



Draft

**Impervious Cover Assessment
for
Deal Lake Watershed**

*Prepared for the Deal Lake Watershed Alliance by the
Rutgers Cooperative Extension Water Resources Program*

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Introduction

Pervious and impervious are terms that are used to describe the ability or inability of water to flow through a surface. When rainfall hits a surface, it can soak into the surface or flow off the surface. Pervious surfaces are those which allow stormwater to readily soak into the soil and recharge groundwater. When rainfall drains from a surface, it is called “stormwater” runoff (Figure 1). An impervious surface can be any material that has been placed over soil that prevents water from soaking into the ground. Impervious surfaces include paved roadways, parking lots, sidewalks, and rooftops. As impervious areas increase, so does the volume of stormwater runoff.



Figure 1: Stormwater draining from a parking lot

New Jersey has many problems due to stormwater runoff, including:

- **Pollution**: According to the 2010 New Jersey Water Quality Assessment Report, 90% of the assessed waters in New Jersey are impaired, with urban-related stormwater runoff listed as the most probable source of impairment (USEPA, 2013). As stormwater flows over the ground, it picks up pollutants including animal waste, excess fertilizers, pesticides, and other toxic substances. These pollutants are then able to enter waterways.
- **Flooding**: Over the past decade, the state has seen an increase in flooding. Communities around the state have been affected by these floods. The amount of damage caused has also increased greatly with this trend, costing billions of dollars over this time span.

- Erosion: Increased stormwater runoff causes an increase in the velocity of flows in our waterways. The increased velocity after storm events erodes stream banks and shorelines, degrading water quality. This erosion can damage local roads and bridges and cause harm to wildlife.

The primary cause of the pollution, flooding, and erosion problems is the quantity of impervious surfaces draining directly to local waterways. New Jersey is one of the most developed states in the country. Currently, the state has the highest percent of impervious cover in the country at 12.1% of its total area (Nowak & Greenfield, 2012). Many of these impervious surfaces are directly connected to local waterways (i.e., every drop of rain that lands on these impervious surfaces ends up in a local river, lake, or bay without any chance of being treated or soaking into the ground). To repair our waterways, reduce flooding, and stop erosion, stormwater runoff from impervious surfaces has to be better managed. Surfaces need to be disconnected with green infrastructure to prevent stormwater runoff from flowing directly into New Jersey's waterways. Disconnection redirects runoff from paving and rooftops to pervious areas in the landscape.

Green infrastructure is an approach to stormwater management that is cost-effective, sustainable, and environmentally friendly. Green infrastructure projects capture, filter, absorb, and reuse stormwater to maintain or mimic natural systems and to treat runoff as a resource. As a general principal, green infrastructure practices use soil and vegetation to recycle stormwater runoff through infiltration and evapotranspiration. When used as components of a stormwater management system, green infrastructure practices such as bioretention, green roofs, porous pavement, rain gardens, and vegetated swales can produce a variety of environmental benefits. In addition to effectively retaining and infiltrating rainfall, these technologies can simultaneously help filter air pollutants, reduce energy demands, mitigate urban heat islands, and sequester carbon while also providing communities with aesthetic and natural resource benefits (USEPA, 2013).

The first step to reducing the impacts from impervious surfaces is to conduct an impervious cover assessment. This assessment can be completed on different scales: individual lot, municipality, or watershed. Impervious surfaces need to be identified for stormwater management. Once impervious surfaces have been identified, there are three steps to better manage these surface

1. ***Eliminate surfaces that are not necessary.*** For example, a paved courtyard at a public school could be converted to a grassed area.
2. ***Reduce or convert impervious surfaces.*** There may be surfaces that are required to be hardened, such as roadways or parking lots, but could be made smaller and still be functional. A parking lot that has two-way car ways could be converted to one-way car ways. There also are permeable paving materials such as porous asphalt, pervious concrete, or permeable paving stones that could be substituted for impermeable paving materials (Figure 2).
3. ***Disconnect impervious surfaces from flowing directly to local waterways.*** There are many ways to capture, treat, and infiltrate stormwater runoff from impervious surfaces. Opportunities may exist to reuse this captured water.



Figure 2: Rapid infiltration of water through porous pavement is demonstrated at the USEPA Edison New Jersey test site

Deal Lake Impervious Cover Analysis

Located in eastern Monmouth County, New Jersey, adjacent to the Atlantic Ocean, the Deal Lake Watershed covers approximately 6.9 square miles with seven different communities (i.e., City of Asbury Park, Village of Loch Arbour, Borough of Allenhurst, Borough of Deal, Borough of Interlaken, Neptune Township, and Ocean Township). Figures 3 and 4 illustrate that the Deal Lake Watershed is dominated by urban land uses. A total of 78.1% of the municipality's land use is classified as urban. Of the urban land in the Deal Lake Watershed, medium density residential is the dominant land use (Figure 5).

The literature suggests a link between impervious cover and stream ecosystem impairment starting at approximately 10% impervious surface cover (Schueler, 1994; Arnold and Gibbons, 1996; May et al., 1997). Impervious cover may be linked to the quality of lakes, reservoirs, estuaries, and aquifers (Caraco et al., 1998), and the amount of impervious cover in a watershed can be used to project the current and future quality of streams. Based on the scientific literature, Caraco et al. (1998) classified urbanizing streams into the following three categories: sensitive streams, impacted streams, and non-supporting streams. Sensitive streams typically have a watershed impervious surface cover from 0-10%. Impacted streams have a watershed impervious cover ranging from 11-25% and typically show clear signs of degradation from urbanization. Non-supporting streams have a watershed impervious cover of greater than 25%; at this high level of impervious cover, streams are simply conduits for stormwater flow and no longer support a diverse stream community.

The New Jersey Department of Environmental Protection's (NJDEP) 2012 land use/land cover geographical information system (GIS) data layer categorizes the Deal Lake Watershed into many unique land use areas, assigning a percent impervious cover for each delineated area. These impervious cover values were used to estimate the impervious coverage for the Deal Lake Watershed. Based upon the 2012 NJDEP land use/land cover data, approximately 32.2% of the Deal Lake Watershed has impervious cover. This level of impervious cover suggests that the streams in the Deal Lake Watershed are likely non-supporting streams.

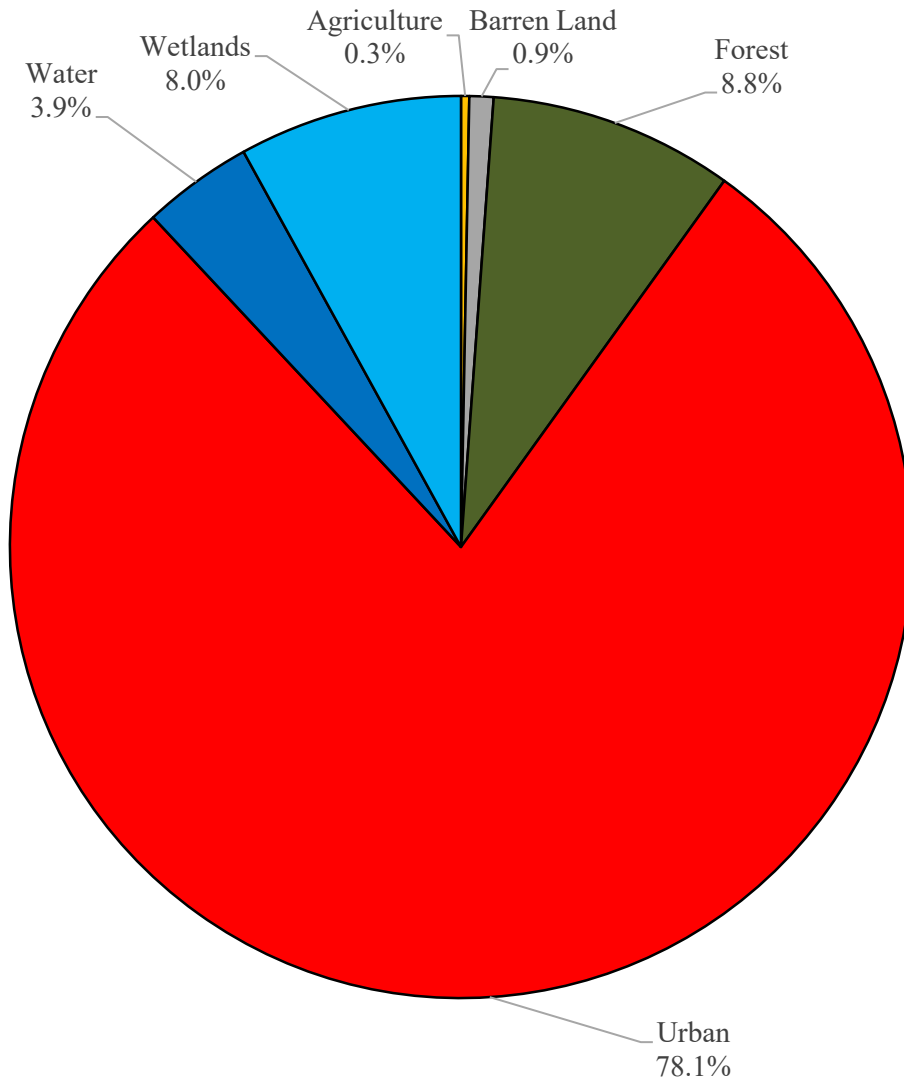


Figure 3: Pie chart illustrating land use in the Deal Lake Watershed

Land Use Types of the Deal Lake Watershed

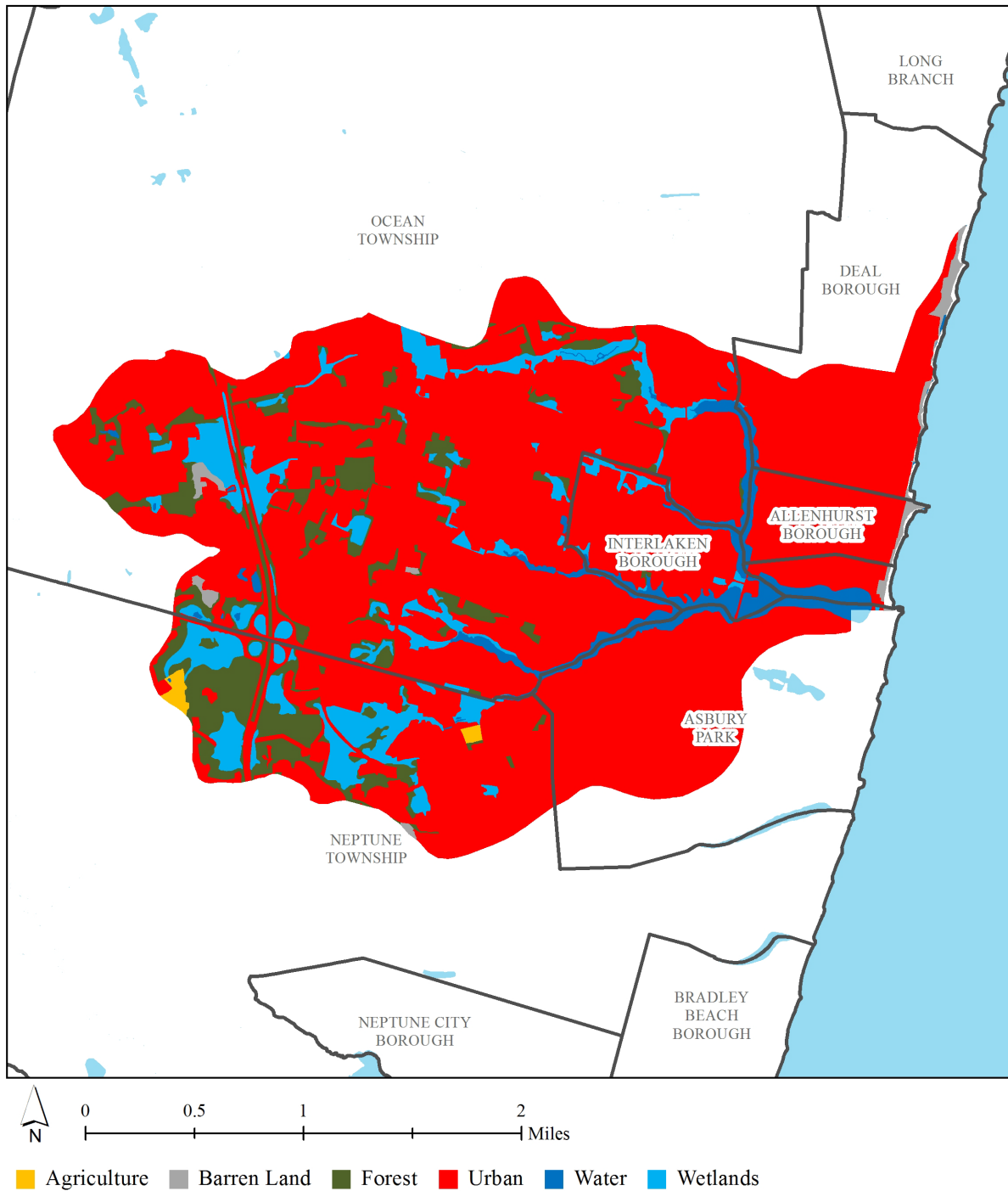


Figure 4: Map illustrating land use in the Deal Lake Watershed

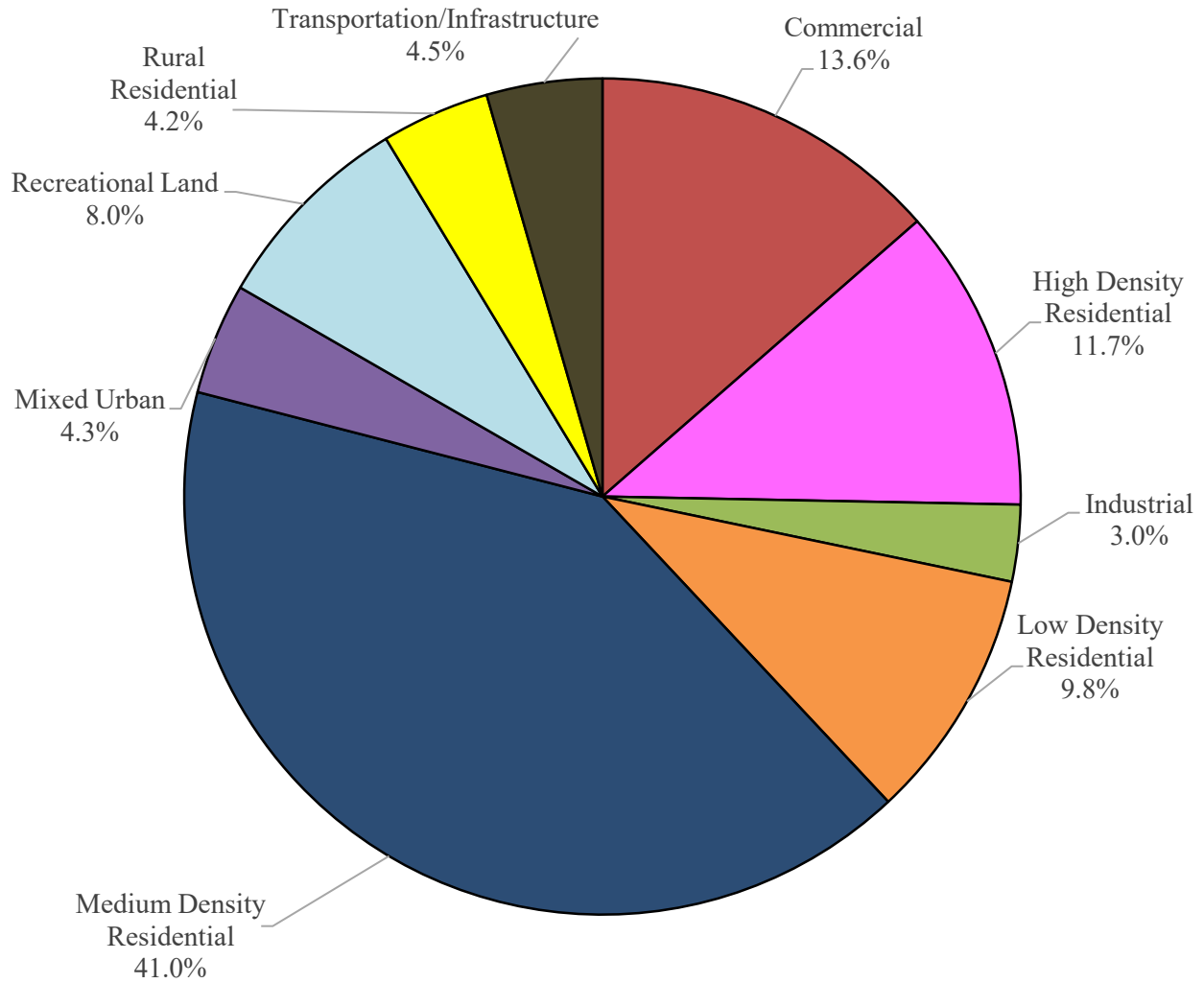


Figure 5: Pie chart illustrating the various types of urban land use in the Deal Lake Watershed

The Deal Lake Watershed consists of land area in seven different municipalities; therefore an impervious cover analysis was performed for each municipality within the Deal Lake Watershed (Table 1 and Figure 6). On a municipal basis, impervious cover ranges from 25.2% in Interlaken Borough to 55.7% in Asbury Park. Evaluating impervious cover on a municipal basis allows a municipality to focus impervious cover reduction or disconnection efforts in areas directly affecting the Deal Lake Watershed.

Table 2 shows the seven municipalities located within the Deal Lake Watershed. In this table, *Land Area* indicates the amount of land from each municipality located within the Deal Lake

Watershed. Similarly, *Impervious Cover* indicates the amount of *Land Area* that is classified as impervious. *Percent IC Contributed Areas* equates to the percentage of impervious cover in the specified municipality as it relates to the total. For example, although the City of Asbury Park only contributes 10.8 % of the total land area for the Deal Lake Watershed, 18.0% of that land is classified as impervious. This is particularly helpful for regional efforts when looking to prioritize implementation.

Table 1: Impervious cover analysis by municipality for Deal Lake Watershed

Municipality	Total Area		Land Use Area		Water Area		Impervious Cover		
	(ac)	(mi ²)	(ac)	(mi ²)	(ac)	(mi ²)	(ac)	(mi ²)	(%)
Allenhurst Borough	163.9	0.26	155.8	0.24	8.1	0.01	57.4	0.09	36.8%
Asbury Park	476.4	0.74	443.5	0.69	32.9	0.05	247.0	0.39	55.7%
Deal Borough	317.4	0.50	311.5	0.49	6.0	0.01	80.1	0.13	25.7%
Interlaken Borough	254.6	0.40	211.5	0.33	43.1	0.07	53.3	0.08	25.2%
Lock Arbour Village	70.9	0.11	52.9	0.08	18.0	0.03	19.6	0.03	37.0%
Neptune Township	748.9	1.17	747.3	1.17	1.6	0.00	193.4	0.30	25.9%
Ocean Township	2,398.2	3.75	2,332.9	3.65	65.3	0.10	719.2	1.12	30.8%
Total	4,430.5	6.92	4,255.5	6.65	175.0	0.27	1,370.0	2.14	32.2%

Table 2: Impervious Cover contributed by municipality in Deal Lake Watershed

Municipality	Land Area (acres)	Impervious Cover (acres)	Percent Impervious Cover	Percent Contributed Total Acres	Percent IC Contributed Acres
Allenhurst Borough	163.90	57.40	35.0%	3.7%	4.2%
Asbury Park	476.36	246.94	51.8%	10.8%	18.0%
Deal Borough	317.43	80.07	25.2%	7.2%	5.8%
Interlaken Borough	254.62	53.31	20.9%	5.7%	3.9%
Lock Arbour Village	70.95	19.61	27.6%	1.6%	1.4%
Neptune Township	748.86	193.39	25.8%	16.9%	14.1%
Ocean Township	2,398.25	719.24	30.0%	54.1%	52.5%
Total	4,430.37	1,369.96	30.9%		

In developed landscapes, stormwater runoff from parking lots, driveways, sidewalks, and rooftops flows to drainage pipes that feed the sewer system. The cumulative effect of these impervious surfaces and thousands of connected downspouts reduces the amount of water that can infiltrate into soils and greatly increases the volume and rate of runoff that flows to waterways. Stormwater runoff volumes (specific to the Deal Lake Watershed) associated with impervious surfaces were calculated for the following storms: the New Jersey water quality design storm of 1.25 inches of rain, an annual rainfall of 44 inches, the 2-year design storm (3.4 inches of rain), the 10-year design storm (5.2 inches of rain), and the 100-year design storm (8.9 inches of rain). These runoff volumes are summarized in Table 3. A substantial amount of rainwater drains from impervious surfaces in the Deal Lake Watershed. For example, if the stormwater runoff from one water quality storm (1.25 inches of rain) in Ocean Township was harvested and purified, it could supply water to 223 homes for one year¹

¹ Assuming 300 gallons per day per home

Municipalities of the Deal Lake Watershed

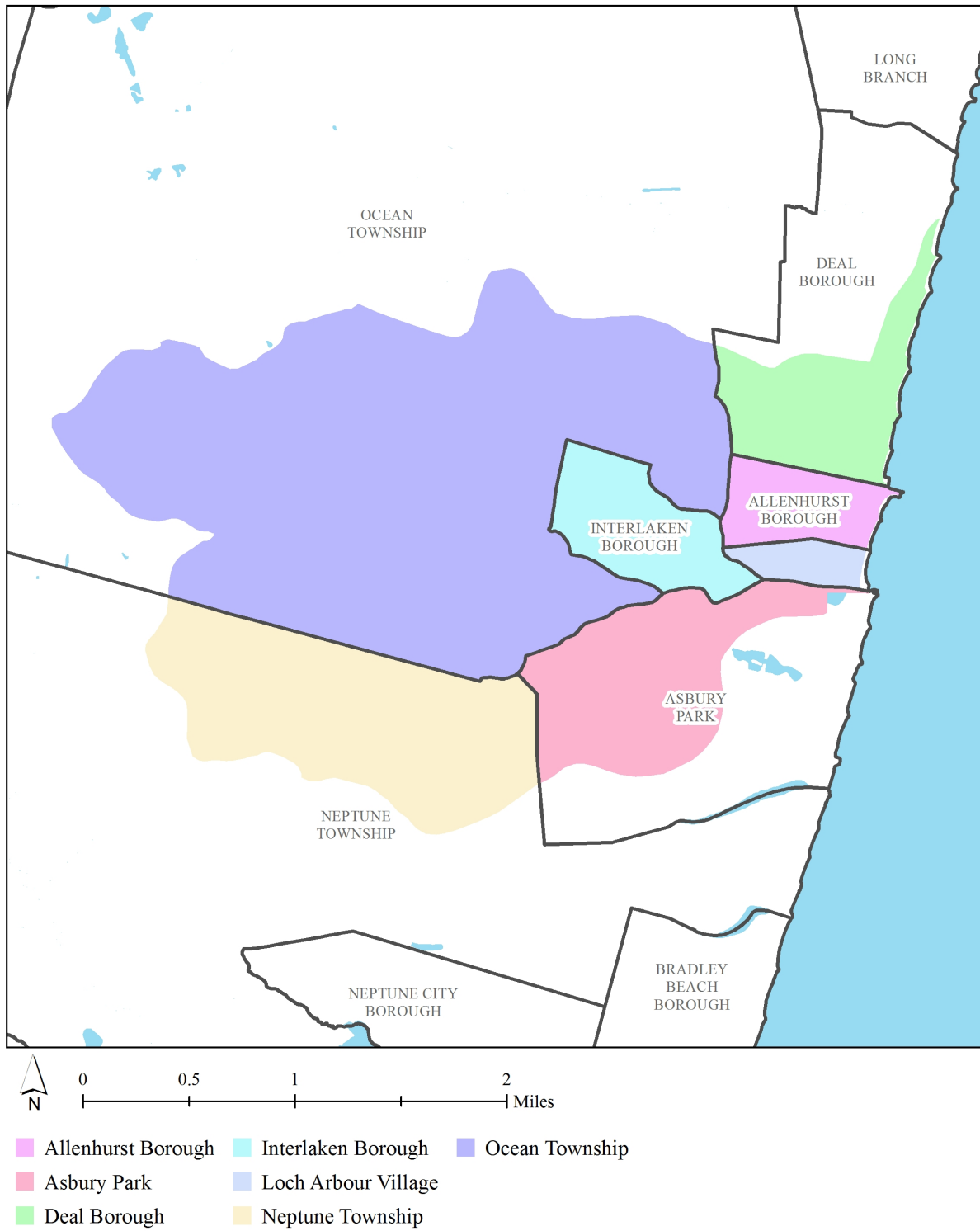


Figure 6: Map of the municipalities in the Deal Lake Watershed

Table 3: Stormwater runoff volumes from impervious surfaces by municipality in the Deal Lake Watershed

Municipality	Total Runoff Volume for the 1.25" NJ Water Quality Storm (MGal)	Total Runoff Volume for the NJ Annual Rainfall of 44" (MGal)	Total Runoff Volume for the 2-Year Design Storm (3.4") (MGal)	Total Runoff Volume for the 10-Year Design Storm (5.2") (MGal)	Total Runoff Volume for the 100-Year Design Storm (8.9") (MGal)
Allenhurst Borough	1.9	68.6	5.3	8.1	13.9
Asbury Park	8.4	295.0	22.8	34.9	59.7
Deal Borough	2.7	95.7	7.4	11.3	19.4
Interlaken Borough	1.8	63.7	4.9	7.5	12.9
Lock Arbour Village	0.7	23.4	1.8	2.8	4.7
Neptune Township	6.6	231.1	17.9	27.3	46.7
Ocean Township	24.4	859.3	66.4	101.6	173.8
Total	46.5	1,636.8	126.5	193.4	331.1

The next step is to set a reduction goal for impervious area in each municipality. Based upon the Rutgers Cooperative Extension (RCE) Water Resources Program's experience, a 10% reduction would be a reasonably achievable reduction for these municipalities in the Deal Lake Watershed. While it may be difficult to eliminate paved areas or replace paved areas with permeable pavement, it is relatively easy to identify impervious surfaces that can be disconnected using green infrastructure practices. For all practical purposes, disconnecting an impervious surface from a storm sewer system or a water body is an “impervious area reduction.” The RCE Water Resources Program recommends that all green infrastructure practices that are installed to disconnect impervious surfaces should be designed for the 2-year design storm (3.4 inches of rain over 24-hours). Although this results in management practices that are slightly over-designed by NJDEP standards, which require systems to be designed for the New Jersey water quality storm (1.25 inches of rain over 2-hours), these systems will be able to handle the increase in storm intensities that are expected to occur due to climate change. By designing these management practices for

the 2-year design storm, these practices will be able to manage 95% of the annual rainfall volume. The recommended annual reductions in runoff volumes are shown in Table 4.

As previously mentioned, once impervious surfaces have been identified, the next steps for managing impervious surfaces are to 1) eliminate surfaces that are not necessary, 2) reduce or convert impervious surfaces to pervious surfaces, and 3) disconnect impervious surfaces from flowing directly to local waterways.

Elimination of Impervious Surfaces

One method to reduce impervious cover is to “depave.” Depaving is the act of removing paved impervious surfaces and replacing them with pervious soil and vegetation that will allow for the infiltration of rainwater. Depaving leads to the re-creation of natural space that will help reduce flooding, increase wildlife habitat, and positively enhance water quality as well as beautify neighborhoods. Depaving also can bring communities together around a shared vision to work together to reconnect their neighborhood to the natural environment.

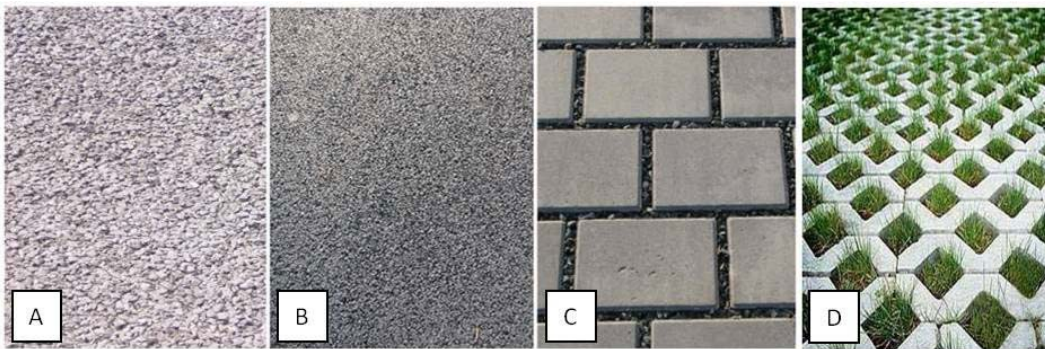
Table 4: Impervious cover reductions by municipality in the Deal Lake Watershed

Municipality	Recommended Impervious Area Reduction (10%) (ac)	Annual Runoff Volume Reduction² (Mgal)
Alленhurst Borough	5.7	6.5
Asbury Park	24.7	28.0
Deal Borough	8.0	9.1
Interlaken Borough	5.3	6.0
Lock Arbour Village	2.0	2.2
Neptune Township	19.3	22.0
Ocean Township	71.9	81.6
Total	137.0	155.5

Pervious Pavement

There are four different types of permeable pavement systems that are commonly being used throughout the country to reduce the environmental impacts from impervious surfaces. These surfaces include pervious concrete, porous asphalt, interlocking concrete pavers, and grid pavers.

“Permeable pavement is a stormwater drainage system that allows rainwater and runoff to move through the pavement’s surface to a storage layer below, with the water eventually seeping into the underlying soil. Permeable pavement is beneficial to the environment because it can reduce stormwater volume, treat stormwater water quality, replenish the groundwater supply, and lower air temperatures on hot days (Rowe, 2012).”



Permeable surfaces: (A) pervious concrete, (B) porous asphalt, (C) interlocking concrete pavers, (D) grid pavers (Rowe, 2012)

Pervious concrete and porous asphalt are the most common of the permeable surfaces. They are similar to regular concrete and asphalt but without the fine materials. This allows water to quickly pass through the material into an underlying layered system of stone that holds the water, allowing it to infiltrate into the underlying uncompacted soil.

Impervious Cover Disconnection Practices

By redirecting runoff from paving and rooftops to pervious areas in the landscape, the amount of directly connected impervious area in a drainage area can be greatly reduced. There are many cost-effective ways to disconnect impervious surfaces from local waterways.

- **Simple Disconnection**: This is the easiest and least costly method to reduce stormwater runoff for smaller storm events. Instead of piping rooftop runoff to the street where it enters the catch basin and is piped to the river, the rooftop runoff is released onto a grassed area to allow the water to be filtered by the grass and soak into the ground. A healthy lawn

typically can absorb the first one to two inches of stormwater runoff from a rooftop. Simple disconnection also can be used to manage stormwater runoff from paved areas. Designing a parking lot or driveway to drain onto a grassed area, instead of the street, can dramatically reduce pollution and runoff volumes.

- Rain Gardens: Stormwater can be diverted into shallow landscaped depressed areas (i.e., rain gardens) where the vegetation filters the water, and it is allowed to soak into the ground. Rain gardens, also known as bioretention systems, come in all shapes and sizes and can be designed to disconnect a variety of impervious surfaces (Figure 7).



Figure 7: Rain garden outside the RCE of Gloucester County office which was designed to disconnect rooftop runoff from the local storm sewer system

- Rainwater Harvesting: Rainwater harvesting includes the use of rain barrels and cisterns (Figures 8a and 8b). These can be placed below downspouts to collect rooftop runoff. The collected water has a variety of uses including watering plants and washing cars. This practice also helps cut down on the use of potable water for nondrinking purposes. It is important to divert the overflow from the rainwater harvesting system to a pervious area



Figure 8a: Rain barrel used to disconnect a downspout with the overflow going to a flower bed



Figure 8b: A 5,000 gallon cistern used to disconnect the rooftop of the Department of Public Works in Clark Township to harvest rainwater for nonprofit car wash events

Examples of Opportunities in the Deal Lake Watershed

To address the impact of stormwater runoff from impervious surfaces, the next step is to identify opportunities in each municipality for eliminating, reducing, or disconnecting directly connected impervious surfaces. To accomplish this task, an impervious cover reduction action plan should be prepared. Aerial photographs are used to identify sites with impervious surfaces in the municipality that may be suitable for inclusion in the action plan. After sites are identified, site visits are conducted to photo-document all opportunities and evaluate the feasibility of eliminating, reducing, or disconnecting directly connected impervious surfaces. A brief description of each site discussing the existing conditions and recommendations for treatment of the impervious surfaces is developed.

Conclusions

Flooding can be reduced and waterways can be improved in the Deal Lake Watershed by better managing stormwater runoff from impervious surfaces in each of the contributing municipalities in this watershed.. This impervious cover assessment is the first step toward better managing stormwater runoff. The next step is to develop an action plan to eliminate, reduce, or disconnect impervious surfaces where possible and practical. Many of the highly effective disconnection practices are inexpensive. All the municipalities in the Deal Lake Watershed can be engaged in implementing these disconnection practices.

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