APPENDIX F. GEOTECHNICAL CONSIDERATIONS

Infiltrating stormwater into soils has the potential to cause adverse geotechnical conditions under certain circumstances if integrated management practices (IMPs) are not properly sited, designed, or maintained. All geotechnical testing, considerations, and designs should be performed only by a licensed, professional geotechnical engineer. The following sections further detail specifics regarding geotechnical testing, reporting, and design for IMPs.

F.1 GEOTECHNICAL CONCERNS

Specific geotechnical issues that need to be assessed when planning for infiltration IMPs include the following:

- **Depth to groundwater:** The ability to infiltrate stormwater is limited in areas with a high groundwater table. A 10-foot separation distance is required from the bottom of the infiltration facility to the seasonal high groundwater level.

- **Soil type:** Native soils that are hydrologic soil group (HSG) A or B are suitable for infiltration without amendments. The Standard Urban Stormwater Mitigation Plan, or County SUSMP (County of San Diego 2012), requires testing of in situ soils by a licensed geotechnical engineer to ensure that infiltration rates are adequate when developers propose infiltration to native soils. If infiltration rates are lower than expected, native soils can be amended to ensure adequate stormwater retention. Other concerns with regard to infiltration of stormwater to soils are the potential for liquefaction during earthquakes, expansion of clay soils, or compression of fill or alluvium. All of these conditions can cause damage to structures and pavements. Developers can refer to local geologic hazard maps or undertake a site-specific investigation of underlying soils to identify the presence of soil types prone to liquefaction or expansion.

- **Steep slopes:** Stormwater infiltration is not recommended on hillsides (slopes of 20 percent or more) because of the risk of downhill seepage that creates surficial slope instability (increased potential of erosion, slumps, or slides). These risks can be mitigated by installing lined facilities that safely direct stormwater to less sensitive areas.

- **Proximity to structures:** Stormwater should not be infiltrated in areas adjacent to improvements that could be damaged by the presence of groundwater. Infiltration facilities should be set back 10–25 feet from building foundations, basements, footings, and retaining walls to prevent the zone of saturation from undermining structures. Including underdrains or liners in the design of an IMP will limit the zone of saturation and help to mitigate risk of damage to structures.

- **Proximity to wells:** Infiltration is not appropriate within 100 feet of water supply wells.

Infiltrating practices might also be restricted in stormwater hotspots such as industrial and high-traffic areas. Infiltration is not permitted if:

- Soil contamination is expected or is present.

- Runoff could unintentionally be received from a stormwater hotspot (as determined in the SUSMP).

- The groundwater table is within 10 feet of the proposed subgrade.
- The site is within 100 feet of a water supply well or septic drain field.
- The site is within 10 feet of a structure or foundation.
- Infiltrated water could interfere with utilities.
- Underlying geology presents risks for sinkholes or liquefaction.
- The project geotechnical engineer does not allow the infiltration.
- Permeability rates are not sufficient.
- The site is within 50 feet of a steep, sensitive slope (as determined in the geotechnical analysis—see Common Design Elements in Appendix A).

More detailed restrictions are listed in the SUSMP (County of San Diego 2012). When infiltration is not feasible, most infiltration IMPs can be designed as filtration IMPs by using an impermeable liner. (See Appendix A.11.6 for details on impermeable liners.)

Infiltration IMPs are best installed at the end of construction, after the site is fully stabilized. If possible, flows should be bypassed until the site is stabilized, as construction-related runoff might contain a high proportion of fine sediment that can clog the basin floor.

F.2 Geotechnical Investigation

Investigations of subsurface conditions are important to identify geologic and geotechnical features and characteristics of a site. Geotechnical investigations include a desktop analysis and a field survey to fully characterize the structural and hydrologic characteristics of a site.

F.2.1 Desktop Analysis

Desktop analyses can be done to generate a conceptual site plan but should always be verified with a field investigation. Desktop analyses can help determine the following characteristics (SEMCOG 2008):

- Mapped soils and HSG classifications
- Geologic conditions such as depth to bedrock and other notable features
- Waterbodies (streams, wetlands, lakes, etc.), floodplains, and hydric or alluvial soils
- Topography and drainage patterns, watershed boundaries, and proximity to steep slopes
- Existing land use
- Proximity to structural foundations, roadway subgrades, utilities, and other infrastructure
- Proximity to water supply wells
- Proximity to septic drain fields

- Past use of the site
- Concept plan for the proposed development

F.2.2 Soil Excavations

The desktop evaluation should be followed by a field investigation performed by a licensed soil scientist or geotechnical engineer that involves exploratory excavations to evaluate soil characteristics. Borings also can be used for soil investigations, although they provide a more limited view of soil horizons and subsurface conditions. The following observations should be collected during soil excavations:

- Soil horizons (upper and lower boundary)
- Soil texture, structure, and color for each horizon
- Color patterns (mottling) and observed depth.
- Structural capacity of soils
- Presence of expansive soil
- Presence of compacted or restrictive layers
- Depth to groundwater table
- Depth to bedrock
- Observance of pores or roots (size, depth)
- Estimated type and percent coarse fragments
- Hardpan or limiting layers
- Strike and dip of horizons (especially lateral direction of flow at limiting layers)
- Proximity to steep slopes
- Proximity to structural foundations, roadway subgrades, utilities, and other infrastructure where known (The project civil engineer needs to coordinate utility placement with the geotechnical engineer.)
- Proximity to water supply wells
- Proximity to septic drain fields
- Additional comments or observations

All testing should be performed at the depth of the proposed subgrade and 3 feet below the proposed subgrade. The number of excavations depends on the site characteristics and proposed development plan, generally as follows (SEMCOG 2008):

- One exploratory investigation per lot, within 100 feet of the proposed IMP, for single-family residential subdivisions with on-lot infiltration
- One exploratory investigation per IMP or acre for multi-family and high-density residential developments
- Four to six exploratory investigation evenly distributed per acre of IMP area for large infiltration areas (basins, commercial, institutional, industrial, and other proposed land uses)

F.2.3 Soil Infiltration Testing

Soil infiltration testing can determine whether infiltration facilities are suitable at the development site. Soil infiltration tests should be conducted in the field during dry weather at least 24 hours after significant rainfall (SEMCOG 2008). At least one infiltration test should be conducted at the proposed bottom elevation of the infiltration facility. A number of methods are available to determine soil infiltration rate, including the double-ring infiltrometer, in situ permeameters, and perc tests. The double-ring infiltrometer test is a common method used, and its procedure is specified in the American Society for Testing and Materials (ASTM) D 3385, *Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer* (ASTM 2009). Once infiltration rates have been determined, IMP designers can use the information to locate the best sites for infiltration IMPs, size them appropriately, and modify them as necessary with engineered soils or underdrains. See section 3.2.1 and Appendix A for further discussion of infiltration IMP design.

F.3 Geotechnical Reports

A qualified engineer practicing geotechnical services must review the proposed IMPs whenever adverse geotechnical conditions exist. Adverse geotechnical conditions should be addressed, and where appropriate, mitigation recommendations should be provided in a site-specific geotechnical report. The impact on existing, proposed, and future improvements including buildings, roads, and manufactured slopes, must be included in the report.

A site-specific preliminary geotechnical report should include the following information, supported by illustrations, geophysical data, field excavation and testing results, modeling and analysis, and references (City of San Diego 2011):

- **Descriptive site information** that describes the purpose and scope of the investigation; a description of site location, access, physiography, vegetation, man-made features, and slope heights and gradients (including an index map); a description of the proposed project or development; and any previous studies relevant to the investigation.
- **Geologic/geotechnical site conditions**, including geologic hazard categories identified on local geologic hazard maps.
- **Geologic/geotechnical analyses** specific to the site and nature of the project. For stormwater IMPs, discussions should focus on the impact of surface and subsurface stormwater flow on slopes, soils, and structures.
- **Conclusions** regarding whether the site is suitable for the intended use, and **recommendations** to mitigate or avoid geologic or environmental hazards associated with stormwater management or

other aspects of the project. Recommendations for further field testing or studies should be included.

- **Authentication** of results, analyses, and conclusions by a qualified engineer practicing geotechnical services.

All infiltration IMPs proposed for a specific project shall be reviewed and approved for use in the project by the project's geotechnical engineer, civil engineer, or other qualified licensed professional to avoid the potential for slope failure, water seepage, or migration under structures or onto neighboring properties, conflicts with underground utilities, or other potential conflicts with engineering and design objectives. Project plans must be designed in accordance with local zoning regulations, ordinances, and community plans and should meet the criteria listed in the SUSMP (County of San Diego 2012).

F.4 References

ASTM (American Society for Testing and Materials). 2009. *Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer*. ASTM D 3385. American Society for Testing and Materials, West Conshohocken, PA

City of San Diego. 2011. *Guidelines for Geotechnical Reports*. Accessed June 5, 2013. http://www.sandiego.gov/development-services/pdf/industry/geoguidelines.pdf.

County of San Diego. 2012. *County of San Diego SUSMP: Standard Urban Stormwater Mitigation Plan Requirements for Development Applications.* http://www.sdcounty.ca.gov/dpw/watersheds/susmp/susmppdf/susmp_manual_2012.pdf.

SEMCOG (Southeast Michigan Council of Governments). 2008. *Low Impact Development Manual for Michigan: A Design Guide for Implementers and Reviewers*. Accessed June 5, 2013. http://library.semcog.org/InmagicGenie/DocumentFolder/LIDManualWeb.pdf.