Policies:

S 3.1 Require the following in landslide potential hazard management zones, or when deemed necessary by the California Environmental Quality Act: (AI 104)

a. Preliminary geotechnical and geologic investigations.

b. Evaluations of site stability, including any possible impact on adjacent properties, before final project design is approved.

c. Consultant reports, investigations, and design recommendations required for grading permits, building permits, and subdivision applications be prepared by State-licensed professionals.

S 3.2 Require that stabilized landslides be provided with redundant drainage systems. Provisions for the maintenance of subdrains must be designed into the system.

S 3.3 Before issuance of building permits, require certification regarding the stability of the site against adverse effects of rain, earthquakes, and subsidence.

S 3.4 Require adequate mitigation of potential impacts from erosion, slope instability, or other hazardous slope conditions, or from loss of aesthetic resources for development occurring on slope and hillside areas.

S 3.5 During permit review, identify and encourage mitigation of onsite and offsite slope instability, debris flow, and erosion hazards on lots undergoing substantial improvements.

S 3.6 Require grading plans, environmental assessments, engineering and geologic technical reports, irrigation and landscaping plans, including ecological restoration and revegetation plans, as appropriate, in order to assure the adequate demonstration of a project's ability to mitigate the potential impacts of slope and erosion hazards and loss of native vegetation.

S 3.7 Support mitigation on existing public and private property that sits on unstable hillside areas, especially slopes with recurring failures where County property or public right-of-way is threatened from slope instability, or where considered appropriate and urgent by the County Engineer, Fire, or Sheriff Department. (AI 100)

Subsidence and Expansive & Collapsible Soils

Subsidence refers to the sudden sinking or gradual downward settling and compaction of soil and other surface material with little or no horizontal motion. It may be caused by a variety of human and natural activities, including earthquakes.

Figure S-7 identifies areas susceptible to subsidence hazards based on geologic and hydrogeologic characteristics that are similar to regions of the County in which subsidence is documented.

Land subsidence and fissuring have been well-documented in Riverside County. Most of the early documented cases of subsidence affected only agricultural land or open space. As urban areas have expanded, so too have the impacts of subsidence on structures for human occupancy. Ground subsidence and associated fissuring in Riverside County have resulted from both falling and rising ground water tables. In addition, many fissures have occurred along active faults that bound the San Jacinto Valley and the Elsinore Trough.

Subsidence typically occurs throughout a susceptible valley. In addition, differential displacement and fissures occur at or near the valley margin, and along faults. In the County of Riverside, the worst damage to structures as a result of regional subsidence may be expected at the valley margins. Alluvial valley regions are especially susceptible.

Expansive soils have a significant amount of clay particles which can give up water (shrink) or take on water (swell). The change in volume exerts stress on buildings and other loads placed on these soils. The occurrence of these soils is often associated with geologic units having marginal stability. Expansive soils can be widely dispersed and can be found in hillside areas as well as low-lying alluvial basins.

Expansion testing and mitigation are required by current grading and building codes. Special engineering designs are used effectively to alleviate problems caused by expansive soils. These designs include the use of reinforcing steel in foundations, drainage control devices, over-excavation and backfilling with non-expansive soil. For new development, future problems with expansive soils can be largely prevented through proper site investigation, soils testing, foundation design, and quality assurance during grading operations as required by the County Building Code. Active enforcement, peer review, and homeowner involvement are required to maintain these standards. Homeowners are important because moisture control and modified drainage can minimize the effects of expansive soils. Homeowners should be educated about the importance of maintaining a constant level of moisture below their foundation. Excessive swelling and shrinkage cycles can result in distress to improvements and structures.

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A well-documented case of property damage due to collapsible soils occurred in the Murrieta area (Shlemon and Hakakian, 1992). There, alluvium was left in place during rough grading, and later collapsed when ground water levels rose significantly. The ground water rose because of new golf course and residential irrigation.

Although expansive soils are now routinely alleviated through the County Building Code, problems related to past, inadequate codes constantly appear. Expansive soils are not the only cause of structural distress in existing structures. Poor compaction and construction practices, settlement, and landslides can cause similar damage, but require different mediation efforts. Once expansion has been verified as the source of the problem, mitigation can be achieved through reinforcement of the existing foundation, or alternatively, through the excavation and removal of expansive soils in an affected area.

Hydroconsolidation, or *soil collapse*, typically occurs in recently deposited, Holocene (less than 10,000 years old) soils that were deposited in an arid or semi-arid environment. Soils prone to collapse are commonly associated with man-made fill, wind-laid sands and silts, and alluvial fan and mudflow sediments

deposited during flash floods. These soils typically contain minute pores and voids. The soil particles may be partially supported by clay or silt, or chemically cemented with carbonates. When saturated, collapsible soils undergo a rearrangement of their grains, and the water removes the cohesive (or cementing) material. Rapid, substantial settlement results. An increase in surface water infiltration, such as from irrigation, or a rise in the ground-water table, combined with the weight of a building or structure, can initiate settlement and cause foundations and walls to crack.

In the County of Riverside, collapsible soils occur predominantly at the base of the mountains, where Holocene-age alluvial fan and wash sediments have been deposited during rapid runoff events. In addition, some windblown sands may be vulnerable to collapse and hydroconsolidation. Typically, differential settlement of structures occurs when lawns or plantings are heavily irrigated in close proximity to the structure's foundation. Forensic indications of collapsible soils include:

- tilting floors;
- cracking or separation in structures;
- sagging floors; or
- non-functional windows and doors.

Policies:

S 3.8 Require geotechnical studies within documented subsidence zones, as well as zones that may be susceptible to subsidence, as identified in Figure S-7 and the Technical Background Report, prior to the issuance of development permits. Within the documented subsidence zones of the Coachella, San Jacinto, and Elsinore valleys, the studies must address the potential for reactivation of these zones, consider the potential impact on the project, and provide acceptable mitigation measures.

S 3.9 Develop a liaison program with all County water districts to prevent water extraction-induced subsidence (AI 4).

S 3.10 Encourage and support efforts for long-term, permanent monitoring of topographic subsidence in all producing groundwater basins, irrespective of past subsidence.

Wind Erosion

Wind erosion is a serious environmental problem attracting global attention. Soil movement is initiated as a result of wind forces exerted against the surface of the ground. Dust particles in the air create major health problems. Atmospheric dust causes respiratory discomfort, may carry pathogens that cause eye infections and skin disorders, and reduces highway and air traffic visibility. Dust storms can cause additional problems. Buildings, fences, roads, crops, trees and shrubs can all be damaged by abrasive blowing soil.

Wind and wind-blown sand are an environmentally-limiting factor throughout much of Riverside County. Approximately 20 percent of the land area of Riverside County is vulnerable to "high" and "very high" wind erosion susceptibility. The Coachella Valley, the Santa Ana River Channel in