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Exhibit R-2, PB 2010 Army RDT&E Budget Item Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 1 - Basic Research					R-1 ITEM NOMENCLATURE PE 0601102A DEFENSE RESEARCH SCIENCES					
COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
Total Program Element	164.633	198.103	173.024						Continuing	Continuing
F20: ADV PROPULSION RSCH	2.185	3.321	3.348						Continuing	Continuing
F22: RSCH IN VEH MOBILITY	.532	.556	.567						Continuing	Continuing
H42: MATERIALS & MECHANICS	2.385	6.311	6.040						Continuing	Continuing
H43: RESEARCH IN BALLISTICS	6.018	8.129	8.252						Continuing	Continuing
H44: ADV SENSORS RESEARCH	3.971	6.192	6.377						Continuing	Continuing
H45: AIR MOBILITY	2.237	2.341	2.373						Continuing	Continuing
H47: APPLIED PHYSICS RSCH	2.752	2.876	2.955						Continuing	Continuing
H48: BATTLESPACE INFO & COMM RSC	6.578	8.891	11.434						Continuing	Continuing
H52: EQUIP FOR THE SOLDIER	.936	.978	1.035						Continuing	Continuing
H57: Single Investigator Basic Research	54.802	63.871	64.988						Continuing	Continuing
H66: ADV STRUCTURES RSCH	1.609	1.711	1.818						Continuing	Continuing
H67: ENVIRONMENTAL RESEARCH	.809	.909	.946						Continuing	Continuing
	.407	.424	.000						Continuing	Continuing

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H68: PROC POLLUT ABMT TECH										
S04: MIL POLLUTANT/ HLTH HAZ	.679	.709	.000						Continuing	Continuing
S13: SCI BS/MED RSH INF DIS	10.271	10.896	10.536						Continuing	Continuing
S14: SCI BS/CBT CAS CARE RS	4.410	6.186	6.539						Continuing	Continuing
S15: SCI BS/ARMY OP MED RSH	6.200	9.525	7.120						Continuing	Continuing
S19: T-MED/SOLDIER STATUS	.695	.751	.000						Continuing	Continuing
T14: BASIC RESEARCH INITIATIVES - AMC (CA)	26.609	24.319	.000						Continuing	Continuing
T22: SOIL & ROCK MECH	2.144	2.221	2.311						Continuing	Continuing
T23: BASIC RES MIL CONST	1.612	1.713	1.770						Continuing	Continuing
T24: Signature Physics and Terrain State Basic Research	1.412	1.452	1.521						Continuing	Continuing
T25: Environmental Science Basic Research	5.365	6.116	7.958						Continuing	Continuing
T61: Basic Research Initiatives - MPMC (CA)	3.675	4.386	.000						Continuing	Continuing
T63: ROBOTICS AUTONOMY, MANIPULATION, & PORTABILITY RSH	.000	1.495	1.230						Continuing	Continuing

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2040 - Research, Development, Test & Evaluation, Army/BA 1 - Basic Research					PE 0601102A DEFENSE RESEARCH SCIENCES					
T64: SCI BS/SYSTEM BIOLOGY AND NETWORK SCIENCE	.000	.000	1.285						Continuing	Continuing
305: ATR RESEARCH	2.201	2.307	2.378						Continuing	Continuing
31B: INFRARED OPTICS RSCH	2.415	2.552	2.676						Continuing	Continuing
52C: MAPPING & REMOTE SENS	2.597	2.698	2.788						Continuing	Continuing
53A: BATTLEFIELD ENV & SIG	2.818	3.002	3.216						Continuing	Continuing
74A: HUMAN ENGINEERING	2.937	5.028	5.703						Continuing	Continuing
74F: PERS PERF & TRAINING	3.372	6.237	5.860						Continuing	Continuing
A. Mission Description and Budget Item Justification										
This program element (PE) fosters fundamental scientific knowledge and contributes to the sustainment of US Army scientific and technological superiority in land warfighting capability and military problems related to long-term national security needs, provides new concepts and technologies for the Army's future force, and provides the means to exploit scientific breakthroughs and avoid technological surprises. The PE fosters innovation in Army niche areas (such as lightweight armor, energetic materials, night vision) and areas where there is no commercial investment due to limited markets (e.g., vaccines for tropical diseases). It also focuses university single investigator research on Army areas of interest, such as high-density compact power and novel sensor phenomenologies. The in-house portion of the program capitalizes on the Army's scientific talent and specialized facilities to transition knowledge and technology into the appropriate developmental activities. The extramural program leverages the research efforts of other government agencies, academia, and industry.										
Projects not specifically addressed through R2a exhibits include Research in Vehicle Mobility that focuses on research within the advanced military ground vehicle mobility/propulsion areas (project F22); environmental research that focuses on research on innovative environmentally-friendly technologies for the future with particular emphasis on energetics processing, surface protection for armaments and tactical vehicles, Soldier support systems, non-stockpile chemical warfare site remediation and decontamination of biological warfare agents (project H67); processes and pollution abatement technology focuses on in-situ explosive biodegradation mechanisms and direct analysis and identification of explosives degradation pathways in contaminated soils and mechanisms of neurotoxicological effects in mammals caused by exposure to RDX and MNX (project H68); military pollutant/health hazards focuses on research is to increase knowledge in the area of toxicology effects of military relevant compounds on mammals as well as endangered species (project S04); S19										

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- T-Medical/Soldier Status that focuses on fundamental science and technology for improved training methods for battlefield medical personnel that includes measurement of tissue properties to permit more accurate simulation of the human body, and development of predictive algorithms for heart and respiration rate (project S19). The work in this PE is coordinated and integrated between four primary contributors: 1) the Army Research, Development, and Engineering Command (RDECOM); 2) the US Army Engineer Research and Development Center (ERDC); 3) the Army Medical Research and Materiel Command (MRMC) laboratories; and 4) the Army Research Institute for Behavioral and Social Sciences (ARI). The basic research program is coordinated with the other Services via Defense Basic Research Advisory Group and other inter-Service working groups. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this PE is primarily managed by: the US Army Research Laboratory (ARL), Adelphi, MD and RDECOM, Aberdeen, MD; the Medical Research and Materiel Command (MRMC), Ft. Detrick, MD; the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS; and the US Army Research Institute for the Behavioral and Social Sciences (ARI), Arlington, VA.				
B. Program Change Summary (\$ in Millions)				
	FY 2008	FY 2009	FY 2010	FY 2011
Previous President's Budget	165.020	176.959	169.627	
Current BES/President's Budget	164.633	198.103	173.024	
Total Adjustments	-.387	21.144	3.397	
Congressional Program Reductions	.000	-7.656		
Congressional Rescissions	.000	.000		
Total Congressional Increases	.000	28.800		
Total Reprogrammings	2.588	.000		
SBIR/STTR Transfer	-2.975	.000		
Change Summary Explanation				
FY09 increase is due to congressional adds.				

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
F20: ADV PROPULSION RSCH	2.185	3.321	3.348						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds research to increase the performance of small air-breathing engines and power trains to support improved system mobility, reliability, and survivability, and ultimately serve to reduce the logistics cost burden for the future. Problems addressed include the need for greater fuel efficiency and reduced weight in these propulsion systems. Technical barriers to advanced propulsion systems are the inadequacy of today's materials to safely withstand higher temperature demands, the lack of capability to accurately simulate the flow physics and the mechanical behavior of these systems, including the engine and drive train. The Army is the lead Service in these technology areas (under Project Reliance) and performs basic research in propulsion, as applicable to rotorcraft and tracked and wheeled vehicles. Technical solutions are being pursued through analysis, code generation, and evaluations to improve engine and drive train components and investigate advanced materials. Component level investigations include compressors, combustors, turbines, energy sources and conversion, injectors, pistons, cylinder liners, piston rings, gears, seals, bearings, shafts, and controls.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Reliable Small Engines for Unmanned Systems: Develops improved tools and methods to enhance the reliability and fuel efficiency of small engines for air and ground vehicles and to enable the use of heavy fuels. In FY09, investigate high priority engine technology shortfalls associated with small unmanned aerial systems (UAS) that can also benefit emerging robotic platforms and energy generation platforms with similar power requirements. Conduct research to establish a small engine-class analytical database and tools. In FY10, will utilize validated suite of system simulation tools to identify and improve component and system operation of current and potential Army small engine applications.	.000	.996	1.030	
Thermal Materials: Investigates new materials needed to withstand the higher temperature regimen of advanced high performance engines, and evaluates improved tools and methods that will accurately simulate the flow physics and the	2.185	2.303	2.318	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
mechanical behavior of future engines and drive trains which will contribute to the design of more fuel efficient and reliable propulsion systems. In FY08, formulated life prediction models for low conductivity thermal barrier coatings to improve the turbine design process and completed the face gear dynamic load prediction modeling computer code to improve the transmission design process. In FY09, investigate synchronized speed control shifting algorithms that could enable variable speed helicopter transmissions and formulate diagnostic fault detection methods to improve the safety and reliability of helicopter transmissions. In FY10, will investigate optimum fiber architecture needed to fabricate uncooled turbine components for increased fuel efficiency and develop improved sand trajectory modeling methodology to improve the safety, durability, and reliability of turbine engines.					
Small Business Innovative Research/Small Business Technology Transfer Programs		.000	.022	.000	
Total		2.185	3.321	3.348	
C. Other Program Funding Summary (\$ in Millions) N/A					
D. Acquisition Strategy N/A					
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.					

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
F22: RSCH IN VEH MOBILITY	.532	.556	.567						Continuing	Continuing
<u>A. Mission Description and Budget Item Justification</u> This project conducts research in support of advanced military vehicle technology with emphasis on advanced propulsion, sophisticated vehicle dynamics and simulation, and advanced track and suspension concepts. Advanced propulsion research will dramatically improve power density, performance and thermal efficiency for advanced adiabatic diesel engines, transient heat transfer, high temperature materials and thermodynamics. This project also supports state-of-the-art simulation technologies to achieve a more fundamental understanding of advanced high-output military engines. The subject research is directed at unique, state-of-the-art phenomena in specific areas such as: 1) non-linear ground vehicle control algorithms, using off-road terrain characteristics; and 2) instantaneous diesel engine optimizations, using advanced analytical and experimental procedures. This work is performed at the Tank and Automotive Research, Development and Engineering Center.										
<u>B. Accomplishments/Planned Program (\$ in Millions)</u>							FY 2008	FY 2009	FY 2010	FY 2011
Small Business Innovative Research/Small Business Technology Transfer Program							.000	.009	.000	
Advanced mathematical algorithms for improved vehicle efficiency: In FY08 explored JP-8 versus DF-2 combustion differences, performed terrain assessment through a novel three dimensional optical technique, investigated physics-based human modeling. In FY09, further investigate JP-8 versus DF-2 combustion differences, expand physics based human modeling effort for vehicle-human interaction dynamics, and explore improved vehicle-terrain methodologies. In FY10, will develop engineering models for JP-8 ignition and combustion profiles, will explore reduced chemical kinetics JP-8 ignition models, will further explore vehicle-human interaction dynamics, and will improve vehicle-terrain modeling methods.							.532	.547	.567	
Total							.532	.556	.567	
<u>C. Other Program Funding Summary (\$ in Millions)</u> N/A										
<u>D. Acquisition Strategy</u> N/A										

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<u>E. Performance Metrics</u> Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.		

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H42: MATERIALS & MECHANICS	2.385	6.311	6.040						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds the Army's basic research in materials science, which includes research into key phenomena enabling the creation and production of revolutionary materials that will provide higher performance, lighter weight, lower cost, improved reliability, and environmental compatibility for Army unique applications. The current approach of using materials to gain added functionality for Army systems is to use a layered approach, whereby each layer provides added capability (i.e. ballistic, chemical/biological, signature, etc.) but ultimately makes the system too heavy and too expensive. Technical solutions are being pursued through understanding the fundamental aspects of chemistry and microstructure that influence the performance and failure mechanisms of ceramics, advanced polymer composites, and advanced metals, with the goal of creating hierarchically organized materials systems that possess multifunctional attributes at greatly reduced weight and cost. These advanced materials will enable revolutionary lethality and survivability technologies for the future. This research supports materials technology applied research in PE 0602105A, project H84.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Materials research and processing at small scale: In FY09, research concept of materials by design which will conduct material modeling studies to enable bottom-up armor materials design. Research methods relating processing to materials microstructure that feeds ballistic property models with focus of the effort largely on ceramics. In FY10, will perform materials research to relate properties observed at small scale to microstructure; and will perform research relating ballistic model output to processing, properties and microstructure.	.000	1.734	1.816	
High deformation rate materials: In FY09, investigate engineered scalable materials for armor applications using nanoscale building blocks; characterize their properties and feed ballistic modeling efforts to rapidly screen for performance. Create underpinning understanding to enable the engineering of expedient materials.	.000	2.224	1.838	

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B. Accomplishments/Planned Program (\$ in Millions)			FY 2008	FY 2009	FY 2010	FY 2011
In FY10, will investigate the relationships existing between high rate properties and prior processing; and will characterize nanoscale materials using high resolution microscopic analytical methods for feedback to processing and modeling research for protection materials.						
Microscopic/Nanostructural Materials: Devise new materials and design capabilities, based upon fundamental concepts derived at the microscopic and nano-structural levels, for the future force. In FY08, implemented and validated models for fragmentation, reactive materials, and ballistic penetration; enhanced processing and non-destructive evaluation for improved armor ceramics; used directed assembly to embed functionality into polymer materials; and validated multifunctional material performance. In FY09, perform comprehensive materials characterization for damage-tolerant sub-micron SiC ceramic materials, and develop 1st-generation phenomenological constitutive and failure model for SiC-N ceramic materials for armor. In FY10, will research grain boundary engineering of ceramics to improve fracture tolerance at low and high rates; and will characterize materials using a combination of electron microscopy and crystallographic orientation tools to identify optimum microstructures for ballistic protection.			2.385	2.262	2.386	
Small Business Innovative Research/Small Business Technology Transfer Programs			.000	.091	.000	
Total			2.385	6.311	6.040	
C. Other Program Funding Summary (\$ in Millions) N/A						
D. Acquisition Strategy N/A						
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.						

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H43: RESEARCH IN BALLISTICS	6.018	8.129	8.252						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project seeks to improve the understanding of the chemistry and physics controlling the propulsion, launch, and flight of gun launched projectiles and missiles, and to understand the interaction of these weapons with armored targets. This research results in basic new knowledge, which allows the formulation of more energetic propellants, more accurate and non-lethal/lethal projectiles and missiles, and advanced armors for increased survivability of Army combat systems. This effort supports the Office of the Secretary of Defense Advanced Energetics Initiative to mature the fundamental technologies required to transition the next generation of energetic materials into field use. This research supports survivability and lethality technology applied research in PE 0602618A, project H80.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Armor research: In FY09, investigate modeling and simulation of ballistic impact events to include modeling materials response with enhanced failure models that capture realistic behavior with minimum parameterization; create fundamental ceramic/glass model and develop mesoscale approaches. For electromagnetic armor technology create physics based models to address coupling ballistic and electrodynamics models for solid mechanics, computational fluid dynamics, and material failure models; and validate model predictions. In FY10, will develop models for armor plate acceleration that do not utilize explosive materials; will obtain laboratory derived mesoscale modeling parameters for ceramic materials to enable modeling of ceramic armor materials at the micro-structural level; and will begin the study of a thermodynamically-consistent equation of state theory.	.000	1.967	2.017	
Launch and flight of gun launched projectiles and missiles: Improve the fundamental understanding of the mechanisms controlling the launch and flight of gun launched projectiles and missiles, and understand the interaction of these weapons with armored targets.	2.544	2.564	2.661	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
In FY08, quantified damage in select ceramics using destructive and non-destructive techniques; devised reactive material ignition model; devised a controlled fragmentation model; and implemented models for urban structural material failure in continuum codes. In FY09, devise 1st-generation physically consistent phenomenological constitutive and failure model for select damage-tolerant ceramics; implement both controlled fragmentation and reactive material ignition models into a continuum mechanics code; and model effects of secondary debris on humans and compare model results with actual human injury data obtained from the medical community. In FY10, will identify the controlling mechanisms through modeling and validation that are responsible for the ballistic effectiveness of ceramic materials; will expand the reactive material ignition model to include a variety of reactive materials with different terminal effects; and will adjust the urban material failure model to account for numerous urban construction materials.					
National Advanced Energetics Initiative: Expand and confirm physics-based models and validation techniques to enable design of novel insensitive propellants/ explosives with tailored energy release for revolutionary Future Force survivability and weapons effectiveness. In FY08, simulated energy transfer and conversion within shocked and heated energetic materials formulations; fabricated and characterized reduced sensitivity nano-engineered energetic materials; derived theoretical descriptions and produced hyper-energetic polymeric nitrogen; characterized structural bond energy release materials; and refined models to include hot fragment impact, shear ignition sensitivity, emerging multiphase fluid dynamics, thermo-mechanical coupling, and reactive materials initiation. In FY09, design smart, molecularly engineered energetics; design insensitive, nano-reactive energetic materials/structural energetic composites; differentiate initiation reactions caused by conductive versus shear stimuli; explore turbulent mixing and combustion in late-time energy release; and characterize sensitivity and performance of insensitive warhead explosive fills and validate refined propellant models. In FY10, will provide new theoretical descriptions, quantum mechanical models, and real-time, in-situ validation measurements of energy storage and release mechanisms in non-traditional condensed phase materials such as structural nano-reactives, metastable polymeric, strained crystals, and diamond-like explosives.		2.600	2.580	2.647	
Extramural research in non-lethal (NL) control methods to exploit potentially innovative approaches that offer unique battlefield and homeland defense capabilities.		.874	.883	.927	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
In FY08, exploited advances in biotechnology to develop more refined modeling and validation techniques to ascertain the effects of blunt trauma and impulse loading at the cellular level. Attempted to coherently combine multiple optical fibers to enhance high intensity laser output at kilowatt levels. In FY09, focus research efforts on bridging gaps that link these governing mechanisms and lay the groundwork for the prediction of overall response, including human functions such as cognitive and physical performance. Attempt to demonstrate man-portable microwave sources operating at 94 GHz for active denial and crowd control, intending to leverage the development of the micro-machined sources. In FY10, will conduct research on high rate response of biological materials, cause of injury, and injury mechanisms for development of novel protection concepts. Will research energy flow processes at interfaces to develop precise control of explosive effects. Will focus on the analysis and understanding of hyper-spectral image data and the development of rigorous mathematical models and hierarchical statistical techniques to characterize ballistic impacts.					
Small Business Innovative Research/Small Business Technology Transfer Programs		.000	.135	.000	
Total		6.018	8.129	8.252	
C. Other Program Funding Summary (\$ in Millions) N/A					
D. Acquisition Strategy N/A					
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.					

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H44: ADV SENSORS RESEARCH	3.971	6.192	6.377						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds basic research to produce future generations of sensors with capabilities beyond those currently being employed. Technical barriers include the fundamental speed and bandwidth limitations of current materials and devices, the efficiency of current algorithms, current computing architectures, organic material lifetimes, the understanding of the fundamental concepts of quantum cryptography, and spatial resolution of current radio frequency (RF) sensors. The technical approach is to exploit large scale electromagnetic (EM) models to predict and explain target and clutter scattering behavior, digital and image processing modules and algorithms, beam propagation and material modeling of nonlinear optical effects, hazardous material detection, remote sensing and intelligent system distributive interactive simulations, unique sensor development, sensor data fusion, and battlefield acoustic signal processing algorithms. Research performed under this project supports survivable sensor systems, organic thin film transistor (OTFT) technology and organic light emitting diode technology for affordable rugged flexible displays, and hazardous material monitoring, both point and remote. Payoffs include low cost compact flexible displays for the Soldier and for the Army, improved radar signal processing techniques that will allow existing systems to improve spatial resolution, improved ultra wideband (UWB) radar technology for detection of explosives including mine detection, through the wall sensing and robotics perception, improved sensor approaches and signal processing techniques for enhanced acoustic/seismic sensing systems in noisy environments, distributed sensor data fusion in ad hoc networks, improved cryptography techniques, and hazardous material and event sensing. This project also funds research in the development of biologically inspired materials for use as sensors as well as for power generation and storage.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Small Business Innovative Research/Small Business Technology Transfer Programs	.000	.079	.000	
Biologically-inspired sensing and power generation: In FY09, conduct research to advance novel biologically inspired sensor methodologies for biological hazards detection and bio-inspired routes to assembly of electronic structures. Research bio-inspired materials for lightweight, portable energy generation and storage.	.000	1.980	2.031	

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B. Accomplishments/Planned Program (\$ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011	
In FY10, will investigate bacteria that remediate energetic materials and produce small organic molecules useful as fuels, bio-inspired structural materials for energy absorption, bioinspired batteries, and biologically directed assembly of electronic structures.					
Improving sensor capabilities: create more survivable/secure systems and displays, and improve hazardous material monitoring. In FY08, developed methods to mitigate sensitivity of imaging radar to multipath-induced false alarms; conducted limited error rate analyses to assess the potential for compromising quantum systems; researched distributed spatial and temporal processing and data fusion algorithms for networks of heterogeneous and possibly mobile sensor nodes; investigated new magnetic sensor technologies for personnel detection; produced final Surface Enhanced Raman Scattering hazardous material sensing assessment report, implemented & filed a patent on a novel class of OTFTs, and developed novel conducting organic materials to improve Organic Light Emitting Diodes (OLED) efficiency. In FY09, research target & clutter scattering to support radar detection of concealed targets; evaluate completed signal processing algorithms for networks of heterogeneous sensor nodes; assess biologically-inspired techniques for advanced photonic structures, and continue to improve high conducting films to integrate with OLED and OTFT development. In FY10, will integrate conductive organic materials and high stability OLED with flexible backplanes and investigate non-linear spectroscopic methods for trace-level detection of hazardous chemicals. Will implement initial distributed sensor data fusion approaches for adhoc networks, will enhance EM scattering models of rooms to include building infrastructure for through-the-wall sensing and perception research, will fabricate and test sample metamaterial antennas.	2.435	2.471	2.618		
Adaptive, active, and intelligent optical systems for high-data-rate military communications and directed energy applications: In FY08, researched potential configurations for small agile adaptive apertures for high-bandwidth optical communications and directed energy applications, and defined conformal adaptive optical components for Gigabit free-space laser communications and directed energy configurations. In FY09, research parameters and define the operational envelope for the use of ultra short (femtosecond) laser illumination for the Army's active imaging and directed energy applications. In FY10, will explore long range atmospheric laser beam propagation paths for military reconnaissance, laser communications, and directed energy applications.	1.536	1.662	1.728		
Total	3.971	6.192	6.377		

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<u>C. Other Program Funding Summary (\$ in Millions)</u> N/A <u>D. Acquisition Strategy</u> N/A <u>E. Performance Metrics</u> Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.		

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H45: AIR MOBILITY	2.237	2.341	2.373						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project supports basic research in aerodynamics for manned and unmanned rotary wing aircraft. The goal of this effort is to develop improved tools and methods to analyze, evaluate, and test rotorcraft unique aerodynamic properties in conventional helicopter and tilt rotor aircraft. The efforts in this project will result in a better understanding of rotorcraft aeromechanics and will result in improved performance, safety and, ultimately, improved combat effectiveness of the manned and unmanned rotorcraft in the future force. This project supports the future force by providing research into technologies that can improve tactical mobility, reduce the logistics footprint, and increase survivability for rotary wing aircraft.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Small Business Innovative Research/Small Business Technology Transfer Programs	.000	.044	.000	
Rotary Wing Aerodynamics: In FY08, began development of new methods for accurate aeroelastic stability prediction. Explored rotor fuselage interactions for complex configurations using advanced computational fluid dynamics methods. Investigated aeromechanics issues for high altitude rotors. In FY09, develop improved modeling methods for active rotors using national full-scale aerodynamic complex validation data, assess capability of state-of-the-art turbulence models for capturing rotorcraft flow physics such as intersecting and vortical flows, and develop improved dynamic stall models for comprehensive analysis. In FY10, will investigate interacting vortex wakes for tandem rotors, will identify the high speed aeromechanics boundaries of compound helicopter configurations, and will examine the adequacy of one dimensional beams versus three dimension finite elements to model rotor structural components in aeromechanics analyses.	2.237	2.297	2.373	
Total	2.237	2.341	2.373	

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<u>C. Other Program Funding Summary (\$ in Millions)</u> N/A <u>D. Acquisition Strategy</u> N/A <u>E. Performance Metrics</u> Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.		

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H47: APPLIED PHYSICS RSCH	2.752	2.876	2.955						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project performs basic research on electronic materials and structures as well as energetic batteries and fuel cells to enable higher performance and more efficient electronic systems. This includes nanoelectronic devices for low-power and high-frequency applications; sensors, emissive nonlinear and nanophase electrode, and electronic materials; thin heterostructure systems where quantum confinement effects are important; advanced batteries and more efficient fuel cells for hybrid power; and the manipulation of cold atoms on a chip for application to very sensitive sensors and ultra-stable atomic clocks. These investigations will impact the development of power sources and specialty electronic materials for the Army's future force, including improved wide band gap semiconductor performance in electric vehicles and advanced radar systems. Applications of cold atom chips include gyroscopes and accelerometers for inertial navigation units, gravitational sensors for detecting underground facilities, very-low-phase noise precision oscillators for low-velocity Doppler radar, and atomic clocks denied global positioning system (GPS) environments for possible space applications. Technical barriers affecting performance, weight, cost, and power consumption will be addressed.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
This research focuses on nanoelectronic devices and sensors; materials for advanced batteries; fuel cells and reformers for Soldier and vehicle power; electronic materials structures and defects of high-temperature wide-band-gap semiconductors for high-power electronic applications; cold-atom chip devices for advanced sensors and ultra-stable atomic clocks; and integration of nanoenergetics and micro electro mechanical system (MEMS) for fuzing and microrobotic applications. In FY08, investigated carbon nanotube (CNT) and other nanowire-based active electronic devices, explored thermal characteristics of relevant nanostructures, and transported atoms to an atom chip chamber; investigated regenerable sulfur sorbents for JP8 reformation and materials for high power Li-ion batteries. In FY09, investigate system insertion for nanoelectronic devices and sensors and failure mechanisms for wide-bandgap electronic devices; attempt measurements of a cloud of cold atoms on an atom chip; and develop capability for creation	2.752	2.841	2.955	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
of bio-inspired materials for batteries and fuel cells. Formulate electrode/electrolyte systems based on fundamental understanding of their interface. In FY10, will attempt to load and launch cold atoms into an atom waveguide. Will integrate nanoporous energetic silicon with MEMS acceleration switch; will investigate functionalization of nanoelectronic devices for chemical detection and implement functionalization protocols. Will use computer modeling and simulation to guide design of reformer components.					
Small Business Innovative Research/Small Business Technology Transfer Programs		.000	.035	.000	
Total		2.752	2.876	2.955	
C. Other Program Funding Summary (\$ in Millions) N/A					
D. Acquisition Strategy N/A					
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.					

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H48: BATTLESPACE INFO & COMM RSC	6.578	8.891	11.434						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project supports basic research to enable intelligent and survivable command and control, communication, computing, and intelligence (C4I) systems for the future force. As the combat force structure becomes smaller and operates in more dispersed formations, information systems must be more robust, intelligent, interoperable, and survivable if the Army is to retain both information and maneuver dominance. This research supports the Army's new Network Science initiative and in the process addresses the areas of information assurance, the related signal processing for wireless battlefield communications, document and speech machine translation, and intelligent systems for C4I. Major barriers to achieving the goals are the inherent vulnerabilities associated with using standardized protocols and commercial technologies while addressing survivability in a unique hostile military environment that includes highly mobile nodes and infrastructure, bandwidth-constrained communications at lower echelons, resource-constrained sensor networks, diverse networks with dynamic topologies, high-level multi-path interference and fading, jamming and multi-access interference, levels of noise in speech signals and document images, new low-density languages, and information warfare threats. The intelligent systems for C4I research will focus on providing the agent technology capabilities that will produce highly relevant tactical events for mounted or dismounted commanders, leaders and soldiers; improve the timeliness, quality and effectiveness of actions; and speed the decision-making process of small teams operating in complex natural or urban terrain.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Design and implement a laboratory scale common information-processing infrastructure, inclusive of service oriented architecture for networking processes that aids in the transformation of data into actionable intelligence to support decision-making under uncertainty. In FY08, investigated the application of information mediation service techniques to produce fused actionable intelligence for military mission planning and execution such that data providers, including robotic sensors, Soldiers, and agency-based data systems, were connected using service oriented architecture networking techniques and information agents. Investigated pose recognition from imagery to determine location in GPS-denied areas.	1.396	1.453	1.522	

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B. Accomplishments/Planned Program (\$ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011	
In FY09, evaluate 3-D scene reconstruction and pose recognition for enhanced situational awareness, along with information mediation improvements to the military operational and tactical decision and planning process. In FY10, will extend scene recognition algorithms to mobile platforms to support biologically inspired collaborative behaviors. Will investigate local and global policy aware information exchange and information exploitation algorithms in collaboration with the Network Science CTA initiative.					
Network Science Technology Experimental Center. Investigate fundamental network behaviors utilizing high performance computing software that enables the design and analysis of mobile ad hoc networks at sufficient levels of fidelity and with sufficient speed to understand network centric warfare (NCW) technologies in the full range of conditions in which they will be employed. Investigate and devise scalable software tools that significantly extend the capabilities to perform simulation, emulation and validation of mobile ad hoc networks. Devise a software environment that will enable the eventual integration and linking of the simulation-emulation-validation cycle. In FY10, will devise advanced computing based tools to accelerate scenario/model development, coupling of different models, verification and validation (V&V), and enhanced multi-disciplinary collaboration through common user interfaces, scalable library routines, pre-processing, scalable optimization routines, and post-processing analysis tools.	.000	.000	1.776		
Perform research to provide communications capability for a fully mobile, fully communicating, and situationally aware force operating in a highly dynamic, wireless, mobile networking environment populated by hundreds to thousands of networked nodes. In FY08, refined scalable algorithms to incorporate technologies in sensor radios. In FY09, perform laboratory analysis to incorporate technologies in mobile radio units. Develop scaling laws for mobile ad hoc and sensor networks under military constraints. In FY10, will perform validation analysis to extract tractable models of network behavior to enhance military network design tools.	1.587	1.651	1.728		
Study the behavior of mobile ad-hoc networks (MANETs) as part of the Army's Network Science initiative. Emphasis is on mobile communications networks research with the Army's University Affiliated Research Center, the Institute for Collaborative Biotechnology at the University of California - Santa Barbara. In FY08, designed formal models, abstractions, and metrics for mobile ad hoc networking and extended them to simulations, and conducted scalability analyses and design models of mobile ad hoc routing protocols and their functional concepts, incorporating biological paradigms where applicable.	.970	.994	1.016		

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B. Accomplishments/Planned Program (\$ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011	
In FY09, conduct component-based performance modeling and analysis of routing protocols and design networking protocols that adapt to varying operating environments in order to optimize performance. In FY10, will develop and compare component based analytical models with executable models to enable the design of robust tactical networks.					
Perform research in protecting information in highly mobile wireless tactical environments with severe bandwidth, energy, and processing constraints and operating without reliance on centralized security services. In FY08, designed and evaluated intrusion detection algorithms on mobile ad hoc networking protocols, including under hostile conditions, using formal methods to represent protocols. In FY09, design and evaluate analytically and via simulation/emulation, robust classes of algorithms that will provide a dynamic architecture that will support detection of attackers under conditions of mobility. In FY10, will refine and evaluate the dynamic security services architecture for mobile tactical networks for assured Soldier communications.	1.605	1.668	1.747		
Establish formal methods for bridging language barriers in tactical environments, incorporating state of the art techniques in machine translation and natural language processing. In FY08, investigated, evaluated, and implemented service oriented architecture (SOA) concepts required to transition language technologies to Deployable Harmony Document Exploitation (DOCEX) System (DHDS) and Distributed Common Ground System-Army (DCGS-A). In FY09, explore multi-engine machine translation architectures for processing and exploiting multi-media, multi-language (e.g. Arabic, Farsi, and Swahili) sources. In FY10, will develop and assess novel metrics for evaluating new multi-engine machine translation architectures.	1.020	1.061	1.112		
Advanced Computing. In FY09, research in advanced computing algorithms and techniques addresses implementation issues for mobile networking, machine based language translation, and information processing infrastructure. Research computer based modeling, simulation and data analysis techniques for the study of scientific phenomena and engineering designs. In FY10, will investigate algorithms, approaches, and methodologies for battle command applications that exploit emerging mobile hybrid computing architectures. Battle command applications will include large-scale battlefield network modeling; real-time algorithms to assist network emulations; comprehensive data representation, models and analysis techniques; information fusion of different data types; engineering design based approaches.	.000	1.987	2.533		

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010
Small Business Innovative Research/Small Business Technology Transfer Programs		.000	.077	.000
Total		6.578	8.891	11.434
C. Other Program Funding Summary (\$ in Millions) N/A				
D. Acquisition Strategy N/A				
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.				

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H52: EQUIP FOR THE SOLDIER	.936	.978	1.035						Continuing	Continuing
<u>A. Mission Description and Budget Item Justification</u> This project supports basic research to achieve technologies for the Soldier of the future which focus on core technology areas that include mathematical modeling, physical and cognitive performance, polymer science/textile technology, nanotechnology, biotechnology, and combat ration research. Effort is targeted on enhancing the mission performance, survivability, and sustainability of the Soldier by advancing the state-of-the-art in the sciences underlying human performance, clothing, and protective equipment to defend against battlefield threats and hazards such as ballistics, chemical agents, lasers, environmental extremes, and ration shortfalls. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Defense of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work is performed and managed by the Natick Soldier Research, Development, and Engineering Center (NSRDEC), Natick, MA.										
<u>B. Accomplishments/Planned Program (\$ in Millions)</u>							FY 2008	FY 2009	FY 2010	FY 2011
Equipment for the Soldier: In FY08, investigated novel markers useful in high sensitivity pathogen detection for ration safety; examined utility function theory to understand behavioral principles and provided a framework for analyzing and predicting long-term acceptance and use of future Soldier system mission gear. In FY09, screen multiple isolates for advancement to biofilm formation for rapid screening of foods for pathogenic bacteria; and address selected behavioral principles most likely to impact long term acceptance and use results. In FY10, will use novel computational methodologies to understand techniques necessary to simulate dynamics/interactions of fluid structure systems undergoing topology change as would be found in parachutes, parafoils and flexible structures.							.936	.978	1.035	
Total							.936	.978	1.035	
<u>C. Other Program Funding Summary (\$ in Millions)</u> N/A										

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<u>D. Acquisition Strategy</u> N/A <u>E. Performance Metrics</u> Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.		

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H57: Single Investigator Basic Research	54.802	63.871	64.988						Continuing	Continuing

A. Mission Description and Budget Item Justification

This extramural research project discovers and exploits new scientific opportunities and technology breakthroughs, primarily at universities, to improve the Army's Transformational Capabilities. Current technologies are unable to meet the operational requirements of the future force. The Army Research Office of the Army Research Laboratory (ARL) maintains a strong peer-reviewed scientific research program through which leap-ahead technological solutions may be discovered, matured, and transitioned to overcome the technological barriers associated with next generation capabilities. Included are research efforts for increasing knowledge and understanding in fields related to long-term future force needs in the physical sciences (physics, chemistry and biology), the engineering sciences (mechanical sciences, electronics, materials science and environmental science (atmospheric and terrestrial sciences)), and mathematical and information sciences (mathematics, computer, and information sciences) and network science. Targeted research programs in nanotechnology, smart structures, multifunctional and microminiature sensors, intelligent systems, countermeasure, compact power, and other mission-driven areas will lead to a Future Force that is more strategically deployable, more agile, more lethal, and more survivable. The breadth of this basic research program covers approximately 900 active, ongoing research grants and contracts with leading academic researchers and approximately 1,600 graduate students yearly, supporting research at nearly 250 institutions in 50 states.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed extramurally by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Basic research in mathematical and computer sciences is the backbone for performing complex, multi-system analysis, modeling and understanding simulation, and information systems. Advancements in mathematical and computer sciences have a direct impact on enhancing the warfighters' decision-making, situation awareness, command and control, as well as on the overall performance of weapon, intelligence, transportation and logistics systems. In FY08, continued efforts focused on devised intelligent processing systems to improve fusion of hard (sensor)/soft (human) information, and also devised new architectures to exploit the network centric nature of the fusion problem. The advancements made in hard/soft fusion results in better operational situational awareness, more informed decision making, and more effective mission planning, training and simulation.	9.944	11.982	12.477	

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B. Accomplishments/Planned Program (\$ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011	
In FY09, devise tools for design of heterogeneous swarms for desired emergent behavior, which leads to better system design or control design for military systems such as UAVs, UGAs, or robotics. In FY10, will demonstrate the effectiveness of the devised products and tools on swarming and sensor fusion in laboratory test-beds. These results will lead to computer techniques designed to identify attacks against information systems, protecting information systems from attacks, and on devising techniques for inherently hardened software. New understanding and knowledge gained will directly contribute to the development of robust and resilient information systems that address the processing and delivery of authentic, secure, reliable, and timely information to the warfighters, regardless of threat conditions.					
Basic research in environmental science possesses three areas: (i) atmospheric science research to measure, model, and theoretically understand the nighttime atmospheric boundary layer; (ii) terrestrial science research to enable the Army to operate effectively in all military operating environments by understanding fundamental terrain and land-based phenomena; and (iii) military habitation science, basic research to allow military power projection that meets operational needs in a sustainable manner. In FY08, environmental science focused on the development of analysis techniques in scale, resolution, and formats for boundary layer wind fields; investigations of energy and mass transfer processes between the atmosphere, the land surface and sub-surface; and improving landmine/unexploded ordinance (UXO) sensing. In FY09, investigate environmental effects on geophysical techniques used remotely to sense both the surface and shallow subsurface and understanding relationships between surface and subsurface characteristics of the soil system, with a focus on soil moisture through a multi-agency R&D initiative. Military habitation science focuses on basic research to support resource reuse and transformation, energy recovery, and energy conversion at base camps. In FY10, will address Army-unique atmospheric operational needs and will investigate automated terrain navigation by autonomous vehicles and will use geographic information systems (GIS)-based approaches for cognitive understanding and utilization of geospatial information, analysis, representation, and modeling of multiple types of geospatial data.	1.985	1.887	2.131		
Basic research in molecular, physiological, and systems biology to improve Soldier performance, to protect Soldiers, and to create new Army materiel and capabilities. In FY08, focused on lower cost technologies for bioremediation, on new biomaterials and technologies for better Soldier protection, and on novel biotechnologies for improved Soldier performance and reduced Soldier casualties. In FY09, the focus is on exploiting the multidisciplinary interface of bionanoengineering to engineer bioinspired nanodevices with novel capabilities, to use biomimetics to create new protective materials, and to understand and engineer	3.970	5.753	5.829		

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
countermeasures to the molecular and physiological factors that impair Soldier cognitive and physical performance. Undertake a systems biology approach to bioremediation focused on the few microbial species capable of degrading toxic halogenated pollutants, investigate modulating the effects of oxidative stress on Soldier health and performance, investigate the biophysics and modeling of spore germination and inactivation for effective biowarfare countermeasures, and explore other species sense and computing capabilities for novel algorithms usable in automated and remote military systems. Study the use of synthetic materials and molecular circuits capable of promoting tissue regeneration, develop tools in synthetic biology to construct genetic programmable circuits that can serve as the basis for chemical and biological sensing, use noninvasive human state sensors, correlate physiological signals with behavioral functions and human performance, and model and engineer relevant microbial species for the optimal synthesis of energy for military specific needs. In FY10, this basic research will be continued with a concurrent transition towards field use.					
Basic research in electronics and photonics for situational awareness, communications, information processing, electro-magnetic warfare, and power efficiency. In FY08, completed model for insights into high power quantum dot lasers for IR countermeasures. Demonstrated increased power at terahertz frequencies for chem/bio (CB) detection and imaging radar applications. Determined frequency limitations of polymer nano-composites, black silicon, and carbon nanotube infrared detectors. Determined required excitations to induce changes in specific biomolecules for advanced nano-architectures. In FY09, devise small tactical antennas operating across high frequency bands; determine feasibility of quartz oscillator infrared detectors; create methods to control magnetization dynamics in nanostructures for high speed electronics; improve mid-IR lasers based on antimonide type-I quantum well lasers in 2-3 micron range; and determine the optical/magnetic properties of doped GaN semiconductors for magnetic semiconductor applications. In FY10, will generate small avalanche photodiode arrays of the (Ga,In)(As,Sb) family providing low noise/high gain for night vision applications in mid infrared spectral region; will show feasibility of electrically-injected room temperature continuous-wave mid-infrared semiconductor lasers based on group IV-VI lead salt materials for optical communications; demonstrate optical subwavelength sensing on biomolecules for CB analysis; and show proof of concept for a single-chip 2.4GHz transceiver on silicon with integrated antenna for improved radio communications.		11.913	12.465	12.981	
Basic research in physics for precision guidance, superior optics, signature management properties, ultra-sensitive sensors, quantum computing, and secure communications.		7.943	9.123	9.501	

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B. Accomplishments/Planned Program (\$ in Millions)			FY 2008	FY 2009	FY 2010
In FY08, extended negative-index materials at visible frequencies; advanced flat lens and sub-wavelength imaging concepts; developed instrumentation for optical lattice emulation of advanced materials; devised tunable microwave (10 - 100 GHz) devices for communications and imaging RADAR; started a thrust in biological assembly of quantum electronics; and fabricated superconducting and ion trap systems to advance quantum information technology. In FY09, will devise flat lenses and sub-wavelength imaging for ultralight optical components and detection of pathogens; will explore physics of attosecond light pulses for remote spectroscopy, armor fatigue analysis and "seeing through the wall"; will conduct optical lattice simulation of magnetism and high temperature superconductivity; will study artificially layered oxides for remote passive sensors and ultra-low power electronics; will devise multi-modal plasmon enhanced environmental sensors, elucidate decoherence in quantum computation platforms and extend ion trap qubit fidelity to solve "unsolvable" problems. In FY10, will demonstrate ultra-light negative-index optical components; will simulate intractable condensed matter theories with optical lattices; will devise ultra cold chemistry concepts heralding novel chemical synthesis routes; will engineer artificial oxides to stimulate a second electronics revolution; and will explore cross-platform qubit entanglement.					
Basic research in mechanical and material sciences for survivable armor, more lethal anti-armor, improved mobility, and flexible displays for Soldier systems. In FY08, obtained full flow field diagnostics around an oscillating rotor blade under realistic helicopter flow conditions; performed precise experiments and detailed simulations to understand the dynamic response and failure of multilayered micro-electro-mechanical systems (MEMS) at both the material and structural levels; discovered new high-pressure states of metallic glass for advanced armor and anti-armor materials systems; and synthesized and demonstrated functional transmembrane proteins in robust nano-structured thin films for Soldier protection applications. In FY09, validate chemical kinetic mechanisms for alternative hydrocarbon-based fuels at high temperature and pressure in diesel and turbine engine applications. Research new materials for armor and Soldier protection, and improve techniques to predict material failures. In FY10, will investigate topological optimization strategies to devise tools to optimize structures based on damage tolerance. Will validate new vorticity-based computational methods for rotorcraft flows capable of convecting the wake without the deleterious effects of numerical diffusion for improved model accuracy. Will research implementation of reduced hydrocarbon combustion kinetics codes into engine models for future fuel flexible engines and devise physical understanding of hypergolic ignition to enable gel-propellant rocket propulsion.			11.691	12.191	12.696
			1.399	2.105	2.193

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B. Accomplishments/Planned Program (\$ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011	
Basic research to gain an understanding of the fundamental aspects of how networks develop, function, and adapt to the environmental and the rate of information flow in manmade and naturally occurring networks. This understanding will have a direct impact on net-centric force operations, such as better communication system design and operations, or more efficient logistics or communications support. In FY08, performed basic research to identify the common elements of various kinds of networks to create a base understanding for a science of networks. The work was aimed at devising theoretical models that can explain and predict network behavior; research developed experimental/theoretical/computational models that investigate the layered structure of social networks of importance to the Army. In FY09, examine mechanisms by which different layers interact with one another. In particular, a universal representation of information (information theory, metrics, topology, etc.) within physical, biological, and social networks is constructed to enable network interfacing and control across multiple scaled networks. Moreover, the barriers to network control across multiple scales is addressed in this general information context. The goal is to gain a deep understanding of network systems that provides a basis for their properties. In FY10, will define and conduct 1st order laboratory experiments and simulation to refine our representations.					
Small Business Innovative Research/Small Business Technology Transfer Programs	.000	1.471	.000		
Basic research in chemical sciences for advanced energy control, protective materials, and threat detection. Advanced energy control will provide light-weight, reliable, compact power sources for the soldier and more effective, lower vulnerability propellants and explosives for tailored precision strikes with minimum collateral damage. Protective materials will shield soldiers and their platforms from ballistic, chemical, and biological threats; and reduce signatures for identification by the enemy while providing clear identification by friendly forces. Threat detection will provide advance warning of explosive, chemical, and biological weapons and dangerous industrial chemicals. In FY08, research focused on fuel reformers, molecular control for chem/bio/explosive detection, and new initiatives on chemical information theory for armor materials. In FY09, research focuses on nano-particle material repair, optical limiting, fuel cell catalysts and membranes, structure/function for protective membrane transport, and reactive surfaces for decontamination. In FY10, research will focus on functionalized morphology, novel reactive monomers, environmentally stable self-assembled materials, and reactions in extreme media.	5.957	6.894	7.180		
Total	54.802	63.871	64.988		

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<u>C. Other Program Funding Summary (\$ in Millions)</u> N/A <u>D. Acquisition Strategy</u> N/A <u>E. Performance Metrics</u> Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.		

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APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 1 - Basic Research				R-1 ITEM NOMENCLATURE PE 0601102A DEFENSE RESEARCH SCIENCES					PROJECT NUMBER H66	
COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H66: ADV STRUCTURES RSCH	1.609	1.711	1.818						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds basic research for improved tools and methods to enable the structural health monitoring capabilities and condition-based maintenance for rotorcraft and ground vehicles. This research also enables the design and use of composite structures that can better address the cost, weight, performance, and dynamic interaction requirements of future platforms identified by the Army Modernization Strategy. Ultimately, these technologies result in safer, more affordable vehicles with a greatly reduced logistics footprint. This project is a joint Army/NASA effort that includes structures technology research into: structural integrity analyses; failure criteria; inspection methods which address fundamental technology deficiencies in both metallic and composite Army rotorcraft structures; use of composite materials in the design and control of structures through structural tailoring techniques; rotorcraft aeroelastic modeling and simulation; helicopter vibration (rotating and fixed systems); and the design and analyses of composite structures with crashworthiness as a goal. The problems in structures are inaccurate structural analysis and validation methods to predict durability and damage tolerance of composite and metallic rotorcraft structures and inadequate structural dynamics modeling methods for both the rotating and fixed system components to address reliability issues for future aircraft. The technical barriers include a lack of understanding of failure mechanisms, damage progression, residual strength, high-cycle fatigue, the transfer of aerodynamic loads on the rotor to the fixed system, and impact of these unknown loads on aircraft components. Technical solutions are focused on: advanced fatigue methodologies for metallic structures, improved composites technology throughout the vehicle, long-term investigation of integrated stress-strength-inspection, advanced methods for rotor system vehicle vibratory loads prediction, improved methods to predict vehicle stability, and improved analyses to address Army Aviation requirements. These advancements will extend service life, reduce maintenance costs, enhance durability, and reduce the logistics footprint of existing and future Army vehicles. As agreed under Project Reliance, this is the only project for rotorcraft and ground vehicle structures basic research within DoD.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Structural Analysis and Vibration Methods: This research devises new structural analysis and validation methods to more accurately predict durability and damage tolerance of composite and metallic rotorcraft structures, and evaluates structural dynamics modeling methods to address critical reliability issues in the rotating and fixed system components of future aircraft.	1.609	1.711	1.818	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
In FY08, researched lightweight damage tolerant structures for future large airframes, analyzed computational fluid dynamic methods to support unsteady low Reynolds number aerodynamic models for flapping wing microsystems. In FY09, evaluate multibody-compatible thin-walled elastic finite element methods to enable aeroelastic predictions for small-scale air vehicle systems. In FY10, will complete characterization testing for materials used in finite element models for delamination fatigue life prediction, and will validate life prediction tools for dynamic rotorcraft sub-components.					
Total		1.609	1.711	1.818	
C. Other Program Funding Summary (\$ in Millions) N/A					
D. Acquisition Strategy N/A					
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.					

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H67: ENVIRONMENTAL RESEARCH	.809	.909	.946						Continuing	Continuing

A. Mission Description and Budget Item Justification

The objective of this project is to focus basic research on innovative technologies for both industrial pollution prevention (P2) that directly supports the Army production base and weapon systems as well as non-stockpile chemical warfare (CW) site remediation. The pollution prevention work invests in next generation manufacturing, maintenance, and disposal methods that will result in significantly reducing the usage of hazardous and toxic substances and their associated costs. The goal is to decrease the overall life-cycle costs of Army systems by 15-30% through the application of advanced pollution prevention technologies. The CW remediation efforts concentrate on the application of biotechnology in the characterization and physical clean up of agent contaminated soils and groundwater and reduced corrosive and more environmentally benign decontamination of biological warfare (BW) agents on field equipment and weapon systems. The goal is to reduce the cost of remediating a site by at least 50% versus the use of conventional methods. CW thrusts include establishing the ecotoxicity of CW compounds, environmental fate and effect of CW compounds in soils and biodegradation of CW compounds. Pollution prevention thrusts include: environmentally acceptable, advanced, non-toxic processes to manufacture lightweight alternative structural materials to enhance weapon system survivability; clean synthesis of more powerful and improved energetic compounds to eliminate the use of hazardous materials and minimize the generation of wastes; and surface protection alternatives to hazardous paints, cadmium, chromium, and chromate conversion metal and composite surfaces.

This project is linked to the Army Environmental Requirements Technology Assessment (AERTA) requirements. The program element contains no duplication with any effort within the Military Departments.

The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and the defense Technology Area Plan (DTAP).

Work is under the direction of the U.S. Army Armament, Research, Development and Engineering Center.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Industrial pollution prevention: In FY08, modeled processing of smart blended polymer nanocomposite and oxygen scavenger formulations; investigated green methodologies for manufacturing reduced sensitivity RDX (RS-RDX); studied ion-assisted biased deposition of adherent pollution-free gun bore coatings, (4) solvent-less process for crystallization of energetic materials; (5) environmentally safe fire-retardant polymers from enzymes and (6) environmentally friendly repair resins.	.809	.906	.946	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
In FY09, develop environmentally benign approaches to nitration reaction in microreactors (ARDEC), conduct modeling, processing, and characterization of highly layered polymer films (NSRDEC), investigate new physical vapor deposition technologies for new ordnance coatings (Benet Labs), develop polysiloxane nanocomposites for environmental and human safe flame-retardant materials (NSRDEC), conduct research on anaerobic hydrogen production from a variant of clostridium phytofermentans (ECBC), investigate bio-based gel coats with zero hazardous air pollutant contents for composites applications (ARL), and research ammonium perchlorate replacements (AMRDEC). In FY10, will continue efforts in FY09 that were selected by the Peer Panel during the Gate Reviews in September 2009 and conduct research on additional new yet undetermined projects.					
Small Business Innovative Research/Small Business Technology Transfer Programs		.000	.003	.000	
Total		.809	.909	.946	
C. Other Program Funding Summary (\$ in Millions) N/A					
D. Acquisition Strategy N/A					
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.					

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H68: PROC POLLUT ABMT TECH	.407	.424	.000						Continuing	Continuing
<u>A. Mission Description and Budget Item Justification</u> This project provides fundamental understanding of the physical, chemical and biological properties and mechanisms that control the degradation and treatment of hazardous wastes on military installations. This research is used to obtain basic technical information necessary for the design of treatment systems for both cleanups of existing hazardous waste sites and control of future hazardous waste generation. Wastes of concern include explosives, propellants, chemical agents and smokes. This project supports applied research efforts in Program Element (PE) 0602720A, Projects AF25 and DO48. Work in this project is performed by the Army Corps of Engineers Engineer Research and Development Center.										
<u>B. Accomplishments/Planned Program (\$ in Millions)</u>							FY 2008	FY 2009	FY 2010	FY 2011
Degradation and treatment of hazardous waste: In FY08 determined which reduction-oxidation (redox) reaction potentials were favorable for cyclotrimethylenetrinitramine (RDX) degradation under environmentally relevant anaerobic conditions. Initiated studies to determine use of bacterial models to fill gaps in basic understanding of how explosives react with biological molecules in biological cells. In FY09, conduct redox system experiments to determine RDX degradation enzymatic processes. Initiate mineralization rates and mass balance studies. Complete explosive exposures and cellular assays, and initiate proteomic and genomic analyses.							.407	.419	.000	
Small Business Innovative Research/Small Business Technology Transfer Program							.000	.005	.000	
Total							.407	.424	.000	
<u>C. Other Program Funding Summary (\$ in Millions)</u> N/A										
<u>D. Acquisition Strategy</u> N/A										

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<u>E. Performance Metrics</u> Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.		

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
S04: MIL POLLUTANT/ HLTH HAZ	.679	.709	.000						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project provides basic research in innovative, less costly, and less time consuming toxicity assessment methods for determining potential human health and environmental effects of military-unique hazardous wastes and chemicals, including explosives, propellants, and smokes. These new testing techniques will help to prioritize hazardous waste and waste treatment technologies and screen new Army chemicals for potential toxic effects. The work is conducted at U.S. Army Center for Environmental Health Research (CEHR) and U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM). Work in this project is performed by the Army Corps of Engineers Engineer Research and Development Center.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Small Business Innovative Research/Small Business Technology Transfer Program	.000	.008	.000	
Human health and environmental effects research: In FY08, initiated research involving neurotoxicants and neurotransmission within specific soil organism to gain fundamental knowledge of network of interactions for future predictive risk models. Continued investigations of adsorption and retention of explosives onto sediments with both weathered surfaces and fresh mineral surfaces created by fracturing. Completed detailed soil sample surface characterization to determine distribution of materials in the range soils. In FY09, complete measurements of the fundamental aspects of control-fractured versus un-fractured mineral surface affects on the fate and transport of explosives. Continue the study of neurotoxicants on neurotransmitter pathway related gene expression in a gene regulatory network. Utilize systems biology, toxicogenomics, computational modeling and bioinformatics in the approach.	.679	.701	.000	
Total	.679	.709	.000	

C. Other Program Funding Summary (\$ in Millions)

N/A

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<u>D. Acquisition Strategy</u> N/A <u>E. Performance Metrics</u> Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.		

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
S13: SCI BS/MED RSH INF DIS	10.271	10.896	10.536						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project supports basic research that provides for healthy, medically protected Soldiers. This project funds basic research leading to medical countermeasures for naturally occurring diseases impacting military operations. Basic research provides understanding of the mechanisms that make organisms infectious and the effective human body response which prevents disease. Understanding the biological characteristics of infectious organisms also enables the development of point-of-care and laboratory-based diagnostic tools. Understanding of disease transmission by insects and other organisms helps in developing new interventions to prevent disease. Infectious disease threats from malaria, diarrhea, and dengue (a severe debilitating disease transmitted by mosquitoes), which are common in Africa, Central, European, Southern, and/or Pacific Commands, are the highest priorities for basic research.

Research conducted in this project focuses on the following four areas:

- (1) Prevention/Treatment of Parasitic (symbiotic relationship between two organisms) Diseases: Conduct basic research to better understand the biology of malaria and Leishmania (a skin-based disease transmitted by sand flies) parasites, and to gain the necessary foundation for discovering medical countermeasures to protect military personnel from infection. Malaria, which can cause fatal and chronic disease, is the most significant military infectious disease threat. Since the malaria parasite becomes resistant to drugs over time, it is necessary to continually search for parasite weaknesses that can be exploited with new, effective, user-friendly drugs and vaccines. A highly effective vaccine could reduce/eliminate the use of anti-malarial drugs and the development of drug resistance to current/future drugs.
- (2) Bacterial Threats: Conduct research to better understand the biology of bacterial organisms and their effects on humans and how to prevent wound infections, diarrhea and scrub typhus (a debilitating mite-borne disease that is developing resistance to currently available antibiotics).
- (3) Viral Threats: Conduct research to better understand highly lethal or incapacitating viruses, including those that cause hemorrhagic diseases (leakage of blood from vessels), such as dengue hemorrhagic fever and hantaviruses (Korean hemorrhagic fever). Basic research includes understanding risk of disease prevalence to the Warfighter, viral biology (including structure, function, lifecycle, and interactions with the environment), the disease process, and interaction with the human body.
- (4) Diagnostics and Disease Transmission Control: Conduct research to investigate the biology of biting insects (including Leishmania-infected sand flies and mosquitoes) and other organisms that transmit disease (called disease vectors) and their control. Expand medical diagnostic and disease surveillance capabilities in the field. This research will help to direct new interventions into preventing disease transmission.

Work is managed by the US Army Medical Research and Materiel Command. The Army is responsible for programming and funding all DoD naturally occurring infectious disease research requirements, thereby precluding duplication of effort within the Military Departments.

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The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD, and its overseas laboratories.					
B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
Diagnostics and Disease Transmission Control: In FY08, conducted basic research to investigate the biology of insect vectors, including vector identification and assembly of insect identification aids for use by Preventive Medicine Units (PMUs) focusing on US Southern Command and Pacific Command regions. Studied biology of insects to better understand ways to control them through novel repellents or insect attractants and insecticides. In FY09, explore the biology of disease carrying insects and methods of control to expand medical diagnostic and disease surveillance capabilities with a focus on providing new approaches. Complete preparation of the PMU identification guides for SOUTHCOM and PACOM. In FY10, will conduct studies on the diversity, description and classification of medically-important insects, including mosquitoes, ticks and spiders as the scientific foundation for a web-based guide to identification. Will explore new designs for devices to collect insects, and will assess medical threats from disease-carrying insects in deployed areas.		2.462	1.823	1.651	
Viral Threats Research: In FY08, performed long-term studies to understand how naturally induced changes in the dengue virus impact the virus's ability to cause disease. In FY09, conduct basic research to understand hemorrhagic viral diseases and other lethal viruses of military importance. Assess emerging viral threats for their potential to impact military operations and to determine whether any identified new threat requires further study. In FY10, will conduct basic research to better understand the biological basis of disease and protection in humans from naturally occurring viruses of military importance. Will develop a better understanding of which parts of the immune system are needed to provide a protective response in humans.		1.109	1.794	1.653	
Bacterial Threats: In FY08, conducted basic research to expand discoveries and studies of those bacterial components that are integral in the disease process and assessed them as potential vaccine or other countermeasure candidates. Assessed proteins from the scrub typhus (a debilitating mite-borne disease that is developing resistance to currently available antibiotics) organism to better define their role in causing disease and use as potential vaccine targets.		1.000	.930	1.474	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
In FY09, identify proteins and other components produced by diarrheal organisms for their role in disease and possible use as a vaccine component. Study bacterial disease factors affecting the health and illness in selected overseas populations at potential candidate vaccine test sites. In FY10, will assess and improve selected proteins and other components identified from diarrheal causing bacteria as potential components of candidate vaccines. Conduct exploratory studies to evaluate methods to prevent wound infection from combat injuries.					
Small Business Innovative Research/Small Business Technology Transfer Program		.000	.149	.000	
Prevention/Treatment of Parasitic (symbiotic relationship between two organisms) Diseases: In FY08, used molecular technology and computer modeling to discover new approaches to address malaria, screened thousands of drugs for antimalarial activity and assessed potential for development as new antimalarial drugs, and searched for new malaria proteins as drug targets and vaccine candidates. In FY09, apply established medicinal chemistry techniques and computer modeling for Structure-Based Drug Design (SBDD) to discover candidate drugs to prevent or treat malaria infection. Employ bioinformatics to identify genes and proteins to help in the discovery of malaria vaccine components. In FY10, will apply new tools for discovery of promising compounds as potential leads to new classes of anti-malarial drugs and for potential vaccine components.		5.700	6.200	5.758	
Total		10.271	10.896	10.536	
C. Other Program Funding Summary (\$ in Millions)					
N/A					
D. Acquisition Strategy					
N/A					
E. Performance Metrics					
Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.					

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
S14: SCI BS/CBT CAS CARE RS	4.410	6.186	6.539						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds basic research to understand the basic mechanisms of severe trauma to advance treatment and surgical procedures to save lives and improve medical outcomes for the Soldier. Experimental models are developed to support in-depth trauma research studies. It includes studies of predictive indicators and decision aids for life support systems; studies to heal and repair burned tissue, Traumatic Brain Injury (TBI), sight, and face trauma; and transplant technology. Such efforts will minimize lost duty time from and provide military medical capabilities for far-forward medical/surgical care of injuries. Starting in FY10, S19 (T-Medical/Soldier Status) funding is merged into project S14.

Research conducted in this project focuses on the following six areas:

- (1) Hemorrhage (bleeding) Control, Blood, and Resuscitative Fluids: Conduct studies of genetic pathways and metabolic mechanisms associated with bleeding to understand the relationships between the human immune processes and blood clotting in trauma. In FY10 and FY11, funding shifts to the Damage Control Resuscitation area.
- (2) Damage Control Resuscitation: Conduct studies of genetic pathways and metabolic mechanisms associated with blood clotting to understand the relationships between the human immune processes and bleeding in trauma; this research area starts in FY10.
- (3) Combat Trauma Therapies: Conduct studies of trauma to tissues and organs, and ways to mitigate and/or repair this damage. Research will address cellular repair/growth mechanisms to treat Traumatic Brain Injury (TBI), eye and facial/maxillary (jaw bone) trauma, and burns.
- (4) Combat Casualty Bioinformatics and Simulation: Conduct basic research to develop improved training simulators and approaches for novel patient monitoring solutions using computational biology (interdisciplinary field that applies computer science, applied mathematics, and statistics to address solutions to biology problems). In-house modeling and simulation research ended in FY08 and is now conducted by the Program Executive Office, Simulation, Training, and Instrumentation (PEO-STR). The bioinformatics area will be funded by the Combat Critical Care Engineering research area in FY11.
- (5) Combat Critical Care Engineering: Conduct basic science studies of vital sign responses to trauma as predictors of medical outcomes and as a basis for developing life saving interventions. This research area starts in FY11.
- (6) Clinical and Rehabilitative Medicine: Conduct basic studies of mechanisms of tissue growth to gain an understanding that will allow us to assist the healing or transplantation process; this research area starts in FY10.

Promising results identified in this project are further matured under PE 0602787A, project 874.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

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APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 1 - Basic Research	R-1 ITEM NOMENCLATURE PE 0601102A DEFENSE RESEARCH SCIENCES		PROJECT NUMBER S14	
Work in this project is performed by the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD; the US Army Institute of Surgical Research (USAISR), Fort Sam Houston, TX; and the Armed Forces Institute of Regenerative Medicine (AFIRM), Fort Detrick, MD.				
B. Accomplishments/Planned Program (\$ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Damage Control Resuscitation: In FY08 and FY09, funding was within the Hemorrhage Control, Blood, and Resuscitation Fluids program area. In FY10, will extend survival studies to determine the biochemical and genetic relationships between blood clotting and inflammation -- factors causing death following severe bleeding.	.000	.000	1.058	
Clinical and Rehabilitative Medicine: Combat casualty care was transferred from project S13. In FY10, will explore different innovative regenerative tissue strategies, including scaffold-like tissue mats containing blood vessels, cell based therapies to augment regenerative tissue, approaches that yield a pool of responding cells that can be cued biologically to specific cell types, and ways to reduce severe scarring that can lead to impaired movement.	.000	.000	3.582	
Combat Trauma Therapies: In FY08, studied the effect of novel neuroprotection therapies on cellular responses to injury, continued to examine delayed cell death mechanisms leading to malfunction of brain electrical impulses using penetrating ballistic-type brain injury (PBBi), and began basic research on tissue reengineering, focusing on cellular-level mechanisms of tissue growth. In FY09, expand PBBi studies to a larger animal model; continue exploring cellular mechanisms of tissue growth through Armed Forces Institute of Regenerative Medicine (AFIRM); and begin basic science exploration of a single dose wound healing therapeutic. In FY10, will realign AFIRM to the Regenerative Medicine program area; will conduct PBBi protein and gene regulation and neuroprotection mechanism studies; will investigate PBBi biomarkers as surrogate markers to show effectiveness of neuroprotection drugs; will refocus dental disease research to repair of maxillofacial bone and soft tissue injury repair; and will begin research in eye trauma to understand the cellular and neuronal mechanisms of eye injuries.	3.604	5.674	1.899	
Combat Casualty Bioinformatics and Simulation: In FY08, refined the diagnosis of severe bleeding; modified and developed new algorithms for real-time qualification of vital-sign data; and developed and started testing hardware/software for real-time collection, qualification, and diagnosis of trauma data.	.584	.000	.000	
Hemorrhage Control, Blood, and Resuscitative Fluids:	.222	.393	.000	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
In FY08, investigated genetic determinants associated with differences in survival from hemorrhage (bleeding) in an animal model. In FY09, more definitive procedures will be used to locate the exact gene(s) involved in animals that demonstrated survival to assist in identifying new forms of treatment for severe hemorrhage. In FY10, this work will be funded under the Damage Control Resuscitation area.					
Small Business Innovative Research/Small Business Technology Transfer Programs		.000	.119	.000	
Total		4.410	6.186	6.539	
C. Other Program Funding Summary (\$ in Millions) N/A					
D. Acquisition Strategy N/A					
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.					

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APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 1 - Basic Research				R-1 ITEM NOMENCLATURE PE 0601102A DEFENSE RESEARCH SCIENCES					PROJECT NUMBER S15	
COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
S15: SCI BS/ARMY OP MED RSH	6.200	9.525	7.120						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds basic research on physiological and psychological factors limiting Soldier effectiveness and on the characterization of health hazards generated by military systems and resulting as a consequence of military operations. This includes research on the neurobehavioral aspects of post traumatic stress and suicide, and developing concepts for medical countermeasures to prevent or mitigate the effects of muscle and bone injury and to reduce the effects of sleep loss and other stressors on Warfighter performance. The hazards of exposure to directed energy, repetitive use, fatigue, heat, cold, and altitude are also investigated under this project.

Research conducted in this project focuses on the following six areas:

- (1) Injury Prevention and Reduction: Conduct research on the body's effects from non-ionizing radiation and directed energy and the physiological mechanisms of musculoskeletal injury.
- (2) Physiological Health: Conduct research on the physiological mechanisms of sleep, fatigue, and nutrition on Soldier performance and well-being.
- (3) Environmental Injury Prevention: Conduct research on the physiological mechanisms of exposure to extreme heat, cold, altitude and other environmental stressors.
- (4) Network Sciences: Conduct research on the fundamental processes of interactions at the molecular and cellular level. In FY10, the funding for Network Science Initiative effort transfers to project T64.
- (5) Computational Biology: Conduct research, using tools that combine biology, computer sciences and mathematics, to solve biological problems that would be difficult or impossible to solve solely through testing in traditional laboratory experiments, animal models or human trials. Research in this area starts in FY11.
- (6) Psychological Health and Resilience: Conduct research into the basic mechanisms of psychological resilience (i.e., mental toughness and the ability to overcome traumatic events) and post-concussion related mental and physical challenges. Studies also include determination of suicide risk and protective factors and treatment for Post-Traumatic Stress Disorder (PTSD).

Promising results identified in this project are further matured under PE 0602787A, project 869.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD; and the US Army Research Institute of Environmental Medicine (USARIEM), Natick, MA.

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B. Accomplishments/Planned Program (\$ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Network Sciences: In FY08, characterized newly discovered networks by developing new mathematical and computational methods that address identified gaps. Investigated whether protein-protein network models, developed for a particular pathogen (infectious agent or germ), are portable to a different pathogen sharing a common set of proteins. In FY09, develop mathematical models to predict host-pathogen protein-protein interaction networks, and metabolic models to predict phenotypical (the genetically and environmentally determined physical appearance of an organism) responses induced by external stimuli. In FY10, the funding for this effort transfers to project T64.	.495	.990	.000	
Injury Prevention and Reduction: In FY08, conducted bone marrow stem cell research as a potential therapeutic intervention for induced eye injury. In FY09, investigate the process by which inheritable information from a gene, such as the DNA sequence, is made into a functional gene product or a protein, and how cellular interactions with the environment affect the nature of bone-marrow derived stem cell treatment for laser eye injury; and investigate the effects of hormone levels on cell control of muscle and bone tissue to enhance tissue repair. In FY10, will investigate hormone and cell-level adaptations in skeletal muscle in response to military-relevant training and injury to include mechanisms of skeletal muscle repair, regeneration, and adaptation; will explore how bone components are associated with stress fracture risk.; will identify laser eye injury thresholds in an animal model for single and repetitive pulsed laser exposures for small and large exposures as a risk assessment tool.	1.498	2.296	1.304	
Environmental Injury Prevention: In FY08, explored tissue protein analysis as a predictor of performance degradation from exposure to cold. In FY09, initiate a rodent animal model of classic heat stroke and examine the efficacy of a novel treatment intervention to enhance long-term recovery and return to duty. In FY10, will explore rodent models of heat stroke to evaluate and enhance long-term recovery and return to duty; investigate dose response of medication countermeasures for the efficacy of preventing altitude illness versus probability and severity of adverse side-effects.	3.040	3.305	1.269	
Psychological Health and Resilience: In FY10, will investigate a behavioral screening tool to induce and evaluate PTSD-like symptoms in rodents; will investigate potential correlations between anti-depressant medication use and suicidal behaviors; will investigate	.000	.000	2.180	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
neuropsychological performance tests/batteries as a diagnostic for concussion in Soldiers; will identify factors that predict or correlate severity of post-concussion symptoms.					
Physiological Health: In FY08, examined individual components of the fatigue performance prediction model within a laboratory environment. In FY09, refine the individual components to establish a more robust fatigue performance prediction model. In FY10, will investigate the extent individual resilience generalizes across various types of sleep loss; will explore the relative effects of countermeasures for reversing deficits caused by fatigue; will investigate and model optimal recovery sleep and recycle rate following missions; and will identify healthy weight management strategies to improve Soldier health and retention.		1.167	2.784	2.367	
Small Business Innovative Research/Small Business Technology Transfer Programs		.000	.150	.000	
Total		6.200	9.525	7.120	
C. Other Program Funding Summary (\$ in Millions) N/A					
D. Acquisition Strategy N/A					
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.					

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
S19: T-MED/SOLDIER STATUS	.695	.751	.000						Continuing	Continuing
<u>A. Mission Description and Budget Item Justification</u> The purpose of this program is to perform research contributing to superior combat casualty care for troops through faster diagnosis and treatment while allowing on-site health care providers to consult with specialists worldwide. This work will focus on advancing the means to determine soldier physiological status and aiding medical diagnosis and treatment. A significant thrust area will work to ascertain the sensors most relevant to determine change in soldier physiological status.										
<u>B. Accomplishments/Planned Program (\$ in Millions)</u>							FY 2008	FY 2009	FY 2010	FY 2011
Small Business Innovative Research/Small Business Technology Transfer Program							.000	.021	.000	
In FY08, initiated algorithm development for early indication of reduction in central blood volume and imminent cardiovascular collapse, and initiated experiments to test a new sensor that tracks pulse pressure changes associated with hemorrhage and physical activity. In FY09, develop algorithms and complete analysis to analyze real-time beat-to-beat electric signals from the body as it approaches shock in controlled human studies. Compare changes in these signals with other changes to determine if these changes in signal provide an early indicator of progression to circulatory shock and therefore represent a simple algorithm for the triage of battlefield casualties. In FY10, this Project will be consolidated with Project S14.							.695	.730	.000	
Total							.695	.751	.000	
<u>C. Other Program Funding Summary (\$ in Millions)</u> N/A										
<u>D. Acquisition Strategy</u> N/A										
<u>E. Performance Metrics</u> Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.										

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
T14: BASIC RESEARCH INITIATIVES - AMC (CA)	26.609	24.319	.000						Continuing	Continuing
<u>A. Mission Description and Budget Item Justification</u> Congressional Interest Item funding provided for Defense Research Sciences.										
<u>B. Accomplishments/Planned Program (\$ in Millions)</u>							FY 2008	FY 2009	FY 2010	FY 2011
Perpetually Assailable and Secure Information System (PASIS)							3.866	3.100	.000	
Functionally Integrated Reactive Surfaces Tech (FIRST) Program							2.319	.000	.000	
Technology Commercialization and Management Network							1.545	1.550	.000	
Cyber Threat Analytics							2.319	2.325	.000	
Document Exploitation for Handwriting Recognition							.966	.000	.000	
Flexible Electronics Research Initiative							.966	1.550	.000	
Integrated Nanosensors for NBC Threat Detection							1.545	.000	.000	
UT-Tyler Organic Semiconductor Modeling and Simulation							.966	1.162	.000	
Imaging Research Center for Research of Disorders Due to Military Training and Performance							.869	.000	.000	
Activated Nanostructures for De-icing							1.159	.000	.000	
John H. Hopps, Jr. Defense Research Scholars Program							1.932	.000	.000	
Global Military Operating Environments							1.545	1.938	.000	
Semiconductor-based Nanotechnology Applications							.774	.000	.000	
Secure Open Systems Institute							2.319	.000	.000	
Silicon Carbide Armor Manufacturing Initiative							2.319	.000	.000	
Nanocrystal Source Display							1.200	1.163	.000	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
Fuel Logistics Reduction Through Enhanced Engine Performance		.000	1.163	.000	
Direct Methanol Fuel Cell Battery Recharger Program (pending transfer to 622705)		.000	2.325	.000	
Nanostructured Materials for Photovoltaic Applications		.000	1.550	.000	
Center for Advanced Energy Storage Research and Technology		.000	1.550	.000	
Sustainable Alternative Energy for DoD		.000	2.325	.000	
Urban Patterns and Signatures to Support Counter-Insurgency Operations		.000	1.163	.000	
SBIR/STTR		.000	.680	.000	
Toxic Particles		.000	.775	.000	
Total		26.609	24.319	.000	
C. Other Program Funding Summary (\$ in Millions) N/A					
D. Acquisition Strategy N/A					
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.					

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
T22: SOIL & ROCK MECH	2.144	2.221	2.311						Continuing	Continuing

A. Mission Description and Budget Item Justification

This basic research project correlates the effects of the micro-scale behavior on the macro-scale performance of geological and structural materials to provide a foundation for the creation of future revolutionary materials and to understand the sensor data within a heterogeneous geological system. This research encompasses geologic and structural material behavior, structural systems, and the interaction with dynamic and static loadings. Research includes: underlying physics and chemistry that controls the mechanics and electromagnetic behavior of geological and structural materials, new techniques that provide measurements at the fundamental scale, and fundamental theories for relating micro-scale phenomena to macro-scale performance. This research provides the basis for applied research in PE 0602784A (Military Engineering Technology), project T40 (Mobility/Weapons Effects Technology), that supports the civil engineering technologies for adaptive protection, scalable weapons effects, near surface computational testbed, and austere entry and maneuver for the future force.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Small Business Innovative Research/Small Business Technology Transfer Programs	.000	.013	.000	
Military Engineering Basic Research: In FY08, produced limited simulation capability for a full, dynamic micro-scale air-water-solid system. Initiated multiple new studies including notable efforts to determine the feasibility of genetic control of specific bacteria to increase biopolymer production for soil stabilization and to determine the feasibility of using natural gamma shadows to detect near surface anomalies. In FY09, produce a simulation capability for a full, dynamic micro-scale air-water-solid system to examine soil moisture in porous media. Develop an initial modeling and experimental capability for the multi-scale structuring of cementitious materials for enhanced impact and penetration resistance applications. In FY10, will develop a model for ultra high strength fiber reinforced concrete (FRC) subjected to highly dynamic loading conditions (e.g., blast, impact, and penetration events). Will gain an understanding of the rate effects in high	2.144	2.208	2.311	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010
performance concrete to determine if meso-scale models under development inherently generate the strain rate effects seen in macroscopic concrete response.				
Total		2.144	2.221	2.311
C. Other Program Funding Summary (\$ in Millions) N/A				
D. Acquisition Strategy N/A				
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.				

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APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 1 - Basic Research				R-1 ITEM NOMENCLATURE PE 0601102A DEFENSE RESEARCH SCIENCES					PROJECT NUMBER T23	
COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
T23: BASIC RES MIL CONST	1.612	1.713	1.770						Continuing	Continuing

A. Mission Description and Budget Item Justification

This basic research project supports facilities research initiatives. The project is focused on forming an explicit and mathematically robust set of algorithms for geometrical reasoning; assessing the conceptual feasibility of applying nanoparticle technology to real-time sensors, thermal conductivity, and high strength materials; and developing novel and advanced concepts for mitigating the effect of chemical and biological agents in built structures. These efforts provide basic research leading to improved design in a range of facilities to optimize facility mission performance, enhance facility security, reduce design and construction errors and omissions, reduce resource requirements, and reduce the environmental burdens over the facility's life. This project provides leap-ahead technologies to solve military-unique problems in the planning, programming, design, construction, and sustainment of deployed facilities, and energy and utility infrastructure. This project supports exploratory development efforts in PE 0602784A (Military Engineering Technology), projects T41 (Military Facilities Engineering Technology) and project T45 (Energy Technology Applied to Military Facilities).

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Small Business Innovative Research/Small Business Technology Transfer Programs	.000	.025	.000	
Facilities Research: In FY08, developed a robust model-based support for "Sensing Through Walls" (STW), taking into account critical high-level building design logic and constraints. Developed predictive understanding of blast wave interaction with man-made barriers. In FY09, conduct validations to support the development of next generation nanotechnology for facilities, sensor coatings, and constitutive models for micro-particle dispersion. Investigate the phenomena that govern the synthesis and properties of carbon nanotube coatings. Also investigate light-triggered release of biocides from liposome photosensitive polymers to neutralize biological contaminants. Finalize the complex interactions between a forest edge and an acoustic wave, including the dependence on acoustic ground impedance, microclimate, and biomass structure.	1.612	1.688	1.770	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010
In FY10, will investigate mechanisms for on-demand release of biocides and free radicals to determine photolytic degradation phenomena. Will develop a fundamental understanding of the use of electrophoresis in producing new composite materials for present and future military applications.				
Total		1.612	1.713	1.770
C. Other Program Funding Summary (\$ in Millions) N/A D. Acquisition Strategy N/A E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.				

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2040 - Research, Development, Test & Evaluation, Army/BA 1 - Basic Research				PE 0601102A DEFENSE RESEARCH SCIENCES					T24	
COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
T24: Signature Physics and Terrain State Basic Research	1.412	1.452	1.521						Continuing	Continuing

A. Mission Description and Budget Item Justification

This basic research project increases knowledge in the areas of terrain state and signature physics. It provides the knowledge base for understanding and assessing environmental impacts critical to battlespace awareness. Projects include fundamental material characterization, investigation of physical and chemical processes, and examination of energy/mass transfer applicable to predicting state of the terrain, which control the effects of the environment on targets and target background signatures and mobility in support of the materiel development community. The terrain state area of terrestrial sciences investigates weather-driven terrain material changes and sensing/inferring subsurface properties. The signature physics area of terrestrial sciences focuses on understanding the dynamic changes to electromagnetic, acoustic and seismic signatures, and energy propagation in response to changing terrain state and near surface atmosphere.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Small Business Innovative Research/Small Business Technology Transfer Programs	.000	.000	.000	
Terrain State and Signature Physics: In FY08, investigated how high frequency radio waves propagate over topographically and electrically complex ground (roughness); specifically, the degree to which roughness controls local and extensive radio frequency (RF) coverage and developed theory to predict coverage given surface roughness and electrical variability. In FY09, investigate the variance in disturbed and undisturbed soil physical, thermal, and optical properties to establish physical parameters that govern the signature response and variance in changing environmental conditions, thus optimizing below surface target detection in prevailing environmental conditions. In FY10, will observe, characterize, and model the variation of forward scattering at near to grazing angles for both vertical and horizontal polarization to determine if significant geometric roughness will deteriorate, rather than not affect, the forward scattering of RF energy; will investigate the controlling influences of radio signal energy loss in deserts	1.412	1.452	1.521	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010
and thus poor depth penetration into low clay soils through examination of gypsum and carbonates by determining the complex permittivity spectra and attenuation rates at clay through sand size. Will test hypothesis that urban ambient sound and vibration signals can be characterized as a baseline for actionable warnings for future sensor arrays.				
Total		1.412	1.452	1.521
C. Other Program Funding Summary (\$ in Millions) N/A D. Acquisition Strategy N/A E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.				

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
T25: Environmental Science Basic Research	5.365	6.116	7.958						Continuing	Continuing

A. Mission Description and Budget Item Justification

This basic research project investigates fundamental scientific principles and phenomena necessary to ensure efficient development of the technologies needed to address Army sustainment issues in the restoration, compliance, conservation, and non-industrial pollution prevention areas. These efforts include: investigating and monitoring contaminated sites, including chemical contamination and unexploded ordnance (UXO) detection/discrimination; better characterization of contaminants through improved risk-based assessment; destruction, containment, or neutralization of organics in water, soil, and sediments resulting from military activities; adhering to applicable federal, state, and local environmental laws and regulations; monitoring and controlling noise generation and transport; protecting and enhancing natural and cultural resources; reducing pollution associated with military activities; and the study of ecosystem genomics and proteomics in support of the Army's new Network Science initiative. The project supports applied research under PE 0602720A (Environmental Quality Technology), project 048 (Industrial Operations Pollution Control Technology), project 835 (Military Medical Environmental Criteria), and project 896 (Base Facilities Environmental Quality).

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Environmental and Ecological Fate of Explosives, Energetics, and Other Contaminants: In FY08, applied computational chemistry to identify molecular structure reactivity to predict degradation mechanisms and products and define the molecular mechanisms of neurotoxicity for an invertebrate neurobiology model to assess sublethal neurotoxic effects of CL-20 and other munitions constituents (MCs). Investigated detection of biomolecule binding and cleavage events using biomolecules as switches for ultra-sensitive monitoring of MCs. Identified reactions between the DNA sequence and contaminant for applications toward contaminant-unique biosensors. Integrated toxicogenomics data with biological network analysis as a basis to identify mechanisms and interactive toxicity effects of MC mixtures. Improved estimates of waterborne lead absorption, distribution, and subcellular partitioning in prey invertebrates and reptiles.	3.256	2.838	3.849	

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APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 1 - Basic Research	R-1 ITEM NOMENCLATURE PE 0601102A DEFENSE RESEARCH SCIENCES			PROJECT NUMBER T25	
B. Accomplishments/Planned Program (\$ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011	
In FY09, define the equilibrium expressions of major tungsten reactions under relevant geochemical conditions and elucidate tungsten toxicity mechanisms related to intracellular phosphorylation reactions. Combine computational and toxicological approaches to assess basis of environmental risk. In FY10, will complete new computational chemistry equations to predict solubility and other physical characteristics of MCs. Will establish biological models of soil invertebrate neurotransmission networks as affected by less-than-lethal doses of RDX. Will construct computational chemistry models of the physiological reaction of bacteria to explosives contaminants. Will investigate the use of engineered proteins as cell-based toxicology sensors of MCs. Will explore the use of endophytes (microorganisms living inside plants) as biosensors of MC contamination.					
Small Business Innovative Research/Small Business Technology Transfer Programs	.000	.136	.000		
Network Science: In FY09, identify and define mechanisms controlling the genetic networks associated with ovarian hormone production. A model ecological system was used to develop numerical-mechanistic descriptions of how learning and environmental heterogeneity contribute to adaptation in hunter prey relationships. Investigate the theories/algorithms of animal learning and communication on the propagation of information affecting the survival of individuals in a hunter prey network in static versus dynamic heterogeneous hunter/prey environments. In FY10, will identify metabolic network control structures that govern the degradation / transformation of RDX. Will determine the relationship of complex biological network architecture to fragility in hormone production.	.000	.976	1.086		
Remediation of Explosives, Energetics, and UXO: In FY08, defined mechanisms of high explosives movement through the unsaturated soil zone to the groundwater to support range management and remediation approaches. Investigated the application of the unique physical, chemical, and biological interactions with the environment of DoD specific nanomaterials to potentially support advanced environmental technologies. In FY09, define and quantify the effect of disturbance on the sorption and transformation properties of explosives in soils. Quantify surface and vadose zone phenomena such as the role of colloidal transport in migration of explosives. In FY10, will complete investigations of degradation of and by nanomaterials.	1.496	1.561	2.302		
Training Land Natural Resources: In FY08, determined potential use of bioassay guided fractionation (BGF) to assess reptilian developmental and reproductive effects, toxicity, and risk of endocrine active compounds for a large number of contaminants. Continued	.613	.605	.721		

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
to establish a basic understanding of physical, chemical, and biological phenomena specific to ecosystem maintenance, mitigation, and rehabilitation. In FY09, describe the complex interactions between forest edge and an acoustic wave (such as artillery) incorporating relevant descriptive parameters into appropriate computational techniques allowing noise impact visualization. Complete determination of responses and impacts of multigenerational RDX exposure. In FY10, will define the fundamental properties of pollination networks on Army ranges. Will investigate environmentally benign bioadhesion resistant coatings (modification of surface microstructure) as a means to reduce transport of invasive species.					
Total		5.365	6.116	7.958	
C. Other Program Funding Summary (\$ in Millions) N/A D. Acquisition Strategy N/A E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.					

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APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 1 - Basic Research				R-1 ITEM NOMENCLATURE PE 0601102A DEFENSE RESEARCH SCIENCES					PROJECT NUMBER T61	
COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
T61: Basic Research Initiatives - MRMC (CA)	3.675	4.386	.000						Continuing	Continuing
<u>A. Mission Description and Budget Item Justification</u> Congressional Interest Item funding provided for Medical Basic Research Initiatives.										
<u>B. Accomplishments/Planned Program (\$ in Millions)</u>							FY 2008	FY 2009	FY 2010	FY 2011
Fighting Drug Resistant Infections							.000	1.938	.000	
Combat Mental Health Initiative							2.708	2.325	.000	
Innovative, Computational Water-Borne Pathogen Research for Chemical/Biological Detection							.967	.000	.000	
SBIR/STTR							.000	.123	.000	
Total							3.675	4.386	.000	
<u>C. Other Program Funding Summary (\$ in Millions)</u> N/A										
<u>D. Acquisition Strategy</u> N/A										
<u>E. Performance Metrics</u> Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.										

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2040 - Research, Development, Test & Evaluation, Army/BA 1 - Basic Research				PE 0601102A DEFENSE RESEARCH SCIENCES					T63	
COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
T63: ROBOTICS AUTONOMY, MANIPULATION, & PORTABILITY RSH	.000	1.495	1.230						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds basic research in technical areas that will expand the autonomous capabilities, utility, and portability of small robotic systems for military applications, with a focus on enhanced intelligence, biomimetic functionality, and robust mobility, to permit these systems to serve as productive tools for dismounted Soldiers. The ability of the Warfighter to command a suite of small unmanned systems (air, ground, and hybrid vehicles) will reduce exposure of the Soldier to harm and will improve the efficiency by which a dismounted unit achieves tactical objectives such as securing a targeted zone. Example missions requiring enhanced autonomy, manipulation, and man-portability include rapid room clearing and interior structure mapping; detection of human presence, chemical/biological/nuclear/radiological/explosive (CBNRE), and booby-traps; surveillance; and subterranean passage detection and exploration. Because of their relatively small size, light weight, and service in dismounted environments, small unmanned systems have unique challenges in perception, autonomous processing, mobility mechanics, propulsive power, and multi-functional packaging that transcend similar challenges associated with large unmanned systems. The Army Research Lab will conduct research in related disciplines, including machine perception, intelligent control, biomimetic robotics, manipulator mechanics, and propulsive power and drives to foster the development of technologies for lightweight, small-volume, environmentally-harsh robotics applications. Machine perception research includes the exploration of lightweight ultra-compact sensor phenomenology and the maturation of basic machine vision algorithms that enable small unmanned systems to more fully understand their local environment. Intelligent control research includes the maturation of autonomous processing capabilities and the advancement of artificial intelligence techniques that lead to reliable autonomous behavior in a large-displacement, highly-dynamic environment and permit unmonitored task performance. Research in biomimetic robotics and manipulator mechanics includes the advancement of mechatronic and biomimetic appendages to enable agile high-speed locomotion, dexterous task-performance, and environmental-manipulation; and the maturing of nonlinear control algorithms to support robust, stable mobility. Propulsion power and drives research includes investigations of engine cycles and alternative hybrid energy conversion techniques to provide compact, lightweight, quiet, low-emission, high-density power sources that support highly-portable unmanned systems capable of performing long-endurance missions.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Defense of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed internally by the Army Research Laboratory (ARL), Adelphi, MD.

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B. Accomplishments/Planned Program (\$ in Millions)				
	FY 2008	FY 2009	FY 2010	FY 2011
Robotics autonomy and human robotic interface research: Several promising high-risk high-payoff areas of basic research will be conducted in-house with a focus on enabling robust autonomous mobility for small robotic systems, including autonomous operations in Global Positioning System (GPS) denied areas, planning, behaviors, intelligent control, and the interface of perception technologies to accomplish Army missions in the area of unmanned systems. In FY09, develop small staring Laser Detection and Ranging (LADAR) and super-resolution LADAR techniques to provide a small lightweight perception capability; study hybrid-electric propulsion systems with appropriate size, weight, and logistics to provide the necessary power for high energy mobility combined with a silent-drive, silent-watch capability; develop autonomous processing techniques and algorithms for navigation, mapping, object recognition, and intelligent decision making to address increasingly complex dismounted scenarios; conduct validations utilizing advanced mechanical and biomimetic components to advance technologies that support high ground speeds, robust maneuvering, and efficient stair and obstacle climbing capabilities. In FY10, will develop dexterous manipulation systems with high density sensors and intelligent control algorithms to support complex task performance such as opening doors and moving objects or impediments. These manipulation systems will be studied statically and in combination with highly mobile robots.	.000	1.453	1.230	
Small Business Innovative Research/Small Business Technology Transfer Programs	.000	.042	.000	
Total	.000	1.495	1.230	
C. Other Program Funding Summary (\$ in Millions) N/A				
D. Acquisition Strategy N/A				
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.				

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APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 1 - Basic Research				R-1 ITEM NOMENCLATURE PE 0601102A DEFENSE RESEARCH SCIENCES					PROJECT NUMBER T64	
COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
T64: SCI BS/SYSTEM BIOLOGY AND NETWORK SCIENCE	.000	.000	1.285						Continuing	Continuing
<u>A. Mission Description and Budget Item Justification</u> This project funds research to conduct studies through a modernized systematic approach that uses iterative computer simulation with mathematical modeling and biological information to analyze and refine biological studies. The information gained provides a better understanding of the overall biological system and its molecular network of interactions, which leads to improved early strategic decision-making in development of preventive and treatment solutions to diseases. This approach establishes a model for application of systems biology processes and knowledge of biological networks to discover medical products that prevent and/or treat diseases or medical conditions. This more complex, yet integrated approach to studying biological systems could potentially reduce both the time and expense of medical product development for the Army. In FY08 and FY09, this research is funded in project S15 and was realigned to this new project in FY10. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the US Army Medical Research and Material Command (MRMC), Fort Detrick, MD.										
<u>B. Accomplishments/Planned Program (\$ in Millions)</u>							FY 2008	FY 2009	FY 2010	FY 2011
Network Sciences Initiative: In FY08 and FY09, this research was/is funded in project S15. In FY10, will complete development of mathematical models, which predict host-pathogen (infectious agent or germ) networks. These mathematical models will be used to predict environmentally-produced observable responses induced by external stimuli at the molecular (genomic, proteomic, metabolomic) level; and will also establish and test mathematical and computational models that address identified gaps in network biology.							.000	.000	1.285	
Total							.000	.000	1.285	
<u>C. Other Program Funding Summary (\$ in Millions)</u> N/A										

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<u>D. Acquisition Strategy</u> N/A <u>E. Performance Metrics</u> Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.		

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APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 1 - Basic Research				R-1 ITEM NOMENCLATURE PE 0601102A DEFENSE RESEARCH SCIENCES					PROJECT NUMBER 305	
COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
305: ATR RESEARCH	2.201	2.307	2.378						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project provides automatic target recognition (ATR) research to enhance the effectiveness of Army systems while simultaneously reducing the workload on the Soldier. This project focuses on the fundamental underpinnings of aided and unaided target detection and identification techniques for land warfare scenarios including tagging, tracking, and locating (TTL) of non-traditional targets. This research enables Army systems that can act independently of the human operator to detect and track targets including clandestine tracking of non-cooperative targets. Such capabilities are needed for smart munitions, unattended ground sensors, and as replacements for existing systems, such as land mines. Critical technology issues include low depression angle, relatively short range, and highly competing clutter backgrounds. The resulting research will provide fundamental capability to predict, explain, and characterize target and background signature content, and reduce the workload on the analyst. This research is aimed at evaluating the complexity and variability of target and clutter signatures and ultimately utilizing that knowledge to conceptualize and design advanced ATR paradigms to enhance robustness and effectiveness of land warfare systems. ATR research strategies include emerging sensor modalities such as spectral and multi-sensor imaging. This research supports several technology efforts including multi-domain smart sensors, third generation Forward Looking Infrared (FLIR), and advanced multi-function laser radar (LADAR).

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
ATR Algorithms: Investigate new algorithms to improve unaided target detection and identification. In FY08, explored advanced methods for aided tracking via fusion of video modalities and detection likelihoods; investigated statistical algorithms for application in hyperspectral imagery; evaluated methods to classify tracked objects in color and FLIR video; and investigated novel nonlinear fusion methods for anomaly detection using hyperspectral and synthetic aperture radar (SAR). In FY09, research novel behavior characterization algorithms for color and FLIR video; research methods to develop ATR algorithms that exploit the fusion of disparate spatial views of a target for unattended ground sensor (UGS) network applications; and design advanced nonlinear band selection methods and implement new hyperspectral algorithms based on the selected bands.	1.213	1.286	1.368	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
In FY10, will enhance hyperspectral anomaly detections and validate rapid reconstruction of hyperspectral images by using 3D compressed sensing techniques; and develop novel fusion detection and classification algorithms based on kernel learning theory.					
TTL: Conduct basic research to support advances in state-of-the-art clandestine TTL for non-traditional hostile force and non-cooperative targets. Specific technical objectives, products, and deliverables are in accordance with the Hostile Forces TTL Capabilities Development Document and the TTL Science and Technology Roadmap. This effort will directly support ARL's efforts in applied research and the Communications-Electronics Research, Development, and Engineering Center's advanced research in clandestine TTL. In FY08, identified and initiated research into technologies that have potential to achieve the goals of clandestine TTL including Radio Frequency (RF) tags, Infrared (IR) tags, and hyperspectral imaging. In FY09, begin to prove technologies selected for further exploration. This includes both device and algorithm development. Transition technologies that are of sufficient technology readiness to applied research. In FY10, will develop an advanced RF Integrated Circuit for an RF Tag and a 2nd generation IR Tag.		.988	.986	1.010	
Small Business Innovative Research/Small Business Technology Transfer Programs		.000	.035	.000	
Total		2.201	2.307	2.378	
C. Other Program Funding Summary (\$ in Millions) N/A					
D. Acquisition Strategy N/A					
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.					

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
31B: INFRARED OPTICS RSCH	2.415	2.552	2.676						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project supports Army research in materials and devices for active and passive infrared (IR) imaging systems and radio frequency (RF) photonics. This research aims to generate new technologies for unprecedented battlefield situational awareness and to continue the dominance of Army units during night operations. To achieve these objectives, IR focal plane arrays (FPAs), and interband cascade lasers (ICLs) with significantly improved performance, lower cost, and increased operating temperatures are required. This research has direct application to Army ground vehicles, aviation platforms, weapon systems, and the individual Soldier. Research is focused on material growth, detector and laser design, and processing for large area multicolor IR FPAs and interband cascade lasers. The principal efforts are directed towards novel materials for detectors and lasers, and investigating energy band-gap structures in semi-conductor materials to enhance the performance of lasers and IR FPAs. In the Area of RF Photonics near-IR modeling and nanofabrication techniques are applied to the design and fabrication of IR photonic-crystal waveguide structures having customized IR properties. Micro Electro Mechanical System (MEMS) configurations are incorporated into the photonic-crystal waveguide structures to enable reconfigurable IR waveguide properties. Customized IR photonic materials and components in conjunction with fiber optic interconnects are applied to the control of microwaves. The technical goals are to manage and control defects in the raw, unprocessed materials, maintaining quality control in the fabrication of the devices and arrays, limiting introduction of impurities in the material, surface passivation of the devices so that they are resistant to degradation over time and thermal management, particularly as it applies to interband cascade lasers.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Increase situational awareness in open and complex terrain; improve target detection, identification, and discrimination; and enhance IR countermeasure (IRCM) protection against missile threats. In FY08, investigated high-power IR lasers for free space (ground-to-satellite and satellite-to-ground) communications, designed 2-color Midwave Infrared/Longwave Infrared (MWIR/LWIR) detector structures, and researched nano-scale photonic crystal waveguide device that can reconfigure by a MEMS feature. In FY09, research frequency modulated IR lasers for covert communication applications, fabricate high operating temperature LWIR Type detector arrays. Investigate dilute Nitride materials. Design and research chip-scale integrated IR-	2.415	2.544	2.676	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
photonic circuit based on the reconfigurable photonic crystal-MEMS waveguide devices; and assemble innovative fiber optic circuits with a patented new concept in photonic crystals for microwave true-time-delay applications. In FY10, will utilize fiber optic integrated circuits to improve mode control of ultra-low-noise microwave oscillator. Will improve LWIR superlattice detectors comparable to Mercury Cadmium Telluride (HgCdTe) but for higher operation temperature.					
Small Business Innovative Research/Small Business Technology Transfer Programs		.000	.008	.000	
Total		2.415	2.552	2.676	
C. Other Program Funding Summary (\$ in Millions) N/A					
D. Acquisition Strategy N/A					
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.					

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
52C: MAPPING & REMOTE SENS	2.597	2.698	2.788						Continuing	Continuing

A. Mission Description and Budget Item Justification

This basic research project increases knowledge of the terrain with a focus on improving the generation, management, analysis/reasoning, and modeling of geospatial data, and the exploitation of multi-sensor data. This fundamental knowledge forms the scientific "springboard" for the future development of applications, techniques, and tools to improve the tactical commander's knowledge of the battlefield. Results of this research are used to extract and characterize natural and man-made features from reconnaissance imagery in near-real time; to exploit terrain analysis and reasoning techniques; and to explore the potential of space technology and tactical geospatial sensor technology to provide real-time terrain intelligence, command and control, and targeting support. This research exploits terrain and environmental data to improve situational awareness and enhance information dominance, leading to increased survivability, lethality, and mobility. The research provides the theoretical underpinnings for PE 0602784A (Military Engineering Technology), project 855 (Mapping and Remote Sensing).

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Small Business Innovative Research/Small Business Technology Transfer Programs	.000	.024	.000	
Sensor Phenomenology and Spatial-Temporal Pattern Discovery: In FY08, explored the synthesis of magnetic semiconductor particles for explosives detection in soils, examined the fate and transport of nanosensors in the operational environment, and explored the use of high quantum yield, lanthanide nanomaterials for remote sensing. Also, discovered spatio-temporal co-occurrence pattern models and interest measures. In FY09, creating recoverable semiconductor particles based on paramagnetic properties for distributed robotic sensing, and examining the quantum confined Stark Effect exhibited in nanoscale wires as a new chemical, biological, radiological, nuclear, and explosive (CBRNE) detection scheme. Also, creating a new taxonomy for multi-scale spatial-temporal cascade patterns. In FY10, will examine the synthesis of high quantum yield optical reporters for remote sensing. Also, will create new interest measures for multi-scale spatial-temporal cascade patterns.	2.597	2.674	2.788	

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B. Accomplishments/Planned Program (\$ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011	
Total	2.597	2.698	2.788		
C. Other Program Funding Summary (\$ in Millions) N/A					
D. Acquisition Strategy N/A					
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.					

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
53A: BATTLEFIELD ENV & SIG	2.818	3.002	3.216						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project provides an in-depth understanding of the complex atmospheric boundary layer associated with high-resolution meteorology, the transport, dispersion, optical properties, and characterization of chemical and biological aerosols, and the propagation of full-spectrum electro-magnetic and acoustic energy. The future force will operate in very complex environments (e.g. urban) and disparate terrain requiring new approaches to understanding, characterizing, and depicting micro-scale atmospheric phenomena. The lack of a complete understanding of the meteorological aspects of the complex micro-scale boundary layer in which the Army operates continues to impact our abilities to provide accurate and timely tactical weather intelligence to battlefield commanders. This project focuses on boundary layer meteorology over land and urban terrain. It supports the Army's transformation to the future force through formulation of future capabilities and techniques in such areas as the characterization and identification of bio-warfare agents, enhanced acoustic, and electro-optic propagation modeling techniques for improved target detection and acquisition, and formulation of objective analysis tools that can assimilate on-scene weather observations and fuse this information with forecasts to provide immediate nowcast products. These capabilities will have a direct impact on ensuring Soldier survivability, weapon system lethality, and the mobility required for future combat operations.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Increase survivability and improve situational awareness through research to enhance accuracy of predictive modeling of the boundary layer and improve the ability to function effectively "anyplace and anytime". In FY08 explored fine-scale structure within urban boundary layer for input to models depicting transport of chem/bio and other dispersants as well as predictions of airframe turbulence for unmanned aircraft. Investigated the vertical flux effects of water vapor in the boundary layer to determine effects on sensor propagation models. In FY09 investigate methods to solve problems encountered in computing wind flows for steep terrain and across large elevation differences introducing immersed boundary methods and vertical coordinate stretching; investigate spectral analysis of measured urban meteorological profiles to produce new wake parameterizations to improve the high resolution urban wind model. Investigate water vapor fluctuation spectra influenced by urban boundary layer for propagation effects	1.066	1.106	1.221	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
on sensor performance and imaging capabilities. Measure and characterize the length scale transitions from 3D isotropic to 2D nonisotropic turbulence in the atmospheric surface layer for their effects on propagation and micro air vehicles. In FY10 will investigate methods for optimizing aircraft routes in adverse weather conditions; will extend physics-based version of the 3DWF microscale wind model to improve fidelity for simulation and prediction of wind fields in urban and complex terrain.					
Research in optical and acoustical propagation in the atmosphere for enhanced Intelligence, Surveillance, and Reconnaissance capabilities for the future force to support situational understanding and rapid targeting. In FY08, measured 2-D Angular Optical Scattering (TAOS) of atmospheric particles using improved instrumentation to improve detection and identification of chem/bio hazards. Implemented an inversion technique to extract the optical constants of the spherical atmospheric aerosol particles to enhance capabilities for discrimination and identification of chem/bio hazards. Investigated effects of single urban structure on sound fields to enhance detection and avoidance capabilities. Implemented model for propagation through atmospheric water vapor fluctuations at TeraHertz frequencies to improve sensor accuracy. In FY09, devise and employ a model for illuminative effects of clouds on night vision devices to improve prediction of range limits, analyze the measurements of heated aerosol particle laser induced fluorescence spectra to enhance identification, investigate techniques for classification of non-spherical aerosol particles for improved chem/bio aerosol identification, and investigate effects of multiple urban structures on sound fields to enhance detection avoidance. Develop building effects parameterizations for acoustic models. In FY10, will design algorithms for atmospheric propagation of acoustic signatures in complex terrain. Will devise methods for determining the effect of the atmosphere on polarimetric imaging. Will measure separated Ultra-Violet Raman spectra of aerosols particles.		1.752	1.896	1.995	
Total		2.818	3.002	3.216	
C. Other Program Funding Summary (\$ in Millions) N/A					
D. Acquisition Strategy N/A					

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<u>E. Performance Metrics</u> Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.		

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
74A: HUMAN ENGINEERING	2.937	5.028	5.703						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project focuses on improving Soldier-system performance in future force environments. Research is on key underlying Soldier performance phenomena such as judgment under uncertainty; echo-location and distance-estimation under degraded conditions; extending and protecting auditory and cognitive performance; human performance in automated, mixed-initiative (human control-machine control) environments; associated neurological dynamics; communications in hearing-degraded conditions; collaborative (team) and independent multi-task, multi-modal, multi-echelon Soldier-system performance, all cast against the influx of emerging Transformation-driven technological solutions and opportunities. Technical barriers include lack of methods for describing, measuring, and managing the interplay of these relatively novel phenomena in the consequent task due to situational complexity and ambiguity that characterize operations in the future force. Technical solutions are being pursued in the areas of data generation and algorithm development in these emerging environments in order to update and improve our understanding of performance boundaries and requirements. These solutions include multi-disciplinary partnerships, metrics, simulation capabilities, and modeling tools for characterizing Soldier-system performance, and provide a shared conceptual and operational framework for militarily relevant research on cognitive and perceptual processes. In the area of neuroergonomics, the study of the brain at work, research is carried out to examine leading edge methodologies and technologies to improve cognitive and behavioral performance, particularly under high stress conditions and to assess how neural pathways implicated in functional processing can be enhanced to improve the training of Soldiers in an operational context.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Research in Cognition and Neuroergonomics: Devise and show fundamental translational principles for neuroscience-based research and theory to complex operations settings in three focus areas: Soldier-system information transfer, commander-level decision making, and individualized analysis and assessment of cognitive performance in operational environments. In FY10, will investigate perceptual-motor interactions, including those between sensory-perceptual channels and motor systems; explore the complex effects of information quality and quantity on physical and cognitive performance; explore the neural representations of command-level decision making through identification of information representation;	.000	.000	1.069	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
examine factors leading to successful or faulty decisions, including biases, heuristics, implicit versus explicit knowledge, context and stressor; identify key individual differences and stressors and investigate their impact on neural processing and cognitive performance; explore the appropriate neuro-sensing approaches for assessment in operational environments.					
Research in Neuroergonomics: Enable systems designs that are consistent with human brain function, taking into account its limitations and exploiting its potentials, to maximize Soldier performance. In FY09, investigate novel approaches to capture brain activity and Soldier behavior in complex, dynamic operationally-relevant environments, examine differences in neural processes between individuals, and explore the neural processes underlying visual scanning. In FY10, will explore the feasibility of using dry, wireless neurophysiological sensors suitable for high-density arrays in operationally-relevant environments; will identify and model specific neural processes underlying visual scanning and target identification.		.000	1.487	1.078	
Small Business Innovative Research/Small Business Technology Transfer Programs		.000	.055	.000	
Research to characterize and enhance Soldier auditory performance: In FY08, determined feasibility and limitations of ultrasonic hearing through a literature search regarding perception of speech signals transmitted in the ultrasonic range. Purchased low power ultrasonic transducers for pilot experiments. Results showed speech not sufficiently intelligible, and transducers became very hot causing discomfort for the user. Increased carrier frequency and greater power (multiple transducers) ruled out due to limited knowledge about stimulation and potential subjects' health issues. Because of these results, other research options will be evaluated. Explored the effect of sound duration on auditory localization accuracy. Stimulus durations of 200-800 ms were used to determine duration effects. Localization accuracy improved with increased duration time for the entire stimuli set. Participants were allowed unrestricted head movement, as in operational environments. The combined effects of constrained head movement and stimulus duration will be investigated in the future. In FY09, investigate synergy between bone conduction (BC) and tactile communication for military applications. Formulate an algorithm for predicting localization error due to headgear. In FY10, will investigate and determine optimum ear coverage by infantry helmets. Will devise binaural criterion of speech intelligibility.		1.225	1.438	1.375	
Soldier performance:		1.712	2.048	2.181	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
In FY08 investigated temporal cognition via dynamic Soldier task performance, cognitive modeling, and neurophysiological evidence. Computational cognitive model validated descriptive models of visual perception. The modeling tool ACT-R (Adaptive Control of Thought - Rational) was used to study timing of cognitive processing using visual perception study of neurophysiological Event Related Potentials (ERP). On a millisecond basis very early "N100" signals in brain-wave pattern were paired with the perceptual encoding phase of the study task and later "P300" signals were paired with a context-updating phase in model. High correlation of model findings & empirical data yielded two important advancements: 1) Cognitive model is a means for validating cognitive correlates of the neurophysiological signals N100 and P300, & 2) ACT-R can relate ERP events to cognitive functions & validate cognitive interpretations of ERPs. Conducted study of physiological correlates of cognitive performance in drive-by-wire control display systems. In FY09, use computer modeling/social network analyses to study Soldier decision-making to examine quality of information flow in defined command & control structures; conduct follow-on study to explore valid robot lexicon for human-robot communication; begin research to determine important variables for human-robot teams control; investigate effect of information quality on low-level decision making. In FY10, will conduct investigations of situational understanding & prediction in uncertain environments; identify usability deficiencies & mismatches between battle command processes & technology enhancements; will further investigate the effects of information presentation on the Soldier's ability to perceive information.					
Total		2.937	5.028	5.703	
C. Other Program Funding Summary (\$ in Millions) N/A					
D. Acquisition Strategy N/A					
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.					

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
74F: PERS PERF & TRAINING	3.372	6.237	5.860						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds behavioral and social science basic research in areas with high potential to improve personnel selection, training, leader development, human performance, and the human and social dynamics of network operations. Research covers areas such as assessment of practical intelligence as an aptitude that can be measured across job domains; identifying principles and potential methods for training and sustaining complex tasks arising from digital, semi-automated, and robotic systems requirements; identifying potential methods for faster learning, improved skill retention, and adaptable transfer of training to new tasks; identifying likely methods for developing leader adaptability and flexibility and for speeding the maturation process; discovering and testing the basic cognitive principles that underlie effective leader-team performance; understanding the role of emotions in regulating behavior; extending social network theory to assist in training effectiveness for counter insurgency operations; and improving the match between Soldier skills and their jobs to optimize performance. Research is focused on fundamental issues that will improve the Army's capability to: (1) select, classify, train, and/or develop Soldiers and leaders who are adaptable in novel missions and operational environments, can function effectively in digital, information rich, and semi-autonomous environments, can effectively collaborate in quickly formed groups and when distributed in high stress environments, and possess interpersonal and intercultural skills and attributes relevant to Joint-Service and multi-national operations; (2) accelerate the training of leadership, interpersonal, and emotional skills that traditionally develop over long periods of time and through direct experience; and (3) support the Army's new Network Science initiative by focusing on the human cognitive and social domains - understanding individual, unit, and organizational behavior within the context of complex networked environments that will be essential for synergy between technology and human performance.

Research in this project is related to and fully coordinated with efforts funded in PE 0602785A, project 790 (Personnel Performance and Training Technology).

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Defense of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the US Army Research Institute for the Behavioral and Social Sciences (ARI), Arlington, VA.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Human Behavior: In FY08, developed methods to identify individuals most susceptible to information biases in complex environments and methods to assess motivation for leadership self-development; identified and developed metrics of individual-difference	2.303	4.131	3.952	

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B. Accomplishments/Planned Program (\$ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011	
variables that predict organizational citizenship and adaptive performance; and continued examination of unbiased testing and relationships of pattern recognition, creativity, and mental flexibility. In FY09, identify and measure individual attributes and learning principles that foster adaptive performance and promote rapid adaptability skill acquisition and retention; develop a new, culture free measure of self-control that will allow prediction of achievement above and beyond cognitive ability; and mature theoretical framework for addressing the human dimension for training and enhanced performance, Soldier retention, productivity, and organizational citizenship. In FY10, will achieve a better understanding of the interplay between cognition and emotion in training, performance, and socio-cultural interactions; will link training methods and learning principles to performance such that they can be incorporated into models that predict job performance and could be used to improve immersive training environments that are tailorable to the individual needs of learners; will systematically examine how nonverbal behaviors are encoded and decoded in human communications in a variety of settings (in particular, we will be concerned with training, leadership, and negotiation types of settings); and will determine whether and how nonverbal behaviors affect outcomes in these environments.					
Small Business Innovation Research/Small Business Technology Transfer Programs	.000	.151	.000		
Network-Human Science: In FY08, conducted research on human use of networks, communication, and command and control technologies to include automated agents, distributed environments, and improved, integrated assessment; and created new technologies for collaborative scientific inquiries into network science, working with the Army Research Laboratory and Army Research, Development, and Engineering Centers. In FY09, conduct research on modeling and simulation of the human use of networks, communication, and command and control technologies to create semantic networks of common sense knowledge in tactical military settings; create new technologies to integrate the human, biological, mathematical, and engineered domains of network science, to extract higher level principles that illuminate each domain in new ways; and explore the regularities of networked social behavior within massively multi-user online environments as simulations of real behavior. In FY10, will create new computational measures of leadership and organizational expertise in on-line networks and distinguish novices from experts in order to rate the reliability of the contributed information; and will match those needing information to those who are able to share it to investigate the dynamics that foster a thriving online community. In all years, research will be done in collaboration with the Army Research Laboratory and Army Research, Development, and Engineering Centers and with researchers at the Army's University Affiliated Research Centers, i.e., the Institute	1.069	1.955	1.908		

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010
for Creative Technologies at the University of Southern California, the Institute for Collaborative Biotechnology at the University of California, Santa Barbara, the Massachusetts Institute of Technology, and Carnegie Mellon University.				
Total		3.372	6.237	5.860
C. Other Program Funding Summary (\$ in Millions) N/A				
D. Acquisition Strategy N/A				
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.				

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