4 ENVIRONMENTAL CONSEQUENCES

This chapter presents an analysis of the potential impacts upon various components of the environment that could result from the SFCP Feasibility Study at Camp Lejeune. It follows a format similar to that of Chapter 3.

As stated in Chapter 2, the only alternative to conducting the SFCP Feasibility Study at Camp Lejeune is the No Action alternative. The No Action alternative would continue the status quo; thus, there would be no change in the existing conditions as discussed in Chapter 3.

4.1 Land Use

4.1.1 General

The Feasibility Study would be of short duration (two one-hour intervals) and would involve the use of existing ranges and facilities that have historically been used for the training of Marine Corps personnel using weapons and explosive devices. Thus, there would be no significant impacts with respect to land use and zoning.

4.1.2 Coastal Zone Management

Pursuant to the Coastal Zone Management Act of 1972 (16 U.S.C. 1451 et seq.), any federal agency activity within or outside the coastal zone that affects any land or water use or natural resource of the coastal zone must be carried out to the maximum extent practicable with the enforceable policies of approved State Management programs. North Carolina has an approved coastal management program that defines the coastal zone or "coastal area" as comprising 20 coastal counties, including Onslow County, in which Camp Lejeune is located, and extending three miles (4.8 km) seaward.

Onslow County's CZM policies, which have been approved by the NC Coastal Resources Commission, are listed in Table 4-1. These policies are applied by the NC Department of Environment and Natural Resources (NCDENR) during their review process. The policy statements apply to:

- CAMA minor and major permitting as required by NCGS 113A-118 prior to undertaking any development in any area of environmental concern;
- Establishment of local planning policy; and

Table 4-1

Onslow County
Land Use/Coastal Zone Management Policy Categories

Resource Protection Policies	Applicability
Soils:	
Septic tank use	no
Wetlands protection	yes
Flood Hazard Area:	
Coordinate development in floodplains with NCDCM, FEMA, COE	no
Groundwater/Protection of Potable Water Supplies:	
Support stormwater runoff regulations	no
Coordinate activities involving USTs installed/abandoned	no
Coordinate ground water protection with adjacent counties	no
Manmade Hazards:	
Coordinate UST regulations with state	no
Expansion of Albert Ellis Airport per Master Plan	no
No bulk storage of hazardous materials in urban areas	no
No toxic waste dump sites in county or on military property	yes
No disposal of toxic wastes in county	no
Stormwater Runoff:	
Support state stormwater runoff regulations	no
Support control of agricultural runoff	no
Support control of forestry runoff	no
Design projects to limit possible stormwater runoff to estuarine waters	no
Cultural/Historic Resources:	
Protect significant architectural/archaeological/cultural resources	no
Industrial Impacts on Fragile Areas	no
Package Treatment Plant Use	no
Marina and Floating Home Development	no
Mooring Fields	no
Off-Road Vehicles – No restrictions	no
Development of Sound and Estuarine Islands	no
Bulkhead Construction	no
Sea Level Rise	no
Maritime Forests:	
Encourage acquisition of high quality tracts for conservation	no
Development of residential nature	no
Estuarine System – develop water dependent uses along Estuarine Shoreline AEC	no
Protection of Outstanding Water Resources at Stump Sound and Bear Island	no
Water Quality Management in White Oak and Cape Fear Basins	no
Community Attitude Toward Resource Management and Production	no
Recreation Resources:	
Support access to waterfront/shoreline	yes
Apply for grant funds	no
Priority to repairing/replacing damaged/destroyed shoreline access facilities	no
Support year-round recreation program	no
Prepare county-wide comprehensive recreation plan	no
Allow golf courses if meet buffer requirements and other regulations	no
Peat or Phosphate Mining	no

Table 4-1 (Continued)

Onslow County
Land Use/Coastal Zone Management Policy Categories

Resource Protection Policies	Applicability
Sewer System:	
Provide water systems to county residents and study expansion	no
Secure grant funding	no
Support "created" wetlands for treating waste effluent	no
Solid Waste:	
Support operations of new county landfill	no
Support education on recycling and waste reduction	no
Support siting of recycling centers in all areas except conservation	no
Support clean community projects	no
Energy Facility Siting and Development:	
Review any applications for electric-generating plants	no
Support preparation of an EIS for new energy-related facilities	no
Community Facilities	no
Redevelopment of Developed Areas	no
Land Use Regulation/Urban Growth Patterns:	
Encourage urban development near existing urban areas	no
Permit residential development to meet market needs	no
Enforce existing regulations	no
Estuarine Access	yes
Types and Locations of Desired Industry	no
Commitment to State and Federal Programs	no
Assistance to Channel Maintenance	no
Assistance in Interstate Waterways	no
Transportation:	
Identifies specific roadway improvements	no
Identifies specific improvements to Albert Ellis Airport	no
Land Use Trends:	
Development of "404" wetlands	no
Expansion of central water and sewer areas	no
Increasing traffic on US 17 and NC24	no
Continued support of economic and industrial development	no
Development of an industrial park	no
Establishment of county wide zoning	no
Development of a new solid waste disposal facility	no
Support the US MCAS New River and Albert Ellis Airport	no
Intergovernmental cooperation	no
Expansion of county-wide recreational opportunities	no
Reduction of the county's substandard dwelling units	no
Low elevation and sea level rise	no
Regulation of nonpoint sources of water pollution	no
Control of development in fragile areas	no
Regulation of corporate farms and increased agricultural runoff	no
Continuing Public Participation Policies	no
Storm Hazard Mitigation	no

- Review of proposed projects requiring state or federal assistance or approvals to determine consistency with local policies.

The policies with relevance to the Feasibility Study include:

- Wetlands protection;
- Exclusion of toxic waste dumps from county or military property;
- Support for access to the waterfront/shoreline;
- Provide estuarine access.

The *Standard Operating Procedures for Range Control* (Base Order MCO P3570.1) restricts activities in wetlands and the disposal of petroleum, oils and lubricants (POL) and other toxic/hazardous materials.

The Feasibility Study would, on one day for about two hours, interfere with the public's access to the waterfront/shoreline and surrounding estuarine areas. The areas that would be closed are Surface Danger Zones (SDZs) and restricted areas established by the Corps of Engineers for the purpose of Marine Corps personnel training; thus, this impact would not be significant.

Per a March 20, 2001 telephone conference with North Carolina Division of Coastal Management, this EA includes a consistency statement. The Feasibility Study is consistent with past and continuing activities at Camp Lejeune involving the firing of large caliber weapons (e.g., howitzers), which have been consistent with Camp Lejeune's mission and with the Coastal Zone Management Program. The Feasibility Study is, therefore, consistent to the maximum extent practicable with the Coastal Zone Management Program of North Carolina. The State of North Carolina concurred with this position in a May 4, 2001 letter to Camp Lejeune.

4.2 Socioeconomics

4.2.1 General

The Feasibility Study would involve no permanent or temporary increase or relocation of personnel. It would involve only a small number of personnel in an SFCP (only 10 personnel), all of whom are currently stationed at Camp Lejeune. Thus, there would be no significant demographic or economic impacts due to implementation of the study.

4.2.2 Environmental Justice

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" requires consideration of whether the Proposed Action would disproportionately affect minority or low-income groups. The analyses in this EA support the conclusion that the Feasibility Study would have no significant environmental effects; thus, there would be no disproportionately high or adverse environmental health or safety impacts to minority or low-income populations. Guidance provided by the Council on Environmental Quality (CEQ 1997) and USEPA (1998) has been considered in developing this analysis.

Similarly, the potential of the Feasibility Study to generate disproportionately high environmental health and safety risks to children, which must be addressed as required by Executive Order 13045 ("Protection of Children from Environmental Health Risks"), is minimal. This Executive Order was prompted by the recognition that children, still undergoing physiological growth and development, are more sensitive to adverse environmental health and safety risks than adults.

4.3 Community Facilities and Services

The Feasibility Study does not involve relocation of, or increases in the number of, personnel at Camp Lejeune. The participating personnel in the SFCP would already be stationed at Camp Lejeune. Thus, there would be no increase in demand for community facilities and services.

The Base would utilize its own emergency and fire services should the need arise. Considering the brief nature of the proposed study, no significant increase in demand for these services is anticipated.

4.4 Transportation

The only impact on transportation facilities would be brief closures of NC 172, Lyman Road, and the AIWW (two one-hour intervals). NC 172 is a two-lane roadway that connects NC 24 to the communities southwest of Camp Lejeune. Much of the road is within the boundaries of the Base; it is this portion that would be closed. Lyman Road is entirely within the Base.

During the study, roadblocks would prevent use of the roadways by civilians and non-participating personnel. Existing warning signs would be modified to alert travelers of the study. Camp Lejeune has procedures in place for closure of roadways (MCP 3570.1A) and has

temporarily closed NC 172 on prior occasions. Closing the roadways would provide the necessary clearances required for the conduct of overhead fire.

The Marine Corps has coordinated with both the Corps of Engineers and the Coast Guard concerning the proposed temporary closure of the AIWW. The N-1/BT-3 Impact Area has an associated restricted area/SDZ already established by the Corps of Engineers for the Marine Corps' use for training operations. The AIWW is currently closed about 20 times per year, with each closure generally lasting about one hour. The Feasibility Study would be a one-time event that would result in about two additional hours (at one-hour intervals) of closure in 2001, and would not constitute a significant impact.

Procedures for closure include publishing a Notice to Mariners, blocking the channel at the north and south boundaries of the Base, and conducting a surface sweep to ensure no unauthorized persons are within the training area. The Base personnel also conduct aerial sweeps to determine the presence of unauthorized persons, marine mammals, and sea turtles.

All airspace over Camp Lejeune is subject to Federal Aviation Administration (FAA) regulations. A major portion of the Base lies within airspace designated by the FAA as Restricted Areas R-5306D and R-5306E. Through a joint letter of agreement signed by the Commanding Generals, 2d MarDiv, 2d MAW, 2d FSSG, and Camp Lejeune, and under MCO P3570.1, Range Control is the scheduling authority for these restricted spaces. The Range Control Duty Officer must notify the Cherry Point Air Traffic Control Facility of the intended use of the airspace by 1600 on the preceding day(s). In addition, Warning Area W-122 overlies Onslow Bay, and is controlled by the Fleet Area Control and Surveillance Facility, Virginia Capes (FACSFAC VACAPES) located at NAS Oceana in Virginia Beach, Virginia.

Both R-5306D and R-5306E include airspace from surface to 17,999 ft (5,486 m) above ground level (AGL). The maximum height of the test fire would be 9,600 ft (2,926 m) AGL. Base Order P3570.1 (SOP) prohibits overflights of the G-10, K-2, and N-1 Impact Areas during live fire operations, unless the aircraft is above the minimum altitude prescribed or is involved in the exercise.

Given the brief time duration of the Feasibility Study, and the precautionary measures to be taken, there would be no significant impact to transportation systems in the vicinity of Camp Lejeune.

4.5 Air Quality

There would be no significant impacts to air quality as a result of the Feasibility Study. The testing is of short duration (several hours over the course of one day). The 12 inert rounds contain no explosive materials. The explosive products of the 12 live rounds are similar to those

generated by ongoing training activities at Camp Lejeune. The detonation process, including the continued combustion that occurs in the plume immediately after initial detonation, results in nearly complete combustion of these explosive compounds to form oxides of carbon, nitrogen, and water.

4.6 Noise

4.6.1 Noise from Troop Movements

The SFCP would contain only 10 personnel, all of whom are currently based on Camp Lejeune. The SFCP would be stationed near the G-10 Impact Area for each firing sequence. These limited troop movements would take place in maneuver areas and ranges that are subject to periodic increases in noise levels from similar, ongoing activities. Thus, there would be no significant noise impact from troop movements.

4.6.2 Noise from Sonic Booms

A sonic boom is a pressure wave formed by an object exceeding the speed of sound. There are several factors that can influence sonic booms including weight, size and shape of the moving object, plus its altitude, attitude, flight path, and atmospheric conditions. A larger and heavier object would create stronger and louder sonic boom than a smaller, lighter object. The speed of the object determines the angle relative to the flight path for the sonic boom.

In the Programmatic EA for Vieques (US Navy, February 2001) the Navy conducted analyses to determine if sound energy from sonic booms associated with 5”/54 guns during NSFS operations could possibly pose a health risk to children or adults swimming in the waters off the beaches of Vieques. The results of that analysis are applicable here.

A sonic boom is a separate and distinct pulse from a gun muzzle blast produced by the projectile fired. For low elevation firings the sonic boom will be less than the gun blast in the vicinity of the blast impingement point on the water. As the projectile travels away from the ship, its speed diminishes and the trajectory rises. This causes the sonic boom pressure incident on the water to decrease with distance away from the ship.

As indicated in the Subchapter 4.10.1, both theoretical and experimental methods have been used to determine the bow shock environment from 5” and 16” projectiles (Pater, 1981, and Miller, 1991). The near field (close to the projectile) was studied by firing 16” projectiles very close to a pressure sensor array. The far field was studied by firing 5”/54 caliber projectiles over instrumentation along the trajectory of the shells over a distance of several miles. Far field measurements were taken with the gun firing at an elevation of 10 degrees, and data were

measured for 32 rounds. Surface sound pressure level measurements were taken beneath the trajectory at eight locations at distances ranging from 3,700 ft (1,128 m) to 48,284 ft (14,717 m) from the gun. The highest sound level measured was 145.1 dB (re 20 µPa), with the preponderance of data much lower (e.g. 120 – 90 dB re 20 µPa) (Pater 1981). Outside a round's line of flight, pressure decreases rapidly.

Using spreading rules for sonic booms as indicated in Subchapter 4.10.1, a maximum peak pressure in water of 195 dB (re 1 µPa) has been calculated for 5''/54 caliber sonic booms. This maximum peak pressure in water equates to 0.815 pounds per square inch (psi). This peak value occurs in the water just below the muzzle of the gun and is considerably lower than the value of 50 psi (about 231 dB re 1 µPa) that has been established as one criterion for swimmer safety (Christian and Gaspin, 1974). The second of the two criteria requires that the positive impulse (integral of pressure over time during the initial positive pressure phase) be less than 2 psi-ms (about 15 Pa-s). Estimates of positive impulse from the cited data (e.g., Pater, 1981) approach 15 Pa-s only within a few meters of the ship.

Because the sound energy from sonic booms would be well within the standards to protect the safety of swimmers, and the maximum calculated sound energy from sonic booms along their trajectory would occur more than 10 miles (16 km) from the closest populated or public areas, people swimming in the waters of Onslow Bay would be completely safe.

Based on the 145-dB level observed at 3,700 ft (1,128 m) and the closest land-to-ship distance (greater than 37,000 ft (11,280 m)), the noise levels on land resulting from NGF would be expected to be in the 90-120 dB range discussed above. These levels are considered as low risk levels of disturbing the public (see Table 3-6). Therefore, the potential noise impact from the Feasibility Study would not be significant.

As part of the Feasibility Study, the Marine Corps will be conducting a noise monitoring program at approximately six locations in and surrounding Camp Lejeune. The specific scope of this monitoring program is to be determined.

4.7 Infrastructure

The SFCP would be made up of 10 personnel, all of whom are currently based at Camp Lejeune. No additional troops would be stationed at Camp Lejeune for this Feasibility Study. Therefore, there would be no impacts to water supply, wastewater treatment, or solid waste facilities.

With the exception of targets, no effects on any structures or facilities near the G-10 Impact Area are anticipated from this exercise.

4.8 Cultural Resources

Camp Lejeune has identified architectural and archaeological National Register sites (both listed and potential) on the Base. Additional cultural resource studies are underway to complete the inventory of archaeological sites.

A 1998 study identified the G-10 Impact Area as a danger area where safety concerns prevent archaeological activities (Louis Berger and Associates, 1998), and the NC State Historic Preservation Office subsequently concurred with this finding. However, damage to as-yet-unidentified archaeological or historical sites that have scientific value is considered unlikely, as the proposed exercise would occur in areas that have been extensively used for previous training exercises. Soil disturbing maneuvers, principally resulting from the operation of vehicles in impact areas (to survey for accuracy of firing), would take place on areas currently used for such operations, reducing the possibility of uncovering any unknown artifacts. Because G-10 is an established impact area, it is likely that any archaeological sites therein no longer have integrity as defined in the criteria for nomination to the National Register of Historic Places. Therefore, there would be no effect to cultural resources as a result of the Feasibility Study.

4.9 Water Resources

The Feasibility Study involves firing 12 inert rounds and 12 HE rounds. Inert rounds are composed essentially of concrete, and would not adversely affect water quality. The HE rounds contain small amounts of trinitrotoluene (TNT) and cyclonite (RDX). Small amounts of other nitroaromatic compounds, such as octogen (HMX), tetryl, and picric acid, are also used in some applications. These compounds could potentially have an adverse effect on surface and groundwater quality. However, the explosive products are similar to those generated by ongoing training activities at G-10. The detonation process, including the continued combustion that occurs in the plume immediately after initial detonation, results in nearly complete combustion of these explosive compounds to form oxides of carbon, nitrogen, and water. Thus, it is unlikely that significant quantities of the parent explosives compounds or the combustion products would be released to the environment from bombing activities.

4.10 Marine Natural Resources

4.10.1 Marine Mammals

There are two areas of potential impact that need to be addressed with respect to marine mammals: the potential effects of naval gunfire noise and the potential for collisions with ships.

Noise Effects

This analysis addresses the potential for gun noise from NSFS to impact protected marine animals in the water. The contention, raised by some citizen groups, is that sound pressure from naval gunfire may propagate into the water and cause harm to marine mammals and other protected species via three mechanisms:

- Noise generated by the blast at the muzzle of the gun propagates through the air into the water;
- Impulse and vibration from the gun blast propagates via the hull of the ship into the water; and
- Sonic boom noise generated by the shell, as it travels to its target, propagates into the water.

Mechanisms for all three paths generate impulsive noise (of short duration and with fast onset of pressure), so that the appropriate impact criteria for marine animals are those for impulsive noise.

Based on measurements and studies conducted over the past 20 years (especially Pater, 1981, Yagla, 1986, USS Cole data, 2000), the Navy has characterized the noise generated by naval guns during NSFS. Of particular interest is the Naval Surface Warfare Center (NSWC) Dahlgren NSFS study conducted during the Vieques Inner Range June 2000 training exercise. Sound measurements were made during the firing of 5"/54 guns by the USS Cole.

The relevant results of these studies are presented below. However, it is first necessary to establish a set of criteria or standards against which to measure predicted noise levels.

Criteria and Thresholds

For impulsive noise in water, the Navy has previously evaluated criteria and thresholds for the potential injury and harassment of marine mammals and other protected marine species. The Navy's evaluations of criteria and thresholds have been based on experiments, actual measurements, and scientific theories for explosive noise, and the evaluations have been developed in cooperation with the medical community, wildlife biologists, and acousticians in government and academia. Although acoustic impact evaluation applications for marine mammals and marine species are relatively new, with data still emerging on sensitivity, there still exists a developing literature and public record on applications to marine mammals and marine species, and the Navy is leading the development of threshold criteria.

The criteria and thresholds that have been developed by the Navy and which are used in this analysis to assess potential harassment and injury to marine mammals are listed in Table 4-2. These criteria and thresholds were developed as part of the USS Seawolf Shock Test Final EIS (Navy,

1998), which was adopted by the NMFS in its final rule (NMFS, 1998) on unintentional taking of marine mammals incidental to the proposed USS Seawolf shock testing. As listed in Table 4-2, the criterion for marine mammal harassment is a dual criterion that consists of both an energy-based temporary threshold shift (TTS) criterion of 182 dB (re 1 μPa^2-sec) and a peak pressure of 12 pounds per square inch (psi). A harassment impact range would be the maximum distance at which either of these two criteria would be exceeded.

Table 4-2

Seawolf FEIS Criteria and Thresholds

Criterion	Threshold
Harassment: all marine mammals and sea turtles except baleen whales, sperm whales, elephant seals, and California sea lions (1)	Energy flux density level in any 1/3- octave band above 100 Hz exceeds 182 dB re 1 μPa^2-sec
Harassment for baleen whales, sperm whales, elephant seals, and California sea lions (1)	Energy flux density level in any 1/3- octave bands above 10 Hz exceeds 182 dB re 1 μPa^2-sec
Harassment for all marine mammals	Peak pressure above 12 psi
Injury for marine mammals and sea turtles [(probability of 50 percent tympanic membrane (TM) (eardrum) rupture]	Energy flux density greater than 1.17 in-lb/in^2 (20.44 milli-Joules/cm^2)
(1)This criterion must be considered together with the threshold of a peak pressure above 12 psi. Reference: Seawolf Shock Trial FEIS (1998) and NMFS Final Rule (1998).	

Transmission of Sound into Water From Gun Muzzle Blast

When a gun is fired from a surface ship, a blast wave propagates away from the gun muzzle. The blast wave is spherical in shape, and reflects off and diffracts around objects in its path. When the blast wave meets the water, it reflects back into the air away from the water and transmits a sound pulse back into the water in proportions related to the angle at which it hits the water. The blast wave transmits propagating energy into the water only in a definite region below the gun. A critical angle beyond which no propagating energy is transmitted into the water can be calculated, and this critical angle (about 13 degrees as measured from the vertical) can be used to determine the region of transmission relative to a ship and gun. Pressure sensors and hydrophones placed into the region of the water where energy can be transmitted can measure the actual pressure entering the water. These measured pressure readings can then be converted to sound pressure levels in decibels (dB) referenced to a specific pressure in micropascals (µPa) and other units as necessary for comparison to marine mammal acoustic impact criteria and thresholds for impulsive sources.

Based on measurements and studies conducted over the past 20 years (especially Pater, 1981; Yagla, 1986; and Dahlgren, 2000), the Navy has determined the noise generated by naval guns during NSFS. Noise transmitted into the water from muzzle blast during the firing of 5”/54 caliber guns has also been determined and documented in a study performed by the Dahlgren Naval Surface Warfare Center Combat System Safety and Engineering Division (Dahlgren, 2000). As

contained in this study, pre-test calculations of expected muzzle blast noise entering the water were performed by three different research personnel/organizations. These calculations yielded an estimated peak pressure level of about 195 to 205 dB (re 1 µPa) at the air-sea interface, about 10 meters below a 5"/54 caliber Naval gun muzzle. Subsequent to these pre-test calculations, a series of pressure measurements were taken during the firing of 5"/54 caliber gun blasts aboard the USS Cole in June 2000. The average pressure measured was about 200 dB (re 1 µPa) at the point of the air and water interface. Down range peak pressure levels, estimated for spherical spreading of the sound in water**,** were calculated based on the USS Cole data to be less than 186 dB (re 1 µPa) at 100 meters. The pressure would be less than this at greater distances. The peak pressure is less than the Seawolf harassment threshold of 12 psi (219 dB re 1 µPa).

As for the second of the two harassment criteria from Seawolf, note that the energy flux density (EFD) levels (greatest in any 1/3 octave band above 10 Hz) were calculated to be 190 dB (re 1 μPa^2-sec) below the gun muzzle and 170 dB (re 1 μPa^2-sec) at 328 ft (100 m) in the water. The range to the 182 dB (re 1 μPa^2-sec) harassment threshold identified in Table 4-2 would be about 98 ft (30 m). The proximity of the calculated threshold distance to a firing ship in conjunction with the standard operating procedures that would be implemented by the Navy to watch for the presence of marine mammals and abort operations until the area has been cleared if marine mammals are present would ensure that no marine mammals would be adversely affected.

Transmission of Sound and Vibration Through a Ship Hull

A gun blast also sends sound waves into the ship structure. The structure-borne sound can also enter the water and propagate away from the ship.

Gun noise entering the water by propagation of sound pressure via the hull of a ship was investigated in conjunction with the measurement of gun blasts aboard the USS Cole in June 2000 as part of the study prepared by the Dahlgren Naval Surface Warfare Center Combat System Safety and Engineering Division (Dahlgren, 2000). As contained in this study, the structural borne component of the sound consisted of low level oscillations on the pressure time histories that preceded the main pulse due the air blast impinging on the water. The structural component for a typical round was found to be 6.19 percent of the air blast, and, therefore, judged as small and not analyzed any further. Because gun noise entering the water via the hull of a ship is only a very small percentage of the sound entering the water from a gun blast, and the acoustic impact of a gun blast (which includes sound via the hull) is unlikely to significantly impact marine mammals, gun noise via the hull would not adversely affect marine mammals.

Transmission of Sound through Air and into Water for a Sonic Boom

The sound generated by a shell in its flight at supersonic speeds above water is transmitted into the water. The Navy has performed extensive studies of the bow shock environment from 5" and 16" projectiles (Pater, 1981, and Miller, 1991). Both theoretical and experimental methods have been

used. The near field (close to the projectile) was studied by firing 16" projectiles very close to a pressure sensor array. The far field was studied by firing 5''/54 caliber projectiles over instrumentation along the trajectory of the shells over a distance of several miles. Far field measurements were taken with the gun firing at an elevation of 10 degrees, and data were measured for 32 rounds. Surface sound pressure level measurements were taken beneath the trajectory at eight locations, on the ground, at distances ranging from 3,700 to 48,284 ft (1,128 to 14,717 m) from the gun. The highest peak pressure level measured in air was 145.1 dB (re 20 µPa), with the preponderance of data much lower (e.g., 120 – 90 dB) (Pater, 1981)

Based on the data in Miller (1991), the equivalent source level for a sonic boom shock wave from a 5"/54 caliber gun shell is about 210 dB (re 1 µPa) at 1 meter. Because the shock wave is incident on the ocean surface at angles less steep than critical, the transmitted wave in water is evanescent (i.e., it does not propagate and the pressure falls off exponentially with depth). When one assumes horizontal firing from a 5"/54 caliber gun at a height of 35 ft (11 m) above the water, the spreading rules for sonic booms (e.g., Pater, 1981) and the above source strength result in a maximum peak pressure in water of 195 dB (re 1 µPa), or about 0.8 pounds per square inch (psi). This is well below the 12 psi (219 dB) threshold for harassment for marine mammals as indicated in Table 4-2. The estimated energy flux density level in the greatest 1/3 octave band above 10 Hz is 180 dB (re 1 μPa^2-sec), which is also less than the 182 dB harassment threshold indicated in Table 4-2. Away from the line of flight or as the shell altitude increases, the levels are lower, decreasing logarithmically according to –15 log (range in meters).

Conclusions

In summary, the sounds generated by 5"/54 naval gun firing during NSFS would all be below injury and harassment levels for marine mammals beyond 98 ft (30 m) from the ship. The closeness of the 98-ft (30-m) radius in conjunction with the standard operating procedures that would be implemented by the Navy to watch for the presence of marine mammals and abort operations until the area has been cleared if marine mammals are present would ensure that no marine mammals would be harassed.

Potential for Ship Collisions

Collision with marine mammals by ships participating in the training would be avoided by the following measures:

- All surface vessels would have two lookouts with binoculars. The duty of the lookouts is to watch for and report to the Officer of the Deck regarding all things in the water with which the vessel may collide, including marine mammals and sea turtles.

- Naval vessels would avoid approaching any whale head on, and would maneuver to keep at least 500 yards (457 m) away from any observed whale.

- Naval vessels shall be alert at all times, use extreme caution, and proceed at a "safe speed" so that the vessel (1) can take proper and effective action to avoid a collision with a whale, other marine mammal, or other listed species; and (2) can be stopped within a distance appropriate to the prevailing circumstances and conditions.

Qualification standards for lookouts include training on marine mammals, as well as all sea life. Lookouts are trained to stay alert to any objects in the water so that collisions can be avoided. Therefore, through adherence to the above operational guidance, ship movements would not affect marine mammals or other protected species.

4.10.2 Turtles

Sea turtles are generally present in Onslow Bay in nearshore waters during the September to November period. Nesting activity begins in late May and lasts through August, with peak activity occurring in June and July. Unlike marine mammals, little is known about the role of sound and hearing in sea turtles. Although they can hear low frequency sound, such as that generated by gun blasts, there is limited information on sea turtle behavioral and physiological responses to low frequency sound underwater (Eckert, 1998, in DON, January 2001).

In the few cases in which low frequency hearing has been studied in sea turtle species, individuals tested showed low sensitivity. Lenhardt (1994; in DON, January 2001), in an unpublished presentation, suggested that maximum sensitivity in sea turtles occurred between 100 and 800 Hz. Ridgway et al. (1969) found 300 and 400 Hz as the maximum sensitivity for green turtles, with a rapid decline in sensitivity for lower and higher signals. This study did not measure hearing capabilities in terms of behavioral responses, as has been done for fish and sharks, but directly measured responses from the ear. While such studies are useful in giving a general indication of sensitivity of the ear to sounds (to both intensity levels and frequency ranges), they generally give only a limited picture of the actual hearing capabilities of an animal.

The effects of sound pressure levels on the hearing of sea turtles are unknown. Other analyses have used a conservative level of 160 dB for defining the potential effect to sea turtles, but based on the few studies to date this represents a level that is probably lower than the actual sensitivity level of these species.

The mitigation measures outlined in the subchapter on marine mammals would also be applicable for the protection of sea turtles; thus, the potential to "take" a turtle would be negligible.

4.10.3 Fisheries

Potential effects of low frequency sound on fish could include permanent or temporary hearing loss, masking of biologically important sounds, and resonance of gas-filled organs (such as swimbladders). However, even if fish were killed or injured as a result of the Feasibility Study, because the noise generated would be limited to several minutes within two one-hour spans, the impacts on overall fish stocks would be negligible in comparison to the number of fish taken through normal commercial fishing activity.

Sargassum habitat and live/hard bottom habitat are the two essential fish habitats that can be found within Onslow Bay. Sargassum habitat is a floating habitat usually associated with open ocean. Although occasional pieces of sargassum may float through the Bay depending on prevailing currents, a year-long study of aerial photos did not identify any sargassum in the Bay. It is unlikely that noise would adversely affect the sargassum itself or the organisms associated with it, particularly considering the short-term nature of this exercise. Live/hard bottom habitat is largely found along the continental shelf outside and seaward of the N-1/BT-3 range, and no impacts to live/hard bottom habitat are expected.

4.10.4 Protected Species

Noise and physical impacts on marine mammals are addressed in Subchapter 4.10.1. The mitigation measures proposed for protection of marine mammals, which would also affect sea turtles, would ensure that the potential to "take" a threatened or endangered animal by noise or physical injury is negligible; therefore, there would be no effect on protected species due to implementation of the Feasibility Study.

4.10.5 Coral Reefs

No coral reefs are present within the N-1/BT-3 range. Therefore, the Feasibility Study would have no impact on coral reefs.

4.11 Land Natural Resources

4.11.1 Topography, Geology, and Soils

The inert and high explosive rounds fired into the G-10 Impact Area would have a minor impact on G-10 soils. This area has been used historically, and is still being used, for similar purposes; thus, the disturbance from the 12 high explosive 5"/54 rounds would not be significant.

4.11.2 Floodplains

A considerable portion of the G-10 Impact Area is within the 100-year floodplain. However, the firing of rounds into these areas would not affect its flood storage or flood-buffering capacity. Thus, the Feasibility Study would not affect the capacity of this area to reduce damage to property, nor to provide the natural and beneficial functions associated with floodplains.

4.11.3 Vegetation and Wetlands

Plant communities within the target and buffer areas of G-10 include longleaf pine savannas, pond pine pocosins, and streamhead pocosins. These communities are currently frequently disturbed by the release of ordnance and periodic fire management. The release of 12 inert and 12 high explosive rounds into the target area, while it may damage individual plants, would have little impact on plant communities. Potential impacts on rough-leaved loosestrife are discussed in Subchapter 4.11.5.

4.11.4 Wildlife

The G-10 Impact Area has been used, and will continue to be used, for training similar to the SFCP training that is the concern of the Feasibility Study. While NGF has not been conducted at Camp Lejeune for a number of years, training with artillery from tank, helicopter, amphibious craft, and riverine assault craft platforms, as well as small arms training, has been ongoing. G-10 is one of the three major impact areas at Camp Lejeune. Therefore, it is reasonable to assume that the wildlife inhabiting or using the impact area are those species acclimated to the noise and disturbance generated by these activities. The Feasibility Study is similar in nature to these activities, and would not adversely affect wildlife through noise or startle reactions.

There is a very low probability that a round, inert or high explosive, could directly impact an animal. With the exception of individuals of the threatened or endangered species addressed in Subchapter 4.11.5, the mortality of a single animal would be unlikely to affect the survival of the species or local populations of that species.

4.11.5 Threatened and Endangered Species

The Feasibility Study may affect but is not likely to adversely affect threatened and endangered species in the G-10 Impact Area based on the following considerations:

- The **red-cockaded woodpecker** (RCW) groups residing in the G-10 Impact Area buffer zone have relatively high productivity. Associated foraging areas would not likely be

affected by the Feasibility Study. High explosive rounds would not introduce impacts or disturbance to the G-10 Impact Area that differ from what is currently experienced. Thus, the Feasibility Study may affect but is not likely to adversely affect RCW.

- Two concentrations of **rough-leaved loosestrife** (RLL) fall within the NSFS buffer area at the southeasternmost edge. High explosive rounds would not introduce impacts or disturbance to the G-10 Impact Area that differ from what is currently experienced. The Feasibility Study does not significantly increase the probability of impacts to these RLL groups. Therefore, the Feasibility Study may affect but is not likely to adversely affect RLL.

- As with RLL, both state endangered and the four state candidate species fall within the NSFS buffer area. Given the current and historical use of the site, and the fact that the Feasibility Study would not significantly increase the probability of impacts to these species, the study may affect but is not likely to adversely affect state endangered or candidate species.

These conclusions are supported by the results of a 1999 USFWS Biological Opinion and recent informal consultation with the USFWS. The 1999 Biological Opinion concerned: depiction of the G-10 Impact Area in the latest Camp Lejeune Military Installation Map; target modification within the G-10 relative to RLL and RCW habitat; and mitigating actions to offset potential impacts to federally-listed species. The USFWS concurred with the Base's conclusion that use of the latest military installation map may affect but is not likely to adversely affect federally-listed species at the installation. The USFWS also agreed with Camp Lejeune's position that target realignment within the G-10 Impact Area may affect but is not likely to adversely affect federally-listed plants or animals.

In the August 2001 informal consultation between Camp Lejeune and the USFWS, the USFWS concurred that the proposed SFCP/NSFS is not likely to adversely affect the RCW, RLL or any other federally-listed species, their formally designated critical habitat, or species currently proposed for federal listing under the ESA.

4.12 Hazardous Materials/Wastes

The inert rounds to be fired into the G-10 Impact Area consist of concrete encased in metal jackets. These rounds would not contain hazardous or toxic materials.

The primary contaminants likely to be released while using live ordnance during training exercises include trinitrotoluene (TNT) and cyclonite (RDX) (URS et al, August 2000). Records indicate that lesser amounts of a number of other nitroaromatic compounds, such as octogen (HMX), tetryl, and picric acid, are also used in some applications, such as fuses and primers. It is

important to note that the detonation process, including the continued combustion that occurs in the plume immediately after initial detonation, results in nearly complete combustion of these explosives compounds to form oxides of carbon, nitrogen, and water. Thus, it is unlikely that significant quantities of the parent explosives compounds or the combustion products would be released to the environment from bombing activities.

The Marine Corps personnel will follow the procedures established by Base Order P3570.1 for the handling of hazardous materials and POL. Thus, there would be no release of these contaminants during the Feasibility Study.

4.13 Safety

Marine Corps Order 3570.1A and Army Regulation 385-63 establish policies and procedures for firing ammunition for training, target practice, and combat. These regulations include standards used for determining SDZs for target areas. Table 4-3 provides definitions of the terms used to describe and define impact areas. Figure 4-1 provides a graphic description of an impact area.

The Navy/USMC has existing data from studies of naval gunfire. These data are used in a model called statistical weapons system to derive the SDZ diagrams (safety fans) for a particular exercise. Safety computations were performed that take into consideration the type of gun to be fired, the water depth required for the ship, and the distances the ship would be from the target within two possible Fire Support Areas. Those safety calculations resulted in the impact areas shown in Figure 4-2.

In this Feasibility Study the ship would use a Fire Support Area (FSA), rather than a Fire Support Station (FSS). An FSS is a stationary point from which the ship may fire. The problem with limiting the ship to a stationary point (FSS) is that ship positioning is inherently less accurate as it is more susceptible to winds and currents. An FSA is an imaginary box (area) that permits the ship to maneuver while firing and makes it less susceptible to winds and currents. The FSA would be a defined area in water with a depth of 46 ft (14 m) or greater off the coast of Camp Lejeune. An FSA allows the ship to maintain a constant course and speed, from which it can pinpoint its position as accurately as a surveyed artillery position. Using an FSA increases safety in that it allows the ship to make instantaneous corrections in order to ensure accurate delivery of the ordnance to the target.

By plotting the left and right limits of fire, a safety fan from each of the four corners of the specific FSA, and ruling out all areas of concern from each point, an acceptable NGF Target Area can be defined. This Target Area can be safely fired into from any position within the defined FSA. The larger NGF Impact Area (Figure 4-2) is the area where 99.9 percent of NGF rounds fired would impact. The NGF Impact Area lies within the existing boundaries for the G-10 Impact Area.

Table 4-3

Surface Danger Zone and Impact Area Terms

Term	Definition
Surface Danger Zone	That segment of the range area which is endangered by a particular type of weapon firing and which consists of the areas below.
Target Area	The point or location to which the weapon is to be fired.
Impact Area	The primary danger area for indirect fire weapons that is established for the impact of all rounds. The impact area is within the approved SDZ.
Probable Error	Measure of the impact distribution in the dispersion pattern around the center of impact, dimensionally expressed in firing tables as one interval of the dispersion rectangle.
Area A	The area (secondary danger area) which parallels the impact area laterally and which is provided to contain fragments from items exploding or ricocheting on the right or left edge of the impact area.
Area B	The area (secondary danger area) which is on the downrange side of the impact area and Area A. It is designed to contain fragments from items exploding on the far edge of the impact area.
Area C	The area (secondary danger area) which is on the uprange side of the impact area and parallel to Area B and which is intended to contain fragments from items exploding at the near edge of the impact area (also referred to as the short limit of the target area).
Area D	The area which is between Area C and Area E and which is considered a safe area for troop occupation for training purposes.
Area E	The area which is between Area D and the firing position and which is endangered by muzzle debris, overpressure, and injurious noise levels. Area E may be occupied only by weapon crews firing from an approved tactical configuration (circular, box, star, etc.).
Source: MCO P3570.1A, Ch.1. Policies and Procedures for Firing Ammunition for Training, Target Practice, and Combat.	

Recent technological advances in NSFS Fire Control Systems (e.g., new NGF technology uses Global Positioning Systems, gyro-stabilized guns, and computer generated solutions), munitions, and tactics techniques and procedures have greatly increased accuracy and reliability of NGF; consequently, SDZ and statistical weapon system data show that firing NGF into the G-10 Impact Area would be safe. In fact, improved NSFS safety allows clearance of overhead fires identical to cannon artillery.

The same laws of physics apply to all ballistic weapon systems (artillery, mortars, naval guns, rifles, etc.). If a projectile is fired at an angle of less than 10 degrees, there is a chance that it will skip on the ground, making its movement less predictable. The best way to describe skipping with regard to weapons is to liken it to skipping a flat rock on the surface of a calm lake. The same bouncing effect may occur if a ballistic projectile strikes a target at an angle of less than 10 degrees. The chance of skipping is greatly reduced if the projectile is fired at an angle of 10 degrees or higher. The existing Camp Lejeune Range Procedures (Base Order P3570.1A) and Marine Corps Artillery Safety SOP, Appendix J) reduce the chance of skipping even further by prohibiting artillery from shooting at an angle lower than 15 degrees.

In accordance with Camp Lejeune's existing procedures, naval guns would not fire at an angle of less than 15 degrees during the Feasibility Study. At 15 degrees or greater, NGF has a higher trajectory and falls at a steeper angle than currently authorized artillery operations. The steeper angle of fall results in an even lower probability of skipping a round; therefore, firing NGF rounds into the G-10 impact area has no greater chance of producing a skipped round than currently authorized and routinely conducted artillery fire into G-10.

The probability of a round skipping (whether artillery or NGF) is also affected by the nature of the ground surface upon which the round impacts. At G-10, the soft composition of the soil further diminishes the potential for a round to skip and the large number of trees and other natural obstacles would provide a natural backstop.

4.13.1 Comparison to Artillery Fire

Execution of NGF can be compared to the currently-employed M198 artillery fire as graphically depicted in Figure 4-3. For the purpose of evaluating impacts, the propensity for skipping and the margin of error are relevant. For both munitions, shooting at a low angle increases the likelihood of skipping. As discussed above, Camp Lejeune procedures prohibit artillery from shooting at an angle less than 15 degrees to prevent skipping. Naval guns also would not fire at an angle less than 15 degrees. This would prevent NGF from having any greater potential for skipping than currently exists with artillery fire.

The terminal velocity and projectile weight (representing the total force of the round as it hits the ground) in conjunction with the angle of fall are the factors than contribute to the probability of

skipping. A naval gun 5”/54 round at 9.3 miles (15 km) has nearly the same terminal kinetic characteristics as a M198 155 mm artillery round fired at 6.2 miles (10 km) except that it is 25 pounds (11.3 kilograms) lighter. Thus, the likelihood of NGF rounds skipping is less than that of artillery.

The firing characteristics of ammunition used for NGF is similar to that of M198s. The target area buffer zones are based on the standard deviation in range (long or short of target) and deflection (left or right of target). The difference in standard deviations is a result of the differing velocities of the projectiles. Table 4-4 provides the standard deviations of the M198 155 mm and the 5”/54 NGF rounds.

Figure 4-3

Comparison of the Margin of Error for Naval Gun Fire vs Artillery

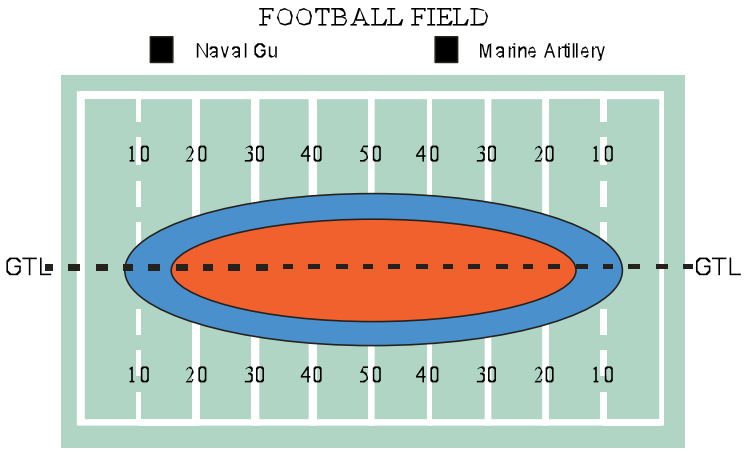

Table 4-4

Comparison of Standard Deviations (SD) of M198 and NGF Firing

Range	Error	M198 (SD)	NGF (SD)
15 km	Range	66 m	80 m
	Deflection	15 m	40 m
18 km	Range	78 m	85 m
	Deflection	23 m	45 m

4.13.2 Access Restrictions

G-10 is an established impact area for live fire. The short duration of the Feasibility Study (about two hours) and firing (several minutes at most), along with the fact that G-10 is a long-established range, help to minimize concerns about safety. The use of G-10 does not require the shutdown of any adjacent ranges, NC 172, Lyman Road, or the AIWW. However, as an additional measure of safety, NC 172, Lyman Road, and the AIWW would be closed during this study. NC 172 and the AIWW have been closed off for training in the past, and existing procedures for closure would be followed for this study.

It is also important to note that there are no residences under the gunfire trajectories; the closest residential area to the NGF Impact Area is about 2.5 miles (4 km) away. With respect to State Park operations, the Marine Corps would communicate with the North Carolina Division of Parks and Recreation to inform them when the Feasibility Study would occur.

Based on the safety computations and precautions described above, as well as the phased approach to the study as described in detail in Chapter 2, no significant impacts with respect to safety are expected as a result of the Feasibility Study.

4.14 Cumulative Impacts

Cumulative impacts have been defined by the Council on Environmental Quality (CEQ) in 40 CFR 1508.7 as:

> Impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions.

The CEQ regulations further require that NEPA environmental analyses address connected, cumulative, and similar actions in the same document (40 CFR 1508.25). This requirement prohibits segmentation of a project into smaller components to avoid required environmental analysis.

This EA evaluated information relevant to environmental concerns associated with the Feasibility Study. The analyses conclude that there would be no significant environmental impacts as a result of the proposed action. Any impacts associated with the Feasibility Study would be localized and temporary (less than 2 hours) in nature and barely discernable from past and existing training activities.

It is foreseeable that as a result of this Feasibility Study further actions to utilize the G-10 area for SFCP training may be proposed. Such proposals would be based upon the success of the proposed Feasibility Study and analysis of data collected during its conduct. Data collected during the Feasibility Study would then be utilized in a subsequent NEPA analysis to predict and assess the significance of any long-term impacts.

4.15 Unavoidable Adverse Impacts

Based on the analysis in this EA, there would be no unavoidable adverse impacts due to the Feasibility Study at Camp Lejeune.

4.16 Relationship Between Local Short-Term Uses of Man's Environment and the Enhancement of Long-Term Productivity

Short-term uses of the environment are those that occur over a period shorter than the life of the Proposed Action. Long-term uses include those impacts that would persist for a period of five years or more, or for the life of the Proposed Action.

The Proposed Action represents a short-term use of the environment. However, it would have a negligible impact on other, more long-term uses, such as use of the area's natural resources, or use of the area for ongoing training activities.

4.17 Irreversible and Irretrievable Commitments of Resources

The proposed Feasibility Study would expend fuel, ammunition, and labor. However, if the results of the study prove that Camp Lejeune is a suitable location for SFCP, the use of Camp Lejeune for this activity could lead to major fuel and labor savings. These exercises are presently conducted at the Vieques Inner Range in Puerto Rico or San Clemente Island in California, at a major expenditure in terms of manpower hours (time for personnel to travel to these destinations from locations on the East Coast) and fuel (time for naval gunfire ships to steam to Vieques from Norfolk, Virginia).

4.18 Mitigation Measures

A variety of mitigation measures have been developed to minimize any potential environmental impacts, as described below.

For Marine Corps Base Camp Lejeune, North Carolina, the Consolidated Public Affairs Office would be designated to receive inquiries and/or comments from the public during the study. The telephone number is (910) 451-7440.

4.18.1 At Sea Activities

The following restrictions are applicable to all ships participating in the Feasibility Study:

- Vessel operators will be cautioned to avoid sea turtles and marine mammals.

- All surface vessels will have two lookouts with binoculars. The lookouts will search the area for marine mammals and sea turtles and report sightings to the Officer of the Deck regarding all things in the water with which the vessel may collide, including whales and sea turtles.

- The participating vessels will avoid approaching any whale head on, and will maneuver to keep at least 500 yards (457 m) away from any observed whale.

- While in transit, Naval vessels will be alert at all times, use extreme caution, and proceed at a "safe speed" so that the vessel: (1) can take proper and effective action to avoid a collision with a whale, other marine mammal, or other listed species; and (2) can be stopped within a distance appropriate to the prevailing circumstances and conditions.

- Vessels participating in the Feasibility Study will not discard refuse overboard or pump bilges while in the waters of Onslow Bay.

4.18.2 Noise

- As part of the Feasibility Study, the Marine Corps will be conducting a noise monitoring program at approximately six locations in and surrounding Camp Lejeune. The specific scope of this monitoring program is to be determined.

4.18.3 Threatened and Endangered Species

- Flora and fauna will not be needlessly damaged or destroyed.

- The SFCP personnel will receive a copy of Camp Lejeune Base Orders 11015.6C and 11015.7C, "Terrestrial Threatened and Endangered Species Protection Program/Measures and Sea Turtle Protection Program" and will abide by the restrictions presented in the Base orders.

- Camp Lejeune contains 65 red-cockaded woodpecker cavity tree clusters. These areas are protected by a 200-foot (61-m) buffer zone clearly marked with single bands of white paint and signs reading “Restricted Area Endangered Species Site, No Vehicles Allowed”, and “Endangered Species Colony Site.” Tracked and wheeled vehicles are restricted to using existing well-defined, main roads/trails in these areas. Within the marked RCW sites, specific ground training activities are prohibited.

4.18.4 Cultural Resources

- If any site of potential historical or archaeological significance (i.e., evidence of human activity during the World War II era, or earlier) is encountered during the study, the installation commander will be notified. The unit commander will order actions in the vicinity halted and the area marked. The unit commander will immediately notify the Base Archaeologist at telephone 451-2148.

4.18.5 Safety

- Fire danger risk for the day will be obtained from Base Range Control Officer and associated restrictions observed. Should a wildfire occur, the unit observing the wildfire will immediately contact the Base Range Control Office, tel. 451-3064 (Blackburn) or Base Range Control Office Safety, frequency 3860 FM.

- The AIWW will be closed for a maximum of two hours during conduct of the Feasibility Study. The closing will be coordinated with, and approved by, the Coast Guard, and a Notice to Mariners published to inform mariners of the closing times and dates.

- Similarly, NC 172 and Lyman Road will be temporarily closed (two hours) during conduct of the Feasibility Study.

- Training areas GC, GD, GE, GH, and GI would be closed during the entire test.

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