LAND USE TOOLS TO PROTECT GROUNDWATER:
PRESERVING RECHARGE

Part 2 of 4 in a Series
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Land Use Tools to Protect Groundwater: Preserving Recharge

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Front Cover Images:
Top: A rain garden in front of a suburban home. (Photo: Minnesota Pollution Control Agency.)
Bottom Left: Permeable interlocking concrete pavement is another tool that helps recharge groundwater in urban areas. (Photo: Michelle DeLaria of the Colorado Association of Stormwater and Floodplain Managers.)
Bottom Center: This parking lot utilizes bioswale in the medians. (Photo: Colorado Association of Stormwater and Floodplain Managers.)
Bottom Right: The Ryerson Woods visitor center in Illinois uses porous asphalt to help preserve groundwater. (Photo: Jessica Dexter, ELPC.)

Back Cover Image: Veer Stock Photography
Introduction

A reliable supply of clean drinking water is a necessity for any growing community. Communities that depend on groundwater for drinking need to ensure that rainfall continues to “recharge” their aquifers as they grow and develop, or else they run the risk of wells drying up.

Geography is the most important factor in groundwater recharge. How water moves across and through the landscape and soaks into the soil obviously depends a great deal on what the terrain looks like (hilly, flat, etc.), what types of soils there are (sandy, clay, etc.) and what development is already on the land. This means that individual counties and municipalities are best suited to design groundwater protections for their citizens. They are also suited to identify and bring community members together to determine and implement the best approach to protect groundwater.

When landscapes are in their natural state, vegetation holds rainwater and melting snow in place, giving the water time to soak into the soil. Some water naturally evaporates, and some is used by plants and trees. The water that makes it past the root zone of surface vegetation is then considered groundwater, which continues to slowly seep down to the shallow or deep aquifers where most communities get their drinking water. This process of replenishing the groundwater supply is called “groundwater recharge.” If our wells

*Generally narrow and long, filter strips slow the rate of runoff, remove pollutants, and help protect surface water and groundwater. Filter strips are commonly used in agriculture, as pictured above, but the concept is beneficial in other types of development — such as parking lot or roadway medians. (Photo: Veer Stock Photography)*

*Under a business as usual scenario, the Illinois State Water Survey predicts adverse effects, including ... degraded water quality and inadequate water supply for community growth.*
use water at a faster rate than the groundwater can be recharged, we risk future water shortages. Under a business as usual scenario, the Illinois State Water Survey predicts adverse effects (including well interference, reduced stream flow, degraded water quality and inadequate water supply for community growth and development) in McHenry and Kendall Counties by 2050.

Unfortunately, when we build on the land surface, natural groundwater recharge becomes difficult. Soils are often compacted, slowing or preventing the downward movement of water. Even worse, most building materials (for example, materials used to build many rooftops, roads, parking lots, driveways, sidewalks, paved patios, and swimming pools) effectively seal off the land surface, allowing no water to seep through at all. These are called impervious surfaces. In modern suburban areas, residential developments would typically cover 12%-60% of a lot with impervious surfaces, while industrial development would cover up to 85% of a lot with impervious surfaces. Studies have shown that in every land use category, the majority of impervious surfaces are dedicated to “car habitat” (roads, driveways, parking lots, etc.). However, with better site design, impervious surfaces can be reduced without impacting the intended land use.

Impervious surfaces reduce the rate of groundwater recharge, and therefore can limit water supply. But increases in impervious surfaces create other kinds of damage as well. Rain that falls on impervious surfaces becomes stormwater runoff. Rather than soaking into the ground where it can be naturally filtered, runoff gathers speed and pollutants (like oil and grease, nitrogen, phosphorus, bacteria and sediment) on impervious surfaces, causing damage downstream. More than 40 studies show a growing scientific consensus that stream degradation (including harm to water quality, aquatic habitat and aquatic species diversity) occurs at a threshold around 10%-15% of impervious surface area in a watershed.

The more we prevent rainwater from soaking into the soil, the greater the volume and velocity of runoff. Greater volume and velocity mean more erosion, greater fluctuations in water levels and an increase in the magnitude and frequency of severe floods. In fact, covering 20%-30% of a land area can double the size of the “one hundred year” flood (the flood that has a 1% chance of occurring in any given year). Greater volumes of water mean more wear and tear on important sewer and stormwater equipment, and flooding can result in expensive damage to roads, bridges and water or sewer lines.

Many of our traditional land use practices treat rain and snow as a waste product, rather than a valuable resource. It has been estimated that, due solely to increases in impervious surfaces over a 15-year period of development in the Chicago metropolitan area, 10 to 24 billion gallons of water (in other words, more than 200 million bathtubs full of water) that could have been used to recharge area aquifers were sent downstream toward the Mississippi River. Our policies need to shift toward a model that encourages recharge over runoff and “keeps water local.”
Fortunately a number of techniques can be used to preserve and promote groundwater recharge on developed sites. The easiest of these is to preserve undisturbed natural areas where water can collect and filter naturally into the ground. Preserving natural areas can provide a number of co-benefits, including aesthetically-pleasing open space, recreational opportunities and ecologically-important habitat. These in turn can have an economic benefit of increasing property values and income from outdoor recreation. Other groundwater recharge features can be incorporated into a site design plan, including vegetative channels and swales, rain gardens, filter strips, porous pavement, and properly-designed dry wells that collect and hold precipitation so that it can soak into the soil.

In order to encourage the techniques that preserve and promote groundwater recharge, communities around the country have developed and used two types of tools to ensure both a vibrant economy and sufficient water supply: Groundwater Recharge Standards and Impervious Surface Performance Standards. The remainder of this paper will discuss those tools in detail. Adopting such policies is critical to groundwater supply protection, but protecting groundwater recharge and limiting impervious surfaces leads to other benefits as well. These benefits include cleaner water, more community open space, healthier rivers and streams, less stormwater to manage, less severe flooding, more reliable base flow for streams and wetlands, and even lower development and maintenance costs.

In order to ensure that our aquifers can continue to provide clean drinking water for our communities and businesses, local governments need to establish groundwater recharge standards for development. Roads, sidewalks and other impervious surfaces (beyond the buildings themselves) can account for over half the cost of a subdivision, and a simple adjustment like reducing a roadway from 32 feet to 30 feet could save a developer up to $100 per linear foot (or $66,000 per city block). Many landscape features that support groundwater recharge also require less time and money in maintenance for homeowners and businesses because native plants require less watering and mowing than traditional lawns.7

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7 A simple adjustment like reducing a roadway from 32 feet to 30 feet could save a developer up to $100 per linear foot (or $66,000 per city block).
In many communities, important groundwater recharge areas have already been paved over. This makes preserving 100% of the recharge potential of the remaining areas especially important. Some communities have adopted a performance standard that simply requires that “new development shall maximize recharge to groundwater.” Others require an applicant to demonstrate that a proposed development will not “adversely affect the recharging of the aquifer.”

While these standards reflect an important objective for development review, both fail to establish a clear target for the amount of recharge that is expected. Reasonable minds may differ as to what constitutes “maximizing” or “adversely impacting” groundwater recharge. Neither policy explains how groundwater recharge will be measured and against what standard, which can lead to confusion and uncertainty and often translates into increased cost and time-consuming challenges during implementation.

A better approach is to establish a performance standard that sets a specific post-construction groundwater recharge goal measured in comparison to the average groundwater recharge on the site prior to development. The best example of this can be found in New Jersey’s stormwater rules, which identify “maintaining groundwater recharge” as one of the

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**Figure 1: New Jersey’s Pre-/Post-Development Groundwater Recharge Calculation Tool**

A screenshot showing the calculation tool for groundwater recharge analysis, demonstrating how pre- and post-development conditions are compared to establish a target for recharge.
explicit goals of the program. Under the New Jersey rules, all major developments (those greater than one acre or that create more than 0.25 acres of impervious surface) must meet minimum performance standards. One of those performance standards requires that a development “maintain 100% of the annual average pre-construction groundwater recharge volume for the site.”11 However, recharge is not allowed in areas with a high contamination risk (such as where hazardous chemicals are stored).

New Jersey’s accompanying stormwater technical manual details the calculation method for comparing the pre-developed hydrologic condition with post-development recharge rates. Applicants enter the location of the proposed development, the area (in acres), the land use(s) and land cover type(s) and the local soil series names into a spreadsheet. The spreadsheet then calculates recharge volumes based on average precipitation data and typical precipitation losses (e.g. through evapotranspiration). This calculation is done for both the existing site and the proposed development. The spreadsheet will then calculate the volume required to be recharged through Best Management Practices (BMPs) in order to attain the 100% recharge performance standard. Groundwater recharge BMPs include dry wells, infiltration basins, and pervious paving systems with storage beds, and the technical manual provides design standards to ensure proper construction - for example requiring that the recharge BMP be designed to pre-treat water to remove pollutants prior to discharge. With the correct data in hand, this process is relatively easy, fast and creates certainty for developers.

Edgewood, Washington also requires that the infiltration rate post-development be the same as the pre-development rate. Crystal Lake, Illinois requires that “at least 95% of the annual stormwater runoff volume from new development should be infiltrated,” and provides a detailed design manual to help accomplish that goal. The State of Wisconsin has adopted a similar but less-protective performance standard in its statewide “Runoff Rules.” In those rules, new or redeveloped residential developments must use BMPs to infiltrate 90% of the pre-development runoff volume, and non-residential (commercial, industrial and institutional) developments and redevelopments must infiltrate 60% of the pre-development volume. However, Wisconsin’s rules suffer from weakening exemptions and very low limitations on the amount of land area necessary to infiltrate runoff. Given that a substantial portion of important groundwater recharge areas have been functionally paved over, the remaining recharge potential must be preserved. The best way to ensure that remaining groundwater recharge potential is preserved is to require future development to maintain 100% of the pre-development recharge volume.

RESOURCES:
Groundwater Recharge Standards

NEW JERSEY ADMINISTRATIVE CODE 7:8

NEW JERSEY STORMWATER BEST MANAGEMENT PRACTICES MANUAL, Chapter 6 “Groundwater Recharge” (April 2004)

EDGEWOOD, WASHINGTON,
Municipal Code Section 14.50.040
http://www.codepublishing.com/wa/edgewood/

WISCONSIN ADMINISTRATIVE CODE, NR 151.12 (c)
http://legis.wisconsin.gov/rsb/code/nr/nr151.PDF

CITY OF CRYSTAL LAKE, ILLINOIS STORMWATER INFILTRATION DESIGN MANUAL
What Does 15% Impervious Surface Area Look Like on a Typical McHenry County Lot?

22,446 sqft
average total lot size

3,367 sqft
15% of average lot size dedicated to house, garage, pavement and other impervious surfaces.

Graphic: Margot Harrington
Land use regulations that aim to protect water quality and/or groundwater recharge by limiting the allowed percentage of impervious surfaces on a parcel are relatively common. Typically these standards are located in zoning ordinances, stating simply that “impervious surfaces shall not constitute more than X% of the lot area.” Some limitations apply only within a particular special protection zone, such as a watershed or aquifer protection area. Some communities also have established different impervious surface limitations for different land uses. But as discussed above, limiting imperviousness has numerous benefits in quantity and quality that extend to both surface and groundwater, so a generally-applicable standard would reap the greatest benefit.

The biggest question in developing this performance standard is deciding what percentage of impervious surface should be allowed. The best-supported limitation is about 10%-15% impervious surfaces on a given lot, as many scientific studies have shown degradation of surface waters at those levels of imperviousness. A substantial number of local governments have adopted an impervious surface limit of 10% or 15% for at least some subsegment of development, including Langlade County, Wisconsin; Wolfeboro, New Hampshire; Northborough, Massachusetts; San Marcos, Texas; Santa Cruz County, California; Austin, Texas; Wake County, North Carolina; and Sanbornton, New Hampshire. An impervious surface limit of 20%-25% is also fairly common, although that level of imperviousness risks real impacts of flooding and water quality degradation. When choosing a percentage limit, decisionmakers should consider what percentage of a watershed has already been converted to impervious surface and the amount of future imperviousness likely to be developed outside of the scope of the new limitation (e.g. public roads).

Limiting a percentage of impervious area is the most important aspect of these types of protections, but setting an ultimate cap is important to ensure that development of a large lot will not lead to a harmful amount of impervious surface within a watershed. For example, a municipality or county may limit impervious surfaces to 15% of lot area or 4000 square feet, whichever is less.

RESOURCES: Impervious Surface Limits

**Wisconsin DNR**, Impervious Surface Area Standards (2000)

**Town of Sanbornton, New Hampshire**, Article 12 Aquifer Conservation District (D)

**City of Austin, Texas**, Ordinance, §30-5-511 (Save our Springs Initiative)
http://www.amlegal.com/austin_tx/

Should a County or Municipality Have Both a Groundwater Recharge Standard and an Impervious Surface Limit?

Generally, yes, adopting both protections is the best practice. A limitation on impervious surfaces alone will help preserve groundwater recharge, but does not in itself ensure that no groundwater recharge capacity is lost. Adopting a groundwater recharge standard without an impervious surface limitation would accomplish the recharge objectives, but wouldn’t guarantee the additional water quality benefits provided by reducing impervious surfaces.

A number of communities have adopted both types of standards, including many Wisconsin counties (which have adopted impervious limitations in addition to the statewide recharge standards) and the City of Crystal Lake, Illinois.

Figure 2: Using Dry Well Technology to Facilitate Recharge of Rainwater from a Rooftop

Graphic: Margot Harrington
Removing Barriers from Existing Stormwater and Zoning Requirements

Groundwater recharge standards and impervious surface limits will achieve the greatest benefit with the least effort if zoning and stormwater ordinances are reviewed to remove requirements that are inconsistent with the groundwater recharge and water quality goals. For example, many communities have historically required downspouts from roofs to be connected to storm sewers. By removing this requirement and offering incentives to disconnect downspouts, communities like Portland, Oregon have saved millions of dollars in sewer, stormwater and water utility improvements that would have otherwise been necessary. Other zoning requirements - such as street width requirements, setbacks, and minimum parking requirements - may inadvertently require more impervious surfaces to be developed than are necessary.

On the surface, it may seem like large lot zoning (e.g. 2 acre or 5 acre minimum requirement for residential development) would be the best choice to keep land area open and encourage groundwater recharge. However, at the regional level, low density development actually creates the need for more impervious surfaces than thoughtfully-concentrated development because the dispersed developments need longer streets, sewers and sidewalks to serve the same number of people.

Groundwater recharge standards should always be accompanied with strong protections against aquifer contamination. Zoning ordinances should ensure that high-risk land uses are not located in important groundwater recharge areas and that all contamination risks are subject to best management practices. Examples of these types of safeguards are discussed at length in ELPC’s report, *Land Use Tools to Protect Groundwater: Overlay Districts*. 

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Top: Permeable interlocking concrete pavers create an attractive patio. (Photo: Colorado Association of Stormwater and Floodplain Managers)

Right: Lake County Forest Preserve District uses porous asphalt for the visitor center parking lot at Ryerson Woods. (Photo: Jessica Dexter, ELPC)
How Should Groundwater Recharge Protections be Adopted?

Groundwater recharge performance standards and impervious surface limitations can be adopted using stormwater management authority or zoning authority. Choosing the appropriate method will require an examination of the authority in your community as well as existing zoning and stormwater requirements. For example, it may make more sense to incorporate either standard into a well-developed stormwater ordinance where relevant definitions have already been established or where a development review process for similar issues already functions smoothly.

Illinois counties have authority to establish zoning restrictions to protect the public health, safety and welfare. Municipalities have explicit authority to use zoning to reduce “the hazards to persons and damage to property resulting from the accumulation or runoff of storm or flood waters” in addition to the standard public health, safety and welfare language. Courts around the country have held that protecting drinking water quality or supply is a valid zoning objective to protect public health, safety and welfare. If groundwater recharge standards and impervious surface limitations are to be adopted through zoning mechanisms, they should at least apply within identified Groundwater Protection Overlay Districts. However, because both policies have multiple benefits in managing stormwater and keeping surface water clean, it may make sense to apply them generally to all development.

Illinois counties have authority to create stormwater ordinances, but municipalities can adopt standards that are more stringent. Counties and municipalities will have to examine their stormwater management plans and statutory authority to determine the best way to adopt groundwater recharge and impervious surface performance standards to protect groundwater supply for their communities.

RESOURCES

DELAWARE NEMO GUIDE TO NATURAL RESOURCE BASED PLANNING, Chapter 2: Impervious Cover

THE IMPORTANCE OF IMPERVIOUSNESS, WATERSHED PROTECTION TECHNIQUES 1(3):100-111
http://www.stormwatercenter.net/Practice/1-Importance%20of%20Imperviousness.pdf

CAPPIELLA, KAREN AND KENNETH BROWN, Center for Watershed Protection, Impervious Cover and Land Use in the Chesapeake Bay Watershed (2001)


1 CMAP, Northeastern Illinois Regional Water Supply/Demand Plan, 43 (March 2010) available at http://www.cmap.illinois.gov/regional-water-supply-planning. (“The most immediate and problematic consequences are likely to be greater drawdown interference, additional streamflow capture, and attendant degradation of local surface water and ecosystem quality. Longer term, it is conceivable that inadequate local water supplies will limit growth and development opportunities without utilizing new sources of water.”)

2 Delaware NEMO Guide to Natural Resource Based Planning, Impervious Cover, 2-2.

3 The Importance of Imperviousness, Watershed Protection Techniques 1(3):100-111 (63%-70% of impervious land area dedicated to transport) and Center for Watershed Protection, Impervious Cover and Land Use in the Chesapeake Bay Watershed iii-iv (2001) (55%-75% of impervious land area dedicated to car habitat).


5 Delaware NEMO Guide to Natural Resource Based Planning, Impervious Cover, 2-1.


7 The Center for Watershed Protection estimates that annual maintenance costs for natural open space are $75 an acre, compared to $240-270/acre for lawns.

8 For further discussion of performance standards designed to protect groundwater, see our previous publication, “Land Use Tools to Protect Groundwater: Overlay Districts” available at elpc.org.

9 Cape Cod Commission Model Aquifer Protection Bylaw, 10.1(c).

10 Cowlitz County, Washington Code Chapter 19.15.160 (D)(1).

11 New Jersey Administrative Code 7:8-5.4 (a)(2). The performance standard provides the alternative of infiltrating the increase of volume for the two-year storm, but for ease of discussing the principle we focus here on the 100% recharge performance standard.


13 55 ILCS 5/5-12001.

14 65 ILCS 5/11-13-1.


16 See our prior publication, “Land Use Tools to Protect Groundwater: Overlay Districts.”

17 55 ILCS 5/5-1062 and 1062.2.
Almost 40 years after Congress passed the Clean Water Act, much work still remains to be done to achieve its mission: restoring and maintaining the nation's waters in order to protect fish and wildlife and safeguard health, safety and enjoyment for people. ELPC's team of attorneys, policy advocates, and communications experts are working to help realize that goal through advocacy to protect and preserve rivers, lakes and streams throughout the U.S. and nationally.

ELPC's Clean Water Team generally works on four fronts.

**First, we work to build the capacity of people to participate more effectively in the public policy process.** This ultimately strengthens the sustainability of our work.

**Second, we work to advance “anti-degradation” rules,** which are meant to maintain the existing quality of pristine waterways and prevent unnecessary new pollution. Often, state officials have ignored this part of the Clean Water Act, but ELPC attorneys have extensive experience developing and working to implement strong rules.

**Third, we work to upgrade water quality standards.** Strong standards ensure state environmental agencies and local municipalities are considering the cumulative impacts of water pollution.

**Finally, we work to implement existing water quality standards.** ELPC attorneys work with state environmental agencies and local municipalities to review permits and ensure they are enforced appropriately.

Today, many waterways have poor water quality and decreasing biological diversity caused by pollution from agriculture, industry, transportation systems, urban runoff, sprawling development and municipal sewage treatment plants. But state and federal procedures exist to prevent harmful pollution and maintain our healthy waterways. ELPC is a public interest watchdog working to ensure those rules are implemented for the well-being of our environment, our economy, and our communities.

For more information, please visit our website: www.ELPC.org/water.
The Environmental Law & Policy Center is the Midwest’s leading public interest environmental legal advocacy and eco-business innovation organization. We develop and lead successful strategic advocacy campaigns to improve environmental quality and protect our natural resources. We are public interest environmental entrepreneurs who engage in creative business dealmaking with diverse interests to put into practice our belief that environmental progress and economic development can be achieved together. ELPC’s multidisciplinary staff of talented and experienced public interest attorneys, environmental business specialists, public policy advocates and communications specialists brings a strong and effective combination of skills to solve environmental problems.

ELPC’s vision embraces both smart, persuasive advocacy and sustainable development principles to win the most important environmental cases and create positive solutions to protect the environment. ELPC’s teamwork approach uses legal, economic and public policy analysis, and communications advocacy tools to produce successes. ELPC’s strategic advocacy and business dealmaking involves proposing solutions when we oppose threats to the Midwest environment. We say “yes” to better solutions; we don’t just say “no.”

ELPC was founded in 1993 and has achieved a strong track record of successes on national and regional clean energy development and pollution reduction, transportation and land use reform, and natural resources protection issues. ELPC’s creative public advocacy effectively links environmental progress and economic development together and improves the quality of life in our Midwestern communities.