RESTORING MOUNTAIN SLOPES AND FORESTS WITH BIOSOLIDS IN THE WASHINGTON CASCADES

Peggy Leonard, Doug Schindler[1], Roberta King and Ken Konigsmark[1]
King County Department of Natural Resources
Wastewater Treatment Division
201 South Jackson Street, KSC-NR-0512
Seattle, WA 98104-3855

Summary
Along the ridges of the Cascade Range east of Seattle, Washington, hundreds of young volunteers have been working for the past five summers to recontour steep slopes and eliminate old logging roads that are visible along the scenic mountain corridor of Interstate-90. A key ingredient in the program is the use of GroCo®, a commercial biosolids–sawdust compost, to increase soil organic matter, nutrients and moisture for rapid revegetation and long-term restoration success.

This "re-greening" program involves many steps, some accomplished by heavy equipment and others by hand labor:

- Restoring the natural slopes of road cuts by pulling up sidecast material;
- Removing culverts to restore natural stream drainages;
- Armoring banks of streams where necessary;
- Mixing biosolids compost into compacted roadbed soils;
- Building terraces where needed to stabilize new slopes;
- Seeding winter wheat to establish a cover crop;
- Covering all exposed soil with straw/hay to minimize erosion and protect seeds;
- Planting with noble fir and other conifers appropriate for the sites.

The program has been developed and managed by the Mountains to Sound Greenway Trust, a coalition of citizens, private landowners, businesses, public agencies, and local governments working to protect and enhance the I-90 corridor from Puget Sound to the east side of the Cascade Mountains. As the population of the Pacific Northwest continues to grow, the Greenway Trust works to preserve open space, working farms and forests, historic sites, trails and other recreation opportunities.

Although the Compost Re-Greening Program is limited in extent, it has attracted attention from politicians, the press, and many local organizations. It is a popular volunteer activity for youth and conservation groups. Just as the program partners had hoped, the volunteers develop a sense of stewardship for the Greenway and its forests. The program is also one of the most effective education tools for raising awareness of biosolids recycling, water quality, and responsible forest management. We have voluntarily restricted the re-greening program to the use of Class A biosolids product (compost), which enables the volunteers to work directly with the material and see for themselves how it improves the soil.

Public-Private Partnership

The Compost Re-greening program is part of a larger, complex multi-party Biosolids Forestry program developed to recycle biosolids locally and generate environmental benefits and timber revenues. In 1995, under the leadership of Jim Ellis, a local civic leader and president of the Mountains to Sound Greenway Trust, an agreement was developed between King County Wastewater Treatment Division (KC), the state Department of Natural Resources (DNR), the Weyerhaeuser Company, the University of Washington, and the Greenway Trust (MTSGT). The agreement consisted of three key components:

[1] Mountains to Sound Greenway Trust, 1011 Western Avenue, Suite 606, Seattle, WA 98104

(1) **Forest expansion and biosolids recycling.** King County acquires forestlands along the Interstate-90 corridor that are threatened by commercial and residential development and conveys these lands to the state DNR to manage in perpetual forestry. Sixty percent of all timber harvest receipts from these lands are distributed to King County Wastewater Treatment Division, 25% to state DNR, and 15% to other county agencies. In turn, DNR provides King County with 3,600 acres of state forestland within the county for biosolids recycling through the year 2044. DNR pays King County $10 a dry ton for biosolids applied to state lands. The University of Washington establishes application rates and provides guidance for the biosolids applications.

(2) **Compost re-greening program.** Under a six-year pilot program, the Mountains to Sound Greenway Trust purchases GroCo® biosolids compost and uses it to restore logged-over mountain slopes and road scars in the Greenway (Interstate 90 corridor). The Trust recruits and manages volunteers from local service and youth groups to perform this work. To fund this portion of the program, the Weyerhaeuser Company increases its use of King County biosolids from 2,000 dry tons a year to 5,000 dry tons a year. Recycling those biosolids on Weyerhaeuser forests rather than eastern Washington wheat fields generates a savings in haul costs for King County that is more than sufficient to pay for the re-greening program.

(3) **Environmental education program.** The Mountains to Sound Greenway Trust conducts a six-year public education program on the safety and ecological necessity of biosolids recycling and the benefits of sustainable commercial forestry. The Greenway Trust not only provides information for the general public, but also develops curricula for middle and high schools and training seminars for teachers.

Biosolids Recycling in the Forest

King County has been applying biosolids in local forests since the early 1970s, when the wastewater utility was known as the Municipality of Metropolitan Seattle (Metro). Research and oversight by the University of Washington College of Forest Resources enabled the program to move from research to demonstration to full-scale operations, attracting the interest of the Weyerhaeuser Company in the mid 1980s. Under a series of contracts, King County began supplying and overseeing the application of biosolids to Weyerhaeuser forest lands and has continued until the present. More than 250,000 wet tons of biosolids have been applied to thousands of acres of commercial Douglas-fir on the company's Snoqualmie Tree Farm since 1987.

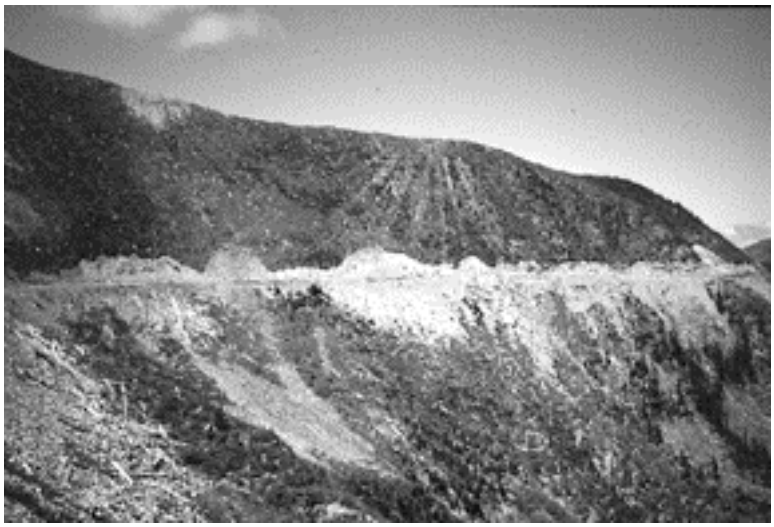
The Washington State Department of Natural Resources (DNR) became a biosolids customer when it joined the Greenway's Biosolids Forestry Program in 1995. The first DNR project was a 20-acre site prominently located along a road heavily used by recreationists in a state forest just outside of Seattle. That project was very successful, and so the DNR began increasing the amount of biosolids used each year. Under the terms of the contract, the DNR biosolids partnership with King County will end in the year 2044.

When the Greenway Biosolids Forestry Program began, The Weyerhaeuser Company also joined as a partner. Although Weyerhaeuser kept its original contract terms with King County, they increased their annual allotment of biosolids to 25,000 tons a year. This increase was estimated to save the county approximately $200,000 a year because some of these tons would have been delivered to eastern Washington at a higher transportation cost (200 miles one way versus 40 miles). More than half of this savings is transferred annually to the Greenway Trust to fund the Compost Re-greening program.

Identifying Sites for the Compost Re-greening Program

Compost Re-greening is one of the most popular Greenway programs; it attracts volunteers and media coverage each summer. Although the fieldwork takes place between June and September after the mountains are free of snow, planning begins much earlier. Greenway staff identify gravel roads that have been used for past logging in the I-90 corridor but will not be needed in the future. Road that are targeted for removal and restoration are those that are most offensive visually and environmentally. These old gravel roads are not only ugly, appearing as scars on an otherwise green hillside, but they are usually the source of polluting sediment that is washed from the roads and into fish-bearing streams. The Greenway

staff identify and work with the landowner to secure permission and access to the road. The roads are usually water-barred and not drivable; the roadbed in many stretches is eroded, cracked or slumped. Usually the landowner provides the labor and equipment to open the road and make it drivable so that the Greenway can deliver its workers and supplies (compost and straw). The major landowners in the program to date have been the state Department of Natural Resources and the Weyerhaeuser Company.



One of the roads targeted by the Greenway Trust for rehabilitation. Note the sidecast debris in the left foreground and the movement of gravel and sediment downslope from the road.

Operational Techniques

Site Preparation. The first equipment on the scene is the tracked excavator (a Caterpillar 330 BL is shown in the picture below). It opens the partially deactivated road by filling in the old water bars and building up the road surface where necessary.

After the road is safe to drive, the compost is moved up to the site by dump truck and unloaded at predetermined sites along the road. A front-end loader moves the compost into smaller piles at 50-foot intervals along the road. Bales of hay/straw and bags of winter wheat seed are placed alongside the compost.

Starting at the far or upper end of the road and working back down the road, the excavator operator begins to remove the road by ripping the inner running surface to a depth of 18 inches. Then he pulls up the sidecast material and the outer running surface.

Restoring Natural Slope. Material that is pulled up from the slope below the road is placed in the cut bank of the road to restore the natural hillslope as much as possible. Stumps and large woody debris are placed on the recontoured slope. The operator attempts, if possible, to leave any established vegetation larger than 3” in diameter. Small coniferous trees that are in the way of the new material are removed and replanted on the new slope. The survival rate for these replanted conifers is about 50%. Deciduous trees have a poorer survival rate and so many of these are added to the new slope as large woody debris.

While restoring the slope, the excavator operator also roughly tamps in a foot trail for use by hikers and those who will return next spring to plant conifer seedlings.

Application of the Compost and Seed. At most of these mountainous sites, the best technique has proved to be spreading of the compost by the excavator. As the excavator operator works to restore the slope, he also spreads about 2 inches depth of GroCo® on the surface, while keeping it about 10 feet away from streams. The majority of the seed is mixed into the compost before it is staged along the road. This works well unless the piles of compost are to sit for more than seven days, in which case the seeds germinate and cover the compost pile with a dense growth of grass.

As the excavator completes an area and continues to back down the road, the volunteers move in to hand seed, spread straw and treat any small areas that need manual labor. Areas not covered by compost, such as stream banks, are seeded by hand from planting bags by volunteers at an approximate rate of 20 pounds per 100 linear feet of road surface. Volunteers are also responsible for hand-spreading straw about 4 inches deep over the compost to protect the seeds from birds and to reduce erosion. This depth of straw requires about 15 bales per 100 linear feet.

The seed is a low-cost chicken feed, actually a variety of winter wheat. The wheat germinates readily at these wet high elevation sites and so helps stabilize the new slopes quickly. It reseeds itself, but slowly loses its dominance over the next 3 years as native species begin seeding in. The first native species to colonize have been fireweed (*Epilobium angustifolium*) and pearly everlasting (*Anaphalis margaritacea*).

Removing Culverts. Large woody debris and boulders washing down the stream have plugged many of the culverts along the road. After the culvert is plugged, the water finds a new course, cutting through the roadbed and increasing the amount of rock and sediment moving downstream. Removing the culvert restores natural drainage patterns. The area is protected against future erosion by heavily armoring the bottoms and sides of the streams with rock. If the creek is dry, the excavator is used to remove the culvert and pull all the fill material out of the stream then hand crews line the bed and sides with rocks. If there is water in the creek, the creek is armored before removing the culvert.

Terraces for Steep Slopes. On the steepest slopes, where the compost and seed won't hold, volunteers build log terraces to help hold the materials in place. The logs are 3 to 8 feet in length, staked to the hillsides. Crews also experimented with willow and alder "wattles", but found these to be flimsy and not effective.

The log terraces have been very successful in selected slopes below roads and the results have been well worth the intensive labor, especially for areas above and surrounding streams. The compost is applied manually by buckets and some very steep areas have required roping the volunteers and rappelling down to the work area.

Tree Planting. The spring following the roadwork, volunteers hike into the area to plant conifer seedlings in the newly restored areas. Planting stock is generally 75% noble fir (*Abies procera*) with the remainder in Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), and Sitka spruce (*Picea sitchensis)* depending on elevation and seedling availability.

The pictures above show one of the roads in the Mine Creek drainage, before and a few weeks after rehabilitation by Greenway crews. In the “after” photo on the right, the winter wheat is thick on the newly contoured slope.

Erasing the Mark of Zorro

One of the most prominent eyesores in the I-90 corridor is an unnamed peak that is visible to all who drive the freeway east from Seattle to the Cascades. This 4,500-foot peak is prominently criss-crossed with the switchbacks of a logging road, hence the nickname “Zorro Road.” The road has washed out in several places, creating landslides and carrying sediment into streams. The road was constructed for hauling logs, so it is surrounded by a large replanted clearcut. It will be many years before the young noble fir plantation will cover the slopes. Greenway staff were eager to eliminate this particular road scar

even though the road was so long that it would require two consecutive summers of re-greening restoration work.

Zorro road was so steep at the top of the ridge that the equipment and procedures used elsewhere on the mountain were impossible. The contractor who bought in the GroCo compost for previous projects refused to operate trucks on the narrow and hazardous Zorro roads. So an earthmover was used to shuttle small loads of compost to stockpile points along the road. Although the tracked excavator for pulling up the sidecast was able to operate at the summit and recontour the road into a natural slope, the earthmover was not able to deliver the compost to the summit because of the hazardous driving conditions.

First Aerial Application

Forest fertilization in Washington is typically performed with helicopters distributing urea pellets. Biosolids have always been ground-applied because of their weight. But in the case of the Zorro peak, aerial application seemed the only option. Only a small amount of compost (less than 200 cubic yards) was needed at the summit, but the compost is crucial for good establishment of vegetation.

The Greenway Trust contracted with Fly Wright helicopters for a one-day operation to shuttle GroCo up to the peak. The GroCo had been stockpiled on a landing on the upper slopes of the mountain, and a loader was on site to fill rectangular metal buckets that help about 1.5 yards of compost each. As the helicopter hovered over the landing, volunteers hooked a bucket to the long cables dangling from the helicopter. When the load was secure, the helicopter lifted, banked, and flew the short trip up to the peak, the bucket of compost swinging in tow below it. Hovering over the drop site, the pilot released the cable on one side of the bucket, spreading the GroCo and seed onto the newly contoured slope. Volunteers then covered the GroCo with hay to protect the seed and prevent erosion. The restoration of Zorro's summit was completed in this manner but at substantial cost.

Volunteer Labor

The Greenway purchases the compost and hires local firms to haul the compost into the remote work sites. They also hire a local firm to operate the excavator that removes culverts, recontours the road and mixes in the compost. But much of the finish and detail work is performed by volunteers, age 12 and up. They spread straw/hay over the freshly applied compost; they spread additional seed where necessary. After culverts are removed, volunteers often armor the creek banks and rebuild streambeds by hand. On steep slopes, where the compost and seed won't hold, volunteers build log terraces to held hold materials in place.

Volunteers are recruited throughout the year by the Greenway Trust for this and other environmental projects. By working in the mountains and camping out (a new experience for many), they develop a sense of ownership about the Greenway and learn about biosolids, forest management, and water quality problems created by the failing roads.

One of the most rewarding partnerships created out of the re-greening program has been with the King County World Conservation Corps, an international program which brings 18- to 24-year-olds to the Puget Sound area for 6 months to work with local members on conservation projects. WCC members take these new environmental restoration techniques back to their home countries. Local WCC members serve as volunteer supervisors, leading crews of both international students and local youths. Other groups that have worked on the re-greening projects include:

King County Youth Volunteer Corps
Snoqualmie Valley Youth Hub
Congresswoman Jennifer Dunn's Youth Advisory Council
YMCA Martin Luther King Child Care
Big Brothers of King County
Campfire Youth Volunteer Corps
YMCA Earth Services Corps
Boy Scout troops
The Sierra Club
The Overlake School
The Bush School
Joint Youth Ministry of Mercer Island
University of Washington
Issaquah Juvenile Court
Friends of the Trail

Quality of the Biosolids Compost

The biosolids used in this program are processed at the two regional wastewater treatment plants in the metropolitan Seattle area. Biosolids from both plants meet Class B pathogen reduction criteria and Table 3 (40 CFR 503) pollution concentrations. Before composting, they average 5-6% organic nitrogen and 1% ammonia nitrogen. All the biosolids produced from both treatment plants are recycled in agriculture (70%), forestry (23%) or delivered to GroCo for composting (7% of total production). GroCo® compost is 2/3 sawdust and 1/3 biosolids, composted in static piles, and aged for one year before being marketed to the general public and commercial landscapers. The finished product meets Class A pathogen reduction, and contains about 1% organic nitrogen with very low metal concentrations. It has been produced and marketed locally since the early 1970s.

Water Quality Monitoring and Research

The University of Washington College of Forest Resources has been involved with local biosolids research and operations for more than 25 years. As a partner in the Biosolids Forestry Program, they provide scientific and technical expertise for both the forest fertilization and the compost re-greening program. Chuck Henry of the UW developed *Guidelines for Use of Composted Biosolids in the Greenway,* a "living" document designed to be modified as the program generates results and new techniques. He and his students initially conducted studies on the stability of GroCo® on steep, ravelly slopes. Also, for the first two years of the program, they inspected all potential sites and offered recommendations for buffer distances, application rates and techniques.

The Greenway Trust was awarded a grant from the US EPA to study the benefits of biosolids in road removals versus NPK fertilizer or more conventional decommissioning techniques that involve no fertilizer or soil amendment. Darlene Zabowski of the UW CFR and her students have established research plots to monitor runoff water quality, plant cover, water infiltration, and soil concentrations of carbon, nitrogen and phosphorus. Early results show that the biosolids and NPK treatments produce 15 to 20 times the vegetative cover of conventional road decommissioning. The biosolids compost treatment consistently resulted in higher water infiltration rates and less surface erosion. The biosolids compost also produced a longer-lasting increase in soil nitrogen and carbon concentrations than the NPK fertilizer. Total phosphorus in the soil was also elevated by the application of the biosolids compost. It appears that erosion control techniques (such as the straw cover) are important to prevent any soil erosion that might carry any high phosphorus-particulates into surface waters. However, because of the improved water infiltration in compost areas, surface runoff is greatly reduced.

Results

In the past five summers, fifteen miles of the most visible and most damaging logging roads in the I-90 Cascade corridor have been reclaimed by the volunteers of the re-greening program. All areas are holding up well and native vegetation is colonizing the areas that were initially seeded with wheat. The winter of 1996/97 brought record levels of rain, snow and flooding to the Pacific Northwest. After snow melt, Greenway staff and volunteers returned to the previous summer's sites. Wheat grass was emerging through the hay and native species were moving in. The sites showed no signs of slides or erosion. All the terraced hillsides had held. On older sites, changes in dominance from wheat to native species are apparent.

The U.S. Forest Service is joining the program in the summer of 2000, with several stretches of road in the Mt. Baker-Snoqualmie National Forest scheduled for decommissioning and reclamation with biosolids compost and Greenway volunteers. The future of the program is under discussion as the funding provided by King County and Weyerhaeuser was budgeted only for the first six years of the Biosolids Forestry Program (1995-2000). The application of Class B biosolids as forest fertilizer to state forests, however, will continue for the full contract term, 1995-2044.