

Military Applications of Geophysics

MAJ Niklas H. Putnam

* Geological Engineering Program, University of Missouri-Rolla,
Rolla, MO, 65401; niklas.putnam@us.army.mil

ABSTRACT

Military engineering geophysical methods can provide timely and reliable critical information to engineers engaged in design, planning, construction, or remediation efforts related highway facilities and other infrastructure. The importance of timeliness and reliability cannot be overemphasized because contingency operations often require that accurate information be acquired very rapidly. Herein, recent case studies documenting the successful applications of geophysical technologies to military engineering problems are presented.

The U.S. Army Corps of Engineers is engaged in many highway and infrastructure projects. Many of these projects would benefit from the utilization of geophysical methods. Yet, because many senior staffers are not familiar with available methodologies, these tools are underutilized.

Cursory bidding process for military contracts and points of contact are summarized to facilitate and expedite the transfer of information to the military engineering sector. It is important that information regarding the usefulness and availability of geophysical methods be disseminated within federal agencies like the military to educate interested personnel and to facilitate rapid and cost-effective construction and mitigation efforts.

INTRODUCTION

From a 'no notice' military engineering contingency context, weather disaster relief or conflict, expedient combat engineering construction methods are used to repair ports of entry and lines of communication to re-establish civil order and rudimentary life support. The purpose of this discussion is *not* how to insert geophysical methods into such operations. Rather, it is how to make these technologies available to the Commander's Engineer Staff in order to assess the extent of damage and/or repair vital infrastructure. During follow-on operational phases, these tools can also assist the Engineer Staff in terms of the rehabilitation or construction of roads, tunnels, bridges, dams, ports and airfields, for examples.

SUMMARY OF THE CORPS OF ENGINEERS' GULF REGION DIVISION CONSTRUCTION EFFORT IN IRAQ

Following the implementation of the Marshall Plan after World War II, the United States military has engaged in major infrastructure rebuilding efforts in South Korea, Bosnia, and most recently Afghanistan and Iraq. Organizationally, the Transatlantic Programs Center (TAC) of the United States Army Corps of Engineers provides stateside assistance to Corps operations in Iraq and Afghanistan (Figure 1). One of the primary functions of TAC is to provide engineering, construction and contracting services for U.S. military organizations during peacetime or contingency operations. In providing engineering services, TAC may award contracts and design or construction management oversight according to host nation or customer needs. TAC supports the Gulf Regional Division's (GRD) provide full spectrum engineering services in Iraq in support of military and civil construction, and logistical services, and to assist the Iraqi government in assuming full responsibility for national reconstruction.

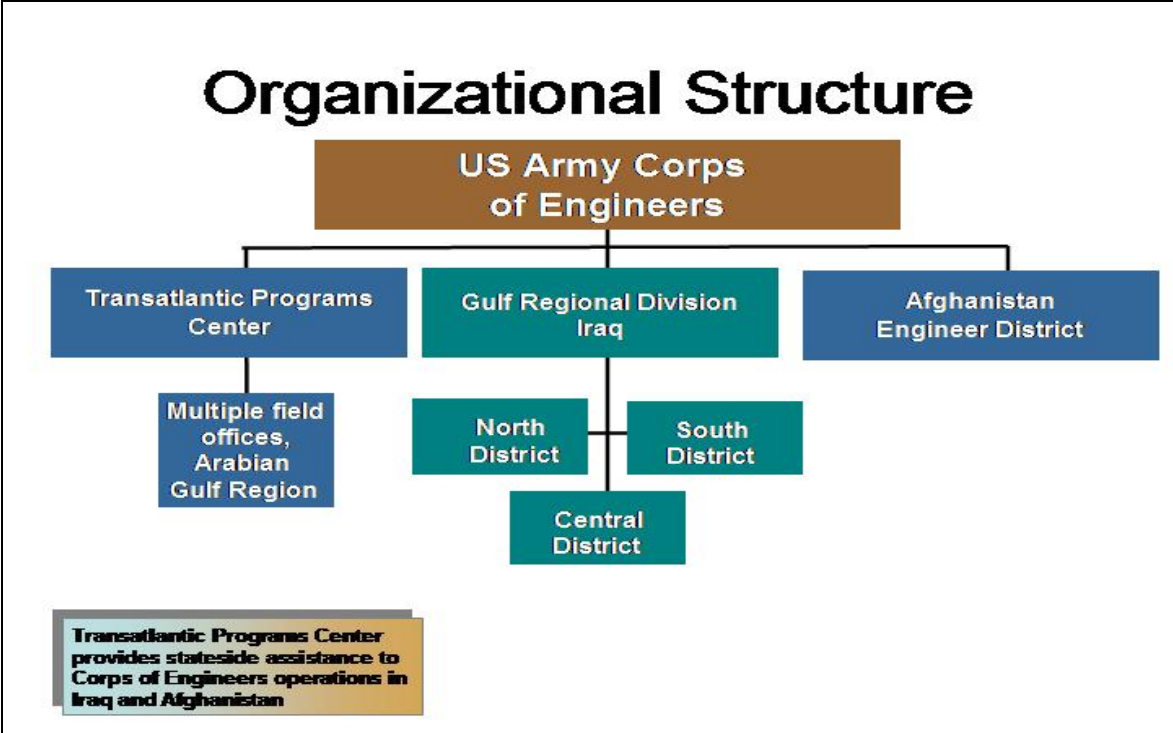


Figure 1. TAC is a subordinate command within the U.S. Army Corps of Engineers comprised of about 360 civilian and military members. It is headquartered in Winchester, Virginia, and has several field offices throughout the Middle East. TAC provides assistance – called reachback – to the Corps’ Gulf Region Division and its districts in Iraq and to the Afghanistan Engineer District.

The GRD has managed over 2600 civil engineering projects totaling \$11.2 billion in support of rebuilding Iraq. Part of the reconstruction effort was improving dusty trails used by everything from four-wheel vehicles to people on foot. Many of these roads are impassable when the rains turn them into muddy quagmires. To remedy the lack of all weather roads between many villages nearly \$40 million was spent to provide hard surfaced all weather roads to these small towns in 15 of the 18 governances. From 20 to 50 miles of road, many only a few miles long, are being built in each governance. The majority of the roads are being built over existing dirt roads, smoothed graded and given a hard surface. They will be 20 feet wide, with improved shoulders. Usually, the construction uses an asphalt finished surface.

Schools	835
Health Clinics	17
Hospitals	21
Water	308
Border Posts	248
Police Stations	350
Military Bases	157
Electrical	221
Village Roads	112
Railroad Stations	85
Fire Stations	85
Oil	27
Other	<u>90</u>
Total Projects	2688

Table 1. Numbers of projects totaling \$11.2 billion were spent on Iraqi reconstruction over 3 years.

MILITARY APPLICATIONS OF NON-INVASIVE GEOPHYSICAL TESTING

Some geophysical methods are well established and routine within the military engineering community. Particularly noteworthy is the use of seismic cone penetrometers, falling weight deflectometers, and Ground Penetrating Radar (GPR) for competency studies on Airfield Concrete Runways by the Air Force Civil Engineering Support Agency located at Tyndall Air Force Base, Florida. One of its missions is to deploy world-wide to evaluate pavements in support of contingency flight operations. Another use of GPR by the U.S. Army is to locate mass graves and weapons caches (Figure 2). This technology was implemented when an Engineer Staff Captain and Geology & Geophysics M.S. graduate from the University of Missouri – Rolla, recognized that GPR was a solution to surveying the subsurface for these anomalies. He used reach back to the United States to find a geophysical firm that could deliver and train this system for its intended use through the contracting apparatus.



Figure 2. Master Sgt. Roy Lee (left) and Sgt. 1st Class James Haftmann, from Multi-National Corps-Iraq, use ground penetrating radar to search for hidden weapons in central Iraq. If located, heavy equipment is used to excavate it. Photo by Sgt. Steven Phillips.

Some geophysical methods have not met with such resounding success. In one after action review, the capacitively-coupled (ground based) resistivity meter lacked an ability to locate sewers and other voids in urban areas where the array length constrained its application. On some occasions, trash zones and subsurface geologic lenses mimicked voids causing non-geotechnical engineers to lose confidence in the method given time and safety considerations.

The use of geophysical methods to evaluate pier structures at neglected port facilities is another example of a fast, inexpensive, and proven technology. The focus of these investigations is typically to determine the length of the piles and determine integrity of the concrete, particularly in the upper portions of the piles. In one case, both Crosshole Sonic Logging and Sonic Echo / Impulse Response methods determined no major defects of tested piles on a 'synchrolift' pier at a reduction in cost for rehabilitation versus reconstruction.

Of particular interest is the ability to identify leaks from public works potable water pipes. It was noted that as much as 40 percent of fresh water was lost due to broken pipes between the water pumping stations and the inhabitants of Baghdad, Iraq. Similarly, LTC Kenneth McDonald, formerly a Project Engineer during early operations in Kosovo, recalls sending out well drilling trucks to find potable water sources with sufficient capacity to support 1,000 person base camps. Each iteration of exploratory drilling cost about \$30,000 using a trial and error method. In retrospect, would the use of a geophysical tool reduced the time and cost involved in finding the required source?

In general, the damage assessment phase is the most likely period to implement the use of geophysical methods. Much the same as civilian counterparts, Commanders' understand and are keenly aware that establishing lines of communication and support will sustain their operation and allow force projection. From a military civil engineering perspective, the following categories, though not exclusive, are relevant areas of concern to military engineers when assessing functionality and safety of infrastructure using geophysical methods applied to the subsurface:

1. Road / Highway / Bridge Decking
2. Airfields (Dirt)
3. Piles / Bridge Scour
4. Locate Voids / Sewers
5. Locate (potable) Water / Ruptured Pipelines

ENABLING THE CORPS OF ENGINEERS TO LEVERAGE GEOPHYSICAL TOOLS

The following section is prefaced by recognizing that there are many research laboratories that continue to refine and offer specialized geophysical method services. However, we also recognize that industry, academia, and other branches of the government may already hold geophysical solutions to civil engineering problems simply because of awareness. Through collaboration, information sharing, and proactively educating fellow geotechnical and civil engineering counter-parts, reconstruction costs can be reduced and timelier results achieved.

According to government contracting sources in the Corps of Engineers' community, companies that provide specialized geophysical method services should gain a tax identification number, register in Central Contractor Registration (CCR) and be able to accept electronic payments. These cursory steps are quintessential for consideration as a subcontractor in support of larger contracts. For more information, access the CCR website at <http://www.ccr.gov>. Currently TAC has 9 active Indefinite Delivery / Indefinite Quantity (IDIQ) contracts [that can be used for a full range of engineering services anywhere in the U.S. Central Command area of operations](#). IDIQ firms are found at <http://www.tac.usace.army.mil>. It is recommended that firms offering geophysical services establish relationships outside the government.

Military engineers should be aware of the potential capability and practical applications of geophysics to civil engineering related problems. The *Applications of Geophysical Methods to Highway Related Problems (Hanna et al, 2003)* is a 'Rosetta Stone' document to educate military engineers on such applications. In addition, a list of geophysical companies along with their capabilities would increase utility and save Staff Engineers valuable time. This list can be compiled from vendors participating at the 2006 Highway Geophysics-NDE Conference.

SUMMARY

In order to fully enable the Corps of Engineers (as a whole organization from district down to brigade-level engineer staffs) to apply efficient and cost effective geophysical methods applied to civil engineering problems, it is incumbent upon the commercial and industrial sectors to educate and avail themselves to future government infrastructure construction efforts. It is recommended that the education and capability of these methods be made available in a more expeditious manner in three ways:

1. Through the dissemination of a geophysical primer focused on civil engineering problems. The *Applications of Geophysical Methods to Highway Related Problems (Hanna et al, 2003)*, is one example of an excellent primer.
2. Geophysical companies should register in the CCR data base, solicit IDIQ firms and be capable of accepting electronic payments.
3. Companies should participate in the author's survey on geophysical capabilities in order to provide vendor information and capabilities to military organizations. The voluntary survey is Appendix A.

REFERENCES

Hanna, K., Jalinoos, F., Sirls, P., & Wightman, E., 2003, *Applications of Geophysical Methods to Highway Related Problems*, Colorado, Central Federal Lands Highway Division.