Michael J Furniss
Hydrology, Soil Science, Climate Change
Conservation Burial Development

SacredFamilyGroves@gmail.com
707-616-5254

Sacred Groves
Green Cemetery Project
Geology, Soils, and Site Suitability

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Geology

The Kneeland area of Humboldt County showcases the complex geological history and ongoing tectonic processes characteristic of the northern California Coast Ranges. Located within the Franciscan Complex, this region represents part of an ancient accretionary wedge that formed during subduction processes along the western margin of North America. The area's geological framework continues to be actively influenced by its proximity to both the Cascadia Subduction Zone to the north and west and the San Andreas Fault system to the south, making it a tectonically dynamic region subject to regular seismic activity.

The bedrock geology primarily consists of Franciscan Complex rocks dating from the Late Jurassic to Cretaceous periods (approximately 150-66 million years ago). These rocks include thick sequences of sandstone, predominantly in the form of greywacke, which originated as turbidity deposits in deep marine environments. Interbedded with these sandstones are shales and mudstones, along with blocks of metamorphosed oceanic basalts (greenstone), deep-marine chert sequences, and bodies of serpentinite derived from altered oceanic crust and upper mantle materials. This assemblage of rocks represents a classic example of a subduction zone mélange, where different rock types have been mixed and deformed through tectonic processes.

Geomorphologically, the Kneeland area is characterized by moderately steep terrain, with an elevation of approximately 2,100 feet at Kneeland Airport. The landscape features multiple marine terraces at different elevations, providing evidence of episodic tectonic uplift throughout the region's history. These terraces, combined with the area's steep slopes and weak bedrock materials, create conditions conducive to mass wasting processes. Extensive landslide deposits are common throughout the area, ranging from shallow soil slips to deep-seated rotational slides and earthflows. The presence of clay-rich mélange materials within the Franciscan Complex particularly contributes to slope instability during periods of heavy rainfall.

Vicinity Map.

The modern landscape continues to be shaped by active geological processes. Ongoing tectonic uplift, coupled with the region's high rainfall and susceptible rock types, drives intense erosional processes. The combination of uplift and erosion has created a deeply dissected landscape with steep-sided valleys and numerous landslide features. Seismic activity remains a significant factor in landscape evolution, with earthquakes capable of triggering new landslides and reactivating existing ones. The area's proximity to the coast also influences local climate conditions, which in turn affects weathering and erosion rates. Additionally, the presence of serpentinite bodies influences local soil development and vegetation patterns, creating distinct ecological niches within the landscape.

The underlying geological structure is complex, with multiple phases of deformation evident in the rock record. Folds, faults, and shear zones are common, reflecting the intense tectonic forces that have shaped the region. Many of these structures continue to influence modern drainage patterns and landscape evolution. The area also contains younger Quaternary deposits, including alluvial materials in valley bottoms and colluvial deposits on slopes, which overlay the older Franciscan Complex rocks and provide important records of more recent geological history.

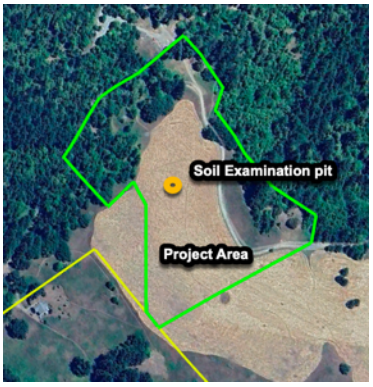
Map showing land elevation contours. The area is in the subwatershed (HUC12) of 180101020408, within the Mad River Basin, and is at elevation of ~2,200 feet.

Soils

The properties of soils in a burial grounds are critically important as this is a medium for burial and decomposition and is central to the biophysical functiong of the cemetery facility..

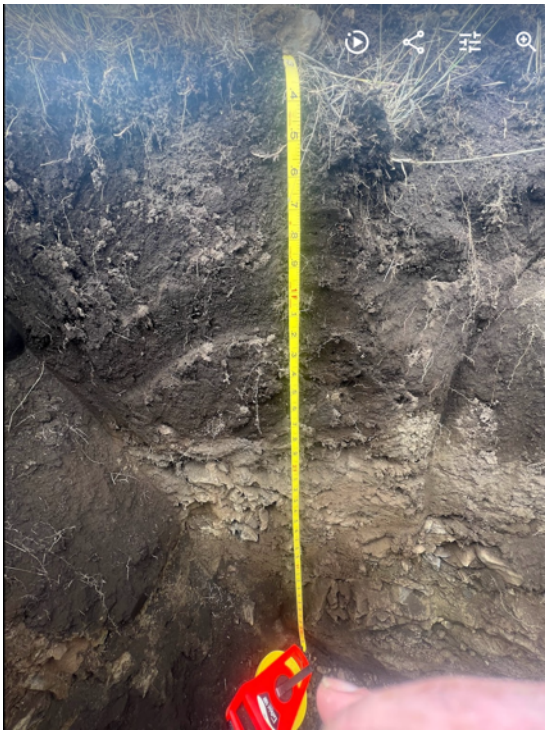
A thorough survey of the soils in the project was conducted in the Summer of 2023 by MJ Furniss (BS in Soil Science and Plant Nutrition; MS in Soil Science, UC Berkeley, US Forest Service Research Branch, Redwood Sciences Lab, Emeritus, and current Adjunct Professor in the Cal Poly Department of Forestry, Fire, and Range Management).

The full area was walked with small soil pits, auger holes, gopher excavations, and a large soil examination pit in what was considered a typical setting in the project area. Vegetation and drainage patterns were observed over 2 years during the wet and dry seasons.



Excavator-dug soil examination pit and location.

The NRCS Cooperative Soil Survey has mapped the predominant soil in the project area as the Winegrass Series.



Detailed view of Winegrass soil

Soil texture is highly favorable. It has a loam texture in the upper and clay loam in the lower horizons. (Both loams and clay loams have well-balanced particle-size distribution and are of high fertility and suitability for plant growth and decomposition, as well as habitat and forage value for wildlife and livestock.)

Soil reaction is very slightly acidic (pH 6.5-6.8), with high cation exchange capacity, and 3-5 percent organic matter in the A horizon.

Rockiness is low, with some rock in the lower horizons and less than 10% rock overall.

Soil depth: Soil depth to bedrock is greater than 80 inches.

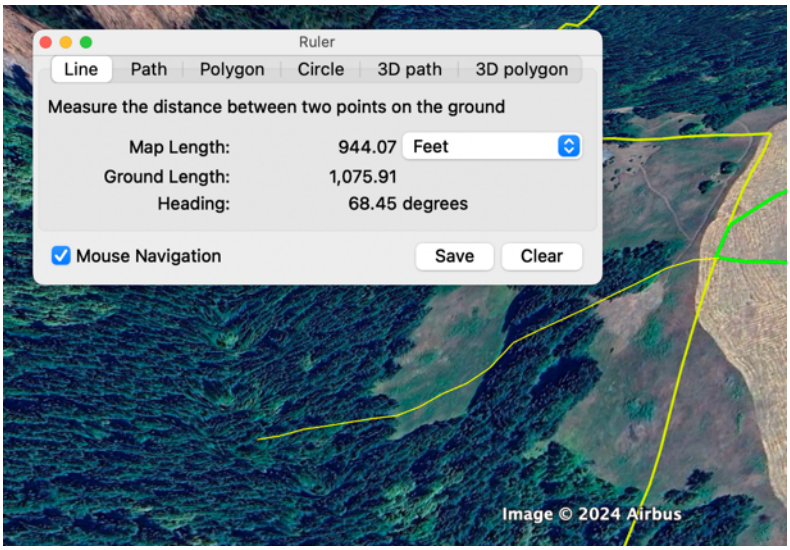
Erosion hazards: There is no evidence of surface erosion (rilling, gullying, sheetwash) in the project area. Erosion hazard is low to moderate and very low with existing soil cover of grasses, forbs, and trees. As long as cover is maintained, erodibilty is low and no surface erosion is expected to occur as a result of project activities.

Drainage, permeability, and percolation rates: Soils are well-drained and have high infiltration capacity, permeability, and percolation rates. No ponding of water or rainfall has been observed over the area, even during extended periods of heavy rainfall and snowmelt.

Groundwater levels: Groundwater is not in evidence in the project area. No wells have been dug in the area, but terrain features and geology suggest that any groundwater is deep and well below the R-horizon of the soils in the area. A seep is present to the south of the area, indicating a near-surface rock shelf.. The water from the seep re-infiltrates in the meadow area and does not connect to surface water—the Black Dog Creek headwater stream is about 1000 feet slope distance below the lower end of the project area, with any hydrologic connectivity to surface waters of the State.

Inclusions and outcrops: One small rocky outcrop is at the project area's southern end. Other mapped soils may occur to a minor extent in occlusions in the project area, including the Pittplace and Scaath Series. These inclusions have similar suitability properties to the Winegrass Soil Series, which predominates in the project area.

Water features: Except for the seep area in the meadow but outside the project area, there are no surface water features in the project area. The closest surface water feature, Black Dog Creek, is approximately 1,000 feet slope distance from the lowest extent of the project area.



Measurement of slope length from the lowest end of the project area to Black Dog Creek. The terrain is shown at 3x exaggeration.

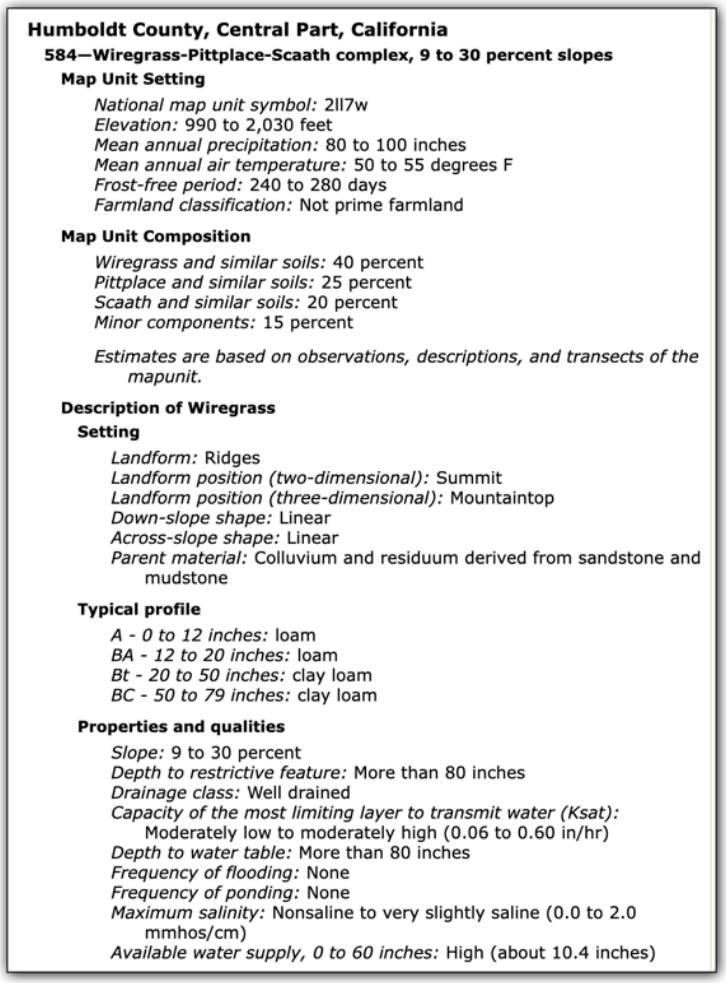
Slope: Slopes are gentle across the project area, from 0-8 %

Mass instability: There is no mass movement (landsliding, slumping, earthflows, etc.) in evidence in the project area.

Inclusions and outcrops: One small rock outcrop is just south of the project area.

Overall suitability: Based on a comprehensive soil survey and analysis of the project area, this site demonstrates excellent characteristics for a green cemetery. The loam-to-clay loam texture provides ideal moisture retention and decomposition conditions while maintaining sufficient drainage that precludes surface runoff. The exceptional soil depth over 80 inches ensures proper burial depths without bedrock interference. The balanced pH and nutrient exchange

capacity support decomposition processes and robust plant growth. The absence of mass wasting or erosion features confirms the site's stability. Deep groundwater and lack of surface water protect water resources. The soil conditions allow for easy excavation and planting. The existing native grass and forb diversity and suitable soil characteristics indicate strong potential for successful savannah conversion, long-term biodiversity, habitat and forage values, and ecological sustainability.



Humboldt County, Central Part, California

584—Wiregrass-Pittplace-Scaath complex, 9 to 30 percent slopes

Map Unit Setting

National map unit symbol: 2ll7w
Elevation: 990 to 2,030 feet
Mean annual precipitation: 80 to 100 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 240 to 280 days
Farmland classification: Not prime farmland

Map Unit Composition

Wiregrass and similar soils: 40 percent
Pittplace and similar soils: 25 percent
Scaath and similar soils: 20 percent
Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wiregrass

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Mountaintop
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Colluvium and residuum derived from sandstone and mudstone

Typical profile

A - 0 to 12 inches: loam
BA - 12 to 20 inches: loam
Bt - 20 to 50 inches: clay loam
BC - 50 to 79 inches: clay loam

Properties and qualities

Slope: 9 to 30 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 10.4 inches)

NRCS cooperative soil survey for Humboldt County, soil series identification, and basic soil properties.