**TC 3-34.80**

# Army Geospatial Guide for Commanders and Planners

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DISTRIBUTION RESTRICTION: Approved for public release; distribution is unlimited.

This publication supersedes TC 3-34.80, dated 14 February 2019.

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# Army Geospatial Guide for Commanders and Planners

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# Preface

*"In a fight between a bear and an alligator,*
*it is the terrain which determines who wins."*
*– Jim Barksdale*

Like the bear and alligator, military leaders must understand how the terrain/environment will influence their operational capabilities before they enter the fight. The geospatial engineer is there to enhance your understanding of where the terrain is advantageous or disadvantageous to mission success.

TC 3-34.80 is designed and developed by current and former senior geospatial engineers to help commanders and staff planners understand the capabilities of geospatial engineering and how to incorporate their capabilities into mission planning and execution. This allows you to see first, understand first, act first, and finish decisively.

Commanders, staffs, and subordinates ensure that their decisions and actions comply with applicable United States, international, and in some cases host-nation laws and regulations. Commanders at all levels ensure that their Soldiers operate in accordance with the law of war and the rules of engagement. (See FM 6-27.)

TC 3-34.80 uses joint terms where applicable. Selected joint and Army terms and definitions appear in both the glossary and the text. Terms for which TC 3-34.80 is the proponent publication (the authority) are italicized in the text and are marked with an asterisk (*) in the glossary. Terms and definitions for which TC 3-34.80 is the proponent publication are boldfaced in the text. For other definitions shown in the text, the term is italicized and the number of the proponent publication follows the definition.

TC 3-34.80 applies to the Active Army, Army National Guard/Army National Guard of the United States and United States Army Reserve unless otherwise stated.

The proponent of TC 3-34.80 is Headquarters, United States Army Training and Doctrine Command (TRADOC). Send comments and recommendations on DA Form 2028 (*Recommended Changes to Publications and Blank Forms*) to Commander, United States Army Maneuver Support Center of Excellence (MSCoE), ATTN: ATZT-CTG, 14010 MSCoE Loop, Fort Leonard Wood, MO 65473-8926.


**ACKNOWLEDGMENTS:**

Most figures courtesy of ©Digitalglobe.

Jim Barksdale quote from Tren Griffin 25iq blog titled "A *Dozen Things I've Learned from Jim Barksdale and "Barksdaleisms*" dated 31 May 2014.

# Introduction

This publication describes the functions performed, and the geospatial support provided, by the geospatial engineer. It provides the background knowledge to enable commanders and staffs to fully leverage their geospatial engineers.

The geospatial engineer collects, generates, manages, and provides the foundational geospatial information for the common operational picture (COP). The geospatial engineer produces terrain visualization products and tailored terrain analysis, thus enabling a comprehensive understanding of the operational environment and informed decision making when the geospatial engineer is integrated into staff processes, the staff is able to better address the commander's questions about the physical environment and its operational effects.

# Chapter 1

# Geospatial Engineering

Geospatial engineering is the generation, management, analysis, and dissemination of positionally accurate environmental information tied to a place, area, or feature on an earth coordinate system. It is a powerful combat multiplier when used effectively. Geospatial engineers provide the Soldier with base map data for their COP, tactical decision aids, and mission-tailored terrain visualization products enabling commanders and staffs to determine operational impacts. Geospatial engineers do not follow a typical training/operational cycle, they are always in an operational mode preparing data and products for their commander's area of interest (AOI) or the next supported mission.

## BACKGROUND

1-1. Geospatial engineering is the one engineer mission that works primarily with information. Geospatial information describes the geographic location and characteristics of natural or constructed features and boundaries on, above, or below the earth's surface. When applied to mission command and staff functions, it provides synergistic effects to all warfighting disciplines throughout the spectrum of conflicts.

1-2. Geospatial engineers are located in geospatial planning cells (GPC) supporting Army Service Component Commands (ASCC). At the corps, division, and brigade combat team levels geospatial engineers are a component of the geospatial intelligence (GEOINT) cell as geospatial engineer teams (GETs). The GET conducts analysis in concert with their GEOINT imagery analyst counterparts to perform full spectrum GEOINT. Geospatial engineers are also located on brigade staffs for most functional and multifunctional brigades.

## FACTORS OF TERRAIN IN MILITARY PLANNING

1-3. Military commanders have long-realized the effects of the physical environment on mission success. Commanders who stand out in history, had the ability to visualize the operational environment and its effects and utilize the terrain to their advantage in the battle. Today's geospatial engineer must represent the physical environment and its effects more accurately and faster to help the commander visualize the operational environment.

1-4. Paper maps and still aerial photography are the traditional sources of information that describe the ground. Technological advances significantly changed the Army's ability to collect, generate, manage, analyze, and disseminate geospatial data and products for the operational environment. The advancements of geographic information systems have allowed the development of new methods of generating and managing geospatial information, making geospatial products, and conducting detailed analysis about the military aspects of terrain.

# GEOSPATIAL INFORMATION AND SERVICES

1-5. *Geospatial information and services* are the collection, information extraction, storage, dissemination, and exploitation of geodetic, geomagnetic, imagery, gravimetric, aeronautical, topographic, hydrographic, littoral, cultural, and toponymical data accurately referenced to a precise location on the Earth's surface (JP 2-03). Geospatial services include tools that enable users to access and utilize data. Common military applications of geospatial information and services include support to planning, training, and operations (navigation, mission planning, mission rehearsal, modeling, simulation, and targeting). The geospatial information and services are tactically employed by geospatial engineers to provide the geospatial foundation for developing shared situational awareness and to improve the understanding of the effects of terrain on friendly and threat courses of action and other conditions of the operating environment.

# OPERATIONAL ENVIRONMENT VISUALIZATION

1-6. Operational environment visualization is the process whereby the commander—

- Develops a clear understanding of the current state with spatial and temporal relationships to the operational environment.
- Envisions a desired end state that represents mission accomplishment.
- Visualizes the sequence of activity that moves the commander's force from its current state to the end state.

1-7. The ability to visualize an operational environment is an essential leadership attribute and the heart of mission command; it is critical to mission accomplishment. The geospatial engineer provides the spatial and temporal canvas to this process. The GETs must continually—

- Collect, capture and generate data required to populate the Theater Geospatial Database (TGD).
- Manage and update the TGD to reflect the ever changing environment.
- Analyze the effects of physical environment on operations.
- Produce standard and nonstandard geospatial products.
- Integrate geospatial information and products into the COP and staff functions.
- Advise users on the best geospatial exploitation products for their requirements.

## Chapter 2

# Organization and Geospatial Support

This chapter describes the key functions performed by geospatial engineers; further explaining how commanders and staffs can effectively incorporate general engineering in support of Army operations.

## GEOSPATIAL SUPPORT

2-1. All GETs are responsible for collecting, generating and managing geospatial databases to support the warfighter's need to understand the operational environment. In addition they author tactical decision aids, and conduct geospatial analysis, tailored to the supported organization, to examine the effects of the physical environment on current or future operations. They disseminate this data and analysis products throughout the mission command enterprise by serving the data and products at command posts from ASCC to brigade. The data services referred to as the Standard and Shareable Geospatial Foundation (SSGF), provide the foundation of a COP and running estimates for the supported command.

## COLLECTION AND GENERATION OF GEOSPATIAL DATABASES

2-2. For geospatial engineers the term collection is expanded from the typical intelligence sensor collect, to include the acquisition of all available geospatial data from authoritative and nonauthoritative sources. The data from nonauthoritative sources must be confirmed by the authoritative sources or means. Each headquarters senior geospatial engineer is military occupational specialty qualified to confirm data in their AOI as authoritative before it is included in their geospatial database and synched with the ASCC's TGD. Gaps in the data coverage are closed using requests for collection by sensors, Soldiers (recon team, and so forth) and authoritative collection agencies such as the National Geospatial-Intelligence Agency, the United States Geological Survey and the United States Army Corps of Engineers. Post processing generates the required data via analysis of the terrain using the information or imagery collected.

## MANAGING GEOSPATIAL DATABASES AND SERVICES

2-3. Managing geospatial databases is the process of continuously optimizing the data and services to provide the best possible geospatial awareness and understanding; this process includes identifying and correcting issues and regular maintenance.

Maintenance tasks must be performed on geospatial databases and on database services to maintain efficient sharing of the information required by the commander and staff. These tasks include creating backups of the databases, compressing geospatial data and databases, updating statistics, rebuilding indexes, and upgrading geospatial databases.

# DIGITAL MAPPING

2-4. Digital mapping is the process by which a collection of geospatial data is compiled and formatted into a scaled 2D or 3D representation of the surface, typically detailing roads, terrain and other points of interest. Maps require large amounts of data collected over time, compiled from imagery analysis as well as street level data from local sources. The digital mapping technologies not only provide the ability to produce traditional topographic maps, but also allow for customized map symbology or hybrid maps that combine imagery with overlaid map symbolization. Digital mapping also provides the ability to rapidly update map data, which allows the addition of newly constructed roads or places to be added to maps in less time than traditional methods.

# GEOSPATIAL ANALYSIS

2-5. A common statement heard from today's military leaders is that "there is too much data," however, there is never too much data, but rather there is too much unmanaged or unstructured data for them to process and visualize how it affects the operation. Most operational data provides the information of what, when, and where that can be brought into geospatial analysis processes to generate products to visualize and understand the operational impacts. Geospatial analysis goes beyond 2D and 3D mapping; it addresses questions about the operational effects of the terrain (for example, mobility analysis) and includes surface analysis of the properties of the physical environment, such as gradient, aspect, and visibility. It also has the ability to utilize statistical data of natural and manmade features as they are associated to locations on the surface to solve problems with multiple parameters like road conditions, human activities, weather effects for route selection or slope, surface materials, and vegetation for landing zones. Geospatial analysis using high resolution data has applications in every Army warfighting function. The Engineer Regiment currently uses geospatial data on construction sites to analyze things like optimal traffic flow patterns, ideal routing of water pipelines, and cut and fill requirements.

# TAILORED GEOSPATIAL SUPPORT

2-6. Geospatial support goes beyond basic maps and standard analysis products. The ability to answer complex questions about the operational effects of the environment is where the capabilities provided by the GEOINT work station and the geospatial engineer excels in providing the answers. Each unit and mission has key elements of terrain that apply to the situation at hand. As the user of a geospatial product, you know its relevancy to your mission and what terrain and condition factors are key influencers to your mission. The key to getting the best product available is your ability to list, define, and prioritize the importance of these factors to the GET. To acquire these types of products, you need to contact your supporting GET and discuss your geospatial requirements.

Formulate the right questions and timelines to get the geospatial information you require to answer your need. This type of analysis typically requires high resolution data sets.

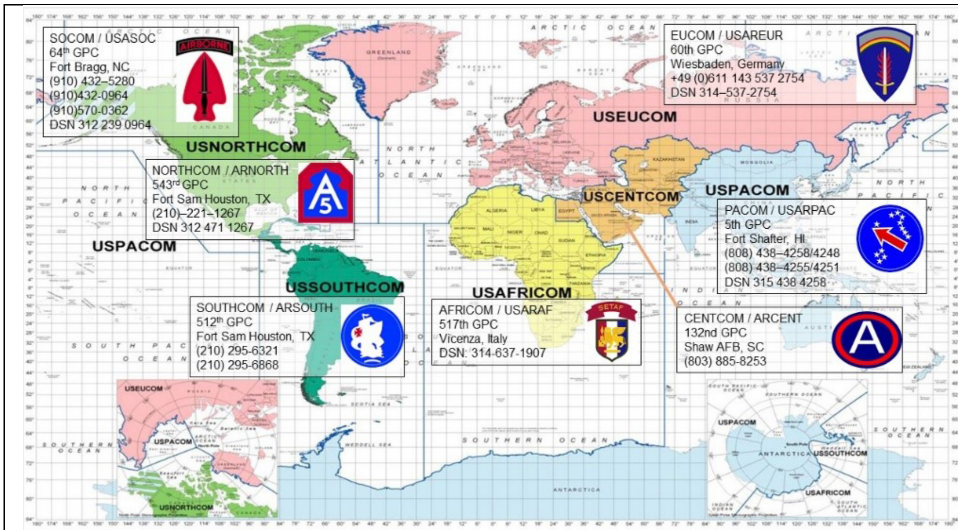
# GEOSPATIAL SUPPORT BY ECHELON

2-7. While all GETs have some capacity to perform all of the geospatial support tasks, the focus of geospatial engineer support varies based on the supported headquarters echelon.

- ASCCs GPCs focus on mapping and geospatial data collection, generation, management, and dissemination to build and provide the TGD. This is a time consuming process, and must be the daily focus of GPCs to meet the Army's geospatial needs.
- At echelons above brigade, the majority of the workload is focused on geospatial analysis supporting the military decisionmaking process in addition to data management and dissemination.
- At the brigade combat team, multifunctional brigades, and separate functional brigades, geospatial engineering is increasingly focused on creating terrain visualization products supporting the military decisionmaking process and intelligence preparation of the battlefield for current and future operations. The brigade level GETs are additionally asked to capture relevant geospatial data collected via reconnaissance, surveys or situational reports and add this information to the geodatabase to be synched with other GET databases within that AOI.

# FINDING GEOSPATIAL ENGINEER SUPPORT

2-8. GETs are assigned to the headquarters of most brigades, and all divisions and corps. GPCs are assigned to ASCCs and are responsible for the associated operational theater. If you are looking for analysis products tailored to support planning for missions or projects, or SSGF data, you should contact the first GET in your chain of command. If you need maps/data outside currently mapped areas or specialized geospatial data your GET should contact the appropriate GPC for the area of concern. See figure 2-1, page 2-4.




**Legend:**

| | | | |
|---|---|---|---|
| AFB | Air Force Base | USAPACOM | United States Army Pacific Command |
| AFRICOM | African Command | | |
| ARCENT | United States Army Central Command | USAREUR | United States Army, European Command |
| ARNORTH | Army North | USARPAC | United States Army, Pacific Command |
| ARSOUTH | Army South | | |
| CENTCOM | Central Command | USASOC | United States Army Special Operations Command |
| DSN | Defense Switched Network | | |
| EUCOM | European Command | | |
| GPC | geospatial planning cell | USASOUTHCOM | United States Army Southern Command |
| HI | Hawaii | | |
| NC | North Carolina | USEUCOM | United States European Command |
| PACOM | Pacific Command | | |
| SC | South Carolina | USNORTHCOM | United States Northern Command |
| SOCOM | Southern Command | | |
| TX | Texas | USPACOM | United States Pacific Command |
| USAFRICOM | United States African Command | | |

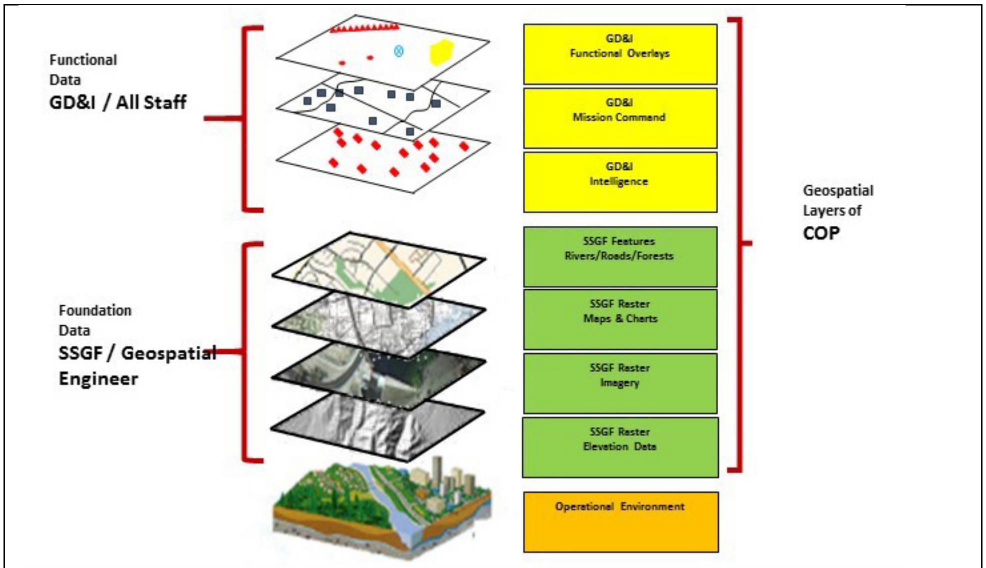
**Figure 2-1. GPC locator**

# Chapter 3
# Common Operating Environment

This chapter explains the designed incorporation of geospatial capabilities into mission command. The common operating environment is an approved standardized set of computing technologies and capabilities that will enable secure and interoperable applications to be rapidly developed then executed across all mission command computing environments from the command posts to the individual Soldier. Among these cross cutting capabilities is the enabling technology of the SSGF. The SSGF standards were adopted to provide for a single set of foundational data for the COP and to minimize the size and effort required to provide the geospatial base to all computing systems.

## STANDARD AND SHAREABLE GEOSPATIAL FOUNDATION

3-1. The SSGF is a common set of the best available geospatial data within operations directorate of a joint staff (J-3), assistant chief of staff, operations (G-3), or brigade or battalion operations staff officer (S-3) directed AOI boundaries that provides the geospatial foundation for all mission command systems. SSGF data is collected and assembled from multiple national sources along with information gathered by scouts and other reconnaissance assets employed by the unit, local information, special operations forces/civil affairs, logistic and construction engineering operations, and other services and foreign nation partners. The SSGF currently consists of four basic types of geospatial data: finished maps and charts, imagery, feature data (hydrology, vegetation, transportation data, and so forth) and terrain elevation data (see figure 3-1, page 3-2). The SSGF forms the foundation on which units build their COP. As the foundation of the COP, the SSGF is relevant to all phases of operations and influences all systems, platforms, and processes that use, produce, store, manage, or disseminate geospatial data that is shared within and between the warfighting functions. The data that makes up the SSGF is provided in specified formats to ensure compatibility with all mission command systems. Geospatial engineers update, manage and maintain the SSGF content to maintain currency and accuracy, and provide it on geospatial web services on which staffs can overlay other information.




**Legend:**

| | |
|---|---|
| COP | common operational picture |
| GD&I | geospatial data & information |
| SSGF | Standard and Shareable Geospatial Foundation |

**Figure 3-1. Geospatial layers of the COP**

# STANDARD AND SHAREABLE GEOSPATIAL FOUNDATION ACQUISITION AND USE

3-2. Use of the SSGF supports mission command by putting current operations, planning efforts, and running estimates in the context of space and time on a common digital map shared and seen by all. Data overlaid on the geospatial foundation includes geospatial data and information; analysis products and decision aides; operational and planning graphics from all warfighting functions and special staff; current operations data; and demographic, cultural, economic, industrial and infrastructure data that ties to a specific location. Acquisition of all SSGF data must be coordinated with the geospatial engineers to ensure that the COP remains standardized and can be managed and updated appropriately.

# STANDARD AND SHAREABLE GEOSPATIAL FOUNDATION SOURCE

3-3. The GPC's foundation is assembled in the TGD (combatant command AOI dataset, called the TGD) from data available at the National Geospatial-Intelligence Agency, Army Geospatial Center, other federal and state agencies, coalition partners, nongovernmental organizations, commercial sources, joint services, and internally generated Army data. From these theater datasets the GPCs make an AOI specific subset available for units at tactical and operational echelons. This subset that the unit takes with them into theater is the unit's SSGF or foundation for the unit's GI&S layers of the COP. This dataset is the single source of authoritative SSGF data used and shared throughout their formation. GETs or GEOINT cells assigned to tactical and operational (brigade/corps) units manage these unit data sets by synchronizing AOI common data across multiple echelons, directly reinforcing the commonality of the COP (see figure 3-1). The GEOINT cell or GET provides the SSGF on the service-enabled command post computing environment network and digital architecture. The units, through the GETs or GEOINT cells, host the data services from battalion to corps level, providing mission command systems, including mounted and hand held systems, use of the SSGF in all geospatial based applications. Thus ensuring that the best available geospatial data, including data produced in the field, is made available to the warfighter at the time and place commander's and staff need it.

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# Chapter 4
# Geospatial Support to the Staff

This chapter provides examples of geospatial products that can be used to enhance mission planning and understanding. These are starting points for mission specific products to answer your questions. When coordinating with your GET, focus on the question you need answered. In a data-rich environment, such as the National Training Center, tactical decision aids can be made within a few hours. In a data-poor environment (a location where there is little or no data), GETs must make the data or refine the imagery and then create the tactical decision aids. This process could take from 3 to 7 days, so coordinate with your GET for an accurate time prediction. It is imperative to request products as early as possible so that this valuable information is available during the planning cycle.

## J-1/G-1/S-1 STAFF SECTION (PERSONNEL)

4-1. The manpower and personnel directorate advises and assists the commander in the management of personnel, personnel replacements, discipline, morale and welfare, and develops personnel and administrative programs, policies, and procedures to support the command's goals and objectives.

### GEOSPATIAL SUPPORT

4-2. The manpower and personnel directorate of a joint staff (J-1)/assistant chief of staff, personnel (G-1)/battalion or brigade personnel staff officer (S-1) personnel section will typically use products to track personnel disposition within the area of operations. Geospatial products that support the J-1/G-1/S-1 include—

- Task organization overlay. (See figure 4-1, page 4-2.)
- Line of communications (LOC).
- Casualty assistance tracking.
- Unit strength overlay.

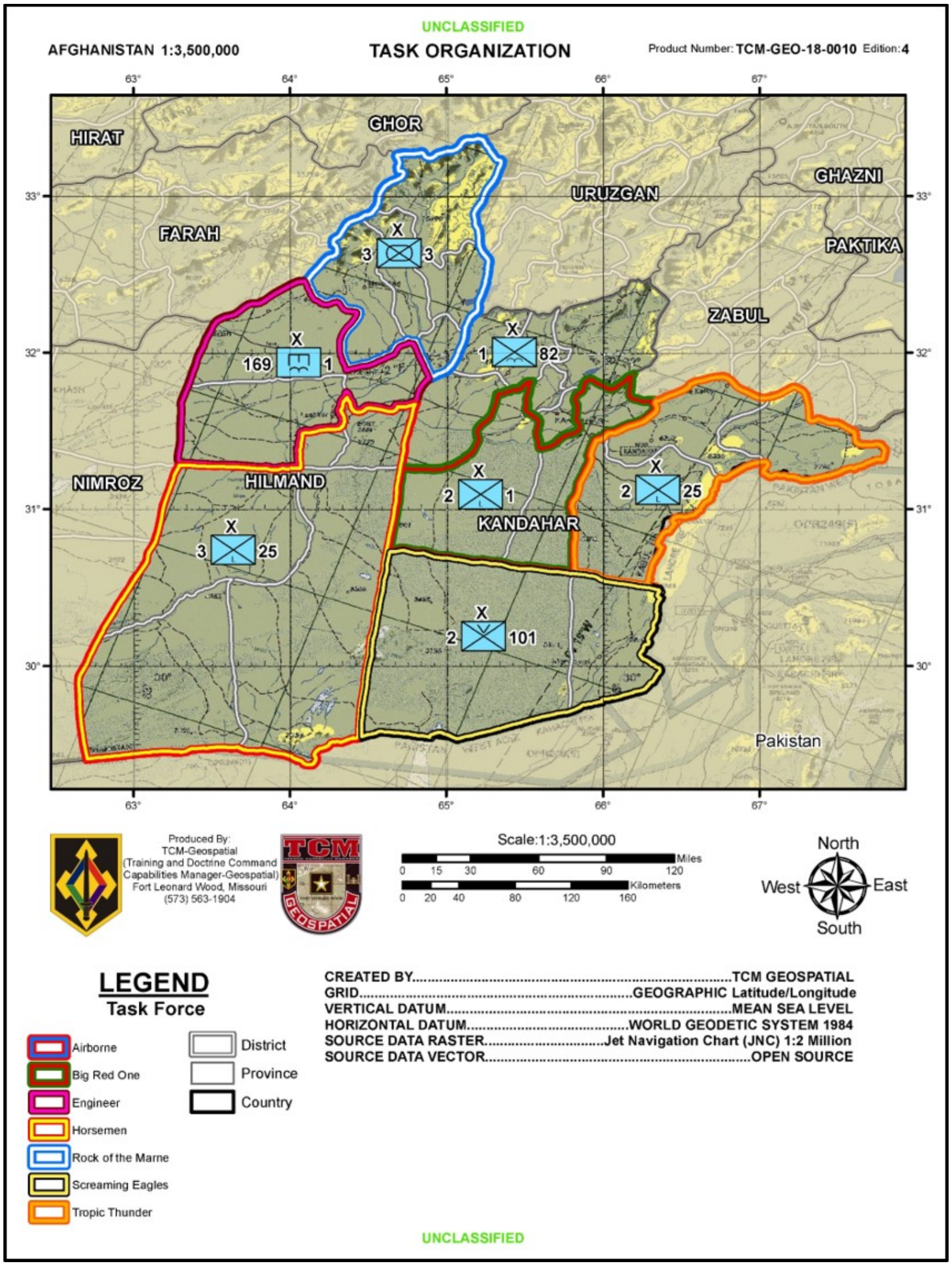


**Figure 4-1. Task organization overlay**

## J-2/G-2/S-2 STAFF SECTION (INTELLIGENCE)

4-3. The intelligence directorate of a joint staff (J-2)/assistant chief of staff, intelligence (G-2)/battalion or brigade intelligence staff officer (S-2) provides the command and Army/ground forces with actionable and tailored intelligence in support of information operations planning and execution.

### GEOSPATIAL SUPPORT

4-4. The J-2/ G-2/S-2 section uses products that help identify observation and fields of fire, avenues of approach, key terrain, obstacles, and cover and concealment (OAKOC) factors to support the intelligence preparation of the battlefield and the joint intelligence preparation of the operational environment. Products that support intelligence include—

- LOC overlay. (See figure 4-2, page 4-4.)
- Combined obstacle overlay.
- Cross country mobility.
- Line of sight analysis.
- Analysis of the area of operations.
- Intelligence preparation of the battlefield.
- Pattern analysis (GEOINT).
- Coherent change detection (GEOINT).
- Joint intelligence preparation of the operational environment.

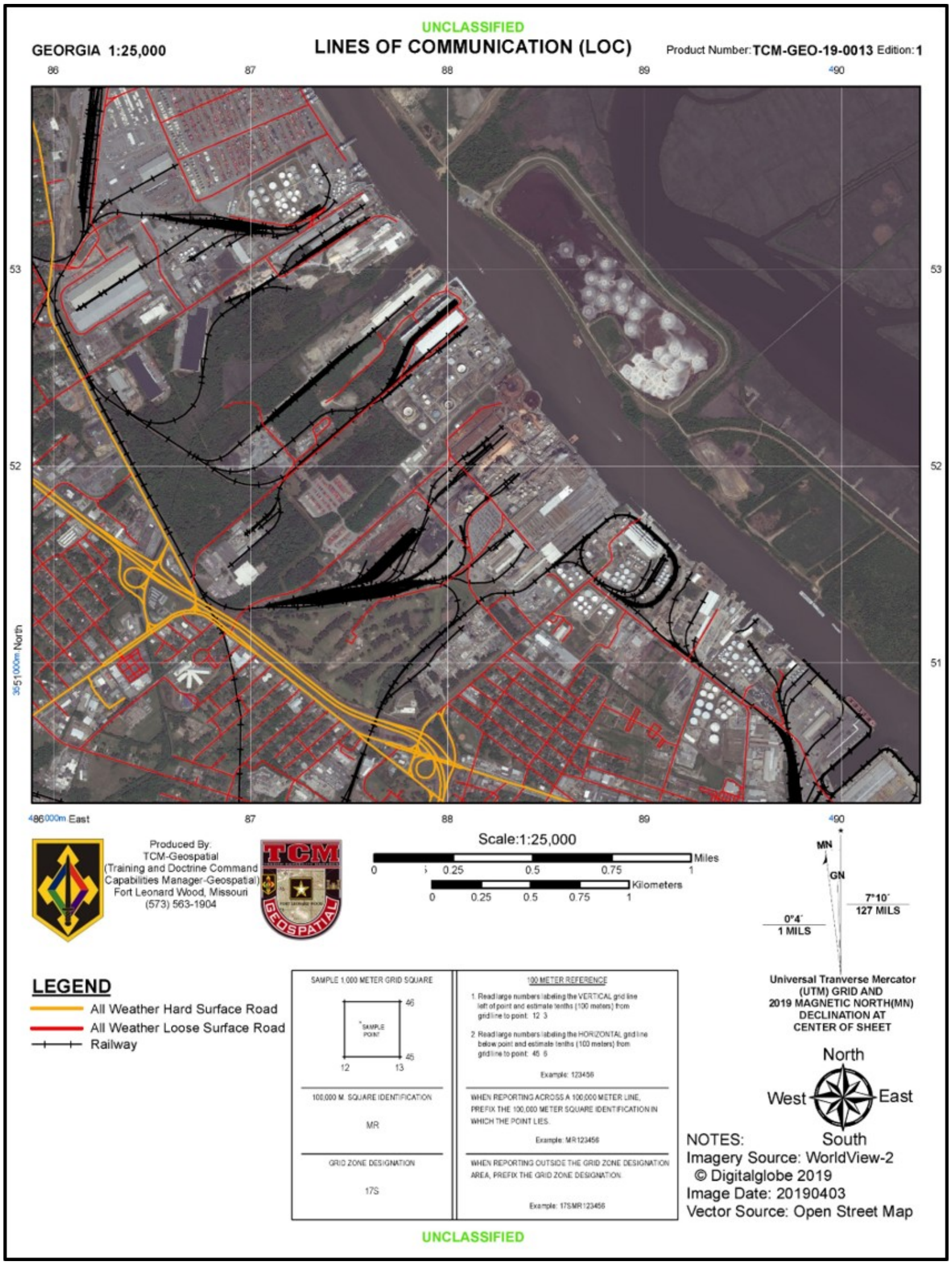


**Figure 4-2. LOC**

# J-3/G-3/S-3 STAFF SECTION (OPERATIONS)

4-5. The J-3/G-3/S-3 operations staff serves as the principle staff section for all matters concerning training, operations, plans, force development and modernization. The J-3/G-3/S-3 section is responsible for advising, planning, coordinating and supervising all current and future command operations.

## GEOSPATIAL SUPPORT

4-6. J-3/G-3/S-3 section uses products that help identify ground avenues of approach and mobility corridors that integrate all obstacles to vehicular movement (built-up areas, highways, railways, airfields, slopes, soils, vegetation, and hydrology) into one overlay to support the military decisionmaking process and operational planning. Products can also depict operational boundaries for planners to visualize friendly forces disposition in the operational environment. Some of the typical geospatial engineer products include—

- Unit boundary overlay. (See figure 4-3, page 4-6.)
- Task organization overlay.
- Combined obstacle overlay.
- Cross country mobility.
- Intelligence preparation of the battlefield.
- Three-dimensional visualization analysis.
- Route analysis.
- Helicopter landing zones analysis.

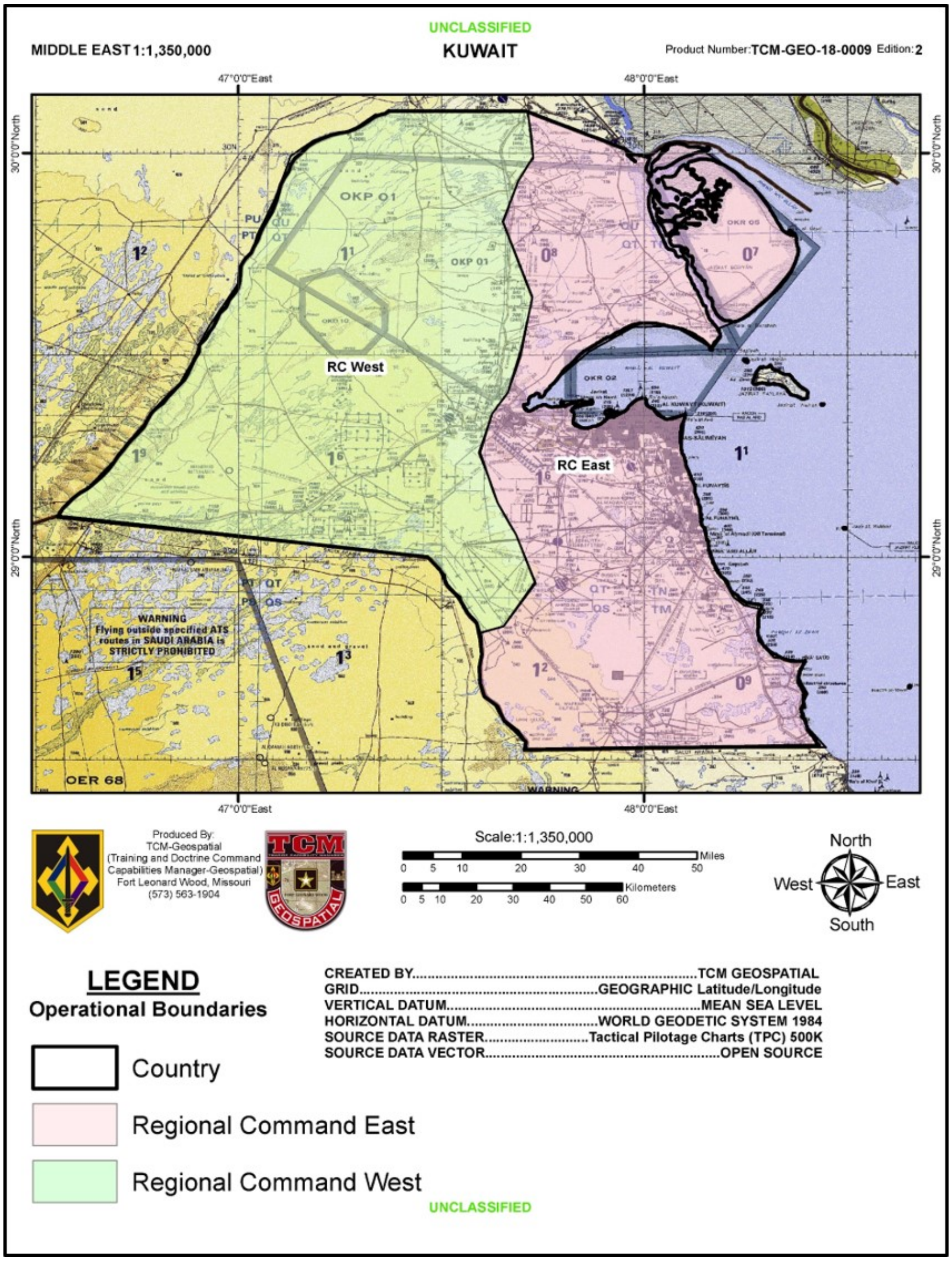


**Figure 4-3. Unit boundary overlay**

# J-4/G-4/S-4 STAFF SECTION (LOGISTICS)

4-7. The logistics directorate of a joint staff (J-4)/assistant chief of staff, logistics (G-4)/battalion or brigade logistics staff officer (S-4) is the principal staff officer for sustainment plans and operations, supply, maintenance, transportation, services, and operational contract support.

## GEOSPATIAL SUPPORT

4-8. The J-4/G-4/S-4 section uses products to identify highways, railways, airfields, and waterways that can be used to move troops and supplies. The Army's ability to carry out its mission depends greatly on its transportation capabilities. These products include information on road widths, gradients, sharp curves, surfaces, and weather categories; rail gauge, number of tracks, and yards; airfield lengths, widths, surfaces, and orientation; ferry and ford sites; and much more. These products are used to select main supply routes and logistic support areas and serve as a basis for the tactical route selection. Geospatial products that support this include—

- Route analysis. (See figure 4-4, page 4-8.)
- Combined obstacle overlay.
- LOC overlay.
- Cross country mobility.
- Logistical support area site suitability analysis.
- Sea ports of departures suitability analysis.
- Aerial ports of departures suitability analysis.
- Time distance route analysis.
- Task organization overlay.

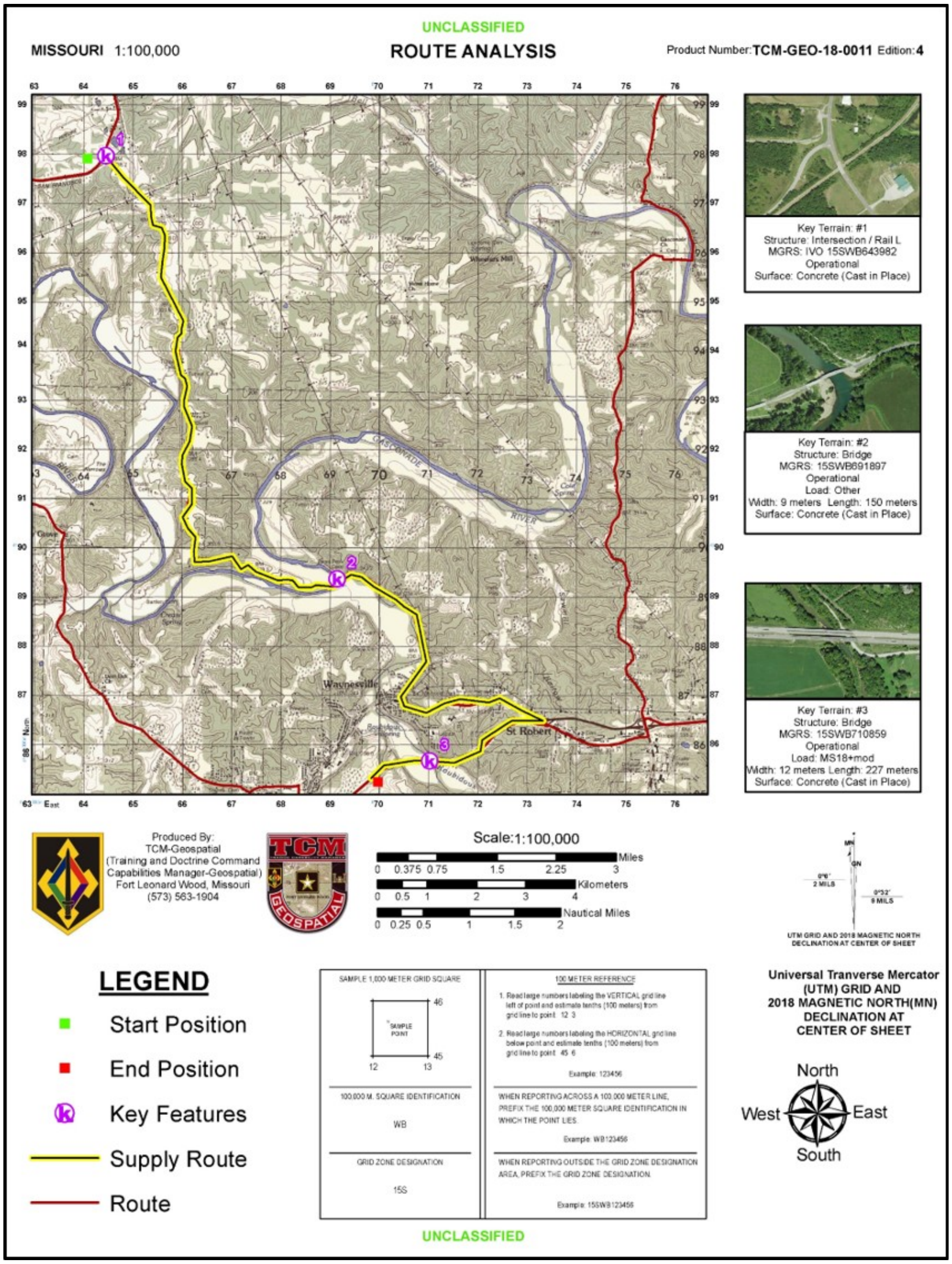


**Figure 4-4. Route analysis**

# J-6/G-6/S-6 STAFF SECTION (SIGNAL)

4-9. The communications system directorate of a joint staff (J-6)/assistant chief of staff, signal (G-6)/battalion or brigade signal staff officer (S-6) is the principal staff officer for all matters concerning network operations (jointly consisting of Department of Defense Information Network Operations and applicable portions of the Defensive Cyberspace Operations), network transport, information services, and spectrum management operations within the unit's area of operations.

## GEOSPATIAL SUPPORT

4-10. The J-6/G-6/S-6 section can use these products to show an area of direct observation possible from one location to another based on the elevation. This allows plans for communications platforms within the area of operations. Products that support the six missions include—

- Line of sight analysis. (See figure 4-5, page 4-10.)
- Key infrastructure.
- Frequency planning and coverage analysis.
- Retransmission site selection analysis.
- LOC analysis.
- Cover and concealment analysis.

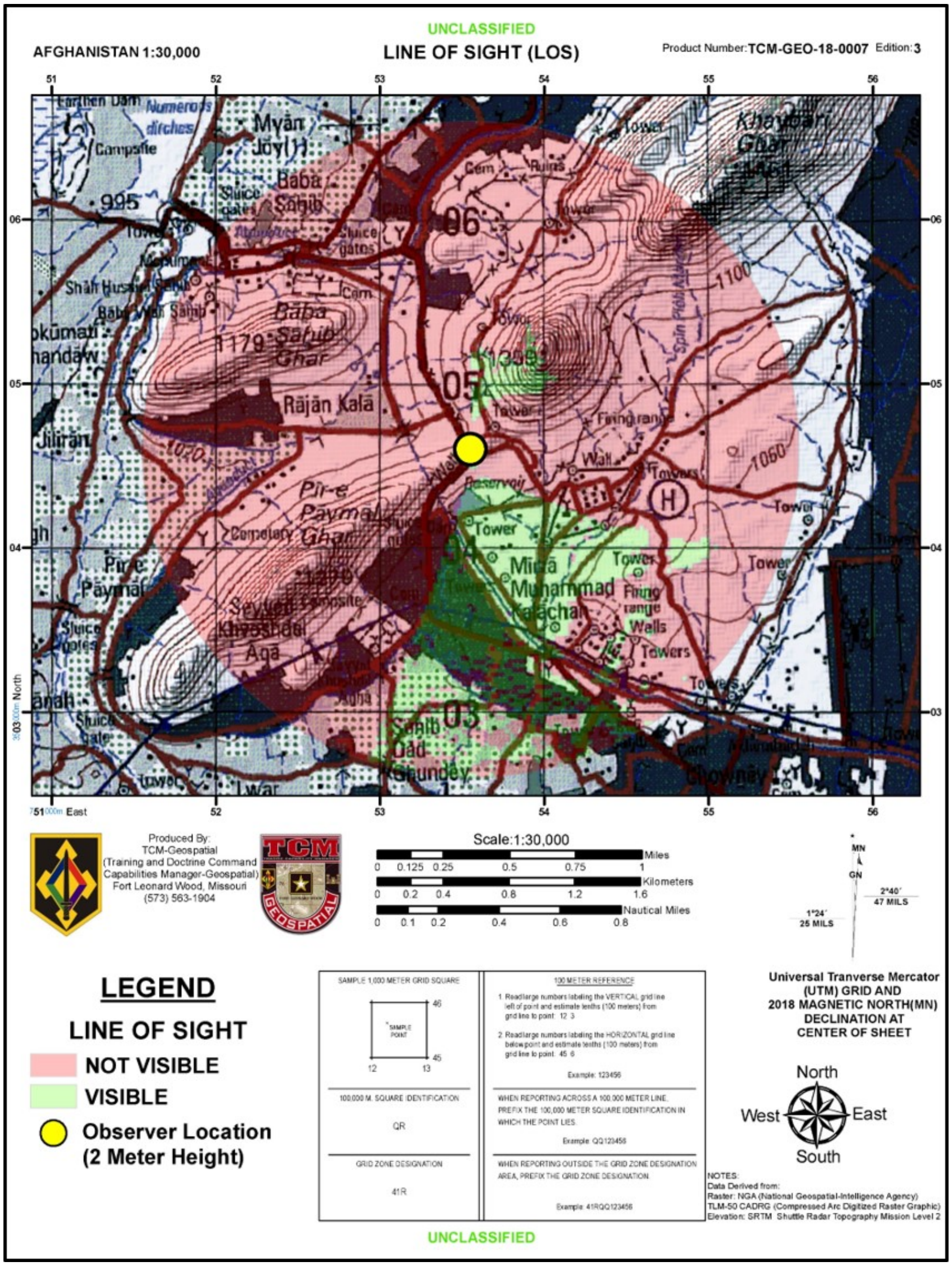


**Figure 4-5. Line of sight**

# ENGINEER OFFICER/STAFF SECTION

4-11. The engineer officer resides in the protection cell and is responsible for planning and assessing survivability operations. The engineer officer is involved in planning and operations with more than just the protection warfighting function. For example, mobility and counter-mobility are part of movement and maneuver, general engineering is part of sustainment, and geospatial engineering supports the intelligence warfighting function.

## GEOSPATIAL SUPPORT

4-12. Engineer sections use these products for site selection based on the size of the area and its proximity to low-lying areas that may be prone to flooding. It is used by engineers to plan base camp locations or to identify construction resources. It can also be used at the macro level to aid in the development or rebuilding of an area. These products are based on vegetation, slope, and soils.

4-13. Interactive products can be produced for regularly reported tracked route status and displaying updates for tactical routes that are shown by military load classifications, road widths, and operating characteristics. These products can include road classifications, bridges, ferries, tunnels, and curves. These products are used to choose maneuver routes to maintain momentum for gaining an advantage. Samples of these products include—

- Combined obstacle overlay. (See figure 4-6, page 4-12.)
- Cross country mobility.
- Mobility/countermobility hazards.
- Route analysis overlay.
- Construction site selection analysis.
- Infrastructure planning and utility repair analysis.
- Bridge analysis.
- ENFIRE consumption.

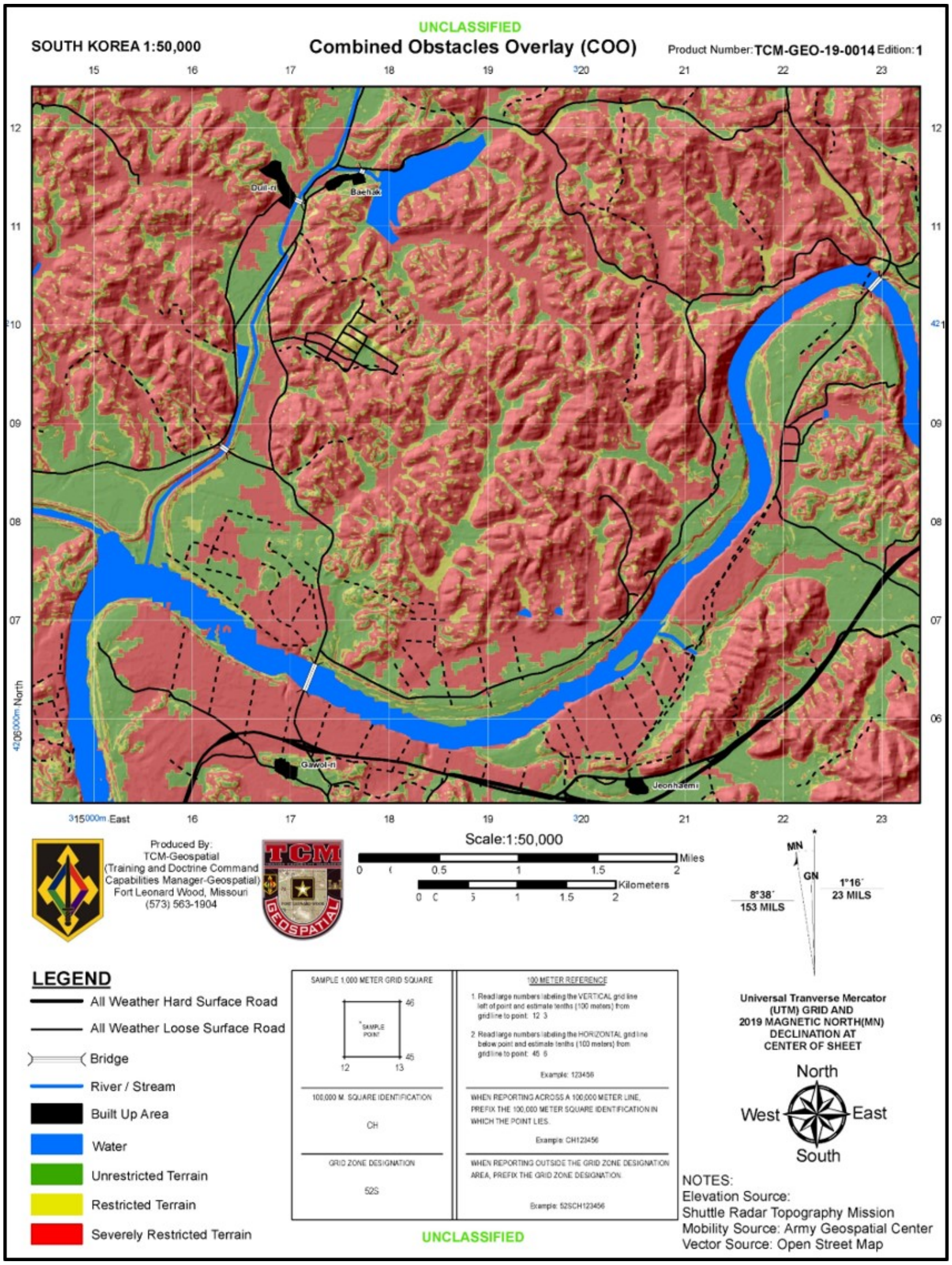


**Figure 4-6. Combined obstacle overlay**

# FIRES/FIELD ARTILLERY SECTION

4-14. The fire support coordinator is responsible for integrating all forms of Army, joint and multinational fires to include nonlethal capabilities. The fires cell provides effective exchange of information to adjacent headquarters, subordinate division elements, and other warfighting functions.

## GEOSPATIAL SUPPORT

4-15. Fires/field artillery section can use specific products to show areas of interest where the primary limiting factor is based on slope steepness. It is especially helpful in determining the suitability of artillery positions. Artillery slope maps identify areas with a 0 to 7 percent slope as suitable and an 8 to 12 percent slope as marginal for artillery battery firing positions. These products can reduce the time when searching for enemy artillery. It can also show areas concealed from known artillery sites and aid in planning safe areas for shoot-and-scoot missions. Some of the geospatial products used to support Fires include the following:

- Artillery slope analysis. (See figure 4-7, page 4-14.)
- Site selection analysis.
- Range fan analysis.
- Line of sight analysis.
- Drop zone analysis.
- Weapon systems fields of fire analysis.
- Cover and concealment analysis.

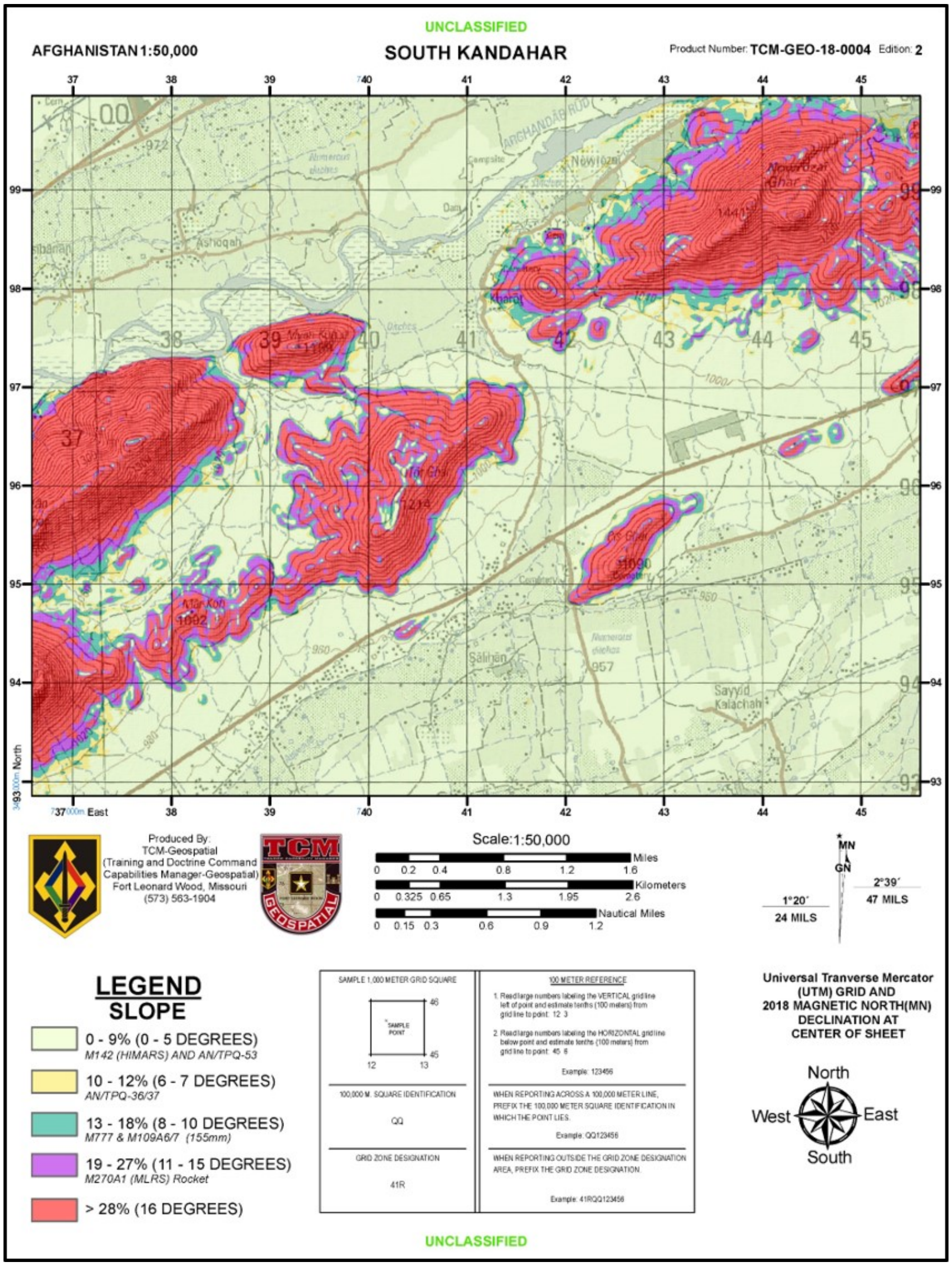


**Figure 4-7. Artillery slope analysis**

# SUSTAINMENT BRIGADES

4-16. The sustainment brigade is a flexible, modular headquarters organization capable of conducting multiple missions, and is a key organization in linking sustainment support from the operational to tactical levels.

## GEOSPATIAL SUPPORT

4-17. Sustainment brigades use these products to show all routes that afford high-speed approach into objective areas by land, water, and air. These can be used by military forces maneuvering into, out of, and around an area of observation. Dual-lane highways; all-weather, hard and loose surface roads; footpaths; airstrips; and railroads are usually shown. Some of the geospatial products used to support Sustainment include the following:

- Logistical support area site suitability analysis. (See figure 4-8, page 4-16.)
- Route analysis.
- Combined obstacle overlay.
- LOC overlay.
- Cross country mobility.
- Forward arming refueling point analysis.
- Time distance route analysis.
- Task organization overlay.

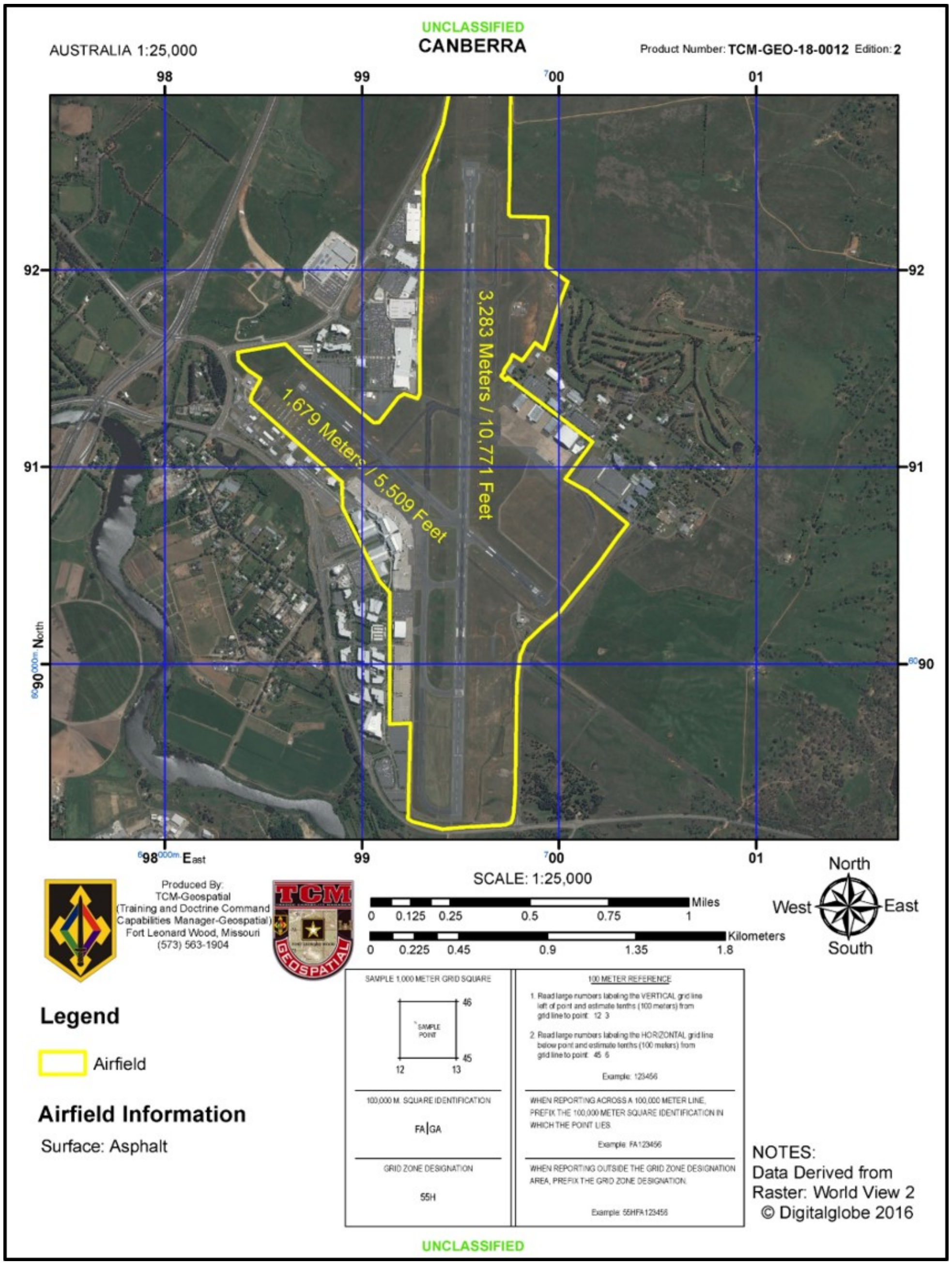


**Figure 4-8. Site suitability analysis**

# AVIATION BRIGADES

4-18. Combat aviation brigades support the operations of a joint force land component, corps, division, or a supported brigade combat team. Containing both manned and unmanned systems, the combat aviation brigade is tailorable to the mission and can support multiple brigade combat teams. The combat aviation brigade typically conducts the following missions: reconnaissance, security, attack, air assault, air movement, command and control support, aeromedical evacuation, personnel recovery, and downed aircraft recovery.

## GEOSPATIAL SUPPORT

4-19. Aviation section/brigade utilize geospatial products to determine zone-of-entry analysis that identify areas where forces, supplies, or equipment can be placed within reach of an objective or mission area. In most situations, it also means a zone of exit. The three considerations of zones of entry are vegetation, slope, and soil.

4-20. These products assist in reducing the analysis time for planners conducting air mobile operations or long-range surveillance insertions or extractions. Some of the geospatial products that support aviation include the following:

- Helicopter landing zones analysis. (See figure 4-9, page 4-18.)
- Drop zones analysis.
- Resupply drop zones analysis.
- Forward arming refueling point analysis.
- Unit boundary map (frequency call signs).
- Aerial ports of departures analysis (airfields, landing zones).
- Vertical obstruction analysis.
- Population analysis overlay.

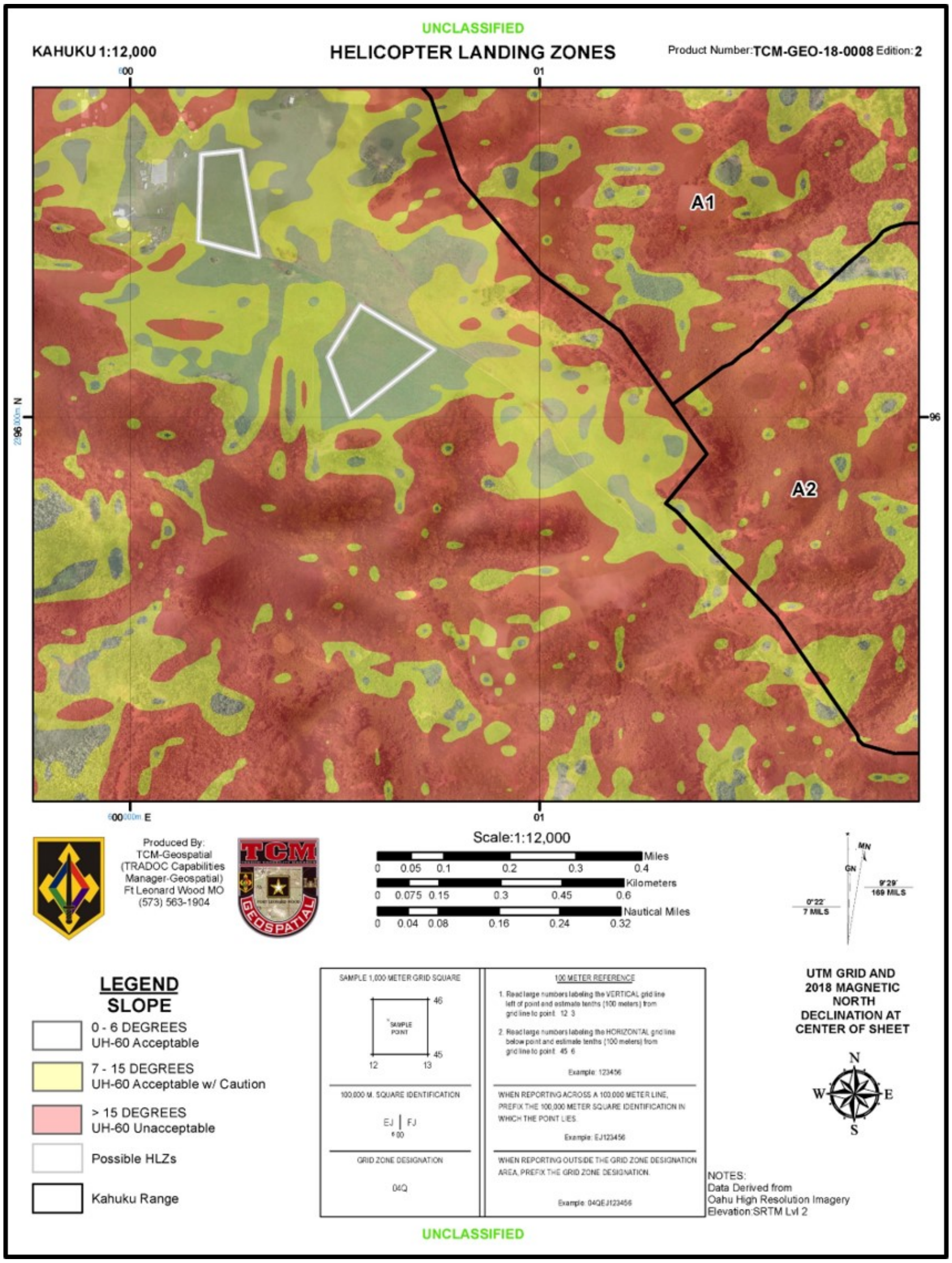


**Figure 4-9. Helicopter landing zones**

# MILITARY POLICE (FORCE PROTECTION)

4-21. The role of the Military Police Corps is to provide the Army with Soldiers who are professionals in policing, investigations, and corrections in order to enable protection and promote the rule of law. Through the three military police disciplines of police operations—detention operations, and security—and mobility support (integrated with police intelligence operations), military police execute missions as part of a combined arms effort through decisive action. Military police support to decisive action is complex and requires an in-depth understanding of the operational environment, the commander's intent, the concept of operations, and the capabilities and limitations of military police in support of the operation.

## GEOSPATIAL SUPPORT

4-22. Military police use geospatial products to help commanders and staffs visualize how certain aspects of the terrain promote crime and criminality and impact traffic and safety. Geospatial technology can greatly enhance the ability of police intelligence analysts to perform crime mapping by enhancing terrain analysis and geographic distribution analysis. Some of the geospatial products that support military police include the following:

- Crime analysis product displays. (See figure 4-10, page 4-20.)
- Incident mapping.
- Crime concentrations, density, or hotspot maps.
- Link analysis.

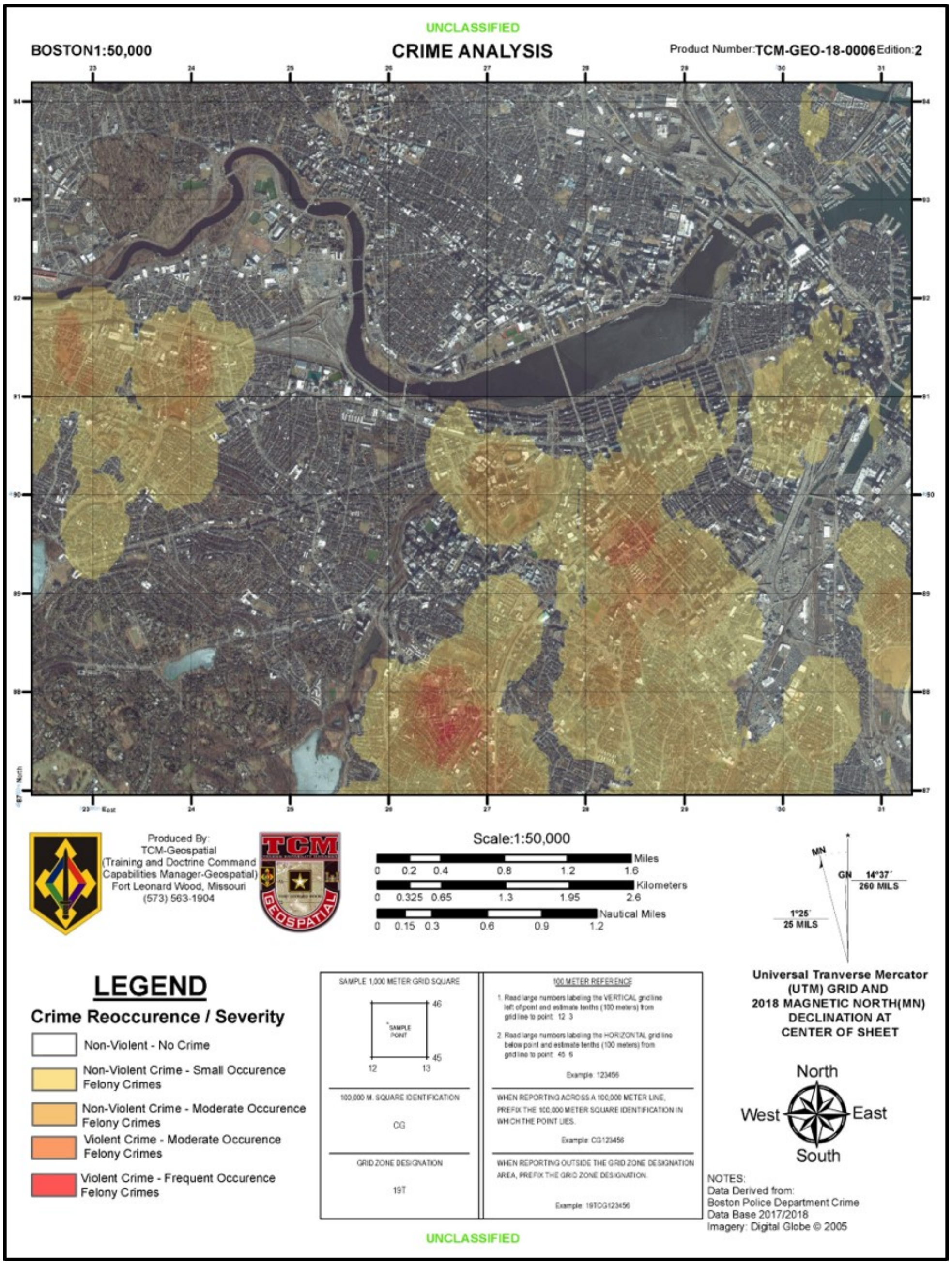


**Figure 4-10. Crime analysis**

# HUMANITARIAN ASSISTANCE AND DISASTER RELIEF

4-23. The United States military normally conducts humanitarian assistance/disaster relief missions in support of other United States Government departments or agencies to alleviate suffering of disaster victims. Some activities that may be conducted include providing logistical support, such as the transportation of humanitarian supplies or personnel; making available, preparing, and transporting nonlethal excess property to foreign countries; transferring on-hand Department of Defense stocks to respond to unforeseen emergencies; and conducting some Department of Defense humanitarian demining assistance activities.

## GEOSPATIAL SUPPORT

4-24. Mission planners can utilize these products to prepare for and support humanitarian assistance and disaster relief operations. Each disaster and associated support will be unique due to differences in scale, environmental factors, geography, and government decisions, but the basic planning considerations and processes, however, remain the same.

4-25. Planners will have to react to indications of pending disaster; determine the nature and characterization of an on-going disaster; visualize the environmental, economic, transportation, logistical or infrastructure constraints on relief operations; and assist United States, allied, affected country and nongovernment disaster responders in the event of an industrial explosion, hurricane, hazardous material spill, flood, landslide, fire, famine, earthquake, drought, cyclone, or avalanche. Some of the geospatial products used to support humanitarian assistance/disaster relief include the following:

- Potential landslide analysis. (See figure 4-11, page 4-22.)
- Critical infrastructure assessment.
- Route analysis.
- Damage assessment analysis (GEOINT).
- Slope analysis.
- Helicopter landing zones analysis.
- Drop zones analysis.
- Resupply drop zones analysis.
- Elevation analysis.

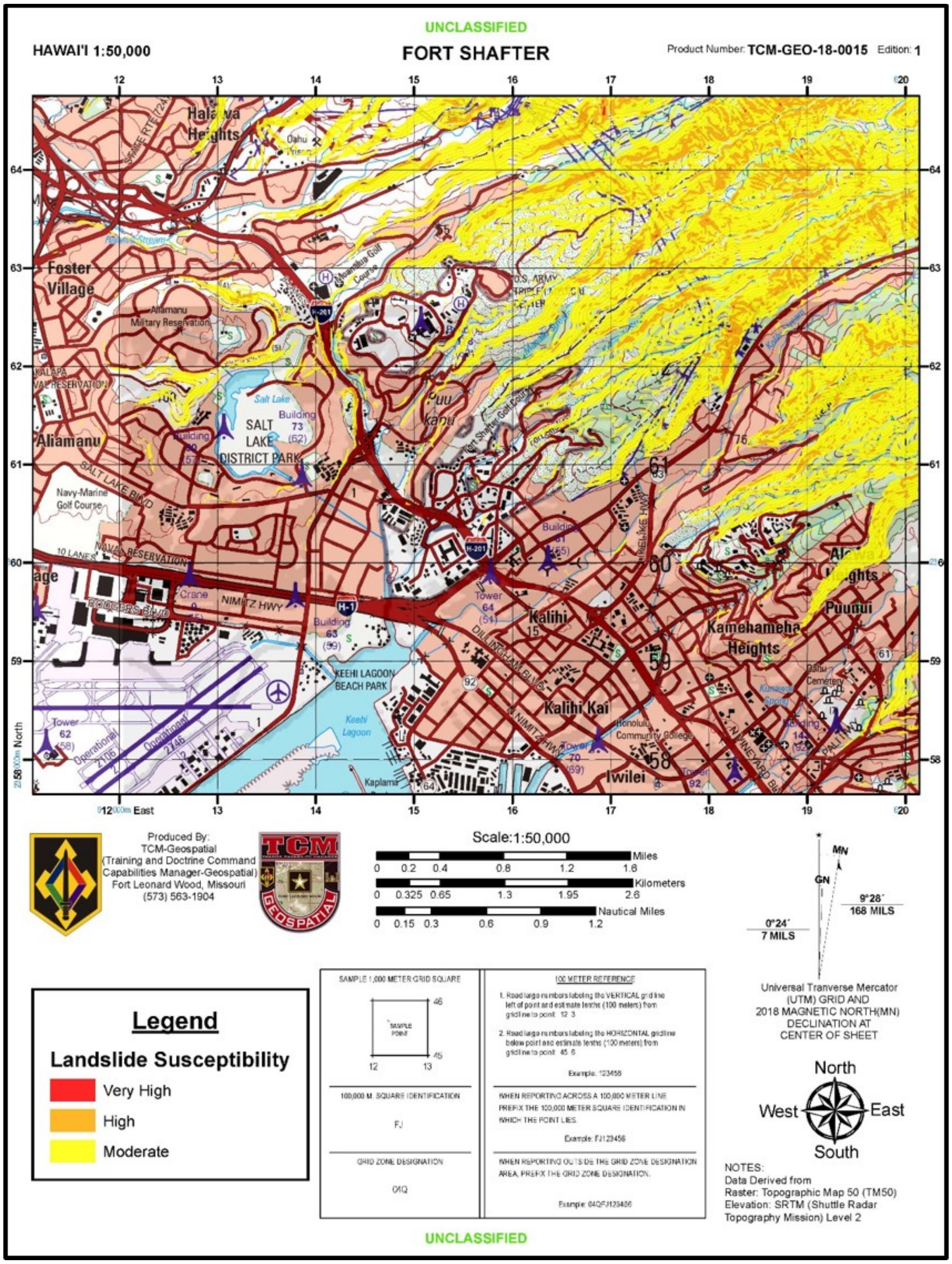


**Figure 4-11. Landslide analysis**

# CIVIL MILITARY OPERATIONS

4-26. The main role of military civil affairs is to prevent and mitigate civilian interference with military operations. Civil affairs soldiers help plan missions that may involve civilians, such as evacuations, and work with civilian aid agencies, nongovernmental organizations and commercial and private organizations.

## GEOSPATIAL SUPPORT

4-27. Civil affairs and other staff overlay the human terrain on the physical terrain and infrastructure in order to better visualize and predict the impacts of civilians on the operational environment. Products that support civil affairs include—

- Ethnic boundaries. (See figure 4-12, page 4-24.)
- AOI.
- Administrative boundaries.
- Religious/tribal sectors.
- LOC overlay.
- Task organization overlay.
- Route analysis.
- Critical infrastructure assessment.

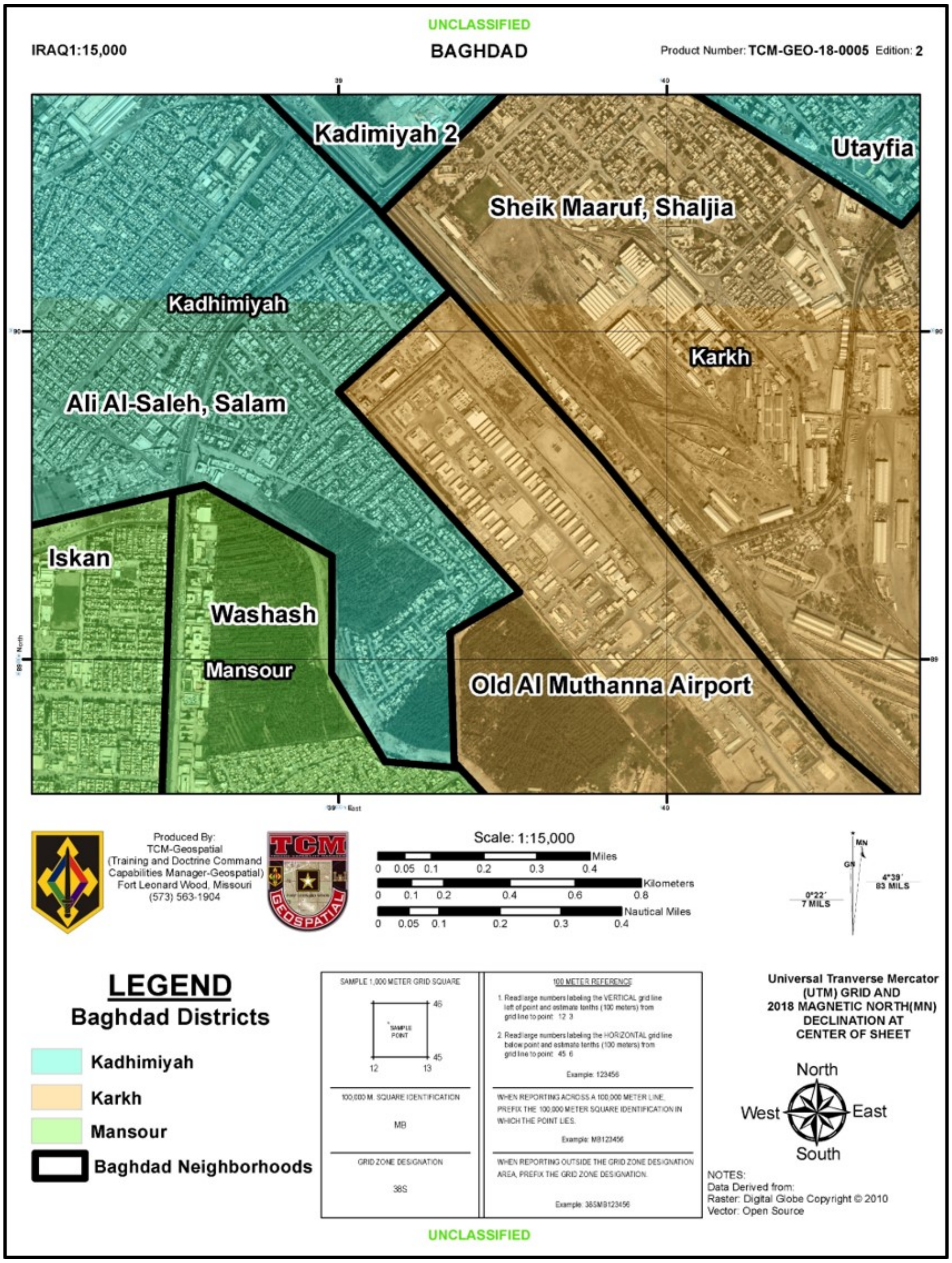


**Figure 4-12. Ethnic boundaries**

## Chapter 5

# Geospatial Dictionary

**Absolute accuracy** (mapping)—how well the position of an object on a map conforms to its location on the earth according to an accepted coordinate system such as geographic coordinates (latitude and longitude) or a State Plane coordinate system.

**Active remote sensing**—remote sensing systems, such as radar, that produce electromagnetic radiation and measure its reflection back from a surface.

**Aerial photograph** (remote sensing, photogrammetry)—a photograph of the earth's surface taken with a camera mounted in an airplane or balloon. Used in cartography to provide geographical information for base maps.

**Anaglyph** (photogrammetry)—a composite picture made by superimposing two images of the same area. The images are displayed in complementary colors, usually red and green, and when viewed through filters of corresponding colors create a three-dimensional image.

**Attribute 1—**information about a geographic feature in a Geospatial Information System (GIS), generally stored in a table and linked to the feature by a unique identifier. Attributes of a river might include its name, length, and average depth. See attribute table. 2. Cartographic information that specifies how features are displayed and labeled on a map; the cartographic attributes of the river in above might include line thickness, line length, color, and font.

**Attribute table**—a table containing descriptive attributes for a set of geographic features, usually arranged so that each row represents a feature and each column represents one attribute. Each cell in a column stores the value of that column's attribute for that row's feature.

**Automated cartography**—cartography that uses plotters, software, and graphic displays to speed tasks traditionally associated with manual drafting. It does not involve spatial information processing.

**Bathymetry—**the science of measuring and charting the depths of water bodies.

**Cartographic license**—the extent to which a cartographer can change the appearance, layout, and content of a map without making it less accurate.

**Cartography**—the design, compilation, drafting, and reproduction of maps.

**Cell size**—also pixel size the area on the ground covered by a single pixel in an image, measured in map units.

**Central meridian** [mapping, navigation]—the line of longitude that defines the center and often the x origin of a projected coordinate system.

**Chart**—a map for air or water navigation.

**Clinometric map**—also slope map. A map that shows steepness with colors or shading.

**Color separation**—1. Preparing a separate printing plate for each color used in producing a map or chart. 2. Scanning a map with color filters to separate the original image into single color negatives.

**Complex polygon**—a polygon that has inner as well as outer boundaries, that is, holes or islands.

**Conflation**—a set of procedures that aligns the features of two geographic data layers and then transfers the attributes of one to the other. See also rubber sheeting.

**Conformality**—the characteristic of a map projection that preserves the shape of any small geographical area.

**Convergence angle**—also meridional convergence. The angle between a vertical line (grid north) and true north on a map.

**Coordinate**—a reference system consisting of a set of points, lines, and/or surfaces, and a set of rules, used to define the positions of points in space in either two or three dimensions. See also geocentric coordinate system, geographic coordinate system, planar coordinate system.

**Coordinate transformation**—also rectification. Converting the coordinates in a map or an image from one system to another, typically through rotation and scaling.

**Database**—one or more structured sets of persistent data, managed and stored as a unit and generally associated with software to update and query the data. A simple database might be a single file with many records, each of which references the same set of fields. Examples of popular databases include Sybase®, dBASE®, Oracle®, and INFOTM. A GIS database includes data about the spatial locations and shapes of geographic features recorded as points, lines, areas, pixels, grid cells, or Triangulated Irregular Networks (TINs), as well as their attributes.

**Database Management System (DBMS)**—a set of computer programs that organizes the information in a database and provides tools for data input, verification, and storage.

**Data Conversion**—translating data from one format to another, usually in order to move it from one system to another.

**Data Dictionary** (metadata)—a set of tables containing information about the data stored in a GIS database, such as the full names of attributes, meanings of codes, scale of source data, accuracy of locations, and map projections used.

**Data Integration**—combining databases or data files from organizations that collect information about the same entities (such as properties, census tracts, or sewer lines). Doing so prevents redundant work and creates new ways to analyze the information.

**Desktop GIS**—mapping software that runs on a personal computer and can display, query, update, and analyze geographic locations and the information linked to those locations.

**Differential correction**—a technique for increasing the accuracy of Global Position System (GPS) measurements by comparing the readings of two receivers, one roving, the other fixed at a known location.

**Digital Elevation Model (DEM)**—also **Digital Terrain Model (DTM)** 1. The representation of continuous elevation values over a topographic surface by a regular array of z-values, referenced to a common datum. Typically used to represent terrain relief. 2. The database for elevation data by map sheet from the National Mapping Division of the United States Geological Survey.

**Digitize**—to convert the shapes of geographic features from media such as paper maps or raster imagery into vector x,y coordinates.

**Distortion**—on a map or an image, the misrepresentation of shape, area, distance, or direction of or between geographic features when compared to their true measurements on the curved surface of the earth.

**Easting**—1. The distance east that a point in a coordinate system lies from the origin, measured in that system's units. 2. The x-value in a rectangular coordinate system.

**Edgematching** [geoprocessing]—assigning the correct coordinate and attribute information to geographic features that connect across the boundaries of adjacent data layers.

**Extrusion**—projecting features in a data layer into three-dimensional space. Points become vertical lines, lines become walls, and polygons become solid blocks.

**Feature**—1. An object in a landscape or on a map. 2. A shape in a spatial data layer, such as a point, line, or polygon, that represents a geographic object.

**Feature class**—in a shapefile, coverage, or geodatabase, a collection of spatial data with the same shape type (for example, point, line, or polygon).

**Feature data set**—in a geodatabase, a collection of feature classes that share the same spatial reference.

**Gazetteer**—a list of geographic places and their coordinates, along with other information such as area, population, and cultural statistics.

**Generalization**—1. Reducing the number of points in a line without losing its essential shape. 2. Enlarging and resampling cells in a raster format. 3. [cartography] Any reduction of information so that a map is clear and uncluttered when its scale is reduced.

**Geocentric** (astronomy, geodesy)—1. Having the earth as a center. 2. Measured from the earth or the earth's center.

**Geocode**—a code representing the location of an object, such as an address, a census tract, a postal code, or x,y coordinates.

**Geodatabase**—a geodatabase represents geographic features and attributes as objects and is hosted inside a relational database management system.

**Geodesy**—the science that determines the size and shape of the earth and measures its gravitational and magnetic fields.

**Geodetic**—also **geodesic** Pertaining to geodesy; relating to the geometry of the earth's surface or to curved surfaces in general.

**Geodetic survey**—a survey that takes the figure and size of the earth into account, used to precisely locate horizontal and vertical positions suitable for controlling other surveys.

**Geographic coordinate system** [geodesy, navigation, surveying]—a reference system using latitude and longitude to define the locations of points on the surface of a sphere or spheroid.

**Geographic Information System**—a collection of computer hardware, software, and geographic data for capturing, storing, updating, manipulating, analyzing, and displaying all forms of geographically referenced information.

**Geography**—1. The study of the earth's surface, especially how climate and elevation interact with soil, vegetation, and animal populations. 2. The geographic features of an area.

**Geometric correction** (remote sensing, photogrammetry)—the correction of errors in remotely sensed data caused by satellites not staying at a constant altitude or by sensors deviating from the primary focal plane. The images are compared to ground control points on accurate base maps and resampled, so that exact locations and appropriate values for pixel brightness can be calculated.

**Georeference**—to assign coordinates from a known reference system, such as latitude/longitude, Universal Transverse Mercator (UTM), or State Plane, to the page coordinates of an image or a planar map.

**Global Positioning System**—a constellation of twenty-four satellites, developed by the United States Department of Defense, that orbit the earth at an altitude of 20,200 kilometers. These satellites transmit signals that allow a GPS receiver anywhere on earth to calculate its own location. The GPS is used in navigation, mapping, surveying, and other applications where precise positioning is necessary.

**Grid Reference System**—a reference system that uses a rectangular grid to assign x,y coordinates to individual locations.

**Ground control** also **control mapping** (surveying, remote sensing, photogrammetry)—a system of points with established positions, elevations, or both, used as fixed references in relating map features, aerial photographs, or remotely sensed images.

**Hypsography**—1. The study of the earth's topography above sea level, especially the measurement and mapping of land elevation. 2. Relief features on a map.

**Image**—1. A graphic representation of a scene, typically produced by an optical or electronic device such as a camera or a scanning radiometer. 2. (remote sensing) A graphic representation of a scene stored as a raster of pixels, each of which has a numeric value that represents the intensity of reflected light, heat, or other electromagnetic radiation for the specific area that it covers. The term is generally used when the radiation is not recorded directly on film.

**Index contour line**—on a topographic map, a contour line that is heavier than the rest and usually labeled with the elevation or depth that it represents. Every fourth or fifth contour line may be an index line, depending on the contour interval.

**International date line**—a meridian of longitude lying 180 degrees east and west of the Greenwich meridian, dividing the world's time zones into those that are twelve hours ahead or twelve hours behind Greenwich standard time. A traveler going west across the date line adds a day; a traveler going east across it subtracts a day.

**Interpolation**—estimating an unknown value that falls between known values.

**Landform**—any natural feature of the land having a characteristic shape, including major forms such as plains and mountains and minor forms such as hills and valleys.

**Landsat** (remote sensing)—earth-orbiting satellites developed by National Aeronautics and Space Administration (NASA) that gather imagery for land-use inventory, geological and mineralogical exploration, crop and forestry assessment, and cartography.

**Large scale** (cartography)—generally, a map scale whose representative fraction is 1:50,000 or larger. A large-scale map shows a small area on the ground at a high level of detail.

**Latitude** (navigation, geodesy)—the angular distance along a meridian north or south of the equator, usually measured in degrees. Lines of latitude are also called parallels.

**Latitude–longitude**—also **lat/long, lat/lon** (navigation, geodesy). The most commonly used spherical reference system for locating positions on the earth. Latitude and longitude are angles measured from the equator and the prime meridian to locations on the earth's surface. Latitude measures angles in a north–south direction; longitude measures angles in the east–west direction.

**Layout** (cartography)—1. The way map elements such as the title, legend, and scale bar are arranged on a printed map. 2. An on-screen document where said map elements are arranged for printing.

**Least-cost path** [network analysis]—the path between two points on a network that costs the least to traverse, where cost is a function of time, distance, or some other factor defined by the user.

**LiDAR** [remote sensing] Short for Light Detection and Ranging—LiDAR uses lasers to measure distances to reflective surfaces.

**Line of sight**—1. A line drawn between two points, an origin and a target, in a three-dimensional scene that shows whether the target is visible from the origin and, if it is not visible, where the view is obstructed. 2. In a perspective view, the point and direction from which the viewer looks into the image.

**Longitude**—the angular distance, expressed in degrees, minutes, and seconds, of a point on the earth's surface east or west of a prime meridian (usually the Greenwich meridian). All lines of longitude are great circles that intersect the equator and pass through the north and south poles.

**Lookup table**—a tabular data file that contains additional attributes for records stored in an attribute table.

**Map**—1. A graphic depiction on a flat surface of the physical features of the whole or a part of the earth or other body, or of the heavens, using shapes or photographic imagery to represent objects, and symbols to describe their nature; at a scale whose representative fraction is less than 1:1, generally using a specified projection and indicating the direction of orientation. 2. Any graphical presentation of geographic or spatial information.

**Map projection** (cartography)—a mathematical model that transforms the locations of features on the earth's curved surface to locations on a two-dimensional surface. It can be visualized as a transparent globe with a lightbulb at its center casting lines of latitude and longitude onto a sheet of paper. Generally, the paper is either flat and placed tangent to the globe (a planar or azimuthal projection), or formed into a cone or cylinder and placed over the globe (cylindrical and conical projections). Every map projection distorts distance, area, shape, direction, or some combination thereof.

**Map units**—the ground units in which the coordinates of spatial data are stored, such as feet, miles, meters, or kilometers.

**Medium scale—**generally, a map scale whose representative fraction is between 1:50,000 and 1:500,000.

**Metadata**—information about a data set. Metadata for geographical data may include the source of the data; its creation date and format; its projection, scale, resolution, and accuracy; and its reliability with regard to some standard.

**Monochromatic**—1. (remote sensing) related to a single wavelength or a very narrow band of wavelengths. 2. (graphics) one color on a contrasting background.

**Mosaic** 1—maps of adjacent areas with the same projection, datum, ellipsoid, and scale whose boundaries have been matched and dissolved. *See also* edge matching.

**Multispectral imaging**—photography that creates imagery from several narrow spectral bands within the visible light region and the near infrared region. A multispectral image contains two or more images, each taken from a different portion of the spectrum (for example, blue, green, red, infrared).

**Nadir** 1. (astronomy)—the point on the celestial sphere directly beneath an observer. Both the nadir and the zenith lie on the observer's meridian; the nadir lies 180 degrees from the zenith and is therefore unobservable. 2. (remote sensing) In aerial photography, the point on the ground vertically beneath the perspective center of the camera lens.

**Neatline** [cartography)—a border drawn around a map to enclose the legend, scale, title, geographic features, and any other information pertinent to the map, often showing tick marks that indicate intervals of distance. On a standard quadrangle map, the neatlines are the meridians and parallels delimiting the quadrangle.

**Null value**—the absence of a recorded value for a geographic feature. A null value differs from a value of zero in that zero may represent the measure of an attribute, while a null value indicates that no measurement has been taken.

**Oblique photograph** (photogrammetry, remote sensing)—a photograph taken with the axis of the camera held at an angle between the horizontal plane of the ground and the vertical plane perpendicular to the ground. A low oblique image shows only the surface of the earth; high oblique includes the horizon. *Compare* vertical photograph.

**Off-nadir** (remote sensing)—any point not directly beneath a scanner's detectors, but rather off at an angle. *See* nadir and zenith.

**Orthocorrection**—also **Orthorectification** (photogrammetry). Correcting distortion in satellite images caused by uneven terrain.

**Orthophotograph**—also **Digital Orthophoto** (remote sensing, photogrammetry). A perspective aerial photograph from which distortions owing to camera tilt and ground relief have been removed. An orthophotograph has the same scale throughout and can be used as a map.

**Overlay**—superimposing two or more maps registered to a common coordinate system, either digitally or on a transparent material, in order to show the relationships between features that occupy the same geographic space.

**Overprinting**—revising a map by printing new information on top of it, usually in a distinctive color such as purple.

**Photogrammetry**—recording, measuring, and plotting electromagnetic radiation data from aerial photographs and remote sensing systems against land features identified in ground control surveys, generally in order to produce planimetric, topographic, and contour maps.

**Physical geography**—the study of the natural features of the earth's surface.

**Planimetric**—1. Two-dimensional; showing no relief. 2. A map that gives only the x,y locations of features and represents only horizontal distances correctly. *Compare* topographic.

**Precision**—1. The number of significant digits used to store numbers, particularly coordinates. *See* single and double precision. 2. The exactness with or detail in which a value is expressed, right or wrong. *Compare* accuracy. 3. A statistical measure of repeatability, usually expressed as the variance of repeated measures about the mean.

**Projection transformation**—also **projection conversion, projection change** The mathematical conversion of a map from one projected coordinate system to another, generally used to integrate maps from two or more projected coordinate systems into a GIS.

**Raster**—1. A spatial data model made of rows and columns of cells. Each cell contains an attribute value and location coordinates; the coordinates are contained in the ordering of the matrix, unlike a vector structure which stores coordinates explicitly. Groups of cells that share the same value represent geographic features. *See also* grid; *compare* vector. 2. The illumination on a video display produced by repeatedly sweeping a beam of electrons over the phosphorescent screen line by line from top to bottom. 3. Also **raster image, bit-map image** A matrix of pixels whose values represent the level of energy reflected or emitted by the surface being photographed, scanned, or otherwise sensed.

**Relational Database Management System (RDBMS)**—data stored in tables that are associated by shared attributes. Any data element can be found in the database through the name of the table, the attribute (column) name, and the value of the primary key. In contrast to hierarchical and network database structures, the data can be arranged in different combinations.

**Remote sensing**—collecting and interpreting information about the environment and the surface of the earth from a distance, primarily by sensing radiation that is naturally emitted or reflected by the earth's surface or from the atmosphere, or by sensing signals transmitted from a satellite and reflected back to it. Examples of remote sensing methods include aerial photography, radar, and satellite imaging.

**Resolution merging**—sharpening a low-resolution multiband image by merging it with a high-resolution monochrome image.

**Rubber sheeting**—also **warping, elastic transformation.** Mathematically stretching or shrinking a portion of a map or image in order to align its coordinates with known control points.

**Scale**—the ratio or relationship between a distance or area on a map and the corresponding distance or area on the ground. *See* bar scale, verbal scale, representative fraction.

**Sensor**—an electronic device for detecting energy, whether emitted or radiated, and converting it into a signal that can be recorded and displayed as numbers or as an image.

**Shapefile**—a vector file format for storing the location, shape, and attributes of geographic features. It is stored in a set of related files and contains one feature class.

**Simplification**—the part of cartographic generalization that eliminates the less essential details from a map whose scale has been reduced.

**Single precision**—a level of coordinate accuracy that stores up to seven significant digits for each coordinate, retaining a precision of 5 meters in an extent of 1,000,000 meters. *See also* double precision.

**Sliver polygons**—small, narrow polygon features that inevitably appear along the borders of polygons following the overlay of two or more geographic data sets.

**Slope**—1. An inclined surface. A slope may be concave, straight, convex, or any combination thereof. 2. A measure of change in surface value over distance, expressed in degrees or as a percentage. For example, a rise of 2 meters over a distance of 100 meters describes a 2-percent slope.

**Spatial analysis**—studying the locations and shapes of geographic features and the relationships between them. It traditionally includes overlay and contiguity analysis, surface analysis, linear analysis, and raster analysis.

**Spatial data** 1. Information about the locations and shapes of geographic features, and the relationships between them; usually stored as coordinates and topology. 2. Any data that can be mapped.

**Spatial modeling**—any procedures that use the spatial relationships between geographic features to simulate real-world conditions, such as geometric modeling (generating buffers, calculating areas and perimeters, and calculating distances between features), coincidence modeling (topological overlay), and adjacency modeling (pathfinding, redistricting, and allocation).

**Stereo-pair** (photogrammetry)—two aerial photographs of the same area taken from slightly different angles that when viewed together through a stereoscope produce a three-dimensional image.

**Structured Query Language (SQL)**—a syntax for defining and manipulating data in a relational database. Developed by IBM in the 1970s, it has become an industry standard for query languages in most relational database management systems.

**Surface**—a geographic phenomenon represented as a set of continuous data, such as elevation or air temperature. Models of surfaces can be built from sample points, isolines, bathymetry, and the like.

**Surveying**—measuring physical, chemical, or geometric characteristics of the earth. Surveys are often classified by the type of data studied or by the instruments or methods used. Examples include geodetic, geologic, topographic, hydrographic, land, geophysical, soil, mine, and engineering surveys.

**Symbol** (cartography)—a mark used to represent a geographic feature on a map. Symbols can look like what they represent (tiny trees, railroads, houses) or they can be abstract shapes (points, lines, polygons). They are usually explained in a map legend.

**Symbolization**—devising a set of marks of appropriate size, color, shape, and pattern, and assigning them to map features to convey their characteristics or their relationships to each other at a given map scale.

**Table** also **relation**—data arranged horizontally in rows and vertically in columns in a relational database system. A table has a specified number of columns but can have any number of rows. Rows stored in a table are structurally equivalent to records from flat files in that they must not contain repeating fields.

**Theme**—1. A vector layer of related geographic features, such as streets, rivers, or parcels, that when juxtaposed with other themes can be used in overlay analysis. 2. A raster layer of geographic information, such as an image or a grid.

**Theme-on-theme selection**—an operation that selects features in one theme using the features in another in order to answer questions about the spatial relationships between them, such as whether one feature lies within another, whether it completely contains another, or whether it is within a specified distance of another.

**Three-dimensional shape**—a point, line, or polygon that stores x-, y-, and z-coordinates as part of its geometry. A point has one set of z-coordinates; lines and polygons have z-coordinates for each vertex.

**Tile**—1. A division of data within a map library, referenced by location. A tile can either be a regular shape, such as a map sheet, or irregular, such as a county border. Splitting a geographical area into tiles makes information easier to retrieve. 2. A cell in a grid, usually accompanied by attribute information.

**Topographic**—1. Having elevation. 2. A map showing relief, often as contour lines, along with other natural and human-made features. 3. Map sheets published by the United States Geological Survey in the 7.5-minute or 15-minute quadrangle series.

**Topography**—the shape or configuration of the land, represented on a map by contour lines, hypsometric tints, and relief shading.

**Topological overlay**—superimposing two or more geographic data sets in order to produce a new geographic layer with a new set of attributes. The geometry and the attributes of the output data layer depend on the type of overlay used.

**Topology**—1. The spatial relationships between connecting or adjacent features in a geographic data layer. Topological relationships are used for spatial modeling operations that do not require coordinate information. *See* arc–node topology, polygon–arc topology. 2. (geometry, mathematics) The branch of geometry that deals with the properties of a figure that remain unchanged even when the figure is bent, stretched, or otherwise distorted.

**Triangulated Irregular Network**—a vector data structure that partitions geographic space into contiguous, nonoverlapping triangles. The vertices of each triangle are data points with x-, y-, and z-values; elevation values at these points are interpolated to create a continuous surface.

**Triangulation** (surveying, navigation)—locating positions on the earth's surface using the principle that if the measures of one side and the two adjacent angles of a triangle are known, the other dimensions of the triangle can be determined. Surveyors begin with a known length, or baseline, and from each end use a theodolite to measure the angle to a distant point, forming a triangle. Once the lengths of the two sides and the other angle are known, a network of triangles can be extended from the first. *Compare* trilateration.

**United States Geological Survey (USGS)**—the national mapping agency of the United States that produces paper maps, digital maps, and DEMs at a variety of scales, including 1:24,000, 1:100,000, 1:250,000, and 1:1 million. Its national map database consists of 1:100,000 maps, available as digital line graph (DLG) and Topologically Integrated Geographic Encoding and Referencing (TIGER) files.

**Universal Transverse Mercator**—a commonly used projected coordinate system that divides the globe into sixty zones, starting at -180 degrees longitude. Each zone extends north– south from 84 degrees north to 80 degrees south, spans 6 degrees of longitude, and has its own central meridian.

**Vector** 1—a data structure used to represent linear geographic features. Features are made of ordered lists of x,y coordinates and represented by points, lines, or polygons; points connect to become lines, and lines connect to become polygons. Attributes are associated with each feature (as opposed to a raster data structure, which associates attributes with grid cells).

**Vertical exaggeration**—a multiplier applied uniformly to the z-values in a three-dimensional model to enhance or minimize the natural variations of its surface. Vertical exaggeration is generally applied more to flat regions than to mountainous ones.

**World Geodetic System of 1984 (WGS84)**—the most widely used geocentric datum and geographic coordinate system today, designed by the United States Department of Defense to replace WGS72. GPS measurements are based on WGS84.

**X-axis**—1. In a planar coordinate system, the horizontal line that runs to the right and left (east–west) of the origin (0,0). Numbers to the east of the origin are positive and numbers to the west are negative. 2. In a spherical coordinate system, the x-axis is in the equatorial plane and passes through 0 degrees longitude. *See* y-axis, z-axis, Cartesian coordinate system. 3. On a chart, the horizontal axis.

**X, Y coordinates**—a pair of numbers expressing a point's horizontal and vertical distance along two orthogonal axes, from the origin (0,0) where the axes cross. Usually, the x-coordinate is measured along the east–west axis and the y-coordinate is measured along the north– south axis.

**X, Y, Z coordinates**—in a planar coordinate system, three coordinates that locate a point by its distance from an origin (0,0,0) where three orthogonal axes cross. Usually, the x-coordinate is measured along the east–west axis, the y-coordinate is measured along the north–south axis, and the z-coordinate measures height or elevation.

**Y-axis**—in a planar coordinate system, the vertical line that runs above and below (north and south of) the origin (0,0). Numbers north of the origin are positive and numbers south of it are negative. 2. In a spherical coordinate system, the y-axis lies in the equatorial plane and passes through 90 degrees east longitude. *See* x-axis, z-axis, Cartesian coordinate system. 3. On a chart, the vertical axis.

**Z-axis**—in a spherical coordinate system, the vertical line that runs parallel to the earth's rotation, passing through 90 degrees north latitude, and perpendicular to the equatorial plane, where it crosses the x- and y-axes at the origin (0,0,0).

**Z-value**—also **Z-coordinate.** The value for a given surface location that represents an attribute other than position. In an elevation or terrain model, the z-value represents elevation; in other kinds of surface models it represents the density or quantity of a particular attribute.

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# Glossary

The glossary lists acronyms and terms with Army or joint definitions. Where Army and joint definitions differ, (Army) precedes the definition. The Army proponent publication for other terms is listed in parentheses after the definition.

## SECTION I – ACRONYMS AND ABBREVIATION

| | |
|---|---|
| **AOI** | area of interest |
| **ASCC** | Army Service component command |
| **attn** | attention |
| **COP** | common operational picture |
| **DA** | Department of the Army |
| **DBMS** | Database Management System |
| **DEM** | digital elevation model |
| **DLG** | digital line graph |
| **DOD** | Department of Defense |
| **DTM** | digital terrain model |
| **FM** | field manual |
| **G-1** | battalion or brigade personnel staff officer |
| **G-2** | assistant chief of staff, intelligence |
| **G-3** | assistant chief of staff, operations |
| **G-4** | assistant chief of staff, logistics |
| **G-6** | assistant chief of staff, signal |
| **GEOINT** | geospatial intelligence |
| **GET** | geospatial engineer team |
| **GIS** | Geospatial Information System |
| **GPC** | geospatial planning cell |
| **GPS** | Global Positioning System |
| **J-1** | manpower and personnel directorate of a joint staff |
| **J-2** | intelligence directorate of a joint staff |
| **J-3** | operations directorate of a joint staff |

| | |
|---|---|
| **J-4** | logistics directorate of a joint staff |
| **J-6** | communications system directorate of a joint staff |
| **JP** | joint publication |
| **lat** | latitude |
| **LiDAR** | light detection and ranging |
| **LOC** | line of communications |
| **lon** | longitude |
| **long** | longitude |
| **MO** | Missouri |
| **MSCoE** | Maneuver Support Center of Excellence |
| **NASA** | National Aeronautics and Space Administration |
| **OAKOC** | observation and fields of fire, avenues of approach, key terrain, obstacles, and cover and concealment |
| **RDBMS** | Relational Database Management System |
| **S-1** | battalion or brigade personnel staff officer |
| **S-2** | battalion or brigade intelligence staff officer |
| **S-3** | battalion or brigade operations staff officer |
| **S-4** | battalion or brigade logistics staff officer |
| **S-6** | battalion and brigade signal staff officer |
| **SQL** | structured query language |
| **SSGF** | Standard and Shareable Geospatial Foundation |
| **TC** | training circular |
| **TGD** | Theater Geospatial Database |
| **TIGER** | Topologically Integrated Geographic Encoding and Referencing |
| **TIN** | Triangulated Irregular Network |
| **TRADOC** | Training and Doctrine Command |
| **USGS** | United States Geological Survey |
| **UTM** | Universal Transverse Mercator |

## SECTION II – TERMS

None.

# References


## REQUIRED PUBLICATIONS

These documents must be available to the intended users of this publication.

*DOD Dictionary of Military and Associated Terms.* July 2019.

ADP 1-02. *Terms and Military Symbols.* 14 August 2018.

## RELATED PUBLICATIONS

These documents contain relevant supplemental information.

### JOINT PUBLICATIONS

Most joint publications are available online at <http://www.jcs.mil/doctrine/dod_dictionary/>.

JP 2-03. *Geospatial Intelligence in Joint Operations.* 5 July 2017.

### ARMY PUBLICATIONS

Most Army publications are available online at <www.armypubs.army.mil> or <https://www.us.army.mil/suite/doc/49685858>.

FM 6-27/MCTP 11-10C. *The Commander's Handbook on the Law of Land Warfare.* 7 August 2019.

## PRESCRIBED FORMS

This section contains no entries.

## REFERENCED FORMS

These documents must be available to the intended users of this publication. Forms are available online: <https://armypubs.army.mil>.

DA Form 2028. *Recommend Changes to Publications and Blank Forms*.

## WEB SITES

Jim Barksdale quote from Tren Griffin 25iq blog titled "A *Dozen Things I've Learned from Jim Barksdale and "Barksdaleisms*" dated 31 May 2014. Web site <https://25iq.com/2014/05/31/a-dozen-things-ive-learned-from-jim-barksdale-and-barksdaleisms/,> accessed 11 December 2018.

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