mobility corridors of different widths as a result of organizational or equipment differences, analysts may conduct two separate evaluations. Identification of mobility corridors requires some knowledge of friendly and threat organizations for combat and preferred tactics. When identifying mobility corridors, analysts must evaluate obstacles and force mobility. The analyst should also consider that—

- Mechanized and armored units generally require large open areas to move.
- Dismounted infantry, most insurgents, and terrorists are less restricted by the presence of obstacles or hindering terrain and prefer areas that provide concealment and cover.
- The mobility corridor used by a jet aircraft with a minimum operating altitude of 1,000 feet is quite different from that considered by a helicopter with a maximum service ceiling of 10,000 feet.

#### *Categories*

Once identified, mobility corridors are categorized according to the size or type of force they will accommodate. Mobility corridors are normally identified for forces two echelons below the friendly command. In addition, where terrain is restrictive, the evaluation may need to look several echelons below the friendly command.

Analysts group mobility corridors together to form AAs. Avenues of approach may include areas of severely restricted terrain since they show only the general area through which a force can move. Analysts depict AAs on an overlay using an outline arrow that encompasses the mobility corridors. Threat AAs are generally depicted in red, friendly AAs are depicted in blue.

#### *Evaluation*

During offensive operations, analysts evaluate AAs to recommend the best route to the command's objective and to identify avenues available to the enemy for force withdrawal or movement of reserves. During the defense, analysts identify AAs that support the threat's offensive capabilities and avenues that support the movement and commitment of friendly reserves.

An evaluation of AAs identifies those that best support maneuver capabilities. This evaluation should be a combined effort performed by the intelligence section, the imagery and mapping officer or GEOINT support team, and the operations section. These AAs are evaluated for—

- Access to key terrain and adjacent avenues.
- Degree of channelization and ease of movement.
- Use of cover and concealment.
- Use of observation and fields of fire.
- Sustainability.
- Directness to the objective.

## SECTION IV. HYDROGRAPHIC ANALYSIS

Sea or hydrographic analysis is the study of areas containing shorelines. Intelligence of coasts and landing beaches is important to military planners because the coast is a country's first line of defense. The hydrographic analysis is subdivided into the offshore, nearshore, and foreshore environments. The land analysis is subdivided into the beach and inland environments. Intelligence personnel conduct hydrographic P&A to evaluate coastal conditions that support amphibious operations. Amphibious operations require detailed oceanography studies that are discussed in Joint Publication (JP) 3-02, *Joint Doctrine for Amphibious Operations*, and FM 34-81, *Weather Support for Army Tactical Operations*.

## Sources of Information

The Naval Oceanographic Office (Major Shared Resource Center, John C. Stennis Space Center, National Aeronautics and Space Administration, MS), conducts comprehensive analysis of littoral and hydrographic factors worldwide. Joint Intelligence Center, Pacific; Joint Forces Intelligence Command; and Marine Corps Intelligence Activity (MCIA) produce detailed imagery-based beach studies. Graphic and text-based analysis are available both online via intelligence link (INTELINK) or intelligence link-SECRET (INTELINK-S) and via request for production validated through the operational chain.

## Hydrographic Conditions

Analysts evaluating the hydrographic conditions of a coastal region study seas and surf, tides, and currents that can affect amphibious landings.

### Seas, Swells, and Surf

Seas are waves that originated in local storms. Swells are waves that have traveled hundreds to several thousands of miles from a distant storm before arriving at the landing site. Breaking waves or surf 4 feet in height normally are considered too high for amphibious assault operations or for logistics over the shore. By identifying the following types of breakers, analysts can determine the trafficability of the nearshore bottom:

- Spilling breakers indicate a gentle sloping bottom. The waves lose energy gradually as they approach shore by breaking only at the crest, and it is common to see a number of such breakers existing simultaneously.
- Plunging breakers indicate an unstable nearshore bottom. These waves break in a rollover, plunging action that causes abrupt changes in the form of a longshore bar or degree of steepness at the shore.
- Surging breakers indicate a steep nearshore gradient and are the least common of all types of breakers. This type of wave peaks near the shoreline, but instead of breaking or spilling, it actually surges up the face of the beach.

### Tides

Tides are the alternate rising and falling of the sea caused by the gravitational attraction of the moon and sun. The tidal range is the complicated product of various forces, including local bottom configuration and the size and configuration of oceanic basins that can alter the height and time of the tides. When identifying beach widths, hazards, and depths, analysts must specify the time of day observations were made to permit tidal computations. Tidal information for most places on the coasts of the world can be obtained from tide tables published by the U.S. Department of Commerce.

### Currents

Currents in the nearshore zone which influence amphibious landing operations are generally classified as wave-generated, tidal, or river currents.

#### *Wave-Generated Currents*

These currents are caused by the angular breaking of waves on the beach slope and the resultant back rush normal to the beach, which results in a littoral current (longshore current) in the nearshore zone, flowing generally parallel with the shoreline. It is found shoreward of the outermost edge of the breaker zone and varies in velocity or force with the force of the waves, their angle of impingement upon the shore, and the steepness of the foreshore. Littoral currents may be insignificant in terms of amphibious operations, or they may be strong enough to cause personnel to lose their footing, to make maneuvering of craft difficult, and to throw landing or assault craft out of control and expose them to broadside attack by the surf. Littoral currents are particularly significant where depths shoreward of the breaker zone are such as to make wading hazardous.

### *Tidal Currents*

These currents affect amphibious landings in the proximity of tidal inlets, estuaries, river mouths, and similar restricted channels. With large tidal ranges these currents may make the maneuver of landing craft on beaches adjacent to the tidal inlet extremely hazardous.

### *River Currents*

Currents that extend from rivers into the open sea are frequently of such strength that they affect the maneuver of landing craft near the river's mouth.

## Beach Selection Considerations

Beaches are the most prevalent natural features of the coastal region. They are accumulations of loose sand, gravel, or boulders that are shaped by waves and currents acting on the shore. Along many lowland coasts, beaches occur as barrier islands that parallel the coast and are separated by a lagoon or bay. Along other stretches of coast, beaches are backed by eroding cliffs, or the beach may be absent with high rocky cliffs facing the waves.

Hydrographic conditions shoreward of the 30-meter depth curve should be thoroughly investigated and surveyed. Shallower depths of the surf zone from 0 to 30 meters are of primary concern in amphibious operations because crafts ground and troops and vehicles disembark in this area. When preparing hydrographic beach surveys, analysts must—

- Record accurate locations of obstructions.
- Determine clear boat passages to the beach.
- Determine trafficability of bottom materials.
- Select suitable beaching locations for amphibious vehicles.
- Determine maneuver areas for crafts.

From a tactical perspective, the ideal sea approaches to the beach should have—

- No obstructions.
- Deep water close inshore.
- Nearshore gradients deep enough for dry-ramp beaching of landing craft and ships.
- Soil composed of firm sand with gentle gradients.
- Small tides.
- No currents or surf.

The ideal beach terrain should be—

- Flat or gently rising.
- Backed by a coastal range high enough to mask the landing area.
- Relatively clear.
- Firm with adequate drainage.

Analysts evaluate the following beach features to determine those areas that come nearest to the optimum landing requirements.

### Size

Analysts measure the beach to determine the force size that can be supported. The beach size also defines requirements for follow-on logistical forces and establishment of logistical base sites or dumps. Analysts determine the usable beach length by measuring, in kilometers, the gross length minus unsuitable landing features, such as rivers and rock outcroppings. When preparing the overlay, analysts describe and plot—

- Unsuitable beach sections.
- Features that might affect movement along the beach.
- Beach widths available at the low-water tide stage (maximum width) and at the high-water tide stage (minimum width), noting each stage of the tide.
- Locations of major changes in width.

## Approaches

Analysts identify major obstructions and obstacles in the offshore approaches for an area seaward of the 30-meter depth curve. More detailed analysis and information are provided shoreward from the 30-meter depth curve giving distances and azimuths of obstructions and obstacles from the centerline of the beach. When describing general approach conditions, analysts note the presence of—

- Shoals.
- Bars.
- Kelp beds.
- Island groups.
- Exposed rocks.

## Gradient

The foreshore gradient may be so steep as to prohibit the landing of vehicles from beached craft without use of matting, or it may be so flat as to cause personnel and vehicles to move great distances from boats over exposed areas to cover. Analysts express the gradient as one unit of vertical rise in relation to horizontal distance (e.g., 1 foot vertical height over 20 feet of horizontal distance = 1:20). Gradient may also be given in percent of slope or degree of angle. Analysts record gradients when—

- High-water zone of the foreshore is much steeper than the foreshore.
- Seasonal gradient changes information is available.
- Backshores are not level.

## Composition

A description of the characteristics of the beach material gives a valuable clue to the slope or gradient of a beach when other information is lacking. Analysts can determine the gradient by the size of the beach material and the character of wave action. The depth of beach materials and the nature of subsurface materials are also indications of beach firmness and trafficability.

## Trafficability

The beach's ability to sustain troop and vehicle traffic depends on factors such as moisture content, slope, grain size, and compacting. When evaluating beach trafficability, analysts must consider the following general rules:

- Changes in beach firmness may occur in short periods of time.
- Sandy beaches are more firm when damp.
- Beach backshores are frequently dry and therefore soft.
- Pebbles and cobbles are firm for bearing capacity but are loose for vehicle traction.
- Clay is soft when wet, but combinations of clay and sand may be firm.
- Fine to coarse sand mixtures tend to be firm.
- Soft zones are common near the upper level of wave wash at high tide because air pockets are trapped under the wet sand.
- Sand beaches exposed to wave action are generally firmer than beaches of similar material in sheltered locations.

## Vegetation

Beach vegetation rarely affects military operations except for mangrove. These tropical trees and shrubs normally grow in sheltered tidal areas that have a soft, fine bottom material, but they may exist on foreshores that do not experience heavy wave action. Analysts identify the mangrove's interlaced roots, which constitute a barrier to movement.

## Natural Obstacles

Analysts evaluate cusps, beach ridges, scarp, and berm to identify areas that could impede movement.

### Natural Cusps

These are more or less evenly spaced ridges or horns of beach material and intervening crescent shaped troughs. The horns trend at right angles to the shoreline and taper to their point seaward. Cusps present on beaches should be noted. There are several characteristics of this beach feature that may be significant in amphibious landings. Along gravel beaches, the cusps may develop very large proportions, rising several feet above adjacent troughs and becoming a serious hindrance to traffic. Cusps are soft, whereas the troughs are usually of the same firmness as the normal beach face.

### Beach Ridges

These continuous mounds or ridges are created by wave action along the upper limits of the beach. They may occur as single ridges or as a series of parallel ridges extending some distance inland. Commonly 3 to 8 feet in height above mean high tide, beach ridges can attain a height of 30 feet on pebble beaches. Ridges may consist of sand, pebbles, or gravel. Gravel or shingle ridges are high and loose and are very difficult to traverse.

### Scarp

This near-vertical face cut into beach materials is caused by erosive wave action and may be a formidable barrier to movement across the beach. Scarps cut into the backshore have permanence, but normal wave action will eliminate foreshore scarps.

### Beach Berm

A horizontal formation of material deposited by wave action, beach berm begins at the limit of normal-wave up rush and extends landward. Where more than one berm exists, they are separated by beach scarps in various stages of deterioration. The seaward margin of a berm is know as the berm crest. Berms are usually dry and soft but may be firm for a short time when damp.

## Manmade Obstacles

Groins, jetties, bulkheads, and sea walls are manmade structures that could hinder beach operations.

### Groins

These structures are used to stabilize a beach. They are long, low, narrow structures extending seaward from the backshore that are built to trap water-suspended sand on shore. Because groins are usually built as a system of structures spaced at regular intervals along the beach, analysts identify them as obstacles to the lateral movement of vehicles.

### Jetties

Used to improve and stabilize inlets and river mouths, jetties project seaward from the shoreline through the normal surf zone. They are larger and more massive than groins. They prevent sand deposits in the channel, regulate the inflow and outflow of tides and river discharge, and protect vessels entering the inlet or river. Analysts evaluate jetties to determine if they are high enough to protect vessels against storm wave action and to prevent sand movement in the channel.

### Bulkheads and Sea Walls

These structures protect areas of the coast against heavy storm wave action. They limit the shoreward movement of destructive waves, but under severe wave action they may cause the removal of sand from the beach. Analysts evaluate bulkheads and sea walls because they are normally strongly built and difficult to break through, which can prevent troop and vehicular movement from the beach to inland areas.

## Exits

Uninterrupted movement inland from a beach is necessary to provide direct, rapid support and supply of combat forces and to avoid the creation of lucrative targets of accumulated material and personnel on beaches. However, movement off a beach inland onto favorable terrain in many localities is one of the most difficult aspects of a landing because of the prevalence of bluffs, dunes, swamp, or lagoons close behind the beach. Existing exits require little or no preparation. They may be manmade or natural, such as roads, ramps, stairs, paths, gullies, dry stream beds, and gaps between dunes. Another characteristic of an exit requiring evaluation is the width. An exit should have a minimum width of 8 feet to permit the passage of vehicles.

# SECTION V. AIRSPACE ANALYSIS

The addition of the airplane and helicopter to the arsenal of war requires that the battlespace be viewed in terms of width, depth, and a third dimension, height or airspace (measured in cubic kilometers). Because airspace has no reference points to guide the analyst and evidence of air activity is erased seconds after the activity occurs, it is often difficult to establish NAIs, TAIs, and air operations decision points. Airspace analysts are required to tie air events to time and the ground and to integrate the terrain analysis with analysis of—

- Aircraft maximum service ceilings.
- Minimum operating altitudes for fixed- and rotary-wing aircraft.
- Maximum effective ranges of air defense weapons systems.

## Geospatial Analysis Support

The intelligence staff receives support from the terrain team during airspace analysis. However, this support must be augmented by personnel from other functional areas with an understanding of the air threat, air defense systems and operations, and close air support techniques.

Geospatial analysis and GEOINT production in support of air defense, counter air, and air-associated operations deal with an environment that extends several thousand meters above ground level and with forces whose mobility is limited only by the ability of their equipment. Terrain analysis is required because aircraft and air defense elements use the terrain to their best advantage.

Standard military topographic maps are not normally considered suitable for other than the most basic airspace analysis. Standard 1:50,000-scale topographic maps are most useful when analyzing the ability of an aircraft to approach, acquire, and engage a target. The analysis of an aircraft’s approach (from air base to target vicinity) or of enemy air corridors should be conducted using standard 1:250,000-scale joint operations graphic-air (JOG-A) specifically designed for this purpose.

## Airspace Evaluation

The third dimension of the battlespace includes the air AO and the air AOI. The air AO is the area where the commander is assigned responsibility and authority for military operations. The air AOI includes airspace adjacent to the air AO and extends into enemy airspace upward to the maximum service ceiling of enemy aircraft and the maximum effective altitude of enemy air defense weapons systems. It takes into consideration any space-capable system, i.e., satellites. In addition, the air AOI may extend as far as enemy airfields and to the maximum range of enemy surface-to-surface missile systems. During the airspace evaluation of the battlespace, analysts identify potential locations of LZs, DZs, FARPs,