National Defence / Défense nationale

B-GL-361-012/FP-001

ENGINEER FIELD MANUAL

VOLUME 12

ACCOMMODATION, INSTALLATIONS AND ENGINEERING SERVICES
(ENGLISH)

(This publication is active on receipt.)

WARNING

ALTHOUGH NOT CLASSIFIED, THIS PUBLICATION, OR ANY PART OF IT, MAY BE EXEMPT FROM DISCLOSURE TO THE PUBLIC UNDER THE ACCESS TO INFORMATION ACT. ALL ELEMENTS OF INFORMATION CONTAINED HEREIN MUST BE CLOSELY SCRUTINIZED TO ASCERTAIN WHETHER OR NOT THE PUBLICATION OR ANY PART OF IT MAY BE RELEASED.

Issued on the Authority of the Chief of the Land Staff

Canada

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Issued on the Authority of the Chief of the Land Staff

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Canada

FOREWORD

1. B-GL-361-012/FP-001, *Field Engineer Manual, Volume 12, Accommodation, Installations and Engineering Services*, is issued on the authority of the Chief of the Defence Staff.

2. Suggestions for amendments shall be forwarded through normal channels to Chief of Land Staff, Attention: Director of Army Doctrine 8 (Protection).

3. This publication is available electronically on both the Defence Information Network (DIN) and the World Wide Web in the Army Electronic Library. Keyword—Army Electronic Library.

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CHAPTER 1
CONCEPT

GENERAL

1. One of the imperative requirements of the Engineer role is to assist friendly troops to live. This is requirement is fulfilled by executing the engineering tasks related to sustainment and protection as described in B-GL-361-001/FP-001 *Land Force Engineer Operations*. Providing an acceptable standard of accommodations, installations and engineering services for any type of operation is a sub-task of sustainment engineering. Scenarios range from the occupation of austere sites, also known as green field sites, to rehabilitation of existing infrastructure. This may also include easily transportable, rapidly erected, durable camp components that are economical to operate and maintain. The 250-person deployable camp is one example.

AIM

2. The aim of this manual is to provide reconnaissance, planning and preliminary design guidance for the construction of initial and temporary standard accommodations, installations and engineering services for deployed Canadian Forces. Permanent and tactical standards are not addressed.

ORGANIZATION AND SCOPE

3. The manual is divided into five chapters: Concept, Selection and Planning Guidelines, Scales of Accommodation and Engineering Services, Preliminary Design Considerations, and Planning for Extreme Climatic Conditions. The first three chapters apply to engineers, staff and commanders, and allows for proper reconnaissance planning and execution at an all-arms level. The last two chapters provide design considerations for specific engineer occupations, though these do not replace the education, training and experience of a qualified Military Engineer. Throughout the manual the term engineer will exclusively refer to Military Engineers.

4. This manual is a technical manual and is intended to complement and assist sound engineering practices and design. This manual does not deal with some specific issues which are better addressed in other source manuals:

a. operation or maintenance of the facility following construction;

b. detailed camp survivability issues and force protection and camp; and

c. strategic decision and planning with respect to who will build the camps (military, civilian contractor or mix).

TYPES OF OPERATIONS

5. The design and planning guidance specified in this manual apply to all deployed operations and environments.

CONSTRUCTION STANDARDS

6. Initial and temporary construction standards (see Annex B for details) will determine the types of materials, equipment and construction used to provide facilities in support of deployed operations. These standards are based on the principle of minimum and maximum essential military requirement. The standards also recognize the benefit of economy of scales incurred due to bulk delivery of services. The degree of improvement increases as the planned period of occupancy is extended. Initial standards refer to those deployed camps of up to 6 months in duration, while temporary standards apply to deployed camps in use from 6 months to 24 months. Homogeneous construction standards might not be applied to all the facilities: some facilities may be purposely at a lower or higher standard. Standards could overlap as camps transition from one standard to the next. Although, the Initial and Temporary Standard are only intended for specified durations, they could be made to last much longer with the appropriate levels of maintenance. Using these criteria minimizes engineer effort while providing facilities consistent with mission requirements, personnel health and safety, and expected

availability of resources. The construction standard will be approved by the DCDS through J3 Engineers.

7. **Construction Standards**. The Canadian Forces guidelines for initial and temporary construction standards are stated below, and are detailed in Annex B (tactical and permanent standards are listed for comparative reasons):

a. **Tactical Standard**:

(1) characterized by tactical harbours, hides or bivouacs;

(2) engineer involvement or support is unlikely; and

(3) established within the means and resources of a unit.

b. **Initial Standard (Less Than 6 Months)**:

(1) characterized by austere facilities requiring minimal engineer effort;

(2) intended for immediate austere operational use by units upon arrival in theatre for a limited time, ranging up to six months (depending on the specific facility); and

(3) may require replacement or upgrade by more substantial or durable facilities during the course of operations.

c. **Temporary Standard (6 to 24 Months)**:

(1) characterized by minimum facilities;

(2) intended for use extending to 24 months;

(3) provides for sustained operations;

(4) replaces initial standard in some cases where mission requirements dictate; and

(5) can be used from the start of an operation when it is judged to be as cost effective or more operationally effective.

d. **Permanent (Greater than 2 years)**:

(1) characterized by purposely built, robust infrastructure; and

(2) could include the occupation of existing buildings upgraded to suit required needs.

CONSIDERATIONS

8. This manual is intended primarily for developing camp facilities within temperate zones. Chapter 5 addresses planning and design changes required due to differences in climatic conditions. Designs or waivers for specific facilities or infrastructure projects in areas not falling within these zones shall be referred to appropriate engineering staff for proper analysis and design.

9. Temperate zones extend throughout the world and include variable climates of the middle latitudes, i.e. between the extremes of tropical and frigid climates. The Temperate Zone is divided into humid long summer, temperate marine and humid sub–tropical regions:

a. **Humid Long Summer**. These climates are prevalent in the lower middle latitudes of North America, Europe, Africa and Asia, with the following climatic properties:

(1) an average temperature of 22^{o}C in the summer with a maximum temperature exceeding 38^{o}C;

(2) an average winter temperature less than 0^{o}C; and

(3) an average annual rain fall of between 500 to 1100 mm with maximum precipitation occurring during the summer months.

b. **Temperate Marine**. These climates are situated on the west coasts of continents in the middle latitudes. Specific areas include northwest Europe, the central Pacific coast of North America, southern Chile, and southwest Australia and New Zealand. General climatic properties are:

(1) mild summer temperatures with highs up to 38°C;

(2) mild winters with averages temperatures above 0°C and in the coldest month a chance of frost; and

(3) an annual average precipitation level of between 500 to 2500 mm.

c. **Humid Sub-tropical**. These climates include the east coasts of all continents just north and south of the tropics. Specific areas include the southeast US, southeast Europe, northern India and Burma, eastern China and southern Japan. General climatic properties are:

(1) A long hot summer season with temperatures similar to the tropics. The average temperature in the summer is 27°C with a maximum temperature greater than 38°C.

(2) The winter months are mild with an average monthly temperature greater than 0°C.

(3) An annual average precipitation level of between 750 to 2000 mm.

WAIVERS

10. Waivers required to deviate from minimum standards are to be directed to the proper authority through the Force Engineer as indicated throughout this document.

ANNEX A
REFERENCES AND STANDARDIZATION AGREEMENTS

1. The following publications are related to and may be used in conjunction with this manual:

a. B-GG-005-004/AF-000 *Canadian Forces Operations*;

b. B-GG-005-004/AF-015 *Military Engineer Support to Canadian Forces Operations*;

c. B-GG-005-004/AF-017 *Health Services Support to Canadian Forces Operations*;

d. B-GG-005-004/AF-011 *Nuclear, Biological and Chemical (NBC) Defence*;

e. B-GL-323-003/FP-001 *Specific Operations, Volume 2, Part 1, Arctic and Sub-Arctic Operations, Basic Cold Weather Training*;

f. B-GL-323-004/FP-001 *Specific Operations, Desert and Extremely Hot Conditions*;

g. B-GL-323-002/FP-001 *Specific Operations, Volume 4, Part 1, Jungle Operations*;

h. B-GL-332-001/FP-001 *Tactical Aide-Memoire*;

i. B-GL-332-006/FP-001 *Insert—Engineers*;

j. B-GL-354-003/FP-001 *Land Force Information Operations—Deception*;

k. B-GL-361-003/FP-001 *Engineer Field Manual, Volume 3, Basic Field Engineering*;

l. B-GL-361-006/FP-001 *Engineer Field Manual, Volume 6, Field Protection*;

m. B-GL-300-006/FP-001 *Land Force Protection*;

n. B-GL-361-009/FP-001 *Engineer Field Manual, Volume 9, Mines and Booby Traps*;

o. B-GL-361-013/FP-001 *Engineer Field Manual, Volume 13, Water Supply*;

p. B-GL-361-016/FP-001 *Engineer Field Manual, Volume 16, Part 2, Horizontal Construction, Roads*;

q. B-GL-361-011/FP-001 *Engineer Field Manual, Volume 11, Military Soils Engineering*;

r. B-GL-364-001/FP-001 *Land Force Counter Surveillance*;

s. B-GA-420-000/FT-D01 *Airfield Engineering Aide Memoire*;

t. CETO C-98-15W-002/MG-007 *Wastewater Treatment Plants*;

u. CETO C-98-15W-002/MG-010 *Water Supply and Distribution Systems—Operations and Maintenance*;

v. CETO C-98-15F-001/DD-001 *Design Criteria Fuel Facilities*;

w. CETO C-98-15F-MIS/TP-012 *Bulk Fuel—Installation and Maintenance Practices*;

x. CETO C-98-15F-003/MS-022 *NATO Standard for the Maintenance of Fixed Aviation Fuel Receipt Storage and Dispensing Systems*;

y. DAOD 4003-0 *Environmental Protection and Stewardship*;

z. DAOD 4003-1 *Hazardous Materials Management*;

aa. DAOD 4007-0 Fire Protection Services;

ab. A-EN-007-000/FP-001 DND Environmental Assessment Manual;

ac. DCDS Instruction 02/2000—*DCDS Direction for International Operations (DDIO)*;

ad. LFCO 11-40 *Fire Safety, Field Exercises*;

ae. LFCO 27-03 *Field Wiring of Semi-permanent Tented Accommodations*;

af. 1 CAD Orders, *Volume 1, 1-108 Fire Safety—Field Exercises and Tented Camp Areas*;

ag. United States Air Force Handbook 10-222, Vol 1, *Guide to Bare Base Development*;

ah. C-09-153-001/TS-000 *Explosives Safety Manual*;

ai. *National Building Code*;

aj. *National Fire Code*;

ak. *Canadian Electrical Code*;

al. CAN/CSA-086.1-M89, *Engineering in Wood* (Limit States Design);

am. CAN/CSA Standard A23.3-M94, *Design of Concrete Structures*;

an. CAN/CSA Standard A23.1-M94, *Concrete Materials and Methods of Concrete Construction*; and

ao. CAN/CSA-S16.1-94, *Limit States Design for Steel Structures*.

2. **International Standardization Agreements**. NATO Standardization Agreements (STANAGS) and Quadripartite Standardization Agreements (QSTAGS) shown in Table 1A-1 have been wholly or partially incorporated into this volume:

STANAG	QSTAG	TITLE
2991		*NATO Glossary of Combat Engineer Terms and Definitions—AAP-19 (C)*
	2028	*Bulk Water Supply on Extended Operations*
	2044	*Hazardous Waste Management*
	1176	*Minimum Scales and Standards for the Provision of Short Term Camps*

Table 1A-1: Applicable International Agreements

ANNEX B
CONSTRUCTION STANDARDS

Serial	Type of Construction	Example of Construction Standard	
		Initial Standard	**Temporary Standard**
1	Personnel housing/messing/ administrative/ mission structures	Tents (may have wood frames and flooring).	Wood-frame structures; re-locatable/mobile structures.
2	Electrical Power	Tactical generators; high/low voltage distribution.	Non-tactical and/or high voltage distribution.
3	Water	Water points; distribution by vehicles and small containers.	Pressurized water distribution systems with limited distribution to hospitals, messes and other large areas.
4	Cold Storage	Portable refrigeration (freezer units for medical, food and maintenance storage).	Refrigeration installed in temporary structures.
5	Sanitation	Pump wagon, pit or burnout latrines, evaporative ponds, lagoons for hospitals.	Waterborne to austere treatment facilities. Priority: hospitals, messes, laundry and shower units, decontamination sites, and other high volume water users.
6	Airfield pavement (based on the type, number, and weight of aircraft involved.)	Tactical surfacing, aggregate soil stabilization, and concrete pads.	Conventional pavement.

Serial	Type of Construction	Example of Construction Standard	
		Initial Standard	**Temporary Standard**
7	POL Storage and Distribution	Bladders and vehicles.	Bladders and steel tanks with limited piping systems in logistics areas.
8	Horizontal Construction	Combat roads, tactical surfacing, aggregate, soil stabilization and dust control.	All weather roads, concrete maintenance pads, engineered site drainage.
9	Heating and Air Conditioning	Integral unit tactical systems.	Installed heating, ventilation and air conditioning systems.
10	Security Engineering	Field defences.	Structures designed to resist specific threats constructed using local materials.

Table 1B-1: Standards of Construction

CHAPTER 2
RECONNAISSANCE, SITE SELECTION AND PLANNING GUIDELINES

GENERAL

1. The planning guidelines in this chapter address general requirements. These standards or guidelines enable engineers, staff, and commanders to determine the location, type and amount of resources necessary to establish initial and temporary standard accommodations, installations and engineering services. Throughout the remainder of the manual, initial and temporary accommodations, installations and engineering services will be jointly referred to as deployed accommodations.

GENERAL PLANNING CONSIDERATIONS

2. The tactical situation, assigned task and contingent strength will influence siting and site layout, while the expected length of deployment will determine the standard of construction. In order to properly plan and execute a detailed reconnaissance the headquarters ordering the establishment of the camp must provide information that will enable detailed planning to commence. Whenever operationally possible, satellite camps should be resisted as they increase security requirements, engineer materials, and labour both for construction and maintenance. To plan and execute reconnaissance for accommodations, installations and engineering services, the following information is required:

a. the commander's mission statement, concept of operations and intent, priorities, and restrictions;

b. number and strength of units;

c. number and type of vehicles (ground vehicles, aircraft, ships) by element, to sub-unit level;

d. probable life expectancy and function of camp;

e. area of operations;

f. sequence of deployment;

g. expected engineer organization and capabilities; as well as, the availability of an engineer surge;

h. availability of engineer material, resources and expected supply system;

i. date required for occupation, including phase-in;

j. threat analysis (affects site layout and survivability);

k. operational requirements (tactical siting, ranges, medical facilities, POL, food services, air conditioning, and storage);

l. dispersed or non-dispersed location of sub-elements;

m. location of existing facilities (e.g. airports, ports, logistic installations, railroads);

n. number of seats available for reconnaissance party;

o. availability of Host Nation (HN) and Allied support;

p. highest military load classification (MLC) of vehicle fleet to be deployed; and

q. any other imposed restriction or limitation (e.g. funding, timings).

SITE SELECTION FACTORS

3. Whenever possible, deployed camps should be sited to make best use of existing infrastructure such as roads, water sources, electrical distribution systems, airfields, ports, railways, etc. The following site selection factors should be considered when conducting a detailed reconnaissance. Their respective priority will be dictated by tactical situation:

a. **Site Availability/Legal Issues**. Issues of propriety must be resolved prior to any construction. Purchase or lease of the campsite must be agreed and legally arbitrated: the terms of such an agreement must be defined in a contract. This is not an engineering issue. Realty asset management is usually a logistics matter, but it will involve many players, for obvious reasons, including host nation authorities, CIMIC coordinators/liaison, owner (if known), Judge Advocate, Canadian authorities designated to formulate and sign contracts (logistics), comptrollers to effect payments, higher coalition HQs.

b. **Time**. Time required to develop a site for occupancy and the time required to fully develop a site must be considered, whether it be time required to clear and develop a green field site, or that required to renovate existing facilities or utilities.

c. **Site Access**. Avoid dense brush, timberland or rolling terrain requiring heavy clearing or grading. Access may also be restricted by existing infrastructure or urban development. Both ingress and emergency egress must be considered.

d. **Fire Prevention**. Factors to include in the evaluation of sites are prevailing winds, 15 metre minimum firebreak (natural or man-made), type and condition of vegetation, proximity to source of water, and access routes for fire fighting and withdrawal. Where possible, camps should not be sited amongst heavy brush or vegetation, but rather in natural firebreaks where the hazard of ground cover fire is less.

e. **Terrain**:

(1) **Soils**. The soil must be capable of supporting heavy loads and traffic in varying weather conditions.

(2) **Drainage**. Water should naturally drain away from the site.

(3) **Vegetation**. Heavy vegetation can dramatically increase the work required to clear a site, and can also prove to be a security and fire hazard.

f. **Roads**. Hard packed road surfaces should be crowned or cross-sloped to shed rainwater, and should be protected from washouts or erosion from the uphill side by means of roadside ditches or drains with culverts crossing at low points. In areas that are prone to frost heave, roads should be located on well-graded, granular materials. Where there is a possibility of snow drifting, roads should be higher than the prevailing ground elevation, and should not be located where existing vegetation or planned facility locations could block snow removal.

g. **Solar Orientation**. In humid long summer and humid sub-tropical climate, orient the longer axis of the facility east-west in order to minimize sun exposure on the walls. In temperate marine climate, orient the longer axis of the facility north-south to provide maximum solar radiation on the walls.

h. **Wind Orientation**. Maximum wind velocities occur during periods of changing temperatures, with snow and silt drifting with winds above 15 km/h. Check for unusual seasonal wind conditions which could effect construction techniques.

i. **Water Sources**. The best source is surface freshwater from lakes and streams, and deep drilled wells. Chapter 4 provides additional information on water sources.

j. **Host Nation Utilities Availability**. Use of HN utilities systems can greatly ease set-up and operation of the deployed camp from an engineer perspective. However, consideration must be given

to the reliability, quality, security, and compatibility of the various utilities available. Agreements/contracts, which address both HN utility reliability and compensation, must be negotiated, and require the expertise of Real Properties personnel, as well as the Judge Advocate General. Further information concerning utilities is provided in Chapters 3 and 4.

k. **Site Security and Force Protection**. Site security and force protection, as factors to be considered during detailed reconnaissance, are based on the requirements of the mission, national policy and the commander's intent for the deployed accommodations. However, the following factors should be considered when planning and designing deployed accommodations:

(1) **Irregular Boundaries**. The protection of sites with irregular boundaries is more challenging.

(2) **Recognizable Landmarks**. Avoid sites with highly recognizable landmarks which may serve as a guide to enemy aircraft or indirect fire.

(3) **Lines of Sight and Fields of Fire**. Where it can be avoided, camps should not be placed in terrain that permits observation and lines of sight from surrounding terrain. If not avoidable, then the outlying areas need to be patrolled or denied to potential threat forces. Likewise, the same logic applies to fields of fire. Terrain should promote own fields of fire but deny fields of fire, including indirect fire, to potential threat forces.

(4) **Mines/Unexploded Explosive Ordnance (UXO)/Booby Traps Clearance**. Although an important point to consider in

site reconnaissance for a camp, or existing infrastructure that was targeted, this manual does not deal directly with the reconnaissance, marking and clearance of areas suspected or confirmed to be mined, or containing UXO or booby traps. If an area is suspected of being contaminated, procedures for corrective action are detailed in B-GL-361-009/FP-001 *Engineer Field Manual, Mines and Booby Traps.*

(5) **Nuclear, Biological, and Chemical Defence (NBCD)**. This manual does not deal directly with the NBCD threat, however B-GG-505-004/AF-011 *Nuclear, Biological and Chemical (NBC) Defence* must be consulted if the threat analysis indicates a NBCD impact on the planning and design of deployed camps.

(6) **Camouflage, Concealment and Non-electronic Deception (CCD)**. This manual does not cover CCD in detail. B-GL-364-001/FP-001 *Land Force Counter Surveillance* and B-GL-354-003/FP-001 *Land Force Information Operations—Deception* may be consulted with respect to applying CCD in the analysis and design of deployed accommodations. Coordination of CCD as part of the planning and design of deployed camps should consider the following points:

(a) CCD planning is to be completed simultaneously with the construction plan, as this will eliminate costs associated with manpower and time;

(b) early CCD planning increases the awareness of all personnel and

eliminates unnecessary ground and terrain disturbances;

(c) where cover and natural concealment is inadequate, camouflage nets may be used; and

(d) coordinated CCD planning is required to effectively camouflage and disperse assets while not affecting operations.

(7) **Dispersal**. The degree of dispersal required between facilities and utility services must be considered; and

(8) **Force Protection**. Force protection must not be an after thought. Security planning during the design and planning stages for the construction of deployed camps is to be completed in accordance with B-GL-300-006/FP-001 *Land Force Protection* and B-GL-361-006/FP-001 *Engineer Field Manual, Field Protection*. However, when it is operationally possible, satellite camps should be minimized, as they increase requirements for security, engineer materials, and labour for construction and maintenance.

l. **Environmental Considerations**. While deployed operations may affect the environment, it is also possible that the environment may affect personnel. Natural hazards, such as disease, and human related hazards, such as waste disposal sites or pollution, may prove to be important factors when selecting a site. Details on environmental considerations during site selection for a deployed camp may be found in Annex A to Chapter 2, as well as in QSTAG 2044 *Hazardous Waste Management*.

m. **Size of Area Available**. For security and safety reasons, all facilities have set minimum separation distances between them and other facilities. Such distances will affect the overall size of the camp being considered. Table 2-1 provides information on these distances. In addition, good planning will include room for expansion of the camp should future changes in the mission occur. Note, however, that while there are advantages to a larger camp, too great a distance between facilities will also affect camp operation due to a requirement for greater security, as well as for additional utilities and roads.

INSTALLATION REQUIREMENTS

4. The general functional requirements of a camp are:

a. unit and sub-unit (and in some cases lower) headquarters;

b. helicopter landing zone for medical evacuation and liaison flights;

c. POL, explosive and ammunition bulk storage;

d. maintenance areas including vehicle wash racks;

e. messing areas (kitchen, feeding area);

f. sleeping accommodation and ablutions;

g. roads and parking areas;

h. Unit Medical Station (UMS);

i. training areas, such as small arms range, etc.;

j. survivability works, such as bunkers, observation posts (OP), and perimeter security fencing;

k. shipping and receiving areas co-located with warehousing;

l. engineer services (see Chapter 3);

m. communications equipment areas, such as towers and generators;

n. sports and recreational facilities, including chapel; and

o. detention or prisoner of war facilities, if applicable.

FUNCTIONAL AREA GROUPINGS

5. Generally, there are four functional areas that should be considered in camp design and construction: domestic, industrial, administrative and operational. When laid out, the function of an area should not negatively affect other areas (e.g. the noise from power generators should not negatively effect personnel in administrative or domestic areas). The following facilities are examples of the four different areas:

a. **Domestic Area**:

(1) officers' mess and living accommodations;

(2) senior NCMs' mess and living accommodations;

(3) junior ranks' mess and living accommodations;

(4) ablutions and laundry; and

(5) UMS and/or hospital facilities.

b. **Industrial Area**:

(1) transport area including vehicle wash rack;

(2) POL facilities;

(3) maintenance shops;

(4) munitions storage;

(5) supply;

(6) engineer shops; and

(7) engineering services.

c. **Administrative Area**:

(1) headquarters' offices and stores;

(2) parade ground;

(3) sports and recreation facilities, including chapel; and

(4) communications.

d. **Operational Area**:

(1) guard room and entrance;

(2) helicopter landing zone and vehicle compound;

(3) perimeter security means and survivability works; and

(4) training areas and ranges.

6. **Guidelines on Siting Functional Areas**. In determining camp layout, functional relationships exist between the various installation requirements. These relationships include the following:

a. The guard house is usually located near the main camp entrance.

b. Transport/parking areas:

(1) are usually located near the main road in order to economize on new road work;

(2) if they cannot be near the main entrance, a separate entrance which can be secured should be provided; and

(3) contain specific parking spots for ambulance, wrecker and mobile repair team (MRT).

c. Supply requires good road access.

d. Headquarters/administration require:

(1) good road access; and

(2) parking for both staff and visitors nearby.

e. Junior ranks living accommodations:

(1) located by sub-unit; and

(2) mess and accommodations should be within walking distance.

f. Warrant officers' and senior NCM's mess and living accommodations:

(1) RSM (and possibly CSMs) in separate accommodations (if possible); and

(2) mess and accommodations should be within walking distance.

g. Officers' mess and living accommodations:

(1) be secluded, but in the vicinity of the headquarters, if possible;

(2) mess and accommodations should be within walking distance; and

(3) CO (and possibly OCs) in separate accommodations (if possible).

h. Kitchen/mess:

(1) near track/road for re-supply and waste pickup; and

(2) relatively close to water production as it is a heavy user.

i. Latrines and ablution areas located downwind but accessible to living and working accommodations.

j. UMS:

(1) should have access to helicopter landing zone; and

(2) ground access should consider emergency traffic.

k. POL should have convenient access to transport and helicopter landing zone.

LIMITING DISTANCES

7. Guidance on the siting of facilities within Canada is provided in the *National Building Code* of Canada. For deployed camps, however, siting must also take into account the following additional limiting distances required for fire fighting and life safety reasons:

GROUP	MINIMUM DISTANCE BETWEEN INDIVIDUAL FACILITIES
Ammunition Compound and any other facility (except POL)	1000 m
POL Facility and Supply	800 m
POL Facility and any other facility (including Ammunition but excluding Supply)	500 m
All other facilities (except Accommodation)	20 m
Accommodation	a) 6 m between tents (see Figure 2-1) b) 6 m between 2 rows of tents (see Figure 2-1) c) 10 m between rows of tents (see Figure 2-1) d) 3 m between support equipment (generator, heater) and tents e) 3 m between ablutions and accommodation f) 20 m between accommodations and other facilities
Vehicle Parking and roadways	3 m between parking and accommodation or assembly facility
Fire Break	15 m between camp and wooded area (fire break)
Fencing	3 m between facility and fencing

Table 2-1: Limiting Distances—Individual Facilities

REMARKS

1. Walk-in refrigerators are not considered facilities/shelters (i.e. no limiting distance applies).

2. Kitchen, mess, and dry storage/food preparation shelters are considered as one facility (for spacing) when erected.

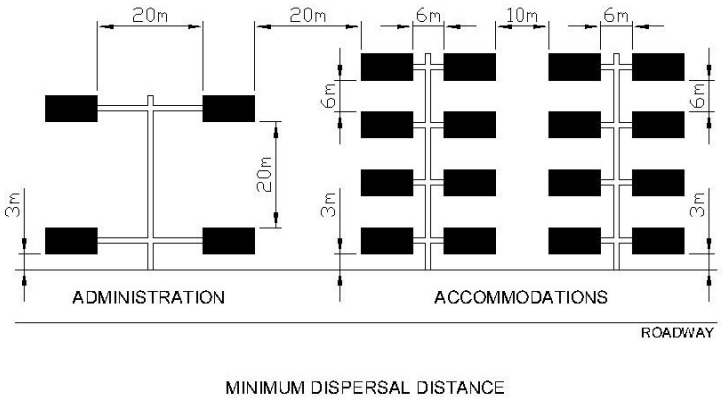

Figure 2-1: Limiting Distances—Accommodation

8. **Limiting Distance Waivers**. In the event that the site selected does not permit the limiting distances indicated in the above tables, waivers are required. Requests for waivers, including substantiation and proposed mitigation, are to be directed through the chain-of-command to the following agencies:

a. All facilities except Ammunition: Canadian Forces Fire Marshall, NDHQ.

b. Ammunition: Directorate Ammunition Program Management, Director General Equipment Procurement Services, NDHQ.

RECONNAISSANCE

9. Planning and reconnaissance are mutually supporting. The requirement for information in order to plan for deployed accommodations is as equally important as the requirement for a reconnaissance plan to decide what type of information needs to be obtained.

a. A military engineer reconnaissance may be required at separate times during the planning process to support strategic, operational and tactical level planning. However, when time is limited, engineer reconnaissance may be combined with that of other levels. In addition, much of the information required to provide engineer intelligence may result from reconnaissance ordered by strategic or operational level commanders. This should not however rule out the presence of a military engineer during reconnaissance at all levels, nor should other branches be relied on to obtain engineer intelligence.

b. A complete and thorough engineer reconnaissance forms the basis for effective and efficient engineering support. Of primary importance in the initial engineer reconnaissance is:

(1) Threat, including hostile forces, local populace, mines and UXO.

(2) Nature of the country, including geography, history and demography. Additionally the political and economic climates are important factors in developing achievable engineer options.

(3) Laws, customs, and agreements of the country. This includes contracting conditions, real estate procedures, environmental laws, cultural impacts on construction, and Host Nation and international agreements.

(4) Engineering environment to include climate and weather; terrain and topography; soils and geology; elevation; vegetation; land use; hydrology; natural resources; and type, nature and amount of available construction equipment and materials.

(5) Level and status of infrastructure to include air and sea ports of debarkation, in-country transportation, and utilities (electrical power, water distribution systems, sanitation facilities, pipelines and communications).

10. **Engineer Reconnaissance Party Composition**. Normally the availability of transport will limit the number of engineers permitted on the reconnaissance. The mission and anticipated existing utilities/facilities will largely determine who will be assigned. In selecting the team, therefore, the following classifications/trades must be considered:

a. CME Officer (24 or 46);

b. MOC 649 with backgrounds in 641, 642, 643, 646, 647, 648 (WO/MWO);

c. MOC 648/649 with drafting speciality (Sgt/WO); and

d. MOC 043 (Sgt/WO) with heavy equipment expertise.

11. **Reconnaissance Party Equipment**. A list of recommended equipment and stores required to complete an accurate technical reconnaissance for deployed accommodations is at Annex B.

12. **Engineer Reconnaissance Proforma**. The Military Engineer Support Technical Reconnaissance Proforma is at Annex C. The technical Proforma addresses the total facility and utilities requirements for the camp, existing on-site facilities, and planning values for calculating shortfalls in accommodations, services or

engineer resources. This Proforma should be customized for each deployment in order to allow for more efficient use.

13. **Basic Building Inspection Checklist**. Where the use and rehabilitation of existing structures and facilities is likely, a basic building inspection checklist (see Annex D) is used for evaluation purposes prior to completing the engineer reconnaissance Proforma.

14. If a site visit and ground assessment are not possible, essential information can be gathered from the following sources:

a. local intelligence unit;

b. flight information publications;

c. topographic maps;

d. foreign or tourist maps/guides;

e. climatic data;

f. gazetteers; and

g. local sources (e.g. city and town halls).

15. The Mapping and Charting Establishment (MCE) can provide or obtain most types of geomatic information. In addition, the Canadian Forces Joint Imagery Centre (CFJIC) can provide satellite imagery.

DESIGN AND SCHEDULING

16. Upon completion of reconnaissance and detailed analysis of construction requirements, the specialist engineer team should complete the camp design and construction plan based on the capabilities of the engineers supporting the operation. The following general list, not in priority, serves as a guide for typical tasks that must be designed and scheduled:

a. mine clearance and explosive ordnance disposal;

b. surveying-in of functional groups and facilities;

c. camp road preparation;

d. water point set up;

e. potable water distribution system;

f. installation of operational power generating system;

g. POL storage;

h. ammunition storage;

i. helicopter landing zone;

j. erection of shelters, and engineering and service shops;

k. installation of ablution and latrine facilities;

l. electrical services to non-essential camp facilities;

m. sanitary landfill;

n. sewage treatment system;

o. sewage collection system;

p. wash rack;

q. survivability works;

r. perimeter security fencing and lighting;

s. ranges and training facilities; and

t. site environmental baseline and environmental assessment.

ANNEX A
ENVIRONMENTAL CONSIDERATIONS

1. **General**. Pertinent information on environmental laws, if they exist, will be available from civil-military cooperation (CIMIC) organizations already in-theatre or the lawful civil authority. The CF will attempt, as a matter of policy, to comply with Canadian environmental standards, in addition to local standards, wherever possible. This is to be tempered, however, by the financial and practical limitations of each particular situation. The objectives to consider on a detailed site selection reconnaissance are to gain and maintain the support of the local population, preserve the environment of the host country, and promote sanitary conditions for the continuing health of Canadian personnel. Environmental assessment for prospective sites is to be completed in accordance with DAOD 4003-0 *Environmental Protection and Stewardship*, A-EN-007-000/FP-001 DND *Environmental Assessment Manual*, and QSTAG2044 *Hazardous Waste Management*.

2. **Baseline Study**.[1] Once a site is selected for occupation, it is imperative that an Occupation Environmental Baseline Study (OEBS) be conducted to thoroughly evaluate and document the condition of the facilities, infrastructure and property. In most instances, the site survey (SS) data already collected will facilitate timely completion of the OEBS. The OEBS quantifies the level of any environmental contamination that may be present, including the relative concentrations of various environmental and industrial health hazards (EIHH) or public health concerns (PHC), and assists in determining what additional precautionary measures should be taken. Depending on the number of unknowns from the SS, the OEBS could include a detailed evaluation of soil and groundwater. The results of the OEBS are to be documented in an engineering report that clearly identifies areas of contamination, contaminant concentrations, and the associated media affected (i.e., water, soil or air). The report shall also make recommendations regarding appropriate force protection measures to prevent or minimize harmful exposure.

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[1] DCDS Instruction 02/2000 - DCDS Direction for International Operations (DDIO), chapter 18

3. **Monitoring**. Procedures will be established to ensure that, where necessary, the residual risk from EIHH and PHC that cannot be avoided or controlled is monitored and specific health surveillance is initiated. There are two types of monitoring programs:

a. **Steady State Monitoring**. A requirement to conduct, where possible, routine air and water sampling for indications of contamination.

b. **Hand-over/Closeout Monitoring**. On hand-over to a relieving CF element or non-CF element, or mission closeout, the conditions of any location are to be appropriately documented in the form of a Hand-over Environmental Baseline Study (HEBS) or a Closeout Environmental Baseline Study (CEBS) and included in the Board of Inquiry proceedings. The CEBS could involve participation from the Host Nation or the receiving body that will eventually take over the site. Ultimately, the HEBS or CEBS will summarize the condition of the site, results of the steady state monitoring program, and highlight any areas of concern and include site remediation recommendations.

4. **Environmental Considerations**:

a. **Water Management**:

(1) **Certification of Local Water Resources**. If local water is to be used for consumption by CF personnel, it must be certified as potable by medical authorities using current preventive medicine procedures. The quality of the water source will determine purification requirements.

(2) **Water Course Protection**. Maximum effort must be made to prevent siltation, bottom damage, bank erosion and/or contamination during movement, construction, maintenance, resupply or other activities on or near water sources.

(3) **Water Conservation**. Maximum effort will be made to prevent wastage and misuse of water stocks.

b. **Solid Waste and Liquid Waste Management**. Disposal of solid and liquid wastes will depend on the waste disposal location and its surrounding environment, and the nature of the operation.

(1) **Solid Waste**. The environmental method of choice for disposing of solid waste or dry garbage should be burial in existing landfills. If existing landfills are not available, waste burial should employ typical landfill operation techniques. Landfill operations will not be conducted in the vicinity of watercourses. Recycling programs should be employed whenever possible.

(2) **Organic Waste**. As with solid waste, disposal should be in accordance with local regulations, through local contract.

(3) **Human Waste**. The preferred methods of disposal in order of precedence are: sanitary water disposal and treatment systems, portable latrines, burnout latrines, and slit trenches.

(4) **Wastewater**. Wastewater will be treated in accordance to accepted environmental practices (outlined in Chapter 4 *Wastewater Utility Systems*). Wastewater contaminated with hazardous material that cannot be separated from the water is not inclusive to this category and must be dealt with accordingly. Wastewater can be categorized as either Grey or Black depending on the level and nature of contaminants. Ideally, all wastewater will either be collected and treated using an

accredited Host Nation facility or be treated using the Relocatable Temporary Camp (RTC) package plant or equivalent. While grey and black water are normally collected and treated together, in some extenuating circumstances, they may be treated separately.

(a) **Grey Water**. Grey water has lower concentrations of contaminates and is associated with the waste from ablutions, showers, laundries or vehicle wash racks (with separators to remove POL). Grey water should be treated through the wastewater utility system but, if required, can be treated separately using a sand filter, lagoon or similar treatment system. Construction shall ensure proper drainage of grey water runoff. All measures will be taken to prevent creation of new pest breeding sites.

(b) **Black Water**. Black water is sewage with a higher concentration of contaminates, usually originating from toilets, urinals, medical facilities (non bio-hazard) and kitchens. Black water must be treated through the wastewater utility system.

c. **Hazardous Materials Management**:

(1) **Hazardous Material Storage**. Hazardous materials will be maintained, as a minimum, in accordance with appropriate national directives.

(2) **Hazardous Waste Disposal**. Hazardous waste such as oily waste and batteries will not be disposed of in or on the ground, or in any waterway. These wastes must be collected in approved CF containers and then processed through an established collection point.

(3) **Medical Waste Disposal**. The disposal of biomedical waste remains the responsibility of the Field Surgical Hospital and Field Ambulance. Hazardous material must not be disposed of in landfill sites. Medical waste in a theatre of operations will be disposed of either by incineration, other suitable method, or by local contract with Host Nation medical agencies. Standards or guidelines for disposal are described in B-GG-005-004/AF-017 *Health Services Support to Canadian Forces Operations*.

(4) **Flora and Fauna Protection**. Destruction of flora and fauna for movement and clearance of small areas (fields of fire, base construction, observation posts, etc.) and for welfare (health and safety requirements) is permitted. Destruction and clearing of large areas must be approved through the Force Engineer.

(5) **Archaeological, Cultural and Historical Preservation**. International protocols concerning archaeological, cultural and heritage sites, buildings and artifacts will be followed. The following guidelines are provided for planning purposes:

(a) basing and construction operations in the vicinity of archaeological and historical buildings and areas should be minimized;

(b) military operations will not employ, target or destroy archaeological, cultural and heritage sites unless absolutely necessary;

(c) looting, desecrating or damaging archaeological, cultural and heritage sites will not be condoned or permitted; and

(d) any damage, whether by hostile or non-hostile forces, to archaeological and historical areas will be reported through operational channels.

d. **Base and Installation Operations**. The operation of camps and installations will conform to the environmental regulations of the appropriate theatre authority.

ANNEX B
RECONNAISSANCE EQUIPMENT CHECKLIST

1. Light source—flashlight or trouble light.

2. Binoculars.

3. GPS and equipment.

4. 10 m pocket tape measure.

5. 50 m surveyor's chain tape.

6. Laser level.

7. Clipboard, notepad, and pencils (dictating device or laptop if necessary).

8. Hammer.

9. Various screwdrivers.

10. 3 to 4 m ladder.

11. Digital camera or camera with film, flash, new batteries (video camera if available).

12. Surveyors level, 7 m rod and tripod.

13. 5–10 survey stakes.

14. Flagging tape.

15. Spray paint for survey marking (contingent on air transport restrictions).

16. Metal detector, prodders, trip wire feelers, mine/UXO signs, mine tape, ballistic protective eyewear and other Personnel Protective Equipment (PPE).

17. Multi-meter.

18. Rope, 11 mm diameter by 40 m long.

19. Pipe wrench 14 inch.

20. Pipe wrench 18 inch.

21. Shovel/spade.

22. Soil and water sample containers.

23. Soil percolation test equipment.

24. Water analysis test kit.

25. Soil analysis test kit.

26. Maps of local area.

27. As a minimum the following references (latest editions) should be taken:

a. B-GL-361-012/FP-012 *Accommodations, Installations and Engineering Services for Deployed Operations;*

b. *National Building Code of Canada*;

c. *Concrete Design Handbook*;

d. *Handbook of Steel Construction*;

e. *Wood Design Manual*;

f. *Canadian Electrical Code*;

g. A-LM-007-009/AX-000 *Environmental Assessment Manual*; and

h. *Canadian Plumbing Code*.

ANNEX C
MILITARY ENGINEER SUPPORT—TECHNICAL RECONNAISSANCE PROFORMA

PART 1—GENERAL

1. Unit:

2. Name:

3. Date:

4. Time Zone:

5. Country:

6. Maps:

   a. Datum Used:

   b. Sheet No/Edition:

7. Contingent Size (copy of TO&E):

   a. Personnel:

      (1) Officers (M/F)—

      (2) Sr NCOs (M/F)—

      (3) NCMs (M/F)—

   b. Sub-units (name and number of personnel):

   c. Vehicles:

SUB-UNIT	HLVW	MVLW	LSVW	ILTIS	AVGP/ APC	HY AFV	LT TRL	HY TRL	ENGR PLANT	ISO	Other	Remarks

8. Op Duration:

9. Type of Op:

10. Op Concept:

    a. (relief/peacekeeping/intervention/support/etc.)

    b. (number of sites/static/mobile/etc.)

11. Meteorological:

	Annual	Spring	Summer	Fall	Winter	Remarks
Rain						
Snow						
Prevailing Wind						
Storms						

12. Country Details:

    a. Capital:

    b. Languages:

    c. Currency:

d. Politics:

e. Ethnic Makeup:

f. Religions:

g. Economics:

h. Industry:

i. Military:

j. Current:

k. Situation:

PART 2—ENGINEERING WORKS—REQUIREMENTS VERSUS EXISTING

13. **Accommodation Standard** (initial, temporary, permanent):

14. **Pers Accommodation Requirements**:

a. function of accommodation (Officer, Snr NCO, NCM, Ablution);

b. type of accommodation (tents, trailers, ISO, etc.);

c. total area required (living area required, number of ablution fixtures) (male/female);

d. quantity required (quantity of type of accommodation); and

e. preparation required (concrete pad, gravel pad, drainage, pre-assembly, assembly crew, etc.).

Function of Accommodation	Type	Total Area Required [2](M/F)	Quantity Required (M/F)	Preparation Required	Remarks

15. Other Accommodation Requirements:

a. function (sub-unit, QM, EME, etc.);

b. office space required (floor area);

c. warehouse space required (storage);

d. total area required;

e. type; (tent, sprung shelter, C-span, weather haven, etc.);

f. dispersal distance;

g. preparation required (concrete pad, gravel pad, drainage, pre-assembly, assembly crew, etc.); and

h. vehicle parking (amount and type required for facility).

[2] Per B-GL-361-012/FP-001

Function	Office	Warehouse	Total Area	Type	Dispersal Distance [3]	Preparation Required	Vehicle Parking	Remarks

16. **WATER SUPPLY** (litres/day):

a. **Potable Water**:

(1) drinking water;

(2) medical requirement, personal (not incl hospitals);

(3) heat treatment;

(4) personal hygiene;

(5) shower;

(6) food preparation;

(7) additional requirement (hospitals);

(8) total potable required; and

(9) total available, including quantity and source.

[3] Per B-GL-361-012/FP-001

Drink[4]	Medical[5]	Heat Treatment[6]	Personal Hygiene[7]	Shower[8]	Food Preparation[9]	Laundry[10]	Additional Reqr	Total Potable	Total Available		Remarks
									Quantity	Source	

b. **Non-potable water**:

(1) sewage system requirements (flush toilets, washing of septic tanks);

(2) fire fighting;

(3) construction (road maintenance, concrete production);

(4) graves registration;

(5) vehicle operations (wash water); and

(6) air operations (wash water).

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[4] Per B-GL-361-012/FP-001

[5] Per B-GL-361-012/FP-001

[6] Per B-GL-361-012/FP-001

[7] Per B-GL-361-012/FP-001

[8] Per B-GL-361-012/FP-001

[9] Per B-GL-361-012/FP-001

[10] Per B-GL-361-012/FP-001

NOTE

Use of non-potable water is contingent on intended application. In some cases filtration of suspended matter may be only requirement. In other cases, pH or hardness may require adjustment.

Sewage System[11]	Fire Fighting	Construction	Graves Registration	Vehicle Operations	Air Operations	Total Non-potable	Remarks

SEWAGE TREATMENT[12]:

Volume Sewage			Volume Grey Water			Total			Remarks
norm	peak	total	norm	peak	total	norm	peak	total	

[11] Per B-GL-361-012/FP-001

[12] Per B-GL-361-012/FP-001

17. **SOLID WASTE**[13]:

SITE	ESTIMATED QUANTITY					
	Solid Waste—Dry		Solid Waste—Wet		Solid Waste—Kitchen	
	Mass (Kg)	Vol (m^3)	Mass	Volume	Mass	Volume

18. **Electrical**:

a. **General Requirement**:

(1) total power required (include voltage, frequencies, quantity);

(2) type of power available, quality(voltages, frequencies, quantity available), distribution method (overhead, underground, generators);

(3) supplier (name, location, affiliation);

(4) cost;

(5) deficiency; and

(6) GENSET required (type/quantity).

[13] Per B-GL-361-012/FP-001

Site	Total Required[14]	Type of Power Available		Deficiency	GENSET Requirements		Remarks
		Quality	Distr		Type	Qty	

b. **Grounding and Bonding**:

(1) type of facility to which grounding and bonding is required; and

(2) type of grounding/bonding required (static, lightning, electrical, isolating).

Type of Facility	Type of Ground/Bonding	Remarks
POL		
TDM		
Aviation		

c. **Lighting**:

(1) function (sub-unit or area);

[14] Per B-GL-361-012/FP-001

(2) type of lighting (security, accommodation, etc.);

(3) total lighting required (include personal use); and

(4) electrical load.

Site	Function	Type Required	Total Lighting Required	Electrical Load (Volts & Watts)	Remarks

19. **Heating**:

a. function (sub-unit);

b. type of heating required (forced air, steam, water, heating for wash water, etc.);

c. quantity required (include personal use);

d. existing heating;

e. deficiency;

f. portable heating required; and

g. fuel requirement/electrical load.

Site	Function	Type Required	Quantity Required	Existing	Deficiency	Portable Heating Required		Fuel Required/ Electrical Load (Volts & Amps)	Remarks
						Type	Qty		

20. **Air Conditioning/Refrigeration**:

a. **General Requirement**:

(1) total cooling required (include personal use);

(2) function (sub-unit);

(3) type of cooling required (freezer, cool air, fridge, etc.);

(4) quantity required;

(5) existing units;

(6) deficiency;

(7) portable requirements (type/quantity); and

(8) electrical load.

Site	Function	Type Required	Quantity Required	Existing	Deficiency	Portable Cooling Required		Electrical Load (Volts & Amps)	Remarks
						Type	Qty		

b. **Ice**:

(1) quantity required (estimate 1.8 kg/pers/day);

(2) supplier (name/location/affiliation); and

(3) costs.

Site	Quantity Required	Supplier	Costs	Remarks

NOTE

Water required for making ice is assumed to be included in the "Drink" portion of Potable Water.

21. **POL Points**:

a. type of fuel and container required (mogas, diesel, avn & misc);

b. area (size of area required);

c. storage requirements (reveting, berms, etc.);

d. dispersal distance; and

e. work required (concrete/gravel pad, excavation, berms, etc.).

Site	Type/Container (jerry can, bladder, drum)				Area	Storage Requirements	Dispersal Distance [15]	Work Required	Remarks
	MOGAS	DIESEL	AVN	MISC					

22. **Ammunition Points/TDMs**:

a. type (nature & quantity of ammunition);

b. quantity of bunkers required;

c. area (size of area required);

d. storage requirements (reveting, berms, etc.); and

e. amount of work required.

[15] Per B-GL-361-012/FP-001

Site	Type	Quantity	Area	Storage Requirements	Dispersal Distance [16]	Work Required	Remarks

PART 3—CAMP AND AREA SECURITY

23. **Security Fencing and Cover-from-view Screening**:

a. function (sub-unit or facility);

b. required type of fencing;

c. required length;

d. existing type of fencing;

e. existing length;

f. condition of existing fence;

g. repairs required to existing; and

h. additional fencing required.

[16] Per B-GL-361-012/FP-001

Site	Function	Required Type	Required Length	Existing				Additional Fencing Required	Remarks
				Type	Length	Condition	Repairs Required		

24. **Defensive Works** (towers, guard posts, OPs, etc.):

Site	OP Towers	Guard Posts	OPs	Def Posn Pers	Bunkers	Def Posn Wpns	Light Towers	Vehicle Gates	Construction Requirements	Material Required

PART 4—MOBILITY/HORIZONTAL CONSTRUCTION

25. **Road Conditions**:

Site	Type	Condition	Repairs Required	Priority/ Time	Materiel	Equipment Labour	Remarks

26. **Bridges, Fords, Ferries**:

Site	Type	Condition	Repairs Required	Priority/ Time	Materiel	Equipment Labour	Remarks

27. **Dust Control** (matting, road oil, water, salt, chemicals, sand bags, etc.).

Site	Location	Method	Quantity Required	Cost	Priority /Time	Equipment Labour	Remarks

PART 5—ENGINEER RESOURCES (REQUIRED & AVAILABLE)

28. **Material**:

Function	Material	Initial Required	Existing Resources	Supplier	Cost	Deficiency	Remarks
	Lumber						
	Plywood						
	Fasteners						
	Sand						

Function	Material	Initial Required	Existing Resources	Supplier	Cost	Deficiency	Remarks
	Gravel (by size)						
	Asphalt						
	Cement						
	Concrete						Classification
	Structural Steel						
	Masonry						
	Geotextiles						
	Culverts						
	Electrical Distribution Equipment						
	Other						

29. **Labour**:

a. Skilled (carpenters/electricians/plumbers, etc.); and

b. unskilled (trades helpers/labourers, etc.).

Site	Quantity Required	Type Skilled or Unskilled	Availability	Contractor	Cost	Remarks

30. **Eqpt** (with or without operators):

Site	Type	Quantity Required	Availability	Contractor	Cost	Deficiency	Remarks
	Dump						
	Dozer						
	FEL						
	Excavator						
	Compactor						
	Drill Rig						
	Trencher						
	Backhoe						
	Grader						
	Scraper						
	20 m^3 Dump						
	Belly Dump						
	Snow Plow						
	Snow Blower						
	Sand Spreader						
	Lowbed						
	Crane						
	Skid-Steer Loader						
	Man-Lift						
	Other						

31. **Requirement for Additional Eqpt** (honey wagon, incinerator, etc.).

PART 6—AIRFIELDS/HELIPORTS

32. **Existing Facilities**:

a. type (runway, taxiway, apron, helipad);

b. size;

c. surface/capacity (concrete, asphalt, gravel);

d. lighting/NVA aids (approach, boundary, threshold, runway, taxiway, ramp, rotating beacons);

e. condition/work required; and

f. remarks (comments on notes, other airfield related structures).

Site	Type	Size		Surface/ Capacity	Lighting/ NVA Aids	Condition/ Work Required	Remarks (comment on Notes)
		Length	Width				

NOTES

1. Overrun is at either end of runway and should be 100 m long with width equal to runway.

2. End clear zone is beyond overrun and is 150 m long and 65 m wide, increasing to 180 m wide, with a max grade of 5%.

3. Approach zone is clear area of 500 m length with 180 m width, increasing to 700 m, with vegetation cleared at a slope of 35:1.

33. **Helicopter LZ Requirement**:

Site	Size	Surface	Lighting	Repairs Required	Remarks

PART 7—FIRE FIGHTING

34. Hazard (structural, aircraft or vehicle crash/rescue, natural cover).

35. Staffing required.

36. Chemicals required.

37. Fire Protection required (vehicles, materials).

38. Equipment available (structural vehicles, aircraft crash/rescue, water carried).

Site	Hazard	Staffing	Chemicals Required	Fire Protection Required	Equipment Available	Remarks
	Structural fire					
	crash/ rescue					
	Natural cover fire					

PART 8—FIELD ENGINEER TASKS

39. **Combat Diving**. Capability Required:

40. **Mines**:

a. Policy (ops, humanitarian, etc.);

b. Priority (ops, routes, etc.);

c. Mine Awareness Training (contingent, civil, etc.);

d. Threat.

Site	Mines Type/Quantity(Estimate required/existing)			Methods (laying)	Training Required	Equipment Required	Remarks
	APERS	Atk	Booby Traps				

41. **Explosive Ordnance Disposal** (EOD) / **Unexploded Explosive Ordnance** (UXO):

a. Policy;

b. Priority (HQs, Comms, etc.);

c. Threat.

Site	Types/Quantity (Estimate)			Capability Required	Limitations	Training Required	Equipment Required	Remarks
	UXO	IED	Search					

ANNEX D
BASIC BUILDING/SITE INSPECTION CHECKLIST

SECTION 1
SITE

1. **Safety**. Check for evidence of:

   a. mines;

   b. other unexploded explosive ordnance (UXO);

   c. booby traps; and

   d. contamination from hazardous materials.

2. **Security**. Check for:

   a. fencing; and

   b. lighting.

3. **Fire**. Check for:

   a. fire hydrants or other sources of water for fire protection; and

   b. possible sources of fire, toxic chemicals, rubbish, etc.

4. **Terrain**:

   a. ensure natural drainage is away from all structures;

   b. avoid, when possible, high ground that dominates the camp;

   c. confirm condition of roads to/from site; and

   d. confirm the availability of fuel and water storage.

5. **Utilities**:

a. check and locate possible sites for water points for both potable and non-potable water (is the local population using surface water or well?);

b. confirm condition of exterior water lines;

c. confirm condition of exterior sewer lines/treatment facility/septic tank (ensure use of confined spaces equipment if visually inspecting lines);

d. locate possible outfalls for treated effluent;

e. confirm type and condition of overhead/underground electrical; and

f. confirm location of oil and gas lines for possible use and safety issues.

SECTION 2
INDIVIDUAL BUILDING

BUILDING EXTERIOR

6. **Roof**:

a. identify roof shape (flat or pitched);

b. if pitched look at roof ridge valleys and edges for misalignment and sagging;

c. if flat, look for low areas, ponding, sagging, and abrupt changes in plane;

d. identify membrane deficiencies (i.e. missing or damaged shingles or tiles, holes, cracks, etc.); and

e. identify any damage to structural system (from attic or roof space if accessible).

7. **Walls**:

   a. determine type of construction (cast-in-place concrete, concrete block, wood frame, etc.);

   b. identify bowing or deformations in the wall membrane;

   c. identify misalignment of wall with foundation;

   d. identify presence of cracks, scaling or holes;

   e. identify presence of rot or rust in structural members or within the wall membrane;

   f. identify signs of termites or carpenter ants (i.e. saw dust-like material lying on the floor);

   g. identify signs of leakage in basements or crawl spaces; and

   h. determine insulation type and amount in walls and attic.

8. **Foundation**:

   a. determine type of foundation; and

   b. identify presence of holes, cracking or scaling of foundation.

9. **Doors and Windows**. Confirm:

   a. operation;

   b. general condition and glazing;

   c. size, for restrictions on use; and

   d. size, for repair/replacement.

10. **Electrical Service**. Confirm:

a. existence; and

b. condition of wiring, meter, panels, transformer, grounds, etc.

BUILDING INTERIOR

11. **Load Bearing Walls, Columns and Beams**:

a. determine type of construction;

b. determine presence of deflection, bowing, sagging, cracks, scaling, rot or rust;

c. determine if members are plumb and level; and

d. confirm size for repair/replacement.

12. **Truss Systems and Ceilings**:

a. confirm presence of water leakage;

b. confirm presence of loose/falling plaster or ceiling tiles; and

c. determine if truss system is structurally adequate.

13. **Floors and Stairways**:

a. determine type of construction;

b. identify presence of water penetration; and

c. identify presence of damaged structural members (from basement or crawl space if accessible), stringers and treads, and floor coverings.

14. **Electrical Panel**:

a. determine location and quantity of electrical panels;

b. note data on panel identification plate, size of main feed, size of circuits;

c. determine type of panel (fuse/breaker);

d. confirm condition of panel; and

e. confirm condition of electrical wiring to panel.

15. **Electrical System**. Confirm:

a. presence of existing light, receptacles and switches; and

b. condition of electrical wiring throughout structure.

16. **Plumbing**:

a. confirm presence of plumbing fixtures and hot water tank;

b. confirm condition of existing fixtures;

c. determine type/size of fixtures for repair/replacement;

d. ensure operation of system;

e. determine existence of sprinkler system;

f. confirm building water service entrance valves;

g. confirm existence of oil/water separator; and

h. confirm connection to municipal sewer, septic tank or other waste collection system.

17. **Ventilation**:

a. confirm existence of ventilation system;

b. note data on system information plate;

c. determine approximate size and type of system;

d. confirm condition of system; and

e. confirm condition of electrical system providing power to system.

18. **Heating and Cooling System**:

a. determine type of system;

b. determine type of fuel and availability;

c. note manufacturer's data on system plate;

d. determine condition of system; and

e. confirm condition of ancillary equipment associated with system.

MISCELLANEOUS

19. Confirm the presence of hazardous materials and chemicals either stored within building or used as construction material (asbestos pipe insulation, asbestos siding, etc.).

20. Confirm the presence of fire and safety hazards.

21. Confirm the state of cleanliness.

22. Confirm restrictions on use of facility including ceiling height (both obstructed and unobstructed), numerous columns, small entries, etc.

23. Confirm special features within facility including overhead lift; compressed air.

24. Confirm past use of site that may be detrimental to health, safety or environment.

25. Estimate age of building.

CHAPTER 3
SCALES OF ACCOMMODATIONS AND ENGINEERING SERVICES

GENERAL

1. This chapter details scales of living and working space, and engineering services, for deployed operations. These are presented only for guidance, therefore, attaining these scales should not be allowed to detract from operations. These scales can be applied either to a new camp design or the assessment and rehabilitation of existing facilities.

2. There is a differentiation between scales and construction standards. A scale defines the allotment of space or engineering services. Construction standards define the type and degree of refinement of facilities and engineering services provided.

SCALES OF LIVING ACCOMMODATIONS

3. Living accommodations encompasses facilities for personnel such as sleeping quarters, messes (including dining areas), ablutions, and storage for personal belongings.

4. Scales of living accommodations are at Annex A.

SCALES OF WORKING ACCOMMODATIONS

5. Working accommodations are provided for unit operations, and encompass such facilities as office accommodation, workshops, stores, communication centres, and hospitals.

6. Scales of working accommodations are at Annex B, in the following tables:

   a. Table 3B-1: Office Accommodation.

   b. Table 3B-2: Workshops.

c. Table 3B-3: Warehouses.

d. Table 3B-4: Communication Centres.

e. Table 3B-5: Hospitals.

SCALES OF SERVICES

7. Scales of engineering services for the following are at Annex C, in the following tables:

a. Table 3C-1: Water Supply.

b. Table 3C-2: Wastewater Production.

c. Table 3C-3: Solid Waste Production.

d. Table 3C-4: Refrigeration.

e. Table 3C-5: Electricity.

f. Table 3C-6: Hardstands.

WAIVERS

8. Waivers required to deviate from prescribed scales are to be directed to the proper authority through the Force Engineer as indicated throughout this document.

ANNEX A
LIVING ACCOMMODATIONS

Serial	Type of Facility	Scale	Remarks
Officers			
1	Sleeping	8 m^2 per person	May have cubicles
2	Mess dining	1 m^2 per person	Normally all mess facilities are shared divided facilities with senior NCMs.
3	Mess ante room	1.4 m^2 per person	
4	Kitchen	90 m^2	1 per 200 persons
5	Washbasins	10% of strength	May be partitioned
6	Showers	10% of strength	Should be partitioned
7	Latrines	10% of strength	Should be partitioned
8	Urinals	5% of male strength	Should be partitioned
Senior NCMs			
9	Sleeping	8 m^2 per person	May have cubicles
10	Mess dining	1 m^2 per person	Normally small groups share divided facilities with officers.
11	Mess ante room	1.4 m^2 per person	
12	Kitchen	90 m^2	1 per 200 persons
13	Washbasins	10% of strength	May be partitioned
14	Showers	10% of strength	Should be partitioned
15	Latrines	10% of strength	Should be partitioned
16	Urinals	5% of male strength	Should be partitioned
Junior NCMs			
17	Sleeping	6 m^2 per person	2-bed cubicles may be provided for shift workers
18	Mess dining	1 m^2 per person	
19	Kitchen	90 m^2	1 per 200 persons
20	Washbasins	10% of strength	May be partitioned
21	Showers	10% of strength	May be partitioned
22	Latrines	10% of strength	May be partitioned
23	Urinals	5% of strength	May be partitioned
24	Canteens	0.8 m^2 per person	Small groups or units may share facilities
25	Recreational rooms	0.8 m^2 per person	Small groups or units may share facilities

Serial	Type of Facility	Scale	Remarks
MISCELLANEOUS			
26	Common Area Fridge	15 ft^3 fridge per every 20 personnel	Only standard temporary accommodations. This is not an entitlement but rather guidance.
27	Guard House	1 per unit	Only units over 200 persons
28	UMS	1 per unit	With medical officer—72 m^2 Without medical officer—54 m^2
29	Laundry Room	1 washer/25 persons 1 dryer/25 persons	
30	Ration Store	72 m^2/unit with kitchen	

Scale of Accommodations for Fitness Facilities—Deployed Camps

	Camp Population			
Facility	<251 pers	251—1400 pers	1401—3250 pers	Comments
Weight Room	100 m^2	200 m^2	200 m^2	
Multi Purpose Exercise Room	100 m^2	200 m^2	400 m^2	
Gym Floor	37 m x 24 m	37 m x 24 m	2 @ 37 m x 24 m	Facility to engage in sports such as basketball or floor hockey. This facility is usually outdoors and represents floor/slab area. May be located indoors if suitable structure is available.
Office and Stores	48 m^2	48 m^2	96 m^2	Estimated space requirement for sports equipment storage and limited offices.

Table 3A –1: Living Accommodations

NOTES

1. Environmental control facilities may be authorized for aircrew sleeping accommodation.

2. 12 m^2 for unit commanding officers and officers of LCol rank and above.

REMARKS

Facilities may be combined to form centralized complexes. Where kitchen facilities are combined to form a central facility catering for more than 200 personnel, the scale to be applied for Mess Dining is 0.7 m^2 per person.

ANNEX B
WORKING ACCOMMODATIONS

Serial	Type of Facility	Scale	Remarks
1	General Administration	7 m^2 per occupant	
2	Senior Officers	12 m^2	
3	Company/Squadron	six 8 m^2 offices spaces; partitioned	Junior Officers / Senior NCMs
4	Battalion/Regiment HQ or equivalent	240 m^2	
5	Brigade HQ or equivalent	550 m^2	This is a guide. A Coalition level HQ may need more.
6	Division HQ or equivalent	9.2 m^2 per occupant	

Table 3B-1: Office Accommodations

Serial	Type of Facility	Scale	Remarks
1	Vehicles	2.2 m^2/vehicle supported	Wheeled and tracked
2	Miscellaneous administration/storage for vehicle workshops	2.3 m^2/vehicle supported	Normally only required for larger workshops with large spare parts holdings
3	Weapons and Electronics	0.4 m^2/per person supported	
4	General Engineering	0.8 m^2/major equipment supported	
5	Ammunition	0.14 m^2/tonne held	
6	Aviation—fixed wing	3600 m^2/squadron	Includes all facilities except ammunition and engineer maintenance
7	Aviation—rotary wing, small fixed wing	1600 m^2/squadron	As for serial 6
8	Small water craft (<30)	18 m^2/craft	

Serial	Type of Facility	Scale	Remarks
9	Small Watercraft—each additional >30	12 m^2/craft	

Table 3B-2: Workshops

NOTES

This scale is for initial planning purposes only. The actual requirement will depend on aircraft type and the support equipment to be installed.

REMARKS

For small independent units, the area of workshop space to be provided may be calculated based on the actual number and type of vehicle to be supported, and the estimated percentage of vehicles likely to be in the workshops at any one time (not to exceed 20%). Authorized vehicle repair bay sizes are:

a. heavy track 136 m^2;

b. heavy wheeled and light track 77.7 m^2; and

c. light wheeled 112 m^2.

Environmental control facilities may be authorized where required for technical reasons.

Serial	Type of Facility	Scale	Remarks
1	Unit QM	0.4 m^2/person supported	
2	General unit storage	0.35 m^2/tonne held	Represents covered storage for 20% (by weight) of unit holdings.
3	Service Battalion (non-vehicular)	0.35 m^2/tonne held	Represents covered storage for 20% (by weight) of stores holdings.
4	Ammunition—ground	0.25 m^2/tonne held	Represents covered storage for 20% (by weight) of ammunition holdings.
5	Ammunition—air	0.35 m^2/tonne held	Represents covered storage for 20% (by weight) of ammunition holdings.
6	Terminals	0.4 m^2/tonne held	For bulk breaking operations only

Table 3B-3: Warehouse

Serial	Type of Facility	Scale	Remarks
1	Battalion/Regiment or equivalent	88 m^2	
2	Brigade or equivalent	106 m^2	
3	Division or equivalent	220 m^2	
4	Phone centre < 1000 lines	150 m^2	
5	Phone centre 1000 to 2000 lines	220 m^2	
6	Phone centre > 2000 lines	360 m^2	
7	Receiver station	150 m^2	
8	Transmitter station	580 m^2	
9	Carrier repeater station	150 m^2	
10	Microwave relay	290 m^2	

Table 3B-4 : Communication Centres

REMARKS

1. The scale allows for equipment areas, office accommodation and rest areas.

2. Environmental control facilities may be authorized where required for technical reasons.

3. Security fittings may be provided where required.

Serial	Type of Facility	Scale	Remarks
1	Wards	8 m^2/bed	
2	Examination Room	0.3 m^2/bed	min 9.2 m^2
3	Medical Officers' Consulting Room	0.3 m^2/bed	min 9.2 m^2
4	Treatment Room	0.3 m^2/bed	min 9.2 m^2
5	Nurses' Station	0.55 m^2/bed	min 9.2 m^2
6	Ward Storage	0.4 m^2/bed	min 9.2 m^2
7	Surgery Suite	368 m^2	
8	Pre-Operating	88 m^2	
9	Intensive Care	368 m^2	
10	X-Ray	88 m^2	
11	Pathology Lab/Morgue	175 m^2	
12	Pharmacy	88 m^2	
13	Administration/Medical	320 m^2	
14	Administration/Supply	550 m^2	
15	Mess/Kitchen	820 m^2	
16	Admission/Discharge	175 m^2	
17	Chapel	88 m^2	
18	Recreation	88 m^2	
19	Maintenance	180 m^2	

Serial	Type of Facility	Scale	Remarks
20	Laundry	130 m^2	
21	Incinerator	2 kg/bed/hr	
22	Dental Clinic 1000 persons 1000–3000 persons	 88 m^2 175 m^2	

Table 3B-5: Hospitals

REMARKS

1. Hospital facilities to be connected to septic/sewage treatment systems.

2. Environmental control to be provided to the following areas: examination rooms, Medical Officers' consulting rooms, surgery, pre-operating, intensive care, X-ray, pathology lab/morgue and dental clinic.

3. Additional environmental control facilities may be authorized where required for medical reasons.

4. Security facilities may be provided where required.

5. This scale does not include living accommodations for hospital staff.

NOTES

One examination and one treatment room per Medical Officers' Consulting room.

ANNEX C
ENGINEERING SERVICES

Serial	Type of Facility	Scale	Remarks
1	Personnel—Combat Troops		
	a. Drinking and individual cooking	7 l/day/person	Increases to 15 l when temperature exceeds 30°C
	b. As per 1a, but allowing for limited personal hygiene	10 l/day/person	Increases to 20 l when temperature exceeds 30°C
	c. Normal planning figure for Protracted General Operations	25 l/day/person	Increases to 45 l when temperature exceeds 30°C
	d. As per 1c plus showering	70 l/day/person	
2	Personnel—Temporary or Semi-Permanent Camps:	Total = 150 L/day/person	Does not account for fire fighting requirement
	a. Potable Water:		
	Drinking	20 l/day/person	
	Medical	7.5 l/day/person	
	Heat treatment	5 l/day/person	
	Personal hygiene	17.5 l/day/person	
	Shower	15 l/day/person	
	Food preparation	25 l/day/person	
	Laundry	10 l/day/person	
	b. Non-potable Water (sewage collection in piped system):	50 l/day/person	
	c. Non-potable Water (fire fighting):	Camp dependent	
3	Medical		
	a. Field Hospital	120 l/day/bed	Water requirements for staff to be in addition to value shown
	b. General Hospital	185 l/day/bed	

Serial	Type of Facility	Scale	Remarks
	c. Mobile medical facilities	120 l/day/bed	
4	NBC Decontamination	20 lL/day/person	Non-potable if possible
5	Vehicle 1st line Topping Up/Minor Cleaning		Wash racks will require built in separators if waste water is to be considered as grey.
	a. Heavy A vehicles (tanks, self-propelled guns etc.)	30 l/day/vehicle	
	b. Light A vehicles (CVR(T),FV432 etc.)	10 l/day/vehicle	
	c. Heavy B vehicles (14T and above)	8 l/day/vehicle	
	d. Light B vehicles (Under 14T)	2 l/day/vehicle	
	e. C vehicles	10 l/day/vehicle	
	f. MRLS	1500 l/day/vehicle	Required after each days' firing by each launcher to remove corrosive efflux residue.
6	Vehicle 2nd Line Washdown/Repairs		Wash racks will require built in separators if waste water is to be considered as grey.
	a. Heavy A vehicles	10 l/day/vehicle	
	b. Light A vehicles	5 l/day/vehicle	
	c. Heavy B vehicles	4 l/day/vehicle	
	d. Light B vehicles	1 l/day/vehicle	
	e. C vehicles	5 l/day/vehicle	
7	Vehicle Decontamination		Water must be free from chemical warfare agent although not necessarily of potable standard.
	a. Tracked vehicles	1000 l/day/vehicle	
	b. Wheeled vehicles.	500 l/day/vehicle	

Table 3C-1: Water Supply

Serial	Source	Quantity (l/person/day)		Remarks
		Black	Grey	
1	Drinking	16/66		Assume 66 l/day/person if additional 50 l/day/person is included for piped sewage collection
2	Medical	7.5		
3	Personal hygiene		17.5	
4	Shower		15	
5	Food preparation	16		
6	Laundry		16	

Table 3C-2: Wastewater Production

REMARKS

1. Peak value can be assumed as 2 to 3 times average flow

2. A definition of black and grey water is provided at Annex A, Chapter 2.

3. Wastewater quantities from field hospital, general hospital or mobile medical facilities may be estimated as 100% of supplied water and are to be considered black.

4. Wastewater from vehicle wash may be estimated as 100% of supplied water and may be considered grey as long as wash rack separators are used.

Serial	Source	Mass (kg/m^3)	Production	
			(kg/person/day)	(m^3/person/day)
1	Dry Solid Waste	60	1.1	0.0183
2	Wet Solid Waste—Kitchen	150	0.7	0.0047
3	Wet Solid Waste—Other	150	0.4	0.0027

Table 3C-3: Solid Waste Production

Serial	Type of Facility	Scale	Remarks
1	Living Accommodation ration store	0.04 m^3/person accommodated	Includes both cooling and freezing facilities. Normally divided 1/3 kitchen, 2/3 unit cool room
2	Living Accommodation messes and canteen	0.05 m^3/member of mess or canteen	
3	Supply Depots—bulk storage (including both cool stores and freezing stores)	0.09 m^3/person supported	Includes hospital and workshop facilities
4	Field Hospital kitchens, messes and canteens	0.06 m^3/bed	Includes allowance for staff on duty
5	Ice requirements	1.8 kg/person/day	Water required for ice is accounted for by Table 3C-1

Table 3C-4: Refrigeration

REMARKS

Refrigeration for unit storage of medical supplies in Unit Medical Stations (UMS), Field Ambulance or Dental clinics not included in accommodation scales, and should be provided from unit equipment tables.

Serial	Type of Facility	Scale	Remarks
1	Basic Load	3.0 kW/hr/person	Includes accommodation (heating, minimal air conditioning), ablutions, kitchen (includes freezer), water (includes hot water), sewage treatment. Does not include workshops or emergency power.
2	Perimeter Lighting	2 kW/hr/50m of fencing	
3	Water Plant	40 kW/hr/unit connected	The exact nature of the water plant will dictate requirement.
4	Deep draft berth	250 kW/hr/berth	
5	Shallow draft berth	1.5 kW/hr/ length of berth	
6	Dry Dock	100 kW/hr/dock	
7	Hospitals	1.6 kW/hr/bed	Does not include emergency power.
8	Covered storage/warehouse	0.002 kW/hr/m^2	
9	Communications Centres		Unit must be consulted for expected load.
10	Workshops	45% of total above mentioned connected load	Can be increased for specific equipment requirements.
11	Generator Sizing		Generators should be sized to include 10% overload **plus** an additional 10% expansion capability.

Table 3C-5: Electricity Requirements

Serial	Type of Facility	Scale	Remarks
1	Unit Vehicles—up to 1 Ton	25 m^2/veh	
2	Unit Vehicles—5 to 10 Ton	40 m^2/veh	
3	Unit Stores	2.5 m^2/tonne held	
4	Unit Hardstand—general hardstanding	50 m^2/100 person	
5	Service Battalion—vehicle storage	40 m^2/veh	
6	Service Battalion—storage areas	1.4 m^2/ ton held	
7	Service Battalion—general hardstanding	50 m^2/100 person	
8.	Service Battalion—foodstuffs/POL	2 m^2/tonne held	
9	Workshops	4 m^2/veh supported and/or 0.25 m^2/major item of equipment supported	
10	Air Terminal—storage areas	5.8 m^2/tonne	
11	Deep draught port (no storage)	2.5 m^2/tonne	
12	Shallow draught port (no storage)	2.0 m^2/tonne	
13	Shallow draught port (include storage)	9.6 m^2/tonne	
14	Transit Terminals—general	1.75 m^2/tonne 40 m^2/veh	
15	Ammunition Storage—ground munitions	1 m^2/tonne held	
16	Ammunitions Storage—air munitions	1.4 m^2/tonne held	

Serial	Type of Facility	Scale	Remarks
17	Aircraft	3.5 to 4 x wing span x length of aircraft m^2/aircraft	Use larger value for smaller aircraft. May be increased to meet dispersal requirements.
18	Engineer Services/resources	Depend on quantity of material and resources to be stored	Would hold engineer resources, materials and perhaps equipment.

Table 3C-6: Hardstand Requirements

CHAPTER 4
PRELIMINARY DESIGN CONSIDERATIONS

GENERAL

1. Quantified requirements, standards or guidelines in this chapter enable specialist engineers to plan or configure individual facilities or utilities, and thereby estimate, design and/or construct complete deployed accommodations and utilities. This information is not a substitute for the knowledge and experience brought to the project by a trained competent engineer.

2. This chapter has been divided into earthworks, engineering services/utilities, fire protection, and design standards.

EARTHWORKS

3. While considered in detail in other publications, the following section is intended to provide basic information with regards to earthwork requirements at a deployed camp.

4. **Site Access**. Avoid dense brush, timberland and rolling terrain requiring heavy clearing or grading. Terrain analysis should include slopes, drainage, vegetation, soil characteristics, flood prone areas and any other unusual conditions affecting site development.

5. **Soils**. Detailed investigation of site soil conditions during the design and planning stages for the construction of deployed camps is to be completed in accordance with B-GL-361-011/FP-001 *Military Soils Engineering*. The following soil types and characteristics must be addressed during initial planning, preparing for site reconnaissance, and designing deployed accommodations.

6. **Types**. Soils are grouped into three major divisions:

   a. **Coarse Grained**:

      (1) **cobbles and boulders**—particles are greater than 60 mm in diameter;

(2) **gravels**—particles between 6 and 60 mm in diameter; and

(3) **sands**—particles between the No 4 and No 200 sieve.

b. **Fine Grained**:

(1) silts; and

(2) clays.

c. **Organic**. Peat.

7. **Symbols**. Soils are described by combinations of letter symbols according to their characteristics:

a. G—gravel;

b. S—sand;

c. M—silt;

d. C—clay;

e. O—organic soils;

f. Pt—highly organic soils (peat);

g. W—well graded;

h. P—poorly graded;

i. d—liquid limit 28 or less and plasticity index 6 or less;

j. u—liquid limit greater than 28;

k. H—high plasticity; and

l. L—low plasticity.

8. **Soil Characteristics**. Annex A lists various soil types as a function of the soil symbol, strength characteristics and possible construction uses. The free draining, coarse-grained soils (GW and GP) which predominate in most regions of the temperate zone make the best sub-grade and sub-base materials, and exhibit almost no tendency toward high compressibility or expansion.

9. **Site Drainage**. The aim of drainage is to keep the sub-grade dry and to prevent water retention on the ground surface. In order to achieve this the drainage system must:

a. intercept and control discharge of surface water from adjoining areas to a release point;

b. prevent sub-surface water from reaching the road or accommodation area; and

c. remove all surface water from ground level as quickly as possible without causing erosion.

10. Factors to be considered regarding drainage are:

a. rainfall;

b. topographic features:

(1) identification of areas that may cause the flow of surface or sub-subsurface water to the site;

(2) the natural direction of surface and sub-surface flow within the area;

(3) natural water courses that can be used for water disposal; and

(4) gradients.

c. soil characteristics, including ground cover and vegetation in the catchment area;

d. level of the water table and its seasonal changes;

e. frost incidence and penetrations;

f. degree to which flood events can be accepted operationally;

g. time, plant, materials and labour available; and

h. environmental considerations, including erosion and sedimentation, both within the camp area and the discharge stream.

11. Drainage systems are to be constructed in accordance with B-GL-332-001/FP-001 *Tactical Aide-Memoire (Volume 2.4), Engineer Insert, Section 805.14 Drainage*, and B-GL-361-016/FP-001 *Engineer Field Manual*, *Volume 16, Horizontal Construction, Roads*.

12. **Roads**. Detailed investigation for constructing or improving existing roads during the reconnaissance, design and planning stages for constructing deployed camps is to be completed in accordance with B-GL-361-016/FP-001 *Engineer Field Manual*, *Volume 16, Horizontal Construction, Roads*, and B-GL-332-001/FP-001 *Tactical Aide-Memoire (Volume 2.4), Engineer Insert, Section 805.15 Surface Expedients and Trackway, and section 805.16*, *Road Repairs*. Information required for the road planning sequence in constructing or improving roads is at Annex B. Current military road standards are at Annex C.

13. **Security**. Lightweight construction materials most likely used in deployed camp facilities and utilities provide little protection if a threat of attack exists. While dispersal of facilities in a high threat area aids in the security and survivability of a deployed camp, additional measures are required to properly protect personnel and critical resources. B-GL-361-006/FP-001 *Engineer Field Manual*, *Volume 6, Field Protection* must be consulted to provide for adequate protection of a deployed camp.

ENGINEERING SERVICES

14. The following minimum guidelines should be met to provide for proper deployed accommodations. Service requirements for infrastructure beyond this scope must be calculated separately.

ELECTRICAL UTILITY SYSTEMS

15. **Introduction**. Electrical power will be required for the following functions:

a. provision of interior and exterior power including perimeter security lighting;

b. running equipment, including communications and computer equipment, maintenance tools and equipment, and kitchen equipment including stoves and microwave ovens;

c. provision of heat, ventilation and air conditioning to all structures; and

d. powering safety systems such as emergency lighting, and smoke and fire alarms.

16. **Electrical Requirements and Distribution**. The provision of electrical utilities should be based on the following guidelines:

a. *The Canadian Electrical Code Part 1* (latest edition) shall be used as the principal guide for all electrical installations and equipment.

b. For most deployments the primary distribution voltage should be 480V, 3 phase, (NATO Standard). The limiting factor for determining the size of feeders for the electrical distribution system is the Power Distribution Unit (PDU) breakers; the 480V distribution breakers located in the PDU are all 100A each. This limits the step-down transformer size to 75 kVa, 3 phase. An internal 480/120/208V, 3 phase, 300 kVa Transformer is also available, and the breakers at 120/208V are either 100A or 400A therefore electrical distribution must be designed with this in mind.

c. Resistive loads, such as electric heat and incandescent lighting designed for operation at 240V, produce less than the nameplate rating when

operating at 208V. An example of this is in perimeter lighting: a halogen lamp rated at 1000W at 240V only produces 850W at 208V. This is also true for electric heaters. This should be considered in the design of the distribution system.

d. Electric heat, air conditioning, and any other large known loads should be calculated at 100% with no demand factors applied to calculations for determining cable, breaker/fuse, or panel sizing.

e. Voltage drop calculations are required to determine the cable size required for all branch circuits and feeder sizes. The distance from the Power Distribution Unit to the point of utilization in some cases is excessive and cables may need to be oversized to minimize the effects of voltage drop.

f. Stand-alone fire alarm stations should be incorporated into the design and strategically placed in conjunction with the contingent firefighter to ensure maximum coverage is obtained for the campsite. The site layout and the contingent firefighter will determine the number of stations required. Testing the fire alarm system is the responsibility of the contingent firefighter.

g. The earth's resistance in the area of a new camp is not known prior to camp installation. Therefore the electrical distribution grounding system must be tested to determine that it is adequate. The resistance for the grounding system should be 10 ohms (maximum) or less. A Megger test will be required at the time of installation to determine the grounding system's resistance, with monthly follow-up testing to ensure the system continues to meet the requirement. All electrical equipment shall be bonded to the grounding system.

h. Grounding and lightning protection for Temporary Depot Munitions (TDM) installations must be determined for the individual site being protected.

i. Airfields and heliports may require lighting, navigational aids, and grounding on a case by case basis.

j. Power generation and main distribution should be provided based on the quantities identified in Table 3C-5.

k. All installed electrical equipment must be capable of operating using 50 or 60 Hz feed with no adverse effect on rated performance or reliability.

l. The urgency of some operations will dictate exclusive use of on-the-ground distribution of electric power in the early phases of deployed accommodations. However, for temporary standard accommodations consideration should be given to the advantages of above or below ground distribution. Paragraphs 18 and 19 address the advantages and disadvantages of the three types of distribution systems.

m. Most countries have a limited electrical power distribution system that would allow either full electrical support to the deployed camp, or a supplement to the electrical generation system provided in the deployed accommodation design. It must be noted that any deployed camp must maintain its own integral generation and distribution system in case local power is shut off. Most power grids outside Canada and the US use power generated at 50 Hz, single or 3-phase, which can be used in many cases to power electrical lights and heating elements. However, only equipment compatible with 50 Hz power should be connected. In any case, redundancy should be considered in the number of connections to the local power grid.

17. **Power Generation**. The design of electrical generation for the provision of power to a deployed camp should adhere to the following design guidelines:

a. Power generation and main distribution should be provided based on the quantities identified in Table 3C-5.

b. For maximum efficiency of both personnel and equipment, the optimum mode of operation is to generate all primary power at a centrally located power plant. However, a dispersed layout can prevent the total loss of electrical generation capability in an area with the threat of attack. The decision for dispersed layout vice a centralized layout must also consider power generating equipment and distribution system equipment (cable) availability.

c. High ambient temperatures adversely affect the performance of diesel and gas turbine electric generators. To reduce these effects the sets should be located so that the prevailing winds will carry the heat away from adjacent generator sets or occupied areas. All generator sets should be protected from blowing dust and sand entering the cooling air intakes. The volume of air intake cannot be restricted or heat build-up will occur, causing loss of power.

d. The system shall be designed to permit operation in power ranges from 100 kW to 2.4 mW, and the generators must be capable of synchronized operation.

e. The operations centre and the Unit Medical Station must have dedicated power supplies, each with a back up generator. While additional power supplies may be attractive, numerous small units are both inefficient and have a higher maintenance cost.

f. For estimating purposes, generator fuel usage may be calculated as: Fuel Usage (L/hour) = Power Generation (kW)/3.7.

18. **Methods of Distribution**. Three options exist for distributing electricity within a deployed camp, with a combination of the three being the most likely solution. These include:

a. **Surface Distribution**. Surface distribution should primarily used for initial camp set-up (0 to 12 Months), with plans to bury the cables during the 6 to 24-month timeframe, if the mission is extended.

b. **Underground Distribution**. Underground distribution should be used for longer-term camp installations (over 12 months), with plans for recovery following camp closure.

c. **Overhead Distribution**. Overhead distribution should be used for longer-term camp installations (over 12 months), with plans for recovery following camp closure.

19. **Option Analysis**. Each of the three options have advantages and disadvantages, as shown at Table 4-1.

METHOD		
Surface	**Advantage**	Fast, easy to lay out Easier maintenance/ troubleshooting Easy recovery on a short deployment Easy to upgrade Visible
	Disadvantage	Subject to mechanical damage (vehicle, pedestrian, warfare) Exposed to elements (rain, snow, ice, UV light) Exposed to personnel (shock hazard) Tripping hazards Shorter life expectancy Aesthetically less pleasing

METHOD		
Under–ground	**Advantage**	Esthetically pleasing
		Mechanically and environmentally protected
		Less exposed to personnel (less shock hazard)
		No tripping hazard
		Long life expectancy
	Disadvantage	Hard to recover and reuse
		Subject to accidental breaks from digging operations
		More time-consuming to install
		Harder to do maintenance/ troubleshoot
		Must use cables rated for direct burial use
Overhead	**Advantage**	Provides a place for camp lighting (interior and perimeter)
		Telecommunications may co-utilize poles
		Less exposed to personnel (less of a shock hazard)
		Easy to do upgrades
		Long life expectancy
		Recoverable
	Disadvantage	Much more time-consuming to install
		Requires the most parts and pieces for a complete installation
		Exposed to the elements (rain, snow, ice, UV light)
		Creates an overhead snag hazard (vehicles)
		Hard to recover and reuse
		Materials may not be readily available (poles)
		Poses the most danger for the installer
		Esthetically less pleasing

Table 4-1: Electrical Distribution Options

20. **Area Lighting**. Area lighting towers are required to enable soldiers to accomplish tasks rapidly and safely when the threat of attack is not high, and to provide temporary security and perimeter lighting in support of the operation. Design guidelines are as follows:

a. Lights should be erected from 3 m to 10 m above the ground.

b. Installation of security area lighting should be considered for the following areas: camp perimeter, POL points, vehicle compounds, medical units, and ammunition storage areas.

c. For perimeter lighting, experience has shown efficiency can be obtained by using 1000 W quartz halogen lamps spaced approximately 50 to 70 m apart facing the camp's perimeter. Other sizes or types of fixture/lamp will require adjustment of this distance.

d. The system must operate on 120/240 V single phase at 50/60 Hz.

WATER UTILITY SYSTEMS

21. **General**. On deployed operations water is the most important aspect of engineering services. Therefore, it is absolutely essential that a source of water that can be made potable is available before consideration is given to any other design requirement. More detailed information on water supply can be found in B-GL-361-013/FP-001 *Engineer Field Manual*, *Water Supply*, and in CETO C-98-15W-002/MG-010 *Water Supply and Distribution Systems—Operations and Maintenance*.

22. **Sources**. Due to unsanitary practices or the deterioration of engineering services, all water in underdeveloped countries and war torn countries should be considered contaminated until tested otherwise. The reconnaissance must first determine the availability of a local treated water source. If no source is available, or if the source is questionable concerning either quality or quantity, other options must be sought.

SOURCE		
Local Infrastructure	**Advantage**	Possible readily available source Consistency in available flow
	Disadvantage	Lack of control on treatment standard Possible detrimental effect on local populace Difficult to secure source
Streams and Rivers	**Advantage**	Often acceptable quality
	Disadvantage	May have seasonal variations in flow including flooding Vulnerable to contamination Difficult to secure source Possible impact on local population
Lakes and Ponds	**Advantage**	Often acceptable quality (though dependant on size) More consistency in available flow
	Disadvantage	Difficult to secure source
Ground Water	**Advantage**	Usually requires less treatment than surface water More difficult to contaminate Possible to locate within secure area
	Disadvantage	Shallow wells may be contaminated Require outside support for drilling Difficult to determine effect on local populace

Table 4-2: Water Sources

23. Besides rivers, lakes and groundwater, other less obvious sources, even if only used temporarily, could be associated with nearby large industries, which at times require an on-site water source or storage capability. Again, water from this source should be considered non-potable until proven otherwise.

24. **Quantity Required**. Required water quantity may be calculated for planning purposes using Table 3C-1. Note that all required water does not need to be potable. Uses for clean but non-potable water may include fire fighting, washing vehicles, controlling dust, and construction. Table 3C-1 provides planning values for this quantity. Sources for required non-potable water are dependent on the intended use, but may include reverse osmosis water purification units (ROWPU) effluent, groundwater, or surface water free of suspended material (i.e. low turbidity).

25. **Treatment Methods**. Where a source exists it must first be tested for potability. If using this source will cause hardship to the local inhabitants, alternative sources should be found. If non-potable, the source must be treated. This treatment can be accomplished using existing or rehabilitated services, or through the use of portable water purification units, e.g. ROWPU. Streams, rivers, lakes and ground water are normally abundant. They generally require only clarification and disinfection to make them potable. However, ground water near industrial areas should be tested for the presence of hazardous wastes, and all water must be tested for the presence of human waste. Preventive Medicine Technicians are responsible for water standards and testing treated water prior to distribution.

26. **Bulk Potable Water Storage and Distribution**. Design guidelines for the system are described in the following sub-paragraphs. It shall be designed to permit a decrease or increase in the holding capacity such that the system has:

a. The capacity to store the larger of either five days of supply of water or the quantity of water required for fire fighting purposes. In many cases this will result in two storage requirements: five days supply of potable water; and a quantity of non-potable water equal to that required for fire fighting purposes.

b. The capability to hold and distribute potable water based on the number of personnel and on the construction standard provided.

c. Storage must be provided with an insulating blanket and agitator to prevent overheating and freezing.

d. A pressurized system that:

(1) Shall be designed to permit circulation to prevent stagnation, freezing or overheating. The water must remain potable for up to 30 days in storage.

(2) Should be provided with an in-line chlorinator with an automatic dispenser and a circulating heat pump to keep the water in the insulated bladders from freezing, and to ensure that the water remains potable in hot climates. Installation of an on-line chlorine analyser may also be considered.

(3) Pumps water at a rate between 0.83 to 8.3 l/s from an indigenous source such as a well, a water bowser, or from a ROWPU located within 500 m with a maximum head of 30 m.

(4) Distributes potable water to service accommodations dispersed over one square km using a maximum pipe length of 750 m at a maximum head of 30 m.

(5) Distribution piping is buried down below the frost line, to a minimum of 1.5 m, and the pipes must not deteriorate when in close proximity with commercial heating tape.

e. Equipment should be resistant to UV rays, fire, water, POL products, insects, animals, rot, mildew and corrosion.

f. Distribution may be either buried or surface laid, or may be by vehicle to individual storage tanks. Note that burial of lines does not necessarily protect them from mechanical damage. Attempts should still be made to prevent vehicles from driving over them.

g. Equipment used in the camps shall meet the principles of the Canadian Plumbing and Electrical Code and associated standards.

h. Electrical equipment must be equipped with automatic Ground Fault Circuit Interrupter.

METHOD		
Surface	**Advantage**	Fast, easy to layout Easier maintenance/ troubleshooting Easy recovery on a short deployment Easy to upgrade Visible
	Disadvantage	Subject to mechanical damage (vehicle, pedestrian, warfare) Exposed to elements (rain, snow, ice, UV light) Tripping hazards Shorter life expectancy Aesthetically less pleasing
Under–ground	**Advantage**	Aesthetically pleasing Mechanically and environmentally protected No tripping hazard Long life expectancy Can prevent freezing and/or overheating

METHOD		
	Disadvantage	Hard to recover and reuse Subject to accidental breaks from digging operations More time consuming to install Harder to do maintenance/troubleshoot
Vehicle Delivery to Tank	**Advantage**	Fast layout Easier maintenance/troubleshooting Less recovery required on redeployment Easy to upgrade Does not depend on pressurized lines Built-in redundancy
	Disadvantage	Labour/resource intensive throughout operation of system Tanks require routine maintenance to maintain water quality Space required at each facility for tank

Table 4-3: Water Distribution Options

WASTEWATER UTILITY SYSTEMS

27. **Introduction**. Quick and proper disposal of wastewater and other wastes is of primary concern for health and environmental protection purposes. Unsanitary conditions can quickly develop with flies, mosquitoes, and rodents soon overwhelming a deployed facility and spreading disease. Whenever possible, any waste disposal system should be compliant with Canadian federal environmental standards (refer to Annex A to Chapter 1). CETO C-98-15W-002/MG-007 *Wastewater Treatment Plants* may be consulted for additional information on wastewater treatment.

28. **Wastewater Sources**. Table 3C-2 contains detailed planning figures to estimate the quantity of wastewater generated in a given area. Note that a value of 2 to 3 may be used to convert from the average daily flow to the peak daily flow.

29. Wastewater must be treated to meet environmental restrictions (Chapter 2, Annex A). It may be classified as either black or grey water. Black water is sewage with a higher concentration of contaminates, usually originating from toilets, urinals or kitchens. Grey water has lower concentrations of contaminates and is associated with the waste from ablutions, showers, laundries or vehicle wash racks. As defined, the level of treatment for black water is greater than that required for grey. It is therefore possible to treat the two streams differently should this provide increased treatment efficiency or should this be necessary due to local conditions.

30. **General Rules for Provision of Field Expedient Sanitation**. The following rules should be observed in the provision of latrines and urinals:

a. All excavated latrines and urinals should be located such that they do not pollute a source of water supply. As a general rule, the bottom of any latrine trench or soakage pit should be at least 900 mm to 1200 mm above the ground water table, and 30 to 45 m down-grade from any well, spring or other surface water source. Other limitations include a minimum distance of 100 m from any kitchen. Under no circumstances should any sanitary appliance be drained into a dry well.

b. Grease traps/oil separators are required in order to prevent grease and oil from kitchens or maintenance shops from entering the wastewater disposal beds. Grease will slow the evaporation process, clog the soil and prevent the water from leaching into the soil. It will also provide food for insects. It is important to note that any grease trap should be of sufficient capacity so that hot, greasy water being added will not heat the cool water already present in the trap. Otherwise the grease will remain uncongealed and pass through the trap.

c. Medical and food preparation personnel require separate latrines to prevent the spread of diseases.

d. Hand washing facilities should be located between or adjacent to all latrines, especially those used by cooks and other food service personnel.

e. Particular care should be exercised to exclude and control flies as they are the major sources of disease related to waste water.

f. In standing camps, latrines should be clearly marked as such, provided with direction signs if necessary, and lighted at night if the tactical situation permits.

g. Floors of latrine structures should be kept dry, with duckboards and perimeter drainage being provided.

h. If latrines are roofed, the roof should slope sufficiently clear of the earth banking to prevent wash-outs in wet weather, with consequent loss of fly-proofing.

i. Closed urinals, latrines, soakage pits and refuse pits should be marked with a contaminated site sign.

31. **Initial Standard—Expedient Field Sanitation Methods**. For deployments utilizing initial standard accommodations, or during the early stages of temporary standard accommodation, expedient field methods may have to be used to dispose of wastewater. There are two sanitation design objectives required, the disposal of black water and the disposal of grey water, both of which are essential if disease-carrying flies are to be combated. The Medical Officer or representative is the immediate adviser on all matters relating to health and hygiene. Note that the use of existing Host Nation Support may greatly ease the task of wastewater disposal, though the method of treatment should be investigated to determine its suitability with respect to DND policy on compliance with Canadian environmental standards (see Annex A to Chapter 1). In cases where Host Nation wastewater systems are not available, use of a civilian contract to provide portable toilets and a pumping service may prove to be a preferred option. Again, however, the final treatment of this sewage must be investigated. The examples of expedient structures that follow conform to the principles of sanitation in the field.

32. **Shallow Trench Latrines**. Immediately after the camp site has been selected, the area for latrines, urinals, etc. must be marked out. The shallow trench latrine is an emergency type method and must not be used for more than two or three days. If the site is likely to be occupied longer, a more permanent type must be constructed. Trenches should be constructed in convenient locations at least 100 m from water supply and kitchens, preferably to leeward, and not in or near gullies. The scale of provision for three days should be:

a. first 100 personnel—5 trenches; and

b. additional 100 personnel—3 trenches.

33. Shallow trench latrines used at this scale should be filled in after 24 hours use. Ground allocated for latrines should be such that during the three days, space is available for three different sets of shallow trench latrines. A suitable type of shallow trench latrine is shown in Figure 4-1. A movable screen to surround the set of trenches in use should be provided.

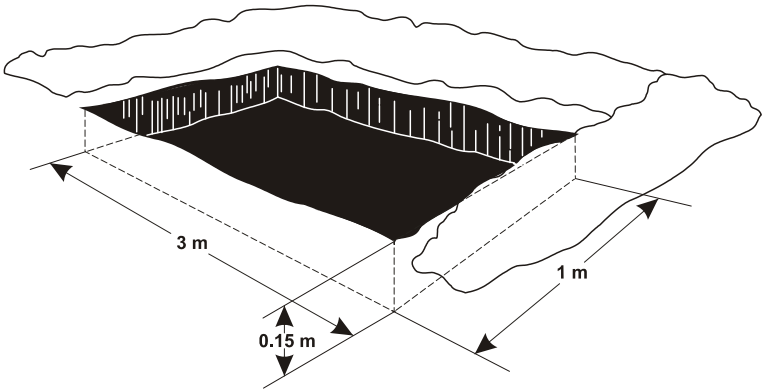

Figure 4-1: Shallow Trench Latrine

34. **Straddle Trench Latrine**. A number of urinals will be required so that there can be no excuse for promiscuous fouling of the ground. One should be sufficient for every 250 men. This latrine consists of trenches dug 0.3 m wide, 0.8 m deep and 1.2 m long. Earth removed is piled to the side of the latrine and used to cover the excreta. The latrine must be filled and abandoned once the holes have been filled to within 0.3 m of the surface. Because of the lack of privacy and crudeness this type of latrine might not be acceptable.

Also, in sandy soils it may be difficult to establish trenches of sufficient depth while maintaining the narrow width. This type of latrine should be considered only as a last resort measure. An example of the straddle trench latrine is shown in figure 4-2. Again, a distance of at least 100 m should be maintained from water supplies and kitchens.

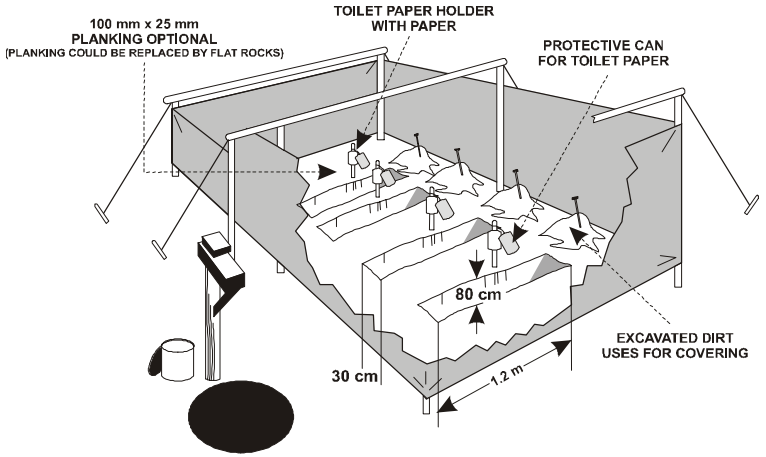

Figure 4-2: Straddle Trench Latrine

35. **Burnout Latrine**. A simple and effective latrine to construct using a 45-gallon drum, it provides ease of construction, portability and maintenance. This is one of the best expedient latrines to use in field conditions. Average use can be estimated at 14 persons/can, with average fuel consumption at 0.5 l/person/day. The average life expectancy of each can is 90 days. A simple burnout latrine is shown in the following figure:

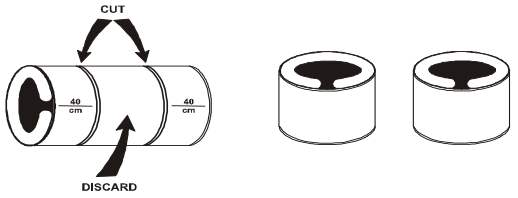

Figure 4-3: Burnout Latrine

36. **Temporary Standard**. Six methods of treating wastewater for temporary standard accommodations are outlined below: dry latrine, holding tank, septic tank, septic field, sewage lagoon, and relocatable sewage treatment plants. As with initial standard accommodations, the use of existing Host Nation facilities may be a preferred option should this satisfy DND policy regarding compliance with Canadian environmental standards (see Annex A to Chapter 1).

37. **Option analysis**. The following table indicates advantages and disadvantages of the various wastewater treatment/disposal methods:

METHOD	TREATMENT STANDARD		
Dry Latrine (Soak Pit)	None	Advantage	Expedient Low construction cost Simple technology Little maintenance Short construction time
		Disadvantage	Site contamination Strong odours Soil conditions may prevent Aquifer conditions may prevent Cell can fill
Holding Tank	Primary	Advantage	Expedient Low construction cost Simple technology Flexible in sizing tanks
		Disadvantage	Regular emptying of tanks required Quality of final effluent controlled by contractor Strong odours Affected by climatic conditions Soil conditions may prevent Tank must be removed upon closure

METHOD	TREATMENT STANDARD		
Septic Tank (must be used in combination with Septic Field)	**Primary**	**Advantage**	Low construction cost Simple technology
		Disadvantage	Soil conditions may prevent Aquifer conditions may prevent High bacterial counts in effluent Periodic emptying of sludge required Strong odours
Septic Field	**Secondary**	**Advantage**	Simple technology Little odour Little maintenance Bacterial counts in effluent Capable of shock loading
		Disadvantage	Large area required for field Soil conditions may prevent Aquifer conditions may prevent Heavy equipment required to construct
Sewage Lagoon	**Secondary**	**Advantage**	Simple technology Variable loading possible Little maintenance
		Disadvantage	Algae and bacteria counts in effluent Heavy equipment required to construct Liner required to prevent leaching Strong odours Large area required for 30 day retention
Packaged Plant	**Secondary**	**Advantage**	May be little maintenance depending on plant Little odour May be capable of shock loading (activated sludge, proteus)

METHOD	TREATMENT STANDARD		
		Disadvantage	May require labour intensive operation (activated sludge) May require skilled operator May not handle shock loads (attached culture, extended aeration) Sludge disposal may be required

Table 4-4: Wastewater Treatment Options

38. **Dry Latrine**. A dry latrine is simply an open pit with a structure constructed over it. Dry latrines are both the easiest form of wastewater disposal to construct and the least efficient. As with initial standard methods, dry latrines should be constructed at least 100 m from a water supply or a kitchen

39. **Holding Tank**. Holding tanks are large fibreglass or concrete tanks with a wooden or concrete block structure constructed over them to house the toilets. The capacity of the tank depends upon projected use and can be of any size. A local contractor is normally hired to pump out the tank. Tanks can be placed in remote locations and do not require water to operate. Odour and insect problems can occur, though they may be controlled with the addition of an aeration system and tank venting. The highly concentrated liquid waste can also be a shock load on a sewage treatment plant. Approximately once a year the tank should be cleaned to eliminate the solid waste build up from the walls. This may be done using a pressure washer on a vacuum truck.

40. **Septic Tank**. A septic tank is a watertight covered receptacle in which sewage is converted into sewage effluent by containing and ensuring the anaerobic digestion of all solid waste. As the tank does not provide secondary treatment, the effluent should receive additional treatment. Usually this is in the form of a septic field. Septic tanks should have a set-back of 15 m from any surface water, and 8 m from any well.

41. **Septic/Leaching/Tile Field**. A septic field is used in conjunction with a septic tank. Consisting of lines of perforated pipes or tiles laid in the ground, it distributes settled wastewater over a large area and allows it to naturally decompose in the environment. The

following conditions are important in the proper operation of a septic field:

a. Groundwater should be well below the pipe/tiles.

b. Subsurface drainage should be away from the field.

c. The field should be constructed away from wells used for drinking water.

d. Adequate soil must exist within 500 mm of surface and extending below pipe/tile for several metres, with size of field determined as follows (see CETO C-98-15W-002/MG-007):

(1) Dig pit to intended depth of burial of pipe/tile (usually 450 to 735 mm below surface).

(2) Dig test hole 300 by 300 mm and 450 mm deep.

(3) Fill hole to depth of 150 mm with water, allow to drain.

(4) Fill with another 150 mm of water and allow to drain to 125 mm depth. Time this rate to drain 25 mm of water.

Time for Water to Drain 25 mm (minutes)	Allowable Rate of Wastewater Application (l/m^2/day)
1	193
2	154
5	116
10	82
30	39
over 30	not suitable for field

Table 4-5: Water Percolation Rate Calculation

42. **Sewage/Stabilization Lagoon**. Sewage lagoons are shallow ponds that provide long detention of wastewater flows, usually 20 to 120 days, during which time decomposition of wastewater takes place

under aerobic and anaerobic conditions. The degree of stabilization produced in a lagoon is significantly influenced by the climatic conditions. During warm, sunny weather the decomposition is rapid, resulting in quick and complete stabilization of waste organics.

CAMP/BASE SIZE (number of personnel)	NUMBER OF LAGOONS	SIZE OF LAGOON (m x m)
750	1	33 x 33
1500	2	33 x 33
2250	3	33 x 33
3000	1	60 x 60
3750	1 1	60 x 60 45 x 45
4500	1 1	60 x 60 45 x 45
5250	1 1	60 x 60 45 x 45
6000	2	60 x 60

Table 4-6: Lagoon Requirements

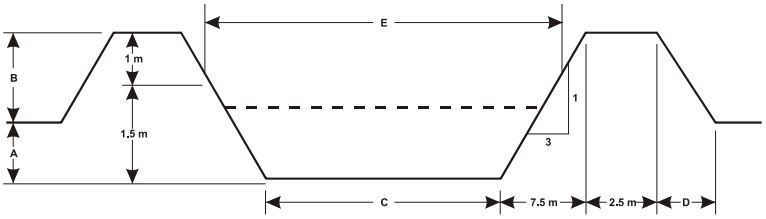

Figure 4-4: Lagoon Construction Details

LAGOON SIZE	A (m)	B (m)	C (m)	D (m)	E (m)
33 m^2	1.4	1.1	24	3.2	33
45 m^2	1.2	1.3	35	3.9	45
60 m^2	1.0	1.5	52	4.5	60

Table 4-7: Lagoon Construction Details

43. **Package Plant/Relocatable Sewage Treatment Plants**. For temporary standard accommodations the design guidelines for acquisition of portable treatment plants are as follows:

a. the system must be designed to operate individually, or in parallel with additional plants, with no degradation in performance;

b. each plant must have the capability to treat and dispose of grey and black water produced by 250 personnel per day including hygiene, cooking, and wash water for clothes and dishes;

c. the system should be gravity fed;

d. the system must meet all relevant Canadian federal environmental regulations; and

e. the structure and ancillary equipment must be capable of withstanding the elements with no deterioration or loss of function.

44. **Effluent Discharge**. Following treatment by a lagoon or packaged plant, the treated effluent must be released to the environment. This may be to a receiving stream, through land spray, or by use of an evaporation lagoon. In releasing to a stream, downstream users of the stream should be considered to ensure that the release has no detrimental effect on their normal way of life. Land spray will require contract support for equipment similar to that used in agricultural spray irrigation. Current and future use of the land must also be considered, as should the potential for contamination of

groundwater. In the case of either release to a stream or land spray, proper chlorine residual must be maintained. Evaporation lagoons may prove efficient in areas where evaporation rates are high or adequate space is available. Evaporation rates around the world may vary from 50 to 300 cm per year—meteorological services may be consulted for the rates at a given site. Note that evaporation lagoons require significant construction and land used will require testing following the deployment.

SOLID WASTE DISPOSAL

45. Solid waste must also be collected and disposed of. The average production of solid waste is shown in Table 3C-3 (these figures do not take into consideration recycling). There are several methods of solid waste disposal. As with wastewater treatment, the preferred method would have the solid waste from either type of deployed camp removed and deposited using either Host Nation landfills or a civilian contractor. In both cases, whenever possible, disposal methods should meet all relevant Canadian and local regulations (see Annex A of Chapter 1). In the event Host Nation or contract support is not available, consideration must be given to burial in a landfill. In some regions of the world, solid waste produced by Canadians may be considered a valuable commodity by the local populace. This may affect the method of disposal or may result in security concerns.

46. Figure 4-5 shows a typical trench method of landfill operation. A dozer digs a trench (preferably perpendicular to the prevailing wind), then waste is dumped into it and spread and compacted by the dozer. At the end of each day the dozer will cover the waste with 150 mm of soil. As the trench is abandoned, it should be covered with 0.75 m of final soil cover and its boundaries marked. If the site soil is porous, it will be necessary to seal the bottom and sides of the trench to prevent contamination of the surrounding area. A commonly used sealing agent is bentonite clay or flexible geo-membrane materials.

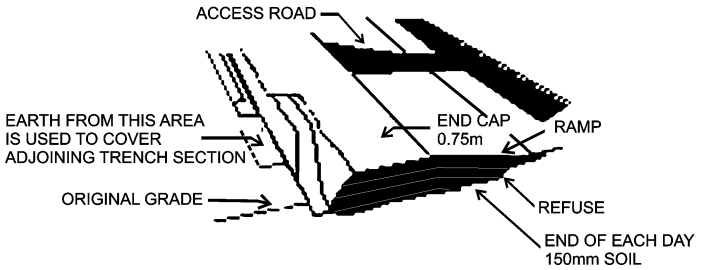

Figure 4-5: Typical Sanitary Landfill Site

47. To minimize the potential for underground pollution the following steps should be followed:

a. The landfill should not be constructed on exposed rock outcrops. A minimum of 10 m of clay overburden must be present between any exposed rock strata and refuse, and all landfills must be located a minimum of 150 m from any wells.

b. Garbage and refuse should not be placed in any mines or other areas where resulting seepage or leaching may carry waste to water bearing strata or wells.

c. The landfill should be located in an area of stable soil to avoid the natural elements removing the covering soil and exposing the waste.

HAZARDOUS WASTE DISPOSAL

48. Specialist designers are required to provide field deployable hazardous waste disposal sites/capability for either type of deployed accommodation. These systems must be designed to store and dispose of waste POL, non-POL or biological hazardous liquid wastes, and hazardous solid waste. Note that the disposal of biomedical waste remains the responsibility of the Field Surgical Hospital and Field Ambulance. Hazardous material must not be disposed of in landfill sites. Any equipment designed or purchased should have the following components or meet the following guidelines:

a. **Waste POL Storage**. A waste POL storage reservoir shall provide the ability to safely store and transport waste POL products from the source to a disposal site.

b. **Non-POL Liquid and Solid Waste Hazardous Waste**. A hazardous waste container used to store, neutralize/stabilize and prepare for shipment or disposal.

c. **Incinerator**. A hazardous material incinerator capable of safely incinerating all potential waste products.

d. Equipment and disposal methods should, whenever possible, meet all relevant Canadian, coalition and local regulations (see Annex A to Chapter 1).

HVAC AND REFRIGERATION

49. Heating, cooling and refrigeration are required for:

a. Maintaining environmental conditions within quarters, offices, workshops, etc. to ensure the survival and/or comfort of personnel.

b. Heating of water for hygiene/laundry use.

c. Creation of ice for use by food services, graves registration, etc. Values required may be calculated per Table 3C-4.

50. In the case of heating facilities used by personnel, attempts should be made to meet minimum and maximum temperatures as outlined below (based on the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) standards and the DGSP Base Service Index):

Facility Use	Temperature Range (^{o}C)		Humidity (%)
	Minimum	Maximum	
Accommodations, Winter	20	23.5	60
Accommodations, Summer	23.5	27	60
Office/Administration	18	22	60
Garage/Workshop/ Hangar	17	20	60
Storage where personnel are employed for short periods or where stored materials require protection from freezing	9	---	---

Table 4-8: Heating/Cooling/Humidity Ranges

51. Water temperature for showers and washing should be maintained between 43^{o}C and 60^{o}C. In all cases, operational necessity and available resources will have priority over the comfort of personnel for both air and water temperatures**.**

TEMPORARY DEPOTS MUNITIONS

52. **Introduction**. The construction of temporary depots for munitions (TDMs) in theatres of operation is a complex engineering task subject to considerable regulation and safety requirements. The successful design of these facilities requires a close working relationship with Director Ammunition Program Management (DAPM) Operations and Policy staff to ensure safe and certifiable facilities are constructed. This section of the manual provides a brief overview of the authorities, design process and construction considerations related to TDM construction. Engineers shall refer to the Canadian Forces publication C-09-153-001/TS-000 *Explosives Safety Manual* if they are engaged in TDM construction. The manual

provides considerable detail and specifications related to TDM design and construction.

53. **Authorities and Regulations**. The construction and operation of ammunition facilities, TDMs and explosive storage sites are regulated in accordance with the *Explosives Safety Manual*. DAPM is the only authority that may certify and authorize the use of ammunition facilities, TDMs and explosive storage sites. Engineers must ensure that they involve DAPM staff early in the design process to ensure compliance with regulations. DAPM also provides considerable advice and expertise on the layout, siting and construction of these facilities. Due to operational circumstances, it is often not possible to satisfy all specifications in the *Explosives Safety Manual*. A ministerial waiver is issued to cover TDMs that are noncompliant due to operational conditions.

54. **Construction and Siting**.

a. **Siting and Quantity Distances**. The choice of a site for a TDM is subject to varying circumstances and considerations. Every effort shall be made to select a location which meets conditions set out in the *Explosives Safety Manual*. TDMs present an obvious risk to personnel and property. Such sites shall be located at carefully calculated distances, known as Quantity-Distances, from each other and from other buildings and installations to ensure the minimum practicable risk to life and property. Detailed instructions for determination of Quantity-Distances and the principles involved are provided in the *Explosives Safety Manual*. A minimum protective zone of 400 m around TDMs is required. Greater protective zones are often required and are dependent on munitions stored and the vulnerability of surrounding facilities.

b. **Extent of Site**. The extent of the site will be governed by the number of magazines and workshops, explosive capacities and the Quantity-Distance requirements. A large site to permit future expansion should be selected.

c. **Outside Hazards**. Ammunition depots and ammunition facilities shall not be located close to potential sources of danger. Therefore, their locality shall be:

(1) remote from factories engaged in the manufacture of ammunition and explosives;

(2) clear of electric power lines;

(3) free from electric generating stations and high powered radio stations;

(4) free from volatile carbon fuel storage installations and pipelines; and

(5) remote from airfields as specified.

d. **General Layout**. An ammunition depot consists of three principal areas:

(1) an explosives area, which shall be enclosed by a fence and may contain magazines, workshops and laboratories;

(2) a destruction area, which should be enclosed by a fence; and

(3) an administration area, which need not be enclosed by a fence and may contain offices, barracks, engineering workshops and garages.

e. **TDM Construction Details and Generic Designs**. The *Explosive Safety Manual* provides considerable material and construction specifications for ammunition storage facilities. Designers should make efforts to comply with these details, however, they are often not practical or possible in austere operational areas. 1 Engineer Support Unit can develop or provide a template for designers engaged in similar projects.

55. **Grounding Requirements**. There are five types of grounding systems at ammunition facilities:

a. **Lightning Protection Ground System**. The purpose of the lightning protection ground system is to maintain the entire ammunition storage or processing facility at one potential to minimize the chance of arcing between metal objects in the facility and to provide a low impedance path to ground for lightning strikes. The resistance of the lightning ground system to earth shall be less than 10 ohms, and the resistance of any metallic component to the lightning ground system shall be less than 1 ohm. For detailed information on lightning protection and grounding installations, see C-98-016-001/DD-*001 Lightning Protection for Explosives Buildings and Lightning Protection Guidelines for DND Critical Buildings*.

b. **Power Ground System**. The purpose of the power ground system is to assure that hazardous potentials do not develop on electrical equipment. It prevents arcing between separate items of electrical equipment due to voltage arising from electrical faults, prevents electric shock hazards to personnel and protects the equipment from over voltage. The basic requirements for power grounding systems are contained in the Canadian Electrical Code.

c. **Static Ground System**. The purpose of the static ground system is to eliminate electric discharges due to static electric charge buildup. The system conducts the charge to ground as rapidly as it is generated. Examples of segments of the static ground system are conductive floors, conductive table tops and ground grab bars. The static ground system shall be connected to the ground girdle (counterpoise), and it shall not be connected directly to gas, steam or air lines, dry sprinkler system piping or lightning down conductors.

d. **Ordnance Ground System**. The purpose of the ordnance ground system is to ensure that electric

currents do not flow between ordnance components when they come in contact or are mated.

e. **Instrumentation Ground System**. The purpose of the instrumentation ground system is to provide error free operation of sensitive electronics instrumentation.

The lightning protection ground system is required at TDMs. The requirement for the static ground system, the ordnance and instrumentation ground system will depend on specific circumstances, but they are generally not installed in temporary facilities. It is recommended that power systems are not installed in TDMs due to costs associated with their specialized construction and the associated power ground system requirement.

56. **Design Process**. The design of TDMs must be undertaken with DAPM input and support. Some of the principal components in the TDM design process are outlined as follows:

a. Determine the maximum types of ammunition and explosives that will be required for the mission. These must be classified by nature, quantity, hazard division and compatibility groups.

b. Determine how many sea containers are required based on storage by sub-unit allocation and by compatibility groups. Additional containers for storage, aids to production, etc. must also be considered.

c. Determine requirements for supporting facilities such as administration areas, alarms, communications, security lighting and perimeter fencing.

d. Determine if sea containers will be separated by inter-quantity (inter-magazine) distances or grouped together and treated as one magazine.

e. Determine berm and/or hesco bastion barricade requirements applying the 2-degree rule.

f. Determine the exterior quantity-distances based on the maximum proposed net explosives quantity (NEQ) (assessing for Hazard Division 1.1) for either individual sea containers or the total NEQ for the grouped configuration.

g. Design TDM layout taking into consideration the interior and exterior quantity-distance and the area required to operate heavy fork lifts, trucks and other vehicles within the ammunition storage area.

h. Design earthworks for drainage, foundations, in and out routes and blast walls.

i. Design lightning and grounding protection.

57. The standard TDM design is usually based on 2:1 hesco bastion (or equivalent) configuration on all sides of the sea containers (less door way) with minimum 50 cm clearance from sea container walls to hesco bastions. Overhead cover should be designed to resist the assessed threat. The cover should be structurally supported and not bare on sea containers. Blast walls are set back from the open side of the sea container. The set back must be sufficient to allow for material handling and traffic flow. Ideally, doors of sea containers must be able to open to 180 degrees to facilitate use of heavy lift equipment. Refer to 1 Engineer Support Unit for design examples and templates.

POL STORAGE AND DISTRIBUTION

58. Design and procurement of a bulk POL storage and distribution system for temporary standard accommodations should meet the following detailed design guidelines:

a. The system should be designed to permit a decrease or increase in holding capacity.

b. Storage tanks should be based on a system of flexible bladders.

c. Each flexible bladder must be contained in a fuel resistant dyke which can be emptied of rain water for fuel. The dyke must be capable of containing 110% of the contents of the bladder.

d. The distribution system should be able to pump and filter (5 micron) POL products at 500 l/min from a POL bowser parked within 100 m or from 500 l drums located within 100 m.

e. The system should be capable of distributing to refuelling tenders located up to 100 m away, and must be capable of filling one bowser using a high volume nozzle or resupplying four vehicles at a time using low pressure nozzles.

f. Equipment must meet all relevant Canadian environmental regulations.

g. The primary method of powering the pumps must be electric, and meet the standard established for the electrical distribution system.

h. All components of the system must meet POL handling safety standards.

59. Additional information on POL storage and distribution may be found in CETOs C-98-15F-001/DD-001 *Design Criteria Fuel Facilities*, C-98-15F-MIS/TP-012 *Bulk Fuel—Installation and Maintenance Practices*, and C-98-15F-003/MS-022 NATO *Standard for the Maintenance of Fixed Aviation Fuel Receipt Storage and Dispensing Systems*.

FIRE PROTECTION

60. The fire fighting plan and procurement of fire fighting resources must meet the detailed design guidelines within LFCO 11-40 *Fire Safety, Field Exercises*. In accordance with this

document, the following are salient points related to the overall design of the camp:

a. Fire points containing fire fighting equipment, i.e. pumps, hoses, nozzles, extinguishers, axes and any other pertinent tools to combat fires, should be distributed throughout the camp in highly visible locations.

b. External audible alarms to sound in the event of fire shall be set up at locations in and around the camp.

61. Water required for fire fighting purposes is dependent on the construction materials used within the camp, as well as resources available to fight the fire. DND fire services personnel must calculate exact quantities required. The camp site plan must be reviewed by fire services personnel to ensure it is in accordance with both DND fire protection policy and the *National Fire Code*.

62. Final authority for any decision related to fire safety is the Canadian Forces Fire Marshall.

DESIGN STANDARDS

63. **Structural Design and Assessment**. The analysis, design and assessment of structures must be completed using basic civil engineering principles and be based on the specifications outlined in appropriate codes that cover the following subjects:

a. *National Building Code*;

b. wood design and analysis;

c. reinforced concrete design and analysis; and

d. structural steel design and analysis.

64. Structural design and assessment must strive to meet the principles of all associated codes and standards.

NATIONAL BUILDING CODE

65. The *National Building Code* specifies minimum regulations for public health, fire safety and structural sufficiency with respect to the public interest. It establishes a standard of safety for the construction of buildings, including extensions or alterations, the evaluation of buildings undergoing a change of occupancy, and upgrading of buildings to remove an unacceptable hazard. It is not intended to be a textbook on building design.

66. Sections of the Code that must be considered for all deployed accommodations are:

a. **Fire Protection, Occupant Safety and Accessibility**. The *National Fire Code* (NFC) and the *National Building Code* must both be considered in building design, construction and maintenance. The later establishes a standard of fire safety for the construction of new buildings and the reconstruction of buildings, including extensions and alterations. The NFC establishes a standard for fire prevention, fire fighting, and life safety in buildings in use.

b. **Structural Design**. This part of the *National Building Code* deals with the loads to be used in design and assessment calculations, and the design methods to be followed. Also included are standards to regulate foundation design and construction, and the design requirements for materials. To correctly apply the structural design requirements of the Code, the climatic loads to be expected in all parts of Canada are required to provide specific values. When deployed accommodations are required outside the territorial limits of Canada, two options are available: the general climatic conditions for the area of operations may be correlated to a similar location in Canada such that the appropriate climatic values may be obtained and the Code applied to the design or assessment; or, meteorological services may be consulted in order to obtain design values similar to

those shown in the Code. The following climatic elements have been tabulated in the Code:

(1) **January Design Temperature**. A building and its heating system should be designed to maintain the inside temperature at a pre-determined level. To achieve this the most severe weather conditions the system will function under must be known. In Canada, the January design temperature is considered to be the lowest temperature encountered. For the design of deployed accommodations within Canada the 2.5% January temperature is the value to be used in the design of heating systems. Outside Canada, the design temperature should be based on the coldest month for that particular area.

(2) **July Design Temperature**. A building and its cooling and dehumidifying systems should be designed to maintain the inside temperature and humidity at pre-determined levels. The July design temperature is the highest outside temperature that could possibly occur in Canada. For the design of accommodations outside of Canada, the design temperature should be based on the hottest month for that particular location. Wind and solar radiation also affect the inside temperature of most buildings and may, in some cases, be more important than the outside air temperature.

(3) **Rainfall Intensity**. Roof drainage systems are designed to carry off the rainwater from the most intense rainfall that is likely to occur. A certain amount of time is required for the rainwater to flow across and down the roof before it enters the gutter or drainage system. Therefore, the drainage system needs to cope with the flow of

rainwater produced by the average rainfall intensity over a period of a few minutes. The 15-minute rainfall is the standard used in Canada and it is expected that this value will only be exceeded once in every ten years.

(4) **Annual Total Rainfall**. The total amount of precipitation that normally falls in one year is used as a general indication of the wetness of a climate.

(5) **Snow Loads**. The roof of a building should be able to support the greatest weight of snow that is likely to accumulate on it most years. The calculation of the design snow load on a roof involves the depth of snow on the ground that has an annual probability of once every 30 years. The heaviest loads frequently occur when the snow is saturated by rain, thus the rain load must be included. Values of the rain load, when added to the snow load, provide a 1 in 30 year estimate of the combined ground snow and rain load.

(6) **Wind Effects**. All structures need to be designed to ensure that the main structural system and all secondary components, such as cladding and appurtenances, will withstand the pressures and suctions caused by the strongest wind likely to blow at that location in most years. When designing deployed accommodations the design hourly wind pressure value to use is the value that has a 10% probability of being exceeded in 10 years.

(7) **Seismic Zones**. The parameters used in establishing the seismic zones are the ground acceleration and ground velocity that have a 10% probability of being exceeded in 50 years.

c. **Environmental Separation**. This part of the Code provides criteria for the design and construction of building elements that separate environments that differ. These include elements that separate conditioned interior spaces from exterior spaces. The requirements address the control of condensation, the control of heat, and air and moisture transfer.

d. **Heating, Ventilation and Air-Conditioning (HVAC)**. This part of the Code is concerned with the effective and safe functioning of HVAC equipment installed in a building.

e. **Housing and Small Buildings**. This part of the Code provides detailed requirements for the design, assessment and construction of houses and small buildings up to 600 m^2 per floor and three storeys high, and applies to all occupancies except assembly, care or detention, and high hazard industrial.

WOOD DESIGN AND ANALYSIS

67. The design and assessment of structural wood is based on CSA Standard CAN/CSA-086.1-M89, *Engineering in Wood* (Limit States Design). The standard provides criteria for the structural design and appraisal of structures or structural elements made from wood or wood products including graded lumber, glued-laminated timber, unsanded plywood, composite building components, shear walls and diaphragms, piling, and structural fastenings. In the design and construction of deployed accommodations either select structural or No 1 grade lumber is to be used.

REINFORCED CONCRETE DESIGN AND ANALYSIS

68. The design of reinforced concrete is based on CAN/CSA Standard A23.3-M94, *Design of Concrete Structures*. The standard provides requirements for the design and strength evaluation of building structures of reinforced and prestressed concrete in

accordance with the *National Building Code*. The design and control of concrete mixtures will be done in accordance with CAN/CSA Standard A23.1-M94, *Concrete Materials and Methods of Concrete Construction*.

69. **Cement**. Different types of Portland cement are manufactured to meet different normal physical and chemical requirements for specific purposes. The following types of cement and admixtures can be used in the construction of deployed accommodations:

a. **Type 10 Normal Portland Cement**. Type 10 cement is a general purpose cement which is suitable for all uses where the special properties of other types of cement are not required. It is used where the cement or concrete is not subject to specific exposures, like sulphate attack from soil or water. It is used in pavements and sidewalks, floors, reinforced concrete buildings, bridges, railway structures, culverts and pipes.

b. **Type 20 Moderate Portland Cement**. Type 20 cement is used where precaution against moderate sulphate attack is important, as in drainage structures where sulphate concentrations in soils and ground waters are higher than normal but not unusually severe.

c. **Type 30 High-Early Strength Portland Cement**. Type 30 cement provides high strengths at an early period, usually less than a week. It is used when forms are to be removed as soon as possible or when the structure must be put into service quickly. In cold weather, its use permits a reduction in the curing period.

d. **Type 40 Low-Heat of Hydration Portland Cement**. Type 40 cement is used where the rate and amount of heat generated must be minimized. It develops strength at a slower rate than Type 10 cement, and it is intended for use in massive concrete structures.

e. **Type 50 Sulphate-Resistant Portland Cement**. Type 50 cement is used only in concrete exposed to severe sulphate action. It is used principally where soils or ground waters have a high sulphate content. It gains strength more slowly than Type 10.

f. **Air-Entraining Admixtures**. The addition of air entraining admixtures produce concrete with improved resistance to freeze-thaw action and to scaling caused by chemicals applied for snow and ice removal. Such concrete contains minute, well-distributed, and completely separated air bubbles.

70. Standard practices in concrete design and specification for deployed accommodations should be based on Type 10 Normal Portland Cement at a specified compressive strength of 25 mPa. In cold weather below 10^{o}C use Type 30 Portland Cement or richer mixtures of Type 10 mixed with an air entrainment admixture.

71. **Reinforcing Steel**. Requirements for concrete reinforcing steel are given in CAN/CSA Standard A23.3-M94, *Design of Concrete Structures*. The primary requirement for reinforcing steel bars is expressed as minimum specified yield strength (grade). Reinforcing bars are classified into three grades based on minimum specified yield strength: 300, 350, and 400 mPa. Grade 400 reinforcing bars are the most frequently used type of reinforcement and should be used when designing reinforced concrete for deployed accommodations.

STRUCTURAL STEEL DESIGN AND ANALYSIS

72. The design of buildings and their structural members made of structural steel shall conform to CSA Standard CAN/CSA-S16.1-94, *Limit States Design for Steel Structures*. The standard provides rules and requirement for the design, fabrication and erection of steel structures for buildings. The term “steel structures” relates to structural members and frames that consist primarily of structural steel components, including welds, bolts or other fasteners required in fabrication and erection.

CANADIAN ELECTRICAL CODE

73. Design of electrical systems and their components shall conform to the most recent edition of the *Canadian Electrical Code*.

NATIONAL FIRE CODE

74. Design shall conform to the most recent edition of the *National Fire Code*.

ANNEX A
SOIL CHARACTERISTICS—GRAVEL AND GRAVELY SOILS

Ser	Group Symbol	Description	Value as foundation when not subject to frost action	Value as base directly under bituminous surfacing	Potential Frost Action	Drainage Characteristics	Suggested Compaction Equipment	Dry Density kg/m^3	CBR
(A)	(B)	I	(D)	(E)	(F)	(G)	(H)	(I)	(J)
1	GW	Well graded gravels, gravel-sand mixtures, little or no fines	Excellent	Good	None to very slight	Excellent	Vibrating roller	2000–2240	60–80
2	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Good to excellent	Poor to fair	None to very slight	Excellent	Smooth wheel roller	1760–2080	25–60
3	GMd	Silty graves, gravel-sand-silt mixtures	Good to excellent	Fair to poor	Slight to medium	Poor to fair	Grid roller	2080–2320	40–80
4	Gmu	Silty graves, gravel-sand-silt mixtures	Good	Poor	Slight to medium	Practically impervious		1920–2240	20–40
5	GC	Clays gravels, gravel-sand-clay mixtures	Good	Poor	Slight to medium	Practically impervious		1920–2240	20–40

Table 4A-1: Soil Characteristics—Gravel and Gravelly Soils

Ser	Group Symbol	Description	Value as foundation when not subject to frost action	Value as base directly under bituminous surfacing	Potential Frost Action	Drainage Characteristics	Suggested Compaction Equipment	Dry Density kg/m^3	CBR
1	SW	Well graded sands, gravelly sands, little or no fines	Good	Poor	None to very slight	Excellent	Vibrating roller, pneumatic tire roller, smooth wheel roller	1760–2080	20–40
2	SP	Poorly graded sands gravelly sands, little or no fines	Fair to good	Not suitable to poor	None to very slight	Excellent		1600–1900	10–25
3	SMd	Silty sands, sand-silt mixtures	Good	Poor	Slight to high	Poor to fair	Light vibrating roller	1920–2160	20–40
4	Smu	Silty sands, sand-silt mixtures	Fair to good	Not suitable	Slight to high	Practically impervious to poor		1680–2080	10–20

Table 4A-2: Soil Characteristics—Gravel and Sandy Soils

Ser	Group Symbol	Description	Value as foundation when not subject to frost action	Value as base directly under bituminous surfacing	Potential Frost Action	Drainage Characteristics	Suggested Compaction Equipment	Dry Density kg/m^3	CBR
1	ML	Inorganic silts and very fine sands, rock flour, silty or clayey silts with slight plasticity	Poor to fair	Not suitable	Medium to very high	Poor to fair	Grid roller, pneumatic tire roller	1600–2000	5–15
2	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clays	Poor to fair	Not suitable	Medium to high	Practically impervious	Smooth wheel roller	1600–1900	5–15
3	OL	Organic silts, organic silty clays of low plasticity	Poor	Not suitable	Medium to high	Poor	Pneumatic tire roller, difficult to compact	1440–1680	4–8

Table 4A-3: Soil Characteristics—Silts and Clays (Liquid limit less than 50)

Ser	Group Symbol	Description	Value as foundation when not subject to frost action	Value as base directly under bituminous surfacing	Potential Frost Action	Drainage Characteristics	Suggested Compaction Equipment	Dry Density kg/m^3	CBR
1	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Poor	Not suitable	Medium to high	Poor to fair	Grid roller, pneumatic tire roller	1280–1600	4–8
2	CH	Inorganic clays of high plasticity, fat clays	Very poor to poor	Not suitable	Medium	Practically impervious	Pneumatic tire roller	1440–1760	3–5
3	OH	Organic clays of medium to high plasticity, organic silts	Very poor to poor	Not suitable	Medium	Practically impervious	Pneumatic tire roller, difficult to compact	1208–1680	3–5
4	Pt	Peat and other highly organic soils	Not suitable	Not suitable	Slight	Poor to fair	Compaction not possible		

Table 4A-4: Soil Characteristics—Silts and Clays (Liquid limit 50 or greater) and Highly Organic Soils

ANNEX B
ROAD PLANNING SEQUENCE

Serial	Stage	Hasty construction of temporary roads	Improvement of existing roads
1	**Preliminary**	a. Ensure that user requirements are clearly specified, especially: (1) tactical or admin limitations on the general alignment; (2) load class of vehicles; (3) number of traffic lanes; (4) permissible relaxation of normal standards; and (5) life of road. b. Study existing maps, air photos, and available information. c. Assess the engineering factors that may affect the alignment. d. Select, in order of merit, alternative alignments that meet all the limitations and estimate the number of bridges/culverts required in each case. e. Check the availability of: (1) plant; (2) labour; and (3) construction materials. f. Determine time available	a. Determine aim e.g. remove bottlenecks, increase capacity, increase load class, improve weather resistance. b. Study road plan if available, and existing maps and air photos, to locate bottlenecks, major damage, badly drained areas and possible detours. c. Obtain available information about present load class of individual bridges and culverts.
2	**Initial recce**	a. Air recce, preferably by helicopter, of alternate routes. b. Hasty ground recce of first choice of alignment, to check: (1) nature of earthwork; (2) soil strength (field test); (3) gradients; (4) siting of culverts and main drainage plan; and (5) potential quarries, gravel pits, and borrow areas c. Select access routes for plant.	a. Recce (preferably air) to: (1) check traffic flow and bottlenecks; (2) establish priorities; (3) locate detours; and (4) find access routes for plant. b. Study surface condition, to determine most urgent tasks, and to assess over-all resources required. On unpaved roads soil samples should be taken as a basis for design.
3	**Route Selection**	In hasty work, this is normally done at Stage 2, as comparison of alternative solutions.	a. Select detours to bypass obstacles or reconstruction work. b. If necessary, re-align the road where bad bends or steep gradients must be eliminated. c. Give consideration to one-way traffic circuits.

Serial	Stage	Hasty construction of temporary roads	Improvement of existing roads
4	**Detailed recce and soil survey**	Not applicable unless the road is scheduled for later development. Work is normally combined with field location or setting out, but some re-alignment may be necessary to avoid unexpected bad areas. If future development is proposed take soil samples.	a. Proposed re-alignments and detours must be examined in detail, to establish feasibility and determine resource requirements. b. Check width and strength of bridges and culverts, and estimate requirements for any necessary reconstruction. c. Examine the route in detail and prepare a schedule of work showing priorities, with estimates of requirements for: (1) widening; (2) drainage improvements; (3) pavement repair; and (4) resurfacing. d. Select access and haul routes, and stores dumping areas.
5	**Design**	a. Based on sub-grade material decide the total thickness of base and sub-base required; and (1) choose the type of base and surface courses, depending on resources available; or (2) Select the type of prefabricated or improvised surfacing to be used as a temporary expedient. b. calculate volume of water to be discharged from each catchment area; (3) determine sizes and shape of side drains; and (4) determine sizes of culverts and outfalls.	a. The restoration or strengthening of the road may involve: (1) patching; (2) surface dressing; (3) laying of a new surface course; or (4) complete redesign and construction of a new base, sub-base and surface.
6	**Planning**	a. Prepare job list. b. Prepare works program (CPM). c. Prepare: (1) plant schedule; (2) labour schedule; (3) stores and material schedule; and (4) transport schedule. d. Ensure: (1) responsibilities are clear; (2) plant, transport, and supplies are delivered by phase; and (3) good communications are available.	a. Prepare works program for major tasks. b. Allot resources to each major task. c. Arrange for strict traffic control and signposting. d. Arrange for breakdown and recovery organizations.

Table 4B-1: Road Planning Sequence

ANNEX C
MILITARY ROAD STANDARDS

SERIAL	CHARACTERISTICS	STANDARD
1	Width	
	a. Travelled way (single lane)	minimum 3.7 m
	b. Travelled way (tanks)	minimum 4.5 m
	c. Travelled way (two lanes)	minimum 7.3 m
	d. Shoulders (each side)	minimum 1.2 m, increase if road banks steep
		minimum 1.8 m
	e. Clearing (beyond shoulders	Radius of curve (m) / Increase (m/lane): 0.5 / 450; 0.7 / 300; 0.9 / 150; 1.6 / 30; 2.3 / 20
	f. Widening on curves.	
2	Grade	
	a. Absolute maximum	Maximum grade vehicle can travel on
	b. Normal maximum	10% or 1:10
	c. Desirable maximum`	3.3% or 1:30
3	Curves	
	a. Normal horizontal curve, minimum radius.	100 m for general purpose road
		50 m 1/4 ton vehicle track
	b. Vertical curve minimum length	30 m for each 4% algebraic difference in grades
	(1) Invert	38 lm for each 4% algebraic difference in grades
	(2) overt	

SERIAL	CHARACTERISTICS	STANDARD
4	Slopes	
	a. Shoulders	1:16
	b. Crown (gravel and sand)	1:24
	c. Crown (paved)	1:48
	d. Superelevation	Radius of curve (m) / Superelevation 20–300 1:14.5 300–450 1:18 450–600 1:24
5	Miscellaneous	
	a. Overhead clearance	4.5 m
	b. Traffic volume	
	c. Passing places single lane	2000 vehicles per day minimum every 400 m

Table 4C-1: Military Road Standards

CHAPTER 5
PLANNING FOR EXTREME CLIMATIC CONDITIONS

GENERAL

1. Climatic conditions can severely affect military engineering support to operations in specific environments. Environmental extremes usually require specialized techniques, procedures and equipment. Quantified requirements, standards or guidelines in this chapter enable specialist engineers to plan or configure individual facilities or utilities, and thereby estimate, design and/or construct complete deployed accommodation and utilities.

TROPICAL ZONE

2. **Genera**l. Wet, hot regions in the tropical zone coincide with the major tropical rain forest areas of the world. In the western hemisphere this area extends from the southern tip of Mexico through Central America to South America. These conditions are also prevalent in the heavily jungled areas of central and east Africa, Southeast Asia, the Asian Islands and the northern coast of Australia. Wet-hot conditions are characterized by high temperature and humidity, and intense solar radiation, where rain forests merge with deciduous secondary growth forests and tropical savannahs. Chilly days and nights are not common, however in winter months the nights are cold enough to require a blanket for sleeping. Rainfall in many parts is greater than in the temperate zone. Predictable tropical downpours are usually followed by clear skies. Except in areas where rainfall may be continuous during the rainy season, most days have some solar radiation. Additional information related to tropical zones can be found in B-GL-323-002/FP-001 *Specific Operations*, *Volume 4, Part 1, Jungle Operations*.

3. **Planning Considerations**. Siting of new facilities for a deployed camp is influenced by the topography and climatic conditions in the area of operations. In siting and planning either type of deployed accommodation the following planning considerations should be addressed:

a. **Site Selection**. Subgrade soil characteristics, ground water and surface drainage are prime considerations for the planner.

b. **Site Improvements**. Site improvements at a deployed camp in the tropics usually involve the complete construction of all facilities. Heavy rainfall imposes a drainage problem of major concern and ground water is usually found within a few centimetres below the surface, forcing the requirement for special design procedures for subgrade drainage. It is advisable to cut the width of roads much wider than normal to allow the roadbed to be dried by solar radiation, and good fill material is almost non-existent in the zone. During the rainy season, above ground sidewalks will be required. Most soils will have a high clay content that will impede drainage and make it difficult to compact.

c. **Solar Orientation**. The sun will be high overhead and therefore maximum use must be made of natural shade features. If natural features are not available, all shelters should be sited in an east-west direction to minimize wall exposure to the early morning and late afternoon sun. Reflected radiation also poses problems in the tropics and the siting of shelters should be avoided near large bodies of water or large areas of pavement.

d. **Wind Orientation**. The wet regions of the zone are characterized by mild winds that blow in the same general direction for most of the year, while in monsoon season high velocity winds occur from several different directions. Even though the wind effect does provide some relief to the oppressive heat of the zone, solar orientation of facilities and shelters should take precedence.

e. **Water Supply Requirements**. A total water consumption planning factor of 190 l/person/day should be used.

f. **Water Storage**. Provide for a 200% reserve.

g. **Water Distribution**. Water distribution lines must be protected from movement in the clay soils, with sand or gravel base for bedding and backfill. Above ground piping should be designed to be insulated and protected with mould resistant coverings.

h. **Electrical Power Generation**. Planning should consider the fact that all power generation will be performed in a high humidity, fungus promoting atmosphere.

i. **Interior Electrical Equipment**. All equipment should be specifically designed for use in the tropics with the following special requirements:

(1) use circuit breakers with bi-metallic thermal elements treated to prevent corrosion or galvanic action; and

(2) use porcelain or fungus and corrosion resistant plastic switches and receptacles.

j. **Exterior Electrical Equipment**:

(1) use oil filled transformers which are hermetically sealed or equipped with inert gas provided by a nitrogen cylinder;

(2) use either silicon bronze, copper, aluminium encased steel, or hot dipped galvanized steel hardware;

(3) use jute protected double tape armoured type cables when buried in coral backfill; and

(4) for buried cables, use material which is resistant to roach, termite and microbial attack and ensure all splices are water proof.

k. **Foundation Requirements**. The use of raised point foundations should be considered since much less of the stored heat from the ground is absorbed and the floor system is allowed to cool through natural ventilation. Also, the structure is separated from the high moisture content of the ground.

l. **Unique Structural Considerations**:

(1) treated timber should be used where wood is in contact with soil or concrete;

(2) for field painting, all steel surfaces should be cleaned and primed using red lead or zinc chromate paint;

(3) aluminium alloys are excellent for use in this zone;

(4) use galvanized steel fasteners; and

(5) use only paints, primers and enamels which contain a fungicide to inhibit growth.

FRIGID ZONE

4. **General**. Frigid zone conditions are found in the northern hemisphere in Alaska, Canada, Greenland, northern Scandinavia, and the northern parts of Russia and Asia. The zone is characterized by deep snow, permafrost, seasonally frozen ground, frozen lakes and rivers, glaciers, and extreme cold, in combination with frequent high winds and either very short or very long periods of daylight. Seasonably frozen ground exists up to depths of 4 m and there is a constant requirement for shelter heat and special winter clothing. During the summer months the zone is characterized by numerous and extensive swamps, lakes and rivers, abundant insects, and, in places, continuous daylight. Temperatures vary considerably between locations within the zone but extreme temperatures of -45^{o}C can be expected in the northern parts while in other areas the summer maximum can exceed 35^{o}C. Additional information related to frigid zones can be found in B-GL-323-003/FP-001 *Specific Operations*, *Volume 2, Part 1, Arctic and Sub-Arctic Operations, Basic Cold Weather Training*.

5. **Planning Considerations**. Siting of new facilities for a deployed camp is influenced by the topography and climatic conditions in the area of operations. In siting and planning either type of deployed accommodation, the following planning considerations should be addressed:

a. **Icing**. In areas where there is a source of water vapour, ice fog occurs mainly at temperatures below -5^{o}C.

b. **Site Access**. Plan on using trees, shrubs, snow fences or structures to keep drifting snow from reaching the camp. In a non-dispersed layout, enough room must be left between the structures for snow removal, with the orientation of the structure perpendicular to the prevailing wind. In a dispersed layout, shelters should be oriented parallel with the wind and site planning must include areas for snow dumping.

c. **Structural Design**. In permafrost areas a common building method is to use steel piles or columns to elevate the floor off the ground. This will keep the ground continually frozen. For buildings that require slab-on-grade for vehicle access, the underlying tundra is to be insulated using select granular fill and styrofoam insulation.

d. **Road Construction**. Where no permafrost is found road construction design and procedures are generally the same for a frigid area as for the temperate climate zone. In permafrost regions where both wooded and open areas exist, roads should be cut through the wooded areas to provide additional protection against degradation of the permafrost from the sun. Roadway grades should not exceed 3 to 5 percent, and roads require a sloping crown for surface drainage in the summer and a flat crown for maximum traction and safety in the winter. Spring and autumn grading of all roads should be a standard task. Where drifting snow could be expected, roads should be placed slightly higher than the surrounding terrain, and away from

vegetation or buildings/obstacles that could impede snow clearance.

e. **Solar/Wind Orientation**. In sub-arctic areas, the longitudinal axis of all shelters should be orientated north-south to take advantage of the maximum solar exposure. However, since solar radiation is minimal, the deciding factor on orientation of shelters will be the direction of prevailing winds, with the longitudinal axis of shelters and major roads being parallel to the wind.

f. **Concrete Placement**. When the air temperature is below 5°C, protection of the concrete by means of a heated enclosure or insulation shall be provided for the basic three day curing period.

g. **Utility Systems**. Design planning must provide the necessary freeze protection for all utility systems using electric tape and insulated lines.

DESERT ZONE

6. **General**. Two different climate sub-zones exist within the desert zone: the hot humid coastal desert, and the hot-dry interior desert. Characteristics common to both sub-zones are an arid, barren environment with stark contrasts of temperature, terrain, vegetation and weather. Temperatures vary according to latitude and season, while precipitation is mostly unpredictable. Desert terrain also varies from place to place with the only common factor being the lack of water. Additional information related to desert zones can be found in B-GL-323-004/FP-001 *Specific Operations, Desert and Extremely Hot Conditions*.

7. **Coastal Desert**. Hot humid conditions are limited to the immediate coast of major bodies of water having a high surface area like the Persian Gulf and the Red Sea. These areas have the world's highest humidity levels where the relatively high temperatures (38°C) often combine with large amounts of water vapour in the surface air. Night-time temperatures range from 15 to 25°C in summer and -1 to 10°C in winter. Annual total rainfall is less in both sub-zones

compared to the tropical or intermediate climate zones. When precipitation occurs it is often a quick violent deluge causing flash flooding. Camps will be subjected to winds from the northwest or southeast gusting up to 120 km/h.

8. **Hot-Dry Sub-zone**. Hot dry conditions are found in the deserts of North Africa, the Middle East, west Pakistan and India, southwest United States and northern Mexico, and Australia. Temperatures on all continents have long periods above 38°C where the ground temperature can be expected to be approximately 45 to 55°C. Humidity in the region is low ranging from 5 to 20 percent, and the minimum temperature in the reverse season is approximately -5°C. Wind and precipitation conditions are generally the same as for the coastal desert sub-zone.

9. **Planning Considerations**. The siting of new facilities for a deployed camp is influenced by the topography and climatic conditions in the area of operations. In siting and planning either type of deployed accommodation the following planning considerations should be addressed:

a. **Trafficability**. In the desert, rainfall and drainage seldom present problems since the soil is normally trafficable to all-wheel drive vehicles. After prolonged traffic, dust and blowing sand will become a factor that can be eliminated with minimal compaction and expedient grading, followed by sprinkling with an asphalt emulsion or other products. Saltwater is also a good treatment for unpaved road.

b. **Solar Orientation**. All facilities should be located with the longitudinal axis in an east-west orientation to minimize exposure to the low angle sun.

c. **Wind Orientation**. Winds in the desert are almost continuous and can achieve close to hurricane force. This has a severe dehydrating effect and carries fine soil particles capable of clogging mechanical systems. For a deployed camp the wind must be deflected and guided with a perimeter berm of equal

height to the maximum height of the shelters, particularly on the prevailing wind side.

d. **Site Drainage**. Avoid low areas since when rain does occur it is sudden and very intense, and usually causes flash flooding.

e. **Water Supply Requirements**. The scarcity of water will possibly force a severe water conservation program.

f. **Water Storage**. Every effort should be made to store drinking water at a temperature of 20^{o}C or less.

g. **Electrical Power Generation**. The design should provide sun and wind screens to protect equipment from the intense solar radiation, wind blown dust and creeping sand dunes. The provision of add on radiators to allow equipment cooling, such that it can be operated above 50^{o}C, must be designed for, and planning should include a larger than normal holding of replacement parts due to the expected higher failure rate. Underground or on the ground distribution is recommended, with all cables suitably protected from sunlight and blowing sands.

h. **Sanitary Systems**. Expect minimal sewage flow due to water scarcity. In areas of severe water shortages, planning should include the recycling of wastewater from showers and laundry for non-potable purposes such as dust control, concrete mixing, fire fighting and vehicle washing.

i. **Foundation Requirements**. When confined and compacted, sand makes an excellent base or foundation for shelters, with wind erosion at the corners of the shelters being prevented through the use of gravel backfill or chemical stabilization. Drifting sand can be controlled by the use of snow fencing.

j. **Ventilation Requirements**. The hot, dry daytime winds should either be lifted, deflected or guided away from shelters. In low humidity areas with a large variation between day and night temperatures, ventilation must be provided at night to cool down the exterior walls of shelters. In high humidity areas with little change between day and night temperatures, there should always be ventilation in facilities not serviced by air conditioning.

k. **Concrete Placement**. When temperatures exceed 32^{o}C the following precautions should be taken:

(1) keep all materials cool and store cement in shade;

(2) spray the gravel with water and if necessary use ice water in the mixture;

(3) set up wind breaks to prevent rapid evaporation;

(4) work at night when the temperatures are lowest; and

(5) cover the concrete with a saturated absorptive fabric (e.g. jute) in order to achieve cooling by evaporation.