Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army											Date: May 2021	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 3: *Advanced Technology Development (ATD)*					R-1 Program Element (Number/Name) PE 0603119A / *Ground Advanced Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
Total Program Element	-	136.544	196.055	23.403	-	23.403	-	-	-	-	-	-
BK8: *Robotics for Engineer Operations Adv Tech*	-	1.922	4.194	6.221	-	6.221	-	-	-	-	-	-
BK9: *Ground System Fluids and Fuels Adv Tech*	-	2.031	1.684	1.745	-	1.745	-	-	-	-	-	-
BL3: *Explosives Forensics Advanced Technology*	-	1.954	2.002	2.096	-	2.096	-	-	-	-	-	-
BL6: *Expedient Passive Protection Advanced Technology*	-	3.643	3.051	0.494	-	0.494	-	-	-	-	-	-
BL8: *Power Projection in A2AD Environments Adv Tech*	-	0.882	1.220	2.970	-	2.970	-	-	-	-	-	-
BM1: *Protection from Advanced Weapon Effects Adv Tech*	-	1.912	2.104	5.868	-	5.868	-	-	-	-	-	-
BO3: *MILITARY ENGINEERING TECHNOLOGY DEMONSTRATION (CA)*	-	124.200	181.800	-	-	-	-	-	-	-	-	-
CJ9: *Ground Enabling University Adv Development*	-	-	-	4.009	-	4.009	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

This PE matures and demonstrates ground movement and maneuver technologies that support and enable the Army's modernization priority for the Next Generation of Combat Vehicles. This PE also matures, integrates and demonstrates advanced technologies that are necessary and foundational for legacy and future ground platforms and ground maneuver. These technology areas include: robotic and autonomous Army Combat Engineer equipment, liquid logistics (i.e., fuels, lubricants, and oils) and related monitoring and distribution, forensic analysis of explosives and other chemical materials, rapidly deployable passive protection technologies, entry and maneuver assessment technologies and structural hardening technologies to protect personnel and critical assets from advanced weapon effects.

All FY20 adjustments align program financial structure to Army Modernization Priorities in support of the National Defense Strategy.

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army	Date: May 2021
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603119A *I Ground Advanced Technology*

Work in this PE complements PE 0602144A (Ground Technology), PE 0602145A (Next Generation Combat Vehicle Technology), and PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Program Change Summary ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	136.793	14.795	19.583	-	19.583
Current President's Budget	136.544	196.055	23.403	-	23.403
Total Adjustments	-0.249	181.260	3.820	-	3.820
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	124.200	181.800			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-124.200	-			
• SBIR/STTR Transfer	-0.249	-0.540			
• Adjustments to Budget Years	-	-	3.820	-	3.820

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Project: BO3: *MILITARY ENGINEERING TECHNOLOGY DEMONSTRATION (CA)*		
Congressional Add: *Electrical System Safety and Reliability*	5.000	5.000
Congressional Add: *Cold Regions Research*	5.000	2.000
Congressional Add: *High-Performance Concrete Technology*	5.000	6.000
Congressional Add: *Lightweight Airfield Matting*	10.000	-
Congressional Add: *Secure Management of Energy Generation and Storage*	3.000	5.000
Congressional Add: *Rapid Low Energy Mobile Manufacturing*	3.000	-
Congressional Add: *Composite Flywheel Technology*	5.000	7.000
Congressional Add: *Lead-Acid Battery Life Extension*	10.000	-
Congressional Add: *Robotic Construction Equipment*	9.700	5.000
Congressional Add: *Terrain Conditions Forecasting*	3.000	-
Congressional Add: *Environmental Sensors for Explosives*	3.000	3.000
Congressional Add: *Robotic 4-D Printing of Geopolymer-Based Composites*	2.000	2.000
Congressional Add: *Waste to Energy Disposal*	3.000	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army	Date: May 2021
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603119A *I Ground Advanced Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Congressional Add: *Advanced Polymer Development for Force Protection*	4.500	-
Congressional Add: *Micrometeorological-Soil Synthetic Test Environment*	1.000	-
Congressional Add: *Partnership and Technology Transfer*	4.000	-
Congressional Add: *Sensor Systems for Underground Detection*	3.000	-
Congressional Add: *UAS Mounted Hostile Threat Detection*	5.000	-
Congressional Add: *Heavy Load Simulator*	6.000	-
Congressional Add: *Measurement and Control of Frozen Surface Properties*	4.000	-
Congressional Add: *Resilient Energy Systems*	2.500	-
Congressional Add: *Operations in Permafrost Environment*	4.000	-
Congressional Add: *Power Generation Technologies in Cold Regions*	5.000	-
Congressional Add: *Sensing and Prediction of Arctic Maritime Coastal Ice Conditions*	5.000	-
Congressional Add: *Thermosyphons*	2.000	-
Congressional Add: *Materials and Manufacturing Technology for Cold Environments*	3.500	4.000
Congressional Add: *Energy Technology Research in Cold and Arctic Regions*	4.000	-
Congressional Add: *Research Facility Modernization*	4.000	6.000
Congressional Add: *Program increase - smart intallation and community program*	-	5.000
Congressional Add: *Program increase - flow battery demonstration*	-	20.000
Congressional Add: *Program increase - corrosion protection and prevention*	-	10.000
Congressional Add: *Program increase - rapid entry and sustainment for the arctic*	-	8.000
Congressional Add: *Program increase - secure management of energy generation and storage*	-	5.000
Congressional Add: *Program increase - water quality and resiliency*	-	5.000
Congressional Add: *Program increase - rare earth element extraction*	-	5.000
Congressional Add: *Program increase - organic light emitting diode*	-	5.000
Congressional Add: *Program increase - coatings technology*	-	5.000
Congressional Add: *Program increase - heavy load simulator*	-	4.200
Congressional Add: *Program increase - integrated microgrids*	-	4.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army	Date: May 2021
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603119A *I Ground Advanced Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Congressional Add: *Program increase - infrastructure resilience and flood assessment*	-	3.000
Congressional Add: *Program increase - single connection quick oil change system*	-	3.000
Congressional Add: *Program increase - clean modular hydro technology*	-	4.000
Congressional Add: *Program increase - accelerator technology for ground maneuver*	-	5.000
Congressional Add: *Program increase - autonomous combat engineering solutions*	-	5.500
Congressional Add: *Program increase - coastal terrain hazard research*	-	8.000
Congressional Add: *Program increase - expeditionary deployment of fully sustainable utility*	-	10.000
Congressional Add: *Program increase - graphene research*	-	5.000
Congressional Add: *Program increase - impacts of soil structures on hydrology*	-	4.000
Congressional Add: *Program increase - operational energy research*	-	1.300
Congressional Add: *Program increase - temperature insensitive high?energy density lithium?ion batteries*	-	2.500
Congressional Add: *Program increase - vehicle performance reliability and operations*	-	3.000
Congressional Add: *Program increase - cross-laminated timber and recycled carbon fiber materials*	-	1.300
Congressional Add: *Program increase - advanced explosion resistant window systems*	-	5.000
Congressional Add Subtotals for Project: BO3	124.200	181.800
Congressional Add Totals for all Projects	124.200	181.800

Change Summary Explanation

Increases in Program Element funding in Fiscal Year (FY) 2022 support new efforts in Project CJ9 (Ground Enabling University Adv Development). Funding increase is also reflective of the maturation of applied research efforts in Program Element 0602144A (Ground Technology).

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 3	R-1 Program Element (Number/Name) PE 0603119A / *Ground Advanced Technology*	Project (Number/Name) BK8 / *Robotics for Engineer Operations Adv Tech*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BK8: *Robotics for Engineer Operations Adv Tech*	-	1.922	4.194	6.221	-	6.221	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

Note

In Fiscal Year (FY) 2022, funding was partially realigned from this Project to Program Element (PE) 0602144A Ground Technology / Project CI2 Ground Enabling University Applied Research, as part of the Program Evaluation Groups (PEG) efficiency drill.

A. Mission Description and Budget Item Justification

This Project matures and demonstrates robotic engineer equipment capabilities that can remotely characterize the environment and operate in the battlespace for autonomous Combat Engineer actions. This Project provides technologies for Combat Engineer mission planning, creating or reducing barriers and obstacles, as well as maintaining, repairing, and constructing expedient infrastructure. These efforts will enhance Combat Engineer missions of mobility, counter mobility, and survivability through semi-autonomous or autonomous 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 is performed 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 related to, and fully coordinated with, PE 0602144A (Ground Technology) / Project BK7 (Robotics for Engineer Operations Technology).

Work in this PE complements PE 0602114A (Ground Technology), PE 0602145A (Next Generation Combat Vehicle Technology), and PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Robotic Integrated Engineer Operations (RIENO)	1.922	-	-
Description: This effort matures and demonstrates remote control and semi-autonomous protocols and processes on small scale construction equipment to provide information that scales to larger legacy equipment as well as assess the applicability of small scale equipment working in collaboration and coordination.			
Title: Beyond-Visual-Line-of-Sight Tele-operated Engineer Operations Demonstration	-	4.194	6.221

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603119A / *Ground Advanced Technology*	**Project (Number/Name)** BK8 / *Robotics for Engineer Operations Adv Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Description: This effort matures and demonstrates remote control and semi-autonomous behaviors on small scale construction equipment to provide information that scales to larger legacy equipment as well as assess the applicability of small scale equipment working in collaboration and coordination. ***FY 2021 Plans:*** Mature tele-operated construction equipment in Global Positioning System (GPS) denied environments; demonstrate semi-autonomous site characterization; demonstrate capabilities to remove or emplace obstacles and manipulate the environment; and mature and demonstrate interface for handheld or mobile devices for construction equipment mission planning and execution. ***FY 2022 Plans:*** Will demonstrate autonomous Engineer site characterization with a semantically labeled site model and change detection; will demonstrate compact track loader and mini-hydraulic excavator performing Combat Engineer tasks at Beyond-Visual-Line-of-Sight (BVLOS) standoff distances to support mobility and maneuver; will demonstrate a universal controller developed by Combat Capability Development Center Ground Vehicle Systems Center for Combat Engineer equipment. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding increase in FY 2022 will support demonstration of capabilities matured for remotely operated Combat Engineer equipment			
Accomplishments/Planned Programs Subtotals	1.922	4.194	6.221

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 3	R-1 Program Element (Number/Name) PE 0603119A / *Ground Advanced Technology*	Project (Number/Name) BK9 / *Ground System Fluids and Fuels Adv Tech*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BK9: *Ground System Fluids and Fuels Adv Tech*	-	2.031	1.684	1.745	-	1.745	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

This Project matures and demonstrates liquid logistics technologies such as enhanced jet fuels, lubricants, oils, powertrain fluids, coolants, bulk fluid treatment, monitoring, metering, storage, and distribution in support of established Army regulations and requirements. This Project matures products and technologies to improve fuel efficiency, meet new hardware fluid requirements, modernize fluids, ensure bulk fluid meets quality requirements, and provide bulk fluid asset visibility, to optimize logistics and reduce logistics requirements. This Project executes the demonstration of enhanced jet fuels for ground systems, gear oils, anti-lock brake system-compatible brake fluid, smart bulk fuel metering and monitoring technologies. This Project matures liquid logistics products and technologies that are critical enablers for multi-domain operations requiring semi-independent operations to enable dispersed operations to extend operational reach, prolong endurance and allow freedom of action for the Joint Force.

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 is performed by the United States (U.S.) Army Futures Command.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Alternative Fuels and Petroleum, Oil & Lubricants ***Description:*** This effort focuses on reducing the logistics footprint, improving fuel efficiency, and ensuring mobility by maturing and demonstrating technologies in areas such petroleum quality monitoring, filtration, storage and distribution, hydraulic fluids; alternative fuels and fuel additives, lubricants, oil, powertrain fluids and coolants.	2.031	-	-
Title: Ground System Fluids and Fuels ***Description:*** This effort focuses on reducing the logistics footprint, improving fuel efficiency, and ensuring mobility by maturing and demonstrating technologies in areas such petroleum quality monitoring, filtration, storage and distribution, hydraulic fluids; enhanced jet fuels and fuel additives, lubricants, oil, powertrain fluids and coolants. Assess additional candidate synthetic fuel blends to determine their suitability for military ground systems.	-	1.684	1.745

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603119A / *Ground Advanced Technology*	**Project (Number/Name)** BK9 / *Ground System Fluids and Fuels Adv Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Qualify candidate fuel efficient gear oils that maintain and improve vehicle axle durability and provide extended performance time over current gear oil for military use. Develop performance requirements for a new military brake fluid that is compatible with ABS brake systems and investigate candidate fluid technologies. Integrate smart fuel metering technology into self-correcting devices that automatically report fuel quantity and conduct fuel filter effectiveness testing to establish fuel particle contamination limits for new fuel monitoring technology. ***FY 2021 Plans:*** Assess the lubrication capacity of fuel additive using improved methods and component test rigs to optimize wear reduction of fuel delivery system components. Complete assessment and demonstrate anti-lock brake system compatible brake fluid in selected ground systems. Establish optimized post filter fuel particle contamination limits for new fuel monitoring technology based on fuel filter effectiveness. Validate performance of current military coolant against candidate extended performance coolants. ***FY 2022 Plans:*** Will continue assessment of the lubrication capacity of fuel additive using improved methods and component test rigs for the initial fuel pump selected to optimize wear reduction of fuel delivery system components. Will conduct fuel injector testing based on the results of the fuel filter effectiveness testing to establish fuel particle contamination limits for new fuel monitoring technology. Will develop criteria and laboratory methodology to assess extended life and performance capabilities of coolants. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	2.031	1.684	1.745

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 3	R-1 Program Element (Number/Name) PE 0603119A / *Ground Advanced Technology*	Project (Number/Name) BL3 / *Explosives Forensics Advanced Technology*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BL3: *Explosives Forensics Advanced Technology*	-	1.954	2.002	2.096	-	2.096	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

This Project matures instrumentation and algorithms required to provide improved point, proximity, and stand-off detection of explosives and precursor materials to enable the warfighter to integrate chemical and explosive hazard detection equipment. This Project integrates explosive detection into the family of Chemical, Biological, Radiological, and Nuclear point and stand-off sensors, alternative chemical detection modalities and algorithms that will improve the probability of detection and attribution of an explosive hazard or Home-made Explosive manufacturing/assembly location.

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 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 Project is related to, and fully coordinated with, PE 0602144A (Ground Technology) .

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Detection Mechanisms for Contaminants	1.954	2.002	2.096
Description: This effort demonstrates improved point and standoff detection of military and homemade explosives and their precursors, and other chemicals and hazardous materials.			
FY 2021 Plans: Develop and demonstrate a chip-scale integrated photonic sensor for the rapid detection of narcotics, explosives, and other molecules of interest at ultra-low concentrations (less than one part per million) in trace solid or liquid residues for forensic attribution. Demonstrate a photonic integrated circuit sensor based on waveguide enhanced Raman spectroscopy and determine detection limits for select explosives and narcotics materials.			
FY 2022 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603119A / *Ground Advanced Technology*	**Project (Number/Name)** BL3 / *Explosives Forensics Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Will further mature novel portable detection technology for further maturity and testing of realistic threats and scenarios. Will continue maturation of photonic integrated circuit (PIC) for chemical sensing to decrease size, weight and power configuration footprint. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	1.954	2.002	2.096

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 3	R-1 Program Element (Number/Name) PE 0603119A / *Ground Advanced Technology*	Project (Number/Name) BL6 / *Expedient Passive Protection Advanced Technology*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BL6: *Expedient Passive Protection Advanced Technology*	-	3.643	3.051	0.494	-	0.494	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

This Project matures and demonstrates rapidly deployable protection solutions to protect small distributed units; decision support applications and software; and tactics, techniques, and procedures to increase the survivability of personnel, critical assets, and facilities from a range of threats. Force protection technologies will be matured and demonstrated for applications in complex and urban environments to protect against advanced energetic threats, large caliber rockets and 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 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 related to, and fully coordinated with, PE 0602144A (Ground Technology) / Project BL5 (Expedient Passive Protection Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Force Protection in the Urban Environment Demonstrations	3.643	3.051	-
Description: This effort matures and demonstrates force protection solutions for urban environments focusing on the use of existing structures; rapidly deployable protection systems; decision support applications and software; and tactics, techniques, and procedures to provide protection with consideration for a complex three-dimensional threat. ***FY 2021 Plans:*** Demonstrate an expedient system to increase levels of protection for existing buildings against blast and indirect fire; validate a rapidly deployable force protection barrier tailored for small units operating in contested environments; provide a rapidly deployable vehicle barrier optimized for heavy vehicle threats; and demonstrate wall blast vulnerability and overhead cover design applications for existing structures. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding decrease in FY22 reflects planned lifecycle of this effort, ending in FY21.			
Title: Protection Against High Trajectory Large Caliber Rocket and Missile Threats	-	-	0.494

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603119A / *Ground Advanced Technology*	**Project (Number/Name)** BL6 / *Expedient Passive Protection Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Description: This effort matures and demonstrates expedient force protection solutions for emerging threats such as large caliber rocket and missile weapon effects. This effort also demonstrates decision support tools to aid the warfighter in selecting protection schemes for survivability from emerging threats supporting All-Domain/Multi-Domain Operations. ***FY 2022 Plans:*** Will assess capabilities of legacy protective systems to protect critical assets and facilities from emerging threat weapon system effects such as large caliber rockets and missiles to establish baseline performance. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding increase in FY22 reflects planned lifecycle of this effort, beginning in FY22.			
Accomplishments/Planned Programs Subtotals	3.643	3.051	0.494

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 3	R-1 Program Element (Number/Name) PE 0603119A / *Ground Advanced Technology*	Project (Number/Name) BL8 / *Power Projection in A2AD Environments Adv Tech*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BL8: *Power Projection in A2AD Environments Adv Tech*	-	0.882	1.220	2.970	-	2.970	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

This Project matures and demonstrates remote assessment technologies to determine entry and maneuver corridors, provides 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 force projection assessments and provide all-season predictions to ensure air and ground battlespace entry and maneuver. This Project also matures and demonstrates 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.

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

Work in this Project is related to, and fully coordinated with, PE 0602144A (Ground Technology) / Project BL7 (Power Projection in A2AD Environments Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Entry and Sustainment in Complex Contested Environments Demonstrations	0.882	1.220	1.579
Description: This effort matures and demonstrates geospatial planning tools to expand engineering analysis of ground surfaces for entry, sustainment, and maneuver operations and to automate processes for selecting suitable maneuver corridors.			
FY 2021 Plans: Demonstrate site selection algorithms for rapidly identifying landing zones during air assault missions and forward arming and refueling needs; mature and demonstrate capabilities to predict off-road mobility in arctic regions.			
FY 2022 Plans: Will mature and demonstrate reconnaissance techniques and mobility algorithms for maneuver in arctic regions; and will demonstrate advanced analysis methods for classifying low-volume roads and predicting deterioration under military vehicle loadings.			
FY 2021 to FY 2022 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603119A / *Ground Advanced Technology*	**Project (Number/Name)** BL8 / *Power Projection in A2AD Environments Adv Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Funding increase in FY22 will support demonstration low-volume road classification and deterioration analysis tools.			
Title: Engineering for Battlespace Maneuver Demonstrations	-	-	1.391
Description: This effort demonstrates material solutions and techniques for expedient repair 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:*** Will demonstrate techniques for rapid soil stabilization to support military ground vehicle maneuver; and will demonstrate tactics, techniques, and procedures as well as material solutions for rapid infrastructure capacity upgrades. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding increase reflects the planned lifecycle progression from PE 0602144A Project BL7, beginning in FY22 to support demonstration of repair technologies and infrastructure capacity upgrades for mobility corridors and restaging areas.			
Accomplishments/Planned Programs Subtotals	0.882	1.220	2.970

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 3	R-1 Program Element (Number/Name) PE 0603119A / *Ground Advanced Technology*	Project (Number/Name) BM1 / *Protection from Advanced Weapon Effects Adv Tech*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BM1: *Protection from Advanced Weapon Effects Adv Tech*	-	1.912	2.104	5.868	-	5.868	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

This Project matures and demonstrates structural hardening solutions and force protection technologies to increase survivability of facilities and provide critical updates to protective design specifications and guidance. Additionally, this project matures and demonstrates passive protection technologies and provides protective design criteria advancements 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 conducted by the United States (U.S.) Army Engineer Research and Development Center and coordinated with U.S. Army Futures Command.

This effort is related to, and fully coordinated with, PE 0602144A (Ground Technology) / Project BL9 (Protection from Advanced Weapon Effects Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Applications of Environmentally-Inspired Unconventional Countermeasures ***Description:*** This effort will demonstrate rapidly-deployable, eco-friendly materials with spectral signatures that alter or obscure underlying target spectral signatures.	0.237	-	-
Title: Defeat of Complex Attack Demonstrations ***Description:*** This effort demonstrates force protection technologies that mitigate the effects of emerging peer and near peer adversaries advanced penetrating threats and high yield blast effects by optimizing high-performance, logistically feasible material solutions and processes. ***FY 2021 Plans:*** Optimize subscale hardening solutions against emerging complex weapon attack scenarios; validate enhanced or layered subscale systems for reduced structural thickness with improved performance. ***FY 2022 Plans:***	1.675	2.104	5.868

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603119A / *Ground Advanced Technology*	**Project (Number/Name)** BM1 / *Protection from Advanced Weapon Effects Adv Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Will demonstrate optimized subscale hardening solutions against emerging complex weapon attack scenarios; and optimize damage prediction and system performance for full-scale demonstration. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding increase reflects the planned lifecycle progression from optimizing subscale hardening elements to supporting large-scale demonstrations of layered hardening solutions with multiple full-scale live-fire weapons.			
Accomplishments/Planned Programs Subtotals	1.912	2.104	5.868

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army												Date: May 2021
Appropriation/Budget Activity 2040 / 3					R-1 Program Element (Number/Name) PE 0603119A / *Ground Advanced Technology*				Project (Number/Name) BO3 / *MILITARY ENGINEERING TECHNOLOGY DEMONSTRATION (CA)*			
COST ($ in Millions)	**Prior Years**	**FY 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
BO3: *MILITARY ENGINEERING TECHNOLOGY DEMONSTRATION (CA)*	-	124.200	181.800	-	-	-	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

Note

Congressional Interest Item funding provided for Military Engineering Technology Demonstration.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Military Engineering Technology Demonstration.

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 2020	FY 2021
Congressional Add: Electrical System Safety and Reliability	5.000	5.000
FY 2020 Accomplishments: Program Increase supported advanced research on Electrical System Safety and Reliability. Work executed under the direction of the Army Futures Command.		
FY 2021 Plans: Program Increase supported advanced research on Electrical System Safety and Reliability. Work executed by Army Futures Command.		
Congressional Add: Cold Regions Research	5.000	2.000
FY 2020 Accomplishments: Program Increase supported advanced research on Cold Regions Research. Work executed under the direction of the Army Futures Command.		
FY 2021 Plans: Program Increase supported advanced research on Cold Regions Research. Work executed by Army Futures Command.		
Congressional Add: High-Performance Concrete Technology	5.000	6.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603119A / *Ground Advanced Technology*	**Project (Number/Name)** BO3 / *MILITARY ENGINEERING TECHNOLOGY DEMONSTRATION (CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
FY 2020 Accomplishments: Program Increase supported advanced research on High-Performance Concrete Technology. Work executed under the direction of the Army Futures Command. ***FY 2021 Plans:*** Program Increase supported advanced research on High-Performance Concrete Technology. Work executed by Army Futures Command.		
Congressional Add: Lightweight Airfield Matting ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Lightweight Airfield Matting. Work executed under the direction of the Army Futures Command.	10.000	-
Congressional Add: Secure Management of Energy Generation and Storage ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Secure Management of Energy Generation and Storage. Work executed under the direction of the Army Futures Command. ***FY 2021 Plans:*** Program Increase supported advanced research on Secure Management of Energy Generation and Storage. Work executed by Army Futures Command.	3.000	5.000
Congressional Add: Rapid Low Energy Mobile Manufacturing ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Rapid Low Energy Mobile Manufacturing. Work executed under the direction of the Army Futures Command.	3.000	-
Congressional Add: Composite Flywheel Technology ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Composite Flywheel Technology.	5.000	7.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603119A / *Ground Advanced Technology*	**Project (Number/Name)** BO3 / *MILITARY ENGINEERING TECHNOLOGY DEMONSTRATION (CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
Work executed under the direction of the Army Futures Command. ***FY 2021 Plans:*** Program Increase supported advanced research on Composite Flywheel Technology. Work executed by Army Futures Command.		
Congressional Add: Lead-Acid Battery Life Extension ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Lead-Acid Battery Life Extension. Work executed under the direction of the Army Futures Command.	10.000	-
Congressional Add: Robotic Construction Equipment ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Robotic Construction Equipment. Work executed under the direction of the Army Futures Command. ***FY 2021 Plans:*** Program Increase supported advanced research on Robotic Construction Equipment Work executed by Army Futures Command.	9.700	5.000
Congressional Add: Terrain Conditions Forecasting ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Terrain Conditions Forecasting. Work executed under the direction of the Army Futures Command.	3.000	-
Congressional Add: Environmental Sensors for Explosives ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Environmental Sensors for Explosives. Work executed under the direction of the Army Futures Command. ***FY 2021 Plans:*** Program Increase supported advanced research on Environmental Sensors for Explosives.	3.000	3.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
Work executed by Army Futures Command.		
Congressional Add: Robotic 4-D Printing of Geopolymer-Based Composites ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Robotic 4-D Printing of Geopolymer-Based Composites. Work executed under the direction of the Army Futures Command. ***FY 2021 Plans:*** Program Increase supported advanced research on Robotic 4-D Printing of Geopolymer-Based Composites. Work executed by Army Futures Command.	2.000	2.000
Congressional Add: Waste to Energy Disposal ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Waste to Energy Disposal. Work executed under the direction of the Army Futures Command.	3.000	-
Congressional Add: Advanced Polymer Development for Force Protection ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Advanced Polymer Development for Force Protection. Work executed under the direction of the Army Futures Command.	4.500	-
Congressional Add: Micrometeorological-Soil Synthetic Test Environment ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Micrometeorological-Soil Synthetic Test Environment. Work executed under the direction of the Army Futures Command.	1.000	-
Congressional Add: Partnership and Technology Transfer ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Partnership and Technology Transfer.	4.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603119A / *Ground Advanced Technology*	**Project (Number/Name)** BO3 / *MILITARY ENGINEERING TECHNOLOGY DEMONSTRATION (CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
Work executed under the direction of the Army Futures Command.		
Congressional Add: Sensor Systems for Underground Detection ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Sensor Systems for Underground Detection. Work executed under the direction of the Army Futures Command.	3.000	-
Congressional Add: UAS Mounted Hostile Threat Detection ***FY 2020 Accomplishments:*** Program Increase supported advanced research on UAS Mounted Hostile Threat Detection. Work executed under the direction of the Army Futures Command.	5.000	-
Congressional Add: Heavy Load Simulator ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Heavy Load Simulator. Work executed under the direction of the Army Futures Command.	6.000	-
Congressional Add: Measurement and Control of Frozen Surface Properties ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Measurement and Control of Frozen Surface Properties. Work executed under the direction of the Army Futures Command.	4.000	-
Congressional Add: Resilient Energy Systems ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Resilient Energy Systems. Work executed under the direction of the Army Futures Command.	2.500	-
Congressional Add: Operations in Permafrost Environment ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Operations in Permafrost Environment.	4.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603119A / *Ground Advanced Technology*	**Project (Number/Name)** BO3 / *MILITARY ENGINEERING TECHNOLOGY DEMONSTRATION (CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
Work executed under the direction of the Army Futures Command.		
Congressional Add: Power Generation Technologies in Cold Regions ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Power Generation Technologies in Cold Regions. Work executed under the direction of the Army Futures Command.	5.000	-
Congressional Add: Sensing and Prediction of Arctic Maritime Coastal Ice Conditions ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Sensing and Prediction of Arctic Maritime Coastal Ice Conditions. Work executed under the direction of the Army Futures Command.	5.000	-
Congressional Add: Thermosyphons ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Thermosyphons. Work executed under the direction of the Army Futures Command.	2.000	-
Congressional Add: Materials and Manufacturing Technology for Cold Environments ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Materials and Manufacturing Technology for Cold Environments. Work executed under the direction of the Army Futures Command. ***FY 2021 Plans:*** Conduct advanced research in Materials and Manufacturing Technology for Cold Environments. Work executed by Army Futures Command.	3.500	4.000
Congressional Add: Energy Technology Research in Cold and Arctic Regions ***FY 2020 Accomplishments:*** Program Increase supported advanced research on Energy Technology Research in Cold and Arctic Regions. Work executed under the direction of the Army Futures Command.	4.000	-
Congressional Add: Research Facility Modernization	4.000	6.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603119A / *Ground Advanced Technology*	**Project (Number/Name)** BO3 / *MILITARY ENGINEERING TECHNOLOGY DEMONSTRATION (CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
FY 2020 Accomplishments: Program Increase supported advanced research on Research Facility Modernization. Work executed under the direction of the Army Futures Command. ***FY 2021 Plans:*** Program Increase supported advanced research on Research Facility Modernization. Work executed under the direction of the Army Futures Command.		
Congressional Add: Program increase - smart intallation and community program ***FY 2021 Plans:*** Program Increase supported advanced research on Smart Installation and Community Program. Work executed by Army Futures Command.	-	5.000
Congressional Add: Program increase - flow battery demonstration ***FY 2021 Plans:*** Program Increase supported advanced research on Flow Battery Demonstration. Work executed by Army Futures Command.	-	20.000
Congressional Add: Program increase - corrosion protection and prevention ***FY 2021 Plans:*** Program Increase supported advanced research on Corrosion Protection and Prevention. Work executed by Army Futures Command.	-	10.000
Congressional Add: Program increase - rapid entry and sustainment for the arctic ***FY 2021 Plans:*** Program Increase supported advanced research on Rapid Entry and Sustainment for the Arctic. Work executed by Army Futures Command.	-	8.000
Congressional Add: Program increase - secure management of energy generation and storage ***FY 2021 Plans:*** Program Increase supported advanced research on Secure Management of Energy Generation and Storage. Work executed by Army Futures Command.	-	5.000
Congressional Add: Program increase - water quality and resiliency	-	5.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
FY 2021 Plans: Program Increase supported advanced research on Water Quality and Resiliency. Work executed by Army Futures Command.		
Congressional Add: Program increase - rare earth element extraction ***FY 2021 Plans:*** Program Increase supported advanced research on Rare Earth Element Extraction. Work executed by Army Futures Command.	-	5.000
Congressional Add: Program increase - organic light emitting diode ***FY 2021 Plans:*** Program Increase supported advanced research on Organic Light Emitting Diode. Work executed by Army Futures Command.	-	5.000
Congressional Add: Program increase - coatings technology ***FY 2021 Plans:*** Program Increase supported advanced research on Coatings Technology. Work executed by Army Futures Command.	-	5.000
Congressional Add: Program increase - heavy load simulator ***FY 2021 Plans:*** Program Increase supported advanced research on Heavy Load Stimulator. Work executed by Army Futures Command.	-	4.200
Congressional Add: Program increase - integrated microgrids ***FY 2021 Plans:*** Program Increase supported advanced research on Integrated Microgrids. Work executed by Army Futures Command.	-	4.000
Congressional Add: Program increase - infrastructure resilience and flood assessment ***FY 2021 Plans:*** Program Increase supported advanced research on Infrastructure Resilience and Flood Assessment. Work executed by Army Futures Command.	-	3.000
Congressional Add: Program increase - single connection quick oil change system	-	3.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
FY 2021 Plans: Program Increase supported advanced research on Single Connection Quick Oil Change System. Work executed by Army Futures Command.		
Congressional Add: Program increase - clean modular hydro technology ***FY 2021 Plans:*** Program Increase supported advanced research on Clean Modular Hydro Technology. Work executed by Army Futures Command.	-	4.000
Congressional Add: Program increase - accelerator technology for ground maneuver ***FY 2021 Plans:*** Program Increase supported advanced research on Accelerator Technology for Ground Maneuver. Work executed by Army Futures Command.	-	5.000
Congressional Add: Program increase - autonomous combat engineering solutions ***FY 2021 Plans:*** Program Increase supported advanced research on Autonomous Combat Engineering Solutions. Work executed by Army Futures Command.	-	5.500
Congressional Add: Program increase - coastal terrain hazard research ***FY 2021 Plans:*** Program Increase supported advanced research on Costal Terrain Hazard Research. Work executed by Army Futures Command.	-	8.000
Congressional Add: Program increase - expeditionary deployment of fully sustainable utility ***FY 2021 Plans:*** Program Increase supported advanced research on Expeditionary Deployment of Fully Sustainable Utility. Work executed by Army Futures Command.	-	10.000
Congressional Add: Program increase - graphene research ***FY 2021 Plans:*** Program Increase supported advanced research on Graphene Research.	-	5.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
Work executed by Army Futures Command.		
Congressional Add: Program increase - impacts of soil structures on hydrology ***FY 2021 Plans:*** Program Increase supported advanced research on Impacts of Soil Structures on Hydrology. Work executed by Army Futures Command.	-	4.000
Congressional Add: Program increase - operational energy research ***FY 2021 Plans:*** Program Increase supported advanced research on Operational Energy Research. Work executed by Army Futures Command.	-	1.300
Congressional Add: Program increase - temperature insensitive high?energy density lithium?ion batteries ***FY 2021 Plans:*** Program Increase supported advanced research on Temperature Insensitive High-Energy Density Lithium-Ion Batteries. Work executed by Army Futures Command.	-	2.500
Congressional Add: Program increase - vehicle performance reliability and operations ***FY 2021 Plans:*** Program Increase supported advanced research on Vehicle Performance Reliability and Operations. Work executed by Army Futures Command.	-	3.000
Congressional Add: Program increase - cross-laminated timber and recycled carbon fiber materials ***FY 2021 Plans:*** Program Increase supported advanced research on Cross-Laminated Timber and Recycled Carbon Fiber Materials. Work executed by Army Futures Command.	-	1.300
Congressional Add: Program increase - advanced explosion resistant window systems ***FY 2021 Plans:*** Program Increase supported advanced research on Advanced Explosion Resistant Window Systems.	-	5.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603119A / *Ground Advanced Technology*	**Project (Number/Name)** BO3 / *MILITARY ENGINEERING TECHNOLOGY DEMONSTRATION (CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
Work executed by Army Futures Command.		
Congressional Adds Subtotals	124.200	181.800

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 3	R-1 Program Element (Number/Name) PE 0603119A / *Ground Advanced Technology*	Project (Number/Name) CJ9 / *Ground Enabling University Adv Development*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
CJ9: *Ground Enabling University Adv Development*	-	-	-	4.009	-	4.009	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

Note

This is a new start in FY 2022.

In FY2022, this is a New Project with funding realigned from PE 0602145 BF8 Artificial Intelligence and Machine Learning Tech.

A. Mission Description and Budget Item Justification

The Project leverages advanced developments and technological innovations 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, by accelerating experiments and demonstrations focused on getting technology to the warfighter more quickly. This Project performs advanced research and development 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 experimentation and demonstration of various advanced 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 advanced research and demonstration 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 0620145A (Ground Technology), PE 0602145A (Next Generation Combat Vehicle Technology) and PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Robust autonomous capabilities for ground vehicles	-	-	2.209

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603119A / *Ground Advanced Technology*	**Project (Number/Name)** CJ9 / *Ground Enabling University Adv Development*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Description: This effort demonstrates and integrates Artificial Intelligence/Machine Learning (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. Work 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 further mature, integrate and demonstrate use of 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 identify terrain features in images and transfer of simulator-learned behaviors to developmental ground platforms. Mature and demonstrate methods of shared control (between human operators and AI/ML systems) that increase overall autonomous system performance with human input. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** In FY22, funding was realigned from PE 0602145 BF8 Artificial Intelligence and Machine Learning Tech			
Title: Human-robot/AI interactions ***Description:*** This effort demonstrates and integrates systems involving physical and cognitive levels of interactions between humans and robots, with the use of reinforcement learning (an area of Machine Learning (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 further mature, integrate and demonstrate use of 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 mature and demonstrate 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 2021 to FY 2022 Increase/Decrease Statement:*** In FY22, funding was realigned from PE 0602145 BF8 Artificial Intelligence and Machine Learning Tech	-	-	1.800
Accomplishments/Planned Programs Subtotals	-	-	4.009

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603119A / *Ground Advanced Technology*	**Project (Number/Name)** CJ9 / *Ground Enabling University Adv Development*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A