RESEARCH NOTES

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Caltrans

Use of Organic Amendments for Disturbed Sites with Harsh Conditions

Two eroding cut slope sites that had been barren for over a decade were evaluated for revegetation potential and then treated to increase rainfall infiltration, rooting depth, and nutrient availability. Plant growth at both sites, one on decomposed granite and one on serpentine (the California state rock), was greatly improved, and maintenance due to erosion processes was reduced or eliminated.

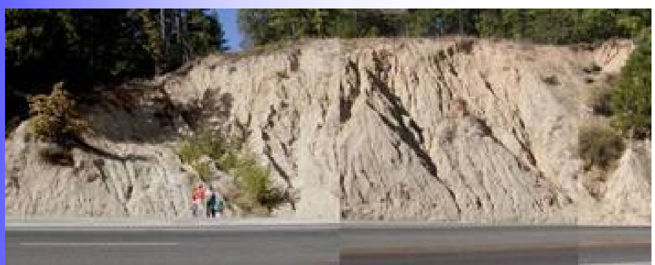

Figure 1. Decomposed Granite at Buckhorn

Why This Research Was Pursued

Highway cut slopes and fills often remain barren or poorly vegetated for long periods of time after construction. In order to establish sustainable native vegetation and attain our erosion and water quality goals, we need to understand the reasons contributing to poor plant establishment on disturbed cut and fill slopes and develop tools to remediate them. On harsher sites, application of fertilizers and erosion control seeding may generate initial plant cover, but plant densities often steadily declined within 3-5 years and the site returned to generally barren conditions, with chronic sediment losses. (Clary, 1983; Nakao et al 1976; Parks and Nguyen, 1984) Decomposed granite and serpentine geological substrates are notorious for their ability to erode and produce sediment. This occurs because the fine particles that crumble out of weathering rock settle into a dense mass. Rainwater runs over the top and cuts gullies. When dry, the materials form crusts or hard-set. When they are rewetted and saturated, they can liquefy and slump. Because of these characteristics, decomposed granites and serpentine outcrops are erosive and unstable when wet and restrict root growth when dry.

This project addresses the task of identifying the various plant growth limiting conditions of impacted and degraded rocky substrates by using soil analysis and comparison to relevant revegetated reference sites, followed by evaluation of potential amendments to correct the limiting conditions.

This study tries to ameliorate the harsh substrate conditions found following road construction, so that the native plants surrounding the site can establish and survive. Because we do not know all conditions required for plant growth, we use "disturbed-but-revegetated" reference sites as examples of adequate soil characteristic. Undisturbed, native sites are not a realistic model for our short term objectives because such soils took hundreds of years to develop.

What Can Be Concluded from the Research?

On composted and tilled plots, native perennial grasses grew and set seed the first year without irrigation and had roots that grew past 2m depth. While on untilled plots, plugs did not put roots any farther than the planting hole, and remained small or died. Native grass from seed, applied the second year after tilling, grew nearly as large as when planted as plugs directly after construction. Untilled plots and tilled plots without amendment had plant growth that was only 10 to 20 % of plant growth in the compost amended plots.

Measurements showed that vegetated plots actually increased their infiltration rates over that measured on reference sites, as plant roots replaced the functions of the compost amendment. Several soil characteristics continued to improve in subsequent seasons after construction, suggesting that the treatments would be sustainable for the local climatic and geological conditions.

Sediment loss was reduced from an estimated 200 to 300 cubic yards per year from the site before treatment, to a minimal amount that required no maintenance attention. – District 2 Maintenance Supervisor

What Do the Researchers Recommend and Implementation Strategies:

In general, sustainable revegetation of disturbed sites requires five conditions:

1. Rooting area. Perennial plants must be able to root deeply (often a meter or more) to survive the summer drought. If the ground does not allow water to penetrate, the site should be excavated or tilled. Loose material must be placed on a horizontal bench to avoid sloughing when saturated. Slopes should not be tilled to a uniform depth all across the slope surface, because the inclined surface where the porous, tilled material meets the underlying substrate creates a slippage plane. These aspects of the project design should be coordinated with geotechnical engineers. An acceptable design solution for successful plant growth must include unrestricted rooting volume of between 300-1000 mm depth.

Figure 2. Serpentine test plots

2. Water Absorption. The surface infiltration of the substrate needs to be adequate to absorb a design storm event. Infiltration rates are often 50 to 100 mm/hr and vary by storm intensity. A 75 mm (3 inch) layer of Coarse, unscreened yard waste compost at 25 % by volume, tilled into the top 225 mm (9 inches). (Finer (10 mm; 3/8 inch screened) compost materials will have less effect to increase infiltration.) To avoid settling and repacking, shredded wood or unscreened compost (10 to 20 % (by volume)) should be incorporated into the soil profile.

In sandy soil, additional soil amendments are required that increase water holding capacity, such as clay materials or composts. These must be incorporated to rooting depth at rates generally between 10 and 25 % by volume. Incorporation deeper in the soil is more effective to avoid evaporation losses at the soil surface.

3. Nutrients. If nutrients are inadequate to support plant growth, add compost. The goal is to provide enough compost to improve water relations without providing so many nutrients that weeds invade or that nitrogen (N) flows out.

The 24% by volume of compost used in the granite test plot provided more total nitrogen (N) than is needed for plant growth on the site, so a modified amendment using a 50:50 mixture of wood shreds with coarse compost is recommended for future projects. 100 mm (4 inch) depth and tilled to 400 or 500 mm. These mixtures, however, have not been specifically tested.

As a general interim recommendation, most disturbed soils will require 25 - 37 mm (1 - 1.5 inches) of compost. Large compost amendments are not advised for dry climates (like the Mohave or the Eastern Sierra) because the salt load from the compost may not be leached during winter rains, or for serpentine substrates because of their ability to increase calcium and promote weedy invasion of these native plant communities.

4. Mulch. Often, the coarse compost can act as a surface mulch. The highly effective treatment used in the slope reconstruction at the Buckhorn summit study site covered the incorporated compost with a 900 g/m2 coir flap over the surface of each lift (bench) and continuing down the slope face, overlapping the fabric on the next lift below.

5. Native fungi and plants. Site-adapted native plants and native or site-collected mycorrhizal fungi need to be present on the site. As soil conditions become more extreme (higher, colder, atypical chemistry, more acid or alkaline, extreme particle size), the selection of site adapted fungal or plant species becomes increasingly important. When nutrients are limited, an effective mycorrhizal fungal symbiont can make the difference between survival or death for a plant. These findings were an indirect result of observing the failure of conventional erosion control plant materials to grow under these harsh site conditions.

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