T engagements as their trusted advisor and conduit for any engagements linked to DHS. Having these and other agency and interagency partners nearby enables the increased ability for low- and no-cost test sites and presents opportunities for leveraging staff (often at no cost) and reducing logistical coordination costs. NUSTL's location in New York City and its multitude of urban test sites eliminates the need for laboratory facility expansion requirements for specialized T&E space.

5.0 Prioritized Schedule for Replacement of and/or Upgrades to Equipment and Systems

In order to continue to meet current mission requirements successfully and to support HSE customers, NUSTL requires funding for facility maintenance and repairs and equipment replacement or upgrades, prioritized as follows:

Priory Level 1

- New construction, facility maintenance and repairs, or other capital improvements that would have safety, security, or laboratory readiness impacts if not implemented.
- Facility maintenance/repairs or equipment replacement that are necessary to execute mission requirements.

Priority Level 2

- New capabilities that are critical to meeting evolving mission requirements and that require additional facility capacity, space requirements, or specialized equipment.
- NUSTL does not have any requirements identified in this category.

Priority Level 3

- New capabilities that are not critical to meeting mission requirements.
- Although these capabilities would enhance the lab's ability to support mission execution, they would not be considered necessary to do so.
- NUSTL does not have any requirements identified in this category.

Table 5-1. NUSTL Infrastructure Requirements Ordered by Priority

Priority Level	Requirement	Year 1	Year 2	Year 3	Out - years
Annual Requirements					
1	Facility Maintenance and Repair	✓	✓	✓	✓
1	Equipment Replacement or Upgrades	✓	✓	✓	✓
One-Time Requirements					
None					

S&T plans to address ongoing facility maintenance and repair requirements based on available resources.

S&T Lab Infrastructure Requirements Assessment - Appendix E: Information Technology

1.0 Introduction

The Department of Homeland Security (DHS) Science and Technology Directorate (S&T) laboratories must keep pace with modern technological advancements in order to remain effective. This includes the information technology (IT) infrastructure of the S&T laboratory network—the backbone of effective mission execution and successful collaboration with both internal and external stakeholders and customers. If IT does not keep pace with technological advancements, it ultimately becomes a hindrance to mission execution.

The budget supporting S&T laboratory IT requirements has remained flat while servicing and technological advancements have increased the demand for IT solutions. Lacking the needed capabilities, S&T lab directors are left with workaround solutions. One representative example: Several S&T labs are responsible for collecting and analyzing large amounts of data on emerging terrorist threats in cooperation with other governmental partners and have had to resort to mailing external hard drives physically, significantly delaying work while increasing the risk to the mission.

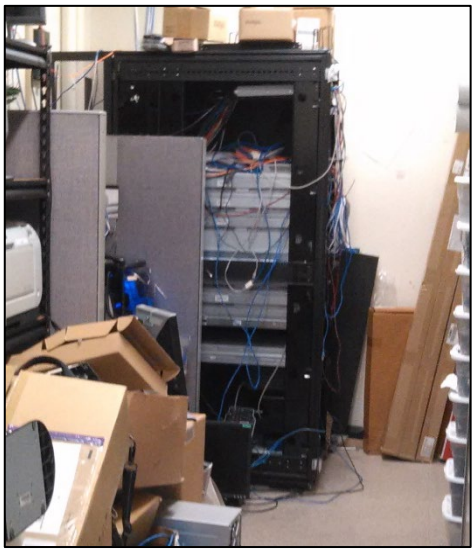

Figure 1-1. Local area network (LAN) servers & switches at the Transportation Security Laboratory

Each year, the technological debt increases, correlated to technological advances. The technology today includes: artifical intelligence (AI), machine learning (ML), in-flight predictive data analytics, software-defined networking and robotic process automation, and real-time collaboration capabilities. Threats continue to evolve, and DHS must work with other governmental agencies and international partners to stay a step ahead of these threats. The S&T labs will need the ability to conduct and share research in real-time with these partners to develop ways to detect and handle these emerging threats. Technological advances will accelerate the disparity between the S&T labs' capability and potential. Without a corrective investment to close this gap, S&T will be unable to support DHS scientific breakthroughs and exponential advances in technology, impeding its mission of providing life-saving technologies that protect the American people.

IT support currently is administered by S&T IT staff, augmented with local S&T lab resources. The coordination between S&T IT staff and at the S&T labs generally is limited to email and conference calls, which burdens staff with manually tracking open tickets and status. Additionally, the infrastructure and software applications in place have been acquired as needed over time, which has resulted in a disparate set of systems that increases the burden of maintenance and probability of errors. Productivity is constrained by day-to-day troubleshooting of basic issues with legacy infrastructure and systems, and this diverts IT staff from higher value activities. Additionally, software and applications used by each S&T lab, such as for records and

workflow management, are different. This leads to an increased burden across the organization for training and maintenance and requires purchasing more software licenses than necessary because of redundancy of functionality.

Investment into the lab IT infrastructure is essential to close the technological gap, to consolidate resources, to standardize equipment and processes, and to support the productive, integrated, and accessible body of knowledge to benefit DHS and the citizens of the United States. This initiative maximizes the use of shared resources (e.g., software licenses, equipment spares, and skilled labor) and reduces the maintenance and troubleshooting burden on IT staff that results from managing diverse legacy equipment and software. Additionally, this initiative improves the availability and reliability of the IT infrastructure upon which the critical research, development, test, and evaluation work of the S&T laboratories depends in support of its Homeland Security Enterprise customer base.

S&T Laboratory IT Modernization Initiative

An IT modernization initiative addressing existing challenges and future capabilities needed to meet mission objectives is currently underway. The strategy aims to improve the reliability, availability, and security of the S&T IT infrastructure.

The modernization effort aims to improve workflow and use resources more efficiently. Guiding principles were developed to influence decision-making at all levels during project execution with a goal to drive progress from the bottom up. The following principals are examples intended to provide guidance to all stakeholders, increasing active engagement and communication between groups:

- Reduce software licensing costs by leveraging existing resources (e.g., Office365 and SharePoint);
- Consolidate and integrate existing systems and processes better to improve workflow;
- Collaborate with regular communication and synchronization to enhance efficiency of integrating multiple solutions simultaneously;
- Empower team members to drive progress through an environment that fosters teamwork and learning; and
- Apply an economic framework to drive decision-making while decentralizing time-critical decisions to reduce product delays.

IT Operations and Support

IT systems comprise the foundational infrastructure that supports both S&T lab equipment data needs and the people and processes that drive the mission. Much of the scientific lab equipment generates or processes large volumes of data. These data require a reliable network backbone and storage to scale to future requirements. Personnel also are very reliant on the IT infrastructure to perform day-to-day tasks, from routing documents and records for approval to accessing research and collaborating with team members. Both staff and the scientific

equipment used are limited to the extent that the IT infrastructure allows; if a network is slow, all software, equipment, and effort that relies on that network would degrade.

For example, the National Biodefense and Countermeasures Center (NBACC) requires large network bandwidth to download publicly available genome sequencing data. Currently, lab personnel download these sequences offsite, often on residential WiFi, and transfer them via removable storage. Network upgrades are underway and are complete at some S&T labs. However, these upgrades are minimal, are insufficient to the extent of still limiting productivity, and struggle to keep pace with increasing demand for larger amounts of data.

Figure 1-2. Large computer cluster at NBACC

The S&T labs frequently collaborate with external partners, sometimes internationally, in real-time on large datasets. IT operations would benefit from new sharing capabilities to establish secure and quick connections with these partners. IT infrastructures also aid in performing transformation and analytics in real-time to streaming data and allow for the labs to become hubs of secure collaboration with other governmental agencies.

IT provides the ability for outreach and support to first responders, such as the Chemical Security Analysis Center (CSAC) granting access to the Chemical Agents Reactions Database (CARD) with critical, time-sensitive information to complete field work. Using a custom mobile application, CSAC could distribute CARD more quickly to inform first responders and law enforcement of the health consequences after human or animal exposure to hazardous chemicals. Faster access to this critical application potentially could save lives but is only possible with a more adaptive and resilient S&T IT infrastructure.

With proper standardization of equipment, software, reporting, processes, and priorities, S&T labs will become more effective and efficient at accomplishing mission objectives. The set of goals for S&T IT is aimed to be to be accomplished within a 5-year period. Currently, a project execution plan is being developed that will consider mission requirements, system dependencies, and available resources to prioritize the project objectives. The execution plan will provide the framework to guide efforts to reach the IT modernization initiative goals while considering applicable guiding principles and remaining in compliance with DHS IT security processes, policies, and mandates.

2.0 Existing Operational Challenges

This section outlines high-level IT challenges faced by the S&T laboratory network. For each challenge, a potential solution and estimated budget are proposed. Many of the solutions provided are interdependent and require additional planning and analysis to maximize the resultant benefits and value realized by S&T and its partners. Each solution addresses a pain point, impediment, or shortfall and will be analyzed against several alternatives to validate its feasibility, desirability, and sustainable viability. Continued evaluation to validate each solution potentially could increase or decrease the final cost. Therefore, the costs must be considered initial rough-order-of-magnitude estimates based on experience and engineering judgment.

2.1. Networks

Need

Many of the S&T labs are challenged with inadequate network capacity and data transfer speeds. In some cases, researchers have had to leave the facility to access the Internet through WiFi hotspots in order to retrieve online resources. Although regular upgrades to the networks are performed, they often lag S&T lab requirements. Some network equipment is deprecated and due for replacement; and some networks lack redundancy and require additional hardware to improve reliability. In some instances, S&T lab networks must pass through equipment owned by other organizations, such as leased spaces or facilities located within a military installation. Upgraded network services, therefore. must be coordinated with other entities and may require funding to support their equipment replacement.

S&T laboratory IT is hosted on two primary networks: LAN-A and SciTech. Although other networks are available, they only serve specialized purposes. Many of the typical collaboration tools such as calendars, Microsoft (MS) Teams, and shared drives are incompatible across network domains. Although a process is already underway to migrate users to a single network, the process is resource-constrained.

Solution

S&T IT staff will need to create a current network diagram and to conduct a comprehensive inventory of all equipment—including make, model, operating system version, and end-of-life/end-of-support timeframes—to aid in determining what equipment must be updated. A study to determine where network bottlenecks occur (e.g., routers, switches, bandwidth) and baseline issues also will need to be conducted. After chokepoints are identified, network stabilization can be alleviated through a combination of upgrading and homogenizing network hardware and internet connection services and offloading resources onto a cloud-based solution. A long-term strategic network upgrade plan then could be established that would influence subsequent IT upgrades because this is the backbone supporting many other IT services.

2.2. IT Infrastructure

Need

Some equipment currently used in IT operations either is insufficient to meet the growing data requirements of the S&T labs or is approaching end-of-service life. The variety of equipment increases the burden to manage configurations, updates, and troubleshooting. In addition to IT hardware, supporting building infrastructure such as server rooms and IT closets lack adequate cooling and power, which has affected equipment reliability negatively. In many cases, servers and network equipment are located in environments not suited for sensitive electronics, such as near a loading dock at the Transportation Security Laboratory (TSL). Many high-performance computing nodes used by NBACC's National Bioforensic Analysis Center are unusable because once they are at full capacity, the power circuits are overloaded. Although IT staff is working to address these issues, funding constraints limit options for temporary workarounds that are targeted to alleviate the most critical symptoms and do not address the root cause.

Figure 2-1. Network and IT equipment near garage entrance of TSL Building 319 without appropriate climate control

Solution

Migrating some resources to a cloud solution decreases the labs' reliance on current equipment, but equipment upgrades are still necessary. This includes replacing heating, ventilation, and air conditioning systems and duct work, upgrading power supplies, and building out new IT closets and server rooms that are suited better to house IT equipment. If the location of hardware is changed, security requirements still must be met. Therefore, security and access control systems also would be included in new buildouts.

2.3. File Sharing

Need

Many labs frequently need to share large amounts of data with both internal partners as well as with external partners, such as vendors and other government organizations. Although the information shared is primarily unclassified, there is a need for Secret and Top Secret/Sensitive Compartmentalized Information-level information. The workaround employed by the S&T labs all have limitations. In some cases, data must be saved to an encrypted external hard drive and physically mailed. The Homeland Security Information Network can be utilized, but it requires a DHS user account, limits file sizes, and has time usage constraints. AppAuth is a shared-drive solution that Information Assurance Information Security has used successfully to provide users with the capability to transfer files between the SciTech and LAN-A domains. It is an available, manually configured workaround that meets only some required functionality of internal users.

Solution

Different file-sharing platforms and tools could be utilized to mitigate these restrictions along with upgrading bandwidth to reduce transfer times. This solution will be confirmed from a rationalization phase environmental assessment by the S&T Chief Information Officer. During this phase, the cloud and network strategy is formulated, a roadmap is planned and prioritized, and the plan is executed. A prioritization model that has proven useful is the Weighted Shortest Job First model used to sequence efforts to provide the best economic outcomes. Adapting lean product development flow to sequence efforts, rather than theoretical, individual return on investment, produces the most favorable results. As applied, this model additionally supports the principles of taking an economic view that ignores sunk costs, uses objective decision rules, and quantifies delay costs. This deliberate strategy holistically can optimize the infrastructure factoring or growth, adaptability, scalability, security, and resilience.

Practicing security-first, the solution will need to meet strict access restriction and user authentication requirements and will require close coordination with IT Security. Some user accounts and user file storage have been migrated to Federal Risk and Authorization Management Program-approved Microsoft's Azure cloud through solutions, such as Office 365 and OneDrive. This approach not only reduces network burden but also provides a real-time automatic backup of user files so that risk of lost work is reduced.

Other solutions also are required to allow for sharing, rather than sending, large data sets with external entities. Hosting information on a cloud service may be explored and would depend on thorough cybersecurity reviews. Some data may be excluded from hosting in a cloud environment, and, therefore, procurement of additional hardware may be required. Hardware to host the data would include servers and supporting facilities or contracting with colocation datacenter space. To ensure security of these data and the rest of the S&T network, additional hardware would be required to facilitate the external connections to the equipment

2.4. Improved IT Services Support

Need

IT services currently are administered by both S&T lab IT and S&T IT staff. The ticketing systems, change management policies, and configuration controls are not aligned or are administered by different systems. For example, if an S&T lab employee submits a service request, it is processed by S&T lab IT personnel. However, escalating issues that are beyond the capabilities of S&T lab IT requires submitting a new ticket through a different system that lacks visibility to the end user. S&T lab staff have faced equipment availability issues in the past when updates took systems offline unexpectedly or functions ceased to operate after an update. The change and configuration management of these systems is challenged by the diversity in managed equipment as well as the fragmented IT support staff.

Solution

Value stream mapping (VSM) is a practice to illustrate, analyze, and improve the steps required to deliver a product or service. A key part of lean methodology, VSM reviews the flow of process steps and information from origin to delivery to the customer. VSM is especially useful to find and eliminate waste (e.g., nonvalue-added activity, overprocessing, delays, poor quality).

Items are mapped as adding value or not adding value from the customer's standpoint, with the purpose of rooting out items that don't add value. An analysis of alternatives would be performed to recommend solutions and tools on the basis of delivering value according to S&T's lab needs.

Common value streams may include the following functions: helpdesk; tier 1-3 support; and maintenance (corrective, adaptive, preventive, and, to stay current, perfective). These are representative examples of a shift from functional stovepipes to achieving a fast and flexible flow of IT services and products to the S&T labs.

One example is consolidating S&T lab service desk solutions to create efficiencies in ticketing while allowing standard performance metrics to be created across all S&T's laboratory IT. A standardized ticketing system would improve transparency to the end user and reduce the amount of overhead tracking various issues that live in multiple ticketing systems currently.

Another example is the standardization of device images and hardware across the S&T labs to improve change and configuration management by reducing the variability of managed systems and the amount of overhead dedicated to tracking system configurations and implementing changes. Infrastructure as a Service, Platform as a Service, and Software as a Service—combined with DevSecOps, containerization, and robust continuous integration/delivery and monitoring of the infrastructure for vulnerabilities—are tools that together can be focused to track the health of network-connected systems and applications to alert IT to issues before they affect lab operations.

2.5. Records and Knowledge Management

Need

The S&T labs require the capability to collaborate securely in real-time on emerging threats with other governmental and international partners. This collaboration capability must include standardized records and knowledge management, real-time audiovisual collaboration, and shared virtual workspaces that provide computing and storage resources. The ability to self-provision such instances from a "menu" of standard configurations is neither difficult nor unreasonable for researchers, data scientists, mathematicians, and forensic analysts to expect.

Across the S&T laboratories, records do not have a standardized structure and nomenclature, though some labs have specific document management requirements to comply with applicable federal regulations or quality processes. Routing of documents for approval typically relies on email, which is extremely inefficient. Records often lack a central repository for completed records with a dedicated file structure. This often results in missing documents or knowledge loss resulting from staff turnover. SharePoint sites that were being used often are outdated. Links are stale and may not resolve to an active page. There are artifacts of past efforts that no longer provide value yet consume resources.

Solution

The S&T labs must have the capability to collaborate in real-time, to comply with record-retention policies, and to capture, index, associate, find, and share knowledge securely. The viability, scalability, and feasibility of a solution depends on the execution of the infrastructure strategy, implemented as a value-stream, and architected to prioritize the delivery of the highest-value, shortest-duration capabilities regularly and at a sustainable cadence. The resulting product of the infrastructure strategy will be that foundation upon which all solutions depend. The collaboration needs for the S&T labs will be filled, and they will start to realize the benefits that accrue from this steady stream of standardized capabilities.

Figure 2-2. Records and Knowledge Management graphic

Solutions may include use of a dedicated SharePoint development team to build out and mange user interfaces that allow for routing and final storage of documents. A third-party, off-the-shelf solution also may be utilized. Additional policy updates may be required to maintain consistency as much as possible.

Knowledge management requires a similar approach as records management and should manage enterprisewide content. Commercial products that support search, document versioning and workflow, and collaboration—such as Documentum or Slack—may be purchased to replace the assortment of tools used differently across the S&T labs. If a government-off-the-shelf or commercial-off-the-shelf solution does not meet the viable, desirable, feasible, and sustainable test, then a custom solution may be an alternative for assessment (e.g., SharePoint with custom user interfaces).

3.0 Future Operational Needs

3.1. Machine Learning/Artificial Intelligence

Need

The volume of data available to the S&T labs continues to grow faster than their capabilities can accommodate. The insights locked in the large data sets remain inaccessible without scalable computing resources. Few labs have the required equipment and software necessary to support advanced ML, AI, and blockchain capabilities required for experimentations, collaboration, learning, and breakthroughs. The S&T labs need these capabilities to support advanced research and development. For example, TSL is working toward the capability to use ML to identify potential weapons and explosives in luggage at airport scanners, which may increase greatly the security for air travel. NBACC currently has limited ML/AI and needs to expand these capabilities for predictive modeling of risks posed by new and emerging biological threats.

Figure 3-1. NBACC user processing bioinformatics data

Solution

Potential solutions will depend heavily on frequency of use, level of security required for the data, and other requirements. A detailed requirements analysis is necessary before considering cloud-based solutions such as Amazon Web Services GovCloud, which can host sensitive data and regulated workloads while addressing stringent government security and compliance requirements. Privacy and cyber security requirements may require an on-premises solution that would require the procurement of servers, network equipment, security equipment, air conditioning, power, and physical security. If all labs may benefit from these capabilities in-house, a single data center dedicated for ML/AI may be used and integrated with S&T's laboratory networks.

3.2. Mobile application development

Need

Most S&T labs have an immediate need requiring mobile access to applications to improve operational efficiency greatly. Two representative examples include creating mobile applications for CSAC's CARD tool and NUSTL's System Assessment and Validation for Emergency Responders (SAVER) program.

CARD provides law enforcement with critical information on chemicals found in clandestine laboratories that may be processing illicit drugs or chemical weapons. CARD provides safe-handling information of potentially lethal chemicals and aids law enforcement in determining what is being manufactured by inputting a list of chemicals found on site.

The SAVER program conducts assessments and validations on commercial equipment and systems and provides this information with relevant equipment information to first responders

through a web portal. This allows first responders to compare equipment used in the field prior to procurement.

CARD and SAVER are currently accessible through a secure web interface to authorized first responders and law enforcement. A mobile application that mirrors the functionality of the web portals would make these tools easier to use and more accessible in the field. This would lead to more timely delivery of potentially lifesaving information and broader adoption of the tools.

Solution

A mobile application development team is required to design the front-end interfaces and write the backend code for the applications on the basis of user requirements. Application development would need to comply with all IT security requirements, and the application development team would need to work closely or be integrated with the S&T IT security team.

3.3. Workflow Management

Need

Workflow management is approached differently and at varying levels across the S&T labs. Most S&T labs do not have a workflow management tool in place. Some rely on Microsoft Teams, which is very limited in workflow management capabilities. Other S&T labs recently have started using Jira. Having sufficient project and workflow management tools would create more effective project planning and completion, reducing the labor hours required.

Solution

A workflow process and procedure first would need to be established and then software may be used to manage the process. Many tools exist that currently can handle these needs, such as Slack or Jira. Having secure, synchronized tools could allow for lab collaboration and more cost-effective training and licensing. Building out SharePoint could be one option to help to manage workflow processes. However, the tools chosen should be standardized across labs and throughout S&T to the extent possible while also being integrated with other solutions that are developed.

3.4. Licensing

Need

S&T lab staff are often unaware of all software tools available to them for use. In some instances, software may be available through DHS or S&T. Some labs have purchased licenses individually for specific software to address a need, while other labs purchased licenses for different software to address the same need. The ability to manage these licenses within a software center would allow for better resource-sharing and reduction of cost and overhead administration. S&T IT currently uses Microsoft System Center Configuration Manager to manage updates and licenses. However, not all licenses are visible or available through this service, and it is not available for devices that do not run on a Windows operating system.

Solution

A full inventory of available software licenses both internal to S&T and through DHS and other government agencies is required first. Then, for each license, work must be done to import that license into the Microsoft System Center Configuration Manager system. Other solutions also may be required to supplement or replace Microsoft System Center Configuration Manager to address all devices, including those that do not run on Windows. Once established, regular maintenance of the managed licenses will be required as new software versions become available.

4.0 Prioritized Schedule for Replacement of and/or Upgrades to Equipment and Systems

Under the S&T laboratory IT Modernization Initiative, a comprehensive and detailed list of challenges and needs has been established to meet mission requirements successfully and to support Homeland Security Enterprise customers. Additionally, new tools and systems developed will be managed iteratively, with lessons learned compounding efficiency gains throughout duplicative projects. The number of solutions will be minimized to address the needs of all S&T labs to increase efficiency further, prioritized as follows:

Priority Level 1

- IT system replacement or upgrades that are necessary to maintain the current mission capabilities.

Priority Level 2

- New capabilities that are critical to meeting evolving mission requirements and that require additional facility capacity, space requirements, or specialized equipment.
- There are no IT requirements in this category.

Priority Level 3

- Other IT investments that are not critical to meeting mission requirements.
- Although these capabilities would enhance the S&T labs' ability to support mission execution, they would not be considered necessary to do so.

Table 4-1. S&T Laboratory IT Infrastructure Requirements Ordered by Priority

Priority Level	Requirement	Year 1	Year 2	Year 3	Out-years
One-Time Requirements					
1	Network Improvement	✓			
1	IT Infrastructure Upgrades	✓			
1	File Sharing	✓			
1	IT Service Support	✓			
3	Records and Knowledge Management			✓	
3	ML/AI			✓	
3	Mobile Application Development			✓	
3	Workflow Management			✓	
3	Licensing			✓	

It should be noted that, because of the uncertainty inherent in IT projects that include discovery, analysis of alternative solutions, and complex delivery, this priority list may shift and will be managed actively throughout IT modernization efforts.

Appendix F - List of Abbreviations

Abbreviation	Definition
24/7	24 hours per day, 7 days per week
AI	Artificial Intelligence
AIT	Advanced Imaging Technology
ATC	Aberdeen Test Center
BNBI	Battelle National Biodefense Institute
BSL	Biosafety Level
CARD	Chemical Agent Reactions Database
CBC	Chemical Biological Center (U.S. Army)
CCDC	Combat Capabilities Development Command (U.S. Army)
CDC	Centers for Disease Control and Prevention
COVID-19	Coronavirus Disease 2019
CSAC	Chemical Security Analysis Center
CSL	Chemical Security Laboratory
CT	Computed Tomography
DHS	Department of Homeland Security
DOD	Department of Defense
DOE	Department of Energy
DSTAR	Detection Sciences Testing and Applied Research
DTC	Detection Technology Center
DT&E	Developmental Test and Evaluation
EDS	Effluent Decontamination System
FBI	Federal Bureau of Investigation
FCA	Facility Condition Assessment
FDNY	New York City Fire Department
FEI	Field Electron and Ion Company
FEMR	Facility for Energetic Material Research
FSLTT	Federal, State, Local, Tribal, and Territorial
FY	Fiscal Year
GB	Gigabyte
GSA	General Services Administration
HME	Homemade Explosive
HSE	Homeland Security Enterprise
HVAC	Heating, Ventilation, and Air Conditioning
IED	Improvised Explosive Device
IRS	Internal Revenue Service
ISO	International Organization for Standardization
IT	Information Technology
IT&E	Independent Test and Evaluation
MicroCT	Micro-Computed Tomography

ML	Machine Learning
MOA	Memorandum of Agreement
MS	Mass Spectrometry
MTA	Metropolitan Transportation Authority
NBACC	National Biodefense Analysis and Countermeasures Center
NBAF	National Bio and Agro-Defense Facility
NBFAC	National Bioforensic Analysis Center
NBTCC	National Biological Threat Characterization Center
NGC	Next-Generation Sequencer
NUSTL	National Urban Security Technology Laboratory
NYPD	New York City Police Department
ONL	Office of National Laboratories
PIADC	Plum Island Animal Disease Center
RDT&E	Research, Development, Test, and Evaluation
S&T	Science and Technology Directorate
SAVER	System Assessment and Validation for Emergency Responders
SCIF	Sensitive Compartmented Information Facility
SEM	Scanning Electron Microscope
SysBio	Systems Biology
T&E	Test and Evaluation
TEDAC	Terrorist Explosive Device Analytical Center
TEM	Transmission Electron Microscope
TIEDS	TEDAC Improvised Explosive Device Synthesis Center
TRMG	Tyndall Reactive Materials Group
TSA	Transportation Security Administration
TSL	Transportation Security Laboratory
TS/SCI	Top Secret/Sensitive Compartmented Information
USDA	United States Department of Agriculture
VDI	Virtual Desktop Infrastructure
VSM	Value Stream Mapping