Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Army											Date: April 2022	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2021**	**FY 2022**	**FY 2023 Base**	**FY 2023 OCO**	**FY 2023 Total**	**FY 2024**	**FY 2025**	**FY 2026**	**FY 2027**	**Cost To Complete**	**Total Cost**
Total Program Element	-	159.358	216.550	52.848	-	52.848	59.131	60.164	67.137	62.911	0.000	678.099
BK7: *Robotics for Engineer Operations Technology*	-	5.700	1.228	1.802	-	1.802	6.431	5.693	3.724	2.074	0.000	26.652
BL1: *Materials and Manufacturing Research Technology*	-	11.783	9.374	4.257	-	4.257	4.302	4.295	7.035	7.033	0.000	48.079
BL2: *Explosives Forensics Technology*	-	1.514	1.582	1.673	-	1.673	1.699	1.713	1.713	1.713	0.000	11.607
BL5: *Expedient Passive Protection Technology*	-	1.413	1.906	4.348	-	4.348	2.944	3.096	4.755	4.129	0.000	22.591
BL7: *Power Projection in A2AD Environments Technology*	-	1.843	3.151	1.871	-	1.871	2.950	2.145	3.588	2.548	0.000	18.096
BL9: *Protection from Advanced Weapon Effects Technology*	-	3.596	4.344	5.062	-	5.062	5.188	4.995	4.778	5.471	0.000	33.434
BN8: *Ground Technology Materials(CA)*	-	131.000	160.150	-	-	-	-	-	-	-	0.000	291.150
CA9: *Predictive Maintenance*	-	2.509	-	-	-	-	-	-	-	-	0.000	2.509
CG5: *Ground Vehicle Sensor Concepts and Technologies*	-	-	4.146	-	-	-	-	-	-	-	0.000	4.146
CG6: *Ground Vehicle Power and Energy Concepts and Tech*	-	-	2.681	2.526	-	2.526	2.594	2.643	4.010	3.959	0.000	18.413
CG7: *Ground Protection Concepts and Technologies*	-	-	14.565	12.344	-	12.344	12.578	12.566	14.195	14.192	0.000	80.440
CG8: *Human Autonomy Teaming*	-	-	8.599	9.086	-	9.086	9.222	9.213	10.534	10.550	0.000	57.204
CI2: *Ground Enabling University Applied Research*	-	-	4.824	3.682	-	3.682	3.889	5.491	4.591	4.590	0.000	27.067

Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Army												Date: April 2022
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602144A *I Ground Technology*							
CV3: *Engineer Enablers Maneuver, LOG, & Sustainment Apl*	-	-	-	2.518	-	2.518	2.185	1.247	1.144	-	0.000	7.094
DA1: *SAFR Alternatives for Readiness Applied Research*	-	-	-	3.679	-	3.679	5.149	6.028	6.030	5.613	0.000	26.499
DB7: *Center for Mobile Power and Energy Apl Research**	-	-	-	-	-	-	-	1.039	1.040	1.039	0.000	3.118

*This project's R-2a exhibit has been suppressed due to funding not beginning until after FY 2023

Note

Project CV3 (Engineer Enablers Maneuver, LOG, & Sustainment Apl) and Project DA1 (SAFR Alternatives for Readiness Applied Research) are New Start Projects for Fiscal Year 2023 (FY23). Project CG5 (Ground Vehicle Sensor Concepts and Technologies) is Terminated starting in FY23.

A. Mission Description and Budget Item Justification

This Program element (PE) researches efforts that support and enable the Army's modernization priority for the Next Generation of Combat Vehicles including systems for the deployment and sustainment of ground movement and maneuver. This PE designs and validates technologies that are necessary and foundational for legacy and future ground movement, maneuver and protection of Soldiers and systems.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas in support of the National Defense Strategy and the Army Modernization Strategy.

Work in this PE supports the Army Science and Technology Ground portfolio.

Work is performed by the United States (U.S.) Army Futures Command and the U.S. Army Engineer Research and Development Center.

Work in this PE complements PE 0602145A (Next Generation Combat Vehicle Technology), PE 0603119A (Ground Advanced Technology), PE 0603462A (Next Generation Combat Vehicle Advanced Technology), PE 0602143A (Soldier Lethality Technology) and PE 0603118A (Soldier Lethality Advanced Technology).

Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Army					Date: April 2022
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*			R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*		
B. Program Change Summary ($ in Millions)	**FY 2021**	**FY 2022**	**FY 2023 Base**	**FY 2023 OCO**	**FY 2023 Total**
Previous President's Budget	158.158	56.400	0.000	-	0.000
Current President's Budget	159.358	216.550	52.848	-	52.848
Total Adjustments	1.200	160.150	52.848	-	52.848
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	160.150			
• Congressional Directed Transfers	-	-			
• Reprogrammings	1.200	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	52.848	-	52.848

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2021**	**FY 2022**
Project: BN8: *Ground Technology Materials(CA)*		
Congressional Add: *Program increase: Ice Engineering Research Facility Modernization*	5.000	-
Congressional Add: *Program increase: Center for Research in Extreme Batteries*	10.000	-
Congressional Add: *Program increase: Cellulose Nanocomposites Research*	5.000	-
Congressional Add: *Program increase: Advanced Polymers for Force Protection*	8.000	8.000
Congressional Add: *Program increase - Advanced Concrete*	4.000	-
Congressional Add: *Program increase - Robotic RTCH*	5.000	-
Congressional Add: *Program increase - Military Waste Stream Conversion*	5.000	-
Congressional Add: *Program increase - High Performance Polymers*	5.000	5.000
Congressional Add: *Program increase - Integrity of Transparent Armor*	5.000	5.000
Congressional Add: *Program increase - Environmental Quality Enhanced Coatings*	5.000	5.000
Congressional Add: *Program increase - Autonomous Digital Design and Manufacturing*	5.000	5.000
Congressional Add: *Program increase - Materials Recovery Technologies for Defense Supply Resiliency*	10.000	10.000
Congressional Add: *Program increase - Materials Manufacturing Processes*	10.000	-
Congressional Add: *Program increase - Additive Manufacturing Machine Learning Initiative*	10.000	5.000
Congressional Add: *Program increase - Rapid Advanced Deposition*	10.000	5.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Army	Date: April 2022
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2021	FY 2022
Congressional Add: *Program increase - Defense Resiliency Against Extreme Cold Weather*	10.000	10.000
Congressional Add: *Program increase - Counter UAS Technology Research*	5.000	-
Congressional Add: *Program increase - Cell-Free Expression for Biomanufacturing*	10.000	-
Congressional Add: *Program increase - Earthen Structures Soil Enhancement*	4.000	4.000
Congressional Add: *Advanced Manufacturing Materials Processes Initiative*	-	10.000
Congressional Add: *Advanced Materials Manufacturing*	-	8.000
Congressional Add: *Anti-Corrosion Materials*	-	7.000
Congressional Add: *Ceramic Materials for Extreme Environments*	-	8.000
Congressional Add: *Climate and Natural Hazards, Snow-Covered and Mountain Environment Sensing Research*	-	6.000
Congressional Add: *Electrolyzer*	-	7.000
Congressional Add: *Flexible Hybrid Electronics and Environmental Sustainability*	-	12.000
Congressional Add: *PFAS Modeling*	-	5.000
Congressional Add: *Polar Proving Ground and Training Program*	-	2.000
Congressional Add: *Rapid Infrastructure Development and Engineering*	-	3.000
Congressional Add: *Rare Earth Initiative*	-	7.000
Congressional Add: *Solid Oxide Fuel Cell Development*	-	10.000
Congressional Add: *Tank Tracks*	-	3.150
Congressional Add: *Verified Inherent Control*	-	10.000
Congressional Add Subtotals for Project: BN8	131.000	160.150
Congressional Add Totals for all Projects	131.000	160.150

Change Summary Explanation

Fiscal Year 2023 (FY23) funding increase reflects the fact that the FY22 President's Budget request did not include out-year funding.

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) BK7 / *Robotics for Engineer Operations Technology*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BK7: *Robotics for Engineer Operations Technology*	-	5.700	1.228	1.802	-	1.802	6.431	5.693	3.724	2.074	0.000	26.652

A. Mission Description and Budget Item Justification

This research investigates and develops standoff robotic capabilities for Combat Engineers to reduce Soldier/Engineer risks and fatalities while conducting activities essential to shaping the environment. It will close the gaps between commercial construction equipment and the requirements of the future Engineer Force to support maneuver, movement, and sustainment. This research will develop the capability to generate a near real-time site model with appropriate engineering details to allow unmanned shaping of the environment through physical interaction (e.g. push, pull, lift, or dig). This effort will also develop the requisite mission planner and task execution controller that accepts input from the user and provides suggestions and feedback based on updates to the site model, reporting from hardware agents, and resource allocation logic. The end state goal is the development of beyond visual line of sight teleoperation and semiautonomous capabilities allowing Engineer robotic support to match pace in near term and future combat environments. This effort will support the development, testing, and evaluation of prototypical robotic Combat Engineer equipment. This Project develops modeling and simulation tools that represent realistic states for Engineer robotic operations and develops and assesses semi-autonomous and autonomous construction equipment technologies needed for remote control Engineer operations.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground Portfolio.

Work in this Project is conducted by the United States (U.S.) Army Engineer Research and Development Center and coordinated with U.S. Army Futures Command.

Work in this Project is coordinated with Program Element (PE) 0603462A (Next Generation Combat Vehicle Advanced Technology).

Work in this Project is related to, and fully coordinated with, PE 0603119A (Ground Advanced Technology) / Project BK8 (Robotics for Engineer Operations Adv Tech).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Beyond-Visual-Line-of-Sight Teleoperated Engr Ops	5.700	1.183	-
Description: This effort develops site characterization technologies, equipment localization technologies, equipment tools, and controls protocols to support remote control and semi-autonomous engineering operations and develops modeling and simulation tools to support remote operations.			
FY 2022 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BK7 / *Robotics for Engineer Operations Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Investigate operator assist capabilities and operator interface aids for remote tool control; refine components to the Engineer specific library for object classification, site localization technologies, and site change and manipulation monitoring. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** This effort completes in Fiscal Year 2022 with transfer of applied technologies to PE 0603119A (Ground Advanced Technology) / Project BK8 (Robotics for Engineer Operations Adv Tech).			
Title: Semi-Autonomous Engineer Operations ***Description:*** This effort will investigate and develop machine tool behaviors to perform semi-autonomous shaping of the terrain through physical interaction with the environment (push, pull, lift, and dig). The effort will develop the necessary decision-making, data fusion, localization, and inter-platform communication to allow semi-autonomy on commercial off the shelf (COTS) equipment. ***FY 2023 Plans:*** Will investigate instrumenting individual motors and movement joints on the heavy Engineer equipment for machine feedback to planning algorithms; will develop the required sensor payload, onboard processing, and path planning and control algorithms on heavy Engineer equipment to enable semiautonomous navigation. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding increase reflects the planned lifecycle for this Project to develop semi-autonomous standoff robotic capabilities for heavy Engineer equipment.	-	-	1.802
Title: FY 2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.045	-
Accomplishments/Planned Programs Subtotals	5.700	1.228	1.802

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BK7 / *Robotics for Engineer Operations Technology*

C. Other Program Funding Summary ($ in Millions)

Remarks

N/A

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) BL1 / *Materials and Manufacturing Research Technology*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BL1: *Materials and Manufacturing Research Technology*	-	11.783	9.374	4.257	-	4.257	4.302	4.295	7.035	7.033	0.000	48.079

A. Mission Description and Budget Item Justification

This Project links materials research, manufacturing processes, and design to enable higher quality additive manufacturing products for Army applications through the development of high performance feedstock materials (polymers, metals, and ceramics), physics-based process models, and in-situ process monitoring. Integration of these tools with process models enables real-time control and manipulation of materials structure and properties to produce three-dimensional hybrid electronics packaging, power and energy sources and converters and new materials/structures for protection. The goal of this work is to develop robust physics-based models to optimize material properties, structures, and manufacturing processes for Army applications in protection, maneuver, power, sensing, and signature management necessary to rapidly respond to emerging and unknown threats in a battlefield environment.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground, Next Generation Combat Vehicle, Long Range Protective Fires, and Soldier Lethality.

Work in this Project is performed by the United States (US) Army Futures Command.

This work is done in coordination with Program Element (PE) 0602145A (Next Generation Combat Vehicle Technology), 0602143A (Soldier Lethality Technology) and 0603118A (Soldier Lethality Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Additive Manufacturing Research	5.240	8.162	3.354
Description: This effort Investigates new additive manufacturing (AM) capabilities that enable production of lightweight materials for protection, lethality, and maneuverability that cannot be produced through traditional manufacturing methods. Efforts include the design and development of new feedstock materials engineered specifically for low-volume additive processes to produce net-shape materials with desired properties and functionalities; integrated process models and real-time monitoring for closed-loop control and production of lightweight materials with optimal architectures, property gradients, and interfaces; and design optimization capabilities that connect materials and manufacturing to access the full design space enabled by additive manufacturing.			
FY 2022 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL1 / *Materials and Manufacturing Research Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Will mature a closed-loop AM process control experimental capability across a broad array of AM technologies by applying a set of in-situ process (or "within" process) monitoring techniques; design and develop an AM machine learning (ML) architecture for advancing real-time AM process controls by applying the following two deep ML frameworks: (1) convolutional neural networks (CNN) supervised deep learning framework for automatically detecting in-process defects and rapidly computing predictive models such as a structure-processing-property relations model; (2) generative adversarial networks (GANs) unsupervised deep learning framework for training the in-situ data sets and generating referenced data sets in real-time to compare them against in-situ process data for detecting AM process anomalies and for predicting the geometry-dependent optimized AM process parameters. ***FY 2023 Plans:*** Will design and develop three-dimensional printed propellants, both rocket and gun charges, which yield optimized pressurization profiles to increase muzzle velocity for increased penetration in direct fire applications and/or increased range for large caliber munitions; conduct experiments of tailorable fragmentation schemes in metals AM printed parts, controlling size and size distribution of fragments as it is integrated with next generation explosive technologies (potentially integrated with AM explosives). ***FY 2022 to FY 2023 Increase/Decrease Statement:*** In Fiscal Year (FY) 2023, funding is realigned to support the creation of Project CZ9 (Foundational Hypersonic Weapons Research) within PE 0602141A (Lethality Technology).			
Title: Energy Sources and Storage ***Description:*** This effort focuses on the design and characterization of chemistries, materials, and components for advanced batteries, fuel reformers, and fuel cells. Potential Army applications include hybrid power sources, smart munitions, hybrid electric vehicles, and soldier power applications. This effort also investigates the applicability of photosynthesis to provide fuel and electricity for soldier power applications, and investigates silicon carbide power module components that could enable compact, high-efficiency, high-temperature, and high-power density converters for motor drive and pulse power applications. ***FY 2022 Plans:*** Will investigate advanced electrolytes to improve safety in ultrahigh energy silicon nanostructured anodes for Soldier-carried batteries including the 3/5 form factor (standard military specification for battery size, with a length over width ratio of 3 to 5) Conformal Wearable Battery (CWB); investigate materials and additives to improving safety in high energy (400 Wh/kg Li-ion); investigate high energy halide intercalation cathodes for transition of metal-free rechargeable batteries (halide intercalation is the reversible inclusion or insertion of a metal hydride molecule or ion into materials with layered structures such as graphite). ***FY 2023 Plans:*** Will investigate ability to incorporate chemically modify and dope silicon-based Li-ion battery anodes as a means to address reactivity to improve ultrahigh energy performance of Soldier-carried batteries; explore ability to combine with advanced high	1.290	0.870	0.903

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL1 / *Materials and Manufacturing Research Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
voltage electrolytes to mitigate risks of fire and thermal runaway in event of damage or abuse; investigate ability to enable fast charge / high power in high capacity anodes including nanostructured Si-, composite-, metal-oxides, and structured anodes; design and develop high ionic conductivity solid-state electrolytes and integral electrode structures as means to further mitigate safety risks in high energy, high rate rechargeable Li-ion battery. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Ballistic, Aero-Optics Materials (BAM) Testing ***Description:*** Develop a national level test facility employing controlled, characterized environmental conditions and novel technology for testing and evaluation of directed energy systems, aerothermodynamic performance at hypersonic speeds, and hyper velocity impacts.	5.253	-	-
Title: FY2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.342	-
Accomplishments/Planned Programs Subtotals	11.783	9.374	4.257

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) BL2 / *Explosives Forensics Technology*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BL2: *Explosives Forensics Technology*	-	1.514	1.582	1.673	-	1.673	1.699	1.713	1.713	1.713	0.000	11.607

A. Mission Description and Budget Item Justification

This Project investigates and develops analytical methods for military explosives, homemade explosives (HME), HME precursors, and residue analysis for forensics attribution purposes. This project pursues research in signatures and algorithms required to provide improved residue analysis of explosives and precursor materials to enable integration into chemical and explosive hazard detection equipment for the warfighter.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground Portfolio.

Work in this Project is performed by the United States (US) Army Futures Command.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Forensic Analysis of Explosives Signatures Applied Research	1.514	1.524	1.673
Description: This effort investigates forensics analytical methods for military explosives, homemade explosives (HME), HME precursors, and residue analysis for attribution. ***FY 2022 Plans:*** Will continue to investigate new technologies (hyperspectral imaging, compressed sensing, augmentation of current technology) for development of advanced concepts and operations of forensic analytical techniques to facilitate chemical and explosive detection and reconnaissance. ***FY 2023 Plans:*** Will mature concepts and technologies in analytical forensics methods leading to the design and development of portable tools and capabilities for the detection of explosives, drugs (synthetic opioids), and other chemical residue analysis for attribution. Further develop inkjet manufactured coupons for quantifiable threat assessments mimicking bulk and trace level hazards of contamination on surfaces to be utilized for assessment of optical and non-optical detection systems. Investigate multi-wavelength, multi-phenomenology orthogonal systems for low level surface detection characteristics. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY2022 SBIR/STTR Transfer	-	0.058	-

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL2 / *Explosives Forensics Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Description: Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	1.514	1.582	1.673

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) BL5 / *Expedient Passive Protection Technology*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BL5: *Expedient Passive Protection Technology*	-	1.413	1.906	4.348	-	4.348	2.944	3.096	4.755	4.129	0.000	22.591

A. Mission Description and Budget Item Justification

This Project designs and develops rapidly deployable passive protective solutions; algorithms for decision support applications and software; and tactics, techniques, and procedures to increase the survivability of personnel, critical assets, and facilities. Through experimental and computational investigation and design, this project develops force protection technologies for complex and urban environments. This Project also develops expedient solutions and decision support applications for protection against advanced energetic threats and large caliber rockets, missiles, and other emerging weapons.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground Portfolio.

Work in this Project is conducted by the United States (US) Army Engineer Research and Development Center and coordinated with US Army Futures Command.

Work in this Project complements Program Element (PE) 0603119A (Ground Advanced Technology) / Project BL6 (Expedient Passive Protection Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Protection Against High Trajectory Large Caliber Rocket and Missile Threats	1.413	1.836	-
Description: This effort investigates high trajectory large caliber rocket and missile weapon effects on critical assets and facilities and develops expedient force protection solutions for these new weapon threats. These solutions include the application of novel protective materials and designs. This effort develops and validates deployable protection systems against these threats and develops decision support tools to aid the warfighter in selecting protective positions. ***FY 2022 Plans:*** Develop new materials and algorithms to protect critical assets in multi-domain operations from emerging threats such as large caliber rockets and missiles and develop new design concepts for passive protection against these threats. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** This effort completes in Fiscal Year 2022 with transfer of applied technologies to PE 0603119A (Ground Advanced Technology) / Project BL6 (Expedient Passive Protection Advanced Technology).			
Title: Assessments of Solutions for Survivability from Emerging Threats (ASSET)	-	-	4.348

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL5 / *Expedient Passive Protection Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Description: This effort investigates emerging weapon threat effects on critical assets, theater of operation facilities, and existing protection technologies; designs and develops rapidly deployable passive protective solutions; algorithms for decision support applications and software; and tactics, techniques, and procedures to increase the survivability of personnel, critical assets, and facilities against emerging threats, such as high trajectory large caliber rockets and missiles as well as UAS threats. This effort integrates experimental and computational analysis. ***FY 2023 Plans:*** Will develop design concepts and models of rapidly deployable protection systems to protect critical semi-fixed assets and facilities from the effects of emerging threats, and will develop fast-running algorithms to estimate the effects of emerging threats on legacy protective systems and new conceptual passive protection designs. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding increase reflects the planned lifecycle for this Project to support increased effort to emerging weapon threat effects and increase the survivability of personnel, critical assets, and facilities.			
Title: FY 2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.070	-
Accomplishments/Planned Programs Subtotals	1.413	1.906	4.348

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) BL7 / *Power Projection in A2AD Environments Technology*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BL7: *Power Projection in A2AD Environments Technology*	-	1.843	3.151	1.871	-	1.871	2.950	2.145	3.588	2.548	0.000	18.096

A. Mission Description and Budget Item Justification

This Project designs and develops remote assessment technologies to determine entry and maneuver corridors, develops site selection tools and decision support technologies for all climates in all season conditions including aviation site selection tools, enhanced automated route reconnaissance technologies, mobility models for extreme climates, and road capacity assessment technologies. These technologies reduce reliance on manned on-site reconnaissance for projection platform assessments and provide all season capacity predictions to ensure air and ground battlespace entry and maneuver. This Project also designs and develops material solutions to repair, rebuild and construct infrastructure required for movement and maneuver in highly contested, complex operational environments such as Anti-Access/Area Denial (A2/AD).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground Portfolio.

Work in this Project is conducted by the United States (U.S.) Army Engineer Research and Development Center and coordinated with U.S. Army Futures Command.

Work in this PE complements PE 0603119A (Ground Advanced Technology) / Project BL8 (Power Projection in A2AD Environments Adv Tech).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Entry and Sustainment in Complex Contested Environments	0.880	1.325	-
Description: This effort designs and develops strategic and tactical level planning tools for assessing engineering behavior of ground surfaces as it relates to battlefield maneuver to include factors affecting on-and-off-road vehicle mobility as well as aviation assembly areas; applies new technologies for data acquisition to engineering design factors to rapidly assess vehicle and terrain interaction.			
FY 2022 Plans: Further develop portions of prediction tools for arctic mobility across snow-covered terrain and in organic soils unique to arctic regions, and validate methodologies for rapid road and trail classification and determine analytical procedures for estimating capacity of low-volume roads for military vehicles.			
FY 2022 to FY 2023 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL7 / *Power Projection in A2AD Environments Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
This effort completes in Fiscal Year 2022 with transition of applied technologies to PE 0603119A (Ground Advanced Technology) / Project BL8 (Power Projection in A2AD Environments Adv Tech).			
Title: Engineering for Battlespace Maneuver ***Description:*** This effort develops the capability to rapidly repair and upgrade damaged infrastructure along mobility corridors and restaging areas to maintain and enhance freedom of maneuver achieving overmatch and tactical advantage in contested complex environments. ***FY 2022 Plans:*** Mature materials and refine techniques for rapid ground stabilization and expedient soil hardening to support military vehicles; enhance techniques for expedient infrastructure upgrades; and develop planning aids for engineer support to route remediation. ***FY 2023 Plans:*** Will determine design and selection protocol for executing rapid soil hardening; will conduct experiments to quantify effectiveness of equipment attachments for executing rapid route remediation; will perform simulations to identify requirements for mechanical stabilization systems to support heavy tactical wheeled vehicle loads. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	0.963	1.711	1.871
Title: FY 2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.115	-
Accomplishments/Planned Programs Subtotals	1.843	3.151	1.871

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL7 / *Power Projection in A2AD Environments Technology*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) BL9 / *Protection from Advanced Weapon Effects Technology*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BL9: *Protection from Advanced Weapon Effects Technology*	-	3.596	4.344	5.062	-	5.062	5.188	4.995	4.778	5.471	0.000	33.434

A. Mission Description and Budget Item Justification

This Project designs and develops structural hardening, high-performance computing capabilities, and force protection technologies to enhance survivability of personnel and critical assets. This project investigates and develops advanced materials for protection against blast, fragmentation, and penetration through physical experiments and modeling and simulation. Additionally, this project investigates, designs, and develops passive protection technologies and protective design criteria to mitigate attack from emerging advanced threats.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground Portfolio.

Work in this Project is performed by the United States (U.S.) Army Engineer Research and Development Center and coordinated with the U.S. Army Futures Command.

Work in this Program Element (PE) complements PE 0603119A (Ground Advanced Technology) / Project BM1 (Protection from Advanced Weapon Effects Adv Tech).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Materials and Modeling for Force Protection ***Description:*** This effort designs and develops advanced composite and other protective materials and multi-scale modeling techniques to reduce material weight and increase resistance against blast and penetration threats; designs and develops innovative virtual material design procedures; and matures manufacturing processes supported by computational modeling and simulation.	1.302	-	-
Title: Defeat of Complex Attack ***Description:*** This effort designs and develops passive protection structural hardening designs and solutions against emerging large-caliber advanced weapons; investigates and validates computational models for predicting residual protective capacity for multi-hit threat scenarios; and designs and develops micro-mechanics-based models and material solutions matured by conducting high-rate experiments. ***FY 2022 Plans:***	2.294	2.759	-

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL9 / *Protection from Advanced Weapon Effects Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Develop a full-scale protection/structural solution with predictive algorithm to mitigate precision strike weapon effects; design multi-hit composite protection subsystems to validate algorithms and material subsystems through testing; and develop a model to inform engineers on protective design guidance. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** This effort completes in Fiscal Year 2022 with transfer of applied technologies to PE 0603119A (Ground Advanced Technology) / Project BM1 (Protection from Advanced Weapon Effects Adv Tech).			
Title: Advanced Materials and Modeling for Force Protection ***Description:*** This effort designs and develops capabilities in the use of poorly-understood and indigenous materials. This effort develops multi-scale material modeling frameworks incorporating physics of deformation and damage mechanisms; a 3D multi-physics material modeling capability to allow for weapons effects models to be informed by remote sensing; and advanced material technologies for force protection. ***FY 2022 Plans:*** Develop and refine algorithms for a multi-scale, materials-by-design methodology to model and enhance concrete protective material solutions for weapons effects; and design and develop metallic, composite, and hybrid material solutions for force protection concepts. ***FY 2023 Plans:*** Will expand the multi-scale materials-by-design tools for unconventional / indigenous materials for force protection, will investigate dynamic material simulation capabilities, multi-functional materials development for kinetic and non-kinetic force protection, and design and develop and conduct advanced high-rate dynamic experiments. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	1.426	1.564
Title: Protection from Advanced Penetrators ***Description:*** This effort designs and develops protective material solutions and enhances M&S tools for designing, analyzing and improving these advanced protective materials to be used in large hardened protective structures; investigates and validates computational models and passive protective solutions for large hardened structures from advanced precision penetrating threat weapons. ***FY 2023 Plans:***	-	-	3.498

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL9 / *Protection from Advanced Weapon Effects Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Will investigate material solutions and structural component enhancements for use in hardened protective structures to mitigate weapons effects of advanced penetrators. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funds increased for protective material technology solutions and enhances modeling and simulation tools for large hardened protective structures.			
Title: FY 2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.159	-
Accomplishments/Planned Programs Subtotals	3.596	4.344	5.062

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) BN8 / *Ground Technology Materials(CA)*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BN8: *Ground Technology Materials(CA)*	-	131.000	160.150	-	-	-	-	-	-	-	0.000	291.150

Note

Congressional Interest Item funding provided for Ground Technology Materials.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Ground Technology Materials.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022
Congressional Add: Program increase: Ice Engineering Research Facility Modernization ***FY 2021 Accomplishments:*** Conducted applied research in Ice Engineering Research Facility Modernization. Work executed by Army Futures Command.	5.000	-
Congressional Add: Program increase: Center for Research in Extreme Batteries ***FY 2021 Accomplishments:*** Conducted applied research in Center for Research in Extreme Batteries. Work executed by Army Futures Command.	10.000	-
Congressional Add: Program increase: Cellulose Nanocomposites Research ***FY 2021 Accomplishments:*** Conducted applied research in Cellulose Nanocomposites. Work executed by Army Futures Command.	5.000	-
Congressional Add: Program increase: Advanced Polymers for Force Protection ***FY 2021 Accomplishments:*** Conducted applied research in Advanced Polymers for Force Protection. Work executed by Army Futures Command. ***FY 2022 Plans:*** Congressional Interest Item funding provided for Advanced Polymers for Force Protection	8.000	8.000
Congressional Add: Program increase - Advanced Concrete	4.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BN8 / *Ground Technology Materials(CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022
FY 2021 Accomplishments: Conducted applied research in Advanced Concrete. Work executed by Army Futures Command.		
Congressional Add: Program increase - Robotic RTCH ***FY 2021 Accomplishments:*** Conducted applied research in Robotic RTCH. Work executed by Army Futures Command.	5.000	-
Congressional Add: Program increase - Military Waste Stream Conversion ***FY 2021 Accomplishments:*** Conducted applied research in Military Waste Stream Conversion. Work executed by Army Futures Command.	5.000	-
Congressional Add: Program increase - High Performance Polymers ***FY 2021 Accomplishments:*** Conducted applied research in High Performance Polymers. Work executed by Army Futures Command. ***FY 2022 Plans:*** Congressional Interest Item funding provided for High Performance Polymers	5.000	5.000
Congressional Add: Program increase - Integrity of Transparent Armor ***FY 2021 Accomplishments:*** Conducted applied research in Integrity of Transparent Armor. Work executed by Army Futures Command. ***FY 2022 Plans:*** Congressional Interest Item funding provided for Integrity of Transparent Armor	5.000	5.000
Congressional Add: Program increase - Environmental Quality Enhanced Coatings ***FY 2021 Accomplishments:*** Conducted applied research in Environmental Quality Enhanced Coatings. Work executed by Army Futures Command. ***FY 2022 Plans:*** Congressional Interest Item funding provided for Environmental Quality Enhanced Coatings	5.000	5.000
Congressional Add: Program increase - Autonomous Digital Design and Manufacturing ***FY 2021 Accomplishments:*** Conducted applied research in Autonomous Digital Design and Manufacturing.	5.000	5.000

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BN8 / *Ground Technology Materials(CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022
Work executed by Army Futures Command. ***FY 2022 Plans:*** Congressional Interest Item funding provided for Autonomous Digital Design and Manufacturing		
Congressional Add: Program increase - Materials Recovery Technologies for Defense Supply Resiliency ***FY 2021 Accomplishments:*** Conducted applied research in Materials Recovery Technologies for Defense Supply Resiliency. Work executed by Army Futures Command. ***FY 2022 Plans:*** Congressional Interest Item funding provided for Materials Recovery Technologies for Defense Supply Resiliency	10.000	10.000
Congressional Add: Program increase - Materials Manufacturing Processes ***FY 2021 Accomplishments:*** Conducted applied research in Materials Manufacturing Processes. Work executed by Army Futures Command.	10.000	-
Congressional Add: Program increase - Additive Manufacturing Machine Learning Initiative ***FY 2021 Accomplishments:*** Conducted applied research in Additive Manufacturing Machine Learning Initiative. Work executed by Army Futures Command. ***FY 2022 Plans:*** Congressional Interest Item funding provided for Additive Manufacturing Machine Learning Initiative (Community Project Funding)	10.000	5.000
Congressional Add: Program increase - Rapid Advanced Deposition ***FY 2021 Accomplishments:*** Conducted applied research in Rapid Advanced Deposition. Work executed by Army Futures Command. ***FY 2022 Plans:*** Congressional Interest Item funding provided for Rapid Advanced Deposition	10.000	5.000
Congressional Add: Program increase - Defense Resiliency Against Extreme Cold Weather ***FY 2021 Accomplishments:*** Conducted applied research in Defense Resiliency Against Extreme Cold Weather.	10.000	10.000

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BN8 / *Ground Technology Materials(CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022
Work executed by Army Futures Command. ***FY 2022 Plans:*** Congressional Interest Item funding provided for Defense Resiliency Against Extreme Cold Weather		
Congressional Add: Program increase - Counter UAS Technology Research ***FY 2021 Accomplishments:*** Conducted applied research in Counter UAS Technology. Work executed by Army Futures Command.	5.000	-
Congressional Add: Program increase - Cell-Free Expression for Biomanufacturing ***FY 2021 Accomplishments:*** Conducted applied research in Cell-Free Expression for Biomanufacturing. Work executed by Army Futures Command.	10.000	-
Congressional Add: Program increase - Earthen Structures Soil Enhancement ***FY 2021 Accomplishments:*** Conducted applied research in Earthen Structures Soil Enhancement. Work executed by Army Futures Command. ***FY 2022 Plans:*** Congressional Interest Item funding provided for Earthen Structures Soil Enhancement	4.000	4.000
Congressional Add: Advanced Manufacturing Materials Processes Initiative ***FY 2022 Plans:*** Congressional Interest Item funding provided for Advanced Manufacturing Materials Processes Initiative	-	10.000
Congressional Add: Advanced Materials Manufacturing ***FY 2022 Plans:*** Congressional Interest Item funding provided for Advanced Materials Manufacturing	-	8.000
Congressional Add: Anti-Corrosion Materials ***FY 2022 Plans:*** Congressional Interest Item funding provided for Anti-Corrosion Materials	-	7.000
Congressional Add: Ceramic Materials for Extreme Environments ***FY 2022 Plans:*** Congressional Interest Item funding provided for Ceramic Materials for Extreme Environments	-	8.000
Congressional Add: Climate and Natural Hazards, Snow-Covered and Mountain Environment Sensing Research	-	6.000

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BN8 / *Ground Technology Materials(CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022
FY 2022 Plans: Congressional Interest Item funding provided for Climate and Natural Hazards, Snow-Covered and Mountain Environment Sensing Research		
Congressional Add: Electrolyzer	-	7.000
FY 2022 Plans: Congressional Interest Item funding provided for Electrolyzer		
Congressional Add: Flexible Hybrid Electronics and Environmental Sustainability	-	12.000
FY 2022 Plans: Congressional Interest Item funding provided for Flexible Hybrid Electronics and Environmental Sustainability		
Congressional Add: PFAS Modeling	-	5.000
FY 2022 Plans: Congressional Interest Item funding provided for PFAS Modeling		
Congressional Add: Polar Proving Ground and Training Program	-	2.000
FY 2022 Plans: Congressional Interest Item funding provided for Polar Proving Ground and Training Program		
Congressional Add: Rapid Infrastructure Development and Engineering	-	3.000
FY 2022 Plans: Congressional Interest Item funding provided for Rapid Infrastructure Development and Engineering		
Congressional Add: Rare Earth Initiative	-	7.000
FY 2022 Plans: Congressional Interest Item funding provided for Rare Earth Initiative		
Congressional Add: Solid Oxide Fuel Cell Development	-	10.000
FY 2022 Plans: Congressional Interest Item funding provided for Solid Oxide Fuel Cell Development		
Congressional Add: Tank Tracks	-	3.150
FY 2022 Plans: Congressional Interest Item funding provided for Tank Tracks		
Congressional Add: Verified Inherent Control	-	10.000
FY 2022 Plans: Congressional Interest Item funding provided for Verified Inherent Control		
Congressional Adds Subtotals	131.000	160.150

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BN8 / *Ground Technology Materials(CA)*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army										Date: April 2022		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*				Project (Number/Name) CA9 / *Predictive Maintenance*			
COST ($ in Millions)	**Prior Years**	**FY 2021**	**FY 2022**	**FY 2023 Base**	**FY 2023 OCO**	**FY 2023 Total**	**FY 2024**	**FY 2025**	**FY 2026**	**FY 2027**	**Cost To Complete**	**Total Cost**
CA9: *Predictive Maintenance*	-	2.509	-	-	-	-	-	-	-	-	0.000	2.509

A. Mission Description and Budget Item Justification

This Project develops and characterizes artificial intelligence (AI) and machine learning (ML) tools and capabilities to intelligently predict and analyze maintenance status for emerging and legacy ground platforms; extracts maintenance data from existing databases, sensor data and inference of missing data via virtual simulations investigating maintenance concepts that employ AI data capture and integrate AI tools into enterprise resource planning for military ground vehicles. Research enables use of predictive maintenance to increase fleet operational readiness through reduced downtime by preventing critical failure during missions, maximizing availability to combatant commands.

The cited work is consistent with Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground Portfolio and the Joint Artificial Intelligence Center (JAIC)

Work in this Project is performed by the United States (US) Army Futures Command.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Predictive Maintenance	2.509	-	-
Description: This effort performs research on AI, deep learning, and predictive analytics to forecast major issues on platforms and enables services to respond to upcoming failures. Focus will be to identify component failure relationships to principal end items for prediction of critical failure prior to corrective maintenance and reactive supply chain requisitions. Research will increase efficiency, decrease fleet operating and sustainment costs for equipment platforms, and reduce the time and costs associated with repair part requisition, management and transportation.			
Accomplishments/Planned Programs Subtotals	2.509	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) CG5 / *Ground Vehicle Sensor Concepts and Technologies*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
CG5: *Ground Vehicle Sensor Concepts and Technologies*	-	-	4.146	-	-	-	-	-	-	-	0.000	4.146

Note

This Project is Terminated starting in Fiscal Year 2023 (FY23).

A. Mission Description and Budget Item Justification

This Project investigates, designs, fabricates, assesses, and characterizes advanced sensor protection technologies, components, and concepts that will enable the future Soldier to see and operate through a laser directed energy weapon attack. Both active and passive protection technologies will be investigated to protect Army sensors that operate in the visible, short-wave infrared, mid-wave infrared, and long-wave infrared spectra from battlefield laser threats. Areas of research include passive optical limiters such as nonlinear organic dyes, semiconductors, and meta-materials, as well as fast active switches and tunable filters. As new laser technologies are developed, effects of those threats will be studied and assessed to determine vulnerability of Army sensor systems and sensor system materials.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground and Next Generation Combat Vehicle portfolios.

Work in this Project is performed by the United States (US) Army Futures Command.

Work in this Project is coordinated with Program Element (PE) 0602145A (Next Generation Combat Vehicle Technology) and PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Laser Protection Technologies	-	3.994	-
Description: This effort designs and develops new materials and devices for the protection of Army sensors and eyes behind day-view optical sights from a variety of laser threats. This research utilizes a combination of technologies based on the nature of the different threats, as well as the fundamental differences in sensors operating over different frequency ranges. Passive optical limiting materials that block specific frequency bands of light will be investigated and developed for the visible and short-wave infrared (SWIR) spectrum, and active meta- material-based solutions will be investigated for uncooled sensors in the long-wave infrared. Vulnerability of sensors and optical sensor systems will be investigated against high-power and ultra-short pulsed laser threats to determine protection requirements.			
FY 2022 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CG5 / *Ground Vehicle Sensor Concepts and Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Will explore concepts to reduce dazzle from high-power handheld lasers; improve optical system protection concepts from high energy lasers (HEL); reduce the threat of jamming from white light continuum generated by ultra-short pulsed lasers (USPLs): use results from first principles modeling to validate and improve chemical mixtures designed for specific laser light absorption. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** In Fiscal Year (FY) 2023, funding for this effort is eliminated.			
Title: FY2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.152	-
Accomplishments/Planned Programs Subtotals	-	4.146	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) CG6 / *Ground Vehicle Power and Energy Concepts and Tech*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
CG6: *Ground Vehicle Power and Energy Concepts and Tech*	-	-	2.681	2.526	-	2.526	2.594	2.643	4.010	3.959	0.000	18.413

A. Mission Description and Budget Item Justification

This Project investigates and develops advanced power and energy technologies for combat ground vehicles that are necessary for parallel hybrid, series hybrid, and all- electric vehicle systems. This Project investigates, designs, and develops electric conversion technologies to reduce size and weight of military vehicles while increasing performance and capabilities to support current and future mission loads and provide improved military vehicle mobility.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground and Next Generation Combat Vehicle portfolios.

Work in this Project is performed by the United States (US) Army Futures Command.

Work in this Project is coordinated with PE 0602145A (Next Generation Combat Vehicle Technology) and PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Advanced Distributed Power for Autonomous Systems	-	1.371	2.526
Description: This effort designs and develops technologies for electrification of both manned and unmanned Next Generation Combat Vehicle platforms. Electrification of these platforms will enable advanced lethality and protection systems, reduced battlefield fuel consumption, and provide new capabilities such as burst acceleration, extended silent mobility, and silent watch. The effort investigates, designs, and develops electric conversion technologies to reduce size and weight while increasing performance and capabilities to support current and future mission loads and provide improved military vehicle mobility. Research focuses on high power/ temperature power electronics, magnetic gears, electric drive motors, and adaptive device and component level control that optimized operation in real time. Investigation of advanced control methods at the module and conversion component levels provides an understanding of the impact real time optimization and energy tracking can have on power conversion optimization and mission effectiveness. The research enables the integration of component state and behavior into system level management algorithms that support non-autonomous and autonomous operations while providing modular and scalable electrification architectures. Efforts will also investigate non-contact magnetic gear technologies coupled with electrical motors and generators to reduce size and weight with an increase in reliability and performance through increased torque and			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CG6 / *Ground Vehicle Power and Energy Concepts and Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
speed operational range. Results of the research inform PE 0602145A (Next Generation Combat Vehicle Technology) / BH5 (Platform Electrification and Mobility Tech). ***FY 2022 Plans:*** Will research control algorithms and topologies for power conversion systems with a focus on stability and improved real time maximum power optimization of component operation; explore coupling of decision making methods to increased awareness of tactical energy effectiveness for increased operational-tempo and to support platform operations and battlespace planning and real time energy tracking through standard energy analysis techniques; model high torque magnetic gear components for platform applications and identify additional optimization strategies and use cases. ***FY 2023 Plans:*** Will experimentally validate high torque magnetic gear designs and optimization strategies. Will investigate and analyze advanced control methods to improve fast battery charging. Will investigate advanced power module concepts through the use of co-design and co-engineering methodologies to increase efficiency, power transfer, and reliability through improved device and thermal control. Will investigate and analyze energy storage / battery technologies with an order of magnitude increase in energy densities. Will research advanced control methodologies at the module and component levels providing higher efficiency and reliability through energy optimization. Will research advanced transformer designs and fabrication to enable high frequency switching with improved thermal management in smaller more efficient packages. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding realigned to Program Element (PE) 0602183A (Air Platform Applied Research) / Project CN1 (Disruptive Countermeasure Concepts for Aviation) to support the creation of ?Deep Autonomous Sensing?. Funding increase supports additional research into fast battery charging technologies for hybrid electric vehicles, as well as energy storage technologies.			
Title: Power Electronic Components and Materials ***Description:*** This effort investigates, designs, and develops electric conversion technologies to reduce size and weight while increasing performance and capabilities to support current and future mission loads and provide improved military vehicle mobility. Research focuses on semiconductor power switches, power switch modules/packaging, and power switch module thermal management. Investigation of high voltage/high frequency power semiconductor materials and devices is concentrated on efficient power switching under militarily relevant temperatures. Design and development of multi-disciplinary parametric design optimization software tools and multi-functional package structures provides advances in device packaging technology to fully realize device performance improvements. Results of the research inform 0602145A BH5 Platform Electrification and Mobility Tech.	-	1.212	-

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CG6 / *Ground Vehicle Power and Energy Concepts and Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
FY 2022 Plans: Will design and model new high performance power module using holistic co-design methods; investigate control and fabrication methods that can enable real time optimization of packaging performance; develop models for power device architectures appropriate for ultra-wide-band gap semiconductors; fabricate and assess initial test structures and devices. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding realigned to Program Element (PE) 0602183A (Air Platform Applied Research) / Project CN1 (Disruptive Countermeasure Concepts for Aviation) to support the creation of ?Deep Autonomous Sensing?.			
Title: FY2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.098	-
Accomplishments/Planned Programs Subtotals	-	2.681	2.526

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) CG7 / *Ground Protection Concepts and Technologies*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
CG7: *Ground Protection Concepts and Technologies*	-	-	14.565	12.344	-	12.344	12.578	12.566	14.195	14.192	0.000	80.440

A. Mission Description and Budget Item Justification

This Project investigates advanced materials and mechanisms to defeat the most common and most dangerous threats that are expected to be encountered by our ground forces in near-, mid-, and far-term. This Project also designs and develops experimental and computational tools and techniques (high resolution instrumentation to observe impact events, theories, and algorithms to explain these phenomena and numerical implementation of these algorithms) for the development of mass-efficient armor mechanisms. This project designs and develops armor mechanisms that will be integrated to create multi-threat armor technologies and form the building blocks for Adaptive and Cooperative Protection Technologies in the Advanced Concepts for Active Defense Project (Program Element (PE) 0602145A Next Generation Combat Vehicle Technology). Additionally, research will focus on subcomponent/component models to predict performance of early concepts and the means to assess effectiveness on ground platforms. The Project will balance designs and developments of active threat defeat measures with the necessary advanced passive and reactive components that will ultimately provide for full system solutions which meet the requirements of current and next generation ground tactical and combat vehicles.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground and Next Generation Combat Vehicle.

Work in this Project is performed by the United States (US) Army Futures Command portfolios.

This Project is coordinated with and transition to Projects in PE 0603462A (Next Generation Combat Vehicle Advanced Technology), PE 0602145A (Next Generation Combat Vehicle Technology), and builds upon weapon target interaction research in PE 0601102A (Defense Research Sciences) / Project AA7 (Mechanics and Ballistics).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Advanced Armor and Protection Technologies	-	7.868	7.211
Description: This effort designs and develops the next generation of lightweight protective concepts and technologies for defeat of current and future threats by utilizing real-time information, combined with threat knowledge, to provide increased protection. This effort investigates the fundamental physics of new terminal effects concepts and provides an understanding of interaction between the platform's defeat mechanism and the threat . The effort also investigates the ability to analytically simulate complex threat interactions. Experiments will be conducted to validate the efficacy of the designs.			
FY 2022 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CG7 / *Ground Protection Concepts and Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Will conduct experiments to validate several computationally designed pulsed power mechanisms to defeat a wide range of shaped charge warheads; conduct research into the understanding of energetic material response to ballistic events; validate an optimized notional hull concept that includes adaptive and active protection concepts for a combined threat suite through computational and experimental methods. ***FY 2023 Plans:*** Will investigate armor mechanism and protection concepts for the robotic combat vehicles to survive direct-fire engagements; will refine methodology to conduct small scale armor survivability experiments to reduce the number of full sized experiments required; design and develop high throughput ballistics metrics and scaling to enable terminal effects research. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** In Fiscal Year 2023 (FY23), funding is realigned to support the creation of Project CZ9 (Foundational Hypersonic Weapons Research) in PE 0602141A (Lethality Technology).			
Title: Computational and Experimental Capability	-	6.165	5.133
Description: This effort will design and develop computational design tools along with diagnostic and experimental capabilities that support the development of advanced protection systems. Such systems include passive, active, and hybrid solutions for defeating (multiple) anti-armor threats and exploit solid-dynamic, explosive-driven, and magneto-hydrodynamic target interactions. This work allows for predicting armor performance and understanding mechanisms, regardless of vehicle platform, with improved and quantified confidence. This effort leverages the Department of Defense and Department of Energy (DOE) Technical Coordination Group Memorandum of Agreement and directly leverages DOE investments in computational platforms for problems in solid dynamics and impact mechanics. ***FY 2022 Plans:*** Will increase computational and material modeling capability to predict performance of hybrid armor protection mechanisms during threat impact; validate improved cineradiography and tomography diagnostic systems in multiple experimental facilities to capture threat interaction with armor mechanisms including multi-energy flash; designs and develops computational capability to couple the blast/fluid/solid/target interactions during threat engagements and reactive models for predicting mass (fragment), momentum (blast), and energy (heat) target effects for non-ideal explosives (a non-ideal explosive's observed detonation velocity is lower than the calculated ideal value from thermo-hydrodynamic theory); explores machine learning methodology for terminal ballistics design applications. ***FY 2023 Plans:*** Will design and develop physically accurate and robust modeling and simulation tools for explosive effects to inform armor development; will continue to mature the capabilities of the multi-physics models needed to rapidly assess threats and develop			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CG7 / *Ground Protection Concepts and Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
protection solutions to defeat those threats; will continue to mature our ballistics and explosive effects diagnostics to better assess terminal ballistics. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned life cycle of this effort.			
Title: FY2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.532	-
Accomplishments/Planned Programs Subtotals	-	14.565	12.344

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) CG8 / *Human Autonomy Teaming*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
CG8: *Human Autonomy Teaming*	-	-	8.599	9.086	-	9.086	9.222	9.213	10.534	10.550	0.000	57.204

A. Mission Description and Budget Item Justification

This Project performs applied research for capabilities that support teams of Soldier and Artificial Intelligence (AI)-enabled systems to execute missions in complex, dynamic, multi-domain operations environments. Centered on ground vehicle mission planning and operations, this Project is focused on core technologies to enable Soldiers and AI-enabled systems to function as a team, to perform at high levels, and to adapt to adversarial actions and new mission requirements. This Project will enable future Soldiers with AI-enabled systems to perform complex missions with increasingly sophisticated technologies, and in increasingly complex, dynamic, socio-technical environments. The applied research will provide the fundamental technologies to enable scalable Soldier-AI teams and team-centered dynamic tasking to effectively utilize the full capabilities of team and technologies. The research will include considerations to reduce data requirements for AI adaptation, increasing appropriate Soldier trust and use of technology, and ensuring ethical behaviors by teams of Soldier and AI-enabled systems. The capabilities created by this research will lead to increased overall Soldier-AI team mission performance, improved Soldier-centric situation awareness technologies, and units that can effectively integrate within a multi-domain battlefield.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground and Next Generation Combat Vehicle portfolios.

Work in this Project is performed by the United States Army Futures Command.

Work in this Project is coordinated with PE 0602145A (Next Generation Combat Vehicle Technology), PE 0603462A (Next Generation Combat Vehicle Advanced Technology) and PE 0602143A (Soldier Lethality Technology) .

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Soldier?AI Team Mission Planning for Dynamic Complex Environments	-	1.218	1.337
Description: Planning in multi-domain operations environments is complex and has increased temporal and spatial sensitivities for Soldiers to integrate with AI-enabled systems to plan and execute missions. This effort investigates the fundamental concepts and technologies to enable Soldier and AI to team together to plan for multidomain operations from a ground vehicle perspective. This effort determines planning enablers to maximize manned-unmanned team performance across squads and platoons and includes mid- to far-term crew station-based emerging technologies in the areas of human- interaction with AI technologies and human-guided machine intelligence. Designs and develops models of both Soldier and AI capabilities and their limitations as a function of the mission environment and mission requirements, and applying those models to form mission plans.			
FY 2022 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CG8 / *Human Autonomy Teaming*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Will investigate initial approaches to leverage Soldier feedback to enable mission-to-mission adaptation of intelligent system behaviors to complement crew performance and meet evolving mission needs. ***FY 2023 Plans:*** Will design and develop capability to leverage multiple forms of Soldier feedback to enable mission-to-mission adaptation of intelligent system behaviors to meet evolving mission needs. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Dynamic Soldier-AI Team Resource Allocation ***Description:*** This effort designs and develops the concepts and technologies necessary to dynamically allocate Soldiers and unmanned systems during missions to adapt mission plans to adversarial actions and other events at a squad and platoon level, including responding to degradation or loss of team capabilities, changes in mission goals or priorities, and responding to adversarial actions. The effort investigates the allocation of Soldiers, platforms, and platform sub-system capabilities with the focus to ensure that future AI and automation capabilities are focused on the circumstances and conditions where they are most likely to be successful, and to ensure that the Soldier's cognition is focused appropriately to ensure mission success. ***FY 2022 Plans:*** Will investigate initial algorithms to generate task allocations across a distributed heterogeneous team to enable rapid team reconfiguration and improve team performance in dynamic environments; conduct experiments to examine approaches for Commanders to coordinate actions of a distributed team through a library of preset formations and crew configurations within the Commander?s interface. ***FY 2023 Plans:*** Will mature algorithms to generate task allocations across a distributed heterogeneous team to enable flexible team reorganization to improve team performance in dynamic environments; will design and develop initial methods to create algorithms that provide a Commander with suggested courses of action to coordinate actions of distributed team through a library of preset formations and crew configurations. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	2.368	2.599
Title: Soldier Cognition-Centric Interface Technologies ***Description:*** This effort designs and develops cognitive-centric displays that ensure Soldiers are focused on aspects of situational awareness, mobility, target engagements, and communications that are critical to mission performance as future crew stations and displays provide vast amounts of multi-domain information that has the potential to distract, overwhelm, and mislead Soldiers. This effort ensures that our systems do not capture and misdirect Soldier attention and/or cognition, maximizing the utility of AI-	-	1.555	1.705

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CG8 / *Human Autonomy Teaming*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
enabled systems to the Soldier. This effort also enables Soldiers to better understand the actions, goals, intents, and general reasoning of the AI systems to ensure they are effectively used, but not inappropriately relied upon. ***FY 2022 Plans:*** Will mature approaches to characterize team cohesion in a distributed Soldier-AI team; continue experiments to investigate approaches to assess and calibrate the crew?s trust in AI-enabled autonomous systems. ***FY 2023 Plans:*** Will conduct experiments to investigate the impact of enabling Soldiers to rapidly train autonomous systems on an individual Soldier?s trust in autonomous systems; will conduct experiments to investigate the ability for Soldier guided adaptation of autonomous systems to capture individual Soldier knowledge, skills, and abilities. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Enabling Soldier-AI Technology Adaptation ***Description:*** This effort designs and develops technologies to rapidly adapt and upgrade AI-enabled system capabilities in response to advancements in AI in the commercial and adversary environments. Focus areas include enabling rapid technology adaption during Soldier experimentation and enabling data to be collected during these events for rapid development of technology updates and modifications. This effort has four goals: 1) increasing the ability of Soldier-AI teams to rapidly adapt to adversarial actions, new technologies, environmental changes, and mission requirements; 2) decreasing the data requirements to train and adapt AI-enabled systems; 3) increasing appropriate Soldier trust and use of technology; and 4) ensuring ethical decisions by using Soldiers to guide the actions and in-field adaptations of Soldier-AI team behaviors. ***FY 2022 Plans:*** Will develop algorithms that learn from natural interactions to allow Soldiers to communicate their intent to adapt and train autonomous systems; investigate novel approaches using interactive machine learning to enhance the robustness of algorithms for assessing effectiveness of Soldier-AI teams; mature novel machine learning approaches to enable Soldiers to rapidly train AI systems in novel situations and environments. ***FY 2023 Plans:*** Will mature algorithms that learn from natural interactions to allow Soldiers to communicate intent for adaptation and training of autonomous systems; will mature algorithms for using interactive machine learning to enhance the robustness of algorithms for assessing effectiveness of Soldier-AI teams; willconduct experiments to investigate effectiveness of leveraging initial algorithms	-	3.144	3.445

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) CG8 / *Human Autonomy Teaming*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
that infer Soldier intent from natural Soldier-system interactions to enhance capability to rapidly train autonomous systems with reduced data requirements. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.314	-
Accomplishments/Planned Programs Subtotals	-	8.599	9.086

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) CI2 / *Ground Enabling University Applied Research*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
CI2: *Ground Enabling University Applied Research*	-	-	4.824	3.682	-	3.682	3.889	5.491	4.591	4.590	0.000	27.067

A. Mission Description and Budget Item Justification

The Project leverages applied research from academia, in the focus areas of ground autonomy, Artificial Intelligence/Machine Learning (AI/ML) and robotics, occupant/vehicle survivability and other ground platform technologies of importance to the Army. This Project performs discovery research efforts to focus more on mid to far-term Army modernization priorities while also maintaining delivery of near-term technologies critical to the next generation combat vehicles. This Project focuses on employment of research technologies originating from extramural applied research in academia pertaining to navigation/routing, autonomous robotic vehicles with the use of artificial intelligence and machine learning as applied to ground mobility and maneuver, and other innovative ground enabling applied research technologies. This effort conducts applied research and development leading to potential emerging technologies in areas of strategic importance to the Army in autonomy, robotics and AI/ML, protection of both platform and occupant, and other ground platform technologies in propulsion, survivability, powertrain, etc., by bringing competitively selected Universities with research and development teams into Technical Alliances.

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

The cited work is consistent with Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States (US) Army Futures Command.

This work is done in coordination with PE 0603119A (Ground Advanced Technology), PE 0602145A (Next Generation Combat Vehicle Technology) and PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Robust autonomous capabilities for ground vehicles	-	3.132	1.949
Description: This effort investigates AI/ML and autonomous mobility-enabled ground vehicles to conduct off-road maneuvers to transition from tele-operated to either fully-autonomous, or semi-autonomous scenarios. Research is conducted in collaboration with university partners to advance autonomous mobility and protection of both occupant and platform in optionally manned and autonomous ground vehicles.			
FY 2022 Plans: Will develop AI/ML methods to enable robust, autonomous, tactical behaviors for multi-agent air and ground vehicle teams beyond existing behaviors such as leader-follower (e.g., flanking, occupying); as well as increase the speed of autonomous behavior acquisition through effective navigation and route planning using techniques to extract terrain features from imagery and transfer			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CI2 / *Ground Enabling University Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
of simulator-learned behaviors to developmental ground platforms. Develop methods of shared control (between human operators and AI/ML systems) that increase overall autonomous system performance with human input. ***FY 2023 Plans:*** Will mature AL/ML methods to enable robust, autonomous, and tactical behaviors for multi-agent air and ground vehicle teams beyond existing behaviors such as leader-follower (e.g., flanking, occupying); as well as increase performance through effective navigation and route planning using techniques to extract terrain features from imagery and transfer of simulator-learned behaviors to developmental ground platforms within academia. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding realigned to PE 0602182A (C3I Applied Research) / CN4 (Real-Time Tactical Networks Applied Research).			
Title: Human-robot/AI interactions ***Description:*** This effort designs and develops systems involving physical and cognitive levels of interactions between humans and robots, with the use of reinforcement learning (an area of ML research) from human feedback, learning from demonstration, and safe human-aware controllers. Work is conducted in collaboration with university partners to advance autonomous mobility as well as other areas of ground platform technologies in propulsion, survivability, powertrain, etc. ***FY 2022 Plans:*** Will investigate and develop AI/ML methods to improve autonomous systems by capturing and learning from human teleoperation commands, human interventions, and other forms of human interaction (e.g., spoken language). Will develop tactics and algorithms on common software platforms which enable robots to deal with complex environments on the fly while working fully autonomously around humans for extended periods of time. ***FY 2023 Plans:*** Will investigate and mature AI/ML methods to improve autonomous systems by capturing and learning from human teleoperation command gestures, human interventions, and other forms of human interaction (e.g., spoken language, augmented reality). Will mature tactics and algorithms on common software platforms which enable robots to deal with complex environments in real time while working autonomously around humans for extended periods of time. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned life cycle of effort	-	1.516	1.733
Title: SBIR/STTR Transfer ***FY 2022 Plans:***	-	0.176	-

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CI2 / *Ground Enabling University Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	4.824	3.682

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) CV3 / *Engineer Enablers Maneuver, LOG, & Sustainment Apl*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
CV3: *Engineer Enablers Maneuver, LOG, & Sustainment Apl*	-	-	-	2.518	-	2.518	2.185	1.247	1.144	-	0.000	7.094

Note

This is a new start in FY 2023.

This is a New Start Project for Fiscal Year 2023 (FY23).

A. Mission Description and Budget Item Justification

This effort designs and develops software tools to modernize the Army's logistics planning capability. The project addresses planning of logistics resupply via distributed supply routes through complex terrain and environmental conditions within a contested environment, while also improving the efficiency of logistics planning, enabling planners to develop and compare courses of action, and simulate logistics activities using complex algorithms. This effort links the engineer applications into a geospatial framework and enables planners to better understand the dynamic scenario development providing a simple and clear critical vulnerabilities assessment, easy visual comparison of inventories available, supply needs within the battlespace, and the logistics options to mitigate potential issues.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work is performed at the U.S. Army Engineer Research and Development Center and coordinated with U.S. Army Futures Command.

This work complements PE 0603119A (Ground Advanced Technology) Project CV5 (Engineer Enablers Maneuver, LOG, & Sustainment Adv).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Planning Logistics Analysis Network System Applied Research	-	-	2.518
Description: This effort will design and develop new engineering applications and methodologies that support improved logistics planning via distributed networks, investigate methods to link existing data describing complex environmental features that impact planning into the engineer applications, and design new automated algorithm technologies to improve the efficiency and effectiveness of the planning decision making.			
FY 2023 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CV3 / *Engineer Enablers Maneuver, LOG, & Sustainment Apl*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Will investigate new algorithms that describe the operating environment as a series of nodes and routes that consider complex battlespace concerns and terrestrial issues such as terrain complexity or weather impacts; will mature components of a multi-modal transportation network model. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** This is a New Start Project for Fiscal Year 2023 (FY23).			
Accomplishments/Planned Programs Subtotals	-	-	2.518

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) DA1 / *SAFR Alternatives for Readiness Applied Research*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
DA1: *SAFR Alternatives for Readiness Applied Research*	-	-	-	3.679	-	3.679	5.149	6.028	6.030	5.613	0.000	26.499

Note

This is a new start in FY 2023.

This is a New Start Project for Fiscal Year 2023 (FY23).

A. Mission Description and Budget Item Justification

This Project will develop safer alternative technologies that enable Army readiness, support supply chain resilience, improve Soldier and worker safety and reduce environmental impacts, including global warming. The Project investigates alternatives for cross-cutting materials, undergoing or threatened by regulatory scrutiny, found in ground vehicles and all other types of Army weapon systems. Research areas of focus include alloys, ceramics, composites, textiles, maintenance fluids, propellants, explosives, and pyrotechnics. This work addresses increasing threats to readiness associated with carcinogenic, toxic, and restricted materials such as lead, beryllium, perchlorates, volatile organic compounds and per- and polyfluoroalkyl substances (PFAS) (forever chemicals), which can diminish Soldier and community health, restrict training and interrupt critical maintenance activities. Future liabilities and risks are characterized early in the life cycle of material development to ensure truly sustainable alternatives. This Project also investigates, develops and designs technologies to allow Soldiers to rapidly prioritize risk for PFAS to enable informed, timely and cost-effective solutions.

The cited work is consistent with the Army Modernization Strategy and provides enabling technologies in support of all Cross Functional Teams.

Work in this Project is performed by the United States (U.S.) Army Combat Capabilities Development Command (DEVCOM) Army Research Laboratory, Aberdeen Proving Ground, MD; the Armaments Center, Picatinny Arsenal, NJ; the Aviation and Missile Center, Huntsville, AL; the Soldier Center, Natick, MA; the Ground Vehicle Systems Center, Warren, MI; and the U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC). It is coordinated with the U.S. Army Futures Command.

This Project complements and transitions technologies to Program Element (PE) 0603119A (Ground Advanced Technology) / Project DA2 (SAFR Alternatives for Readiness Advanced Tech).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: PFAS Risk Reduction Applied Research	-	-	0.778
Description: This effort will design and develop a novel rapid risk characterization framework that will be validated with a rapid fate and transport screen, a break through toxicity screening, and treatment approaches.			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** DA1 / *SAFR Alternatives for Readiness Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
FY 2023 Plans: Will design and develop a framework for case studies to detail per- and polyfluroroalkyl substance (PFAS) toxicity through outdoor experimental system studies of the natural environment under controlled conditions (mesocosms) that examine toxicity in various geophysical conditions. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** This is a New Start Project for Fiscal Year 2023 (FY23).			
Title: Safer Alternatives for Readiness (SAFR) Applied Research ***Description:*** Design and develop novel cross-cutting solutions to eliminate Soldier and worker exposure to airborne lead from energetic materials; efficiently and safely demilitarize materiel; support the next generation of enhanced and sustainable munitions; reduce the use of toxic and hazardous chemicals in cleaners, degreasers, lubricants and fluids to ensure Soldier and ground vehicle readiness; and minimize the life cycle health and safety risks associated with emerging high-performance materials. ***FY 2023 Plans:*** Will research green chemistry approaches to energetic material synthesis methods; will explore novel non-metallic and non-energetic initiation techniques to replace lead-based primary explosives; and will investigate non-chemical surface cleaning and preparation techniques for relevant substrates. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** This is a New Start Project for Fiscal Year 2023 (FY23).	-	-	2.901
Accomplishments/Planned Programs Subtotals	-	-	3.679

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A