Watershed & Sewershed

In this Unit:

This Unit has been modified by permission by the Newtown Creek Alliance from the original with assistance from the National Wildlife Federation's Greenpoint Eco-Schools Program. The original module was developed by the Gowanus Canal Conservancy.

Unit Overview

Essential Questions:

• How does the land around the Creek (both above and below ground) affect the health of the Creek?
• How does the movement of water through either natural or built systems differ in form and function?
• How does your behavior and other human activities impact the health of the Creek?
• How can individuals and communities restore our natural watersheds and human-made sewersheds?
• How can individuals and communities positively impact the functions of the Creek?

Teacher's Introduction: page 4

Lessons & Objectives:

- Understand and explain how water flows through a watershed
- Understand and explain how water flows through a sewershed
- Understand and explain how a combined sewer works
- Describe the difference between a watershed and sewershed

- Observe a topographic map of Newtown Creek
- Determine where the water flows on a topographic map of the Creek
- Compare the boundaries of the Newtown Creek Watershed and Sewershed
- List pollutants that exist within the Newtown Creek Watershed and Sewershed
- Predict how pollutants move through the Newtown Creek Watershed and Sewershed

- Understand how some surfaces absorb water
- Compare the difference between a permeable and impermeable surface
- Compare surfaces in the Newtown Creek Watershed and Sewershed and describe which ones are more desirable for the ecosystem
- Draw conclusions about what types of surfaces do the best job absorbing water

- Observe different types of land surfaces next to the Creek
- Map and record data about land surfaces
- Compare and contrast how water and pollutants move over different land surfaces
- Identify Combined Sewer Overflow discharge points on the Creek
- Explain impacts of CSOs on the Creek
- Discuss different ways to lessen the negative impact of Combined Sewer Overflows
- List at least three ways to increase stormwater retention.

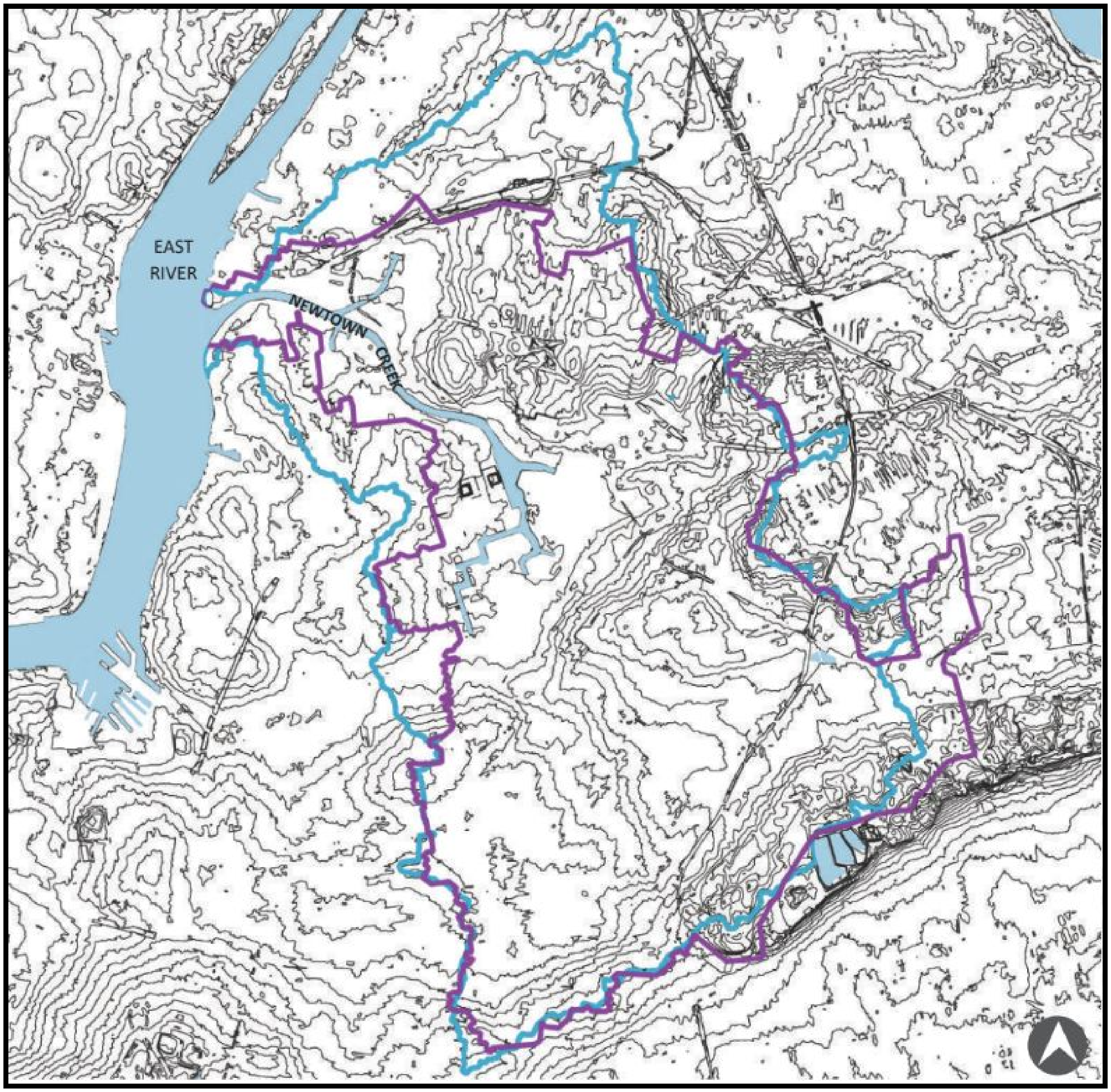
- Name and locate on a map the sites visited during the Field Lesson
- Use the data collected to calculate and graph percentages of different surfaces.
- Design site improvements that increases stormwater retention in the Newtown Creek

watershed.

Teacher's Introduction

What are Watersheds and Sewersheds?

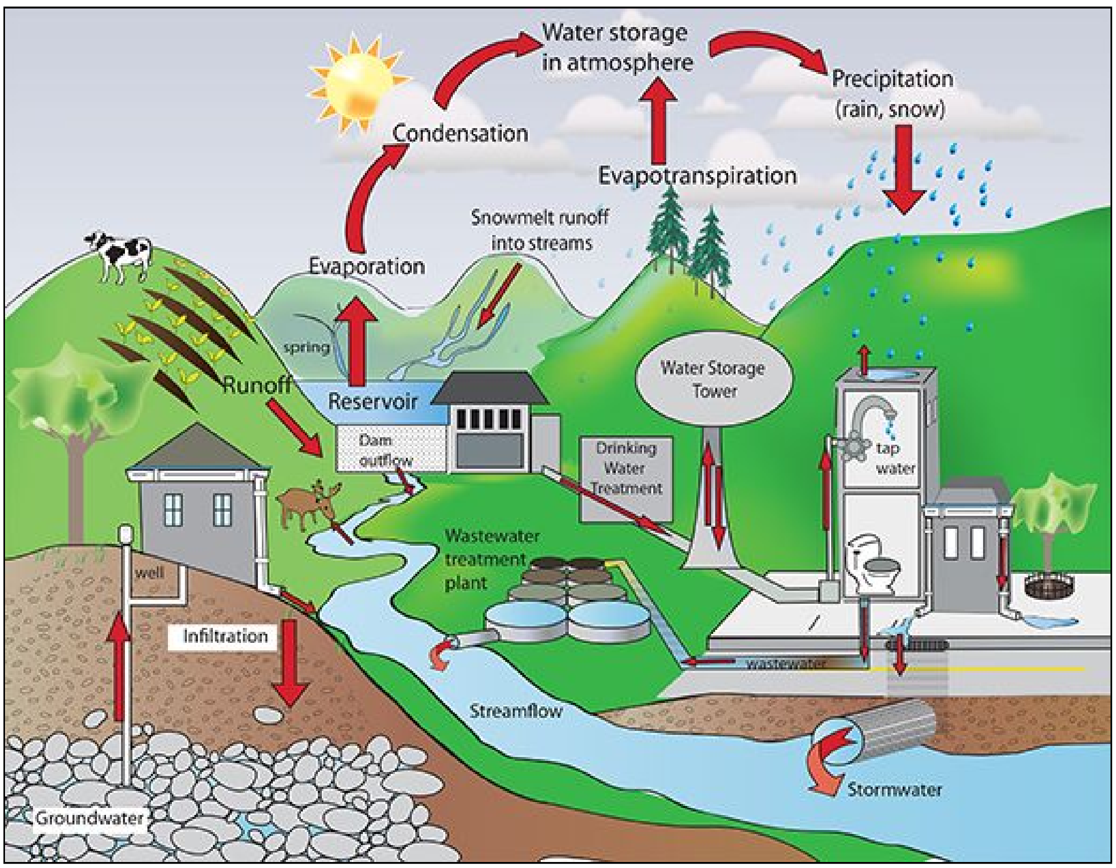
Both a watershed and a sewershed describe an area of land and how water flows within that area.



Newtown Creek Topographic Map with Watershed and Sewershed Outline. This map shows contour lines which represent a change in elevation. The Newtown Creek Watershed outline (in blue) represents the highest points in the area of land around Newtown Creek. The Sewershed outline (in purple) represents the area of stormwater capture that affects Newtown Creek. (Source: Korin Tangtrakul NYC Soil & Water

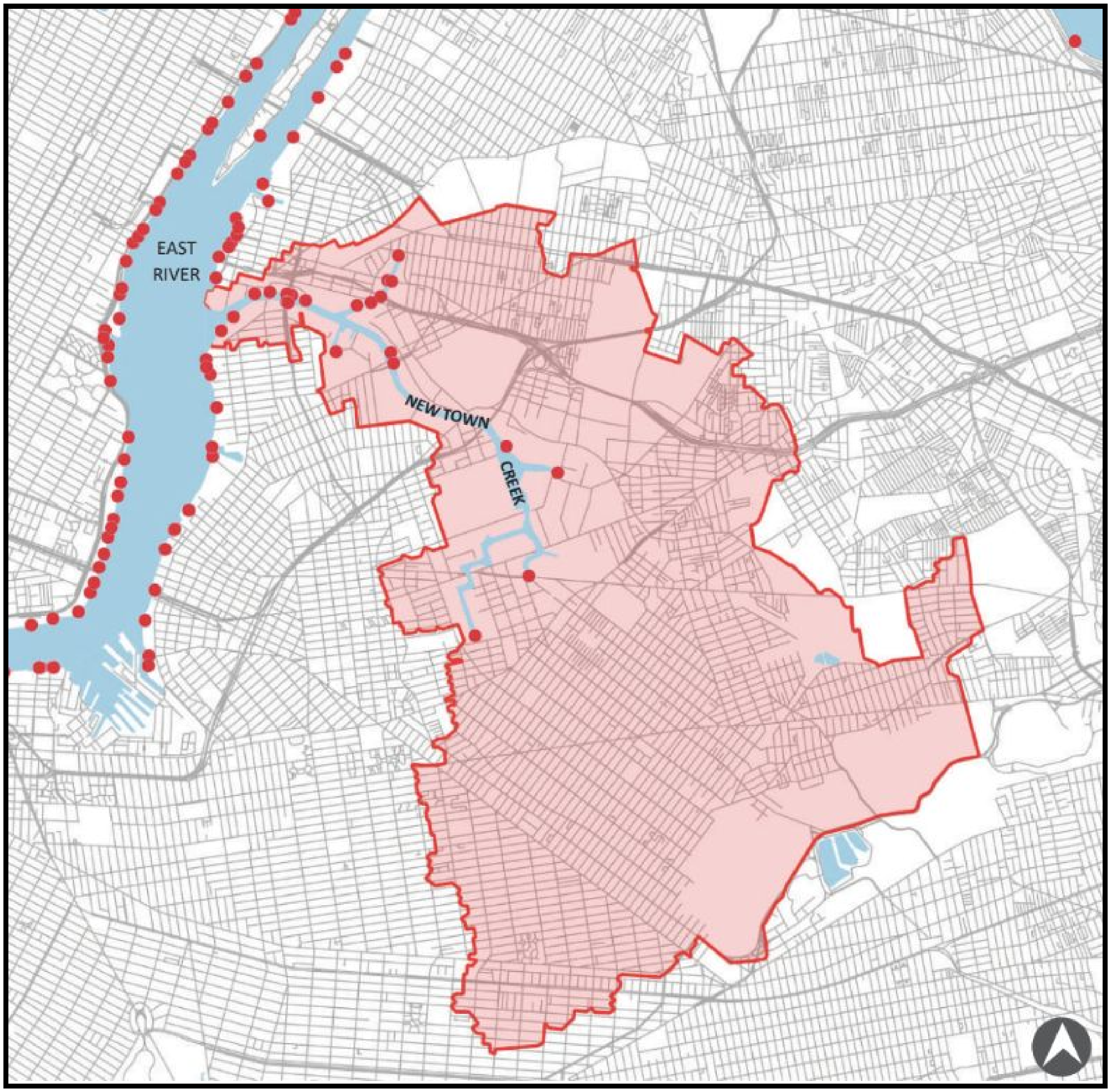
Conservation District)

A **watershed** is a basin-shaped area of land defined by high points (ridges) and low points (receiving water body). Imagine an umbrella turned upside down in the rain, and how water would flow and collect in the center. Since rain falls everywhere, all land is part of a watershed with a receiving body of water. Water “sheds” or flows off the ridges, down the slope and into the lowest lying body of water, which may be a lake, reservoir or river. As water flows downhill, it is also absorbed into the ground, lessening the amount that ends up directly running into the waterbody.



Typical watershed/sewershed graphic (Source: Cary Institute)

When sewage infrastructure is constructed, drainage patterns in a watershed are altered. A **sewershed** describes an area of land and how water flows through the built environment; over the streets, sidewalks, buildings and how it drains into pipes that carry it to treatment plants or to surrounding waterbodies. Sometimes watershed and sewershed boundaries overlap closely. A sewershed may be constructed to utilize the natural topography of the watershed. NYC is made up of 14 sewersheds, each of which direct stormwater and wastewater to a wastewater treatment plant. When the sewer pipes reach their capacity of volume, which usually happens during a rainstorm, an overflow system is triggered and the excess effluent is discharged at combined sewage overflow (CSO) points, which are located on NYC water bodies. Combined sewage overflow is a significant source of pollution in our public waterways. It contains both the untreated stormwater runoff and any pollution that has collected on the streets and the untreated sanitary sewage from homes, restaurants, businesses, and factories.



This map shows the area of land that drains to Newtown Creek during a rainstorm and CSO outfall points (red dots) along the Creek. (Source: Korin Tangtrakul NYC Soil & Water Conservation District)

Why Teach About Watersheds and Sewersheds?

The concepts of a watershed and sewershed illuminate how human activity around the Creek — even a mile upland — affects water quality.

In the case of the Creek, humans in the surrounding the Newtown Creek Sewershed are the primary source of ongoing pollution that perpetuates poor water quality in the Creek. **Combined Sewer Overflow (CSO)**, or, untreated sewage and stormwater that pollutes local waterbodies, is the most important concept to understand when considering the Creek.

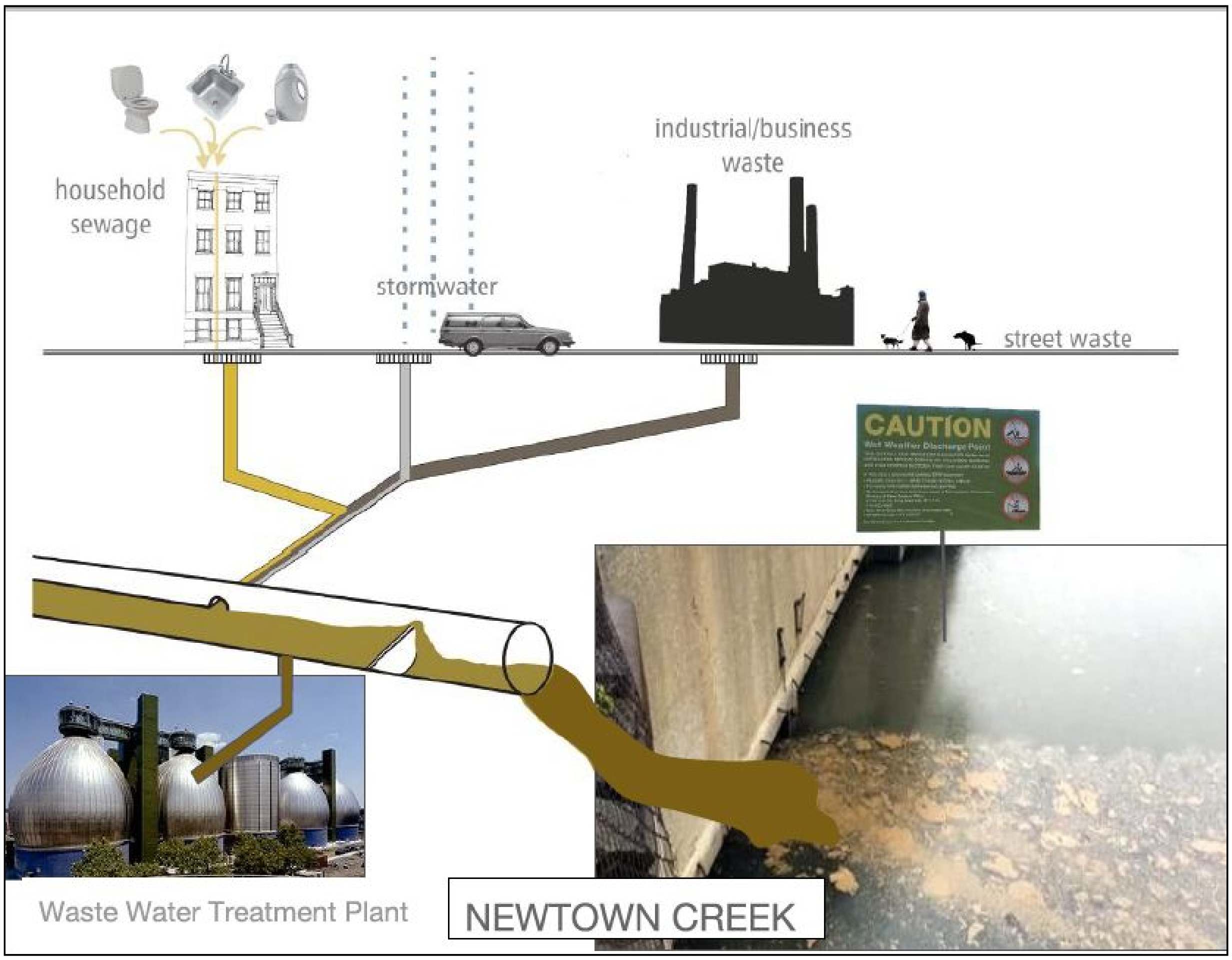


Diagram depicting how sewage, stormwater and street waste travel to the same pipe during a rain storm and end up in our urban waterbodies, such as Newtown Creek.

Combined Sewer Overflow
The Biggest Source of Ongoing Pollution in Newtown Creek

While the NYC sewer system significantly improved how waste water is managed, it has its limits. As little as 1 inch of rainfall can overwhelm the capacity of the sewer system in New York City, which occurs in about 75 out of 100 annual rainfall events. This is because the sewer system simply is not large enough to carry both stormwater and a normal volume of sewage at the same time to a water treatment plant.

Learning about the Newtown Creek Sewershed will reveal how day-to-day activities in cities can impact waterbody health.

During most rainstorms in the Newtown Creek Sewershed:

- Stormwater runoff collects chemicals and pollutants off the surrounding streets, discharging pollution in the Creek
- Waste flushed down a toilet or dumped down a drain can be discharged into the Creek.
- Impermeable surfaces, such as concrete pavement and rooftops, which are common in cities, increase combined sewage overflow.
- Permeable surfaces, such as gardens, green roofs, and bioswales, can absorb stormwater before it reaches the sewer system, and decrease combined sewage overflow and improve water body health

This unit focuses on measuring and analyzing land surface permeability, or how surfaces either absorb or shed water in a sewershed. Students measure and compare land surfaces, and learn how land around the Creek and combined sewage overflow affect the Creek's water quality. By understanding the benefits of green infrastructure and simple ways to decrease sewage overflow, students can advocate for healthier water quality for the Creek and influence the behavior of their peers and families.

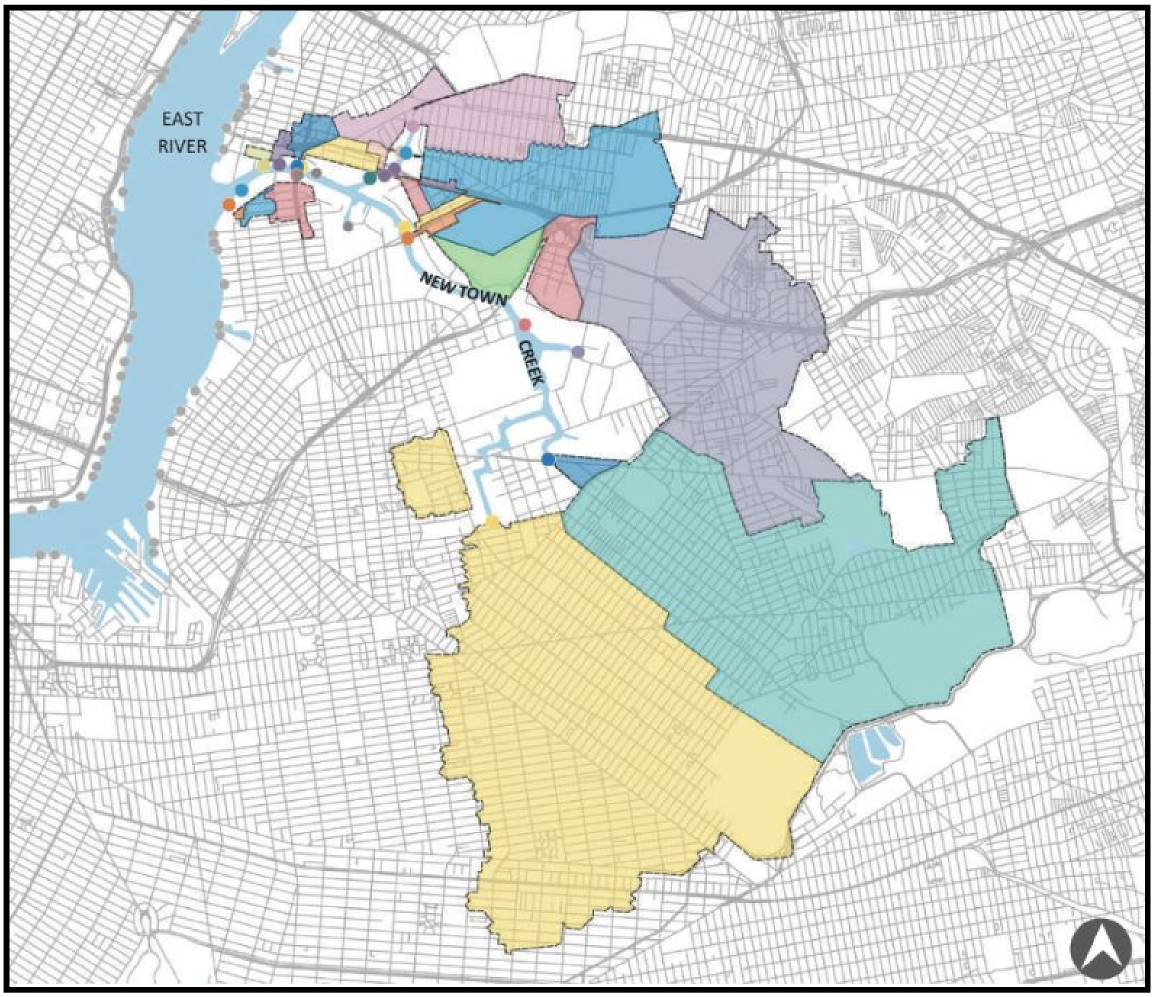
Measuring permeability builds additional skills, including:

- Reading Maps, specifically topographic
- Making predictions and hypotheses
- Measurement and accuracy
- Data collection and recording
- Analysis and interpretation of data
- Comparison of data

How Does it Work?

The flow of water along streets collects oil, litter, dog poop, road salt and other chemicals and debris along its path, and all which enter sewer drains as stormwater runoff. The flow of sewage generated from households, businesses and industry enter the same system of pipes. Contaminates from sanitary waste include cooking oils, human feces, detergents, dyes, bleach, pharmaceuticals, and anything else poured down residential, commercial or industrial drains.

When the sewer pipes reach their capacity of volume, an overflow system is triggered and the excess effluent is discharged at combined sewage overflow (CSO) points, which are located on nearby water bodies. There are 450 CSO outfall points in water bodies throughout NYC, each of which is connected to the drainage system of a sub sewershed.



This map shows the areas of land that drain to Newtown Creek during a rainstorm and which CSO outfalls each area drains to, or the CSO-shed. (Source: Korin Tangtrakul NYC Soil & Water Conservation District)

City wide, 27 billion gallons of stormwater runoff and untreated sewage are discharged into NYC water bodies each year. CSO events pollute the Creek with pathogens, nutrients (too much of a good thing becomes a bad thing in this case - see algae blooms), sediment, debris, chemicals, oil and more. This contamination comes from normal daily business and household activity in the Newtown Creek sewershed during a rainstorm, including flushing toilets and draining sinks, along with all of the untreated runoff from streets. Combined sewer overflow is the primary source of ongoing contamination coming from the sewershed that negatively impacts the water quality of the Creek.

CSO & Stormwater Discharges into Newtown Creek

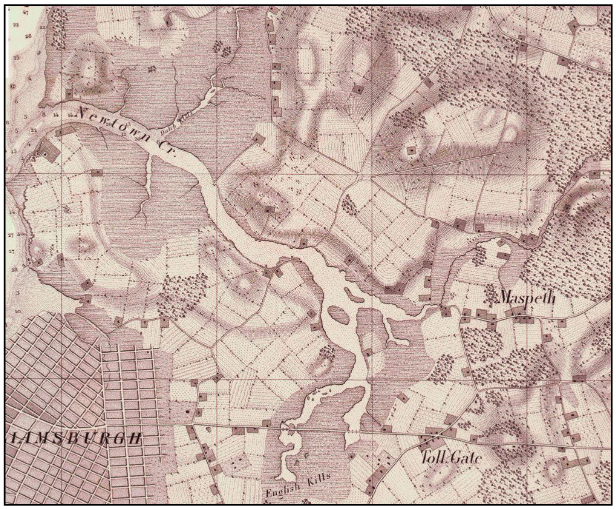
Type of Event	Number of Events[a]	Total Annual Volume[b]
CSO Discharge	438	1,162.9

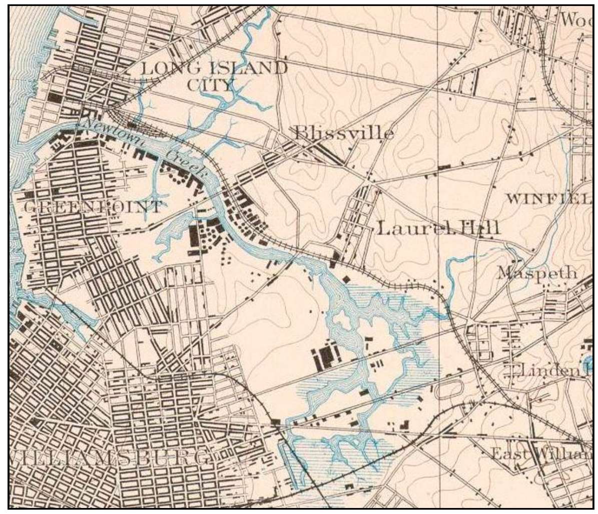
Notes:
(a) from 22 individual outfalls located around the Creek
(b) Measured in millions of gallons

Source: 2017 Long Term Control Plan NYCDEP

Background on Newtown Creek Watershed & Sewershed.

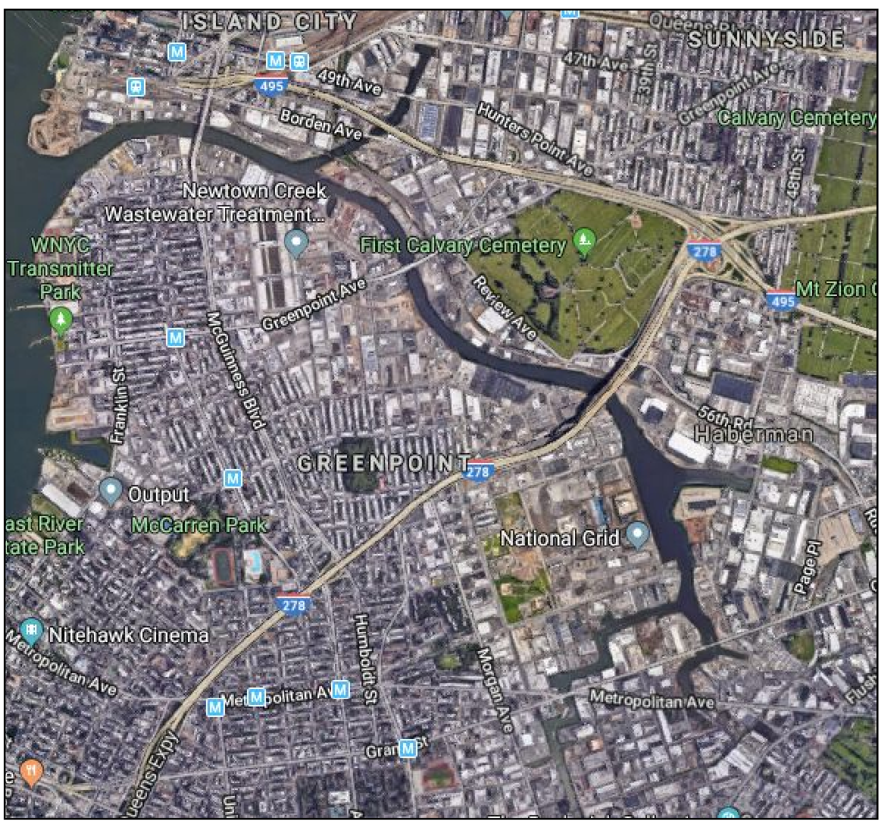
Why do we have problems with Combined Sewer Overflow today? Today's Newtown Creek Sewershed functions as a drainage system, but in a very different way than the historic tidal Creek, salt marsh and cultivated land that once surrounded this body of water.





These two images show the transition of the land surrounding Newtown Creek changing from thousands of acres of salt marsh and few farms in 1844 (left) to 1891 communities around Newtown Creek already beginning to develop and heavy industry is already present.

Today, all of the land surrounding the Creek, except for First Calvary Cemetery, is heavily built up.



Key Changes in the Newtown Creek Watershed during Urbanization of the 1800's

- Much of the ground surface that previously absorbed rainwater was covered with non-absorptive (impermeable) paved streets and buildings.
- Sewers were built to direct rainwater into underground pipes, which either discharge directly into the Creek or connect into the combined sewer system that overflows into the Creek.

Population growth and industrial activity in Brooklyn caused increased trash and sewage, which was often dumped directly into nearby water bodies. This waste caused water bodies all over NYC, including the Newtown Creek, to become cesspools of pathogens. Poor water quality negatively impacted human, plant and wildlife health and destroyed populations of native aquatic species, such as oysters. The city began constructing sewer and water treatment infrastructure to manage waste and create more sanitary conditions. The construction of the sewer system changed the way that water flowed across the urbanizing landscape and created a patchwork of 14 areas of land across NYC called sewersheds.

Sewershed infrastructure is comprised of roads, drains, pipes, overflows and treatment plants. Every impermeable road has at least a slight slope along its length and width, to move water to a drain at the low point, generally next to the curb. Water runs down to the curb, and along the curb to the drain. The drain connects to underground pipes that either discharge directly into nearby waterbodies, or connect into the combined sewer system and nearest wastewater treatment plant.

The Newtown Creek Sewershed/Watershed area includes the neighborhoods of Greenpoint, East Williamsburg, Bushwick, Bed Stuy, Crown Heights, Ridgewood, Maspeth, Sunnyside, and Long Island City it also includes parts of the Upper East Side, Lenox Hill, Midtown East, Murray Hill, the East Village, Greenwich Village, Tribeca, Lower East Side, Two Bridges, and Battery Park, all Manhattan neighborhoods. Just about 1.2 million people live in the Newtown Creek sewershed/watershed area, 658,400 in Brooklyn, 33,900 in Queens and 484,200 in Manhattan. It includes residential, industrial and commercial land use. Before these neighborhoods in the three different boroughs were built and before the Creek's edges were hardened with bulkheaded edges, water would infiltrate into the ground or flow across this watershed to the tidal creeks that flowed into a salt marsh. The salt marsh Creek functioned as a natural drainage system during rainstorms, tides and flooding.

Accumulated Newtown Creek Watershed & Sewershed Data

	Acreage	Approximate Population	Approximate Stormwater: 1" storm
Brooklyn	9,045	658,400	245.60
Queens	1,272	33,900	34.53
Manhattan	3,744	484,200	101.63
Totals	**14,061**	**1,176,500**	**381.76**

This table shows the area, population, and approximate stormwater runoff during a 1 inch storm in the three boroughs that rely on the Newtown Creek Waste Water Treatment Plant (the sewershed) to manage waste water.

Improvements to Stormwater Management

While the Creek continues to be polluted by combined sewer overflow, there are coordinated efforts underway to positively improve its water quality. One strategy is to reduce CSO through **Green Infrastructure (GI)**.

In New York City, Green Infrastructure (GI) describes an array of practices that use or mimic natural systems to manage urban stormwater runoff. Green Infrastructure controls stormwater by using it as a resource rather than a waste. Water is either directed to engineered systems for infiltration or detained at a slower rate into the ground, and/or vegetative uptake and evapotranspiration before it enters the combined sewer system.

A NYC Rain Garden (also known as a bioswale) captures stormwater as it flows down the street. (Source: NYC Department of Environmental Protection)

NYC has identified priority watersheds that have high rates of combined sewage overflow causing very low water quality. Under the Federal Clean Water Act, the NYC Department of Environmental Protection is required to improve the water quality of these waterbodies by limiting the discharge volume during CSO events. GI is an integral strategy in the DEP Long Term Control Plan (LTCP) for achieving higher water quality standards. DEP is the city agency primarily responsible for NYC water and is the governmental agency that constructs Green Infrastructure.

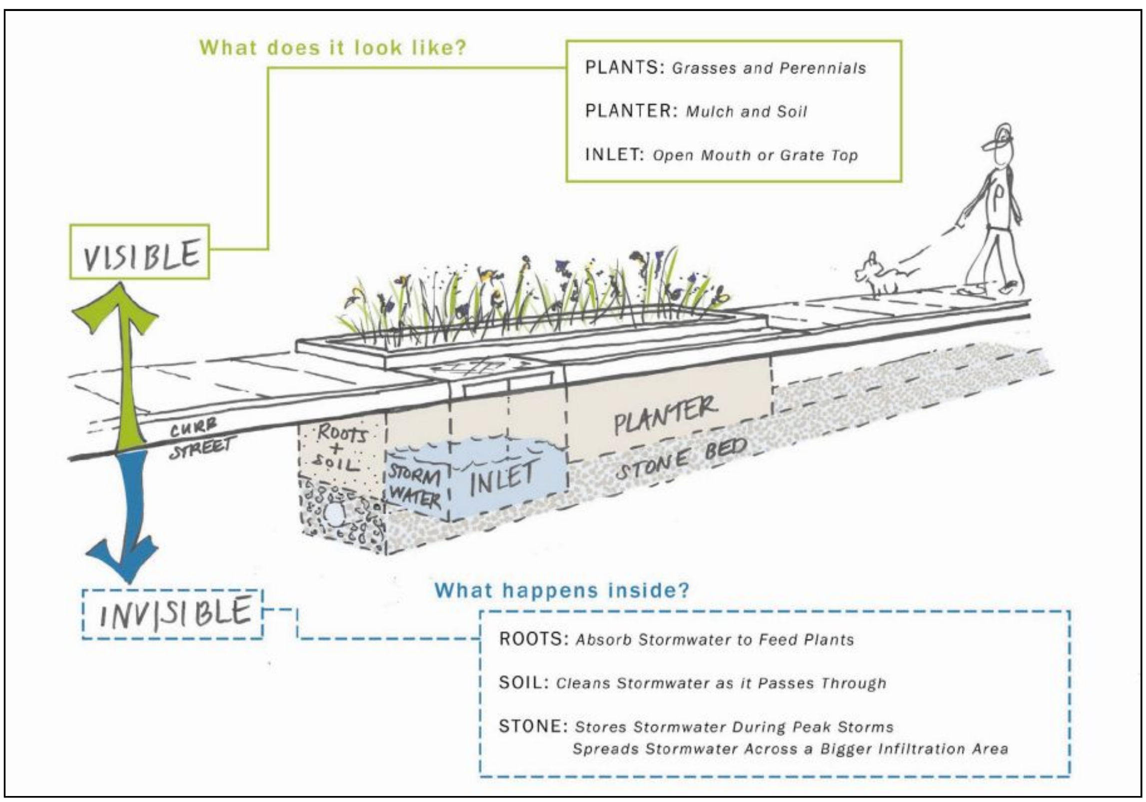
Rain Gardens

A rain garden is also scientifically known as a bioswale. “Bio” comes from the Greek meaning “life” and a “swale” is a low-lying or hollow stretch of land, especially a wet or marshy depression between ridges. Therefore it can be understood as a sunken, planted area that absorbs and retains rainwater as it runs along a street towards a sewer drain.

Bioswales can manage about a 1-inch rainfall — most of the rain events in NYC are 1.2 inches and below. They are not designed to manage significant flooding or sea level rise, but can reduce the burden on the sewer system from rain storms, thus decreasing sewage overflow into local waterways like Newtown Creek. The typical 20’L x 5’W bioswale can capture roughly 2,244 gallons of stormwater during one storm.

Starting in 2015, thousands of bioswales have been constructed across NYC in order to manage stormwater runoff, including hundreds in the Newtown Creek Watershed.

Once bioswales are built they need ongoing maintenance in order to be effective for stormwater management. Litter and sediment can build up and block inlets and outlets; plants need to be pruned and weeded, and soil needs to be graded. While the city takes care of most bioswales, volunteers have an important role in helping to maintain these important gardens.



What a bioswale looks like underground. (Source: NYC Department of Environmental Protection.)

Other Solutions to CSOs and increased stormwater absorption

- Greenstreets could decrease CSOs by 14,800 gallons
- Street trees could decrease CSOs by 13,170 gallons
- New green roofs could decrease CSOs by 810 gallons; retrofitted green roofs could decrease CSOs by 865 gallons; and incentivized green roofs could decrease CSOs by 12,000 gallons
- Rain barrels could decrease CSOs by 9,000 gallons.

Types of GI include:

- Bioswales
- Blue Roofs
- Stormwater Detention tanks
- Stormwater Greenstreets
- Rain Gardens
- Cisterns & Rain Barrels
- Green Roofs
- Permeable Paving

(Source: Riverkeeper)

Vocabulary

Vocabulary Note: Some of this vocabulary is referenced in other parts of this curriculum. All vocabulary and definitions appear in the glossary of the curriculum.

Background Vocabulary:

brackish
bulkhead
canal
conservation
contaminate
ecosystem
estuary
habitat
organism
pollutants
pollution
stewardship
toxic
urban
water cycle

Essential Vocabulary:

adaptation
bioswale
buffer
catch basin
conservation
combined sewer system (cso)
combined sewer
detention
discharge
drainage
erosion
field site
floatables
flood zone
green infrastructure
green roof
groundwater
impermeable
impervious
infrastructure
outfall
permeable
point source pollution
retention
runoff
stormwater management
sewershed
storm drain
topographic map
topography
urban ecology
watershed

Lesson I Watershed & Sewershed Models

PLEASE NOTE: These lessons were purposefully written with built-in flexibility. You are encouraged to adapt the time, materials, procedures and handouts to fit your students, your teaching and your school.

Activity Overview

Watersheds and sewersheds are two different systems that water moves through and both are vital for the health of a community. There are complex relationships between humans and the environment in relation to both watersheds and sewersheds. Students will explore 3D models of general watersheds and sewersheds (either bought or handmade) in order to understand how they work and how they compare to each other. Watersheds are topography based and reflect how water moves in according to gravity and geography. Sewersheds are made entirely of human-made *built* systems. Simply put, watersheds run down hills and sewersheds through pipes.

Learning Objectives

- Students will understand and explain how water flows through a watershed.
- Students will understand and explain how water flows through a sewershed.
- Students will understand and explain how a combined sewer works.
- Students will describe the difference between a watershed and sewershed.
- Students will understand the relationship between the environment and a watershed system and sewershed system.
- Students will understand the relationship between humans watershed and sewershed systems.

Vocabulary

Try to incorporate vocabulary words from the “Watershed & Sewershed Introduction” word list throughout the lesson.

Tips for Teachers

- Consider using and/or modifying portions of the Watershed & Sewershed Teacher’s Introduction or one of the other Units as a text for your students.
- In this lesson students make their own, simple watershed and sewershed models. You can also buy watershed and sewershed models.

- Watershed models are expensive and bulky to store, but can last many years if well cared for. www.enviroscape.com
- A great sewershed model is called “Sewer in a Suitcase” and made by the Center for Urban Pedagogy (CUP). http://welcometocup.org/Projects/Workshops/SewerInASuitcase
- Both homemade and purchased models work best with students in small groups.
- Consider having students stand, instead of sit, around the models so they can easily see all aspects of the model.
- If you use a model as a demo in front of the whole class take extra care to make sure all students can see the model.

Activity #1 Create A Watershed (Short Version)

Students will create a watershed model in the classroom to represent their local watershed. Teachers prepare materials ahead of time as this lesson will take some set-up and clean up.

Materials

- paper (photocopy paper works well)
- permanent marker
- washable marker
- spray bottle
- water

Procedure

1. Separate students into pairs or small groups.
2. Pass out 2 pieces of paper and markers to each group.
3. Crumple up the two pieces of paper together.
4. Open both papers on the desk and separate the papers so the students have two similar, hilly terrains (i.e. two watershed models).
5. Draw the ridgelines (high points) on both models to mark the watershed boundary using permanent marker.
6. Explore the different parts of the model (e.g. hills and valleys).
7. Spray one of the two models with water using the spray bottle and discuss results.
8. Set aside the first model (that is now wet).
9. Name and then place different pollutants on the second model using the

washable marker.
10. Spray the second model with water and discuss results.

Activity #2 Create A Watershed (Extended Version)

This is an extended version of Activity #1 using more materials and thus more time. Students will create a watershed model using more materials in the classroom to represent their local watershed. Teachers prepare materials ahead of time as this lesson will take some set-up and clean up.

Materials

- large aluminum tray
- several pieces of paper (newspaper or variety of colored powders or dyes (cocoa, fruit drinks, food coloring, etc.),
- spray bottle
- water.

Procedure

- Separate students into pairs or small groups.
- Pass out paper, tape, aluminum foil or plastic wrap, and small model pieces to each group.
- Crumple several pieces of paper.
- Place paper in aluminum pan to represent different elevation levels of land. Use tape if necessary.
- Cover the paper with aluminum foil or plastic wrap.
- Place small model pieces on the watershed if desired.
- Explore the different parts of the model (e.g. hills, valley, river, creek, estuary).
- Spray the model with water using the spray bottle and discuss results.
- Name and then place different pollutants (i.e. powders and food coloring) on the model.
- Spray the now polluted model with water and discuss results.

Discussion Questions

Note: Discussion questions are designed to be inserted throughout the procedures.

1. What is a watershed?
2. Why are watersheds important?
3. What are the features of a watershed that we represented in our model?
4. How does water flow in the watershed?
5. What features are similar to something you know or have seen in the Creek?
6. Sketch your watershed model. Add to your sketch throughout the procedure.
7. What do you predict will happen when you spray water on your watershed model?
8. What happened when you sprayed water on your watershed model? Record your observations in words and/or diagrams.
9. Which direction did the water flow? What factors influence the direction of the water flow?
10. Where did the water collect? Explain why it's collected there.
11. Where does the water collect in the Creek watershed?
12. Name some different types of things you might find that could pollute the Newtown Creek watershed? (Think about what you see on the street outside your school.)
13. What do you predict will happen when you spray water over the pollutants on your watershed model?
14. What happened to the pollutants when you sprayed water over them?

Activity #3 Create A Sewershed

Students will create a sewershed model in the classroom to represent a real sewershed in their neighborhood. Teacher prepare materials in advance, as it will take time to set-up and clean-up.

Materials

- Yogurt container - 32 oz.(*Prep the yogurt containers by carefully cutting two holes: a dime-sized hole in the bottom-center of the yogurt container and a second, stamp-sized hole in the side of the yogurt container approximately a half-inch up from the bottom).*
- Knife
- Permanent marker

- Aluminum tray
- Small cup
- Large cup
- Coffee filter - large
- Rubber band
- Glitter
- CSO Diagram

Procedure

1. Separate students into pairs or small groups.
2. Pass out materials.
3. Place the coffee filter on the bottom of the yogurt container and secure in place with rubber band. Be careful NOT to cover the hole on the side of the container.
4. Fill the small cup with water and mix in glitter.
5. Discuss what the mixture represents. Then write “Sanitary Sewer” on the small cup.
6. Hold yogurt container over the aluminum tray, pour “Sanitary Sewer” effluent into the yogurt container and discuss results. (The coffee filter should catch the glitter and the filtered water should pour out the hole in the bottom of the yogurt container.)
7. Discuss what each part of the model represents. Then label the yogurt container “Newtown Creek Sewershed,” the coffee filter “Sewage Treatment Plant”
8. Refill the small cup with water and mix in glitter.
9. Fill the large cup with water and mix in glitter.
10. Discuss what the mixtures represent, then write “Storm Sewer” on the large cup.
11. Quickly pour both the “Sanitary Sewer” and “Storm Sewer”” effluent into the yogurt container (i.e. create a rainstorm) and discuss the results. (The coffee filter should continue to catch some glitter, but some water and glitter should also flow out the hole in the side of the container.)
12. Discuss what each part of the model represents. Then label the hole in the side of the container “Combined Sewer Outfall (CSO).” *See Teacher’s Introduction and Resources at the end of the Unit for more on CSO’s.*
13. Students receive the CSO Diagram and use it to compare and contrast with their model.

Discussion Questions

Note: Discussion questions are designed to be inserted throughout the procedures.

- Describe what the sewershed model looks like. What features does it include?

- Sketch your sewershed model. Add labels to your sketch throughout the procedure.
- What is a sewershed? How is it different from a watershed?
- What features are similar to something you know or have seen in the Newtown Creek sewershed?
- Why are sewersheds important?
- What are the features of a sewershed that we represented in our model?
- How does water flow in the sewershed?"
- What is a sanitary sewer? What does it connect to? What kinds of waste or pollutants might you find in a sanitary sewer?
- What is a sewage treatment plant? What happens to the sewage there?
- What do you predict will happen when you pour the sanitary sewer effluent into the Newtown Creek sewershed? What did happen? What was the result? What role did the coffee filter play?
- What is a storm sewer? What does it connect to? What kinds of waste or pollutants might you find in a storm sewer?
- What is a combined sewer? What does it connect to? What kinds of waste or pollutants might you find in a combined sewer?
- What does CSO stand for?
- What do you predict will happen when you pour the combined sewer effluent into the Newtown Creek sewershed? What did happen? What was the result? What role did the hole in the side of the yogurt container play?
- How could you reduce the pollutants in the sanitary sewer?
- How could you reduce the pollutants entering the storm sewer?
- How could you reduce the amount of water and pollutants coming out of the CSO?
- What are some larger scale actions that could reduce the amount of pollutants affecting the Newtown Creek sewershed?
- What types of Green Infrastructure or other possible interventions could be designed and built that would help prevent pollutants from entering Newtown Creek?
- Describe the similarities and difference between the watershed and sewershed.
- (If you read some background information from the Watershed and Sewershed Introduction) How does the information you read about watersheds and sewersheds compare and contrast to your sewershed experiment?

Lesson II Newtown Creek Watershed and Sewershed Maps

PLEASE NOTE: These lessons were purposefully written with built-in flexibility. You are encouraged to adapt the time, materials, procedures and handouts to fit your students, your teaching and your school.

Activity Overview

Newtown Creek is part of a large estuary and also has it's own watershed and sewershed. In this lessons students will expand their knowledge about watersheds and sewersheds by focusing on their local waterway as an example. Students will explore various maps of the Newtown Creek Watershed and Sewershed in order to understand how water and other materials flow through them. This lesson will allow them to become familiar with map reading and the topography and geography of Newtown Creek.

Learning Objectives

- Students will become familiar with reading and understanding topographic maps.
- Students will determine where the water flows on a topographic map of the Creek.
- Students will compare the boundaries of the Newtown Creek Watershed and Sewershed.
- Students will learn about the different pollutants that exist within the Newtown Creek Watershed and Sewershed and how they're managed.
- Students will predict how pollutants move through the Newtown Creek Watershed and Sewershed.

Time

45 minutes

Vocabulary

Incorporate Watershed & Sewershed vocabulary words throughout the lesson.

Tips for Teachers

- Consider using and/or modifying portions of the Watershed & Sewershed Introduction as a text for your students.

Map Exploration Activity

Materials

Required

- Newtown Creek Topographic Map
- Newtown Creek Topographic Map with Watershed Outline
- Newtown Creek Topographic Map with Watershed and Sewershed Outline
- Markers
- Colored pencils
- Eye droppers
- Water
- Newtown Creek Street Map with Watershed and Sewershed Outline
- Newtown Creek Watershed Map with Water Flow Arrows
- NYC Map with Newtown Creek
- Newtown Creek Sewershed Map
- New York City Topographical Map
- Newtown Creek Sub-sewershed Map

Optional

Procedure

1. Hand out the **Newtown Creek Topographic Map**.
2. Explain how contour lines show elevation on topographic maps.
3. Color contour rings to see differences in elevation.
4. Use the eye droppers to drip water on either side of the ridgeline and record where the water goes.
5. Hand out a **Newtown Creek Topographic Map *with Watershed Outline***.
6. Compare their your own ridgelines to the watershed outline.
7. Draw arrows on the Newtown Creek Topographic Map with Watershed Outline to indicate the flow of water.
8. Hand out the **Newtown Creek Topographic Map with Watershed *and Sewershed Outline***.
9. Review the definition of sewershed and compare the similarities and differences between the watershed and sewershed boundaries.
10. Hand out the **Newtown Creek *Street Map* with Watershed and Sewershed Outline**.
11. Mark your school, your home or another significant landmark on the map with an ‘X.’

12. Draw an arrow that predicts how water would flow from this location. (You may need to provide an additional resource like Google Maps or a street map in order for students to pinpoint their location.)

Discussion Questions

- What is a topographic map? What are contour lines?
- How are topographic maps helpful when studying watersheds?
- Look at the topographic map of the Newtown Creek Watershed. Describe what you see. Where are the contour lines far apart? Close together? Where do they create circles?
- What does the topographic map tell you about land and shape of the Newtown Creek Watershed?
- Compare the ridgelines you drew to the Watershed Outline map. Where are they the same? Where are they different?
- What could account for the differences between the ridgelines on the two maps?
- Where is the steepest topography on the map? What is at the top of this hill? What is at the bottom? What is the name of this neighborhood?
- What factors cause water to flow toward Newtown Creek?
- Knowing where the sewershed is, how does that change where or how you would draw your arrows on the map? Why?
- What do you predict will happen with water that falls within the Newtown Creek watershed, but outside the sewershed? (see the map for areas that do NOT overlap).
- After reviewing these maps, what do we know about Newtown Creek as a watershed and as a sewershed?
- Where would the precipitation flow that originates where you drew an ‘X’?
- List pollutants you have seen at the location where you drew an ‘X’. What would happen to these pollutants during a rainstorm?
- Where do you predict pollutants would end up considering both the watershed and the sewershed and any other contributing factors? Explain why.
- How could we minimize the effect of pollutants on the Newtown Creek Watershed and Creek based on what we know about how water flows through the watershed and sewershed?
- How are maps a helpful resource in providing us information about a specific place?

Lesson III Permeable vs. Impermeable Surfaces

PLEASE NOTE: These lessons were purposefully written with built-in flexibility. You are encouraged to adapt the time, materials, procedures and handouts to fit your students, your teaching and your school.

Activity Overview

Permeable surfaces absorb water and impermeable surfaces do not. This is a very important concept for how stormwaters, and therefore waste, flows in a watershed and sewershed system. Students will soak up water with different types of sponges and pour water on different outdoor surfaces to understand the differences, and the pros and cons of permeable and impermeable surface. Sponges are an excellent representation of how different types of ground interact with stormwater. Some absorb a good deal of water, like highly permeable soil, some only a little, just like compacted soils, and some not all, like asphalt and much of the built environment. Understanding these concepts and term terms is important for the Applied Learning Lesson especially in relation to green infrastructure.

Learning Objectives

- Students will understand how some surfaces absorb water
- Students will compare the difference between a permeable and impermeable surface
- Students will draw conclusions about what types of surfaces do the best job absorbing water and the value of those permeable surfaces
- Students will compare surfaces in the Newtown Creek Watershed and Sewershed and describe which ones are more desirable for the ecosystem

Time

45-90 minutes

Vocabulary

See Watershed & Sewershed Introduction for a list of vocabulary words from which to choose

Tip for Teachers

- This lesson ties in very closely to the Flora and Fauna Mini-Unit. You could easily change what the different types of sponges represent to correspond with different types of plants and trees.
- Consider using and/or modifying portions of the Watershed & Sewershed Introduction or the Flora & Fauna Introduction as a text for your students.

Materials

- Observation/Inference Chart
- Surface Types Examples in the Newtown Creek Watershed
- Aluminum trays
- Water
- Aluminum foil (or something else non-absorbent like fleece or wool) different types of sponges. Below are some suggestions as to what different types of surfaces different types of sponges could represent in the watershed.
- Water bottle
- Sponges

Sponges

- Sponge surface diagram
- Car-washing sponge to represent loose, very permeable soil.
- Green scouring sponge to represent compacted, barely-permeable soil.
- Hard sponge that has totally dried up for the “bone-dry sponge”.
- Dishwashing sponge to represent compacted, less-permeable soil.
- Aluminum foil, or even certain types of fleece or wool (something that does not absorb liquid to represent an impermeable surface.)

Activity #1: Surface Type Exploration/Teacher Demonstration

Procedure – Surface Types Exploration

Teacher Demonstration

1. Separate students into small groups.
2. Hand out Observation/Inference Chart.

3. Each group gets an aluminum tray, a measuring cup and several types of sponges.
4. Observe the different sponges and describe what they look like in the “Observation” section of the Observation/Inference Chart.
5. Predict which sponges will hold the most water based on the observations and record predictions in the “Inferences/Predictions” section of the Observation/Inference Chart.
6. Fill the aluminum tray with a 1⁄2 inch of water.
7. Place one sponge in tray and gently hold down for 10 seconds. Do not touch the sponge in any other way!
8. Take sponge out and squeeze it into the measuring cup and record results in the “Notes/Results” section of the Observation/Inference Chart.
9. Do this with each sponge.
10. Compare your predictions with your results.
11. Hand out the Surface Types Example in the Newtown Creek Watershed.
12. Compare the results of the sponge experiment with the Surface Types Example in the Newtown Creek Watershed.

Discussion Questions

- Which sponge held the most water? Why do you think this was the case?
- Which sponge held the least? Why do you think this was the case?
- How did the size of the holes in the sponge relate to how much water it could hold?
- How did the absorption of the impermeable object (i.e. the aluminum foil or the wool) compare to the sponges?
- Which sponges match which surface types best? Explain why.
- Where in the Newtown Creek Watershed would you expect to find these different surface types? Where would you find impermeable surfaces? Where would you find highly permeable surfaces?
- What are some of the pros and cons of impermeable surfaces? (e.g. Impermeable surfaces are better to play basketball on because you can’t dribble on gravel, but impermeable surfaces create a lot of runoff.)
- What are some pros and cons of permeable surfaces?
- Why are permeable surfaces important for absorbing water?
- Why are they important in relation to the health of the Creek?

Activity #2 Surface Type Exploration

Procedure – Dry vs Damp Sponges/ Water Absorption

1. Use the Observation Chart.
2. Hand out one sponge that is "bone dry" and one that is damp (wet all the way through and wrung out).
3. Observe the two sponges and describe what they look like in the "Observation" section
4. of the Observation/Inference Chart.
5. Predict which sponge will hold more water and how much water each will hold.
6. Record predictions in the "Inferences/Predictions" section of the Observation Chart
7. Place sponge in tray and gently hold down for 10 seconds. Do not touch the sponge in any other way.
8. Take sponge out and squeeze it into the measuring cup and record results in the "Notes/Results" section of the Observation/Inference Chart.
9. Do this with each sponge.
10. Compare your predictions with your results.

Discussion Questions

- Which sponge held the most water? Why do you think this was the case?
- Which sponge held the least? Why do you think this was the case?
- Why do you think one type of sponge holds more water than the other?
- How does the wetness of the soil relate to the soil's ability to hold water?
- How do the dry and damp sponges compare to the environment? Which surface types are like the dry sponge? Which surface types are like the damp sponge?
- In the Newtown Creek Watershed why might we want some surfaces to absorb rainwater? Why might we want other surfaces to cause rainwater to runoff?
- Which surface types are more desirable for the health of the Newtown Creek and watershed ecosystems? Explain your answer.
- (If you read some background information from the Watershed and Sewershed or Flora and Fauna Introduction) How does the information you read compare and contrast to your experiment? Cite specific parts of the text.

Activity #3 - Explore the Schoolyard

Materials

- Observation/Inference Chart
- Water bottles or bucket

Procedure

1. Use the Observation/Inference Chart.
2. Take students outside, around the school grounds.
3. Observe, list, and describe all the different surfaces they encounter (concrete, asphalt, tree pit, grass, mulch, etc.) in the “Observation” section of the Observation/Inference Chart.
4. Predict which surfaces are permeable and impermeable, based on the previous sponge experiments and record predictions in the “Inferences/Predictions” section of the Observation/Inference Chart.
5. Choose one particular surface type to experiment on.
6. Using your water bottle or bucket, pour water on your chosen surface type.
7. Record results in the “Notes/Results” section of the Observation/Inference Chart.
8. Compare your predictions with your results.
9. Repeat steps 5-7 as many times as you have time for.
10. Compare how quickly the water is absorbed (if at all) on the different surfaces.

Discussion Questions

- What types of surfaces did you observe in your schoolyard?
- Based off your observations, how do you imagine rainwater flowing in your schoolyard?
- Which types of surfaces will create the most runoff?
- Which types of surfaces do we see the most of in the Newtown Creek Watershed?
- How do you think the different surfaces will impact the Newtown Creek ecosystem?
- Which surfaces do you think generally have a positive impact on the ecosystem? Why?
- Which surfaces do you think generally have a negative impact on the ecosystem? Why?

Field Lesson: Watershed and Sewersheds

PLEASE NOTE: These lessons were purposefully written with built-in flexibility. You are encouraged to adapt the time, materials, procedures and handouts to fit your students, your teaching and your school.

Activity Overview

This is an opportunity to bring your students outdoors and introduce them to various aspects of the Newtown Creek watershed and sewershed and to specifically look at the permeable and impermeable surfaces in the Newtown Creek watershed/sewershed. Hands-on and place based experiential learning adds dimensions to learning that is difficult to recreate in the classroom. The field lesson can be applied to any Field Trip Site listed below.

Suggested Field Trip Sites (please refer to Field Trips Section of Intro Unit for site-specific details).

1. McCarren Park Demonstration Garden
2. Kingsland Wildflowers Rooftop
3. Manhattan Ave. Street End Park
4. Newtown Creek Nature Walk

Learning Objectives

- Students will practice applying their knowledge in a classroom to a specific location in the field.
- Students will become familiar with how a local waterway can function both as part of a watershed and a sewershed.
- Students will observe different types of land surfaces next to the Creek.
- Students will observe, map and record surface land type.
- Students will compare and contrast how water and pollutants move over different land surfaces.
- Students will explain impacts of CSOs on the Creek.
- Students will discuss different ways to reduce the negative impact of CSOs.
- Students will practice making observations on both the natural and built environment and the relationship between water and waste systems.

Time
Can vary from 60 minutes to several hours

Vocabulary
See Watershed & Sewershed Introduction for a list of vocabulary words from which to choose.

Tips for Teachers

- Choose one or more of the sites listed in the Newtown Creek Field Sites Information section of the Curriculum Introduction.
- Always visit the Field Site prior to bringing your students there.
- Consider using and/or modifying portions of the Watershed & Sewershed Introduction as a text for your students.

Discussion Points
For each discussion point, decide which teaching method works best for you and your students. You may want to directly point to a particular a feature of the watershed/sewershed and describe it or you may want students to scavenger hunt for a feature or something in-between.

- Topography
- Watershed vs. sewershed
- Built vs. "Natural" environment
- Different forms of pollutants (e.g. litter, oil, detergents, sediments)
- Point source vs. non-point source pollution
- Permeable vs. impermeable surfaces
- Direct runoff vs. conservation buffer
- Green Infrastructure
- Retention and Detention of stormwater
- Soft shore vs. hard shore (i.e. bulkheads)
- CSOs and storm drains
- Flood management
- Stewardship of watershed

Group #1 Activity - Mapping the Permeable and Impermeable Surfaces

Materials

- Clipboards
- Journals
- Ruler, yardstick or tape measure
- Land Surface Survey
- Site Map (for your chosen Field Site)

Procedure

1. Separate students into small groups.
2. Hand out a Site Map and a Land Surface Diagram to each group.
3. Stand in a central area on the site with the whole class and compare the boundaries on the Site Map to where those boundaries are on the actual site.
4. Assign each group an area to survey. If you have more than one group working in an area, have them start on opposite sides.)
5. Students identify all the different surface types in their area and other observations on their Land Surface Survey .
6. ***Optional:*** Students pace out the length and width of each surface area and draw it on the Site Map as accurately as possible. For example, students may pace out the size of a sidewalk, the size of a tree pit and the size of a patch of bare soil.
7. ***Optional:*** Allow students to problem solve how they can pace out the areas accurately. You may also choose to provide them with a measuring tool such a ruler, yardstick or measuring tape.
8. Students note any other features of their area on the Site Map (e.g. trees, piles of trash, bulkhead, soft shore, etc.)
9. Bring Site Map, Land Surface Surveys and all data back to the classroom for
10. the Post Lesson.

Group #2 Activity - Make It Rain

Materials

- Clipboard
- Observation Inference Chart
- Water

Procedure

1. Find ways to bring water with you in the field. For example:

   a. carry a gallon jug of water
   b. have each student carry an extra bottle of water for this purpose
   c. portable water sprayer ($50-$100)
2. Hand out the Observation Inference Chart.
3. At each possible location on your walking tour have the students predict what will happen when it rains at that location. Will the pollutants on the street (litter, oil, etc.) enter the storm drain or runoff directly into the Creek?
4. Pour water on the street. Try to choose a location that has at least a slight grade to it so that the water will clearly flow downhill. Try to choose a location that has some litter or sediment that will flow along with the water.
5. Have the students observe and record the results as the water flows.
6. Compare the results to their predictions.

Group #3 Activity - Litter Picker

Materials

- Garbage bags
- Disposable gloves
- Hand sanitizer
- Trash Grabbers

Procedure

1. Have students predict what will happen to the litter in the next rainstorm.
2. Discuss the specific issues litter presents for our water bodies (e.g. animals confuse it for food).
3. Have students pick up litter and bag it.
4. Bring it back to the school and weigh it.
5. Give prizes to the students who collected the most litter.

Journal Prompts

We recommend having students write in their journals at the end of the field experience and consider some or all of the following questions. Also refer to the “Journal Writing” section of the **Introduction & Methodology** for more suggestions about journaling.

- Where along your walking tour did you see examples of the watershed? The sewershed?

- How has the human population and consumption of resources in the Newtown Creek Watershed impacted the Creek’s ecosystem?
- What pollutants did you observe? Describe them in detail including material, size, shape, color, smell, etc.
- Where did you predict these pollutants may end up after a rainstorm?
- In your opinion, which pollutant that you observed would be most harmful to the health of the Creek?
- What evidence do you have to support your opinion?
- Describe something you observed along your walking tour (that is either part of the built environment or the urban ecology) that you believe helps improve the health of the Creek? Describe in detail.
- Choose a location along your walking tour that is in need of improvement. What could you design/propose/build at that location that would help improve the health of the Creek?

Applied Learning Lesson: Designing Green Infrastructure Improvements to the Newtown Creek Watershed

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PLEASE NOTE: These lessons were purposefully written with built-in flexibility. You are encouraged to adapt the time, materials, procedures and handouts to fit your students, your teaching and your school.

Design Challenge

Activity Overview

Green infrastructure mimics the natural water cycle by creating permeable surfaces, designed to absorb water. This is critical, especially in urban areas with old infrastructure (CSO's) and heavily built communities with a good deal of precipitation. Based off of previous Lessons and their experience in the field, students will apply their knowledge to design and develop ways to improve water quality and ecosystem health of Newtown Creek. Students will have the opportunity to share their green infrastructure recommendations and ideas with Newtown Creek Alliance and other members of the community.

Learning Objectives

- Students will name and locate on a map the sites visited during the Field Lesson.
- Students will use collect data to calculate and graph percentages of permeable and impermeable surfaces at the design site.
- Students will apply their previous knowledge to design site improvements that will increase stormwater absorption or collection in the watershed.
- Students will practice applying their knowledge from the classroom to a real world issue and specific local place.
- Students will learn the importance of building a relationship with a specific site over time.
- Students will gain experience designing green infrastructure improvements to benefit a local waterway that has been historically polluted.

Time

45-90 minutes

Vocabulary

See Watershed & Sewershed Introduction for a list of vocabulary words from which to choose.

Tips for Teachers

- Remind students that they do not need to be proficient artists when doing sketches. Stick figure drawings will suffice.
- Consider using and/or modifying portions of the Watershed & Sewershed Introduction as a text for your students.

Materials

Materials from Field Lesson (completed)

- Site Map (and blank copy)
- Surface Types Examples in Newtown Creek Watershed
- Journal entries
- Other student work (e.g. photos)
- Google image of Newtown Creek Neighborhood
- Green Infrastructure Images

Design Procedure

1. Separate students into the small groups. You may choose to use the same groups they were in during the Field Lesson or new groups. Consider whether you want the students in the group to have worked on the same area in the field or different ones.
2. Hand out the Site Map (Manhattan Ave Street End Park)
3. Review the Field Sites visited during the Field Lesson.
4. Mark on the Newtown Neighborhoods Map the location of the Field Site(s) visited.
5. Each student in the group shares some observations or thoughts about their field site based on their worksheets and/or journal entries. Students, think back to what you observed in the field!
6. If you visited more than one Field Site during the Field Lesson, choose one Field Site on which to focus.
7. Use the Site Maps and Land Surface Survey from the Field Lesson to calculate the percentage of permeable and impermeable surface on their site.
8. Graph the percentages of permeable and impermeable surface.
9. Review the Discussion Questions below, referring to the information from your Field Lesson (i.e. Site Map, Land Surface Survey, journal entries).
10. Each student gets a clean copy of the Site Map.

11. Brainstorm ideas that will increase stormwater retention on the field site.
12. Each student uses the brainstorm ideas to sketch the site improvements for stormwater retention on the clean Site Map.
13. Each student presents and explains his/her design to the group.
14. The group members critique each others' designs and write down the best elements from each sketch.
15. Hand out Green Infrastructure Images.
16. Compare the Green Infrastructure Images with the list of best elements from each sketch and decide if there is any other elements you want to include in your design.
17. The group gets a clean copy of the Site Map.
18. The group works together to create ONE final design incorporating the best elements from each individual's design.
19. The group works together to write an explanation and defend each element of their design.
20. Groups recombine so all students are with new group members.
21. Each student shares the sketch and explains the design with the new group members.

Discussion Questions

1. Describe your Field Site, its location and what surrounds it.
2. What types of pollutants did you observe on the Field Site?
3. What types of human behaviors lead to these pollutants being in the watershed? (e.g. littering, dumping chemicals down storm drains, not securing garbage can lids)
4. How will water move over this Field Site when it rains? Where will it go?
5. What will happen to the pollutants when it rains?
6. Where is stormwater being retained on this Field Site?
7. Where is stormwater draining into the sewer system?
8. Where would more permeable surfaces be beneficial? Why?
9. What types of additional permeable surfaces would work best this Field Site? Why?
10. What is green infrastructure and why is it important, especially in urban areas?"
11. "How will your design improvements help the health of the Creek?
12. Why is your design worth building?

13. How does it feel to design something that could help your local waterway?

Extension Lesson – Bronx River Compare and Contrast

The Bronx River provides an interesting point for comparison, because unlike Newtown Creek it has a freshwater source that is an important part of its watershed. In fact, the Bronx River is the only freshwater river within the borders of New York City. The Bronx River Watershed, which extends from the Kensico Dam in Westchester to the East River in New York City, is approximately 24 miles long. The watershed is relatively long and narrow and drains about 56 square miles. In the Bronx, the Bronx River watershed covers about 4,150 acres of land and is densely developed. The Hunts Point water treatment plant, located west of the Bronx River watershed, receives stormwater captured from about 60% of the Bronx River watershed. The majority of the remaining stormwater either enters the Bronx River in the form of run-off or is released into the in the Bronx River at CSOs. Like the Newtown Creek, the Bronx River also has significant sewershed.

In order to learn more about the Bronx River in order to compare and contrast with the Creek, you could visit the Bronx River with your class by working with organizations such as Rocking the Boat or The Bronx River Alliance. If you are not able to take the time to visit the Bronx River you can take a virtual tour online.

Resources

Rocking the Boat - http://www.rockingtheboat.org/
The Bronx River Alliance - http://www.bronxriver.org
Bronx River Virtual Tour -
http://www.nycgovparks.org/park-features/virtual-tours/bronx-river/band- select

Common Core Standards

Lesson I

English Language Arts Standards Science and Technical Subjects

Key Ideas and Details Grades 6-8

CCSS.ELA-LITERACY.RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.

CCSS.ELA-LITERACY.RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Craft and Structure Grades 6-8

CCSS.ELA-LITERACY.RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.

Integration of Knowledge and Ideas Grades 6-8

CCSS.ELA-LITERACY.RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

CCSS.ELA-LITERACY.RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

English Language Arts Standards Speaking & Listening

Comprehension and Collaboration Grades 6-8

CCSS.ELA-LITERACY.SL.6-8.1

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6-8 topics, texts, and issues, building on others' ideas and expressing their own clearly.

Next Generation Science Standards

MS.Human Impacts

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Lesson II

English Language Arts Standards Science and Technical Subjects

Key Ideas and Details Grades 6-8

CCSS.ELA-LITERACY.RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.

CCSS.ELA-LITERACY.RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Craft and Structure Grades 6-8

CCSS.ELA-LITERACY.RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.
Integration of Knowledge and Ideas Grades 6-8
CCSS.ELA-LITERACY.RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
CCSS.ELA-LITERACY.RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
English Language Arts Standards Speaking & Listening
Comprehension and Collaboration Grades 6-8
CCSS.ELA-LITERACY.SL.6-8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6-8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
Next Generation Science Standards
MS.Human Impacts
MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Lesson III
English Language Arts Standards Science and Technical Subjects
Key Ideas and Details Grades 6-8
CCSS.ELA-LITERACY.RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.
CCSS.ELA-LITERACY.RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
Craft and Structure Grades 6-8
CCSS.ELA-LITERACY.RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.
Integration of Knowledge and Ideas Grades 6-8
CCSS.ELA-LITERACY.RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
CCSS.ELA-LITERACY.RST.6-8.9
Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
English Language Arts Standards Speaking & Listening

Comprehension and Collaboration Grades 6-8
CCSS.ELA-LITERACY.SL.6-8.1
Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6-8 topics, texts, and issues, building on others' ideas and expressing their own clearly.

Next Generation Science Standards

MS.Human Impacts

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ESS4-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Field Lesson

English Language Arts Standards Science and Technical Subjects

Key Ideas and Details Grades 6-8
CCSS.ELA-LITERACY.RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
Craft and Structure Grades 6-8
CCSS.ELA-LITERACY.RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.
English Language Arts Standards Writing: History/Social Studies, Science, & Technical Subjects
Texts Types and Purposes Grades 6-8
CCSS.ELA-LITERACY.WHST.6-8.1 Write arguments focused on discipline-specific content.
CCSS.ELA-LITERACY.WHST.6-8.1.B Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.
Production and Distribution of Writing Grades 6-8
CCSS.ELA-LITERACY.WHST.6-8.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

English Language Arts Standards Speaking & Listening

Comprehension and Collaboration Grades 6-8
CCSS.ELA-LITERACY.SL.6-8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6-8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
Grade 6
CCSS.ELA-LITERACY.SL.6.1.D
Review the key ideas expressed and demonstrate understanding of multiple perspectives

through reflection and paraphrasing.
CCSS.ELA-LITERACY.CCRA.SL.1
Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

Next Generation Science Standards

MS.Human Impacts MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ESS4-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Applied Learning Lesson

English Language Arts Standards Science and Technical Subjects

Key Ideas and Details Grades 6-8
CCSS.ELA-LITERACY.RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
Craft and Structure Grades 6-8
CCSS.ELA-LITERACY.RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.
English Language Arts Standards Writing: History/Social Studies, Science, & Technical Subjects
Texts Types and Purposes Grades 6-8
CCSS.ELA-LITERACY.WHST.6-8.1 Write arguments focused on discipline-specific content.
CCSS.ELA-LITERACY.WHST.6-8.1.B Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.
Production and Distribution of Writing Grades 6-8
CCSS.ELA-LITERACY.WHST.6-8.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Research to Build and Present Knowledge Grades 6-8
CCSS.ELA-LITERACY.WHST.6-8.7
Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

English Language Arts Standards Speaking & Listening

Comprehension and Collaboration Grades 6-8
CCSS.ELA-LITERACY.SL.6-8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6-8 topics, texts, and

issues, building on others' ideas and expressing their own clearly.
CCSS.ELA-LITERACY.SL.6-8.1.B Follow rules for collegial discussions, set specific goals and deadlines, and define individual roles as needed.
CCSS.ELA-LITERACY.CCRA.SL.1 Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
Grade 6
CCSS.ELA-LITERACY.SL.6.1.C Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.
Grade 7
CCSS.ELA-LITERACY.SL.7.1.C Pose questions that elicit elaboration and respond to others' questions and comments with relevant observations and ideas that bring the discussion back on topic as needed.
Grade 8
CCSS.ELA-LITERACY.SL.8.1.C
Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.
Mathematics Standards Standards for Mathematical Practice
Grades 6-8
CSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively
CSS.MATH.PRACTICE.MP5 Use appropriate tools strategically
CSS.MATH.PRACTICE.MP6 Attend to precision
Mathematics Standards Statistics & Probability
Summarize and describe distributions Grade 6
CCSS.MATH.CONTENT.6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

Next Generation Science Standards

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Additional Resources

Texts:

- **Open Sewer Atlas Grey to Green**

http://opensewerlas.tumblr.com/greytogreen

- **Paddling Down Newtown Creek is Actually Awesome; Curbed.com**

https://ny.curbed.com/2014/7/17/10072014/paddling-down-polluted-newtown-creek-is-actually-awesome

- **Mr. Trash Wheel Cleans Up Baltimore Harbor with a Dash of Humor; PBS Newshour**

https://newsela.com/read/elem-mr-trash-wheel-cleans-up-baltimore-harbor/id/42309/

Videos:

- **A great video by the Bronx RIver Alliance illustrating CSO's and GI.**

http://bronxriver.org/greeninfrastructure

- **Clips of CSO's on Newtown Creek**

http://www.newtowncreekalliance.org/combined-sewer-overflow/

- **Rain Garden/ Bioswale during a storm**

https://www.youtube.com/watch?v=qbHZ748AbEU

- **Recycled Toilets for Rain Gardens**

https://www.youtube.com/watch?v=VdeC5XDC9M4

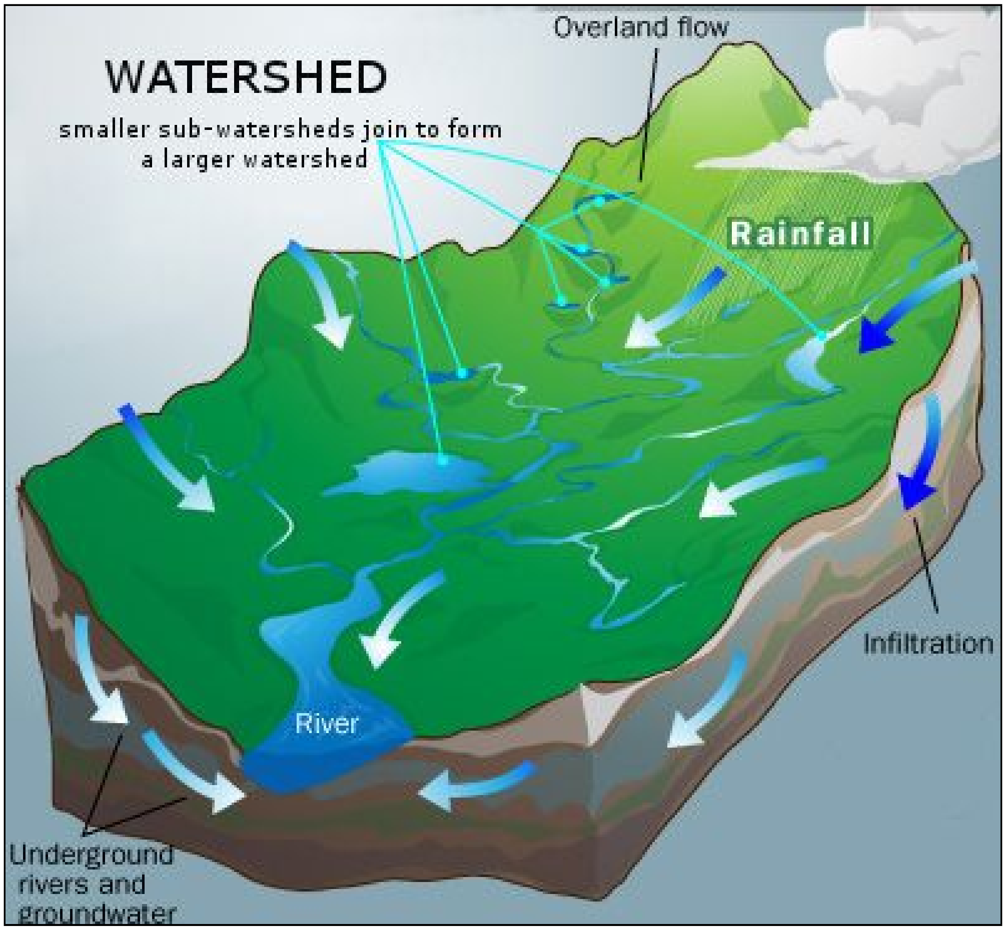
- **Natureworks; Sustainable Urban Design: Green Infrastructure**

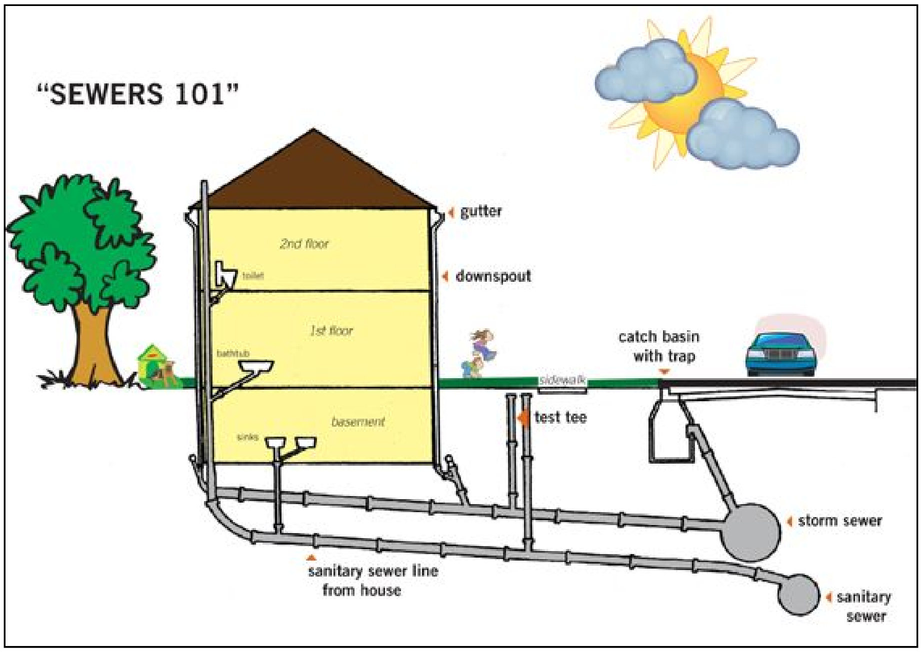
https://www.natureworkseverywhere.org/resources/sustainable-urban-design-toolkit/

Rainwater Collection Calculator

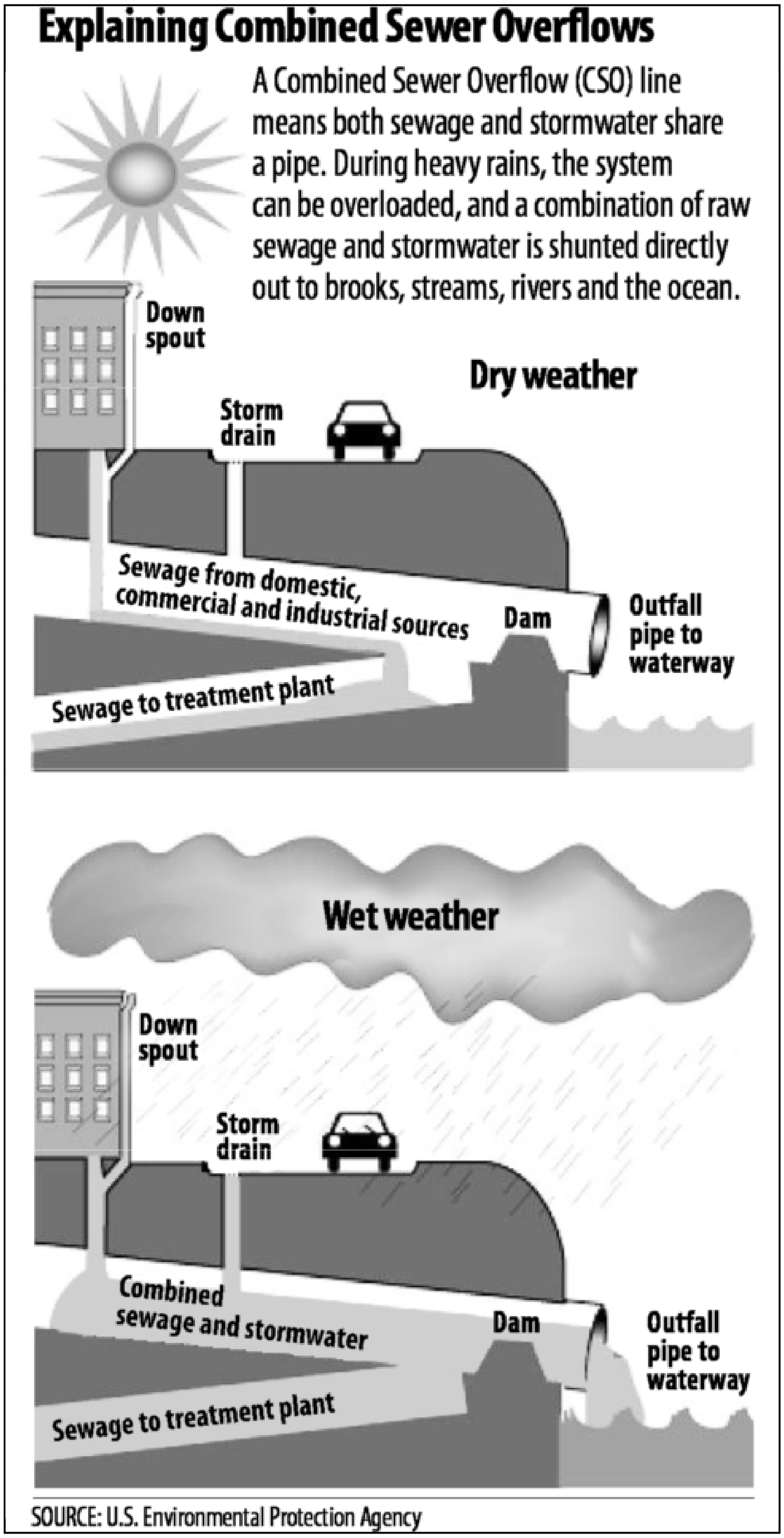
- https://www.gardeners.com/how-to/rain-barrel-for-rainwater-collection/5497.html

Images:

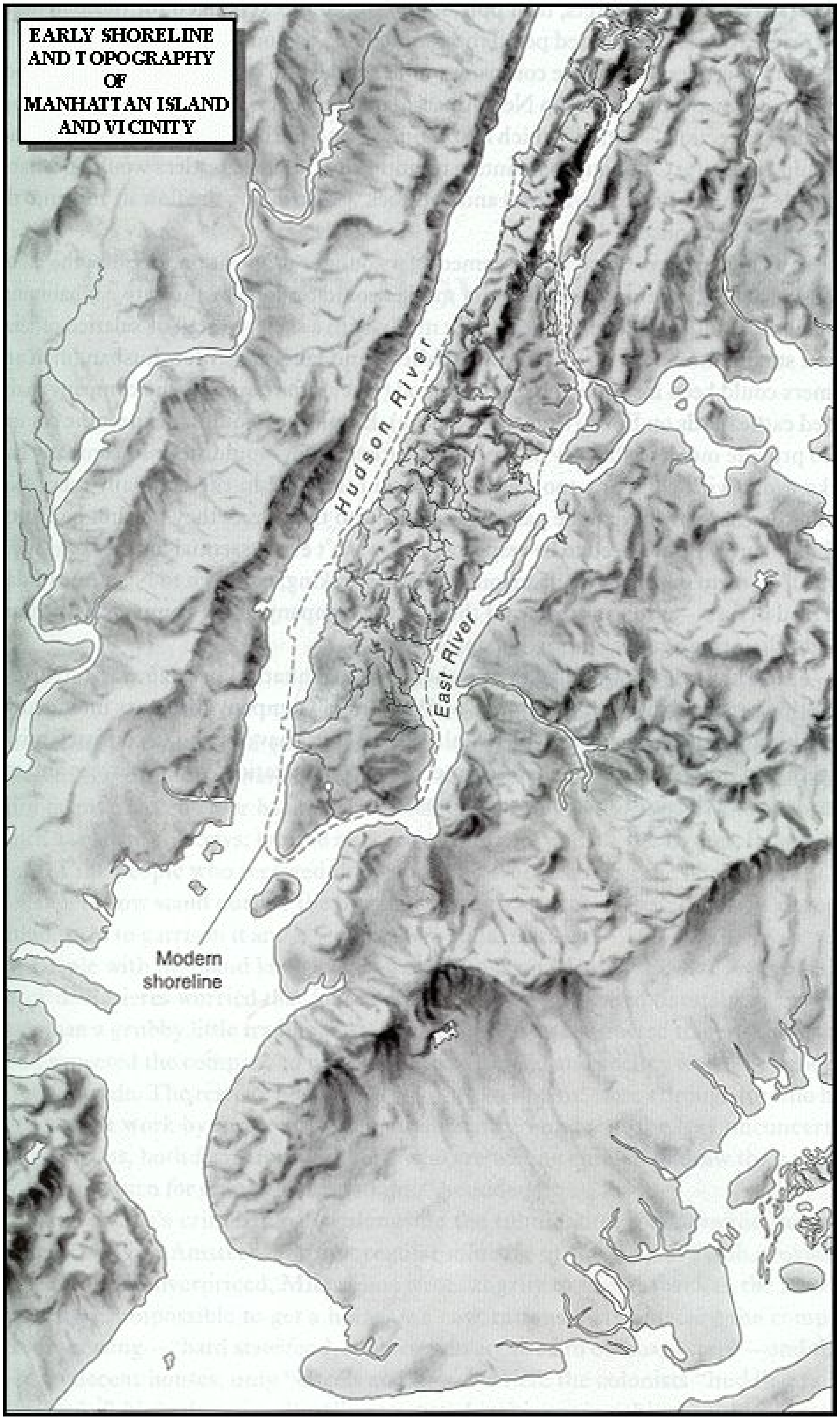




"SEWERS 101"
gutter
2nd floor
toilet
downspout
1st floor
bathtub
catch basin
with trap
sidewalk
basement
sinks
test tee
storm sewer
sanitary sewer line
from house
sanitary
sewer



Explaining Combined Sewer Overflows
A Combined Sewer Overflow (CSO) line means both sewage and stormwater share a pipe. During heavy rains, the system can be overloaded, and a combination of raw sewage and stormwater is shunted directly out to brooks, streams, rivers and the ocean.
Down spout
Dry weather
Storm drain
Sewage from domestic, commercial and industrial sources
Dam
Outfall pipe to waterway
Sewage to treatment plant
Wet weather
Down spout
Storm drain
Combined sewage and stormwater
Dam
Outfall pipe to waterway
Sewage to treatment plant
SOURCE: U.S. Environmental Protection Agency


EARLY SHORELINE AND TOPOGRAPHY OF MANHATTAN ISLAND AND VICINITY
Hudson River
East River
Modern shoreline

Handouts

Field Site Metadata

Fill in the following information about the Field Site you are visiting

Student Name:

Location:

Site Name____

Time________________ Day_________________

Year________________ Month_______________

Weather Temperature:___________

Describe the weather:

Cloud Type:

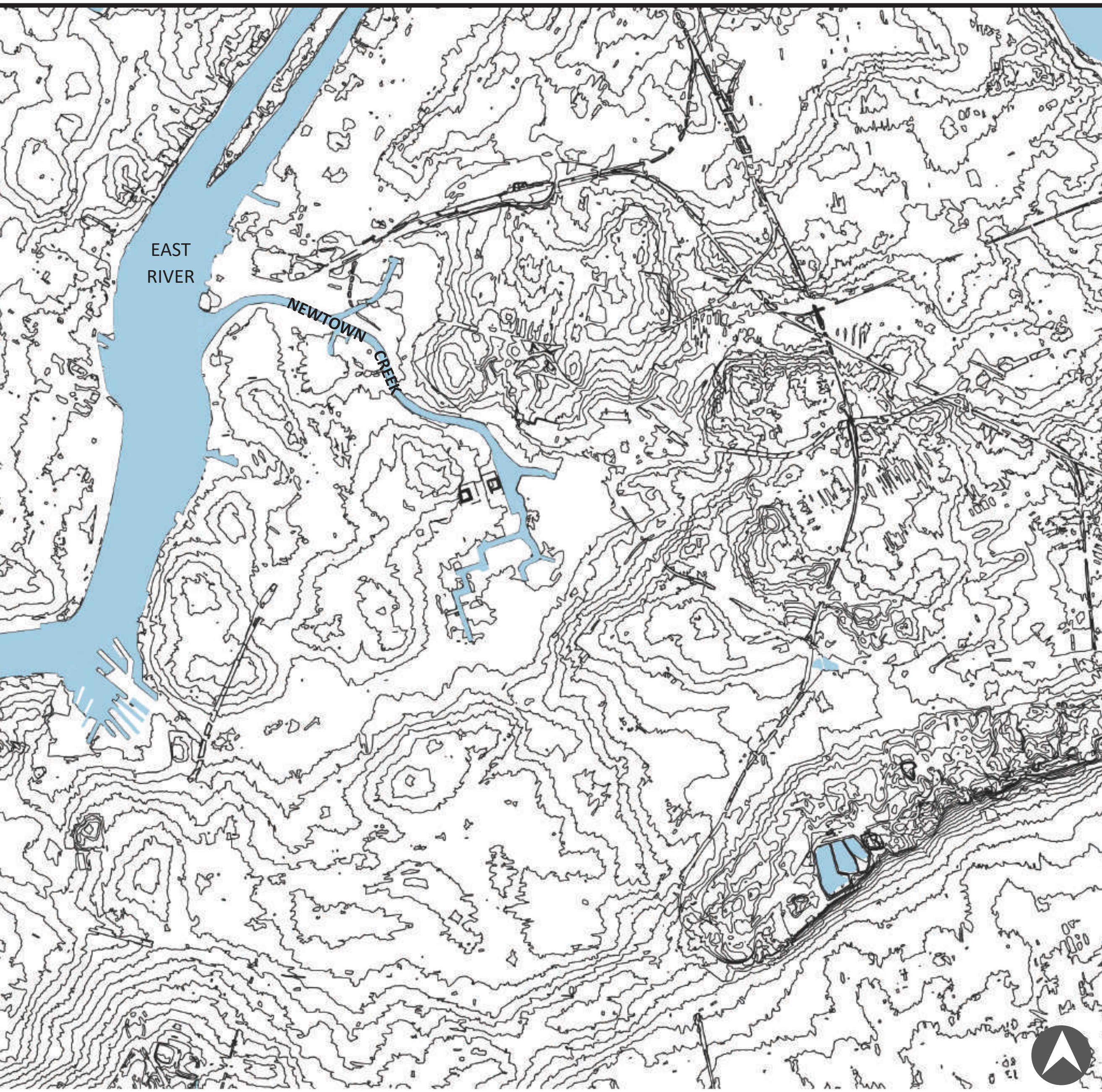
Cloud Cover:

- ☐ No Clouds
- ☐ Some Clouds (Partly Cloudy)
- ☐ Lots of Clouds

Description of Site & Conditions:

Newtown Creek Topographic Map

This map shows contour lines which represent a change in elevation.



Notes:

Map Key:

Water

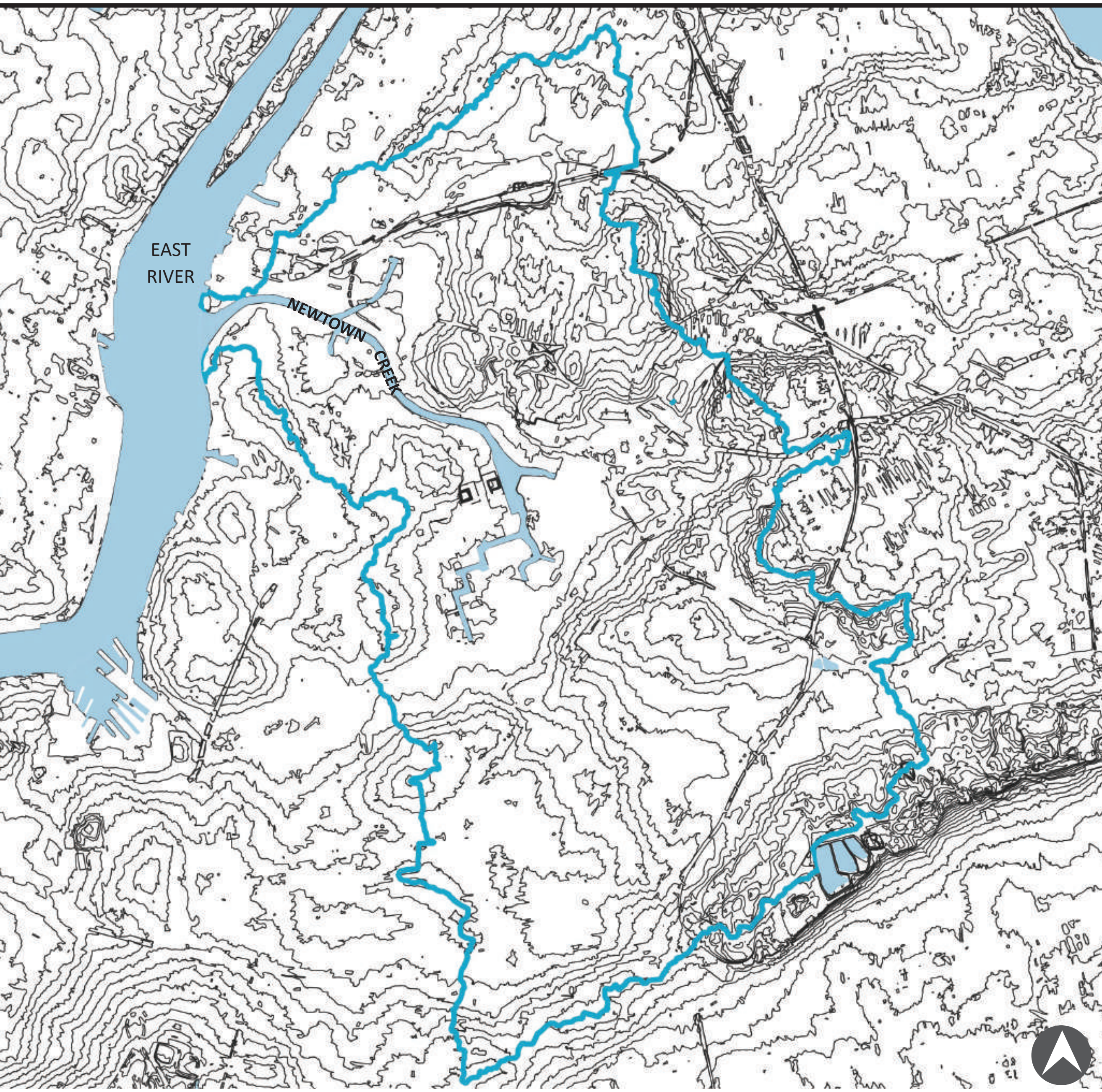
Land contour lines

NCA
NEWTOWN CREEK ALLIANCE

Map developed by Korin Tangtrakul
NYC Soil & Water Conservation District.

Newtown Creek Topographic Map with Watershed Outline

This map shows contour lines which represent a change in elevation. The Newtown Creek Watershed outline represents the highest points in the area of land around Newtown Creek.



Notes:

Map Key:

Water

Land contour lines

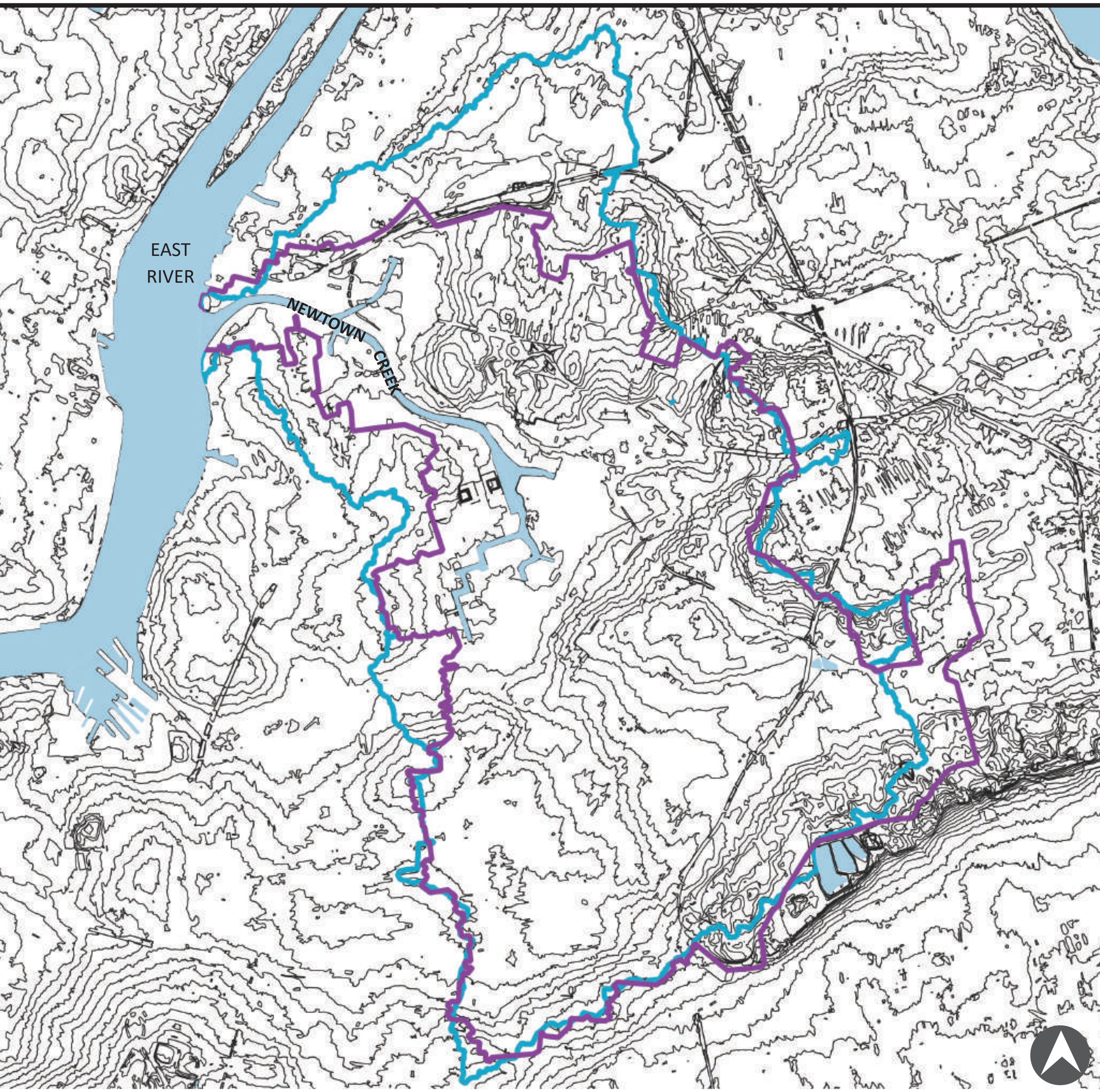
Watershed

NCA
NEWTOWN CREEK ALLIANCE

Map developed by Korin Tangtrakul
NYC Soil & Water Conservation District.

Newtown Creek Topographic Map with Watershed and Sewershed Outline

This map shows contour lines which represent a change in elevation. The Newtown Creek Watershed outline represents the highest points in the area of land around Newtown Creek. The Sewershed represents the area of stormwater capture that effects Newtown Creek.



Notes:

Map Key:

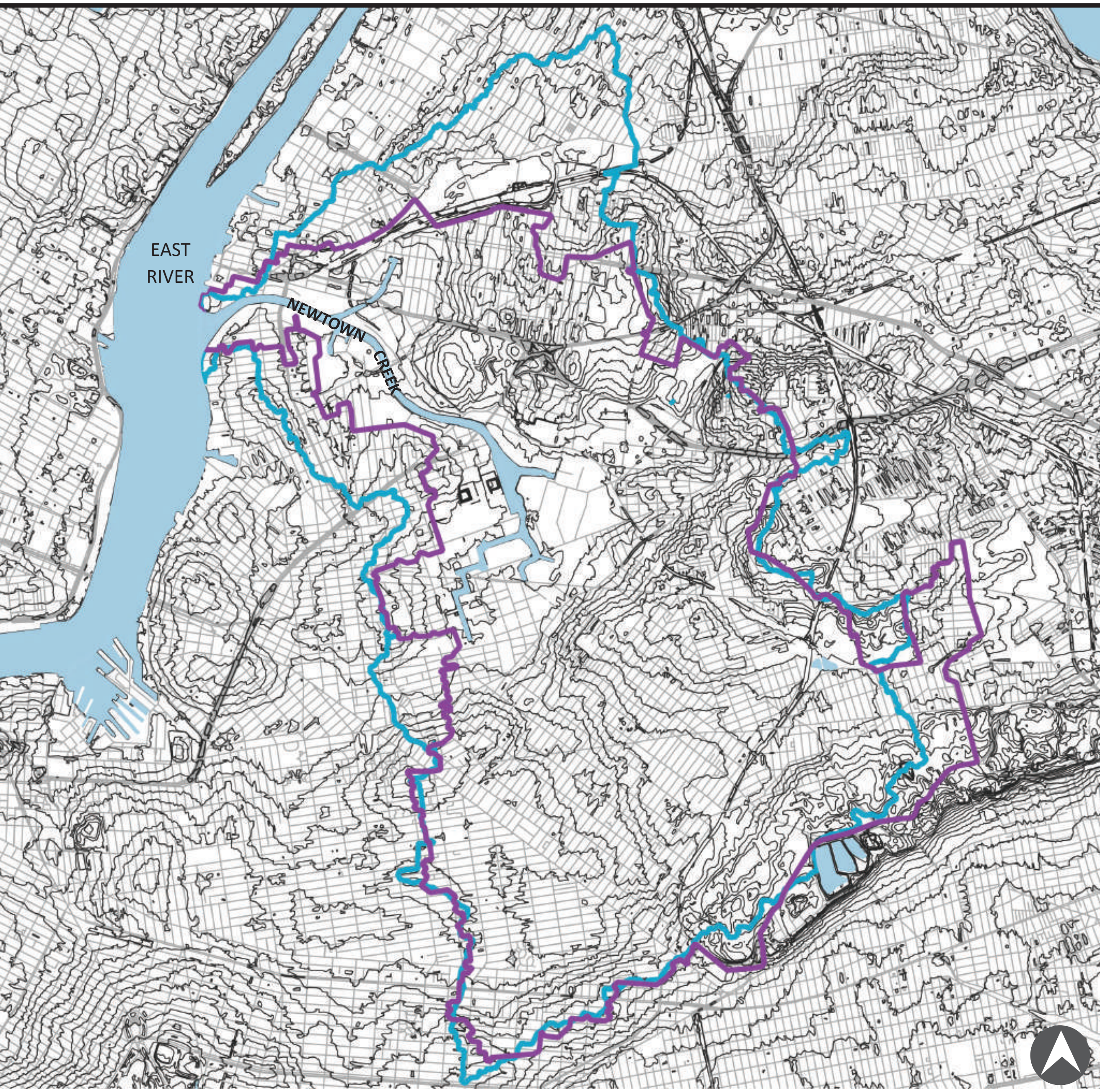
- Water
- Land contour lines
- Watershed
- Sewershed

NEWTOWN CREEK ALLIANCE

Map developed by Korin Tangtrakul
NYC Soil & Water Conservation District.

Newtown Creek Street Map w/ Watershed & Sewershed

This map is a street map showing outlines of the Newtown Creek Watershed and Sewershed with contour lines.



Notes:

Map Key:

- Water
- Land contour lines
- Street grid
- Watershed
- Sewershed

NCA
NEWTOWN CREEK ALLIANCE

Map developed by Korin Tangtrakul
NYC Soil & Water Conservation District.

Newtown Creek Watershed Map with Water Flow

This topographic map shows the direction that water flows in the Newtown Creek Watershed. Contour lines represent a change in elevation.

Notes:

Map Key:

Water

Watershed

10 ft contour lines (elevation from sea level)

0, 10, 20 ft

30, 40 ft

50, 60 ft

70, 80 ft

90, 100 ft

over 100 ft

Direction of water flow

NCA
NEWTOWN CREEK ALLIANCE

Map developed by Korin Tangtrakul
NYC Soil & Water Conservation District.

NYC Map with Newtown Creek Sewershed

This map shows where the Newtown Creek Sewershed is relative to the greater New York City.

Notes:

Map Key:

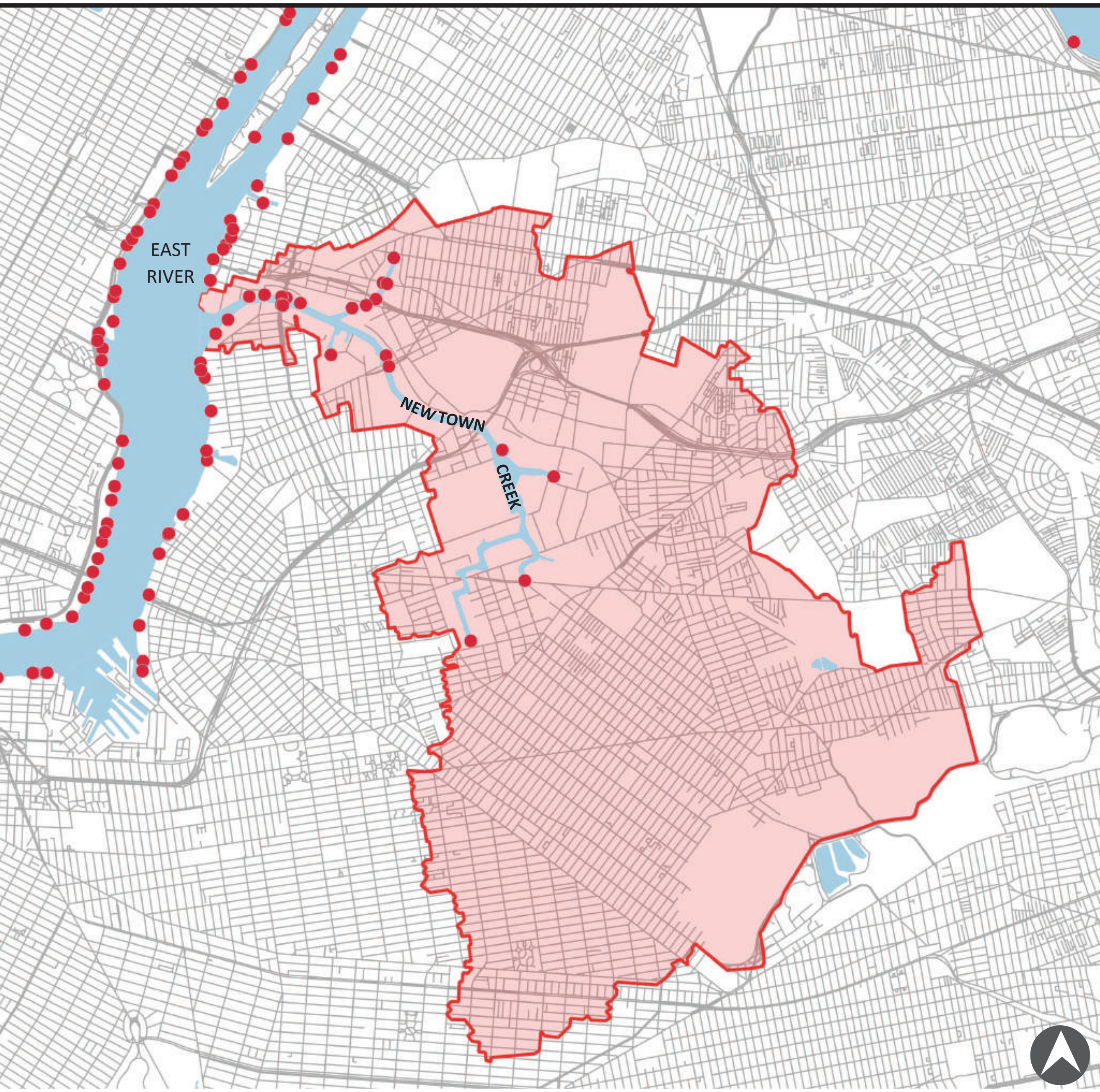
Water

Sewershed

Map developed by Korin Tangtrakul
NYC Soil & Water Conservation District.

Newtown Creek Sewershed Map

This map shows the area of land that drains to Newtown Creek during a rainstorm and CSO outfall points along the Creek.



Notes:

Map Key:

Water

CSO outfalls

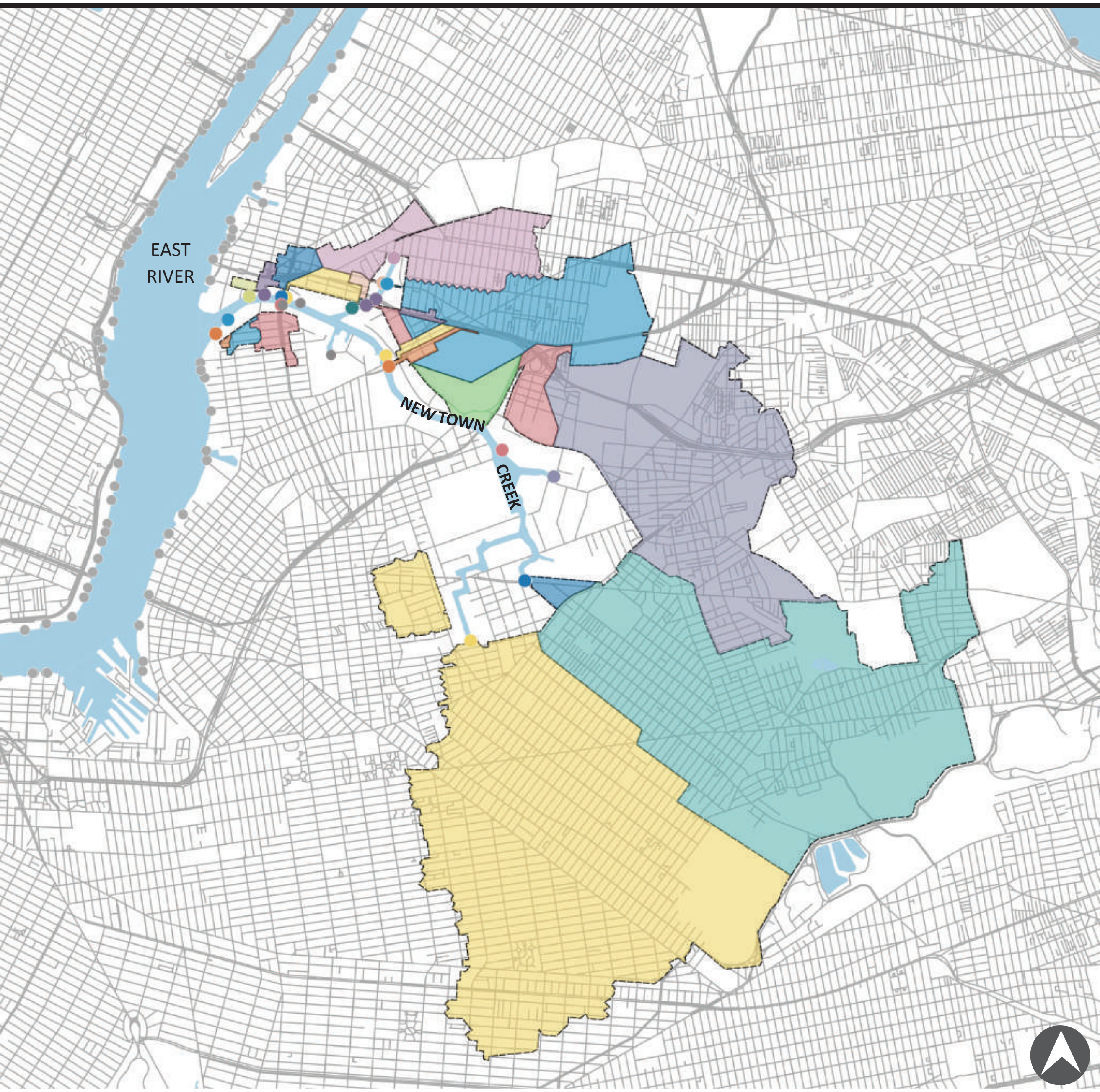
Sewershed

NCA
NEWTOWN CREEK ALLIANCE

Map developed by Korin Tangtrakul
NYC Soil & Water Conservation District.

Newtown Creek CSO-shed Map

This map shows the areas of land that drain to Newtown Creek during a rainstorm and which CSO outfalls each area drains to, or the CSO-shed.



Notes:

Map Key:

- Water
- CSO outfalls
- CSO-sheds

NEWTOWN CREEK ALLIANCE

Map developed by Korin Tangtrakul
NYC Soil & Water Conservation District.