Chapter 11. Geology, Seismicity, Soils, and Mineral Resources

11.1 Overview

This chapter discusses the geologic and seismic setting of the ARC facility, describes the soils on the site, and provides an overview of mineral resources in the vicinity. It also summarizes the regulations applicable to geologic practice (including construction earthwork) at ARC, as well as relevant policies, measures, and best management practices (BMPs) that address potential onsite seismic and geologic hazards. Information in this chapter was obtained from the November 2009 NASA ARC ERD (NASA 2009), NADP EIS (Design, Community & Environment 2002), and other sources.

11.2 Regulatory Background

11.2.1 Federal Regulations

11.2.1.1 National Environmental Policy Act

NEPA requires federal agencies to include in their decision-making process appropriate and careful consideration of all environmental effects of a proposed action and of possible alternative actions. Measures to avoid or minimize the adverse effects of proposed actions and to restore and enhance environmental quality as much as possible must be developed and discussed where feasible.

11.2.2 State Regulations

11.2.2.1 Alquist-Priolo Earthquake Fault Zoning Act

California's Alquist-Priolo Earthquake Fault Zoning Act (Public Resources Code Section 2621 et seq.), originally enacted in 1972 as the Alquist-Priolo Special Studies Zones Act and renamed in 1994, is intended to reduce the risk to life and property from surface fault rupture during earthquakes. The Alquist-Priolo Act prohibits the location of most types of structures intended for human occupancy across the traces of active faults and strictly regulates construction in the corridors along active faults (earthquake fault zones). It also defines criteria for identifying active faults, giving legal weight to terms such as *active*, and establishes a process for reviewing building proposals in and adjacent to Earthquake Fault Zones.

Under the Alquist-Priolo Act, faults are zoned, and construction along and across them is strictly regulated if they are "sufficiently active" and "well-defined." A fault is considered *sufficiently active* if one or more of its segments or strands shows evidence of surface displacement during Holocene time (defined for purposes of the act as referring to approximately the past 11,000 years). A fault is considered *well defined* if its trace can be clearly identified by a trained geologist at the ground surface or in the shallow subsurface using standard professional techniques, criteria, and judgment.

11.2.2.2 *Seismic Hazards Mapping Act*

Like the Alquist-Priolo Act, the Seismic Hazards Mapping Act of 1990 (Public Resources Code Sections 2690-2699.6) is intended to reduce damage resulting from earthquakes. While the Alquist-Priolo Act focuses on surface fault rupture, the Seismic Hazards Mapping Act addresses other earthquake-related hazards, including strong groundshaking, liquefaction, and seismically-induced landslides. Its provisions are similar in concept to those of the Alquist-Priolo Act. The state is charged with identifying and mapping areas at risk of strong groundshaking, liquefaction, landslides, and other corollary hazards, and cities and counties are required to regulate development within mapped Seismic Hazard Zones.

Under the Seismic Hazards Mapping Act, permit review is the primary mechanism for local regulation of development. Specifically, cities and counties are prohibited from issuing development permits for sites within Seismic Hazard Zones until appropriate site-specific geologic and/or geotechnical investigations have been carried out and measures to reduce potential damage have been incorporated into the development plans.

11.2.2.3 *Surface Mining and Reclamation Act*

The principal legislation addressing mineral resources in California is the Surface Mining and Reclamation Act of 1975 (SMARA) (Public Resources Code Sections 2710–2719), which was enacted in response to land use conflicts between urban growth and essential mineral production. SMARA provides a comprehensive surface mining and reclamation policy to encourage the production and conservation of mineral resources while ensuring that adverse environmental effects of mining are prevented or minimized, that mined lands are reclaimed and residual hazards to public health and safety are eliminated, and that consideration is given to recreation, watershed, wildlife, aesthetic, and other related values.

SMARA provides for the evaluation of an area's mineral resources using a system of Mineral Resource Zone (MRZ) classifications that reflect the known or inferred presence and significance of a given mineral resource. The MRZ classifications are based on available geologic information (including geologic mapping and other information on surface exposures, drilling records, and mine data) and on socioeconomic factors, such as market conditions and urban development patterns. The MRZ classifications are defined as follows:

- MRZ-1: Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence
- MRZ-2: Areas where adequate information indicates that significant mineral deposits are present, or where it is judged that a high likelihood for their presence exists
- MRZ-3: Areas containing mineral deposits, the significance of which cannot be evaluated from available data
- MRZ-4: Areas where available information is inadequate for assignment into any other MRZ

SMARA governs the use and conservation of a wide variety of mineral resources. However, certain activities and resources are exempt from the provisions of SMARA, including excavation and grading conducted for farming, some types of construction, and recovery from flooding or other natural disaster. Solar extraction of salt and related minerals from sea and bay waters is also exempt from SMARA governance.

11.2.2.4 *California Building Standards Code*

The California Building Standards Code (CBSC) (Title 24, California Code of Regulations [CCR]) embodies the state's minimum standards for structural design and construction. CBSC is based on the widely used Uniform Building Code (International Conference of Building Officials 1997), as modified for California conditions. Key modifications provide additional stringency for mitigation of seismic hazards through appropriate design and construction.

CBSC provides a comprehensive set of standards for all aspects of construction. Chapters in the code with particular relevance to geologic and geotechnical practice include those addressing excavation, grading, and fill placement; foundation investigations and foundation design; and seismic design/seismic hazard mitigation.

11.2.3 **Local Regulations**

11.2.3.1 *Santa Clara County Mineral Resources Policies*

The current Santa Clara County General Plan (County of Santa Clara 1994) contains a number of policies that recognize the importance of the county's mineral resources and establish a planning framework to ensure that they remain available in the future. Several of the policies are countywide, as summarized below.

- Countywide Resource Conservation Policy C-RC 44: Recognizes the need to ensure continued availability of mineral resources to meet long-term demand
- Countywide Resource Conservation Policy C-RC 45b: Recognizes the need to preserve economically important mineral deposits (particularly construction aggregate) and access routes, with the aim of maintaining and supplying current and future demand
- Countywide Resource Conservation Policy C-RC-46: Establishes the goal of protecting regionally significant mineral resource sites and access routes from incompatible land uses and development that would preclude or unnecessarily limit resource availability

Additional policies apply to the county's unincorporated rural areas, as follows.

- Rural Unincorporated Area Resource Conservation Policy R-RC 67: Establishes the goal of ensuring that local mineral resources are recognized for their importance to the local, regional, and state economies

- Rural Unincorporated Area Resource Conservation Policy R-RC 70: Identifies the need to consider the importance of mineral resources to their market region as a whole when making land use decisions involving mineral resource areas of state or regional significance
- Rural Unincorporated Area Resource Conservation Policy R-RC 71: Recognizes the need to identify additional mineral resource areas besides those that are currently designated by the State of California in order to augment diminishing supplies available from existing quarries

11.3 Regional Setting

11.3.1 Topography

The ARC site is located on nearly flat topography at the north end of the Santa Clara Valley, a gently sloping, northwest-trending depression bounded by the Santa Cruz Mountains to the west and south, and the Diablo Range to the east. About 15 miles wide at its northern end along the margin of San Francisco Bay, the valley narrows to a width of slightly more than 2 miles at its southern end. It is part of a regionally extensive topographic depression that includes San Francisco Bay, as well as the Petaluma, Sonoma, and Napa valleys to the north. Topography in the Santa Clara Valley, as in the rest of the Bay Area, is largely controlled by strands of the San Andreas Fault system.

Current elevations on the valley floor range from mean sea level (MSL) along the margin of San Francisco Bay to about 200 feet above sea level in the south near the intersection of State Route 82 and U.S. Highway 101 (US-101). Between 1932 and 1968, a large portion of the Santa Clara Valley experienced marked subsidence because of groundwater overdraft; subsidence rates in some areas approached 0.30 meter (1 foot) per year. In response, the SCVWD established a program in the late 1960s to create numerous surface reservoirs that would promote artificial recharge of aquifers. Combined with increased reliance on imported sources of supply and control of groundwater pumping rates, this program has been successful in raising the water table, and subsidence is no longer considered a serious problem.

11.3.2 Geology

Bedrock exposed in the Santa Cruz Mountains to the west of the Santa Clara Valley includes Mesozoic Franciscan Complex sandstone and marine sedimentary rocks of Miocene age. To the east, the core of the Diablo Range uplift is also composed of Franciscan Complex rocks (sandstone, chert, and ultramafic rocks) overlain by and faulted against Miocene marine and terrestrial sedimentary rocks. Low hills situated where the Santa Clara Valley narrows along US-101 consist of Franciscan chert, ultramafic rocks, and sandstone. Both the Santa Cruz Mountains and Diablo Range are flanked by extensive aprons of Quaternary alluvial fan deposits recording uplift and erosional dissection of the ranges.

The Santa Clara Valley formed as a down-dropped block between two major faults: the San Andreas Fault to the west and the Hayward Fault to the east. Sediments filling the valley depression include alluvial fan and fluvial deposits that interfinger to the north (toward

San Francisco Bay) with estuarine "bay mud" deposits. Surface geologic maps show alluvial fan deposits extending northeast approximately to US-101. North of US-101, finer-grained floodplain deposits predominate, with the Bay itself fringed by mud. To the south, the transition from finer-grained interfluvial deposits to coarser alluvial fan sediments is approximately coincident with a steepening of the present topographic slope near US-101.

The upper 75 meters (250 feet) of the valley fill comprises four separate stratigraphic units of Quaternary (Pleistocene and Holocene) age. They include "bay muds" (clay and silty clay units deposited in an estuarine setting in San Francisco Bay) and fluvial and alluvial units. Pleistocene units are typically partially consolidated, and Holocene units are unconsolidated. A marked unconformity separates the Upper Pleistocene units of the Santa Clara Valley from overlying Holocene strata. Complex interfingering relationships between estuarine bay muds and alluvial/fluvial facies likely record sea level fluctuations.

Bay muds are divided into older and younger subunits. Their "older bay mud" is as much as 45 meters (150 feet) thick and is further subdivided into lower and upper informal units. The lower unit consists of light gray silty clay and the upper unit is dominated by sand and gravel, but contains interbeds of clay, silty clay, and clayey sand. The older bay mud was primarily deposited in fluvial and alluvial fan settings. The "younger bay mud" ranges from 5 meters (15 feet) to 15 meters (50 feet) thick. It consists primarily of dark gray to dark brown organic clay containing minor peat and clayey sand and is interpreted as estuarine and marine deposits. Local sand lenses may represent stream deposits. Holocene alluvium consists of interbedded sand and gravel with lesser silt and clay. These strata are interpreted as recording fluvial and alluvial deposition.

11.3.3 **Seismicity**

The Santa Clara Valley is located in one of the most seismically active regions of the United States. Seismic activity in the area has occurred mostly along the San Andreas Fault, including the great San Francisco earthquake of 1906 and the Loma Prieta earthquake of 1989. At least 10 other earthquakes with magnitudes greater than 6.0 on the Richter scale have occurred in the Bay Area in the past 100 years. The maximum credible earthquake or design basis for the San Andreas Fault is magnitude 8.3. For the Hayward and Calaveras faults, the maximum credible earthquake is magnitude 7.5. There have been important quakes on other faults, notably the Hayward.

11.4 Existing Site Conditions

11.4.1 **Topography**

ARC is located approximately 1 mile south of the San Francisco Bay margin in an area that historically supported tidal salt marsh and mud flats. The former salt ponds are now part of the USFWS SBSPRP. Consistent with the historic loss of these habitats Bay-wide, the large area north and northeast of ARC is now diked and consists of evaporation ponds that were formerly used for commercial salt production. The northernmost portion of the ARC site is located within the 100-year tidal floodplain.

Topography at the ARC site is nearly flat. From north to south, the site rises at a slope generally less than 1%, ranging in elevation from approximately 0.6 meter (2 feet) below MSL near its northern boundary to approximately 10 meters (33 feet) above MSL in the south. Elevation change from east to west is minimal. The principal topographic features on the site are low levees constructed to protect roads and structures from Bay waters during high storm tides.

Between 1932 and 1969, the area that is now the ARC site experienced 1.5 to 2 meters (4.9 to 6 feet) of subsidence because of groundwater overdraft. As described in Regional Setting above, efforts to arrest subsidence through artificial groundwater recharge and improved stewardship have largely been successful. Fluctuation in groundwater levels during wet or dry years, which might previously have threatened buildings, is now unlikely to cause any structural damage. However, structures such as long utility lines and stormwater channels that are more sensitive to local subsidence are designed to minimize any problems.

11.4.2 Geology

Bedrock underlying the ARC site is believed to belong to the Franciscan Formation of late Jurassic age. Bedrock at the site is overlain by 460 meters (1,495 feet) or more of alluvium and bay muds of Pleistocene and Holocene age.

11.4.3 Seismicity

No faults recognized as active by the State of California or the current CBSC traverse the ARC site, and the ARC site is not within any Earthquake Fault Zone identified by the state pursuant to the Alquist-Priolo Earthquake Fault Zoning Act. Consequently, surface rupture is considered unlikely to affect the site. Nonetheless, because of its location, the site could experience strong groundshaking generated by earthquakes on any of several faults in the region (San Andreas, Hayward, and Calaveras).

11.4.4 Soils

Surface soils along the San Francisco Bay margin typically consist of silt and clay. The ARC site is located on soils assigned to Sunnyvale silty clay, Alviso clay, Bayshore clay loam, and Pacheco loam classification. However, soils at ARC have been substantially altered by land uses during the past 100 years. The majority of the site's upland areas and portions of its wetlands now support artificial fill and/or impervious cover overlying native soils. Native soil is typically exposed only in the diked brackish marshes and open grasslands on the northwest portion of the site, and even in these areas some alterations related to land use have occurred. For instance, diking and draining have altered the surface and shallow groundwater hydrology of the sites and eliminated the natural tidal influence on soils. Nonetheless, as discussed in detail in Chapter 12, *Vegetation and Wetlands*, the soils remain saline and this salinity maintains salt marsh vegetation in areas that are now removed from tidal influence.

The following sections provide additional detail on Sunnyvale silty clay, Alviso clay, Bayshore clay loam, Pacheco loam, and artificial fill materials, as well as kitchen midden deposits that may be present in some areas.

11.4.4.1 *Sunnyvale Silty Clay, Drained*

About 70% of the ARC site is situated on Sunnyvale silty clay, drained, including the developed southern and central portions of the site. Sunnyvale silty clay typically forms in low-level positions on alluvial plains. The surface soil consists of 28 to 45 centimeters (11 to 18 inches) of moderately alkaline dark gray calcareous silty clay. The subsoil consists of 65 to 80 centimeters (26 to 32 inches) of light gray and gray strongly calcareous silty clay. The substratum is mottled light gray slightly calcareous silty clay alluvium. Sunnyvale silty clay is not included in the National Hydric Soil Series List; however, it exhibits hydric characteristics at ARC.

Sunnyvale silty clay has a water storage capacity of 23 to 25 centimeters (9 to 10 inches). Runoff rates are very slow and erosion is negligible. Permeability of the subsoil is slow, and ponding may occur in winter months.

Sunnyvale silty clay is highly expansive. The inherent fertility of this soil is high. However, the choice of plants is limited because the soil drains poorly and the soil textures are fine or very fine.

11.4.4.2 *Alviso Clay*

The north portion of the Eastside/Airfield area, which represents about 25% of the ARC site, is situated on Alviso clay. Alviso clay typically forms on tidal flats and may be subject to flooding at high tides, where it is not protected by levees. The surface soil consists of 15 to 25 centimeters (6 to 10 inches) of neutral to moderately alkaline dark gray clay. A layer of organic material is locally present in the upper few centimeters of the surface soil. The subsoil consists of 75 to 100 centimeters (30 to 40 inches) of moderately alkaline gray silty clay. The substratum is gray silty clay overlying layered basin sediments. Alviso clay is included on the National Hydric Soil Series List.

Alviso clay is very poorly drained and has a water storage capacity of 10 to 20 centimeters (4 to 8 inches). Runoff rates are very slow and erosion is negligible. The subsoil is slowly permeable, so ponding may occur. The water table is typically 0.3 to 1 meter (1 to 3 feet) below the ground surface.

Alviso clay is highly expansive. The inherent fertility of this soil is very low. The choice of plants is further limited by soil moisture, and by salinity and/or alkalinity.

11.4.4.3 *Bayshore Clay Loam*

The east edge and southwest corner of the ARC site, comprising about 3% of ARC's total area, are situated on Bayshore clay loam. Bayshore clay loam typically forms in low-level positions on alluvial plains. The surface soil consists of 28 to 40 centimeters (11 to 16 inches) of dark gray calcareous clay loam, overlying subsoil consisting of 53 to 93 centimeters (21 to 37 inches) of light gray and white strongly calcareous clay loam. The substratum consists of light gray gravelly loam.

Bayshore clay loam is poorly drained and has a water storage capacity of 20 to 25 centimeters (8 to 10 inches). Runoff rates are very slow and erosion is negligible. The subsoil is moderately slowly permeable.

Bayshore clay loam is moderately expansive. The inherent fertility of this soil is very low. The choice of plants is further limited by soil moisture, and by salinity and/or alkalinity.

11.4.4.4 *Pacheco Loam, Clay Substratum*

The western portion of the Bay View area, along Stevens Creek, is situated on Pacheco loam, clay substratum. The area underlain by Pacheco loam represents about 3% of the ARC site. The surface soil consists of 35 to 45 centimeters (14 to 18 inches) of moderately alkaline grayish brown fine sandy loam, loam, and clay loam. The subsoil consists of 45 to 63 centimeters (18 to 25 inches) of moderately alkaline mottled light gray loam. The substratum is clay.

Pacheco loam is poorly drained and has a water storage capacity of 10 to 20 centimeters (4 to 8 inches). Runoff rates are very slow and erosion is negligible. The subsoil is slowly permeable, and the water table may be within 0.6 meter (2 feet) of the surface during and following the wet season.

Pacheco loam is moderately expansive. The inherent fertility of this soil is moderate. The choice of plants is limited by soil moisture.

11.4.4.5 *Artificial Fill*

Developed portions of the ARC site, including the golf course, levees, and areas where buildings are present, are underlain by artificial fill consisting of native soil mixed with gravel, concrete, asphalt, and other materials. Characteristics of the fill differ from site to site, depending on the native soil, added materials, and degree of compaction, which varies with land use. For instance, the golf course was constructed on fill that resembles Sunnyvale and Alviso clays. Fill underlying runway areas, roads, and levees consists of basin clays mixed with gravel and is substantially compacted. All fills for roads, buildings, airfields, and runways are engineered.

11.4.4.6 *Kitchen Middens*

There are two areas at Ames Research Center, one on the northern end of the Bay View area and one in the middle of the Eastside/Airfield area, where soils are classified as kitchen middens. Kitchen middens represent areas that were used as cooking or camping sites by Native Americans. The native soil material is typically dark gray, friable, calcareous loam or clay loam, mixed with ashes, charcoal, shell fragments, stones, and sparse bones or bone fragment.

Kitchen middens typically occur on nearly level to gently sloping topography, as at ARC. In most places, native soil underlies the middens at depths of 0.3 to 0.6 meter (1 to 2 feet).

Kitchen middens are well drained and have a water storage capacity of 20 to 25 centimeters (8 to 10 inches). Runoff rates are moderate and erosion is not usually a hazard.

However, permeability is slow and heavy rains can lead to localized ponding and/or flooding.

Fertility is moderate and the rooting zone is very deep. Elsewhere in the Santa Clara Valley, kitchen middens support irrigated row crops, prunes, apricots, walnuts, and pasture.

11.5 Environmental Requirements

The following section describes policies, measures, and BMPs adopted by NASA to minimize potential adverse effects from onsite seismic and geologic hazards.

11.5.1 NASA Procedural Directive 8500.1, NASA Environmental Management

Per NPD 8500.1, it is NASA policy to: maintain compliance with all applicable federal, state, and local environmental requirements; to incorporate environmental risk reduction and sustainable practices to the extent practicable throughout NASA's programs, projects, and activities; and to consider environmental factors throughout the life cycle of programs, projects, and activities (as defined in NPD 7120.4, *NASA Engineering and Program/Project Management Policy*, and related documents), including planning, development, execution, and disposition activities. Examples of environmental factors include consideration of environmental impacts as required by the NEPA and NHPA; the proposed use of hazardous materials; the potential for waste generation; the need to acquire necessary permits, waivers, and authorizations; and the use of environmentally-preferable materials and processes wherever practicable.

11.5.2 Ames Procedural Requirements 8500.1, Ames Environmental Procedural Requirements

APR 8500.1 sets forth general procedural requirements to ensure compliance with applicable federal, state, and local environmental laws; regulations and EOs; and NASA policies and procedures. Organizational directors, division chiefs, branch chiefs, section heads, supervisors, managers, and CORs are responsible for planning, designing, constructing, managing, operating, and maintaining facilities in conformance with applicable regulatory directives, and should obtain environmental review from the Environmental Management Division early in project planning consistent with NASA's NEPA implementing procedures (NPR 8580.1 and EO 12114), NASA policies and procedures for programs and projects (NPR 7120), and NASA regulations related to environmental quality (14 CFR 1216). Program and project managers should coordinate with the Environmental Management Division in a timely manner to ensure that any new or modified programs, projects, and activities comply with regulatory requirements.

11.5.3 Ames Environmental Work Instructions

Ames's EWIs, which replace the previous Ames Environmental Procedures and Guidelines (APR 8800.3), set forth requirements to ensure that programs, projects, and activities at ARC comply with applicable federal, state, and local laws; regulations and EOs; and NASA policies and procedures. Each EWI lists relevant regulatory authorities and documents, assigns individual and organizational responsibilities within ARC, and identifies specific requirements applicable to the work being performed.

The following EWIs are relevant to operations and future development at ARC and effects related to seismic and geologic hazards.

- EWI 12, Public Involvement
- EWI 14, NEPA and Environmental Justice
- EWI 18, Environmental Requirements for Construction Projects (Under review)

11.5.4 Measures for Seismic Safety

To the extent feasible, structures are sited and constructed to minimize the possibility of serious structural damage, human injury, and loss of life in earthquakes up to and including the design basis event. All new construction is required to meet the seismic requirements of the current CBSC. In addition, many older buildings on the site, such as Hangar 3 and Building N-210, have been or will be seismically upgraded. NASA has committed to ensuring that all future rehabilitation of historic structures within the Shenandoah Plaza Historic District follows the *Guidelines for the Rehabilitation of Historic Structures* developed by the Architectural Resources Group for NASA, and that all rehabilitation of historic buildings within the ARC site follows the Secretary of the Interior's *Guidelines for the Rehabilitation of Historic Structures* in order to maximize seismic safety while minimizing effects on the integrity of any National Register-listed or eligible structure.

Hazards from seismically-induced settlement and liquefaction are evaluated for all new major structures. NASA Ames requires the preparation of a soils report for all new construction, and ensures that the recommendations of these studies are incorporated into building design and construction.

Certain pipelines crossing the site are very prone to damage from seismic activity. Disruption of the high-pressure air system that serves several buildings would pose a threat to safety. Damage to a utility or fuel line (for example, a break in a sewer or natural gas main) could be reasonably controlled by pipeline shutdown, prompt cleanup, and repair.

11.5.5 Soils Measures

Erosion prevention measures are implemented during all construction and grounds maintenance activities.

In addition, as discussed in Measures for Seismic Safety above, all new construction will include geotechnical analyses of proposed sites to determine the design and construction measures necessary to address the risk of structural damage from expansive and/or corrosive soils.

11.5.6 **Stormwater Best Management Practices**

Stormwater BMPs are implemented during all building, construction, and landscaping activities at ARC. This may include the planting and maintenance of vegetation, diversion of run-on and runoff, placement of sandbags, and silt screens or other sediment control devices. Any site where soils are exposed to water and wind and result in soil erosion[5] and sedimentation[6] problems.

Human activities can accelerate erosion by removing vegetation, compacting or disturbing the soil, changing natural drainage patterns and by covering the ground with impermeable surfaces (pavement, concrete, and buildings). When the land surface is developed or "hardened" in this manner, storm water cannot seep into or "infiltrate" the ground. As a result, larger amounts of water move more quickly across the site, which can carry more sediment and other pollutants to creeks and streams. Because the vegetation primarily consists of marshlands and grasslands, soil erosion prevention is not required in many areas of ARC. However, erosion prevention measures are considered during any construction and / or grounds maintenance activities.

Targeted constituents in these BMPs are:

- Sediment
- Heavy Metals
- Toxic Materials

The requirements of these BMPs are the following:

- Identify areas, which, due to topography, activities, or other factors, have a high potential for significant soil erosion, and identify structural, vegetative, and / or stabilization measures used to limit erosion
- Retain as much vegetation (plants) onsite as possible
- Minimize the time that soil is exposed. Water exposed areas to control dust
- Prevent runoff from flowing across disturbed areas (divert the flow to vegetated areas)
- Stabilize the disturbed soils as soon as possible by planting vegetation or hydroseeding
- Slow down the runoff flowing across site (regrading, silt fences, planting)
- Provide drainage ways for the increased runoff (use grassy swales rather than concrete drains)
- Remove sediment from storm water run-off before it leaves the site

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[5] Erosion is a natural process in which soil and rock materials are loosened and removed.

[6] Sedimentation occurs when soil particles are suspended in surface runoff or wind and are deposited in streams and other water bodies.

- For large piles of soil where tarps or other covers are not feasible, place filtering media (e.g. straw bales, rocks, silt fences, etc.) around the base of each pile or at the storm drain inlet to remove these materials from rainwater run-off

11.5.7 NASA Ames Development Plan Final Programmatic Environmental Impact Statement

The NADP EIS identifies the following mitigation measures to address potential seismic and soil-related impacts from build out of NADP Mitigated Alternative 5.

11.5.7.1 *Mitigation Measure GEO-1*

All rehabilitation of historic structures within the Shenandoah Plaza Historic District would follow the Guidelines for the Rehabilitation of Historic Structures developed by the Architectural Resources Group for NASA and within the Ames Campus would follow the Secretary of the Interior Guidelines for the rehabilitation of Historic Structures in order to maximize seismic safety while minimizing effects on the integrity of any structure on or eligible for the National Register of Historic Places.

11.5.7.2 *Mitigation Measure GEO-2*

All new buildings at Ames Research Center would be designed to meet the current Uniform Building Code regulations for seismic safety.

11.5.7.3 *Mitigation Measure GEO-3*

All new construction would be designed based on geotechnical analyses of proposed sites to determine the structural measures necessary to counter the shrink-swell potential of the soil and the risk of structural damage from ground subsidence.

11.5.7.4 *Mitigation Measure GEO-4*

Prior to construction of individual facilities, NASA and its partners would conduct detailed geotechnical investigations of all proposed building sites, and would incorporate the engineering recommendations of these studies into building design and construction.