The Dangers of Infrastructure Byproducts and What We Can Learn From Muriel Rukeyser's "The Book of the Dead"

Aaron Pinnix

In December 2020, the journal *Science* published an article proving that the chemical 6PPD, which is used worldwide in car tires as a means of impeding rubber oxidation, causes extreme morbidity among U.S. Pacific Northwest coho salmon.[1] Up to 90% of a returning salmon population may die from exposure to 6PPD, which gets delivered to streams via tire wear and road runoff. As the authors note, it is unlikely that salmon are uniquely sensitive to this chemical, and as such 6PPD is probably killing fish around the world.[2] Part of the challenge of addressing 6PPD is that not only is it so small as to almost escape awareness, it is also a substance with a specific purpose in the larger infrastructure of roads and cars, and through the fulfilment of this purpose becomes subsumed within the smooth functioning of road infrastructure. Often infrastructure byproducts like 6PPD only gain our attention once they have accumulated to the point that significant disruptions occur to the processes of life itself. For instance, the scientists who discovered 6PPD's toxicity worked backward from acute mortality events to discern the root chemical cause.[3] This sort of scalar shift, in which miniscule byproducts are discovered to have outsized effects, is part of the work that both science and literature do—to make visible that which might otherwise remain invisible.

In 1930, work began on a 3.75 mile long tunnel to divert the New River to a hydroelectric plant in Gauley Junction, West Virginia that would, in turn, produce electricity for a metallurgical plant. The hydroelectric project, the tunnel, and the metallurgical plant were all, through legalistic sleight-of-hand, owned by Union Carbide and Carbon Corporation. The tunnel was discovered to have very high concentrations of

1 Zhenyu Tian et al., "A Ubiquitous Tire Rubber–Derived Chemical Induces Acute Mortality in Coho Salmon," *Science* 371, no. 6525 (December 3, 2020): 185–189.

2 Tian et al., "Ubiquitous," 189.

3 Tian et al., "Ubiquitous," 185.

valuable silica and was expanded into a mine.[4] 4,887 men, many of whom were migrants and/or Black, worked on this project, and at least 2,982 men worked in the tunnel. For the sake of expediency and profit, safety measures like using masks and wetting the silica were ignored. As a result, airborne silica caused significant health problems for the miners, and an estimated 764 miners died from silicosis, in which silica accumulates within and cuts up the lungs, causing scaring and ultimately suffocation.[5]

In 1936, the poet Muriel Rukeyser drove to West Virginia to report on the Gauley Tunnel disaster. By this point Rukeyser, although only 22, was already an established poet—her first poetry collection, *Theory of Flight*, had been selected to receive the Yale Younger Poets Prize in 1935.[6] In 1938, she published the documentary poem series "The Book of the Dead" in her collection *U.S 1*, named after the East Coast highway she took from New York City to West Virginia. "The Book of the Dead" turned out to be an early entry in a lifetime of socially-attentive works about America. The first line of "The Book of the Dead" is "These are roads to take when you think of your country," a line that unifies thinking of one's country, here America, with the road infrastructure that makes this country accessible, and perhaps in some way constitutes it.[7] In other words, critical consideration, location, and infrastructure overlap. Later in the text, after readers have encountered the mortal dangers of silica and its uses in steel and concrete, a version of this line returns as "this is the road to take when you think of your country,/ between the dam and the furnace, terminal," unifying thinking of one's country with the infrastructure projects of the hydroelectric dam and steel furnace, while also emphasizing with the word "terminal" how such projects can entail mortal costs.[8] Here, infrastructure projects and the country they create can be dangerously intertwined.

Significant attention in "The Book of the Dead" is paid to the greed that underlay such dangerous working conditions.[9] As Rukeyser points out, the contractors organizing the tunnel "neglected to provide the workmen with any safety device."[10] The effect was that "Almost as soon as work was begun in the tunnel/ men began to die

4 Tim Dayton, *Muriel Rukeyser's The Book of the Dead* (Columbia: University of Missouri Press, 2003), 16.

5 Dayton, *The Book of the Dead*, 17.

6 Dayton, *The Book of the Dead*, 13.

7 Muriel Rukeyser, "The Book of the Dead," in *The Collected Poems of Muriel Rukeyser*, eds. Janet E. Kaufman and Anne F. Herzog (Pittsburgh: University of Pittsburgh Press, 2005), 73.

8 Rukeyser, "The Book of the Dead," 97.

9 Here and throughout, I refer to the poetry series as a whole, rather than identifying individual poems, though it is worth noting that twenty poems make up the series, and while each poem touches upon different aspects of the disaster, they also work in conjunction with each other, with themes reappearing and developing over the course of the text.

10 Rukeyser, "The Book of the Dead," 75, 76.

among dry drills. No masks."[11] The motivation for this was profit: "A fellow could drill three holes dry for one hole wet."[12] Mitigating or ignoring standard safety protocols meant the silica could be drilled faster, and thanks to the Great Depression, laborers were numerous and deemed replaceable. Thus, "The ambulance was going day and night."[13] Sick workers were misdiagnosed as having "pneumonia" or "fever," and Union Carbide would fire workers as soon as they said they felt ill.[14] Similarly, Union Carbide utilized the legal system to styme accountability.[15] Altogether, "The Book of the Dead" shows how workers were sacrificed for profit.

The privatization of public utilities, an issue infrastructure projects face today, is also discussed in "The Book of the Dead." As Rukeyser points out, the project was originally licensed "to develop power for public sale," but instead sold all power to the metallurgical plant.[16] As Bruce Robbins notes in "The Smell of Infrastructure," public utilities "are required by law to render adequate service at reasonable prices to all who apply […]. It is because these services are deemed essential to the public welfare that they are regulated directly by the government."[17] That the project wholly benefited Union Carbide speaks to the mendacity of the project, but it also implicates governmental acceptance of such privatization. As Rukeyser points out, after the disaster Congress failed to pass "A bill to prevent industrial silicosis."[18] Instead, "Bill blocked; investigation blocked," implicating a degree of governmental complicity in the ability of businesses to place profit over workers' health.[19]

Generally (though perhaps incorrectly), infrastructure is understood as invisible, except for when it falters. As Adam Rothstein points out, "Visibility, or lack thereof, is [a] common theme in infrastructural research […]. The infrastructure itself is designed to be kept out of sight." In response to the question of "why do we go to the effort to make [infrastructure] visible?," Rothstein replies: "Perhaps because of the lengths those in power will go to control the visibility of infrastructure."[20] The Gauley Tunnel project became visible due to the large number of workers that died, but Union Carbide worked hard to obfuscate these deaths, for instance by quickly

11 Rukeyser, "The Book of the Dead," 79.
12 Rukeyser, "The Book of the Dead," 105.
13 Rukeyser, "The Book of the Dead," 80.
14 Rukeyser, "The Book of the Dead," 85, 87.
15 Rukeyser, "The Book of the Dead," 92.
16 Rukeyser, "The Book of the Dead," 76. See also Dayton, *The Book of the Dead*, 18.
17 Bruce Robbins, "The Smell of Infrastructure: Notes Toward an Archive," *Boundary 2: An International Journal of Literature and Culture* 34, no. 1 (Spring 2007): 26.
18 Rukeyser, "The Book of the Dead," 102.
19 Rukeyser, "The Book of the Dead," 104.
20 Adam Rothstein, "How to See Infrastructure: A Guide for Seven Billion Primates," *Rhizome*, July 2, 2015, https://rhizome.org/editorial/2015/jul/02/how-see-infrastructure-guide-seven-billion-primate/.

burying the dead.[21] Rukeyser is undertaking this task of making visible what was hidden, but this task is also the same of the scientists who discovered 6PPD as being the root cause of acute mortality events in coho salmon. In both instances, the normative invisibility of infrastructure is overturned in favour of showing the broader negative effects of infrastructure on life itself.

Part of what I think we can learn from "The Book of the Dead" lies in the text's attention to how something as small as silica can undergird infrastructure projects. Silica (silicon dioxide, SiO_2), sometimes referred to as quartz, is a hard mineral used to make concrete, bricks, and tiles more robust. The popularly available Portland cement contains about 25% silica, though concrete may contain up to 70% silica.[22] Even a short amount of exposure to airborne silica, for instance in breathing in dust while mixing concrete, can cause irreversible lung tissue damage. This becomes even more notable when we consider concrete's importance to infrastructure projects. Every year, three new tons of concrete are laid per each person on Earth. It is the second most consumed material, next to water.[23] Concrete production creates 4 to 8% of the world's carbon dioxide, with only coal, oil, and natural gas being greater sources of greenhouse gases. An article in *The Guardian* identifies concrete as "The Most Destructive Material on Earth," noting that "If the cement industry were a country, it would be the third largest carbon dioxide emitter in the world with up to 2.8bn tonnes, surpassed only by China and the US."[24] If we consider the effects of silica, concrete becomes even more deadly. As Rukeyser notes, in 1938 "500,000 Americans" had silicosis.[25] More contemporarily, as of 2012 "More than 23 million workers in China and more than 10 million in India are exposed to silica dust," and "1.7 million people in the United States and 3 million in Europe [are] similarly exposed," while "more than 24,000 workers in China die each year from silicosis."[26] Rukeyser was calling attention to a threat that has only grown as our usage of concrete, and thus of silica, has developed.

---

21 Rukeyser, "The Book of the Dead," 93.

22 Veronica Stanley, "A Close Look at Portland Cement," *The Synergist*, February 2018, https://synergist.aiha.org/201802-close-look-at-portland-cement.; Health and Safety Executive, "Control of Exposure to Silica Dust: A Guide for Employees," UK Government, March 2013, https://www.hse.gov.uk/pubns/indg463.pdf.

23 Colin Gagg, "Cement and Concrete as an Engineering Material: An Historic Appraisal and Case Study Analysis," *Engineering Failure Analysis* 40 (May 2014): 114.

24 Jonathan Watts, "Concrete: The Most Destructive Material on Earth," *The Guardian*, February 25, 2019, https://www.theguardian.com/cities/2019/feb/25/concrete-the-most-destructive-material-on-earth.

25 Rukeyser, "The Book of the Dead," 103.

26 Tan Ee Lyn, "China Study Finds Mine Workers at Higher Risk of Cancer, Heart Disease," *Reuters*, April 19, 2012, https://www.reuters.com/article/us-china-mines-disease-idUSBRE83I04S20120419.

Overall, I think we should consider how infrastructure depends on material byproducts that are released throughout the various stages of infrastructure construction, usage, and deterioration. By the term "byproduct" I mean both definitions provided in the *OED*: "A secondary product; a substance of more or less value obtained in the course of a specific process, though not its primary object," as well as something that is "transferred."[27] Silica, for instance, was initially a secondary product of the tunnelling project, while also being transferred into the miners' lungs. 6PPD is a byproduct of car tire wear and is also transferred into streams and waterways. Via the creation and usage of infrastructures such byproducts are transferred to locations where they have negative effects on life.

Central to discovering and attending to infrastructure byproducts is the task of making the invisible visible via processes of scalar shift. For instance, "The Book of the Dead" describes a series of x-rays taken over a ten-month period that track the accumulation of silica in a miner's lungs. By using language to make the silica visible, both through the poem's contraction of ten months to a few stanzas and in representing the piercing vision of x-rays, Rukeyser is calling attention to the cumulative effects of silica.[28] In turn, silica gets connected in the text with a wide range of infrastructures, including roads, mines, dams, and electrical grids, as well as the bodies of knowledge represented in medical reports and judicial and legal proceedings. This process of interconnecting the miniscule and vast aligns with Lynn Keller's discussion in *Recomposing Ecopoetics: North American Poetry of the Self-Conscious Anthropocene* of using scalar shift as a tool for comprehending the Anthropocene, even while "The Book of the Dead" precedes by almost 75 years Keller's examples of works by contemporary poets. As Keller points out, "Fundamental to the concept of the Anthropocene is its bringing together—and even into collision—vastly discrepant scales."[29] In addition to thinking "in scales of deep time and space," we must also "shrink our gaze to attend to the surprisingly grand significance of microbes and microfauna […] of the health effects of minute amounts of toxic chemicals.[30] While preceding knowledge of the Anthropocene, "The Book of the Dead" attends to how miniscule particulates can have outsized effects. At one point, silica even becomes the speaker of the text, describing "my death upon your lips" and how "Now they are feeding me into a steel mill furnace," supplying silica with a degree of agency and subjecthood

27 *Oxford English Dictionary Online*, "by-product, n.," accessed September 3, 2022, https://www.oed.com/view/Entry/25592?redirectedFrom=byproduct.

28 Rukeyser, "The Book of the Dead," 83.

29 Lynn Keller, *Recomposing Ecopoetics: North American Poetry of the Self-Conscious Anthropocene* (Charlottesville: University of Virginia Press, 2017), 32.

30 Keller, *Recomposing Ecopoetics*, 33.

that threatens the reader.[31] These sorts of scalar shifts help the reader to conceptualize silica's dangerous materiality in ways that move beyond silica's miniscule size.

Byproducts like silica and 6PPD are central to the operations of infrastructure, but because of their small size often remain invisible to us until we consider their large-scale repercussions. We often discuss infrastructure projects in relation to their intended goals, but as silica and 6PPD show, there are also important unintended effects. Michelle Murphy argues that such oversights in our accounting may be purposeful, noting, for instance, that our understanding of industrial chemicals are inherited from "corporate forms of technoscience" that emphasize "discrete molecules" as if such molecules remain isolated and without context.[32] In turn, these constricted models are used in environmental regulations that industrial lobbyists ensure depend on "corporate-produced data" that "structurally will not count side effects, fallouts, or discards."[33] In other words, part of why more attention may not be paid to a dangerous particulate like silica or 6PPD is because of the dominance of corporate-influenced models for understanding and regulating such particulates. Indeed, it may surprise you to learn that about 2,000 times more particle pollution is produced by tires than vehicle exhaust, and though tires introduce 250 different chemicals into the environment, many of which are carcinogenic, there is little regulation on what chemicals tires can contain.[34] These sorts of oversights are beneficial for companies who get to treat the environment, much like Union Carbide treated its workers, as disposable. As Rukeyser notes, after "They poured the concrete," "stocks went up."[35]

I introduced 6PPD and its effects on coho salmon at the start of this article because I want to show how infrastructure byproducts affect more than just humans. Rukeyser excellently attends to how silica adversely affects human life, but we might also consider how infrastructure can have substantial, though perhaps often-overlooked, effects on the creatures around such infrastructures. As Stephanie Wakefield and Glenn Dyer argue, while infrastructure may seemingly appear "immanent to life, banal and commonplace," the study of infrastructure ought to "reorient the way we think about power, life, and revolution, and to set out adequate starting

31 Rukeyser, "The Book of the Dead," 95.

32 Michelle Murphy, "Alterlife and Decolonial Chemical Relations," *Cultural Anthropology* 32, no. 4 (November 18, 2017): 495.

33 Murphy, 495–496.

34 Damian Carrington, "Car Tyres Produce Vastly More Particle Pollution than Exhausts, Tests Show," *The Guardian*, June 3, 2022, https://www.theguardian.com/environment/2022/jun/03/car-tyres-produce-more-particle-pollution-than-exhausts-tests-show.

35 Rukeyser, "The Book of the Dead," 101.

points from which to begin rebuilding all three."[36] I think attending to infrastructure byproducts could prove a productive inroad toward reorienting how "we think about power, life, and revolution," since attending to infrastructure byproducts challenges assuming that infrastructure is either immanent to life or banal, and instead focuses attention on how infrastructure can disrupt the operations of life in ways that may initially be difficult to discern. Thus, attending to infrastructure byproducts could prove a robust tool in both infrastructure studies and the environmental humanities by helping us to better comprehend infrastructures' effects and entanglements with the world. Considering the upstream and downstream costs of the construction and operations of infrastructure—the silica poisoning of miners and laborers, the carbon dioxide footprint of concrete, the life-disrupting effects of 6PPD—should be part of our accounting when discussing infrastructure. Much like 6PPD's disruption of the life processes of salmon reveals the entanglement of road infrastructure with aquatic life, considering infrastructure byproducts offers a more expansive understanding of humans' relations with the living world.

36 Stephanie Wakefield and Glenn Dyer, "Notes from the Anthropocene #2: Infrastructure," *Brooklyn Rail*, March 5, 2015, https://brooklynrail.org/2015/03/field-notes/notes-from-the-anthropocene-2-infrastructure.