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Water, Air, Trees: Building Interest in Earth Space Science through Local Environmental History

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School Theme:

My school has a social justice theme, specifically it is a magnet school using the theme, "Facing History and Ourselves." Facing History and Ourselves is an organization that does quite a lot of outreach and education, as well as writing curriculum, running workshops for teachers and students, and putting together resources for teachers and classrooms. Facing History and Ourselves describes itself as "an active and continuous process that calls on each of us to connect the choices of the past to those we face today. To build a more just and equitable future, we must face our history in all its complexity."[1] This historical theme is challenging to engage with in introductory scientific units about electricity, magnetism, and radiation, but it fits well into a conversation around climate change and other environmental issues.

Issues related to our theme that come up in a discussion on environmental science include:

- the disparity in health and access between people of color and white people, and also people of lower socioeconomic status and people who are more wealthy
- questions of whether people *should* take action, and what action(s) may be morally required
- understanding the global history of colonialism, including how Europe benefited from centuries of taking wealth and natural resources from everywhere else and now seeks to restrict the ability of the countries that had their resources taken to follow the same path toward industrialization

Each of these discussions is important, but they all boil down to the same thing: a discussion on what is fair and what is right, and ultimately what we must do to ensure future generations have a habitable planet. Unfortunately in this case, what is fair and right and beneficial for future generations is also expensive, and so people have known what they should do for decades but we have not done it, because it is expensive and it does not directly benefit us!

Explanation of the mini-unit approach:

I have been teaching some version of an environmental science unit for the last 14 years in PhyChem, which is the 9th grade science course that NHPS has offered since the early 2000s, but this year is the last year we are offering it. Next year we will be teaching an Earth Space science course that we will call Integrated Science. Since the environment is very clearly part of Earth and because environmental issues such as climate change are such a big focus now and likely into the future, I do expect that the environment will still be a main portion of this curriculum, but it will be in a new format and with additional content pieces that I am less familiar with. This change means that I do not have experience with the curriculum I will be teaching next year, and cannot point to the parts of it I know students will struggle with or will lose interest in, because I do not know that yet.

School logistics:

My school does not ability group, so the classes are mixed level but this course is designed for ninth graders. Ninth grade has some unique challenges at the moment, because a number of my students did not have a science teacher last year, and quite a few didn't have one for at least 2 years! I expect this trend to continue, at least for the short term, as we as a nation face a teacher shortage and many middle schools in New Haven do not have adequate science staff to teach all of their students. This means that in addition to teaching students in a mixed ability group, I also have to account for significant differences in background knowledge about *everything*! This is about scientific information but also has to do with skills we associate with a science classroom, even up to and including using a ruler, which I had to teach to multiple students this fall.

I applied to this program mostly with the intent to build interest and buy in into a unit on environmental science, because talking about the Great Pacific Garbage Patch is interesting to a few, while talking about a place they have actually been is interesting to many more students. Add in a discussion related to race and socioeconomic status, and many of my students sit up and listen! As I said earlier, the end product I am aiming for has changed, but my intent to build interest has not.

Approaches:

Intersection-

Science curricula nationwide have moved to include, and even focus on, the environmental issues we are causing both because they are full of complex scientific truths, but also because they are problems that our children will inherit, and they need solutions. Despite being a science teacher teaching a science course, I cannot focus solely on science, because science is part of our world, it is not separate from the world.

> "With traditional research, the knowledge we gain is one-dimensional and has less complexity, leaving us less equipped to solve the pressing social issues around us. In other words, when we look at the world one issue at a time—identifying climate change vulnerabilities based solely on

> race, or building safety nets based on disability status alone—entire communities fall through the cracks," Jackson says. "An intersectional lens provides a more complete and honest picture of the multiple factors that shape people's everyday lives. It can be difficult and sometimes messy, but whether you're a scientist or an activist, thinking about various forms of oppression in a simultaneous, integrated manner will likely help you arrive at a better and more equitable answer to the problem at hand." [2]

Recognizing our own intersectionality is important, but it is also important to recognize that the topics we study also exist inside a complex network of intersecting spaces. A discussion of climate change that does not include mention of politics, racism, or capitalism is incomplete and dishonest.

Decompartmentalizing-

Discussing the intersectionality of the topics we cover makes these topics more approachable for students, but it also helps combat the tendency that high school students have to think each subject they learn is separate and distinct from the other subjects they learn. "Students often do not see the relevance of prior material because they compartmentalize knowledge by course, semester, professor, or discipline and so they don't even think to bring that knowledge to bear. This compartmentalization leads students to organize knowledge in a way that is very different from yours and can impede its use."[3] This tendency toward compartmentalization makes it harder for them to transfer knowledge and skills learned in one subject into another. Sometimes that looks like their math teacher and I both having to teach them how to graph, because while it is the exact same skill, because the skill is being used in different subjects, many students do not recognize it as the same. Sometimes instead it is content knowledge, for example a topic often taught in eighth grade includes that the continental plates move because of the convection currents of the mantle, and most students struggle to connect that to the convection currents in the air that we discuss in ninth grade. I have no research to back this up, but I have noticed that the more intentional I am in the classroom about recognizing the intersectionality of topics, and sometimes even talking through different aspects of my own intersectionality if and when it applies, the easier it is for my students to see that their academic knowledge and skills can be similar–learned in one course and yet transferable to another.

Teaching students in a way that encourages them to decompartmentalize their learning is really important. It helps them to be more flexible thinkers and enables them to be successful with complex tasks that require multiple skill and knowledge sets. More importantly, since they are only in school for a short time and with each teacher for an even shorter time, if they struggle to access their knowledge outside of individual academic classes, we are not setting them up for long term success outside of high school. If we rarely (or never) ask them to practice putting all of the pieces together, they will not have the ability to do so when it is needed. "Students must develop not only the component skills and knowledge necessary to perform complex tasks, they must also practice combining and integrating them to develop greater fluency and automaticity. Finally, students must learn when and how to apply the skills and knowledge they learn."[4]

Storytelling-

In addition to asking students questions that make them examine the different spheres that our topics reside in, one of the ways that I teach is by telling stories. It sounds silly, and it is not an approach to education that I learned about in my teacher prep program, but I just do not know any other way to stand in a room with twenty people who are trying to make meaning of some information I have shared with them, without telling them a story that puts the information into a real world context. I did not even realize this was a thing that I

did frequently enough for it to stand out, but many MANY of my former students have commented on it, so it must be something that I did a lot without realizing it. Now that I am aware however, I am intentional about the stories that I tell. The general theme from my former students is that they remember my stories and through those stories, they remember my content, so I will continue, both to tell stories and to be intentional with the stories that I tell. Science often contains topics that are difficult for students to conceptualize because while they can see the effects of many things, they literally cannot see an atom, they cannot see carbon dioxide in the atmosphere, they cannot see the mantle moving underground, etc. so it often feels for them like they're believing me because I am the teacher, but only because I am the teacher. And, if I want them to be able to do more than just believe me, but to integrate the new information with what they already know, I have to help them, and one of the easiest ways I know how to do that is to tell a story.

> "Stories can be used to explain and illustrate abstract ideas or concepts in a way that makes them accessible and attainable. Stories bring facts to life, make the abstract concrete and, through meaning making, walk the listener through the mind of the scientist or mathematician (Ellis, 2005) to understand the value and application of such concepts. Wells (1986) argued that storytelling is a fundamental means of meaning making." [5]

Inquiry-

Another approach I use in the classroom is inquiry. While it is a long-time buzzword, it is also really the basis of science. We want to know what will happen if. We want to know why this. We want to know how that. This curiosity is first- one of my favorite things to see in my students. Curious students are engaged, they are learning, they are motivated, and they remember. This curiosity also leads students who may be hesitant about science to recognize that science is a lot more about how you think than it is about what you can memorize. I have a handful of students every year who anticipate that high school science will be memorizing the Periodic Table or learning all the scientific names for all the animals. It is of course neither, and generally they are relieved to find out that I have not memorized the Periodic Table (it's arranged in a reference table so nobody ever needs to!) nor do I know all the scientific names of all the animals (I have Google for that!)

I love to get my students thinking. If I can show them something that makes them pause and that they cannot immediately figure out, I consider it a good lesson. If I can get them to try to figure out possible reasons why this or consequences of that on their own, even if their explanations aren't perfectly accurate, I consider it a great lesson. Inquiry, like many buzzwords, has almost as many explanations as it there are people who use the word, but this explanation resonates with me:

> "Inquiry-based science adopts an investigative approach to teaching and learning where students are provided with opportunities to investigate a problem, search for possible solutions, make observations, ask questions, test out ideas, and think creatively and use their intuition. In this sense, inquiry-based science involves students doing science where they have opportunities to explore possible solutions, develop explanations for the phenomena under investigation, elaborate on concepts and processes, and evaluate or assess their understandings in the light of available evidence. This approach to teaching relies on teachers recognizing the importance of presenting problems to students that will challenge their current conceptual understandings so they are forced to reconcile anomalous thinking and construct new understandings." [6]

Group Work-

Group work is often joked about. The teacher does not want to teach so they have students teach themselves,

one person does all the work, and everyone else learns nothing. This is certainly possible, but I aim for a slightly better approach. I often have students work in groups. Sometimes it is for a few minutes in class just to be exposed to others' ideas or to provide an intermediate or revision step between coming up with one's idea and sharing it with the entire class. Sometimes students will work in groups for a longer time, to produce a project or to learn a specific content that not everyone is learning about. There is also a very real practical aspect to group work in a science classroom; I often do not have enough equipment, supplies, or even space to have each student work individually on any sort of hands-on activity, so I put them into groups to allow everyone to access the activity without having to buy a class set of what is often expensive materials or spill out into the hall.

One of my favorite group projects involves students being grouped together to learn about and become the class experts on a topic, each group having a different topic. Each group is given both text and video-based resources to use, so that reading skills–which vary greatly among my students–are not a barrier to their ability to learn and understand their source material. They prepare, they help each other understand the source material, and they polish their reasons and arguments within their group, because they are the students who know their topic the best. Then they debate with each other. I run two rounds of debate, which allows me to pick the students from each group who are more comfortable speaking to go first, and provide a model for their partners to follow, it also means that there is always an audience, so I have students give feedback to their partners that day, because it always takes me a couple days to give feedback to every participant. This exercise is graded, but is effectively practice for the final project of that unit, which has my students being interviewed one-on-one by upperclassmen about their topic. They prepare for certain questions, the interviewers are allowed to ask related follow up questions and they take notes which they give to me, I also make certain to interview every single student, and then I read over all the notes about each students' answers to grade them. This uses a group approach to learning and to refining their ideas and arguments, but also requires individual understanding of their material and individual participation, which is why it is one of my favorite group projects, and I am going to try to adapt this particular project's framework to one of the topics in my new curriculum.

Anti-racism in the science classroom:

Anti-racism is a recent buzzword, but is also incredibly important, as a human certainly, but especially as an educator. In short, anti-racism is working towards dismantling racist power structures, and while we cannot take on the entire structure and organization of our national government within our classrooms, teachers can work on whatever falls within their sphere, from their own classroom policies to examining the effect of racism on pieces of their content. The NSTA (National Science Teaching Association) suggests the following two actions, among others, to create an anti-racist science classroom:

1. **Create a culture of discourse on social justice.** As science teachers, we have a responsibility to practice the nature of science in our classrooms, which includes arguing from evidence on societal issues that directly impact our BIPOC students. Our students must feel heard and validated while participating in the science and engineering practices innovated by the *Framework*.
2. **Cultivate learning experiences that embrace each of your students.** Actively seek phenomena that speak to the cultures, communities, and lived identities of our students. We must advocate for increased diversity in our curriculum and instruction and amplify the voices of Black and indigenous scientists' contributions to STEM.[7]

As we explore environmental problems in the world, we will explore the ways in which people of color are

exposed to more pollutants in their communities. This comes from the placement of waste treatment facilities, toxic waste disposal sites, and industrial and chemical plants; they are all more likely to be found in and around places with a higher percentage of POC residents and low income residents.

> "Environmental racism refers to the unequal access to a clean environment and basic environmental resources based on race. Communities of color are disproportionately victimized by environmental hazards and are far more likely to live in areas with heavy pollution. People of color are more likely to die of environmental causes, and more than half of the people who live close to hazardous waste are people of color." [8]

This links right into the second item on the NSTA's list, seeking examples that link to my students' communities. In looking at New Haven's history, we are looking at their community. A lot of what we will look at is negative. We will look at the old red lined map of New Haven from the thirties, and compare it to current maps showcasing a variety of neighborhood by neighborhood data. We will see that many of the neighborhoods graded red and yellow then, are still the neighborhoods in town with the least tree cover, they are the neighborhoods with the highest incidence of COVID outbreaks in 2020, they are the neighborhoods with the lowest percentage of home ownership. We will also look at the harbor with all the oil tanks on it and why they are there. We will look at Murphy Roach Recycling and how they keep expanding.

This cannot be all we look at though, instead I need to show the activists in their city who are working to make positive changes in their communities. Doreen Abubakar who turned the Mudhole into the Learning Corridor, a place where people can learn outdoor skills and hobbies–among other things. Domingo Medina who started a composting company in town because he knew many people wanted to compost but could not. Alex Rodriguez who works for Save our Sound and tried to do outreach to local people to get them to help locally. And others, who are doing their part to make our city greener, safer, and healthier.

Action:

There are a number of local organizations that accept volunteer help. I'd love to connect with one for some ecology work, which would be especially useful to my students as many of them struggle to get the ten hours of community service that our school (and I believe NHPS) require of every student every year. Another activity I'd like to do with my students is what we often call "citizen science" or "community science." While they are different, both involve people doing active research, whether it's counting individuals of a plant or animal species in a given area or calculating the brightness of the sky (or certain stars) to determine air pollution levels, or anything in between. The difference between citizen science and community science has to do with who is in charge of the task, citizen science tends to have an actual researcher in charge of organizing the tracking tasks and the data while community science is usually based in a local group, though the actual tasks tend to be pretty similar. Any and all of these would be great for students to get involved with – both because the environmental problems we study tend to feel really overwhelming and taking action helps with that, and also because it's really great for high school students to see that "science" isn't just people in white coats in a lab, in fact it's often people knee deep in muck outside somewhere.

One idea I have specifically for students is grading water quality. I'd like to have my students examine the invertebrate species that live in the nearby river (the Mill River) to determine how sensitive they are to pollution. There are keys put out by the EPA that allow students to relatively quickly identify the different species of invertebrates that live in each area, and they include whether the animal is considered "very sensitive," "sensitive," "tolerant," or "very tolerant." Based on the percentage of each category we find, we

can assign the water a grade. If the water has only tolerant and very tolerant animals living in it with no or very few sensitive individuals, it is likely polluted. There is a unit in my new curriculum that deals with water. The new curriculum is not fully written, including the water unit, so I cannot say exactly what that will entail, but if it fits at all, I will have my students do this. If it does not, I will look into other citizen or community science opportunities that will allow my students to do "real" science while also liking what they are doing to what they are learning in the classroom.

Both of these options, grading the water quality and participating in citizen or community science opportunities locally fit in with my school's motto: "Think critically, Be responsible, Get involved." Getting involved can look like a variety of things from political to social to environmental efforts, and certainly being part of local scientific research to help improve the environment would fit the bill. In addition, there are benefits for the students to getting involved in citizen science.

> "For student participants, the immersive experience of citizen science makes learning fun and offers a clear integration of science understanding with real-world application. Working together, citizen scientists and professional researchers help create a community of more knowledgeable and better-informed community members who can respond quickly and effectively to issues that arise in our rapidly-changing world." [9]

Helping my students see that they can get involved in science, whether as a career or just as a weekend activity once in a while, opens doors for them. No longer is "science" something one needs advanced degrees to participate in, no longer is it something that is esoteric and shrouded in complex words, no longer is it something confined to a lab, it is open to all of us and can be really fun to participate in.

Additional instructional strategies/materials:

- Videos
- Readings
- Notes
- Organizers - for notes, writing, and discussions

Units

Note About Content Standards:

While the curriculum will certainly tie into the standards, which are the Next Generation Science Standards, the purpose of the following mini units, which range in length from six to nine days is not to provide content instruction, but instead to build interest and allow students to see the importance and relevance of this course in their daily lives. Because of this, these instructional activities, while important to my previously stated goal, are NOT designed to fit any content standards. Some of them may, especially the cross-cutting concepts in the NGSS; students will be looking at maps and data – including data that they collect, they will be noticing patterns and trends, they will be drawing conclusions, but none of what follows is designed to cover any content standards and therefore I don't mention the standards at all.

Interest Building Unit Number 1 - Water

In the new curriculum is a unit on water. It includes information about the water cycle, how humans are interrupting the water cycle, a discussion of the fairly minimal percentage of Earth's water that is actually drinkable and how humans seem to be doing their damnedest to make sure even that little bit is polluted. This is a perfect place to tie the curriculum back to New Haven, because New Haven is a coastal city that has 3 rivers running through it; the West River, the Quinnipiac River, and the Mill River. We will focus mainly on the Mill River, because part of what this piece will include is hands on work in one of the rivers, and we can walk to the Mill River from our school, though much of what is said about the Mill River is applicable to the other two and many other rivers as well.

Day 1: Watershed Areas

Have students look at historic maps of New Haven and identify all of the water - Mill, Quinnipiac, and West Rivers and the harbor. Students brainstorm using a topographical[10] map where each river's watershed areas are and then also where the water from each river goes.

Days 2 & 3: Water Pollution

Students use an article written by Melissa Denchak[11] as a starting point. In groups, they look into the types of pollution we can expect to see in the rivers in New Haven. Once they have some ideas of what to expect, they can look at more articles: *Yale Daily News* from 1971[12] , *NBC Connecticut* from 2022[13] , *New Haven Register* from 2019[14] , and also look for their own.

Days 4-6: Wikipedia

I love to use Wikipedia as a place to get initial background information, because while yes it is not considered a scholarly source, entries are typically written at a lower reading level than many scholarly articles, and the link-dense text means that students who do not understand a term or connection as they are reading are typically able to click and read and then continue. Additionally, the reference list is usually a helpful place for students to look for additional information.

The Wikipedia entry for the Mill River[15] gives some information about historic industrial uses of the Mill River, and therefore potential sources of pollution, but I do wish it had more. While I will not have them submit them, this sort of lack in Wikipedia provides a great opportunity for students to then write their own Wikipedia entries that are more focused on the history and pollution of the Mill River. They will do this in pairs, as this sort of assignment is often overwhelming to students individually, and the partner approach also (usually) catches mistakes better than a solo approach. After students write their entries, they will trade and edit another group's entry. Students will be able to do their own research, but will also be provided a few suggestions of topics and websites to look into to get started.

Days 7 & 8: Dichotomous Key

We will then switch gears and learn to use a dichotomous key. This takes some practice but is not difficult. We start by playing 20 questions (yes or no questions only) to try to identify a specific classroom object.

Example: If the object is a green spiral notebook on my table, questions might go in order: 1) Does it belong to a student? No. 2) Is it bigger than a desk? No. 3) Is it permanent? No. 4) Can one write with it? No. 5) Is it a book? Yes. 6) Is it a textbook? No. 7) Is it a book to write in? Yes. 8) Is it on a shelf? No. 9) Is it on the table? Yes. 10) Is it green? Yes.

Now, a dichotomous key is not exactly like 20 questions, because instead of yes or no questions, one provides multiple options and it MUST be one of them: 'this or that.' However, students enjoy playing 20 questions and it is close enough to help them get started with the idea. After a few rounds, we might then move into a version more like a key, in which 2 options are offered. In the above question 6, instead of asking about just a textbook, one could ask "Is it a book to read, or a book to write in?"

After this, students can go outside to take photos of 8-12 living things and make a key that they can use to identify those specific organisms. The first question would likely be "Is it a plant, an animal, or a fungus?" and continue from there, perhaps specifying whether a plant is a tree or a bush, whether the leaf edge is smooth or slightly jagged or deeply toothed, perhaps looking at colors of flowers, and other similar easily distinguished differences.

The last practice activity would be to project images of different species that we would expect to see at the mill river and then to have students use the actual key to identify them, first as a whole group, then in pairs correcting each other, and then as individuals. Before this happens, as a group, we would read over the key and discuss unfamiliar vocabulary as well as projecting examples of what each option looks like.

Day 9: Grading the River

Students will walk down to the river. In this instance, it will not be just me with one class for a period, but instead all of the 9th grade and their other teachers, and likely a few others, will head down for an extended period of time. If we can arrange it, we may take most of a day and have students working in shifts, some at the river, some cleaning up East Rock Park for service hours, maybe even some listening to a talk by one of the park rangers about something related to this unit. If not, this may take two hours or so from start to finish.

Materials Needed:

- Keys[16] - printed in color and laminated to protect from water
- Data recording sheets
- Pencils (not pens, pencils will write when wet)
- Hip waders for adults going into the water (2-3 pairs)
- Nets
- Shovels
- Trays
- Buckets / bowls
- Magnifying glasses
- Forceps / probes
- Rubber gloves (if desired)
- Paper towels

I and the other adults going in will go into the water and use the shovel to stir up the muck at the bottom of

the river. We then use the net to scoop as much muck as we can without breaking it. The scoop is transferred to the students' trays, and they walk off to sort and ID their invertebrate specimens, leaving space for the next students to come get samples. As each group sorts their specimens, they are to use the key to identify each individual, and then tally the numbers of individuals on the data sheet. After they have identified an invertebrate, it is put into a bowl or bucket with a small amount of river water along with any non-living things such as rocks or leaves and any potential vertebrates like small fish, to return to the river when they are done. This last step is imperative as we do not want to disturb the ecosystem more than necessary.

Students will work in pairs or triples, both because it is easier logistically to not have 90+ sets of equipment, but also because it will likely make identification easier if students have someone to double check their identifications with. (Additionally, not every student will feel comfortable touching these animals, even with gloves.) Once each group has been able to tally the number of individuals of each species, we will identify the category each species falls into: very tolerant, tolerant, sensitive, or very sensitive. Once we know how many individuals (not species!) we were able to find in each category, we look at the percentage of all the individuals found that fall into each category, and use that to draw conclusions about the level of pollution that is present in the water.

It is likely that the Mill River Watershed Association[17] or Save the Sound[18] would be interested in the data we collect, as they are involved in efforts to clean up and protect the Mill River. If so, we will share the data we collect, as well as recording it ourselves so that years down the line, we have historic data to compare to. This would allow us to see if the water quality is improving, deteriorating, or staying approximately the same.

Note: This unit would not work well in the winter months! Additionally, we would expect to see different species and different life stages of the same species at different times of year, so if we want to be able to accurately compare historical data, we need to be careful to complete the specimen collection at the same time of year.

Interest Building Unit Number 2 - Air

Air is everywhere, but is it all the same? No! Air quality varies widely, based on a variety of factors, one of which is pollution. Proximity to air pollution sources is a risk factor for a number of things, including Asthma and other respiratory diseases, cardiovascular issues such as heart attacks and strokes, and cancers, along with other negative health effects. Because of this, it is healthiest to stay as far away from air pollution as possible. And yet, that is not always possible, especially for people of color and people in lower socio-economic groups.

Day 1: Environmental Racism

Begin class with a discussion of what the phrase environmental racism means. Students' initial ideas will (mostly) be incorrect; the most common answer I got this year was 'the environment being racist,' which is on the right track but incorrect. After students have discussed, share the definition and give them a couple more minutes to process it, possibly write a two sentence summary of their thoughts in their journals or have a quick partner discussion. Then show this video about the history of environmental justice[19] . Let them just

watch, without any notes requirement, but instruct them to have paper to jot notes in case they want to. Stop the video at 2:00 when it talks about the switch from protecting low income and minority communities to protecting all people and ask if there are any parallels to today, then take a few minutes to talk about why this switch caused harm. When the video is over, allow time to discuss and debrief, because students will have feelings and opinions about this. It may seem like a lot was not accomplished in this lesson, but for most students, this is their first encounter with a form of racism that they have experienced their whole life but have not been able to put into words, and it is emotional, give time for them to process their emotions.

If there is time, have the students read excerpts from either or both of these articles [20&21] , either together as a class or have desk pairs read different articles and then jig saw to share. If there isn't time for this, have them do either or both readings for homework and come in with five things they want to ask or say.

Day 2: Air Pollution

Give notes detailing what air pollution is, common sources, common pollutants, the ways in which air pollution negatively impacts the environment and human health, and ways we can reduce air pollution. In this discussion, also make sure to talk about the significant differences in average exposure between Whites and People of Color in America.

Some statistics it may be helpful to include:

- "71% of African Americans live in counties in violation of federal air pollution standards compared to only 58% of non-Hispanic whites (EPA).
- "Communities of color have higher rates of exposure to air pollution (Yale):
    - "Whites had the lowest exposure rates for 11 of the 14 pollutants
    - "Hispanics had the highest exposure rates for 10 out of the 14 pollutants studied
    - "African Americans had higher exposure rates than whites for 13 out of the 14 pollutants
- "African Americans are ~1.5 times more likely to have asthma and 3 times more likely to die from asthma than non-Hispanic whites (AAFA). Black women have the highest death rate at the hands of asthma.
- "Black people experience 56% more pollution than their consumption generates (PNAS).
- "Black people are exposed to 1.54 times more fine particulate matter than white people and are 3 times more likely to die due to air pollutants (EPA, NEJM).
- "Communities living below the poverty line have a 35% higher burden from particulate matter emissions (Sierra Club).
- "Black Americans are more likely than white Americans to have elevated blood lead levels (Harvard, CDC):
    - "11.2% of African American children are poisoned by lead
    - "4% of Mexican-American children
    - "2.3% of white children" [22]

The whole article these statistics are from is interesting and some students may be interested enough to read it, but only the first part applies to this lesson.

Day 3: Case Study - Oakland California - Background Information

Begin by discussing how freeways were built: they were typically built quickly, without input from residents, and often through neighborhoods with high numbers of POC residents, which displaced many people and

made it hard for those communities to come back together. Show this video[23] about highways after the discussion to reinforce and illustrate the points that were discussed, or at the start to help frame the discussion.

Discuss the risk factors of living near highways; air pollution from the vehicle emissions, particulate pollution from tires, during the era of leaded gas there was a significant risk of lead poisoning, and of course noise pollution.

Discuss the fact that highways often create barriers that separate people from others and from resources. Frequently highways are built on or separate people from green spaces and parks. Because of this, highways often result in reducing opportunities for children to play outside safely.

Read excerpts of this article[24] about highways together as a class and project some of the images from it for discussion.

Days 4-5: Case Study - Oakland California - The 580 and 880 Freeways

Start class by asking “Why would a highway not allow trucks?” and ask students to brainstorm in pairs. Answers will vary but will likely include noise, pollution, and especially considering the Merritt doesn’t allow trucks a discussion of the size of the road. (Note: the Merritt was built in the 1930s, heavy duty trucks as we know them today were not a consideration.)

After this discussion, have students read this article[25] about air pollution and transportation. Have students pay especial attention to the section explaining the increased risks associated with trucks and other “heavy duty” vehicles versus cars and other personal vehicles, and follow the link in that section to a flier[26] put out by the EPA for additional information.

Discuss why trucks on a highway increase the air pollution that will be produced on that highway. Then ask again “Why would a highway not allow trucks?” and see if the answers have changed. Ask them to think back to what we have covered the last few days when it comes to race as a risk factor for pollution exposure.

Have students read this article[27] about 2 freeways in Oakland, CA together as a class, annotating their own copies. Ask them to write down how they think the residents are affected by these two highways. After reading, have them discuss in small groups before sharing their thoughts with the whole group.

Days 6-7: Case Study - Oakland, California - Action

The article read at the end of day 5 ends with this quote:

> “What can I do?
>
> “Everyone deserves to breathe clean air, and you can make a difference by advocating for common-sense solutions to reduce levels of harmful air pollution.” [27]

To end this unit, students will write a letter to either the mayor of Oakland, CA or to the Governor. In this letter they will explain why the banning of trucks on the I-580 is so unfair to the people who live near the I-880. They will need to discuss specifics relating to air pollution, health risks, and environmental racism

versus environmental justice.

Interest Building Unit Number 3 - Trees

This piece doesn't fit as nicely as the water piece into my new curriculum, but I still think it is worthwhile. In a unit centered around the question of what human activities can influence the temperature, the unit is lacking a discussion of trees. Trees, and other vegetation as well but especially trees, can influence the temperature of an area, so they should be a part of the discussion.

Day 1: Red Lining

Start class asking students to recall what they learned about environmental racism. Put a definition on the board and, depending on whether students have switched into class since the last discussion, be rather brief or fairly thorough. Show this video[28] about the practice of red lining. Again, let students watch without a notes requirement but do encourage them to have paper out in case they want to write something down. And again, let them debrief afterward, because these topics are heavy. After some discussion, show the following images of New Haven: the red lined map put out in 1937 by the Home Owners Loan Corporation[29] , a COVID outbreak map from April, 2020[30] , the tree cover map of New Haven from 2016[31] , and average annual household income by neighborhood, based on 2000-2020 data[32] .

(Extension: Share this longer video[33] on red lining and its consequences with any students who are interested.)

With the first image up, let students examine. Many who live in town will start searching for their neighborhoods, the ones who do not may look for their friends' or family's homes, or for the school, their elementary schools, etc. Talk about what it might have meant for families in neighborhoods in 1937 if their neighborhood was red or yellow vs green or blue. Then give them time to look and write down observations for each of the next three images, especially comparing the first to each of the other images, but ask them not to call answers out. Eventually, after all students have noted at least 1-2 observations, ask students to share. Talk about why these maps line up, and how actions and policies from decades and even centuries ago can create legacies that still influence our world today, and in this case this historic action is part of the legacy that we call systemic racism.

After we've examined the maps, ask students what some of the differences are between the greener neighborhoods and the grayer neighborhoods in the tree cover map: What do each look like? Feel like? What is present in each neighborhood? Etc. Show this video[34] to introduce the urban heat island effect.

For homework, have students look over this website[35] showcasing data relating to housing segregation in New Haven and make some observations about what trends they notice.

Day 2: Urban Heat Island Effect

Begin class asking why cities are usually hotter than surrounding towns and rural areas. Have students who were absent the previous class watch the urban heat island effect video during this discussion. Give notes on

what exactly the urban heat island effect is, maybe 20 minutes, and include details about how brick, stone, concrete, asphalt all absorb heat and re-radiate it, and how plants work against this, both by providing shade and by providing moisture which cools the environment as it evaporates. Discuss the relative amounts of buildings and pavement versus green space in cities and urban areas. Then have students check out the EPA page on the urban heat island effect[36] . Ask them to look around, maybe read the abstracts of some of the linked articles and definitely check out both the Heat Island Impacts and Heat Island Cooling Strategies pages linked toward the bottom.

Before this lesson, see if every science teacher across town (which covers every school, except Mayo and the younger Hooker school) can get a class to go outside and take temperature readings at noon. If they are willing, ask that they take two temperature readings, one as close to the front door as possible while being in the sun, and the other as close to the front door as possible while being in the shade. For each, I'm going to stipulate that the sunny or shady patch needs to be at least 2 square feet, so we don't wind up trying to hold a thermometer in the shade cast by a flagpole, or something equally ridiculous. I'll also ask them to measure how far from the front door each location was, which could become a useful measurement skills lesson for them, but may also yield some interesting information if any school's distance is particularly long.

Have students look this data over and then also find each school on a map of New Haven. While all NHPS schools are considered urban, ask students to discuss the neighborhood in which each school is located, and if they feel like they can point to any trends between the temperature readings and the neighborhoods where we find the schools. Schools like Edgewood and Hale are very suburban, while Coop is much more urban and Metro and HSC are fairly removed from the city and are somewhat industrial. While I don't think a single day's temperature information is enough to base any conclusions upon, looking at this data will still be interesting and may show some trends.

Ask students to look at schools they attended, students from out of district middle schools may partner with someone who attended in district, and consider what other factors may be affecting temperature: proximity to water, elevation, windiness, etc. Maybe not in each section, but by the end of this lesson in each section, we will likely have notes about additional factors associated with almost all the schools. These notes can be compiled in a Google doc that is then sent home to students with instructions to look over what additional trends they can notice that relate to temperature outside of the urban heat island effect.

Day 3-5: Cooling The Neighborhood

In groups, assign students to cool our neighborhood. They need to identify at least one aspect of the neighborhood as it is that increases the heat, and then at least four strategies that they think would cool the neighborhood. Once they have identified these five things, they need to explain why the current factor they identified increases the heat, and why each identified strategy is able to cool the environment. As an extension, some groups could also give an anticipated amount that the temperature would decrease if the strategy is employed. This project could be a great place for a map drawn to scale, if time and math skills allow.

(Optional) Day 6: Seeing the Urban Heat Island Effect in Person

King Robinson is a large school with a large parking lot and quite a lot of surfaces that will likely increase the heat whilst standing in its parking lot. Just behind it is a beautiful park with lots of tree cover, a pond, and a splash pad that may be operating during the fall or late spring, all of which would make this area significantly cooler than the school. With permission from King Robinson's administration, I'd like to bring students there

to measure and map the area, and then to take temperature readings in various places around the exterior of the school and in the park.

Continuing This Theme: Ongoing

Students who are interested will be encouraged to contact URI, Urban Resources Initiative to ask for a tree (or a few) to be planted at NHA. If URI plants a tree, the residents, in this case they would be students, are responsible for watering the tree regularly, so the group of them could divvy up who is going to take this responsibility on and when.

Notes

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[2] "Yale Experts Explain Intersectionality and Climate Change." *Yale Sustainability*, 28 July 2022, sustainability.yale.edu/explainers/yale-experts-explain-intersectionality-and-climate-change.

[3] Carnegie Mellon University. *Students Compartmentalize Knowledge and Skills and Hence Can't Draw on Them - Eberly Center - Carnegie Mellon University*, www.cmu.edu/teaching/solveproblem/strat-cantapply/cantapply-06.html. Accessed 2 June 2023.

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[6] "What Is Inquiry-Based Science?" *Smithsonian Science Education Center*, 10 Nov. 2015, ssec.si.edu/stemvisions-blog/what-inquiry-based-science.

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[12] Walker, Henry. “Polluters Turn Mill River Dirty Blue.” *Yale Daily News*, 1 Nov. 1971, p. 1.

[13] “Clean up Underway after 2.1 Million Gallons of Sewage Spills in the Mill River.” *NBC Connecticut*, 8 July 2020, www.nbcconnecticut.com/news/local/new-haven-mayor-city-health-dept-to-discuss-sewage-spill-in-mill-river/2299485/.

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[18] “Press Release: Save the Sound Launches Mill River Urban Waters Initiative: Community Outreach, Engagement, and Leadership Program.” *Save the Sound*, 3 May 2022, www.savethesound.org/press-release-save-the-sound-launches-mill-river-urban-waters-initiative-community-outreach-engagement-and-leadership-program.

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[22] Matta, Natasha. “Environmental Racism by the Numbers.” *Medium*, 25 Mar. 2022, medium.com/environmental-justice-coalition/environmental-racism-by-the-numbers-c7d3ceb7539c.

[23] *“How highways wrecked American cities*,” YouTube, 11 May 2016, https://www.youtube.com/watch?v=odF4GSX1y3c. Accessed 2 July 2023.

[24] Dottle, Rachael, et al. “Mapping the Past and Future of Urban Highways.” *Bloomberg.Com*, 28 July 2021,

www.bloomberg.com/graphics/2021-urban-highways-infrastructure-racism/.

[25] "Cars, Trucks, Buses and Air Pollution." *Union of Concerned Scientists*, www.ucsusa.org/resources/cars-trucks-buses-and-air-pollution. Accessed 2 July 2023.

[26] *Federal and California Light-Duty Vehicle Emissions Standards for ... - EPA*, nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100XCIV.pdf. Accessed 2 July 2023.

[27] "A Tale of Two Freeways." *Environmental Defense Fund*, www.edf.org/airqualitymaps/oakland/tale-two-freeways. Accessed 2 July 2023.

[28] "*How Redlining Shaped Black America As We Know It*," YouTube, 26 Apr. 2019, https://www.youtube.com/watch?v=2o-yD0wGxAc. Accessed 2 July 2023.

[29] "CT Data Story: Housing Segregation in Greater New Haven." *DataHaven*, ctdatahaven.org/reports/ct-data-story-housing-segregation-greater-new-haven. Accessed 31 July 2023.

[30] Tyisha Walker-Myers, "Covid Call: 'Let's Change the Map.'" *New Haven Independent*, 1 Feb. 2022, www.newhavenindependent.org/index.php/article/black_hispanic_caucus_speech1/.

[31] "Urban Tree Canopy Metrics." *Urban Resources Initiative*, 20 June 2020, uri.yale.edu/maps/urban-tree-canopy-metrics.

[32] *New Haven, Connecticut (CT) Income Map, Earnings Map, and Wages Data*, www.city-data.com/income/income-New-Haven-Connecticut.html. Accessed 31 July 2023.

[33] *"Redlining: Mapping Inequality in Dayton & Springfield,"* YouTube, 28 Feb. 2022, https://www.youtube.com/watch?v=yt72OXJ8LPQ. Accessed 2 July 2023.

[34] *"Extreme heat is worse in redlined neighborhoods*," YouTube, 4 Aug. 2020, https://www.youtube.com/watch?v=uibxHzqZn-A. Accessed 2 July 2023.

[35] "CT Data Story: Housing Segregation in Greater New Haven." *DataHaven*, ctdatahaven.org/reports/ct-data-story-housing-segregation-greater-new-haven. Accessed 2 July 2023.

[36] *EPA*, www.epa.gov/heatislands/learn-about-heat-islands. Accessed 2 July 2023.

Appendix A: Implementing District Standards

The district uses the Next Generation Science Standards (NGSS) and while we do occasionally mix up middle and high school standards between grades 8 and 9, I've only included high school standards in this list.

NGSS Standards that are relevant to the previous mini-units – which unit is noted in parentheses:

Earth Space Science:

- HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. (Water and Air)
- HS-ESS3-3: Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. (Air and Trees)

Life Science:

- HS-LS2-6: Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. (Water)
- HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. (Trees)
- HS-LS4-6: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. (Air)
- HS-LS4-7: Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. (Air)
- HS-LS4-8: Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. (Air)

Obtaining, Evaluation, and Communicating Information:

- HS-LS4-4: Construct an explanation based on evidence for how natural selection leads to adaptation of populations. (Air)
- HS-LS4-5: Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. (Air)
- HS-LS4-6: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. (Water)
- HS-LS4-7: Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. (Water and Trees)
- HS-LS4-8: Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. (Water)

Energy:

- HS-ESS3-2: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. (Trees)

Annotated resource list for teachers and students

Water Unit

This is the key that students will need to use to identify the freshwater invertebrates that they will find in the Mill River.

1. *Aquatic Macroinvertebrate Identification-Key2.Pdf - the University Of ...*, www.uwa.edu.au/study/-/media/Faculties/Science/Docs/Aquatic-macroinvertebrate-Identification-key2_w.docx. Accessed 2 July 2023.

As the title suggests, this is an overview. I assigned this as whole class reading, which is typically done aloud together.

2. Denchak, Melissa. "Water Pollution: Everything You Need to Know." *Water Pollution Definition - Types, Causes, Effects*, 11 Jan. 2023, www.nrdc.org/stories/water-pollution-everything-you-need-know#categories.

These are resources relating specifically to the Mill River / industrial operations that have polluted the Mill River – all of these are resources that students can use for research; I wouldn't necessarily assign any of them as classroom or homework reading:

3. Brogard, Allegra. "The Mill River Revival." *The Yale Herald*, 22 Aug. 2020, yale-herald.com/2020/01/31/the-mill-river-revival/.
4. "Clean up Underway after 2.1 Million Gallons of Sewage Spills in the Mill River." *NBC Connecticut*, 8 July 2020, www.nbcconnecticut.com/news/local/new-haven-mayor-city-health-dept-to-discuss-sewage-spill-in-mill-river/2299485/.
5. Gabe LePage, Leah Snavely. "Brownfields in New Haven." *ArcGIS StoryMaps*, 14 May 2021, storymaps.arcgis.com/stories/e10107f8e5144389918cf2fb41b84e58.
6. Passapera, Daniel. "A Look into the Conservation Efforts on Hamden's Mill River." *Org*, 5 Dec. 2022, hqnn.org/2022/12/05/life-flows-through-hamdens-mill-river-and-many-are-trying-to-save-it/.
7. "Press Release: Save the Sound Launches Mill River Urban Waters Initiative: Community Outreach, Engagement, and Leadership Program." *Save the Sound*, 3 May 2022, www.savethesound.org/press-release-save-the-sound-launches-mill-river-urban-waters-initiative-community-outreach-engagement-and-leadership-program.
8. Sai Rayala, 11:53 pm, Apr 08. "Environmental Advisory Council Discusses Toxins near English Station Soil." *Yale Daily News*, 9 Apr. 2021, yaledailynews.com/blog/2021/04/08/environmental-advisory-council-discusses-toxins-near-english-station-soil/.
9. Stannard, Ed. "Water Seeps from New Haven Power Plant Site into Polluted Mill River." *New Haven Register*, 11 Aug. 2019, www.nhregister.com/news/article/Water-seeps-from-New-Haven-power-plant-site-into-14294395.php.
10. Walker, Henry. "Polluters Turn Mill River Dirty Blue." *Yale Daily News*, 1 Nov. 1971, p. 1.

Topographic map of New Haven:

11. "New Haven Topographic Map, Elevation, Terrain." *Topographic Maps*, en-gb.topographic-map.com/map-fct13l/New-Haven/?center=41.31712%2C-72.91016. Accessed 2 July 2023.

Resources provided for the Mill River Wikipedia entry project: (5 are also used elsewhere)

12. * "New Haven Mill River Planning Study Final Report Final Web.Pdf." *Google Drive*, docs.google.com/file/d/0BzUrwcfp8hjRblBiNElKQXBIRDA/edit?pli=1&resourcekey=0-r-Z7P29U-4JDc4AcGP4GPQ. Accessed 3 July 2023.
13. Denchak, Melissa. "Water Pollution: Everything You Need to Know." *Water Pollution Definition -*

Types, Causes, Effects, 11 Jan. 2023, www.nrdc.org/stories/water-pollution-everything-you-need-know#categories.
14. Sai Rayala, 11:53 pm, Apr 08. “Environmental Advisory Council Discusses Toxins near English Station Soil.” *Yale Daily News*, 9 Apr. 2021, yaledailynews.com/blog/2021/04/08/environmental-advisory-council-discusses-toxins-near-english-station-soil/.
15. Gabe LePage, Leah Snavely. “Brownfields in New Haven.” *ArcGIS StoryMaps*, 14 May 2021, storymaps.arcgis.com/stories/e10107f8e5144389918cf2fb41b84e58.
16. Passapera, Daniel. “A Look into the Conservation Efforts on Hamden’s Mill River.” *Org*, 5 Dec. 2022, hqnn.org/2022/12/05/life-flows-through-hamdens-mill-river-and-many-are-trying-to-save-it/.
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18. Walker, Henry. “Polluters Turn Mill River Dirty Blue.” *Yale Daily News*, 1 Nov. 1971, p. 1. “Clean up Underway after 2.1 Million Gallons of Sewage Spills in the Mill River.” *NBC Connecticut*, 8 July 2020, www.nbcconnecticut.com/news/local/new-haven-mayor-city-health-dept-to-discuss-sewage-spill-in-mill-river/2299485/.
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20. “New Haven Topographic Map, Elevation, Terrain.” *Topographic Maps*, en-gb.topographic-map.com/map-fct13l/New-Haven/?center=41.31712%2C-72.91016. Accessed 2 July 2023.

Air Unit

A summary of a study, not full of technical jargon, explains the link between communities of color and higher exposure to air pollution.

21. * “Racial, Ethnic Minorities and Low-Income Groups in U.S. Exposed to Higher Levels of Air Pollution.” *News*, 24 Jan. 2022, www.hsph.harvard.edu/news/press-releases/racial-ethnic-minorities-low-income-groups-u-s-air-pollution/.

Emphasizes that it’s race and not income that is the biggest risk factor

22. * “People of Color Hardest Hit by Air Pollution from Nearly All Sources.” *UW News*, www.washington.edu/news/2021/04/28/people-of-color-hardest-hit-by-air-pollution-from-nearly-all-sources/. Accessed 2 July 2023.

Excerpts of this would work for students, but not the entire article. That said, images are great, possibly for projecting to the class, relates to when and how highways were built

23. Dottle, Rachael, et al. “Mapping the Past and Future of Urban Highways.” *Com*, 28 July 2021, www.bloomberg.com/graphics/2021-urban-highways-infrastructure-racism/.

Mostly for teachers, though excerpts may work well with students. Relates to when and how highways were built.

24. * Susaneck, Adam Paul. “Mr. Biden, Tear down This Highway.” *The New York Times*, 8 Sept. 2022, www.nytimes.com/interactive/2022/09/08/opinion/urban-highways-segregation.html.

Good summary of the issues with the two highways, easy to read.

25. * Klivans, Laura. “Trucks Are Banned on Oakland’s I-580. These Sixth Graders Wondered Why.” *KQED*, 1 July 2021, www.kqed.org/news/11879641/trucks-are-banned-on-oaklands-i-580-these-sixth-graders-wondered-why .

GREAT statistics relating race and air pollution. The rest of the article doesn’t apply to the unit, but may be interesting to students.

26. Matta, Natasha. “Environmental Racism by the Numbers.” *Medium*, 25 Mar. 2022, medium.com/environmental-justice-coalition/environmental-racism-by-the-numbers-c7d3ceb7539c.

Useful for whole class reading and to frame discussions:

27. “Cars, Trucks, Buses and Air Pollution.” *Union of Concerned Scientists*, www.ucsusa.org/resources/cars-trucks-buses-and-air-pollution. Accessed 2 July 2023.
28. *Federal and California Light-Duty Vehicle Emissions Standards for ... - EPA*, nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100XCIV.pdf. Accessed 2 July 2023.
29. “A Tale of Two Freeways.” *Environmental Defense Fund*, www.edf.org/airqualitymaps/oakland/tale-two-freeways. Accessed 2 July 2023.

Used excerpts from these two articles to introduce environmental racism:

30. II, Vann R. Newkirk. “Environmental Racism Is Real, According to Trump’s EPA.” *The Atlantic*, 29 June 2021, www.theatlantic.com/politics/archive/2018/02/the-trump-administration-finds-that-environmental-racism-is-real/554315/.
31.“What Is Environmental Racism and How Can We Fight It?” *World Economic Forum*, www.weforum.org/agenda/2020/07/what-is-environmental-racism-pollution-covid-systemic/. Accessed 2 July 2023.

Videos to show in class during this unit:

Regarding highways:

32. *YouTube*, YouTube, 11 May 2016, https://www.youtube.com/watch?v=odF4GSX1y3c. Accessed 2 July 2023.

Regarding environmental justice:

33. *YouTube*, YouTube, 4 Aug. 2017, https://www.youtube.com/watch?v=30xLg2HHg8Q. Accessed 2 July 2023.

Resources provided for the letter to the Oakland, CA government project: (are also used elsewhere)

Resources relating to environmental racism / environmental justice:

34. *YouTube*, YouTube, 4 Aug. 2017, https://www.youtube.com/watch?v=30xLg2HHg8Q. Accessed 2 July

2023.
35. II, Vann R. Newkirk. “Environmental Racism Is Real, According to Trump’s EPA.” *The Atlantic*, 29 June 2021, www.theatlantic.com/politics/archive/2018/02/the-trump-administration-finds-that-environmental-racism-is-real/554315/.
36. “What Is Environmental Racism and How Can We Fight It?” *World Economic Forum*, www.weforum.org/agenda/2020/07/what-is-environmental-racism-pollution-covid-systemic/. Accessed 2 July 2023.
37. Matta, Natasha. “Environmental Racism by the Numbers.” *Medium*, 25 Mar. 2022, medium.com/environmental-justice-coalition/environmental-racism-by-the-numbers-c7d3ceb7539c.
38. Dottle, Rachael, et al. “Mapping the Past and Future of Urban Highways.” *Com*, 28 July 2021, https://www.bloomberg.com/graphics/2021-urban-highways-infrastructure-racism/

Resources relating to air pollution:

39. “Cars, Trucks, Buses and Air Pollution.” *Union of Concerned Scientists*, www.ucsusa.org/resources/cars-trucks-buses-and-air-pollution. Accessed 2 July 2023.
40. *Federal and California Light-Duty Vehicle Emissions Standards for ... - EPA*, nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100XCIV.pdf. Accessed 2 July 2023.
41. “A Tale of Two Freeways.” *Environmental Defense Fund*, www.edf.org/airqualitymaps/oakland/tale-two-freeways. Accessed 2 July 2023.
42. * Klivans, Laura. “Trucks Are Banned on Oakland’s I-580. These Sixth Graders Wondered Why.” *KQED*, 1 July 2021, www.kqed.org/news/11879641/trucks-are-banned-on-oaklands-i-580-these-sixth-graders-wondered-why.
43. * *EPA*, www.epa.gov/mobile-source-pollution. Accessed 3 July 2023.
44. * *EPA*, www.epa.gov/transportation-air-pollution-and-climate-change/smog-soot-and-other-air-pollution-transportation. Accessed 3 July 2023.
45. * *EPA*, www.epa.gov/transportation-air-pollution-and-climate-change. Accessed 3 July 2023.

This video is also pertinent to this project but doesn’t fall neatly into either category:

46. *YouTube*, YouTube, 11 May 2016, https://www.youtube.com/watch?v=odF4GSX1y3c. Accessed 2 July 2023.

Tree Unit

Great data available about housing in New Haven, lots of graphs and charts:

47. “CT Data Story: Housing Segregation in Greater New Haven.” *DataHaven*, ctdatahaven.org/reports/ct-data-story-housing-segregation-greater-new-haven. Accessed 2 July 2023.

GREAT information about the urban heat island effect, including links it covers a lot of information:

48. *EPA*, www.epa.gov/heatislands/learn-about-heat-islands. Accessed 2 July 2023.

Helpful summary of environmental justice for students who might have missed a class or might just need additional exposure to understand concepts

49. * *YouTube*, YouTube, 26 Jan. 2016, https://www.youtube.com/watch?v=dREtXUij6_c. Accessed 2 July 2023.

Videos to show in class during this unit:

Regarding red lining:

50. YouTube, YouTube, 26 Apr. 2019, https://www.youtube.com/watch?v=2o-yD0wGxAc. Accessed 2 July 2023.
51. *YouTube*, YouTube, 28 Feb. 2022, https://www.youtube.com/watch?v=yt72OXJ8LPQ. Accessed 2 July 2023.

Regarding the urban heat island effect:

52. *YouTube*, YouTube, 4 Aug. 2020, https://www.youtube.com/watch?v=uibxHzqZn-A. Accessed 2 July 2023.

Resources provided for the urban heat island effect reduction project: (2 are also used elsewhere)

53. *Treekeeper 8 System for New Haven, CT*, newhavenct.treekeepersoftware.com/index.cfm?deviceWidth=1669. Accessed 3 July 2023.
54. “Urban Resources Initiative.” *Urban Resources Initiative*, uri.yale.edu/. Accessed 3 July 2023.
55. *EPA*, www.epa.gov/heatislands/learn-about-heat-islands. Accessed 2 July 2023.
56. *YouTube*, YouTube, 4 Aug. 2020, https://www.youtube.com/watch?v=uibxHzqZn-A. Accessed 2 July 2023.
57. Friends of East Rock Park. *Friends of East Rock Park*, friendsofeastrockpark.org/. Accessed 3 July 2023.
58. Ariel Bintang, Haonan Li. “East Rock: Factories and Tenements to a Street-Car Suburb.” *ArcGIS StoryMaps*, 17 Aug. 2021, storymaps.arcgis.com/stories/233e0b73199944fca35739c8c41878bd.

(An asterisk indicates a resource NOT mentioned or linked within the unit itself.)