SWDIV G1000tg
Site Development, Site Grading and Site Storm Drainage
Technical Guide

04/02

TECHNICAL GUIDANCE

FOR

CIVIL ENGINEERING DESIGN

OF

SITE DEVELOPMENT,

SITE GRADING, AND

SITE STORM DRAINAGE

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PART 1 - GENERAL

1. INTENT: The purpose of this document is to provide technical guidance and outline technical requirements for the more typical aspects of the civil design portion of Design-Build contracts for Southwest Division, Naval Facilities Engineering Command. This Technical Guide specifically describes minimum acceptable standards for design and construction of Site Development, Site Grading, and Site Storm Drainage for Design-Build Projects. The information provided in this guide shall be utilized by civil designers in the development of their portion of the plans, specifications and calculations and shall serve as minimal civil design guidance. This is a guide only and is not intended to cover every situation or restrict innovative design alternatives and good common sense design decisions. Questions or recommendations for improvement of this document should be brought to the attention of SOUTHWESTNAVFACENGCOM.

2. GUIDANCE AND CRITERIA: For further guidance and sources of criteria refer to the latest revision of:

a. The Request for Proposals for the particular D-B contract.

b. The Southwest Division AE Guide - “GUIDE FOR ARCHITECT-ENGINEER FIRMS”.

c. Applicable Design Manuals, Military Handbooks, and various other military publications.

d. Section G1000 Guide Specifications (particularly the guide or criteria notes accompanying the guide specification sections).

e. Local municipal, regulatory or permitting agency manuals for guidance concerning preparation of permits (stormwater, sanitary, etc).

f. "Parking Area Criteria For Vehicles" (NAVFAC Drawing Number 1404837).

g. Contact the Activity concerning site-specific issues and user requirements. This contact is particularly important in projects that involve Physical Security applications.

h. Department of Transportation Standard Specifications for Roads and Bridges for the State where the project is located.

i. "General Requirements For Shore Based Airfield Marking And Lighting" (NAVAIR 51-50AAA-2).

PART 2 - SITE DEVELOPMENT

1. SITE LAYOUT: The site layout should satisfy the functional and operational requirements of the new facility. Depending upon the scope of the project, the layout should be approached from an interdisciplinary viewpoint to ensure proper coordination of the final design. As a minimum, the layout should integrate the new construction into the context of the site and surrounding base environment so that consideration is given to the following:

a. Existing traffic patterns are not adversely affected.

b. Utility and storm drain runs are minimized.

c. Setback requirements are in compliance with respect to property lines, applicable codes and security.

d. Security requirements are implemented, particularly where security fencing and associated inside and outside security clear zones are involved.

e. Tree removal is kept to a minimum.

f. Natural topographic features are preserved to the best extent possible to minimize cut and fill.

g. Aesthetic relationships are balanced.

h. Maintenance costs are kept minimal.

i. Phasing, scheduling and constructability issues are considered, particularly where existing security fencing is being removed and installation of new security fencing must be delayed due to other site preparation work.

j. Solar impact versus facility orientation.

1.1 SITE ANALYSIS: Prior to the actual site layout, the site must be evaluated with respect to two important factors:

a. The opportunities and constraints of the site in relation to the proposed development (factors such as elevation, environmental contamination, soil types, water table elevation, stormwater management, flood zone, etc.).

b. The impact upon the Activity at large, especially the immediate adjacent areas.

1.1.1 A preliminary site visit should be conducted. Photographs of the site and existing as-built record drawings should be obtained (if available) which may provide general topographic information, utility and stormwater drainage availability and soil boring log information near the site. Secondly, detailed consultations with the user should be accomplished in order to clearly define requirements and preferences. The above information should then be assessed to determine the preliminary configuration and location of the major site elements (building location and orientation, parking areas, stormwater detention facilities, and access and egress to the site). The results of the above analysis should then be presented to the user for review, preferably before any actual surveys or subsurface explorations are accomplished.

1.2 SUBSURFACE EXPLORATION: The Design-Build Contractor and the Architect/Engineer of Record shall be responsible for obtaining all necessary soils exploration, testing and geotechnical analysis. A local professional geotechnical engineer, is strongly recommended. The amount of geotechnical investigation

necessary should be determined based on discussions with the geotechnical consultant, structural engineer, civil engineer, and local stormwater-permitting agency. Additionally, if the site is known to have environmental contamination, the appropriate environmental regulatory agency should be contacted to determine if additional testing will be required. This also applies to remote sites that will probably require a septic tank or well. Subsurface investigations will be performed in accordance with the requirements of all local, state, and federal regulatory agencies. See paragraph 1.7, Section 5, "Pavement" below for additional requirements for subsurface exploration with respect to pavement design.

1.3 SURVEY: A topographic survey shall be performed on the project site which provides the location of all aboveground and underground natural and constructed features and associated elevations. The order of the survey shall be as required to facilitate design and construction of the facility including any easements or property boundary establishments that may be required, including security clear zones (outside and inside) associated with boundary or restricted area security fencing. The survey shall be based on the National Geodetic Vertical Datum (NGVD 88) or other established datum, which shall be clearly identified, and the North American Datum (NAD83) coordinate system for horizontal control. Typically, contour intervals shall be on a 0.25 m (one foot) interval except in extreme flat or hilly terrain. Two temporary benchmarks shall be established at the project site that can be utilized for horizontal and vertical control during construction and the permanent benchmark used shall be identified on the drawings. Existing station as-built drawings may be used to identify utilities and storm drains, however, all information shall be field verified. To the maximum extent possible, all pavement types and thicknesses (including pavement layer thicknesses) shall be identified. The thicknesses may be obtained by reviewing existing as-built information, digging at the edge of the pavement, consulting with station personnel and applying good engineering judgment. Soil borings for the sole purpose of determining pavement thicknesses will not be allowed unless approved by SOUTHWESTNAVFACENGCOM.

1.3.1 WETLANDS: Should unexpected wetlands be encountered during the survey, SOUTHWESTNAVFACENGCOM should be contacted immediately..

1.4 PARKING LAYOUT: The parking layout shall be designed in accordance with NAVFAC Definitive Drawing 1404837, "Parking Area Criteria For Vehicles". For typical applications (90-degree parking), parking stalls shall be 2740 mm x 5640 mm (9 ft X 18.5 ft) and aisle widths 7925 mm (26 ft). Parking stripes shall be 101 mm (4 in) wide and white. The total parking requirement (number of spaces) shall be coordinated with the user and be based on the construction funds available, the maximum number of spaces that may be constructed in accordance with NAVFAC planning criteria for the particular project, and geometric limitations of the site. To conform to security related restrictions, which are identified on the NAVFAC Definitive Drawing, the parking area location and layout shall conform to the following restrictions:

a. Parking of privately owned vehicles (POV's) within 6.1 m (20 feet) of any building is prohibited for <u>any</u> project.

b. Parked vehicles within either the 6.1 m (20-foot) minimum outside security zone or the 9.1 m (30-foot) minimum inside security zone associated with restricted area security fencing (if applicable to the project) are prohibited. They are a hindrance to observation and a potential aid in circumventing the fence.

c. Where necessary on a site constricted by restricted area security clear zones, the designer may utilize parking area circulation drives as part of the security clear zone; in such cases, careful attention needs to be paid to the topography and features between the edge of the pavement and the Security Barrier (fence or building wall) to assure that vehicular traffic safety hazards and security clear zone violations are considered and avoided.

d. The security representative for the Activity shall identify other restricted areas where POV parking may be prohibited. These may include areas around flight line or aviation type facilities, controlled industrial facilities, certain waterfront facilities and magazines.

1.4.1 HANDICAP PARKING: Handicap parking and associated ramps/walks shall meet the requirements of the ADA (Americans with Disabilities Act) accessibility guidelines.

1.4.2 MOTORCYCLE PARKING: Motorcycle parking will typically be required on facilities such as barracks. Consult with the user on the number of spaces required. Motorcycle parking areas should be of 101 mm (4 in) thick concrete and stalls should be 3050 mm x 1525 mm (10 ft X 5 ft).

1.4.3 BICYCLE PARKING: Consult with the user on this requirement. Normally, bicycle parking is only required on facilities such as barracks. Provide a designated area of adequate size to accommodate the bicycle rack.

1.4.4 PARKING AREA CIRCULATION: Provide a system with adequate striping and signage which will allow for safe, convenient and logical circulation throughout the parking area. The system should allow for all types of traffic, which may be associated with the facility including deliveries, emergencies and garbage pick-up. The system should, however, discourage through traffic.

1.4.5 TURNING RADII: Clearly indicate turning radii requirements on parking area entrances and islands. Where heavy trucks will have to enter the parking lot to make garbage pick-ups, for example, the Design-Build Contractor's Architect/Engineer of Record shall determine the required turning radii based on truck size and maneuverability.

1.5 SITE APPURTENANCES

1.5.1 SIDEWALKS: Typically, sidewalk requirements should be determined on the basis of need and capacity. The user should be consulted on any special walk requirements for such facilities as barracks where extra wide walks may be required for marching purposes and/or muster formation. Generally, sidewalks shall be constructed of 101 mm (4 in) thick plain concrete with appropriate jointing shown on the plans. Tooled joints should be placed at intervals equal to the width of the sidewalk. Expansion joints should be placed at all intersections and where the walk abuts any structure. Where a sidewalk runs adjacent to a parking area and the layout utilizes curbing, the designer should consider an integral curb and walk, which is a sidewalk with a thickened edge.

1.5.2 CURB OR CURB AND GUTTER: Curb, or curb and gutter, should be utilized to aid in the collection of stormwater runoff, confine traffic and control erosion. The designer should investigate existing adjacent facilities to ensure site compatibility and continuity with respect to its use. Generally, curb, or curb and gutter, will be utilized in built-up areas where existing facilities have established a prior need for such use.

1.5.3 WHEELSTOPS: Provide 1830 mm (6 ft) long precast wheel stops anchored to pavement with rebar at parking spaces adjacent to sidewalks or integral curb and walk. Coordinate with the activity for wheel stop requirements at other locations. The front face of the wheel stop shall be located 760 mm (2-ft 6 in) from the edge of the pavement or sidewalk.

1.5.4 GUARD POSTS: Guard posts shall be 914 mm (3 ft) high 101 mm (4 in) diameter steel pipe filled with concrete and painted yellow. Provide guard posts around any structures that are subject to damage from vehicular traffic and mowing equipment. Ensure that an adequate foundation is designed for the guard post.

1.5.5 SIGNAGE AND MARKINGS: Provide stop signs, handicap parking signs, no parking signs, etc., and associated pavement markings as required to facilitate proper utilization of the project site. Signage and markings shall be in accordance with the Federal Highway Administration's manual on Uniform Traffic Control Devices. Coordinate with the activity for activity specific requirements.

1.5.5.1 SECURITY SIGNAGE: For projects which include security fencing, including Station boundary fencing, consult with the Activity representatives to verify their site specific and project specific signage requirements. In general, the routes for these types of fencing and entry points/gates should be posted with signage identifying the fencing as either a Government Property boundary or a Restricted Area boundary. Navy Security Instructions include specific requirements in regards to this type signage and there may also be site specific Activity requirements to be met. Comply with provisions included in the Base Exterior Architecture Plan (BEAP). The provision of such signage can be accomplished in one of three ways: either as "government-furnished/government installed" (GFGI) signage (most frequent case); or as "government-furnished/contractor installed" (GFCI) signage; or as "contractor-furnished/contractor installed" (CFCI) signage.

1.5.6 TRASH DUMPSTER ENCLOSURE: Consult with the user on this requirement. If a dumpster is required, the enclosure should be designed by an architect, but the pavement in and around the enclosure should be designed by a civil or geotechnical engineer. Typically, the "floor" or pavement inside the enclosure and the pavement in front of the enclosure [for a distance of at least 3.05 m (10 ft)] should be designed and constructed of concrete. The enclosure should be located in a location which allows convenient access for the dumpster truck.

1.5.7 MECHANICAL ENCLOSURE: A mechanical enclosure will be required on most facilities for mechanical and electrical equipment. The design and location of the enclosure will be an interdisciplinary responsibility. The civil designer should review the location of the enclosure to ensure that all servicing, clearance and code requirements are met and that no existing or new utility or storm drainage conflicts are present.

1.5.8 FENCES: Fencing requirements shall be assessed based on security and safety requirements. For safety applications, a fence of the appropriate design should be provided around retention or detention basins particularly in residential housing areas, playgrounds, childcare facilities, and other similar applications where a fence will enhance the welfare and safety of children. If a fence is required for any other application, the Design-Build Contractor’s Architect/Engineer of Record shall consult with the Activity Security Officer to determine if the fence must comply with applicable security criteria. For security applications, refer to SWDIV Section F1000tg – “Exterior Site Related Physical Security Systems Technical Guide”, which identifies

applicable NAVFAC design criteria containing detailed guidance for security fencing, gates, and other security features. For most security applications, the following guidance is applicable:

a. Use chain-link fencing. NAVFAC guide specification NFGS-02831 and federal specification RR-F-191 are the primary criteria documents for security fencing components. Specify the steel materials options; do not specify the aluminum fabric, posts, or accessories options for security applications.

b. Provide a fence with a total height of 2440 mm (8 feet); 2135 mm (7-foot)-high fence fabric plus 305 mm (1 ft) vertically for 3-strands of barbed wire on 45-degree outrigger. Specify 9 gauge steel fabric with openings not greater than 51 mm (2 in) and with twisted and barbed selvages at both top and bottom.

c. Use of top rails is prohibited. Show and specify use of top tension wire instead.

d. Keep the number of gates and perimeter entrances to the minimum required for safe and efficient operation.

e. Generally, grounding is not required for chain link fences mounted on metal posts. However, fences shall be grounded on each side of every gate and at other locations when the fencing is near and parallel to high tension power lines; at intervals of 300 m to 450 m (1000 to 1500 feet) when the fencing runs through isolated areas and at lesser distances depending on proximity of the fencing to public roads, highways, and buildings; when the fencing is around or within any explosives storage (magazine), production, operating, or handling areas. Refer to SWDIV Section F1000tg – “Exterior Site Related Physical Security Systems Technical Guide”, which identifies applicable NAVFAC Design Criteria containing more detailed guidance (MIL-HDBK-1013/10, paragraph 2.3.9).

f. Unless otherwise directed, locate the security fence at least 9.1 m (30 ft) from structures. Provide an outside security clear zone not less than 6.1 m (20 ft) wide immediately outside the fence. Keep this area devoid of buildings, parking areas, poles, guy line anchors, shrubs, trees, sign boards, and any other object that could conceal personnel or hinder observation. Provide a similar interior security clear zone at least 9.1 m (30 ft) wide immediately inside the fence. Unless specifically authorized, including concurrence of the Installation/Base Security Officer (Navy)/Provost Marshal (Marine Corps), ensure this inside clear zone meets the requirements of the exterior clear zone, except for the installation of protective lighting poles/masts and other features which do not hinder observation.

g. Where existing security fencing is being removed and installation of new security fencing must be delayed due to other site preparation work, security shall be maintained by phasing or sequencing of the work.

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SECTION 3

GRADING AND STORM DRAINAGE

1. DESIGN CRITERIA: Grading, drainage design and associated construction (storm water management) shall meet the requirements of the applicable regulatory agency that governs storm water management and/or the State's Department of Transportation where the project is located.

2. FACILITY DEGREE OF PROTECTION: The degree of protection for a facility against flooding is expressed in terms of years (storm frequency). Of utmost importance is prevention of flooding of buildings. A building's minimum finished floor elevation shall be established based on local flood plain elevation data and the degree of protection (in years) required for a particular building. For contributing watersheds less than 40 ha (100 acres), which will be typical for the majority of facilities, the following storm frequencies (in years) shall be utilized to establish elevation requirements:

a. Industrial, administrative and housing facilities - 50 year storm.

b. Hazardous, chemical, communication, hospitals and defense operational facilities - 100 year storm.

c. Recreational facilities - 25 year storm.

For facilities with contributing watersheds greater than 40 ha (100 acres), refer to military handbook 1005/3 "Drainage Systems", for degrees of protection. The degree of protection (in years) for the drainage systems, roads, and parking areas shall be in accordance with local permitting or regulatory requirements.

3. STORMWATER MANAGEMENT

3.1 GENERAL INFORMATION: This document only refers to surface storm drainage, underground closed conduit gravity drainage systems and storage facilities. Pressure systems will only be used where minimum velocity requirements cannot be maintained and grades simply will not allow the use of a gravity system. Pressure systems are covered in other criteria and should be addressed on an individual basis.

3.2 DESIGN REQUIREMENTS: To the maximum extent possible, the following objectives and principles should be applied in the design of a storm water management system:

a. The volume, rate, timing and pollutant load of storm water after development should closely approximate the conditions that existed before development such that existing system capacity requirements do not increase.

b. The storm water management system should mimic (and use) the features and functions of the natural drainage system and follow the contour of the existing topography.

c. Utilize surface drainage or "sheet flow" in lieu of closed conduit systems if land uses permit.

d. Maximize on-site storage of storm water.

e. The design should ensure that adequate erosion and control practices are applied during both the construction and operational phase of the facility.

f. The storm water management plan should comply with local regulatory requirements and EPA requirements with respect to the NPDES Construction Notice of Intent permit.

3.3 SURFACE STORM DRAINAGE

3.3.1 GRADING REQUIREMENTS: Grade the site to provide positive drainage away from the building. For the first 3050 mm (10 ft), provide a minimum slope of 5 percent and, where possible, 10 percent. Establish finished floor elevations at least 152 mm (6 in) above finished grade at perimeter of building. Provide a ramp or walk to meet the finished floor at the building entrance. Ensure that the drainage system does not adversely affect surrounding sites. Discharge areas, drainage ditches and swales shall be protected to prevent erosion by appropriate means such as sod, rip rap, paved surface, etc. Minimum grades shall be as follows:

a. 0.5 percent for concrete paved surfaces and 1.0 percent for asphalt surfaces.

b. 0.5 percent for unpaved surfaces.

c. 1.0 percent for paved ditches.

d. 2.0 percent for unpaved ditches.

3.4 UNDERGROUND STORM DRAINAGE

3.4.1 SYSTEM DESIGN: The following design criteria shall be utilized in the design of an underground storm drainage gravity system:

a. OVERLAND FLOW: Overland flow values and associated design parameters such as rainfall data, storm frequency, storm water quality standards and hydrograph computation methods can vary significantly and shall be computed in accordance with local regulatory requirements. If there are no regulatory requirements where the project is located, utilize the design methodologies given in Military Handbook 1005/2, "Hydrology".

b. MINIMUM PIPE SIZE: Storm drainage pipe (not including roof drainage) shall have a minimum inside diameter of 305 mm (12 in) except as indicated in paragraph 3.13.2 for underground drainage crossings below security fencing.

c. COVER REQUIREMENTS: The system should initially be evaluated based on a cover requirement of 610 mm (2 ft.) for typical traffic loadings. When 610 mm (2 ft.) of cover is unobtainable, pipe material selection and bedding requirements should be evaluated to ensure the load carrying capacity of the pipe is not exceeded (see paragraph 3.7.1 for additional information).

d. SLOPE, VELOCITY AND FLOW REQUIREMENTS: Design pipe slopes to provide a minimum flow velocity of 0.75 m/s (2.5 ft/sec) using the Manning equation (with an "n" value of 0.013 for smooth wall pipes) with the pipe flowing full and under no surcharge at peak flow conditions. A minimum flow velocity of 0.60 m/s (2.0 ft/sec) will be acceptable only if appreciable cost benefits can be realized. Maximum flow velocity shall be 4.5 m/s (15 ft/sec).

e. OUTLET REQUIREMENTS: The design of culverts and storm drains shall take into consideration tail water and the effect it has on the capacity of the pipe. Discharge areas shall be protected to prevent erosion.

f. HYDRAULIC CONSIDERATIONS: Where storm drains enter and leave drainage structures such as manholes or catch basins, the inlet pipe crown elevation should be equal to or greater than the outlet pipe crown elevation to minimize hydraulic turbulence at the junction. Also, the slope of the flow channel in the manhole or catch basin shall be approximately equal to the slope of the inlet pipes. Regardless of hydraulic considerations, do not decrease the pipe size in the direction of flow.

3.5 ROOF DRAINAGE: Most roof drainage will be discharged vertically at locations along the perimeter of the building into the underground drainage systems. Wherever possible, locate roof drain connections at manholes or other access structures. Otherwise, connect roof drains with appropriate fittings to the receiving pipe.

3.6 SYSTEM LAYOUT: The system should be laid out to minimize piping runs. Normally, provide straight alignments for piping between storm drainage structures with deflection at structures no greater than 95 degrees for main line flow and 120 degrees for contributory flow lines. Use of curvilinear piping is not allowed. The following additional guidance should be applied to system layout:

a. Junctions (primarily manholes) should be located out of paved areas if possible.

b. Storm drainage piping should never go under buildings and should be a parallel distance of at least 3050 m (10 ft) from building foundations.

c. Conflicts at sanitary sewer and water crossings should be avoided. Conflict boxes will not be allowed unless absolutely necessary.

d. Storm drainage piping shall be laid in its own trench.

e. Catch basins, drop inlets and manholes should be located as required to collect surface runoff and convey it off the site. Provide a structure at pipe junctions and where there is a change in the horizontal or vertical alignment of a pipe run. For cleaning purposes, provide a manhole or catch basin at least every 120 m (400 ft) for pipes 1220 m (48 in) in diameter and smaller and at least 240 m (800 ft.) for pipes larger than 1220 m (48 in) in diameter.

3.7 MATERIAL SELECTION

3.7.1 STORM DRAINAGE PIPE: For most typical installations, storm drainage pipe (not including roof drainage) shall be reinforced concrete pipe conforming to ASTM C 76, Class III; or PVC, SDR 35 unless loading conditions and soil conditions warrant a different Class or strength of pipe. Where cover requirements cannot be met, consider reinforced concrete arch shaped pipe or reinforced concrete elliptical pipe conforming to ASTM C 506 and ASTM C 507, respectively. Also, consider different bedding materials to enhance the load carrying capacity of the pipe. Refer to the Concrete Pipe Design Manual (latest edition) of the American Concrete Pipe Association for guidance and design procedures by which the applicable Class or strength of pipe can be determined. Construction vehicular traffic loadings should be considered in the selection of pipe Class/strength. The minimum cover of pipes shall be 305 mm (12 in) regardless of class or strength of pipe selected. Measure the cover from the top of the pipe to the bottom of rigid pavement and to the top of flexible pavement or finished grade. Use of other pipe materials will be considered provided it is appropriate for intended use the civil engineer submits load calculations.

3.7.1.1 CORRUGATED ALUMINUM OR STEEL PIPING: Use of corrugated aluminum or steel piping shall be considered in areas subject to high settlement of soils. The inside of the corrugated pipe should be lined for improved hydraulic performance. Both the aluminum and steel pipe should have an appropriate coating (i.e. bituminous, zinc, polymer, etc.) based on the corrosiveness of the soil and drainage the pipe will be exposed to (i.e. highly acidic or highly alkaline soils, tidal drainage, etc.).

3.7.2 ROOF DRAINAGE: Provide PVC pipe ASTM D3034, SDR 35 to convey the roof drainage from downspouts to a manhole or catch basin in the drainage system. Provide ductile iron pipe (ASTM A746) for pipes that cross traffic pavements if there is less than 610 mm (2 ft.) of cover.

3.8 PIPES WITH FREE OUTLETS: Culverts and underground storm drainage pipes shall have either concrete headwalls, end walls, wing walls, flared or mitered end sections at free outlets.

3.9 SAFETY: In residential housing areas where the ends of storm drains are not otherwise protected, i.e., by a fence or physical land feature, provide hinged grates at both ends of culverts 24 inches in diameter and larger.

3.10 CATCH BASINS, MANHOLES AND DROP INLETS: Ensure that catch basins, manholes and drop inlets are of adequate size to accommodate inlet and outlet pipes and receive overland flow design values. Where a connection is made to an existing structure, the flow channel shall be reworked as necessary and the connection shall be grouted to be watertight.

3.11 CATCH BASIN GRATES: Design catch basin grating to withstand traffic loading requirements and be of "bicycle proof" design. Reference the appropriate federal specification or manufacturer to identify the desired grating to be used.

3.12 STORMWATER STORAGE FACILITIES: Storm water storage facilities will typically consist of detention or retention facilities or swales. A detention facility temporarily stores a given volume of storm water runoff and provides for treatment generally through physical or biological processes with subsequent gradual release of storm water into surface waters of the state. A retention facility permanently stores a given volume of storm water by complete on-site storage with no discharge into surface waters of the state; discharge in a

retention facility is accomplished only through evaporation or infiltration. The requirement for storm water storage facilities will be based on local regulatory requirements, where applicable. Where no storm water management regulations exist, the drainage designer shall consider the following:

a. IMPACT OF STORMWATER RUNOFF: Consider the impacts of changes in storm water volume, peak flow rates, and quality in the receiving stream associated with project.

b. MITIGATION OF ADVERSE IMPACT: If it is determined that the project will increase the likelihood or extent of minor flooding, accelerate erosion, or degrade the water quality of the receiving stream, the designer shall employ a management plan which utilizes storm water storage facilities to mitigate adverse impacts.

3.13 SECURITY REQUIREMENTS FOR DRAINAGE SYSTEMS

3.13.1 SURFACE DRAINAGE BELOW SECURITY FENCING: Provide security barriers at all locations where security fences must cross drainage ditches or swales to assure that intruders are prevented from passing under the fence without a delay. Depending upon the configuration of the drainage channel (width, depth, side slopes) and flow conditions within the channel, there are several alternative design solutions that may be selected to suit a particular situation. They range from a relatively simple additional segment of fencing to extend from the bottom portion of the main fencing section to the grade at the channel bottom with fastening and anchorage enhancements to the more complex, such as a steel bar grill work or change to an underground system of structures with multiple 255 mm (10 in) diameter piping. Refer to SWDIV Section F1000tg – “Exterior Site Related Physical Security Systems Technical Guide”, which identifies applicable NAVFAC Design Criteria containing more detailed guidance.

3.13.2 UNDERGROUND DRAINAGE CROSSINGS BELOW SECURITY FENCING: Pipes crossing under security fences which have a cross-sectional area of 620 cm^2 (96 in^2) or greater, with the smallest dimension being more than 150 mm (6 in), or which are larger than 255 mm (10 in) in diameter, require protective measures. These measures require the provision of either multiple pipes of 255 mm (10 in) diameter (maximum) when passing under security barriers and/or other security enhancements at unprotected drainage structures within the system to deny or delay an intruder attempting to circumvent the fence. Depending upon the configuration of the underground system and type and location of unsecured drainage structures that may be accessible to an intruder, there are several alternative design solutions that may be selected to suit a particular situation. They range from relatively simple, such as using lockable manhole covers and grates inside a secured area, to the more complex, such as a steel bar grill work on open pipe ends or system of structures with multiple 255 mm (10 in) diameter piping. Refer to SWDIV Section F1000tg – “Exterior Site Related Physical Security Systems Technical Guide”, which identifies applicable NAVFAC Design Criteria containing more detailed guidance.

END OF SECTION