THE CORPS ENGINEER BATTALION IN CONTINGENCY OPERATIONS

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Corps engineer battalions have acquired more responsibility to provide support across the spectrum of conflict in the areas of mobility, countermobility, survivability, and general engineering. The various organizational designs of corps engineer units limit their capability to provide support in all four areas. The central research question asks: Is the proposed echelons above division engineer battalion design a better one for active and reserve component corps engineer forces to respond in a contingency? The method of evaluation is an adaptation of the seven characteristics of the Army Transformation Force: agility, deployability, lethality, responsiveness, survivability, sustainability, and versatility. The research evaluates the engineer units deployed under the current force structure in their ability to accomplish engineer support requirements (based upon the Army Facilities Components System) for a two-division peacekeeping deployment to Africa. The study then examines the ability of a hypothetical engineer force built around a proposed multifunctional corps engineer battalion design in the same operation. It also compares the two forces in personnel, equipment, and structure using the objective tables of organization and equipment. The force built around the proposed multifunctional battalion design is superior in all seven characteristics and has pronounced advantages in agility, deployability, responsiveness, survivability, and versatility.

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ABSTRACT

THE CORPS ENGINEER BATTALION IN CONTINGENCY OPERATIONS by MAJ James H. Raymer, 190 pages.

Corps engineer battalions have acquired more responsibility to provide support across the spectrum of conflict in the areas of mobility, countermobility, survivability, and general engineering. The various organizational designs of corps engineer units limit their capability to provide support in all four areas. The central research question asks: Is the proposed echelons above division engineer battalion design a better one for active and reserve component corps engineer forces to respond in a contingency? The method of evaluation is an adaptation of the seven characteristics of the Army Transformation Force: agility, deployability, lethality, responsiveness, survivability, sustainability, and versatility. The research evaluates the engineer units deployed under the current force structure in their ability to accomplish engineer support requirements (based upon the Army Facilities Components System) for a two-division peacekeeping deployment to Africa. The study then examines the ability of a hypothetical engineer force built around a proposed multifunctional corps engineer battalion design in the same operation. It also compares the two forces in personnel, equipment, and structure using the objective tables of organization and equipment. The force built around the proposed multifunctional battalion design is superior in all seven characteristics and has pronounced advantages in agility, deployability, responsiveness, survivability, and versatility.

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

LIST OF ACRONYMS

AC	active component
ACE	armored combat earthmover
AFCS	Army Facilities Components System
APC	armored personnel carrier
AVIM	aviation intermediate maintenance
AVLB	armored vehicle-launched bridge
AVUM	aviation unit maintenance
CALL	Center for Army Lessons Learned
CSC	construction support company
CSE	combat support equipment company
DEUCE	deployable universal combat earthmover
DOS	days of supply
DS	direct support
EAC	echelons above corps
EAD	echelons above division
ERI	Engineer Restructure Initiative
FM	field manual
GPD	gallons per day
GS	general support
HEMTT	heavy expanded mobility tactical truck
HHC	headquarters and headquarters company
HMMWV	high mobility, multipurpose wheeled vehicle

LE	light equipment
LMTV	light medium tactical vehicle
LOC	lines of communication
LOGCAP	Logistics Civilian Augmentation Program
MANSCEN	Maneuver Support Center
METT-T	mission, enemy, terrain, troops, time available
MICLIC	mine clearing line charge
MKT	mobile kitchen trailer
MLC	military load classification
MOS	military occupational specialty
MRC-E	major regional contingency - east
MRC-W	major regional contingency - west
MTOE	modified table of organization and equipment
MTV	medium tactical vehicle
OTOE	objective table of organization and equipment
PLS	palletized load system
PQ	primary question
RC	reserve component
QQ	quartic question
SASO	stability and support operations
SEE	small emplacement excavator
SQ	secondary question
SRC	standard requirements code

STON	short ton
TAA	Total Army Analysis
TQ	tertiary question
TM	technical manual
UN	United Nations

CHAPTER 1

INTRODUCTION

Since 1988, the U.S. Army has reduced the total number of corps combat and combat heavy engineer battalions on active duty from sixteen to five and fifteen to seven, respectively. The number of corps engineer battalions in the reserve component, though substantially larger, has also decreased. While the number of active component engineer battalions within the heavy divisions has increased from ten to eighteen, these units are significantly smaller in size and much more restricted in capability than the corps battalions they replaced. This new engineer force structure is intended to provide a mechanized engineer battalion, oriented towards mobility and survivability, to each divisional maneuver brigade on the battlefield. The corps commander then allocates corps combat and combat heavy engineer battalions in support of other units or main effort divisions in the area of operations. The U.S. Army now possesses a total of five corps combat and seven combat heavy engineer battalions on active duty to provide this augmentation, with additional forces in the reserve component. Three current corps engineer battalion designs support the heavy division. Each one provides specific types of support on the battlefield and in the area of operations. Corps mechanized battalions are almost identical in capability to the heavy division engineer battalions, but have a larger staff.[1] Corps wheeled battalions provide additional mobility, countermobility, and survivability support to corps close operations in the defense and to corps rear operations.[2] Combat heavy battalions execute a wide variety of construction missions.[3] The Maneuver Support Center at Fort Leonard Wood has proposed an initiative to create a multifunctional combat engineer battalion design which combines the capabilities of these three formations and other existing unit types. These multifunctional battalions would replace the corps combat wheeled, corps combat mechanized, and combat heavy engineer battalions currently in the force.

This thesis answers the primary research question (PQ), Is the proposed echelons above division (EAD) engineer battalion design a better one for active and reserve component corps engineer forces to respond in a contingency operation?

At the close of the Reagan administration, sixteen active-duty corps combat and fifteen combat heavy engineer battalions augmented the ten active-duty divisional mechanized engineer battalions. At that time, the U.S. Army had already begun activating divisional engineer brigades with three subordinate engineer battalions within each of the heavy divisions. The reduction in the active force from eighteen to ten divisions during the 1990s also reduced the number of corps combat and combat heavy engineer battalions from sixteen to five and fifteen to seven, respectively. At the same time, it increased the number of divisional battalions from ten to eighteen as each heavy division gained an engineer brigade of three battalions. The active force restructuring therefore resulted in the gain of eight divisional engineer battalions, but the loss of nineteen corps engineer battalions. The number of reserve component corps engineer battalions also decreased by a total of 29 battalions.[4] This simple comparison of the number of battalions gained or lost does not show the details of the restructuring. The shift of battalions to the heavy divisions resulted in a very different mission and set of capabilities for the divisional engineer battalions.

When heavy divisions had a single engineer battalion, there were six companies and 899 personnel in this formation: four combat engineer companies, a bridge company, and a headquarters company. Typically, one combat engineer company supported each maneuver brigade. The new division engineer battalions have only three combat engineer companies and less than one-half the personnel of the old battalion. Each battalion, however, supports a maneuver brigade. The new divisional engineer brigade, with 1354 personnel, is not three times as large as the old battalion was.[5] Its battalions, with 433 personnel, do not have the float bridge company and horizontal construction equipment of the old single divisional battalion, though they are more capable of supporting the maneuver brigade's mobility and survivability requirements than one company was under the old organization.[6] Each maneuver battalion or task force now has sufficient engineer support to breach two lanes simultaneously through a complex obstacle. By taking personnel and equipment from the deactivating heavy divisions of III, V, and VII Corps, as well as a few personnel from the deactivating corps combat battalions, the heavy divisions increased the available engineer support to the maneuver brigades, particularly in the areas of mobility and survivability. At the same time, the Corps of Engineers reduced its active component personnel from 43,643 in 1988 to 20,972 in 2000.[7]

Currently, the heavy divisions possess three engineer battalions to support the three maneuver brigades; some of these divisions have already deactivated the engineer brigade headquarters in the initial conversion to the Force XXI structure. They have lost the bridge company and the dedicated asset (the D Company in the old divisional battalion) to support the division cavalry squadron. Another loss in engineer capability has occurred in echelons above the division. Currently, there are only two active-component corps mechanized battalions (with armored and tracked vehicles) to provide augmentation to the organic engineers of the heavy divisions (to include the 2nd Infantry

Division in Korea). Beyond that, one corps combat wheeled, two corps airborne, and seven combat heavy battalions exist to augment the divisions, but they do not possess the tracked vehicles to maneuver with the heavy divisions. More battalions become available when the reserve component engineer forces are mobilized. The PQ asks, Is the proposed EAD engineer battalion design a better one for active and reserve component corps engineer forces to respond in a contingency operation? The secondary (SQ), tertiary (TQ), and quartic (QQ) questions are:

SQ. What are the strengths and weaknesses of the proposed EAD battalion design according to the method of evaluation?

SQ. What are the strengths and weaknesses of the current force structure according to the method of evaluation?

TQ. What makes one kind of engineer unit better than another to support this contingency operation (method of evaluation)?

TQ. How does the proposed EAD engineer battalion design provide this engineer support for the contingency?

TQ. How does the current engineer force structure provide this engineer support for the contingency?

QQ. What engineer support is required in this contingency operation?

QQ. What is the contingency operation to be used? Obviously, a variety of contingency scenarios exist. To narrow the scope of the primary research question, the research design will use a corps-level scenario involving a light infantry division and a mechanized infantry division conducting a peacekeeping operation in an African country split in two by the terms of a negotiated settlement. After a long civil war, the existing government has agreed to allow rebels of a different ethnic and religious background to form their own state in the southern one-third of the country. Two U.S. Army divisions deploy to keep the peace between the two sides and assist international organizations in efforts to stabilize the situation in the new southern state, which suffers from famine, disease, and large numbers of displaced persons. The area of operations has no infrastructure in the following areas: water purification and distribution, electrical production and distribution, fuel distribution, road transportation, and waste disposal. A developed port, road network, and fuel pipeline system are available for use in a neighboring country to move assets to the border of the area of operations.

The study can use several assumptions to assist in the development of a research methodology. The engineer units possess 100 percent of the personnel and equipment (from organic or prepositioned sources) in the objective table of organization and equipment (OTOE). The state of training and readiness for the troops in the engineer units under the current force structure and in the proposed EAD battalions is the same. The allocation rules are not yet established for the proposed EAD battalion. The research methodology will assume the allocation of one of the proposed EAD engineer battalions to replace each of the corps mechanized, wheeled, or combat heavy battalions currently authorized for support under the rules established by the Total Army Analysis (TAA) process. While no doctrine exists for the employment of the proposed EAD battalions, the research methodology assumes that the proposed battalion will employ the various types of platoons in the same way that the current corps engineer battalions employ them.

The thesis must define several key terms based upon the proposed research question. A contingency operation, as defined in FM 101-5-1, *Operational Terms and*

Graphics, is "an emergency involving military forces caused by natural disasters, terrorists, subversives, or by required military operations. Due to the uncertainty of the situation, contingencies require plans, rapid response, and special procedures to ensure the safety and readiness of personnel, installations, and equipment."[8] The research methodology will include a contingency scenario to describe and quantify engineer support requirements at echelons above division.

An integrated concept team composed of personnel from the Maneuver Support Center (MANSCEN), the two engineer commands (ENCOM), reserve component engineer brigades, the National Guard Bureau (NGB), and the Office of the Chief, Army Reserve (OCAR), is currently studying the proposed multifunctional EAD engineer battalion design. It is still considered a proposal under evaluation at the MANSCEN. It is not scheduled for field release, Total Army Analysis, or Force Design Update (FDU) in the immediate future. It may become a component of the overall engineer force modernization plan associated with Army Transformation.[9] The battalion would replace all corps combat mechanized, corps combat wheeled, and combat heavy engineer battalions in the current force structure. The proposed EAD battalions will also eliminate the combat support equipment (CSE), construction support (CSC), and dump truck companies currently allocated to support the corps engineer battalions. When the term *current force structure* is used, it refers to the combination of corps mechanized, corps wheeled, and combat heavy engineer battalions, as well as the CSE, CSC, and dump truck companies, allocated to support the committed maneuver division in the area of operations.

Limitations and delimitations help define the scope of the thesis. Limitations are weaknesses imposed by constraints or restrictions beyond the control of the researcher. Delimitations are constraints imposed by the researcher on the scope or content of the study so that research will be feasible.[10] The following is a limitation of the thesis: The proposed design of the EAD battalion is just that: proposed. The Engineer School expects the structure to change based upon further analysis and recommendations. This study may reach conclusions already noted and acted upon by the Engineer School, but the thesis may also help to recommend a solution to the leadership at Fort Leonard Wood.

The following are delimitations of the thesis:

1. The contingency scenario previously described is only one possible example of such an operation. While the thesis will only examine one contingency, it will address the ability of the proposed EAD battalion to replace the current force structure in contingencies across the spectrum of conflict.

2. The research methodology in the thesis will only address the corps-level engineer support to the maneuver divisions in a contingency. It will not address engineer support to other corps-level and higher units, nor will it address the work of divisional engineers. It will not address support to other government agencies or nongovernmental organizations (NGO).

3. The researcher must determine a method of evaluation that defines a set of criteria to measure whether one unit is better than another unit. The U.S. Army has defined a set of characteristics for the Transformation Force.[11] They are useful as a method of evaluation for this thesis. These characteristics are:

Agility is the conceptual and physical ability of Army forces to transition within or between types of operations without augmentation, a break in contact, or additional training, and to execute operations more swiftly than their opponents can do so. The mental agility of commanders and staffs to adapt strategies and tactics to meet mission requirements in dynamic environments is a prerequisite for decisive full spectrum operations. Agile forces are capable of transitioning quickly from low-intensity environments to high-intensity ones, then back again.

Deployability is the ability to rapidly deploy, employ, and sustain forces beginning within hours of notification. Deployable units can quickly build specific force packages for different scenarios and move them by sea and air to a distant area of operations.

Lethality is the ability of Army forces to generate overwhelming lethal effects by combining elements of combat power. When deployed, all units must generate combat power and contribute to the fight.

Responsiveness is the ability to quickly and decisively respond to directly affect the outcome of the situation or crisis.

Survivability is the combination of technology and methods that afford the maximum protection to Army forces during the conduct of full spectrum operations.

Sustainability is the ability to sustain Army forces. It is the capacity to sustain and continue operations longer than any adversary confronted while simultaneously reducing logistics demand and unit footprint.

Versatility is the ability of Army forces to conduct full spectrum operations with tailored forces and minimal organizational adjustments in minimal time. Multifunctional force packages are able to reorganize and adapt to changing missions.

By adapting these seven characteristics of the Transformation Force to a corps engineer force, a distinct set of criteria emerges to measure the ability of corps engineer forces to support divisions in a contingency. These criteria provide a framework that shows what the answer to the research question will look like at the end of the process. The seven characteristics also describe the capabilities of the transforming maneuver force that corps engineers will support and can logically serve as the basis for a comparison of the engineer structures. Such a set of criteria will clearly define what is being considered to arrive at the conclusion of which unit is better. While the model scenario is a peacekeeping operation, the proposed EAD battalion design would also replace the current force structure in a medium-intensity or high-intensity conflict. The method of evaluation must address the capability of the proposed battalions to replace the current ones in those environments.

This thesis will examine the design of the proposed EAD engineer battalion operating in a contingency environment and whether that design is better able to accomplish engineer missions than the current force structure. The vast reduction in the quantity of engineer battalions above the division level, coupled with the engineer restructuring initiative to place an armored, mobility-focused mechanized engineer battalion in support of each maneuver brigade, has greatly increased the task load of the corps combat and combat heavy engineer battalions. To answer the PQ, there are a series of SQs, TQs, and QQs to investigate as well. This chapter has also presented a series of assumptions, definitions, limitations, and delimitations to set the boundaries for answering the PQ. It has provided a set of criteria as a method of evaluation for determining if the proposed engineer battalion design is better than current force structure. The thesis will now review the current body of literature related to the research.

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[1]United States Army, FM 5-100-15; *Corps Engineer Operations* (Washington, DC: Department of the Army, 1995), 1-12.

[2]Ibid., 1-14.

[3]Ibid.

[4]Ronald L. Johnson, "State of the Engineer Regiment" (briefing presented at the Command and General Staff Officer Course, Fort Leavenworth, Kansas, on 3 August 1990), handout to attendees, slide 38.

[5]Alan Schlie, "Close Up: Engineer Restructure Initiative," *Engineer 5-93-1* (February 1993): 21.

[6]Ibid., 22.

[7]Johnson, "State of the Engineer Regiment," slide 38.

[8]United States Army, FM 101-5-1; *Operational Terms and Graphics* (Washington, DC: Department of the Army, 1997), 1-37.

[9]Mark H. Potter, "EAD BN Design," Electronic mail message to author, Ft. Leavenworth, KS, 22 November 2000.

[10]Philip J. Brookes, Ph.D., Student Text 20-10; *Master of Military Art and Science (MMAS) Research and Thesis* (Fort Leavenworth, KS: U.S. Army Command and General Staff College, 2000), 19.

[11]United States Army Command and General Staff College, Student Text 3-0; *Operations* (Fort Leavenworth, KS: U.S. Army Command and General Staff College, 2000), 3-2.

CHAPTER 2

LITERATURE REVIEW

The body of literature on the structure of the EAD combat engineer battalion is not large. However, a body of literature does exist that covers engineer operations in various conflicts. Through examination of the missions accomplished, the environment, the forces used, and the comments of participants, the researcher encountered data with direct bearing on the design of an EAD combat engineer battalion and what missions these units have performed in past operations. Contingency operations began in earnest with the Vietnam War and have continued until the present day. This chapter will address relevant literature on these operations and on engineer force structure, generally in chronological order.

The literature on engineer support to U.S. Army contingency operations prior to World War Two is scarce. The official history of U.S. Army counterinsurgency and contingency operations doctrine mentions road building and infrastructure development as means of employing the destitute masses in foreign lands and contributing to national development.[1] The infantry and cavalry forces involved in these operations largely supported themselves in the areas of mobility, countermobility, survivability, and general engineering. Military engineers did provide topographic support and expertise in the construction of fortified works.

Army engineers units deployed to Lebanon in 1958 during the 102-day intervention. Corps engineers deployed as part of the 201st Logistical Command and worked to build supply storage areas and roads, as well as increase force protection levels, for that unit.[2] Beirut was not an austere area and the units procured needed material and support from local sources, to include real estate and billets for the troops.[3]

In 1973, Major General Robert Ploger published his account of U.S. Army engineer operations in Vietnam from 1965 until 1970. His monograph covers the initial deployment of engineer forces into theater, the growth and development of the engineer force structure, work accomplished in Vietnam, the "Vietnamization" of engineer programs, and an evaluation of the engineer effort in Vietnam as a whole. Ploger, as the first commander of 18th Engineer Brigade in Vietnam, addresses many issues that engineer force structure developers still grapple with today when designing the force. These issues include contingency operations, active-reserve component mix, contractor roles, command and control of engineer units in the division and corps area of operations, joint engineer operations, engineer priorities in theater, and training requirements. Several of his observations are worth noting here, as they have bearing on the design of the proposed EAD engineer battalion. Ploger regarded engineer operations in Vietnam as a contingency initially faced with a seemingly insurmountable task. "The expanding involvement of the Army Engineer forces was more a reaction to the growing U.S. strength in Vietnam than the execution of a precisely drawn plan. From the time the first large contingent of Army engineer troops waded ashore at Cam Ranh Bay in June 1965, the demands upon the engineers were so immediate and overwhelming that their initial mission appeared impossible."[4] Ploger notes that initial engineer planning for Vietnam was truly conducted under crisis conditions:

> Early planning for the buildup and operations in Vietnam had little more to go on than tentative indications of the number of maneuver battalions that might be deployed. There was no generally accepted tactical concept, campaign plan, or scheme of logistic support upon which effective engineer planning could be

based. In fact, subsequent difficulties tended to confirm that there had been a remarkable lack of appreciation of the amount of engineer effort required to support deployments of the scale being considered in early 1965.[5]

During the planning period, reserve component engineer forces were considered as an integral part of any increase in efforts in Vietnam. President Johnson announced on 28 July 1965 that the nation would create larger forces in Vietnam by expansion of the active army through increased draft calls.[6] Ploger noted the impact on the engineer plan:

> Since major planning policies for expanded U.S. activity in Southeast Asia had been based on the now fallacious assumption that a significant proportion of the necessary manpower would come from Reserve components, the stage was set for shortages not only of units but also of men with technical training and managerial ability. In the understandable desire to maximize its readiness to fight, the Army tries to retain a high proportion of combat formations in its active forces in peacetime. The cost is always a shortage of ready-to-go support units, including engineers.[7]

In July 1965, twenty combat engineer battalions and four construction engineer battalions made up the active duty engineer force in the continental USA. By July 1968, the U.S. Army had deployed twenty of these battalions to Vietnam.[8] Ploger, in hindsight, considered the proportion of engineer forces in the active component "woefully inadequate."[9]

Contractors arrived in Vietnam to support the initial advisory effort. In 1964, 5,000 troops at six sites received contracted engineer support; by the end of 1965, this had expanded to 48,000 troops at eleven sites. Ploger noted that "the presence of some engineers, including competent contractors, in Vietnam perhaps fostered a false confidence that needs could be met. All available engineer resources were actually already committed. . . . In South Vietnam, the Army engineers were introduced at the latest possible moment that could permit success."[10]

As the quantity of nondivisional engineer units increased in Vietnam, the theater commander continued to assign all of them to the 18th Engineer Brigade, which reported directly to U.S. Army, Vietnam. Thus, no direct relationship existed between the engineer brigade, including its subordinate groups and battalions, and the combat forces. Ploger overcame this by authorizing direct coordination between the field force, its divisional engineers, and the EAD engineer groups, rather than assigning the nondivisional battalions to the divisions in an attached or operational control (OPCON) relationship.[11] Later, as more engineer units arrived and tactical responsibilities grew in the two field force (corps-equivalent) commands, operational control of the nondivisional engineer units became increasingly a matter of controversy. Combat divisions, despite their organic engineer units, wanted additional engineer units to facilitate rapid response to crisis tactical situations. While the 18th Engineer Brigade commander resisted this as a potential dilution of the maximum construction capacity then required, one of the field force commanders supported the idea. Eventually, different arrangements were made in each command, with II Field Force gaining operational control of the two nondivisional battalions and three separate companies in its area of operations.[12]

When the U.S. force buildup began in earnest in 1965, the United States Marine Corps (USMC) exercised tactical responsibility in the I Corps tactical zone near the border with North Vietnam. The U.S. Navy, already operating the port at Da Nang and providing logistical support to the USMC forces ashore, picked up engineer responsibility for the entire zone.[13] This arrangement continued to exist until early 1967, with any U.S. Army units in this zone receiving additional engineer support from USMC and United States Navy (USN) engineer formations. After the 23rd Infantry Division moved into the

I Corps Tactical Zone in early 1967 to counter increased enemy activity, the 45th Engineer Group extended its operating area into this zone. Afterwards, Army, Navy, and Marine engineers worked together to support military operations.[14]

On 4 November 1965, Ploger briefed General Westmoreland on the initial engineer operations in country and recommended a priority of engineer work for Vietnam. The top ten on the list, in order, were clearing and grubbing of troop areas; field fortifications; clearing fields of fire; water supply points; tank landing ship (LST) ramps and bollards; materials for pit latrines; flight strips with access roads; roads and hardstands at ports; hospitals; and ammunition storage areas with access roads.[15]

As the engineer work progressed in Vietnam, Ploger commented on the training of engineer forces for the tasks encountered in theater:

> The entire military procedure being followed in Vietnam put pressures on the Army engineers that they had never before experienced. Providing base camp security at night by floodlighting the surrounding area demanded generators capable of producing sustained electrical power. Construction plans called for sophisticated products, while the draftee-soldier and even many of the Regulars provided for the job had limited training and virtually no experience at the level of sophistication demanded. In short, expectations directed towards engineer troops were at a new high, while the preparedness of engineer soldiers appeared to be approaching a new low.[16]

Lieutenant General Carroll H. Dunn wrote a second monograph on engineers in Vietnam, specifically focusing on base development. Dunn served as Chief of Military Construction, and later Assistant Chief of Staff for Logistics, from January 1966 until the fall of 1967. Unlike Ploger, Dunn focuses exclusively on the general engineering associated with base construction. Several observations are worth noting. Commenting on planning prior to the troop buildup in mid-1965, Dunn notes that "while the situation which materialized after 1965 was much more extensive and the base development requirements were much greater than those represented in base development plans, Army planning before 1965 should have identified base requirements early in the buildup."[17] Dunn also commented on the role of the contractor: "Although forty-two construction units of battalion strength were deployed to South Vietnam, the requirements for base development were of such magnitude that the contractor force supplied a greater construction capability than the entire military force."[18] In retrospect, corps engineers in Vietnam confronted most of the issues that U.S. troops would encounter in later contingency operations, including an extensive base development requirement from the beginning of operations and the need for skilled construction personnel to meet this demand.

After the body of work covering the Vietnam conflict, commentary on engineer force structure above the combat division remained rare until Operations Desert Shield and Desert Storm. Somewhat prophetically, Charles L. Toomey, an engineer officer at the School for Advanced Military Studies, published a monograph in June 1990 on the ability of active-duty Army engineer forces to meet the base development requirements for a rapid-deployment contingency into Oman to defeat a Soviet-supported invasion from Yemen. Several months later, U.S. Central Command (USCENTCOM) would test his conclusions in a massive force buildup farther north on the Arabian Peninsula. In his work, Toomey sets out base development requirements for the theater that are not too different from those in Vietnam in terms of tasks and priorities. As opposed to a 500,000-man force in Vietnam, Toomey sets the Oman-U.S. force at 155,000.[19] Calculating the amount of work needed versus the forces available in theater, he notes that the 9.1 Army combat heavy engineer battalion equivalents will encounter a cumulative shortfall of

261.4 battalion-days in the work schedule by the fortieth day after the deployment order (D+40).[20] Toomey concludes that:

> The active Army engineer force would be hard-pressed to meet the requirements of a contingency such as the Oman scenario. The capability exists in the active components but a deployment on the scale of the scenario depicted would strip the Army of its most ready construction asset. Nearly all construction assets would be deployed to one region of the world for one contingency. It would then fall to the reserve component engineers to give depth to our overall ability to meet other simultaneous crises.[21]

As a potential solution, Toomey advocates an increase in the construction capability of the active force, specifically recommending more combat heavy battalions and light equipment companies (like the 618th Engineer Company at Fort Bragg, North Carolina).[22]

Jerry T. Mohr, another engineer officer, presented a monograph at the School for Advanced Military Studies in 1990. Entitled "AirLand Battle Future: Combat Engineer Force Structure," Mohr's work examines the adequacy of the mechanized division engineer brigade established in the Engineer Restructure Initiative (ERI) to support the maneuver force. This work addresses what the division expects from the EAD engineer units and is thus important to this study.

The corps combat mechanized engineer battalion, stripped of its horizontal construction equipment, is an agile force designed to support the rapidly moving armored cavalry regiments and corps artillery battalions in fast-paced operations. Mohr notes the doctrinal shift that places this formation and its operations almost exclusively in the tactical battle area.[23] The corps wheeled battalion ensures the mobility of all units from the tactical support area to the rear edge of the battle area. This unit becomes critical to maintaining the routes designed to support the direct corps-level logistical throughput to maneuver brigades.[24] Both types of battalions are capable of reinforcing the countermobility and survivability capability of the divisional engineer battalions in those rare instances when they will operate in the defense under the offensive-oriented doctrine. Mohr notes how the doctrine requires highly mobile corps engineer battalions, since the corps engineer must "quickly employ the mechanized and wheeled combat engineer battalions to shape the battlefield under corps control . . . to wrest the initiative away from the enemy."[25] The old corps mechanized battalion design had a mix of mechanized combat vehicles and wheeled construction equipment. Mohr noted that this design was not suitable for the new doctrine, as "either the corps mechanized engineer battalion ends up dragging unnecessary earthmoving equipment in the battle area, slowing its supported unit's movement, or it wastes the use of tracked engineer vehicles in the tactical support area."[26]

Retired Command Sergeant Major Alan Schlie, an analyst in the Directorate of Combat Developments at the U.S. Army Engineer School at Fort Leonard Wood, Missouri, published an article on the history of ERI in 1993. He noted that one of the changes caused by ERI was to make the CSE companies a repository of heavy survivability and countermobility equipment for the heavy divisions. Combat heavy battalions became echelons above corps (EAC) assets, but retained responsibilities in the corps area.[27]

Following the Operation Desert Storm, U.S. Army engineers entered a decade of stability and support operations (SASO). Hurricane Andrew relief, humanitarian assistance in Somalia, intervention in Haiti, and peacekeeping in the Balkans brought new missions and priorities for an engineer force structure designed to support a fluid mechanized battle like Desert Storm.

After the Hurricane Andrew relief mission in Florida, several units published accounts of their work and lessons learned on the mission in *Engineer*, a professional journal. One commander stated, "The initial engineer mission never includes all eventual tasks! Nobody is smart enough to define everything in advance."[28]

Pete Malley, a force developer at the U.S. Army Engineer School, addressed this change in missions briefly in a 1994 article entitled, "Engineer Force Structure: Past, Present, and Future." Spending the majority of the article describing the TAA process, Malley notes that the TAA-2001 called for five corps mechanized engineer battalions to support a major regional contingency-west (MRC-W) scenario. An additional five would support the major regional contingency-east (MRC-E) scenario, plus one more battalion forward deployed in Europe, for a total of eleven battalions.[29] The active force provided only three of these battalions, with fourteen more available in the reserve component.[30]

In an article prepared for *Engineer*, Robert L. Davis and Mark D. Feierstein detail the construction of a base camp in Somalia by a combat heavy engineer battalion. The authors note that, "Military engineers did not build Victory Base by themselves. Brown and Root played an integral role by providing contracted equipment, services, material, and construction."[31] The combat heavy battalion proved itself as a unit capable of "speed and versatility of construction in support of combat operations."[32]

The 10th Mountain Division operated in Somalia with significant corps-level augmentation, to include an engineer group, one combat heavy battalion, and two CSE companies.[33] Major Wayne Whiteman, the assistant division engineer, noted that the command and control issue of divisional versus nondivisional engineers emerged, specifically concerning who would be the principal advisor to the maneuver commander. He also noted that each SASO was different, such as the contrast between Hurricane Andrew and Somalia, and that, "Force structure design and task organization of augmentation engineers are major tasks that must be addressed early in the planning cycle by the divisional engineer battalion command and staff."[34] Whiteman also stresses using contracting to "save troop effort and enhance success."[35] In another article on Somalia, Peter Madsen, a light division engineer battalion commander, noted that force protection and base construction were major engineer missions in both the peacemaking and peacekeeping phases of the operation.[36]

The evaluation team from the Center for Army Lessons Learned (CALL) in Somalia made recommendations for units deploying into future austere theaters in a 1993 article in *Engineer*. The team recommended that prior to deployment, units should consider ordering the bill of materials (BOM) for complete troop camps according to the designs in the Army Facilities Components System (AFCS).[37] A 1994 article in *Engineer*, written by Sheldon Kauffman, a company commander in the 41st Engineer Battalion, noted that U.S. and United Nations (UN) forces had found no existing infrastructure in Somalia when they arrived in 1992. Even after engineers completed extensive work creating rudimentary lines of communication (LOC), the country lacked the civil support system to maintain it. Heavy rains and maintenance shortfalls closed routes that had been reopened only two months before.[38]

In another article written for the same professional bulletin, Bill Breyfogle noted the importance of engineer units deploying with all of their equipment for a stability and support scenario. His advice is to "deploy with your entire range of engineer personnel, equipment, and supplies, and be prepared to provide flexible and versatile support."[39] He also notes the presence of civilian contractors and advises the engineer leader to "plan on contracting for civilian services and/or equipment."[40]

Alan Schlie published another article in *Engineer* following the 1994 Senior Engineer Leaders Training Conference (SELTEC). In it, he addressed concerns about the utility of the ERI concept in the changing and uncertain future of Army engineer missions increasingly oriented towards SASO. He challenged engineer leaders to accept the challenge posed by the new ERI units and make the necessary efforts in training and education. Schlie encouraged RC units to move forward with ERI reorganization of their formations. Commenting on the roles of the heavy division engineer battalion, the corps mechanized and wheeled battalions, and the CSE companies, he declares that "all engineer battalions are not designed with equal capabilities, but that does not mean that one is better than another. It means that each has a specific place and function on the battlefield. . . . And it means that commanders must ensure their superiors know which missions their unit can and cannot accomplish."[41]

Bruce Porter addressed the issue of the redesigned CSE company in ERI for a 1994 article in *Engineer*. Like Schlie, he urged the RC CSE companies to reorganize to the new modified table of organization and equipment (MTOE) as soon as possible and train to fight with the AC maneuver units they would support in war. Porter noted that the new emphasis on SASO had made the CSE company even more important, as divisions needed the bulldozers for various missions in both Hurricane Andrew relief and Somalia.

He also noted that while the new CSE company technically retained the capability to perform earthmoving support missions in the division and corps rear area, combat heavy battalions usually had the primary responsibility for these missions.[42] He also emphasizes that the ERI design for the CSE company gives it three identical platoons for easy attachment to the companies of a heavy divisional or corps mechanized engineer battalion.[43]

William Schneck, a civilian technician at the Countermine Division of the Night Vision and Electronic Sensors Directorate, published a study of route clearance in Vietnam and Somalia in 1995. He concludes that current engineers could conduct a deliberate route clearance for land mines and booby traps four to twelve times as fast as Vietnam-era units due to advances in detection technology.[44] This is a significant mission in areas, like Bosnia, where combatants have placed land mines indiscriminately throughout the area of operations. Divisional engineer battalions now train extensively for this mission.

When Joint Task Force (JTF) 180 deployed to Haiti in September 1994, a robust engineer package accompanied the joint force. Two corps combat airborne battalions, one combat heavy battalion, and one United States Air Force (USAF) rapid, engineer-deployable, heavy, operational repair squadron (RED HORSE) conducted general engineering to sustain and support over 20,000 deployed troops. An article for *Engineer* by two captains in the 20th Engineer Brigade provides an account of the missions performed by these engineers in the first months of the operation. They judged it as a "textbook example of a successful contingency operation."[45] The 20th Engineer Brigade had deployed three battalions, including two multifunctional corps airborne units, to Haiti within fourteen days of notification. It had completed a wide variety of missions to support U.S. forces, UN personnel, and the Haitian people, and was among the initial group of major subordinate commands to depart the island. The EAD engineer commander had defined an end state for mobility, survivability, and general engineering in conjunction with the maneuver commander, achieved his vision, and returned home within sixty days.

The final significant body of literature deals with engineer operations in the Balkans. CALL sent an assessment team to Europe in 1993 to evaluate the readiness of forces there to conduct a potential deployment to Bosnia in a peacekeeping scenario. David Brown, the engineer member of the team, grouped his comments into six areas: communication and reaction to constant change, prestocked material shortages, engineer equipment maintenance challenges, mine and countermine operations, sustainability of lines of communication, and follow-on operations. Since Brown wrote his article a full two years before U.S. troops moved to Bosnia as part of the Implementation Force (IFOR), planners resolved many of the issues he identified prior to the actual deployment.[46] He made the following comment that echoes the thoughts of Robert Ploger and Charles Toomey:

> The total engineer force maintains more than 70 percent of its capability in the Reserve Component (RC). Railroad repair units are found only in the RC. Port construction, prime power and pipeline construction units are limited to one or two Active Component (AC) companies, with the remainder in the RC. The limited number of available AC combat and construction battalions would require alert and movement of CONUS-based AC or RC engineers to complete in-theater missions and provide backfill for replacement and rotation. Considerable time is required to approve the call-up of reserve forces, prepare them for deployment, and move them into a theater of operations. Many of these engineer forces will be critical to theater opening operations during the first 30-45 days of operations. The Army's ability to place these units at the critical point during the critical time is based on decisions made at least 120 days before on-the-ground operations begin.[47]

In a clear reference to the importance of nation building, Brown also envisioned that in Bosnia and most other potential SASO scenarios, engineers should be perceived as a humanitarian force, in the country to provide humanitarian assistance to a starving and demoralized population. Engineers must complete projects that both support the deployed forces and benefit the country and the people. Ideally, operations that benefit the people are preferred over combat-related operations. Like other SASO missions, general engineering associated with sustainment and base development becomes a critical consideration. In Bosnia, base camp construction was a joint operation, involving U.S. Navy mobile construction battalions (Seabees), USAF RED HORSE units, and U.S. Army engineers.[48] Planners note that contractor support is not always available immediately. "The Logistics Civilian Augmentation Program (LOGCAP) contract can serve as an engineering and logistics force multiplier when its benefits and limitations are well understood. LOGCAP can bring added capability to a deployed military force, but the LOGCAP response time and quality control are subject to some of the same factors that affect the deployment of a military force."[49]

Major Andrew Goetz visited Bosnia as a CALL representative between March and May of 1996. He published a two-part photo essay in *Engineer* detailing his observations. Major Goetz noted the huge emphasis on force protection and mine clearance, as well as the "staggering quantity" of construction and barrier materials managed by the 1st Armored Division Engineer Brigade.[50] Goetz comments on the strengths and shortfalls of the current ERI engineer brigade force structure in the second installment of his photo essay. He offers some engineer mission parameters common to recent operations. "From an engineer perspective, Joint Endeavor is not very different from Operation Desert Shield: entry into a theater without pre-existing U.S. facilities, no immediate combat operations, great demands for force protection, and significant construction requirements."[51] While the heavy division engineer brigade is well equipped for mobility and countermobility support, Goetz offers several suggestions to increase its capability to provide survivability and general engineering support. These include greater construction management capability, increased haul capacity in order to self-deploy on a contingency mission to an austere theater and to conduct extended operations, the replacement of some armored combat earthmovers (ACE) with D-7 bulldozers, and the provision of more power tools to combat engineer platoons for carpentry work.[52]

Based on his participation as an engineer battalion commander in Operation Joint Endeavor, James R. Rowan calls for a new multirole engineer battalion in a 1997 article in *Engineer*. Using Task Force Volturno (a unit composed of a corps mechanized engineer battalion, three bridge companies, and a combat support equipment company) as an example in its support of the 1st Armored Division in Bosnia, Rowan declares that, "The multirole engineer battalion works – it was validated in the Balkan theater of operations. While this operation had a specific mission with a unique set of METT-T, it is possible to extrapolate and visualize that the concept has great potential for any operation where corps engineers will be called into a division sector."[53] Rowan envisioned the addition of bridging and horizontal construction units to the existing corps mechanized engineer battalion MTOE.[54]

Robert L. McClure, commander of the 1st Infantry Division Engineer Brigade, published an article in *Engineer* in April 2000 concerning engineer operations in Kosovo. He noted that the division engineer brigade organization proved its worth "by integrating engineers from outside the division, indeed around the world, into the task force effort," especially in base camp planning and construction.[55] He describes mission demands that were "simple, daunting, and as broad as any the Corps of Engineers has ever faced.[56] These included providing direct engineer support to the maneuver commander with mobility and force protection and building two base camps for 7,000 troops. The deadline happened to be less than 90 days after many of the construction units arrived on site. McClure notes the presence of several U.S. Navy mobile construction battalions and the operations of the famous construction firm Brown and Root, Inc., under the LOGCAP. He also commented that the heavy division engineer battalions have been "cut to the bone and are on the verge of becoming irrelevant on the battlefield."[57]

For the October 2000 issue of *Engineer*, Kevin Lindsay wrote an article addressing the future of the entire engineer force "to stimulate thought and discussion on possible future directions for engineers."[58] He uses the same seven characteristics of the Transformation Force seen in chapter 1 of this thesis as a guide. Among the many ideas for future divisional and corps engineers that Lindsay presents in his essay, one calls for a reduction in the number of types of corps engineer battalions. Specifically, he suggests the conversion of all corps engineer battalions to a structure very similar to the current corps airborne and corps light battalion designs:

> A more efficient system would be to convert current combat heavy, corps wheeled, and mechanized battalions to multifunctional combat-construction battalions. Separate horizontal, vertical, and bridge companies would then be attached to these multifunctional battalions based on the mission, enemy, terrain, troops, and time available (METT-T). Each battalion – consisting of three line companies with one horizontal platoon and two combat platoons each and a vertical platoon and construction management section in the headquarters and headquarters company (HHC) – could work anywhere from the brigade rear to the theater rear. This would reduce the amount of task organization changes to a bare minimum.[59]

After consideration of this body of work, several trends emerge in EAD engineer support to contingency operations. First, though EAD engineer units have conducted a wide variety of missions during these deployments, construction has always held a high position on the commander's list of tasks. General engineering work associated with base development was a very high priority in Vietnam, Somalia, Haiti, Bosnia, and Kosovo, but divisional engineer units have become increasingly less capable of performing the construction mission. EAD engineer units need vertical construction capability to accomplish this work and units with such capability become force multipliers. Second, during operations in Haiti and Bosnia, multifunctional EAD engineer battalions performed useful service, though in the latter case a local commander created the organization after arriving in theater. Some engineer commanders and planners have argued for the permanent establishment of such units within the force, though the organization advocated by each one was different. Third, previous contingency operations in Southeast Asia, Africa, and the Balkans have all presented the initially deployed engineer force with an extensive construction mission immediately upon arrival in the area of operations. Units required the assets needed to plan, conduct, and manage construction operations immediately. Fourth, the role of the reserve component in providing engineer support to a large contingency troop deployment is critical. In actual operations in Vietnam and in planned corps operations in Southwest Asia, the existing active force was barely sufficient to meet the construction demands of the deployed force. The U.S. Army Reserve and National Guard contain the vast majority of EAD engineer units, so LOGCAP has played an important role in providing additional capability during operations in the 1990s, when contingency deployments were frequent and usually involved a division-size or smaller element.

To answer the primary research question, the research methodology in the next chapter must provide data to determine the best organization for the EAD engineer battalion to support contingency operations. The thesis will consider the four trends in EAD engineer support to contingencies as described in the preceding paragraph, both in the model scenario and in the method of evaluation. The model will require engineer forces to perform an extensive construction mission, focused on base development, immediately upon arrival in the area of operations. The model will provide data to compare the capabilities of the proposed multifunctional EAD engineer battalion design with those of the current force structure in the performance of construction operations. The evaluation criteria will address characteristics of a particular battalion design or force structure that offer an advantage to reserve component EAD engineer units deploying in a contingency operation.

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CHAPTER 3

RESEARCH METHODOLOGY

The purpose of this chapter is to establish a methodology for answering the PQ, Is the proposed EAD engineer battalion design a better one for active and reserve component corps engineer forces to respond in a contingency operation? The study compares two EAD engineer forces providing support to a multidivisional contingency deployment. One force consists of units found in the present force structure, while the other replaces them with the proposed EAD battalion design. The steps of the research methodology are:

1. Establish a method of evaluation.

2. Define the contingency scenario and the characteristics of the area of operations.

3. Establish the task list for EAD engineers using FM 101-10-1/2 and the Army Facilities Components System (AFCS).

4. Determine the amount of horizontal, vertical, and general labor effort required to complete this task list.

5. Establish the composition of the EAD engineer force in the scenario under the current force structure using Total Army Analysis 2007 (TAA-07) allocation rules.

6. Establish the composition of the EAD engineer force in the scenario using the proposed EAD engineer battalion design.

7. Calculate the personnel and equipment strengths of the two engineer forces, as well as details on the organizational structure, using the Objective Tables of Organization

and Equipment (OTOE) for the component units. Use the Engineer School briefing for the proposed EAD battalion design as an OTOE.

8. Convert personnel and equipment strengths of each engineer force to AFCS construction capacities (horizontal, vertical, and general) using TM 5-304.

9. Calculate time required by EAD engineer force (current structure) to complete the task list. Using these figures and the results of step 7, evaluate this engineer package using the method of evaluation established in step 1.

10. Calculate time required by EAD engineer force (proposed EAD battalion design) to complete the task list. Using these figures and the results of step 7, evaluate this engineer package using the method of evaluation established in step 1.

The reader now has a general understanding of the steps in the research methodology. A detailed presentation of each step follows. Step 1 establishes the criteria for evaluating which engineer force structure is better in a contingency scenario. The seven characteristics of the U.S. Army Transformation Force form the basis for this method of evaluation. They are:

1. Agility. An agile corps engineer unit has the ability to conduct mobility, countermobility, survivability, and general engineering missions in support of a division without augmentation, pause, or special training. It can rapidly change from construction to combat operations and back again. Agile forces keep the same command and control team that they have trained with prior to deployment. The study measures this as the number of mechanized combat, wheeled combat, assault and obstacle, vertical construction, and horizontal construction engineer platoons available to support the divisions. It also measures agility in the need for mission-based task organization in the

area of operations that involves moving a platoon or company to a different battalion with unfamiliar techniques and procedures.

2. Deployability. A deployable corps engineer unit can deploy by ground or maritime assets to an area of operations. The equipment of corps engineer forces, in general, does not permit rapid deployment by air. Only corps airborne and corps light battalions, as well as light equipment companies, are designed for rapid deployment by air. Other corps engineer units are not. These units can deploy personnel or even a specially organized equipment package by air, but the majority of the unit's equipment usually travels by sea or land. The proposed EAD battalion design is not intended to replace the corps airborne or light battalions for this very reason. Deployability is measured in the potential to rapidly create a force package for a specific mission. This quality is important to both AC and RC engineer battalions. The latter not only have to deploy from the United States to the area of operations, but they also must move to their mobilization station in the United States and prepare for deployment. The ability to rapidly assemble and move the deploying force to the mobilization station offers an important advantage to RC engineer units.

3. Lethality. A lethal corps engineer unit has sufficient work capacity, specifically measured in the areas of mobility, countermobility, survivability, and general engineering. The study measures this in the exact number of specific pieces of equipment and the number of personnel in each military occupational specialty (MOS) associated with the four mission areas listed above and how these numbers affect the speed of mission accomplishment.

4. Responsiveness. A responsive corps engineer unit, once in the area of operations, can anticipate and quickly respond to requests for support. It can independently move assets to a location and accomplish engineer missions. The study measures this in the number of personnel available in the S-2, S-3, and S-6 sections, the number of company headquarters available, and the ability of the force to move its equipment and secure itself during travel to and from, as well as at, the work location. The staff sections named conduct reconnaissance of work locations and material sources, plan construction, and coordinate work with relevant local authorities. Company commanders are trained to command and control engineer forces composed of several platoons and associated support elements. An engineer unit that cannot secure itself is less capable of rapid response than one that can secure itself.

5. Survivability. A survivable corps engineer unit has equivalent levels of individual and vehicle protection when compared to the maneuver units it supports. The study measures this in the number of engineer platoons with equivalent levels of protection capable of supporting the division maneuver forces in combat operations.

6. Sustainability. A sustainable corps engineer unit has the capability to supply and maintain itself on the battlefield without relying on assets from the maneuver units that it supports, while still maintaining a reduced logistics footprint and replenishment demand. The study measures this in the number of fuel transporters, mobile kitchens, and maintenance sections/platoons available, as well the number of systems that assigned mechanics and unit repair part allowances must support.

7. Versatility. A versatile corps engineer unit can tailor forces to operate with a division and provide the required engineer support with minimal organizational

adjustments. This implies multifunctional engineer forces that have the capability to perform all engineer missions while deploying a smaller force package overall. The study measures this in the ability of the companies and battalions to complete the missions in the scenario and the size of the force deployed.

Step 2 of the research methodology defines the contingency scenario and the characteristics of the area of operations. The contingency operation used to evaluate the two corps engineer forces places a light infantry division and a mechanized infantry division in a peacekeeping operation in a land-locked region of Africa. After a long civil war and protracted negotiations involving the United States as an intermediary, an existing national government agreed to allow rebels of a different ethnic and religious background to form their own state in the southern one-third of the country (see figure 1). When the United Nations Security Council failed to approve the resolution for an international peacekeeping force, the United States deployed the two divisions to Africa to assume this role. In addition, various international and nongovernmental organizations had operated in the area providing humanitarian assistance during the long period of conflict. Their continued presence and efforts remained an integral part of the overall plan to stabilize the new southern state. Suffering from famine, disease, and an enormous number of displaced persons, the area of operations in the new southern state has no infrastructure in the following areas: water purification and distribution, electrical production and distribution, fuel distribution, road transportation, and waste disposal. A developed port, road network, and fuel pipeline system are available in a neighboring country to move personnel, equipment, and supplies to the southern border of the new state.

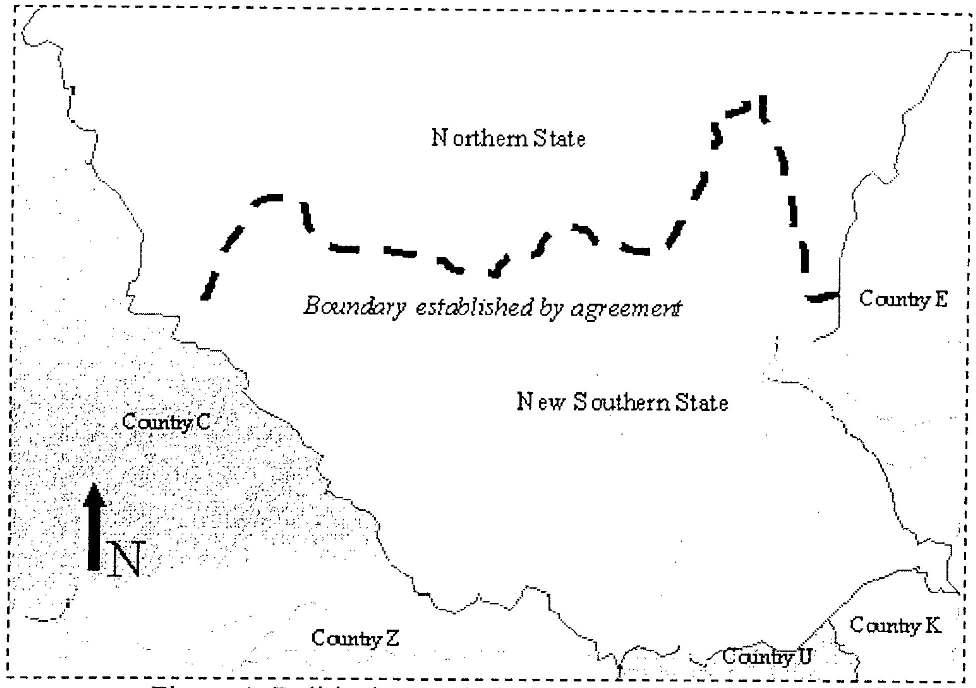

Figure 1: Political Boundaries of Area of Operations

Step 3 of the research methodology establishes a task list for EAD engineers in the contingency operation. There are a variety of engineer units in the area of operations. The light division has an organic battalion of combat engineers. The mechanized infantry division has an organic engineer combat brigade. These engineers operate in direct support of the maneuver force in the areas of mobility, countermobility, and survivability. They are not, either by doctrine or by equipment allocation, suited to perform significant construction work. In this scenario, they support the missions of the infantry and armor battalion task forces conducting peacekeeping operations. While the corps engineer force can augment divisional engineers as necessary to support the tactical operations of maneuver units, it will focus on providing general engineering construction support to the two divisions in a variety of categories. This is the primary doctrinal mission for corps engineer forces in the scenario. While they would undoubtedly find themselves reacting to unforeseen mobility, survivability, and other requirements as the operation progresses, the model does not consider such missions and focuses on the general engineering construction requirement. This engineer mission category provides a doctrinal and quantifiable basis to compare the two EAD forces. Following the planning guidance in FM 101-10-1/2, these construction categories include airfields and heliports, ammunition storage facilities, detention facilities, general supply storage facilities, hospitals, land clearing and site preparation, maintenance facilities, pipelines and storage facilities for bulk fuel, potable water supply facilities, road and bridge construction on lines of communication (LOC), sewage treatment facilities, and troop camps with appropriate force protection measures.[1] To facilitate later comparisons, the scenario must quantify the work required in each of the construction areas listed above in terms of horizontal, vertical, and general engineering effort. An available resource to do this is the Army Facilities Components System (AFCS). This system "provides data to military planners so that they can prepare contingency plans and support estimates."[2] The following paragraphs describe an estimate of the construction that the corps engineer force will perform in support of the two divisions deployed to Africa for the operation (see appendix A).

The two deployed divisions have a total of 148 rotary wing aircraft in six different battalion-sized units.[3] In the model, EAD engineers will construct six heliports, each capable of holding 27 aircraft, in accordance with a design from the AFCS. The available AFCS manuals list this category of construction as under revision, so the study uses the overall construction effort in man-hours for AFCS installation AG1331, a 27-aircraft heliport design for an air cavalry troop in a support area.[4]

The deployed forces require construction of five runways capable of handling the C-130 aircraft. Again, the AFCS lists this category as under revision, so the study uses the overall work estimate in man-hours for AFCS installation AG5041, a design for a C-130 runway in the rear area with minimum facilities.[5] The study will assume that the proportion of horizontal, vertical, and general construction effort for both AG1331 and AG5041 is equal to that of the road facility 853121 (a two lane road with a six-inch crushed stone surface).[6]

For the peacekeeping operation, the two deployed divisions will store one day of supply (DOS) of ammunition for a high-intensity defense in bunkers. For the light and mechanized divisions, this ammunition weighs 234 and 1487 short tons (STON), respectively.[7] Using an average gross storage factor of 8.05 square feet per STON of ammunition, the space required is 13,854 square feet.[8] Eighteen steel arch magazines (AFCS facility 421424), 25 feet by 32 feet, can store this ammunition.[9]

The deploying force will require detention facilities. During the Vietnam War, the ratio of prisoners of war to civilians taken into custody was one to six. The average division in that conflict took 423 prisoners per year. Another planning factor states that if the civilian population is supportive of the military force, only 0.05 percent to 0.1 percent of the population will require detention.[10] Assuming a civilian population of one million persons in the area of operations, these percentages produce between 500 and 1,000 detainees. Using the lower figure of 500, two prisoner of war stockades with a 250-man capacity (AFCS installation ND1615) provide the needed detention facilities.[11]

General supply storage facilities are included as part of the AFCS troop camp design. Certain items in supply classes I (subsistence), VI (personal demand items), VIII (medical), and IX (repair parts) require cold storage. In addition, some items in supply classes I, II (clothing, tentage, and individual items), III (packaged petroleum, oil, and lubricants), IV (construction and barrier material), VI, VII (major end items), VIII, and IX require covered storage. The study uses the formula (requirement = population x gross storage factor x stockage objective) in FM 101-10-1/2.[12] For planning purposes, the light division has 11,676 personnel and the mechanized division has 16,589 personnel.[13] Table 1 shows the computation of refrigerated storage requirements (total of 10,082 cubic feet):

Table 1. Refrigerated Supply Storage Requirements

Class of Supply	Population	Gross Storage Factor	Stockage Level (days of supply)	Required Storage Volume (cubic feet)
I	28,265	0.0835	3	7,080
VI	28,265	0.0221	3	1,874
VII	28,265	0.0048	3	407
IX	28,265	0.0017	15	721

Table 2 shows the calculation of covered storage requirements (total of 10,858 square feet). As shown in the upcoming discussion of troop camp construction, the plans for these installations exceed the space requirements calculated above for refrigerated and covered storage.

Table 2. Covered Supply Storage Requirements

Class of Supply	Population	Gross Storage Factor	Stockage Level (days of supply)	Required Storage Area (square feet)
I	28,265	0.0353	3	2,993
II	28,265	0.0169	3	1,433
III	28,265	0.0005	3	42
IV	28,265	0.0073	2	412
VI	28,265	0.0248	3	2,102
VII	28,265	0.0055	1	155
VIII	28,265	0.0054	3	457
IX	28,265	0.0077	15	3,264

Each division will require four 100-bed hospitals to augment the capabilities of each medical company in the forward support and main support battalions. Engineers will construct 8 hospitals using AFCS installation GH0151 (a 100-bed facility with steel buildings and concrete floors) as the design.[14]

Construction of the various facilities requires engineers to clear the sites of vegetation and remove the subsurface root system. This process is called clearing and grubbing. The AFCS includes this work in the construction plan for installations that require it. The installations that account for this ground preparation in the plans are airfields, heliports, detention camps, hospitals, and troop camps. For other areas, pipelines, and roads, the study uses the figures for AFCS facilities 932000 and 932004 (one acre of site preparation and clearing and grubbing a one-mile by fifty-foot strip, respectively).[15] For these facilities, the model includes the preparation of a strip 1,094-miles long by 50-feet wide for roads and pipelines and 233 acres for other items.

The study estimates requirements for covered tank and automotive maintenance areas from FM 101-10-1/2.[16] The troop camp installation plans include permanent maintenance facilities for ground vehicles. Aviation covered maintenance facility requirements are also taken from FM 101-10-1/2.[17] The AFCS lists the aviation maintenance hangar category as under revision, so the study will adapt installation MT1161, an 18-bay direct support maintenance shop, to this purpose.[18] FM 5-104 calls for such flexibility in the use of designs as a principle of theater of operations construction.[19] The proportion of horizontal, vertical, and general construction effort required is equivalent to AFCS facility 341923 (an 80-foot by 80-foot wood frame maintenance shop with concrete floors and a corrugated steel roof with a 20-foot minimum clearance).[20] Table 3 shows computation of tank-automotive and aviation maintenance facility requirements. The upcoming discussion of troop camp construction shows that the AFCS designs for those installations exceeds the requirements for covered maintenance facilities for ground vehicles. Eighteen of the previously mentioned AFCS installation MT1161 approximate the construction of the AVUM and AVIM requirements listed in table 3.

The two divisions require a means to move bulk fuel into the area of operations and store it. Due to the size of the area of operations, the study estimates fuel consumption as 20 percent of an attack scenario in a major theater war-west (MTW-W). In the MTW-W, a light division uses 91,158 gallons per day (GPD), while the mechanized division uses 504,059 GPD.[21] Thus, the total requirement per day is 119,043

GPD. One petroleum barrel equals 42 gallons, so this is a daily requirement of 2,835 barrels per day. To maintain three days of supply (DOS) as a bulk fuel stockage level, the storage requirement is 8,505 barrels. The study adapts AFCS facility QD1019 (an eight-mile pipeline of four-inch diameter pipe capable of moving 7,000 barrels per day) to construct a 911-mile pipeline to support the area of operations.[22]

Table 3: Tank-Automotive and Aviation Covered Maintenance Area Requirements

Unit (see explanation below table)	Space Requirement (square feet)	Number in Light Infantry Division	Number in Mechanized Division	Total Space Requirement
A	53,000	1	1	106,000
B	50,000	1	1	100,000
C	25,000	3	3	150,000
D	84,000	1	1	168,000
E	5,130	3	3	30,780
F	5,588	1	0	5,588
G	5,562	0	1	5,562

A: Aviation Unit Maintenance (AVUM), Attack Helicopter Battalion
B: AVUM, Cavalry Squadron
C: AVUM, General Support Helicopter Company
D: Aviation Intermediate Maintenance (AVIM) Company, Division
E: Forward Direct Support (DS) Maintenance Company
F: General Support (GS) Maintenance Company
G: GS Heavy Equipment Maintenance Company

While pipeline construction companies from EAC engineer assets would probably arrive to help with this mission, the OTOE mission statement for lettered companies in the combat heavy engineer battalion includes pipeline construction.[23] The pipeline will deliver fuel to petroleum tank truck loading facilities (AFCS number QE1019).[24] These have more capacity than necessary (each one can fill twenty trucks per day with 5,000 gallons each), but it is the smallest design available. The study allocates five of these loading facilities (each one will support two troop camps).

The area of operations is arid and requires development of a potable water supply system. The water requirement for camps is 100 gallons per man per day. The requirement in hospitals is 200 gallons per bed per day.[25] With a camp capacity of 28,500 troops and 800 hospital beds, the total daily requirement is 3,010,000 GPD. FM 101-10-1/2 calls for a storage requirement of 50 percent of the total requirement, or 1,505,000 gallons. The study allocates five miles of AFCS facility 842004 (a four-inch diameter water pipe with pumps) to construct water supply pipelines to each of the ten troop camp areas.[26] Water storage calculations require 72 tanks using AFCS facility 842105 (a 21,000 gallon tank).

The area of operations requires a lines of communication (LOC) road construction program of 1,465 kilometers (911 miles). This is the same distance as the pipeline. Land LOC construction is by far the largest part of the engineer effort. As a historical note, the road construction program in Vietnam was one of the largest single engineer projects undertaken by the U.S. military in a foreign country, with 4,106 kilometers of planned highways. By 1970, 11,000 of the 26,000 men in U.S. Army Engineer Command Vietnam worked on some aspect of this road construction program.[27] In this study, the land LOCs will connect the major population centers and the troop camps. The study uses AFCS facility 853121, a two-lane road with a six-inch wearing course of earth or crushed stone.[28] The plan assumes paving of 20 percent of this distance to help suppress dust in populated areas and increase the strength of heavily trafficked portions. The study uses AFCS facility 853128 (an asphalt hot mix laid on an existing base course) for paving requirements.[29] Bridging on the routes as part of the program is covered by AFCS installation FB2575 (a package of bridge construction material), which allows for 7.5 meters of military load class (MLC) 60 bridging in two directions or MLC 70 in one direction per kilometer of road.[30]

The planning factor for sewage treatment is 70 percent of the total potable water requirement.[31] The study uses 21 primary and secondary treatment sewage disposal plants (AFCS installation PS3271) to calculate the work effort associated with sewage disposal and treatment.[32] Each plant has a capacity of 100,000 GPD.

Construction of troop camps is an important part of long-duration peacekeeping missions and helps to maintain troop morale. The deployed force requires the construction of nine 3,000-man camps and one 1,500-man camp to shelter the combined population of 28,265 soldiers in the two divisions. The 3,000-man camp is AFCS installation NT5621.[33] The 1,500-man camp is installation NT4621.[34] Both camps contain wood frame barracks, headquarters and unit supply buildings, showers and latrines, a camp exchange, and a dispensary. In the 3000-man camp, there are three maintenance shops with 3,072 square feet of floor area each. In the 1,500-man camp, there is one such maintenance shop. The 3,000-man camp also has three warehouse buildings with 2,000 square feet of floor space each; the 1,500-man camp has two such buildings. Facility 431610 provides rat-proof walls, ceilings, and floors for refrigerated areas in these warehouses.[35] Facility 432221 provides an ice plant with a 3.6 ton per day capacity for each of the ten camps.[36] These two types of facilities are included in the work required for general supply storage requirements, not the troop camps.

The troop camps require force protection measures outside of the installation plan. The 3,000-man camps require 12,000 feet of security fencing with lighting, while the 1,500-man camp needs 9,000 feet. AFCS facility 710901 provides work requirements for this security fencing.[37] Each security fence will have four gates for vehicles and personnel using facility 710904.[38] A guard tower is constructed every 1,000 feet along the fence (facility 711201).[39] One squad bunker (facility 041026) is constructed along the fence perimeter every 200 feet.[40]

Step 4 of the research methodology determines the amount of construction effort required to complete the engineer work in the scenario. The AFCS divides construction effort into three labor categories: horizontal, vertical, and general. Horizontal labor includes the following eight types of equipment: lift/load (cranes, crane shovels), grading (graders), compaction (vibratory, pneumatic, and sheepsfoot rollers), excavating (bulldozers, backhoes, scoop loaders), hauling (dump trucks, scrapers), concrete mixing, bituminous distribution, and asphalt paving.[41] Vertical labor capacity includes such skilled specialties as carpenters, masons, electricians, plumbers, divers, metal workers, and pipeline specialists. General labor includes all unskilled workers assisting the horizontal and vertical labor force. General laborers can accomplish tasks requiring no prior training, skill, or use of mechanical or electrical equipment.[42] Table 4 presents a summary of the horizontal (equipment-hours), vertical (man-hours), and general construction effort (man-hours) for corps engineer missions in the scenario (see appendix B). The percentages of effort associated with the construction category in the three labor categories and the total labor requirement are indicated in parentheses below the man or equipment-hours figure. General supply storage effort reflects only ice plants and the refrigeration of a portion of the storage buildings included in the troop camp designs. Land clearing efforts for airfields, heliports, detention facilities, hospitals, and troop camps are included as part of the effort for those particular construction categories.

Table 4: Summary of Construction Effort for Model Contingency Operation

Construction Category	Horizontal (Equip.-Hrs.)	Vertical (Man-Hrs.)	General (Man-hrs.)	Total
Airfields and Heliports	**129,114** (2.99%)	**36,711** (0.76%)	**224,609** (2.70%)	**390,434** (2.23%)
Ammunition Storage	**3,834** (0.09%)	**3,726** (0.08%)	**4,554** (0.05%)	**12,114** (0.07%)
Detention Facilities	**4,440** (0.10%)	**7,030** (0.15%)	**6,840** (0.08%)	**18,310** (0.10%)
General Supply Storage	**710** (0.02%)	**11,257** (0.23%)	**2,990** (0.04%)	**14,957** (0.09%)
Hospitals	**27,200** (0.63%)	**454,840** (9.41%)	**82,776** (0.99%)	**564,816** (3.23%)
Land Clearing	**48,695** (1.13%)	**0** (0.00%)	**33,783** (0.41%)	**82,478** (0.47%)
Maintenance, Aviation	**11,574** (0.27%)	**698,112** (14.44%)	**73,494** (0.88%)	**783,180** (4.48%)
Pipeline	**23,013** (0.53%)	**331,221** (6.85%)	**215,631** (2.59%)	**569,865** (3.26%)
Petroleum Product Storage	**15,135** (0.35%)	**46,955** (0.97%)	**45,360** (0.54%)	**107,450** (0.62%)
Roads (LOC)	**3,792,255** (87.95%)	**1,127,696** (23.33%)	**6,589,768** (79.17%)	**11,509,719** (65.89%)
Bridges (LOC)	**85,788** (1.99%)	**306,656** (6.34%)	**234,388** (2.82%)	**626,832** (3.59%)
Sewage Treatment	**2,100** (0.05%)	**126,840** (2.62%)	**34,986** (0.42%)	**163,296** (0.94%)
Troop Camps	**122,665** (2.84%)	**1,449,707** (29.99%)	**470,729** (5.66%)	**2,043,101** (11.70%)
Force Protection	**7,380** (0.17%)	**152,940** (3.16%)	**289,903** (3.48%)	**450,223** (2.58%)
Totals	**4,311,853** (100%)	**4,834,306** (100%)	**8,323,061** (100%)	**17,469,220** (100%)

An examination of table 4 shows that construction of LOC roads and bridges requires over two-thirds of the total construction effort. These roads and bridges also encompass almost 90 percent of the horizontal construction effort. Engineers must construct these LOC facilities and the pipeline along a route of more than 900 miles. In contrast, the model distributes the other construction between eight principal base cluster locations in the area of operations (see figure 19 in appendix A). The eight base cluster locations are concentrated nodes of engineer activity where the majority (almost two-thirds) of vertical construction work occurs. The eight camp figure is a conservative estimate. When U.S. forces arrived in Bosnia in 1995, initial construction plans included 12 large base camps for the deploying 1st Armored Division.[43] The installations, facilities, and major troop units at each base cluster location in the scenario are as follows:

Location A contains a 3,000-man troop camp, a petroleum storage tank complex, a 100-bed hospital, heliport, and a general support aviation company AVUM facility. Major units located here include a mechanized brigade headquarters, an armored battalion task force, and a mechanized infantry battalion task force. This location has one of the three existing airfields in the entire area of operations.

Location B contains two 3,000-man troop camps, a C-130 airstrip, a 100-bed hospital, a division cavalry squadron AVUM facility, a 250-man detention camp, and the mechanized division AVIM facility. Major troop units located here include the mechanized division headquarters, a cavalry squadron, an armored battalion task force, a mechanized infantry battalion task force, and a light infantry battalion task force.

Location C contains a 3,000-man troop camp, a C-130 airstrip, a heliport, a petroleum tank storage complex, a 100-bed hospital, and a general support aviation company AVUM facility. This location has the second existing airfield. Major troop units located here include a mechanized brigade headquarters, a mechanized infantry battalion task force, an armored battalion task force, and an attack helicopter battalion.

Location D contains a 3,000-man troop camp, a 100-bed hospital, a petroleum storage tank complex, a C-130 airstrip, a heliport, and a general support aviation company AVUM facility. Major troop units located here include a mechanized brigade headquarters, and armored battalion task force, and a mechanized infantry battalion task force.

Location E contains a 3,000-man troop camp, a 100-bed hospital, a petroleum storage tank complex, a heliport, and a general support aviation company AVUM facility. The third existing airfield is located here. Major troop units located here include a light infantry brigade headquarters and three light infantry battalion task forces.

Location F contains a 3,000-man troop camp, a heliport, a C-130 airstrip, a 100-bed hospital, and AVUM facilities for a cavalry squadron and a general support aviation company. Major troop units located here include a light infantry brigade headquarters, two light infantry battalion task forces, and a cavalry squadron.

Location G contains a 3,000-man troop camp and a 1,500-man troop camp, a 100-bed hospital, a petroleum storage tank facility, a C-130 airstrip, a 250-man detention facility, an attack helicopter battalion AVUM facility, and a division AVIM facility. Major troop units located here include a light infantry division headquarters, a mechanized infantry battalion task force, a light infantry battalion task force, and an attack helicopter battalion.

Location H contains a 3,000-man troop camp, a 100-bed hospital, a C-130 airstrip, a heliport, and a general support aviation company AVUM facility. Major troop units located here include a light infantry brigade headquarters and two light infantry battalion task forces.

Table 5 contains the total amount of horizontal, vertical, and general construction labor required to accomplish the tasks from table 4 in each of the eight base cluster locations (see appendix C).

Table 5: Work Effort at Eight Base Cluster Locations in Area of Operations

Base Cluster Location	Horizontal Construction Effort (Equip.-Hours)	Vertical Construction Effort (Man-Hours)	General Construction Effort (Man-Hours)
A	39,260	298,533	126,252
B	60,597	621,380	227,579
C	40,526	362,749	134,116
D	54,179	308,758	153,558
E	38,834	298,119	125,746
F	47,550	351,089	146,958
G	61,102	545,698	201,354
H	46,485	292,913	140,797
Total	388,535	3,079,244	1,256,362

The total horizontal effort in table 5 (388,535 equipment hours), representing all horizontal work not associated with the pipeline and the LOC roads and bridges, is only 9.01 percent of the total horizontal effort in the model as shown in table 4. The vertical effort in table 5 (3,079,244 man-hours) represents 63.70 percent of the total vertical effort in the model, while the general construction effort (1,256,362 man-hours) is 15.09 percent of the total amount in the model.

Step 5 of the research methodology establishes the composition of the EAD engineer force in the scenario under the current engineer force structure. Maneuver divisions receive engineer support for planning purposes in major regional contingencies according to the Total Army Analysis allocation rules. Table 6 shows the allocation of engineer units to support the divisions in the contingency scenario used for the study.[44]

The proposed EAD battalion design would replace the combat heavy, corps mechanized, and corps wheeled battalions, as well as the CSC, CSE, and dump truck companies. The corps light battalion, the light equipment company, and the multirole bridge company appear in both engineer forces studied. The capabilities of the corps light battalion and CSE company are included in the study of each of the two engineer forces, but the multirole bridge companies are not.

In this scenario, each of the two EAD engineer forces would receive the same number of multirole bridge companies, corps light battalions, and light equipment companies. The only organic battalion bridge asset in the corps mechanized or the proposed EAD battalion design is the Armored Vehicle-Launched Bridge (AVLB). Combat heavy, corps wheeled, and corps light battalions have no bridges. The composition of the EAD engineer force in this study has little effect on the role of corps bridge companies. Like the divisional engineer battalions, the bridge units would perform their doctrinal missions as part of the total engineer force in this scenario. These might include constructing assault and float bridges until permanent replacements are built, ferrying equipment along rivers (especially in the eastern portion of the area of operations), and hauling materials with bridge transport trucks.

Table 6: Total Army Analysis 2007 (TAA-07) Engineer Unit Allocation Rules

Allocation Per	No. of CH	No. of CM	No. of CW	No. of CL	No. of CSC	No. of CSE	No. of DT	No. of LE	No. of MRBC
HD	1	2	0.5	0	0	0	0	0	2
LD	1	0	1.5	1	0	0	0	0	2
CH	0	0	0	0	0.33	0	0	0	0
CM	0	0	0	0	0	1	0	0	0
CW	0	0	0	0	0	1	0	0	0
CL	0	0	0	0	0	0	0	1	0
CSC	0	0	0	0	0	0	1	0	0
CORP	0	0	0	0	0	0	0	0	1

HD: Heavy Division
LD: Light Division
CH: Combat Heavy Engineer Battalion
CM: Corps Mech Engineer Battalion
CW: Corps Wheeled Engineer Battalion
CL: Corps Light Engineer Battalion
CSE: Combat Support Equipment Company
DT: Dump Truck Company
CSC: Construction Support Company
LE: Light Equipment Company
MRBC: Multirole Bridge Company
CORP: Corps

The quantity of divisional engineer battalions and corps bridge companies is fixed and separate in this study and these units contribute to the overall engineer effort primarily in the areas of mobility and survivability. On the contrary, the corps light battalion and light equipment companies have significant doctrinal roles and capabilities in the area of general engineering. Thus, the AFCS work capability of each EAD engineer force includes the contribution of these units.

Based on the allocation rules in the table 6, the study will consider the following units as the corps engineer force under the current force structure to support the light infantry division and mechanized division deployed to Africa: 2 combat heavy engineer battalions, 2 corps wheeled engineer battalions, 2 corps mechanized engineer battalions, 1 CSC company, 4 CSE companies, 1 dump truck company, 1 corps light engineer battalion, and 1 light equipment company. Some of these units might come from the reserve component. This package would involve the commitment of the majority of the active-duty corps engineer units. To maintain the capability to respond top other contingencies and considering the amount of time required to complete the construction missions, RC engineer units would certainly provide at least some of the committed force.

While TAA allocation rules are only guidance for planning purposes, the engineer force they produce for this scenario is similar to ones seen in actual operations and suggests that the rules are indeed valid for the scenario. For the initial deployment into Bosnia as part of Operation Joint Endeavor, the 1st Armored Division deployed two brigades. Each brigade had its habitual support from a battalion in the division's engineer brigade. A corps mechanized battalion and a combat heavy battalion were in general support to the division, as well as three bridge companies and two CSE companies.[45] In addition, two battalion-size engineer units from other services deployed to Bosnia to construct base camps.[46] If this force supporting two maneuver brigades is extrapolated to two divisions, the engineer force is larger than that provided by the TAA allocation rules. Operations in Haiti placed two corps airborne battalions, a combat heavy battalion, an Air Force engineering squadron, and a CSE company in support of two brigades from the 10th Mountain Division for initial operations in country.[47]

Step 6 of the research methodology establishes the composition of the EAD engineer force in the scenario using the proposed EAD battalion design. No allocation rules exist for the proposed EAD battalion design. The study assumes that the one battalion of the proposed EAD design would replace a corps wheeled, a corps mechanized, or a combat heavy battalion and its supporting CSE, CSC, and dump truck companies. Using this assumption, the engineer package deployed to support the two divisions consists of 6 proposed EAD engineer battalions, 1 corps light engineer battalion, and 1 light equipment company. Again, some of these units would probably come from the reserve component. The engineer mission is too extensive to simply commit the majority of AC corps engineer forces to it for the duration.

Step 7 of the research methodology calculates the personnel and equipment strength of the two engineer forces (under the current force structure and the proposed EAD battalion design), as well as details of their organizational structures. The OTOEs of the various types of battalions and companies provide the data for these calculations. The U.S. Army Engineer School briefing (contained in appendix D) on the proposed EAD battalion design is used in place of an OTOE for that unit. These calculations are presented in appendix E. Results from these calculations provide the basis for the next step.

Step 8 of the research methodology converts the personnel and equipment strengths calculated in the previous step into AFCS unit construction capacities. Using the procedures described in TM 5-304 for estimating horizontal, vertical, and general construction labor capacity, the study can determine the capability of each type of battalion and company to complete the tasks in the model. The study assumes that all troops and equipment can work for ten hours each day.[48] In this study, the M-9 armored combat earthmover (ACE) is not considered as a piece of horizontal construction equipment for performing the construction tasks in the model. It is designed to move earth for mobility, countermobility, and survivability missions, but not general engineering ones.[49] The model assumes that the ACE and its operators in the corps engineer battalions augment the efforts of their counterparts in the divisional engineer battalions. Combat engineers of military occupational specialty (MOS) 12B are general labor assets. In any MOS, only troops in the grade of E-5 and below are labor assets. Calculations are presented in appendix F.

Table 7 presents the daily work capacity of the corps mechanized battalion as compiled from the Objective Table of Organization and Equipment (OTOE).[50] Table 8 presents the capability of the corps wheeled engineer battalion as compiled from the OTOE.[51] Table 9 shows the capability of the combat heavy engineer battalion according to the OTOE.[52] Table 10 presents the capability of the corps light engineer battalion as compiled from data in the OTOE.[53] Table 11 shows the capability of the CSE company according to the OTOE.[54] Table 12 presents the capability of the CSC company as compiled from data in the OTOE.[55]

Table 7: Construction Capability of Corps Mechanized Battalion (TOE 05435L200)

Labor Type	Number of Personnel or Pieces of Equipment	Man-Hours or Equipment-Hours per Day
Total Vertical Skills:	**0**	**0**
Carpenter/Mason	0	0
Electrician	0	0
Plumber/Pipe Fitter	0	0
Metal Worker/Welder	0	0
Total Horizontal Construction Equipment:	**24**	**240**
Lift/Load	0	0
Grading	0	0
Compaction	0	0
Excavation	6	60
Hauling	18	180
Concrete Mixing	0	0
Bitumen Distribution	0	0
Asphalt Paving	0	0
General Construction Skills (Combat Engineer)	**272**	**2720**

Table 8: Construction Capability of Corps Wheeled Battalion (TOE 05425L000)

Labor Type	Number of Personnel or Pieces of Equipment	Man-Hours or Equipment-Hours per Day
Total Vertical Skills:	**0**	**0**
Carpenter/Mason	0	0
Electrician	0	0
Plumber/Pipe Fitter	0	0
Metal Worker/Welder	0	0
Total Horizontal Construction Equipment:	**108**	**1080**
Lift/Load	3	30
Grading	9	90
Compaction	6	60
Excavation	36	360
Hauling	54	540
Concrete Mixing	0	0
Bitumen Distribution	0	0
Asphalt Paving	0	0
General Construction Skills (Combat Engineer)	**233**	**2330**

Table 9: Construction Capability of Combat Heavy Battalion (TOE 05415L000)

Labor Type	Number of Personnel or Pieces of Equipment	Man-Hours or Equipment-Hours per Day
Total Vertical Skills:	**201**	**2010**
Carpenter/Mason	165	1650
Electrician	18	180
Plumber/Pipe Fitter	18	180
Metal Worker/Welder	0	0
Total Horizontal Construction Equipment:	**132**	**1320**
Lift/Load	3	30
Grading	9	90
Compaction	8	80
Excavation	38	380
Hauling	63	630
Concrete Mixing	3	30
Bitumen Distribution	7	70
Asphalt Paving	1	10
General Construction Skills (Combat Engineer)	**0**	**0**

Table 10: Construction Capability of Corps Light Battalion (TOE 05445L200)

Labor Type	Number of Personnel or Pieces of Equipment	Man-Hours or Equipment-Hours per Day
Total Vertical Skills:	**36**	**360**
Carpenter/Mason	30	300
Electrician	2	20
Plumber/Pipe Fitter	4	40
Metal Worker/Welder	0	0
Total Horizontal Construction Equipment:	**107**	**1070**
Lift/Load	3	30
Grading	9	90
Compaction	12	120
Excavation	42	420
Hauling	41	410
Concrete Mixing	0	0
Bitumen Distribution	0	0
Asphalt Paving	0	0
General Construction Skills (Combat Engineer)	**162**	**1620**

Table 11: Construction Capability of Combat Support Equipment Company (TOE 05423L000)

Labor Type	Number of Personnel or Pieces of Equipment	Man-Hours or Equipment-Hours per Day
Total Vertical Skills:	**0**	**0**
Carpenter/Mason	0	0
Electrician	0	0
Plumber/Pipe Fitter	0	0
Metal Worker/Welder	0	0
Total Horizontal Construction Equipment:	**60**	**600**
Lift/Load	3	30
Grading	6	60
Compaction	9	90
Excavation	15	150
Hauling	27	270
Concrete Mixing	0	0
Bitumen Distribution	0	0
Asphalt Paving	0	0
General Construction Skills (Combat Engineer)	**0**	**0**

Table 12: Construction Capability of Construction Support Company (TOE 05413L000)

Labor Type	Number of Personnel or Pieces of Equipment	Man-Hours or Equipment-Hours per Day
Total Vertical Skills:	**0**	**0**
Carpenter/Mason	0	0
Electrician	0	0
Plumber/Pipe Fitter	0	0
Metal Worker/Welder	0	0
Total Horizontal Construction Equipment:	**32**	**320**
Lift/Load	3	30
Grading	0	0
Compaction	0	0
Excavation	10	100
Hauling	10	100
Concrete Mixing	0	0
Bitumen Distribution	3	30
Asphalt Paving	6	60
General Construction Skills (Combat Engineer)	**0**	**0**

Table 13 shows the capability of the dump truck company according to the OTOE.[56] This company is peculiar in that the only individuals in the company who are engineers are the company commander and executive officer. Soldiers from the Transportation Corps operate the dump trucks!

Table 13: Construction Capability of Dump Truck Company (TOE 05424L000)

Labor Type	Number of Personnel or Pieces of Equipment	Man-Hours or Equipment-Hours per Day
Total Vertical Skills:	**0**	**0**
Carpenter/Mason	0	0
Electrician	0	0
Plumber/Pipe Fitter	0	0
Metal Worker/Welder	0	0
Total Horizontal Construction Equipment:	**30**	**300**
Lift/Load	0	0
Grading	0	0
Compaction	0	0
Excavation	0	0
Hauling	30	300
Concrete Mixing	0	0
Bitumen Distribution	0	0
Asphalt Paving	0	0
General Construction Skills (Combat Engineer)	**0**	**0**

Table 14 presents the capability of the light equipment company as compiled from data in the OTOE.[57] Table 15 presents the capability of the proposed EAD engineer battalion design. The study compiled the data from the briefing on the proposed multifunctional EAD engineer battalion design prepared by Pete Malley, a force development specialist for the U.S. Army Engineer School at Fort Leonard Wood, Missouri (see appendix D).[58]

Table 14: Construction Capability of Light Equipment Company (TOE 05443L200)

Labor Type	Number of Personnel or Pieces of Equipment	Man-Hours or Equipment-Hours per Day
Total Vertical Skills:	**0**	**0**
Carpenter/Mason	0	0
Electrician	0	0
Plumber/Pipe Fitter	0	0
Metal Worker/Welder	0	0
Total Horizontal Construction Equipment:	**69**	**690**
Lift/Load	3	30
Grading	9	90
Compaction	6	60
Excavation	24	240
Hauling	27	270
Concrete Mixing	0	0
Bitumen Distribution	0	0
Asphalt Paving	0	0
General Construction Skills (Combat Engineer)	**0**	**0**

Table 15: Construction Capability of Proposed EAD Battalion Design

Labor Type	Number of Personnel or Pieces of Equipment	Man-Hours or Equipment-Hours per Day
Total Vertical Skills:	**75**	**750**
Carpenter/Mason	48	480
Electrician	9	90
Plumber/Pipe Fitter	18	180
Metal Worker/Welder	0	0
Total Horizontal Construction Equipment:	**130**	**1300**
Lift/Load	3	30
Grading	9	90
Compaction	8	80
Excavation	36	360
Hauling	63	630
Concrete Mixing	3	30
Bitumen Distribution	7	70
Asphalt Paving	1	10
General Construction Skills (Combat Engineer)	**197**	**1970**

Step 9 of the research methodology calculates the time required by the EAD engineer force under the current structure to accomplish the engineer tasks as quantified in step 4. These time figures and the results of step 7 (the daily work capacity of the various units for use with AFCS construction requirements) provide data to evaluate the current engineer force against the criteria established in step 1. Using the capabilities in tables 7 through 14, the current force structure engineer support package for the two divisions deployed to Africa has 4,380 man-hours available per day in vertical labor, 10,060 equipment-hours per day in horizontal labor, and 11,720 man-hours per day in general labor. Using this daily quantity of labor available, table 16 shows the number of days the current force structure needs to accomplish the work effort in each category (horizontal, vertical, and general) previously detailed in table 4 (see appendix G). One working day equals ten hours.

The study evaluates the engineer force supporting the two divisions in this contingency using measurable representations of agility, deployability, lethality, responsiveness, survivability, sustainability, and versatility. The study will now examine the strengths and weaknesses of the current force structure using these seven qualities. Using the previously defined measurements for agility, the current force structure provides an engineer package with 12 mechanized combat engineer platoons, 24 wheeled combat engineer platoons, 6 mechanized assault and obstacle platoons, 13 vertical construction platoons, 25 horizontal construction platoons, 3 dump truck platoons, 9 obstacle sections, and 6 horizontal construction sections. There are also three asphalt paving sections and one quarry section (see appendix E).

Table 16: Days Required by Current Force Structure to Accomplish Work

Construction Category	Days for Horizontal	Days for Vertical	Days for General
Airfields and Heliports	12.83	8.38	19.16
Ammunition Storage	0.38	0.85	0.39
Detention Facilities	0.44	1.61	0.58
General Supply Storage	0.07	2.57	0.26
Hospitals	2.70	103.84	7.06
Land Clearing	4.84	0.00	2.88
Maintenance, Aviation	1.15	159.39	6.27
Pipeline	2.29	75.62	18.40
Petroleum Product Storage	1.50	10.72	3.87
Roads (LOC)	376.96	257.46	562.27
Bridges (LOC)	8.53	70.01	20.00
Sewage Treatment	0.21	28.96	2.99
Troop Camps	12.19	330.98	40.16
Force Protection	0.73	34.92	24.74
Total Number of Days	**429**	**1104**	**710**

As shown previously in table 5, the majority of the work effort in the eight principal locations is vertical. Table 17 shows the number of days the current force structure uses to accomplish each of the three categories of work if all available assets were focused at only one location (see appendix H).

It is unlikely that all of the engineers would work at one location, then move to the next one, until all work is completed. But table 17 does show that the eight locations differ much more in the amount of vertical work required than in the amount of horizontal or general work. The 13 vertical platoons all originate from three parent organizations: the corps light battalion and the two combat heavy battalions. If the commander places one engineer battalion headquarters at each of the seven locations and give one of these headquarters responsibility for the eighth location, all of the battalions (except the corps light) still require task organization to accomplish the work. In at least four of the eight major construction sites, these platoons will operate away from their parent battalion. The other types of platoons will encounter the same situation, as only the corps light battalion has all three types of labor capacity (horizontal, vertical, and general) within its organization. The combat heavy battalions must provide vertical platoons to the corps mechanized and corps wheeled battalions. The combat heavy battalion needs combat engineer platoons for general construction labor to avoid diverting vertical or horizontal skills to that area. The model could assume a habitual training relationship between the CSE, CSC, dump truck, and LE companies and the engineer battalions they support according to the allocation rules, even if these companies were RC units. But whole platoons and perhaps even companies from the engineer battalions would still have to operate in the contingency as part of units they have never trained with prior to the deployment.

Table 17: Days to Accomplish Work at Each Base Cluster Location in Model (Current Force)

Base Cluster Location	Horizontal Work (Days)	Vertical Work (Days)	General Work (Days)
A	3.9	68.2	10.8
B	6.0	141.9	19.4
C	4.0	82.8	11.4
D	5.4	70.5	13.1
E	3.9	68.1	10.7
F	4.7	80.2	12.5
G	6.1	124.6	17.2
H	4.6	66.9	12.0
Total	38.6	703.0	107.2

During a deployment sequence, the current force structure does not lend itself to formation of a tailored force package for a specific mission. Upon notification of deployment, four of the seven battalions (corps mechanized and corps wheeled) lack organic vertical assets. Two (corps mechanized) lack organic horizontal assets. Two lack combat engineers (combat heavy) and five lack armored vehicles (corps wheeled, combat heavy, and corps light). Tailoring a package requires action by the corps engineer except for the corps light battalion. In the scenario used for this study, the six battalions deploying could tailor packages prior to departure, but the resulting organization would need time to train as a unit in even the most basic of skills, such as convoy movement. This same line of reasoning applies to RC units as well. If the deployed engineer force includes a significant number of reserve formations, these units would have to move to mobilization station, conduct mandatory training, and then deploy. It leaves them even less time to tailor specific packages prior to arrival in theater. This is especially significant considering that RC battalions often have component companies in separate armories at different locations. It is difficult to bring subordinates units together to exercise tailored battalion packages during each year's available training time.

As measured in the MOS and equipment strength, the current force structure brings substantial engineer capability to the area of operations. There are a total of 4,883 personnel. Table 18 shows strengths by grade and MOS. The personnel strength is lowest in the vertical military occupational specialties (51-series). This lack of vertical construction capability results in the much greater time required to complete the vertical work in the model.

Table 18: Personnel Strengths by Grade and MOS (Engineer Specialties)

Military Occupational Specialty	Grades	Quantity
12B Combat Engineer	E-6 and E-7	214
12B Combat Engineer	E-5	258
12B Combat Engineer	E-4 and below	914
51B Carpenter-Mason	E-5 and below	360
51H Construction Engineer Supervisor	E-6 and E-7	64
51K Plumber	E-5 and below	40
51R Interior Electrician	E-5 and below	38
51T Technical Engineer	E-6 and E-7	5
51T Technical Engineer	E-5 and below	52
62E Heavy Construction Equipment Operator	E-5 and below	553
62F Crane Operator	E-5 and below	78
62G Quarrying Specialist	All	16
62H Concrete Asphalt Specialist	All	48
62J General Construction Equipment Operator	E-5 and below	253
62N Construction Equipment Supervisor	E-6 and E-7	119

In the area of equipment, the current force structure arrives in the area of operations with 56 M-113 Armored Personnel Carriers (APC), 24 Armored Vehicle-Launched Bridges (AVLB), 36 Armored Combat Earthmovers (ACE), 30 Volcano scatterable mine systems, 54 Mine Clearing Line Charge (MICLIC) systems, 364 High Mobility, Multipurpose Wheeled Vehicles (HMMWV), 290 five-ton or Medium Tactical Vehicle (MTV) dump trucks, 28 fourteen-ton palletized load system (PLS) dump body modules, and 102 twenty-ton dump trucks. There are 78 graders, 92 D-7 bulldozers, 27 D-5 bulldozers, 66 scrapers, 108 Small Emplacement Excavators (SEE), and 61 bucket loaders. A complete listing of equipment is contained in appendix E. There are no significant equipment weaknesses in the force. All equipment required to conduct mobility, countermobility, survivability, and general engineering missions at the EAD level is present.

In the area of responsiveness, the current force structure varies across the different types of battalions. Table 19 compares the size of the S-2, S-3, and S-6 sections in the current force. The combat heavy and corps light battalions have construction sections in the S-3 capable of planning and executing quality control. The corps mechanized and corps wheeled battalions do not. Thus, only 3 of the 7 battalions are fully staffed and trained to supervise and control construction at the eight principal locations in the model. The S-6 section has gained increasing importance in SASO scenarios, but only two battalions have one. The corps mechanized, corps wheeled, and corps light battalions have military intelligence officers in the S-2 position. This enhances their ability to support maneuver units in combat operations.

Table 19: Comparison of S-2, S-3, and S-6 Sections in Current Force Structure

Battalion Type	Number of S-2 personnel	Number of S-3 personnel	Number of S-6 personnel
Corps Mechanized	Included with S-3	23	0
Corps Wheeled	Included with S-3	16	10
Combat Heavy	6	25	0
Corps Light	9	23	0

The current force structure has 35 company commanders. Seven of these captains command battalion headquarters companies. All of these captains have adequate training to manage significant construction projects. Only two of the seven battalions have armored vehicles to place in convoys; five of the seven have combat engineer soldiers.

Doctrinally, all of the battalions should secure themselves traveling to and from mission locations and possess sufficient equipment to perform this task.

In the area of survivability, only two battalions (corps mechanized) can operate as part of the mechanized combined arms team in a high-intensity battle. The other battalions do not possess the tracked armored vehicles to do so. The other five battalions can operate with the light division. There are a total of 12 mechanized combat engineer platoons and six assault and obstacle platoons available to support the mechanized infantry and tank battalions on the battlefield, while 24 wheeled combat engineer platoons and 9 obstacle sections can support the light infantry battalions.

To sustain itself in the area of operations, the current force structure has 23 mobile kitchen trailers for class I supply support. This provides a ratio of more than one trailer per two companies and delivers a robust feeding capability. For bulk class III supply, the force has 43 heavy expanded mobility tactical truck (HEMMT) fuel carriers and seven 5-ton or MTV fuel carriers. For other supplies, there are 64 HEMTT cargo trucks, 188 two-and-one-half ton or light medium tactical vehicle (LMTV) cargo trucks, 28 five-ton or MTV cargo trucks, and 14 palletized load system (PLS) transporters. There are 98 forty-ton trailers and 29 twenty-five ton trailers with tractors for moving heavy equipment.

From the maintenance perspective, there are 9 company maintenance sections, 10 company maintenance platoons, 4 battalion maintenance platoons, and 8 direct support maintenance platoons or sections. The combat heavy and corps light battalions have company maintenance platoons, as does the LE company. There are 51 contact trucks, 30 HEMTT wreckers, 9 five-ton or MTV wreckers, and 6 M-88 armored recovery vehicles. In addition, there are 15 hydraulic tool system repair trailers and 23 lubrication trailers.

As a whole, the engineer force has a strong maintenance package that can provide the doctrinal maintenance support required. The only area of concern is in tracked vehicles. The two battalions that have tracked vehicle mechanics (corps mechanized) depend on units outside the engineer package for direct support maintenance on these vehicles. The other five battalions can seek assistance from the direct support platoons in the corps light and combat heavy battalions.

In the area of versatility, the current force structure deploys 4,883 personnel that can accomplish the horizontal work in the model in 429 days, the vertical work in 1,104 days, and the general work in 710 days. This assumes that no additional missions distract the units from the construction in the model. In all likelihood, such additional requirements would increase the duration of work. The current force structure is capable of accomplishing all missions, but appears to be very strong in the horizontal aspect though somewhat lacking in vertical capability. The total effort in the model is composed of 24.7 percent horizontal, 27.7 percent vertical, and 47.6 percent general labor. In the total deployed force of 4,883, there are 1,067 MOS 62-series soldiers (horizontal labor), or 22 percent of the total. There are 1,386 MOS 12-series soldiers (general labor), or 28 percent of the total. Finally, there are only 559 MOS 51-series (vertical labor) soldiers, or 11 percent of the total. The disparity between the vertical workload and the assets to accomplish it is clearly evident.

Step 10 of the research methodology calculates the time required by the engineer force using the proposed EAD battalion design to accomplish the engineer missions in the scenario as quantified in step 4. These time figures and the results of step 7 provide data to evaluate the proposed engineer force composed of multifunctional battalions against the criteria established in step 1. Using the capabilities in tables 10, 14, and 15, the engineer force using the proposed EAD battalion design supporting the two divisions deployed to Africa has 4,860 man-hours available per day in vertical labor, 9,560 equipment-hours per day in horizontal labor, and 13,440 man-hours per day in general labor. Using this daily quantity of labor available, table 20 shows the number of days the current force structure needs to accomplish the work effort in each category (horizontal, vertical, and general) previously detailed in table 4. One working day equals ten hours.

The study will now examine the strengths and weaknesses of the proposed EAD battalion engineer force deployed to Africa using the seven qualities of the Transformation Force. In terms of agility, the force built around 6 proposed EAD battalions provides an package with 18 mechanized combat engineer platoons, 6 wheeled combat engineer platoons, 18 mechanized assault and obstacle platoons, 19 vertical construction platoons, 24 horizontal construction platoons, 1 dump truck platoon, and 3 obstacle sections. There are also six asphalt-paving sections, but no quarry sections.

As shown previously in table 5, the majority of the work effort in the eight principal locations is vertical. Table 21 shows the number of days the current force structure uses to accomplish each of the three categories of work if all available assets were focused at only one location. This table shows that the eight locations differ much more in the amount of vertical work required than in the amount of horizontal or general work. The 19 vertical platoons are spread almost uniformly throughout the force. Each of the six proposed EAD battalions has three vertical platoons and the corps light battalion has one. In fact, all of the battalions now have horizontal, vertical, and general labor capability. If the commander places one engineer battalion headquarters at seven of the locations and give one of these headquarters responsibility for the eighth location, all of the battalions have the essential elements to complete the mission. A platoon might move from one battalion to another to weight a particular effort, but it is not necessary.

Table 20: Days Required by Proposed EAD Battalion Design Force to Accomplish Work

Construction Category	Days for Horizontal	Days for Vertical	Days for General
Airfields and Heliports	13.51	7.55	16.71
Ammunition Storage	0.40	0.77	0.34
Detention Facilities	0.46	1.45	0.51
General Supply Storage	0.07	2.32	0.22
Hospitals	2.85	93.59	6.16
Land Clearing	5.09	0.00	2.51
Maintenance, Aviation	1.21	143.64	5.47
Pipeline	2.41	68.15	16.04
Petroleum Product Storage	1.58	9.66	3.38
Roads (LOC)	396.68	232.04	490.31
Bridges (LOC)	8.97	63.10	17.44
Sewage Treatment	0.22	26.10	2.60
Troop Camps	12.83	298.29	35.02
Force Protection	0.77	31.47	21.57
Total Number of Days	**451**	**995**	**619**

During a deployment sequence, the proposed EAD battalion structure allows the formation of a tailored force package for a specific mission. The battalion commander has mechanized, assault and obstacle, vertical, and horizontal platoons, in addition to specialized construction assets in the headquarters company, from which he can form a task-organized unit. The battalion can codify various packages in standard operating procedures and train these packages in evaluations and readiness exercises. Upon notification of deployment, the package forms and prepares for the specific circumstances of the mission. Tailoring a package is a battalion commander function in both the proposed EAD battalion and the corps light battalion, with the former having more options. In the scenario used for this study, the seven battalions deploying could tailor packages prior to departure and fully expect them to perform admirably immediately upon arrival in the area of operations.

Table 21: Days to Accomplish Work at Each Base Cluster Location in Model (Proposed EAD BN Force)

Base Cluster Location	Horizontal Work (Days)	Vertical Work (Days)	General Work (Days)
A	4.1	61.4	9.4
B	6.3	127.9	16.9
C	4.2	74.6	10.0
D	5.7	63.5	11.4
E	4.1	61.3	9.4
F	5.0	72.2	10.9
G	6.4	112.3	15.0
H	4.9	60.3	10.5
Total	40.6	633.6	93.5

The presence of multifunctional companies in the proposed EAD battalion is advantageous for deploying RC forces. While the battalion headquarters might still be separated from its component companies, each company has the assets to form and deploy tailored packages from its organic assets. The company commander can designate and rehearse these packages during training with greater ease than a battalion or brigade attempting to bring together scattered assets from across one or more states. This enables the package to arrive at the mobilization station more rapidly and thus move to the area of operations sooner.

The proposed EAD battalion force's lethality, as measured in MOS and equipment strength of the proposed EAD force structure, is strong in all areas. There are a total of 5,146 personnel. Table 22 shows strengths by grade and MOS. The personnel strength is lowest in the vertical MOSs (51 series). This is the principal cause of the extended time required to accomplish the vertical work in the model. In the area of equipment, the proposed EAD battalion force comes to the area of operations with 102 M-113 Armored Personnel Carriers (APC), 72 Armored Vehicle-Launched Bridges (AVLB), 72 Armored Combat Earthmovers (ACE), 42 Volcano scatterable mine systems, 78 Mine Clearing Line Charge (MICLIC) systems, 346 High Mobility, Multipurpose Wheeled Vehicles (HMMWV), 266 five-ton or Medium Tactical Vehicle (MTV) dump trucks, 72 fourteen-ton PLS dump body modules, and 36 twenty-ton dump trucks. There are 72 graders, 54 D-7 bulldozers, 27 D-5 bulldozers, 54 Deployable Universal Combat Earthmovers (DEUCE), 72 scrapers, 60 Small Emplacement Excavators (SEE), and 69 bucket loaders. A complete listing of equipment is contained in appendix E. There only significant equipment weaknesses in the force is the lack of dedicated quarrying assets. Aside from this, the proposed EAD battalion force has all the equipment required to conduct mobility, countermobility, survivability, and general engineering missions.

In the area of responsiveness, the proposed EAD battalion has significant staff capability. There are 15 personnel in the S-2 section, 22 personnel in the S-3 section, and 12 personnel in the S-6 section. All EAD battalions, as well as the corps light one, have construction sections in the S-3 capable of planning and executing quality control. All 7 battalions are fully staffed and trained to supervise and control construction at the eight principal locations in the model. The S-6 section has gained increasing importance in SASO scenarios; six of the seven battalions now have one. The proposed EAD battalion design does not have a military intelligence officer in the S-2 position. This could reduce its ability to support maneuver units in combat operations, especially if the battalion headquarters must act as a tactical planning staff.

Table 22: Personnel Strengths by Grade and MOS (Engineer Specialties)

Military Occupational Specialty	Grades	Quantity
12B Combat Engineer	E-6 and E-7	196
12B Combat Engineer	E-5	378
12B Combat Engineer	E-4 and below	966
51B Carpenter-Mason	E-5 and below	318
51H Construction Engineer Supervisor	E-6 and E-7	82
51K Plumber	E-5 and below	112
51R Interior Electrician	E-5 and below	56
51T Technical Engineer	E-6 and E-7	7
51T Technical Engineer	E-5 and below	67
62E Heavy Construction Equipment Operator	E-5 and below	719
62F Crane Operator	E-5 and below	87
62G Quarrying Specialist	All	0
62H Concrete Asphalt Specialist	All	72
62J General Construction Equipment Operator	E-5 and below	176
62N Construction Equipment Supervisor	E-6 and E-7	116

The proposed EAD battalion force has 29 company commanders. Seven of these captains command battalion headquarters companies. All of these captains have adequate training to manage significant construction projects and should have some construction management experience at home station training involving vertical and horizontal construction platoons. Six of the seven battalions have armored vehicles to place in convoys and all seven have combat engineer soldiers. All of the battalions have the necessary personnel and equipment to secure themselves traveling to and from mission locations.

In the area of survivability, all six EAD battalions have 3 mechanized platoons and 3 assault and obstacle platoons that can operate as part of the mechanized combined arms team in a high-intensity battle. Only the corps light battalion does not possess the tracked armored vehicles to do so, but it can operate with the light division. There are a total of 18 mechanized combat engineer platoons and 18 assault and obstacle platoons for supporting the mechanized infantry and tank battalions on the battlefield, while six wheeled combat engineer platoons and three obstacle sections can support the light infantry battalions.

To sustain itself in the area of operations, the proposed EAD battalion force has 27 mobile kitchen trailers for class I supply support. This is almost one trailer per company and gives the commander a generous feeding capability. For bulk class III supply, the force has 36 heavy expanded mobility tactical truck (HEMTT) fuelers and 6 five-ton or MTV fuelers. For other supplies, there are 114 HEMTT cargo trucks, 141 two-and-one-half ton or light medium tactical vehicle (LMTV) cargo trucks, 94 five-ton or MTV cargo trucks, and 36 palletized load system (PLS) transporters. There are 60 forty-ton trailers and 27 twenty-five ton trailers with tractors for moving heavy equipment.

From the maintenance perspective, there are 7 company maintenance sections, 22 company maintenance platoons, no battalion maintenance platoons, and 7 direct support maintenance platoons or sections. All lettered companies in the proposed EAD force have a company maintenance platoon. There are 31 contact trucks, 24 HEMTT wreckers, 5 five-ton or MTV wreckers, and 24 M-88 armored recovery vehicles. In addition, there are 28 hydraulic tool system repair trailers and 8 lubrication trailers. As a whole, the engineer force has a very strong maintenance package.

In the area of versatility, the proposed EAD force deploys 5,146 personnel that can accomplish the horizontal work in the model in 451 days, the vertical work in 995 days, and the general work in 619 days. This assumes that no additional missions distract the units from the construction in the model and in all likelihood, the work would take longer. The proposed EAD battalion force is capable of accomplishing all missions, but appears to be strong in the horizontal aspect though somewhat lacking in vertical capability. The total effort in the model is composed of 24.7 percent horizontal, 27.7 percent vertical, and 47.6 percent general labor. In the total deployed force of 5,146, there are 1,170 MOS 62-series soldiers (horizontal labor), or 23 percent of the total. There are 1,540 MOS 12-series soldiers (general labor), or 30 percent of the total. Finally, there are only 642 MOS 51-series (vertical labor) soldiers, or 12 percent of the total. The disparity is evident between the vertical construction requirement and the assets to accomplish this work.

Using the ten-step research methodology, the study has now answered the SQs, TQs, and QQs stated in chapter one. The methodology has established a method of evaluation that defines what makes an engineer force better to respond in contingency operations (step 1). It has also described a contingency scenario and the EAD engineer support (in terms of a quantifiable task list) required by the maneuver units in that contingency (steps 2 through 4). The methodology has established the composition of two EAD engineer forces to support the contingency, one using the current force structure and the other using the proposed multifunctional EAD battalion design (steps 5 and 6). The methodology has calculated the time required by each engineer force to accomplish the scenario's EAD engineer task list and has also evaluated each engineer force separately using the criteria as defined in the method of evaluation (steps 7 through 10). Chapter 4 will compare and analyze the results of steps 9 and 10 in the research methodology to determine if the proposed multifunctional EAD battalion design is a better one for corps engineer forces in contingency operations.

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[1]United States Army, FM 101-10-1/2; *Staff Officers' Field Manual Organizational, Technical, and Logistical Data Planning Factors* (Washington, DC: Department of the Army, 1990), 1-30.

[2]United States Army, TM 5-304; *Army Facilities Components System User Guide* (Washington, DC: Department of the Army, 1990), 1-1.

[3]United States Army Requirements Documentation Directorate, "SRC 77000A000 LID (Doctrinal)" and "SRC 87000A600 HVY DIV, ME (3 CO/BN)," *Consolidated TOE Update April 2000* [TOE on-line]; available from http://www.usafmsardd.army.mil; Internet; accessed 12 February 2001.

[4]US Army, FM 101-10-1/2, 1-48.

[5]Ibid., 1-49.

[6]United States Army, TM 5-301-4; *Army Facilities Components System – Planning (Desert) with Change 1* (Washington, DC: Department of the Army, 1982), 10-75.

[7]United States Army Command and General Staff College, ST 101-6; *G1/G4 Battle Book* (Fort Leavenworth, KS: US Army Command and General Staff College, 2000), 1-6.

[8]US Army, FM 101-10-1/2, 1-41.

[9]US Army, TM 5-301-4, 10-32.

[10]US Army, FM 101-10-1/2, 4-3 - 4-4.

[11]Ibid., 9-16.

[12]US Army, FM 101-10-1/2, 1-41.

[13]United States Army Requirements Documentation Directorate, "SRC 77000A000 LID (Doctrinal)" and "SRC 87000A600 HVY DIV, ME (3 CO/BN)," *Consolidated TOE Update April 2000* [TOE on-line]; available from http://www. usafmsardd.army.mil; Internet; accessed 12 February 2001.

[14]United States Army, TM 5-301-1; *Army Facilities Components System – Planning (Temperate)* (Washington, DC: Department of the Army, 1979), 9-79.

[15]US Army, TM 5-301-4, 10-97.

[16]US Army, FM 101-10-1/2, 1-38.

[17]Ibid., 1-37.

[18]US Army, FM 101-10-1/2, 1-50.

[19]US Army, FM 5-104, 5.

[20]US Army, TM 5-301-4, 10-29.

[21]US Army Command and General Staff College, ST 101-6, 1-5.

[22]US Army, TM 5-301-4, 9-62.

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[24]Ibid., 9-65.

[25]US Army, FM 101-10-1/2, 1-43.

[26]US Army, TM 5-301-4, 10-58.

[27]Robert R. Ploger, *US Army Engineers, 1965-1970*, Vietnam Studies (Washington, DC: Department of the Army, 1974), 116-117.

[28]US Army, TM 5-301-4, 10-75.

[29]Ibid., 10-76

[30]Ibid., 9-3.

[31]US Army, FM 101-10-1/2, 1-43.

[32]US Army, TM 5-301-1, 9-156.

[33]Ibid., 9-150.

[34]Ibid., 9-148.

[35]US Army, TM 5-301-4, 10-32.

[36]Ibid., 10-32.

[37]Ibid., 10-45.

[38]Ibid., 10-45.

[39]Ibid., 10-46.

[40]Ibid., 10-5.

[41]US Army, TM 5-304, E-2.

[42]Ibid., 2-2.

[43]Shep Barge, "Base Camp Construction and Operation," Center for Army Lessons Learned (CALL) *News From the Front*, May-June 1996; available from http://call.army.mil/products/nftf/may_jun.96/mj96-2.htm; Internet; accessed 22 October 2000.

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[47]Darren Klemens and Kelly Slaven, "Task Force Castle: Joint Engineer Operations in Haiti," *Engineer* 5-95-1/2 (April 1995) [journal on-line]; available from http://call.army.mil/call/trngqtr/b4fy96/castle.htm; Internet; accessed 22 October 2000.

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[49]United States Army Engineer School, "M9 Armored Combat Earthmover (ACE)," [equipment description on-line]; available from http://www.wood.army.mil/DCD/nolimits/ENDIV/EN_Materiel/ACE_M9.htm; Internet; accessed 7 December 2000; and Andrew Goetz, "Photo Essay from Operation Joint Endeavor – Part II," *Engineer* 5-96-4 (December 1996) [journal on-line]; available from http://call.army.mil/call/trng qtr/tq2%2D98/goetz2.htm; Internet; accessed 22 October 2000.

[50]United States Army Requirements Documentation Directorate, "SRC 05435L200 ENGR CBT BN, CORPS(MECH)," *Consolidated TOE Update April 2000* [TOE on-line]; available from http://www.usafmsardd.army.mil; Internet; accessed 7 December 2000.

[51]United States Army Requirements Documentation Directorate, "SRC 05425L000 ENGR BN (CORPS) WHL," *Consolidated TOE Update April 2000* [TOE on-line]; available from http://www.usafmsardd.army.mil; Internet; accessed 7 December 2000.

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[58]Peter Malley, "*Force XXI: Echelons Above Division Battalion Design*," Briefing delivered at United States Army Engineer School, January 2000 (U.S. Army Maneuver Support Center, Fort Leonard Wood, Missouri), 16-27. This briefing is included as appendix D.

CHAPTER 4

ANALYSIS

The purpose of this chapter is to describe and analyze the outcomes of the research methodology in chapter three. In order to determine if the proposed EAD corps engineer battalion design is a better one for AC and RC corps engineer forces to respond in a contingency operation, the research placed two engineer forces, one using the current force structure and another using the proposed EAD battalion design, in a SASO scenario in Africa. The two engineer forces were different in their capabilities to accomplish the work effort in the model. The study has evaluated each force independently according to seven criteria: agility, deployability, lethality, responsiveness, survivability, sustainability, and versatility. Now, the thesis will compare the results of this evaluation.

The study measures agility as the number of mechanized, assault and obstacle, vertical construction, and horizontal construction engineer platoons available to support the two divisions. It also measures agility in the need for mission-based task organization in the area of operations that involves moving a platoon or company to a different battalion with unfamiliar techniques and procedures. Figure 2 presents a graphical comparison of the two engineer forces. The proposed EAD force is superior in the number of mechanized combat engineer platoons, assault and obstacle platoons, and vertical construction platoons. It also has more paving sections. The current force has more wheeled combat engineer platoons and horizontal construction platoons. It also has more dump truck platoons, obstacle sections, horizontal sections, and quarry sections.

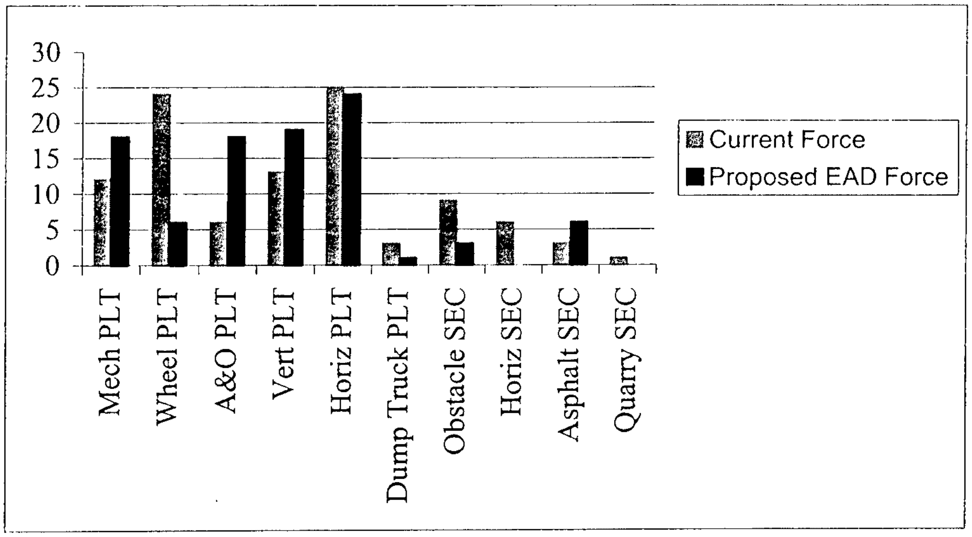

Figure 2: Comparison of Quantity of Different Types of Platoons and Sections

The model separated the work required at eight locations from the LOC road and bridge construction and the pipeline. These eight locations represent the nodes of base development in the area of operation. The amount of time each force requires to accomplish the total work requirement at these eight locations is compared in figure 3.

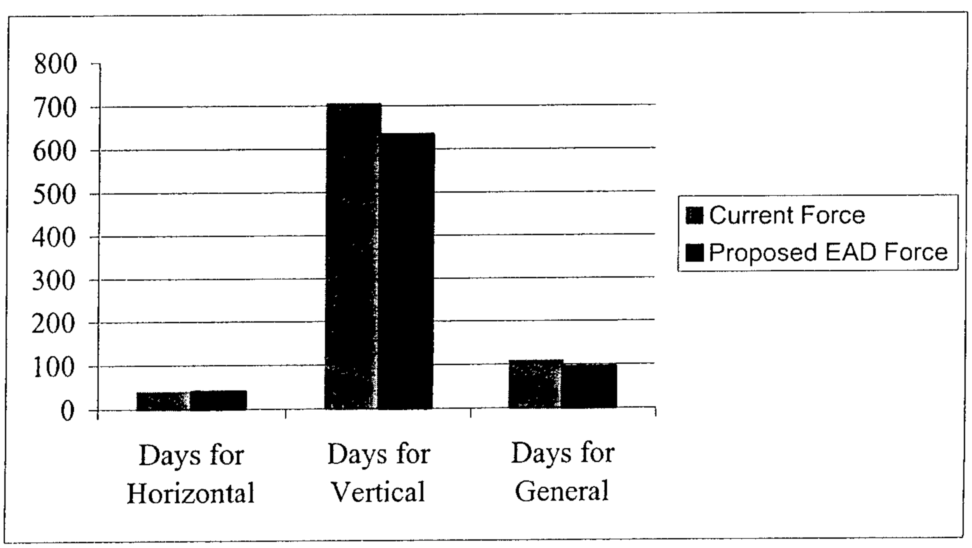

Figure 3: Comparison of Time Required to Accomplish Work at the Eight Base Locations

The proposed EAD force needs two days more to accomplish the horizontal construction work, 70 days less to accomplish the vertical work, and 14 days less to accomplish the general work. The figure shows that there is a great deal more vertical work to accomplish at the eight locations than horizontal or general construction. However, each location still requires horizontal, vertical, and general construction assets. Under the current force structure, only the corps light battalion has all three types of assets within its organization. In the model, each of six engineer battalion headquarters could manage construction at one location, while the seventh one has to manage two sites. Only the corps light battalion could begin work on all types of tasks with organic assets. The corps mechanized battalions could obtain horizontal assets from the CSE companies, but no vertical assets. The corps wheeled battalions have no vertical assets. The combat heavy battalions have no general assets. The corps mechanized battalions have to detach combat engineer platoons or companies to the combat heavy battalions for general labor, while the combat heavy battalions must detach vertical platoons or companies to the corps mechanized and wheeled battalions. These platoons and companies will operate under battalion headquarters with unfamiliar command and control procedures.

The proposed EAD battalion force has seven battalions, each with horizontal, vertical, and general assets. While the corps engineer might move vertical platoons not gainfully employed at one site to another one with unfinished construction, this is not immediately necessary to start operations. Each of the seven battalions can move to its base location and begin work without the attachment of additional assets.

In an overall evaluation of agility, the proposed EAD battalion force is more agile than the current force structure. The proposed EAD battalion force has more mechanized platoons, assault and obstacle platoons, vertical platoons, and asphalt paving sections. The current force structure is superior to the proposed EAD battalion force in the number of wheeled combat engineer platoons, horizontal platoons, dump truck platoons, and horizontal, obstacle, and quarry sections (these last three units are not even found in the proposed EAD battalion). Thus, the proposed EAD battalion force is superior in three of the four types of platoons considered in the measurement of agility. It is also superior in its ability to accomplish all missions without moving platoons and companies from one battalion to another.

The study measures deployability as the potential to rapidly create a force package for a specific mission. The current force structure has four different types of battalions and four different types of separate companies. If a combat heavy battalion requires mechanized combat engineers for a deployment, it must seek augmentation from the corps. If a corps mechanized battalion requires vertical construction troops, it must also ask for augmentation. Only the corps light battalion can tailor a force with horizontal, vertical, and general (combat engineer) construction assets from its own organization, though it cannot provide armored vehicles. The current force structure can create a package by using the appropriate attachment orders and command relationships, but these units are often not located at the same garrison headquarters, nor have they trained together prior to the creation of the tailored package.

The proposed EAD battalion force has seven battalions with horizontal construction platoons, vertical construction platoons, and combat engineer platoons for general construction labor. Six of the battalions also have armored vehicles. These battalions can organize special packages based on theater contingency plans and exercise them as part of the training program. Operating procedures are standardized and understood. The proposed EAD force could rapidly adjust these packages for the actual mission if necessary. In an overall evaluation of deployability, the proposed EAD battalion force is clearly more capable of rapidly creating a force package for a specific mission. The presence of multifunctional engineer units at the company level also has significant positive impact on the deployability of RC engineer units. Commanders can train and rehearse such packages with greater frequency and also have all assets at one location. This enables them to move to a mobilization station more rapidly and deploy to the area of operations.

The study measures lethality in terms of engineer-related work capacity. It compares the number of specific pieces of equipment and the number of personnel in each military occupational specialty (MOS) associated with mobility, countermobility, survivability, and general engineering and how these numbers affect the speed of mission accomplishment.

In the area of combat engineers (12-series MOS), figure 4 compares the two engineer packages. The proposed EAD force is superior in the number of MOS 12B combat engineers in the grades of E-5 and below by a total of 172 personnel. The current force structure has 18 more 12B noncommissioned officers in the grades of E-6 and E-7. A comparison of vertical construction engineers (51-series MOS) is shown in figure 5. The proposed EAD battalion force has more of each 51-series MOS except 51B (carpenter-mason). The current force has 42 more of this MOS.

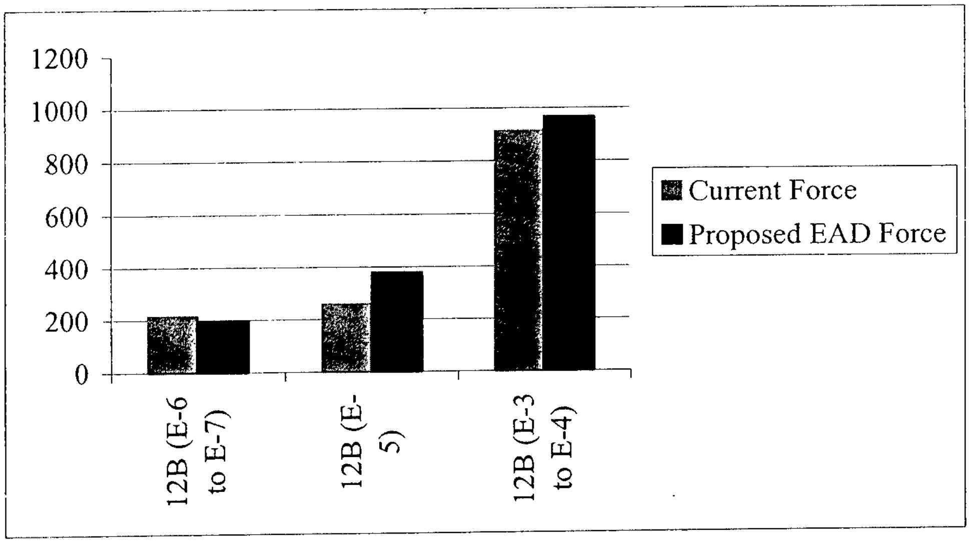

Figure 4: Comparison of Number of 12-Series MOS Soldiers

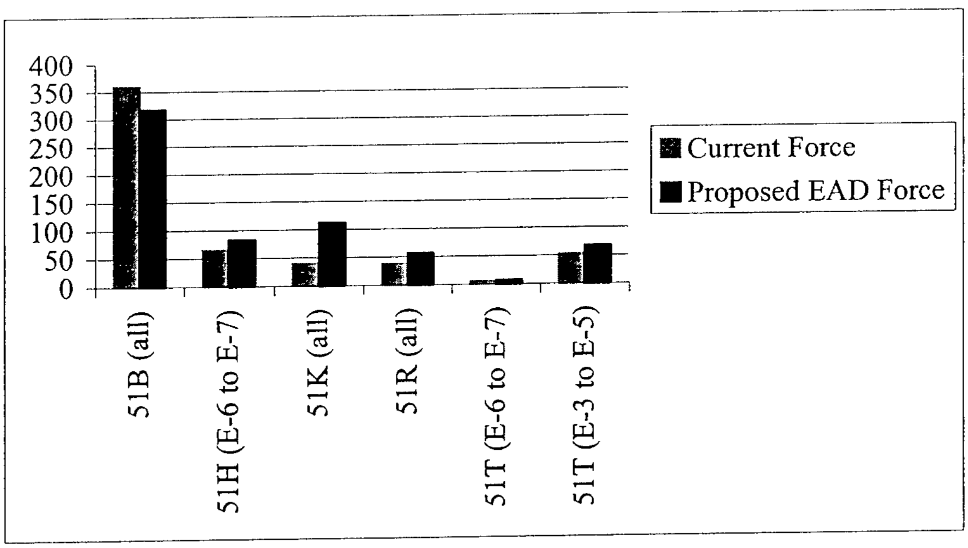

Figure 5: Comparison of Number of 51-Series MOS Soldiers

In the area of horizontal construction soldiers (62-series MOS), figure 6 compares the two engineer forces. The current force structure has more soldiers in MOS 62G (quarry specialist) and 62J (general construction equipment operator). It also has three more non-commissioned officers in MOS 62N (construction equipment supervisor).

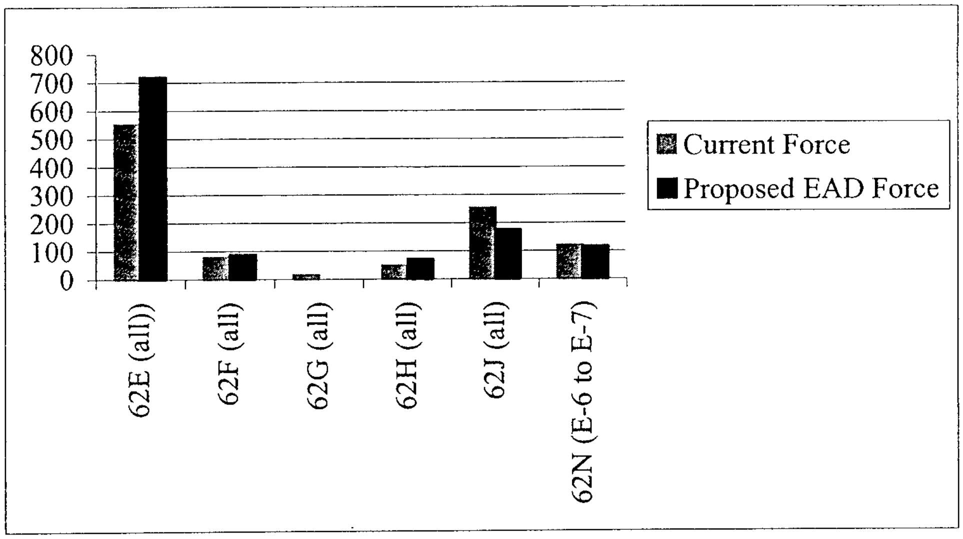

Figure 6: Comparison of Number of 62-Series MOS Soldiers

In combat engineer equipment associated with mobility, countermobility, and survivability, figure 7 compares the two force structures. The proposed EAD battalion force is clearly superior in the number of armored personnel carriers (APC), armored vehicle-launched bridges (AVLB), armored combat earthmovers (ACE), Volcano scatterable mine systems, and mine clearing line charges (MICLIC).

Figure 8 compares the equipment of the two forces in the lifting and loading category of general engineering. The current force structure is superior or equal in the number of cranes and quarrying shovels.

Figure 9 compares the grading and compaction equipment in each force associated with mobility and general engineering. The current force structure has equal or slightly numbers of graders, towed and self-propelled vibratory rollers, towed pneumatic rollers, and self-propelled sheepsfoot rollers.

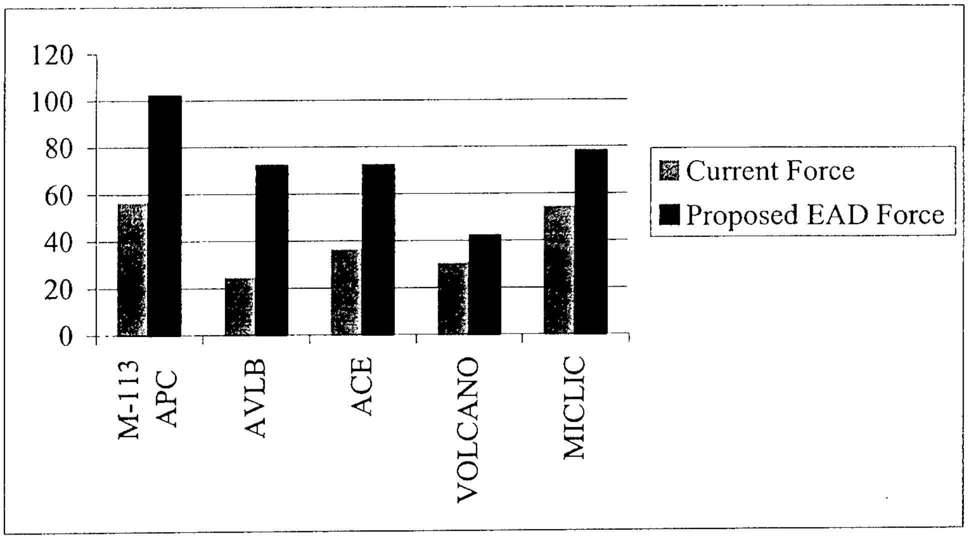

Figure 7: Comparison of Combat Engineer Equipment

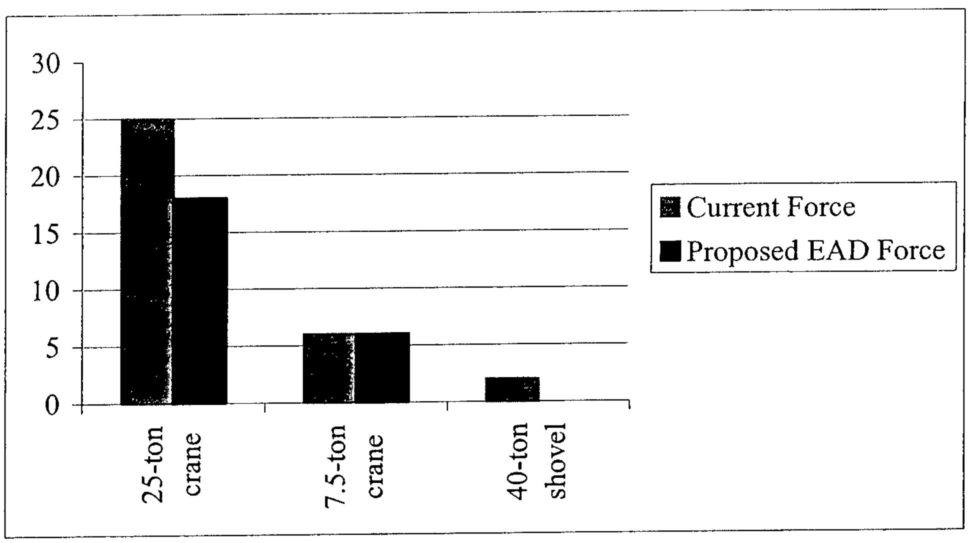

Figure 8: Comparison of Lifting and Loading Equipment

Excavation equipment operates across the spectrum of mobility, countermobility, survivability, and general engineering. Figure 10 compares the two forces. The current force structure has 38 more D-7 bulldozers, 48 additional small emplacement excavators (SEE), and 3 more large bucket loaders. The proposed EAD force brings 54 deployable universal combat earthmovers (DEUCE), 11 more small bucket loaders, and 10 more hydraulic excavators. The DEUCE is commercially available and a replacement for the D-5 bulldozer. This is in direct contrast to the ACE, which does not replace the D-7 bulldozer.

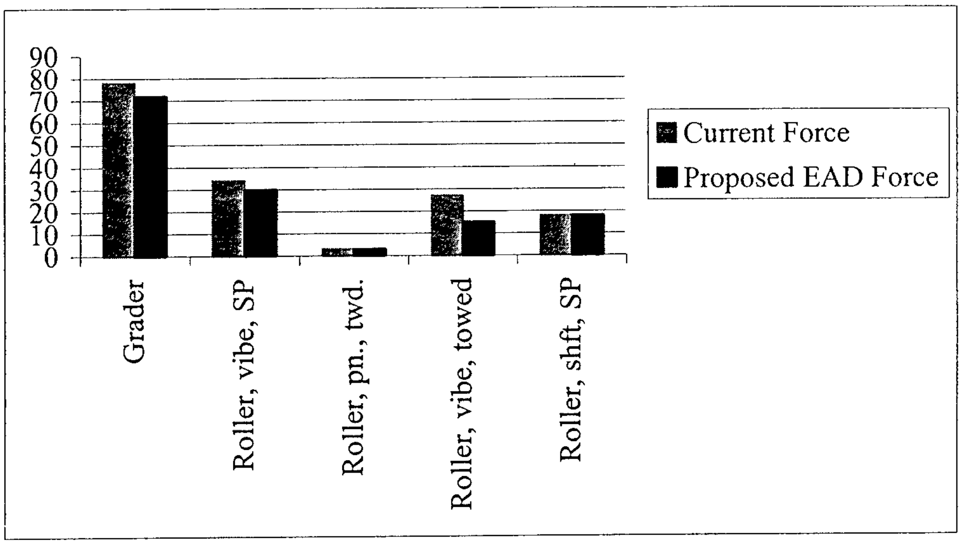

Figure 9: Comparison of Grading and Compaction Equipment

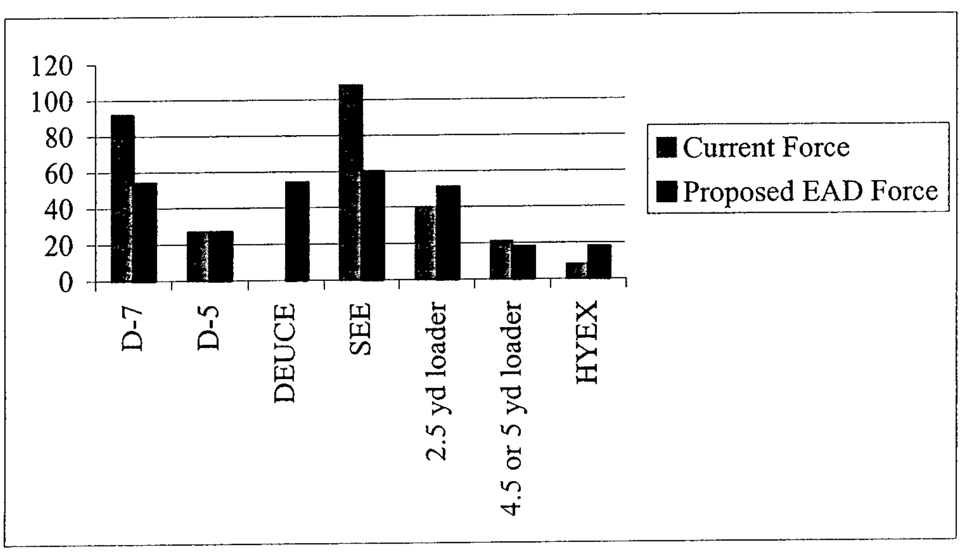

Figure 10: Comparison of Excavation Equipment

Hauling equipment works in mobility, survivability, and general engineering. Figure 11 compares the two engineer forces in this area. The current force structure has 24 more medium tactical vehicle (MTV) or 5-ton dump trucks and 66 more 20-ton dump trucks. The proposed EAD force has 44 more palletized load system (PLS) 14-ton dump modules and 6 more scrapers.

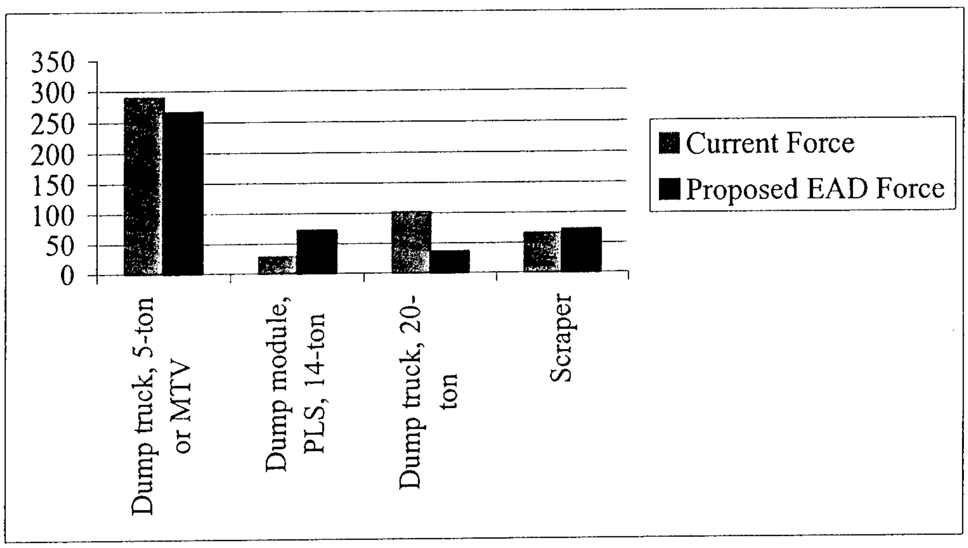

Figure 11: Comparison of Hauling Equipment

The final three areas of equipment are concrete mixing, bitumen (asphalt) distribution, and asphalt paving and rolling. These are associated with general engineering. Figure 12 compares the equipment in these three areas. Some of the items of equipment, such as the towed aggregate spreader and the PLS bitumen spreader module, perform the same function. The overall conclusion is that the proposed EAD force has more concrete mixing, bitumen distribution, and asphalt paving capability. The two forces have equal numbers of asphalt rollers.

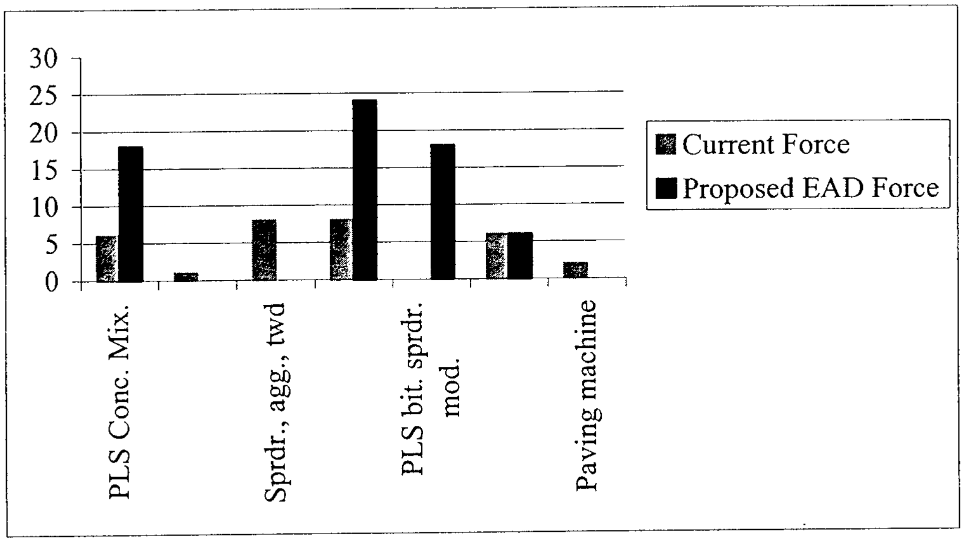

Figure 12: Comparison of Concrete Mixing, Bitumen Distribution, and Asphalt Paving and Rolling Equipment

In an overall evaluation of engineer work capacity, the proposed EAD battalion force is superior in combat engineering and some vertical construction capacity. It is superior in its capability to conduct mobility, countermobility, and survivability missions in support of the maneuver force. In the area of general engineering, it is only superior in concrete mixing, bitumen distribution, and asphalt rolling and paving capability. Its vertical superiority is in the areas of plumbing, interior electricity, drafting, soils testing, and surveying. The current force structure has more vertical capacity in carpentry and masonry, as well as more equipment for compacting, excavating, grading, hauling, lifting, and loading. The proposed EAD battalion is clearly more lethal in the amount of mechanized combat engineer equipment, but its engineer work capacity is greater only in certain areas. In the examination of the time required to finish the work in the model, the above considerations of numbers of troops and equipment take on a more tangible measurement. Figure 13 shows the number of days each engineer force requires to accomplish all work in the model in each of the three labor areas. As expected from the comparison of horizontal construction equipment, the current force structure finishes this work 22 days earlier. The proposed EAD structure finishes the vertical work 109 days earlier and the general work 91 days earlier. This time difference does not address any augmentation of the vertical construction effort by LOGCAP or troop self-help projects, but these additions would come from assets outside the engineer force. Since the vertical work takes the longest to accomplish by far, the proposed EAD force finishes all construction over three months earlier. The proposed EAD force also has an advantage in the more technical vertical construction specialties. Combat engineers can assume the role of carpenters and masons far more easily than they can become plumbers, electricians, surveyors, or draftsmen. This, coupled with its greater combat engineering capability in support of the maneuver force, gives the advantage in engineer work capacity and lethality to the proposed EAD battalion force.

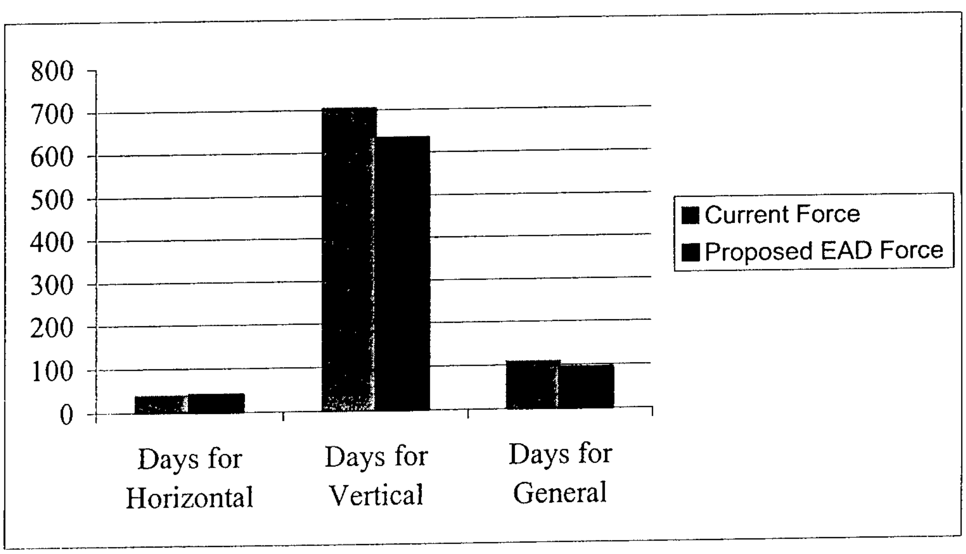

Figure 13: Comparison of Time to Accomplish Work in Model

The study measures responsiveness in the number of personnel available in the S-2, S-3, and S-6 sections, the number of company command-sized headquarters available, and the ability of the force to secure itself in travel to and from, as well as at, the work location. The proposed EAD battalion force has a larger number of personnel assigned to the S-2, S-3, and S-6 sections. All seven battalions have a construction section as part of the S-3. The only aspect in which the current force structure stands out is the fact that five of the seven battalions have a military intelligence officer as the S-2. The proposed EAD battalion design has an engineer officer as the S-2. Figure 14 shows the comparison of the number of personnel in each of the three types of staff sections. The proposed EAD battalion force gains a total of 134 personnel in the manning of these three sections. The current force structure has 35 company commanders, as opposed to only 29 in the proposed EAD battalion force. The current force structure has only two battalions with armored vehicles and 5 battalions with combat engineers. While 51-series and 62-series soldiers should train to secure themselves while traveling and while at work locations, better-armed combat engineers and armored vehicles can make this task easier. The proposed EAD engineer force has six battalions with armored vehicles and all seven have combat engineers. In an overall assessment, the increased planning, construction management, and reconnaissance capabilities on the staffs in the proposed EAD battalions, coupled with the presence of combat engineers in each battalion and armored vehicles in all but one battalion for escort and security, make the proposed EAD force superior in responsiveness.

The study measures survivability in the number of engineer platoons with equivalent levels of protection that are capable of supporting the division maneuver forces in combat operations. The proposed EAD battalion structure has 18 mechanized engineer platoons and 18 assault and obstacle platoons capable of operating with heavy maneuver forces on a fluid battlefield. The current force structure has only 12 and 6, respectively. While the current force has 24 wheeled engineer platoons and 6 obstacle sections that can operate with light forces, these are limited in their ability to support heavy forces. Only two of the seven battalions (the corps mechanized ones) are equipped for this. In the proposed EAD battalions, each battalion has some capability to support mechanized forces, though not as much as a corps mechanized battalion. In an overall assessment, the proposed EAD battalion force is more survivable. It has more armored vehicles and a greater number of combat engineers capable of operating with heavy or light maneuver forces.

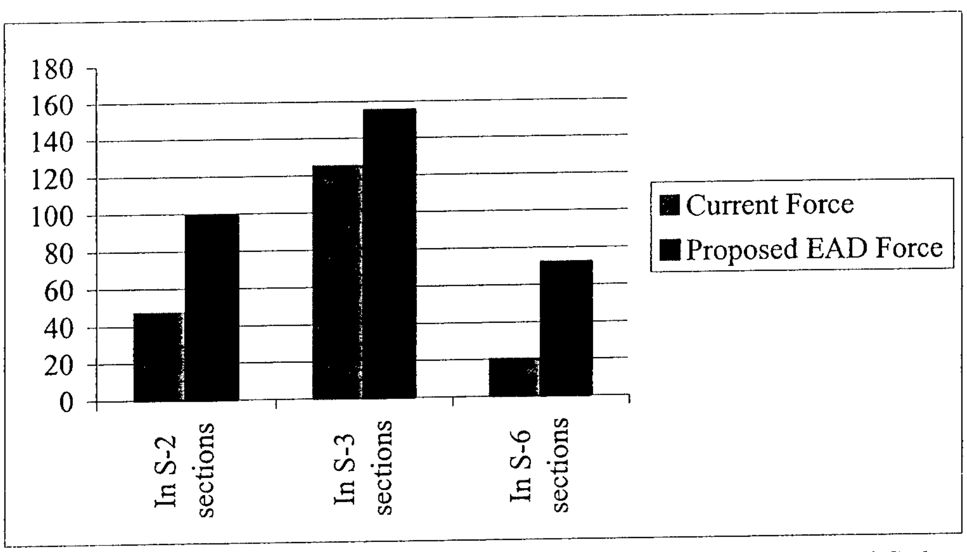

Figure 14: Comparison of Staff Section Strengths in S-2, S-3, and S-6

The study measures sustainability in the number of fuel transporters, mobile kitchens, and maintenance platoons and sections available, as well as the number of systems which unit maintenance personnel and repair parts stockage must support. Figure 15 compares the number of mobile kitchen trailers and fuel transporters in the two engineer forces. The current force structure has a larger number of fuel transporters, including 7 more heavy expanded mobility tactical truck (HEMTT) ones. It has four fewer mobile kitchen trailers.

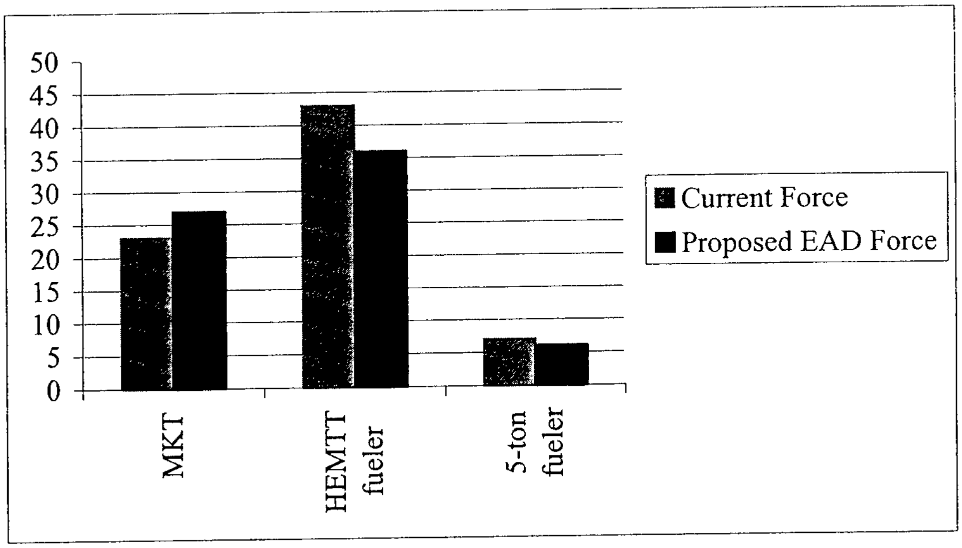

Figure 15: Comparison of Mobile Kitchens and Fuel Transporters

Figure 16 compares the maintenance organizations of the two force structures. The proposed EAD battalions have a maintenance platoon in each lettered company and a DS maintenance section in each battalion. Only the corps light battalion and the two combat heavy battalions in the current force structure have this arrangement. The corps mechanized and corps wheeled battalions have a consolidated battalion maintenance platoon. The current force structure has one more DS maintenance section, but four of the eight DS maintenance sections are from CSE companies. They are specifically designed to support the independent operations of those units.

The proposed EAD battalions must also maintain a much wider variety of equipment, including tracked and wheeled vehicles and heavy construction equipment. Figure 17 shows a comparison of some maintenance equipment items in the two forces. The current force structure has more assets for recovering wheeled vehicles, while the proposed EAD battalion structure has more equipment to recover and repair tracked vehicles (such as M-88 recovery vehicle and the hydraulic-system test and repair trailer for the armored combat earthmover). With the greater number of tracked vehicles in the proposed EAD engineer package, this is logical and necessary. The proposed EAD force has 24 M-88 recovery vehicles to support a total of 102 M-113 APCs, 72 AVLBs, and 72 ACEs, representing a ratio of approximately 1 recovery vehicle per 10 tracked vehicles. The current force structure has 6 M-88 vehicles to support 56 M-113 APCs, 24 AVLBs, and 36 ACEs. The ratio in this case is almost 1 to 20. The proposed EAD force almost doubles the ratio of tracked recovery vehicles to armored combat vehicles. This is a significant increase in recovery capability.

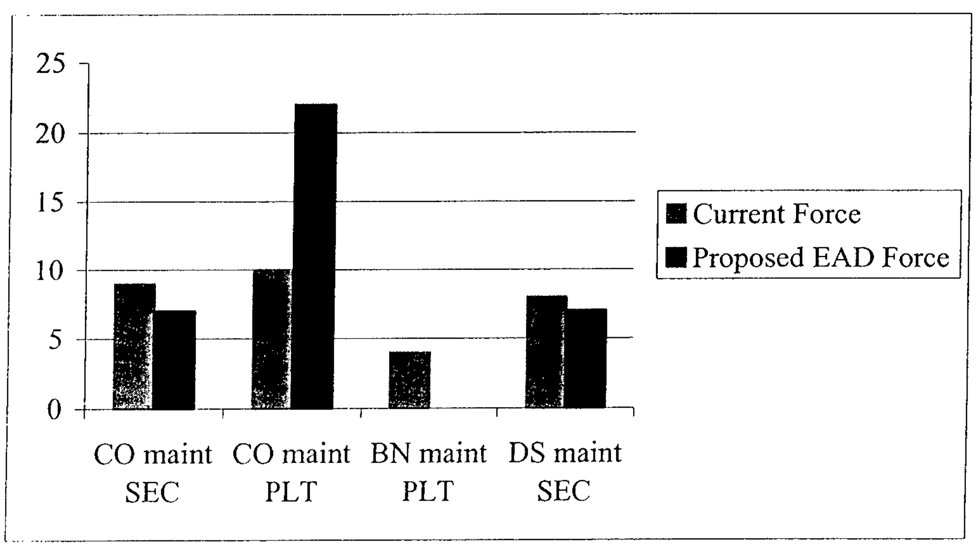

Figure 16: Comparison of Maintenance Organizations

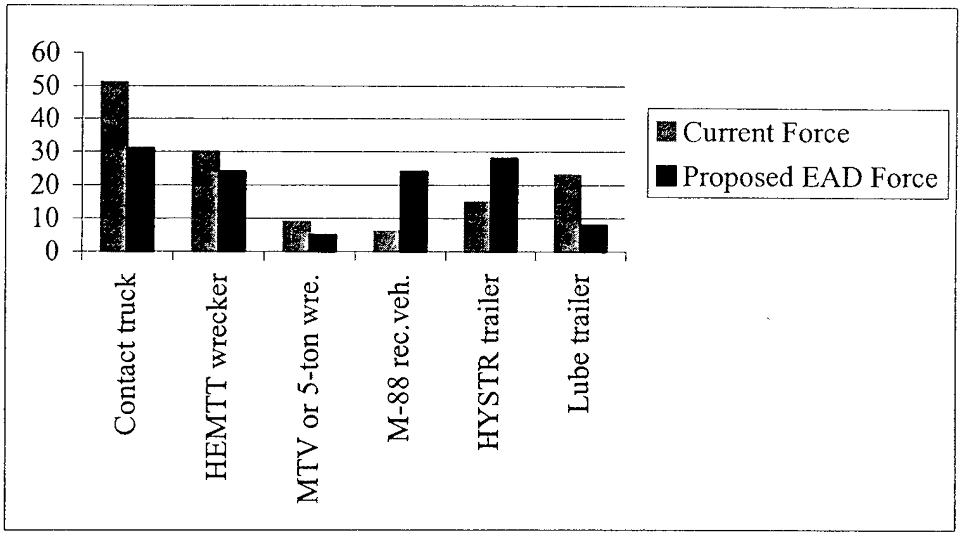

Figure 17: Comparison of Select Maintenance Equipment Assets

In an overall evaluation of sustainability, the proposed EAD battalion structure has a slight advantage, primarily due to the robust maintenance at company level. The proposed EAD battalion design structure has more food preparation capability, but less fuel transport capability. The current force structure has a greater fuel transport capability primarily because each of the four CSE companies has three HEMTT fuel transporters to facilitate independent operations. All companies in the proposed EAD force (including the corps light one) have a maintenance platoon, but this is increasingly unusual in an army that consolidates maintenance assets at higher levels to reduce the logistical footprint. However, these companies must also maintain tracked, wheeled, and engineer equipment. The EAD battalion structure has the luxury of company maintenance platoons, but the current force structure has adequate assets to maintain its equipment according to doctrine.

The study measures versatility in the ability of the companies and battalions to complete the missions in the scenario and the size of the force deployed. Figure 18 compares the overall strength of the deployed engineer force and the total number of 12-series, 51-series, and 62-series soldiers in the grade of E-3 to E-7. The proposed EAD battalion force increases the total number of personnel by 5.4 percent from the current force. Each of the three principal engineer MOS series also increases in comparison to the current force structure. The number of 12-series MOS soldiers for combat engineering and general construction labor increases by 11.1 percent. The number of 51-series MOS soldiers for vertical construction labor increases by 14.8 percent. The number of 62-series MOS soldiers for horizontal construction increases by 9.7 percent. However, the horizontal equipment assets do not enable the proposed EAD battalion force to accomplish the horizontal work in the entire model more rapidly. In fact, the amount of time increases by 5.1 percent in comparison to the current force structure. The time the proposed EAD battalion force needs to accomplish the vertical and general construction work decreases by 9.9 percent and 12.8 percent, respectively. This is logical considering the increase in 51-series and 12-series soldiers.

Historically, commanders have demanded vertical construction capability from engineers during contingency operations. This capability creates the improved living quarters, dining facilities, showers, and latrines that boost troop morale. An engineer force will never have sufficient vertical capability to satisfy all demands, but the proposed multifunctional battalion design starts to address the issue directly with the 14.8 percent increase in available vertical assets. This increase, primarily in plumbers and electricians, stresses the more technical specialties. Most combat engineers can function adequately as a carpenter or mason with some supervision; that is not the case with plumbing and electrical wiring. The added vertical construction expertise also makes the proposed multifunctional battalion design more capable of integrating and managing civilian contractors when they arrive in theater. The battalion is capable of performing technical construction work with its own assets and thus has the expertise to supervise and manage specialized contractors.

In an overall assessment of versatility, the proposed EAD battalion force is superior. While it deploys 263 more soldiers, it can accomplish the overall amount of work in the model more rapidly than such an increase would indicate at first glance. In terms of the total force deployed, the proposed EAD engineer package has 65.1 percent in 12-series, 51-series, or 62-series MOS positions, as compared to 61.6 percent in the current force structure. The increase in the proposed EAD structure of 62-series personnel, however, is not reflected in an increased horizontal work capacity. The versatility of the proposed EAD battalion design also enables an engineer commander to respond to new demands once his unit arrives in the area of operations. The engineer commander has a full complement of assets to complete mobility, countermobility, survivability, and general engineering missions in support of the maneuver commander's requirements and vision. Historically, engineer commanders have noted that the list of tasks is never complete until units arrive on the terrain and assess the situation firsthand. A multifunctional engineer battalion with a full range of capabilities is far better prepared to respond to additional construction demands than one with only combat engineers, while still retaining the capability to clear mines and fight as part of the maneuver force if necessary. It can rapidly transition from general engineering to combat engineering and back again without augmentation or additional training. It is an asset to the commander across the spectrum of conflict.

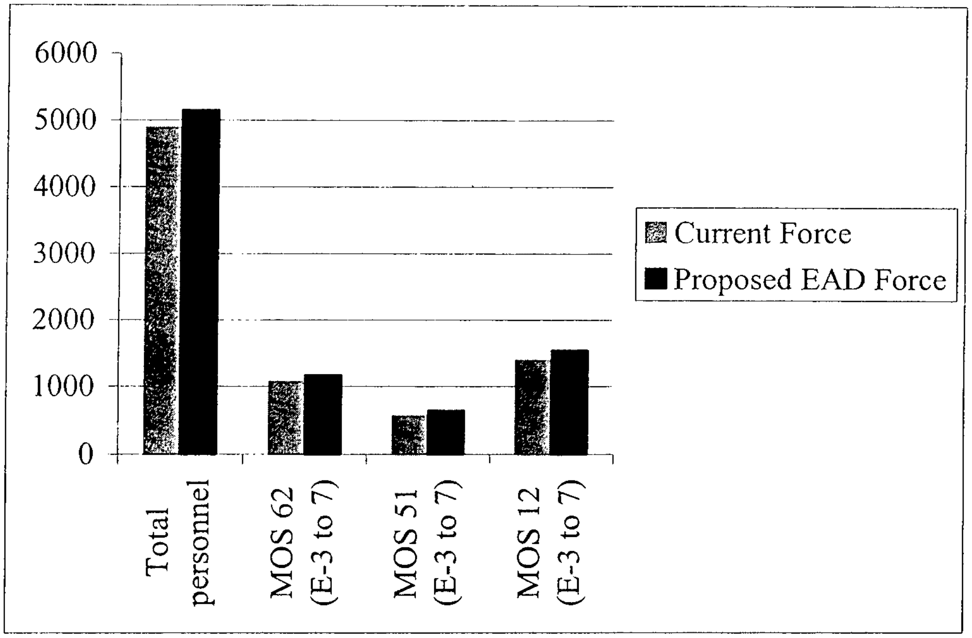

Figure 18: Comparison of Personnel Strengths

The comparison has found the proposed EAD battalion force superior to the current engineer force in all seven criteria. The advantage is more pronounced in the areas of agility, deployability, responsiveness, survivability, and versatility. However, the outcomes are sensitive to the assumptions made in the research process. In chapter one, the study assumed that all units possessed 100 percent of their personnel and equipment strengths as listed in the OTOE. It also assumed a uniform level of training in the soldiers of each force structure, as well as a similar doctrinal use of the various types of engineer platoons, regardless of which engineer package they operate with in the model. These assumptions are logical and necessary to isolate the organizational composition of the two engineer packages for comparison. Another assumption in chapter one, however, has tremendous bearing on the outcome. This was the assumption that six proposed EAD battalions would replace the six engineer battalions (two combat heavy, two corps mechanized, and two corps wheeled) in the current force structure, along with their supporting CSC, CSE, and dump truck companies. If this assumption is changed so that five or seven proposed EAD battalions replace the current force structure for supporting the two divisions in Africa, the outcome changes. Specifically, if only five proposed EAD battalions, one corps light battalion, and one light equipment company make up the proposed EAD battalion force, the total number of personnel is reduced from 5,146 to 4,414. The amount of vertical labor available per day decreases from 4,860 man-hours to 4,110 man-hours. The number of horizontal equipment-hours per day decreases from 9,560 to 8,260. The number of general labor man-hours decreases from 13,440 to 11,470. These new figures are all less than those of the current force structure. These reduced amounts of work effort available cause the amount of time needed to complete the horizontal, vertical, and general construction tasks at the 8 base cluster locations to increase by 6, 115, and 16 days, respectively.

The model assumed a ten-hour workday for both personnel and equipment. This is in accordance with the AFCS User Guide. Increasing the time available each day for work uniformly impacts both force structures. The practice of counting only personnel in the grade of E-5 and below as labor assets is also used in this guide. The selection of the AFCS facilities and installations for the model influences the amount of labor required in the horizontal, vertical, and general areas. However, each engineer force package must still do the same work. Historical evidence supports the research methodology in the fact that almost two-thirds of the total effort is for the LOC road and bridge construction program. Experience also shows that base camp development requires intensive vertical construction effort.

One of the unusual outcomes of the research is that while the proposed EAD force structure has more 62-series soldiers, it can accomplish less horizontal work per day. The AFCS determines the horizontal work capability of a unit by considering the total number of pieces of asphalt paving and rolling, bitumen distribution, compaction, concrete mixing, excavation, grading, hauling, lifting, and loading equipment. It does not consider the number of personnel with horizontal construction skills. Though outside the assumptions of this study, more operators could perhaps use fewer pieces of equipment more efficiently and achieve better results.

The model for the contingency is only one of many that are possible. The location, the mission, and the deployed maneuver force all affect the quantity and type of work that the supporting engineer force must perform. Changing one of these factors could change the outcome of the evaluation and comparison of the two engineer force structures. However, this study has considered a broad range of characteristics needed by an engineer force to support maneuver units across the full spectrum of conflict. The analysis in this chapter has shown that an engineer force composed of battalions with the proposed EAD multifunctional design is better than a force using the current force structure to respond to the requirements of a contingency operation. The proposed EAD battalion design offers the most pronounced advantages over current units in the areas of agility, deployability, responsiveness, survivability, and versatility. Based on this answer to the PQ, conclusions on the study of the proposed multifunctional EAD engineer battalion design and recommendations for further action and research are contained in chapter 5.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

This thesis answered yes to the research question, Is the proposed echelon above division engineer battalion design a better one for active and reserve component corps engineer forces to respond in a contingency operation? The corps engineer force composed of six proposed EAD battalions, one corps light battalion, and one LE company was clearly more agile, deployable, responsive, survivable, and versatile than the two corps mechanized battalions, two corps wheeled battalions, two combat heavy battalions, one corps light battalion, four CSE companies, one CSC company, one dump truck company, and one LE company allocated by the current force structure. The proposed EAD engineer force was at least as lethal and sustainable as the current force structure.

Chapter 1 described the changes in the heavy division engineer forces under the ERI and how that change placed the burden of engineer support, except for mobility, on the corps engineer battalions. It also assumed that the proposed EAD engineer battalions would replace the corps engineer battalions in the current force structure at a one-for-one basis. It identified the seven characteristics of the Transformation Force as the basis for a method of evaluation to answer the PQ.

Chapter 2 reviewed the existing literature on engineer support to contingency operations and developments in engineer force structure. There are recurring trends in engineer contingency operations. The demands on engineer troops are enormous from the outset. Initial assessments rarely include all of the engineer effort required as the operation continues. The active component engineer forces are severely strained to accomplish all the required missions. Contractors appear in the area of operations before or soon after the arrival of engineer forces. A common description of the operation is one with no immediate combat operations, a huge demand for force protection, and significant construction requirements. In contrast to the doctrinal focus of engineer mobility support to the combined arms attack, engineer forces have needed units capable of performing a wide variety of missions. This thesis has studied a current force development initiative at the U.S. Army Engineer School and has verified that a multifunctional corps engineer battalion offers advantages to corps engineer forces in contingency operations.

Chapter 3 described the model for the contingency scenario in Africa. The study defined the current force structure's engineer support to the deployed maneuver forces in this contingency and the engineer force package that would replace it if the proposed EAD battalion design were adopted. Using FM 101-10-1/2 and the AFCS, the study established a work requirement in terms of horizontal, vertical, and general construction effort associated with the engineer support required by the two deployed divisions. This chapter also described measurable criteria based upon the seven characteristics of the Transformation Force to determine which engineer force is better to support a contingency operation. The study established the work capacity of each of the two engineer force packages using TM 5-304 and determined the time required for each force to perform the work requirement. It independently evaluated each force structure against the criteria of agility, deployability, lethality, responsiveness, survivability, sustainability, and versatility.

Chapter 4 compared the results of the evaluation of the two engineer forces in chapter 3 to determine which force structure was better. The force built using the proposed EAD battalion design emerged superior, particularly in agility, deployability, responsiveness, survivability, and versatility. The study then examined the assumptions of the research methodology and their potential influence on the outcomes if these assumptions changed. This chapter also described some anomalies in the outcomes. Though the contingency scenario involved in this study was only one of many possible cases and thus is insufficient justification by itself for adoption of the proposed EAD battalion design, the research considered a variety of engineer capabilities required to support U.S. Army forces across the full spectrum of conflict. The proposed EAD battalion emerged superior in the majority of these characteristics.

In justifying the need for the proposed EAD battalion design, the U.S. Army Engineer School named several reasons for change (see appendix D).[1] The first stated that the current force structure was a Cold War era design and that units were not agile, deployable, responsive, sustainable, or versatile. This study has found that the proposed EAD battalion design is indeed superior in all of these characteristics as defined in the study. The second reason noted that units could not deploy without augmentation from other types of EAD or EAC engineer units. Corps mechanized and wheeled battalions need CSE companies for horizontal support and companies from the combat heavy battalion for vertical construction capability. The study confirmed this as true and showed how the proposed EAD battalion design begins to address this problem. The third reason stated that majority of units were neither modular nor tailorable for operations in all environments across the full spectrum of operations. The study examined the current force structure and found that only the corps light battalion provides all three types of labor assets, yet it still lacks the armored vehicle assets to support heavy forces. The proposed EAD battalion design would not replace the corps light engineer battalion, but it does go a step further by providing all three types of labor assets and a mechanized combat engineer capability. The fourth reason noted that engineer units in the current force structure deploy personnel and equipment not required in the theater of operations. Examples include tracked versus wheeled vehicles, armored combat earthmovers versus bulldozers, and 12-series combat engineers versus 51-series or 62-series construction engineers. The proposed EAD battalion design would do the same if the entire battalion deployed. The study also showed that combat engineers providing general construction labor are almost 50 percent of the total labor requirement. Considering these findings, the fourth reason seems to reflect the difficulty of identifying all engineer requirements in advance more than deficiencies in the force structure. Commanders deploy assets that are not required initially in the area of operations so that they have additional capability to respond to missions not foreseen in the initial plan.

The study did not address the last three reasons for change identified by the U.S. Army Engineer School. The fifth reason states that engineer units require significant lift assets to deploy and arrive late to the area of operations. The proposed EAD battalion does not really change the equipment that deploys in an operation. It is unclear if the proposed EAD battalion force in the study would require significantly less space and weight aboard ships or aircraft to deploy, as it is composed of the same types of platoons as the current force structure. The sixth reason notes that command and control of the numerous EAD and EAC separate engineer units in a corps is difficult. Are they controlled by engineer brigades, groups, or by divisional engineer commanders? From Vietnam to Somalia to the Balkans, EAD and EAC engineer units have found themselves in varied command and control arrangements depending on the mission and the peculiar characteristics of the operation. How the proposed EAD battalion design can completely resolve this issue is unclear. However, it does begin to address the issue by making an engineer battalion commander with a full range of assets available to maneuver commanders. He can support the needs of a maneuver commander at a base cluster location, while simultaneously reporting progress to the corps and theater engineers and acting upon their guidance in relation to the overall engineer priorities for the area of operations. The analysis in chapter 4 showed that the multifunctional battalions could complete the mission faster and had better command and control structures to plan and respond to additional engineer requirements. Finally, the Engineer School stated that major commands have deployed the wrong type of engineer units. As noted by Alan Schlie in chapter 2, this seems to indicate the problem of engineer commanders not clearly articulating what their units can and cannot accomplish. The proposed EAD battalion design addresses this problem by standardizing units and giving each corps engineer battalion commander the capability to perform the full range of engineer tasks.

In the course of the research involved in this thesis, the author identified several areas meriting further examination. The ERI moved the divisional engineer forces away from a multifunctional unit to one focused on providing mobility support to the maneuver brigades. The maneuver brigades switched from M-60 tanks and M-113 APCs to M-1 tanks and M-2 infantry fighting vehicles (IFV) at the same time that ERI was implemented. The Grizzly and Wolverine systems, designed to replace the Combat

Engineer Vehicle (CEV) and the Armored Vehicle-Launched Bridge (AVLB) and provide adequate support to the M-1 and M-2 vehicles in the maneuver brigades, are still not fielded throughout the force. Experience suggests that divisions have needed multifunctional engineer support on almost all operations across the spectrum of conflict. From Vietnam to Desert Shield and from Somalia to the Balkans, operations have typically involved no immediate combat operations, but massive requirements for force protection and base development. Were Grizzly and Wolverine delayed by inadequate funds, or by the fact that the maneuver force did not perceive a need for them as operations switched towards stability and support scenarios in the last decade, or both?

All fixed and float bridging is now consolidated under corps control in bridge companies. Divisions and their subordinate formations no longer possess the organic assets to actually conduct deliberate river crossings during training. A corps multirole bridge company is not always stationed on the same post to train with the maneuver formations of a division. Nor are these bridge companies always able to conduct training with corps engineer battalions, even though a corps engineer battalion commander is usually, by doctrine, the crossing area engineer for a division river crossing.[2] The Training and Doctrine Command has identified river crossing as a weakness throughout the force during Battle Command Training Program (BCTP) exercises. Would the incorporation of bridge companies in a multifunctional corps engineer battalion or the placement of a bridge company back in the heavy division help to address the weaknesses in division river-crossing operations observed during the BCTP?

Base development construction requirements suggest a need for pure construction units. Is the combat heavy engineer battalion still necessary as an EAC unit even if a multifunctional EAD battalion design is adopted?

Division engineers find themselves improvising to meet requirements in SASO scenarios. They do not have the equipment or the expertise to address the construction needs of maneuver forces upon arrival in the area of operations. Should combat engineers in the U.S. Army be trained in 51-series construction specialties as an additional skill and should they have the required tools added to their equipment allowances to act as vertical construction assets?

The research methodology focuses on the number of pieces of horizontal equipment, rather than the number of MOS 62-series soldiers. The proposed force, though possessing more 62-series soldiers, could accomplish less horizontal work. The model assumed a ten-hour operating day for equipment. Can engineer units, using additional 62-series personnel and the cross-training of other specialties as heavy equipment operators to man equipment in round-the-clock shifts, increase the length of the working day from ten to eighteen or twenty hours and become more productive with less equipment?

The multifunctional design of the proposed EAD engineer battalion also raises important issues concerning training. A company with five different types of platoons has a diverse set of training requirements. Does the company have the capability to effectively resource, execute, and evaluate training for its five platoons, or will it require extensive assistance from the battalion?

At the combat training centers, divisional engineers rarely receive the extensive corps-level engineer augmentation that they would receive according to the allocation rules. This is due to a variety of factors including funding and reserve component unit training dates. The current corps mechanized and corps wheeled battalions often train independently of the maneuver units they would support in wartime. The proposed EAD battalions would probably find themselves in a similar situation with some additional issues. How does the battalion headquarters train and fight as part of the combined arms team on the mechanized battlefield when only half of its platoons are equipped to fight in that environment? How is a fighting team built within the company when the platoons are not all designed for the same fight? Company cohesiveness is an essential element of an effective fighting force. "It was not just a lettered company in a numbered battalion in a numbered regiment in a numbered division. It meant far more than that. It was my home; it was 'my' company. I belonged in it and nowhere else."[3] If the battalion headquarters, mechanized platoons, and assault and obstacle platoons go forward to support an armored cavalry regiment in the covering force area, who assumes control of the vertical and horizontal construction platoons? Are the companies reorganized to place all the armored assets in one or two companies, while the construction assets are concentrated in the other two? How does this contribute to team building when units are not habitually training in their wartime configuration? Is the multifunctional battalion design more effective if it has a mechanized combat engineer company, a vertical construction company, and a horizontal construction company, rather than multifunctional companies?

All of the above issues are important questions concerning engineer force structure. As the U.S. Army progresses in its transformation to an Objective Force capable of deploying five divisions in 30 days to an area of operations, the Corps of Engineers must consider its future support to the maneuver brigades and the force as a whole. The multifunctional proposed EAD battalion design is a part of that process, but it is designed to support the legacy force. Nevertheless, the Army should consider moving to this structure now. If multifunctional engineer units are indeed the wave of future engineer force development, perhaps the Transformation Force should incorporate that capability into its organic engineer elements.

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[1]Peter Malley, "*Force XXI: Echelons Above Division Battalion Design*," Briefing delivered at United States Army Engineer School, January 2000 (U.S. Army Maneuver Support Center, Fort Leonard Wood, Missouri), 5. This briefing is included as appendix D.

[2]United States Army, FM 5-100-15, *Corps Engineer Operations* (Washington, DC: Department of the Army, 1995), 7-7.

[3]Eugene B. Sledge, *With the Old Breed at Peleliu and Okinawa* (Novato, CA: Presidio Press, 1981; reprint, New York: Oxford University Press, 1990), 98 (page citation is to the reprint edition).

APPENDIX A

MAP OF AREA OF OPERATIONS AND BASE CLUSTER DESCRIPTION

The map (not to scale) in this appendix (Figure 19) is a depiction of the area of operations. The northern state and the new southern state are depicted with the agreement boundary. The area enclosed by this boundary and the borders with countries C, E, K, U, and Z is the area of operations for the peacekeeping mission.

The lines of communication (LOC) road and pipeline routes, as well as existing airfields, are indicated. The boundary between the two infantry divisions in the peacekeeping force divides the area of operations into an eastern and western portion. Each portion contains four base cluster locations labeled with letters A through D in the east and G through H in the west. The road distance from location A to E is 530 kilometers. The road distance from location E to G is 150 kilometers. The road distance from location G to C is 500 kilometers. The road distance from location D to C is 285 kilometers.

Base cluster location A contains a mechanized brigade headquarters, a mechanized infantry battalion task force, an armor battalion task force, and a general support helicopter company. Facilities constructed at this location include a 3,000-man troop camp, a petroleum/oil/lubricants (POL) storage tank facility, a 100-bed hospital, a heliport, and an aviation unit maintenance (AVUM) facility.

Base cluster location B contains the mechanized infantry division headquarters, a division cavalry squadron, and armor battalion task force, a mechanized infantry battalion task force, and a light infantry battalion task force. Facilities constructed at this location include two 3,000-man troop camps, an airstrip, a 100-bed hospital, an AVUM facility, a detention facility, and a divisional aviation intermediate maintenance (AVIM) facility.

Base cluster location C contains a mechanized brigade headquarters, a mechanized infantry battalion task force, an armor battalion task force, an attack helicopter battalion, and a general support aviation company. Facilities constructed at this location include a 3,000-man troop camp, a POL storage tank facility, a 100-bed hospital, two AVUM facilities, and a heliport.

Base cluster location D contains a mechanized brigade headquarters, an armor battalion task force, a mechanized infantry battalion task force, and a general support aviation company. Facilities at this location are a 3,000-man troop camp, a 100-bed hospital, a POL storage tank facility, an AVUM facility, an airstrip, and a heliport.

Base cluster location E contains a light infantry brigade headquarters, 3 light infantry battalion task forces, and a general support aviation company. Facilities in this base cluster are a 3,000-man troop camp, a POL storage tank facility, a 100-bed hospital, an AVUM facility, and a heliport.

Base cluster location F contains a light infantry brigade headquarters, 2 light infantry battalion task forces, a cavalry squadron, and a general support aviation company. Facilities located at this base cluster are a 3,000-man troop camp, 2 AVUM facilities, a 100-bed hospital, an airstrip, and a heliport.

Base cluster location G contains a light infantry division headquarters, a mechanized infantry battalion task force, a light infantry battalion task force, and an attack helicopter battalion. Facilities in this base cluster are one 3,000-man troop camp, one 1,500-man troop camp, a 100-bed hospital, a POL storage tank farm, an AVUM facility, a detention facility, an AVIM facility, and an airstrip.

Base cluster location H contains a light infantry brigade headquarters, 2 light infantry battalion task forces, and a general support aviation company. Facilities in this base cluster are a 3,000-man troop camp, a 100-bed hospital, an AVUM facility, an airstrip, and a heliport.

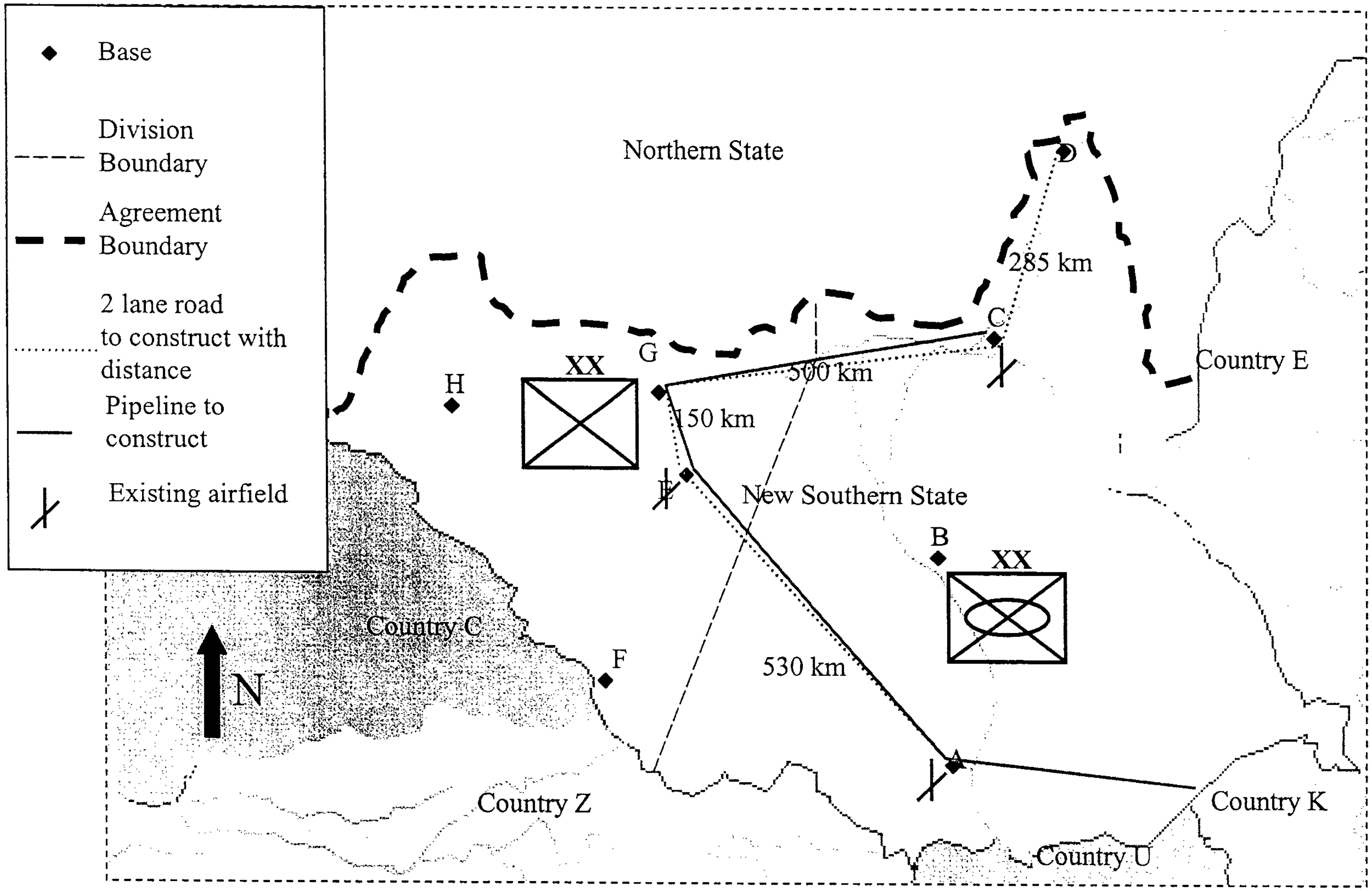

Figure 19: Schematic of Area of Operations

APPENDIX B

MODEL OF WORK EFFORT USING ARMY FACILITIES COMPONENT SYSTEM

This appendix contains the Microsoft Excel spreadsheet used to calculate the construction effort for the contingency scenario. The entries in each column are explained below:

Column 1: The facility or installation number according to the Army Facilities Components System (AFCS). This column is repeated to enable the reader to more easily follow the calculations from sheet to sheet.

Column 2: A description of the facility or installation.

Column 3: Equipment-hours of horizontal work required in order to construct one of the facilities or installations in the first column.

Column 4: Man-hours of vertical work required in order to construct one of the facilities or installations in the first column.

Column 5: Man-hours of general work required in order to construct one of the facilities or installations in the first column.

Column 6: Total man-hours and equipment-hours of work required constructing one of the facilities in column 1. This column is the sum of columns 3, 4, and 5.

Column 7: Number of the facilities or installation in column 1 required in the scenario.

Column 8: Total equipment-hours of horizontal work required constructing the number of facilities or installations in column 7. This column is the product of column 3 and column 7.

Column 9: Total man-hours of vertical work required constructing the number of facilities or installations in column 7. This column is the product of column 4 and column 7.

Column 10: Total man-hours of general work required constructing the number of facilities or installations in column 7. This column is the product of column 5 and column 7.

Column 11: Total man-hours and equipment-hours of work required constructing the number of facilities or installations in column 7. This column is the sum of columns 8, 9, and 10.

Column 12 (and continued in other columns to right): These columns have text comments related to the computation of the number of each facility or installation required (column 7).

		Construction effort in man-hours			
1	2	3	4	5	6
Fac. or Inst #	Description	Horizontal	Vertical	General	Total
Airfields and Heliports					
AG1331	Heliport, 27 a/c for air cav troop, in spt area	9254	2631	16099	27984
AG5041	Runway, C-130, rear area, minimum facilities	14718	4185	25603	44506
Sewage treatment (Installation PS 3271)					
831401	Siphon chamber (100k GPD)	1	206	70	277
831402	Imhoff tank (wood) (100k GPD)	8	2600	350	2958
831403	Chlorine contact chamber (100k GPD)	0	141	36	177
831404	Trickling filter (100k GPD)	55	2395	550	3000
831405	Final settling tank (100k GPD)	0	470	80	550
831502	Sludge drying bed (100k GPD) (2 each)	36	228	580	844
Potable water supply					
842003	Water dist. main, 1 mile at 6 in. w/fittings	817	1127	230	2174
842004	Water sup. pipeline, 100 GPM w/pump, 1 mile	759	920	265	1944
842105	Water tank and tower, 21k GAL, w/acces.	0	483	0	483
Troop camps (Installation Number NT5621 (3000-man); NT4621 (1500-man)					
214122	Shop, motor repair, wood frame (3 each), 48x64x14	150	3876	1143	5169
441122	Storehouse, wood frame building (3 each) 20x100x8	135	2427	678	3240
551122	Dispensary, troop, wood frame building	39	1566	150	1755
611124	HQ and unit supply building (15 each)	420	6465	1200	8085
611125	HQ and unit supply building (3 each)	135	2625	558	3318
700570	Water distribution for 3000 man troop camp	720	1674	1600	3994
700571	Drainage for 3000 man troop camp	510	1114	1932	3556
700572	Electric distribution for 3000 man troop camp	334	2980	1260	4574
722125	Barracks, 50 man, wood building (57 each)	2565	42807	10602	55974
722125	Quarters, 24 officers, wood building (7 each)	315	6083	1302	7700
723228	Bath and latrine, 500 man, wood frame	39	1754	150	1943
723522	Bath and latrine, 720 man, wood frame (4 each)	180	9692	744	10616
726224	Kitchen and mess hall (6 each)	834	52704	15180	68718
741321	Dayroom, recreational, wood frame (6 each)	258	5208	1068	6534
741323	Guard hose, wood frame	33	626	115	774
741325	Camp exchange, wood frame	45	1121	186	1352
842105	Water tank tower, 21k GAL (2 each)	0	840	0	840
842110	Sump, fire protection, 10k GAL (4 each)	64	432	464	960
932000	Site preparation, one acre (27 each)	2376	0	864	3240
214122	Shop, motor repair, wood frame, 48x64x14	50	1292	381	1723
441122	Storehouse, wood frame building (2 each), 20x100x8	90	1618	452	2160
551122	Dispensary, troop, wood frame building	39	1566	150	1755
611124	HQ and unit supply building (8 each)	224	3448	640	4312
611125	HQ and unit supply building	45	875	186	1106
700470	Water distribution for 1500 man troop camp	540	1448	848	2836
700471	Drainage for 1500 man troop camp	192	544	404	1140
700472	Electric distribution for 1500 man troop camp	168	1470	640	2278
722125	Barracks, 50 man, wood building (29 each)	1305	21779	5394	28478
722125	Quarters, 24 officers, wood building (3 each)	135	2607	558	3300
723228	Bath and latrine, 500 man, wood frame	24	941	61	1026
723522	Bath and latrine, 720 man, wood frame (2 each)	90	4846	372	5308
726224	Kitchen and mess hall (3 each)	417	26352	7590	34359
741321	Dayroom, recreational, wood frame (2 each)	86	1736	356	2178
741323	Guard hose, wood frame	33	626	115	774
741325	Camp exchange, wood frame	45	1121	186	1352
842104	Water tank tower, 10500 GAL	0	240	0	240
932000	Site preparation, one acre (16 each)	1408	0	512	1920

		Construction effort in man-hours			
1	2	3	4	5	6
Fac. or Inst #	Description	Horizontal	Vertical	General	Total
Hospitals (Installation GH0151)					
500310	Water distribution 100 bed hospital	365	756	337	1458
500311	Sewerage, 100 bed hospital	345	800	525	1670
500312	Electrical distribution, 100 bed hosiptal	120	1685	695	2500
511114	Admin, admission, and disposition bldg	96	2358	460	2914
512112	Eye, ear, nose, throat, and pharmacy bldg	53	1984	254	2291
512315	Dispensary bldg	61	2350	296	2707
513311	X-ray, lab, and dental bldg	110	4382	600	5092
514411	Surgery, centralized material bldg	102	5230	545	5877
515112	Ward building, acute type (4 each)	348	9976	1676	12000
515611	Linen exchange and supply bldg	79	2120	378	2577
516611	Mess building	112	3632	595	4339
517111	Barracks building (2 each)	106	1646	508	2260
517113	Quarters, male oficer	53	1118	254	1425
517115	Quarters, female officer	53	1188	254	1495
518112	Utility building	53	2379	254	2686
518311	Utility building (2 each)	106	5638	508	6252
518513	Utility building	53	2799	254	3106
519113	Recreation building (3 each)	102	1269	516	1887
519311	Special services building	72	1873	385	2330
519711	Walkway corridor with roof (14.4 each)	504	3456	648	4608
842110	Sump, fire protection, 10000 GAL (2 each)	32	216	232	480
932000	Site preparation, 1 acre (5.4 each)	475	0	173	648
Force protection					
041001	OP or cmd post, log, with 45cm overhead cvr.	0	52	35	87
040402	Concrete arch bunker comp. in place (8.5x6.5)	13	87	147	247
041026	Squad size or cmd post w/ dim. lumber	0	120	426	546
710901	Security fence with lighting, 1000 feet	53	543	294	890
710904	Gate for security fence, man/vehicle	9	138	55	202
711201	Guard tower, 16x16 ft. Platform shelter, 22 ft. Hi.	7	117	35	159
Maintenance shops (aviation only)					
MT1161	DS 18 bay facility, 28800 square feet	643	38784	4083	43510
Supply storage					
341132	Wood frame warehouse, conc.ftgs., metal roof,	28	580	83	691
	80x32 with 8 ft. Clearance				
341134	16 x 80 ft additional bay for 341132	9	301	81	391
341166	Corrugated steel cladding with doors, screened	5	104	28	137
	openings, vents, for warehouse 100 ft perimeter				
341601	Sliding door, dual track, for 10x12 opening in	0	18	9	27
	warehouse				
401127	Electrical distribution for dry covered cargo stor.	7	33	29	69
	25,000 sq ft.				
431610	Rat-proof ceiling, walls, floor, cold store warehs.	0	587	0	587
	80 x 220				
432221	Ice plant, 3.6 tons/day, wood frame	71	1067	299	1437
348492	Liner, reflective type insulation for ceiling	2	37	5	44
	1000 sq ft., wood frame warehouse bldgs				

1	2	3	4	5	6
		Construction effort in man-hours			
Fac. or Inst #	Description	Horizontal	Vertical	General	Total
Ammo storage					
421424	Magazine, steel arch, 25x 32 feet	213	207	253	673
POW camp (installation ND1615)					
ND1615	Military prisoner stockade, 250 man	2220	3515	3420	9155
710902	Security fence Type X, 1000 feet (4.8 each)	254	1402	1413	3069
710903	Security fence Type Y, 1000 feet (1.9 each)	105	485	489	1079
710904	Veh-man gate for security fence (5 each)	46	690	276	1012
711201	Guard tower 16x16 (8 each)	55	938	276	1269
722002	Tentage, 10-16 feet x 32 feet (3.4 each)	0	0	156	156
853110	Road, single lane, 1 mile graded (0.1 mile)	232	0	254	486
932000	Site prep, 1 acre (15.1 acres)	1528	0	556	2084
Pipeline (adaptation of inst QD1019 for 911 miles)					
123402	Tank, POL, 250bbl with 4 inch pipe	29	115	52	196
124201	Pump station, fuel supply POL	6	40	23	69
125011	Pipeline POL 5 miles with 4" groove	58	1265	828	2151
125021	Pipeline, POL 3 miles 4" API groove	104	1449	966	2519
125291	Pump station POL for 4" pipeline	40	115	40	195
710903	Security fence type Y 333 feet	17	77	77	171
710904	Vehicle/man gate for security fence	9	138	55	202
POL Loading Tank Farm (QE1019)					
QE1019	Truck loading site, 20 trucks at 5000 gal/day	3027	9391	9072	21490
	Maximum of 4 products, fill 20 trucks/prod/day				
123104	Loading pump for 2tk/trk/5car inst. (4 each)	46	391	115	552
123211	Flood pump 785 bpm 6" manifold	12	247	63	322
123231	Dist manifold f/drum + can loadg inst	6	52	12	70
123402	Tank, POL, 250 BBL with 4" pipe (3 each)	86	345	155	586
123406	Tank, POL 1000 BBL with 4" pipe (1 each)	92	368	150	610
123408	Tank, POL 3000 BBL with 6" pipe (8 each)	828	2852	1932	5612
124201	Pump station fuel supply, POL (3 each)	17	121	69	207
124302	Loading facility for 2 fuel trucks	173	375	1213	1761
125007	Pipeline POL 1 mile of 6" groove (8 each)	280	2944	2024	5248
125016	Pipeline POL 1000 ft of 4" API groove	6	104	63	173
125017	Pipeline POL 1000 ft of 6" API groove (2 each)	12	265	161	438
611114	HQ BLDG, unit supply co, steel frame 20x40	25	362	135	522
710903	Security fence TYPE Y 1000 feet (2.7 each)	149	689	696	1534
710904	Veh-man gate for sec. fence (2 each)	18	276	110	404
853111	Road, sin. lane 1 mile 4" earth/stone (0.5 each)	1277	0	2174	3451
Bridging (on LOCs)					
FB2575	3000 lin. Ft. bridging MLC 60 2d or 70 1d	21447	76664	58597	156708
Roads (LOC program)					
111118	Road, 2 lane, w/rein. plast. mat., 1 mile	80	0	357	437
853121	Road, 2 lane, 6 in. Earth or crushed stone, 1 mi.	3925	1116	6828	11869
853128	Road, 2 lane, 3 in.hot mix on exis. base, 1 mi.	1190	610	2030	3830
852010	Road maintenance, asphalt surface, double lane	4888	1576	6854	13318
	100 miles for 30 days				
852012	Road maintenance, dirt surface, double lane	4140	0	5520	9660
	100 miles for 30 days				
Land clearing (except for airfields, heliports, troop and POW camps, hospitals)					
932000	Site preparation (1 acre)	101	0	37	138
932004	Clearing and grubbing, 1 mile x 50 feet	23	0	23	46

	Number	Construction effort in man-hours			
1	**7**	**8**	**9**	**10**	**11**
Fac. or Inst #	required	Horizontal	Vertical	General	Total
Airfields and Heliports					
AG1331	6	55524	15786	96594	167904
AG5041	5	73590	20925	128015	222530
		129114	**36711**	**224609**	**390434**
Sewage treatment (Installation PS 3271)					
831401	21	21	4326	1470	5817
831402	21	168	54600	7350	62118
831403	21	0	2961	756	3717
831404	21	1155	50295	11550	63000
831405	21	0	9870	1680	11550
831502	21	756	4788	12180	17724
		2100	**126840**	**34986**	**163926**
Potable water supply					
842003	0	0	0	0	0
842004	50	37950	46000	13250	97200
842105	72	0	34615	0	34615
		37950	**80615**	**13250**	**131815**
Troop camps (Installation Number NT5621 (3000-man); NT4621 (1500-man)					
214122	9	1350	34884	10287	46521
441122	9	1215	21843	6102	29160
551122	9	351	14094	1350	15795
611124	9	3780	58185	10800	72765
611125	9	1215	23625	5022	29862
700570	36	25920	60264	57600	143784
700571	36	18360	40104	69552	128016
700572	9	3006	26820	11340	41166
722125	9	23085	385263	95418	503766
722125	9	2835	54747	11718	69300
723228	9	351	15786	1350	17487
723522	9	1620	87228	6696	95544
726224	9	7506	474336	136620	618462
741321	9	2322	46872	9612	58806
741323	9	297	5634	1035	6966
741325	9	405	10089	1674	12168
842105	9	0	7560	0	7560
842110	9	576	3888	4176	8640
932000	9	21384	0	7776	29160
214122	1	50	1292	381	1723
441122	1	90	1618	452	2160
551122	1	39	1566	150	1755
611124	1	224	3448	640	4312
611125	1	45	875	186	1106
700470	4	2160	5792	3392	11344
700471	4	768	2176	1616	4560
700472	1	168	1470	640	2278
722125	1	1305	21779	5394	28478
722125	1	135	2607	558	3300
723228	1	24	941	61	1026
723522	1	90	4846	372	5308
726224	1	417	26352	7590	34359
741321	1	86	1736	356	2178
741323	1	33	626	115	774
741325	1	45	1121	186	1352
842104	1	0	240	0	240
932000	1	1408	0	512	1920
		122665	**1449707**	**470729**	**2043101**

	Number	Construction effort in man-hours			
1	**7**	**8**	**9**	**10**	**11**
Fac. or Inst #	required	Horizontal	Vertical	General	Total
Hospitals (Installation GH0151)					
500310	8	2920	6048	2696	11664
500311	8	2760	6400	4200	13360
500312	8	960	13480	5560	20000
511114	8	768	18864	3680	23312
512112	8	424	15872	2032	18328
512315	8	488	18800	2368	21656
513311	8	880	35056	4800	40736
514411	8	816	41840	4360	47016
515112	8	2784	79808	13408	96000
515611	8	632	16960	3024	20616
516611	8	896	29056	4760	34712
517111	8	848	13168	4064	18080
517113	8	424	8944	2032	11400
517115	8	424	9504	2032	11960
518112	8	424	19032	2032	21488
518311	8	848	45104	4064	50016
518513	8	424	22392	2032	24848
519113	8	816	10152	4128	15096
519311	8	576	14984	3080	18640
519711	8	4032	27648	5184	36864
842110	8	256	1728	1856	3840
932000	8	3800	0	1384	5184
		27200	**454840**	**82776**	**564816**
Force protection					
041001	0	0	0	0	0
040402	0	0	0	0	0
041026	585	0	70200	249210	319410
710901	117	6201	63531	34398	104130
710904	40	360	5520	2200	8080
711201	117	819	13689	4095	18603
		7380	**152940**	**289903**	**450223**
Maintenance shops (aviation only)					
MT1161	18	11574	698112	73494	783180
	0	0	0	0	0
	0	0	0	0	0
	0	0	0	0	0
	0	0	0	0	0
		11574	**698112**	**73494**	**783180**
Supply storage					
341132	0	0	0	0	0
		0	0	0	0
341134	0	0	0	0	0
341166	0	0	0	0	0
		0	0	0	0
341601	0	0	0	0	0
		0	0	0	0
401127	0	0	0	0	0
		0	0	0	0
431610	1	0	587	0	587
		0	0	0	0
432221	10	710	10670	2990	14370
348492	0	0	0	0	0
		710	**11257**	**2990**	**14957**

	Number	Construction effort in man-hours			
1	7	8	9	10	11
Fac. or Inst #	required	Horizontal	Vertical	General	Total
Ammo storage					
421424	18	**3834**	**3726**	**4554**	**12114**
POW camp (installation ND1615)					
ND1615	2	**4440**	**7030**	**6840**	**18310**
710902	2	508	2804	2826	6138
710903	2	210	970	978	2158
710904	2	92	1380	552	2024
711201	2	110	1876	552	2538
722002	2	0	0	312	312
853110	2	464	0	508	972
932000	2	3056	0	1112	4168
Pipeline (adaptation of inst QD1019 for 911 miles)					
123402	45	1305	5175	2340	8820
124201	45	270	1800	1035	3105
125011	114	6612	144210	94392	245214
125021	114	11856	165186	110124	287166
125291	45	1800	5175	1800	8775
710903	45	765	3465	3465	7695
710904	45	405	6210	2475	9090
		23013	**331221**	**215631**	**569865**
POL Loading Tank Farm (QE1019)					
QE1019	5	**15135**	**46955**	**45360**	**107450**
123104	5	230	1955	575	2760
123211	5	60	1235	315	1610
123231	5	30	260	60	350
123402	5	430	1725	775	2930
123406	5	460	1840	750	3050
123408	5	4140	14260	9660	28060
124201	5	85	605	345	1035
124302	5	865	1875	6065	8805
125007	5	1400	14720	10120	26240
125016	5	30	520	315	865
125017	5	60	1325	805	2190
611114	5	125	1810	675	2610
710903	5	745	3445	3480	7670
710904	5	90	1380	550	2020
853111	5	6385	0	10870	17255
Bridging (on LOCs)					
FB2575	4	**85788**	**306656**	**234388**	**626832**
Roads (LOC program)					
111118	0	0	0	0	0
853121	911	3575675	1016676	6220308	10812659
853128	182	216580	111020	369460	697060
852010	0	0	0	0	0
		0	0	0	0
852012	0	0	0	0	0
		3792255	**1127696**	**6589768**	**11509719**
Land clearing (except for airfields, heliports, troop/POW camps, hospitals)					
932000	233	23533	0	8621	32154
932004	1094	25162	0	25162	50324
		48695	**0**	**33783**	**82478**

1	12					
Fac. or Inst #	Comments					
Airfields and Heliports						
AG1331	For 149 a/c in two divisions					
AG5041	For Ar Rank, Waw, Raga, Jonglei, and Tambura					
	These figures (total work effort) are from FM 101-10-1/2, pages 1-48,49					
	If you apply same percentages as the LOC road construction (installation 853121)					
Sewage treatment (Installation PS 3271)						
831401	70% of total potable requirement					
831402	2107000	GPD				
831403						
831404						
831405						
831502						
Potable water supply		From FM 101-10-1/2, pg 1-43				
842003	Camps are 100 gal/man/day	2850000	GPD			
842004	Hospitals 200 gal/bed/day	160000	GPD			
842105	Storage is 50% of requireme	1505000	GAL			
	5 miles of pipeline per camp					
Troop camps (Installation Number NT5621 (3000-man); NT4621 (1500-man)						
214122	1 per 101-300 vehicles	Total space 82944 square feet				
441122	2 sq ft per man	Total space 54000 square feet				
551122	1 per 1000-3000 men					
611124	1 per 200 men					
611125	1 per 1000 men					
700570	25 GPD per man	Multiply by 4 for 100 GPD				
700571	17.5 GPD per man	Multiply by 4 for 100 GPD				
700572	Light and power					
722125	40 sq ft per man					
722125	80 sq ft per officer					
723228	1SH/10, 1ST/10					
723522	1SH/24, 1ST/20E					
726224	1 per 500 men					
741321	5 sq ft per man					
741323	1 per 250-3000 men					
741325	1 per 1000-3000 men					
842105						
842110	eff rad 500 feet					
932000						
214122		Total space 3072 square feet				
441122		Total space 4000 quare feet				
551122						
611124						
611125						
700470		Multiply by 4				
700471		Multiply by 4				
700472						
722125						
722125						
723228						
723522						
726224						
741321						
741323						
741325						
842104						
932000						

1	12					
Fac. or Inst #	Comments					
Hospitals (Installation GH0151)						
500310	50 GPD per bed					
500311	25 GPD per bed					
500312	Light and power					
511114	1 per 100 beds					
512112	1 per 100-200 beds					
512315	1 per 100 beds					
513311	1 per 100-200 beds					
514411	1 per 100-200 beds					
515112	25 beds each					
515611	1 per 100 beds					
516611	1 per 100 beds					
517111	40 sq ft per man					
517113	14 male officers					
517115	13 female officers					
518112	80 EM and 2 NCOs					
518311	1 per 2 wards					
518513	13 female/14 male officers					
519113	Patients/EM/Officer					
519311	1 per 100-300 beds					
519711	Connect buildings					
842110	eff rad 500 feet					
932000						
Force protection						
041001						
040402	4 gates per camp					
041026	1 squad bunker every 200 feet					
710901	3000 man camps need 12000 feet					
710904	1500 man camp needs 9000 feet					
711201	1 guard tower per 1000 feet	117				
Maintenance shops (aviation only)						
MT1161	Unit	Number	Space per	Total space		
	Forward DS tk/auto maint C(	6	5130	30780	Covered by troop camps	
	Maintenance CO (GS)	1	5588	5588	Covered by troop camps	
	Hvy Eqip maint CO (GS)	1	5562	5562	Covered by troop camps	
	AVUM, attack BN	2	53000	106000	Use MT1161 with the	
	AVUM, cav sqdn	2	50000	100000	H/V/G effort proportional	
	AVN spt avn CO	6	25000	150000	to facility 341923	
	AVIM	2	84000	168000	for aviation (FM 101-,	
Supply storage					10-1/2, pg 1-50)	
341132	Using the GSF x population x stock OBJ					
	Need 10858 sq ft covered storage					
341134	Need 10082 cu ft refrig storage					
341166						
341601	Based on troop camp design, only need to refrigerate					
	part of one warehouse at each camp					
401127	Rest of storage requirements fulfilled by					
	installation design					
431610	1 set will cover refrig. storage for 10 camps					
432221	1 per camp for ice					
348492						

1	12		
Fac. or Inst #	Comments		
Ammo storage			Need 8.05 sq ft per STON
421424	LT DIV = 234, MECH 1487 STON		Store 1 DOS for high intensity defense
	13854.05	square feet	Need 18 bunkers
POW camp (installation ND1615)			
ND1615	One per division		
710902	Also, FM 101-10-1/2, pg 4-4 says		
710903	0.05% of population wil be detained		
710904	(if population is friendly). Also,		
711201	in Vietnam average division		
722002	captured 423 EPWs per year		
853110	(1 of 6 detainees was EPW)		
932000	500 is 0.05% of 1,000,000 people.		
Pipeline (adaptation of inst QD1019 for 911 miles)			
123402	In ST 101-6, for an MTW-W attack, the 2 divisions would use 595,217 gal/day		
124201	Use 20% of this for scenario		
125011		2834.3667	
125021	Provide 2835 bbl/day		
125291	Need 911 miles of pipeline		
710903	Need 1 pump station per 20 miles		
710904	Number of stations	45.55	
POL Loading Tank Farm (QE1019)			
QE1019	One per two camps		
123104			
123211			
123231			
123402			
123406			
123408			
124201			
124302			
125007			
125016			
125017			
611114			
710903			
710904			
853111			
Bridging (on LOCs)			
FB2575	Plan 7.5 meters (24.8 feet) per km of road		
	10987.5	Need 4 sets	
Roads (LOC program)			
111118	Need 1465 kilometers (911 miles)		
853121	Pave 20% of this (heavy traffic areas)		
853128	Dirt	1465	
852010	Paved	293	
852012			
Land clearing (except for airfields, heliports, troop and POW camps, hospitals)			
932000	21 acres for sewage plants, 12 acres for aviation		
932004	911 miles of road, 20% more for pipeline		
	200 acres for POL loading tank farms		

APPENDIX C

CALCULATION OF WORK EFFORT AT EACH BASE CLUSTER LOCATION

This appendix contains the Microsoft Excel spreadsheet used to calculate the construction effort at each of the eight base cluster locations. The entries in each column are explained below:

Column 1: The type of facility or installation.

Column 2: The number of facilities or installations in column 1 required in the scenario.

Column 3: Total equipment-hours in horizontal effort required constructing one of the facilities or installations in column 1.

Column 4: Total man-hours in vertical effort required constructing one of the facilities or installations in column 1.

Column 5: Total man-hours in general effort required constructing one of the facilities or installations in column 1.

Columns 6-13: Number of the facilities or installations in column 1 located at each particular base cluster (A through H).

Column 14: Sum of columns 6 through 13 and equal to column 2.

Column 15: Total horizontal labor effort required constructing the number of facilities or installations in column 2. It is the product of column 3 and the appropriate column among 6 through 13 for that particular base cluster location.

Column 16: Total vertical labor effort required constructing the number of facilities or installations in column 2. It is the product of column 4 and the appropriate column among 6 through 13 for that particular base cluster location.

Column 17: Total general labor effort required constructing the number of facilities or installations in column 2. It is the product of column 5 and the appropriate column among 6 through 13 for that particular base cluster location.

The sum of columns 15, 16, and 17 is listed at the bottom of each of those columns. These figures are the total horizontal, vertical, and general construction effort required at that base cluster location.

Location A

1	2	Per facility of installation 3	4	5	Quantity at location: 6	7	8	9	10	11	12	13	14	Man or Equipment Hours 15	16	17
Type	**No.**	**Horizontal**	**Vertical**	**General**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Total**	Horizontal	Vertical	General
Airfields	5	14718	4185	25603		1		1		1	1	1	5	0	0	0
Heliports	6	9254	2631	16099	1		1	1	1	1		1	6	9254	2631	16099
AVUM (GS CO)	6	643	38784	4083	1		1	1	1	1		1	6	643	38784	4083
AVUM (CAV)	2	964.5	58176	6124.5		1				1			2	0	0	0
AVUM (ATK)	2	964.5	58176	6124.5			1				1		2	0	0	0
AVIM	2	1929	116352	12249		1					1		2	0	0	0
Sewage Treatment	21	100	6040	1666	2	4	3	3	2	2	3	2	21	200	12080	3332
Potable water main	50	817	1127	230	5	10	5	5	5	5	10	5	50	4085	5635	1150
Potable water tanks	72	0	483	0	7	16	7	7	7	7	14	7	72	0	3381	0
3000 man troop camp	9	12842	152358	49792	1	2	1	1	1	1	1	1	9	12842	152358	49792
1500 man troop camp	1	7087	78485	22601							1		1	0	0	0
Hospital	8	3400	56855	10347	1	1	1	1	1	1	1	1	8	3400	56855	10347
Force Protection Fence	117	53	543	294	12	24	12	12	12	12	21	12	117	636	6516	3528
FP Gates	40	9	138	55	4	8	4	4	4	4	8	4	40	36	552	220
FP Towers	117	7	117	35	12	24	12	12	12	12	21	12	117	84	1404	420
FP Bunkers	585	0	120	426	60	120	60	60	60	60	105	60	585	0	7200	25560
General Supply	10	71	1125.7	299	1	2	1	1	1	1	2	1	10	71	1125.7	299
Ammo	18	213	207	253	3	4	3	3	1	1	2	1	18	639	621	759
POW camp	2	2220	3515	3420		1					1		2	0	0	0
POL tank farm	5	3027	9391	9072	1		1	1	1		1		5	3027	9391	9072
Land clearing tank farms	200	101	0	37	40		40	40	40		40		200	4040	0	1480
LC sewage plants	21	101	0	37	2	4	3	3	2	2	3	2	21	202	0	74
Land clearing AVUM/AVIM	12	101	0	37	1	2	2	1	1	2	2	1	12	101	0	37
					Total Work at Location A >>>>>									39260	298534	126252
					Roads (LOC), pipelines, bridges (LOC) ARE NOT INCLUDED											

Location B																
		Per facility of installation			**Quantity at location:**									Man or Equipment Hours		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Type	**No.**	**Horizontal**	**Vertical**	**General**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Total**	Horizontal	Vertical	General
Airfields	5	14718	4185	25603		1		1		1	1	1	5	14718	4185	25603
Heliports	6	9254	2631	16099	1		1	1	1	1		1	6	0	0	0
AVUM (GS CO)	6	643	38784	4083	1		1	1	1	1		1	6	0	0	0
AVUM (CAV)	2	964.5	58176	6124.5		1				1			2	964.5	58176	6124.5
AVUM (ATK)	2	964.5	58176	6124.5			1				1		2	0	0	0
AVIM	2	1929	116352	12249		1					1		2	1929	116352	12249
Sewage Treatment	21	100	6040	1666	2	4	3	3	2	2	3	2	21	400	24160	6664
Potable water main	50	817	1127	230	5	10	5	5	5	5	10	5	50	8170	11270	2300
Potable water tanks	72	0	483	0	7	16	7	7	7	7	14	7	72	0	7728	0
3000 man troop camp	9	12842	152358	49792	1	2	1	1	1	1	1	1	9	25684	304716	99584
1500 man troop camp	1	7087	78485	22601							1		1	0	0	0
Hospital	8	3400	56855	10347	1	1	1	1	1	1	1	1	8	3400	56855	10347
Force Protection Fence	117	53	543	294	12	24	12	12	12	12	21	12	117	1272	13032	7056
FP Gates	40	9	138	55	4	8	4	4	4	4	8	4	40	72	1104	440
FP Towers	117	7	117	35	12	24	12	12	12	12	21	12	117	168	2808	840
FP Bunkers	585	0	120	426	60	120	60	60	60	60	105	60	585	0	14400	51120
General Supply	10	71	1125.7	299	1	2	1	1	1	1	2	1	10	142	2251.4	598
Ammo	18	213	207	253	3	4	3	3	1	1	2	1	18	852	828	1012
POW camp	2	2220	3515	3420		1					1		2	2220	3515	3420
POL tank farm	5	3027	9391	9072	1		1	1	1		1		5	0	0	0
Land clearing tank farms	200	101	0	37	40		40	40	40		40		200	0	0	0
LC sewage plants	21	101	0	37	2	4	3	3	2	2	3	2	21	404	0	148
Land clearing AVUM/AVIM	12	101	0	37	1	2	2	1	1	2	2	1	12	202	0	74
						Total Work at Location B >>>>>								60597.5	621380	227580
						Roads (LOC), pipelines, bridges (LOC)										
						ARE NOT INCLUDED										

Location C

1	2	Per facility of installation 3	4	5	Quantity at location: 6	7	8	9	10	11	12	13	14	Man or Equipment Hours 15	16	17
Type	**No.**	**Horizontal**	**Vertical**	**General**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Total**	Horizontal	Vertical	General
Airfields	5	14718	4185	25603		1		1		1	1	1	5	0	0	0
Heliports	6	9254	2631	16099	1		1	1	1	1		1	6	9254	2631	16099
AVUM (GS CO)	6	643	38784	4083	1		1	1	1	1		1	6	643	38784	4083
AVUM (CAV)	2	964.5	58176	6124.5		1				1			2	0	0	0
AVUM (ATK)	2	964.5	58176	6124.5			1				1		2	964.5	58176	6124.5
AVIM	2	1929	116352	12249		1					1		2	0	0	0
Sewage Treatment	21	100	6040	1666	2	4	3	3	2	2	3	2	21	300	18120	4998
Potable water main	50	817	1127	230	5	10	5	5	5	5	10	5	50	4085	5635	1150
Potable water tanks	72	0	483	0	7	16	7	7	7	7	14	7	72	0	3381	0
3000 man troop camp	9	12842	152358	49792	1	2	1	1	1	1	1	1	9	12842	152358	49792
1500 man troop camp	1	7087	78485	22601							1		1	0	0	0
Hospital	8	3400	56855	10347	1	1	1	1	1	1	1	1	8	3400	56855	10347
Force Protection Fence	117	53	543	294	12	24	12	12	12	12	21	12	117	636	6516	3528
FP Gates	40	9	138	55	4	8	4	4	4	4	8	4	40	36	552	220
FP Towers	117	7	117	35	12	24	12	12	12	12	21	12	117	84	1404	420
FP Bunkers	585	0	120	426	60	120	60	60	60	60	105	60	585	0	7200	25560
General Supply	10	71	1125.7	299	1	2	1	1	1	1	2	1	10	71	1125.7	299
Ammo	18	213	207	253	3	4	3	3	1	1	2	1	18	639	621	759
POW camp	2	2220	3515	3420		1					1		2	0	0	0
POL tank farm	5	3027	9391	9072	1		1	1	1		1		5	3027	9391	9072
Land clearing tank farms	200	101	0	37	40		40	40	40		40		200	4040	0	1480
LC sewage plants	21	101	0	37	2	4	3	3	2	2	3	2	21	303	0	111
Land clearing AVUM/AVIM	12	101	0	37	1	2	2	1	1	2	2	1	12	202	0	74
					Total Work at Location C >>>>>									40526.5	362750	134117
					Roads (LOC), pipelines, bridges (LOC)											
					ARE NOT INCLUDED											

Location D																
		Per facility of installation			Quantity at location:									Man or Equipment Hours		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Type	No.	Horizontal	Vertical	General	A	B	C	D	E	F	G	H	Total	Horizontal	Vertical	General
Airfields	5	14718	4185	25603		1		1		1	1	1	5	14718	4185	25603
Heliports	6	9254	2631	16099	1		1	1	1	1		1	6	9254	2631	16099
AVUM (GS CO)	6	643	38784	4083	1		1	1	1	1		1	6	643	38784	4083
AVUM (CAV)	2	964.5	58176	6124.5		1				1			2	0	0	0
AVUM (ATK)	2	964.5	58176	6124.5			1				1		2	0	0	0
AVIM	2	1929	116352	12249		1					1		2	0	0	0
Sewage Treatment	21	100	6040	1666	2	4	3	3	2	2	3	2	21	300	18120	4998
Potable water main	50	817	1127	230	5	10	5	5	5	5	10	5	50	4085	5635	1150
Potable water tanks	72	0	483	0	7	16	7	7	7	7	14	7	72	0	3381	0
3000 man troop camp	9	12842	152358	49792	1	2	1	1	1	1	1	1	9	12842	152358	49792
1500 man troop camp	1	7087	78485	22601							1		1	0	0	0
Hospital	8	3400	56855	10347	1	1	1	1	1	1	1	1	8	3400	56855	10347
Force Protection Fence	117	53	543	294	12	24	12	12	12	12	21	12	117	636	6516	3528
FP Gates	40	9	138	55	4	8	4	4	4	4	8	4	40	36	552	220
FP Towers	117	7	117	35	12	24	12	12	12	12	21	12	117	84	1404	420
FP Bunkers	585	0	120	426	60	120	60	60	60	60	105	60	585	0	7200	25560
General Supply	10	71	1125.7	299	1	2	1	1	1	1	2	1	10	71	1125.7	299
Ammo	18	213	207	253	3	4	3	3	1	1	2	1	18	639	621	759
POW camp	2	2220	3515	3420		1					1		2	0	0	0
POL tank farm	5	3027	9391	9072	1		1	1	1		1		5	3027	9391	9072
Land clearing tank farms	200	101	0	37	40		40	40	40		40		200	4040	0	1480
LC sewage plants	21	101	0	37	2	4	3	3	2	2	3	2	21	303	0	111
Land clearing AVUM/AVIM	12	101	0	37	1	2	2	1	1	2	2	1	12	101	0	37
						Total Work at Location D >>>>>								54179	308759	153558
						Roads (LOC), pipelines, bridges (LOC)										
						ARE NOT INCLUDED										

Location E																
		Per facility of installation			Quantity at location:									Man or Equipment Hours		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Type	**No.**	**Horizontal**	**Vertical**	**General**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Total**	Horizontal	Vertical	General
Airfields	5	14718	4185	25603		1		1		1	1	1	5	0	0	0
Heliports	6	9254	2631	16099	1		1	1	1	1		1	6	9254	2631	16099
AVUM (GS CO)	6	643	38784	4083	1		1	1	1	1		1	6	643	38784	4083
AVUM (CAV)	2	964.5	58176	6124.5		1				1			2	0	0	0
AVUM (ATK)	2	964.5	58176	6124.5			1				1		2	0	0	0
AVIM	2	1929	116352	12249		1					1		2	0	0	0
Sewage Treatment	21	100	6040	1666	2	4	3	3	2	2	3	2	21	200	12080	3332
Potable water main	50	817	1127	230	5	10	5	5	5	5	10	5	50	4085	5635	1150
Potable water tanks	72	0	483	0	7	16	7	7	7	7	14	7	72	0	3381	0
3000 man troop camp	9	12842	152358	49792	1	2	1	1	1	1	1	1	9	12842	152358	49792
1500 man troop camp	1	7087	78485	22601							1		1	0	0	0
Hospital	8	3400	56855	10347	1	1	1	1	1	1	1	1	8	3400	56855	10347
Force Protection Fence	117	53	543	294	12	24	12	12	12	12	21	12	117	636	6516	3528
FP Gates	40	9	138	55	4	8	4	4	4	4	8	4	40	36	552	220
FP Towers	117	7	117	35	12	24	12	12	12	12	21	12	117	84	1404	420
FP Bunkers	585	0	120	426	60	120	60	60	60	60	105	60	585	0	7200	25560
General Supply	10	71	1125.7	299	1	2	1	1	1	1	2	1	10	71	1125.7	299
Ammo	18	213	207	253	3	4	3	3	1	1	2	1	18	213	207	253
POW camp	2	2220	3515	3420		1					1		2	0	0	0
POL tank farm	5	3027	9391	9072	1		1	1	1		1		5	3027	9391	9072
Land clearing tank farms	200	101	0	37	40		40	40	40		40		200	4040	0	1480
LC sewage plants	21	101	0	37	2	4	3	3	2	2	3	2	21	202	0	74
Land clearing AVUM/AVIM	12	101	0	37	1	2	2	1	1	2	2	1	12	101	0	37
						Total Work at Location E >>>>>								38834	298120	125746
						Roads (LOC), pipelines, bridges (LOC)										
						ARE NOT INCLUDED										

Location F																
		Per facility of installation			Quantity at location:									Man or Equipment Hours		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Type	No.	Horizontal	Vertical	General	A	B	C	D	E	F	G	H	Total	Horizontal	Vertical	General
Airfields	5	14718	4185	25603		1		1		1	1	1	5	14718	4185	25603
Heliports	6	9254	2631	16099	1		1	1	1	1		1	6	9254	2631	16099
AVUM (GS CO)	6	643	38784	4083	1		1	1	1	1		1	6	643	38784	4083
AVUM (CAV)	2	964.5	58176	6124.5		1				1			2	964.5	58176	6124.5
AVUM (ATK)	2	964.5	58176	6124.5			1				1		2	0	0	0
AVIM	2	1929	116352	12249		1					1		2	0	0	0
Sewage Treatment	21	100	6040	1666	2	4	3	3	2	2	3	2	21	200	12080	3332
Potable water main	50	817	1127	230	5	10	5	5	5	5	10	5	50	4085	5635	1150
Potable water tanks	72	0	483	0	7	16	7	7	7	7	14	7	72	0	3381	0
3000 man troop camp	9	12842	152358	49792	1	2	1	1	1	1	1	1	9	12842	152358	49792
1500 man troop camp	1	7087	78485	22601							1		1	0	0	0
Hospital	8	3400	56855	10347	1	1	1	1	1	1	1	1	8	3400	56855	10347
Force Protection Fence	117	53	543	294	12	24	12	12	12	12	21	12	117	636	6516	3528
FP Gates	40	9	138	55	4	8	4	4	4	4	8	4	40	36	552	220
FP Towers	117	7	117	35	12	24	12	12	12	12	21	12	117	84	1404	420
FP Bunkers	585	0	120	426	60	120	60	60	60	60	105	60	585	0	7200	25560
General Supply	10	71	1125.7	299	1	2	1	1	1	1	2	1	10	71	1125.7	299
Ammo	18	213	207	253	3	4	3	3	1	1	2	1	18	213	207	253
POW camp	2	2220	3515	3420		1					1		2	0	0	0
POL tank farm	5	3027	9391	9072	1		1	1	1		1		5	0	0	0
Land clearing tank farms	200	101	0	37	40		40	40	40		40		200	0	0	0
LC sewage plants	21	101	0	37	2	4	3	3	2	2	3	2	21	202	0	74
Land clearing AVUM/AVIM	12	101	0	37	1	2	2	1	1	2	2	1	12	202	0	74
						Total Work at Location F >>>>>								47550.5	351090	146959
						Roads (LOC), pipelines, bridges (LOC)										
						ARE NOT INCLUDED										

Location G																
		Per facility of installation			Quantity at location:									Man or Equipment Hours		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Type	**No.**	**Horizontal**	**Vertical**	**General**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Total**	Horizontal	Vertical	General
Airfields	5	14718	4185	25603		1		1		1	1	1	5	14718	4185	25603
Heliports	6	9254	2631	16099	1		1	1	1	1		1	6	0	0	0
AVUM (GS CO)	6	643	38784	4083	1		1	1	1	1		1	6	0	0	0
AVUM (CAV)	2	964.5	58176	6124.5		1				1			2	0	0	0
AVUM (ATK)	2	964.5	58176	6124.5			1				1		2	964.5	58176	6124.5
AVIM	2	1929	116352	12249		1					1		2	1929	116352	12249
Sewage Treatment	21	100	6040	1666	2	4	3	3	2	2	3	2	21	300	18120	4998
Potable water main	50	817	1127	230	5	10	5	5	5	5	10	5	50	8170	11270	2300
Potable water tanks	72	0	483	0	7	16	7	7	7	7	14	7	72	0	6762	0
3000 man troop camp	9	12842	152358	49792	1	2	1	1	1	1	1	1	9	12842	152358	49792
1500 man troop camp	1	7087	78485	22601							1		1	7087	78485	22601
Hospital	8	3400	56855	10347	1	1	1	1	1	1	1	1	8	3400	56855	10347
Force Protection Fence	117	53	543	294	12	24	12	12	12	12	21	12	117	1113	11403	6174
FP Gates	40	9	138	55	4	8	4	4	4	4	8	4	40	72	1104	440
FP Towers	117	7	117	35	12	24	12	12	12	12	21	12	117	147	2457	735
FP Bunkers	585	0	120	426	60	120	60	60	60	60	105	60	585	0	12600	44730
General Supply	10	71	1125.7	299	1	2	1	1	1	1	2	1	10	142	2251.4	598
Ammo	18	213	207	253	3	4	3	3	1	1	2	1	18	426	414	506
POW camp	2	2220	3515	3420		1					1		2	2220	3515	3420
POL tank farm	5	3027	9391	9072	1		1	1	1		1		5	3027	9391	9072
Land clearing tank farms	200	101	0	37	40		40	40	40		40		200	4040	0	1480
LC sewage plants	21	101	0	37	2	4	3	3	2	2	3	2	21	303	0	111
Land clearing AVUM/AVIM	12	101	0	37	1	2	2	1	1	2	2	1	12	202	0	74
						Total Work at Location G >>>>>								61102.5	545698	201355
						Roads (LOC), pipelines, bridges (LOC)										
						ARE NOT INCLUDED										

Location H																
		Per facility of installation			Quantity at location:									Man or Equipment Hours		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Type	**No.**	**Horizontal**	**Vertical**	**General**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Total**	Horizontal	Vertical	General
Airfields	5	14718	4185	25603		1		1		1	1	1	5	14718	4185	25603
Heliports	6	9254	2631	16099	1		1	1	1	1		1	6	9254	2631	16099
AVUM (GS CO)	6	643	38784	4083	1		1	1	1	1		1	6	643	38784	4083
AVUM (CAV)	2	964.5	58176	6124.5		1				1			2	0	0	0
AVUM (ATK)	2	964.5	58176	6124.5			1				1		2	0	0	0
AVIM	2	1929	116352	12249		1					1		2	0	0	0
Sewage Treatment	21	100	6040	1666	2	4	3	3	2	2	3	2	21	200	12080	3332
Potable water main	50	817	1127	230	5	10	5	5	5	5	10	5	50	4085	5635	1150
Potable water tanks	72	0	483	0	7	16	7	7	7	7	14	7	72	0	3381	0
3000 man troop camp	9	12842	152358	49792	1	2	1	1	1	1	1	1	9	12842	152358	49792
1500 man troop camp	1	7087	78485	22601							1		1	0	0	0
Hospital	8	3400	56855	10347	1	1	1	1	1	1	1	1	8	3400	56855	10347
Force Protection Fence	117	53	543	294	12	24	12	12	12	12	21	12	117	636	6516	3528
FP Gates	40	9	138	55	4	8	4	4	4	4	8	4	40	36	552	220
FP Towers	117	7	117	35	12	24	12	12	12	12	21	12	117	84	1404	420
FP Bunkers	585	0	120	426	60	120	60	60	60	60	105	60	585	0	7200	25560
General Supply	10	71	1125.7	299	1	2	1	1	1	1	2	1	10	71	1125.7	299
Ammo	18	213	207	253	3	4	3	3	1	1	2	1	18	213	207	253
POW camp	2	2220	3515	3420		1					1		2	0	0	0
POL tank farm	5	3027	9391	9072	1		1	1	1		1		5	0	0	0
Land clearing tank farms	200	101	0	37	40		40	40	40		40		200	0	0	0
LC sewage plants	21	101	0	37	2	4	3	3	2	2	3	2	21	202	0	74
Land clearing AVUM/AVIM	12	101	0	37	1	2	2	1	1	2	2	1	12	101	0	37
						Total Work at Location H >>>>>								46485	292914	140797
						Roads (LOC), pipelines, bridges (LOC)										
						ARE NOT INCLUDED										

APPENDIX D

FORCE XXI: ECHELONS ABOVE DIVISION BATTALION DESIGN

This appendix contains a January 2000 briefing on the proposed multifunctional corps engineer battalion design prepared by Mr. Peter Malley of the U.S. Army Engineer School. MG Robert Flowers, the Commandant of the U.S. Army Engineer School, directed Mr. Malley to develop this battalion design in May 1999. He approved the design in August 1999, at which time Mr. Malley began using this briefing to present the idea to the engineer community. This is a "snapshot" in time of the organization and composition of the proposed design. It should enable the reader to see the proposed EAD engineer battalion design as it existed when the research occurred. The reader may also use it as a substitute for the objective table of organization equipment for the multifunctional EAD engineer battalion, since no requirement or authorization documents currently exist for the proposed design.

UNITED STATES ARMY ENGINEER CENTER

Force XXI

ECHELONS ABOVE DIVISION

BATTALION DESIGN

ESSAYONS — "Let US Try" — 1

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ECHELONS ABOVE DIVISION BATTALION DESIGN

AGENDA

- INTRODUCTION
- BACKGROUND - WHY?
- CONCEPTS, MISSIONS, & DESIGN
- DTLOMS
- TIMELINES

Echelons Above Division Engineer Battalion Design

WHY?

MG FLOWERS GUIDANCE

To develop/design an Echelons Above Division Battalion that is responsive, deployable, agile, versatile and sustainable. This battalion will have the capabilities to perform combat, horizontal, and vertical missions to support the division, corps, and Army.

ECHELONS ABOVE DIVISION ENGINEER BATTALION

WHY CHANGE

- Current Structure is still under the "Cold War" era. Units are not responsive, deployable, agile, versatile, or sustainable. Units structured under "AOE" Army requirements.
- Units cannot simultaneously deploy without another type of EAD or EAC unit to support:
  - Mechanized & Wheel CBT Bns must have Cbt Spt Equip Co for horizontal support
  - Mechanized & Wheel Battalions must have Combat Heavy Bn to perform Vertical and Horizontal missions beyond the capabilities of the CSE.
- Majority of units are not modular nor tailorable for operations in all environments across full spectrum of military operations.
  - Division XXI area of operations - 200 x 120 kms
  - Corps XXI area of operations - 250,000 kms.
- Engineers deploy personnel & equipment not required in theater of operations: i.e. tracks versus wheels, ACEs versus Dozers, combat engineers versus horizontal and/or vertical engineers.
- Engineers are "large" and require many sorties - get to the fight late.
- Command & Control of numerous EAD/EAC separate units in Corps is "difficult" - Who controls ? Brigade, Group or Combat Battalion Commanders?
- Force providers (MACOMs) have deployed "the wrong type" of engineer units.

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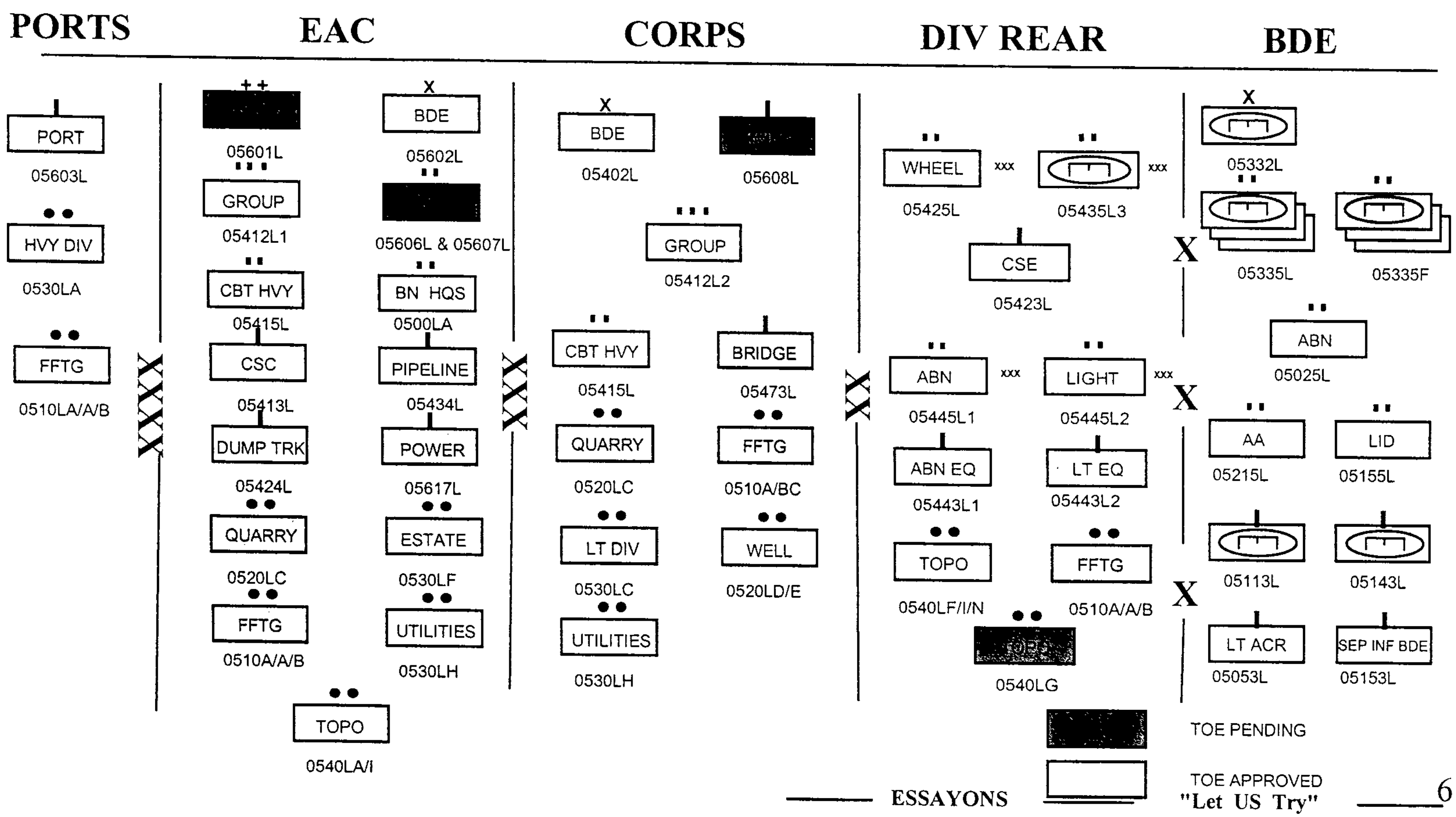
ENGINEER (EAD) BATTLEFIELD DOCTRINE



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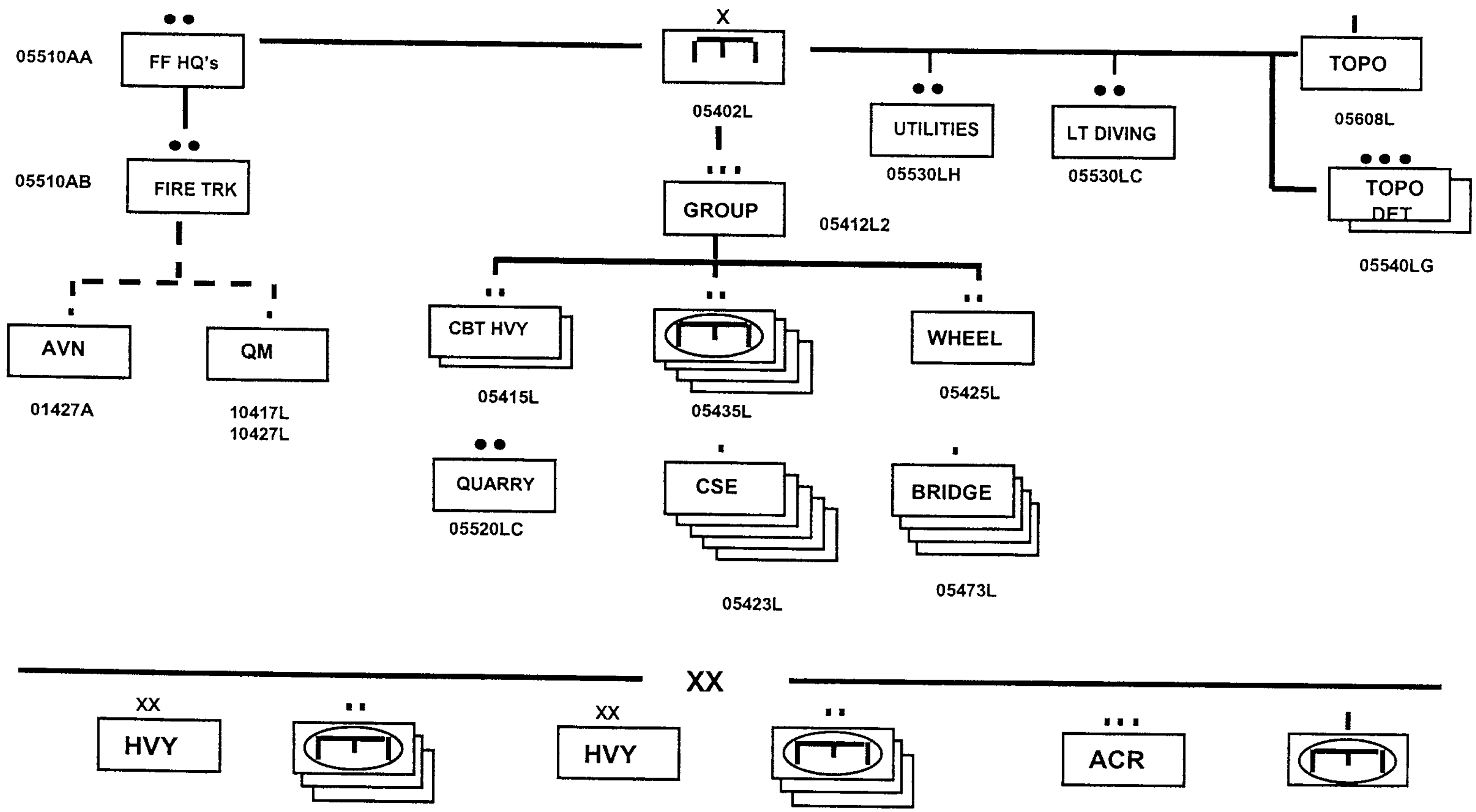
ENGINEER STRUCTURE AT CORPS



ESSAYONS "Let US Try" 7

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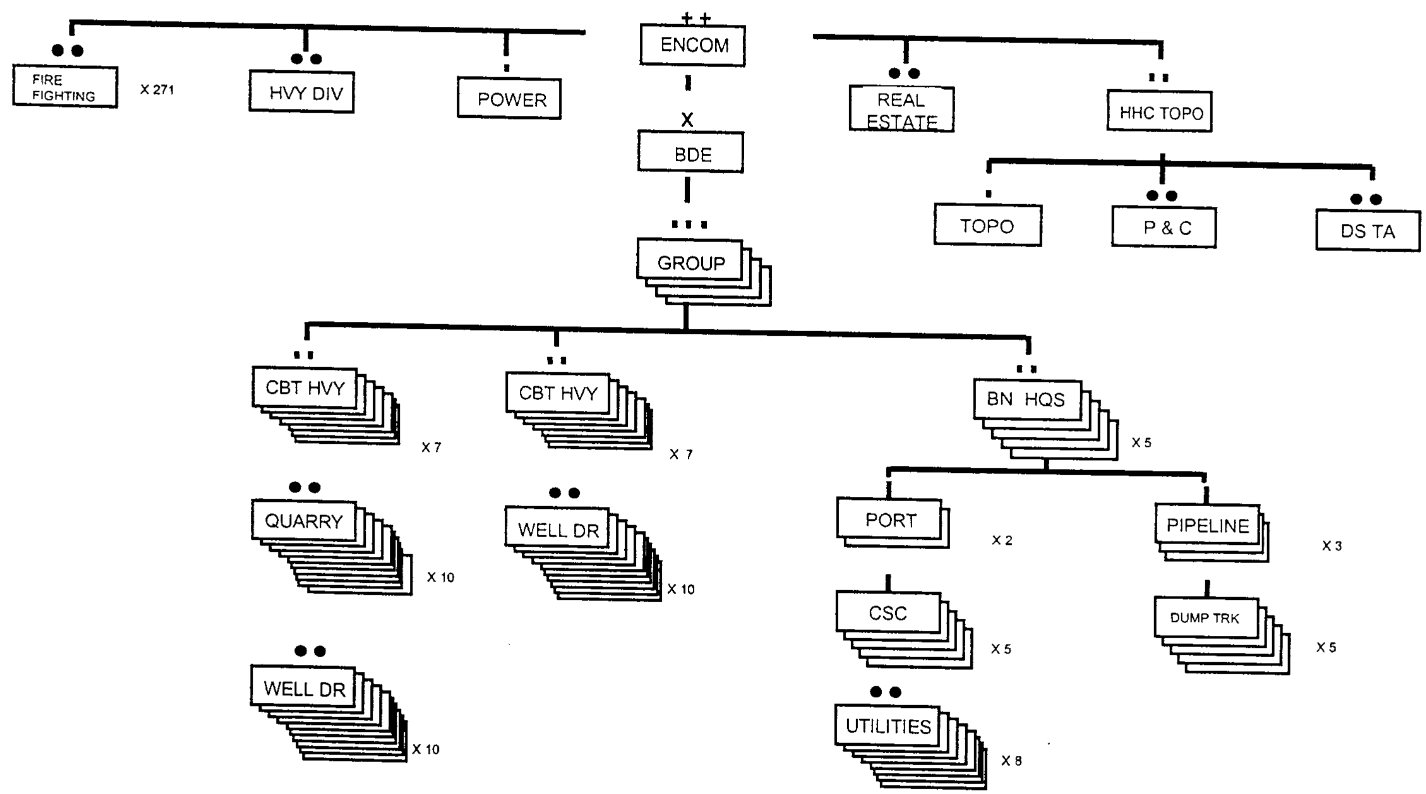
ENGINEER STRUCTURE AT EAC



ESSAYONS "Let US Try" 8

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ENGINEER FORCE STRUCTURE - FY 00 TO FY 05

PERSONNEL

	AC	NG	AR	TOTAL
CBT	12,926	18,684	5,203	36,813
CS	7,781	19,171	11,923	38,875
CSS	265	3,064	3,387	6,716
TOTAL	20,972	40,919	20,513	82,404
% FORCE	(25%)	(50%)	(25%)	(100%)

C2 & BATTALION STRUCTURE

COMBAT

TYPES OF UNITS	AC	NG	AR	TOTAL
BDE , HVY DIV	5	7	0	12
BN, HVY DIV	15	22	0	37
BN, HVY DIV FXXI	3	0	0	3
BN, AIRBORNE DIV	1	0	0	1
BN, AIR ASSAULT DIV	1	0	0	1
BN, LT INFANTRY DIV	2	1	0	3
HHC,GRP COMBAT	2	3	2	7
BN, CORPS WHEEL	1	6	3	10
BN, CORPS MECH (APC)	0	5	3	8
BN, CORPS MECH (FULL)	2	0	2	4
BN, CORPS ABN	2	0	0	2
BN, CORPS LT	0	1	2	3

COMBAT SUPPORT

TYPES OF UNITS	AC	NG	AR	TOTAL
ENCOM	0	0	2	2
HHC, BDE, TA	0	2	1	3
HHC, BDE, CORPS	2	1	1	4
HHC, GRP CONSTR	1	7	2	10
BN, CBT HVY	7	19	14	40
BN, HHC TOPO	2	1	0	3
TM, BN HQS	0	8	2	10

COMBAT SERVICE SUPPORT

TYPES OF UNITS	AC	NG	AR	TOTAL
BN, HHC PRIME POWER	1	0	0	1

Echelons Above Division Engineer Battalion Design

CONCEPT, MISSIONS, & UNIT DESIGN

ECHELONS ABOVE DIVISION BATTALION DESIGN

CONCEPT

- Current structure requires different “types” of En Combat Battalion’s and Companies that must be “task organized” to support CBT, CS,and CSS organizations. Force Providers must decide “what type” of unit is required.
- One type of EAD Battalion that has the capabilities for performing combat, horizontal, and vertical missions as well as having combat engineers (12 series), equipment operators (62 series), and vertical (51 series) personnel assigned.
- The Engineer Line Company platoon’s are the “key” to the operations & missions.
- EAD Battalion will be modular and tailorable and can be deployed as a battalion, company, or platoon based on METT-T. It is design to support ALL divisions and Echelons Above Division organizations throughout the theater of operations.
- Unit is not required to be 100% Mobile. Unit will deploy with personnel/equipment that is required based on METT-T with the remaining equipment staying at home station.
- En units that possess special capabilities. i.e. Corps Airborne & Light Battalion’s, Headquarters Teams, bridging, pipeline, port opening, topographic companies, quarry, utilities, well drilling and fire fighting teams will not be changed.

ECHELONS ABOVE DIVISION BATTALION DESIGN

DIVISION & CORPS MISSIONS

- Provides C2 & staff supervision for assigned and attached units.
- Conducts breaching operations of natural or man-made obstacles and improving trafficability of routes for cavalry regiments, field artillery, logistic units, and other non-divisional units.
- During deliberate breaches at division or brigade level, may provide support to the breach force, (preserving the divisional engineers for follow-on operations); follow and widen breaches conducted by divisional engineers; or breach obstacle bypassed by the division engineer units.
- Constructs tactical obstacles & defensive positions
- Employs fixed and floating bridges with support from the Engineer Multirole Bridge Company
- Emplaces and maintains assault bridges.
- Constructs, repairs, and maintains landing strips, heliports, CPs, LOC and tactical routes, culverts, fords and other horizontal construction related tasks.
- Provides initial base-development planning that identifies requirements for logistics support and troop bed-down facilities.

ECHELONS ABOVE DIVISION BATTALION DESIGN

DIVISION & CORPS MISSIONS

- Provide support to division and corps aviation operations to include coordinating and assisting the emplacement of scatterable mines by helicopters and fixed-wing aircraft to block enemy penetrations, turn enemy formations or protect the flanks of corps counterattacks.
- Provide general engineering support to the Aviation assets in division and corps; such as, erecting aviation logistics and maintenance facilities, constructing forward area rearm/refuel points (FARP) and low-altitude parachute extraction zones (LAPES).
- Provide engineer support for Field Artillery and Air Defense Artillery units which include digging in fire-direction centers, building protective berms, and breaching scatterable minefields.
- Provide general engineering support to the tactical C2 nodes which include the construction of bunkers and other structures, such as NBC collective protective shelters, to protect commanders, staff, and critical signal nodes.
- Provide engineer support for the division and corps units chemical decontamination requirements; such as, route reconnaissance, site selection, site preparation, and engineer planning.

ECHELONS ABOVE DIVISION BATTALION DESIGN

ECHELONS ABOVE CORPS MISSIONS

- There are twenty-three (23) engineer tasks that the En Combat Heavy Battalion is required to support: (CINC approved for TAA 07)
  - War Damage Repair (7 tasks)
    - Roads/Highways · Pipeline · Army Airfields
    - Highway Bridges · Ports
    - Railroads · Railroad Bridges
  - Facility Maintenance (3 tasks)
    - Roads/Highways · Ports · Railroads
  - Facility Construction (13 tasks)
    - Troop Camps · Replacement Camps · Internment/Resettlement Camps
    - General Supply Storage · Ammunition Storage · Refrigerated Storage
    - Administrative Space · Maintenance Facilities · Road Hardstands
    - POL Storage · Medical/Dental Clinics · Deployable Medical Systems
    - ADA Sites

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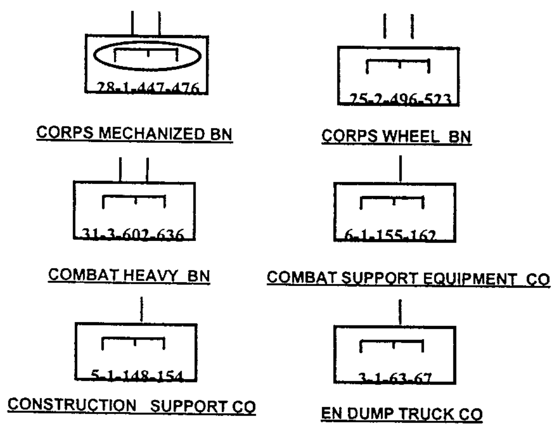
ECHELONS ABOVE DIVISION BATTALION DESIGN

CURRENT EAD STRUCTURE

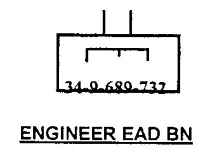


TAA - 05 FORCE STRUCTURE
CURRENT BN'S & PERSONNEL

	AC	NG	AR	TOTAL
TOTAL BN's	10	30	22	62
PERSONNEL	5,931	21,938	14,651	42,520*

* Personnel - Total number is based on Bn's listed as well as all of the CSE, CSC, and Dump Truck Companies.

PROPOSED EAD STRUCTURE



DRAFT

TAA - 05 FORCE STRUCTURE
PROPOSED BN'S & PERSONNEL

	AC	NG	AR	TOTAL	DELTA
TOTAL BN's	8	29	20	57	- 5
PERSONNEL	5,856	21,228	14,651	41,724	- 796

ESSAYONS "Let US Try" 15

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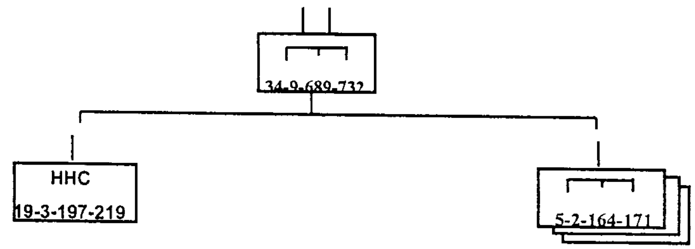
ECHELONS ABOVE DIVISION BATTALION DESIGN

DRAFT



MAJOR EQUIPMENT RECAP

17 - APC
2 - M577
12 - AVLB
12 - ACE
6 - VOLCANO
12 - MICLIC
12 - 2 1/2T TRAILER
50 - HMMWV
36 - MTV DUMP TRUCK
19 - HEMTT CARGO
20 - LMTV CARGO TRUCK
14 - LMTV TRAILER
9 - 1 1/2 TON TRAILER
13 - MTV CARGO TRUCK
12 - MTV TRAILERS

9 - GRADERS
9 - D7 DOZERS
9 - DEUCES
9 - SCRAPERS
6 - SEE
6 - 2 1/2 CY SCOOP LOADER
3 - 25 TON CRANE
16 - MET
10 - 40T SEMITRAILER
6 - WATER DISTR, 2500 GAL
5 - ROLLER VIB
3 - COMPACTOR, HIGH SPEED
9 - TAMPER VIB
6 - CONCRETE VIB
3 -SCOOP LOADER 5 CY
3 - HYEX

3 - 250 CFM
4 - CONTACT MAINT
4 - HMMWV, HVY VARIANT
4 - WELDING TRAILER
3 - AMBULANCE HMMWV
4 - HEMTT WRECKER
4 - M88A2
6 - HEMTT POL
4 - HYSTRU
1 - LUBE TRAILER
1 - SHOP EQUIP ORG, LT
3 - SHOP EQUIP WOOD
3 - HETO
3 - CONCRETE MIXER MODULE: PLS 2600 GALLON
12 - DUMP BODY MODULE: PLS 14 TON

2 - FORKLIFT
5 - WATER TRAILERS
4 - MKT
4 - KCLFF
3 - 3/4T HIGH MOB TRAILER
1 - HEATER OIL
2 - KETTLE HEATING BITUMEN
2 - MELTER ASPHALT
1 - MIIXER ROTARY TILLER
1 - ROLLER MOTORIZED STEEL WHEEL
6 - HEAVY PLS TRANSPORTER
6 - PLS TRAILERS
4 - SPREADER AGGREGATE TOWED
3 - BITUMINOUS SPREADER MODULAR: PLS 2500 GALLON
6 - 20 TON DUMP TRUCK

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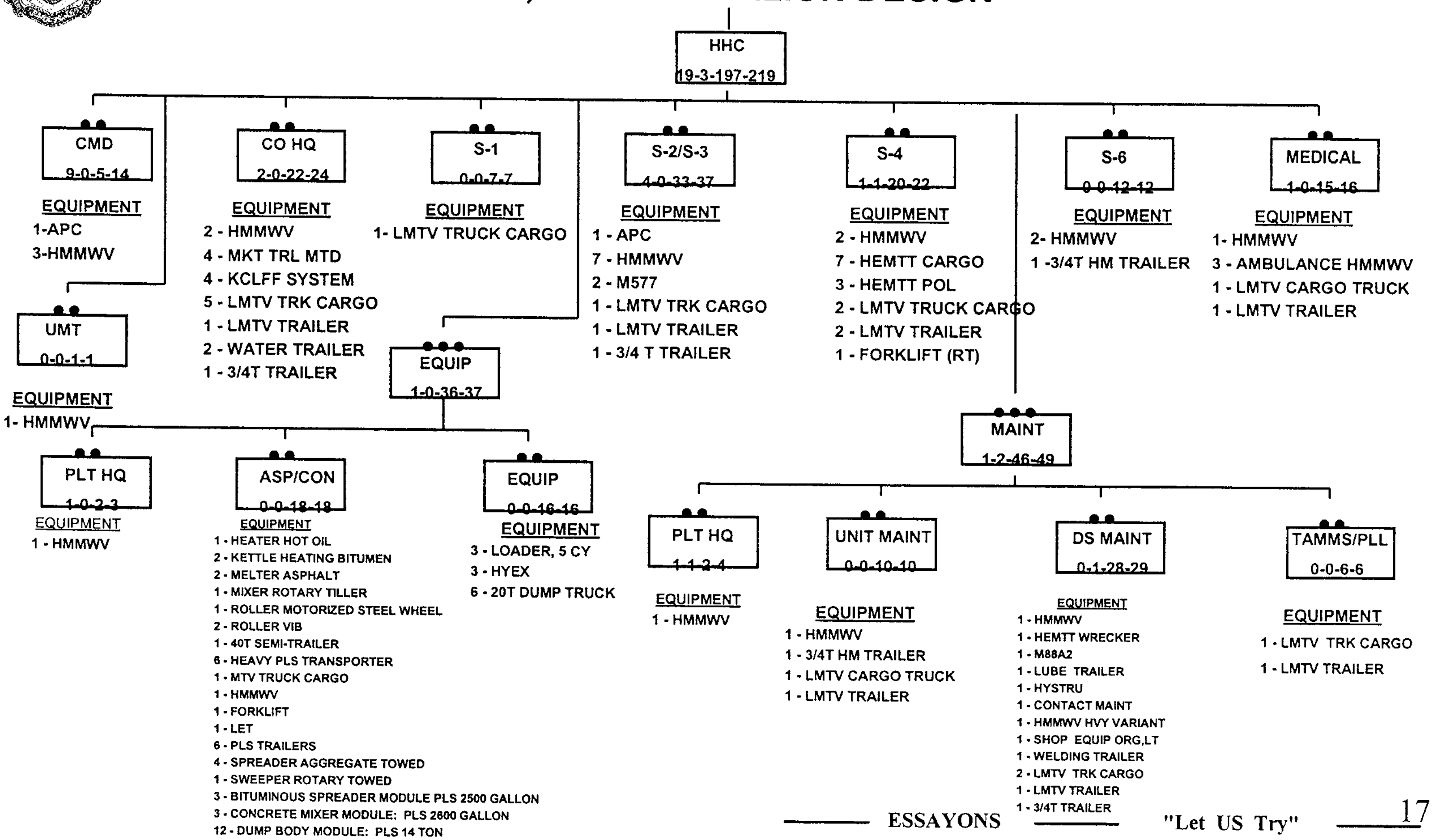
HHC, EAD BATTALION DESIGN



ESSAYONS "Let US Try" 17

STAFF SECTIONS - BN HEADQUARTERS

CMD 9-0-5-14

PERSONNEL
- 1- CDR (LTC/21B)
- 1 - XO (MAJ/21B)
- 1 - S3 (MAJ/21B)
- 1 - S1 (CPT/21B)
- 1 - S4 (CPT/21B)
- 1 - S2 (CPT/35D)
- 1 - MAINT OFF (CPT/21B)
- 1 - S6 (CPT/25A)
- 1 - CHAPLAIN (CPT/56A)
- 1 - CSM (E-9/00Z)
- 4 - WHL VEH DRIVER (E-4/12B)

EQUIPMENT
- 1-APC
- 3-HMMWV

S-1 0-0-7-7

PERSONNEL
- 1- SR PERSONNEL SGT (E-7/75H)
- 1 - PERSONNEL SVC SGT (E-6/75H)
- 1 - PERSONNEL ADMIN SGT (E-5/75B)
- 1 - LEGAL SPECIALIST (E-4/71D)
- 1 - ADMIN SP (E-4/71L)
- 1 - PERSONNEL ADMIN SP (E-4/75B)
- 1 - MAIL DELIVERY CLERK (E-3/71L)

EQUIPMENT
- 1- LMTV TRUCK CARGO

UMT 0-0-1-1

PERSONNEL
- 1- CHAPLAIN ASSISTANT (E-4/71M)

EQUIPMENT
- 1- HMMWV

MEDICAL 1-0-15-16

PERSONNEL
- 1- PHYSICIAN ASSIST (LT/65D)
- 1- TREATMENT TM NCO (E-6/91B)
- 3 - AMBULANCE TM LDR (E-5/91B)
- 1 - MEDICAL SPEC (E-4/91B)
- 6 - COMBAT MEDIC (E-4/91B)
- 1 - MEDICAL SPEC (E-3/91B)
- 3 - AMBULANCE AIDE/DR (E-3/91B)

EQUIPMENT
- 1- HMMWV
- 3 - AMBULANCE HMMWV
- 1 - LMTV CARGO TRUCK
- 1 - LMTV TRAILER

S-6 0-0-12-12

PERSONNEL
- 1- SECTION NCO (E-7/31U)
- 1 - TEAM CHIEF (E-5/31U)
- 3 - FWD SIGNAL SPT NCO (E-5/31U)
- 1 - SR SIG SPT SYS MAINT (E-5/31U)
- 1 - RADIO RETRANS OP (E-4/31U)
- 1 - SIGNAL SPT SYS MAINT (E-4/31U)
- 1 - SIGNAL INFO SVC SP (E-4/31U)
- 1 - RADIO RETRANS OPR (E-3/31U)
- 1 - SIGNAL SPT SYST MAINT (E-3/31U)
- 1 - SIGNAL SPT SYS SP (E-3/31U)

EQUIPMENT
- 2- HMMWV
- 1 -3/4T HM TRAILER

DISCUSSION POINTS

- Command Section - **Is there sufficient staff to C2 assigned and attached engineer units?**
- S-1 - Number of soldiers assigned is based on the number of personnel in the battalion **(MARC driven).**
- Unit ministry Team - No change to current requirements
- Medical - added PA & 3 Ambulances with medic's as well as combat medic's for the line companies **(MARC driven will need sufficient justification to make this happen).**
- . S-6 - Number of soldiers assigned in the is based on switchboards & radios. **(MARC driven requirement) - What type of radio's are required and all OPFAC rules will require a change?**

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STAFF SECTIONS - BN HEADQUARTERS

S-2/S-3 (4-0-33-37)

S-2 (1-0-14-15)

PERSONNEL
- 1- RECON OFFICER (1LT/21B)
- 1 - INTELLIGENCE SGT (E-7/12B)
- 1 - INTELLIGENCE ANALYST (E-5/96B)
- 2 - ASAS OPER (E-4/96B)
- 3 - SECTION LEADER (E-6/12B)
- 3 - RECON SGT (E-5/12B)
- 3 - RECON WHL VEH DRIVER (E-4/12B)
- 1 - WHEEL VEH DRIVER (E-3/12B)

EQUIPMENT
- 4 - HMMWV
- 1 - 3/4T HM TRAILER
- 1 - ASAS

S-3 (3-0-19-22)

PERSONNEL
- 1- PLANS OFFICER (CPT/21B)
- 1 - CIVIL ENGINEER (CPT/21B)
- 1 - OPERATIONS OFFICER (CPT/21B)
- 1 - OPERATIONS SGT (E-8/12Z)
- 1 - CONSTR INSPECTOR (E-7/51H)
- 1 - NBC STAFF NCO (E-7/54B)
- 1 - CONSTR FOREMAN (E-7/62N)
- 1 - TECH ENGR NCO (E-6/51T)
- 3 - TECH ENGR SGT (E-5/51T)
- 3 - TECH ENGR SPEC (E-4/51T)
- 3 - TECH ENGR SPEC (E-3/51T)
- 3 - TRACK VEH OPER (E-3/12B)
- 2 - WHEEL VEH OPER (E-3/12B)

EQUIPMENT
- 1 - APC
- 3 - HMMWV
- 2 - M577
- 1 - LMTV TRK CARGO
- 1 - LMTV TRAILER

S-4 (1-1-20-22)

STAFF (1-1-8-10)

PERSONNEL
- 1 - OPERATIONS OFFICER (1LT/21B)
- 1- PROPERTY BOOK OFF (W-2/920)
- 1 - SECTION NCO (E-7/92Y)
- 1 - SUPPLY SGT (E-6/92Y)
- 1 - SUPPLY SGT (E-5/92Y)
- 2 - SUPPLY SPEC (E-4/92Y)
- 1 - ADMIN SPEC (E-4/71L)
- 1 - MHE OPERATOR (E-3/92A)
- 1 - SUPPLY SPEC (E-3/92Y)

EQUIPMENT
- 1 - HMMWV
- 2 - LMTV TRUCK CARGO
- 2 - LMTV TRAILER
- 1 - FORKLIFT (RT)

TRANS (0-0-12-12)

PERSONNEL
- 1- SECTION LEADER (E-6/12B)
- 1 - PETRL HVY VEH OPR (E-5/77F)
- 7 - HEAVY VEHICLE DRIVER (E-4/12B)
- 2 - PETRL HVY VEH OPR (E-4/77F)
- 1 - WHL VEH DRIVER (E-4/12B)

EQUIPMENT
- 7 - HEMTT CARGO
- 3 - HEMTT POL
- 1 - HMMWV

DISCUSSION POINTS

- S-2 - Added Recon capability (3 tm's - one E-6,E-5,&E-4 w/equip). **Is there sufficient justification?** Added ASAS system with operators. **Is it required?**
- S-3 - added a Plans and Civil Engineer Officers, Construction NCO's, and 51T's (Construction Survey, Soils, and Drafting),
- S-4 - added PBO & Operations Officer, consolidated support platoon (transportation & POL) assets.

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HEADQUARTERS COMPANY, BATTALION

HQ CO
2-0-22-24

PERSONNEL

1- COMMANDER (CPT/21B)
1 - OPERATIONS OFF (1LT/21B)
1 - FIRST SGT (E-8/12Z)
1 - OPERATIONS SGT (E-7/12B)
1 - SR FOOD OPNS SGT (E-7/92G)
1 - SR FIRST COOK (E-6/92G)
1 - SUPPLY SGT (E-6/92Y)
3 - COOK (E-5/92G)
6 - COOK (E-4/92G)
1 - ARMORER (E-4/92Y)
2 - VEHICLE DRIVERS (E-3/12B)
4 - COOK (E-3/92G)
1 - SUPPLY SP (E-3/92Y)

EQUIPMENT

2 - HMMWV
4 - MKT TRL MTD
4 - KCLFF SYSTEM
5 - LMTV TRK CARGO
1 - LMTV TRAILER
2 - WATER TRAILER
1 - 3/4T TRAILER

DISCUSSION POINTS

- Mess personnel & equipment has been placed under the command of the Company commander
- The number of mess personnel & equipment required is based on MARC. **Is there sufficient justification to justify to quartermaster school on adding more MKT's to this organization?**

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SPECIAL EQUIPMENT PLATOON, BN HEADQUARTERS

EQUIP
1-0-36-37

PLT HQ
1-0-2-3

PERSONNEL
1 - PLT LEADER (1LT/21B)
1 - PLT SGT (E-7/62N)
1 - WHEEL VEH DR (E-4/62E)

EQUIPMENT
1 - HMMWV

ASPHALT & CONCRETE
~~0-0-18-18~~

PERSONNEL
1 - PAVING OP SUPV (E-6/62H)
3 - CONCRETE/ASPHALT (E-5/62H)
1 - GEN CONSTR EQUIP OP (E-5/62J)
1 - HVY VEH DR (E-4/62H)
4 - CONCRETE/ASPHALT (E-4/62H)
2 - GEN CONSTR EQUIP OPR (E-4/62J)
3 - CONCRETE/ASPHALT (E-3/62H)
2 - GEN CONSTR EQUIP OP (E-3/62J)
1 - MHE OPERATOR (E-3/92A)

EQUIPMENT
1 - HEATER HOT OIL
2 - KETTLE HEATING BITUMEN
2 - MELTER ASPHALT
1 - MIXER ROTARY TILLER
1 - ROLLER MOTORIZED STEEL WHEEL
2 - ROLLER VIB
1 - 40T SEMI-TRAILER
6 - HEAVY PLS TRANSPORTER

EQUIPMENT
1 - MTV TRUCK CARGO
1 - HMMWV
1 - FORKLIFT
1 - MET
6 - PLS TRAILERS
4 - SPREADER AGGREGATE TOWED
1 - SWEEPER ROTARY TOWED
3 - BITUMINOUS SPREADER MODULE PLS 2500 GALLON
3 - CONCRETE MIXER MODULE: PLS 2600 GALLON
12 - DUMP BODY MODULE: PLS 14 TON

EQUIP
0-0-16-16

PERSONNEL
1 - SECTION SGT (E-6/62N)
3 - CRANE OPER (E-5/62F)
2 - HVY VEH DR (E-5/88M)
3 - CRANE OPER (E-4/62F)
2 - GEN CONSTR EQUIP OP (E-4/62E)
2 - HVY VEH OPER (E-4/88M)
2 - HVY VEH OPER (E-3/88M)
1 - GEN CONSTR EQUIP OP (E-3/62E)

EQUIPMENT
3 - LOADER, 5 CY
3 - HYEX
6 - 20T DUMP TRUCK

DISCUSSION POINTS

- Personnel & equipment taken from the current En Combat Heavy Bn design. **Can the personnel and equipment assigned perform the division, corps, and echelon above corps missions?**

MAINTENANCE PLATOON, BATTALION HEADQUARTERS

MAINT 1-2-46-49

PLT HQ 1-1-2-4

PERSONNEL

1- PLATOON LEADER (1LT921B)
1-SPT AUTO MNT OFFICER (W4/915E)
1 - MECH MAINT OPS NCO (E-8/63Z)
1 - WHEEL VEHICLE DRIVER (E-4/62B)

EQUIPMENT

1 - HMMWV

UNIT 0-0-10-10

PERSONNEL

1- Motor SGT (E-6/63B)
1 - EQUIP REC/PARTS SGT (E-5/92A)
1 - LT WHL VEH MECH (E-5/63B)
1 - HVY WHL MECH (E-5/63S)
1 - LT WHL VEH MECH (E-4/63B)
1 - HVY WHL MECH (E-4/63S)
1 - TRACK VEH MECH (E-4/63Y)
1 - QM/CM EQUIP REP (E-4/63J)
2 - LT WHL VEH MECH (E-3/63B)

EQUIPMENT

1 - HMMWV
1 - 3/4T HM TRAILER
1 - LMTV CARGO TRUCK
1 - LMTV TRAILER

DS MAINT 0-1-28-29

PERSONNEL

1- EN REP TECH (W4/919A)
1 - CONSTR EQUIP SUPV (E-7/62B)
1 - SR CONSTR EQUIP REP (E-6/62B)
1 - AUTO REP SGT (E-6/63H)
1 - MACHINIST (E-5/44E)
1 - CONSTR EQUIP REP (E-5/62B)
2 - TRACK VEH REP (E-5/63H)
1 - WHL VEH REP (E-5/63W)
1 - RECOVERY VEH OPER (E-5/63Y)
2 - CONSTR EQUIP REP (E-4/62B)
2 - TRACK VEH REP (E-4/63H)
2 - WHL VEH REP (E-4/63W)
1 - QM/CM EQUIP REP (E-4/63J)
1 - METAL WORKER REP (E-4/44B)
1 - PWR-GEN EQUIP REP (E-4/52D)
1 - RECOVERY VEH OP (E-4/63S)
1 - RECOVERY VEH OP (E-4/63Y)
2 - CONSTR EQUIP REP (E-3/62B)
3 - TRACK VEH REP (E-3/63H)
2 - WHL VEH REP (E-3/63W)
1 - MACHINIST (E-3/44E)

EQUIPMENT

1 - HMMWV
1 - HEMTT WRECKER
1 - M88A2
1 - LUBE TRAILER
1 - HYSTRU
1 - CONTACT MAINT
1 - HMMWV HVY VARIANT
1 - SHOP EQUIP ORG,LT
1 - WELDING TRAILER
2 - LMTV TRK CARGO
1 - LMTV TRAILER
1 - 3/4T TRAILER

TAMMS/PLL 0-0-6-6

PERSONNEL

1 - MAT CON/ACCTG SUPV (E-6/92A)
1 - MAT CON/ACCTG NCO (E-5/92A)
2 - MAT CON/ACCTG SP (E-4/92A)
2 - MAT CON/ACCTG SP (E-3/92A)

EQUIPMENT

1 - LMTV TRK CARGO
1 - LMTV TRAILER

DISCUSSION POINTS

- Personnel & equipment based on MARC. The Unit & DS maintenance structure was based on the En Combat Heavy Bn - **Is it the right design - personnel & equipment? Is there justification for W4 (915E & 919A)?**

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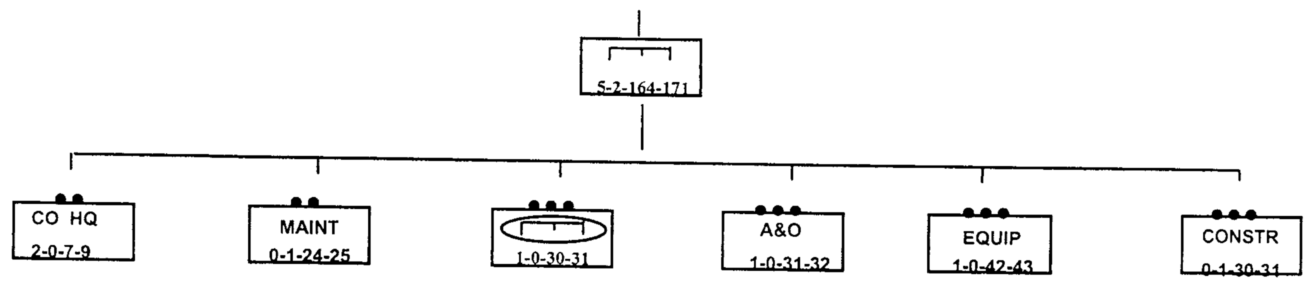
ENGINEER LINE COMPANY, EAD BATTALION DESIGN



CO HQ — EQUIPMENT
- 1 - APC
- 1 - HMMWV
- 1 - LMTV TRK CARGO
- 1 - LMTV TRAILER
- 1 - WATER TRAILER

MAINT — EQUIPMENT
- 1 - HMMWV
- 1 - CONTACT MAINT
- 1 - HMMWV HVY VARIANT
- 1 - HYSTRU
- 1 - HEMTT WRECKER
- 1 - M88A2
- 1 - WELDING TRAILER
- 1 - LMTV TRUCK CARGO
- 1 - LMTV TRAILER
- 1 - HEMTT POL

1-0-30-31 — EQUIPMENT
- 1 - HMMWV
- 4 - APC
- 3 - MTV DUMP TRK
- 3 - 1 1/2T TRAILERS

A&O — EQUIPMENT
- 3 - HMMWV
- 4 - AVLB
- 4 - ACE
- 2 - VOLCANO
- 4 - MICLIC
- 4 - 2 1/2T TRAILER
- 4 - HEMTT CARGO

EQUIP — EQUIPMENT
- 2 - HMMWV
- 3 - DEUCES
- 3 - DOZERS
- 3 - GRADERS
- 3 - SCRAPERS
- 2 - 2 1/2 CY LOADER
- 2 - SEE
- 1 - 25T CRANE
- 2 - WATER DISTR, 2500 GAL
- 1 - COMPACTOR, HIGH SPEED
- 1 - ROLLER, VIB
- 2 - TAMPER, VIB
- 5 - LT EQUIP TRANSP (LET)
- 3 - 40 TON SEMI-TRAILERS
- 6 - MTV DUMP TRUCKS
- 3 - MTV CARGO TRUCKS

CONSTR — EQUIPMENT
- 1 - HMMWV
- 3 - MTV DUMP TRUCKS
- 1 - MTV CARGO TRUCK
- 4 - MTV TRAILERS
- 1 - SHOP EQUIP WOOD
- 1 - HETO
- 1 - 250 CFM
- 2 - VIB, CONCRETE
- 1 - TAMPER, VIB

CO HQS & MAINTENANCE SECTIONS

CO HQ
2-0-7-9

PERSONNEL

1 - COMMANDER (CPT/21B)
1 - OPERATIONS OFFICER (1LT/21B)
1 - FIRST SERGEANT (E-8/12Z)
1 - OPERATIONS SGT (E-7/12B)
1 - SUPPLY SGT (E-6/92Y)
1 - NBC NCO (E-5/54B)
1 - ARMORER (E-4/92Y)
1 - WHEEL VEH DRIVER (E-3/12B)
1 - TRACK VEH DRIVER (E-3/12B)

EQUIPMENT

1 - APC
1 - HMMWV
1 - LMTV TRUCK CARGO
1 - LMTV TRAILER
1 - WATER TRAILER

MAINT
0-1-24-25

PERSONNEL

1 - ENGR REP TEC (W-3/919A)
1 - MOTOR SGT (E-7/63B)
1 - SR CONSTR EQUIP REP (E-6/63B)
1 - CONSTR EQUIP REP (E-5/62B)
1 - LT WH VEH MECHANIC (E-5/63B)
1 - EQUIP REC/PARTS SGT (E-5/92A)
1 - RECOVERY VEH OPR (E-5/63Y)
1 - M1 TANK AUTO MECH (E-5/63E)
1 - TRACK VEH MECH (E-5/63Y)
1 - MACHINIST (E-5/44E)
1 - QM/CM EQUIP REP (E-4/63J)
2 - CONSTR EQUIP REP (E-4/62B)
1 - M1 TANK AUTO MECH (E-4/63E)
1 - TRACK VEH MECH (E-4/63Y)
1 - RECOVERY VEH OPR (E-4/63S)
1 - RECOVERY VEH OPR (E-4/63Y)
1 - EQUIP REC/PARTS SP (E-4/92A)
1 - METAL WORKER REP (E-4/44B)
1 - PWR-GEN REP (E-4/52D)
2 - CONSTR EQUIP REP (E-3/62B)
1 - LT WH VEH MECHANIC (E-3/63B)
1 - M1 TANK AUTO MECH (E-3/63E)
1 - PETROL HVY VEH OPR (E-4/77F)

EQUIPMENT

1 - HMMWV
1 - CONTACT MAINT
1 - HMMWV HEAVY VARIANT
1 - HYSTRU
1 - HEMTT WRECKER
1 - M88A2
1 - WELDING TRAILER
1 - LMTV TRUCK CARGO
1 - LMTV TRAILER
1 - HEMTT POL

DISCUSSION POINTS

- Co HQ's - **Is there a requirement to have Bradley's?**
- Co Maintenance - Personnel & equipment is based on MARC driven requirements. Unit maintenance structure was based on the En Combat Heavy Line Co. **Is there justification for a CW3 or CW2 warrant officer and is all the "right" equipment captured?**
- **Does each company need their own ULLS box?**

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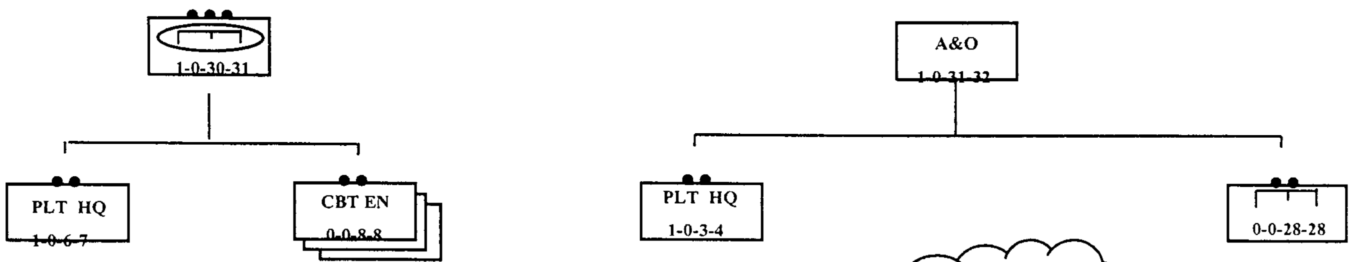
COMBAT PLATOONS



PLT HQ (1-0-6-7)

PERSONNEL
1 - PLT LDR (1 LT/21B)
1 - PLT SGT (E-7/12B)
1 - TRACK VEH DRIVER (E-3/12B)
4 - WHEEL VEHICLE DRIVER (E-3/12B)

EQUIPMENT
1 - HMMWV
1 - APC
3 - MTV DUMP TRUCKS

CBT EN (0-0-8-8)

PERSONNEL
1 - SQUAD LEADER (E-6/12B)
2 - TEAM LEADERS (E-5/12B)
3 - COMBAT ENGR (E-4/12B)
1 - COMBAT ENGR (E-3/12B)
1 - TRACK VEH DRIVER (E-3/12B)

EQUIPMENT
1 - APC
1 - 1 1/2T TRL

PLT HQ (1-0-3-4)

PERSONNEL
1 - PLT LDR (1 LT/21B)
1 - PLT SGT (E-7/12B)
2 - WHL VEH DRIVER (E-3/12B)

EQUIPMENT
2 - HMMWV

Where is the best place to put the 8 12B's lost? Do we need more MICLIC's/ACEs?

0-0-28-28

PERSONNEL
1 - SEC LDR (E-6/12B)
4 - GRIZZLY TM LDR (E-5/12B)
2 - ACE OPER (E-5/12B)
4 - AVLB CDR (E-5/12B)
2 - VOLCANO TM LDR (E-5/12B)
2 - ACE OPER (E-4/12B)
4 - GRIZZLY OPER (E-4/12B)
4 - AVLB OPER (E-4/12B)
4 - HEAVY VEH OPER (E-4/12B)
1 - WHL VEH OPER (E-3/12B)

EQUIPMENT
4 - GRIZZLEY
4 - AVLB
4 - ACE
4 - MICLIC
4 - 2 1/2T TRL
2 - VOLCANO
4 - HEMTT CGO
1 - HMMWV

DISCUSSION POINTS

- Line Platoon & Squads - **APC or Bradleys?**
- A & O Plt - **Replace Wolverine with AVLB. What will replace Grizzly? - Additional APC's, MICLIC's and additional 12B's?**

ENGINEER EQUIPMENT PLATOON - LINE COMPANY

EQUIP
1-0-42-43

PLT HQ
1-0-3-4

PERSONNEL
1 - PLT LDR (1 LT/21B)
1 - PLT SGT (E-7/62N)
2 - WHL VEH DRIVER (E-3/62E)

EQUIPMENT
2 - HMMWV

EMBANKMENT
0-0-14-14

PERSONNEL
1 - SECTION SGT (E-6/62N)
1 - CONST EQ OP (E-5/62E)
1 - CRANE OP (E-5/62F)
2 - CONST EQ OP (E-4/62E)
3 - VEHICLE OP (E-4/62E)
1 - CRANE OP (E-4/62F)
2 - CONST EQ OP (E-3/62E)
3 - VEHICLE OP (E-3/62E)

EQUIPMENT
2 - 2 1/2 CY SCOOP LOADER
3 - SCRAPERS
1 - 25 TON CRANE
6 - MTV DUMP TRUCK
1 - MTV TRUCK CARGO

GRADING/ & COMPACT
0-0-10-10

PERSONNEL
1 - SEC LDR (E-6/62N)
1 - CONSTR EQUIP OPER (E-5/62E)
1 - GEN CONSTR EQUIP OPER (E-5/62J)
3 - EQUIP VEH DRIVERS (E-4/62E)
1 - CONSTR EQUIP OPER (E-4/62E)
1 - GEN CONSTR EQUIP OPER (E-4/62J)
1 - CONSTR EQUIP OPER (E-3/62E)
1 - GEN CONSTR EQUIP OPER (E-3/62J)

EQUIPMENT
1 - MTV TRUCK, CARGO
1 - MTV TRAILER
3 - GRADERS
2 - LT EQUIP TRANS (LET)
2 - WATER DIST, 2500 GAL
1 - COMPACTOR, HIGH SPEED
1 - ROLLER VIB
2 - TAMPER VIB

EXCAVATION
0-0-15-15

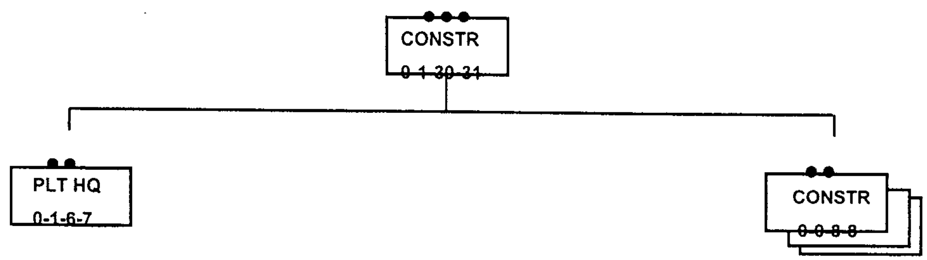
PERSONNEL
1 - SECTION SGT (E-6/62N)
3 - CONST EQ OP (E-5/62E)
1 - GEN CONSTR OP (E-4/62J)
5 - CONST EQ OP (E-4/62E)
1 - VEHICLE DRIVER (E-4/62E)
3 - CONST EQ OP (E-4/62E)
1 - GEN CONSTR OP (E-3/62J)

EQUIPMENT
3 - DEUCES
3 - D7 DOZERS
2 - SEE
3 - LT EQUIP TRANS (LET)
3 - 40T SEMITRAILER
1 - MTV TRUCK

DISCUSSION POINTS

- Platoon design taken from the Combat Heavy line company
- Is the construction equipment the right MIX?
- Personnel - the right MOS's & Ranks?

CONSTRUCTION PLATOON, ENGINEER COMPANY



PLT HQ

PERSONNEL

1 - UTIL OPS & MAINT TECH (W3/210A)
1 - PLT SGT (E-7/51H)
1 - CARPENTRY/MASONRY SGT (E-5/51B)
3 - CARPENTRY/MASONRY SP (E-4/51B)
1 - GEN CONSTR EQUIP OPER (E-4/62J)

EQUIPMENT

1 - HMMWV
1 - SHOP EQUIP WOOD
1 - MTV TRUCK CARGO
1 - TAMPER VIB
1 - HETO
1 - 250 CFM
2 - VIB CONCRETE
1 - MTV TRAILER

CONSTR

PERSONNEL

1 - CONSTR SECTION LDR (SSG/51H)
2 - CARPENTRY/MASONRY SGT (E-5/51B)
1 - CARPENTRY/MASONRY SP (E-4/51B)
1 - PLUMBER/PIPEFITTER (E-4/51K)
1 - CARPENTRY/MASONRY SP (E-3/51B)
1 - PLUMBER/PIPEFITTER (E-3/51K)
1 - INTERIOR ELECTRICIAN (E-3/51R)

EQUIPMENT

1 - MTV DUMP TRUCK
1 - MTV TRAILER

DISCUSSION POINTS

- Can we justify a CW3 - 210A in design?
- Are there too many Vertical MOS's - overkill?
- Is the equipment right?

Echelons Above Division Engineer Battalion Design

DTLOMS

Echelons Above Division Engineer Battalion Design

DTLOMS

- **DOCTRINE** All manuals will have to be changed to reflect new concept. (DOT) - **Army & Engineer Manuals?**

- **TRAINING** Training issues will have to be developed as well as solutions. (DOT) - **Main Concern is training the RC force on "long training courses"and low density courses.**

- **LEADERSHIP** Leadership issues will have to be developed as well as solutions. (DOT). - **TOTAL force will be affected by changes - All officers will be required to know combat as well as construction requirements.**

Echelons Above Division Engineer Battalion Design

DTLOMS

- **ORGANIZATION** — Major changes are required. Design will affect total Engineer Force Structure. (En DCD). **Stationing will be an issue - no changes in component structure.**

- **MATERIAL** — Cost will be determine after the "final" design has been completed. (En DCD). **BOIP's will have to be changed or adjusted to meet new requirements - Is it affordable?**

- **SOLDIER** — All engineer MOS's may be affected. Grade structure and standard grade positions will have to be adjusted. (EPPO & En DCD) **Next few slides identify the growth and loss by grade & MOS for Active, National Guard, and Army Reserve. Can all components support?**

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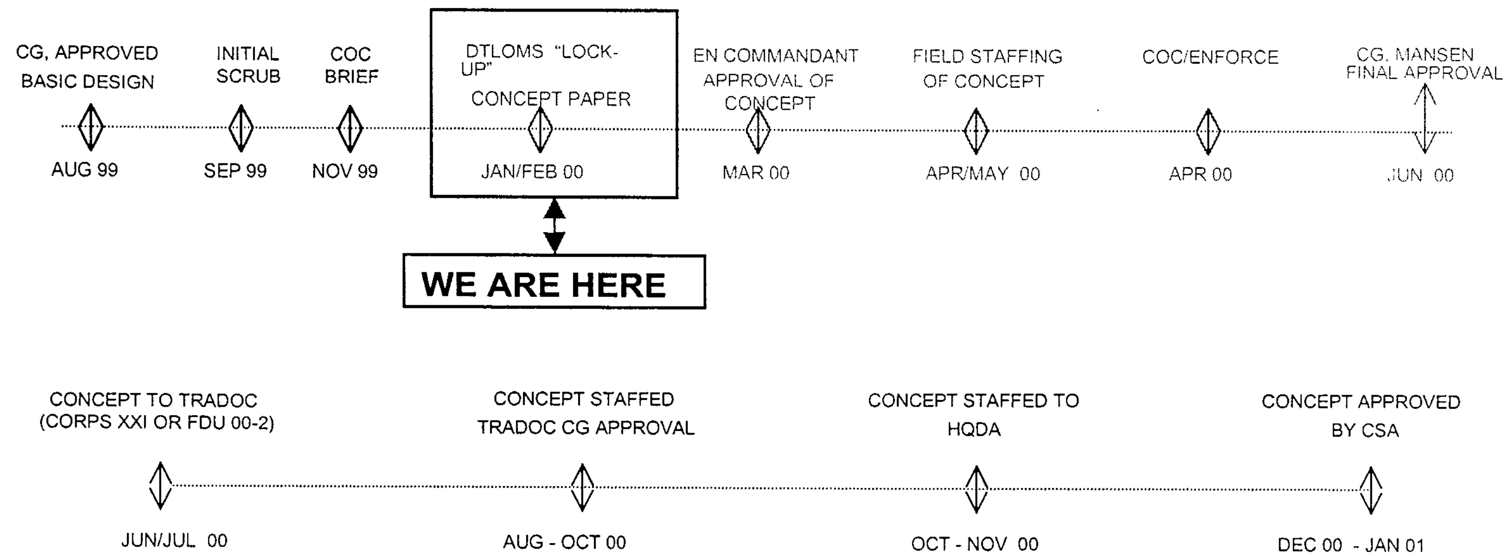
ECHELONS ABOVE DIVISION BATTALION DESIGN

MILESTONES



Questions?

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Force Structure & Concepts Br, Engr Div
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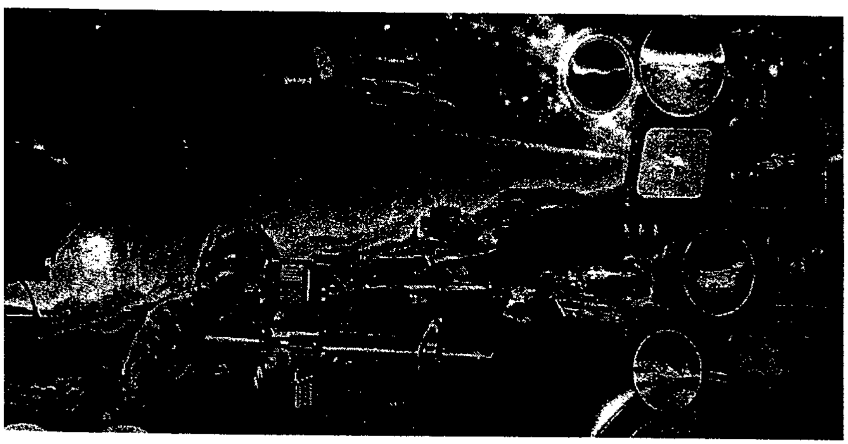
email: MALLEYP@wood.army.mil or



APPENDIX E

COMPARISON OF CURRENT FORCE STRUCTURE AND PROPOSED ECHELONS ABOVE DIVISION BATTALION FORCE USING OBJECTIVE TABLES OF ORGANIZATION AND EQUIPMENT AND U.S. ARMY ENGINEER SCHOOL BRIEFING

This appendix shows the Microsoft Excel spreadsheet used to calculate the personnel and equipment strengths of each of the two force structures compared in the thesis. The column entries are explained below:

The two rows entitled "Quantity IAW current allocation" and "Quantity assumed with new EAD" indicate the quantity of each type of battalion in that engineer force. Below these two rows, the columns contain information as follows:

Column 1: Nomenclature or description of position, organization, or item
Column 2: Number in Corps Light Engineer Battalion
Column 3: Number in Corps Mechanized Engineer Battalion
Column 4: Number in Combat Heavy Engineer Battalion
Column 5: Number in Corps Wheeled Engineer Battalion
Column 6: Number in Combat Support Equipment Company
Column 7: Number in Construction Support Company
Column 8: Number in Dump Truck Company
Column 9: Number in Light Equipment Company
Column 10: Number in proposed Echelons Above Division Battalion Design

Column 11: Total provided by all engineer units in the force derived from the current force structure. Number = (1 x column 2) + (2 x column 3) + (2 x column 4) + (2 x column 5) + (4 x column 6) + (1 x column 7) + (1 x column 8) + (1 x column 9).

Column 12: Total provided by all engineer units in the force derived using the proposed EAD battalion design. Number = (1 x column 2) + (1 x column 9) + (6 x column 10).

Column 13: Percentage difference between the two forces. Number = 100% x (column 12 – column 11) / column 11.

1	SRC 05445L200	SRC 05435L200	SRC 05415L000	SRC 05425L000	SRC 05423L000	SRC 05413L000	SRC 05424L000	SRC 05443L200	SRC Unknown	Current Force	New EAD Force	Percentage Difference
	2	3	4	5	6	7	8	9	10	11	12	13
	Corps Light	Corps Mech	Cbt Heavy	Corps Wheel	CSE	CSC	DUMP TRK	LIGHT EQP	New EAD BN	Provides	Provides	from current
Quantity IAW current allocation	1	2	2	2	4	1	1	1	0			
Quantity assumed with new EAD	1	0	0	0	0	0	0	1	6			
Personnel Breakdown												
Total Strength (OTOE)	570	480	634	523	162	141	66	184	732	4883	5146	5.4%
Commissioned/Warrant	37	29	35	27	7	6	4	7	43	264	302	14.4%
NCO	188	156	202	186	52	47	23	52	248	1606	1728	7.6%
Private soldier	345	295	397	310	103	88	39	125	441	3013	3116	3.4%
12B NCO (E-6 and E-7)	34	42	0	48	0	0	0	0	27	214	196	-8.4%
12B NCO (E-5)	36	57	0	54	0	0	0	0	57	258	378	46.5%
12B Combat Engineer	126	215	0	179	0	0	0	0	140	914	966	5.7%
51B Carpenter/Mason	30	0	165	0	0	0	0	0	48	360	318	-11.7%
51H Cons. Eng. Sup. (E-6 and E-7)	4	0	30	0	0	0	0	0	13	64	82	28.1%
51K Plumber	4	0	18	0	0	0	0	0	18	40	112	180.0%
51M Firefighter	0	0	0	0	0	0	0	0	0	0	0	N/A
51R Interior Electrician	2	0	18	0	0	0	0	0	9	38	56	47.4%
51T Tech. Engineer (E-6 and E-7))	1	0	2	0	0	0	0	0	1	5	7	40.0%
51T Technical Engineer	9	1	11	1	3	1	0	4	9	52	67	28.8%
62E Hvy. Const. Equip. Opr.	60	0	97	39	30	24	0	77	97	553	719	30.0%
62F Crane operator	6	0	10	6	6	7	0	9	12	78	87	11.5%
62G Quarrying specialist (all)	0	0	0	0	0	16	0	0	0	16	0	-100.0%
62H Conc./asph. Equip. Spc.(all)	0	0	12	0	0	24	0	0	12	48	72	50.0%
62J Gen. Const. Equip. Opr.	29	6	27	27	18	11	0	21	21	253	176	-30.4%
62N Constr. Eq. Sup. (E-6 and E-7)	13	3	15	6	10	5	0	13	15	119	116	-2.5%
S-3 section strength	23	23	25	16	N/A	N/A	N/A	N/A	22			
S-2 section strength	9	with S-3	6	with S-3	N/A	N/A	N/A	N/A	15			
S-6 section strength	0	0	0	10	N/A	N/A	N/A	N/A	12			
Tracked combat vehicles												
M113 APC or Bradley	0	28	0	0	0	0	0	0	17	56	102	82.1%
M577 C2 APC	0	2	0	0	0	0	0	0	2	4	12	200.0%
AVLB or Wolverine	0	12	0	0	0	0	0	0	12	24	72	200.0%
ACE	0	18	0	0	0	0	0	0	12	36	72	100.0%
Grizzly (to replace CEV)	0	6	0	0	0	0	0	0	12	12	72	500.0%
Other combat equipment												
Volcano SCATMIN	6	6	0	6	0	0	0	0	6	30	42	40.0%
MICLIC	6	12	0	12	0	0	0	0	12	54	78	44.4%

	SRC 05445L200	SRC 05435L200	SRC 05415L000	SRC 05425L000	SRC 05423L000	SRC 05413L000	SRC 05424L000	SRC 05443L200	SRC Unknown	Current Force	New EAD Force	Percentage Difference
1	2	3	4	5	6	7	8	9	10	11	12	13
	Corps Light	Corps Mech	Cbt Heavy	Corps Wheel	CSE	CSC	DUMP TRK	LIGHT EQP	New EAD BN	Provides	Provides	from current
Wheeled transport vehicles												
Trailer, 11 ton	0	3	0	0	0	0	0	0	0	6	0	-100.0%
Trailer, 4 ton bolster	18	12	0	36	0	0	0	0	0	114	18	-84.2%
Trailer, 6 ton storage	0	0	0	0	6	3	0	0	0	27	0	-100.0%
Trailer, POL 5000 gal	0	0	0	0	0	1	0	0	0	1	0	-100.0%
Trailer, 2.5 ton	0	0	0	0	0	0	0	0	12	0	72	N/A
Trailer, LMTV	14	20	40	9	3	4	1	2	14	171	100	-41.5%
Trailer, 1.5 ton	0	18	0	0	0	0	1	0	9	37	54	45.9%
Trailer, MTV	1	0	0	0	0	1	1	1	12	4	74	1750.0%
Trailer, water 400 gal	3	3	6	3	1	1	1	1	5	34	34	0.0%
Trailer, 0.75 ton	1	0	0	0	0	0	0	0	0	1	1	0.0%
Trailer, 0.75 ton HIMOB	3	3	6	3	0	0	0	0	3	27	21	-22.2%
Trailer, PLS	0	0	6	0	0	2	0	0	6	14	36	157.1%
HMMWV	37	36	42	43	16	9	3	9	50	364	346	-4.9%
HMMWV (heavy variant)	0	0	0	0	0	0	0	0	4	0	24	N/A
HMMWV ambulance	1	0	1	0	0	0	0	0	3	3	19	533.3%
Dump truck, MTV or 5 ton	32	18	30	54	9	0	0	18	36	290	266	-8.3%
Dump truck, 20 ton	0	0	9	0	12	6	30	0	6	102	36	-64.7%
Dump body module, PLS 14 ton	0	0	12	0	0	4	0	0	12	28	72	157.1%
Cargo truck, HEMTT	0	13	6	13	0	0	0	0	19	64	114	78.1%
Cargo truck, LMTV or 2.5 ton	18	21	29	17	6	6	3	3	20	188	141	-25.0%
Cargo truck, MTV or 5 ton	10	0	5	0	0	1	1	6	13	28	94	235.7%
Transporter, heavy PLS	0	0	6	0	0	2	0	0	6	14	36	157.1%
Tractor, wheeled MET or MTV	15	0	32	12	10	11	0	12	16	166	123	-25.9%
Semi-trailer, 40 ton	0	0	22	12	6	6	0	0	10	98	60	-38.8%
Semi-trailer, 25 ton	15	0	1	0	0	0	0	12	0	29	27	-6.9%
Maintenance equipment												
Contact truck	4	3	6	3	4	4	0	3	4	51	31	-39.2%
Wrecker, HEMTT	0	3	5	4	1	1	1	0	4	30	24	-20.0%
Wrecker, 5 ton or MTV	4	0	0	0	1	0	0	1	0	9	5	-44.4%
M88A2 recovery vehicle	0	3	0	0	0	0	0	0	4	6	24	300.0%
Lube trailer	1	1	5	1	1	2	1	1	1	23	8	-65.2%
Shop equipment organic. LT	1	1	1	1	1	0	0	1	1	12	8	-33.3%
Hydraulic Sys. Test/Repair Unit	4	1	1	1	1	1	0	0	4	15	28	86.7%
Miscellaneous												
Mobile kitchen trailer	2	2	3	2	1	1	1	1	4	23	27	17.4%
Kitchen, company level field feeding	2	0	0	0	0	0	0	0	4	2	26	1200.0%
POL truck, HEMTT	0	3	9	3	3	1	0	0	6	43	36	-16.3%
POL truck, 5 ton	3	0	0	0	0	1	0	3	0	7	6	-14.3%
Forklift	0	1	3	1	1	1	0	0	2	15	12	-20.0%
Crane, 25 ton	0	0	3	3	3	1	0	0	3	25	18	-28.0%
Crane, 12.5 ton	0	0	0	0	0	0	0	0	0	0	0	N/A
Crane, 7.5 ton	3	0	0	0	0	0	0	3	0	6	6	0.0%
Water distributor, 2500 gal	3	0	6	3	3	1	0	3	6	37	42	13.5%

	SRC 05445L200	SRC 05435L200	SRC 05415L000	SRC 05425L000	SRC 05423L000	SRC 05413L000	SRC 05424L000	SRC 05443L200	SRC Unknown	Current Force	New EAD Force	Percentage Difference
1	2	3	4	5	6	7	8	9	10	11	12	13
	Corps Light	Corps Mech	Cbt Heavy	Corps Wheel	CSE	CSC	DUMP TRK	LIGHT EQP	New EAD BN	Provides	Provides	from current
Const. Equip., earth												
Grader	9	0	9	9	6	0	0	9	9	78	72	-7.7%
Bulldozer, D7	0	0	21	12	6	2	0	0	9	92	54	-41.3%
Bulldozer, D5	15	0	0	0	0	0	0	12	0	27	27	0.0%
DEUCE	0	0	0	0	0	0	0	0	9	0	54	N/A
Scraper	9	0	12	0	6	0	0	9	9	66	72	9.1%
SEE	18	6	6	18	6	0	0	6	6	108	60	-44.4%
Bucket loader, 2.5 yd	9	0	6	6	0	1	0	6	6	40	51	27.5%
Bucket loader, 4.5 or 5 yd	0	0	2	0	3	5	0	0	3	21	18	-14.3%
Const. Equip., compact/quarry												
Roller, vibe SP S12916	0	0	5	0	6	0	0	0	5	34	30	-11.8%
Roller, pneu. twd. tired S12164	3	0	0	0	0	0	0	0	0	3	3	0.0%
Roller, twd. vib. S10682	9	0	0	6	0	0	0	6	0	27	15	-44.4%
Comp., hi-spd. SP CCE E61618	0	0	3	0	3	0	0	0	3	18	18	0.0%
Tamper, pist-ham. CCE V11001	0	0	14	3	3	0	0	0	9	46	54	17.4%
Roller, motorized 2 CCE S11711	0	0	1	0	0	4	0	0	1	6	6	0.0%
Shovel, 40 ton F40474	0	0	0	0	0	2	0	0	0	2	0	-100.0%
Rock crusher	0	0	0	0	0	1	0	0	0	1	0	-100.0%
Rock washer	0	0	0	0	0	0	0	0	0	0	0	N/A
Rock drill	0	0	0	0	0	0	0	0	0	0	0	N/A
Conveyors	0	0	0	0	0	0	0	0	0	0	0	N/A
Pile driver, 7k or 12k lbs	0	0	3	0	3	2	0	0	0	20	0	-100.0%
Const. Equip., paving												
Oil heater, trailer mtd. K25215	0	0	1	0	0	2	0	0	1	4	6	50.0%
Bitumen kettle heater L21347	0	0	2	0	0	0	0	0	2	4	12	200.0%
Asphalt melter, skid mtd. M32780	0	0	2	0	0	2	0	0	2	6	12	100.0%
Asphalt mixing plant M57048	0	0	0	0	0	1	0	0	0	1	0	-100.0%
Distributor, Liquid Bitum. G27938	0	0	0	0	0	1	0	0	0	1	0	-100.0%
Spreader, aggregate, towed S13546	0	0	3	0	0	2	0	0	0	8	0	-100.0%
Spreader, aggregate BW U12063	0	0	4	0	0	0	0	0	4	8	24	200.0%
Mod. bitum spreader, 2600 gal PLS	0	0	0	0	0	0	0	0	3	0	18	N/A
Paving machine N75124	0	0	0	0	0	2	0	0	0	2	0	-100.0%
Sweeper, rotary towed U76871	0	0	1	0	0	2	0	0	1	4	6	50.0%
Const. Equip., misc.												
Air compressor, 250 cfm P11866	6	0	7	0	3	2	0	3	3	37	27	-27.0%
Hydraulic excavator Z39575/39507	0	0	3	0	0	2	0	0	3	8	18	125.0%
Hydr/elec tool out. W58348/58486	6	0	6	3	0	0	0	0	3	24	24	0.0%
Welding trailer	1	1	5	4	1	2	1	1	4	29	26	-10.3%
Vibrator, concrete pneu. Y02450	6	0	12	0	0	0	0	0	6	30	42	40.0%
Mixer, rotary tiller M55384	0	0	1	0	0	0	0	0	1	2	6	200.0%
Shop, equipment, wood T16988	1	0	6	0	0	0	0	0	3	13	19	46.2%
Concrete mix mod., PLS 2600 gal	0	0	3	0	0	0	0	0	3	6	18	200.0%

	SRC 05445L200	SRC 05435L200	SRC 05415L000	SRC 05425L000	SRC 05423L000	SRC 05413L000	SRC 05424L000	SRC 05443L200	SRC Unknown	Current Force	New EAD Force	Percentage Difference
1	2	3	4	5	6	7	8	9	10	11	12	13
	Corps Light	Corps Mech	Cbt Heavy	Corps Wheel	CSE	CSC	DUMP TRK	LIGHT EQP	New EAD BN	Provides	Provides	from current
Unit breakdown, organizational												
Lettered companies	3	3	3	3	0	0	0	0	3	21	21	0.0%
Other companies	1	1	1	1	1	1	1	1	1	14	8	-42.9%
Combat platoons mech	0	6	0	0	0	0	0	0	3	12	18	50.0%
Assault and obstacle platoon	0	3	0	0	0	0	0	0	3	6	18	200.0%
Obstacle Section	3	0	0	3	0	0	0	0	0	9	3	-66.7%
Combat platoons wheel	6	0	0	9	0	0	0	0	0	24	6	-75.0%
Equipment section, paving	0	0	1	0	0	1	0	0	1	3	6	100.0%
Equipment section, quarry	0	0	0	0	0	1	0	0	0	1	0	-100.0%
Equipment platoon, horizontal	3	0	3	0	3	1	0	3	3	25	24	-4.0%
Equipment section, horizontal	0	0	0	3	0	0	0	0	0	6	0	-100.0%
Construction platoon, vertical	1	0	6	0	0	0	0	0	3	13	19	46.2%
Dump truck platoons	0	0	0	0	0	0	2	1	0	3	1	-66.7%
Company maint. Section	1	0	1	0	1	1	1	0	1	9	7	-22.2%
Company maint. Platoon	3	0	3	0	0	0	0	1	3	10	22	120.0%
Battalion maint. Platoon	0	1	0	1	0	0	0	0	0	4	0	-100.0%
DS maint. Platoon or Section	1	0	1	0	1	1	0	0	1	8	7	-12.5%
Medical section	1	1	1	1	0	0	0	0	1	7	7	0.0%

APPENDIX F

COMPARISON OF CURRENT ENGINEER FORCE AND PROPOSED ECHELONS ABOVE DIVISION BATTALION FORCE USING ARMY FACILITIES COMPONENTS SYSTEM WORK CAPACITIES

This appendix shows the Microsoft Excel spreadsheet used to calculate the work capacity of each of the two force structures compared in the thesis using the Army Facilities Components System (AFCS). The column entries are explained below:

The two rows entitled "Quantity IAW current allocation" and "Quantity assumed with new EAD" indicate the quantity of each type of battalion in that engineer force.

Below these two rows, the columns contain information as follows:

Column 1: Nomenclature or description of position or item

Column 2: Number in Corps Light Engineer Battalion

Column 3: Number in Corps Mechanized Engineer Battalion

Column 4: Number in Combat Heavy Engineer Battalion

Column 5: Number in Corps Wheeled Engineer Battalion

Column 6: Number in Combat Support Equipment Company

Column 7: Number in Construction Support Company

Column 8: Number in Dump Truck Company

Column 9: Number in Light Equipment Company

Column 10: Number in proposed Echelons Above Division Battalion Design

Column 11: Total provided by all engineer units in the force derived from the current force structure. Number = (1 x column 2) + (2 x column 3) + (2 x column 4) + (2 x column 5) + (4 x column 6) + (1 x column 7) + (1 x column 8) + (1 x column 9).

Column 12: Total provided by all engineer units in the force derived using the new EAD battalion design. Number = (1 x column 2) + (1 x column 9) + (6 x column 10).

Column 13: Percentage difference between the two forces; number = 100% x (column 12 – column 11) / column 11.

The final sheet presents a summary of each engineer force's horizontal, vertical, and general construction capability in man-hours or equipment-hours. These numbers are the summation of columns 11 and 12 by category or sub-category (i.e. vertical construction skills or lift/load equipment within horizontal construction equipment).

	SRC 05445L200	SRC 05435L200	SRC 05415L000	SRC 05425L000	SRC 05423L000	SRC 05413L000	SRC 05424L000
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Corps Light	Corps Mech	Cbt Heavy	Corps Wheel	CSE	CSC	DUMP TRK
Quantity IAW current allocation	1	2	2	2	4	1	1
Quantity assumed with prop. EAD	1	0	0	0	0	0	0
Vertical Construction Skills							
Carpenter/Mason	30	0	165	0	0	0	0
Electrician	2	0	18	0	0	0	0
Plumber/Pipe fitter	4	0	18	0	0	0	0
Metal Worker/Welder	0	0	0	0	0	0	0
Horizontal Construction Equip.							
Lift/Load Equipment							
Crane, 25 ton	0	0	3	3	3	1	0
Crane, 12.5 ton	0	0	0	0	0	0	0
Crane, 7.5 ton	3	0	0	0	0	0	0
Shovel, 40 ton F40474	0	0	0	0	0	2	0
Grading Equipment							
Grader	9	0	9	9	6	0	0
Compaction Equipment							
Roller, vibe SP S12916	0	0	5	0	6	0	0
Roller, pneu. twd. tired S12164	3	0	0	0	0	0	0
Roller, twd. vib. S10682	9	0	0	6	0	0	0
Comp., hi-spd. SP CCE E61618	0	0	3	0	3	0	0
Excavation Equipment							
ACE	0	18	0	0	0	0	0
Bulldozer, D7	0	0	21	12	6	2	0
Bulldozer, D5	15	0	0	0	0	0	0

	SRC 05445L200	SRC 05435L200	SRC 05415L000	SRC 05425L000	SRC 05423L000	SRC 05413L000	SRC 05424L000
1	2	3	4	5	6	7	8
	Corps Light	Corps Mech	Cbt Heavy	Corps Wheel	CSE	CSC	DUMP TRK
DEUCE	0	0	0	0	0	0	0
SEE	18	6	6	18	6	0	0
Bucket loader, 2.5 yd	9	0	6	6	0	1	0
Bucket loader, 4.5 or 5 yd	0	0	2	0	3	5	0
Hydraulic excavator Z39575/39507	0	0	3	0	0	2	0
Hauling Equipment							
ACE	0	18	0	0	0	0	0
Dump truck, MTV or 5 ton	32	18	30	54	9	0	0
Dump truck, 20 ton	0	0	9	0	12	6	30
Dump body module, PLS 14 ton	0	0	12	0	0	4	0
Scraper	9	0	12	0	6	0	0
Concrete Mixing							
Concrete mix mod., PLS 2600 gal	0	0	3	0	0	0	0
Bitumen Distribution							
Distributor, Liquid Bitum. G27938	0	0	0	0	0	1	0
Spreader, aggregate, towed S13546	0	0	3	0	0	2	0
Spreader, aggregate BW U12063	0	0	4	0	0	0	0
Mod. bitum spreader, 2600 gal PLS	0	0	0	0	0	0	0
Asphalt Paving/Rolling Equip.							
Roller, motorized 2 CCE S11711	0	0	1	0	0	4	0
Paving machine N75124	0	0	0	0	0	2	0
General Construction Skills							
12B NCO (E-5)	36	57	0	54	0	0	0
12B Combat Engineer	126	215	0	179	0	0	0

	SRC 05443L200	SRC Unknown	Current Force	Proposed EAD Force	Percentage Difference
1	**9**	**10**	**11**	**12**	**13**
	LIGHT EQP	New EAD BN	Provides	Provides	from current
Quantity IAW current allocation	1	0	Hours per day, troops:		10
Quantity assumed with prop. EAD	1	6	Hours per day, equip.:		10
Vertical Construction Skills					
Carpenter/Mason	0	48	3600	3180	-11.7%
Electrician	0	9	380	560	47.4%
Plumber/Pipe fitter	0	18	400	1120	180.0%
Metal Worker/Welder	0	0	0	0	N/A
Horizontal Construction Equip.					
Lift/Load Equipment					
Crane, 25 ton	0	3	250	180	-28.0%
Crane, 12.5 ton	0	0	0	0	N/A
Crane, 7.5 ton	3	0	60	60	0.0%
Shovel, 40 ton F40474	0	0	20	0	-100.0%
Grading Equipment					
Grader	9	9	780	720	-7.7%
Compaction Equipment					
Roller, vibe SP S12916	0	5	340	300	-11.8%
Roller, pneu. twd. tired S12164	0	0	30	30	0.0%
Roller, twd. vib. S10682	6	0	270	150	-44.4%
Comp., hi-spd. SP CCE E61618	0	3	180	180	0.0%
Excavation Equipment					
ACE	0	12	360	720	100.0%
Bulldozer, D7	0	9	920	540	-41.3%
Bulldozer, D5	12	0	270	270	0.0%

	SRC 05443L200	SRC Unknown	Current Force	Proposed EAD Force	Percentage Difference
1	**9**	**10**	**11**	**12**	**13**
	LIGHT EQP	New EAD BN	Provides	Provides	from current
DEUCE	0	9	0	540	N/A
SEE	6	6	1080	600	-44.4%
Bucket loader, 2.5 yd	6	6	400	510	27.5%
Bucket loader, 4.5 or 5 yd	0	3	210	180	-14.3%
Hydraulic excavator Z39575/39507	0	3	80	180	125.0%
Hauling Equipment					
ACE	0	12	360	720	100.0%
Dump truck, MTV or 5 ton	18	36	2900	2660	-8.3%
Dump truck, 20 ton	0	6	1020	360	-64.7%
Dump body module, PLS 14 ton	0	12	280	720	157.1%
Scraper	9	9	660	720	9.1%
Concrete Mixing					
Concrete mix mod., PLS 2600 gal	0	3	60	180	200.0%
Bitumen Distribution					
Distributor, Liquid Bitum. G27938	0	0	10	0	-100.0%
Spreader, aggregate, towed S13546	0	0	80	0	-100.0%
Spreader, aggregate BW U12063	0	4	80	240	200.0%
Mod. bitum spreader, 2600 gal PLS	0	3	0	180	N/A
Asphalt Paving/Rolling Equip.					
Roller, motorized 2 CCE S11711	0	1	60	60	0.0%
Paving machine N75124	0	0	20	0	-100.0%
General Construction Skills					
12B NCO (E-5)	0	57	2580	3780	46.5%
12B Combat Engineer	0	140	9140	9660	5.7%

Summary	Current	Proposed EAD	Change from		
	Force	Force	Current		
Vertical Construction Skills	4380	4860	10.96%		
Horizontal Construction Equip.					
Lift/Load Equipment	330	240	-27.27%		
Grading Equipment	780	720	-7.69%		
Compaction Equipment	820	660	-19.51%		
Excavation Equipment					
Including ACE	3320	3540	6.63%		
Not including ACE	2960	2820	-4.73%		
Hauling Equipment					
Including ACE	5220	5180	-0.77%		
Not including ACE	4860	4460	-8.23%		
Concrete Mixing	60	180	200.00%		
Bitumen Distribution	170	420	147.06%		
Asphalt Paving/Rolling Equip.	80	60	-25.00%		
Total horizontal with ACE	10420	10280	-1.34%	ACE used as hauler or	
Total horizontal w/o ACE	10060	9560	-4.97%	excavator, not both!	
General Construction Skills					
ACEs used as horizontal assets	11360	12720	11.97%		
ACE not used as horizontal assets	11720	13440	14.68%		

APPENDIX G

SUMMARY OF TOTAL WORK EFFORT USING ARMY FACILITIES COMPONENTS SYSTEM AND TIME REQUIRED BY EACH ENGINEER FORCE TO ACCOMPLISH THIS WORK

This appendix shows the Microsoft Excel spreadsheet used to calculate a summary of the total work effort (in man-hours, equipment hours, and percentages) in the contingency scenario under the Army Facilities Components System for each of the construction categories in FM 101-10-1/2. The column entries are explained below:

Column 1: Description of row entries. The first group of rows (Construction Category) shows the quantity of labor effort for each category outlined in FM 101-10-1/2. The second group of rows (Total work effort) shows the total horizontal, vertical, and general labor requirement. It is the sum of each column from the first group of rows. The third group of rows (Daily Quantities Available) shows the amount of work effort each engineer force can put forth per day. The fourth group of rows (Percent of work effort by type) shows the percentage of the total horizontal, vertical, and general labor effort, as well as the total labor effort) associated with each construction category. As an example, Roads (LOC) require 87.95 percent of the total horizontal construction labor effort, 23.33 percent of the total vertical construction labor effort, 79.17 percent of the general construction labor effort, and 65.89 percent of the total construction labor effort. The last two groups of rows (Days to accomplish work) show the number of days each of the two engineer forces in the study need to finish the horizontal, vertical, and general construction labor efforts associated with each construction category. These figures are obtained by dividing the numbers in the first group of rows (Construction Category) by the daily quantities of work available in the third group of rows.

Column 2: Quantities (equipment-hours or days) or percentages associated with horizontal construction effort.

Column 3: Quantities (man-hours or days) or percentages associated with vertical construction effort.

Column 4: Quantities (man-hours or days) or percentages associated with general construction effort.

Column 5: Quantities (man/equipment-hours) or percentages associated with total construction effort (the sum of columns 2, 3, and 4).

Summary of total work effort and capability of each engineer force to do this work.				
	Construction effort in man-hours			
1	2	3	4	5
Construction Category	Horizontal	Vertical	General	Total
Airfields and heliports	129114	36711	224609	390434
Sewage treatment	2100	126840	34986	163926
Potable water supply	37950	80615	13250	131815
Troop camps	122,665	1,449,707	470,729	2,043,101
Hospitals	27,200	454,840	82,776	564,816
Force protection	7,380	152,940	289,903	450,223
Maintenance shops (aviation)	11,574	698,112	73,494	783,180
Supply storage	710	11,257	2,990	14,957
Ammo storage	3,834	3,726	4,554	12,114
POW camps	4,440	7,030	6,840	18,310
Pipeline	23,013	331,221	215,631	569,865
POL loading tank farm	15,135	46,955	45,360	107,450
Bridging on LOCs	85,788	306,656	234,388	626,832
Roads (LOCs)	3,792,255	1,127,696	6,589,768	11,509,719
Land clearing	48,695	0	33,783	82,478
Total work effort	4,311,853	4,834,306	8,323,061	17,469,220
Percent of total work effort	24.7%	27.7%	47.6%	100.0%
Daily Quantities Available (ACE does not work as horizontal asset)				
IAW Current Force Structure	10060	4380	11720	
With proposed EAD Battalions	9560	4860	13440	
Percent of work effort by type (H, V, G, Total)				
Airfields and heliports	2.99%	0.76%	2.70%	2.23%
Sewage treatment	0.05%	2.62%	0.42%	0.94%
Potable water supply	0.88%	1.67%	0.16%	0.75%
Troop camps	2.84%	29.99%	5.66%	11.70%
Hospitals	0.63%	9.41%	0.99%	3.23%
Force protection	0.17%	3.16%	3.48%	2.58%
Maintenance shops (aviation)	0.27%	14.44%	0.88%	4.48%
Supply storage	0.02%	0.23%	0.04%	0.09%
Ammo storage	0.09%	0.08%	0.05%	0.07%
POW camps	0.10%	0.15%	0.08%	0.10%
Pipeline	0.53%	6.85%	2.59%	3.26%
POL loading tank farm	0.35%	0.97%	0.54%	0.62%
Bridging on LOCs	1.99%	6.34%	2.82%	3.59%
Roads (LOCs)	87.95%	23.33%	79.17%	65.89%
Land clearing	1.13%	0.00%	0.41%	0.47%
Total	100.00%	100.00%	100.00%	100.00%

1	2	3	4	
Days to accomplish work (current force)	Horizontal	Vertical	General	
Airfields and heliports	12.83	8.38	19.16	
Sewage treatment	0.21	28.96	2.99	
Potable water supply	3.77	18.41	1.13	
Troop camps	12.19	330.98	40.16	
Hospitals	2.70	103.84	7.06	
Force protection	0.73	34.92	24.74	
Maintenance shops (aviation)	1.15	159.39	6.27	
Supply storage	0.07	2.57	0.26	
Ammo storage	0.38	0.85	0.39	
POW camps	0.44	1.61	0.58	
Pipeline	2.29	75.62	18.40	
POL loading tank farm	1.50	10.72	3.87	
Bridging on LOCs	8.53	70.01	20.00	
Roads (LOCs)	376.96	257.46	562.27	
Land clearing	4.84	0.00	2.88	
Total	429	1104	710	
Days to accomplish work (proposed EAD battalion force)				
Airfields and heliports	13.51	7.55	16.71	
Sewage treatment	0.22	26.10	2.60	
Potable water supply	3.97	16.59	0.99	
Troop camps	12.83	298.29	35.02	
Hospitals	2.85	93.59	6.16	
Force protection	0.77	31.47	21.57	
Maintenance shops (aviation)	1.21	143.64	5.47	
Supply storage	0.07	2.32	0.22	
Ammo storage	0.40	0.77	0.34	
POW camps	0.46	1.45	0.51	
Pipeline	2.41	68.15	16.04	
POL loading tank farm	1.58	9.66	3.38	
Bridging on LOCs	8.97	63.10	17.44	
Roads (LOCs)	396.68	232.04	490.31	
Land clearing	5.09	0.00	2.51	
Total	451	995	619	

APPENDIX H

SUMMARY OF TOTAL WORK EFFORT USING ARMY FACILITIES COMPONENTS SYSTEM AND TIME REQUIRED BY EACH ENGINEER FORCE TO ACCOMPLISH THIS WORK AT EIGHT BASE CLUSTER LOCATIONS

This appendix shows the Microsoft Excel spreadsheet used to calculate a summary of the total work effort (in man-hours or equipment hours) in the contingency scenario under the Army Facilities Components at each of the eight base cluster locations. A summary of the time required by each of the two force structures compared in the thesis to accomplish the work at each of these locations is also presented. The column entries are explained below:

Column 1: Base cluster location or description of entry in row. The first group of rows shows the horizontal, vertical, and general construction labor effort associated with each of the eight base cluster locations. The total amount of work, by construction labor effort type, is then presented. The total work effort in each of the three labor areas, including the roads (LOC), bridges (LOC0, and pipelines, is shown. The percentage of the total model work effort in the eight base cluster locations is calculated. In terms of the total construction requirement in the model, including LOC roads and bridges and the pipeline, the eight base cluster locations represent 9.01 percent of the horizontal construction labor effort, 63.7 percent of the vertical construction labor effort, and 15.09 percent of the general construction labor effort.

The remainder of the calculations show the daily amount of labor effort each of the two engineer forces can produce and the number of days each force requires to accomplish the work at each of the eight base cluster locations. These time figures are obtained by dividing the amount of work at each base cluster by the amount of labor each engineer force can produce per day.

Column 2: Quantity associated with horizontal construction effort.

Column 3: Quantity associated with vertical construction effort.

Column 4: Quantity associated with general construction effort.

		Total Work Effort (Man or equipment-hours)		
1		2	3	4
Location		**Horizontal**	**Vertical**	**General**
A		39260	298533.7	126252
B		60597.5	621380.4	227579.5
C		40526.5	362749.7	134116.5
D		54179	308758.7	153558
E		38834	298119.7	125746
F		47550.5	351089.7	146958.5
G		61102.5	545698.4	201354.5
H		46485	292913.7	140797
Total		388535	3079244	1256362
Total work effort for model including LOC work		4311853	4834306	8323061
Percentage of Total Work At Locations A-H		9.01%	63.70%	15.09%
Daily work effort available to engineer force under current structure				
		10060	4380	11720
Days to accomplish work at each location by current force structure				
Location		**Horizontal**	**Vertical**	**General**
A		3.9	68.2	10.8
B		6.0	141.9	19.4
C		4.0	82.8	11.4

1		2	3	4
Location		**Horizontal**	**Vertical**	**General**
D		5.4	70.5	13.1
E		3.9	68.1	10.7
F		4.7	80.2	12.5
G		6.1	124.6	17.2
H		4.6	66.9	12.0
Total		38.6	703.0	107.2
Daily work effort available to proposed multifunctional EAD BN force				
		9560	4860	13440
Days to accomplish work at each location by proposed EAD BN force				
Location		**Horizontal**	**Vertical**	**General**
A		4.1	61.4	9.4
B		6.3	127.9	16.9
C		4.2	74.6	10.0
D		5.7	63.5	11.4
E		4.1	61.3	9.4
F		5.0	72.2	10.9
G		6.4	112.3	15.0
H		4.9	60.3	10.5
Total		40.6	633.6	93.5

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