CHAPTER 8

Selected Infrastructure Topics

8-1. Introduction. Base camps often require extensive infrastructure to support operations and ensure an adequate quality of life for base camp residents. The standard to which the infrastructure is developed depends on the base camp's function, size, and life span. Developing and sustaining the camp's infrastructure presents significant challenges, in particular resource and environmental constraints. Added to this challenge is the need to integrate survivability measures throughout the base camp. Areas of particular concern include sanitation, water supply, energy, solid waste, and survivability measures. JP 3-34 establishes a baseline of facility standards and allowances based on the base camp's anticipated life span. These standards are further defined in theater-specific guidance documents (see Appendix C).

8-2. Sanitation. Adequate sanitation is necessary for the quality of life of base camp residents and for environmental protection. Dealing with sanitation issues consumes a considerable portion of the base camp leadership's time. Developing plans early that will support sanitation measures can reduce management issues, improve base camp quality of life, and mitigate environmental concerns.

a. Wastewater. Dealing with wastewater, including gray water and black water, creates significant issues for base camp planners and managers. Common gray water sources include laundries, wash racks, and showers, while black water come from various types of toilet facilities. The measures used to handle these waste streams will vary according to base camp population, base camp standards, contractor services, and base camp location. As a general rule, more austere standards will be associated with base camps that have short life spans, and more primitive means of dealing with wastewater will be used. However, there may be circumstances when the method used will be more typically associated with more robust base camps. Whenever possible, base camp commanders will want to use the best available and efficient system in order to improve quality of life. Location of wastewater disposal must be considered early in the planning phase to minimize odors and prevent contamination of water supplies. A number of methods exist to deal with wastewater issues.

(1) *Burn out latrines*. Burn out latrines are often the first method used for field sanitation. They can be constructed by engineer or other military personnel and use vehicle fuel mixed with the waste in order to burn it. They offer the advantages of being easily constructed with limited skills, tool sets, and materials; they do not take up large amounts of base camp area; they can be located anywhere within the camp consistent with good field sanitation practices; and they minimize the amount of remaining waste that must be disposed of. While effective in many regards, they do present quality of life issues and require separate facilities (generally tubes embedded in the ground in crushed rock) for liquid waste.

(2) *Porta-johns*. Most base camps employ porta-johns at some point in their development. Porta-joins require minimal labor to construct, and they can generally be located anywhere within the base camp. While these facilities are suitable, they generally require contractors for servicing and, unlike burn out latrines, the waste must be moved to a sanitary landfill site.

(3) *Sewerage lagoons*. Sewerage lagoons may be developed in support of base camp operations. They provide a means of treating and disposing both black and gray water, while avoiding the need for contractors to remove waste to landfills (assuming that the overall system integrates flush toilets to dispose of solid wastes). They do, however, require significant land area, proper soil types to reduce the danger of groundwater contamination, and adequate pitch from the facilities to the lagoon to allow for water flow. Odor can be a concern if not properly designed. Lagoons should be located downwind of base camp and a significant distance from water supply. While military engineers may construct simple holding ponds, actual lagoons that provide for proper breakdown of wastes require engineering advice from civil engineers.

(4) *Septic system and leach fields*. A septic system and leach fields allow for both black and gray water treatment and disposal. While an efficient means of disposal, as with lagoons, they require a significant amount of area. In addition to the space requirement, they also need distribution pipes, distribution boxes, septic tanks for solids, crushed rock, and geotextile fabric. These requirements may add to the overall logistics burden. While not completely removing the land area for use, they do limit use of the leach field area to traffic that will not crush the pipe system. Mound systems may be required for high groundwater conditions. For poor percolating soils, alternate secondary treatment such as Multi-Flo aeration units must be designed. Simple constructed wetlands provide final pathogen removal for surface water discharge. Septic system treatment requires civil engineering expertise and site testing to be installed properly.

(5) *Wastewater treatment facilities*. Currently, the military has a limited ability to construct and operate wastewater treatment facilities. Military assets are limited to water purification units which are generally not used to handle black or gray water. Some small, portable or semiportable systems are available from contractors, and the military has engaged USACE reachback assistance or private industry with the requirement to develop portable, scalable systems that will support base camp operations. The use of wastewater treatment systems can greatly reduce logistics requirements by recycling water for use in areas such as toilets, wash racks, and for dust abatement.

b. Dining facilities. Base camps, whether used for military or civilian disaster relief purposes, often have allowances for DFACs. These may be a tent that personnel simply eat in or a structure that resembles a DFAC on an established military installation. Army cooks generally prepare meals using mobile kitchen trailers able to feed up to 350 people or containerized, trailer-mounted systems that can feed up to 600 people. Contractor-operated DFACs, on the other hand, can be quite large and require extensive cooking and food storage facilities (to include refrigeration requirements). Regardless of the size,

DFAC operations require large quantities of water for cooking and cleanup. While units in the field may establish gray water soakage pits for DFAC wastewater, larger base camps will require other options.

c. Personal hygiene. Ensuring personal hygiene is crucial for the health of deployed military personnel. At the most austere end of the standards spectrum, military personnel use field expedient showers to provide a minimal level of hygiene. Military units may also take advantage of laundry and bath units that provide special tents with hot and cold water for showers. Established base camps under more robust standards may use contractor-supplied, prefabricated shower trailers that are often self-contained with water heating and recycling systems. In other cases, military engineers or contractors may construct shower facilities from available materials. As with all wastewater, there is the need to dispose of or recycle it properly.

8-3. Water Supply. Base camps need water for everything from drinking, to sanitation, to vehicle radiators. Since local water systems are often not safe, available, or reliable, other methods of obtaining water must be used. The most common source of drinking water is bottled water. While bottled water is safe and convenient, it does require transportation into the base camp, and the empty bottles represent a significant portion of the base camp's solid waste management. Water purification and well drilling present more sustainable alternatives to the use of bottled water.

a. Water purification. Production of bulk water for all purposes is often accomplished by water purification—generally through the use of ROWPUs. These units are provided by both the military and contractors. Water purification units require adequate space to set up operations, and they must be in close proximity to a surface water source such as streams. In some cases, it may be possible to tap into existing water distribution systems, including fire hydrants. Caution must be exercised to ensure that existing systems meets water quality standards. Also, using existing systems may not be possible if it has a negative impact on the local population.

b. Well drilling. In some cases, well drilling may be an option. Military personnel and civilian contractors both have the capability of drilling water wells. However, before drilling, a study of the hydrogeology and hydrology of the area is required to determine if it is practical. The study should incorporate a test well drilling program. Initial information on hydrogeology is available via USACE reachback. Drilled wells may be integrated into a water distribution system within the base camp, or water may go into storage tanks or bladders for distribution by vehicles. Groundwater normally has a low chemical or biological threat of contamination and does not usually experience a large seasonal variation in quantity. After preventive medicine personnel test approve a groundwater source, treatment is not usually required; however, chlorination is recommended. (See FM 5-484/NAVFAC P-1065/Air Force Manual [AFMAN] 32-1072 for more information.)

8-4. Energy. Base camps require power generation equal to that of a small city. In fact, the inefficiencies inherent in power generation systems and in the design of the facilities typically result in significant power waste. For instance, in hot climates where air conditioning is required, it is not unusual to see air conditioning units capable of cooling a large house being used to cool a small tent. Energy consumption in base camps requires a significant amount of resources. Power generation requires fuel for the generators, materials (such as cables) to establish power distribution, maintenance personnel (often civilian contractors) to maintain and service equipment, and spare parts for the variety of generators that may be in service.

a. Base camp power issues. Most base camps are powered by individual generators that feed power either to a specific facility or piece of equipment, or to a group of structures such as a housing area. While the generators may be attached to a distribution system within the area to which they provide power, they are seldom networked into a comprehensive power grid. Planning for power requirements and integrating the generation and distribution network into the base camp is a significant part of effective base camp planning.

(1) *Generator placement.* Generators must be placed close to the equipment, buildings, or areas that they support in order to minimize the materials needed to establish the distribution system and to avoid voltage drops that can impair equipment function. They must also be located to allow for easy service and maintenance, in particular refueling.

(2) *Generator protection.* Generators should be protected against enemy action and accidents, whenever possible. Protection measures may include overhead roofs, protective walls or berms, and secondary containment measures for fuel spills. In addition to providing protection for generators, the use of protective walls or berms will help to reduce noise pollution.

(3) *Power distribution.* Power cables and distribution boxes feed power from the generator to the various facilities that it supports. In some cases, voltage transformers may also be required to step up or step down voltage as required. Additionally, most U.S. equipment operates at 110 volts, while most foreign countries use 220-volt systems. The cable network itself may be employed above or below ground. In either case, appropriate safety measures must be implemented to prevent damage to cables and to reduce electrocution hazards to personnel.

(4) *Electrical system design*. Most military engineers and engineer units are not trained to establish power distribution networks. While there are some military personnel trained to develop these systems, they are generally few in number. If personnel with the required experience are not available, planners must contact civilian SMEs and will often be required to employ civilian contractors to establish the power grid.

b. Base camp standards related to power generation. Depending on the allowable standard, base camps may be powered by organic military equipment, Army prime power units, or a mix of civilian generators. While the more robust standards may allow for the development of a centralized power system, the more austere standards will rely on de-centralized power generation and distribution (see Appendix C).

(1) *Organic unit equipment.* Military units are generally equipped with a limited number of power generators. Most of these generators range from 3 to 10 kilowatts and are designed to support CP operations and provide a limited amount of power for items such as unit light sets. While other, larger generators (generally ranging from 30 to 100 kilowatts) are available, they are normally dedicated to the operation of specific equipment items and facilities; for example, water purification units, radars, and rock crushers and facilities such as field hospitals. This limited amount of power generation capability should only be depended on for base camps constructed to the organic standards; it should be replaced where possible by more substantial systems as soon as they become available.

(2) *Prime power.* The Army's 249th Engineer Battalion (Prime Power) can provide a limited amount of power generation capability for both military operations and civilian emergencies. Prime power platoons can develop up to 3 megawatts of power, and they have a limited capability to construct and repair overhead power distribution systems. They are also able to provide the expertise needed to conduct power studies and determine power requirements and develop distribution plans. (See FM 3-34.480 for more information.)

(3) *Military base camp sets*. The military employs modular base camp sets, such as Force Provider and Harvest Falcon, to establish base camps on short notice. These preconfigured sets include generation capability sufficient to support the anticipated base camp size.

(4) *Commercial generators*. Once a base camp is established, commercial generators are the most common means of providing power. These generators, whether purchased directly by military units or provided by contractors, produce power to support all aspects of base camp life, thereby freeing up military generators to focus on specific unit requirements. Commercial generators employed in base camps are usually arranged with a generator supporting a specific facility (such as a DFAC) or a group of facilities (such as a block of housing units). In some circumstances, a large generator may provide power to an entire base camp via an electrical distribution system.

c. Other considerations for power generation may include the use of the existing civilian power grid, energy conservation measures, and developing technology.

(1) *Existing civilian power grids*. In well-developed countries with adequate electrical distribution systems, it may be possible to use the existing power network. This may prove to be more efficient and reliable than generator systems; however, certain

restriction will apply. If the network will not support the additional load, the public perceives that U.S. forces are using resources they need. If the threat level is high, using the existing network will not be a viable option.

(2) *Energy conservation measures.* In some cases it may be efficient to introduce energy conservation into the power management program. Measures such as enforcing temperature settings, limiting use of certain items, and designing structures for energy efficiency may reduce the overall electrical load required. While most of these measures would be adopted for base camps at the higher end of the standards scale, some measures, such as providing insulation for tents and limiting power use to certain items, can be implemented at all standard levels.

(3) *Developing technology*. Various initiatives are underway to develop improved electrical generation and distribution systems. Some of these include the use of fuel cells, generators that operate from hydrogen generation, and microgrid systems that control the distribution and generation of electrical power. These systems, when fully matured, may make it possible to reduce the sustainment requirements associated with providing electrical support to base camps.

8-5. Solid Waste. Base camps generate solid waste typical of a small town. This waste includes all types of paper, glass, wood, plastics of all types, metals, and DFAC wastes as well as specific items ranging from broken auto parts to televisions and freezers. Disposing of this waste has become a significant issue for base camp managers. (See TM 5-634/NAVFAC MO-213/Air Force Regulation [AFR] 91-8 for more information.)

a. Landfills. A common method of disposing of solid waste is the use of landfills (see Unified Facilities Criteria [UFC] 2-240-10A for more information). These areas may be used to dispose of most nonhazardous materials. They must be designed to accommodate the population over the anticipated base camp life span. Often, multiple landfill sites will be required, which must be approved by the CCDR responsible for the area of landfill location. Depending on the circumstances, substantial coordination with the HN may be required to obtain the necessary land and possibly environmental permits and studies. Planning considerations when establishing landfills include—

- Locate the landfill downwind from the base camp (or at least downwind from housing, medical, and dining facilities).
- Locate the landfill in a controlled area where personnel using the site are not subject to enemy attack and local civilians will not have access.
- Locate the landfill away from runways (bird hazard), floodplains, wetlands, aquifers, seismic zones, and unstable areas.
- If HN contractors are dumping at the site, coordinate with the supported unit for security considerations.
- Provide recommendations to the base camp residents on items to avoid placing in the landfill, including liquid or hazardous waste.

- Plan for daily and final landfill soil cover materials with proper compaction for control of vectors, water infiltration, gas migration, and erosion, as well as support for vegetation, vehicular traffic, and fire resistance.
- If necessary (due to the depth of the groundwater level and the slope of the land), plan for a liner and a leachate collection system and monitoring (during the life of the landfill and during post-closure) of the landfill for contamination that may migrate off-site.
- Provide proper drainage control around the landfill.
- Address additional environmental requirements (for example, explosive gas control).
- Develop record keeping requirements for the closure plan.
- If off-site landfills are used, temporary holding facilities at the base camp will be required.

b. Burn pits. Burn pits are used to dispose of paper, some plastics, and other combustible items. While burn pits reduce the overall waste volume and may be the preferred means of disposing of certain waste streams, they present some health and quality-of-life issues. As with landfills, burn pits should be located downwind of housing, medical, and dining facilities, whenever possible, and the content entering the burn pit should be monitored to prevent the disposal of HM/HW. Burn pits are a possible solution for smaller camps that do not have contractor support. Mobile incinerators and mobile waste-to-energy systems would be much better than burn pits as long as they are modular, mobile, and simple enough for service members to use and maintain. Live ammunition and batteries must be kept out of burn pits, incinerators, and landfills.

c. Recycling. Recycling offers an opportunity to reduce solid waste requirements and the overall logistics burden. While smaller base camps or those with shorter life spans will often not have provisions for recycling, it can be an advantage on larger camps. Presently, recycling on military base camps is limited to certain items. While items such as plastic, glass, and metal cans are not generally recycled, other items of military use may be. These items include storage containers, wood that may be reused for construction, vehicle parts from damaged or destroyed vehicles, and items that service members may procure such as tables, chairs, and televisions. Provision for a recycling center for items such as these can reduce the overall solid waste burden. In addition, it may be possible to establish sites to store waste POL for future recycling.

d. Commercial contractors. Base camps often use commercial contractors to remove solid waste. In some cases, the waste is disposed of on the base camp; in other cases, it is removed and disposed of in local landfills. When facilities on the base are used, planners should integrate them into the base camp plan. When commercial contractors are used, security and liability concerns may need to be addressed. The supported units may need to develop security measures, such as ECPs, to manage contractors who are removing waste from the base camp.

e. Composting. DFAC waste, wood chips, shredded cardboard, paper, hay, and sewage sludge can be successfully mixed and composted using the AGILE Flex (or similar) composting system. The compost is processed over a six-week period into a usable soil amendment and can serve as a good fill for landfills. Odor can be a major concern if anaerobic conditions occur (due to the lack of adequate turnover). Protective measures for consideration include potable water well and setback distances, vector and dust control measures, surface water runoff requirements, and minimum static water table depths.

f. Incinerators, burn boxes, or air curtain destructors. Medical incinerators should be the standard incinerator used for medical waste because of their optimum design to withstand high temperatures. Commercial incinerators are available that will reduce some components of the solid waste stream to ash (for example, DFAC waste, paper, cardboard, and a wide variety of plastics). Burn boxes or air curtain destructors are least desirable and should be avoided whenever possible because of the air pollutants that result and the high amounts of fuel needed to cause efficient burning (one gallon of fuel per cubic meter of waste). Careful sorting is required to remove ammunition, glass, batteries, metal of all types, and most wood products. Incinerators are also expensive to purchase and operate. Finally, incineration can produce potentially toxic ash. If there are a significant number of batteries in the waste stream, the ash may become contaminated with heavy metals. Composting is typically the preferred method to remove DFAC waste, paper, and cardboard from the solid waste stream. Plastics, POL, and other chemicals are efficiently reduced by incineration. Recycling programs can be used to reduce plastic components more efficiently.

g. Petroleum-contaminated soils (PCS). PCS may be land farmed as they are in the United States. Land farming is an aerobic microbial, ambient temperature process that uses the PCS, a micronutrient source (such as compost), a bulking agent (such as straw or wood chips), and time. The components are mixed and kept somewhat moist so that the microbial community will “eat” the petroleum products within the soil over time. Land farming can be successful on virtually any size plot. PCS from outlying camps or isolated spills can be consolidated and treated at a central location. The bioremediation produces a nutrient-rich soil amendment with greatly reduced petroleum concentrations that can be used for a wide variety of purposes. Disposing of PCS by any other method (for example, putting in containers for third-party disposal) is very expensive and should be avoided in all but extreme circumstances. By using proper base material, such as geotextile liners, clay, or bentonite, groundwater sources can be protected from leachate.

h. Hazardous waste. Management and disposal of HW can be a significant issue. It is important that the waste is carefully managed and disposal options are identified early. HW must be collected in an orderly satellite accumulation point (SAP) as soon as it becomes a hazard. HW is best collected in the original or similar container (55-gallon drum) and must be clearly marked and dated. Ideally it is kept in a covered area, on pallets to be kept off the soil, and have a secondary containment system. A SAP is a temporary storage area, not a permanent solution. If there is a Defense Reutilization and

Marketing Service (DRMS) available, they may accept some HW. Often, however DRMS does not have the necessary agreements in place to transport and dispose of this material. Other means of ultimate disposal include a certified HW incinerator or contract disposal. Finally, HM can be cross-leveled across organizations with the establishment of a hazardous materials mart (HAZ MART) operation. A HAZ MART diverts HM from becoming HW via a central collection point for unused or partially used HM that units turn in and can be reissued to other units. It is not a HW collection point.

i. Integrated waste management. The best approach to handling solid waste is an integrated program that incorporates the best methodologies for the given location to reduce the number of solid waste components that must be destroyed. An integrated approach can conserve resources through a recycling plan and reduce landfill and contractor requirements for removing certain components of the waste system. For smaller base camps, this approach is not economical or practical. Since most of these camps are run by service members with little contractor support, the process must be simple. Whatever the size of the base camp, there must be a plan. However, the plan often depends on the population and the contractor support available. An example of integrated waste management includes—

- Waste segregation at the source into recyclables (plastics, wood, cardboard, and metal).
- Compostable material (DFAC wastes, paper, wood chips, other organics).
- HW.
- Medical waste.
- DRMS-acceptable materials (demilitarized equipment, furniture, computers, hardware, and clothing).
- Burn waste.
- PCS.
- Solid wastes for landfill deposit.

8-6. Protection Considerations. Protection refers to the related tasks and systems that preserve the force so that the commander can apply maximum combat power. Survivability, and in particular survivability construction, refers to measures taken that protect personnel, equipment, and structures from attack and mitigate damage that may result. These measures include those that either conceal potential targets or protect potential targets against damage or destruction. Base camp planners work with the supported units to integrate protection considerations and survivability measures into base camp planning, design, and construction. FM 5-103 and the *Joint Forward Operations Base (JFOB) Force Protection Handbook* provide further guidance on survivability and protection considerations. See FM 3-10 for a broader discussion of protection considerations.

a. Entry control points. Base camps require secure entry and exit locations to control traffic and prevent infiltration by hostile forces. As well as protecting the base camp against infiltration by hostile elements, the ECP must also be able to protect itself

against attack. Common threats against ECPs include attacks by vehicle and suicide bombers as well as direct attacks by small arms and rocket-propelled grenades. ECPs must be designed to allow for the efficient flow of personnel and equipment (and possibly HN labor and supplies) while still providing adequate security against various threats. Multiple ECPs may be necessary for a base camp.

b. Perimeter security. Base camps often employ perimeter security measures in the form of fences, protective walls, or earth berms. These structures enclose the entire base camp area and provide for protection against observation and direct fire. Guard towers, constructed using various methods, are employed to provide additional security. Base camp planners are often called on to support the design of perimeter security features. As with all construction in the TO, the design takes into account available materials and labor skills as well as the supported unit's security requirements.

c. Standoff distances. When planning a base camp, maintaining standoff distances can be an important means of enhancing survivability. Standoff in the larger sense refers to locating the base camp away from populated areas or potential attack locations. This will prevent enemy forces from coming within firing range of the camp without detection. In some cases, this may require removing buildings and clearing the terrain around the camp. For example, trees and rubble piles along the camp perimeter could be removed and flattened to provide clear fields of observation. Maintaining standoff distances also refers to keeping those structures, such as perimeter walls, fencing, and predetonation screens (screens that detonate rocket-propelled grenades or contact-fused munitions before hitting their target), at the required distance from the facilities that they are protecting. Maintaining these standoff distances and employing measures to keep potential enemy forces at a safe distance from potential targets can greatly enhance survivability.

d. Base camp site plan. The base camp site plan integrates efficient overall use and protection requirements. While the base camp location is partially selected based on the tactical situation, planning within the base camp also integrates measures that will increase protection. For example, ammunition holding areas (AHAs) and fuel storage areas will be located away from critical assets and housing areas, and ECPs will be located to minimize civilian vehicle traffic into certain areas of the base camp.

e. Protective construction and facility hardening. Various methods exist for hardening structures against attack. While unit commanders will want to provide the maximum amount of protection possible, certain structures will receive the highest priorities. These include C2 facilities, critical radar units, AHAs, fuel storage areas, and personnel housing. Other common sites include medical facilities, DFACs, and power generation equipment. Survivability measures include measures as simple as placing sand bag walls around tents and as extensive as providing overhead cover for important buildings. Base camp planners integrate facility hardening into the overall plan by ensuring that adequate space is available around structures or groups of structures to

integrate survivability measures. Planners also provide design and construction advice on the development of various survivability measures.