Combined Sewer Overflow Lab: NYSSLS Alignment

Teacher guide for the student worksheet at mrsajdak.com/sewer-overflow (two pages, 14 questions). Environmental Science: water pollution, urban runoff and engineering solutions. It also fits Earth science (the water cycle in a city) and Living Environment (human impact on ecosystems). Plan on one class period. © 2026 Ryan Sajdak. Free to use, share and change under CC BY-NC-SA 4.0 (creativecommons.org/licenses/by-nc-sa/4.0): give credit, do not sell it, share your version the same way.

Objectives

The same two statements are printed at the top of the worksheet, each with a box to tick.

I can	Questions
use a model to explain how a pipe that carries both sewage and rain ends up spilling into a river.	1 to 7, 11 to 13
use numbers from a simulation to compare ways to cut sewer overflows and defend the best one.	8 to 10, 14

Performance expectations: building toward

The lab and worksheet give students evidence for these performance expectations. They are one step on the way, not a full assessment of any of them.

> **HS-ESS3-4**
> *"Evaluate or refine a technological solution that reduces impacts of human activities on natural systems."* Worksheet link: students measure the overflow a city's sewer sends to a river (Q5 to Q7), then test three real solutions, storage, green infrastructure and a bigger interceptor, against two storms (Q8 to Q10), and choose one (Q14).

> **HS-ETS1-4**
> *"Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem."* Worksheet link: the city, sewer and river are three linked systems; one change to the sewer shows up in the river's *E. coli* and the hours the beach is closed (Q8, Q11 to Q13).

> **HS-ETS1-3**
> *"Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts."* Worksheet link: Q10 shows that no fix wins every storm, and Q14 asks for a choice with evidence from two storms and a stated cost.

DCI ESS3.C Human Impacts on Earth Systems: *"Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation."* DCI ETS1.B Developing Possible Solutions: *"Both physical models and computers can be used in various ways to aid in the engineering design process."*

Part by part

Part	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts	What students do
1. One pipe, two jobs Q1 to 4	SEP 2 Developing and using models SEP 4 Analyzing and interpreting data	ESS3.C human impacts ESS2.C the roles of water	Systems and System Models; Energy and Matter (flows of matter)	Read the two sources at four times of day, find that rain swamps sewage about 40 to 1, trace the extra water into the tank and over the weir, and see the tank drain back to the plant after the storm.

2. Storms and streets Q5 to 7	SEP 4 Analyzing and interpreting data SEP 5 Using mathematics and computational thinking	ESS3.C ESS2.C	Cause and Effect	Compare four storms and find that total rain, not intensity, drives the overflow. Pave the city from 10% to 95% and watch the overflow go from nothing to 13,801 m^3.
3. Fix the sewer Q8 to 10	SEP 6 Constructing explanations and designing solutions SEP 5	ETS1.B developing possible solutions ESS3.C	Systems and System Models; Stability and Change	Test three upgrades against two storms, one change at a time, and find that the best fix depends on the storm: storage wins a thunderstorm, green infrastructure wins an all-day soaker.
4. The river Q11 to 13	SEP 4 SEP 6	ESS3.C LS2.C ecosystem dynamics	Scale, Proportion, and Quantity; Cause and Effect	Run the same overflow into a low and a high river, separate dilution (the peak) from flushing (the hours closed), and explain why a beach stays closed ten hours after the overflow stops.
Wrap it up Q14	SEP 7 Engaging in argument from evidence	ETS1.B	Cause and Effect	Choose one upgrade, defend it with numbers from two storms, and name its cost.

Running it

- **Timing:** about 10 minutes per part. Part 1 is the slowest because students drag the time slider to exact hours: show them that clicking the slider and using the arrow keys moves it one minute at a time.
- **It is deterministic.** Every setting gives every student the same numbers every time, so the answer key is exact. The results boxes fill in the moment a slider moves; students do not have to play the storm to read them.
- **Sticking points:** presets only change the rain, so students must put the other sliders back themselves before Parts 3 and 4 (the worksheet reminds them). In Part 3 they forget to reset one upgrade before trying the next. In Q13 they read the rain band as the overflow; the overflow is the brown line on the flow graph.
- **Units:** 1 m^3 is 1,000 liters, about 264 gallons. 1 mm/h of rain on the 100-hectare city is 1,000 m^3 an hour before any soaks in. An Olympic pool holds about 2,500 m^3, so the starting tank is two pools.

Also in play

- **Explore, then explain, then apply:** Q1 to Q3 are data and observation. The READ FIRST box on the worksheet then names what they saw (combined sewer, interceptor, regulator, weir, storage tank, outfall, CSO) before the questions that use the words.
- **Misconceptions:** "sewage overflows because people flush too much" (Q1 and Q2: homes send the same trickle all day; rain is 40 times bigger); "the hardest rain does the most damage" (Q6: the gentle soaker overflows three times as much); "once the overflow stops, the water is safe" (Q13); "a bigger pipe fixes it" (Q8: a doubled interceptor is the weakest fix for a thunderstorm).
- **Nature of models:** the city is made up, with realistic numbers: 100 hectares, 20,000 people, 300 L of sewage per person per day with a daily swing. Runoff uses the rational method ($Q = C \cdot i \cdot A$) with a 20-minute delay for travel through streets and pipes. The river below the outfall is one well-mixed 1 km reach (60,000 m^3), with *E. coli* of about 5 million CFU/100 mL in raw sewage, 10,000 in stormwater and 50 upstream, and die-off of 0.8 per day. It leaves out soil getting wetter during a storm, pipe travel times, the "first flush" of dirt, and currents that carry pollution farther downstream. A good closing question: which of those would make the real overflow worse?
- **Close to home:** Buffalo has a combined sewer system, and Buffalo Sewer Authority has a long-term plan to cut its overflows that mixes storage, bigger pipes and green infrastructure (its Rain Check program). Students can look for CSO outfall signs along Buffalo's rivers and creeks.

Standards text is that of the Next Generation Science Standards, which the New York State P-12 Science Learning Standards follow for these performance expectations. Sources: U.S. EPA, combined sewer overflows and the CSO Control Policy; U.S. EPA Recreational Water Quality Criteria for the 235 CFU/100 mL single-sample *E. coli* level; the rational method as given in standard hydrology texts. The answer key is a separate file, kept off the public site. Teachers can ask for it by email: rsajdak@buffaloschools.org.