DRAFT VERSION OF THIS LESSON:
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The Contents of Runoff and How it Affects Our Local Water Resources

High School

1) **Goals and objectives:** Students will conduct research and examine data to draw conclusions on runoff and pollution. Students will be able to describe the impact of runoff to water sources in general and in their local communities, and research ways we can prevent dangerous runoff from polluting our necessary water resources.

2) **NGSS Standards:**

   HS.ESS3.4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]

Background Information for Teachers: With more frequent severe storms, water runoff and flooding are an increasingly important aspect of infrastructure planning. With that said all urban and suburban areas use impermeable surfaces and materials so the water cannot properly drain and it picks up toxic chemicals from these surfaces. This purification could be protected by the marshlands that were once part of the ecosystem but they were replaced with a water treatment plant that does the same job but, less effectively. Destroying natural resources to replace them with more infrastructure is counterintuitive and dangerous. The pollutants and plastics we use so frequently are slowly chipping away at the quality of our drinking water. Students should be made aware of the reasons that these chemicals can end up in drinking water and why even trace amounts are dangerous. But it is also important to touch on new purification methods that can attack these bad actors.

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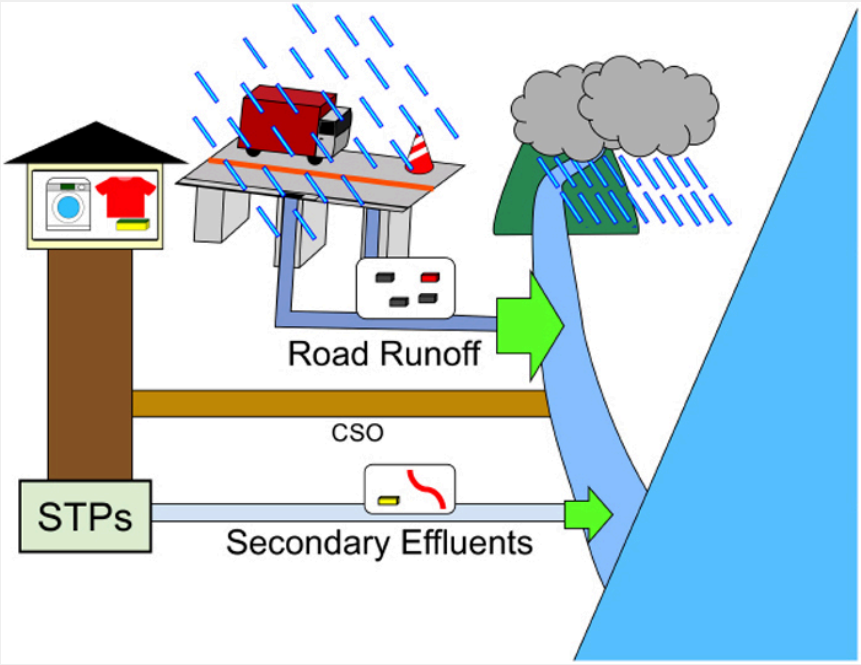

Chemical compounds found in bodies of water and runoff:

- Lake chemical compounds: calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), bicarbonate (HCO3), sulfate (SO4), and chloride (Cl)
- Ocean chemical compounds: chloride (Cl^-), sodium (Na^+), sulfate (SO^{2-}_4), magnesium (Mg^{2+}), calcium (Ca^{2+}), and potassium (K^+)
- Estuary chemical compounds are made up of both lake and ocean chemical compounds, creating what's known as *brackish water*
- Lake chemical compounds after runoff and what's referred to as *nutrient pollution*: nitrates (NO3-) and phosphates (PO43-), which are mostly from fertilizer and sewage
- Ocean chemical compounds after runoff and such: Lead (Pb), Chromium (Cr), Cadmium (Cd), and Zinc (Zn), which is mostly from car tires
- Estuary chemical compounds after runoff and such: Lead (Pb), Chromium (Cr), Cadmium (Cd), and Mercury (Hg)
- "Fertilizers and pesticides from agricultural and urban runoff and sewage seepage from the groundwater enter lakes and cause elevated levels of nitrates and phosphates. These can lead to harmful algal blooms and eutrophication, which can be harmful to both aquatic life and human health." This typically leads to an overgrowth of certain algaes that are toxic and harmful to lake organisms. Ultimately, this results in an imbalance within lake ecosystems to the point where they become inhabitable for most organisms.

3) **Use this link to the slideshow (**this should be copied and modified to support the teacher's instructional decisions)

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4) **Materials:**
    1. Note cards with chemical names on it- NOTECARDS
    2. Glass vials to collect river water- COLLECTION VIALS
    3. Chlorine Test Strips - Cl TESTING STRIPS
    4. pH Test Strips- pH TESTING STRIPS
    5. Phosphorus and Phosphate Test Strips- P TESTING STRIPS
    6. Nitrate Test Strips- NO3 TESTING STRIPS

5) **Keywords:**
    Run off
    Pollutants
    Microplastics
    Impermeable surfaces
    Purification

6) **Activities and Instructions:**

Option A: Chemical Compounds and their prevalence in your water

1) List of the chemicals commonly found and a couple others that are not, and provide students (in groups) with the list in note card form
2) Have these students decide which are in water, then rank them from highest to lowest by sorting the notecards
3) Reveal the information and talk about what products or processes make these chemicals present. Talk about why it can be hard to purify these chemicals out of the water.
4) Then, describe modern resources for purification that improve the quality of the final product i.e drinking water.

Option B: Go to a nearby stream/river/estuary and collect a sample of the water with the glass vials

1) Bring students to visit a nearby stream/river/estuary and collect a sample of the water in the glass vials
2) Head back to class and use the samples of waters to test for certain pollutants
3) Use the test strips that include:
    A. pH test strips
    B. Nitrate test strips
    C. Phosphate test strips
4) Have students assess the levels of PH, Nitrate, and Phosphate of the water samples with these resources:
    A. pH:https://www.epa.gov/caddis-vol2/ph
    B. Nitrate:https://ei.lehigh.edu/envirosci/watershed/wq/wqbackground/nitratesbg.html

C. Phosphate:https://ei.lehigh.edu/envirosci/watershed/wq/wqbackground/phosphatesbg.html#:~:text=A%20reading%20between%201.1%2D4.0%20mg%2FL%20is%20good.

Conclusion: After completing one or both activities, lead a discussion summarizing what the students learned over the course of the activity(ies). Ask them to describe one technological solution on a note card as an exit slip.

Additional Resources:
Savebarnegatbay.org
Human Disturbances to Estuaries
Street Runoff and Urban Wastewater
Ozone Water Purification
https://www.jstage.jst.go.jp/article/emcr/1/0/1_20200006/_article/-char/ja/Human Disturbances to Estuaries: Estuaries Tutorial (noaa.gov)

Ozone Water Purification
https://ozonesolutions.com/blog/ozone-vs-chlorine/#:~:text=Ozone%20is%20one%20of%20the,while%20chlorine%20cannot%20kill%20protozoa.

Project SEAs other lesson plans:
https://sites.google.com/tcnj.edu/projectsea/curriculum-resources-for-teachers