Score Four:

Students, Schools, Streams, and the Bay

Students doing real-world science and math, campus environmental investigations, and sustainable stormwater projects to improve the quality of their streams, communities, and the Chesapeake Bay.

The Interstate Commission on the Potomac River Basin

The gardens and trees we plant are just the beginning.
Students are putting down roots for healthy streams, cleaner air, beautiful spaces, wildlife habitat, and life-long stewardship.

The Interstate Commission on the Potomac River Basin (ICPRB) developed the lessons in the *Score Four Program* in partnership with the Elms Environmental Education Center and the Science, Technology, Engineering and Mathematics Program of St. Mary's County Public Schools, and the support of multiple authors. We thank Kenmoor Middle School, Prince Georges County Public Schools, for enabling us to pilot the *Score Four Program* with their students, 2014-2015.

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Interstate Commission on the Potomac River Basin, 30 W. Gude Drive, Suite 450, Rockville, MD 20850.

Table of Contents

Each section of this notebook represents a step towards your classes' Student Stormwater Action Project. Consider using this binder for field notes, research results, drawings, and photos, so it can serve as a record of the year's efforts, enabling you to compare investigation results from year to year, as well as to incorporate your own lesson ideas, new resources, and "lessons learned."

For Teachers

Score Four:

Students, Schools, Streams, and the Bay

1. **Foster a generation of stewards with Meaningful Watershed Educational Experiences at your school.**
2. **Engage students in real-world science, geography investigations, math, and communication skills.**
3. **Address Environmental Literacy, Next Generation Science, STEM, C3 Social Studies Framework for Inquiry.**
4. **Preserve waterways through student stormwater sustainable practices on your campus.**

WITH THE SCORE FOUR PROGRAM THE PROCESS IS AS IMPORTANT AS THE END GOAL. Score Four lessons culminate with student-led stormwater-reduction projects on your campus — but before one shovel of dirt is turned, students are engaged in cross-curricular hands-on inquiries about their school's watershed and grounds.

Using scientific practices, students assess permeability, stormwater dynamics, pollution sources, and soils. Integrating their new-found knowledge with Score Four project-planning tools, they then select a location and project to reduce stormwater runoff. Their Student Stormwater Action Project (SSAP) could be a native garden, conservation landscape, tree planting, rain garden, or another sustainable option. The next steps: selecting appropriate native plants, creating project designs, and planning maintenance, all done through teamwork, class discussions, and presentations.

By the time the students turn the ground for their new project, they have ownership for it. Plus, they understand how and why their project will help their local stream. Along the way, they will have practiced scientific field methods and everyday math, improved their communication skills, and gained the ability and, hopefully, the desire to carryout stormwater pollution solutions in their communities.

FOR TEACHERS, THE SCORE FOUR PROGRAM PROVIDES a series of investigations that can be adapted to different curricula and ages. Beginning the program in the fall builds flexibility into the schedule and gives more opportunities for outdoor learning.

The lessons in this series are geared to the completion of conservation landscape; they are, however, effective in preparing other sustainable stormwater projects, such as rain gardens or food forest. The Resource section provides information on the development of many sustainable stormwater projects.

A Score Four program fulfills the requirements for a Meaningful Watershed Educational Experience (MWEE), as well as Maryland Environmental Literacy (MEL) Standards 1, 2, 3A, and 5A.

Table 1 (p. 2-3) shows how the Score Four framework dovetails with MWEEs and MEL Standard 1, Environmental Issue Investigation and Student Action.

Table 1: Score Four Framework

In Conjunction with Maryland Environmental Literacy (EL) Standard 1 and Meaningful Watershed Educational Experiences (MWEE)

EL Topic A: Environmental Issue Investigation (or *MWEE*)	**Suggestions Regarding MWEE and EL requirements**	**LESSONS AND ACTIVITIES** All Score Four lessons, presentations, and resources are at www.potomacriver.org/scorefour. Links are provided below to Teacher Lesson Plans (TLP) and Student Handouts (SH). Lessons continue to be added (TBA).
EL Indicator 1: Identify an environmental issue (***MWEE**: Choose issue.)*	*Possible Issue:* How do human activities affect: ▪ local water pollution? ▪ local stream ecosystems? ▪ the Chesapeake Bay? ▪ our local watershed?	**SCORE FOUR SECTION A: EXPLORING YOUR WATERSHED** **Presentation**: • Score Four: Watersheds, Land Use, and Sustainable Practices (PDF/PPT). Use entire presentation or just the sections on water pollution, watersheds, and land use. **Associated Score Four Student Inquiries**: ▪ Topography, Landuse, and Stormwater Chemistry. Use all or parts of this 3-part inquiry. The TLP includes all sections and the presentation. ▪ Topography SH (upper grades) ▪ Stormwater Chemistry SH (gr. 7-12) ▪ *Or* FieldScope Map Inquiry (gr. 6-12). Presentation: PDF/PPT, TLP SH **Other Options for Engagement and Inquiry:** ▪ Visually assess nearby stream (ICPRB Physical Assessment lesson – **TBA**) ▪ Assess stream water chemistry. Presentation: PDF/PPT, TLP SH(Middle School, High School) ▪ Make and use Watershed Connections Models and Activities or other watershed models.
EL Indicator 2: Develop and write research questions related to the environmental issue. *(**MWEE:** Create organizing and supporting questions.)*	*Students pose organizing question, such as:* ▪ How does land use in the school's watershed affect local streams? *Students pose supporting questions*: ▪ How does the impervious surface on our school grounds contribute to stream pollution? ▪ How much stormwater runoff is generated on our campus? ▪ What pollutants are contained in runoff from school grounds and surrounding watershed? ▪ How does surrounding land use our local stream ecosystem?	
EL Indicator 3: Communicate the issue.	Share issue, research questions & results with other classes or community throughout the project. Don't miss the opportunity to involve other disciplines or grades.	Many possibilities for students, including: ▪ Post maps & research in hall. ▪ Communicate project with articles, videos, blogs. ▪ Provide presentation to other classes or parents. ▪ Share findings in Science Fair.
Indicator 4: Design and conduct the research.	*Hands-on Multidisciplinary Investigations:* Different classes can investigate different supporting questions or aspects of them. Use Score Four investigations to answer questions on permeability and stormwater paths. Definitely include Campus Assessment.	**SCORE FOUR SECTION B: ASSESSING YOUR CAMPUS** ▪ Permeability Prediction (gr. 5-8), optional. **TLP SH** ▪ Permeability Field Investigation (gr. 6-12), optional. **TLP SH** ▪ Campus Assessment. Presentation: PDF/PPT, **TLP SH** ▪ Soils Lessons and Inquiries - Presentation: Soil Basics (Middle School: PDF/PPT, High School: PDF/PPT) - Soil Components (texture and soil identification) **TLP SH** - Soil Percolation Investigation **TLP SH**
Indicator 5: Use data and references to interpret findings.	Interpret findings recommend possible sites for a conservation landscape. Alternatively, upper-level students research stormwater solutions, present pros and cons, and recommend a project (source materials at Resources).	▪ Lesson: View or review Score Four: Watersheds, Land Use, and Sustainable Practices (PDF/PPT) section on stormwater runoff solutions. ▪ Presentation: Conservation Landscapes (PDF/PPT) ▪ Class recommends solutions and possible sites.

<table>
<tr><td colspan="3">EL Standard 1 Topic B. Action Component (or MWEE Student Action Project)
The Action Component of Score Four involves student inquiries to determine the best location and attributes of their stormwater-reduction project, all leading to its implementation. NOTE: If grants or donations of materials are needed, the teacher(s) may need to determine the type of stormwater-reduction project ahead of time and make behind-the-scene preparations. Students can still be involved in the research and selection of the site, the project design, the maintenance plans, and the evaluation method.</td></tr>
<tr><td>EL Indicator 1:
Develop and implement an environmental action plan.

(MWEE: Plan and implement a student action project, considering alternatives in the process.)</td><td>Consider stormwater solutions and conduct research to select solution. Solutions can involve conservation landscapes, rain gardens, riparian buffers, and more. The adjacent Score Four lessons are geared to conservation landscapes, but can be adapted to all these efforts.

Score Four investigations provide answers that help students determine the most appropriate stormwater solution and site location. Students can determine additional questions to be answered.

Before taking on a project, teachers and students should determine how it will be evaluated and maintained. (Indicator 3.)</td><td>SCORE FOUR SECTION C: PLANNING YOUR PROJECT

This section covers the identification of project goals through investigations and student decision-making processes. It includes plant selection and project design and implementation for their SSAP.

Score Four presentations:
▪ Conservation Landscapes (PDF/PPT)
▪ or Conservation Gardens: Why They Are Needed Plus Planning & Planting Tips (this presentation can be broken into sections) TBA

Perform the following inquiries to determine the best solution:
▪ Sun/shade Observation SH
▪ Project Goals. This activity guides student selection of secondary goals for their action project. SH
▪ Site Selection. This activity guides student selection of a site for their SSAP. SH
▪ Site Conditions and Project Characteristics for conservation landscapes, trees, food forests. Raingarden plants have different requirements. SH
▪ Plant Selection and Garden Design. Use for conservation landscapes, tree plantings, food forests.
- Presentation: Native Plants and Plant Selection (PDF/PPT)
- Presentation: Garden Design (PDF/PPT)
- Plant Selection and Garden Design SH
- Planning Color for the Seasons SH
▪ For food forests, rain gardens, and tree plantings, see Resources for specific guidance.
▪ If doing a rain garden, see Site Assessment for Rain Gardens for instructions on Percolation Test and Slope determination (TBA)

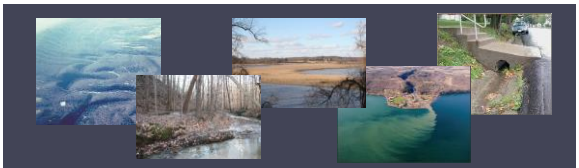
Other project planning factors: Is it practical for the class to develop within the timeframe and budget? What help could be obtained and how? What tools and supplies are needed? How to organize the work day? Can the project be maintained?
▪ Presentation: Maintenance (PDF/PPT)
▪ Maintenance Agreement for Schools TLP
▪ Maintaining Your Project SH</td></tr>
<tr><td>EL Indicator 2:
Communicate, evaluate and justify views</td><td>Indicator 1 and Indicator 2 loop until the action project is picked, implementation plans are finalized, and project is implemented.</td><td>Students share results of their investigations and select project with teacher guidance and feedback.</td></tr>
<tr><td>EL Indicator 3.
Analyze effectiveness of action

(MWEE:
Evaluate the project.)</td><td>Before implementation, pick evaluation methods that will show whether the project's goal(s) are met.

Consider setting up long-term projects that can provide future research projects for students.</td><td>Have student design evaluations that consider pre- and post- student attitudes and knowledge, as well as environmental data, such as: stormwater chemistry from the site, soil porosity, soil biological activity, soil chemistry, stormwater quantity.</td></tr>
</table>

Exploring Your Watershed

Score Four: Students, Schools, Streams, and the Bay



Watershed Connections
Conexiones de la Cuenca

Part 1: Maryland Waterways and Watersheds
Parte 1: Canales de Maryland y Cuencas Hidrográficas

A partnership of the Interstate Commission on the Potomac River Basin and the Patuxent River Park, Maryland-National Capital Park and Planning Commission
Una colaboración entre Comisión Interestatal de la Cuenca del Río Potomac y el Parque del Río Patuxent (Miembro de la Comisión de Parques y Recreación de Maryland y la Capital Nacional)

Interstate Commission on the Potomac River Basin
Comisión Interestatal de la Cuenca del Río Potomac
(301) 984-1908 | info@icprb.org | www.PotomacRiver.org

Maryland Treasures
Tesoros de Maryland


1

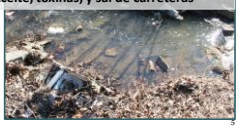

2


3


4

Maryland's "Other" Waterways
Los "otros" canales de Maryland

Oil, toxins, and road salt
Aceite, toxinas, y sal de carreteras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Acid Mine Drainage
Desague ácido minero


6

Channelization
Canalizaciones


7

Erosion and Sedimentation
Erosión y Sedimentación


8

Troubled waters…
Aguas en problemas…


9

- **46%** of Maryland's Streams are in "Poor" Condition.
- **46%** de los ríos y arroyos de Maryland's están en condiciones "Pobres".

- Only **12%** are in "Good" Condition
- Sólo el **12%** están en "Buenas" condiciones

Good Health, Poor Health —
what does it mean?

Buena Salud, Mala Salud —
¿Qué significa?

Healthy streams have…
Arroyos sanos tienen…


Photos: 10, 11, 12, 13, 14, 15, 16

- Plants and tres growing along bank
  Plantas y árboles creciendo en las riberas
- Diverse hábitats
  Diversos hábitats
- Chemical and physical properties aceptable for aquatic life
  Propiedades físicas y químicas aceptables para la vida acuática
- Safe water for human recreation
  Aguas para la recreación humana

Download this PowerPoint on our website.
www.potomacriver.org/scorefour

What makes an "unhealthy" stream?
¿Qué son arroyos "enfermos" o "no-saludables"?

Good Streams
Arroyos Saludables

- Plants along the bank
  Plantas en las riberas
- Diverse habitats
  Hábitas variados
- Chemical properties aceptable for aquatic life
  Propiedades químicas acceptables para la vida aquática
- Safe for human recreation
  Seguros para la recreación humana.

Versus

Poor Streams
Arroyos No-Saludables

- Lack habitats
  Carecen de hábitats
- Are polluted
  Están contaminados
- Lack tres, plants, and shade
  Carecen de árboles, plantas, y sombra
- Unsafe for public use
  No aptos para el uso público
- Filled with trash and sewage
  Llenos de basura y aguas negras



10,17, 18

Why it matters…
¿Por qué es importante?…

- Main source for drinking water
  La fuente principal de nuestra agua de beber

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Why it matters…
¿Por qué es importante?…

- Lowers the beauty of a stream
  Le resta belleza a el arroyo
- Deters swimming, wading, boating…
  Prohíbe el uso recreativo como nadar, vadear, pezcar…

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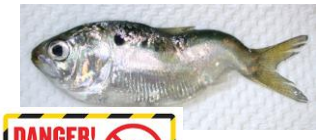
Why it matters…
¿Porqué nos importa?

- Pollution affects our food supply

  La contaminación affecta nuestras fuentes de alimento





21-23

Why it matters…
¿Porqué nos importa?



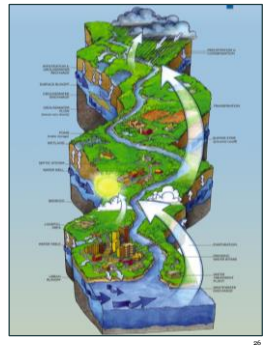


24,25, 26

Protecting Our Water Resources
Protegiendo nuestras fuentes de agua

To protect and restore wáter quality, we need a **watershed perspective**.

Para proteger y restaurar nuestra calidad de agua necesitamos ***perspectiva de cuenca.***



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What is a watershed?
¿Qué es una Cuenca ?

Watershed: An area of land where the water drains into a common source, such as a stream, pond, or bay.

Cuenca: Un área de tierra en dónde el agua se escurre en una fuente común como un arroyo, estanque, o bahía.

A **watershed perspective** looks at how our land use affects our waterways.

Una **Perspectiva de cuenca** explora el cómo el uso de los terrenos afecta nuestros cuerpos de agua.

Our Chesapeake Bay Watershed
Nuestra Cuenca de la Bahía del Chasapeake

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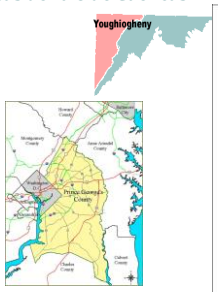
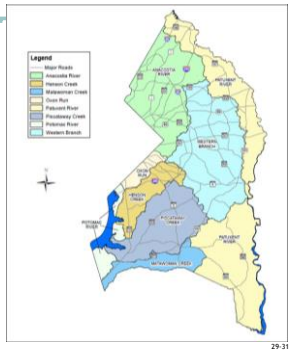
- Maryland is nested in one of largest watersheds on the East Coast, the Chesapeake Bay drainage basin. Maryland está alojada en una de las cuencas más grandes de la costa este, la Cuenca de la Bahía del Chesapeake.
- What other states are part of the Chesapeake Bay Watershed? ¿Qué otros estados son parte de la Cuenca de la Bahía del Chesapeake?

Watersheds within watersheds
Cuencas dentro de Cuencas





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http://www.anacostiaws.org/explore/maps

True or False?
¿Cierto o Falso?

1. A watershed only includes the land surface. **FALSE**
   Una cuenca sólo incluye la superficie terrestre. **FALSO**
2. A watershed is a building for holding run-off water after a rainstorm. **FALSE**
   Una cuenca es un edificio que sirve para almacenar escorrentía después de que llueve. **FALSO**
3. The way land is used in a watershed affects water quality. **TRUE**
   La manera en que usamos los terrenos afecta la calidad del agua. **CIERTO**
4. Everyone lives in a watershed. **TRUE**
   Todo el mundo vive en una cuenca. **CIERTO**
5. Watersheds are drawn on maps according to political jurisdictions. **FALSE**
   Las cuencas se dibujan en los mapas siguiendo jurisdicciones políticas. **FALSO**
6. Some watersheds are hilly; others are relatively flat. **TRUE**
   Algunas cuencas son inclinadas y otras relativamente llanas. **CIERTO**

Picture References – Incomplete
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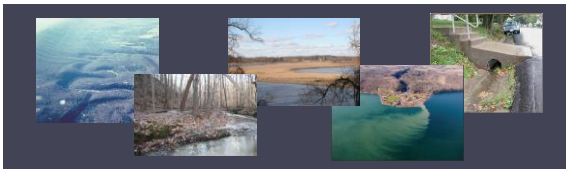

Watershed Connections
Conexiones de la Cuenca

Part 2: Land Use - How infiltration, runoff, and water quality differ in different landscapes
Parte 2: Uso de terrenos - Cómo la infiltración, escorrentía, y calidad de agua se diferencian de acuerdo con el manejo de terrenos…

A partnership of the Interstate Commission on the Potomac River Basin and the Patuxent River Park, Maryland-National Capital Park and Planning Commission
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Solar Energy
Energía Solar

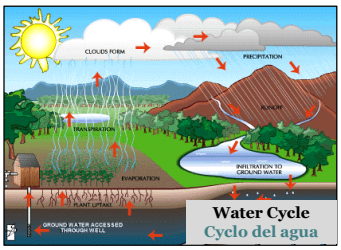
Condensation
Condensación

Precipitation
Precipitación

Evaporation
Evaporación
or
o
Transpiration
Transpiración

Infiltration
Infiltración

Runoff
Escorrentía



Water Cycle
Cyclo del agua

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Land Use:
How infiltration, runoff,
and water quality
differ in different landscapes…

Uso de terrenos:
Cómo la infiltración, escorrentía,
y calidad de agua se diferencian de acuerdo con el manejo de terrenos…

Wetlands
Humedales

Wetlands include:
Los humedales incluyen:

- Forested swamps in the low-lying flood-plains of rivers.
  Pantanos boscosos en los terrenos llanuras de inundación de las riberas.
- Marshes bordering the Chesapeake Bay and our large tributaries.
  Ciénagas que bordean la bahía del Chesapeake y nuestros grandes tributarios.

Wetlands now only cover 10% of Maryland;
73% have been destroyed since pre-colonial times.
Solo el 10% de Maryland está cubierto por humedales;
73% de los húmedales han sido destruídos desde los tiempos coloniales.

Wetlands
Humedales

- **Act as natural water filters**
  Actúan como filtros de agua naturales
  - Plants absorb pollutants.
    Las plantas absorben contaminantes.
  - Roots and leaves slow water flow and catch sediment in the water
    Raíces y hojas reducen la velocidad del flujo de agua y retienen sedimentos suspendidos en el agua.
- **And sponges**
  Y esponjas
  - Organic-rich soil hold water.
    Suelos ricos en materia orgánica retienen agua.
  - Water-loving plants draw up and transpire water.
    Plantas con alto consumo de agua absorben la humedad del suelo y la transpiran.

Forests
Bosques

Let's discover some connections between forests and water quality.
Descubramos las conexiones entre los bosques y la calidad del agua.

Where does the rain go in this scene?
¿A dónde va la lluvia en esta escena?

Download this PowerPoint on our website.
www.potomacriver.org/scorefour

Agriculture
Agricultura

- Where does the rain water go?
  ¿A dónde va la lluvia?
- What does the runoff carry?
  ¿Qué transporta la escorrentía?

45-47

Effects of Land Use: Farm Land
Efectos del Uso de Terrenos: Granjas

INPUTS
ENTRADA

- Fertilizer – excessive nitrogen and phosphorous downstream
  Fertilizante – Nitrógeno y fósforo excesivo río abajo
- Pesticides
  Pesticidas
- Animal waste runoff
  Escorrentía de desechos

RESULTS
RESULTADOS

- Algae blooms
  Efloraciones de algas
  - Reduced oxygen
    Niveles reducidos de oxígeno
  - Reduced aquatic life
    Muerte a vida acuática

INPUT
ENTRADA

- Excessive sediment in rivers
  Sedimento excesivo en los ríos

RESULTS
RESULTADOS

- Murky waters: less sunlight reaches plants
  Aguas turbias: menos luz para las plantas acuáticas.
- Fewer underwater plants = reduced dissolved oxygen
  Menos plantas acuáticas = menos oxígeno disuelto.
- Buried bottom hábitat
  Hábitat de fondo enterrado
- Clogged gills for fish and smaller invertebrates
  Agallas de peces y organismos acuáticos tapadas

Cities and Suburbs
Ciudades y Suburbios

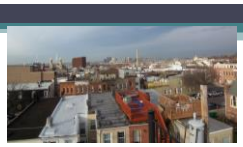
36,37

39-40

Stormwater Runoff
Escorrentía pluvial

Stormwater runoff is rain or melted snow that runs off impermeable surfaces, such as roofs and pavement, and picks up contaminants as it flows downslope into waterways.

La escorrentía pluvial contaminada es la lluvia o nieve derretida que corre sobre los techos, pavimento, y superficies impermeables que recoge contaminantes a su paso.

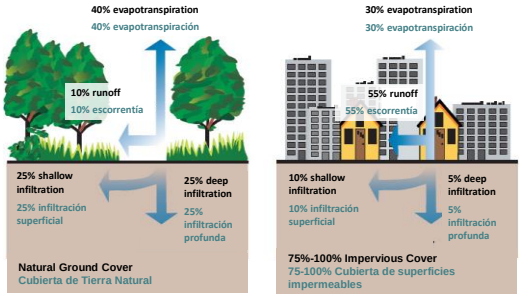


Stormwater runoff is the only growing source of water pollution in the Chesapeake Bay.
Escorrentías pluviales son la única fuente de contaminación en la Bahía del Chesapeake que continúa en aumento.

44

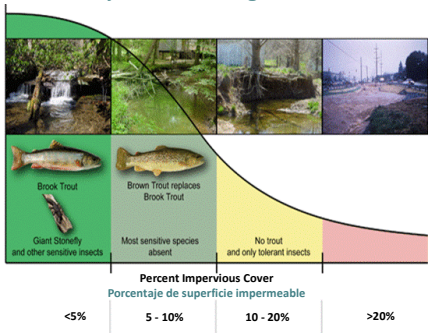
1. Why is increased impervious surface linked to stream erosion?
   ¿Porqué el aumento en superficies impermeables esta relacionado con la erosión de los arroyos?
2. What are some effects of stream erosion?
   ¿Cuáles son algunos efectos de la erosión de riachuelos?

Forests versus Cities
Bosques versus Ciudades



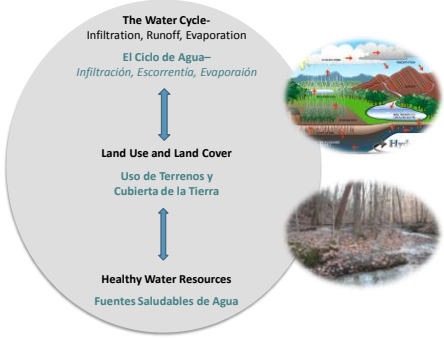
42

Land Use and Water Quality
Uso de Terrenos y la Calidad de Agua



43

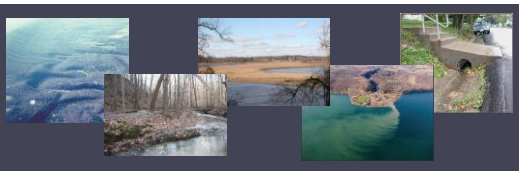
It's All Connected
Todo está conectado



Picture References – Incomplete
Referencias de las fotos - Parcial

33. Rivulet, Woodland, Patuxent River Park, Rebecca Wolf
34. Woods, Patuxent River Park, Rebecca Wolf
35. Woods, Patuxent River Park, Rebecca Wolf
36. Parking Lot, Rebecca Wolf
37. Drain, Rebecca Wolf
39. To Be Found
40. Sedimentation Pond, Rebecca Wolf
41. Storm Outlet, Rebecca Wolf
42. *Protecting Water Quality from Urban escorrentia*. Environmental Protection Agency <http://www.epa.gov/owow/NPS/urban_facts.html>

43. *Maryland Streams Take a Closer Look*, MDNR
44. Maryland Streams Take a Closer Look, MDNR.



Watershed Connections
Conexiones de la Cuenca

Part 3: Best Management Practices and Stormwater Solutions
Parte 3: Mejores prácticas de manejo y Soluciones a la escorrentía pluvial

A partnership of the Interstate Commission on the Potomac River Basin and the Patuxent River Park, Maryland-National Capital Park and Planning Commission
Una colaboración entre Comisión Interestatal de la Cuenca del Río Potomac y el Parque del Río Patuxent (Miembro de la Comisión de Parques y Recreación de Maryland y la Capital Nacional)

Interstate Commission on the Potomac River Basin
Comisión Interestatal de la Cuenca del Río Potomac
(301) 984-1908 | info@icprb.org | www.PotomacRiver.org

Protecting Our Watershed
Protegiendo Nuestra Cuenca

Enough of the Bad Stuff!
What can we do to protect our streams?

¡Suficiente con las malas noticias!
¿Qué podemos hacer para proteger nuestras corrientes de agua?

Best Management Practices for farms
Mejores prácticas de manejo para granjas

- Tree buffers by streams
  Árboles amortiguadores cerca de los arroyos
- Fences around animals
  Verjas para controlar el ganado
- Less fertilizer
  Menos fertilizante
- Crop rows parallel to slope
  Hileras de cultivo paralelas a la inclinación
- No-till farming
  Cultivar sin arar

48

Stormwater Solutions
Soluciones a la escorrentía pluvial

Conservation Gardens
Jardines de Conservación

- Slow down the runoff.
  Desaceleran la escorrentía.
- Spread it out.
  Esparcen el agua.
- Let it soak in.
  Promueven la infiltración.

Better yet…
Mejor aún…

- Plant and protect forests
  Siembra y protége bosques

Rain Gardens
Jardines de Lluvia

- The basin catches runoff and allows it to infiltrate.
  La ensenada/cuenca atrapa la escorrentía y le permite infiltrarse en el suelo.
- The plants and soil bacteria clean the stormwater.
  Las plantas y las bacterias del suelo limpian las aguas pluviales.
- Provides food for butterflies, birds, insects, rabbits, squirrels, mice…
  Proporciona comida para mariposas, aves, insectos, conejos, ardillas, ratones…

51,52

Download this PowerPoint on our website.
www.potomacriver.org/scorefour

Rain Barrels
Barriles de lluvia

- Catch stormwater from gutters.
  Recoger la lluvia de las canaletas en los techos.
- Direct it over a garden or lawn.
  Dirigirlo sobre un jardín o césped.
- Reduce water use during droughts.
  Reducir el uso del agua en periodos de sequía.
- Use for water education.
  Uso para la educación del agua.

Contest Fairfax County website



Change impervious surfaces to natural ones
Cambia superficies impermeables por superficies naturales

From green roofs to grass swales…

Desde techos verdes a cenagales de grama…


55-56-57

…to pervious pavement
…a suelos permeables


What YOU can do everyday…
¿Qué TU puedes hacer en el día a día?

- Scoop the poop.
  Recoje los desechos.
- Recycle and dispose trash properly.
  Recycla y dispon de la basura correctamente.
- Use less fertilizer and pesticides.
  Usa menos fertilizantes y pesticidas.
- Keep waste out of storm drains.
  Mantén los desechos alejados de los alcantarillados.
- Raise awareness.
  Desarrolla conciencia en las personas a tu alrededor.

59

It's your world. Envision it.

Es tu mundo. Visualízalo.

58

Resources for Student Research
Recursos para la investigación estudiantil

- Daniels. M, Pennington. J, Sharpley. A. Best Management Practices for Livestock Farms, University of Arkansas Cooperative Extension
- *Maryland Department of Natural Resources*. Web. 2 Dec. 2011. <http://www.dnr.state.md.us/streams/OurMDStreams.asp>.
- http://www.dnr.state.md.us/streams/publications.asp
- http://www.dnr.state.md.us/streams/pdfs/state_factsheet.pdf
- http://www.dnr.state.md.us/streams/pdfs/md-streams.pdf: interactive map to find the health of your stream and watershed. No special software needed.
- Impervious Surface and Flooding: http://ga.water.usgs.gov/edu/impervious.html

Picture References – Incomplete
Referencias de las fotos - Parcial

45. Crop Rows: To Do. Maybe. *Cropland*. Photograph. *Allamakee SWCD*. Web. 09 Feb. 2012. <http://allamakeeswcd.org/conservation-practices/cropland-2/>.
46. Crop Rows: - Source Unknown
47. Cows in stream: - Source Unknown
48. Farming Best Management Practices - *Source Unknown*
49. Marsh, Rebecca Wolf
50. http://www.dogster.com/files/post_images/e51efaf193ecf5a9718b0991a5c9f097.jpg
51. - Source Unknown
52. - Source Unknown
53. - Source Unknown
54. "LID Urban Design Tools - Rain Barrels & Cisterns." *Low Impact Development (LID) Urban Design Tools*. Web. 13 Jan. 2012. <http://www.lid-stormwater.net/raincist_specs.htm>.
55. Green Roof - Source Unknown
56. Grass Swale - Source Unknown
57. Gravel Swale - Source Unknown
58. *File:Natural Playground by The Natural Playgrounds Company.jpg*. Photograph. *Wikipedia, the Free Encyclopedia*. Web. 1 Feb. 2012. <http://en.wikipedia.org/wiki/File:Natural_Playground_by_The_Natural_Playgrounds_Company.jpg>.
59 a& b. Patuxent River Park Watershed Models, photo by Tarryn Lee, 2012.

Updated 10/2017

FieldScope Map Inquiry
Investigación cartográfica en FieldScope

Score Four: Students, Schools, Streams, and the Bay
Score Four: Estudiantes, Escuelas, Arroyos y la Bahía

Rebecca Wolf and Nguyen Le
Interstate Commission on the Potomac River Basin
Comisión Interestatal para la Cuenca del Río Potomac

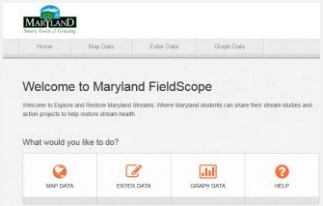
How FieldScope Maps Can Support Your Watershed Inquiries

De qué forma los mapas de FieldScope pueden ayudar con tus investigaciones de la cuenca

Maryland Fieldscope
FieldScope de Maryland

FieldScope is an online mapping program where students can analyze, interpret, and share environmental data about their school's watershed or an adopted stream.

FieldScope es un programa de cartografía por internet donde los estudiantes pueden analizar, interpretar y compartir información medioambiental sobre la cuenca de su escuela o de un curso de agua adoptado.



Outline of this PowerPoint:
Reseña de esta presentación de PowerPoint:

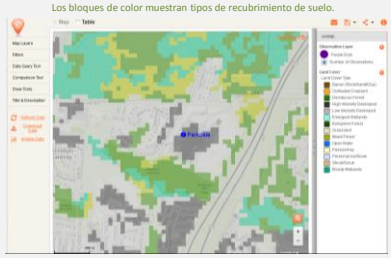
- **Introduction**
  Introducción
  - Find out what you will be analyzing and learning from FieldScope.
    Descubre qué analizarás y aprenderás con FieldScope.
- **FieldScope Map Inquiry Instructions**:
  Instrucciones de consulta cartográfica en FieldScope:
  - *Part One: FieldScope Basics*
    Parte uno: aspectos básicos de FieldScope
    - Learn how to use FieldScope and become familiar with tools you will need for this activity.
      Aprende cómo usar FieldScope y familiarizarte con las herramientas que necesitarás para esta actividad.
  - *Part Two: Explore Your Watershed*
    Parte dos: explora tu Cuenca
    - Analyze and explore different data layers in your watershed.
      Analiza y explora distintas capas de datos de tu cuenca.

- You can use FieldScope to analyze and explore the following features:
  Puedes usar FieldScope para analizar y explorar las siguientes características:
  - Watersheds
    Cuencas
  - Rivers and Streams
    Ríos y arroyos
  - Land Cover
    Recubrimientos de suelo
  - Impervious Surfaces
    Superficies impermeables
  - Impermeability
    Impermeabilidad
  - And more…
    Y mucho más…
- You will create a map that consists of:
  Crearás un mapa del siguiente tipo:
  - A base map with roads and some geographic features
    Un mapa base con carreteras y algunos accidentes geográficos
  - **Data layers that go over the base map and show specific aspects of those areas,** such as land cover and impervious surfaces.
    Capas de datos que van sobre el mapa de base y muestran aspectos específicos de esas zonas, tales como el recubrimiento del suelo y las superficies impermeables.
- You can save your map for later use.
  Puedes guardar tu mapa para usarlo más adelante.

Example of a Data Layer
Ejemplo de capa de datos

This data layer shows the land cover around Parkdale High School in Riverdale, Maryland.
Esta capa de datos muestra el recubrimiento de suelo alrededor de Parkdale High School en Riverdale, Maryland.

- The base map shows houses and streets.
  El mapa de base muestra casas y calles.
- The blocks of color show types of land cover.
  Los bloques de color muestran tipos de recubrimiento de suelo.



1. *Using the legend, name two types of land cover in this area.*
   Usando la leyenda, nombra dos tipos de recubrimiento de suelo en esta zona.
2. *What land cover is not on this map?*
   ¿Qué recubrimiento de suelo no está en este mapa?

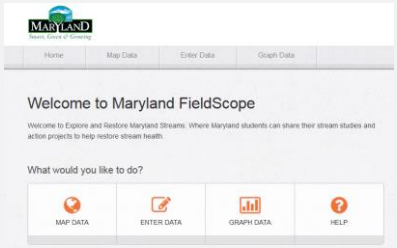
FieldScope Map Inquiry Instructions
Investigación cartográfica en FieldScope Instrucciones

Part One: FieldScope Basics
Parte uno: aspectos básicos de FieldScope

The following slides will familiarize you with FieldScope.
Las siguientes diapositivas te familiarizarán con FieldScope.

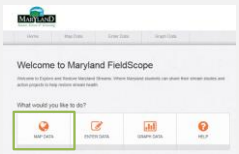
How We Get to FieldScope and What We See
Cómo llegamos a FieldScope y qué vemos

1. Go to: http://maryland.fieldscope.org/
   Visita:

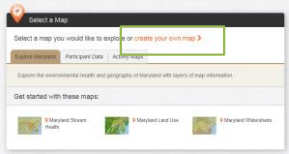


Starting Your Map: A Few Easy Steps
Cómo comenzar tu mapa: algunos pasos sencillos

2. Click on "**Map Data**."
   Haz clic en "**Map Data**" (datos del mapa).



2. Click on "**Create Your Own Map.**"
   Haz clic en "**Create Your Own Map**" (crea tu propio mapa).

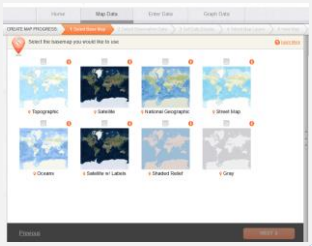


4. **Selecting a Base Map.**
   Selecciona un mapa de base.

A base map is the bottom layer of your map. Other map layers with data will be displayed over the base map.
Un mapa de base es la capa inferior de tu mapa. Sobre el mapa de base, se mostrarán otras capas cartográficas con datos.

Learn more about different base maps on the following slides.
Obtén más información sobre los distintos mapas de base en las siguientes diapositivas.

Then, select your chosen base map and click "**Next.**"
Luego, selecciona el mapa de base que elegiste y haz clic en "**Next**" (siguiente).



- Topographic base map
  Mapa de base topográfico

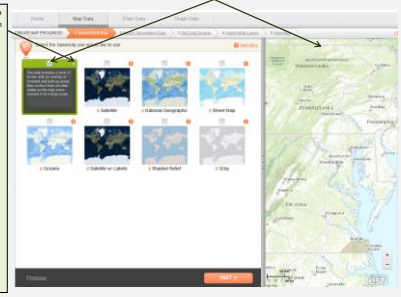
Checking the base map will show you a preview on the right side.
Al verificar el mapa de base, se mostrará una vista previa sobre el lado derecho.

Hovering over the Orange Info Icon will give you a description of the base map.

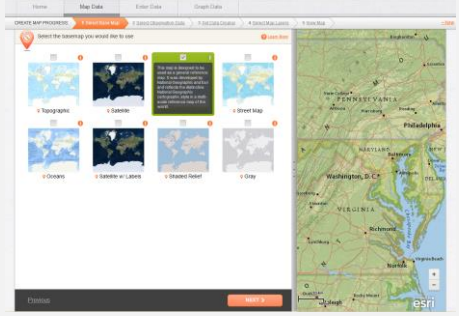
Al colocar el cursor sobre el icono naranja de información, aparecerá una descripción del mapa de base.

"This map includes a view of terrain with an overlay of forested and built-up areas. Map contour lines are also visible on the map when zoomed in to a large scale."

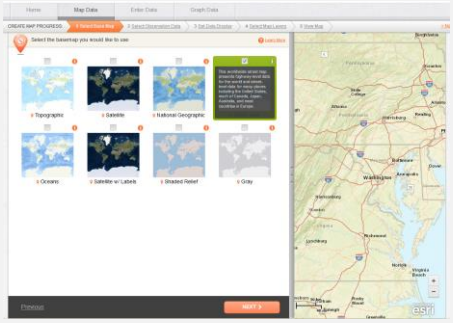
"Este mapa incluye una vista de terreno con una capa de zonas forestadas y urbanizadas. Las líneas de contorno del mapa también son visibles en este al aumentar a una escala mayor."



- National Geographic base map
  Mapa de base de National Geographic



- Street Map base map
  Mapa de base de calles

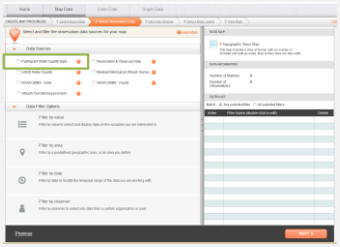


5. Selecting Observation Data.
Selección de datos de observación.

"Select Observation Data" enables you to select the sources of data for your map. This includes data from the U.S. Geological Survey, Maryland Biological Stream Survey, other schools and organizations.
"Select Observation Data" (seleccionar datos de observación) te permite seleccionar las fuentes de información para tu mapa. Esto incluye datos de la organización U.S. Geological Survey y del programa Maryland Biological Stream Survey, así como de otras escuelas y organizaciones.

We will not be looking at specific stream data, so you will *de-select* the **"Participant Water Quality Data"** during your exercise.

No buscaremos datos de cursos de agua específicos, de modo que desmarcarás la opción **"Participant Water Quality Data"** (datos de calidad del agua del participante) durante tu ejercicio.

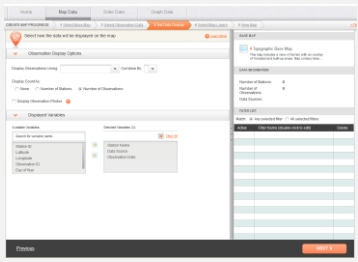


6. Setting Data Display.
Configuración de la información en pantalla.

"Select Data Daisplay" enables users to modify how observation data is displayed on a map.
"Select Data Display" permite que los usuarios modifiquen cómo se muestran los datos de observación en un mapa.

We will not make changes to this during our exercise.
No cambiaremos esto durante nuestro ejercicio.

Click **"Next."**
Haz clic en **"Next"** (siguiente).



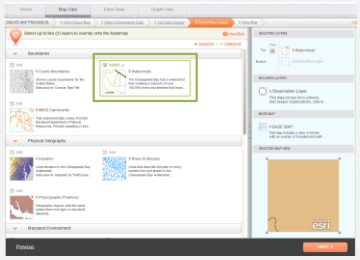
7. Selecting Map Layers.
Selección de capas cartográficas.

*With "Select Map Layers" you can select which data layers you want to view on your map. **Up to 2 layers can be selected at a time.** You may go back to the menu to switch the map layers any time.*
*Con "Select Map Layers" (seleccionar capas cartográficas), puedes elegir los datos que quieres ver en tu mapa. **Se pueden seleccionar hasta dos capas a la vez.** Puedes regresar al menú para cambiar las capas en cualquier momento.*

While learning to use tools, we will use one map layer.
Mientras estemos aprendiendo a usar las herramientas, utilizaremos una capa cartográfica.

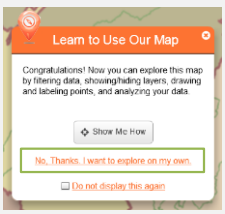
Select **Watersheds**.
Selecciona **"Watersheds"** (cuencas).

Then, click **"Next."**
Luego, haz clic en **"Next"** (siguiente).



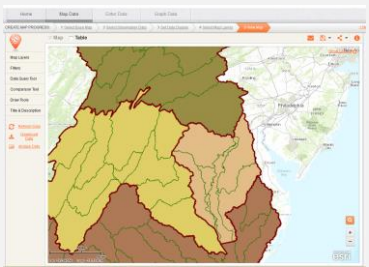
A pop-up will appear.
Aparecerá una ventana emergente.

- If you would like to watch a FieldScope Tutorial Video, then click on **"Show Me How."**
  Si quieres ver el video tutorial de FieldScope, haz clic en **"Show Me How"**.
- Otherwise, click on **"No, Thanks. I want to explore on my own."**
  De lo contrario, haz clic en **"No, Thanks. I want to explore on my own"** (No, gracias. Quiero investigar por mi cuenta).



8. Viewing Your Map.
Cómo ver tu mapa.

Now, you will see your map. It should look similar to the example below.
Ahora verás tu mapa. Este debería verse parecido al del ejemplo a continuación.



What watershed is represented by this layer?

¿Qué cuenca está representada en esta capa?

Key FieldScope Tools
Herramientas fundamentales de FieldScope

Now that you have your map, you will use online tools to research the data layers. The following slides will introduce some key FieldScope tools that enable you to adjust the view and use the map for research.

Ahora que tienes tu mapa, utilizarás herramientas en internet para investigar las capas de datos. Las diapositivas a continuación presentarán algunas herramientas fundamentales de FieldScope que te permitirán ajustar la vista y el uso del mapa para investigar.

- Transparency
  Transparencia
- Layer Visibility
  Visibilidad de la capa
- Draw Tools
  Herramientas de dibujo
- Legend
  Leyenda
- Search
  Búsqueda
- Zoom In / Zoom Out
  Acercar / Alejar

Tabs on the Left Side
Pestañas en el lado izquierdo

On the left side are tabs that you can use to adjust various settings on your map.
En el lado izquierdo se encuentran pestañas que puedes utilizar para ajustar varios configuraciones en tu mapa.

9. Using Map Layers
Uso de las capas cartográficas

The "Map Layers" tool allows you to adjust the visibility of your map layers.
La herramienta "Map Layers" (capas cartográficas) te permite ajustar la visibilidad de las capas cartográficas.

Click on "**Map Layers.**"

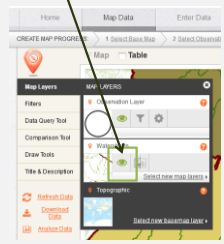
Haz clic en "**Map Layers**".

a. Layer Visibility.
Visibilidad de la capa

Layer Visibility – the EYE – shows or hides the layer.
Visibilidad de la capa: el OJO muestra u oculta la capa.

Click on the **eye**, **the visibility tool**, on the Watersheds layer. What happens?
Haz clic en el **ojo**, **la herramienta de visibilidad**, en la capa de la cuenca. ¿Qué sucede?

Make the Watersheds layer visible again, click on the **eye**.
Haz visible nuevamente la capa de las cuencas haciendo clic en el **ojo**.

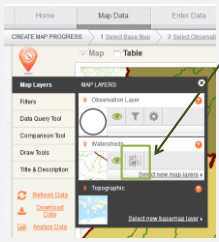


b. Transparency
Transparencia

Transparency controls how much you can see through the layer. At 0% transparency, the layer is opaque. When new layers are added to a map, they initially are set to 0% transparency.
La transparencia controla cuánto puedes ver a través de la capa. Con una transparencia del 0 %, la capa es opaca. Cuando se añaden capas nuevas a un mapa, estas están configuradas inicialmente en un 0 % de transparencia.

Click on the **transparency bar**. What happens when you slide the transparency bar to **100%**?
Haz clic en la **barra de transparencia**. ¿Qué sucede cuando deslizas la barra de transparencia al **100** %?

Move the **transparency bar** until you can see the base map and the watersheds map. What percentage works for you?
Mueve la **barra de transparencia** hasta que puedas ver el mapa de base y el mapa de las cuencas. ¿Qué porcentaje funciona mejor para ti?



Layers Revealed
Capas mostradas

This is how the same map appears when the transparency of the Watersheds layer is set to **50%**. You can see both the base map and the Watersheds layer.

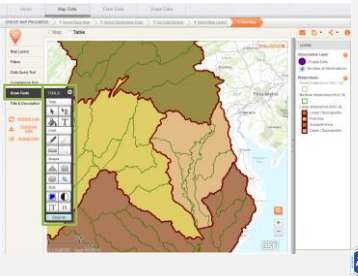
Así es cómo aparece el mismo mapa cuando la transparencia de la capa de las cuencas se establece en **50 %**. Puedes ver ambas, la capa del mapa de base y la de las cuencas.

10. Using Draw Tools.
Uso de las herramientas de dibujo.

The Draw Tools Box allows you to insert text, shapes, and lines on your map and to explore data more closely.
El cuadro de herramientas de dibujo te permite insertar texto, formas y líneas en tu mapa y analizar datos en mayor detalle.

Click on **"Draw Tools."**
Haz clic en **"Draw Tools"** (herramientas de dibujo).

Hover over each tool to see what it does. Which tool can be used to measure distances on your map?
Coloca el cursor sobre cada herramienta para ver qué hace. ¿Qué herramienta se puede usar para medir distancias en tu mapa?

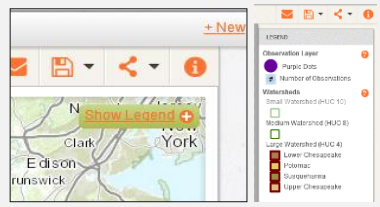


11. Using the Legend.
Uso de la leyenda.

In the top right corner of your map, is a "Show Legend" link. A legend lists what the symbols and colors mean on your map.
En el ángulo superior derecho de tu mapa hay un enlace "Show Legend" (mostrar leyenda). Una leyenda describe el significado de los símbolos y colores.

Click on **"Show Legend."**
Haz clic en **"Show Legend"**.

Look at the legend. What are the largest subwatersheds in the Chesapeake Bay Watershed?
Mira la leyenda. ¿Cuáles son las subcuencas más grandes en la cuenca de la bahía de Chesapeake?



12. Using the Search and Zoom Features.
Uso de las funciones de búsqueda y zoom.

Click on the **search tool** and enter the name of the city in which you live.
Haz clic en la **herramienta de búsqueda** e ingresa el nombre de la ciudad en que vives.

What happens when you close the search bar?
¿Qué sucede cuando cierras la barra de búsqueda?

You can search for a location by clicking on the search tool, the magnifying glass, at the bottom right of your screen. The zoom tool (+ and -) is below the search tool.
Puedes buscar una ubicación haciendo clic en la herramienta de búsqueda, la lupa, que aparece en la parte inferior derecha de tu pantalla. La herramienta de zoom (+ y -) se encuentra debajo de la herramienta de búsqueda.

FieldScope Map Inquiry Instructions
Investigación cartográfica en FieldScope Instrucciones

Part Two: Explore Your Watershed
Parte dos: explora tu cuenca

At this point, students can work on their own computers with their worksheets independently, or the class may choose to follow the instructions on this presentation.
A esta altura, los estudiantes pueden trabajar en sus propias computadoras con las hojas de trabajo de forma independiente, o bien la clase puede optar por seguir las instrucciones de esta presentación.

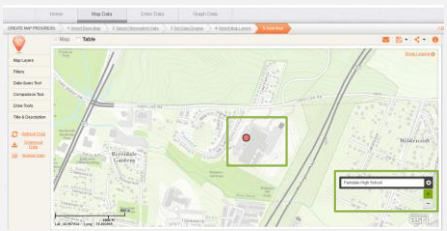
Explore Your Watershed
Explora tu cuenca

- The following slides will walk you through examining your local school watershed.
  Las siguientes diapositivas te guiarán durante la evaluación de la cuenca de tu escuela local.
- We will locate your school and analyze the following:
  Ubicaremos tu escuela y analizaremos lo siguiente:
  1. Locate your school — Ubica tu escuela
  2. Watersheds — Cuencas
  3. Rivers and streams — Ríos y arroyos
  4. Land cover — Recubrimientos de suelo
  5. Impervious surfaces — Superficies impermeables
  6. Impermeability — Impermeabilidad
  7. Stream health — Estado sanitario del curso de agua
- In the following example, we are using:
  En el ejemplo a continuación, utilizamos:
  - The topographic base map — el mapa de base topográfico
  - Parkdale High School as an example location — Parkdale High School como ejemplo de ubicación

1. Locate Your School
Ubica tu escuela

a. Use the search tool (magnifying glass) to locate your school. Put in the address or name of your school. The location will appear as a red dot. Keep the search tool open.
Utiliza la herramienta de búsqueda (lupa) para ubicar tu escuela. Ingresa la dirección o el nombre de tu escuela. La ubicación aparecerá como un punto rojo. Mantén la herramienta de búsqueda abierta.

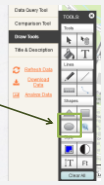
b. Zoom all the way into your campus.
Haz zoom hasta llegar a tu predio escolar.



Creating a Marker and Label for Your School
Creación de un marcador y una etiqueta para tu escuela

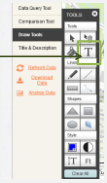
Creating a Marker
Crear un marcador

- Click on **Draw Tools** to open the tool box.
  Haz clic en "**Draw Tools**" (herramientas de dibujo) para abrir el cuadro de herramientas.
- Click on the **Circle Tool.**
  Haz clic en la herramienta de **círculo**.
- Press down on the map where you want the symbol and gently drag outwards to create a circle. Then let go.
  Presiona en el mapa el lugar donde quieres poner el símbolo y arrástralo suavemente hacia afuera para crear un círculo. Luego suelta el símbolo.
- If you are unsatisfied with your shape or its location, use: The **Select Tool** to move it, or the **Erase Tool** to delete it.
  Si no quedas satisfecho con tu forma o la ubicación, usa la **herramienta de seleccionar** para moverlo o la **herramienta de eliminar** para borrarlo.

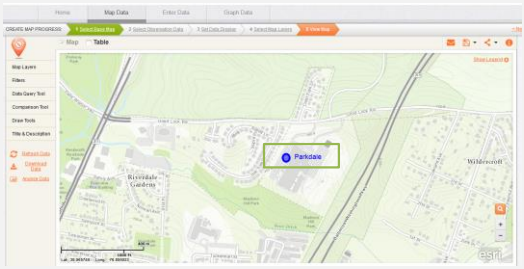


Creating a Label
Crear una etiqueta

- Click on **Draw Tools** to open the tool box.
  Haz clic en "**Draw Tools** " (herramientas de dibujo) para abrir el cuadro de herramientas.
- Click on the **Add Label Tool.**
  Haz clic en la **herramienta para añadir una etiqueta.**
- Click where you want to place the text and type it in.
  Haz clic donde quieras ubicar el texto y escribe.
- Close the draw and search tools. Zoom out to see the results.
  Cierra el dibujo y las herramientas de búsqueda. Aleja la vista para ver los resultados.



Example
Ejemplo



2. Locating Your Local Watershed
Ubicar tu cuenca local

The Watersheds layer should still be on your map.
La capa de las cuencas todavía debería estar en tu mapa.

The Chesapeake Bay Watershed consists of large and small watersheds. To learn in which large and small watersheds (subwatersheds) the school is located, click on the school's location. A pop-up will appear.
La cuenca de la bahía de Chesapeake está formada por cuencas grandes y pequeñas. Para saber en qué cuencas grandes y pequeñas (subcuencas) se encuentra la escuela, haz clic en la ubicación de esta. Aparecerá una ventana emergente.

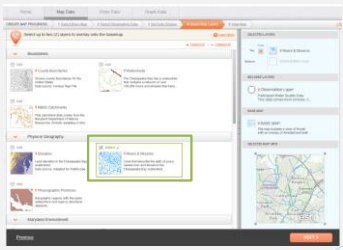
¿En qué cuenca pequeña se encuentra tu escuela?

¿Qué te dice esto acerca del lugar hacia donde drena por último la escorrentía pluvial de tu predio escolar?

3. Viewing Nearby Rivers and Streams
Ver ríos y arroyos cercanos

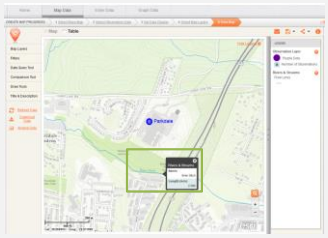
To observe small, nearby waterways, you will add the "**Rivers and Streams**" layer to your map.
Para observar cursos de agua pequeños en los alrededores, añadirás la capa "**Rivers and Streams**" (ríos y arroyos) a tu mapa.

- Click on "**4 Select Map Layers**" on the top bar.
  Haz clic en "**4 Select Map Layers**" (4 Seleccionar las capas cartográficas) en la barra superior.
- Check the "**Rivers and Streams**" box to add it to your map.
  Marca la casilla "**Rivers and Streams**" (ríos y arroyos) para añadirla a tu mapa.
- Click "**Next**" to view your map.
  Haz clic en "**Next**" (siguiente) para ver tu mapa.



Make sure you are zoomed in enough to see what streams are in your watershed and around your school.
Asegúrate de hacer zoom para ver qué cursos de agua se encuentran en la cuenca y en los alrededores de la escuela.

Click on the stream that is nearest to your school to see more information.
Haz clic en el arroyo más cercano a tu escuela para ver más información.



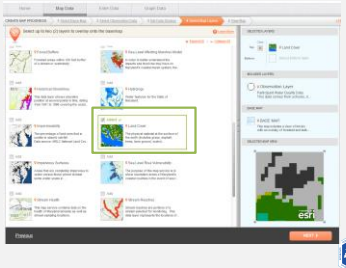
1. *Does the stream have a name? If so, what is it?*
   ¿El curso de agua tiene un nombre? Si lo tiene, ¿cuál es?
2. *Use the measure tool (Draw Tools Box) to measure how far the stream is from your campus. What did you get?*
   Utiliza la herramienta de medición (cuadro de herramientas de dibujo) para medir la distancia del curso de agua hasta tu predio escolar. ¿Qué resultado obtuviste?
3. *One way to tell which direction the stream is flowing, is to find where it joins a larger stream or river. What river does your stream flow to?*
   Una forma de saber en qué dirección corre el curso de agua es encontrando dónde se une a un río o arroyo más grande. ¿Hacia qué río corre tu curso de agua?

4. Land Cover Layer
Capa de recubrimiento del suelo

Now you will observe Land Cover on your map. This layer will show you the physical material on the surface of the earth, such as grass, asphalt, trees, bare ground, and water.
Ahora observarás el recubrimiento del suelo en tu mapa. Esta capa te muestra el material físico de la superficie de la tierra, tal como el césped, el asfalto, los árboles, el terreno pelado y el agua.

Add the **"Land Cover"** layer to your map.
Añade la capa **"Land Cover"** (recubrimiento del suelo) a tu mapa.

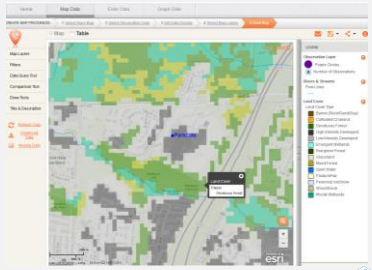
- Click on **"4 Select Map Layers"** on the top bar.
  Haz clic en **"4 Select Map Layers"** (4 Seleccionar las capas cartográficas) en la barra superior.
- Uncheck the **"Watersheds"** box to remove it from your map.
  Desmarca la casilla **"Watersheds"** para quitarla de tu mapa.
- Check the **"Land Cover"** box to add it to your map.
  Marca la casilla **"Land Cover"** (recubrimiento del suelo) para añadirla a tu mapa.
- Click **"Next"** to view your map.
  Haz clic en **"Next"** (siguiente) para ver tu mapa.



Adjust the transparency settings (Map layers, transparency tool) so that you can view land use, as well as the streams and base map.
Ajusta la configuración de la transparencia (capas cartográficas, herramienta de transparencia) de modo que puedas ver el uso del suelo, así como los cursos de agua y el mapa de base.

Show the legend, if it isn't showing. Hover over the question mark by Land Cover. How recent is the data on this map?
Haz visible la leyenda si no se muestra. Coloca el cursor sobre el signo de pregunta junto a "Land Cover". ¿Cuán recientes son los datos de este mapa?

Click on any location to see what the land cover type is. What types of land cover are in the area surrounding the stream closest to your school?
Haz clic en cualquier ubicación para ver cuál es el tipo de recubrimiento de suelo. ¿Qué tipos de recubrimiento de suelo hay en la zona que rodea el curso de agua más cercano a tu escuela?

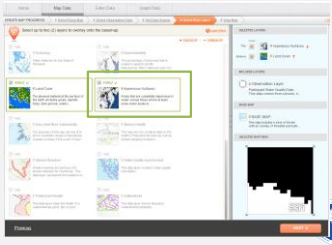


5. Impervious Surfaces Layer
Capa de superficie impermeable

Now you will observe the Impervious Surfaces layer on your map. Impervious surfaces are areas cannot absorb or allow water to soak into the ground. This layer shows areas that are completely impervious to water versus those where at least some water soaks in. You will be able to view areas that have been categorized as impervious and pervious.
Ahora observarás la capa de superficies impermeables en tu mapa. Las superficies impermeables son zonas que no absorben el agua o no permiten que esta penetre en el suelo. Esta capa muestra las zonas que son completamente impermeables al agua en comparación con aquellas en las que esta penetra al menos un poco. Podrás ver zonas que han sido categorizadas como impermeables y permeables.

To add the **Impervious Surfaces** layer to your map:
Para añadir la capa **"Impervious Surfaces"** (superficies impermeables) a tu mapa:

- Click on **"Select Map Layers."**
  Haz clic en **"Select Map Layers"** (seleccionar capas cartográficas).
- Uncheck the **"Rivers and Streams"** layer box to remove it from your map.
  Desmarca la casilla de las capas **"Rivers and Streams"** (ríos y arroyos) para quitarla de tu mapa.
- Check the **"Impervious Surfaces"** layer box to add it to your map.
  Marca la casilla **"Impervious Surfaces"** para añadirla a tu mapa.
- Click **"Next"** to view your map.
  Haz clic en **"Next"** (siguiente) para ver tu mapa.
- Adjust the transparency settings, as needed.
  Ajusta la configuración de transparencia, según sea necesario.



Click on any location to see if the surface is categorized as impervious or pervious. If it is impervious, you will see a number 1 in the bottom right-hand corner of the information box. If it is pervious, you will see a 0.
Haz clic en cualquier ubicación para ver si la superficie está clasificada como permeable o impermeable. Si es impermeable, verás un número 1 en el ángulo inferior derecho de la casilla de información. Si es permeable, verás un 0.

Generally, where do you find the greatest amount of impervious surfaces?
Por lo general, ¿dónde encuentras la mayor cantidad de superficies impermeables?

How do you think the stream health is affected by the amount of impervious surfaces in your watershed?
¿Cómo crees que el estado sanitario del curso de agua se ve afectado por la cantidad de superficies impermeables de tu cuenca?

What are possible ways your class could verify the impermeability of different areas of your campus (known as, "ground truthing")?
¿Cuáles son las formas posibles de que tu clase verifique la permeabilidad de las distintas zonas de tu predio escolar (conocido como "comprobación en el terreno")?

Why might it be necessary to "ground truth" the map data?
¿Por qué puede ser necesario "comprobar en el terreno" los datos del mapa?

6. Bringing It All Together
Integración de todos los elementos

Make a hypothesis about the health of the stream ecosystem nearest to your school.
Elabora una hipótesis acerca del estado sanitario del ecosistema del curso de agua más cercano a tu escuela.

Consider your map data and what you have learned about the relationships of different land uses to stream health. Make a hypothesis about the health of your stream, based on the types of land uses and land cover in the area draining to your stream.
Considera los datos de tu mapa y lo que has aprendido acerca de las relaciones de los distintos tipos de uso del suelo con el estado sanitario del curso de agua. Elabora una hipótesis acerca del estado sanitario de tu curso de agua en función de los tipos de uso del suelo y del recubrimiento del suelo en la zona que drena en tu curso de agua.

You could state that the stream health is good, fair, or poor, based on your reasons. Or you could pick a specific feature, such as the amount of erosion or aquatic life you expect in the stream.
Puedes afirmar que el estado sanitario del curso de agua es bueno, aceptable o deficiente en función de tus razones. O bien, podrías elegir una característica específica, tal como la cantidad de erosión o la vida acuática que esperas en el curso de agua.

7. Checking Your Hypothesis
Verificación de tu hipótesis

If you cannot test your stream quality, you can see if your hypothesis agrees with stream surveys that have been done by government and citizen organizations.
Si no puedes probar la calidad de tu curso de agua, puedes ver si tu hipótesis concuerda con los estudios de los cursos de agua efectuados por el gobierno y organizaciones ciudadanas.

If you are in Maryland, check your hypothesis by doing one or both of the following:
Si te encuentras en Maryland, verifica tu hipótesis haciendo una de las siguientes acciones o las dos:

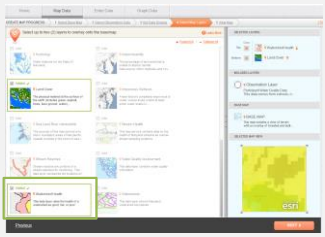
7a. Observe Watershed Health on your FieldScope Map. This layer incorporates the results of stream and watershed surveys done by the Maryland Department of Natural Resources.
Observa el estado sanitario de la cuenca en tu mapa de FieldScope. Esta capa incorpora los resultados de estudios de cuencas y cursos de agua realizados por el Departamento de Recursos Naturales de Maryland.

7b. Check the health of your stream by going to a different website, hosted by the Maryland Department of Natural Resources.
Verifica el estado sanitario de tu curso de agua visitando un sitio web diferente auspiciado por el Departamento de Recursos Naturales de Maryland.

7a. Watershed Health Layer
Capa del estado sanitario de la cuenca

To add the **"Watershed Health"** layer to your map:
Para añadir la capa **"Watershed Health"** (estado sanitario de la cuenca) a tu mapa:

- Click on **"Select Map Layers"** on the top bar
  Haz clic en **"Select Map Layers"** (seleccionar las capas cartográficas) en la barra superior.
- Uncheck the **"Impervious Surfaces"** box to remove it from your map.
  Desmarca la casilla **"Impervious Surfaces"** (superficies impermeables) para quitarla de tu mapa.
- Check the **"Watershed Health"** box to add it to your map.
  Marca la casilla **"Watershed Health"** (estado sanitario de la cuenca) para añadirla a tu mapa.
- Click **"Next"** to view your map.
  Haz clic en **"Next"** (siguiente) para ver tu mapa.
- Adjust the transparency, as needed.
  Ajusta la transparencia, según sea necesario.

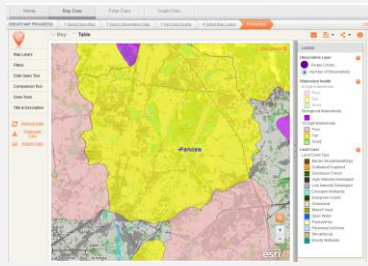


Match the color of your watershed with the colors on the legend. What is the health of your watershed?

Usa el mismo color de la leyenda para tu cuenca. ¿Cuál es el estado sanitario de tu cuenca?

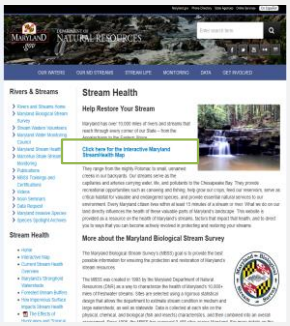
Is it what you expected? If not, do you have ideas on why it is different?

¿Es lo que esperabas? Si no lo es, ¿se te ocurre alguna idea acerca de por qué es diferente?



7b. Maryland DNR Stream Health
Estado sanitario de los cursos de agua del Depto. de Recursos Naturales de Maryland

- Go to: http://dnr.maryland.gov/streams/Pages/streamhealth/default.aspx
  Visita:
- Click on **"Click here for the Interactive Maryland Stream Health Map"**
  Haz clic en **"Click here for the Interactive Maryland Stream Health Map"** (haz clic aquí para acceder al mapa interactivo del estado sanitario de los cursos de agua de Maryland)



Enter the name of your stream or your school location in the search box.
Ingresa el nombre de tu curso de agua o la ubicación de tu escuela en el cuadro de búsqueda.

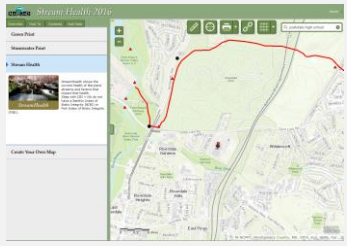
Streams that have been assessed are shown in colors or as triangles. Click on these symbols to learn more. It is possible that your stream has yet to be assessed.
Los cursos de agua ya evaluados se muestran en colores o como triángulos. Haz clic en estos símbolos para obtener más información. Es posible que tu curso de agua aún se encuentre pendiente de evaluación.

What is the health of your stream?

¿Cuál es el estado sanitario de tu curso de agua?

Is it what you expected? If not, do you have ideas on why it is different?

¿Es lo que esperabas? Si no lo es, ¿se te ocurre alguna idea de por qué es diferente?



Assessing Your Campus

Score Four: Students, Schools, Streams, and the Bay

Permeability Prediction — Teacher

Purpose

This lesson presents the concepts of permeability and impermeability and the related factors of infiltration and runoff. Students examine a map of their school grounds and make predictions on the permeability of each area. In doing so, they are encouraged to think critically about the permeability of their school grounds and possible implications. This activity can be used alone or as a precursor to the Permeability Field Investigation.

Skills Exercised: mapping, math (percentages), critical thinking.

Grades: 6-8

Time: Preparation takes 10-15 minutes. The lesson requires 20-35 minutes. This lesson may be an in-class activity or given as a homework assignment.

Background

Harking back to the water cycle, when it rains, some of the rainfall runs into streams or lakes, some evaporates or transpires, and some *infiltrates* into the ground. The amount that infiltrates depends upon many factors, including land cover, the type of soil, and the *permeability* of the ground. Forests usually have permeable surfaces and subsurfaces, as both the surface and soil contain pores, or holes, created by leaves, roots, organisms, organic matter, and the spaces between mineral particles. Such permeable surfaces allow rain drops to soak into and through the ground, filtering pollutants before the water reaches the stream.

In contrast, surfaces such as roofs, roads, and sidewalks are not porous. Precipitation cannot infiltrate these *impermeable* areas. Compaction from vehicle and foot traffic also reduces soil porosity; therefore, lawns, football fields, and walking paths can become impermeable or semi-permeable. Rainwater runs off impermeable areas, carrying pollutants to the nearest storm drain or body of water. Such excess runoff in urban areas is called *stormwater runoff*.

Teacher Instructions

Preparation

Prepare a map of the school with a grid overlay dividing the school campus into small squares. (An example follows the teacher instructions.) A gridded map can be created using Microsoft Word, as described below:

1. Download a map of your school from Google Earth or Google Maps. (Use the screenshot function or the snipping tool to capture the image on the screen, and crop accordingly.)
2. Save the image to your computer.
3. Open Microsoft Word.
4. Adjust the page to landscape or portrait accordingly.
5. Insert a table. (In the example provided, the table is 19x12. The table should create squares that are large enough to see map details, but small enough to be specific and make a conclusion about the permeability of the area.)
6. Each of the cells in the table should be squares. To adjust this, select the entire table. Then go to Layout and change the height and width. (In the example, the cell height and width is 0.5”)
7. Label the first row using numbers, and label the first column using letters, skipping the first cell.
8. Insert the image and change the Text Wrapping to *Behind Text*.
9. Move your image to fit appropriately.
10. Crop the image and/or adjust the margins if necessary.

The Activity

The Student Permeability Prediction Handout provides instructions and follow-up discussion questions. Each student or team should be given a gridded map. Students will estimate the permeability of the area in each box of the grid by writing a rating of 0, 1, or 2 in each box:

- 0 = impermeable, meaning precipitation cannot enter the ground.
- 1 = semi-permeable, meaning that precipitation can enter the ground somewhat.
- 2 = permeable, meaning that precipitation enters the ground easily.

Once the students have completed the grid, they will answer the follow-up questions. The questions require that the students calculate percentages of impermeable and permeable surfaces and consider how impermeable surfaces would affect the quality of a local stream.

Permeability Prediction

Teacher

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
A																		
B																		
C																		
D																		
E																		
F																		
G																		
H																		
I																		
J																		
K																		

Background
Información previa

As you discovered in the Soil Texture Investigation, the texture of soil reflects the amount of sand, clay, and silt in that soil. Recall that sand has relatively large particles and that clay has miniscule ones. These minerals also have spaces between their particles, called *pores*. Smaller minerals fit more closely together and so have smaller pores. The soil's composition and its *porosity* (the volume of pores in the soil) influence the ability of water to infiltrate and *percolate* (pass down) through the soil. Interestingly, porosity also affects the soil's capacity to store, or retain, water.

Como descubriste en la investigación de texturas de suelos, estas reflejan la cantidad de arena, arcilla y limo presentes en ellos. Recuerda que la arena tiene partículas relativamente grandes y que las de arcilla son minúsculas. Estos minerales también tienen espacios entre sus partículas, denominados *poros*. Los minerales más pequeños se aglutinan más y, por lo tanto, tienen poros más pequeños. La composición del suelo y su *porosidad* (el volumen de poros del suelo) incide en la capacidad de infiltración y *percolación* (traspaso) del agua a través del suelo. Curiosamente, la porosidad también afecta la capacidad del suelo de almacenar o retener agua.

In this activity, you will investigate the percolation rates of sand and clay, as well as soil samples from your school grounds.

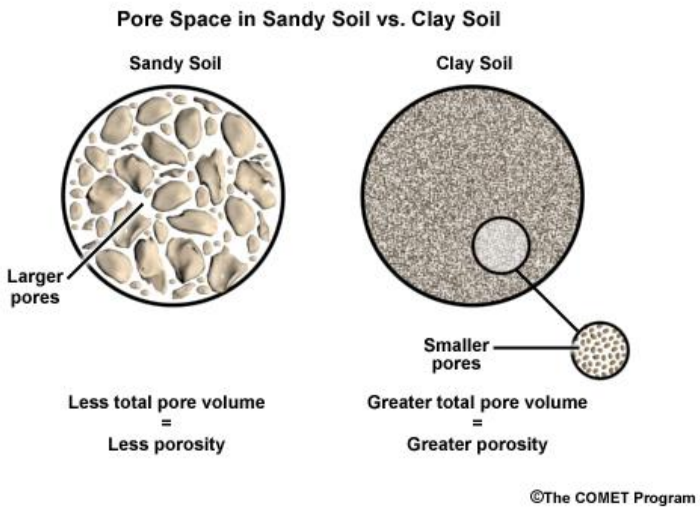
En esta actividad, investigarás el coeficiente de percolación de la arena y la arcilla, así como muestras de suelo del predio escolar.

Definition
Definición

Loam is soil that consists of about equal parts sand and silt and a smaller portion of clay. Loam also usually includes *organic matter* (decomposed plants, animals, bacteria, and fungi). The composition of loam enables it to retain nutrients and water, while also allowing the percolation of water. These features make loam excellent for gardening and reducing erosion and stormwater runoff.

El suelo franco contiene aproximadamente las mismas proporciones de arena y limo con un poquito de arcilla. Por lo general, también incluye materia orgánica (plantas en descomposición, materia animal, bacterias y hongos). La composición del franco permite conservar nutrientes y agua, y al mismo tiempo permite la percolación del agua. Estas características hacen que el franco sea excelente para la jardinería, así como para reducir la erosión y la escorrentía pluvial.

Is your school soil loam?
¿El suelo de tu escuela es franco?



Materials
Materiales

- Water
  Agua
- 1 Timer
  1 cronómetro
- 1 Measuring cup or beaker
  1 taza de medidas o vaso de precipitación
- 1 clear 2-liter bottle top for **each** soil sample
  1 mitad superior transparente de una botella de 2 litros para **cada** muestra de suelo
- 1 clear 2-liter bottle bottom or similar container for **each** soil sample
  1 mitad inferior transparente de una botella de 2 litros para **cada** muestra de suelo
- 1 piece of window screen for **each** soil sample
  1 trozo de tejido de mosquitero de ventana para **cada** muestra de suelo
- 500 mL of each soil sample: sand, clay, loam, school soil
  500 ml de cada muestra de suelo: arena, arcilla, franco, suelo del predio escolar
- Extra containers to place wet bottle tops containing wet soil samples
  Recipientes adicionales para colocar las mitades superiores de botella que contienen las muestras de suelo mojadas
- Containers or buckets to place wet soil samples to be dried and stored for future use
  Recipientes o baldes para poner muestras de suelo mojadas a secar y guardar para próximos usos

Pre-Lab
Previo al procedimiento de laboratorio

Predict water percolation by answering the **A**-lettered questions in the **Percolation Test Chart**.
Haz una predicción de la percolación de agua contestando las preguntas con la letra **A** en el **cuadro de la prueba de percolación**.

Lab Procedure
Procedimiento de laboratorio

Before starting, read the entire procedure. Assign each group member a job: Reader, Timer, Measurer, Pourer, Data Recorder.
Antes de empezar, lee el procedimiento completo. Asigna una función a cada integrante del grupo: leer, cronometrar, medir, verter, registrar datos.

1. Balance the top half of the 2-liter bottle upside down in the bottle's bottom half. Center the window screen in the top part; press the screen down inside the bottle to cover the opening.
   Equilibra la mitad superior de la botella de 2 litros de forma invertida en la mitad inferior de la botella. Centra el mosquitero en la parte superior; empuja el mosquitero hacia adentro de la botella para cubrir la abertura.

2. While holding the screen in place, pour 500 mL of soil into the top.
   **Clay can be approximated and needs to be placed so that it leaves no gaps along the bottle sides.*
   Mientras sostienes el mosquitero en el lugar, vierte 500 ml de suelo en la parte superior.
   **La arcilla se puede aproximar y es necesario colocarla de modo que no queden huecos en los costados de la botella*.

3. Fill the measuring cup with 500 mL of water.
   Llena la taza de medidas con 500 ml de agua.

4. Start the timer and begin to pour the water at the same time.
   Inicia el cronómetro y comienza a verter agua al mismo tiempo.

5. When the water first drips into the bottom of the bottle, record the time on the **Data Table**.
   DO NOT stop the timer.
   Cuando el agua comience a gotear hacia el fondo de la botella, registra el tiempo en la **tabla de datos**.
   NO detengas el cronómetro.

6. After 4 minutes, remove the top bottle half. Measure how much water is in the bottom.
   Record this amount on the **Data Table**.
   Luego de 4 minutos, quita la mitad superior de la botella. Mide cuánta agua hay en el fondo.
   Registra la cantidad en la **tabla de datos**.

7. Answer all of the **B**-lettered questions in the **Percolation Test Chart** for that soil sample.
   Contesta todas las preguntas con la letra **B** en el **cuadro de la prueba de percolación** correspondiente a esa muestra de suelo.

8. Repeat steps 1-7 with your other soil samples, if applicable.
   Repite los pasos 1 a 7 con tus otras muestras de suelo, si corresponde.

9. Use the class data to answer the **Post-Lab Discussion Questions**.
   Utiliza los datos de la clase para contestar las **preguntas para comentar posteriores al procedimiento de laboratorio**.

Percolation Test Chart
Cuadro de prueba de percolación

A. Prediction Predicción **B. Observation** Observación	**Sand** Arena	**Clay** Arcilla	**Loam** Franco	**School Soil** Suelo del predio escolar	**Explanation** Explicación
1A. Will the water run out through the bottom of the bottle? ¿El agua pasará hasta el fondo de la botella?					
1B. Did the water run out of the bottom of the bottle? ¿El agua pasó hasta el fondo de la botella?					
2A. How many ml of water will run out? ¿Cuántos ml de agua pasarán?					
2B. How many ml of water percolated through? ¿Cuántos ml de agua percolaron?					
3A. How many seconds will it take for the water to pass through the soil? ¿Cuántos segundos tardará el agua en traspasar el suelo?					
3B. The time it took for the water to percolate Tiempo que tardó el agua en percolar					
4A. What will the water look like when it comes through? ¿Qué aspecto tendrá el agua cuando salga?					
4B. What does the water look like? ¿Qué aspecto tiene el agua?					

Class Data Table
Tabla de datos de la clase

	Sand Arena		**Clay** Arcilla		**Loam** Franco		**School Soil** Suelo del predio escolar	
	Amount percolated after 4 min. (mL) Cantidad de percolación luego de 4 min. (ml)	Time for water to percolate (sec.) Tiempo de percolación del agua (seg.)	Amount percolated after 4 min. (mL) Cantidad de percolación luego de 4 min. (ml)	Time for water to percolate (sec.) Tiempo de percolación del agua (seg.)	Amount percolated after 4 min. (mL) Cantidad de percolación luego de 4 min. (ml)	Time for water to percolate (sec.) Tiempo de percolación del agua (seg.)	Amount percolated after 4 min. (mL) Cantidad de percolación luego de 4 min. (ml)	Time for water to percolate (sec.) Tiempo de percolación del agua (seg.)
Team 1 Equipo 1								
Team 2 Equipo 2								
Team 3 Equipo 3								
Team 4 Equipo 4								
Team 5 Equipo 5								
Team 6 Equipo 6								
Average Promedio								
Average Rate mL/sec Coeficiente promedio ml/seg.								

Post-Lab: Discussion Questions
Preguntas para comentar posteriores al procedimiento de laboratorio

1. Which soil had the most water percolate after 4 minutes?
   ¿Qué suelo tuvo mayor percolación luego de 4 minutos?

2. Which had the least?
   ¿Cuál tuvo menos?

3. Which soil had the fastest percolation rate?
   ¿Qué suelo tuvo el coeficiente de percolación más veloz?

4. Which had the slowest?
   ¿Cuál fue el más lento?

5. EXTRA CREDIT CHALLENGE: Rain gardens reduce water pollution by catching stormwater runoff so that it is used by the garden plants and slowly filter through the garden soil. From these results, how would a rain garden function if it were mostly sand? How would it function if it was mostly clay? What if there was a layer of clay under loam? How could you test your answer to this last question?

   DESAFÍO CON CRÉDITO SUPLEMENTARIO: Los jardines de lluvia reducen la contaminación del agua al recoger la escorrentía pluvial para que sea utilizada por las plantas del jardín y para que se filtre lentamente a través del suelo. A partir de estos resultados, ¿cómo funcionaría un jardín de lluvia si estuviera compuesto mayormente de arena? ¿Cómo funcionaría si estuviera compuesto mayormente de arcilla? ¿Qué sucedería si hubiera una capa de arcilla debajo del franco? ¿Cómo podrías comprobar tu respuesta a esta última pregunta?

Background
Información previa

As you remember from the Water Cycle, when it rains, some of the rain *infiltrates*, or seeps into the ground. Some runs off into streams or lakes. Some evaporates. In forests, much of the rain infiltrates into the ground because the surface is *permeable*, meaning that it has small holes that water can enter and pass through. Permeable surfaces allow the rain drops to soak into the ground. If the ground itself is porous (filled with small holes), the water will continue percolating down through the soil; in the process, many pollutants will be filtered out before the water reaches a stream or ground water.

Como recordarás del ciclo del agua, cuando llueve, un poco de lluvia se *infiltra* o se absorbe en el suelo. Un poco corre hacia arroyos o lagos. Otro poco se evapora. En los bosques, buena parte de la lluvia se infiltra en el suelo porque la superficie es *permeable*; es decir, que tiene pequeños orificios por los que el agua puede penetrar. Las superficies permeables permiten que las gotas de lluvia penetren en el suelo. Si el suelo en sí es poroso (lleno de pequeños orificios), el agua continuará percolando a través del suelo; en el proceso, se pueden filtrar muchos contaminantes antes de que el agua llegue a un arroyo o al agua subterránea.

Definitions
Definiciones

Permeable or pervious describes a surface that allows water (or fluid) to pass through.
Permeable describe una superficie que permite que penetre el agua (o un fluido).

Impermeable or impervious describes a surface that does not allow water to pass through.
Impermeable describe una superficie que no permite que se filtre el agua (o un fluido).

In contrast, when it rains in urban areas, the water cannot infiltrate into *impermeable* surfaces such as roofs, roads, and sidewalks. With nowhere else to go, the rain water runs rapidly off the surfaces and carries pollutants into the nearest body of water. This is called *stormwater runoff*.

Por el contrario, cuando llueve en zonas urbanas, el agua no se puede infiltrar en superficies *impermeables*, tales como techos, carreteras o aceras. Al no tener adónde ir, el agua de lluvia comienza a correr rápidamente por las superficies y transporta contaminantes al cuerpo de agua más cercano. Esto se denomina *escorrentía pluvial*.

It is important to keep in mind that not all surfaces have the same level of permeability. Some areas are compacted by machines or foot traffic. This reduces the amount of pores on their surfaces and in the underlying ground. In the following assignment, you will consider the factors that influence an area's permeability and predict which areas on your school campus are more permeable than others.

Es importante tener presente que no todas las superficies tienen el mismo nivel de permeabilidad. Algunas zonas están compactas por las máquinas o el tránsito peatonal. Esto disminuye la cantidad de poros en sus superficies y en el suelo subyacente. En la siguiente tarea, considerarás los factores que influyen en la permeabilidad de una zona y predecirás qué zonas de tu predio escolar son más permeables que otras.

Instructions
Instrucciones

You are given a map of your school with a grid. The grid on the map divides your school campus into small sections. Predict how permeable the area in each box is by writing a rating of 0, 1, or 2 in the box. A rating of 0 means that stormwater runoff cannot enter the ground. A rating of 2 means that stormwater runoff enters the ground very easily.

Se te proporcionará un mapa de tu escuela con una cuadrícula. La cuadrícula en el mapa divide tu predio escolar en varias secciones pequeñas. Predice cuán permeable es la zona en cada cuadro dándole un puntaje de 0, 1 o 2 en el cuadro. Un puntaje de 0 significa que la escorrentía pluvial no penetra en el suelo. Un puntaje de 2 significa que la escorrentía pluvial penetra en el suelo con facilidad.

- 0 = impermeable
  0 = impermeable
- 1 = a little permeable
  1 = un poco permeable
- 2 = very permeable
  2 = muy permeable

When you have completed the grid, answer the questions.
Cuando completes la cuadrícula, contesta las preguntas.

Questions
Preguntas

1. What percent of your school campus was rated as 0, impermeable?
   ¿Qué porcentaje de tu predio escolar obtuvo un puntaje de 0, es decir, impermeable?

2. What percent of your school campus was rated as 1, semi-permeable?
   ¿Qué porcentaje de tu predio escolar obtuvo un puntaje de 1, es decir, semipermeable?

Calculations: **Cálculos:**
$\frac{\text{\# of boxes for rating}\ /\ \text{Cantidad de cuadros para calificar}}{\text{Total \# of boxes}\ /\ \text{Cantidad total de cuadros}} \times 100 = \ \%$
Example: ***Ejemplo:***
$\frac{\text{60 boxes for rating of 0}\ /\ \text{60 cuadros con un puntaje de 0}}{\text{216 boxes}\ /\ \text{216 cuadros}} \times 100 =$ **27.8% impermeable** **27,8% impermeable**

3. What percent of your school campus was rated as 2, permeable?
   ¿Qué porcentaje de tu predio escolar obtuvo un puntaje de 2, es decir, permeable?

4. Which areas did you rate as 1 and why?
   ¿Qué zonas calificaste con 1 y por qué?

5. Based on your map and what you have learned, how do you think the amount of impermeable surfaces on your school grounds affects the quality of your stream next to your school? Explain why and provide examples.
   En función de tu mapa y lo que has aprendido, ¿de qué forma crees que la cantidad de superficies impermeables de tu predio escolar afectan la calidad del curso de agua junto a tu escuela? Explica por qué y proporciona ejemplos.

Extra Credit
Crédito adicional

1. Using a red marker, circle areas on the map where you think the most stormwater runoff comes from during a rain storm.
   Con un marcador rojo, encierra con un círculo las zonas del mapa de donde crees que proviene la mayor parte de la escorrentía pluvial durante una tormenta.

2. Using a blue marker, put stars on spots where you think a Best Management Practice (BMP) could help reduce the amount of stormwater runoff on your school campus. BMPs include rain barrels, trees, and gardens.
   Con un marcador azul, coloca estrellas en los lugares donde crees que una mejor práctica de gestión (BMP, por sus siglas en inglés) podría ayudar a reducir la cantidad de escorrentía pluvial en tu predio escolar. Las mejores prácticas de gestión incluyen bidones para recoger agua de lluvia, árboles y jardines.

Using the scientific method to guide this outdoor investigation, students test the permeability of different school-ground areas, record and organize the results with maps and tables, and make recommendations for sustainable stormwater practices. The following are included:

Concepts: Permeability, infiltration; surface water runoff on different surfaces; sustainable practices that reduce storm water runoff on the school grounds; reliability in scientific research.

Skills: Using Scientific Method; methods for recording and organizing data; communicating results; recommending sustainable stormwater practices; basic math and averaging with extensions for volume and unit conversion.

Grades: 5-10

Time: 60 to 90 minutes, depending upon number of test sites, extensions, and involvement of students in map preparation.

MD STEM Standards of Practices: 1, 2, 3.

Prior Knowledge

This activity works well after the Score Four Watersheds, Land Use, and Sustainable Practices (PPT) presentation and FieldScope (or other map) activity; the Watershed Connections model activities; or other lessons that provide the necessary background for students to form a hypothesis and discuss the issues and possible solutions.

Prepare students to understand and/or participate in the design of this field study by reinforcing concepts of hypothesis, accuracy, reliability, and validity.

Supplies for Each Team

- 6-inch PVC pipe 3-in diameter (can be cut with a hacksaw). Draw a line .25 inches (.6 cm) from the bottom on this cylinder with a Sharpie. (Option: coffee cans with both ends removed. Make sure the cans are the same size and that sharp ends are covered with duct tape.)
- 1000 ml-measuring cup
- Stop watch
- Small map of school grounds
- Clear ruler with metric marks
- Red, green, and yellow markers and pencil
- Directions for Permeability Field Test
- Field Observation Sheet
- Container of water for multiple sites (could be a 2-liter soda bottle)

Supplies For Whole Class

- Large map of school yard on large paper
- Large pad of paper, easel, markers, pencil for class data table
- Extra water

Preparation

Make Large & Small Campus Maps: Make a large map of the school grounds, depicting the school and campus areas that have different uses and/or land cover — for example, gardens, woods, parking lots, playgrounds, paths, sidewalks, or athletic fields. You can print out a computer satellite map of the grounds, or have students create a line drawing. The map is used for preliminary discussion and the class data. (A large paper map

provides the benefit of a physical communication piece to display about your project, but some teachers prefer displaying the large maps and data on PowerPoint.) *Each team also needs a small version of this map.*

Outdoor Discussion with Map: Take your students outside and, using the map(s), ask them which areas on the school grounds might have differing amounts of *permeability*. Explain that they will do a field test to assess the permeability of areas on the school grounds that have different uses or land cover. Discuss factors that could affect the ability of water to *infiltrate* into the soil.

Hypothesis: Ask your students to make group hypotheses about which *area has the greatest permeability and which has the least*. The hypotheses should be backed by information from lessons or observations. For instance, gardens could be the most permeable because roots create air spaces in the soil or the ground is looser. The playground could have less infiltration if it has been compacted by students (fewer air spaces for water to infiltrate). A paved parking lot would not allow water to infiltrate into the ground.

Methods

Setting Up the Field-Test Process: For higher grade levels, the students should give input to this part of the experimental design, considering the concepts of accuracy, reliability, repeatability, and validity, as they do so. Our suggestions follow.

1. Divide the class into four to six teams and call them Teams A, B, C, etc.
2. Decide how many teams will test each area — keeping in mind that the *data from each area will be averaged*; the more tests in each area increases the *validity* of the results.
3. Have the class discuss which areas to test. The areas should be distinctly different uses or land covers. (Alternately, teachers can select the areas and assign each team several areas to test.)
4. Explain that each team will *use the same methods* to test a *different spot within that area to maintain reliability and validity*.

   Time-saving options: Focus your investigation on one side of the school; have different classes test different areas, and combine the results from both classes; or each team could test 3-4 different areas, with each area being tested by a minimum of 3 teams.

   Added Challenges: If age appropriate, introduce the concept of *random sampling within the defined areas* by having each team pick a number from a hat. Then one team member twirls around in the center of the area (with eyes closed) and walks that # of steps to the spot to be tested.)

Permeability Field Test (see Student Directions, page 4): These directions can be copied for the students.

- Demonstrate the test and go over the *Team Field Observation Table* (page 6).
- Provide each team with the materials listed on page 1. Assign "jobs" for the team members. For example, holding the cylinder, pouring the water, working the timer, recording the data, and marking the map. Have each team practice the procedure.

  - Ask the students why it is important for all of the teams to use the same procedure. Answer: *Reliability* — if one team were to use a different amount of water, the results would not be consistent with the other teams' data. Repeatedly using the same methods helps ensure consistency of the results. This makes it possible to average the results and have a reliable conclusion, or to recognize an anomaly.
  - Ask them why they have assigned jobs and need to practice the procedure. It improves *accuracy*, because the students are less likely to make a mistake in the procedure. It improves *reliability* of the results, because the students are more likely to do each test the same and the same as the other students.

Recording the Results

Each team records their data and observations on the Team Map and Team Field Observation Table. When the field tests are done, the class gathers to record the results on the group map and a group table.

Group Map: Each team marks their sites on the large map according to the following:

- If all the water seeped into the ground within **3 minutes**, put a **GREEN dot** on the test site. Draw an arrow showing the direction of flow.
- If **less than 2 cm** infiltrated into the ground, mark the test site with a **RED arrow**, showing the direction of water flow.
- If **some water remained in the cylinder, but greater than 2 cm infiltrated** into the ground, put a **YELLOW dot** on the test site. Draw an arrow showing the direction of flow.
- Extrapolate the results: If all the test sites in a designated area have the same color of dots, mark the entire area with that color (or stripes of that color).
- Make a map key. Have the students define what the colors and symbols represent – *permeable, semi-permeable, or impermeable.*

Group Table: Have the group make a table to record their results, or use the one provided on page A. The students will *average* their results.

Conclusions and Recommendations

Sample class discussion questions

- Which areas are the most permeable and impermeable? Was the group hypothesis correct? Why or why not?
- What direction would runoff flow in different areas of the school yard?
- Which areas would have the most stormwater runoff? (What other information might be needed to quantify this question? Answer: size of the area or the roof; slope.)
- Which areas might have puddles?
- Why does the water infiltrate at different speeds in different areas? Possible answers:
    - The area is compacted by people walking or playing on it.
    - Heavy lawn mowers frequently run over it.
    - There is clay underneath the top soil or near the surface.
    - There is mulch and dried leaves on top of the ground.
    - There are plants with roots in the soil.
    - There is more sand or loam or organic material in the soil.
- How does these findings relate to stream water quality in their watershed?

- PRACTICAL APPLICATION: Where could sustainable stormwater practices, such as gardens or rain barrels, be installed to reduce stormwater runoff? *(See the rain garden resource booklets on your CD for more information on this.)*
    - Have students suggest best management practice and discuss the pros and cons of each type.
    - Students can discuss what else they would need to know before deciding what practices would be most effective.

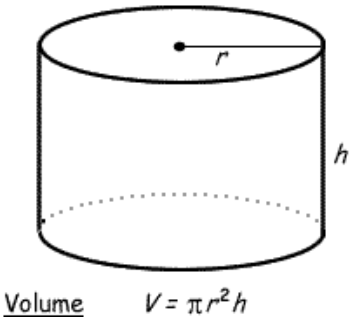
Procedure

As you complete each test, mark the *site on your map, and* record your observations on the Team Field Observation Sheet. Label each test site according to your team's letter and the number of the test. (If you are team A, your first site will be labeled A1, your second site, A2, and so on.)

Each team member should do his or her assigned task throughout the investigation (Reader, Recorder(s), Holder, Timer, Pourer). Read and *practice* these instructions before you start.

1. Fill your cup or bottle with 650 ml of water.
2. Push the cylinder into the ground to the black line on the cylinder. (For areas where the pipe *cannot* be put in the ground, go to Step 3.) Do the following steps:
    - One person applies constant pressure to the top of the container to prevent water from leaking out around the bottom.
    - The Timer starts the stopwatch at the same time the Pourer begins to pour water into the cylinder.
    - *If the water infiltrates before 3 minutes*, the Timer stops the watch at that point. The Data Recorder writes the length of time on the Team Field Observation Sheet.
    - Stop the watch at 3 minutes. If water remains in the cylinder, measure from the rim of the cylinder to the water level (in centimeters). The Data Recorder notes this on the Observation Sheet.
3. If the cylinder cannot be put into the ground, you will pour the water on the surface and record what happens on your table and map.
    - Does it pool?
    - Does it flow in a certain direction? Make a red arrow on your map that shows which direction the water flows.

Extensions



Volume $V = \pi r^2 h$

Finding the volume of a cylinder:

The volume is found by multiplying the *area of one end of the cylinder (base) by its height.*

Since the end (base) of a cylinder is a circle, the area of that circle is given by the formula: area = π r^2

$volume = \pi r^2 h$	where: π is Pi, approximately 3.142 r is the radius of the circular end of the cylinder h height of the cylinder

Extension 1 – Volume:

What volume of water is needed to fill the cylinder?

Have the students use the metric system to measure the cylinder's height (from the marked line) and diameter. They will determine the radius by dividing the diameter in half.

Our cylinder: Diameter = 7.7 cm. Height = 14.6

$volume = \pi r^2 h$ = 3.14 x (7.7 cm ÷2)^2 x 14.6 = 679.8 ml

Students also can determine the volume of water that percolated, using same method. Conversely, they can determine the volume of water left in the container, which represents runoff.

Extension 2 – Rate of Infiltration and Conversions: Although most sciences use the metric system, the science of hydrology often uses English units. The rate of infiltration is measured in either mm/hour or inches/hour. Have them convert their measurements (cm/minutes) to mm/hour or inches/hour. Naturally, if the test was done for 24 hours, as it is by soil conservation scientists, this rate could differ, which raises another point of discussion about the accuracy of the results.

Other Extensions

- Have students hypothesize what variables might be included in a formula for the amount of runoff that runs off roofs and then research the formula on the internet. The students could then calculate how much runoff would be expected on the school grounds from the school roof. (Many reliable internet sites on rain barrels and rain gardens include formulas. Good sources include county environmental departments. Also see the rain garden booklets provided on ICPRB's Score Four Resources.)
- Have students consider variables on the ground and in the soil that would affect the rate of infiltration (e.g., types of vegetation, recent rain activity, soil types.) The National Soil Conservation Service website provides lessons and videos on this subject. Ensuing Score Four lessons also focus on this topic.

TEAM FIELD OBSERVATION SHEET

Weather: Did it rain yesterday? _____

TEST SITE NUMBER (For example, A1, A2, A3…	**TEST SITE DESCRIPTION** (Examples: garden, foot path, playground, parking lot)	**TIME FOR WATER TO INFILTRATE (sec.)** (If the water would not infiltrate, write impermeable.)	**Distance from rim to the water level (cm)** (The amount that infiltrated.)	**OBSERVATIONS** • Note things that could have influenced your results, for instance: Was the ground wet? Did water seep out your cylinder?

EXAMPLE CLASS TABLE

Directions:

Time to infiltrate: If the water did not infiltrate within 180 seconds, write **>180 sec**. If it did not infiltrate at all, write Impermeable.

Averaging: When the water does not infiltrate within 180 seconds, it will take creative thinking to "average" the Time-to-Infiltrate results. Your class can decide the appropriate value to use, or whether to just to consider the average amount of water that infiltrated for that site.

Distance from rim: If the water did not infiltrate into the ground at all, write zero.

	Test Site 1		**Test Site 2**		**Test Site 3**		**Test Site 4**	
	Time to Infiltrate (seconds)	Distance from Rim to Water Level (cm)	Time to Infiltrate (sec.)	Distance from Rim to Water Level (cm)	Time to Infiltrate (seconds)	Distance from Rim to Water Level (cm)	Time to Infiltrate (seconds)	Distance from Rim to Water Level (cm)
Team A								
Team B								
Team C								
Team D								
Team E								
Average								
Is it Permeable or Semi-permeable Or Impermeable?								

	Test Site 5		Test Site 6		Test Site 7		Test Site 8	
	Time to Infiltrate (sec.)	Distance from Rim to Water Level (cm)*	Time to Infiltrate (sec.)	Distance from Rim to Water Level (cm)	Time to Infiltrate (sec.)	Distance from Rim to Water Level (cm)	Time to Infiltrate (sec.)	Distance from Rim to Water Level (cm)
Team A								
Team B								
Team C								
Team D								
Team E								
Average Time to Infiltrate								
Is it Permeable or Semi-permeable or Impermeable?								

Objective
Objetivo

- To learn about the concept of permeability, infiltration, and surface water runoff on different surfaces.
  Aprender acerca del concepto de permeabilidad, infiltración y escorrentía superficial en distintas superficies.
- To compare results to permeability data from maps.
  Comparar los resultados con los datos de permeabilidad de los mapas.
- To define parameters of the field test (for higher grades).
  Definir parámetros de la prueba de campo (para grados superiores).

Materials for Each Team
Materiales para cada equipo

- 6-inch PVC pipe 3-in diameter
  Tubo de PVC de 6 pulgadas con 3 pulgadas de diámetro
- 1000 ml-measuring cup
  Taza de medidas de 1000 ml
- Stop watch
  Cronómetro
- Small map of school grounds
  Mapa pequeño del terreno de la escuela
- Clear ruler with metric marks
  Regla clara con marcas en escala métrica
- Red, green, and yellow markers and pencil
  Marcador rojo, verde y amarillo y lápiz
- Directions for Permeability Field Test
  Instrucciones para la prueba de campo de permeabilidad
- Field Observation Sheet
  Hoja de observaciones de campo
- Container of water for multiple sites (could be 2-liter soda bottle)
  Recipiente de agua para múltiples sitios (podría ser una botella de refresco de 2 litros)

Background
Información previa

In this field inquiry, your class will investigate different land uses or covers on your campus and determine whether they are permeable, semi-permeable, or impermeable. The different areas should include gardens, mulched areas, sport fields, sidewalks, wooded edges, walking paths, and other types of land-use areas on your campus.
En esta investigación de campo, tu clase investigará distintos usos del suelo o de los recubrimientos de tu predio escolar y determinará si estos son permeables, semipermeables o impermeables. Las distintas zonas deben incluir jardines, zonas cubiertas por abono, campos de deporte, aceras, bordes arbolados, caminos y otros tipos de usos del suelo en zonas de tu predio escolar.

- The class will start by *forming hypotheses* about which area under investigation is most permeable and which area is least permeable.
  La clase comenzará elaborando hipótesis acerca de cuál de las zonas que se investigan es más permeable y cuál es menos permeable.

- Then teams will go to the different areas and conduct the permeability field test. The *procedure* for this test is on the next page.
  Luego, los equipos irán a las diferentes zonas y realizarán una prueba de campo de permeabilidad. El procedimiento para esta prueba se encuentra en la página siguiente.

- Afterwards, you will *compile the class results* on a class table or graph and a large map of the campus.
  A continuación, recopilarás los resultados de la clase en una tabla o gráfica grupal y en un mapa grande del predio escolar.

- From these results, you will *draw conclusions* about stormwater runoff on the campus and *make recommendations* about possible areas where rain gardens, conservation gardens, rain barrels, or trees could reduce the amount of stormwater.
  A partir de estos resultados, sacarás conclusiones sobre la escorrentía pluvial en el predio escolar y harás recomendaciones acerca de las posibles zonas donde los jardines de lluvia, las zonas verdes de conservación, los bidones para la recolección de lluvia o los árboles podrían reducir la escorrentía de agua pluvial.

Field Test Procedure
Procedimiento de prueba de campo

Your team will do the following procedure. For consistency, each team member will do an assigned task throughout the investigation (Reader, Recorder(s), Holder, Timer, Pourer). Read and *practice* these instructions before you start.
Tu equipo seguirá el siguiente procedimiento. Para mantener la uniformidad, durante la investigación se asignará una tarea a cada integrante del equipo (leer, registrar, sostener, cronometrar, verter). Lee y *practica* estas instrucciones antes de empezar.

As you complete a test, **mark the test site on your map**. Label each test site according to your team's letter and the number of the test. (If you are team A, your first site will be labeled A1, your second site, A2, and so on.) **Record your observations on the Team Field Observation Sheet**.
A medida que completes la evaluación, marca el sitio de prueba en tu mapa. Etiqueta cada sitio de prueba según la letra de tu equipo y el número de prueba. (Si eres el equipo A, tu primer sitio se etiquetará "A1", tu segundo sitio "A2" y así sucesivamente.) **Registra tus observaciones en la hoja de observaciones de campo del equipo**.

1. Fill your cup or bottle with 650 ml of water.
   Llena la taza o la botella con 650 ml de agua.

2. Push the cylinder into the ground to the black line on the cylinder. (For areas where the pipe *cannot* be put in the ground, go to Step 3.) Do the following steps:
   Introduce el cilindro en el suelo hasta la línea negra. (En los lugares en donde *no se pueda* introducir el tubo en el suelo, consulta el paso 3.) Sigue los pasos que se detallan a continuación:

   - One person applies constant pressure to the top of the container to prevent water from leaking out around the bottom.
     Una persona aplica presión constante a la superficie del recipiente para evitar pérdidas de agua en la parte inferior.

   - The Timer starts the stopwatch at the same time the Pourer begins to pour 650 ml of water into the cylinder.
     El integrante a cargo de cronometrar inicia el cronómetro al mismo tiempo que el integrante que se ocupa de verter comienza a verter 650 ml de agua en el cilindro.

   - *If the water infiltrates before 3 minutes*, the Timer stops the watch at that point. The Data Recorder writes the length of time in seconds on the Team Field Observation Sheet.
     Si el agua se infiltra antes de 3 minutos, el cronometrador detiene el cronómetro en ese momento. El integrante encargado de registrar datos anota el tiempo en segundos en la hoja de observaciones del equipo.

   - Otherwise, stop the watch at 3 minutes. If water remains in the cylinder, measure from the rim of the cylinder to the water level (in centimeters). The Data Recorder notes this on the Observation Sheet.

De lo contrario, se debe detener el cronómetro a los 3 minutos. Si queda agua en el cilindro, mide desde el borde del cilindro hasta el nivel del agua (en centímetros). El encargado de registrar datos anota esto en la hoja de observaciones.

3. If the cylinder cannot be put into the ground, you will pour the water on the surface and *record what happens on your Observation Sheet and map.*
   Si el cilindro no se puede introducir en el suelo, vierte el agua en la superficie y *registra lo que sucede en tu mapa y en la hoja de observaciones*.

   - Does it pool?
     ¿Se estanca?

   - Does it flow in a certain direction? Make a red arrow on your map that shows which direction the water flows.
     ¿Corre en alguna dirección? Dibuja una flecha roja en tu mapa que muestre la dirección en que corre el agua.

RESULTS: Directions for the Group Map
RESULTADOS: instrucciones para el mapa grupal

Each team marks their sites on the large map according to the following:
Cada equipo marca sus sitios en el mapa grande de acuerdo con lo siguiente:

- If all the water seeped into the ground within **3 minutes**, put a **GREEN dot** on the test site.
  Si el suelo absorbió toda el agua en **3 minutos o menos,** marca un **punto VERDE** en el sitio de prueba.

- If **some water remained in the cylinder, but greater than 2 cm infiltrated** into the ground, put a **YELLOW dot** on the test site.
  Si **quedó algo de agua en el cilindro, pero más de 2 cm de agua se infiltraron** en el suelo, marca un **punto AMARILLO** en el sitio de prueba.

- If **less than 2 cm** (or no water) infiltrated into the ground, mark the test site with a **RED Dot, and red arrow** if you tested the direction of water flow.
  Si se infiltraron **menos de 2 cm** (o nada de agua) en el suelo, marca el sitio de prueba con un **punto ROJO** y con una **flecha roja** si hiciste la prueba de la dirección hacia la que corre el agua.

- Extrapolate the results: If all the test sites in a designated area have the same color of dots, mark the entire area with that color (or stripes of that color).
  Extrapola los resultados: si todos los sitios de prueba en una zona designada tienen los puntos del mismo color, marca toda la zona con ese color (o con franjas de ese color).

- Make a map key. Define which colored dots represent *permeable, semi-permeable, or impermeable.*
  Elabora una referencia cartográfica. Define qué colores de los puntos representan sitios *permeables*, *semipermeables* o *impermeables*.

TEAM FIELD OBSERVATION SHEET
HOJA DE OBSERVACIONES DE CAMPO DEL EQUIPO

Weather: Did it rain yesterday? _____
Estado del tiempo: ¿ayer llovió? _____

TEST SITE NUMBER (For example, A1, A2, A3… **NÚMERO DEL SITIO DE PRUEBA** (por ejemplo: A1, A2, A3...)	**TEST SITE DESCRIPTION** (Examples: garden, foot path, playground, parking lot) **DESCRIPCIÓN DEL SITIO DE PRUEBA** (ejemplos: jardín, camino, patio de juego, estacionamiento)	**TIME FOR WATER TO INFILTRATE (sec.)** (If the water would not infiltrate, write impermeable.) **TIEMPO DE INFILTRACIÓN DEL AGUA (en seg.)** (si el agua no se infiltra, escribe "impermeable").	**Distance from rim to the water level (cm)** (The amount that infiltrated.) **Distancia desde el borde hasta el nivel de agua (en cm)** (la cantidad que se infiltró)	**OBSERVATIONS** • Note things that could have influenced your results, for instance: Was the ground wet? Did water seep out your cylinder? **OBSERVACIONES** • Anota elementos que podrían haber influido en tus resultados; por ejemplo: ¿el suelo estaba mojado?, ¿el agua se escurrió de tu cilindro?

EXAMPLE CLASS TABLE
EJEMPLO DE TABLA DE CLASE

Directions:
Instrucciones:

- *Time to infiltrate:* If the water did not infiltrate within 180 seconds, write **>180 sec**. If it did not infiltrate at all, write Impermeable.
  Tiempo de infiltración: si el agua no se infiltró en 180 segundos, escribe **> 180 seg**. Si no se infiltró nada de agua, escribe "impermeable".

- *Averaging:* When the water does not infiltrate within 180 seconds, it will take creative thinking to "average" the Time-to-Infiltrate results. Your class can decide the appropriate value to use, or whether to just to consider the average amount of water that infiltrated for that site.
  Promedio: si el agua no se infiltró en 180 segundos, habrá que pensar de forma creativa cómo "promediar" los resultados del tiempo de infiltración. Tu clase puede decidir qué valor apropiado usar o si tener en cuenta únicamente la cantidad promedio de agua que se infiltró en ese sitio.

- *Distance from rim:* If the water did not infiltrate into the ground at all, write zero.
  Distancia desde el borde: si el agua no se infiltró en el suelo, escribe "cero".

	Test Site 1 Sitio de prueba 1		Test Site 2 Sitio de prueba 2		Test Site 3 Sitio de prueba 3		Test Site 4 Sitio de prueba 4	
	Time to Infiltrate (seconds) Tiempo de infiltración (en segundos)	Distance from Rim to Water Level (cm) Distancia desde el borde hasta el nivel de agua (en cm)	Time to Infiltrate (seconds) Tiempo de infiltración (en segundos)	Distance from Rim to Water Level (cm) Distancia desde el borde hasta el nivel de agua (en cm)	Time to Infiltrate (seconds) Tiempo de infiltración (en segundos)	Distance from Rim to Water Level (cm) Distancia desde el borde hasta el nivel de agua (en cm)	Time to Infiltrate (seconds) Tiempo de infiltración (en segundos)	Distance from Rim to Water Level (cm) Distancia desde el borde hasta el nivel de agua (en cm)
Team A **Equipo A**								
Team B **Equipo B**								
Team C **Equipo C**								
Team D **Equipo D**								
Team E **Equipo E**								
Average **Promedio**								
Is it Permeable or Semi-permeable Or Impermeable? **¿Es permeable, semipermeable o impermeable?**								

	Test Site5 Sitio de prueba 5		Test Site 6 Sitio de prueba 6		Test Site 7 Sitio de prueba 7		Test Site 8 Sitio de prueba 8	
	Time to Infiltrate (seconds) Tiempo de infiltración (en segundos)	Distance from Rim to Water Level (cm) Distancia desde el borde hasta el nivel de agua (en cm)	Time to Infiltrate (seconds) Tiempo de infiltración (en segundos)	Distance from Rim to Water Level (cm) Distancia desde el borde hasta el nivel de agua (en cm)	Time to Infiltrate (seconds) Tiempo de infiltración (en segundos)	Distance from Rim to Water Level (cm) Distancia desde el borde hasta el nivel de agua (en cm)	Time to Infiltrate (seconds) Tiempo de infiltración (en segundos)	Distance from Rim to Water Level (cm) Distancia desde el borde hasta el nivel de agua (en cm)
Team A **Equipo A**								
Team B **Equipo B**								
Team C **Equipo C**								
Team D **Equipo**								
Team E **Equipo E**								
Average **Promedio**								
Is it Permeable or Semi-permeable Or Impermeable? **¿Es permeable, semipermeable o impermeable?**								

Background

Two primary goals of the Score Four program are to involve students in the planning and implementation of a stormwater solution. In "Exploring Your Watershed," students investigated the local watershed and various land-use effects on nearby streams. In this Campus Assessment, small teams of students assess the school campus for specific aspects of stormwater inputs, as well possible areas for corrective stormwater practices. They will tour the school campus to observe:

- The pattern of storm water on the campus – where it is generated, flows, ponds, and exits the school grounds.
- Problem areas, such as eroding hillsides, or wet areas.
- Options for stormwater-reduction projects, such as Bay-Wise gardens, conservation landscapes, rain gardens, tree plantings, meadows, or rain barrels (also known as Best Management Practices, BMPs, or Student Sustainability Projects.)

Standards: **Next Generation Science Standards**: 5-ESS3-1, MS-ESS3-3, HS-ESS3-3, HS-ESS3-4.

Skills Exercised: field observations, field data collection, analysis with maps, critical thinking, communication, sketching, or computer technology.

Grades: 6-12

Time: 60-90 minutes, depending upon whether the entire school campus is assessed and whether the students are involved in preparing the map and map key.

Materials for Each Team:

- ___ Map of the school (from the computer or drawn)
- ___ Paper to sketch on.
- ___ Directions and the Map Key
- ___ Pencils or colored pens
- ___ Clip board or hard writing surface
- ___ Container of water
- ___ Camera (optional)

Teacher Instructions

The Campus Assessment involves three parts:

1. Preparation: prepare maps and go over instructions (student map preparation is optional).
2. Assessment: tour the school campus to record features listed on the key.
3. Follow-up class discussion.

Preparation

MAP: Each team needs a map of the school and a features key. Teachers can prepare the maps or direct their students to do so. Having students create the maps can add an art or technology element, and might improve their observations. Following are methods for creating maps.

- Hand draw.
- Use Microsoft Office (PowerPoint or Publisher) to draw lines and symbols.
- Download from Google Earth or Google Maps, or another source.

The adjacent map key can be used, or students can develop their own as a class. The adjacent key is also on the student handout.

Review the instructions on the Student Handout and assign students to teams. It is important that students understand their job within their team, what to observe, and how to record their observations. It can be helpful to practice with the class in one area of campus.

Assessment

During the assessment the students look for and record the elements on the key. The assessment works best when the class works in the same area of the school grounds. In this way the teacher and assistants can guide the students, and results can be compiled and discussed.

Observing stormwater flow is easiest during or after a rain event. Since this usually is not practical, students can observe patterns of stormwater flow, such as the following:

- Areas where the grass is flattened and may be leaning in the direction of flow
- Areas where dirt has collected from erosion.
- Areas that remain wet
- Eroded slopes
- The direction of water, when it is poured on a surface
- Stormwater drains
- Paths from downspouts.

MAP KEY	
G	Garden (outline the shape)
T	Tree (or draw a stick tree)
Woods	Woods (or draw multiple stick trees)
SD	Storm drains
Dwn	Downspouts on the school (Draw an arrow showing the direction of flow on the ground.)
→	Stormwater flow path
IM	Impervious surfaces on the ground. Draw an arrow for the direction of flow.
PND	Areas where stormwater ponds on the grounds. (Draw the area.)
ER	Areas of erosion (including bare patches on the lawn).
Dch	Stormwater ditches
Hill	Hills or steep slopes
SAP	Possible Stormwater Action Project locations
Ut	Any marked underground utilities, if known.
Tsh	Trash source

Follow-up

After the assessment, each team answers the Discussion Questions (on Student Handout) and teams present their findings to the class.

The class discusses problems and solutions. At this point the class could agree upon 2-3 locations to investigate as sites for stormwater solutions.

If stormwater BMPs have been discussed, students also can agree upon possible solutions to further investigate. Such solutions include conservation or Bay-wise Gardens, tree plantings, food forests, rain gardens, meadows, and rain barrels. Not all BMPs are optimal for all situations, and will require some investigation of the sites, researching the solutions, and consideration of your resources. Of the ones mentioned here, conservation gardens and tree plantings require the least planning. If an area does not percolate, rain gardens might require expertise. See the Resources section for information on various BMPs and the Site Assessment for a Rain Garden.

Objectives
Objectivos

In this field inquiry, you team up with fellow students to do a stormwater assessment of your campus. Such assessments are done by landscape architects, water resource professionals, and home owners as a first step in determining optimal stormwater solutions for properties. Your objectives follow.
En esta investigación de campo, te reunirás en equipo con otros compañeros para evaluar el agua de lluvia en tu predio escolar. Los arquitectos paisajistas, los profesionales de recursos hídricos y los dueños de viviendas hacen estas evaluaciones como primer paso para determinar las mejores soluciones para las propiedades respecto al agua pluvial. Tus objetivos se detallan a continuación.

1. Record the sources and patterns of stormwater runoff on your campus.
   Registra las fuentes y los recorridos de la escorrentía pluvial en tu predio escolar.

2. Identify areas that contribute to stormwater pollution, such as eroding hillsides, patches of bare lawn, or trash sources.
   Identifica las zonas que contribuyen a la contaminación del agua pluvial, como laderas en proceso de erosión, partes de césped pelado o fuentes de residuos.

3. Identify landscape features.
   Identifica las características del terreno.

4. List two or three possible locations for YOUR Stormwater Action Project.
   Enumera dos o tres lugares posibles para TU proyecto de medidas respecto a las aguas pluviales.

Materials for Each Team
Materiales para cada equipo

- — Map of the school (from the computer or drawn).
  Mapa de la escuela (de la computadora o dibujado)
- — Paper to sketch on
  Papel para hacer bosquejos
- — Directions and the Map Key
  Instrucciones y referencias cartográficas
- — Pencils or colored pens
  Lápices o bolígrafos de colores
- — Clip board or hard writing surface
  Tabla con sujetapapeles o superficie rígida para escribir
- — Container of water
  Recipiente para el agua
- — Camera (optional)
  Cámara (opcional)

Campus Assessment — Student
Evaluación del agua pluvial del predio escolar — Estudiante

Instructions: Observe Stormwater Runoff Flow Paths and Problems

Instrucciones: observa los caminos que recorre la escorrentía de agua pluvial y los problemas asociados

Observing stormwater flow and stormwater problems is easiest – and most fun – during or after it rains. Most likely, that won't be possible for your class, so tips on determining this information follow.
Observar el flujo y los problemas de agua pluvial es más fácil y más divertido cuando llueve o inmediatamente después. Lo más probable es que esto no sea posible para tu clase, de modo que siguen algunos consejos para determinar esta información.

- **Find and mark the following on your map, using the symbols in your map key:**
  Encuentra y marca lo siguiente en tu mapa utilizando los símbolos de las referencias cartográficas:
  - Stormwater downspouts on your building
    Caños de bajada pluvial en tu edificio
  - Stormwater ditches, gutters, or gullies, where rainwater collects and flows
    Zanjas, canaletas o sumideros en los que se recoge y corre agua pluvial
  - Stormwater drains, into which water flows
    Drenajes pluviales hacia los cuales corre el agua
  - Impermeable areas, such as parking lots
    Zonas impermeables, como parcelas de estacionamiento
  - Hills
    Colinas
  - Places in the lawn where the grass is flattened and may be leaning in the direction of flow
    Lugares de césped aplanado que pueden inclinarse hacia la dirección en que corre el agua
  - Areas where dirt has collected from erosion.
    Zonas en las que se ha juntado tierra de la erosión
  - Areas that remain wet.
    Zonas que permanecen húmedas
  - Places that are eroding.
    Lugares que están en erosion
- **Mark the direction of the water flow for all the identified areas.**
  Marca la dirección en que corre el agua de todas las zonas identificadas.
  - If you cannot tell the slope of the surface, pour water on it to see which direction the water flows.
    Si no distingues la pendiente del terreno, vierte agua para ver en qué dirección corre.

MAP KEY REFERENCIAS CARTOGRÁFICAS	
G	Garden (outline the shape) Jardín (delinea la forma)
T	Tree (or draw a stick tree) Árbol (o dibuja un bastón para representar un árbol)
Woods	Woods (or draw multiple stick trees) Bosque (o dibuja varios bastones de árboles)
SD	Storm drains Alcantarillas
Dwn	Downspouts on the school (Draw an arrow showing the direction of flow on the ground.) Caños de bajada en la escuela (dibuja una flecha que muestre la dirección del recorrido en el terreno)
→	Stormwater flow path Recorrido del agua pluvial
IM	Impervious surfaces on the ground. Draw an arrow for the direction of flow. Superficies impermeables en el terreno (dibuja una flecha que muestre la dirección del recorrido)
PND	Areas where stormwater ponds on the grounds. (Draw the area.) Zonas donde el agua pluvial se estanca en el terreno (dibuja la zona)
ER	Areas of erosion (including bare patches on the lawn). Zonas de erosión (incluidas las partes de césped pelado)
Dch	Stormwater ditches Zanjas de desagüe de agua pluvial
Hill	Hills or steep slopes Colinas o pendientes pronunciadas
SAP	Possible Stormwater Action Project locations Posibles lugares para el proyecto de medidas respecto a las aguas pluviales
Ut	Any marked underground utilities, if known. Todo servicio público subterráneo marcado, si se conoce
Tsh	Trash source Fuente de residuos

Mark your observations on your map, using the abbreviations and symbols in the Map Key. If the area you are assessing does not show up well on the map, make a simple line drawing of the area, keeping features in proportion as much as possible. You can add items to the key that are not on it.
Marca tus observaciones en el mapa empleando las abreviaturas y símbolos de las referencias cartográficas. Si la zona que evalúas no se ve bien en el mapa, haz un dibujo lineal de ella; trata de mantener la proporción de las características en la mayor medida posible. Puedes añadir elementos que estén faltando en las referencias cartográficas.

Field Notes: Put additional observations here.
Notas de campo: Añade observaciones adicionales aquí.

Discussion Questions
Preguntas para comentar

1. Were there any areas that had stormwater runoff problems? If so, describe them and the location.
   ¿Había áreas con problemas de escorrentía de agua pluvial? Si las había, descríbelas e indica la ubicación.

2. Where did most of the stormwater runoff come from?
   ¿De dónde provenía la mayor parte de la escorrentía de agua pluvial?

3. What areas could be possible sites for a Stormwater Action Project to reduce stormwater runoff on the campus? Why would these areas be good sites?
   ¿Qué zonas podrían ser posibles lugares para un proyecto de medidas respecto a las aguas pluviales en el predio escolar? ¿Por qué esos sitios serían adecuados?

Updated 8/2017

Soil Basics (Or the world under our feet)
Conceptos Básicos del Suelo (El mundo bajo nuestros pies)

Score Four: Students, Schools, Streams, and the Bay
Score Four: Estudiantes, Escuelas, Arroyos y la Bahía

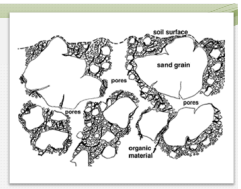
Rebecca Wolf and Nguyen Le
Interstate Commission on the Potomac River Basin
Comisión Interestatal para la Cuenca del Río Potomac

Soil: The Foundation For a Plant's Success
Suelo: La Base para el Éxito de las Plantas

- Soil provides plants with:
  El suelo provee a las plantas:
  - Nutrients
    Nutrientes
  - Minerals
    Minerales
  - Water
    Agua
  - Oxygen
    Oxígeno

It's Not Just Dirt
No es sólo tierra

Soil consists of:
Suelo consta de:

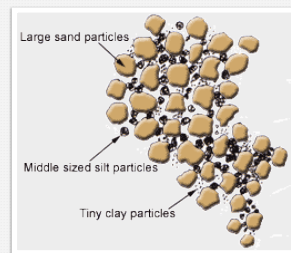


- ***Mineral particles*** – sand, silt, or clay.
  Partículas minerales – arena, limo, o arcilla.
- ***Pore Spaces*** between mineral particles.
  Poros o espacios – entre partículas minerales.
- ***Organic matter –*** decomposing plants, animal matter and droppings.
  Materia orgánica– plantas en descomposición, materia animal, y heces fecales.
- ***Small organisms*** – worms and insects and microorganisms, such as bacteria and fungi.
  Organismos pequeños – gusanos, insectos, y organismos microscópicos tales como hongos y bacterias.

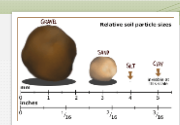
Soil: It's a Mix
Suelo: Es una mezcla

The three minerals that comprise soil are:
El suelo está compuesto de tres minerales:

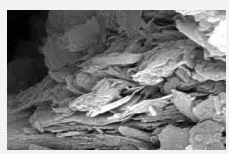
- Sand
  Arena
- Silt
  Limo
- Clay
  Arcilla



More On Minerals
Más acerca de los minerales



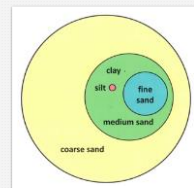
- These minerals are classified by size.
  Estos minerales están clasificados por tamaño.
- You can see…
  Puedes ver…
  - Sand with your eye or magnifying glass
    Arena, visible a simple vista o con una lupa
  - Silt with microscopes.
    Limo con microscopio
  - Clay with electron microscopes.
    Arcilla con microscopio de electrones



Clay particles are flat like paper.
Las partículas de arcilla son planas como el papel!

How soil feels to the touch tells us what it is!
¡Sabemos qué hay en el suelo por cómo se siente!

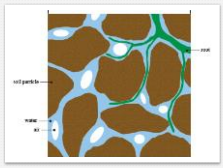
- The minerals in a soil affects how it feels to the touch. This is called its ***soil texture***.
  Los minerales en el suelo afectan cómo se siente al tocarlo, a esto se le llama ***textura del suelo***.
  - The particles feel differently, because of their different sizes and structures.
    Las partículas se sienten diferentes debido a su tamaño y estructura.
  - We can tell the general composition of soil from its texture.
    Podemos inducir la composición general del suelo através de su estructura.



How would you expect sand to feel in comparison to clay?
Cómo esperarías que se sienta la arena en comparación con la arcilla?

Pore Space – where lots of action takes place
Poros – donde occure mucha acción

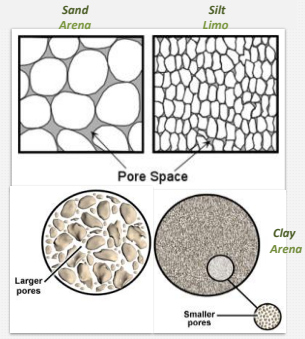
- The spaces between individual soil particles are called pore spaces.
  Los espacios entre partículas de suelo se llaman poros
- Pore spaces house water, oxygen, and microorganisms.
  Los poros albergan agua, oxígeno y microorganismos.
- Plant roots grow into and make pore spaces.
  Las raíces de las plantas crecen dentro y crean poros.



Pore Space
Poros

Different types of minerals have different sized pore spaces.
Diferentes minerales producen tamaños de poros diferentes.

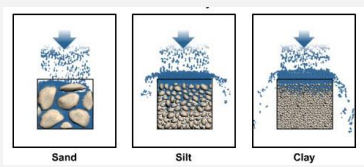
- Which type of mineral has the largest pore spaces?
  ¿Qué tipo de mineral produce los poros más grandes?
- How about the smallest?
  ¿Cuál produce los más pequeños?



Porosity and Permeability – related, but different
Infiltración y Porosidad – relacionados pero diferentes

Porosity – Soil scientists define porosity as the *volume* of pores for a given amount of soil.
Porosidad – Los científicos de suelo definen la porosidad cómo el *volumen* de poros en una determinada cantidad de suelo.

- Which mineral is most porous (has the greatest volume of pores for the same amount)?
  ¿Cuál material es más poroso? (Tiene más cantidad de poros por cantidad de suelo)?
- But which is most permeable? (Which will rain pass through the fastest?
  ¿Cuál material es más permeable? (Por cuál material el agua se infiltrará en el suelo más rápido?)

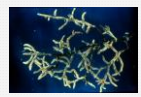


Healthy Soil Supports Many Diverse Lifeforms
Un Suelo saludable alberga una gran diversidad de organismos

Micro-organisms:
Microorganismos:


Bacteria
Bacteria


Nematodes
Nematodos


Fungus roots
Hongos de raíz (micorrizas)

Organisms visible to the eye:
Organisms visibles al ojo:


Tiny to large insects & spiders
Insectos & arañas grandes o pequeños


Earth worms
Lombrices de tierra


Tiny springtails
Brincacolas pequeñitos

https://www.nrcs.usda.gov/wps/portal/nrcs/photogallery/soils/health/biology/gallery/?cid=nrcs88&position=Promo

Review
Repaso

1. What different factors cause pore spaces in soil?
   ¿Qué diferentes factores causan espacios de poros en el suelo?
2. Which would retain water the best – a sandy soil or a clayey soil?
   ¿Cuál suelo retendrá mejor el agua: un suelo arenoso o un suelo arcilloso?
3. What types of organisms do you think you might find in your school soil?
   ¿Qué tipo de organismos crees que encontrarías en el patio de tu escuela?

Application Question To Think About
Pregunta de Aplicación para Pensar

Rain gardens are meant to catch large amounts of storm water and then let it slowly seep into the soil over one to two days.
Los jardines de lluvia están diseñados para atrapar grandes cantidades de lluvia y permitir que se infiltre en el suelo lentamente en el periodo de un día o dos.

- **Which mix of soils would work best in a rain garden? And why?**
  ¿Qué mezcla de suelo funcionaría mejor en un jardín de lluvia y porqué?

Investigations and Activities
Actividades de Investigación

Collect soil samples from the schoolground:
Colecciona muestra de suelo en tu escuela:

- Soil Components Texture Investigation
  Investigación de Componentes y Textura del suelo
- Soils Percolation Investigation
  Investigación de Percolación del Suelo
- Send to lab to have analyzed and/or use soil chemistry kits to learn pH and other chemical. characteristics.
  Envíalas muestras a un laboratorio para ser analizadas y/o usa un kit de muestras químicas de suelo para investigar el pH y otras características químicas

Resources for Teachers
Recursos para Maestros

- Flow diagram for Texture by Feel. Commonly used in the field. Provided by the USDA Natural Conservation Resources Service. (Click here for a high-resolution version of the graphic.)
  Esquema de Textura por Tácto. Usado comunmenteen el campo. Ha sido provisto por "USDA Natural Conservation Resources Service". (Haga aquí para una versión de alta resolución.)
- Soil Science Society of America provides an excellent bank of soils lessons for multiple grades covering texture, biology, chemistry, forensics, and more. http://www.soils4teachers.org/lessons-and-activities#General9
  Asociación Americana de Ciencia de Suelo: provee un excelente banco de lecciones acerca del suelo para múltiples grados que cubren tópicos cómo: textura, biología, química, ciencias forenses, y más. http://www.soils4teachers.org/lessons-and-activities#General9
- Basic Hydrologic Science Course Runoff Processes Section Four: Soil Properties. In depth explanations with public domain graphics. http://wegc203116.uni-graz.at/meted/hydro/basic/Runoff/print_version/04-soilproperties.htm?vm=r#12
  Ciencia Hidrológica Básica, Procesos de escorrentía, Sección Cuatro: Propiedades del suelo. Explicaciones a fondo con gráficas de dominio público. http://wegc203116.uni-graz.at/meted/hydro/basic/Runoff/print_version/04-soilproperties.htm?vm=r#12
- Soil Biology Primer, Natural Resources Conservation Service, USDA.
  https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/biology/
  Introducción a la Biología de Suelos, Servicio de Conservación de Recursos Naturales, USDA.
  https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/biology/

Definitions for teachers
Definiciones para maestros

Source (unless otherwise noted): Soil Health and Glossary, National Resources Conservation Service
Fuente (a menos que se indique lo contrario): Glosario de Salud del Suelo, Servicio Nacional de Conservación de Recursos:
https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/?cid=nrcs142p2_053848

- **Actinomycetes**: A large group of bacteria that grow in long filaments that are too small to see without magnification. Actinomycetes generate the smell of "healthy soil," and are important in decomposing cellulose, chitin, and other hard-to-decompose compounds, especially at higher pH levels. Many produce antibiotics.
  Actinobacteria/Actinomicetos: Un grupo grande de bacterias que crece en forma de filamentos largos y son muy pequeñas para verse a simple vista. Los actinomicetos generan el olor a "tierra saludable", y son importantes descomponedores de celulosa, quitina, y otros compuestos difíciles de descomponer especialmente en ambientes con pH alto. Muchos producen antibióticos.
- **Arthropods**: Invertebrate animals with jointed legs. They include insects, crustaceans, sowbugs, springtails, arachnids (spiders), and others.
  Artrópodos: Animales invertebrados de patas articuladas. Este grupo incluye los crustáceos, insectos, arácnidos (arañas), cochinillas, brinca colas, entre otros..
- **Bacteria**: Microscopic, single-celled organisms. They include the photosynthetic cyanobacteria (formerly called blue-green algae), and actinomycetes (filamentous bacteria that give healthy soil its characteristic smell).
  Bacterias: Organismos microscópicos unicelulares. El grupo incluye a las cianobacterias fotosintéticas (antes llamadas algas azul-verdosas), y los actinomicetos (bacterias filamentosas que le dan a la tierra su olor característico).
- **Fungi**: Multi-celled, non-photosynthetic organisms that are neither plants nor animals. Fungal cells form long chains called hyphae and may form fruiting bodies such as mold or mushrooms to disperse spores. Some fungi such as yeast are single-celled.
  Hongos: Organismos no-fotosintéticos (pueden ser unicelulares como las levaduras, o multicelulares como las setas) que no son ni plantas ni animales. Los hongos multicelulares poseen células que crecen en largas cadenas llamadas hifas, y muchos producen cuerpos fructíferos como los mohos y las setas, para dispersar esporas.
- **Mineral:** A mineral is an element or chemical compound that is normally crystalline and that has been formed as a result of geological processes" (Source: Nickel, E. H., **1995**). "Minerals are naturally-occurring inorganic substances with a definite and predictable chemical composition and physical properties." (Source: O' Donoghue,**1990**).
  Minerales: Un elemento o químico que es normalmente cristalino y ha sido formado como resultado de procesos geológicos. (Fuente: Nickel, E. H., **1995**). "Los minerales son sustancias inorgánicas que ocurren naturalmente que poseen una composición química definida y propiedades físicas predecibles." (Fuente: O' Donoghue,**1990**).

Definitions for teachers
Definiciones para maestros

Source (unless otherwise noted): Soil Health and Glossary, National Resources Conservation Service
Fuente (a menos que se indique lo contrario): Glosario de Salud del Suelo, Servicio Nacional de Conservación de Recursos:
https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/?cid=nrcs142p2_053848

- **Mycorrhizal associations:** A symbiotic association of certain fungi with roots. The fungi receive energy and nutrients from the plant. The plant receives improved access to water and some nutrients. Except for brassicas (mustard, broccoli, canola) and chenopods (beets, lamb's-quarters, chard, spinach), most plants form mycorrhizal associations.
  Asociaciones micorrizas: Una asociación simbiótica de ciertos hongos con las raíces de las plantas. Los hongos reciben energía y nutrientes de la planta. La planta recibe acceso a más agua y nutrientes a través del hongo. A excepción de las brasicáceas (mostaza, brócoli, canola) y las ruderales (remolacha, espinaca, aceiga), todas las plantas forman asociaciones micorrizas.
- **Organic matter:** any material that is part of or originated from living organisms. Includes soil organic matter, plant residue, mulch, compost, and other materials.
  Materia orgánica: cualquier material que es parte de o originado por organismos. Incluye materia orgánica en el suelo, residuo de plantas, mantillo, composta, y otros materiales.
- **Permeability:** the qualitative estimate of the ease with which fluids, gases, or plant roots pass through soil.
  Permeabilidad: El estimado cualitativo de la facilidad con la cual fluidos, gases, o raíces pueden pasar por el suelo.
- **Porosity:** the volume of pores in a soil sample divided by the bulk volume of the sample.
  Porosidad: El volumen de los poros en una muestra de suelo, dividido por el volumen total de la muestra.
- **Silt:** a granular material of a size between sand and clay, whose **mineral** origin is quartz and feldspar. Silt may occur as a soil (often mixed with sand or clay) or as sediment mixed in suspension with water (also known as a suspended load) in a body of water such as a river. (source: Wikipedia)
  Limo: material granular el cual su tamaño se encuentra entre arena y arcilla, y su origen mineral es el cuarzo y el feldespato. El cieno ocurre en forma de suelo (a menudo mezclado con arena y arcilla), o sedimento mezclado en suspensión con agua (también conocido como sedimento suspendido) en cuerpos de agua, como los ríos (Fuente: Wikipedia)

Background

This short investigation introduces soil science and is meant to follow the 10-minute Score 4 presentation, "It's Not Just Dirt." The lesson is geared towards the information needed when planning a garden, conservation landscape, or rain garden.

Students will define properties of the three types of mineral particles in soils: sand, silt, and clay. These minerals differ in size and composition. Sand has the largest particles; silt has much smaller ones; clay particles are so small they must be seen with a powerful electron microscope. Soils have different *textures* according to the proportions of sand, silt, or clay particles in the soil.

Students will determine the textural characteristics of sand, clay, and silt (sample answers on page 2; directions on the student activity page).

Students will discover that:

- Sand has a gritty feel and will not adhere together as a ball when squeezed.
- Silt (if available) feels smooth, like powder.
- Moist clay sticks together, is malleable, and does not feel silky smooth or gritty.

The students will use this information to determine whether soil samples from the school grounds are sand, clay, silt, or a mixture of the minerals.

Standards:
MD State Curriculum: 2.0 Earth/Space Science
Next Generation Science Standards: 5-ESS3-1, MS-ESS3-3, HS-ESS3-2, HS-ESS3-3, HS-ESS3-4.

Skills Exercised: Observation, data collection, critical thinking – making inferences from data

Grades: 3-12. Teachers should demonstrate the procedure beforehand. Grades 6-12 can do the procedure in teams. Soil activities that are more complex can be used with higher grades as a follow-on activity. See Resources.

Lab Time: 20 minutes

Materials:

1 tablespoon of each soil sample per student or team (enough to fill a student's palm):

- ___ Sand (can be purchased)
- ___ Silt (can be purchased or obtained by allowing it to settle — see soil experiment in a jar.)
- ___ Clay (can be purchased at craft stores)
- ___ School soil from the top 1-4 inches of soil
- ___ Spray bottle of water or dropper
- ___ Paper towels
- ___ Containers for each soil sample

Answers to Texture Test Chart

Using your soil sample, answer the following questions. Put the answer in the column for your sample.	Sand	Clay	Silt	School Soil
a. Can you form a ball?	*Yes*	*Yes*	*No*	*Yes*
b. Does it stay a ball when squeezed?	*No*	*Yes*	*No*	*Yes*
c. Can you form a ball and then roll the ball into a snake?	*No*	*Yes*	*No*	*Yes*
d. Can you form a ring with the snake shape?	*No*	*Yes*	*No*	*No*
e. Does your sample feel gritty?	*Yes*	*No*	*No*	*Yes*
f. Does your sample feel like flour or powder?	*No*	*No*	*Yes*	*No*
g. Does your sample feel neither gritty nor smooth?	*No*	*No*	*No*	*No*
h. What color is the sample?	*Beige*	*Gray*	*Gray*	*Reddish brown*

The school soil above could be characterized as sandy clay. Other investigations, such as the flow diagram (see resources) could make a more definitive determination.

Resources:

- Flow diagram for Texture by Feel. This simple sediment diagnostic is commonly used in the field. This version is provided by the USDA Natural Conservation Resources Service. (Click here for a high-resolution version of the graphic.)
- Soil Science Society of America provides an excellent bank of soils lessons for multiple grades covering texture, biology, chemistry, forensics, and more. http://www.soils4teachers.org/lessons-and-activities#General9 . See their Texture Lesson.

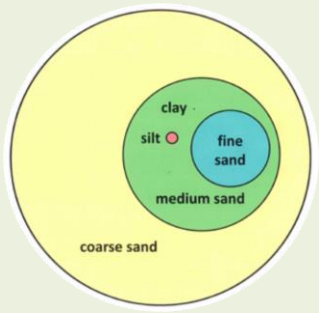
Credit: The lab was derived from Holding onto the Green Zone, A Joint Project of the Bureau of Land Management, the University of Wisconsin-Extension, and the USDA Cooperative State Research, Education, and Extension Service. This publication is part of the Creek Freaks program of the Izaak Walton League of America Creek Freaks.

Background
Información previa

Soil is more complex than most people realize. Healthy soil consists of the following elements:
El suelo es más complejo de lo que la mayoría de las personas piensan. Un suelo sano se compone de los siguientes elementos:

- Mineral particles — sand, silt, or clay
  Partículas minerales: arena, limo o arcilla.
- Organic matter — decomposing plants, animal matter and droppings
  Materia orgánica: plantas en descomposición, materia animal y excremento.
- Small organisms — worms and insects and microorganisms, such as bacteria and fungi
  Organismos pequeños: gusanos e insectos y microorganismos, como bacterias y hongos.
- The space between mineral particles (pore space).
  El espacio entre las partículas minerales (espacio poroso).

Mineral Particles
Particulas minerales



If a particle of clay were as big as the dot in this graphic, the silt and sand would be as large as depicted.

Si una partícula de arcilla fuera tan grande como el punto en este gráfico, el limo y la arena serían tan grandes como se representan.

This investigation explores the *three types of mineral particles in soils: sand, silt, and clay*. These minerals differ in size and composition. Sand has the largest particles; silt has much smaller ones; clay particles are so small they must be seen with a powerful electron microscope.
Esta investigación explora los tres tipos de partículas minerales en los suelos: arena, limo y arcilla. Estos minerales difieren en tamaño y composición. La arena tiene las partículas más grandes; las del limo son mucho más pequeñas; las partículas de arcilla son tan pequeñas que se deben mirar con un microscopio electrónico potente.

Soils have different *textures* according to the proportions of sand, silt, or clay particles in the soil. In the following activity, you will determine the textural characteristics of sand, clay, silt. From the information you gather, you will estimate the mineral composition of a soil sample from your school grounds.
Los suelos tienen distintas *texturas* según las proporciones de partículas de arena, limo o arcilla del suelo. En la siguiente actividad, determinarás las características de textura de la arena, la arcilla y el limo. A partir de la información que recabes, estimarás la composición mineral de una muestra de suelo de tu predio escolar.

Soil Texture Investigation
Investigación de texturas de suelos

Materials
Materiales

- Samples of sand, clay, silt, and school soil
  Muestras de arena, arcilla y suelo del predio escolar
- Spray bottle of water or dropper
  Botella de agua con atomizador o cuentagotas
- 3 spoons
  3 cucharas

Procedure
Procedimiento

Each person in your team can do each of the following steps. One person should record the answers.
Cada persona de tu equipo puede seguir cada uno de los pasos a continuación. Una persona debería registrar las respuestas.

1. Put 3 teaspoons of your first soil sample, sand, into your palm.
   Pon 3 cucharadas de té de tu primera muestra de suelo, arena, en la palma de la mano.
2. Moisten the soil sample with the spray bottle or dropper. Your sample should be moist, not wet. Knead it to break up lumps. It is the proper consistency when it is moldable, like moist putty. If it is too wet, add more sand. If it is too dry, add more water.
   Humedece la muestra de suelo con el atomizador o el cuentagotas. Tu muestra debería quedar húmeda, no mojada. Amásala para deshacer los grumos. La consistencia adecuada se alcanza cuando la muestra queda moldeable, como masilla húmeda. Si está demasiado mojada, añade más arena. Si está demasiado seca, añade más agua.
3. Use this sample to answer the questions in **Texture Test Chart**. Write your answers in the appropriate column.
   Utiliza esta muestra para contestar las preguntas en el **cuadro de prueba de texturas**. Escribe tus respuestas en la columna adecuada.
4. Put 3 teaspoons of clay in your palm. Follow steps 2-3 with the clay sample.
   Pon 3 cucharaditas de arcilla en la palma de tu mano. Sigue los pasos 2 y 3 con la muestra de arcilla.
5. Repeat the procedure with 3 teaspoons of silt and then with your school soil sample.
   Repite el procedimiento con 3 cucharaditas de limo y luego con la muestra de suelo del predio escolar.
6. After all the samples have been tested, answer the **Discussion Questions**.
   Luego de haber hecho las pruebas con todas las muestras, responde las **preguntas para comentar**.

Texture Test Chart
Cuadro de prueba de texturas

Using your soil sample, answer the following questions. Answer yes or no in the column for your sample. Basándote en tu muestra de suelo, responde las siguientes preguntas. Contesta "sí" o "no" en la columna correspondiente a tu muestra.	**Sand** **Arena**	**Clay** **Arcilla**	**Silt** **Limo**	**School Soil** **Suelo del predio escolar**
a. Can you form a ball? ¿Puedes formar una pelota?				
b. Does it stay a ball when squeezed? ¿La forma de la pelota se mantiene al apretarla?				
c. Can you form a ball and then roll the ball into a snake? ¿Puedes formar una pelota y luego hacerla rodar hasta darle la forma de una serpiente?				
d. Can you form a ring with the snake shape? ¿Puedes formar un anillo con la forma de serpiente?				
e. Does your sample feel gritty? ¿Tu muestra es grumosa?				
f. Does your sample feel like flour or powder? ¿Tu muestra es como harina o polvo?				
g. Does your sample feel sticky? ¿Tu muestra es pegajosa?				
h. What color is the sample? ¿De qué color es la muestra?				

Discussion Questions
Preguntas para comentar

1. From the Background paragraph and your Texture Test results, describe two characteristics of sand.
   Teniendo en cuenta el párrafo de información previa y los resultados de tu prueba de texturas, describe dos características de la arena.

2. From the Background paragraph and your Texture Test results, describe two characteristics of moist clay.
   Teniendo en cuenta el párrafo de información previa y los resultados de tu prueba de texturas, describe dos características de la arcilla húmeda.

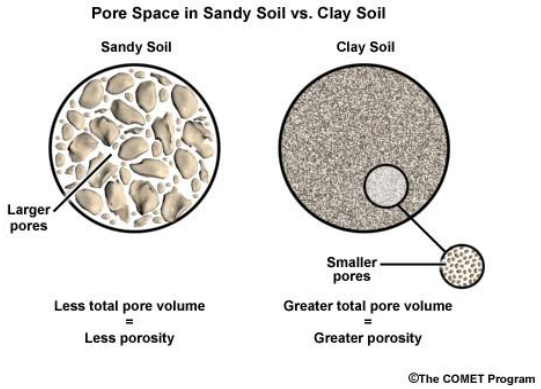
3. How was the school soil sample similar or different than the sand and silt characteristics?
   ¿En qué se asemejaba o diferenciaba la muestra de suelo del predio escolar de las características de la arena o el limo?

4. Using the information you gathered, how would you classify the school soil—as sand, silt, clay, silty clay, sandy clay, or loam? (*Loam* is about equal portions of sand and silt with a little bit of clay.)
   Empleando la información que recabaste, ¿cómo clasificarías el suelo del predio escolar: como arenoso, limoso, arcilloso, arcilloso limoso, arcilloso arenoso o franco? (El suelo *franco* contiene aproximadamente las mismas proporciones de arena y limo con un poquito de arcilla.)

Soils Percolation — Teacher

Background

In this investigation, students further explore soil properties, particularly the relationship between particle size and percolation. They also are introduced to the word, *loam*. This investigation provides valuable information if your class is planning a natural stormwater solution, particularly a rain garden. It will help students understand why an area with clay soil drains poorly and would be inappropriate for a rain garden unless the soil is replaced. Understanding how and why different soils have different water-retention or percolation properties can also help students grasp the importance of using native plants that are suited for specific soils and drainage conditions.



Standards:
Next Generation Science Standards: MS-ESS3-3, HS-ESS3-2, HS-ESS3-3, HS-ESS3-4.

Skills Exercised: the scientific method; data collection; math (averaging, determining rates); critical thinking (drawing conclusions from data); teamwork; communication skills; experiment set-up.

Grades: 9-12; can be adjusted by teachers for lower grades and different skill levels.

Time: 60-90 minutes, if each team does 3 samples, the experiments, follow-up group summarization and clean-up.

Teacher Instructions

This investigation is designed to be done by teams of 4-5 students and to include a class follow-up period for sharing and discussing the results. Teachers should review the *Student Soils Percolation* handout, which includes:

- The Lab Procedure
- Percolation Test Chart that guides predictions and observations
- Class Data Table
- Post-Lab Discussion Questions

Depending upon the time available, the teacher will decide whether each team will do one or all of the soil samples, and whether they will prepare the lab materials or just do the procedure. *(Instructions on lab setup are provided on a separate page,* so that it can be done by the students, if desired.) It is important that students understand that consistency in their methods is important and that each soil be tested by three teams or 3 times by each team for more reliable results.

It is recommended that teachers perform this lab ahead of time and make any necessary adjustments for their student populations.

Before the Lab, the teacher assigns teams and reviews the student instructions with the students. Each team will have "jobs" (Reader, Timer, Measurer, Pourer, Data Recorder). Demonstrating the lab to is effective. Students might need help in positioning the clay so that it does not leak on the bottle edges.

Students should complete the Pre-Lab predictions by answering the **A** lettered questions in the shaded areas of the **Percolation Test Chart**. As the students perform the experiment, they will complete the **B-** lettered questions.

After the experiment, the class completes a **Class Data Table**. The students average their results and determine the rate of percolation (ml/sec). If there are outliers in their data, they should discuss possible reasons. The completed table provides the basis for answering the **Post-Lab Discussion Questions in the student worksheet**, which can be done as a class, in teams, or individually.

Materials for Entire Class:

- Empty clear 2-liter soda bottles cut as described (one bottle per soil sample)
- Soil samples: dry sand, moist clay, dried loam, dried school soil
    - The clay needs to be moist to be handled; if teachers want the soil samples to be the same (having less variables), moist samples can be used.
    - The results will differ if lumpy loam or school soil is used, because there are usually larger pores between aggregates. For this inquiry, it is best to break up the lumps.
    - Students could compare these variables within one soil sample, as a further investigation.
- Small mesh window screen
- Containers to hold dry and wet soil samples, one for each soil type
- Containers or baggies to hold used soil samples, one for each soil type
- Timers (1 per group)
- Measuring cups or beakers (1 per group)
- Water (500 mL per test)

Materials for each team of 4-5 students:

- Water
- 1 Timer
- 1 Measuring cup or beaker
- 1 clear 2-liter bottle top for *each* soil sample
- 1 clear 2-liter bottle bottom or similar container for *each* soil sample
- 1 piece of window screen for *each* soil sample
- Soil samples: sand, clay, school soil, and loam or silt, if available.
- Container for bottle tops holding wet soil

Clean Up:

1. Put used water in a bucket and dump outside, not in the sink.
2. Collect the used soil samples in specified containers, one for each soil type. They can be left out to dry and be reused. Mold will grow, if they are stored wet. The clay needs to be sealed in air-tight containers or bags after excess water has been removed.

Additional Resources:

Grades 10-12: ***Water Movement in Soil***, USDA Natural Resources Conservation Service. Best seen after the presentation and investigation. Provides more detail on soil texture, water movement factors, land-use connections; graphics demonstrate water movement. https://www.youtube.com/watch?v=vmo0FRAVgkM&feature=youtu.be

Lab Preparation:

1. Empty, rinse, and remove labels from bottles.
2. Cut the window screen into 5x5 inch circles (**Figure 1**).
3. Cut the 2-liter bottles approximately 6 inches from the bottom of the container (**Figure 2**).
4. The top of the bottle will be inverted into the bottom of the bottle. The window screen will be placed into the top of the bottle, covering the opening. *Note: the window screen needs to be placed tightly so that the soil will not fall through.* (**Figure 3**).

Figure 1

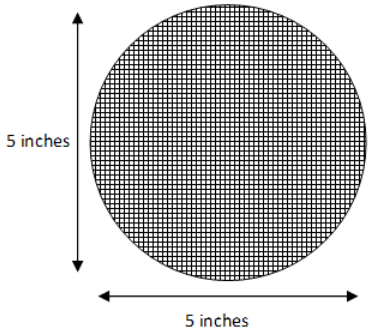
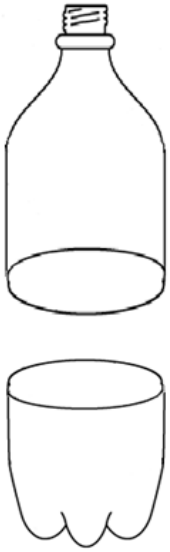


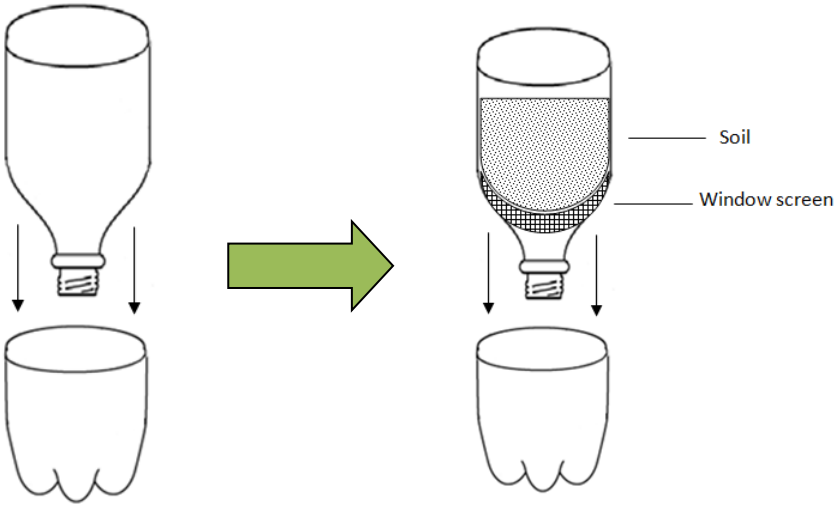
Figure 2



Unlike this drawing the bottom part will be larger than the top.

6 inches

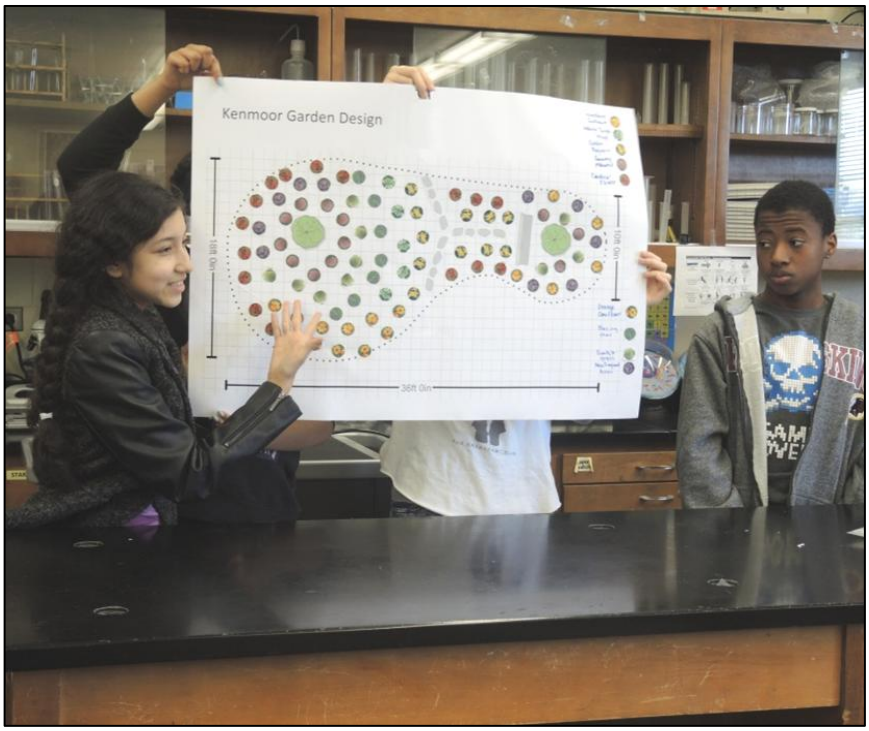
Figure 3



Planning Your Project

Lobelia cardinalis,
Cardinal Flower

Asclepias incarnata,
Swamp Milkweed



The activities and lessons in this section will lead you and your class through the planning of your project. Student lessons and worksheets correspond to each of the following steps.

Project Goals

While the primary goal of your project will be to reduce stormwater runoff, your Stormwater Action Project can also serve other goals for humans, animals, and the environment. The goals that you and your class select will help to shape your project.

Site Selection

The location of your stormwater project is a key consideration. Use the findings from the previous investigations and lessons to compare the potential sites for your project.

Sun/Shade Observation

It is important to select plants that are adapted to the amount of sunlight that reaches the site you and your class have selected. This activity will help your class determine whether the site is a full sun, partial shade, or full shade light condition.

Site Characteristics and Preferences

This activity summarizes the findings from previous investigations into one table for easy reference when you and your class begin to research and select plants.

Plant Selection

Refer to the completed Site Characteristics and Preferences table as you research and select plants. You will need to select plants that meet the site requirements.

Recommended Materials:

- U.S. Fish & Wildlife Service *Native Plants for Wildlife Habitat and Conservation Landscaping for the Chesapeake Bay Watershed* booklet
- List of available plants from local native plant nurseries

Garden Design

A garden design shows the shape of your garden and the placement of plants, trees, and shrubs. The design is usually done on a grid, so that you can plan the garden dimensions and pick the right number of plants.

Recommended Materials:

- Easel sized graph paper (25” x 30”)
- Small graph paper (11x17)
- Colored Pencils
- Compasses

Updated 10/2017

Conservation Landscapes and Garden Goals
Paisajes de Conservación y Metas para Jardines

Score Four: Students, Schools, Streams, and the Bay
Score Four: Estudiantes, Escuelas, Arroyos y la Bahía

Rebecca Wolf and Nguyen Le
Interstate Commission on the Potomac River Basin
Comisión Interestatal para la Cuenca del Río Potomac

What is a Conservation Landscape?
¿Qué es un Paisaje de Conservación?

A garden or landscape that uses materials and methods to:
Es un jardín o paisaje que utiliza materiales y métodos diseñados para:

- Benefit the local environment.
  Beneficiar el ambiente local.
- Provide pleasure and beauty for humans.
  Proveer bienestar y belleza para los seres humanos.

Conservation Garden Elements
Elementos de un Jardín de Conservación

Native Plants
Plantas autóctonas

Definition:
A native plant is any plant that historically grew in the region.

Definición:
Una plantas autóctona es aquella que históricamente hablando ha crecido en la región.

Conservation Garden Elements
Elementos de un Jardín de Conservación

Benefits of native plants:
Beneficios de las plantas autóctonas:

- Need less (or no) fertilizer.
  Necesitan poco (o ningún) fertilizante.
- Need less (or no) pesticides.
  Necesitan poco (o ningún) pesticida.
- Have much deeper roots than turf grasses, increasing soil porosity.
  Tienen raíces mucho más profundas, que aumentan la porosidad del suelo.
- Provide habitat for native insects, birds, and other wildlife.
  Proveen hábitat para insectos nativos , pájaros, y vida silvestre.

Conservation Garden Elements
Elementos de un Jardín de Conservación

Mulch
Mantillo

Definition:
A layer of shredded bark, grass clippings, leaves, hay, newspaper, or cardboard placed over the soil.

Definición:
Una capa de pedazos de corteza, grama, hojas, papel periódico, o cartón que se coloca sobre el suelo.

Mulch reduces the need for watering in this garden.
El mantillo reduce la necesidad de riego en este jardín.

Conservation Garden Elements
Elementos de un Jardín de Conservación

Benefits of mulch:
Beneficios del mantillo:

- Maintains moisture in the soil.
  Mantiene la humedad del suelo.
- Maintains soil temperature.
  Mantiene la temperatura del suelo
- Reduces erosion by covering bare soil.
  Reduce la erosión cubriendo el suelo desnudo.
- Absorbs stormwater runoff.
  Absorbe la escorrentía pluvial.
- Adds nutrients and organic matter to soil as it decomposes.
  Añade nutrientes y material orgánico al suelo mientras se descompone
- Directs foot traffic.
  Ayuda a dirigir el tráfico peatonal
- Can enhance visual appeal.
  Es más atractivo visualmente
- Reduces weeds.
  Reduce las plantas no deseadas.

Download this PowerPoint on our website.
www.potomacriver.org/scorefour

Conservation Garden Elements
Elementos de un Jardín de Conservación

Compost
Composta

Definition:
Decomposed organic material, such as leaves, plants, fruit and vegetable scraps, and animal manure mixed into garden soil.

Definición:
Material orgánico descompuesto, tales como: hojas, plantas, frutas, restos vegetales, y desperdicios de animales mezclados con el suelo de jardín.

Conservation Garden Elements
Elementos de un Jardín de Conservación

Benefits of compost:
Beneficios de la composta:

- Adds nutrients and beneficial microbes to the soil.
  Añade nutrientes y microorganismos beneficiosos al suelo.
- Organic matter & microbes cause soil to form lumps (aggregates), increasing its porosity.
  La materia orgánica y los microorganismos causan que el suelo se coagule (forme agregados) lo que incrementa su porosidad.
- Organic matter holds water in the soil.
  La materia orgánica retiene agua en el suelo.

Do's & Don'ts of Conservation Landscapes
Que Hacer o No-Hacer en Jardines de Conservación

DO replace turf grass with a planned landscape that uses native trees, shrubs, and plants.
Reemplaza la grama con un paisaje planeado que utilice árboles nativos, arbustos, y plantas.

DO remove invasive species from the area.
Remueve plantas invasivas del área.

DO pick plants that suit your site and your project goals.
Elije plantas apropiadas para tu área y tus metas de proyecto.

DO NOT use commercial fertilizers or pesticides.
NO Utilices fertilizantes comerciales o pesticidas.

Ferns thrive in this shady backyard.
Los helechos prosperan en áreas de sombra.

Conservation Garden Benefits Summary
Resúmen de los Beneficios de un Jardín de Conservación

- Helps control erosion and other runoff problems.
  Ayudan a controlar la erosión y otros problemas de escorrentía.
- Conserves water.
  Conserva agua.
- Removes pollutants from stormwater runoff.
  Remueven contaminantes de la escorrentía pluvial.
- Promotes healthy soils
  Promueve suelos saludable.
- Provides habitat for wildlife.
  Provee hábitats para la vida silvestre.
- Reduces air pollution.
  Reduce la contaminación de aire.
- Is managed to conserve energy, reduce waste, and eliminate or minimize the use of pesticides and fertilizers.
  Se maneja para conservar energía, reducir desperdicios, y eliminar o reducir el uso de pesticidas y fertilizantes.

Part 2: Choosing Your Garden Goals
Parte 2: Escojiendo las Metas de tu Jardín

The **goals you choose** for your conservation landscape (or a different Stormwater Action Project) will influence its location, your plant choices, and other aspects of your project.

Las **metas que tu elijas** para tu paisaje de conservación (o proyecto de Manejo de Escorrentía Pluvial) influenciará su localización, las plantas que escojas, y demás aspectos de tu proyecto.

Your Number 1 Goal: Reduce Stormwater Runoff
Tu Meta Principal: Reducir la escorrentía pluvial

Gardens to reduce the sediments and other pollutants in the Chesapeake Bay!
Los jardines reducen los sedimentos y contaminantes que llegan a la bahia del Chesapeake.

Other Possible Goals
Otras Metas Posibles

A pollinator garden.
Un jardín para polinizadores.

Attract bees and other pollinators with pesticide-free flowering plants.
Atraer abejas y otros polinizadores a plantas libres de pesticidas

Other Possible Goals
Otras Metas Posibles

A butterfly garden.
Un jardín para mariposas.

Provide host plants needed by specific species to reproduce and survive.
Provee plantas huéspedes necesarias para especies de mariposas durante su reproducción y supervivencia.

Other Possible Goals
Otras Metas Posibles

A bird "sanctuary".
Un santuario para aves.

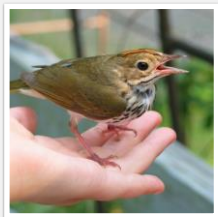
Attract many species with a variety of short and tall plants and shrubs that provide food, nesting sites, and protection.

Atraen muchas especies usando variedad de plantas altas y bajas, además de arbustos que proveen alimento, espacio de anidaje, y protección.

Other Possible Goals
Otras Metas Posibles

Plan to **support many types of wildlife** by using plants that attract insects that in turn attract ...
Aumentar la biodiversidad usando plantas que atraen insectos para a su vez atraer...

- Birds
  Aves
- Reptiles
  Reptiles
- Amphibians
  Anfibios
- Mammals
  Mamíferos



What about water features for frogs and birds?
¿Qué tal si incluímos agua para ranas y pájaros?

Other Possible Goals
Otras Metas Posibles

Grow people food.
Cultivar comida para humanos.

Other Possible Goals
Otras Metas Posibles

Start an outdoor classroom.
Comenzar un un aula al aire libre.

Team and Class Discussions
Equipos y Discusiones de Clase

- Are there other goals you want for your project?
  ¿Existen otras metas que les gustaría establecer para su proyecto?
- Which of the goals did you like the best and why?
  ¿Cuales metas les gustaron más y porqué?
- Before deciding on your project goals, discuss:
  Antes de decidir cuales son sus metas, discutan:
  - Can our goals be achieved in the site(s) we have selected?
    ¿Se pueden lograr los objetivos en el área destinada?
  - Will these goals need to be accomplished in stages?
    ¿Se necesita satisfaces las metas en etapas?
  - What resources are needed to achieve these goals? Do we have them?
    ¿Qué recursos son necesarios para este proyecto? ¿Tenemos los recursos?
  - How can the project be maintained?
    ¿Cómo manejaremos el mantenimiento?
  - Are there other factors that need to be considered?
    ¿Existen otros factores que necesitemos considerar?

Team and Class Discussions
Equipos y Discusiones de Clase

If the answers to these questions are:
Si las respuestas son:

- "**Yes**" → start the planning process.

  "**Si**" → Comienza la planificación.

- "**No**" → your class needs to rethink your goals and possibly consider a different type of Stormwater Action Project.

  "**No**" → Tu clase necesita evaluar de nuevo tus metas y escoger otro proyecto de Manejo de Escorrentía Pluvial.

Goals
Objetivos

Project goals need to be set at the beginning of any project. Your Student Stormwater Action Project is no different. While the *primary goal will be to reduce stormwater runoff*, your Stormwater Action Project also can serve other goals for humans, animals, and the environment. Below are other possible goals for your conservation landscape or garden.

Los objetivos se deben establecer al principio de cualquier proyecto. Con tu proyecto estudiantil de medidas respecto a las aguas pluviales pasa lo mismo. Aunque el *objetivo principal será reducir la escorrentía pluvial*, tu proyecto también puede ser útil para otros objetivos en favor de los seres humanos, los animales y el medioambiente. A continuación, se encuentran otros objetivos posibles para la conservación del terreno o el jardín:

- Provide pollen for butterflies, birds, and insects.
  Suministrar polen a las mariposas, aves e insectos.
- Provide habitat and food for wildlife.
  Proporcionar un hábitat y alimento a la vida silvestre.
- Create an outdoor classroom or sitting area.
  Crear una clase al aire libre o una zona para sentarse.
- Provide food for humans.
  Proporcionar alimento a los seres humanos.
- Provide a beautiful space for students and teachers to enjoy.
  Ofrecer un lindo espacio para que los estudiantes y los docentes disfruten.
- Provide places for the scientific observation of plant growth, soil changes, pollination, etc.
  Ofrecer lugares para la observación científica del crecimiento de las plantas, los cambios de suelo, la polinización, etc.
- Reduce carbon dioxide air pollution.
  Reducir la contaminación del aire producto del dióxido de carbono.
- Provide education on stormwater reduction (through signage).
  Educar sobre la disminución de aguas pluviales (mediante la señalización).

Envision your school project. What goals do want to set for your project?
Visualiza tu proyecto escolar. ¿Qué objetivos quieres establecer para tu proyecto?

Picking the Best Location
Elección de la mejor ubicación

The location of your stormwater project is a key consideration. For instance, a Conservation Garden might reduce stormwater runoff on two different sites, but one of those locations might not be visible to students. If your goals include student usage or public educational value, the site with little visibility would be a poor choice.
La ubicación de tu proyecto de agua pluvial es un elemento fundamental que hay que considerar. Por ejemplo, una zona verde de conservación puede reducir la escorrentía de agua pluvial en dos sitios diferentes, pero uno de estos lugares podría no ser visible para los estudiantes. Si tus objetivos incluyen el uso por parte de los estudiantes o el valor educativo para el público en general, un sitio con poca visibilidad sería una mala elección.

Use the findings from your investigations and goal-setting session to answer the following questions. The answers can guide your classes' decision-making process. Feel free to add other characteristics to this decision-making-table.
Utiliza los hallazgos de tus investigaciones y de la sesión de definición de objetivos para contestar las siguientes preguntas. Las respuestas pueden guiar el proceso de toma de decisiones de tu clase. Siéntete en libertad de añadir otras características a esta tabla de toma de decisiones.

Use the chart below to help your class select a site for your project.
Utiliza el cuadro a continuación para ayudar a tu clase a seleccionar un sitio para tu proyecto.

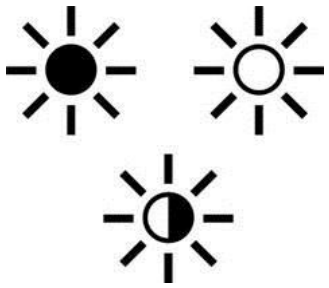
Questions to Consider **Preguntas que hay que considerar**	**Site A** **Sitio A**	**Site B** **Sitio B**	**Site C** **Sitio C**	**Comments** **Comentarios**
Would a project on this site reduce stormwater runoff? ¿Un proyecto en este sitio reduciría la escorrentía pluvial?				
Would this site support any wildlife-related goals? ¿Este sitio es compatible con los objetivos relacionados con la vida silvestre?				
Is it important that the project be visible to students and the public? ¿Es importante que el proyecto sea visible para los estudiantes y el público en general?				
• Does the area have high visibility? ¿La zona es de alta visibilidad?				

Is it important that students can get to the site easily? ¿Es importante que los estudiantes puedan acceder al sitio con facilidad? • If so, can they? Si lo es, ¿pueden hacerlo?				
Can the site be watered and maintained easily? ¿El sitio se puede regar y mantener con facilidad?				
Is there ever standing water on the site? ¿Hay agua estancada en el sitio?				
Does the site present particular challenges? If so, note them. (Challenges could include steep slope, deep clay, and invasive plants.) ¿El sitio presenta problemas específicos? En caso afirmativo, anótalos. (Los problemas pueden incluir pendientes pronunciadas, arcilla profunda y plantas invasoras.)				
Does the amount of sunlight on the site support your project goals? (This question might require plant research.) ¿La cantidad de luz solar en el sitio es adecuada para los objetivos de tu proyecto? (Esta pregunta podría exigir una investigación de plantas.)				

Sun/Shade Observation
Observación del sol y la sombra

Student
Estudiante

Background
Información previa



Whether you are planting a garden, trees, or a meadow, it is important to select plants adapted to the amount of sunlight that reaches your site.

Ya sea que estés plantando un jardín, árboles o una pradera, es importante que selecciones plantas que se adapten a la cantidad de luz solar que reciba tu sitio.

Different plants have adapted to grow under different lighting conditions. Some require *Full Sun* (at least 6 hours of light) during the growing season for optimal growth. Some do best in *Partial Shade* (3 to 6 hours of direct sunlight). Others grow well in *Shade* (less than 3 hours of direct sunlight or filtered light.)

Las distintas plantas se han adaptado para crecer bajo diferentes condiciones de iluminación. Algunas necesitan *plena exposición al sol* (por lo menos seis horas de luz) durante la temporada de crecimiento para que este sea óptimo. A otras les va mejor con *sombra parcial* (tres a seis horas de luz solar directa). Otras crecen bien a la *sombra* (menos de tres horas de luz solar directa o luz filtrada).

Does your potential site(s) receive sun all day or just for part of the day? You will perform the following two exercises to determine the amount of light that will reach your site during the growing season.

¿Tu posible sitio recibe sol todo el día o solo durante una parte? Harás los dos ejercicios a continuación para determinar la cantidad de luz que llegará a tu sitio durante la temporada de crecimiento.

PART 1. Sun-Shade Estimate
PARTE 1. Estimación de sol y sombra

It helps to understand the angle of sunlight that will fall upon your site during the growing season. Although the sun rises in the east and sets in the west, the positions of the sunrises and sunsets change during the course of a year.

Resulta útil entender el ángulo en que llegará la luz solar a tu sitio durante la temporada de crecimiento. A pesar de que el sol nace en el este y se oculta en el oeste, las posiciones de los amaneceres y atardeceres cambia durante el transcurso del año.

1. From what compass direction does the sun rise in late March? Northeast, East, or Southeast?
   ¿En qué dirección de la brújula nace el sol a fines de marzo: noreste, este o sureste?

   _____

2. From what compass direction does the sun rise in late June? Northeast, East, or Southeast?
   ¿En qué dirección de la brújula nace el sol a fines de junio: noreste, este o sureste?

   _____

3. Where does it set in July?
   ¿Dónde se oculta en julio?

   _____

4. Identify North on your school property. Considering the position of the sun's path during the summer, do you think your planting site will receive:
   Identifica el norte en tu predio escolar. Considera el recorrido del sol durante el verano. ¿Crees que tu sitio de plantación recibirá:

   a) Morning sun?
      luz matutina? _____

   b) Afternoon sun?
      luz vespertina? _____

   c) Morning shade?
      sombra matutina? _____

   d) Afternoon shade?
      sombra vespertina? _____

PART 2. Sun-Shade Observation
PARTE 2. Observación del sol y la sombra

Pick two times in the morning and at least two times in the afternoon to observe the light conditions on your site(s). For instance, make morning observations at 9:00 and 11:00 a.m. and afternoon observations at 1:00 and 4:00 p.m. Do your observations on a sunny day, and record them on the following chart. (This chart can be used for up to two locations.)
Elige dos momentos en la mañana y por lo menos dos momentos en la tarde para observar las condiciones de iluminación en tu sitio o sitios. Por ejemplo, haz observaciones matutinas a las 9:00 y las 11:00 a. m. y observaciones vespertinas a la 1:00 y las 4:00 p. m. Haz tus observaciones un día soleado y anótalas en la tabla a continuación. (Esta tabla se puede usar hasta en dos ubicaciones.)

Date **Fecha**	**Location 1** **Ubicación 1**		**Location 2** **Ubicación 2**	
Time of observation **Hora de observación**	**Note "sun" or "shade"** **Anota "sol" o "sombra"**	**Note "shade" if this area will be shaded by trees or buildings during summer.** **Anota "sombra" si esta zona está sombreada con árboles o edificios durante el verano.**	**Note "sun" or "shade"** **Anota "sol" o "sombra"**	**Note "shade" if this area will be shaded by trees or buildings during summer.** **Anota "sombra" si esta zona está sombreada con árboles o edificios durante el verano.**

1. From your observations, how many hours of sunlight do you estimate your site will receive each day from May through August?
   A partir de tus observaciones, ¿cuántas horas de luz estimas que recibirá tu sitio cada día de mayo a agosto?

2. Would some areas of your garden receive less light than others, due to shade from structures?
   ¿Algunas áreas de tu jardín recibirán menos luz que otras debido a la sombra de las estructuras?

3. Based on Exercise 1 and your observations, would you classify this site as Full Sun, Partial Shade, or Shade? Why?
   En función del ejercicio 1 y tus observaciones, ¿cómo clasificarías este sitio: como de pleno sol, sombra parcial o sombra? ¿Por qué?

4. Extra Credit Research Question: What are two native plants that would do well with this lighting?
   Pregunta de investigación con crédito adicional: ¿qué dos plantas autóctonas se adaptarían bien con esta iluminación?

Directions
Instrucciones

Different species of plants and trees have evolved to grow best under different soil, light, and moisture conditions. The best way to pick native plants that will thrive in your garden is to identify ones that fit your site conditions. It is important that the plants also fulfill your project goals. The tables in this exercise will help you and your classmates select the best plants, trees, or shrubs for your Student Stormwater Action Project.
Distintas especies de plantas y árboles han evolucionado para crecer mejor en distintas condiciones de suelo, luz y humedad. La mejor forma de elegir plantas autóctonas que crezcan en tu jardín es identificar aquellas que se adaptan a las condiciones de tu sitio. Es importante que las plantas también cumplan con los objetivos de tu proyecto. Las tablas de este ejercicio te ayudarán a ti y a tus compañeros de clase a seleccionar las mejores plantas, árboles o arbustos para tu proyecto estudiantil de medidas respecto a las aguas pluviales.

Use findings from previous investigations to complete the table below. Circle the conditions that fit your site. Include additional notes, such as whether the site gets morning or afternoon sunlight.
Utiliza los hallazgos de las investigaciones anteriores para completar la siguiente tabla. Encierra en un círculo las condiciones que se adaptan a tu sitio. Incluye notas adicionales, tales como si el sitio recibe luz solar en la mañana o en la tarde.

SITE CONDITIONS **CONDICIONES DEL SITIO**		**NOTES** **NOTAS**
Hardiness Zone (Standard that determines which plants are most likely to thrive at a location, based on winter temperature.) **Zona de tolerancia climática** (estándar que determina qué plantas tienen mayor posibilidad de crecer en un lugar en función de las temperaturas de invierno)	1 2 3 4 5 6 7 8 9 10 11 12	
Soil What kind of soil does the site have? **Suelo** ¿Qué tipo de suelo tiene el sitio?	Sand / Arena Loam / Franco Clay / Arcilla	
What is the pH? ¿Qué es el pH?		

Light How much light does the site get? **Luz** ¿Cuánta luz recibe el sitio?	○ Full Sun Totalmente soleado	◗ Part Shade Parcialmente sombreado	● Full Shade Totalmente sombreado	
Moisture Is the site dry, moist, or wet, for most of the time? **Humedad** ¿El sitio está seco, húmedo o mojado la mayor del tiempo?	Dry Seco	Moist Húmedo	Wet Mojado	

Summarize:
Resumen:

List the conditions for which your plants or trees must be suited (for example, Zone 7a, clay, pH 7.5, part shade, wet in the spring, dry in the fall).
Detalla las condiciones a las que deben adaptarse tus plantas o árboles (por ejemplo: zona 7a, arcilla, pH 7,5, parcialmente sombreado, mojado en primavera, seco en otoño).

In the following table, circle the characteristics you want your garden project to have. Your class decided upon some of these preferences earlier, but other characteristics relate specifically to plant selection. If you select many preferences, consider rating the choices in the notes section.
En la siguiente tabla, encierra en un círculo las características que quieres que tenga tu proyecto de jardín. Tu clase ya decidió acerca de algunas de estas preferencias, pero otras características se relacionan específicamente con la selección de plantas.

PREFERED PROJECT CHARACTERISTICS **CARACTERÍSTICAS PREFERIDAS DEL PROYECTO**		**NOTES** **NOTAS**
Maintenance Can your class support plants that need high maintenance, such as frequent watering or pruning? **Mantenimiento** ¿Tu clase está en condiciones de encargarse de plantas que necesitan mucho mantenimiento, como riego o poda frecuente?	Low / Bajo Medium / Medio High / Alto	
Bloom Time When would you prefer for plants to flower? **Época de floración** ¿Cuándo preferirías que florecieran las plantas?	March / Marzo April – May / Abril – mayo May – June / Mayo - junio July / Julio August - September / Agosto - septiembre	
Wildlife Habitat Circle the wildlife you want to attract, if any. **Hábitat de la fauna silvestre** Encierra en un círculo la fauna silvestre que quieres atraer, si corresponde.	Butterflies / Mariposas Insects / Insectos Birds / Aves Small Mammals / Mamiferos pequeños	
Edible Fruits & Nuts **Frutas y nueces comestibles**	Important / Importante Semi-important / Importancia media Not important / Sin importancia	

Fall Color This could be colorful leaves or grasses or branches of shrubs. **Color de otoño** Podrían ser hojas o plantas herbáceas coloridas o ramas de arbustos.	Important Importante Semi-important Importancia media Not important Sin importancia	
Winter Color This could include grasses or evergreens. **Color de invierno** Podrían ser plantas herbáceas o árboles de hoja perenne.	Important Importante Semi-important Importancia media Not important Sin importancia	

Summarize:
Resumen:

Discuss which ones characteristics are most important; then list the characteristics in order of importance.
Comenta qué características son más importantes; luego, anótalas en orden de importancia.

Planning Color for the Seasons
Planificación de color para las estaciones

Student
Estudiante

When choosing plants for your site, consider plants, shrubs, and trees that provide blooms or other colorful features, such as berries or leaves, at different times of the year — especially when school is in session. This chart is an easy way to plan for year-round color and interest.
An example of a completed chart is pictured below. Fill in your own chart on the back.

Al elegir plantas para tu sitio, ten en cuenta plantas, arbustos y árboles que tengan floración u otras características coloridas, como frutos del bosque u hojas, en distintos momentos del año, sobre todo en época de clases. Este cuadro es una forma sencilla de planificar para que haya colores e interés todo el año. A continuación se detalla un ejemplo de un cuadro completado. Completa tu propio cuadro al dorso.

Seasonal Plant Palette for Quiet Waters Planting

Latin Name	Interest	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ceanothus *americanus*	Bloom												
	Berry												
	Leaf or Bark												
Chionanthis *virginicus*	Bloom												
	Berry												
	Leaf or Bark												
Clethra *alnifolia* 'Compacta' or 'Hummingbird	Bloom												
	Berry												
	Leaf or Bark												
Comptonia *peregrina*	Bloom												
	Berry												
	Leaf or Bark												
Gaylussacia *baccata*	Bloom												
	Berry												
	Leaf or Bark												
Gaylussacia *frondosa*	Bloom												
	Berry												
	Leaf or Bark												
Ilex *glabra* 'Nordic'	Bloom												
	Berry												
	Leaf or Bark												
Itea *virginica* 'Henry's Garnet	Bloom												
	Berry												
	Leaf or Bark												

Garden palette provided by Carole Barth, Prince George's County Department of the Environment.

Planning Color for the Seasons — Student
Planificación de color para las estaciones — Estudiante

Plant Name Nombre de la planta	Plant Type Tipo de planta	Interest Interés	JAN Enero	FEB Feb	MAR Marzo	APR Abr	MAY Mayo	JUN Jun	JUL Jul	AUG Agosto	SEP Sep	OCT Oct	NOV Nov	DEC Dic
		Bloom Floración												
		Berry Fruto												
		Leaf, Bark Hoja, corteza												
		Bloom												
		Berry												
		Leaf, Bark												
		Bloom												
		Berry												
		Leaf, Bark												
		Bloom												
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		Leaf, Bark												
		Bloom												
		Berry												
		Leaf, Bark												

Maintaining Your Project

Score Four: Students, Schools, Streams, and the Bay

Maintenance of Your Stormwater Action Project

Mantenimiento de tu proyecto de medidas respecto a las aguas pluviales

All gardens and tree plantings need maintenance. When done regularly, maintenance can be fun. It is a chance to be outside, to notice the changes in your plants, to see your first flowers blossom, and to watch the butterflies and birds that come to the garden.
Todos los jardines y plantaciones de árboles necesitan mantenimiento. Si se hace de forma regular, puede ser divertido. Es una oportunidad de estar al aire libre, observar los cambios en tus plantas y ver florecer tus primeras flores y las mariposas y los pájaros que vienen al jardín.

When projects are not maintained, the plants and trees die, weeds take over, and your site loses the capacity to reduce stormwater.
Cuando los proyectos no se mantienen, las plantas y los árboles mueren, la maleza avanza y tu sitio pierde la capacidad de reducir el agua pluvial.

We hope you will take pride in caring for your Stormwater Action Project, so that it will provide benefits to the environment and students for years to come. The following information and the maintenance chart describe the maintenance needed. It is important that involved teachers and students or student clubs ensure that such maintenance will be done.
Esperamos que te enorgullezcas de cuidar tu proyecto de medidas respecto a las aguas pluviales para que este beneficie al medioambiente y a los estudiantes en los años venideros. La información y el cuadro a continuación describen el mantenimiento necesario. Es importante que los docentes y los estudiantes o los clubes de estudiantes se aseguren de que se realice dicho mantenimiento.

Summer is an especially critical time for your plants and trees. We hope that students will take the lead in arranging summer volunteer schedules or reach out to the community and watershed organizations for assistance.
El verano es un momento particularmente especial para tus plantas y árboles. Esperamos que los estudiantes tomen la iniciativa de organizar cronogramas con voluntarios de verano o recurran a la comunidad y las organizaciones de la cuenca para obtener ayuda.

Watering is Essential – Spring through Fall

El riego es fundamental: desde la primavera hasta el otoño

Plants
Plantas

- *Hand water*, using a container or hose, around base of each plant for 1-2 minutes. Allow the water to soak into the ground, and take care not to wash away the mulch or soil.
  Riega a mano, con una manguera o un recipiente, alrededor de la base de cada planta durante uno o dos minutos. Deja que el suelo absorba el agua y procura no lavar el mantillo o el suelo.

- Here is a guideline for watering.
  A continuación, encontrarás una guía de riego.
  - First 2 Weeks: water 3 times per week
    Primeras dos semanas: riega tres veces por semana.
  - Second 2 weeks: water 2 times per week

Observe your plants regularly, especially in the first months after planting. If the soil is dry, water. If the plants are drooping, water! If the ground is soaking, don't water!

Observa tus plantas con regularidad, sobre todo en los primeros meses después de plantar. Si el suelo está seco, riégalas. Si las plantas languidecen, ¡riégalas! Si el suelo está empapado, ¡no riegues!

Siguientes dos semanas: riega dos veces por semana.

- Next 6 weeks: water 1 time per week
  Siguientes seis semanas: riega una vez por semana.
- When it rains one or more inches a week, watering may be unnecessary. Typically, watering is not needed from Nov. 30 – April 15, unless there is an extended warm dry spell in late winter or early spring.
  Si llueve una pulgada o más por semana, puede ser que no sea necesario regar. Por lo general, no es preciso regar entre el 30 de noviembre y el 15 de abril, a menos que a finales del invierno o principios de la primavera se dé un período de sequía.

Trees
Árboles

- Trees that have been in the ground less than 3 years require 25 gallons of water, or about 1.5 inches of rainfall, per week.
  Los árboles que han estado plantados por menos de tres años necesitan 25 galones de agua, o alrededor de 1,5 pulgadas de lluvia, por semana.

- Track rainfall totals from the weather reports or with a rain gauge. If less than 1.5 inches of rain falls in a week, it's time to water. Casey Tree Foundation will send your class a free rain gauge, if you take the 25 to Stay Alive Pledge on their website.
  Haz un seguimiento de las precipitaciones totales usando los informes del estado del tiempo o un pluviómetro. Si las precipitaciones son inferiores a 1,5 pulgadas en una semana, es hora de regar. La fundación Casey Trees enviará un pluviómetro gratis a tu clase si te comprometes con la promesa de 25 galones para que sobrevivan los árboles en su sitio web.

Mulching – Spring and Fall
Cobertura con mantillo: primavera y otoño

Mulching is when we put a layer of shredded bark around plants and trees. Mulch acts like the fallen leaves in a forest: it reduces weed growth, keeps the moisture in soil from evaporating, regulates soil temperature, and adds organic matter to the soil.
Cubrir con mantillo es cuando ponemos una capa de astillas de corteza alrededor de las plantas y los árboles. El mantillo actúa como las hojas caídas en un bosque: disminuye el crecimiento de maleza, evita la evaporación y de esa manera mantiene la humedad del suelo, regula su temperatura y le añade materia orgánica.

Mulch slows down weeds, but it doesn't stop all of them.
Get the best of weeds, by pulling them regularly, and making sure you get their roots.

El mantillo merma la proliferación de la maleza, pero no la detiene por completo. Derrota la maleza asegurándote de arrancarla de raíz de forma periódica.

The mulch in your garden will decompose over time (enriching your soil as it does). This means that new mulch needs to be added. *At the beginning of the school year and at the end of winter make sure that:*
El mantillo en tu jardín se descompondrá con el tiempo (y enriquecerá tu suelo en el proceso). Esto significa que es necesario añadir mantillo nuevo. *Al inicio del año escolar y al final del invierno, asegúrate de que:*

- Your site has a minimum of 3 inches of mulch.
  Tu sitio tenga por lo menos tres pulgadas de mantillo.

- That the surface of the mulch hasn't hardened. If this has occurred, rake away the old mulch and apply a fresh layer.
  La superficie del mantillo no se haya endurecido. Si ocurre esto, rastrilla el mantillo y aplica una capa nueva.

Mulch Dos and Don'ts
Qué hacer y qué no con el mantilla

- Mulch should be placed in a donut shape around trees *at least 3 inches away from tree trunks or shrubs*.
  El mantillo se debe colocar en forma de rosquilla alrededor de los árboles *a una distancia de por lo menos tres pulgadas de los troncos de los árboles o arbustos*.

- Use natural mulch with no dye.
  Utiliza mantillo natural sin teñir.

- Shredded hardwood mulch is preferred, but composted wood chips, or grass clippings can be used.
  Se recomienda usar el mantillo de corteza de madera dura, pero también se pueden usar virutas de madera o pasto cortado.

- Adding compost under the mulch will benefit your soil and plants.
  Añadir compost bajo el mantillo beneficiará tu suelo y las plantas.

Weeding – Spring, Summer, and Fall
Desmalezar: primavera, verano y otoño

Smaller weeds are easier to pull than big ones, so don't let them grow! Many weeds and invasive plants reproduce from their roots (rhizomes), as well as seeds. Therefore, it is important to dig out the roots (with a hoe, hand trowel, or other tool) and to remove weeds before they produce seeds. At the minimum, weed every 2 to 3 weeks.
Las malezas más pequeñas son más fáciles de arrancar que las grandes, de modo que ¡no las dejes crecer! Muchas malezas y plantas invasoras se reproducen a partir de las raíces, así como de las semillas. Por lo tanto, es importante desenterrar las raíces (con una azada, palita de jardín u otra herramienta) y retirar las malezas antes de que produzcan semillas. Como mínimo, desmaleza cada dos o tres semanas.

Other Fall or Spring Maintenance
Otro mantenimiento de otoño o primavera

Spreading Plants: The magic of gardens is that perennials will spread. Every 3 to 5 years, fast growing flowers, such as Obedient Plant, may need to be divided, or reduced in size by removing some of the plants with their roots. Signs of overcrowding include reduced flowering and weak, spindly stems. Extra plants represent opportunities for sharing, garden expansion, or a new garden!
Plantas que se propagan: la magia de los jardines es que las plantas perennes proliferan. Cada tres a cinco años, las flores de crecimiento rápido, tales como la planta obediente, se pueden dividir o reducir de tamaño quitando algunas de las plantas con sus raíces. Los signos de superpoblación incluyen una disminución de la floración y tallos débiles y larguiruchos. Las plantas adicionales representan una oportunidad para compartir, ampliar el jardín ¡o comenzar un jardín nuevo!

Fertilizer: Because your site has been planted with appropriate native plants and is mulched regularly, fertilizer is not needed.
Fertilizante: debido a que tu sitio ha sido plantado con plantas autóctonas adecuadas y a que ha sido cubierto con mantillo de forma regular, no se necesita fertilizante.

Dead stems and seed heads: Leaving stems and seeds in gardens throughout the winter provides food and shelter for birds and wildlife. In the late winter or early spring, old stems can be cut to about 3- 4 inches and dried grasses to about 6 inches. Old leaf litter and stems can replenish your compost pile.
C*abezas de semillas y tallos muertos*: dejar los tallos y las semillas en los jardines durante el invierno proporciona comida y refugio a las aves y la vida silvestre. Al final del invierno o a principios de la primavera, se pueden cortar los tallos viejos para que midan tres o cuatro pulgadas y los pastos secos para que midan alrededor de seis pulgadas. La hojarasca y los tallos viejos pueden rellenar tu pila de compost.

Tree and Shrub Pruning: Pruning can be done to shape shrubs or a trees. It is unlikely that pruning will be needed in the first few years. Minor pruning will not adversely affect trees and shrubs at any time of the year. Major pruning should be done in late winter to early spring.
Poda de árboles y arbustos: la poda se puede hacer para dar forma a los árboles y los arbustos. Es poco probable que sea necesario podar en los primeros años. La poda menor no perjudicará los árboles y los arbustos en ningún momento del año. La poda principal se debe hacer al final del invierno y principios de la primavera.

A handy maintenance schedule is on the following page. Your class should make its own schedule and assign people to specific jobs. If you need more volunteers, consider advertising your project to get student or parent volunteers.
En la página siguiente se encuentra un cronograma de mantenimiento. Tu clase debe hacer su propio cronograma y asignar personas a trabajos específicos. Si necesitas más voluntarios, considera promocionar tu proyecto para conseguir estudiantes o padres voluntarios.

Chart for Planning Maintenance of Conservation Landscapes & Bay-Wise Gardens Cuadro para planificar el mantenimiento y la conservación del paisaje y jardines eficientes para la bahía												
Task **Tarea**	**Month** **Mes**											
	January Enero	February Febrero	March Marzo	April Abril	May Mayo	June Junio	July Julio	August Agosto	September Septiembre	October Octubre	November Noviembre	December Diciembre
Monitoring[1] Seguimiento[1]			■	■	■	■	■	■	■	■	■	
Apply mulch[2] Aplicar mantillo[2]				■	■	■	■	■	■	■	■	
Cut back perennials and grasses[3] Cortar plantas perennes y pastos[3]		■	■	■								
Watering[4] Riego[4]				■	■	■	■	■	■	■	■	
Weeding as needed[5] Desmalezado según sea necesario[5]				■	■	■	■	■	■	■	■	
Replace, thin, and add plants as needed[6] Reemplazar, reducir y añadir plantas según sea necesario[6]				■	■	■	■	■	■	■		
Snow management[7] Manejo de la nieve[7]	■	■	■								■	■

(Adapted from the District of the Department of the Environment Rain Garden and BayScape Maintenance Schedule)

1. Check for weeds and depth of mulch. Remove trash or other debris from garden.
   Verifica si hay malezas y la profundidad del mantillo. Retira residuos u otros restos del jardín.

2. Apply shredded cedar or hardwood mulch in April and November to maintain a depth of 3 inches.
   Aplica mantillo de cedro o de corteza de madera dura en abril y noviembre para mantener una profundidad de tres pulgadas.

3. Cut back perennials (not shrubs or trees) to about 4 inches.
   Corta las plantas perennes (salvo arbustos o árboles) para que midan aproximadamente cuatro pulgadas.

4. Water to an equivalent of 1" per week until established. Once established (about a year), water from May to October when there has been no rain for 10 days or more.
   Riega un equivalente a 1" por semana hasta que se asiente. Una vez que se asiente (en aproximadamente un año), riega de mayo a octubre cuando no haya llovido por diez días o más.

5. Clean up winter weeds in late February/early March and then weed every two to four weeks, as necessary, from April to November.
   Limpia las malezas de invierno a finales de febrero o principios de marzo y luego desmaleza cada dos a cuatro semanas, según sea necesario, de abril a noviembre.

6. Replace dead plants and thin plants if needed from June to October. The optimum times for adding or moving plants are April through May and September through October.
   Si es necesario, reemplaza las plantas muertas y las plantas débiles de junio a octubre. El mejor momento para añadir o mover plantas es de abril a mayo y de septiembre a octubre.

7. Avoid placing snow on top or in close proximity to garden. Limit deicing salt within close proximity of garden.
   Evita poner nieve sobre el jardín o en sus cercanías. Limita las sales para deshielo en las proximidades del jardín.

Resources

Funding Sources

Listed below are just a few examples of many funding sources available. Many counties and large municipalities in the Chesapeake Bay Watershed offer rebates or other incentives to encourage homeowners, religious organizations, and businesses to adopt stormwater Best Management Practices on these properties. Look for the counties' or cities' environmental or land-use departments for this information.

- Local civic clubs and businesses
- Garden centers and local garden clubs
- Chesapeake Bay Trust offers multiple grant opportunities throughout the year. (http://www.cbtrust.org/grants)
- The Home Depot Foundation Community Impact Grants (http://corporate.homedepot.com/grants/community-impact-grants)
- Lowe's Charitable and Educational Foundation (Many teachers have success with their local stores) (http://lowes.com/community)
- MD Department of Natural Resources, Marylanders Plant Trees provides $25-off tree coupons, vendor lists, and other information. (http://dnr2.maryland.gov/forests/Pages/MarylandersPlantTrees/Introduction.aspx)
- Prince George's County Department of the Environment's Arbor Day Every Day and Clean-Up Green-Up programs provide free trees for schools to plant and maintain.
  (http://www.princegeorgescountymd.gov/515/Arbor-Day-Every-Day)
  (http://www.princegeorgescountymd.gov/2590/Clean-Up-Green-Up)
- RainScapes for Schools, Montgomery County Department of Environmental Protection provides funding for rain gardens, conservation landscapes, and canopy trees on Montgomery County school properties. They also offer a High School Plant Growing Program. Their applications provide easy instructions. (https://www.montgomerycountymd.gov/water/rainscapes/schools.html)

Stormwater Solutions – Conservation Landscaping, Rain Gardens, Trees…

Conservation Landscaping or Bay-Wise Gardening

- University of Maryland Extension:
  - Bay-Wise Gardening provides publications and ample information on Bay-Wise Gardening. (http://extension.umd.edu/anne-arundel-county/master-gardeners/bay-wise-gardening)
  - List of Master Gardeners who can provide advice or assistance for your project (https://www.extension.umd.edu/baywise/program-certification)
- Montgomery County Department of Environmental Protection, Conservation Landscaping includes simple explanation and resource links. (http://www.montgomerycountymd.gov/DEP/water/conservation-landscaping.html)
- City of Rockville, MD provides a comprehensive list of resources for rain gardens and conservation gardens. (http://www.rockvillemd.gov/index.aspx?NID=831)

Rain garden Lessons and Guides

- *Rain Garden Curricular Sampler*, Earth Partnership for Schools, University of Wisconsin-Madison Arboretum, provide a series of campus assessments and other cross-curricular inquiries, leading

to the development of a rain garden. (https://arboretum.wisc.edu/content/uploads /2015/04/RGS-Full-Rain-Garden-Sampler-2011.pdf)

- Guidelines for Rain Garden, Prince George's County, MD, provides easy sizing calculations, etc. (http://www.princegeorgescountymd.gov/DocumentCenter/View/180)
- Rain Garden Templates from the Low Impact Development Center make designing your garden much easier! (http://lowimpactdevelopment.org/rain-garden-templates-for-maryland/
- The NEMO Rain Garden Website, University of Connecticut and NOAHH, gives short step-by-step how-to videos. Their free Rain Garden app for phones also provides a series of how-to videos and plant selections for your state. (http://nemo.uconn.edu/raingardens/index.htm)
- *Rain Garden Design and Construction A Northern Virginia Homeowner's Guide* (http://www.fairfaxcounty.gov/nvswcd/raingardenbk.pdf)
- *Rain Garden Manual for Schools A How-To Manual For Fayette County Public Schools* (www.sustainability.fcps.net/media/641050/rain%20garden%20manual%20for%20schools.pdf)
- *Rainscaping with Rain Gardens…Working with Nature to Transform Stormwater Runoff into Garden Oases* (http://www.chesapeakeecologycenter.org/wp-content/uploads/2016/05/RainScaping-with-Rain-Gardens.pdf)

School Yard Habitat and Outdoor Classrooms

- Schoolyard Habitat Guide, U.S. Fish & Wildlife Service: although not geared towards storm-water solutions, this site provides a downloadable 132-page guide for creating habitat areas, with **good tips on the planning, maintenance, and community engagement**. (https://www.fws.gov/cno/pdf/HabitatGuideColor.pdf)
- Schoolyard-Habitats How-to-Guide, National Wildlife Federation: this site includes a downloadable guide for creating habitat areas. The assessment and planning portions may provide you with ideas. (http://www.nwf.org/Garden-For-Wildlife/Create/Schoolyards/Resources.aspx)

Native Plant Research and Sources

Selecting the Right Native for Your Site:

- Native Plants for Wildlife Habitat and Conservation Landscaping Chesapeake Bay Watershed Guide, U.S. Fish & Wildlife Service. We at ICPRB use this as our number 1 resource in picking the right native plant for the right spot. (http://www.nativeplantcenter.net/wp-content/uploads/2016/05/chesapeakenatives.pdf or http://www.nativeplantcenter.net/)
- Lady Bird Johnson Wildflower Center provides good supplemental information and pictures. (http://www.wildflower.org/plants/)
- Missouri Botanical Garden Plant Finder provides great supplemental information and pictures. (http://www.missouribotanicalgarden.org/plantfinder/plantfindersearch.aspx)

Native Plant Nurseries and Sales

- Maryland Native Plant Society
  - Native Plant Sales (http://mdflora.org/plantsales.html)
  - Native Plant Nurseries (http://mdflora.org/publications/nurseries.html)
- Chesapeake Natives, Upper Marlboro, Md., takes orders (http://chesapeakenatives.org/)
- Environmental Concern, St Michaels, Md. (http://www.wetland.org/)

- Pennsylvania Native Plant Society provides sources in Pennsylvania, as well as national suppliers. (http://www.panativeplantsociety.org/native-plant-sources-in-pennsylvania.html)
- Virginia Native Plant Society provides a downloadable list of Virginian native plant nurseries. (http://vnps.org/conservation/plant-nurseries/)
- West Virginia Native Plant list provided by the West Virginia Department of Natural Resources. (http://www.wvdnr.gov/Wildlife/NativeVegetation.shtm)

Maps for Watershed Inquiries

- Maryland Land Use Maps (http://mdpgis.mdp.state.md.us/landuse/imap/index.html)
- U.S. Topographic Maps (http://nationalmap.gov/ustopo)
- Maryland Department of Natural Resources Stream Health Map (http://geodata.md.gov/streamhealth/)
- National Geographic FieldScope:
    - Chesapeake Bay Watershed Project (http://chesapeake.fieldscope.org/)
    - Maryland FieldScope (http://maryland.fieldscope.org/)

Soil Lessons and Labs

- **Soil Health** USDA Natural Resources Conservation Service (NRCS): Soil Health, Soil Biology (with incredible photos of microscopic bacteria, fungi, and other soil microorganisms, that can be used with permission), and other resources, including Educator Lessons & Experiments.
    - Gallery of Soil Microorganisms (http://www.nrcs.usda.gov/wps/portal/nrcs/photogallery/soils/health/biology/gallery/?cid=1788&position=Promo)
    - NRCS Soil Education Lesson Plans by Grade Levels (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/7thru12/?cid=nrcs142p2_054303)
    - On-Line Soil Biology Primer (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/biology/)
- **Soil Testing in Maryland**: University of Maryland Extension provides detailed fact sheets on most aspects of gardening. Their soil information follows.
    - Reasons for soil testing and good video showing method for soil collection. For soil chemistry readings for students, see the FAQs and fact sheets about fertilizers and lead in soil. (http://extension.umd.edu/hgic/soils/soil-testing)
    - List of Soil Testing Laboratories with instructions (http://extension.umd.edu/sites/default/files/_docs/programs/hgic/HGIC_Pubs/HG110_HG110a_Selecting%20and%20Using%20a%20Soil%20Test%20Lab.9_2015.pdf)
- **Soil Testing in West Virginia:** West Virginia Extension Service, West Virginia University: soil sampling instructions, video, and laboratory (http://anr.ext.wvu.edu/soil/taking_a_good_soil_sample)
    - West Virginia University Soil Testing free soil sampling for WV residents (http://soiltesting.wvu.edu/)
- **Soil Testing in Virginia**: Virginia Tech Soil Testing Laboratory. Also see links to local Cooperative Extension Office on this site. (http://www.soiltest.vt.edu/)