National Defence / Défense nationale

B-GL-361-015/FP-001

ENGINEER FIELD MANUAL

VOLUME 15

GEOMATICS SUPPORT

(ENGLISH)

(This publication is effective upon receipt.)

WARNING

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Issued on Authority of the Chief of the Land Staff

Canada

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FOREWORD

1. B-GL-361-015/FP-001, *Field Engineer Manual, Volume 15, Geomatics Support*, is issued on the authority of the Chief of the Land Staff.

2. This manual is written to provide engineer units with the information needed to conduct and advise on Geomatics support operations in the field. The doctrine and concepts in this publication apply to field operations, both domestically and internationally, at the tactical and operational levels.

3. The aim of Geomatics Support Operations is to provide current and accurate geospatial information on the battlespace to the commander, throughout all phases of an operation. To accomplish this aim, engineers execute tasks against three principle requirements:

a. to support mission analysis and enhance decision making;

b. to facilitate access to geospatial information on the force command and control information system; and

c. to provide geospatial information and services for mission execution and manoeuvre.

4. The terminology used in this publication is consistent with B-GL-303-002/FP-Z03, *Army Vocabulary* and AAP-6 (U) *NATO Glossary of Terms and Definitions*.

5. This publication is effective upon receipt.

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

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CHAPTER 1
PROVISION OF GEOMATICS SUPPORT TO OPERATIONS

Confirmation of the ground is of the greatest assistance in battle. Therefore, to estimate the enemy situation and to calculate distances and the degree of difficulty of the terrain so as to control victory are the virtues of the superior general.

Sun Tzu, *The Art of War* (c. 500 BC)

INTRODUCTION

1. Information operations and the digitization of the battlefield are dramatically changing the way a commander views and conducts operations. A vital component to the commander is the ability to gain and maintain information dominance, allowing him to rapidly and accurately assess situations and tailor assets to suit the mission.

2. National geomatics resources consist of a small National Defence Headquarters staff organization (J2 Geomatics and Imagery) and an independent DCDS field unit—MCE. A core capability of the MCE is to ensure the provision of geomatics support to operations—to include the capability to deploy a task tailored geomatics support squadron (Geo Sp Sqn). Additionally, geomatics support teams are embedded in the combat engineer regiments to support respective brigades.

3. The aim of this chapter is to introduce the capabilities and principles of geomatics support to operations.

INFORMATION OPERATIONS—GEOMATICS

4. B-GG-005-004/AF-015 *Military Engineer Support to Operations* and B-GL-361-001/FP-001 *Land Force Engineer Operations* provide a doctrinal introduction to information operations and geomatics (the fifth engineering task). Information operations strategies are being developed into both CF force structure and operational planning in current defence planning guidance.

5. Information operations (IO) are those operations that gain information and knowledge that enhances friendly execution of operations, while denying the enemy similar capabilities by whatever means possible. The application of IO enhances battlefield visualization and improves designation of main effort, control of

operational tempo and synchronization. IO occur within the global information environment (GIE)—those information processes and systems beyond the influence of the military or government but which directly impact the success or failure of military operations. To conduct IO, commanders must effectively deal with both the manoeuvre-oriented battlefield and that portion of the GIE relevant to military operations. This area of GIE is termed the *military information environment* (MIE) and includes information systems and organizations, friendly and adversary, military and non-military, that support, enable, or influence military operations.

6. Information is the raw data that must be processed to allow the commander and his staff to have a better situational awareness. This information is processed and becomes intelligence, which plays a vital role in IO through its influence on the commander's battlefield visualization, which is created by the situational awareness and common operating picture. Intelligence also plays an important role in the commander's ability to gain information dominance over the enemy. The commander must be provided a continuous understanding of friendly situation, enemy intentions and the environment in which operations are being conducted.

7. The availability of information will increase due to advances in satellite imagery, global positioning systems, integrated sensor technology, and greater access to the GIE. This increase in information must be processed by better systems than formerly used to avoid overloading the commander and his staff. The intelligence, surveillance, and target acquisition and reconnaissance (ISTAR) system is intended to speed up the intelligence processing. This improved intelligence flow will permit commanders to achieve a greater and enhanced situational awareness, allowing faster decision/action cycles. Digital geospatial information is an integral part of this information and intelligence process, allowing the maintenance of full situational awareness of assigned areas of operations, interest, and influence.

GEOMATICS SUPPORT—THE FIFTH ENGINEERING TASK

8. Geomatics are those scientific and engineering activities involved in the capture, storage, analysis, processing, presentation, dissemination, and management of geospatial information. The physical environment in which operations are conducted is a common denominator to the attacker and defender—whoever exploits its advantages and avoids its challenges by having a better understanding

of the physical environment and makes the best use of terrain enjoys a key tactical advantage.

9. In support of current and future operations, engineer units provide battlefield terrain knowledge that is synthesized with information gathered through the formation's operational and engineer intelligence collection plan. These contribute to the commander's situational awareness and battlefield visualization. Situational awareness of the terrain is commonly referred to as Brown SA. This support to the commander permits achieving three goals:

a. project a clearer understanding of the current operating picture;

b. envision the desired end state; and

c. visualize the sequence of activities from the current state to the desired end state.

10. Engineers, through national means, provide a graduated response to geospatial information requirements that starts prior to the commitment of forces and close combat. Using a standard methodology, MCE uses existing global foundation data (FD) consisting of controlled imagery, elevation data and features to support strategic level planning and initial operations. This data will be further updated and enhanced to support operational level and specific tactical level mission requirements:

a. **Strategic Level Mission Planning**. As the area of operation (AO) is identified, available maps, charts, and digital geographic information (DGI), at 1:1,000,000 scale, are provided on-line to support mission analysis and courses of action development. Low resolution imagery (10 m or greater) will also be obtained and provided to planning staff. This data forms the initial operating dataset (IODS). This allows planners and decision makers to identify any limitations on force capabilities caused by the physical environment. IODS will also form the starting point for operational level planning and will be used in initial information and decision briefs**.**

b. **Task Force Operational Planning**. As the area of interest (AI) is delineated by the planning HQ, intensification of detail is undertaken using 1:250 000 scale maps, charts, intelligence sources,

and medium resolution imagery (5 to 10 m). A variety of sources are used, including alliances, bilateral or multilateral agreements, open source purchase, or commercial satellite imagery. The FD is thus enhanced to produce a minimum essential dataset (MEDS) to meet staff requirements for the preparation of estimates and deployment concepts of operations. An analysis of the physical environment must be part of the operational commander's planning process and will include information from national and allied sources. This information will be made available to the tactical level formation HQ.

c. **Formation Tactical Level Planning**. As high resolution imagery (1 to 5 m) and geospatial information are made available at 1:50,000 scale by contributing nations, a mission-specific dataset (MSDS) is developed. Detailed 3-D views and mobility analyses are produced to support estimates of the situation, reconnaissance task orientation, and the refining of groupings and tasks. Further refinement to meet specific requirements takes place in theatre such that large-scale views of the area of influence may be developed. The bulk of geomatics support is dedicated to supporting specific tactical needs.

GEOMATIC SUPPORT SERVICES

11. At the tactical level, geomatics support is provided in the form of information (maps, charts, and tactical decision aids) or five services that portray the terrain for the commander and his staff:

a. **Terrain Visualization/Analysis**. Focused on the commander's decision/action cycle, geomatics support teams (GSTs) are available to undertake terrain analysis and provide terrain visualization (TVis), which provides either a static or dynamic 3-D view of the terrain using complex (i.e. multi-scale, multi-source, multi-type) datasets and other on-line data sources. These teams undertake to identify those terrain characteristics that can affect each course of action, with a view to:

(1) developing impacts of the terrain, with a view to focusing the mission planning effort; and

(2) predicting the effects of terrain and weather on deployment and manoeuvre.

b. **On-line Access**. With the increasing use of map background displays, geomatics resources provide the geospatial information that is used, making sure that it is fully available. The GSTs maintain the geodatabases of deployed command and control information systems up to date, ensuring freedom of action. This support is provided on-line throughout the Joint Task Force (JTF). Having a mandate to condition and disseminate data and information in a form contributing to the common operating picture, principle competencies are:

(1) review holdings, project future requirements, and arrange collection of military geographic information through formation assets; and

(2) condition information by sourcing, validating, and synthesizing it into a database made available on the JTF geospatial data (geo) server.

c. **Map Supply**. Commanders and deployed forces will continue to rely on hardcopy information products such as maps, charts, and designated substitutes. At the simplest level, these products provide a common operating picture that can be updated by the traditional means of traces, updates, overprints, and pen amendments. A deployed force/formation map supply point is required to be operated by engineers to ensure timely and effective provision of hardcopy and softcopy geospatial information. This map supply point will rely on national, alliance, or theatre resources, and will:

(1) monitor stock levels, arrange shipping, arrange local storage, or break down theatre supplied bulk stocks; and

(2) prepare unit loads and arrange transport within force/formation resources.

d. **Field Survey**. The indirect firepower assets of the deployed force are vitally dependent on quality targeting information. MCE will provide independently operating survey teams to support the force by extending theatre or formation level survey control to support locating artillery and fire planners with precise location solutions. Additional support to formation level activities include gathering elevation data, locating obstacles, and providing technical advice to GPS users, both PLGR (Precise Lightweight GPS Receiver) and tactical navigation systems. However, the principle competencies are to:

(1) conduct small team GPS survey control/positioning/geo-referencing operations at a variety of scales; and

(2) establish the geo-reference network for imagery ground truth support.

e. **Reprographics**. Contributing to information dominance, engineers make available near real-time, hard copy information on the physical environment, including terrain, hydrography, and culture. Culture could include infrastructure, products showing ethnic or political concentrations, or similar information requirements identified by the commander. The reprographics capability provides rapid response, low-volume/high-rate plotting. Reprographics competencies address requirements for large format and photographic printing not supported by the Land Force Command and Control Information System Version One (LFC2IS V1) or other deployed C2IS. Reprographics competencies include the requirements to:

(1) manipulate, publish, manage, and reproduce information and imagery; and

(2) plot route designations, unit dispositions, communications coverage zones, fire

control measures, mine contamination areas, and other information sets.

PRINCIPLES OF GEOMATICS SUPPORT

12. There are five main principles that underpin the provision of geomatics support:

a. **Maintenance of the Archive**. The majority of geomatics products are derived from a geospatial data warehouse, which must be fully maintained in peacetime to ensure a responsive production capability during a crisis. Upon deployment, value-added information must be regularly archived at the JTFHQ to ensure no loss of data in theatre. This data must also be transferred back to warehouses located at MCE or in a sanctuary.

b. **Economy of Effort**. Geomatics resources are scarce and therefore employment of these assets must be coordinated in the most effective and efficient manner within a prioritized framework. This is achieved through:

(1) Burden sharing, through international co-operation and standardization. This will reduce the number of geomatics products that will have to be produced to those that are not otherwise available or that cannot be acquired.

(2) Centrally coordinating geomatics assets.

(3) Monitoring technical developments to ensure production methods and support activities provide maximum efficiency.

(4) Using substitute products when suitable to avoid using scarce resources.

c. **Flexibility**. Flexibility is required to allow national geomatics resources to be used in the most effective manner. Flexibility requires:

(1) early warning to allow the deployment, re-deployment, and re-allocation of resources;

(2) a rapid response and surge production capacity;

(3) GSTs that are established and equipped to deploy in support of operations;

(4) a flexible, well-trained workforce; and

(5) effective command and control arrangements and secure communications links between MCE and the deployed teams, commands, and allied map-producing agencies.

d. **Interoperability**. Land, air, and maritime units must operate jointly as part of a national, alliance, or coalition force; therefore, they must be operating from a common understanding of the battle space, which translates into the need for standardization. Most significantly, this means a common reference system and the ability to use and exchange digital geographic information.

e. **Integration**. The foundation data process commences with the collection of available source material through the delivery of a wide range of finished products, from maps to digital geographic information, as well as analysis services, and advice. This concept is further enhanced in the field by adding to base mapping, thereby producing tailored products to meet mission-specific requirements.

CHAPTER 2
COMMAND, CONTROL, LIAISON, AND ADVICE

Speed is of the essence in war. Take advantage of the enemy's unpreparedness, make your way by unexpected routes, and attack the enemy where he is unguarded.

Sun Tzu, *The Art of War* (c. 500 BC)

SECTION 1
INTRODUCTION

GENERAL

1. The MCE is responsible for the provision of geomatics support to deployed CF units, up to and including a deployed JTF. This support is provided by both base plant activities from the unit's base location and the deployed geomatics support squadron (Geo Sp Sqn), directly supporting the CF in the field. The GSTs, now integral to each engineer regiment, also provide direct support in a decentralized manner.

2. The variety of geomatics tasks on operations is diverse and encompasses geodetic and topographic survey, terrain analysis, terrain visualization, field reprographics, geomatics information distribution, and geomatics information management. The resources that provide these functions are limited, and, in times of increased requirements, certain functions will require surged reinforcement to meet the demand. Achieving the optimum use of these resources, especially during changing tactical situations, demands an efficient and flexible system of command and control. The senior geomatics officer must be able to coordinate the allocation of all geomatics resources within the supported formation in order to maintain the freedom to execute the geomatics operational priorities, as is deemed appropriate. If a geomatics support team is deployed, the senior engineer is responsible to advise the commander and staff on the effective allocation of geomatics resources.

3. For the purposes of this chapter, the following assumptions have been made:

   a. Within the scope of a main contingency force (MCF) deployment, the Geo Sp Squadron, (possibly a sub unit of the Engineer Support Unit (ESU)), will provide deployed geomatics support to all CF

formations, including a JTFHQ and up to three environmental components, including a deployed brigade generated by the Land Force.

b. Based on the doctrinal model in Figure 1, the manpower available for the deployed squadron will not exceed 3-23-26.

c. In most cases, where the CF would operate as part of a combined expeditionary operation, Canada will not be the lead nation for the provision of geomatics support. The Geo Sp Squadron, remaining an integral sub unit of the ESU (if deployed), would establish liaison and coordinate efforts with the Force Geomatics unit staff.

d. By providing deployed support to an MCF deployment, the MCE's capacity to meet production demands will be greatly strained. Therefore, this requirement will have to be satisfied using alternate means within imposed resource constraints including: burden sharing, acquisition, producing that which cannot be acquired, and using substitute products where they meet the intended purpose.

AIM

4. The aim of this chapter is to outline the command and control of geomatics support assets and the provision of geomatics advice and liaison within a deployed Canadian formation, task force, or environmental component.

SCOPE

5. This chapter will consider the following aspects:

a. factors affecting command;

b. grouping and deployment;

c. command and control relationships;

d. control measures;

e. orders;

f. liaison and advice; and

g. communications.

SECTION 2
COMMAND

FACTORS AFFECTING COMMAND

6. **Principles of Employment**. The Geo Sp Squadron is required to provide a variety of capabilities to the supported forces. The composition of the deployed support elements will depend on the formation being supported and the scope of the operation. Depending on the designated tasks, elements of Geo Sp Squadron may be assigned in varying command and control relationships to support the JTFHQ, component command HQ, or individual units. In these cases, the supporting geomatics commander must have the capability to plan for and to control all deployed geomatics resources following the basic principles of employment, which are:

a. centralized control;

b. allocation of priorities;

c. early warning; and

d. continuity.

7. **Technical Direction**. As with other engineer commanders, the geomatics commander will carry out the dual functions of technical direction of deployed geomatics resources and senior geomatics adviser to the operational commander. In order to exercise technical direction, all the geomatics elements within the squadron, from team commander upwards, need to be linked via a technical network to ensure the most economical employment of MOC 142 geomatics technicians and resources. This chain of technical direction will also help ensure that a common operating picture is maintained at all levels and that all geomatics tasks contribute effectively to the commander's plan.

8. **Geomatics Advice at the Operational Level**. On behalf of CO ESU/JTF Engr, the geomatics commander is an adviser to the supported operational commander. Where possible and where resources are available, geomatics advice should be available to the commanders and staffs, at every level. (Within the scope of an MCF deployment, this could be to the JTF, brigade and/or component level as well as units.) Operations involving a Vanguard deployment could

have geomatics advisers at the BG/TF level. The incorporation of a geomatics adviser into the reconnaissance groups at the strategic and operational levels is essential to provide early advice of the potential geomatics specifics that could affect the planning and execution of a particular operation or deployment. Additionally, this practice also ensures that the principles of timeliness and early warning for geomatics requirements are achieved. Specialist knowledge is required to gain the maximum output from the range of systems and data available, and the geomatics advisor is responsible to ensure that the formation/JTF commander and his staff are served effectively by the MCE. The provision of geomatics advice to the supported operational commander, although the responsibility of the geomatics commander can be achieved, indirectly, through the squadron LO. Advice should be available to the commander at all stages of an operation, although the most critical phases are likely to be during initial planning and the subsequent reconnaissance.

9. **Geomatics Advice at the Tactical Level**:

a. **Geomatics Advice to the Brigade**. The provision of geomatics advice to the supported brigade commander is the responsibility of the CO of the Combat Engineer Regiment (CER). This can be achieved, directly or indirectly, through the Engineer Support Coordination Centre (ESCC) assisted by the GST. Advice should be available to the commander at all stages of an operation, although the most critical phases are likely to be during initial planning and the subsequent reconnaissance.

b. **Geomatics Advice to the Battle Group**. In the event that a GST is deployed in support of a battle group, the provision of geomatics advice to a supported BG commander is the responsibility of the Fd Sqn OC assisted by the GST.

10. **Location of the Commander**. The senior geomatics commander's location depends upon the relative importance of the tasks underway and being planned. His location will be linked to the following activities:

a. **Planning**. During the planning stages the geomatics commander should be located at or near the supported JTFHQ to advise the operational commander and staff on the geomatics aspects for

the forthcoming operation, including the employment of squadron resources. This decision would be coordinated with CO ESU/JTF Engr. After the engineer planning is complete, the geomatics commander then moves to be with either their own troops or with the ESU HQ. The commander will then normally be represented at the supported headquarters by an LO, who will most likely be the topographic troop commander.

b. **Offensive Operations**. Because of the small size and the movement and changing location of the tactical command post during offensive operations, the geomatics commander will unlikely be co-located with the operational commander. In his place, the interests of geomatics will be looked after by the commander's engineer advisor. The geomatics commander will be kept up to date on the operational planning within the supported headquarters, to facilitate his ability to modify his own planning to best suit the commander's plan. He will be able to influence the level of geomatics support by reassigning troops to tasks best suitable for meeting the operational priorities.

c. **Defensive Operations**. The geomatics commander should divide time between deployed assets, own headquarters, the supported headquarters, and other deployed allied geomatics organizations during these operations. The geomatics commander should do this to ensure that all geomatics assets maintain the common operating picture being provided to their supported formations or commands and to determine priorities for support. The time the geomatics commander spends with deployed elements will depend on how much time is spent providing geomatics advice to their own supported operational headquarters and coordinating activities within the overall operational geomatics support plan.

11. **Affiliations**. Due to the varied nature and technical complexity of geomatics support, it is essential that formations and units that will be routinely supported have regular opportunities for

contact training with geomatics support assets. Where possible, the full operational level of support should be provided for exercises and opportunities for closer affiliation and understanding of the MOC 142 geomatics technician's unique capabilities.

GROUPING AND DEPLOYMENT

12. **General**. The senior geomatics officer controls all geomatics tasks in the JTF area of operations. Direction will be provided by the JTF engineer and CO ESU or in the case of a combined operation the chief geomatics officer within the operational command headquarters.

13. **Grouping**. Grouping is the tailoring of a force for an operation. This procedure allows the commander to rearrange the forces to best meet the anticipated tasks essential to the mission. When establishing the grouping, the commander will state the command relationships of the various assets. The relationships will be established by the status of command, decided on by the commander, and will determine the degrees of command and control for operational and administrative purposes. Grouping will need to be coordinated with the JTF Engr and CO ESU. Figure 1 shows the complete doctrinal order of battle (ORBAT) of the deployed Geo Sp Squadron within the deployed ESU.

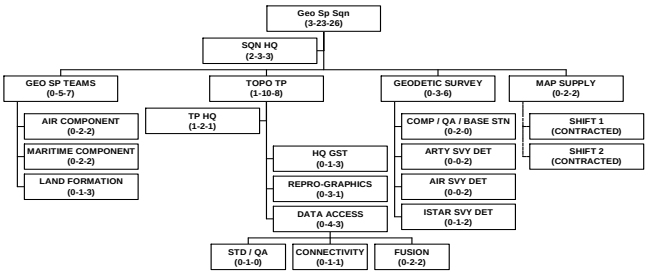

Figure 2-1: Deployed Geomatics Support Squadron

14. **Deployment**. Chapters 3, 4, 5, 6, and 7 describe the employment, capabilities, and specific command relationships of geomatics personnel during operations. As with other scarce engineer resources, geomatics assets can either be centralized and controlled at the JTFHQ level or decentralized to support environmental component HQ. In practice, Geo Sp Squadron assets will most likely be deployed

in the theatre of operations, with the main effort centralized at the JTFHQ level and certain assets decentralized to lower HQ. This is further elaborated upon in the following paragraphs.

SECTION 3
COMMAND AND CONTROL RELATIONSHIPS

GENERAL

15. The command relationships applied to the Geo Sp Squadron or other deployed geomatics assets will be critical and will determine whether that support will retain the flexibility to regroup to meet changing priorities. A summary of the various command and control relationships is listed in the following paragraphs in order of precedence.

16. **Operational Command (OPCOM)**. OPCOM is the authority granted to a commander to assign missions or tasks to subordinate commanders, to deploy units, to reassign forces, and to retain or delegate operational/tactical command or control, as may be deemed necessary. Geo Sp Squadron will generally remain OPCOM to the ESU. The Geodetic Survey Section and the Map Supply Section will most likely remain under command to Geo Sp Squadron. Command and control of the remaining squadron assets will most likely be delegated to the JTFHQ and the component HQ. If the regimental GSTs are augmented from the MCE, the augmentees will normally be deployed OPCOM to the CER.

17. **Operational Control (OPCON)**. OPCON is the authority delegated to a commander to direct forces assigned so that the commander may accomplish specific missions or tasks that are usually limited by function, time, or location. Topo Tp and the Geo Sp Tms will most likely be assigned OPCON to the JTFHQ and component HQs, respectively. The Geodetic Survey Section might be placed OPCON to a component HQ for a specific task, such as providing control for weapon platforms. When geomatics support capabilities are required at the BG level, a GST could be deployed OPCON to the Field Engineer Squadron in support of the BG engr, ops and int staff.

18. **Tactical Command (TACOM)**. A commander assigned forces under TACOM may allocate tasks to those forces but only within the parameters of the current mission given to that commander by the higher authority that assigns the forces. It is unlikely that any geomatics assets will be assigned TACOM during operations.

19. **Tactical Control (TACON)**. TACON gives the assigned commander the ability to control the tactical movement of assigned assets within boundaries for the duration of the assigned task. No ability to change the mission or tasking exists, and no regrouping of assets is allowed. TACON of the section or field parties on the ground will normally be delegated to the appropriate tactical headquarters. For example, TACON could apply to the Geodetic Survey Section establishing theatre control at the beginning of a deployment as they complete their tasks within a given component's area of operations.

DELEGATION OF COMMAND RELATIONSHIPS

20. **Delegation**. When changing the grouping of geomatics assets, it should be noted that the commander may, under the advice of the engineer, choose to delegate command and control authority for one of their assets to a subordinate formation or unit but only at the same or lesser status of command. For example, a GST assigned OPCON to a formation may not be delegated OPCOM to a subordinate unit, whereas a GST assigned OPCOM to a formation could be delegated with any appropriate level of command.

21. **Timing**. The timing of grouping and regrouping is important since reorganization, no matter how short in duration, will entail a break in the tactical or strategic cohesion; it will result in a loss of effectiveness and tempo until the reorganization is complete and normal operations resume. Changes to grouping should occur either well before a specific phase of an operation or during lulls in an operation to permit regrouped elements time to establish communications, liaison, logistic support, and to receive new orders.

22. **Degree of Administrative Command or Control**. In developing a specific grouping, the geomatics commander must establish an operational grouping that can be supported. In most cases, the organic communications unit, responsible for a formation headquarter's communications and general administrative support, will provide support. However, it is essential that prior to detaching or regrouping geomatics assets, the geomatics commander ensures that support will be provided and the necessary transfer of control is detailed in the Geomatics Annex to the Operations Order. This transfer of control may be caveated to reflect the necessity for administrative control but not OPCON.

SECTION 4
CONTROL

CONTROL MEASURES

23. The deployed Geo Sp Squadron will use the same control measures employed by the general staff during operations. These include:

a. command relationships;

b. establishment of priority tasks;

c. tasking of specific assets to designated tasks;

d. designating the geographic limits of exploitation for specific assets (boundaries);

e. times for task completion;

f. standards and specifications for work;

g. tasking progress reports from detached assets;

h. submission by detached assets of reports and returns; and

i. special instructions, including standing operating procedures (SOPs).

24. **Special Instructions**. Normally, all necessary control measures would be provided for in Annex M to the national Operation Order. In the event that this does not occur, specific instructions for geomatics control policy will be issued by another agency.

25. **Standing Operating Procedures**. Basic Squadron SOPs will be derived from formation/JTF/ESU SOPs and instructions. These should be supplemented with additional SOPs covering the technical and unique aspects of geomatics support operations. These SOPs, when promulgated, rehearsed, and known to all personnel, will greatly assist the commander in the control of geomatics operations.

ORDERS

26. At the strategic level, J2 Geo staff officers will provide input into CF Operation Orders using either a separate annex or a geomatics sub paragraph. Similarly, at the JTF level, within the advisory role, OC Geo Sp Squadron will provide input into the JTF order using a

separate annex or geomatics sub paragraph. OC Geo Sp Squadron will issue direction to subordinates through a squadron Operation Order. This could include warning orders, movement orders, formal Operation Orders, and overlay orders. As a sub unit of the ESU the squadron Operation Order could be issued as an annex of the ESU Operation Order to streamline the planning process.

27. **The Geomatics Annex M**. It is essential that operational and contingency plans have a Geomatics Support Annex to define those geomatics support activities critical to the success of the mission and to detail how the support will be provided. Within NATO, this annex is designated as Annex M. Many allies also place geomatics support requirements in Annex M, notably for their joint and combined plans. CF plans may place geomatics requirements in an alternate location. It is important that geomatics support requirements be defined and consolidated in one central, consistent location. It is preferred that such requirements be clearly identified in a stand-alone annex and not be embedded in the annex for other types of support.

28. It should be noted that the Geomatics Annex is to provide technical direction to geomatics commanders, to inform supported troops of the geomatics support they will receive, and to provide details of necessary coordination requirements. The annex is not a replacement for the squadron Operation Order; this will be produced by the geomatics commander subsequent to the Geomatics Annex.

29. J2 Geo staff, the formation geomatics staff officer, or the geomatics commander of deployed geomatics assets can advise in the preparation of a Geomatics Support Annex. The annex should address situation, mission, execution, designated material and special products, coordinating instructions, administration and logistics, and command and signals. There should be tabular appendices to indicate areas where map or chart (or other product) coverage is required, types of products (including services) required, quantities required for all phases of the operation (including replenishment), etc. A Geomatics Support Annex would be based upon formation geomatics policies, directives, and standard operating procedures, and an outline is in Annex A for reference. It should be noted that the template in Annex A is written for the strategic level prior to a deployment. The framework would still apply at the operational level; however, the content would be in greater detail and would focus on the theatre of operations.

30. **Geomatics Operation Order**. An operation order, by definition, is a commander’s directive to subordinate commanders for

the purpose of effecting the coordinated execution of an operation. The purpose of a Geomatics Operation Order is to give subordinates the details of the geomatics role in an operation, to enable them to issue their own orders, and to ensure coordination. The orders are based on the supported Formation Order as well as the higher formation or supported formation Geomatics Annex. At the brigade level, most geomatics operations are usually simple enough to be controlled by oral orders.

SECTION 5
LIAISON

LIAISON

31. **General**. Liaison is defined as "that contact or intercommunication maintained between elements of military forces to ensure mutual understanding and unity of purpose and action." Liaison is maintained for the purposes of ensuring co-operation, coordination, and understanding between commanders and staffs of headquarters or units that are working together. Liaison can be achieved by personal contact between commanders and staffs and by exchange of LOs.

32. The Geo Sp Squadron has an LO within the squadron ORBAT to provide a continuous link between the supported formation/JTF engineer staff and the deployed geomatics commander. On the rare occasion, this officer will be required to provide a continuous presence at the corps or operational command headquarters to provide a direct link to the operation chief geomatics officer.

33. The use of LOs is extremely important as they will represent their commanders at the formation headquarters with whom they are working. They do not provide geomatics advice but must seek it from their own commanders when required.

34. The LO is the personal representative of the squadron commander and, as such, must fully understand the geomatics plan and squadron SOPs. The LO must be able to interpret them to the assigned headquarters staff and, in turn, must take an active and informal part in the headquarters' activities so that his or her commander is kept well informed.

35. The LO should possess sound professional knowledge. The LO should have the confidence of his or her commander and be

capable of speaking for the commander with authority. He must have the appropriate personnel, transport, and communications to be effective.

ADVICE

36. **General**. On behalf of CO ESU/JTF Engr, the provision of geomatics advice to the supported commander is the responsibility of the geomatics commander. This can be achieved directly or indirectly through the squadron LO. Advice should be available to the commander at all stages of an operation, although the most critical phase is likely to be during the initial planning and the subsequent reconnaissance.

37. Specialist knowledge is required to gain the maximum output from the range of systems and data available, and the geomatics advisor is responsible to ensure that the formation/JTF commander and his staff are served effectively by MCE.

SECTION 6
COMMUNICATIONS

INTRODUCTION

38. **General**. There is a requirement for good lines of communication between the deployed squadron and the MCE, based in Canada, and also between the squadron headquarters and detached elements within the formation/JTF operational area. Inadequate communications links will impede the ability to retain good command and control of the deployed squadron; additionally, it will slow the rate of data access and development—this is the responsibility of the signals community to resolve. This means that the provision of communications must be considered at two levels as outlined below:

a. strategic communications; and

b. tactical communications.

39. **Strategic Communications**. Geomatics support resources require the ability to pass information and digital data between the base plant in Canada and the deployed assets. Implicit to these requirements is the need for wide-band satellite links between the base-plant organization in Canada and the deployed geomatics support headquarters. These links will allow for the passage of large data files

to and from the operational theatre, significantly enhancing the level of support provided in theatre and reducing the burden of data creation for the deployed assets. The intention is to use the communications infrastructure provided by JSR for this purpose.

40. **Tactical Communications**. With the advent of Command and Information Systems and the digitized HQ, Geo data will be passed through a network. Implicit is the need for a system able to pass a lot of data quickly and compatible in combined operations. Further, the deployed squadron requires a full array of combat net radio systems, providing secure VHF and HF communications. It is essential that these systems provide the deployed assets the means to communicate between themselves and their supported formations.

ANNEX A
ANNEX M TO OPERATIONS ORDERS TEMPLATE

SECTION 1
ANNEX M TO (OP PLAN / OP ORDER / IMPLEMENTATION SUPPORT ORDER)

GLOBAL GEOSPATIAL INFORMATION & SERVICES (GGI&S)

REFERENCES: (Security Class as required)

A.—National, Allied formations OPLAN

B.—NATO Geographic Policy (Dated) or CF Doctrine (Geomatics Sp)

C.—Position referencing (datum & grid) directives

D.—Senior Annex M/Geo Operating Instructions

E.—Specific Geo STANAGs/QSTAGs/Regulations

F.—Map catalogues or Specific Maps, etc.

1. **SITUATION**:

   a. **General**. Include a statement that indicates to whom this annex applies for the planning and conduct of geomatics support. Also include a statement indicating the level (e.g., operational, tactical) for which support will be provided as part of the operations to assist in achieving all of the formation's objectives. Refer to the standard geomatics products that are required to support this plan (see Appendix 1). Refer to the area coverage and quantitative requirements using an appendix if necessary or by portraying them graphically. Identify the non-standard products also required to support the plan:

      (1) **Phase 1—Planning**. Summarize the requirements for geomatics resources and map depot activities. Include the area of operations, emphasizing timelines and phasing of this operation. Highlight POCs and the task of the MCE Geospatial

Information Coordination Centre (GICC), to advise concerning requirements as a compliment to J2 Geo Ops and MCE HQ.

(2) **Phase 2—Deployment**. Indicate requirements to move units from their peacetime locations into the area of operations; identify printing and distribution requirements. There may be a requirement for nations to contribute map print assets either at home or on deployment.

(3) **Phase 3—Employment**. Geomatics support during this phase is usually a reactionary operational necessity; indicate if this is the case or state another.

(4) **Phase 4—Redeployment**. Summarize the requirements for redeploying geomatics resources and map depot activities. Include the disposition of all residual geomatics products and the formations that will be included in the coordination of this action.

b. **Assumptions**. The assumptions should state expected conditions over which the commander has no control. The following areas of concern should be commented on. The following assumptions were used in the development of this annex (add/delete/modify as required):

(1) Sources from which geomatics products will be supplied; host nations or on-site authorities are expected to provide additional maps of operational area—areas of influence. Host nations will grant release authority for Canada to have access to any coverage that another nation may hold of their territory, through Department of Foreign Affairs and International Trade (DFAIT) initiatives.

(2) Nations may be requested to honour outstanding map supply credits (within existing MOUs). On a case by case basis,

nations may be asked to assume production responsibility for some designated map series; the organization to act as the interface between the requester and producing nations must be specified.

(3) Which resources will be assigned to operate the theatre map depot (TMD) and subsequently ship to the regional or forward map depot (RMD / FMD). The CF will not be the source of maps, charts, and other geo products for non-CF agencies. Identify which maps or charts may not be available.

(4) Which resources will be assigned to coordinate theatre geographic support. Any map or chart purchases will be charged to the operation. Securing funding authority during a crisis should not delay commercial purchases if funds are within remaining NDHQ J2 Div O & M budgets.

c. **Services Priorities and Product Availability**. The priorities must be unambiguous, clearly indicating the priority for delivering services to units/HQs and the priority to enhance deficient geomatics products. Listing all geo sp tasks will provide deployed geo assets the necessary clarification to enhance split-based operations and limit conflict over who is doing what and where. For example:

(1) **Map Distribution**. Products required for this operation will be distributed in the following priority:

(a) Planning requirements (products at a scale of 1:250K or smaller); and

(b) Operations requirements (products at a scale of 1:50K or larger).

(2) **Product Availability**:

(a) **Topographical Products**. Identify stock of products held by the CF Map Depot/Hydrographic

Services Office (HSO), being shipped directly from the US National Imagery and Mapping Agency (NIMA) or Host Nation, or being reprinted (with due date), etc. Highlight methods of supply or, if required, a distribution plan can be included as an appendix (see distribution plan in Appendix 2).

(b) **Air Charts/Flight Information Publications** (**FLIPs**). FLIPs are held at the Squadron/Wing level. Present FLIP cycle is in effect (dates), encompassing all GPH series FLIPs. FLIP re-issue (if required) will occur (date—if required, method of re-supply can be stated here or in the distribution plan if one is attached as an appendix). In the event of emergency stock requirements, requests can be made through the GICC.

(c) **Hydrographic Charts and Companion Products**. Sufficient stocks (and air products if required) are held by individual HMC ships. Special or additional products will be supplied to the ships through the HSOs. Re-supply (if required) will be through the HSOs (date—if required, method of re-supply can be stated here or in the distribution plan if one is attached as an appendix).

d. **Supporting Capabilities**. The provision of geomatics support is a national responsibility. Identify allied/host nations who will provide products (maps and charts) but do not provide

services (terrain analysis, map distribution, etc). Identify sources from which geomatics products will be supplied including theatre support if available from the lead geo nation:

(1) **Internal** (CF).

(2) **External** (Allied).

(3) **Deployed** (MCE).

e. **Designated Geospatial Information and Special Products**. All products designated by joint force (JF) policy must be listed. An appendix (see table, Appendix 2) is preferable. A listing should be used for an order to facilitate the sending of the order by message. The JF policy must cover the datum, grid, ellipsoid, etc. to be used for navigation systems, survey systems, Global Positioning System (GPS) receiver settings, targeting, etc. It may also cover specific standards for digital geospatial data exchange and the application of only certified data and data manipulation tools.

2. **MISSION**. To provide the GGI&S required to support (Op Plan, Operation Order).

3. **EXECUTION**:

a. **Concept for Geomatics Support**. Give a clear statement on how geomatics support will be provided in order to meet the commander's overall mission (deployed or garrison-based), highlighting the purpose of the geomatics support to be provided. Will a surge capability be deployed (with a phased draw down)? Will a collective effort be put into establishing control and a map distribution point, as the priority tasks, then an equal focus on the five plus one geomatics support tasks? Comments on the following should be included:

(1) The Task Force (JF/TF) will deploy with sufficient deployment & reserve stocks (basic load (BL) and maintenance load—(ML)) for the duration of the operation or XX days usage of BL + ML requirements.

(2) Resupply of products will be in accordance with the distribution plan (if required) attached at Appendix 2 (see paragraph 1.c.(2)) and limitations on sharing data with non-Canadian or non-DND personnel.

(3) National support, quick response, new product requirements, and possible requirements for MCE base-plant support will be resolved by J2 Geo Operations.

(4) The system of providing geomatics support for related maritime and air operations should be stated as well as the method of supplying maps/charts either through national resources at home station prior to deployment or from related operational areas or air bases.

(5) Specify any unique geometric equipment requirements; there is a growing requirement to pass large volumes of digital data via electronic means. These requirements will have to be addressed.

b. **Grouping and Tasks**. Identify the resources assigned or attached and those required where not currently assigned. Specify the command and administrative relationships and the duration of support required (if known):

(1) **Groupings**.

NOTE

J3 P&O and J4 Log/NDLCC are responsible for the provision of equipment and vehicles in accordance with Appendix 5 attached.

(2) **Establishment of Survey Control**. Concept for geodetic framework plan and operating concept—centralized or decentralized for survey teams.

(3) **Map Supply**. Provision of products and supply network: TMD/RMD/FMD, Map Supply Points (JTF/Bde), and where the MCE/Geo Sp Squadron will support/establish in theatre.

(4) **TERA and TVis**. Concept for enhancing the geomatics common operating picture (COP) linked to new data sources. Detail deploying capabilities and manning limitations with respect to 24/7operations.

(5) **Digital Geospatial Information (DGI) Access and Management**. Concept for provision of geo data to C3IS in theatre; updating and control of geo data on networks.

(6) **Operational Reprographics**. Detail capabilities and tasking routines.

(7) **Advice and Liaison**. Identify links to other national assets deployed, any limitations to taskings, and concepts for burden sharing.

c. **Staff and HQ Responsibilities**. Clearly identify the detailed responsibilities at NDHQ, the Joint Force/Task Force HQs, and supporting HQs. Break down who does what in Canada and in theatre. Describe the requesting and tasking procedures, providing the framework for subsequent taskings to the (deployed) Geo Sp Squadron assets.

(1) **J2 Geomatics NDHQ** (National Command) will:

(2) **JHQ Chief Geographic Officer** (CF JHQ/HQ LFA/HQ 1 CAD) will:

(3) **TF Sector HQ—Component HQ** (Bde/Wing/Task Gp) will:

(4) **CO MCE** (national supporting commander) will:

(5) **OC Geomatics Sp Squadron** (Deployed—as part of ESU) will:

d. **Coordinating Instructions**. Comments on the responsibilities of producing nations, role specialization nations, and lead nation are also required.

(1) **Release Authority**. Comment on the releasability restrictions of designated products (controlled distribution, "eyes only," etc.), who the authority for release is (e.g. J3 P&O Ops staff), and how and where any problems are to be resolved. Comments to cover both national and in-theatre release are required.

(2) **Introduction of New Products**. Indicate how and who will introduce new editions (or products) and destruction procedures for old editions.

(3) **Datum/Grid**. Indicate the datum and coordinate system that will be used: the Universal Transverse Mercator (UTM) map coordinates derived from World Geodetic System (WGS 84). (Particular attention must be paid to the map legend.)

(4) **Current Stocks**. Provide a general statement regarding the availability and adequacy of the geomatics data and related material required to support the plan.

(5) **Noted Geographic Errors**. Indicate point of contact on how problems with new editions, grid errors, map disagreement with ground truth, or units reporting coordinates in other than WGS 84 values—all of which could endanger life or effect operations—are to be reported.

(6) **Funding of Geomatics Products**. Comment on how geomatics products will be funded, both in a national and in-theatre setting.

(7) **Provision of Products to Other Forces**. Comment on how geomatics products will be provided, both in a national and in-theatre setting.

4. **SERVICE SUPPORT**. This area should cover (other paragraphs can be added as required):

a. **Supply and Storage Facilities**. Locations. See Appendix 2.

b. **Transportation**. Comment on arrangements to move maps and products as arranged with J4 Mov/NDMCC to theatre and in-theatre details. (It should be noted that geomatics support personnel require the provision of vehicles.)

c. **FIN—Accounting**. Requirements to account for geomatics products for tracking and billing purposes.

d. **Sustainment**. Identify the Movement Priority Code (MPC) for any and all geo products shipped through J4 Log—Mov/NDLCC/NDMCC/CMTT:

(1) **Stock Levels/Inventory Control**. Refer to the standard scales of issue for topo, hydro, and aero products.

(2) **Consumption**. Comment on supply discipline and usage.

(3) **Replenishment**. Comment on national solution and CF Map Depot manning status.

(4) **Restocking**. Comment on the theatre solution if planning to set up stand alone CF distribution points.

5. **COMMAND AND SIGNALS**:

a. **Command Relationships**. Clearly identify who is the senior geo officer in theatre, who is geo advisor to the JF commander, and how they can be contacted. Detail the command and control relationships between the levels of command and attached geomatics supporting assets. (Include primary and alternate locations for all geomatics support assets):

(1) **J2 Geomatics NDHQ** (National Command).

(2) **JHQ Chief Geographic Officer** (CF JHQ/HQ LFA/HQ 1 CAD).

(3) **TF Sector HQ**—Component HQ (Bde/Wing/Task Gp)

(4) **CO MCE** (national supporting commander).

(5) **OC Geomatics Sp Squadron** (Deployed) as part of ESU.

b. **Communications**. Provide a statement describing the scope and types of any special communications support that is required for geomatics operations (this should be coordinated between J2 GI OPS and J6 staff). Deployed MCE assets have limited communications capabilities; thus, explicit tasks need to be assigned to ensure that the JF/TF assets effectively support the MCE. This is especially important in the case of electronic distribution of DGI to users and the deployed detachments/ sections in the ESU Geo Sp Squadron.

c. **Links to National/Host/Allied Capabilities**. Information and contacts need to be provided (can be included in Appendix 4).

d. **Reports**. Indicate requirement for reports, such as, in the case of a NATO mission, the initial Geographic Situation Report (GEOSITREP) and follow-on timings. See Appendix 3 for format.

LIST OF APPENDICES

1. **Appendix 1**. Geomatics Requirement List and Planning Tables (Locally reproduced).

2. **Appendix 2**. Distribution Plan—Storage Location Graphics/Maps.

3. **Appendix 3**. Reporting and GEOSITREP Format.

4. **Appendix 4**. Geomatics Points of Contacts.

5. **Appendix 5**. Geo Sp Squadron TFMT/TO&E Requirements.

6. **Appendix 6**. Designated Products (Map Index Coverages).

7. **Appendix 7**. Authorized Users to Receive Def Geo Products.

CHAPTER 3
TERRAIN ANALYSIS AND TERRAIN VISUALIZATION

And therefore I say, know the enemy, know yourself; your victory will never be endangered. Know the ground, know the weather; your victory will then be total.

Sun Tzu, *The Art of War* (c. 500 BC)

SECTION 1
INTRODUCTION

BACKGROUND

1. Terrain analysis and terrain visualization concern themselves with the collection, interpretation, and production of information to assess the characteristics of the ground on military operations. An in-depth study of the geospatial and military aspects of the battlespace can permit the commander to visualize the terrain and what effects it will have upon operations. The information acquired can be textual or graphic in format and can cover the continuum from extremely complex to very simple in nature.

2. In the past, failure to recognize the implications of terrain has meant the difference between success and defeat on the battlefield. It was not until after WWII that serious and sustained attention was given to the problem of evaluating and predicting terrain conditions. The stimulus was provided by the Cold War and the realization that central Europe could again become a battleground. As NATO forces prepared for the defence of Western Europe in the early 1950s, the operational research section of the British Army on the Rhine was given the responsibility for the collection of soil data and preparation of "going maps" for the British area of responsibility (AOR) in Germany and the adjacent areas in Belgium and Holland. The basic concern in this mapping project was cross-country mobility, in particular the identification and delineation of areas that were impassable or difficult for heavy tracked vehicles such as tanks. Similar trafficability maps were prepared by the US Army Engineer School, Fort Belvoir, for the American AO in Germany.

3. During the last 25 years, it has become apparent that terrain information has relevance to a wide range of military activities, in addition to cross-country mobility. Combat commanders need to

know as much as possible about the battlefield if they hope to control the action upon it.

4. During the planning phase of an operation, all the terrain characteristics must be taken into account in order to get a true representation of the battlefield. The army's increased reliance on speed and mobility makes timely and accurate terrain information more important than ever before. Slope, vegetation, soils, drainage, waterways, roads, railroads, bridges, and other terrain factors must be taken into account in the planning phase and the carrying out of combat manoeuvres.

5. In 1989, terrain analysis expanded to 1st Canadian Division Intelligence Company with the provision of a terrain analysis team. The team's task was to provide geospatial information relevant to the 1 Canadian Division's mission, now referred to as the CF Joint Headquarters (CF JHQ).

6. In support of a MCF deployment, the Geo Sp Sqn is capable of fielding a total of four teams: one to the CF JHQ and up to three to support Formation HQ and Environmental Component Headquarters. This capability does not include the GSTs integral to the engineer regiments, which could be augmented with Geo Sp Squadron resources based on a specific requirement (this is further elaborated upon in Chapter 8.)

AIM

7. The aim of this chapter is to outline the terrain analysis (TERA) and TVis support provided to a deployed Canadian formation, task force, or environmental component.

SCOPE

8. The scope of this chapter will consider the following aspects for the provision of TERA and TVis:

a. definitions and principles;

b. organization and role;

c. TERA—basic principles;

d. TVis—basic principles; and

e. command and control.

SECTION 2
DEFINITIONS AND PRINCIPLES

DEFINITION

9. **Terrain Analysis** is the process of collecting, collating, analyzing, and evaluating natural and man-made features and the integration of climatological factors upon these features within the intelligence process, in order to give a true representation of the effects of the ground on military operations.

10. **Terrain Visualization** is a method that enables a terrain analyst to provide the commander and staff automated assistance in visualizing the terrain and to display and plot digital geospatial information.

PRINCIPLES

11. The requirement for a commander to do ground appreciation still exists. The process has always been carried out in some form or another, but the terms “terrain analysis and terrain visualization” describe the first three steps in the commander's ground appreciation:

a. presentation of terrain information relevant to the aim;

b. evaluation of the terrain information leading to deductions on the enemy's likely use of the ground; and

c. evaluation of the terrain information leading to deductions that will influence how the commander makes the best use of the ground.

12. For these reasons, it is necessary to maintain and develop relevant terrain information to support the commander and staff throughout the decision/action cycle. The seven military characteristics of terrain using the well established mnemonic FLOCARK are:

a. F—features (including observation, fields of fire, cover, concealment, and obstacles);

b. L—lanes;

c. O—objectives;

d. C—canalizing ground;

e. A—approaches;

f. R—rate avenues of approach (AA); and

g. K—key terrain (KT) and vital ground (VG).

ORGANIZATION AND ROLE

13. **Organization**. Focused on the commander's decision cycle, the GST is available to undertake terrain analysis and provide terrain visualization using complex data sets and multiple on-line data sources. Assigned to the CF JHQ, an environmental component/TF or a subordinate Canadian mechanized brigade group (CMBG) or Wing GST undertake to identify those terrain characteristics that could affect each course of action the formation is planning, with principal capabilities concentrating to:

a. develop impacts, focusing the mission planning effort; and

b. predict effects of terrain and weather on deployment and manoeuvre.

14. **Role—To Support Mission Analysis and Enhance Decision Making**. To provide the commander with timely and accurate terrain information within the area of concern.

SECTION 3
TERRAIN ANALYSIS—BASIC PRINCIPLES

15. TERA plays a key role in providing detailed and timely information on the battlespace, incorporating the effects of weather, with the ultimate goal of enhancing the decision/action cycle inherent in the OPP. G3/G2 staffs are primarily concerned with supporting the commander's risk analysis of friendly and enemy manoeuvre courses of action. The commander must also consider weather and terrain in order to exploit the available combat power to the maximum advantage. Engineers are concerned with immediate battlefield terrain knowledge to facilitate terrain utilization decisions. Exploiting enhanced or value-added information and data sets allows engineer TERA resources to focus on mobility, counter mobility and survivability planning.

16. TERA plays a key role in conducting intelligence preparation of the battlefield (IPB), involving the analysis of selected geospatial information of a given geographical area and determining the effects of natural and man-made features on military operations in concert with the weather. It should be understood that the aim of TERA is to reduce the amount of time required for field reconnaissance—not to replace it. TERA can speed up the formation planning process and unit battle procedure. It is also essential to understand that TERA is a mixed analogue/digital information service provided by engineers, rather than a collection of products. There are three approaches to answering environment or terrain-based questions and providing decision aids for the commander and his staff:

a. **Environment/Terrain Study Approach**. Assessments are made in response to specific questions, such as: a country brief for a humanitarian mission: an inter-country border study for security operations: or an analysis of the area of operations (AO) for combined warfighting. The product is in text format with small-scale decision aids. It identifies any limitations on military aspects and force capabilities that may be caused by the physical environment.

b. **Multi Purpose Database Approach**. This approach exploits special terrain factor overlays to answer any one of a multitude of terrain-related questions, such as a cross-country mobility assessment for vehicle type. The product is an overlay appropriate to the planning map scale. Critical to this process is the existence of a current and accurate TERA database of selected geospatial information consisting of six *(*minimum) terrain factor overlays: surface configuration (slope), vegetation, surface materials (soils), surface drainage, man-made features (transportation), and obstacles. These factors are limited to natural and man-made features of military significance.

c. **Intelligence Preparation of the Battlefield (IPB) Approach**. IPB is a systematic and continuous approach to analyzing the enemy, weather, and terrain to determine enemy capabilities, vulnerabilities, and probable courses of action for a

specific geographic area. Integrated with the staff planning process, it assists commanders in the development of their plans and provides a basis for tactical decision making and synchronization of combat power on the battlefield. Describing the battlefield, is predominantly carried out by the GST using TERA techniques. The Int Staff and Metrological Techs contribute to the this effort as well, and brigade engineer staff is responsible to devise methods of exploiting the findings of the TERRA analysis by allocating resources to tame or harness terrain challenges or advantages.

17. The analysis of the AO report for NATO warfighting is prepared by the GST with the assistance of the intelligence analyst, when requested and time allows. It is the intelligence analyst who has the responsibility to provide information on the enemy as it pertains to the AO. The GST will provide an analysis of the AO for the JHQ down to the brigade level, in conjunction with the report, five standard traces are included as follows(other mission-specific information, such as transportation infrastructure and hazardous areas, can also be incorporated):

a. cross-country movement (restricted/severely restricted);

b. concealment;

c. river-crossing information;

d. helicopter-landing zones (HLZ); and

e. lines of communication (LOC), including bridge information.

INTELLIGENCE PREPARATION OF BATTLEFIELD

18. The IPB process is typically fully employed at divisional level and above. At brigade level and below, the limitations of staff, time, and information will influence the detail and formality but should not affect the process. The IPB process integrates enemy doctrine with weather and terrain and relates these factors to the mission and specific situation. The steps of the IPB process are:

a. define the battlefield environment;

b. describe the battlefield's effects;

c. evaluate the threat; and

d. determine threat courses of action.

19. The IPB process is controlled by the force/formation G2. It is driven by a multidisciplinary approach with "Describing the Battlefield" as step 2 in the IPB process. The GST is responsible for describing and depicting the battlespace, as well as exploiting the geospatial information database to produce specific outputs. The GST will produce a combined obstacle overlay (COO) based on formation SOPs. The COO is a product that depicts battlefield effects on mobility and can be a single overlay or multiple overlays keyed to 1:50 000 or 1:250 000 various factors are evaluated and integrated using overlays such as drainage, slope, transportation routes, vegetation, surface material, and linear obstacles. These factors formulate the TERA Database. Its exact form depends on the tactical or operational level requirements. If available, and time permits, soil and weather will also be considered. The characteristics of weather are: temperature and humidity, precipitation, wind, visibility, and clouds. The COO is forwarded to G2 to analyze the terrain and weather effects on the configuration of the enemy forces in the area of operations. The G3 will use the same information to assess the effect on friendly operations.

INTELLIGENCE, SURVEILLANCE, TARGET ACQUISITION, RECONNAISSANCE

20. The role of ISTAR is to integrate the intelligence function with surveillance, target acquisition, reconnaissance and other information generating assets in order to improve a commander's SA, streamline decision-making processes and cue manoeuvre, strike and/or other ISTAR assets.

21. In order to be effective, the ISTAR process must commence as early as possible, usually in concurrence with Step 2 of IPB—"describe battlefield effects". That is, initial NAI can be identified based on restrictive terrain and its effect on movement as well as key terrain and vital ground. As terrain will dictate movement, it will also impact on placement of NAI/TAI and Decision Points (DP) (concurrent with step 2 of IPB).

22. The ISTAR Coordination Centre (ISTAR CC) and the All Source Cell (ASC) form the nucleus of ISTAR operations. The ASC

provides coordination and analysis under the direction of the ISTAR CC.

23. Assisting the G2 Plans are the Geomatics cell and the Meteorology cell in the execution of IPB and the input of weather and terrain to the enemy course of action assessments. This G2 Plans team coordinates its efforts with those of the ASC. This coordination consists of providing terrain analysis products and meteorological forecasts to the ASC so that the ASC can complete the picture of Brown SA.

APPROACH TO TASKS

24. In order to make the terrain products valuable, the following characteristics must be adhered to:

a. timeliness;

b. accuracy; and

c. currency (the information must be up to date).

25. The manner in which a GST approaches a task is identical to the intelligence cycle in that it follows these four stages:

a. direction;

b. collection;

c. processing (collation, evaluation, analysis, integration, and interpretation); and

d. dissemination.

DATA COLLECTION

26. The collection stage requires the GST to contact various federal, provincial, and military geomatics agencies to acquire data that may be relevant to the task. This data may include:

a. standard operational maps;

b. digital mapping products:

(1) raster data (e.g. geo-referenced images, scanned maps);

(2) vector data (e.g. intelligent point, line and area features); and

(3) matrix data (e.g. elevation data).

c. town plans;

d. multi-spectral imagery;

e. remote-sensed imagery;

f. reconnaissance reports;

g. intelligence reports;

h. resources data (water, forestry);

i. geological maps;

j. periodicals; and

k. tourist guides.

PROCESSING

27. The third stage is to process all the material collected and produce a database. Several methods of producing terrain analysis databases exist. The two main methods are:

a. Production of databases in a base plant production environment, usually due to the labour intensity and required resources of the task. The base plant could produce:

(1) tactical terrain analysis database (TTADB) at 1:50 000 scale;

(2) planning terrain analysis database (PTADB) at 1:250 000 scale; and

(3) interim terrain data (ITD).

b. Production of databases by a GST in theatre through data extracted primarily from topographical maps, reconnaissance photos, and other local sources.

TERRA DATABASE

28. **Terrain Analysis Database**. This database contains the six primary themes that are subdivided into sub themes. These are used as the basis to produce any product requested by a user. The primary themes and some of their sub themes are:

a. **Surface Configuration**. Surface configuration refers to the shape of the earth's surface. This includes the hills and valleys, mountains and plains, and all other natural irregularities, both major (macro relief) and minor (micro relief). Consequently, surface configuration refers to the earth's natural and manmade features collectively and has significant impact on all tactical decisions:

(1) **Landform**. Landforms are the physical expression of the land surface. The principal groups of landforms are plains or plateaux, and hills and mountains. Within each of these groups are surface features of a smaller size, such as flat lowlands and valleys. Each type of landform and sub landform region results from the interaction of earth processes in a region with given climate and rock conditions. A complete study of a landform includes determination of its size, shape, arrangement, surface configuration, and relationship to the surrounding areas.

(2) **Topography**. Topography refers to the configuration of the earth's surface, including its relief and the position of streams, roads, cities, etc.

(3) **Relief**. Local relief is the difference in elevation between the points in a given area. The elevation irregularities of the land are represented on graphics by contours, hypsometric tints, shading, spot elevations, and hachures.

(4) **Micro Relief**. Surface roughness is synonymous with micro relief and covers the expression of the land surface or surface geomorphic features that are less than the contour lines on the base map in height.

(5) **Slope/Gradient**. Slope can be expressed as the slope ratio or gradient, the angle of slope, or the percentage of slope. The

angle of slope in degrees is the angular difference the inclined surface makes with the horizontal plane. The tangent of the slope angle is determined by dividing the vertical distance by the horizontal distance between the highest and the lowest elevations of the inclined surface. Slope information that is available to the analyst in degrees or in ratio values may be converted to percentage of slope by using a nomogram.

b. **Vegetation**. Vegetation may be the most important terrain factor or may be negligible. The importance of vegetation is proportional to the density. Vegetation will affect military tactics, decisions, and events. As an obstacle to movement, vegetation will slow down the advance of vehicles and personnel as well as limit the landing capability of helicopters. Vegetation could effectively conceal troop movement, negate effective use of sensors and block observation and fields of fire. To make reliable evaluations pertaining to the military aspect of terrain, data must be collected on the potential effect of vegetation on key terrain features, observation, cover and concealment, obstacles, and avenues of approach. In addition, the availability of natural fuel, shelter, food, and construction material, as well as an area's susceptibility to fire and blow down are concerns that must be evaluated.

c. **Physical Materials of the Earth**:

(1) **Geological Makeup** (**Rocks**). Three major types of bedrock exist: igneous, metamorphic, and sedimentary rocks. All types have several sub type and categories attached to them.

(2) **Surface Materials** (**Soils**). Since soils vary in their ability to withstand vehicle passes and their ease of digging, military planners rely on soil analysis. Soil type, drainage characteristics, and moisture content affect road construction, material location, and

trafficability determination. The soil factor overlay breaks down the most probable soil types, characteristics, and distribution.

d. **Hydrology**. Hydrology is concerned with the characteristics of surface and sub surface water. This terrain group is closely associated with the other terrain groups because many of its characteristics are directly or indirectly influenced by them. Today, with the concept of rapid mobility, it is vital for commanders to know what streams exist, where they are, their size, and how much water they are likely to have during each season of the year.

e. **Manmade Features**:

(1) **Urban Areas**. Urban area intelligence is important in the planning of tactical operations and logistical support for operations. Knowledge of the characteristics of the urban area may also be important in the conduct of domestic operations, civil affairs, and in information operations. Although information on urban areas is more accessible than in rural areas, the amount of detail required necessitates a substantial encyclopedia for baseline planning.

(2) **Rural Areas**. In planning operations, consideration must be given to the effects rural areas will have on the national economy, as well as those areas outside the principal urban centres of a country. Farmlands, villages, natural resources, and other non-urban features are important considerations for tactical operations.

(3) **Transportation** (**Ground**):

(a) **Railways**. Railways constitute the backbone of the bulk cargo carrying transportation system in many countries, even in those areas where a complementary road

system has been extensively developed. The suitability for long-distance mass movement and low susceptibility to the vagaries of the weather make them particularly useful for logistical support. Railways assume increased military importance in areas where the soil is generally untrafficable, the road network poor, and the rail transportation extensive.

(b) **Roadway**. An adequate road system is a fundamental logistical requirement in the conduct of any tactical military operation. Military interest in the road and railway network of a given area or country covers all physical characteristics of the existing road-track-trail system and the various administrative and operational aspects pertaining to construction and maintenance. Terrain studies must provide information on the existing routes and, if available, information on where new routes will be needed to support planned operations.

(4) **Transportation** (**Air**):

(a) **Airfields**. Airfields are important for modern operations. Airfields permit the rapid movement of cargo and personnel, including medical evacuation. Airfields are essential to most fixed-wing operations and are desirable for rotary-wing operations.

(b) **Tactical Aviation Facilities**. These are areas specifically designated and marked for

helicopter landing and takeoff. Heliports are permanent facilities. Helicopter landing sites (HLS) are natural or temporary, and a HLZ consists of one or more sites.

(5) **Water Transportation**. Information on ports, naval bases, and shipyard facilities is essential for estimating capacities, capabilities, vulnerabilities, and other items of military significance. The enormous increase in the bulk cargo carrying capacity of ships has necessitated construction of more massive and complicated pier and wharf structures and offshore terminals:

(a) **Ports**. Ports are settlements with installations for handling waterborne shipping. Principal port facilities are berthing space, storage space, cargo-handling equipment, cargo trans-shipment facilities, and vessel-servicing facilities. Ports are classified on an area-wide basis rather than on a worldwide basis. A principal port in a small maritime nation may be equivalent to a much lesser port in the more extensive port system of another system. In wartime, principal and secondary ports and bases are prime targets for destruction; as a result, the relative importance of minor ports increases.

(b) **Harbours**. Harbours are areas where the anchorage and shore are protected from the sea and storms by natural and man-made barriers. Areas that do not have this protection but are still suitable for vessel anchorage are termed open anchorage or roadsteads. A good

harbour must have deep water, adequate protection from storms, enough space to accommodate a large number of vessels, and a shoreline that can be developed as a port or as a site for industry. Harbours may be situated on the sea, estuaries, or inland lakes and rivers and may easily be recognized by abundant traffic and port facilities.

f. **Obstacles**. An obstacle is any natural or man-made terrain feature that slows, diverts, or stops the movement of personnel or vehicles. Obstacles are classified as natural, such as escarpments, or man made, such as built-up areas and cemeteries. For classification purposes, obstacles must be at least 1.5 m high, 250 m long, and have a slope greater than 45% (so that military vehicles are unable to travel).

SYNTHESIS

29. The synthesis products are compiled using both the user parameters in conjunction with the database. In order for the products to conform to the request, the analyst must be in direct contact with the requester. Precise direction must be arranged in order to complete a viable product and avoid delay and misunderstanding in the completion of the synthesis product.

DISSEMINATION

30. How the product is disseminated depends on what the user wants and how much time is available. The presentation may be any combination of the following:

a. briefings;

b. overlays;

c. overprint;

d. special maps or plans;

e. written reports; and/or

f. a combination of the above products.

SECTION 4
TERRAIN VISUALIZATION—BASIC PRINCIPLES

31. Commanders and their staff routinely evaluate a myriad of complex factors in preparation for military operations. Critical decisions that will determine the success or failure of an operation are derived from these analyses. Providing the commander with the ability to realistically and effectively see the battlefield utilizing TVis and analyze the greatest number of physical environmental factors possible is a fundamental service offered by the engineers.

32. The concept of TVis is to provide mission-focused geospatial information to the staff supporting mission planning; this is a basic and fundamental requirement. TVis provides the commander with a three-dimensional insight into the impact of the local environment in an area of operation. By understanding the effects of weather on the terrain, seeing the opportunities it offers, and anticipating when they will come into play, the commander is able to set the terms of battle to maximize his or her performance and take advantage of the limitations of the enemy forces.

33. Supporting current and future operational and tactical planning, TVis includes the capability of database development, data analysis, and data display. Upon notification of a possible operation, the commander and staff want immediate knowledge of the area of operation and the projected area of interest. Digital data must be available over the entire area of interest in all databases exploited by the several command and control systems and mission planning and rehearsal systems used by planners. The terrain coverage must be in sufficient detail to support mission execution as well as planning and rehearsal processes. With this complete coverage, and with the power to determine the significance of the terrain to the mission, the commander has the means for TVis and all users have a common image/background of the battlespace as their frame of reference.

34. TVis is produced in specialist geographic information systems (GIS) and displayed through visualization software, thereby allowing terrain visualization applications to create an entryway to the virtual battlefield. Presenting an integrated view of the physical environment, with the tools to interact with the depicted representation, terrain visualization provides the commander the best

measure of the battlefield to complete the essential mission analysis. Mission analysis is the fundamental activity that initiates the estimate process and focuses on the commander's decision cycle, enlisting specialist engineer work to identify those terrain characteristics that could affect the accomplishment of the mission. Thus, TVis can provide support throughout the estimate process and can serve as a decision aid during execution.

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CHAPTER 4
MAP SUPPLY

SECTION 1
INTRODUCTION

GENERAL

1. The supply of paper maps and charts and digital geospatial data forms a fundamental and essential part of operational geomatics support. Unless standard, amended or response products are distributed efficiently and promptly, the considerable investment in acquisition and production of this information will have been wasted. More importantly, the soldier in the field will be denied a tool on which he depends.

2. The MCE maintains a Map Supply Detachment under command of the Geo Sp Sqn. Doctrinally, the detachment consists of four personnel, commanded by a warrant officer (WO), who run a map supply point (MAPSP). They will support a JTF as part of a larger national or combined map supply organization.

AIM

3. The aim of this chapter is to outline the map supply services provided to a deployed JTF or allied or coalition forces.

SCOPE

4. This chapter will describe provision of map supply under the following headings:

a. general operating principles;

b. the map supply system;

c. equipment; and

d. command and control.

SECTION 2
GENERAL OPERATING PRINCIPLES

GENERAL

5. The operating principles most applicable to a successful map supply operation are economy, flexibility, and anticipation.

ECONOMY

6. By ensuring judicious ordering and issuing of map stocks and digital information, the waste of a costly and limited resource is minimized. Unit and formation scales of issue will be established by J2 Geomatics Operations environmental staff and must be adhered to (example in Annex A).

FLEXIBILITY

7. The map supply system must be flexible in tailoring support according to the AOR and the size and composition of the supported force. The system may require augmentation in the critical early days of an operation. The MAPSP may require extra personnel initially and may have to be mobile. In addition, the Canadian MAPSP must conform to the configuration and procedures of the theatre map supply system as run by the lead nation.

ANTICIPATION

8. The time consuming and technical task of generating geographic products and the logistic burden of delivering them to units in theatre require that planning for map supply begins at the very earliest stages of mission planning. As such, it is essential that there be a geomatics staff presence in strategic and operational level HQs and that geomatics staff be included in planning from the earliest stages. Once in theatre, close links to central staffs must be maintained to enable early warning of changes to AORs and/or introduction of new products.

SECTION 3
THE MAP SUPPLY SYSTEM

GENERAL

9. Geo Sp Squadron is equipped to field a MAPSP. This detachment is adequate to support the JTF organization that Canada might field and should suffice to support any subordinate organizations, depending on Canada's role. To do so, the MAPSP must fit into the larger, theatre map supply system, which consists of, as a minimum, a TMD.

THEATRE MAP DEPOT

10. Theatre map depot is the term used to define an operational map depot established to support an operational force in a theatre of operations. The size of the TMD will be based on the theatre of operations, geographic AOR, and the forces to be supported. The TMD will be deployed into a suitable location in the rear support area of the theatre of operations, usually near the point of disembarkation, for ease of logistic re-supply.

11. The TMD will be established early in any operation to form the basis of the operational map supply system.

12. Upon arrival in theatre, units and formations may be issued bulk stocks, covering administrative and training areas as well as operational areas, at the TMD. Alternately, maps may be issued to contributing nations for distribution to their forces prior to entry into theatre.

13. The TMD will be expected to hold initial issues and maintenance stock for theatre troops covering the immediate operational area, with reduced quantities of the geographic area of interest. The chief GEO officer is responsible for assessing the initial issues and maintenance stock requirements based on the scales of issue tables as well as the AOR and coalition make up and concept of operations. The TMD will require a large warehouse or hangar for accommodation.

14. The purpose of the TMD is:

a. to supply incoming forces with operational map packs;

b. to support deployed MAPSPs;

c. to support the forward map distribution point, if deployed;

d. to support forces deployed in the rear support area (RSA) with their geographic requirements;

e. to be a customer source for geomatics advice; and

f. to be a focal point and management centre for the operational map supply system in theatre.

15. In the event that Canada takes the role of lead nation for an operation, there would be a requirement to provide a TMD. While Geo Sp Squadron could provide the expertise and supervision, much augmentation would be required, to include:

a. extensive host nation support;

b. funds for local purchase or rental of:

(1) material handling equipment;

(2) real estate;

(3) pallets;

(4) racking;

c. labour; and

d. transport.

FORWARD MAP DISTRIBUTION POINT

16. A forward map distribution point (FMDP) is the term used to describe a small mobile map depot. The size of the FMDP will depend upon the operational area of the formation or formations supported. A FMDP will be deployed when the line of communication between the supporting map depot and the deployed MAPSPs becomes so great that rapid operational support is not possible.

MAP SUPPLY POINT

17. MAPSP is the term used to describe a vehicle equipped to carry mapping for issue in the field. The crew of a MAPSP consists of two MOC 142 geomatics technicians. The WO is designated as the

MAPSP commander. The second detachment member is able to take over command of the MAPSP at any time should the MAPSP commander be indisposed.

18. The MAPSP is equipped and staffed to support a CF MCF operation. Although it could hold most of the MCF load for a short term (i.e. in the event of a complete change of AOR), it generally holds maintenance stock consisting of about 10 % of the MCF initial issue. It would normally be located in the MCF rear services area, moving forward as required to distribute maps and other geomatics products to the environmental components. The MAPSP and higher map supply facilities are re-supplied through the logistic transport system.

19. The basic tasks performed by the MAPSP are:

a. monitoring of stock levels and consumption rates and management of paper and soft copy digital geomatics products through an inventory control tracking system (ICTS) or through the system dictated by the lead nation;

b. arranging local storage for products and sourcing at theatre level;

c. breaking down theatre supplied bulk stocks;

d. preparing formation or unit loads; and

e. arranging shipping or unit collection.

SECTION 4
EQUIPMENT

20. The equipment required for map supply is dependant on the level of map supply to be performed and on the size of formations to be supported:

a. **TMD**. Operation of a TMD would require the following:

(1) real estate/infrastructure;

(2) power;

(3) computer with inventory tracking software;

(4) material handling equipment;

(5) pallets;

(6) racking; and

(7) transport.

b. **FMDP and MAPSP**. The FMDP and MAPSP are intended to be more mobile than the TMD, and would require the following:

(1) HLVW (heavy logistic vehicle wheeled) with pallet loading system;

(2) storage container;

(3) shelving and cabinets;

(4) power (dedicated or generator); and

(5) computer with inventory tracking software.

SECTION 5
MAPSP COMMAND AND CONTROL

21. As with other controlled stores, map supply is controlled by the G3 ops staff at the various levels of command, taking into account advice from the geomatics commanders and staff. The MAPSP is a unique asset, which should be controlled by the highest Canadian HQ in an operational theatre, unless Canada plays the lead nation role. In the latter case, it would be necessary to establish a TMD. The MAPSP would then either be delegated to a lower HQ or would be incorporated into the TMD operation.

22. The MAPSP could remain under command of the Geo Sp Squadron or, alternatively, be placed OPCON to either the JTFHQ or JTFSGHQ. If moving forward to distribute maps and other geomatics products to the environmental components, TACON would most likely be assigned to the nearest component HQ.

23. The MAPSP, at a minimum, will require daily maintenance. This administrative responsibility is implied in the OPCOM and OPCON command relationships. If assigned TACON to a HQ, this support must be specifically arranged.

ANNEX A
TOPOGRAPHIC (PAPER) MAP SCALES OF ISSUE

1. The tables below provide figures for map scales of issue to CF units under the following force employment scenarios: combat operations, peace support operations, and domestic operations. The quantities in the table represent the number of maps required by a specific unit for each title within their AOR. For example, if a major unit on a combat operation has a bn AOR that covers four 1:50k topo maps, that unit would require 400 copies of each of the four titles for a total of 1600 maps for the bn AOR.

2. The map scales were derived using baseline figures from NATO HQ Allied Command Europe Rapid Reaction Corps (ARRC) providing geographic support to the NATO led Stabilisation Force in Bosnia (SFOR) in line with Canadian Army doctrine. Combat map scales figures were calculated at x2 PSO figures, and domestic scales were calculated at ½ PSO figures.

3. While the current example illustrates the requirements for paper maps, the immediate future sees the requirement for storage and issue of digital geospatial products as well as classified products. These issues are being addressed now and will be promulgated once more users have a requirement for this type of information.

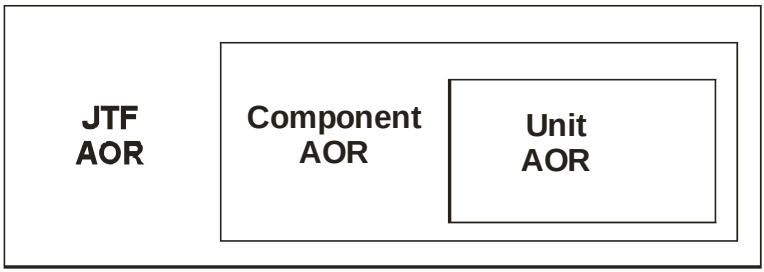

Figure 4A-1: Map Scales in Relation to AOR

4. Combat Operations:

	Unit Size	1:25 K MTPs	1:50K Topo Line Maps Area of Influence			1:250K TLMs / JOGs Area of Interest			1:500K TPC
		AOR	Bn AOR	Bde AOR	Div AOR	Bn AOR	Bde AOR	Div AOR	AOR
Cbt Units	Div HQ	10	0	0	50	0	0	50	20
	Bde HQ	10	0	30	10	0	20	10	10
	Major Unit	20	400	50	20	100	20	5	5
	Minor Unit	10	200	25	10	50	10	5	5
	Indep Coy	10	0	15	5	0	10	5	5
	Indep Pl	5	0	5	1	0	5	1	2
CS & CSS	Bn	20	0	100	25	0	50	30	5
	Indep Coy	10	0	30	10	0	20	10	2
	Indep Pl	5	0	10	5	0	10	5	1

5. Peace Support Operations:

	Unit Size	1:25 K MTPs	1:50K TLMs Area of Influence			1:250K TLMs/JOGs Area of Interest			1:500K TPCs
		AOR	Bn AOR	Bde AOR	Div AOR	Bn AOR	Bde AOR	Div AOR	AOR
Cbt Units	Div HQ	5	0	0	25	0	0	25	10
	Bde HQ	5	0	15	5	0	10	5	2
	Major Unit	10	200	25	10	50	20	5	2
	Minor Unit	5	100	15	5	25	10	5	2
	Indep Coy	5	20	15	5	15	10	5	5
	Indep Pl	2	10	5	1	1	5	1	2
CS & CSS	Unit	10	0	50	20	0	25	15	2
	Indep Coy	5	0	15	5	0	10	5	1
	Indep Pl	2	0	5	2	0	5	2	0

6. **Domestic Operations**:

	Unit Size	1:25K MTPs	1:50K TLMs Area of Influence			1:250K TLMs/JOGs Area of Interest			1:500K TPCs
		AOR	Bn AOR	Bde AOR	Div AOR	Bn AOR	Bde AOR	Div AOR	AOR
Cbt Units	Div HQ	2	0	0	10	0	0	10	5
	Bde HQ	2	0	10	5	0	10	5	5
	Major Unit	5	100	25	10	25	10	5	2
	Minor Unit	5	50	15	5	15	5	5	2
	Indep Coy	2	15	10	2	10	5	2	2
	Indep Pl	1	0	5	1	1	2	1	1
CS & CSS	Unit	5	0	25	10	0	10	5	2
	Indep Coy	2	0	5	2	0	5	2	1
	Indep Pl	1	0	2	1	0	2	1	0

CHAPTER 5
GEOSPATIAL DATA MANAGEMENT

SECTION 1
INTRODUCTION

GENERAL

1. Success on the modern battlefield will be strongly influenced by the ability of the commander to get inside the opponent's decision/action cycle. The complex nature of manoeuvre warfare requires a staff to assist the commander in preparing for and conducting the fight, thereby, requiring all staffs to operate from a COP.

2. Traditionally, the backdrop for this COP has been a hardcopy map, with acetate overlays depicting various aspects of the terrain and the battle. Unfortunately, while this enabled those in the headquarters to have a COP, those not collocated were at a serious disadvantage because of the time delay required to copy and disseminate the overlays (not to mention the inherent risk of introducing errors). Fax technology did little to eliminate these problems and in fact introduced other problems including scale distortion.

3. The introduction of the digital era has brought hope that digital technology will eliminate the above problems and ensure a COP across the battlefield. While digital mapping and GIS will go a long way toward achieving the desired endstate, it too is not an answer in itself. It has often been said that a computer with a bullet hole in it is a paperweight while a map with a hole in it is a map with a hole in it. Further, when a mapping agency provides a CD-ROM containing DGI, there is no inherent grid system, no scale, no orientation and no ready means of accessing marginalia and metadata. Drawing an analogy with the paper map, receiving DGI is rather like receiving a printed list of coordinated points, being given a blank sheet of paper and some ink, and being told to draw your own map. With all the geospatial data (commonly referred to as "geo data") potentially available to the staff for use in LFC2IS or other deployed C2IS, there is an increased demand for geospatial data management.

4. The MCE maintains a Data Access Section under command of the Topographic Troop (Topo Tp), a sub unit of the Geo Sp Squadron. Doctrinally, the section consists of seven personnel, commanded by a warrant officer. All personnel will be MOC 142

geomatics technician specializing in data management and GIS. The section commander will be a GIS specialist.

5. The role of the Data Access Section is to condition and disseminate geospatial data and information in a form contributing to the common operating picture.

AIM

6. The aim of this chapter is to outline the management of geospatial data within the context of a deployed Geo Sp Squadron.

SCOPE

7. This chapter will consider the following aspects for the provision of geospatial data:

a. general operating principles;

b. grouping and deployment;

c. command and control; and

d. glossary of terms.

SECTION 2
GENERAL OPERATING PRINCIPLES

PRINCIPLES OF SURVEY

8. The principles of survey are the cornerstone on which geospatial information is based. The principles apply equally well to data management as to conventional field survey. They are:

a. control;

b. economy of accuracy;

c. consistency;

d. independent check;

e. safeguarding; and

f. revision.

CONTROL

9. The accuracy of all geospatial data is intimately linked to the establishment of sound survey control. In the case of DGI, this control can be viewed in a more liberal sense and include the parameters around which geospatial data is hung such as datum, spheroids, projections and grid systems. Further, with respect to imagery, control includes all the parameters which define the geometry at the exact moment the image was sensed, including the orbital ephemeris, the look angle and the wavelength (and polarisation) of the radiation source.

10. An extension of the principle of control is the aspect of controlling the passage of information. While the LFC2IS or other deployed C2IS are the basis of ensuring a COP, it will only be effective if everyone is operating off the same data. Implicit within the role of the Data Access Section is the responsibility of ensuring that not only is the most up-to-date data available, but that there is only one edition of data being used.

ECONOMY OF ACCURACY

11. This principle is particularly relevant to DGI and disregarding it will pose significant problems. DGI can be extremely bulky and therefore it is imperative that the user is provided with the exact data set required. For example, it would be extremely inefficient to provide a strategic planner all the 1:50 000 scale mapping of the area when all that is required is 1:1 000 000 scale mapping. Providing too much large-scale data would bog down the system. Additionally, why pay for current imagery with 1m spatial resolution when archived data with 25m resolution will meet the strategic requirement?

12. DGI is only one aspect of the COP. Operational information is the other. Traditionally, this has been portrayed graphically on acetate overlays, which are referenced to a specific map. The principle remains unchanged when the transformation is made to digital technology the background geospatial data will be maintained on the geo server (geospatial data server) and in general will only require minor updates during the course of an operation. The dynamic operational or tactical data, including geo-referencing links, will be maintained on separate LFC2IS servers. The Data Access Sect has the responsibility for maintaining a current database of geospatial data resident on the geo server. A separate organisation within the headquarters will be responsible for maintaining and managing the

tactical information. The two servers will be separate but linked. This will ensure all staff in the headquarters are using the same geospatial and tactical data, thus enabling a common view of the battlespace

CONSISTENCY

13. DGI, when presented to the user, must be consistent in terms of accuracy and geospatial parameters. For example, it becomes very difficult to draw conclusions about information given in a local datum and having the mapping portrayed in a global datum, such as WGS 84.

14. Generalization, the degree of information portrayed at various scales, is a significant hurdle that must be overcome when attempting to provide DGI with a zoom capacity. The situation is aggravated when operational data layers are referenced to a specific map scale. Due to the errors that can be introduced when attempting to change scale with these operational layers, they should only be displayed at the original scale.

INDEPENDENT CHECK

15. Perhaps the single most important of the six principles, ‘independent check’ is paramount in ensuring a COP. The modern battlefield will likely be characterised by the passage of massive amounts of incoherent data. In order to ensure that this becomes presented as coherent information, all levels of the ‘data chain’ must independently check the validity and accuracy of data being presented. This must start at the grass roots where the raw data is independently verified. The process is repeated as the information is passed up the chain. In this way, data that ends up in the common geo server is validated and accurate. That is to say, every effort must be made to reduce the effects of poor data integrity.

16. Data Access Section’s responsibility for data begins when the data is received in the section. While it must be assumed that the data being transferred to the section is accurate and has been independently verified, the Data Access Section will conduct gross error checks on all incoming data.

SAFEGUARDING

17. The foundation on which a COP is based is clearly the geospatial database that supports all geomatics software. Every effort

must be made to ensure the integrity of this crucial asset. This begins at the lowest level where copies of reports are kept. Within Data Access Section, the database is electronically backed up as prescribed by the applicable SOPs (standing operating procedures) or as directed by the G3/Ops O. In addition, copies of the database are physically separated from the section's location and stored in SHQ and transmitted back to MCE. Furthermore, a library of softcopies (and the affiliated database) of all products is maintained. The media used to store this data must be stable and protected from the physical and potentially harmful electronic environment.

18. Redundancy is emphasised in all aspects of Data Access Section's SOPs. In addition to the aspect of data mentioned above, the systems and all affiliated equipment are also duplicated. For example, there are two geo servers with their own power supplies that provide uninterrupted service in the event of power degradation or system failure.

19. Finally, the catch release copy of any hardcopy product produced by the Reproduction Section is archived within the Tp HQ with a digital copy being placed on the geo-server in Data Access Section.

REVISION

20. One of the key functions of the Data Access Section will be to determine 'what data is out there?'. Assessing the significance of changes to the data, as it becomes available, is also important. For example, a preliminary investigation may have revealed that a bridge was Military Load Class (MLC) 60. Engineer recce subsequently shows that the bridge is actually MLC 62. While important to note, it is probably not mission critical information. Clearly this would not be the case if the bridge had been destroyed and the approaches mined or the MLC was, in fact, below MLC 60.

ASSUMPTIONS

21. In considering the role of the Data Access Section and of data management as a whole, the following points should be borne in mind:

a. The provision of geospatial data must be balanced against the users' requirements i.e. the data requirements of a staff officer are vastly different from those of the deployed GST.

b. Data requirements will change during the course of an operation.

(1) **Initial Operating Data Set (IODS)**. Initially, small scale, 1:1 000 000 mapping and imagery will be required. This is commonly referred to as ‘Strategic Force Employment Planning Data’ or IODS and will be used by strategic/operational staffs to support decision briefs without specialist operator assistance.

(2) **Minimum Essential Data Set (MEDS)**. As the operation matures, data at the 1:250 000 scale will be needed. Known as ‘Task Force Operational Planning Data’ or **MEDS**, these data sets will be used by staffs to assist them in the preparation of estimates and the deployment concepts of operation. The completed MEDS, containing standard coverages, is provided to the JTF commander and his staff through on-line geo-servers. Due to the variable quality of data attribution and area coverage, the MEDS is intended for exploitation using low-level GIS by a trained user, and not necessarily for direct use by the staff.

(3) **Mission Specific Data Sets (MSDS)**. Finally, as the operation matures to the fullest extent, data will be required at the 1:50 000 scale (or larger if available). These ‘Tactical Operations’ data sets, known as MSDS, will be used by the fighting forces to conduct tactical operations such as reconnaissance and by commanders to assist with task definition. GSTs will use these data sets to provide speciality products and to produce 3-D views, with data manipulation being achieved through the use of a high-end GIS. Again, this data will be made

available through the geo server, which would be linked to the LFC2IS servers.

c. As a result of the rapid rate of change in technology, this chapter will only discuss equipment in the broadest sense when describing the concept of data management, thereby attempting to avoid becoming tied to a specific software application or platform.

d. The Data Access Section is unlikely to deploy independently of the Topo Tp, which in turn will be collocated with the Geo Sp Squadron in the ESU. This will serve to ensure that the command and control of vital geomatics engineer assets are controlled at the highest level.

e. In response to Canada's obligations to alliances, and given the scale and complex nature of modern conflict, it is likely that Canada will deploy as part of a coalition. This fact has spurred NATO and other allies to establish interoperability standards; equally applicable to geospatial data. While these standards, Digital Geographic Information Exchange Standard (DIGEST) for example, provide guidance, they do not ensure interoperability because of the variable nature of the GIS software. Consequently, one of the major tasks for the Data Access Section will be to de-conflict the data sets provided by allied geomatics specialists and ensure that the data is available for use in a compatible format.

f. The Data Access Section will not be directly involved with the distribution of standard paper mapping but will hold copies of all applicable mapping for its own purposes. As such it will be able to distribute electronic copies of standard mapping through the geo server. In a similar vein, the section is not responsible for the distribution of CD-ROMs of standard mapping but again will hold copies of all applicable CD-ROMs for source data and archive purposes.

GENERAL OPERATING PRINCIPLES

22. It must be understood that the ‘principles of surveying’ must be applied in order to ensure the efficient and accurate management of geospatial data.

23. The heart of the Data Access Section is the geo server, which will distribute geospatial data to the CF C2IS within the headquarters. This server will be robust and completely redundant at all levels, mitigating the possible adverse effects expected in the hostile environment of the modern battlefield.

24. Data made available on the server will be certified and constantly revised, ensuring that all users have the most up-to-date data available. To the greatest extent possible all data will be ‘hung’ on the NATO standard WGS 84 datum and projected with the Military Grid Reference System (MGRS). If this is not the case, then the section will ensure that the non-geospatial data user is made aware of the change and of the implications of the local datum and coordinate system. As far as the user is concerned, the data will be available in a ‘read only’, ready-to-use format.

TYPES OF DATA

25. For the purposes of this chapter, the five types of data which can be exploited by Data Access Section are listed:

a. paper;

b. standard digital products;

c. imagery and photography;

d. reports; and

e. plans and orders.

26. **Paper**. This data format includes the traditional standard mapping and non-standard products produced by the GSTs and National Mapping Agencies. It should be emphasized that while the Data Access Section is not directly involved with the distribution of standard mapping products, these products are valuable and reliable sources of data, particularly during the initial phases of a conflict.

27. **Standard Digital Products**. Typical standard digital data includes products such as ARC Digitized Raster Graphics (ADRG) and Digital Terrain Elevation Data (DTED) which are produced by

mapping agencies to recognized specifications. Also included in this category is commercially available digital data.

28. **Imagery and Photography**. Any digital satellite imagery, photography or scanned imagery, or photography would be classed in this category of data. Also included would be the digital data from classified sources such as remotely piloted vehicles (RPVs) and video footage from a combat camera and other recce sources.

29. **Reports**. This broad class of data covers the following:

a. Intelligence Reports (INTREP);

b. Engineer Recce Reports (ENGRRECCEREP);

c. Meteorological Reports (METREP);

d. general reports such as Location Reports (via SAS OSPR/CSPR messages or voice), Shell Reports (SHELREP), and Situation Reports (OWNSITREP).

SECTION 3
GROUPING AND DEPLOYMENT

GROUPING

30. Topo Tp's Data Access Section, commanded by a MOC 142 Warrant Officer, is seven strong and is structured to provide a 24/7 capability. The section's primary role is to ensure that current, accurate and validated geospatial data is made available through the geo server in order to establish a COP. The section should not deploy independently and will usually be collocated with the Topo Tp.

DATA FLOW

31. On receipt of a Warning Order (Wng O), MCE will begin population of the IODS using all available standard mapping, elevation data and archived imagery. The data will be collated, validated and placed on the geo-server, in Data Access Section, for use by non-geomatics staff.

32. As soon as data becomes available, the MEDS will be populated. This will involve large amounts of standard mapping and elevation data as well as archived and mission specific imagery. Given the vital nature of geo spatial data, the early deployment of GSTs and survey teams is essential. As these teams start to collect

theatre specific data, this data will again be validated and added to the MEDS by MCE base plant resources. In turn, as the database is further populated, the GSTs start to use the data to produce products that are then fed back to the Data Access Section for inclusion in the data available on the geo server.

33. Finally, as more and more specific data becomes available, the MSDS becomes populated, allowing GSTs access to large-scale information. Using this information, the GSTs produce specific products for their supported commanders. Again, these products get included in the larger data set held by Data Access Section for publication on the geo server.

34. At all stages, there is connectivity between MCE in its garrison location and Data Access Section deployed, which supports a split-based production capability. Concurrently, there is connectivity between the Data Access Section and the Field Reprographic Section (Fd Repro Sect). See Figure below for a graphical view of the data flow.

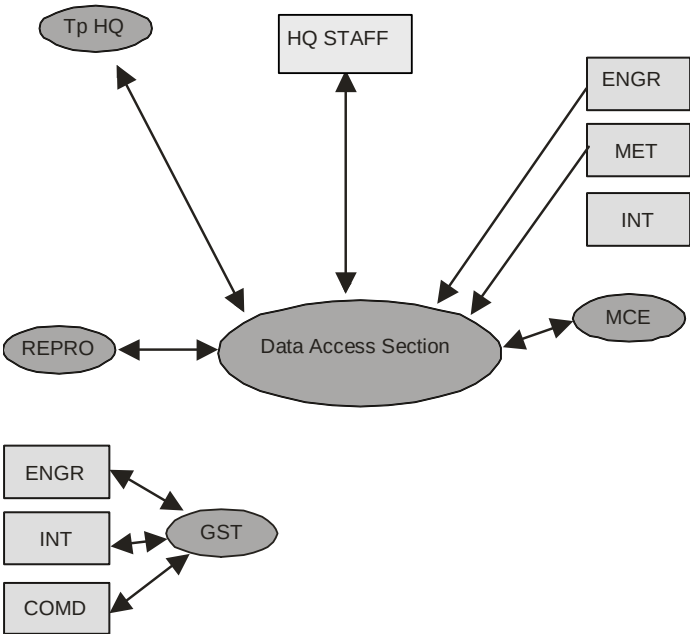

Figure 5-1: Data Flow

GEO-SERVER

35. The geo server is the heart of the geospatial data management process. It will be of sufficient capacity to allow the simultaneous transfer of numerous large files. Associated with it must be a very large capacity storage device (on the order of several terabytes). The server must be connected to the LFC2IS or other deployed C2IS via wide band fibre-optic link.

COMMUNICATIONS

36. The Data Flow (Figure 5-1) clearly depicts the substantial requirement for wide band communication links between the Data Access Section and MCE/deployed GSTs. Due to the potentially large distances involved, it is evident that the most economically feasible means of achieving near real-time data transfer is through satellite links. In the absence of suitable compression software, the only viable method of ensuring connectivity is to have an integral satellite communications capability within the Data Access Section. This will alleviate the pressure on national communications links that the transferring large geospatial data files would induce. The ideal situation would be to have dedicated satellite communications not only between Data Access Section and MCE but also between Data Access Section and the deployed GSTs. However, in the absence of such links, the use of CD-ROM exchange on an as-required basis provides an acceptable but less efficient alternative.

SECURITY

37. In the era of information warfare, the obvious weakness in the geospatial data management process is the information itself. Data is most vulnerable while being transmitted between the various communication nodes. However, the geo server is also potentially vulnerable to attacks by maliciously introduced viruses and general data corruption through non-hostile action. Every effort must be made to ensure that data is protected and backed up. This is in keeping with the principle of safeguarding.

EQUIPMENT

38. The provision of a detailed breakdown of the equipment holdings for the Data Access Section is outside the scope of this

document. However, a summary of the key components shall be provided as follows:

a. dedicated wide bandwidth satellite communications link to MCE;

b. fibre optic LAN within the JTFHQ;

c. large capacity primary and backup data storage facility for softcopy data;

d. storage facilities for hardcopy data;

e. wide band data link to the Fd Repro Sect;

f. primary and alternate large capacity geo-server;

g. primary and alternate power supply;

h. high-end GIS on a powerful platform;

i. three vehicles with container office space trailers;

j. two radio communication (VHF) means and a field telephone; and

k. tentage and standard camp stores for a section of seven personnel.

CHAPTER 6
OPERATIONAL REPROGRAPHICS

SECTION 1
INTRODUCTION

GENERAL

1. The changing nature of preparation for conflict, from deliberate planning for a forecasted contingency to time sensitive planning for a crisis, has accentuated a need to provide commanders and tactical units with increased knowledge of the battlefield in an expeditious manner. Despite movement toward increased use of digital media, without full digitization and interoperability between formations, environments, and national forces, there remains a requirement for production of hardcopy geomatics products.

2. Operational Reprographic Section (Op Repro Sect) consists of a section of four personnel commanded by a warrant officer. They deploy with a 24/7 capability to import digital data, or alternatively, to scan media such as maps, charts, aerial photography, and imagery. This section, or a supporting GST, utilizing specialized software can then rapidly update, modify, or add detail to the source image to meet specific mission requirements. The Fd Repro Sect can then plot a hardcopy version of the product(s) in limited quantity or cut a softcopy on
CD-ROM.

AIM

3. The aim of this chapter is to outline the operational reprographic services provided to a deployed Canadian formation or task force.

SCOPE

4. This chapter will describe provision of operational reprographic services under the following headings:

a. general operating principles;

b. Op Repro Sect; and

c. command and control.

SECTION 2
GENERAL OPERATING PRINCIPLES

GENERAL

5. Once running smoothly, no amount of hard work by the technicians can increase the production of a press or plotter. As such, it falls to operations staff to rationalize and prioritize reprographic requests when they outstrip the capacity of the systems to meet the demands. Difficult decisions can be minimized, however, through observation of the principles of economy and anticipation.

ECONOMY

6. Reproduction in the field, no matter at what level, is a very costly undertaking in terms of manpower, supply, and maintenance. It is essential that the load on the field reprographic system not be increased through demand for unnecessary products or inappropriate quantities.

7. Economy is also important in determining the specifications required of a given job. For example, while scanning input sources at very high resolution may result in an end product that is most pleasing to the eye, it takes up significantly more computer memory, slows down file management processes, and ultimately slows production. The same applies for colour scanning and colour products versus black and white. Product specifications should be sufficiently stringent to reflect actual requirements but not overly so. It is essential that advice is received from the Topo Tp HQ or Op Repro Sect before finalizing the product specifications.

ANTICIPATION

8. Since no large format field printing capability is maintained below a NATO multinational division level, it is critical that large-run reprographic tasks be anticipated well in advance. This anticipation is so that large jobs can be sent to a field press and subsequently scheduled, printed, and returned in the required time frame. In general, any reprographic task requiring more than 200 copies is sent to a field press rather than the Op Repro Sect. This 200 copy limit is a significant cost, both financially and in re-supply terms, in order to save time. Sending the job to a field printing press will be more effective. For example, a field press could print several thousand

copies of a product for the same cost as plotting 200 copies at the Op Repro Sect.

SECTION 3
OPERATIONAL REPROGRAPHIC SECTION

GENERAL

9. For routine, very low volume reproduction of terrain analysis, 3-D visualization, or other graphic products, all GSTs possess a plotting capability. They can be tasked with production of five to 20 copies of a product for use by the formation that they support. They also have a limited capacity to copy CD-ROM, but this capacity is primarily intended for the transfer or exchange of geospatial data and to back up workspaces, and not as a reprographic facility.

10. The CF no longer maintains the capability to print in the field. Any high volume, hardcopy products must either be printed in Canada or by allied nations. The lead nation of a corps or larger size deployment would normally provide both a large and small format field printing capability within the theatre geomatics organization. Op Repro Sect will support Canadian formations or task forces with versatile and rapid reaction but low volume reproduction (plotting) capability.

CAPABILITIES

11. Fd Repro Sect provides 24/7 rapid response plotting (maximum 36 inch, or 91.5 cm, width) at a rate of 35 to 40 sheets per hour of any one hardcopy product. This is accomplished through a truck-mounted array of ink jet plotters controlled by a central server. Products may include:

a. copies of existing hardcopy maps or charts;

b. terrain analysis and visualization products;

c. photographic or satellite imagery or image maps;

d. operational overlays; and

e. special graphics products.

12. These products can be introduced to the system as hard or soft-copy originals. The section fields a large format high-resolution colour scanner to convert hard copy sources to digital format. Within

a JTFHQ or Bde HQ using LFC2IS, the resulting scanned images can be accessed and shared by all HQ staff through connection to the public servers. As such, these sources can not only be reproduced, but can be amended, updated, or otherwise modified to serve the commander's or the supported formation's requirements. However, for such modification tasks, the formation's GSTs should be considered first because they are in closer contact with the supported staff and extensive product enhancement work will ultimately slow down reproduction.

13. Op Repro Sect will also have the capability to copy CD-ROM. It will be equipped with a high-speed mastering device that will enable limited distribution of digital data on this medium, primarily to other geomatics units, sections, or detachments.

SECTION 4
COMMAND AND CONTROL

14. As part of a MCF or Vanguard deployment, Topo Tp would normally be assigned to provide support to the JTFHQ. Typically, this would include the Topo Tp HQ, Op Repro Sect, Data Access Section, and the HQ GST. All Topo Tp elements would be linked via a LAN established by the JTFHQ integral signal support unit and also connected to the LFC2IS public servers, if present. In this way, the Op Repro Sect's wide format scanner can be used to input data into the geospatial database maintained by the Data Access Section. Hence it will be available for exploitation by the HQ GST and for use by the commander and HQ staff using LFC2IS. Besides advising on the section's capabilities and coordinating their tasking, the Topo Tp HQ provides quality control and ensures geomatic integrity of products. For example, the Topo Tp HQ ensures that all products, regardless of source, are referenced to the appropriate prescribed theatre position reference system.

CHAPTER 7
GEODETIC AND TOPOGRAPHIC SURVEY

SECTION 1
INTRODUCTION

GENERAL

1. Weapon, navigation, and target acquisition systems require precise geodetic position and azimuth information on a common geodetic datum and grid reference system that are guaranteed to agree with international standards recognized by all coalition/multinational maritime, ground, and air forces. The provision of geodetic data can be mission critical, and failure to ensure that systems are operating on a common reference framework can be potentially catastrophic.

2. The MCE maintains a Field Survey Section (Fd Svy Sect) under command of the Geo Sp Squadron. The section is commanded by a warrant officer. It is designed to operate as three independent geodetic survey detachments to carry out precise geodetic positional surveying, using the GPS and electronic total station (ETS) equipment, and to collect geo-referenced terrain information. A fourth team will establish the base station and conduct compilations and quality assurance of field observations. All personnel will be MOC 142 geomatics technicians specializing in field survey. The section commander will have a geodetic survey specialist qualification.

AIM

3. The aim of this chapter is to outline the provision of geodetic and topographic surveys to a deployed Canadian formation, JTF, or allied coalition forces.

SCOPE

4. This chapter will consider the following aspects for the provision of geodetic and topographic surveys:

a. general operating principles;

b. grouping and deployment;

c. equipment capabilities;

d. command and control; and

e. glossary of terms.

SECTION 2
GENERAL OPERATING PRINCIPLES

TYPES OF SURVEY

5. For military purposes, there are three general types of surveys:

a. geodetic;

b. topographic; and

c. engineering.

6. The Fd Svy Sect commonly undertakes both geodetic and topographic surveys. However, it can also be employed to carry out large-scale engineering surveys. GSTs could carry out topographic or engineering surveys using the ETSs. They could also assist the Fd Svy Sect in carrying out geodetic surveys using GPS receivers; however, they could not do this on their own.

7. **Geodetic Surveying**. This is the process of measurement with a view to determining the size and shape of the earth. It provides the main framework within which all topographic and engineering surveys can be located. It is usually conducted at scales of 1:50 000 and smaller (i.e. 1:100 000).

8. **Topographic Surveying**. This involves the measurement of natural and artificial features on the earth's surface in order that a map of these features may be drawn. It is usually conducted at scales of 1:25 000 or larger (i.e. 1:12 500).

9. **Engineering Surveying**. This will be primarily terrestrial surveying in support of a construction project undertaken by engineers. ETS and levelling will be the primary activities and the survey team will lay out construction sites under the supervision of the construction site supervisor. The scale of the survey will be dictated by the site diagrams or blue prints, and the survey will be conducted on an autonomous flat plain without the requirement to incorporate datum or projection details.

PRINCIPLES OF SURVEY

10. The principles on which surveys are based are unchanging and have been tested and proven effective since the early days of surveying. Methods and practices may change, but the principles remain the same. These principles must be followed to achieve successful survey work. They are:

a. consistency;

b. control;

c. economy of accuracy;

d. independent check;

e. revision; and

f. safeguarding.

CONSISTENCY

11. Surveys must be consistent in their accuracy. Having ascertained a standard of accuracy, all stages of the survey must conform. The stages that provide control for the survey are likely to be more accurate. All parts of single stages must be carried out to the same standards of accuracy.

CONTROL

12. The accuracy of any survey, however large or small, depends upon the establishment of a carefully surveyed network or framework of control. This network or framework should encompass the whole area to be surveyed. Once this network or framework has been established, the survey is then considered to be free from error.

13. Subsequent surveys are then carried out within this framework and are adjusted to it. This principle is commonly known as *working from the whole to the part.*

14. This principle is vital to all surveys, whatever their extent, if consistency and accuracy are to be maintained. The methods employed to provide this framework vary with the type and accuracy of the survey conducted. Some of the methods used are as follows:

a. the GPS;

b. traversing;

c. triangulation; and

d. trilateration.

ECONOMY OF ACCURACY

15. It is important to weigh the accuracy of survey required against the time and resources available, prior to commencing the survey. Greater accuracy requires more expensive and time consuming methods. Within certain limits, increasing the number of observations can increase accuracy. It should be remembered that no survey can be more accurate than the control upon which it is based. If control has been established to +/- 10 mm then subsequent distances measured to +/- 1 mm are precise but have no greater accuracy than +/-10 mm to +/- 1 mm.

16. Accuracy depends upon the elimination or reduction of errors. Therefore, it is essential that the surveyor understands the nature of errors and plans the work in such a way as to reduce the errors to an acceptable level.

INDEPENDENT CHECKS

17. Errors in surveys are extremely expensive, and every operation should be subject to checks. Where possible, a system of self-checks should be employed. Where this is not possible, checks should be applied as independently as possible and should not just be a repetition of the previous operation. For example, if a distance measured is to be checked, then it should be remeasured using a different system or different units.

18. A different person should recompute computations that are not completely and independently self-checking. No conferring should be done except for the final results. If possible, a completely separate method of computation should be employed.

REVISION

19. Whenever a survey is initiated, the method(s) to be employed should be studied in light of the method that will later be employed for revision. In areas where rapid development is taking place, revision is

a major task. Provided the original survey was properly designed and executed with revision in mind, it becomes a simple task.

20. It is important to note that a survey carried out for one task may in the future be used for another. The surveyor should anticipate this possibility and consider whether making some small adjustment to the methods can make the work generally more useful, rather than just being useful for the immediate task requirements.

SAFEGUARDING

21. There are certain precautions that the surveyor must take to ensure that the work is preserved for the future and that records are properly kept. Some are listed as follows:

a. Duplicate records must be made and include the backing up of digital data, such as raw observation files before computation.

b. When travelling long distances, duplicates should travel by a different mode or method (i.e. by post).

c. Work must be conducted in such a way that it is easy for another surveyor to understand it. This emphasizes the need to adhere to SOPs.

d. All records must be fully maintained and properly set out.

e. Survey marks must be as permanent as possible and easily re-established from other adjacent marks. They should include a buried mark.

f. Records must be made as to the location and re-establishment of permanent marks using station descriptions.

g. Permanent marks should be sited so as not to be disturbed for as long as possible (10 years).

ASSUMPTIONS

22. When considering the employment of field surveyors, the following assumptions should be made:

a. Command of the section will remain with Geo Sp Squadron.

b. The section or individual field survey parties could be placed OPCON or TACON of the unit or formation they are supporting.

c. The section will be fully equipped to carry out its task independently of Geo Sp Squadron; however, it will be dependent on the supported unit or formation for administrative and logistic support, a minimum being the requirement for daily maintenance.

d. Generally, all final coordinates are to be provided in WGS 84, or as defined by NATO, or the coalition chief geographic officer. In many cases, the common geodetic datum will be WGS 84, which will be commonly combined with the MGRS.

GENERAL OPERATING PRINCIPLES

23. The principles of surveying will be best applied throughout to produce the coordinates for a network of points from the *whole to the part*. Best available coordinates are to be provided in a timely fashion and upgraded as more accurate and recent information/data becomes available to be incorporated into the network.

24. The coordinate system authorized by NATO is WGS 84, which provides a common and unique, worldwide referencing system. This coordinate system is the basis for GPS coordinates. Where mapping cannot be provided with a WGS 84-based grid or overprint, then the coordinates will have to be supplied in the local/national coordinate system of the operational area.

25. Transformation parameters from WGS 84 to local datums and projections are available from the NIMA in the USA, from Military Survey in the UK, and from *Natural Resources Canada* (NRCan) in Canada. If the coordinates are used with the wrong datum and projection, errors, normally in the area of +/- 500 m but up to a maximum of +/- 1200 m may be encountered. The Fd Svy Sect has the expertise to carry out datum transformations at a local level if required.

26. Geodetic GPS receivers will generally be the primary survey tool and can produce coordinates at all required accuracies. It should be noted that the GPS satellites transmit their signals on very low power; the signal received is susceptible to loss of position/data due to both overhead obstructions or cover and deliberate or accidental

jamming. This means that a secondary/reversionary method of surveying is required, such as using theodolites or distance measuring equipment.

27. Initial networks and control points should be coordinated from local control points for which the WGS 84 coordinates are available. These local control points could be in a neighbouring country not involved in the fighting or operations. Once the WGS 84 coordinates have been confirmed, the complete network should be re-adjusted or transformed into WGS 84 coordinates because some weapon systems/delivery platforms are only able to work in WGS 84.

SECTION 3
GROUPING AND DEPLOYMENT

GROUPING

28. The basic deployable field survey unit is a Fd Svy Sect, consisting of nine personnel and four GPS receivers in four vehicles. This setup allows for the formation of a maximum of four field survey parties of two surveyors, each with their own GPS receiver and vehicle. This structure optimizes the survey while maintaining the principles of control, consistency, economy of accuracy, and independent checks.

29. It should be noted that all surveys, especially tactical surveys, should have a minimum of two field survey technicians in each field party. This structure ensures that independent checks are completed prior to departing the survey location and speeds up documentation at the site. The cost in personnel, material, and time cannot be wasted through poor checking procedures, and, in many tactical situations, the surveyors will only have limited opportunities to carry out a task.

30. The field survey party led by the section commander will also have a dual role as the computational cell for the section. Two separate computers are required for survey computations to facilitate the conduct of independent checks on the results. If large or complicated surveys are being tasked, then it should be understood that time must be allowed, once the field survey parties return with the data, for comprehensive computations and analysis of results. The organizational chart for the Fd Svy Sect is shown in Figure 4.

31. The Fd Svy Sect is a limited asset that must be controlled at the highest level, typically operating at the JTF level (e.g., establishing

theatre control) but could also provide support to an environmental component or individual unit.

32. The Fd Svy Sect is not established to operate completely independent of logistic and administrative support. The unit being supported must provide this. If local operational requirements dictate the use of additional vehicles and personnel for movement, then the field survey parties will require augmentation by the supported unit for the duration of the survey task(s).

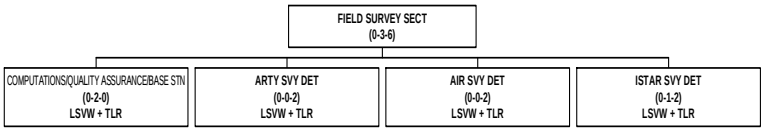

Figure 7-1: Geodetic Survey Section

GEODETIC POSITIONING AND AZIMUTH DETERMINATION

33. **Theatre Geodetic Network**. The requirement to provide precise positional information as part of a theatre control network was largely ignored during the Cold War period since all the control necessary was already available in Western Europe. However, operations over the last ten years in other areas have clearly demonstrated that for large parts of the world, control networks either do not exist, or, where they do, they are inadequate or in local geodetic datums unsuitable for use by Canadian, NATO, or coalition forces. Therefore, one of the first tasks carried out in a theatre of operations will be the transfer of geodetic control points from known locations to sites inside the operational theatre. For example, this task was achieved in the former Yugoslavia by the transfer of control by simultaneous observation of GPS satellites in the UK, Germany, and two sites in theatre.

34. **Weapon Platform and Location System Requirements**. The need to support weapon platforms and target acquisition systems will be reduced with the introduction of large numbers of GPS receivers (such as the CF's PLGR +96), which will provide coordinates accurate to +/- 10 m. However, some systems will continue to require support where ground coordinates requirements are very precise and where accurate azimuth determinations are needed. This list of systems includes combat aircraft inertial navigation system calibration points, GPS calibration points, and the provision of

position and azimuth for some weapon platforms such as air defence, missile, and radar systems.

35. **GPS Jamming**. The ease with which GPS can be jammed renders the CF vulnerable if there is an extensive dependence on this system as the primary means of positioning and navigation. Jamming is of considerable concern, particularly since so many weapon platforms, navigation, targeting, and communication systems rely on GPS. A one-watt jammer, weighing less than one kilogram, can disrupt the reception of GPS signals (both on the ground and in the air) over an extensive range. Some weapon platforms will have to cope with the loss of GPS in the event of widespread jamming, with no alternative being provided. However, for some systems, this situation will be unacceptable, and the survey section will be obliged to provide suitable control using other methods such as the use of ETSs. The extent and accuracy of this capability will depend on a number of local operational factors, such as the availability of control data already in the area, accessibility to local government geodetic information, and the tactical situation.

DEPLOYMENT CAPABILITIES

36. To ensure that the provision of geodetic positioning and azimuth determination is successfully achieved in operational theatres, Geo Sp Squadron will provide the following capabilities:

a. **Geodetic Survey**. In conjunction with other NATO or coalition forces, the survey section will be prepared to transfer control from outside the theatre of operations to secure sites inside the theatre of operations, as and when required. Using these new points, control can then be transferred to local control networks as designated by the relevant formation headquarters within the theatre of operations. These networks can be used for a number of purposes:

(1) **Map and Imagery Control**. The provision of accurate maps and digital geospatial data relies on good geodetic information being available in the area of interest. The data collected in theatre can be passed back to base plant facilities in the MCE to support split-based production tasks.

(2) **Support to Artillery Assets**. The Fd Svy Sect can provide precise positioning and azimuth information for exploitation by artillery survey teams in their support to gun batteries, locating systems, and air defence assets.

(3) **Support to Air Assets**. The Fd Svy Sect can provide precise positioning and azimuth information for combat aircraft calibration points and in support of the targeting process.

(4) **Support to ISTAR Assets**. The Fd Svy Sect can provide precise positioning and azimuth information for unmanned aerial vehicle calibration points and a variety of sensor platforms such as space-borne, Coyote, EW, ADATS (Air Defence Anti-Tank System), and other locating systems. Additionally, the section can carry out ground truthing for exploitation in imagery analysis.

b. **Large-Scale Surveys**. The section maintains the capability to conduct large-scale surveys of sites, such as barracks, ammunition depots, and airfields. The section will be able to produce new site plans or revise existing documents.

c. **Operational Geodetic Data Archive**. Under the direction of the senior geomatics officer in the operational theatre, the section will maintain or contribute to an archive of all available geodetic information. This will include all data available in base plant locations, all locally gathered information, and all observations taken in theatre. These archives will be used for reference purposes during routine GPS operations, but they will also provide control networks should GPS become jammed or unavailable for some other reason. The operational geodetic archives will also be valuable for the subsequent restoration of normalcy, once the operation is over or a steady state is achieved.

d. **Data Collection**. The section will maintain the capability for collecting data for purposes other than geodetic or topographical surveys. Data may be required for the enhancement of other products such as mapping and terrain analysis, and the use of section personnel for this purpose may be required. Familiarity with the physical terrain will be an advantage, and section personnel will either be able to collect data, or brief, train, and manage non-MOC 142 personnel who are assigned to this task.

e. **Field Checking**. The currency and accuracy of mapping and digital geospatial information relies on a combination of locally gathered and remotely sensed data. Satellite imagery can provide a wealth of information about the terrain, but it will not always give the full picture of the ground. Field survey parties may be required to complete field checks, such as collecting information on local names or bridge classifications and characteristics. These tasks also include ground truthing to encompass the clarification of vegetation types and densities.

f. **Geodetic Advice**. The extensive proliferation of GPS systems in the battlespace, the most significant to the Land Force being the PLGR, will result in numerous geodetic control problems being encountered by users of these systems. Users will require advice and assistance to troubleshoot problem areas. MOC 142 geomatics technicians will increasingly be called upon to resolve these problems since they have the necessary in-depth knowledge of both geodesy and GPS to diagnose faults and may have the expertise to rectify them.

SECTION 4
EQUIPMENT CAPABILITIES

37. The standard tools used for most operational survey work will be P/Y-code geodetic GPS receivers, supported by ETS as necessary. Details on the equipment are summarized in this section.

38. **Ashtech Z-XII GPS Receiver**. The Ashtech Z-XII GPS receiver has an L1/L2 antenna, a 12-channel all-in-view operation, and a full wavelength carrier on L1/L2. The current fleet of receivers do not have the Y and P code capability. This survey equipment is used to establish horizontal and vertical control within an area of operation using GPS and also using the precise encoded military signal. This GPS receiver has the following accuracy specifications when used in these configurations:

a. static mode of 5 mm +/- 1 ppm;

b. kinematic mode 2 cm +/- 1 ppm; and

c. real-time differential position <1 m root mean square (rms).

39. **Sokkia Set2000 ETS**. The Sokkia Set2000 ETS and Prism set, with expert survey software, is used for large- or small-scale surveys and to position points where the GPS receiver cannot be used. Some of the features that are available with this instrument are traversing, resection, remote elevations, construction set out, area calculations, intersections, point projections, and transformations. The following specifications are given for this instrument:

a. angle measurement accuracy 2”; and

b. distance measurement range for a single prism up to 2700 m and a triple prism up to 3500 m.

CHAPTER 8
GEOMATICS SUPPORT TEAMS

SECTION 1
INTRODUCTION

1. Within the context of a MCF deployment, the ESU Geo Sp Sqn would assign the four GSTs to provide support to the JTFHQ and three environmental component HQs. This would be considered a force employment role and serves as the primary focus of this manual. Integral to each combat engineer regiment is also one GST, which primarily exists as a training element and could be employed in a force generation role or a force employment role on a Bde deployment. While the capabilities of regimental and Geo Sp Squadron GSTs are essentially the same, their method of employment is subtly different.

2. The aim of this chapter is to outline the capabilities and employment of GSTs in both force employment and force generation roles.

SECTION 2
ROLE AND CAPABILITIES

3. The role of a GST is to provide dedicated geomatics support to a formation or unit HQ. The GST will be integral to the HQ and fully involved in the commander's decision/action cycle.

4. Chapter One identified the five geomatics support services, and Chapter Two detailed aspects of command, advice, and liaison. Together, these form the "5 plus 1" geomatics support tasks. The Geo Sp Squadron is capable of conducting all these tasks fully and concurrently, given its various integral specialized elements. GSTs can also carry out the "5 plus 1" tasks; however, this would be to a lesser degree and only in a consecutive fashion. The capabilities of GSTs related to these tasks, whether from Geo Sp Squadron or the engineer regiments, are as follows:

a. **Terrain Analysis and Visualization**. Analysis and Visualization are the primary tasks of the GST. Furthermore, the GST is the only Geo Sp Squadron element capable of providing these tasks. Terrain Analysis and Visualization is discussed fully in Chapter 3.

b. **Operational Reprographics**. The GST has a very limited low-volume plotting and CD-writing capability. As mentioned in Chapter 6, the Op Repro Sect at the JTFHQ has this as its main focus and a much greater capability to provide reprographics.

c. **Field Survey**. Given a GPS receiver and in conjunction with other MOC 142 geomatics technicians in theatre, the GST could be employed as a survey team in a geodetic survey task. Also, given an ETS , the GST could, on its own, conduct large-scale site and engineer surveys. Using the PLGR (precise lightweight GPS receiver), the GST can provide positioning information of features to +/- 10 m. The GST could additionally provide advice to users of GPS receivers.

d. **Data Access**. The GST could assist in identifying and validating local sources of geospatial data for integration into the geospatial database maintained by the Data Access Section at the JTFHQ;

e. **Map Supply**. The GST could assist in determining requirements for both hardcopy maps and CDs of geospatial data and in their distribution from the MAPSP (map supply point). The GST is not equipped for bulk storage of hard and soft copy products.

f. **Command, Advice, and Liaison**. The GST would typically be assigned under OPCON to the supported HQ and would provide advice on geomatics matters to the commander and staff throughout the decision/action cycle. The GST would also maintain liaison with other geomatics personnel in the area of operations, including Geo Sp Squadron, allied, and host nations.

SECTION 3
EMPLOYMENT

5. The preferred command and control arrangement for the GST (regimental or from Geo Sp Squadron) is with the engineer advisor, who also functions as the formation terrain expert. This would be the

JTF engineer at JTFHQ, the engineer CO through the ESCC at a brigade HQ, or equivalent engineer advisor at the air/maritime component HQ. Other suitable options would be under the G2 or G3 staff functions. Ultimately, the specific employment and grouping of the GST is a commander's decision with input from his engineer advisor. The key factors for effective GST employment are:

a. establishment of a well defined chain-of-command;

b. setting of priorities; and

c. availability of the GST services to the commander, all staff functions, and subordinate units.

6. For international operations, the MCE has the prime responsibility to provide deployed geomatics support as per the following scenarios:

a. BG deployment—four person GST at seven days notice to move (NTM);

b. vanguard deployment—task-organized Topo Tp to the ESU at 21 days NTM; and

c. MCF deployment—task-organized Geo Sp Squadron to the ESU at 90 days NTM.

7. In support of ROTO ZERO, and sustained international operations, the MCE provides specialist predeployment training for GSTs prior to their embarkation. While focussed on the specific mission, the training covers all "5 plus 1" tasks including the unique/additional effort encountered during a ROTO ZERO deployment.

8. The regimental GSTs have force generation as their primary focus. On exercise, the GST will support brigade and unit level training in accordance with formation SOPs. The regimental GST provides geomatics support to the brigade engineer, G2, G3, G4, and G5 staffs. For large-scale exercises, the MCE can augment the regimental GST with additional personnel on a case-by-case basis.

9. The second focus of the regimental GST is support to domestic operations, again employed with the CER ESCC at brigade HQ. For routine domestic operations, the regimental GST will be able to provide the required close support. For larger scale domestic operations, the MCE can augment the regimental GST with additional personnel as required. In the event of very large-scale/national

domestic operations, the MCE (ESU if deployed) will take the lead role in providing deployed geomatics support, and the regimental GST would most likely be placed OPCON of the MCE/ESU Topo Tp or Geo Sp Squadron.

10. The table below summarizes the division of responsibilities regarding brigade and MCE GSTs in relation to operations and exercises. Further detail on employment of the regimental GST is found in the Terms of Reference in Annex A.

	International Operations	**Domestic Operations**	**Training**
MCE/ESU GST	Prime support responsibility	Assume lead role for very large/national domestic op.	Augmentation to Regt GST on case-by-case basis.
Regt GST	Augmentation to MCE/ESU, (by exception) Deployed on Bde operation).	Provide Support to routine domestic ops.	Primary support responsibility

Table 8-1: Division of Responsibilities Matrix.

ANNEX A
TERMS OF REFERENCE—ENGINEER REGIMENT—GEOMATICS SUPPORT TEAM

INTRODUCTION

1. The provision of geomatics support in the army is a general support engineering task. This support is to be provided to the current Canadian mechanized brigade group (CMBG) through an engineer Regt GST. A Regt GST will consist of two members (peace time restricted manning), a MOC 142 geomatics technician Sgt and a MOC 142 geomatics technician MCpl (Master Corporal).

AIM

2. The aim of this paper is to provide guidance to regimental COs to ensure full employment of the combat engineer regiment CER / ESR GSTs.

CAPABILITIES

3. **Concept of Operations**. Doctrinally the GST is on the strength of the CER and an element of RHQ Tp. The products produced by the GST are of interest to many agencies but the greatest task load is likely to originate from the G2. Geomatic support to the IPB process and ISTAR process is indispensable. Consequently, in the interest of maximized efficiency it may be best to group the GST to the Bde HQ under the auspices of the G2. An important consideration is to ensure there is only one stream of assigning tasks to the GST to eliminate conflict of priorities. Grouping will be a decision by the CO of the CER in consultation with the Commander. The intent is to establish an efficient process. So long as engineer staff are present during operational decision making, they can continue influencing decisions on how best to interpret and exploit terrain from an engineering perspective. Brown SA is a G2 responsibility but terrain analysis remains an engineer responsibility. The Regimental IO will play a key role as to linking ESCC activities and G2 activities and to mentor the GST. Furthermore, both the GST and Engineer IO will be working in conjunction with G2 Plan. In as much, the role of the GST is varied:.

a. The Regt GST is required to provide timely information on the effects of the terrain to the CER

CO as the Bde Comd's key advisor on terrain, and to Regt Squadron OCs for BGp Comds. This is currently achieved through a mix of manual and digital TERA and TVis techniques.

b. The GST will assist the appropriate brigade HQ staff to ensure that the headquarters generates the most current Brown SA for executing ops.

c. It can also assist in ensuring that brigade HQ and units have the mapping that they require for specific operations and exercises. With the increasing requirement to provide digital output, as army formations move towards digital C2I systems, the Regt GST will ensure the CER/ESR has the most complete view of the battlespace.

d. The combined skill sets that the Regt GST members bring with them are numerous and specialized, the daily routine for the GST has the potential to include many different tasks and responsibilities. A detailed list is included in Appendix 1.

e. On exercises and domestic operations, the employment concept has the GST deploying with the Regt Fmn Engr—ESCC at Bde HQ. CF JHQ will continue to receive its integral geomatics support from their TERA team with the new J2 Environment (formally J2 Geo & Met / formally J2 Geo). Where the brigade is required to deploy on a complex domestic or international operation, additional supporting resources will be provided to the brigade from the MCE in Ottawa.

4. **Key Tasks**. Not in order of priority, the Regt GST has the following key tasks:

a. provision of mapping from RHQ to the regiment;

b. coordinate map supply within the formation to ensure the provision of mapping to units;

c. on demand, the provision of TERA and TVis products;

d. on demand, the provision of geo-graphics for RHQ and formation staff;

e. reproduction of briefing and planning aids;

f. on-line accessing terrain information from the MCE (conversely, supplying information to MCE);

g. advise CMBG personnel on geomatics support that is available from the MCE;

h. management of the formation's digital geomatics database; and

i. limited survey and to provide GPS instruction to formation personnel.

5. **System Maintenance**. The Regt GST is equipped with one Deployed Geomatics Support System—Light (DGSS—Light).

a. The Regt Log O will provide the day-to-day consumable system supplies. Maintenance of the system hardware is assumed to be a brigade/area/army task:

(1) **Unit—First Line**. All necessary arrangements mandated by Fmn Sigs SOPs and funding are to be worked out by the Regt MaintO.

(2) **Base—Second Line**. Required local measures for contracts in the local community, for repairs authorized by 'Base Tech Svcs' and funding are to be worked out by the next level of authority.

(3) **National—Third Line**. Accessing army national procurement (NP) funds by DLR 7—J3 Engineer Operations 4 will ensure upgrades are undertaken consistent with the configuration standard set by the CO MCE (for DCDS systems).

b. An equipment list of the DGSS-Light is attached in Annex B. The principle hardware of this deployable system are:

(1) 1 X Dell workstation;

(2) 1 X 36" CMYK (4 colours) plotter; and

(3) 1 X 36" colour scanner.

6. **Mobility—An MLVW**. The DGSS-Light configuration includes 1 X MLVW with SEV, 1 X 2.5T trailer, 1 X 5KW generator, canvas penthouse, and modular tents. The complete DGSS-Light can be operated out of the MLVW, or it can be relocated into any building or MEXISHELTER.

a. The now fixed ERP, and DMilE sourcing, establishes an MLVW as the Regt GST vehicle since current sourcing of LSVW Box/Shelter is problematic. The procurement and rebuilding of the Regt GST vehicles and requirements are being DLR/DMilE organized, with technical assistance from the MCE.

b. Once the GST MLVW is set up, the GST will have no integral rover vehicle and must rely on RHQ for transport from tactical locations to task sites for data collection. It is important to consider if the Regimental HQ Tp Comd tasks the GST to conduct reconnaissance or assist with surveys.

TRAINING

7. **Engineer Battle Task Standards (EBTS)**. MCE will continue to coordinate with DAT 3-4 on the geomatics support EBTS (of which there are currently five) to ensure uniform standards across the regiments. There will be an ongoing requirement to maintain currency and skill upgrade for the members of the Regt GSTs.

8. **Regt GST Software**. The software that the GST uses is at the leading edge of GIS technology and the requirement for ongoing local training is continuous as upgrades occur:

a. Consequently, time must be set aside in regimental routine during non-operational/exercise periods to allow for skills maintenance (if software is not used on a regular basis).

b. As temporary duty funds will not permit returning to Ottawa for training on all upgrades, new training will include locally arranged courses, self-taught packages, and on-line computer based instruction.

9. **Annual MCE Seminar**. Since there is an increased number of teams now posted outside of Ottawa, the MCE will now conduct an annual workshop and briefing seminar to which the Regt GST

members will be invited. When convened, it will be recommended that the GST members be allowed to return to the MCE to participate in this training session.

10. **Career Courses—MOC/OSQ**. With the increase of three (potentially four) Regt GSTs, there is the obvious potential that the junior member will have to attend the MOC Geo Tech 6A, conducted in Ottawa. Additionally, out-service-training in the form of the Advanced Terrain Analysis Course at Fort Belvoir, Va. is also a possibility for the senior member of a Regt GST.

SUPPORT TO DEPLOYED OPERATIONS

11. For a battle group deploying on international operations, geomatics support should be allocated by the MCE in Ottawa, leaving the Regt GST to carry on its standard support to the brigade. The current standard for a ROTO ZERO is a GST of four personnel. To support a continuous rotation program (e.g., Op PALLADIUM), the standard is a GST of two personnel.

APPENDICES

12. **Appendix 1**—CER GST Daily Routine.

13. **Appendix 2**—DGSS-Light Configuration.

APPENDIX 1
REGIMENTAL GST DAILY ROUTINE

1. **General**. Knowing the range of skills and capabilities resident in the team, the GST commander (MOC 142 Sgt position) is responsible to sort and control the tasking of the GST. The GST technician (MCpl position) is capable of planning his own work in the absence of the GST commander. Not in an order of priority, the routine for the GST can be divided into five areas: support to domestic operations, support to exercises, general military training including physical fitness training, geomatics-specific training, and general duties related to regimental life.

2. **Support to Domestic Operations**. The GST, when in support of a tasked BGp or supporting the CMBG HQ deploying on a domestic operation, will produce tactical decision aids in accordance with the published formation planning process:

   a. The provision of support will include the preparation and population of a terrain analysis database (TADB) with data at various scales (1:50 000 and 1:250 000) at the garrison location and its subsequent modification with geospatial information collected in the area of operations.

   b. The GST commander will be responsible for maintaining a daily log, prioritizing work orders, and providing geomatics advice. The MCpl will assume responsibility for the provision of mapping products from the CFMD. The GST can also scan and make multiple plots of overlay traces that are prepared by the CMBG HQ staff.

3. **Support to Training and Exercises**. On exercise, the GST will support brigade unit-level training, in accordance with formation SOPs from the CER ESCC, in the production of tasked tactical decision aids:

   a. In support of this requirement, in conjunction with the MCE in Ottawa, the GST will have to prepare and populate a database for the training areas used by the brigade. This will be an ongoing task; the GST Comd is the OPI. The same types of products that are produced for operations will also be produced for training but may be done with reduced

level of granularity or level of detail, as local resources permit.

b. The detail and depth found in tactical decision aids may have to be sacrificed in exercise products due to operational commitments or other routine tasks. The GST will be responsible for ensuring the provision of geomatics products in support of brigade- and unit-level exercises.

4. **General Military Training (GMT)**. The GST will take part in all GMT conducted by the CER including PT periods, range qualifications, etc. They will maintain their levels of physical fitness and battle fitness training standards.

5. **Geomatics Specific Training**. The GST Comd is responsible for ensuring the standard of training for the GST. Time must be set aside to ensure that GIS skills, TERA skills, and TVis skills are developed and maintained. Both hardware and software skills must be constantly reinforced to ensure no loss of skills.

6. **Regimental Life**. As military engineers, both members of the GST will be expected to fully participate in all aspects of regimental life.

7. **Miscellaneous**. As mentioned previously, the GST brings with it a very specialized and value-added complement of skill sets. In addition to the previously mentioned tasks, members of the CER GST may be capable of providing assistance:

a. to the base CE section, through the provision of survey; and

b. to locating troop, assisting the Arty Regt with establishing survey control.

APPENDIX 2
DGSS-LIGHT CONFIGURATION

Item	Qty
HARDWARE	
Dell Workstation	1
Intel Pentium IV Xeon 1.7 MHz (X2)	
NVIDIA QUATRO PRO GRAPHICS.	
FX6+ Texture Memory	
36 Gb SCSI Hard Drive (X3)	
CD-R Drive	
Windows 2000 Pro	
Keyboard	
Mouse	
1024 MB RAM	
USR 56K Faxmodem	
Iomega 2GB JAZ Drive	
ADR 50 Onstream Backup Drive	
16x CD Jukebox	
Ultra 160 RAID 5 Disk Interface	
Power Cord	
21" Monitor (CTX Graphic)	1
36" Scanner SCSI (CONTEX)	1
36" Plotter (HP Designjet 1055C)	1
HP Deskjet 1220Cxi colour printer	1
HP Scanjet 6300C scanner	1
8 Port Hub	1
APC Smart UPS 1400	2
Portable Line Conditioner (STABILINE)	1
Camcorder (Canon JI-8)	1
Digital Camera (Kodak DC280)	1
Carrying Cases (3 cases)	1

Item	Qty
Notebook Computer	1
Internal DVD ROM /CD-ROM and LS120 MB Floppy	
20 GB Hard Drive	
Mobile Pentium III 700 MHz	
256 MB RAM	
Windows 2000 Pro	
PLGR	1
PS/2 Mouse	1
PC Card—SCSI adaptor	1
PC Card—56K USR Modem	1
PC Card—Network Card	1
Pelican Hardcase	1
Paper Cutter	1
Laminator	1
Labelling Machine (KROY)	1
SOFTWARE **	
ArcView GIS 8.2	1
ArcView Spatial Analyst 8.1	1
ArcView 3-D Analyst 8.1	1
ArcView ArcPress 8.1.2	1
ArcView Network Analyst	1
ERDAS Imagine Professionnel 8.5	1
ERDAS Vector 8.5	1
ERDAS Virtual GIS 8.5	1
ACD See	1
Easy CD Creator V 5	1
WinZip 8.0	1
Norten Ghost	1
Adobe Graphics Studio	1
MS Office 2000	1

Item	Qty
MS Encarta 2000	1
McAfee Anti Virus	1
TOTAL	

GLOSSARY OF TERMS

ACE. Allied Command Europe.

AZIMUTH. The horizontal direction of a line measured clockwise from True North or a reference plane.

COLLATION. The process whereby data that has been sourced gets collected and prepared for either conditioning or processing.

COMMON OPERATING PICTURE. The common operating picture (COP) is a visual product through which SA is presented to assist the commander and staff in the decision-making process. The COP is part of the command and control process and is the mechanism through which reports, returns and planning information are compiled and presented

CONDITIONING. To put into proper form for action or use, a three stage process involving sourcing, validation and synthesis.

DATUM. A reference surface consisting of five quantities: the latitude and longitude of an initial point, the azimuth of a line from this point, and two constants necessary to define the reference spheriod. It forms the basis for the computation of horizontal control surveys in which the curvature of the earth is considered.

GEODESY. The science that deals with the measurement and representation of the earth, including its gravity field, in a 3-D time-varying space.

GEODETIC. The process of enhancing the value of geodetic and geophysical data by analysis, evaluation, computation, and adjustments.

GEOID. The equipotential surface in the gravity field of the earth that coincides with the undisturbed mean sea level extended continuously through the continents. The direction of gravity is perpendicular to the geoid at every point.

GPS (Global Positioning System). A navigation system that relies on an artificial constellation of 24 satellites orbiting the earth at an altitude of 20 000 km and an inclination of 55° in three orbital planes. The GPS has been designed in order that at least four satellites are visible 24 hours a day from any point on the earth's surface.

GRID. A rectangular coordinate system that is superimposed on maps, charts, and other similar representation of the earth's surface.

GYROSCOPIC THEODOLITE. A theodolite (survey instrument) with a gyroscopic compass attached or built in, whereby a true azimuth reference can be established in any weather, day or night, with or without the use of stars.

INFORMATION OPERATIONS (IO). Those operations that gain information and knowledge that enhances friendly execution of operations, while denying the enemy similar capabilities by whatever means possible. The application of IO enhances battlefield visualization and improves designation of main effort, control of operational tempo and synchronization

MGRS (Military Grid Reference System) or Universal Transverse Mercator (UTM). A military grid system based on the Mercator projection, applied to maps that use a standard-scale grid square, based on a point of origin on a map projection of the earth's surface, in an accurate and consistent manner.

NATO. North Atlantic Treaty Organisation.

NRCan (Natural Resources Canada). The agency responsible for civilian geographic data in Canada.

PLGR (Precise Lightweight GPS Receiver). Hand-held GPS unit used by field troops and accurate to +/- 10 m.

SITUATIONAL AWARENESS. Situational awareness (SA) is the representation of knowledge that will assist the commander in his decision making. SA has three components:

a. **Blue SA**. The product of the processes which provides information on the friendly forces disposition and the overall battlefield geometry (i.e. boundaries, control measures, etc). It also provides commanders with asset visualization, the accurate status of his own and other friendly forces' human, materiel and information resources.

b. **Red SA**. The product of the processes which provides information on the enemy location, disposition, status and intention.

c. **Brown SA**. The product of the processes, which provides information on all aspects of the environment where operations are conducted. It consists primarily of terrain and meteorological information but could also include information about

environmental and NBC hazard, space, geo-spatial relationship, the electromagnetic spectrum, politics, economics, sociology and law.

SOURCING. This involves the extraction of features and facts, from processed hardcopy data such as existing topographical maps, air photos, soils maps, satellite imagery, human intelligence (HUMINT), and field recce.

SPHEROID. A mathematical figure closely approaching the geoid in form and size and used as a surface of reference for geodetic surveys. See **datums**.

SYNTHESIS. The process whereby compiled, geospatial data is integrated into a highly structured, but generic terrain analysis database (TADB).

TERRAIN ANALYSIS. Is the process of collecting, collating, analyzing, and evaluating natural and man-made features and the integration of climatological factors upon these features within the intelligence process, in order to give a true representation of the effects of the ground on military operations.

TERRAIN VISUALIZATION. Is a method that enables a terrain analyst to provide the commander and staff automated assistance in visualizing the terrain and to display and plot digital geospatial information.

TOPOGRAPHY. The configuration of the surface of the earth, including its relief, the position of its streams, roads, cities, etc. The earth's natural and physical features collectively. A single feature such as a mountain or valley is a topographic feature.

TRAVERSING. A method of surveying in which length and direction of lines between points on the earth's surface are obtained by or from field measurements and used in determining positions of the points.

TRIANGULATION. A method of survey in which the stations are points on the ground and are located at the vertices of a chain or network of triangles. The angles of the triangles are measured instrumentally, and the sides are derived by computation from the selected sides, which are termed baselines, the lengths of which are obtained from direct measurements on the ground.

TRILATERATION. A method of survey wherein the lengths of the triangle sides are measured, usually by electronic methods, and the angles are computed from the measured lengths.

VALIDATION. To condition newly catalogued data by reviewing and screening it to ensure that it is relevant to the stated requirement, its accuracy is in accordance with standards, sources are identified and the currency is confirmed.

WGS 84 (World Geodetic System 84) is a consistent set of parameters describing the size and shape of the earth, the positions of a network of points with respect to the centre of mass of the earth. This is the common geodetic datum in use by coalition forces and NATO.