Impervious Cover

Impervious cover is any surface in the landscape that cannot effectively absorb or infiltrate rainfall. This includes driveways, roads, parking lots, rooftops, and sidewalks. When natural landscapes are intact, rainfall is absorbed into the soil and vegetation. These mediums naturally slow down, spread out, and soak up precipitation and runoff. Water percolating into the soil becomes a stable supply of groundwater, and the runoff is naturally filtered of impurities before it reaches creeks, streams, rivers, and bays.

Excess impervious cover creates a landscape that cannot absorb or infiltrate rainfall.

As areas become more developed, the amount of impervious cover increases, and natural filter systems are no longer in place to intercept the runoff. This has serious implications for water quality and flood control. Typical pollutants in runoff from impervious areas include pesticides, oil, litter, fertilizers, sediment, salt, and bacteria. A growing body of scientific literature has shown that groundwater recharge, stream base flow, and water quality measurably change and can decrease as impervious cover increases. Studies have shown a direct relationship between the intensity of development, as indicated by the amount of impervious surface, and the degree of damage in a watershed.

The Implications of Impervious Cover

Water bodies become degraded as the percentage of impervious cover in a watershed increases. Hydrologically, this means reduced volumes of water to recharge base flows and increased runoff from rains, increasing peak flows. These two things, respectively, exacerbate drought and flooding impacts. According to the National Weather Service, major floods can develop from as little as 2.2 inches of rain over a six-hour period in northern Delaware, one-third less precipitation than is needed to trigger the same degree of flooding in less-developed parts of the state. Center for Watershed Protection studies indicate that the size of one-hundred-year floods (or floods that have a one percent chance of occurring in any given year) can potentially double in watersheds with impervious cover levels greater than 20—30 precent.[1]

The other impacts on water quality include chemical, physical, and biological degradation. Chemically, an increased presence of bacteria, nutrients, pathogens, and sediment in receiving waters can limit the viability of drinking water and recreational activities. Physically, decreases in stream bank stability, the amount of large woody debris, and channel roughness consequently lower the quality of habitat available for biologic species. Biologically, species diversity declines, biological interactions are altered, and pollution-tolerant organisms become more prevalent.

Based on research in Delaware and elsewhere, streams can show signs of degradation and can be considered stressed in watersheds where the impervious coverage exceeds 10—15 percent. Impervious cover can be an important and measurable indicator of stream water quality and watershed health. Therefore, it is important to understand the typical percentage of impervious surface associated with various urban and suburban land uses. Table 1 illustrates the typical impervious surface coverage for land uses common in Delaware and other states.

Additional impervious area, in the form of roads, is needed to link dispersed communities

Most developed land uses exceed the threshold of 10—15 percent impervious cover, which defines a healthy watershed or stream system. It may initially appear from Table 1 that dispersed development would be desirable; that building homes on lots of one or two acres with scattered commercial areas (the “sprawl scenario”) would result in the lowest percentage of impervious surface coverage. However, on a regional or watershed level, greater overall water supply and quality protection is achieved through more concentrated development. Under the sprawl scenario, development is spread over a much broader area, and additional impervious area in the form of roads would be needed to link the dispersed houses and communities together. University of Delaware Water Resources Agency research estimates that roadways are typically 50 percent impervious cover, including the median and rights of way. Therefore, dispersed development can result in a significant increase in the total impervious cover in the watershed. Concentrated development results in greater protection for the overall watershed, as a much larger percentage of the watershed is left in its natural condition, preserving water supply and quality. In addition, such centralized development can be directed away from sensitive areas, such as stream banks, to minimize the negative impact on water quality.

Table 1. Typical Percent Impervious Coverage of Land Uses in Delaware

Land Use	% Impervious Cover
Commercial and business district	85%
Industrial	72%
Residential district with 1/8 acre or less lot size (town houses)	65%
1/4 acre lot size	38%
1/3 acre lot size	30%
1/2 acre lot size	25%
1 acre lot size	20%
2 acre lot size	12%

Sources: University of Delaware, Water Resources Agency, 1998; USDA, Soil Conservation Service, TR-55, 1983.

As land-use decision makers are evaluating development projects, it is important that they understand the connection between land use and impervious cover percentages and their impact on water bodies. A decision maker can minimize the percentage of impervious cover and its impact through informed and educated decision making. Being aware of the implications of high percentages of impervious cover in a concentrated area and taking steps to reduce and mitigate it accordingly is a key tool in reducing the negative impacts of impervious cover.

Good Practices for Local Governments

The best management practices (BMPs) for impervious cover address watershed zoning based on impervious cover thresholds, innovative planning approaches, new development, and retrofitting existing development.

Plan

Watershed management and impervious cover thresholds are tools available to assist planners with wise land-use decisions to protect water supplies. Watershed zoning based on impervious cover thresholds is a measurable and scientifically defensible technique to protect stream water quantity and quality in watersheds. Watersheds provide the natural boundaries to guide the land planning decisions that affect stream water quality; after all, watersheds know no political boundaries. By employing these concepts in the county and municipal zoning codes, growth can be concentrated into those areas with existing development and infrastructure and away from the undeveloped watersheds. Proposals are under way to modify the New Castle County Zoning Code to incorporate these watershed-based impervious cover thresholds in the Christina Basin of Delaware.

For stream health and groundwater recharge, it is essential to consider the effect of impervious surfaces on groundwater recharge areas. In order to maximize the amount of groundwater recharge, planning tools and BMPs can be used to minimize the impact of impervious cover on the natural environment by effectively reducing the volume of runoff leaving a site, maintaining the volume of natural recharge, and preventing the discharge of pollutants into the groundwater system. Chapter 6 — Source Water Protection contains information on land-use tools, sediment and stormwater controls, suburban/urban BMPs, and nonregulatory approaches that can be used to maximize groundwater recharge.

Using cluster development to direct impervious cover away from natural resource areas can be an effective planning tool to protect water resources. Cluster development concentrates development and impervious cover rather than dispersing it throughout a site while maintaining designated open-space areas. Cluster development uses a variety of planning and design tools to enable development while minimizing the impacts of the impervious surfaces on water supply and quality. The open-space areas preserve natural resources while maximizing the overland flow of the runoff. This provides infiltration, which results in slowing, holding, and treating the water running off the impervious areas on the site. In order to realize these types of developments, local officials need to incorporate appropriate language into local ordinances and

comprehensive land-use plans (see Chapter 8 — Resources for Writing Ordinances that

Protect Natural Resources). These types of development balance the economic needs of a community while preserving open space and protecting local water resources.

The best management practices and planning techniques described above do not completely eliminate the negative impacts of impervious cover, but as natural areas are continually developed, these techniques should be considered by local land-use planners, decision makers, and developers.

Minimize

Local governments can encourage, assist, or require builders to minimize impervious surfaces. Techniques that can be used to minimize impervious cover include, but are not limited to, reducing the scale of the size of streets, setbacks, parking spaces, lot sizes, driveways, and sidewalks. Creative grading and drainage techniques can be used in order to reduce stormwater runoff and encourage infiltration. Existing subdivision codes, zoning regulations, parking and street standards, and various other regulations may impede some of these impervious cover minimizing techniques. It would be prudent to review these regulations to remove these impediments where appropriate.

Mitigate

Forms of stormwater management, such as green technology, wet ponds, dry ponds, and manufactured BMP devices, are frequently used to mitigate the impacts of impervious surfaces in existing and new developments. Choosing which technique to apply to a specific site is dependent upon the amount of runoff that needs to be intercepted, the lot size, the permeability of the soils, and several other site-specific factors. A more detailed discussion of stormwater management techniques is included in Chapter 5 — Managing Stormwater.

A rain barrel, used to collect runoff from the impervious roof.

Maintain

There are many developed areas that cannot use the plan, minimize, or mitigate strategies to reduce impervious cover. In these areas, it is important to maintain the existing impervious cover in a way that encourages the flow of the runoff through the stormwater system and reduces the pollutant loads in that runoff. There are a variety of stormwater BMPs that can be used to promote flow through the system while providing stormwater treatment for trash, litter, coarse sediment, oil, and other debris before the runoff proceeds through the system. For example, street sweeping seeks to remove the buildup of pollutants that have been deposited along the street or curb, using a vacuum-assisted sweeper truck. Additional tools include catch basin inserts, oil/grit separators, hydrodynamic structures, and a variety of proprietary tools. In addition to these BMP tools, maintaining existing BMPs that mitigate impervious cover impacts, such as wet ponds, dry ponds, and manufactured BMP devices, according to the appropriate maintenance standards is essential to their proper functioning and role in reducing impervious cover impacts. If these stormwater BMP tools are employed and proper maintenance occurs, the impacts of the existing impervious cover runoff can be reduced.

Tradeoffs

Ignoring the negative impacts of increased impervious cover can lead to economic disaster and social difficulties. There are several examples of this in the past few years in northern Delaware, where near-record flooding incidents have resulted in devastation for homeowners and infrastructure. Heavy rains and flash floods have submerged low-lying areas, washed out roads, and swept away bridges. In September 2004, 149 of 159 homes in the Glenville community of northern Delaware became uninhabitable. Homes in the nearby Yorklyn and Hockessin areas were also damaged and uninhabitable. This is a result of increased runoff rates and peak discharge rates (as well as development in the floodplains). The increased impervious surfaces in this area, in addition to flawed planning, have created a situation where the runoff can no longer be absorbed, which, combined with increased peak discharges, results in severe and numerous flooding events. In instances such as this, the area may be in need of federal disaster assistance as well as state and local aid. This will cost the local, county, state, and federal governments, as well as insurance companies, large amounts of money while displacing residents and damaging the community character. Circumstances such as these demonstrate the need to proactively reduce the amount of impervious cover.

The up-front costs of reducing impervious cover through BMP implementation and specific planning techniques can be high, but not necessarily. In some cases, reducing impervious cover and utilizing these thresholds for watershed management can also save money. Roads, sidewalks, and other infrastructure can account for over half the cost of a subdivision. For example, if a 32-foot-wide roadway were narrowed to 30 feet, the savings would be up to $100 per linear foot or up to $528,000 per mile. Reducing the imperviousness of new development not only benefits the environmental health of streams, the economy, and the local community, but it also results in economic savings for the development.[3,4]

Without the use of BMPs, innovative planning techniques, watershed zoning based on impervious cover, and other tools, the negative impacts of impervious cover will become far worse than they are today. In order to protect our communities and water bodies, when possible, it is most beneficial and cost-effective to work to reduce impervious cover thresholds through zoning ordinances and prior to developing sites rather than working to reduce impervious cover impacts after the fact on existing development.

For Further Information

There are numerous resources that provide more information related to the impacts of impervious cover and how to mitigate its impact on the community and local streams. The following web sites are just a few of the resources that contain information about impervious cover:

The Center for Watershed Protection provides local governments and watershed organizations with the technical tools for protecting our streams, lakes and rivers. The

center has developed a multidisciplinary strategy for watershed protection that encompasses watershed planning, watershed restoration, stormwater management, watershed research, better site design, education and outreach, and watershed training.
www.cwp.org

The Delaware Department of Natural Resources and Environmental Control (DNREC) Sediment and Stormwater Program can provide assistance in finding information pertaining to impervious cover.
www.dnrec.state.de.us/DNREC2000/Divisions/Soil/Stormwater/StormWater.htm

The Stormwater Manager's Resource Center (SMRC) provides technical assistance to local governments and stormwater practitioners on stormwater management issues. Created and maintained by the Center for Watershed Protection, the SMRC has everything you need to know about stormwater in a single site.
www.stormwatercenter.net/

The University of Delaware's Institute for Public Administration, Water Resources Agency (IPA-WRA) provides technical assistance for water resources and watershed policy to governments in Delaware and the Delaware Valley.
www.wr.udel.edu

Questions to Ask During the Development Process

- Have the impervious surfaces been minimized?
- Have pervious alternatives been considered?
- What efforts will be taken to minimize site disturbance and soil compaction?
- Are the impervious surfaces located appropriately in relation to the natural resource assessment?
- Are the impervious surfaces located appropriately with respect to groundwater infiltration and recharge areas?
- Have the BMPs that have previously been installed to reduce the impacts of impervious cover been maintained?

References

1. Center for Watershed Protection. March 2003. *Impacts of Impervious Cover on Aquatic Systems*. Watershed Protection Research Monograph No. 1. Ellicott City, Maryland.

2. CH2M-Hill. 1993. *Costs of Providing Government Services to Alternative Residential Patterns.* Committee on Population Growth and Development, USEPA Chesapeake Bay Program. Annapolis, MD. 168 pp.

3. Schueler, T. 1997. Comparative Pollutant Removal Capability of Urban BMPs: A Reanalysis. *Watershed Protection Techniques.* 2(4): 515-520.

4. Schueler, T. 1994. Use of Cluster Development to Protect Watersheds. *Watershed Protection Techniques.* 1(3): 137-140.