LOW-IMPACT LAND DEVELOPMENT: THE PRACTICE OF PRESERVING NATURAL PROCESSES

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"Man is rich in proportion to the things that he can leave alone."
—*Henry David Thoreau*

"Attitudes toward the land must ultimately be based on attitudes toward life."
—*Clarence Glacken*

INTRODUCTION

Land development is a human activity that has tremendous impacts on the structure and function of the landscape. Those impacts, more often than not, disrupt and degrade natural processes on the site and in adjacent or functionally connected landscapes. The Nature Conservancy has identified habitat degradation due to development as the greatest threat to biodiversity in the United States, partially responsible for the threatened status of 85% of the species that have been identified as such (Stein 2000). In recent decades, development has affected more land than ever before. According to the U.S. EPA, the rate of conversion of land from undeveloped to developed is 2.65 times the rate of population growth in the U.S., a signal of sprawling, land-consumptive development. Not only are more undeveloped sites, or greenfields, being impacted by development, but the impacts appear to be more severe than in previous eras. A recent article in Landscape Architecture Magazine titled "Why Suburbs Will Never Have Tall Trees: Modern Construction Methods Doom Trees Before They've Even Been Planted," makes the observation that older neighborhoods throughout North America appear to provide a suitable environment for tree growth resulting in mature urban forests, while modern-era developments are frequently conspicuous due to the short-lived, stunted, or diseased trees that struggle to survive on these sites (Kidd 2006).

Modern construction equipment is partly to blame for creating such difficult growing conditions, but, perhaps more importantly, our modern equipment has made it possible to push development further into marginally suitable or just plain unsuitable land. Developers of our continent's first towns and neighborhoods were limited by the ability of their machinery (or at least the cost-effectiveness of their machinery) to access steep slopes, to move large amounts of earth or to "improve" poorly drained or erodible soils. Today, we can cost-effectively do all of these things, and some of the undeveloped, marginally-suitable land is especially attractive to developers due to its impressive views, acreage, and availability.

With these trends in mind, developers and land planning professionals must seek to lessen the footprint that development leaves on the landscape. Advances in the fields of ecology, geomorphology, and other sciences have given us a deeper understanding of the natural processes that occur in, through, and around any given site. Innovative applications by landscape architects, landscape ecologists, planners, and other design professionals have demonstrated that it is possible to accommodate development in a way that preserves and protects these natural processes. This article will summarize some of the important benefits that healthy natural areas provide, and outline a methodology for low-impact land development.

THE BENEFITS OF HEALTHY NATURAL VEGETATION

Portions of the Earth that retain functionally intact ecosystems and natural processes provide the basic life-support system for all life. This life-support system includes the free ecosystem services that maintain a stable and suitable atmosphere, freshwater supplies, and climate. Additionally, these areas provide recreational, spiritual, and educational opportunities for people who visit or live within them. Some of the

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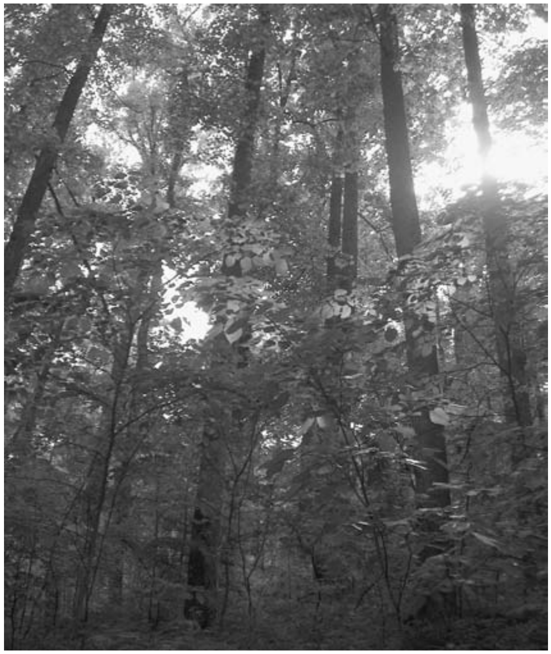
FIGURE 1. Clearing and mass-grading have become common practices that contribute to the degradation of natural processes on greenfield sites.

FIGURE 2. Existing vegetation provides valuable ecosystem services.



free ecosystem services provided by trees and other vegetation are described below.

Trees and other vegetation act as natural stormwater management controls. Tree canopies intercept rainfall before it hits the ground—as much as 50% of the annual rainfall on a forested site may be intercepted by the tree canopy (Selby 1982). They also evapotranspire moisture from the soil which makes room for additional infiltration during future storm events. A study by American Forests found the value of the stormwater volume benefits of the Washington, D.C. urban forest (46% coverage) to be worth $4.7 billion. This value was determined by estimating the cost of construction of the 949 million cubic feet of stormwater detention that would be necessary to provide an equivalent level of stormwater volume reduction (2006). More and more local governments are recognizing the good deal that trees offer and are enacting tree preservation ordinances in response.

The stormwater quantity benefits of trees have a positive impact on water quality as well. Reduced flows cause less damage to stream channels, reducing the amount of bank erosion and channel widening or downcutting. The erosion control benefits of vegetation extend onto upland sites as well—vegetation has been recognized as the single most important factor in minimizing excessive erosion. Trees also improve water quality by lowering temperatures of runoff.

Trees provide important air quality services. Trees, including their leaves, branches, trunks, roots, and surrounding soil are pollution sinks (GHASP 1999). They remove pollutants from the atmosphere and sequester or metabolize them. Leaves remove gaseous pollutants such as ozone, nitrogen dioxide, sulfur dioxide, formaldehyde, benzene, and hydrogen fluoride through uptake. Moisture and sunlight influence the ability of vegetation to uptake pollutants, and performance may diminish during periods of low soil moisture, such as drought (GHASP 1999). Soil removes gaseous pollutants through microbial, physi-

TABLE 1. Trees and air quality around the country. Redrawn from American Forests (2006).

City	Pounds of pollutants removed annually by trees	Annual value trees with of respect to air pollution
Washington, DC	878,000	$2.1 million
Atlanta, GA Metro Area	19,000,000	$47 million
Portland, OR Metro Area	2,000,000	$4.8 million
Denver, CO Metro Area	1,100,000	$2.6 million

cal, and chemical processes. It has been found that healthy soil is more effective than degraded soil (GHASP 1999). Trees remove a tremendous amount of carbon dioxide, a significant greenhouse gas, from the atmosphere. An acre of trees absorbs about 2.6 tons of CO_2 per year, an amount equal to driving a car 26,000 miles (American Forestry Association 1992). Finally, trees and other vegetation produce oxygen which is necessary for the survival of humans and other living creatures.

Trees can reduce energy use by helping to mitigate the heat island effect that is associated with urban development. Urban areas may be as much as 8–10 degrees warmer than outlying areas due to reduced tree canopy coverage and increased absorption of heat in impervious materials. Trees and other vegetation reduce temperatures by shading pervious surfaces, converting solar energy into carbohydrates and energy, and through evapotranspiration (GHASP 1999). A study by American Forests found that the urban tree cover in Atlanta had a value of $2.8 million based on estimated savings of residents' air-conditioning bills (American Forests 2006). Trees Atlanta reports that strategically planted shade trees can reduce residential cooling costs by 30–40% during the summer months (Southface Energy Institute 2006).

The benefits mentioned above may seem abstract to some developers or property owners. Obviously, the millions of dollars of value in stormwater management and air quality services do not directly impact an individual's pocketbook. The energy savings benefit the person paying the utility bills, but not necessarily the developer. Probably the most significant value of trees and other vegetation to the developer is the impact that they have on property values. The presence of trees on developed lots can increase property values up to 12%, and on undeveloped lots up to 27% (Smardon 1988). Thompson and Sorvig (2000) report similar numbers, stating that healthy vegetated sites have 5–20% higher property values than sites that have been cleared and graded during construction.

LOW-IMPACT LAND DEVELOPMENT

Balancing the need for development with the protection of the environment is not a new concept. Frederick Law Olmsted certainly recognized the need to integrate these two concerns when he advocated for the creation of Central Park in New York and the restoration of the Back Bay Fens in Boston, Massachusetts. Ian McHarg brought a vision and a process for land planning based on the suitability of the land for various uses to the planning professions when he published *Design With Nature* in 1969. Many other practitioners have followed who have contributed valuable techniques, practices, and methodologies to achieve the goal of developing land in an ecologically sensitive, socially functional, and economically viable manner. This section organizes many principles of conservation planning, low-impact development, stormwater management, landscape ecology, and sustainable design into six steps to achieve low impact land development. (See the following references: Arendt 1999; Balmori 2004; CWP 1988; Hinman 2005; McHarg 1969; RMI 1998; Vick 2006; USGBC 2005).

Steps to Achieve Low-impact Land Development

1. **Identify and Understand** the ecological and cultural context of the site.
2. **Preserve** functioning natural processes.
3. **Minimize** the size and severity of the development footprint.
4. **Utilize** built surfaces to contribute to the health of the site.
5. **Mitigate** the remaining impact of development.
6. **Restore and Integrate** natural processes into the everyday experience of the built environment.

Identify and Understand the ecological and cultural context of the site. In order to make responsible decisions about the future of a site, it is important to fully comprehend the variables that influence that site.

Perform a site *inventory and analysis* that clearly characterizes the site, noting existing: vegetation, surface and subsurface hydrology, physiography, soils, wildlife habitat, microclimates, infrastructure, human communities and artifacts, and any other relevant characteristics. Examine the site at least one scale larger and one scale smaller than the one at which you will be designing. For example, if you are developing a land use plan for a small town, you should also look at the regional scale for context and the site scale or specific opportunities or constraints. Analyze all this information to determine the suitability of the site to support the proposed uses.

Become familiar with the *regulatory environment* you are working in. Federal, state, and local laws that may be applicable to your project include: erosion and sediment (E&S) control requirements including NPDES (National Pollution Discharge Elimination System), tree preservation requirements, stream buffer requirements, floodplain requirements, grading/clearing requirements, zoning codes, and more.

Get to know the *needs of your client and other stakeholders* who will use or be affected by your project. Clearly define a site program that will successfully accommodate the proposed use of the site within the existing environmental context. Consider who will provide long-term management/maintenance of the site and how that will occur.

Preserve functioning natural processes. Healthy ecosystems and natural processes provide free ecosystem services that reduce the need for intrusive engineered solutions. Modern development has encroached further into areas that were previously considered unbuildable, threatening intact natural areas. If preserved, these areas may offer amenity benefits that improve the well-being and quality of life of nearby communities. Additionally, conservation of existing vegetation can save the contractor and client money by reducing the amount of money spent on sediment and erosion control and final landscaping (RMI 1998). At the UPS headquarters in Atlanta, careful planning and construction practices tucked the new building into an existing forested site, clearing only the footprint of the building and a narrow staging area. Construction costs were 3–5% over normal due to changes in the architecture to accommodate the strict clearing limits, but these costs were more than recovered in avoided landscape costs (RMI 1998).

The following portions of a site should be the priority for preservation:

- Large tracts of native vegetation that connect and create contiguous riparian protection areas.
- Natural drainage patterns, including streams, floodplains, and wetlands.
- Groundwater recharge areas.
- Good soils—those with high infiltration rates or high fertility.
- Vegetated steep or erodible slopes.
- High quality or rare ecosystems or habitat.
- Large tracts of critical habitat and wildlife habitat area that create or connect contiguous protection areas.
- Productive farmland.

Minimize the size and severity of the development footprint. In order to make it possible to preserve the areas identified in Step 2, it will be necessary to limit the extent of the developed portion of the site through careful planning. At the same time, make every effort to minimize the impact to natural processes within the limits of disturbance by limiting the severity of the development impact.

Planning and Design Phase

When possible, the development footprint should be limited to previously developed portions of a site. On greenfield sites, a key strategy for minimizing the development footprint is cluster development. Local development ordinances may discourage cluster development by requiring large minimum frontages, setbacks, and lot sizes. It is important that policymakers revise these out-of-date ordinances to allow for more flexible and creative planning. Ideally, lot size and density should be separated in zoning ordinances. In other words, an area zoned to allow a density of 1 unit/2 acres should not require two-acre lots. Rather, for a given parcel that is going to be subdivided and developed, smaller lot sizes should be permitted and the overall density of 1 unit/2 acres should not be exceeded. This flexibility will encourage cluster development and facilitate conservation of natural areas. Arendt (1999) encourages discounting constrained land (floodplains, stream buffers, etc.) to prevent allowing more units than would be possible under conventional zoning.

Slope-related ordinances are often used by communities to attempt to control how much of a site may be cleared. Thompson and Sorvig (2000) recommend that grading and clearing regulations should be performance-based—stating a clear minimum vegetated area to be preserved or a maximum disturbed area. Table 2 gives examples of four communities in which minimum *Undisturbed Area Requirements* are set based on the percent slope of the land. Ordinances such as this may be created to accomplish one of three goals: 1) Growth control, 2) Environmental protection and/or 3) Hazard management (Marsh 1998). When they are enacted, it is necessary to also establish a procedure for determining slopes within the jurisdiction or developing a slope map for the entire jurisdiction that will be adhered to, as well as a procedure to review development plans and proposals and to enforce the ordinance.

TABLE 2. Open space requirements for different slope categories in different communities. Redrawn from Marsh (1998); Burks data from Randolph (2004).

Percent Slope (avg.)	Chula Vista, CA	Pacifica, CA	Thousand Oaks, CA	Burks Co., PA
10	14%	32%	32.5%	8–15% slope = 60%
15	31%	36%	40%	
20	44%	45%	55%	15–25% slope = 75%
25	62.5%	57%	70%	
30	90%	72%	85%	25% + slope = 85%
35	90%	90%	100%	
40	90%	100%	100%	

When development does occur on sloping topography, every attempt should be made to minimize the cut and fill necessary to develop the site. Roadways often require significant grading to meet safety standards. The site plan should be designed with an efficient road network that maximizes connectivity and minimizes the total linear feet of roadways. Buildings should be designed to fit the site rather than altering the site to accommodate generic building plans, as shown in the contrasting photos in Figure 3 and Figure 4. Consider orienting the long axis of buildings parallel to contours and staggering floors to work with the slope. If passive solar heating/cooling and natural daylighting are also considerations for the building, careful attention should be paid to maximize these concerns while minimizing grading. Parking may be incorporated into the building footprint by locating it below-grade or on the first floor of the building. Surface parking on sloping topography should be broken into smaller bays that can be terraced down the slope rather than grading the site to accommodate one large lot.

Utility easements and construction access and staging should not be afterthoughts of site planning. Whenever feasible, cluster utilities into common trenches and/or easements. Combine easements with other uses that require clearing such as public roads or multi-use trails. Limit construction access to one route, if possible. Locate access and construction staging where future roads or development will be located.

FIGURE 3. Example of a mass-graded site accommodating a building. Notice the retaining wall on the right property edge and the lack of vegetation on the site.

FIGURE 4. Example of a custom building designed to accommodate the topography of the site. Notice the mature trees that were preserved, approximately ten feet from the footprint of the building.

Construction Phase

Construction is responsible for some of the highest erosion rates that have been measured (Goudie 2000). Erosion on construction sites occurs at rates 2 to 40,000 times greater than pre-construction erosion rates (Wolman and Schick 1967). Even agricultural lands, known to have high rates of erosion, generate 5 to 20 times less sediment per unit volume of runoff than construction sites (Fennessey and Jarrett 1984). Sediment from construction sites ends up in nearby streams and other surface water bodies, degrading aquatic habitat and altering stream morphology. Not only does erosion cause downstream environmental problems, but it also represents a significant loss of resources from the construction site.

Soil, along with air and water, is the media that supports life on this planet. Soil is a living system, including not only a mixture of clay, sand, and loam, but also bacteria and fungi, mites and earthworms, microrhizae, and other living organisms. Undisturbed soils are composed of distinct layers, or horizons. This soil profile consists of the O horizon made up of organic materials such as leaf litter; the A horizon, made up of topsoil containing organic and mineral components; the B horizon, made up of weathered parent material; and the C horizon, made of unmodified parent material. The soil profile develops over time, under favorable conditions reaching a healthy, steady state in 100 to 2000 years (Odum 1997). Unnecessary loss of this resource is a tragedy.

FIGURE 5. Erosion from construction sites is a major source of non-point source pollution.

Appropriate erosion and sediment control should be established either before or immediately after clearing and grading begins and maintained until construction is complete and the final landscaping is established. For large projects, phasing should be required in order to limit the amount of bare earth exposed at any one time.

Erosion is not the only cause of soil degradation during construction. Grading practices disrupt the soil profile, altering the structural and chemical properties of the soil. Soil structure is also altered during construction by compaction. Soil compaction increases the density of the soil, making it less penetrable by roots, limiting the exchange of oxygen and carbon dioxide between roots and the atmosphere, and reducing water infiltration rates (Goudie 2000). Heavy machinery is often the culprit in causing soil compaction, but even foot traffic is capable of causing significant compaction. Several studies have shown that grazed grasslands have considerably lower infiltration rates than ungrazed grasslands due to the compaction from cattle.

Several strategies can help to minimize unnecessary damage due to construction. First and foremost—NO speculative land clearing should be permitted (Figure 6). Clearing of vegetation from development sites should only be permitted based on detailed site plans that include final architectural plans for any buildings. Plans should include prominent limits of clearing indicated on the demolition plan, grading plan, and any other plan that may be used for site work by site contractors.

Determining the limits of clearing should be based on the capabilities of the most appropriate construction equipment possible and careful consideration of the results from Steps 1 and 2. Several publications have provided specific restrictions on grading limits, and these are summarized in Table 3. The practice of restricting development to a defined envelope around the perimeter of a building or other built surface is often referred to as footprint clearing, footprinting, or envelope clearing. It would be difficult to achieve these restrictions with much of the poorly planned development that occurs today. Mass grading flat building pads often requires extensive cut and fill that would extend well beyond these proposed limits.

FIGURE 6. Speculative land clearing such as this should not be permitted. Land clearing for development should only be approved based on complete construction plans for the site.

FIGURE 7. Comparison of tree save areas created by limiting clearing to a 15 ft envelope around the building and driveway footprint at three different densities.

Therefore, footprint clearing restrictions encourages placing buildings on the most suitable portions of a site or customizing the architecture and site improvements to fit the land that they will be built on.

Another positive result of footprint clearing is that it indirectly accommodates density. Proposed land conservation strategies should not interfere with establishing high-density development in suitable areas. Footprinting obeys this rule by being most restrictive in low density greenfield developments in which the limits of disturbance must literally be carved out of the existing vegetation. On the other hand, in high-density developments, where allowable clearing limits overlap, it is still permissible to clear the interior of the site and areas between closely spaced buildings. Pockets of land that fall outside of allowable clearing limits but inside the outer limits of disturbance will serve as valuable remnants of existing vegetation within the development. Figure 7 shows a simple comparison between the effects of footprint clearing at three different residential densities. The comparison assumed a completely wooded site to begin and shows a 1440 sq. ft. house footprint and a 12 ft. wide driveway. A cost comparison looked at the cost of footprint clearing versus completely clearing the site for the three densities (Table 4). The comparison shows a cost savings at all three densities; however, the savings are greatest for the lower density development. It is reasonable to conclude that footprint clearing is an extremely cost-effective development strategy, as well as being environmentally beneficial.

Existing vegetation that is to remain on the site needs to be protected during construction. The most effective procedure involves three levels of protec-

TABLE 3. Selected published clearing and grading limits.

Source	Clearing and grading limits
EarthCraft Community Guidelines (2006)	30′ around building perimeter
LEED v2.2 (2005)	40′ around the building perimeter
	10′ around walkways, parking, and minor utilities
	15′ around primary roads and main utilities
	25′ around porous pavements
The LAND Code (2003)	length of the largest piece of equipment + 5 meters around any built structure or surface
Center for Watershed Protection (1988)	10′ around the building perimeter

TABLE 4. Site development expenses related to clearing either an entire site or a 15 ft. envelope around the building and driveway footprint at three different densities.

Landscape Activity	1/8 acre lot, 1200 sq. ft. footprint home		1/2 acre lot, 1200 sq. ft. footprint home		1 acre lot, 1200 sq. ft. footprint home	
	15′ footprint cleared	entire site cleared	15′ footprint cleared	entire site cleared	15′ footprint cleared	entire site cleared
Tree protection fencing	$352.44	*$0.00	$806.34	$1,388.40	$806.34	$1,666.08
Cut and chip trees up to 12″	$496.85	$575.00	$635.72	$2,300.00	$635.72	$4,600.00
Grub stumps and remove	$318.64	$368.75	$407.69	$1,475.00	$407.69	$2,950.00
Fine grading	$111.88	$141.48	$163.20	$789.60	$163.20	$1,660.80
Turf	$909.03	$1,149.53	$1,326.00	$6,415.50	$1,326.00	$13,494.00
Irrigation	$839.10	$1,061.10	$1,224.00	$5,922.00	$1,224.00	$12,456.00
TOTAL	$3,027.94	$3,295.86	$4,562.95	$18,290.50	$4,562.95	$36,826.88
Savings of footprint clearing	**8% savings**		**75% savings**		**87% savings**	

* Assumes adjacent lots would be developed simultaneously

tion. First, use brightly colored and sufficiently sized fencing to create explicit visual communication of the area to be protected—four foot tall orange construction fencing works well. This area should protect, at a minimum, the critical root zones of all trees that are to be saved. The critical root zone can be determined by measuring a circle around the tree with a radius of 1.25 times the diameter (in inches) of the trunk. Fencing should be in place from pre-construction until final acceptance.

Second, educate the contractors (and subcontractors) that will be working on the site. It is important that all contractors on the site understand the meaning and the importance of the tree preservation areas, not just the clearing and grading contractors. Other activities such as staging, stockpiling materials, and simply driving across the site can have significant impact on trees. Provide signage indicating the purpose of fencing. Conduct on-site job meetings with equipment operators.

FIGURE 8. Examples of poor tree-save fencing installation (left) and proper tree-save fencing installation (right).

When appropriate, require E&S or other training for contractors on the site. Activities that should be prohibited in tree preservation areas include:

- Construction traffic (vehicular or pedestrian)
- Material stockpiling
- Grading
- Trenching
- Rinsing of equipment or disposal of any construction materials (concrete, paint, plastics, etc.)
- Any construction activity!

Finally, incorporate financial motivation into contracts and agreements with contractors to encourage compliance. Incentives or bonuses may be awarded for adhering to stated construction limits. More commonly, monetary penalties are specified for encroachment on preservation areas. This usually takes the form of a unit of measurement and a multiplier. For example, a dollar amount per square foot of encroachment into specified tree preservation areas, or a dollar amount per caliper inch of damaged or destroyed tree. In some cases where significant individual specimen trees need to be protected, consider determining the monetary value of the individual trees to be levied on any contractor who damages or destroys that tree. Resources for determining the value of mature trees are available from the Council of Tree and Landscape Appraisers.

Utilize built surfaces to contribute to the health of the site. Advances in construction materials and practices have made it easy to create multi-functional built surfaces that allow or incorporate natural processes in addition to their primary intended use. For example, use paved parking lots to manage stormwater by using porous pavements. Porous pavements provide the structural capacity necessary for vehicular traffic while they maintain the connection between soil and precipitation, allowing rainwater to infiltrate into the ground, nourish vegetation, and recharge the groundwater table. Use roof surfaces as catchment areas for rainwater harvesting systems to store rainwater on-site where it can be used later for irrigation or other uses. Another multi-functional possibility for roof surfaces is to provide a structure for green roof vegetation—incorporating shelter, stormwater management, heat island mitigation, wildlife habitat, and possibly human recreation into one design solution. Incorporate vegetation into paved surfaces whenever possible. Structural soils allow heavy use and compaction of surfaces, while providing sufficient void space for root growth in planted trees.

Mitigate the remaining impact of development. Despite following the four previous steps, development will still have a significant impact on the structure and function of natural processes on the site. This step involves assessing those impacts and attempting to mitigate them on-site rather than transferring damage to adjacent or downstream properties.

Manage stormwater quantity and quality. Where appropriate, utilize stormwater best management practices (BMPs) to mimic the pre-development hydrology of the site. Bioretention, infiltration basins, vegetated swales, stormwater wetlands, and many other practices should be carefully planned and distributed throughout the site to keep the appropriate amount of stormwater on-site and get it into the ground where it is available to plants and contributes to maintaining groundwater levels. Many incredible sources are available for guidance on low impact stormwater design, some of which are listed at the end of the References section of this article.

Manage preserved natural areas and vegetation for long-term health and sustainability. In most developed areas, a hands-off approach to the management of natural areas is a bad idea. Unmanaged or ignored natural areas will decline due to abuse by people (dumping, off-road vehicles, etc.); introductions of invasive exotic plants, animals, and diseases from adjacent developed areas; alteration of microclimates; alteration of disturbance regimes; fragmentation of habitat; pollution; overexploitation, and other impacts. Instead, these preserved areas should be actively and sensitively managed to combat these threats. It is important to understand the process of succession and to allow preserved areas to partially maintain themselves through the reproduction and recruitment of beneficial species.

Landscape practices that actively discourage succession and development of healthy ecosystems (such as lawns) should be minimized and installed only to the extent that is necessary for functional reasons. For example, manicured turfgrass is justified for ball fields, public spaces that hold large gatherings, and small areas in private yards for recreation, but it is not appropriate for acres of unused corporate landscaping or even for the majority of landscaping on private lots. Designed landscapes that encourage soil development, water infiltration, plant regeneration, and biodiversity are preferred. In an article by J. Keating, David Swenk, a planning and development employee with the County of Santa Barbara, California, states: "Trees provide habitat for diverse species of wildlife; they improve air quality, lower ozone levels, and help cool the city," and asks "With all trees' benefits, it begs the question: Does everyone need a 10,000-square-foot lot of just grass?"

Mitigate soil degradation by amending soils that have been impacted by construction. It may be necessary to mechanically "de-compact" soils by plowing, tilling, or aerating the soil with machinery. It is generally a bad idea to import topsoil from another site because that simply degrades the other site in a sort of game of musical chairs. Instead, it is quite possible to amend existing soils to restore the physical and chemical traits necessary for healthy plant growth and infiltration. Compost may be an important part of soil amendments and can be applied over large areas with pneumatic blower trucks.

Restore and Integrate natural processes into the everyday experience of the built environment. The advancement of engineering and industry over the last century has led to improvement of the quality of life for many Americans; however, it has also severed ties to the environment for many people. With a buffer of conditioned air, tinted windows, altered topography, engineered infrastructure, and manicured landscaping separating us from the environment, nature has become irrelevant to many. However, nature remains a part of our developed landscapes. Weather continues to affect us, and natural processes continue to occur, although in many cases, dysfunctionally.

Design and planning can, and are, beginning to change this disconnect. Designs that recognize the connectivity to other sites and other scales, such as watersheds, no longer succumb to the "out of sight, out of mind" attitude. Developments that preserve natural processes, such as the hydrologic cycle, and make them visible through innovative planning and attractive designs, educate people and reconnect them to the local environmental context in which we live. An educated public and relevant environmental concerns lead to greater stewardship of the land that we depend on. And a widespread ethic of stewardship *is* possible. Consider the effects of soil loss during the dust bowl era. In the early twentieth century, soil loss had become such a problem that the federal government established the Soil Conservation Service in 1930. Through the aggressive and cooperative efforts of the federal government, state governments, land-grant universities, counties, and county agents to educate landowners, new techniques were put into practice, massive rates of soil loss were reduced, and individuals and communities adopted a soil conservation ethic (Odum 1997). Unfortunately, concern waned and an increase in erosion and soil loss occurred in the 1970s due to the industrialization of farming and the large-scale consumption of the countryside by urban sprawl. However, it remains clear that the public is capable of adopting a conservation ethic.

FIGURE 9. Application of compost mulch as a soil amendment and erosion control technique on disturbed soil.

Designs are more meaningful to people if they respect the unique characteristics of the site and the region. One can maintain/enhance a sense of place by using local construction materials that reflect the colors and textures of the region, native plants that have evolved with the region's climate and provide habitat for native wildlife, and development patterns and architecture that respond to local climate, site characteristics, and community needs and values. Most states have Native Plant Societies that can provide detailed lists of appropriate native plants for specific regions of the Country.

CONCLUSION

Land development practices throughout the last half century have resulted in tremendous changes in our landscapes and in the natural processes at work in them. We have, in recent decades, witnessed many of the results of the patterns and practices that have guided development, including: soil loss, vegetation loss, habitat degradation, water and air pollution, and automobile-focused human communities. Due to these results, we are now in an era where it has become our responsibility to rethink the way we build; to accommodate the needs of an ever-growing population in a more sustainable way.

In light of our understanding of 1) the value of undisturbed and restored natural areas, 2) the impact of conventional development, and 3) the proven success of low-impact land development practices and techniques, every land planner and developer has to ask herself or himself the following question: Will the legacy of today's development be stunted and dysfunctional sites or will it be healthy landscapes that nurture and inspire the stewardship of future generations?

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