CHAPTER 5
Construction Contracts

Contracting became a widely used and reasonably successful alternative to troop construction. Contractors performed much of the rear area construction under the supervision of the theater engineer. Contract construction requirements ranged from meeting the simple needs of soldiers, such as life support areas, to combat needs, such as helipads. As the Defense Department's contract construction agent in Southwest Asia, the U.S. Army Corps of Engineers awarded and administered these construction contracts through MEAPO(SWA). The mission was to support the requirements of all the services, and MEAPO(SWA) struggled to ensure that everyone's needs were met.

Engineer troops and contractors sometimes worked together. Occasionally, using contractors was cheaper than having troops lay asphalt themselves with leased equipment, and it freed troops for other tasks. Sometimes, troops performed the initial grading, leveling, and compacting, and hauled the marl. Contractors later laid the asphalt.

At the 24th Infantry Division (Mechanized) area at Thadj, Saudi Arabia, engineer troops put down M–2 matting for helipads, but they had only enough matting to install one pad for each helicopter, not enough to cover the entire area. A contractor applied dust palliative around those individual pads. In another instance, the Dhahran Area Office staff modified the design of the helicopter ramp at Ras al–Mishab to include greater troop effort. MEAPO(SWA) sometimes called on local commanders to augment contractors with military engineers when the contractor could not finish the project quickly enough to meet the theater requirements. Task Force 43, for example, assisted contractors on some projects.[1]

Life Support Areas

The Corps' first and largest construction contract was for six base camps. The contract was urgent because troops in the desert needed the facilities as quickly as possible, and the emergency military construction funds authorized under Title 10, U.S. Code, Section 2803, that would be used to fund the base camps, had to be obligated by 30 September 1990, the end of the fiscal year. Cox's staff had only four weeks to develop the criteria and advertise and award the contract.

From the beginning, Army planners recognized the need to construct base camps for arriving troops who would otherwise be camping in the sand. In late August, the chief of staff of the XVIII Airborne Corps, Colonel James Frederick, informed General Pagonis that the XVIII Airborne Corps might need

as many as twenty 5,000-troop base camps to stage and base troops in its sector, and he listed locations for the first three.[2]

Without conferring with any of the engineers in the theater, both ARCENT(Rear) and Forces Command planners at Fort McPherson prepared three DD Form 1391s to construct six initial standard base camps (each housing 5,000 troops with a mess hall and showers) for Army forces deployed in Saudi Arabia at an estimated cost of $30 million in military construction funds. These projects provided the basic infrastructure on which temporary standard prefabricated buildings could be constructed when additional funds were reprogrammed or made available by Congress. MEAPO(SWA) warned that $30 million would not build six base camps because of the inflated cost of construction materials in the theater, particularly plywood.

Representatives from Corps headquarters, South Atlantic Division, MEAPO, Army headquarters, and Forces Command met on 31 August to discuss base camp development. The meeting revealed that too many agencies were developing base camp plans, too many cost estimates were being produced and circulated, multiple definitions were being used to describe the level of base camp development, and no formal process existed to disseminate information and make decisions. As participants discussed the Army Facilities Component System's initial and temporary standards, they found that the initial standard had been pared down by some and enhanced by others based on what each believed to be the customer's guidance or requirements.

MEAPO representatives, acting on advice from MEAPO(SWA), outlined an initial standard more austere and cheaper than what Forces Command had developed. Forces Command added to the confusion by submitting its own DD Form 1391. The command had developed its plans before ARCENT engineers had arrived in the country and had based its plans on information from various sources rather than a specific ARCENT request. MEAPO passed its package to MEAPO(SWA) along with a list of options that Forces Command could select from and remain within the $30 million limit. Participants agreed that Forces Command should review this list of options, incorporate its choices on the DD Form 1391, and send it to MEAPO.[3]

On 12 September 1990, Colonel Miller met privately with General Al-Otaishan to discuss construction of the base camps. The next day the ARCENT engineer briefed General Pagonis and Brigadier General James Monroe, ARCENT's G-4, on the base camp construction program. Meanwhile, the ARCENT engineer, the ARCENT commander, and the XVIII Airborne Corps commander, Lieutenant General Gary E. Luck, met to determine the location, construction type, and facilities requirements for the initial six base camps. General Luck approved the locations and priorities. MEAPO now had enough information to advertise the construction contract for the $30 million base camp. On 14 September Assistant Secretary Susan Livingstone, who oversaw the Corps' military construction, approved the contract up to but not

including the award because Congress preferred that funding came from some third party such as Saudi Arabia or Japan.[4]

MEAPO(SWA) was involved in the difficult process of working with the XVIII Airborne Corps representatives and a Saudi officer to secure host nation approval of the base camp sites. On 15 September 1990 the commander of the Royal Saudi Land Forces' eastern area was briefed, and he deferred the matter to his superiors in Riyadh. On 17 September, Pagonis met with Major General Saleh Bin Al–Mohaya, commander of the Ministry of Defense and Aviation's eastern province, who approved the locations. General Al–Mohaya, in turn, deferred the decision to his superior, General Khalid. General Yeosock appealed directly to him for help in securing approval of the base camp construction plan. Yeosock emphasized the urgency of the matter. General Starling also appealed to the Saudi general for assistance in planning and designing the camps, arranging connections to local utilities, and selecting sites.[5]

Using the authority of the Competition in Contracting Act (Title 10, U.S. Code, Section 2304) for "unusual and compelling urgency," MEAPO acquired a list of all contractors currently working in Saudi Arabia and asked them to submit information about their capabilities.

MEAPO(SWA) established a prequalification board to review data submitted by prospective contractors. Voting members of the board were Lieutenant Colonel Cox and his chief of contracting, chief of construction, chief of engineering, and chief counsel. The board evaluated the firms on their ability to mobilize 200 skilled workers and managers by 25 September 1990, the date MEAPO expected to issue the "notice to proceed," and on their ability to mobilize 800 more workers within 30 days of the notice. Contractors also had to demonstrate that they could administer a heavy construction project the size of a base camp. They had to have successfully completed construction projects worth at least $30 million in the last five years. They had to have enough skilled workers and managers. They also had to have enough equipment available or obtainable in Saudi Arabia, be registered to perform work in Saudi Arabia, and have a joint venture partner or authorized Saudi agent.[6]

MEAPO evaluated 69 firms, and prequalified 14—two American, four Saudi, one Saudi with a U.S. subsidiary, and seven Korean. Because of time constraints, MEAPO excluded contractors who were not in Saudi Arabia, no matter how well qualified. Some of these contractors protested because they believed the Corps was excluding them from what they mistakenly thought was a huge, multimillion dollar contracting effort in Saudi Arabia.[7]

When the Assistant Secretary of the Army for Civil Works, Robert W. Page, who oversaw the Corps' international activities, reviewed the prequalified bidder list, he found it unacceptable because it did not include enough U.S. contractors. On 18 September 1990, he directed MEAPO to cease all actions related to the list. At a meeting with General Ray the next morning, Page agreed to let the Corps proceed with the review and award of the contract using its

standard procedures for overseas construction. But he also directed the Corps to allow three unsolicited proposals from concerned U.S. contractors who claimed they could fulfill the Corps' requirements—Zachary from San Antonio, Texas, Harbert from Birmingham, Alabama, and Turner from New York.[8]

MEAPO had considered these three firms in the formal prequalification procedures, but the board had determined they were unqualified according to the criteria it had established. If it accepted unsolicited proposals from these firms, MEAPO counsel argued, it would be legally obligated to open the competition to all firms that were considered but disqualified.

Colonel Miller personally reviewed the prequalification procedures and concluded that the three firms Page mentioned had received fair and equal consideration along with the other international firms. It would be unethical, he argued, to receive unsolicited proposals from those firms after the fact. Such action would be unfair to other firms that had submitted proposals and would damage the Corps' credibility. Miller warned that if directed to receive the unsolicited proposals from the three firms, he would have to cancel the current solicitation, delaying the contract award past 30 September. The authority to reprogram fiscal year 1990 funds would then be lost.[9]

Based on this response, later that day, Page conceded that MEAPO had done everything possible to solicit U.S. firms, especially the three firms in question. After further reviewing the Corps' contracting procedures, Page concluded that the Corps had used "the best and prudent judgment in moving forward, particularly with the stress placed upon you by the military to bed down our troops as quickly as possible." With time constraint as the driving force behind the initial criteria, he added "you have exercised proper diligence and procedure." In the future, however, Page wanted new criteria for contracting: a firm had to be American or Saudi Arabian; any foreign firm bidding on a contract had to have an American or Saudi joint venture partner; and qualifying factors for all firms would be their experience, general knowledge of the scope of work, and recent experience in that geographical part of the world.[10]

Responding to Page's direction that only U.S. and Saudi firms be considered in the future or that foreign firms had to have a U.S. or Saudi joint venture partner, the MEAPO counsel countered that this would violate the Competition in Contracting Act. Page apparently had a change of heart and in a brief note observed, "You did a good job—The heat seems to be off and in fact may have turned positive."[11]

MEAPO issued the "request for proposal" to the 14 prequalified firms on 19 September, giving each six days to prepare its proposal. MEAPO(SWA) received proposals from 10 of the 14 firms on 25 September. The contract was structured so the base bid included mobilization and demobilization, surveying, and clearing and grubbing. The bid included tent hardstands, latrines, showers, and dining facilities. All other items were identified as contract options.

Including all options, the high offer of $133 million was from J.A. Jones Construction Company of Charlotte, North Carolina. The low offer of $53 million came from Mechanical and Civil Engineering (MACE), Saudi Arabia, LTD., which was affiliated with Globeways Inc. of Tulsa, Oklahoma.

Since all proposals were much higher than the $30 million allowed, MEAPO could not award the project with all the options. With the approval of General Pagonis and General Luck, the project was scaled down. For $30 million, MEAPO could not require the contractor to lay out roads at the camps, as originally planned, but hoped that since the contractor had to travel in the area, he would gradually build the roads. MEAPO could only require the contractor to clear the area, construct a dining room (no kitchens), and provide some bathroom facilities. For $30 million, the contractor had to mobilize at six 260-acre areas located in different parts of the country.[12]

Corps contracting officials had secured a waiver of the 21-day mandatory congressional notification period, but the contract still had to be expedited. Assistant Secretary Livingstone had to approve the contract by 29 September so it could be awarded by 30 September, the end of the fiscal year. On 26 September, Livingstone authorized the Corps to award the base camp contract using the $30 million in reprogrammed military construction funds, provided it included a termination clause in case an alternate source of funding became available.[13]

The Corps awarded the contract on 28 September to MACE for $26,347,014 and set a completion date of 10 January 1991—a 90-day on the ground performance period. The contract called for the construction of six initial standard, temporary base camps for units deployed to Saudi Arabia. Billeting areas would consist of graded and compacted earth suitable for erecting tents. The contract also provided for dining facilities (cement block structures with heating and air conditioning), showers, and latrines. The Corps planned to use engineer troops to upgrade the camps by constructing roads, vehicle parking, helicopter pads, tent pads, warehouses, and sunshades.[14]

Surprisingly, General Schwarzkopf was not informed about the base camps until 2 October. After hearing the proposal, he sternly informed his staff that they did not have the authority to approve the construction of base camps. He demanded that they brief him again before spending a nickel on such construction.

On 6 October CENTCOM and the services laid out a more detailed proposal to complete the six base camps already contracted for and to construct an additional 18 camps. During the briefing, Lieutenant Colonel Cargill explained that the projects would get "the ball rolling to provide facilities to enable our soldiers to survive in the desert." Schwarzkopf strenuously objected to the use of the term "survive." The soldiers, he barked, were "surviving" quite well.

The general insisted that the Army use the term "life support area" rather than "base camp." He observed that U.S. forces did not know where they would be in six months so the services should not spend money they could not justify. The experienced commander also noted that the fire bases the United States built in Vietnam were a mistake that should not be repeated. He did not want the Army to develop the "base camp mentality" that it had in Vietnam. Nor did he want his troops housed in permanent facilities where they would be vulnerable to attack. Camping in the desert, he insisted, would keep the troops sharp, mentally and physically.

Schwarzkopf approved the initial six camps—now called life support areas—so long as they were built primarily for sustainment. These would be secured areas where troops could rest and refit, enjoy a few comforts they did not have in the desert, and then return to the desert for training exercises. He directed his staff to proceed slowly with the remaining camps.[15] General Schwarzkopf also directed that troops in each camp be disbursed for greater security. Each of the six 5,000-troop life support areas would be divided into four smaller modules a kilometer apart, capable of supporting 1,250 soldiers.

The Corps temporarily delayed implementing the contract while its contracting officer negotiated the price of dividing the modules. Spreading the camps out increased the contractor's costs, so other items in the contract had to be cut out. Water wells costing $800,000 were scrapped and a more austere design was adopted for the dining facilities. The Dhahran Area Office also made changes in the latrines that saved $750,000 and helped pay for the dispersal.[16]

Dividing the camps delayed the completion of the contract. The Corps issued an unpriced notice to proceed to the contractor on 15 October for dividing the life support areas. MACE began to bring its construction equipment onsite. The contractor had difficulty getting access to the site for life support area A at King Fahd International Airport because certain approvals were required from airport officials. Work was also delayed at life support area B (Phoenix) because a local landowner complained that the proposed camp was on his farm. The claim of the landowner was resolved, and the farm was relocated. By the end of October, the contractor had completed his survey of life support area F (Pulaski) and begun surveying life support areas C (Bastogne) and E (Abqaiq).

As siting problems continued, MEAPO(SWA) and ARCENT asked Saudi officials to intervene. The Minister of Defense formed a committee in Jeddah to resolve the issue. Meanwhile, MEAPO(SWA) directed the contractor to stop all site work associated with life support area A. By mid-November, the contractor had poured concrete for the dining hall foundations on life support areas C, D, and F. ARCENT directed MEAPO(SWA) to phase the construction to allow troop engineers to work alongside the contractor to upgrade the camps.[17]

On 6 December, as a result of the host nation implementation plan that had been signed a month earlier, the contract for life support area construction was turned over to the Saudi Arabian government. By then, the contractor had completed 84 percent of the work for sites B, C, D, E, and F, but site A was only 45 percent complete. The Saudis turned over the completed life support areas B, C, D, E, and F to U.S. forces in mid-March, weeks after the war had ended. Although the original contract stipulated that the life support areas be completed in mid-January, the contractor did not complete life support area A until the end of April.[13]

Schwarzkopf's objections to spending large sums on life support areas were to some extent vindicated. The ground war ended so quickly and the life support areas took so long to complete that they were never used for the purpose intended. American soldiers never occupied them because by the time the camps were completed, the soldiers had moved into the forward areas.

Although critics complained that the United States received little but leveled-out sand for its $30 million, others disagreed. Corps contract specialist Kay Bauer noted that the Corps did not have the normal 60 to 70 days to work out the arrangements, and the cost of doing business was higher in Saudi Arabia than in the United States. Competition determined price, she explained, and "we got what we reasonably could have expected to get." Mobilizing workers and equipment was expensive, and the contractor had a short performance time of 90 days.

Also, much of the contractor's work was not readily apparent, such as the installation of tanks and sewers. The cement-block dining facilities had air conditioning and reinforced slabs. The contractor had had to establish work camps, air-conditioned supply trailers, and office work space. He had brought

Grader spreads marl at a life support area.

in generators and provided running water. The road construction element had been taken out of the contract, but the contractor had built crude roads to bring in his equipment. The contractor worked on roads for 60 days and used what amounted to a platoon's worth of equipment-four dump trucks, two bulldozers, a bucket loader, a road grader, and compaction equipment-adding considerably to his cost.[19] Given the amount of work that the contractor performed and his expenses, the costs of the life support areas were probably reasonable.

Main Supply Routes

The construction of main supply routes was critical for logistics support and for moving troops. Initially engineers paid little attention to theater planning for main supply routes because the existing highway network in Saudi Arabia gave adequate support during the initial deployment phase. Main supply route Audi, a good multilane road, stretched from Dhahran along the coast to just north of Jubail. Dodge (Tapline Road) ran northwest from Audi to Hafar al Batin and then across Saudi Arabia. Two major southern routes were Toyota and Nash. Toyota was an excellent multilane road that ran between Dhahran and Riyadh, and Nash ran north from Riyadh to Hafar al Batin where it intersected with Dodge. Some roads were in good shape initially, but none could withstand the high volume of military traffic. Few secondary roads existed. Forward logistics

Soldiers from the 20th Engineer Brigade compact the ground for a new road in Southwest Asia.
(U.S. Army photo by SSG Martello, 20th Engineer Brigade, Public Affairs Office)

bases were far from ports and airfields. For example, the distance from Dhahran to King Khalid Military City was 334 miles.[20]

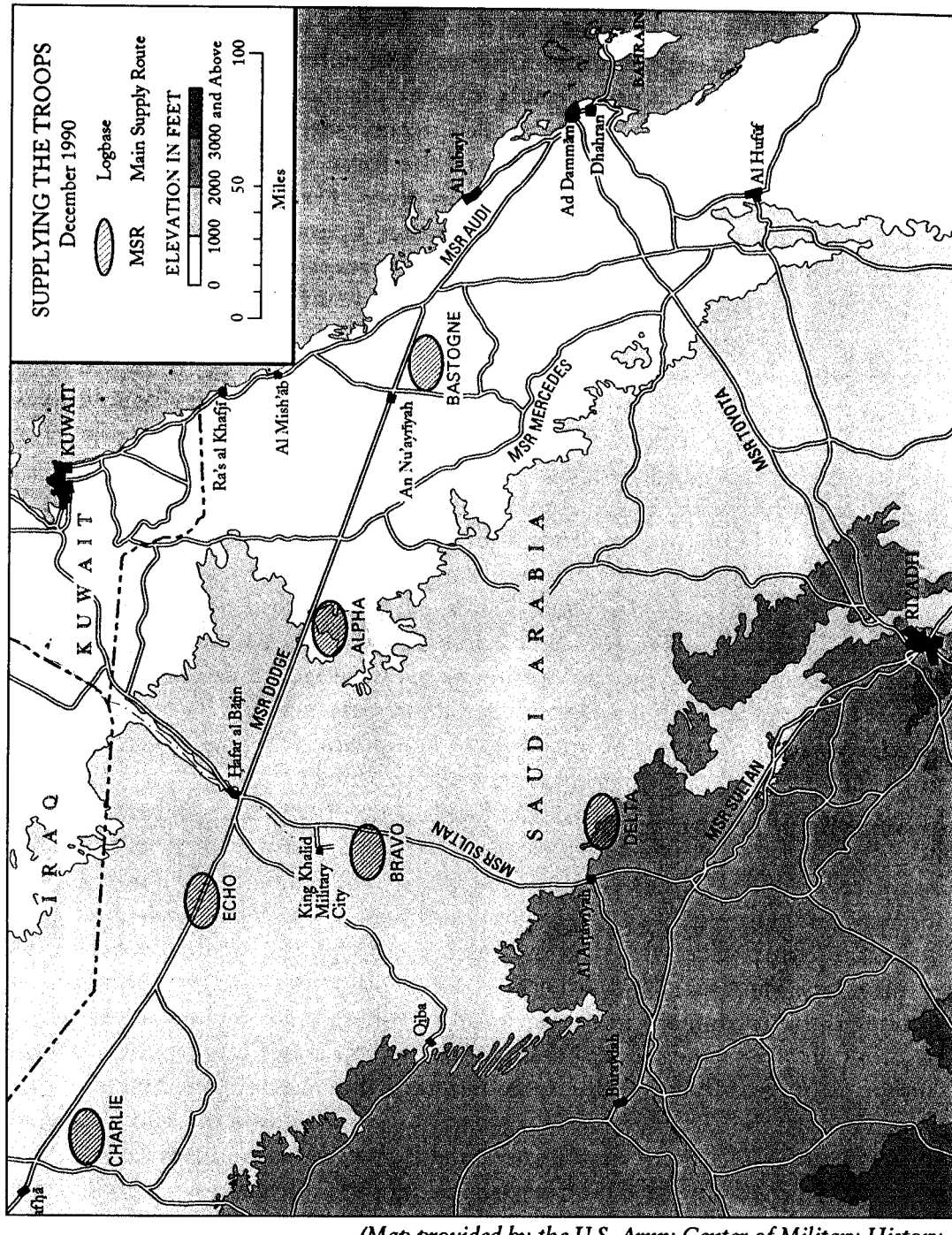
Because of these existing roads, theater planners failed to anticipate the transportation problems that would occur with the second phase of deployments and massive movement of the force to forward positions. As a result, overpasses and bypasses were not in place at critical road junctions. U.S. forces did not control quarries and crusher operations that could reliably delivery construction materials and did not have responsive contract capabilities to produce asphalt or pave roads. CENTCOM was forced to divert the corps' combat engineer battalions from forward support missions and training to road maintenance. Construction, maintenance, and repair of these routes remained a high priority. By mid-January the equivalent of ten engineer battalions was building and improving 3,250 kilometers (1,950 miles) of corps-level and theater-level main supply routes.[21]

Combat heavy battalions were poorly equipped for road maintenance. The battalions' MTOE (modified table of organization and equipment) did not provide for adequate compaction equipment or water and asphalt distribution equipment. Trucks to distribute water or asphalt and vibratory rollers to compact soil were all scarce. Task Force 43 had only two 35-year-old pavers that frequently broke down. Cutting edges for road grader blades were also scarce because the hard desert soil wore them out quickly. The motorized road grader was the most important piece of equipment for road construction and maintenance, and additional graders were procured.[22]

Lieutenant Colonel Gilbert Van Sickle, one of Pagonis' engineers, learned to look at how native contractors constructed roads rather than use U.S. standards and designs—especially when the standard materials were unavailable. During his 21 trips to Southwest Asia, Van Sickle had gained valuable experience with exercise-related construction and in working with contractors. Van Sickle and other engineers with experience in Southwest Asia modeled the Jordanians in using vibratory rollers for compaction. Army units without previous experience in that part of the world tried to use their standard methods of road building, the same methods they used in Europe.

Through the 20th Engineer Brigade, Van Sickle shared his knowledge with units in the XVIII Airborne Corps. By the time those engineers began work, they had learned a great deal from observing the contractors. Upon its arrival, VII Corps moved straight out into the desert, so Van Sickle could not help its engineers. Soldiers with the 265th Engineer Group, a National Guard unit from Marietta, Georgia, and the 92d Engineer Battalion from Fort Stewart, Georgia, had experience constructing roads in desert environments.[23]

Most of the area was sand, 6 to 9 inches deep. Because the sand had a consistent gradation, it did not compact. Engineers had to look for alternative materials and methods of construction. Army doctrine and training specifies that engineers first remove the overburden or organic material (the top surface)



(Map provided by the U.S. Army Center of Military History.)

and build roads from this base. But when they scraped off the surface materials in the desert, they removed the stable base. As a result, the road turned to dust, or mud if it rained, and vehicles were forced to drive off the road. The construction technique eventually adopted was to use a road grader to clear any rubble off the surface of the desert and build up the road above the desert rather than cut into the desert and apply dust palliative.[24]

Soldiers and equipment from the 20th Engineer Brigade work on a new road *bed.* *(U.S.* Army ***photo by SSG Martello, 20th Engineer Brigade, Public Affairs Office)***

Rock was generally not available for the base course for roads. Marl, a clay-type soil rich in calcium carbonate, is quarried in the region and was the most abundant and cost-effective material for road construction. In fact, it was the only widely available material in Saudi Arabia that could be compacted for roads. Marl, a crumbly substance, did not have to be crushed. Its slight moisture content made it easy to compact. Engineers dug the marl out with bulldozers, dumped it on the roads with bucket loaders, wetted it down, and compacted it with graders. Once dried, it had the consistency of concrete. Marl, however, failed after torrential rains and became very dusty after use by vehicles. In areas where it failed, high-priced crushed rock was used.

The application of cold mix asphalt-- sand, gravel, and RC-1 (a rapid cure asphalt)-was another paving process. It was not as good as hot mix asphalt and could not withstand as heavy a load, but hot mix asphalt required batch plants, which no longer exist in active Army units. Engineers using hot asphalt needed a batch plant near the work site because the asphalt hardens over time as it

cools. In some areas paving plants did not appear until late in the operation. By contrast, the cold mix could be hauled long distances.[25]

Troops and contractors sometimes shared the road construction effort. At King Fahd International Airport, for example, roads were a chalky white dust that created health hazards. To reduce the hazard, troop units prepared a base course, and the contractor did the actual paving.[26]

Engineers at echelons above corps constructed 1,133 kilometers of roads, and engineers with the two corps constructed 3,209 kilometers of roads. Yet, the main supply routes the Army built never reached the quality of the existing paved roads. The Army's roads north and west of King Khalid Military City were damaged by rain soon after completion. These roads, Cargill concluded, "were never really able to do what we intended for them to do."[27] The roads served an immediate need but would not hold up in the long term and could not carry the volume of traffic required.

Dust Palliatives

Besides contracts to construct life support areas and main supply routes, the Corps awarded contracts to apply dust palliative. Blowing dust in Saudi Arabia chewed up expensive equipment, created costly maintenance problems, and threatened the safety of helicopter pilots trying to take off or land in the thick clouds of dust. The steady winds blew soil particles across the desert surface

"White-out conditions endangered helicopters trying to land.
(U.S. Army photo, Center of Military History)

wearing them down to an almost microscopic size. Dust on the battlefield obscured vision, coated sighting instruments, and sometimes helped the enemy detect the location of U.S. forces. In its after action report, the U.S. Army Engineer School candidly conceded that the requirement to control dust "far exceeded the engineers' capability to deal with this problem."[28]

Airfield matting, like the M–19 matting brought from Europe, effectively prevented dust but was too expensive to use in all areas. Other methods, such as cutback asphalt, asphalt emulsions, and road tars, were needed to cover the large areas surrounding the matting. They could be applied as a penetration treatment or as admixtures. With admixtures, engineers loosened or broke up the soil and sprayed an asphalt emulsion on it. At approximately $1.80 per square meter, asphalt emulsions were the cheapest form of dust control. Other methods were coarse aggregate, vegetation, resins, brine solutions (which did not work in Saudi Arabia), cement and lime, and crude oil and waste oil. Crude oil did not cure and added no structural strength to the soil. Since the oil remained liquid, it turned the loose soil into a black, oozing mass, coating vehicles, equipment, and personnel. It also polluted the environment.[29]

Soon after the Corps first arrived in Saudi Arabia, Lieutenant Colonel Tomasik directed MEAPO(SWA) to evaluate various methods of dust control such as sand still, magnesium chloride, and peneprime for trafficability, availability, and cost. MEAPO gathered information on cutback asphalt, emulsified asphalt, calcium chloride, magnesium chloride, crude oil, diesel fuel, burnt motor oil, and other dust control substances.

A MEAPO expert, J. R. Ramos, recommended using CSS–1 as a dust palliative. CSS–1 was a cationic emulsified asphalt that provided a nonstick, dust-free surface as durable as the material to which it was applied. This environmentally acceptable material was not as volatile as cutback asphalt and did not have the humidity and reapplication requirements or the corrosive properties of salt emulsions. Moreover, emulsified asphalts were readily available in Saudi Arabia and could be applied by low-pressure spraying equipment, common to paving operations. Ramos recommended using emulsified asphalt in areas with compacted or stabilized soils with heavy foot or vehicle traffic (such as roads) and in loose sand areas with light foot and no vehicle traffic (such as nontrafficked areas adjacent to heliports, airfield aprons, and runway shoulders), but not in loose sand areas with heavy foot or any vehicle traffic.[30]

Army experts recommended using cutback asphalt as prescribed in Army technical manuals, but these materials often had to be worked into the soil to be effective. Combat heavy engineer battalions with the equipment needed to work cutback asphalt into the soil would not start arriving in the theater until late October.

In early October, ARCENT approved the use of waste motor oil and other petroleum products as dust palliatives but, because of the environmental impact,

restricted their use to vehicle and pedestrian traffic areas such as roads, parking lots, and foot paths. Treatment was only effective on compacted areas. Engineers used field expedient methods to distribute the liquid. One method included putting a 53-gallon drum with a 3/8-inch hole in the bottom on the back of a truck. The oil had to be distributed as evenly as possible. Tomasik directed that the oil not be used as dust palliatives outside vehicle and pedestrian traffic areas, especially near water sources, residential areas, agricultural areas, and grazing land for livestock.

MEAPO engineers cautioned that crude oil and diesel fuel should be used only as a last resort. They feared that approval to use oils or fuels would prompt wide, indiscriminate application. The environmental concerns were serious. Also, vehicles and boots tracked the oil all over, making surfaces slick.[31]

As part of the search for appropriate dust control, the U.S. Army Engineer Waterways Experiment Station, a Corps laboratory in Vicksburg, Mississippi, wrote "Dust Control in Desert Environments." No one material could be singled out as the most acceptable for all situations, it reported. Rather, the best method for a particular area depended on such factors as traffic (type, volume, magnitude of wheel loads), soil properties, topography/surface features, climate, availability and cost of materials, and requirements and availability of construction equipment and personnel. In a follow-up paper, laboratory personnel noted that dust control on or near helipads was a major problem. Constructing flexible pavement and using open-graded crushed stone were two methods under consideration. In areas such as refueling, rearming, and maintenance pads with significant foot traffic, flexible pavement might be the better alternative. At least one crushed stone helipad had already been constructed.[32]

On 8 November, representatives from the South Atlantic Division, the Waterways Experiment Station, Corps headquarters, and MEAPO met in Winchester, Virginia, to review MEAPO's proposal for controlling dust and to discuss testing some commercial dust palliatives. At the meeting, Ramos, who had recently returned from a 60-day assignment in Saudi Arabia, reported that contractors were stabilizing the soil effectively with asphalt emulsions.

For nontrafficked areas, contractors sprayed the emulsion on the exposed surface. This controlled the dust effectively but did not hold up under traffic. For trafficked areas, a base section was treated with asphalt emulsion to a depth of 3 inches. The contractor then mixed and compacted the stabilized material. Ramos found that roads stabilized by this method held up well under equipment with rubber tires such as fuel trucks and jeeps but not under tracked vehicles. Asphalt emulsion penetrated better and was more effective than cutback asphalt. In addition, it was available in the country, recyclable, and inexpensive. Surface spray applications cost about $.30 per square meter, while the blended procedure for trafficked areas cost $1.85 per square meter.[33]

Hand application of dust palliative at Al Hasa.

The Dhahran Area Office awarded an open-ended contract for dust palliatives in early October 1990. Delivery order #1 of the contract was to stabilize approximately 330,000 square meters of uncompacted, medium-grain sand with fines at Al Hasa Airport outside Hofuf for the 82d Aviation Brigade. Tamimi Company of Dammam completed the work on 13 November 1990. The area was backgraded by a dozer and graded with two passes of a road grader. CSS-1 asphalt concentrate (0.875 liters per square meter) was mixed with water at a ratio of 6:1 and applied with penetrations up to half an inch. The area held up well. Twenty helicopters operated in the area daily but did not land on these stabilized areas. On the negative side, spreaders had to have balloon tires to operate in some areas, and only two such spreaders were available in the country at the time. Also, areas with sand berms required hand application. It took the contractors 8 days to spray the 3,600-meter long sand berm that surrounded the airfield.

The delivery order also included treatment of roughly 10,000 square meters of road, which had a minimum of 9 inches of compacted marl. The contractor removed the top 3 inches of marl, mixed it with water and roughly 8 liters per square meter of asphalt concentrate, and then spread and compacted the mixture. Operators used the same equipment to process the soil in the trafficked areas that they used in other paving operations.[34]

MEAPO(SWA) received a tasking on 9 October to upgrade 4,000 meters of a road 7 meters wide at King Fahd International Airport by applying 2 inches of asphalt for dust abatement to a subbase constructed by a combat engineer battalion. The contractor was delayed because the engineer troops preparing the base course lacked adequate equipment.

Another tasking was to add dust abatement (a 2-inch surface course of asphalt) to an existing stabilized marl base (more than a million square meters) also at King Fahd International Airport that U.S. forces were using as a temporary parking apron. Many helicopters were housed there before deployment to other locations. MEAPO awarded the indefinite delivery order construction contract on 14 November, and within days the contractor had begun grading and paving operations. By early December two contractors were laying 6,000 to 7,000 tons of asphalt per day using five spreaders. Although the cost of the contract was roughly $4 million, the amount was not excessive considering a single air brigade had already spent $82 million to repair blades and engines damaged by the dust.[35]

In early November MEAPO(SWA) awarded delivery order #2 on the contract with Tamimi Company to apply dust palliative to 26,500 square meters of trafficked area and approximately 290,000 square meters of graded, uncompacted, fine sand. The areas to be stabilized surrounded 80 helipads at Thadj and 20 helipads at Jelady plus two 100-foot-square hot refueling pads-where helicopters refuel without turning off their engines. The contractor was also to provide dust palliative to roughly 20,000 square meters of road leading to the pads.

At Thadj, Tamimi applied a 60 percent water/40 percent asphalt CSS-1 solution at a rate of 7 liters per square meter. Work at Thadj progressed slowly due to limited equipment and water. Two independent laboratories in Saudi Arabia tested the asphalt at Thadj and found the quality to be acceptable. The treated area could take limited foot traffic but not vehicle traffic. The Jelady

Emulsified asphalt was used as a dust palliative at Thadj.

work was planned for December, but the Dhahran Area Office did not award any other delivery orders under this contract because the Saudis took over contracting responsibilities.[36]

General Storat later contended that the most effective method of dust control was crude oil. Diesel fuel was also effective but was a greater environmental hazard. The use of MC–1 and RC–1, he added, was somewhat effective at heliports with no vehicle traffic, but engineers could not keep traffic off the roads long enough for the mixture to cure. Lieutenant Colonel Van Sickle reported that the asphalt emulsion MC–1 was readily available and worked well, but asphalt spreaders were scarce. Ultimately, MC–1 did not cure fast enough or penetrate well enough, causing it to roll back up on vehicle tires. RC–1 evaporated too quickly, without penetrating the soil.

Eventually, crude oil and diesel fuel became the most common dust palliatives used in the theater north of Tapline Road. More than 3 million gallons of crude oil and diesel fuel were spread on main supply routes. Both penetrated well and were easily compacted. No dust palliative held up well in heavily trafficked areas, and vehicle operators tended to drive on any black surface even if it was designated as a nontraffic area.[37]

Helipad/Heliport Construction and Apron Expansion

The sand and grit blowing across the Saudi desert created an urgent need for heliport and helipad construction. Pilots took off and landed in what troops called "white-out" conditions where they had little or no visibility. In October, the commander of the Army's Aviation Systems Command, Major General Donald R. Williamson, reported that the helicopters in Saudi Arabia faced "tremendous logistics and maintenance problems" due to extremely high temperatures and blowing sand and dust. In just a few hours, the sand rapidly eroded layers of protective paint and skin on the rotor blades. Ingested sand ate away at compressor blades in engines at an alarming rate. The aviation command tried painting a protective coating on every rotor blade, but the sand was so abrasive that this coating was only a stopgap until the command could provide blades with a longer-lasting protective tape. It also explored methods of filtering out the sand before it destroyed the engines to buy time while it developed ways to get particle separators into Saudi Arabia. Several commanders grounded their aircraft to save them for possible combat operations.

Williamson complained that commanders could get asphalt pads and short runways for their helicopters but were hamstrung by funding limitations. "In my estimation," he argued, "the savings in resupply and parts alone would pay for these costs in less than 30 days, and improved readiness would be the payoff." The "very serious" situation justified waivers to normal operating procedures.[38]

In response to the problem addressed by Williamson, MEAPO(SWA) awarded some major contracts for helipad and heliport construction. In late September, ARCENT directed the construction of heliports at various locations, and MEAPO issued the solicitation package on 28 September 1990. MEAPO(SWA) personnel began, drafting plans for a 125-helicopter helipad at Thadj on 24 September after learning that the 20th Engineer Brigade was prepared to do the work but lacked a plan of construction. On 3 October, they reviewed the draft plans with the brigade, and a few days later the plan went to the ARCENT engineer for approval. Using M-19 matting, the 20th Engineer Brigade constructed helipads at Thadj and Jelady for approximately 100 helicopters of the 24th Aviation Brigade. MEAPO provided an equipment leasing package to augment the engineer brigade.[39]

In response to the ARCENT commander's directive to move helicopters forward and a Saudi requirement to vacate Dhahran air base's flight line, ARCENT initiated a program in November to construct temporary standard heliports at nine sites, including King Fahd International Airport. Through an agreement with the Saudi Arabian government, construction began on a facility for roughly 100 helicopters from the 18th Aviation Brigade at the Dhahran air base to be completed by 15 November. Space for another 100 helicopters was scheduled for completion by 15 December. The austere facility would include a 6-inch compacted aggregate base, a 2-inch asphalt overlay, helipad markings, and helicopter tiedowns. CENTCOM approved 11 such projects at nine separate sites, totaling roughly $81 million.

Two asphalt paving machines work side by side at the King Fahd International Airport. Five of these machines were used simultaneously to handle the daily requirment of

Workers place concrete at one of the four CH-47 helicopter refueling pads. A mechanical screen saved time, allowing the placement of 2,400 cubic meters of concrete in two weeks.

By mid-December, with support from the 416th Engineer Command, MEAPO(SWA0 had designed 10 of the 13 projected helipads throughout the theater for the Army and had passed those designs to the Saudis for funding and construction. The projects were either under construction or out for bid. When completed, the 13 helipads could accommodate about 1,900 helicopters. The Army tried to balance troop and contractor efforts and use designs that were both safe and effective.[40]

On 24 November, MEAPO(SWA) signed a contract with Al Shuwayer to construct a helicopter apron at King Fahd International Airport. In mid-December, it signed a $10 million contract with Harabi Company to expand a helicopter apron at Riyadh air base and with Al Khereijy to construct two refueling pads at Dhahran. In January, MEAPO(SWA) contracted with Al Turuq Trading Company for a 250-aircraft heliport at Inland Pumping Station #3 and with Gaid Contracting for helicopter ramps at Ras Al Mishab. The next month it signed a contract to expand an apron at Al Qaysumah.

Perhaps the most challenging helipad and apron construction occurred at King Khalid Military City. With the arrival of VII Corps and the movement of troops westward, the need for helipads and heliports at King Khalid Military City became particularly critical. This installation became "the center of gravity" for many multinational combat and logistics units. Pagonis planned to construct the largest logistics base there since Long Binh during the Vietnam War.[41]

In late November, MEAPO(SWA) identified construction requirements at King Khalid Military City. While at a staff meeting in Dhahran on 26

November, Colonel Roger Scearce from the support command headquarters at King Khalid Military City mentioned that the apron there could only support two aircraft, not enough to open an aerial port of departure. After the meeting, Lieutenant Colonel Cox quietly pulled Scearce aside and told him that the Corps had designed and constructed the military city. Cox asked Scearce if he wanted the Corps to explore ways to expand the aircraft capability there. Scearce agreed, indicating that his goal was to park ten C–5 aircraft on the apron at one time.

That night Cox called MEAPO staff in Winchester and asked them to prepare a design package for a 10-aircraft apron at King Khalid Military City. Four days later, on 30 November, he had the design in hand. The Dhahran Area Office quickly reproduced the solicitation package for the apron expansion design and turned it over to the Saudis on 3 December. On 29 December the Saudis hired Ijzala Trading and Construction to pave 171,375 square meters to expand the parking apron at King Khalid Military City for ten C–5 aircraft at a cost of over $10 million.[42]

In addition, Corps contractors constructed a heliport for 200 helicopters. With the increasing workload at King Khalid Military City, Corps officials decided to establish a resident office there. Captain Steve Adams left for the installation on 11 December to coordinate with ARCENT and the SUPCOM and prepare office space. Adams brought a fax machine and computers and obtained telephones, including a phone for secured communications. He relied heavily on a phone answering machine because he was often at heliport projects up to 190 kilometers (a 2-hour and 10-minute drive) away. Adams' missions there included latrine, shower, and washstand distribution; dust palliative for the 1st Cavalry Division; and real estate support. His office grew to eight people, including some from the 308th Engineer Detachment (Real Estate) who helped lease facilities and a civilian resident engineer.[43]

The operations at King Khalid Military City did not run as smoothly as Army officials might have liked. It was one of the wettest winters in recent years. Several rain storms caused delays. At other times, dust storms hampered work. One laborer working on the heliport project was killed when a grader operator accidentally backed over him.

New problems arose as the United Nations' 15 January deadline for an Iraqi withdrawal approached. Just when the need for helipad and apron expansion projects became more urgent, frightened workers began to disappear from the work site. On 17 January, the day the coalition forces launched the air attack against Iraq, one contractor was still bringing up equipment. The contractor had watched five other contractors leave their job sites, but he promised the Corps he would stay. When additional equipment arrived the next morning, however, the crew of nine shrank to three. Some anxious workers rode home on the backs of the flatbed trucks. One worker who complained that work at King Khalid Military City was too dangerous returned to Riyadh, but

after an Iraqi Scud hit within a block of his home, he volunteered to return to work.

Captain Adams invited some of the workers to his residence and offered them protection and help if they would return to work. After some cajoling, workers began returning. Adams issued the workers some German protective masks, and the Corps' construction representative, Ed Miranda, demonstrated how to use them. Many Arab men wear beards, but after Miranda explained that beards might prevent the masks from sealing well, the workers shaved. One worker became so adept at putting on his gas mask that when he was startled by the sound of an aircraft dropping its fuel tank, he put on his mask between the time he jumped off his equipment and the time he hit the ground.[44]

The major contractor at King Khalid Military City agreed to return with a full force on 19 January. Working with the ARCENT engineer, Adams arranged for troop units to help the contractor. The Dhahran Area Office helped the 411th Engineer Brigade acquire leased dump trucks to form a provisional dump truck company. ARCENT detailed Task Force 43 to carry on the construction, and the sight of troops at work reassured the contractor. Contract workers drifted back, and even when a jet crashed 100 yards from the site and the ground war had begun, they stayed on the job. Support from Task Force 43 kept the project on schedule. It provided dump trucks, a bulldozer, some scrapers, and night lights, so work could continue around the clock.

The Corps enlisted the task force to remove material from the site and provide lights and haul capability because its contractor was having difficulty with his aggregate supply. The contractor hauled aggregate from 300 kilometers away, while the engineer troops used heated-bed asphalt trucks to haul asphalt from the contractor's plant 20 kilometers away. In the early construction phases, Task Force 43 provided 10 percent of the contractor's work force and 14 percent of the engineer equipment. By late January, the contractor had mobilized more than 100 people and 50 pieces of equipment, and the task force did less work.[45]

When completed, the apron at the installation was 800 by 250 meters of solid asphalt paving, the equivalent of a paved road 28 kilometers by 9 meters. The first aircraft, three C–130s, used the apron on 16 February, just a month after the original contract was let. The first C–141 used the project a few days later. By the end of February, C–5s, C–141s, and C–130s were landing daily, and the heliport project was nearly complete. Given the siting problems, host nation contracting procedures, and the start of hostilities, Corps officials called the project "a success story."[46]

The apron expansion became one of the most important projects during the war. King Khalid Military City replaced Dhahran as the principal aerial port of debarkation when the ground war began. If the 4-day war had lasted longer, the airfield at King Khalid Military City would have been a major station for resupplying troops and carrying out casualties. Soldiers and contract workers

A contractor and Dave Greenwood, Corps representive, inspect the pavement thickness at the Camp Eagle II paving project. Located near King Fahd International Airport, Camp Eagle II was the base camp for the 101st Airborne Division (Air Assault).

completed the project with remarkable speed and MEAPO staff saved time by making a major design change-cutting the amount of base course required-during construction.[47]

As with the dust palliative contracts, the benefits of helipad, heliport, and apron construction contracts far outweighed the costs. Colonel Cargill observed that $6 million was not unreasonable for a helipad that would hold 100 Apache helicopters, each worth $6 million. The 101st Aviation Brigade spent $82 million between August and November on rotor blades and engines for its helicopters. Comparatively, paving a helipad at King Fahd International Airport cost only $4 million.[48]

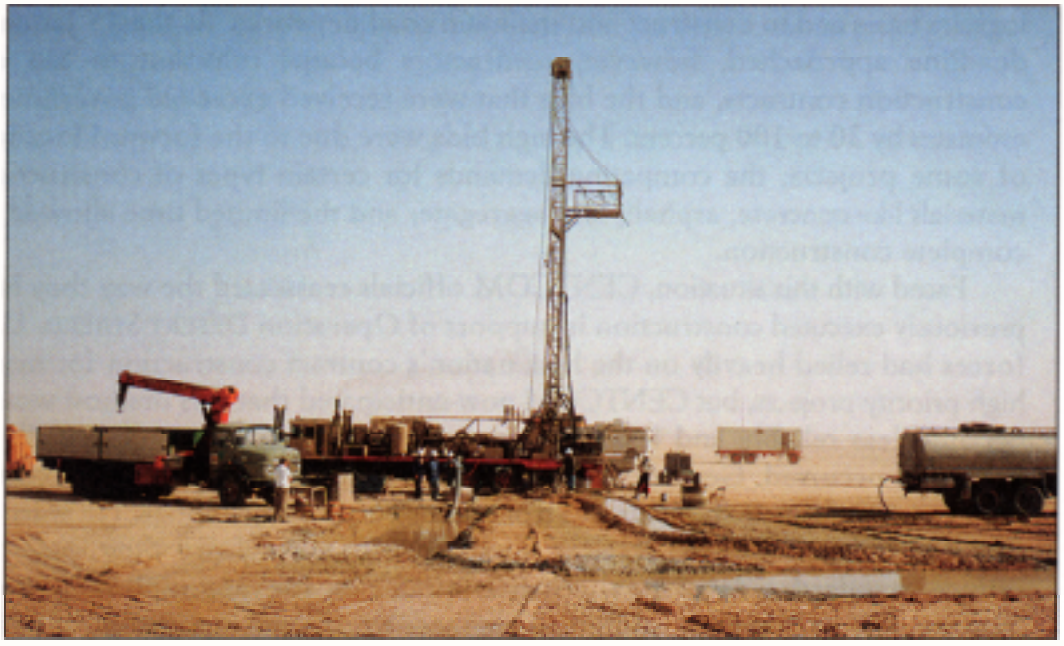
Well Drilling

Contract construction also involved drilling water wells. Initially planners assumed that the Saudi Arabian government would provide enough bottled water, but as they developed plans for offensive operations, they realized that they would have difficulty transporting bottled water to the forward areas. Officials granted permission to drill wells near the Iraqi border.

The Army deployed seven engineer well drilling detachments (including one for command and control) to the theater. Four active component detachments arrived in September, and three reserve detachments followed in January. The three reserve detachments were used initially to support the facilities engineering mission of the 1030th Engineer Battalion at Dhahran and

during the ground war were placed in support of VII Corps. The active component detachments worked under the 20th Engineer Brigade supporting the XVIII Airborne Corps. Three of the four detachments drilled for water at life support area C (Bastogne). When that effort failed, one of reserve units, the 865th Engineer Detachment (Well Drilling), attempted to drill two wells at life support area F (Pulaski). The first attempt failed but the second produced water. The 865th Engineer Detachment drilled the only new well in the theater, but by the time the well was complete, U.S. forces had moved out of the area.[49]

The U.S. Air Force and the Marine Corps were more successful than the Army Army well drilling, oriented as it was toward Europe, worked poorly in the desert. If Saudi Arabia had not already had some wells, the U.S. military would have had difficulty. Lieutenant Colonel Van Sickle observed the Army's well drilling program was "broke." The Army well drilling detachments were neither equipped nor trained to succeed in the desert. Their equipment was new but inadequate, and the units had not been trained in drilling deep wells. Army well drilling rigs were designed to drill 600 feet. This capacity was adequate in Germany, but not in the deserts of Saudi Arabia where the water tables were more than 1,500 feet below ground. The Army had not brought its water well completion kit tools and had to purchase a kit to give the 600-foot rig a 1,500-foot capability. Contractor equipment, which could drill 5,000 feet, Van Sickle observed, made the Army rigs look like "tinker toys." Constructing these deep wells with existing Army equipment took more than 60 days, and soldiers could not wait that long for water.[50]



A contractor drills for water in the Saudi Arabian desert.

To augment the Army's well drilling capability, the Corps awarded well drilling contracts. In September officials determined that two wells were needed at each of the six life support areas. On 29 September the Dhahran Area Office issued an indefinite delivery contract to Hajjan Drilling Establishment to develop up to 12 water wells at various locations. ARCENT canceled the contract on 6 November.[51]

On 10 December the Dhahran Area Office awarded two drilling contracts, one for wells at life support areas A and E and one for the other four life support areas. By early January the contractors had drilled to 722 feet at life support area B, 1,123 feet and 299 feet at life support area C, 1,257 feet at life support area D, 230 feet at life support area E, and 985 feet at life support area F. The contractor had not yet begun drilling at life support area A because of problems with security passes. After the hostilities ended, the Corps signed a $26,667 contract with Al Mobarak to inspect and repair pumps and develop a well at King Khalid Military City. The project was completed on 28 March 1991.[52]

The deficiencies in the Army well drilling program did not significantly affect Army operations because the Army could rely heavily on the huge quantities of bottled water that the Saudis provided.

Contract Support in the Forward Areas

By the end of December CENTCOM had more than 120 approved major construction projects in the theater. Projects that CENTCOM had turned over to the Saudis for contract construction were being expedited to support forward logistics bases and to construct and maintain road networks. As the 15 January deadline approached, however, contractors became reluctant to bid on construction contracts, and the bids that were received exceeded government estimates by 30 to 100 percent. The high bids were due to the forward location of some projects; the competing demands for certain types of construction materials like concrete, asphalt, and aggregate; and the limited time allowed to complete construction.

Faced with this situation, CENTCOM officials reassessed the way they had previously executed construction in support of Operation DESERT SHIELD. U.S. forces had relied heavily on the host nation's contract construction for many high priority projects, but CENTCOM now anticipated that this method would become less reliable and less responsive in the forward areas, especially if hostilities occurred. General Starling recommended that the services reassess their construction requirements and troop construction capabilities. He warned that CENTCOM and the services might need to scale down their projects, reduce standards, develop alternative strategies for accomplishing their missions, and even deploy additional engineer troops and equipment. If Saudi or Japanese government funds were not responsive enough, U.S. funding for emergency construction under Section 2808 could be used.[53]

Contract awards by the Saudi Arabian government had, in fact, slowed for lack of competitive bidders and rapidly escalating prices. To expedite projects, CENTCOM requested that the Saudis award the contracts on a sole source basis. Frightened contract workers walked off two construction sites in northern Saudi Arabia, temporarily halting construction. During the offensive, many workers in the rear and forward areas disappeared for days—or in some cases weeks. One frantic contractor kept his workers on-site only by promising extra pay. With many workers absent, projects took longer to complete or were not completed at all.

CENTCOM reviewed the status of the construction projects to determine which had to be accelerated and which could be delayed. CENTCOM struggled to execute critical projects through revised arrangements with contractors. Some critical projects such as the ramp expansion and helipads at King Khalid Military City and the helicopter ramps at Ras al Mishab were accomplished with troop units using contractor materials. To ensure that construction materials were delivered, CENTCOM provided military escorts for civilian convoys and increased the stockpiles of material in the forward areas. Sometimes troops teamed up with contractor drivers with orders to take over the vehicle and continue driving if necessary. By late January many workers had returned.[54]

CENTCOM refused to supply contractors with chemical defense equipment because this was the contractors' responsibility. Contractors spent days contacting manufacturers of chemical defense equipment, but Defense Department requirements had severely depleted the supplies. Eventually CENTCOM provided some equipment for contract workers. During hostilities, however, workers continued to abandon their job sites, and sometimes the contractors themselves left the area. In one case a major contractor fled to London with a $12 million check, which was later recovered. In other instances, contractors were willing to continue work, but they were barred from construction sites for security reasons.

Colonel Braden later recommended that the services be prepared to provide their contractors with chemical protection gear. He also recommended that contractors be screened for reliability and that engineer troops be brought into the theater and properly allocated to avoid relying heavily on contractors.[55]

Construction to Support Redeployment

The value of the projects under construction in mid-March, several weeks after the ground war ended, was $64,263,152. Of this, $62,494,618 was from host nation support and $1,768,534 from the Gulf Peace Fund. The value of projects completed totaled $107,258,513, most of which came from host nation support. At the time the Gulf War ended, the Corps had projects worth $500 million either awaiting award or under design. Roughly $200 million of these projects were eventually canceled because of the rapid conclusion of the

war.[56] The Corps' emphasis shifted quickly to constructing facilities for redeployment, and construction expenditures dropped dramatically.

The redeployment of equipment and personnel began with the XVIII Airborne Corps, followed rapidly by VII Corps. Redeployment officially began on 10 March. By the end of May, more than 365,000 soldiers from the two corps had left the theater, at an average rate of 5,000 soldiers a day, faster than personnel had entered.[57]

Engineer operations shifted to construction projects for redeployment, especially vehicle washing facilities and hardstands for staging the equipment before and after it was cleaned. The U.S. Department of Agriculture insisted that all equipment be thoroughly cleaned before it was returned home to prevent importing crop-infesting insects. Dust palliative was required at the wash racks because the cleaned equipment and vehicles could not be parked back in the dust while awaiting shipment to the United States or Europe.

Staging areas and wash racks for military vehicles became the dominant construction requirement. Contractors and troops established wash sites at Dammam, Dhahran (where the VII Corps would redeploy), Jubail, and King Khalid Military City (where the XVIII Airborne Corps would redeploy). The plan called for 80 wash points at an estimated cost of $8.6 million, but this was later revised to provide 60 wash points at King Khalid Military City at an estimated cost of $6.6 million.

Soldiers clean vehicles at a wash rack in Saudi Arabia.

U.S. government vehicles at a sterile area near the port of Dammam, Saudi Arabia, await return to the United States. *(U.S. Amy photo by SGT John Bohmer)*

In early March the Corps received requests to install 50 wash racks at Dhahran, King Khalid Military City, King Fahd International Airport, and Dammam. The Dhahran Area Office purchased membrane that the 411th Engineer Brigade installed at the Dhahran temporary wash rack.

On 19 March representatives from the Dhahran Area Office and Bechtel met with the ARCENT SUPCOM engineer to draft a revised plan for wash facilities at Dhahran and King Khalid Military City. The first precast ramps for the temporary wash facility at Dhahran were delivered on 27 March. The Dhahran Area Office awarded the construction subcontract for the permanent wash facility at Dhahran air base on 26 March. The office completed the design for the paved redeployment assembly area in Jubail. Securing approval for these projects was difficult because Saudi officials resisted funding any new projects.[58]

Despite the challenges presented by redeployment, by early May **1991,** the Corps had completed $135,280,121 in construction: **$37,978,398** with U.S. funding, $94,711,723 with Saudi funding, and $2,590,000 with Japanese funding through the Gulf Peace Fund.[59]

Observations

Construction requirements changed continually throughout Operation DESERT SHIELD/DESERT STORM and to a lesser extent during redeployment. The changes posed a particular challenge for MEAPO(SWA) staff. In one instance,

during a visit to King Fahd International Airport the theater commander was alarmed to see roughly 800 helicopters sitting close together on the helipad and ordered that they be dispersed. CENTCOM directed the Dhahran Area Office to design new helipads for dispersing these helicopters. The office awarded a contract for construction of the pads and spent days working with the contractor to adjust the design because adequate material was not available. When the contractor went out to conduct the initial site survey, the general officer responsible for the helicopters directed him to stop work because he did not believe it was necessary to disperse the aircraft. Much valuable office staff time was wasted.[60]

Because of the changing circumstances, MEAPO(SWA) staff found it impossible to anticipate requirements far enough in advance. Requirements for the construction of heliports and airfields were generated at the division and corps level. As tactical plans developed, the locations of proposed aviation facilities changed, so planners could not project requirements far enough into the future to allow time to construct heliports and airfields under contract. Many aviation facilities constructed by contract were never used because units moved to other locations before the projects were completed.[61]

Meeting the expectations of units and dealing with delays in the contracting process made MEAPO(SWA)'s work even more challenging. Captain Adams, who had much direct contact with troop units, aptly observed, "Everybody wanted to be in their facility yesterday." If an engineer troop unit had responsibility for the construction, soldiers could see the engineers start working at the job site right away. By contrast, federal acquisition regulations required that a contract go through a 30-day process before award. During that time, soldiers saw no activity at the site and got the impression that nothing was being done. Most units had little experience working with contractors.[62]

Lieutenant Colonel Cargill conceded there were delays in construction but added, "...we have done most of the construction expeditiously, well within the time that it could be expected to take."[63] Cox observed that the engineering and construction process moved too slowly at times, but generally the Corps did "a very credible" job of moving projects to completion. Contractors often completed projects in 30 to 40 days that normally took 120 days.[64]

Using contractors for construction in an austere theater clearly had both advantages and disadvantages. General Storat, for example, argued that troop construction was more flexible and responsive to a broad range of missions. He recommended that military leaders use contracting to supplement troop construction, not replace it. Lieutenant Colonel Van Sickle expressed satisfaction with the responsiveness of contractors. While some greedy contractors took advantage of the situation and inflated their prices, he conceded, others operated within a 10-percent profit margin. Given their overhead and potential losses, he added, 10 percent was reasonable. Prices could vary widely, for example, laying hot mix asphalt ranged from 25 to 70

riyals per square meter. Three or four contractors consistently received work because they settled for a reasonable profit margin, while contractors demanding a 30-percent profit margin did not get as much work.[65]

The 416th Engineer Command staff observed that contractors supplemented troop capability effectively and were more familiar with local construction techniques and materials. However, contractors were not available in high-risk areas and took longer to mobilize than troops. In addition, the use of contractors required a formal design and contracting process. By contrast, troops were more flexible for contingencies, used expedient construction techniques, and did not require a lengthy approval process. Yet, they did not always have the required equipment (such as distributors or rock crushers) and had to be supplied with materials.[66]

Although military engineers had varied opinions about the value and reliability of contractors during combat, they agreed that contractors contributed significantly to the war effort. They also agreed that contractors should supplement engineer troops, not replace them. The Persian Gulf War experience clearly indicated that the use of engineer troops and the use of contractors each had advantages and disadvantages. Military planners and policymakers must weigh these factors carefully when determining the appropriate role for contractors in future contingencies.