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Impervious Cover Assessment
for
Long Branch, Monmouth County, New Jersey

Prepared for Long Branch 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 United States Environmental Protection Agency (USEPA, 2013), over 90% of the assessed waters in New Jersey are impaired, with urban-related stormwater runoff listed as the most probable source of impairment. As stormwater flows over the ground, it picks up pollutants including animal waste, excess fertilizers, pesticides, and other toxic substances. These pollutants are then carried with the flow of the runoff to nearby waterways.
- Flooding: Over the past decade, the state has seen an increase in flooding. Communities around New Jersey 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. According to First Street Foundation (2021), for properties in New Jersey currently at risk

of financial loss from flooding, the average expected annual loss per property is projected to be $4,412 in 2021 and will grow to $6,755 for these same properties in 2051.

- 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 through the destruction of habitat.

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 principle, 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, 2015).

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

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 while maintaining functionality. A parking lot that has two-way car ways could be converted to one-way car ways. Permeable paving materials such as porous asphalt, pervious concrete, or permeable paving stones can be substituted for impermeable paving materials (Figure 2).

3. ***Disconnect impervious surfaces from flowing directly to local waterways.*** Disconnection involves incorporating green infrastructure strategies between impervious surfaces and local waterways. The stormwater runoff can be captured, treated, and slowed down, which can significantly reduce pollutant loading and erosion.

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

<u>Long Branch Impervious Cover Analysis</u>

Long Branch is located in Monmouth County, New Jersey and covers approximately 5.5 square miles. Figures 3 and 4 illustrate that Long Branch is dominated by urban land uses. A total of 87.1% of the municipality's land use is classified as urban. Of the urban land in Long Branch, medium density residential is the dominant land use (Figure 5).

According to Schueler (1994), Arnold and Gibbons (1996), and May et al. (1997), there is a significant link between impervious cover and stream ecosystem impairment. Impervious cover is directly 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.

Urbanizing streams can be classified into three categories (Schueler, 1994 and 2004):

- Sensitive — Sensitive streams typically have a watershed impervious surface cover from 0-10%.
- Impacted — Impacted streams have a watershed impervious cover ranging from 11-25% and typically show clear signs of degradation from urbanization.
- Non-supporting — 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.

Schueler et al. (2009) reformulated the impervious cover model, and this new analysis determined that stream degradation was first detected between 2% to 15% impervious cover. The updated impervious cover model recognizes the wide variability of stream degradation at impervious cover below 10%. The updated model also moves away from having a fixed line between stream quality classifications. For example, 5 to 10% impervious cover is included for the transition from sensitive to impacted, 20 to 25% impervious cover for the transition from impacted to non-supporting, and 60 to 70% impervious cover for the transition from non-supporting to urban drainage.

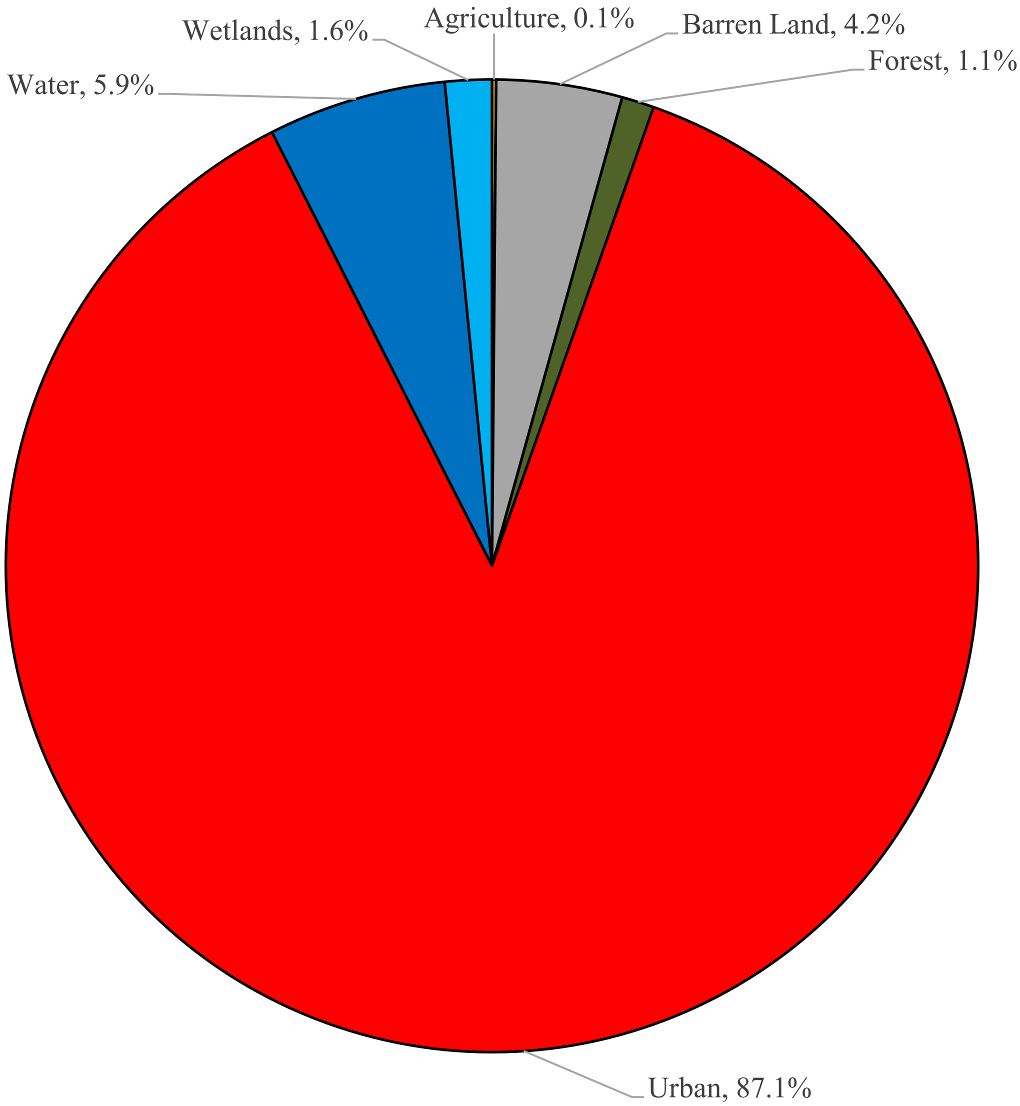


Figure 3: Pie chart illustrating the land use in Long Branch

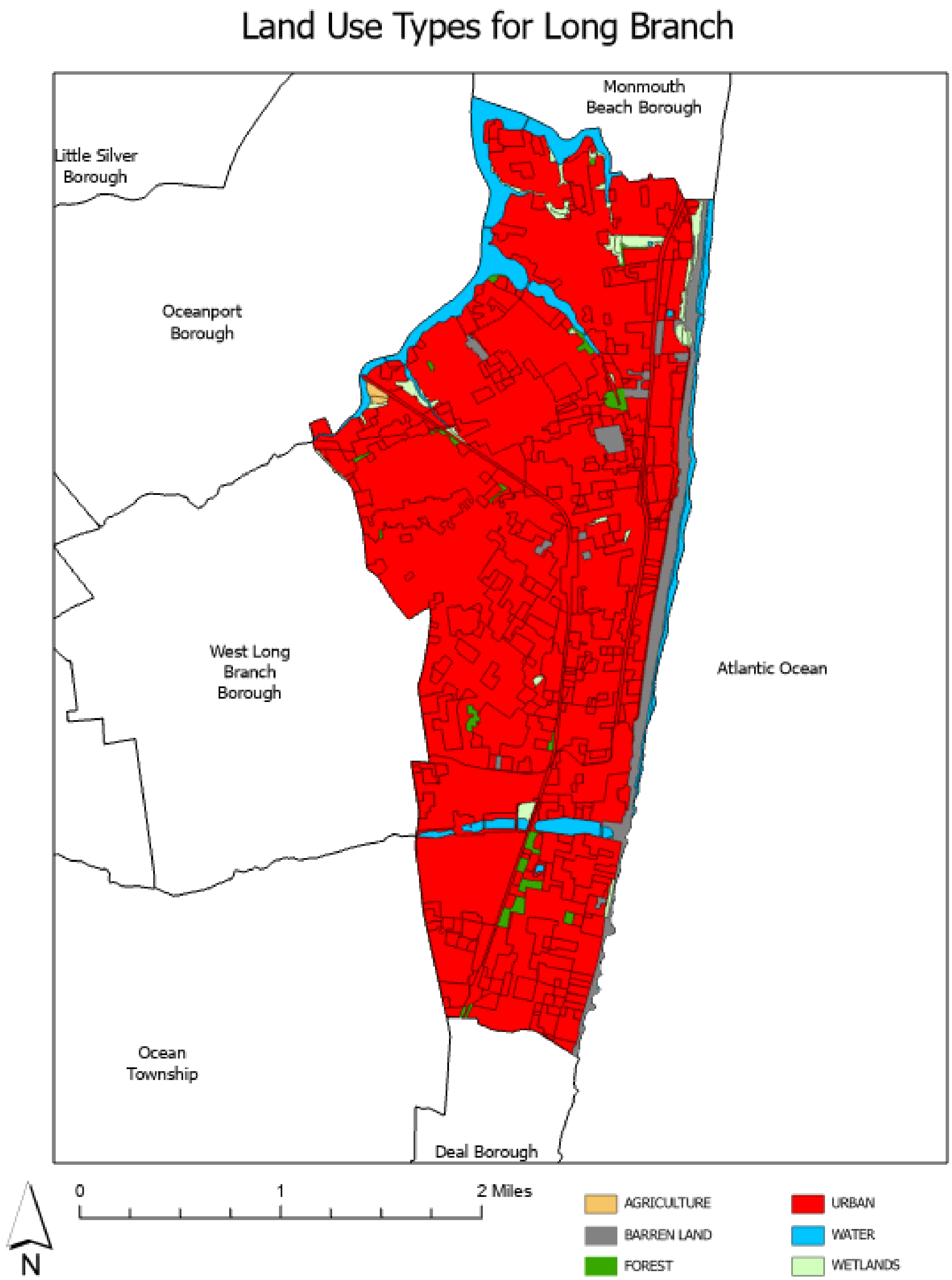


Figure 4: Map illustrating the land use in Long Branch

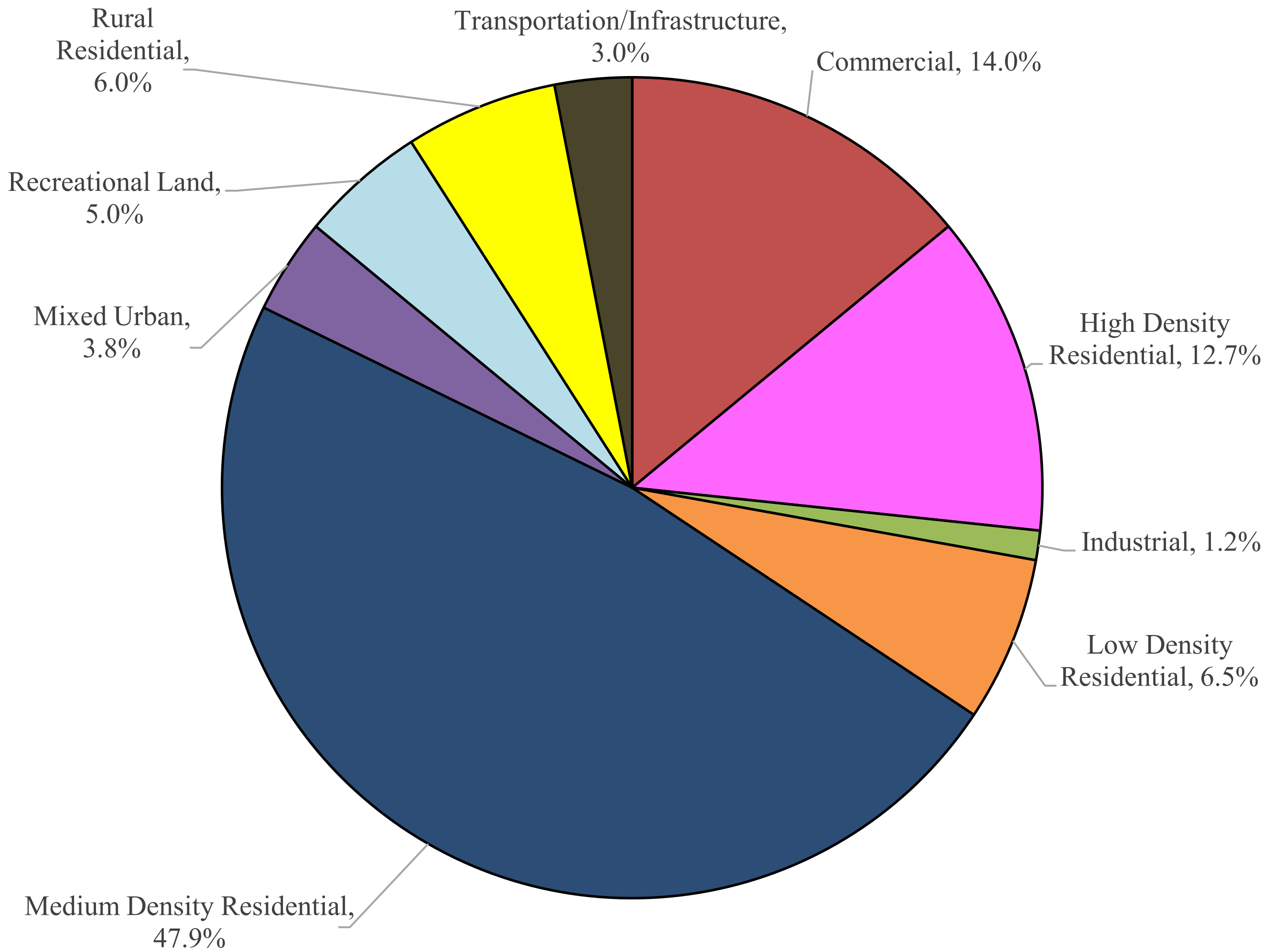


Figure 5: Pie chart illustrating the various types of urban land use in Long Branch

The New Jersey Department of Environmental Protection's (NJDEP) 2020 land use/land cover geographical information system (GIS) data layer categorizes Long Branch into many unique land use areas. The impervious coverage for Long Branchy was estimated by using the 2015 impervious cover layer from NJDEP. Approximately 55.9% of Long Branch has impervious cover. This level of impervious cover suggests that the streams in Long Branch are likely non-supporting streams.

Water resources are typically managed on a watershed/subwatershed basis; therefore, an impervious cover analysis was performed for each subwatershed within Long Branch (Table 1 and Figure 6). On a subwatershed basis, impervious cover ranges from 3.7% in the Atlantic Coast (Navesink River to Whale Pond) subwatershed to 61.8% in the Branchport Creek subwatershed. Evaluating impervious cover on a subwatershed basis allows the municipality to focus impervious cover reduction or disconnection efforts in the subwatersheds where frequent flooding occurs.

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 Long Branch, Monmouth County) associated with impervious surfaces were calculated for the following storms: the New Jersey water quality design storm of 1.25 inches of rain over two hours, an annual rainfall of 47.6 inches, the 2-year design storm (3.38 inches of rain over 24 hours), the 10-year design storm (5.28 inches of rain over 24 hours), and the 100-year design storm (9.12 inches of rain over 24 hours). These runoff volumes are summarized in Table 2. It is also important to consider future precipitations events, as climate change increases the intensity of precipitation during storms. The stormwater runoff volumes considering the future climate change precipitation projections according to NJDEP adjustment factors (2023) were also calculated for the following storms in the year 2100: the 2-year design storm (4.02 inches of rain over 24 hours), the 10-year design storm (6.22 inches of rain over 24 hours), and the 100-year design storm (11.26 inches of rain over 24 hours). These future projected runoff volumes for Long Branch are summarized in Table 3.

Table 1: Impervious cover analysis by subwatershed for Long Branch

Subwatershed	Total Area		Land Use Area		Water Area		Impervious Cover		
	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(%)
Atlantic Coast (Navesink River to Whale Pond)	131	0.2	89	0.1	42	0.1	3	0.0	3.7%
Atlantic Coast (Whale Pond to Shark River)	13	0.0	13	0.0	0	0.0	1	0.0	5.6%
Branchport Creek	1,524	2.4	1,389	2.2	135	0.2	859	1.3	61.8%
Long Branch direct Atlantic drainage	1,103	1.7	1,101	1.7	2	0.0	680	1.1	61.7%
Poplar Brook	367	0.6	367	0.6	0	0.0	152	0.2	41.4%
Whale Pond Brook	367	0.6	339	0.5	28	0.0	149	0.2	43.9%
Total	3,505	5.5	3,298	5.2	208	0.3245	1,843	2.9	55.9%

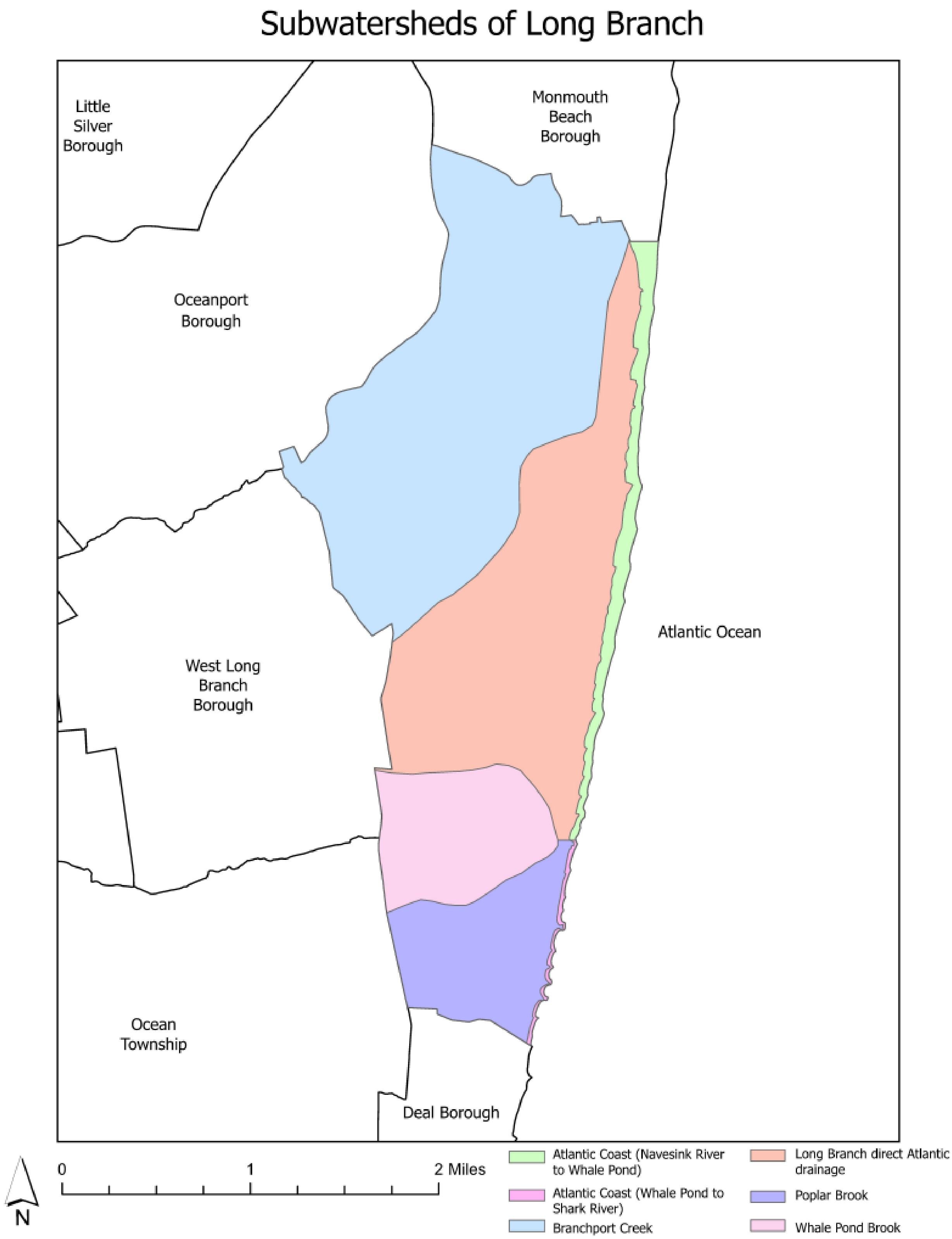


Figure 6: Map of the subwatersheds in Long Branch

Table 2: Stormwater runoff volumes from impervious surfaces by subwatershed in Long Branch for current rainfall

Subwatershed	**Total Runoff Volume for the 1.25" NJ Water Quality Storm (MGal)**	**Total Runoff Volume for the NJ Annual Rainfall of 47.6" (MGal)**	**Total Runoff Volume for the 2-Year Design Storm (3.38") (MGal)**	**Total Runoff Volume for the 10-Year Design Storm (5.28") (MGal)**	**Total Runoff Volume for the 100-Year Design Storm (9.12") (MGal)**
Atlantic Coast (Navesink River to Whale Pond)	0.1	4.3	0.3	0.5	0.8
Atlantic Coast (Whale Pond to Shark River)	0.0	1.0	0.1	0.1	0.2
Branchport Creek	29.2	1,110.1	78.8	123.1	212.7
Long Branch direct Atlantic drainage	23.1	878.3	62.4	97.4	168.3
Poplar Brook	5.2	196.5	14.0	21.8	37.7
Whale Pond Brook	5.0	192.1	13.6	21.3	36.8
Total	62.6	2,382.3	169.2	264.3	456.4

Table 3: Stormwater runoff volumes from impervious surfaces by subwatershed in Long Branch for climate change rainfall in 2100

Subwatershed	Total Runoff Volume for the 2-Year Design Storm (4.02") (MGal)	Total Runoff Volume for the 10-Year Design Storm (6.22") (MGal)	Total Runoff Volume for the 100-Year Design Storm (11.26") (MGal)
Atlantic Coast (Navesink River to Whale Pond)	0.4	0.6	1.0
Atlantic Coast (Whale Pond to Shark River)	0.1	0.1	0.2
Branchport Creek	93.7	145.1	262.6
Long Branch direct Atlantic drainage	74.2	114.8	207.8
Poplar Brook	16.6	25.7	46.5
Whale Pond Brook	16.2	25.1	45.4
Total	201.2	311.3	563.5

A substantial amount of rainwater drains from impervious surfaces in Long Branch. For example, if the stormwater runoff from one New Jersey water quality storm (1.25 inches of rain over two hours) in the Branchport Creek subwatershed was harvested and purified, it could supply water to 266 homes for one year[1].

[1] Assuming 300 gallons per day per home

The next step is to set a reduction goal for impervious area in each subwatershed. A 10% reduction would be a reasonably achievable reduction for these subwatersheds in Long Branch. 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. The RCE Water Resources Program recommends that all green infrastructure practices that are installed to disconnect impervious surfaces should be designed for the current 2-year design storm (3.38 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 two hours), these systems will be able to handle the projected increase in storm intensities that are expected to occur due to climate change. By designing green infrastructure management practices for the 2-year design storm, management of 95% of the annual rainfall volume can be achieved (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 while providing aesthetic value to the community. Because many depaving projects can be completed at the neighborhood scale, opportunities for community engagement and education will become available.

Table 4: Impervious cover reductions by subwatershed in Long Branch

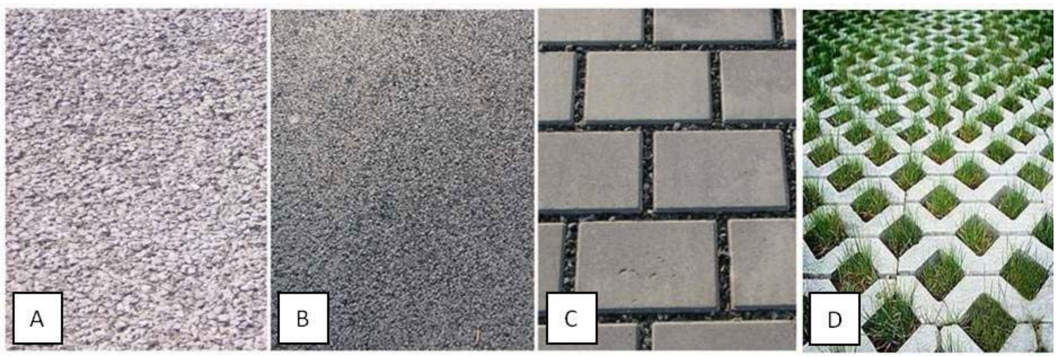
Subwatershed	Recommended Impervious Area Reduction (10%) (ac)	Annual Runoff Volume Reduction[2] (Mgal)
Atlantic Coast (Navesink River to Whale Pond)	0.3	0.4
Atlantic Coast (Whale Pond to Shark River)	0.1	0.1
Branchport Creek	85.9	105.5
Long Branch direct Atlantic drainage	68.0	83.4
Poplar Brook	15.2	18.7
Whale Pond Brook	14.9	18.3
Total	184.3	226.3

[2] Annual Runoff Volume Reduction =
Acres of IC x 43,560 ft^2/ac x 47.6 in x (1 ft/12 in)x 0.95 x (7.48 gal/ft^3) x (1 MGal/1,000,000 gal)
All BMPs should be designed to capture the first 3.38 inches of rain from each storm. This would allow the BMP to capture 95% of the annual rainfall of 47.6 inches.

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 composition allows water to quickly pass through the material into an underlying layered system of stone that contains 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 directing/diverting 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, sizes, and scales 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 installed below downspouts to collect rooftop runoff. The collected water has a variety of uses including watering plants and washing cars, ultimately reducing the use of potable water for non-drinking purposes. Rain barrels and cisterns must be designed with an overflow valve to allow excess water to be diverted to a nearby 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

Conclusions

Long Branch can reduce flooding and improve its waterways by better managing stormwater runoff from impervious surfaces. This impervious cover assessment is the first step toward better managing stormwater runoff. The next step is to develop an impervious cover reduction action plan to eliminate, reduce, or disconnect impervious surfaces where possible and practical. Many of the highly effective disconnection practices are inexpensive. The entire community can be engaged in implementing these disconnection practices.

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