Avoid Impacts

Minimizing Soil Compaction

Healthy soils, which have not been compacted, perform numerous valuable stormwater functions, including:

- Effectively cycling nutrients
- Minimizing runoff and erosion
- Maximizing infiltration of stormwater and water-holding capacity

- Absorbing and filtering excess nutrients, sediments, and pollutants to protect surface and groundwater
- Providing a healthy root environment
- Creating habitat for microbes, plants, and animals
- Reducing the resources needed to care for turf and landscape plantings.

When soils are overly compacted, the soil pores are destroyed and permeability is drastically reduced. In fact, the runoff response of vegetated areas with highly compacted soils closely resembles that of impervious areas, especially during large storm events.[52]

Minimizing soil compaction is the practice of protecting and minimizing damage to existing soil quality caused by the land development process. Minimizing soil compaction is not only important for drainage of a site and the successful use of other LID site planning and design techniques and structural stormwater BMPs, but also for minimizing impacts to established vegetation. Heavy equipment used within the drip line of a tree can cause soil compaction, resulting in the death of tree roots. Damage done to a tree's root system may take 3 to 4 years after construction to become evident in a tree's canopy. Maintaining healthy soil can significantly reduce the cost of landscaping vegetation (higher survival rate, less replanting) and landscaping maintenance.

Specific techniques to minimize soil compaction include:

- Fencing off an area during construction ("no disturbance areas") to minimize unnecessary soil disturbance and compaction. Vehicle movement, storage, or equipment/material lay-down are not to be permitted in such areas.

- Use of the smallest (lightest) equipment possible and minimizing travel over areas that will be revegetated (e.g., lawn areas) or used for infiltration of stormwater runoff from impervious surfaces such as adjacent pervious areas.

- Prohibiting the use of excavation equipment within the limits of infiltration-based structural stormwater BMPs to avoid compaction of the bottom of the infiltration system. A hydraulic excavator or backhoe loader, operating outside the limits of the infiltration system, should be used to excavate and place materials in the excavation, which should then be raked by hand.

- Restoring soils compacted as a result of construction activities or prior development. This typically requires modification of the underlying soils to restore the pre-development infiltration rate and soil porosity and improve soil quality to support vegetation. The soil should be treated by scarification, ripping (tilling), or use of a shatter-type soil aerator to a depth of 9 to 12 inches or more depending on site and soil conditions. Amendment with 2

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[52] Schueler, T.R. 1995. *Site Planning for Urban Stream Protection*. Metropolitan Washington Council of Governments, Washington, D.C

to 4 inches of topsoil or organic material may be required to improve plant establishment based on soil testing results.

Minimizing Site Disturbance

Land disturbance, including clearing and grading, can dramatically alter the pre-development hydrology of a site, exposing soils to erosion, compacting the soils by heavy equipment, and altering the natural terrain and drainage patterns. The limits of clearing and grading refer to the part of the site where development will occur. This includes impervious areas such as roads, sidewalks, and buildings, as well as pervious areas such as lawn and open drainage systems. Limiting the land area disturbed by development (i.e., development footprint) is most effectively addressed at the site planning level.

Specific techniques for minimizing site disturbance include:

- Land disturbance activities should be limited to only those areas absolutely necessary for construction purposes. The disturbance limits should reflect reasonable construction techniques and equipment needs together with the physical constraints of the development site such as slopes, soils, and natural features to be avoided (including avoiding disturbing topsoil).

- At a minimum, the 100-year floodplain, wetlands and associated buffers, areas with erodible soils, forested areas and other natural open space to be protected, and areas designated for stormwater practices should be protected from disturbance and/or compaction.

- Limits of disturbance may vary by type of development, size of lot or site, and by the specific development feature involved. For example, for sites not previously developed or graded, limit site disturbance with the following recommendations:[53]

  - 40 feet beyond the building perimeter and parking garages

  - 10 feet beyond surface walkways, patios, surface parking and utilities less than 12 inches in diameter

  - 15 feet beyond primary roadway curbs and main utility branch trenches

  - 25 feet beyond constructed areas with permeable surfaces (such as permeable paving areas, infiltration-based stormwater BMPs, and playing fields) that require additional staging areas to limit compaction in the constructed area.

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[53] U.S. Green Building Council (USGBC). 2018. LEED Version 4 for Neighborhood Development. Updated July 2, 2018.

- Use of "site fingerprinting" to minimize land clearing and grading by establishing a limit on the percentage of a parcel that can be developed, ensuring that a minimum percentage of the parcel remains in a natural undisturbed state. This technique reduces clearing to the minimum area required for building and roadway footprints, construction access, and safety setbacks.
    - For example, on previously developed or graded sites, restore or protect a minimum of 50% of the site area (excluding the building footprint) or 20% of the total site area (including building footprint), whichever is greater, with native or adapted vegetation.[53]
- The limits of land disturbance (and no disturbance) should be depicted on the approved site plans and should be delineated in the field with tape, signs, or orange construction fence prior to commencing land disturbance activities. These limits should be reviewed and modified as necessary during a mandatory on-site preconstruction meeting.
- Maintain the area outside the limits of disturbance at natural grade and retain existing, mature vegetated cover.
- As described in the Connecticut Soil Erosion and Sediment Control Guidelines, implement proper construction sequencing to reduce the duration of soil exposure. Construction sequencing is a site-specific work schedule that coordinates the timing of site development related land-disturbance activities and the implementation of temporary and permanent erosion and sediment control measures during any particular phase to minimize soil erosion and sedimentation. Wherever practicable, site construction activities should be phased, with each phase having its own construction sequence and erosion and sediment control measures, to avoid the disturbance of over 5 acres at one time or 3 acres for sites that discharge directly to impaired waters consistent with the requirements of the CT DEEP Construction Stormwater General Permit.
- Existing topsoil should be stored on-site and reused during final grading to the maximum extent practicable. Stockpile areas should be clearly identified on the site plan.
- As-built topographic surveys should be required for site compliance to prevent more cut and/or fill than shown on an approved site plan.
- Existing stands of forest should be identified and protected before construction activity begins to the maximum extent possible.
- Individual large trees (i.e., trees with a Diameter at Breast Height or DBH of 24 inches or greater measured 4.5 ft from the ground surface) should be retained whenever feasible; the area within the drip line, or crown of the tree, should be fenced or roped off to protect trees and their roots from construction equipment.

- Performance bonds should be required to ensure that sites are cleared and graded according to the approved site plan and to cover the replacement cost of trees and other vegetation earmarked for preservation when damaged by construction activities (up to two years after completion of construction).

- Developments that are designed to "fit the terrain" of the site require significantly less grading and soil disturbance than those that are designed without regard for the existing topography. Road patterns should match the landform by placing roadways parallel to contour lines where possible. In doing so, natural drainageways can be constructed along street rights-of-way, thereby reducing the need for storm pipes.

Protecting Sensitive Natural Areas

Sensitive natural areas include woodlands, significant tree species, wetlands and watercourses, floodplains, and other hydrologically sensitive and naturally vegetated areas. Preserving and avoiding land disturbance activities in close proximity to these resources are important strategies for preserving predevelopment hydrology, water quality, important ecological functions, and the natural character and aesthetic value of a site.

Protecting sensitive natural areas involves delineating and defining sensitive natural areas before performing site layout and design. Once sensitive natural areas on a site are delineated, ensure that these areas and native vegetation are protected in an undisturbed state throughout the design, construction, and occupancy stages of a project.

If an area is permanently protected under a conservation easement or other legally enforceable deed restriction that ensures perpetual protection of the proposed area, the project proponent can subtract the conservation area from the total site area when calculating the applicable Water Quality Volume. The easement must clearly specify how the natural area vegetation shall be managed and boundaries will be marked. Managed turf (e.g., playgrounds, regularly maintained open areas) is not an acceptable form of vegetation management. Credits for protecting sensitive natural areas are described in the Section titled LID Site Planning and Design Credits.

Preserving Vegetated Buffers

Vegetated buffers are naturally vegetated areas between developed land and surface waterbodies and wetlands. Vegetated buffers protect water quality by providing shade for cooling, stabilizing banks, mitigating flow rates, and providing for pollutant removal by filtering runoff and promoting infiltration. Vegetated buffers also provide flood storage and wildlife habitat.

Preservation of vegetated buffers involves delineating and preserving naturally vegetated buffers and implementing measures to ensure that buffers and native vegetation are protected throughout planning, design, construction, and occupancy. General guidelines and standards for vegetated buffers include:

- A minimum buffer width of 100 feet as measured from the edge of a resource (wetland, top bank elevation of a stream, etc.) is recommended to preserve most buffer functions. Larger buffer widths (up to 300 feet or more) may be necessary for critical resources such as public drinking water supplies or based on site characteristics such as slope, soils, land use, vegetation type, and other factors.

- The minimum recommended buffer width may not be achievable on existing developed sites. The greatest buffer width that is practical should be maintained and restored and should not be reduced to less than 25 feet or below local or state regulatory requirements.

- Other environmental features important to water quality preservation and enhancement should be included within the buffer, such as the 100-year floodplain and steep slopes.

- Vegetated buffers should be protected during construction. Buffer zones and limits of disturbance should be shown on every drawing within every set of construction plans including, but not limited to, clearing and grading plans and sediment control plans. Buffer limits should be staked out in the field prior to any construction activity. Limits of disturbance should be marked with orange construction fence barriers with accompanying signs.

- The vegetative species should reflect the predevelopment, natural vegetative community present in the area. This can be achieved by either preserving the existing vegetation or managing a disturbed buffer. Disturbed areas should be either planted with native species or allowed to revert to the natural vegetation over time, with an invasive species management plan. Some selective clearing may be allowed in the outer portion of a buffer to allow for removal of dead or diseased trees, especially those that pose a safety hazard.

- Although buffers should remain in a natural vegetated state, certain uses and activity restrictions are appropriate in different zones within the buffer depending on the width and density of vegetation. The inner half of the buffer along the shoreline or bordering wetland should remain as a "no touch" zone, with uses limited to passive recreation such as limited access paths for walking and canoe launches. The outer zone may be managed for heavier foot and bicycle traffic and may be acceptable for stormwater BMPs. Specific uses or activities within the upland review area associated with state jurisdictional wetlands also may be dictated by local inland wetlands and watercourses regulations.

- Design site runoff to enter the buffer as sheet flow. Where necessary, incorporate stormwater BMPs to retain and treat concentrated stormwater inflow to the buffer.

Avoiding Disturbance of Steep Slopes

The potential for soil erosion is significantly increased on slopes of 25% (4H:1V slope) or greater. Development on steep slopes also results in a larger disturbance footprint than development on flatter slopes. Development (clearing, grading, or other soil disturbance) on slopes of 25% or greater should be avoided.

Siting on Permeable and Erodible Soils

Whenever possible, highly erodible soils should be left undisturbed and protected from disturbance during site construction. Gravel soils tend to be the least erodible. As clay and organic matter increase, soil erodibility tends to decrease. Infiltration-based structural stormwater BMPs and pervious areas used for infiltration of runoff from adjacent impervious surfaces should be located on those portions of the site with the most permeable soils.

Protecting Natural Flow Pathways

Natural drainage features such as vegetated swales and channels and natural micro-pools or depressions should be preserved or incorporated into the design of a site to take advantage of their ability to infiltrate and attenuate flows and filter pollutants. Site designs should use and/or improve natural drainage pathways whenever possible to reduce or eliminate the need for stormwater pipe networks. Natural drainage pathways should be protected from significantly increased runoff volumes and flow rates through the use of upstream stormwater BMPs that control runoff volume and flow rate. Level spreaders, erosion control matting, revegetation, outlet stabilization, and check dams can also be used to protect natural drainage features.

Conservation and Compact Development

Compact development is a site development strategy that incorporates smaller lot sizes to reduce overall impervious cover while providing more undisturbed open space and protection of water resources. The strategy relies on mixed-use development patterns, which generate less stormwater than the typical single-use suburban model. In addition to stormwater and water quality benefits, compact development also promotes livability, walkability, and transportation efficiency, including a reduction in greenhouse gas emissions. This approach is also consistent with State of Connecticut policies to promote compact, transit accessible, pedestrian-oriented, mixed use development patterns and land use.

In a residential setting, compact development is referred to as “conservation” or “open space” development. Conservation development concentrates density in one portion of the site while preserving a large percentage of the site as open space. The similar concept of “cluster zoning” was adopted by many communities in the 1980s but did not include clear rationale or objective analysis to determine what open space or natural resources were most important to protect on a site. Conservation development promotes the use of existing opportunities and constraints to shape the final site design.[54] Conservation development is most effective for reducing impervious cover when used in conjunction other LID site design strategies that reduce the impacts of development such as narrower streets and reduced parking. Conservation subdivisions have also been shown to have marketing and sales advantages, as buyers prefer

[54] Rhode Island Department of Environmental Management (RIDEM) and Coastal Resources Management Council (CRMC). 2011. Rhode Island Low Impact Development Site Planning and Design Guidance Manual.

lots close to or facing protected open space. Conservation subdivisions have also been shown to appreciate faster than counterparts in conventional developments.[55]

Municipal land use regulations dictate the extent to which compact development strategies are allowed. Although many communities in Connecticut allow various forms of compact development, communities may need to re-evaluate local zoning and subdivision regulations to effectively promote the use of compact development strategies. The information sources listed at the end of this chapter provide additional information on how communities can modify local land use regulations to promote the use of compact development and related LID site planning and design techniques.