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Resource Operations of the Ecological Digital Humanities

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LARGE-SCALE INDUSTRIAL PROCESSES AND NETWORKS OF EXTRACTION, SLOW VIOLENCES WROUGHT ACROSS TOXIC LANDSCAPES, AND RAPidly shifting atmospheric, oceanic, and hydrologic cycles are altering the conditions of human and nonhuman existence in ways that challenge the limits of existing media technologies. The last of these transformations—the fluctuating distributions of water—is the focus of this essay. Hydrologists are struggling to model and predict the intensities of drought, the changing supply of watersheds, the dispersions of chemicals through streams and rivers, and the failures of aging infrastructure. Water transports contaminants too small to identify by sight, requiring technologies that can register tiny particles on a massive scale. Water complicates boundary-making projects—it moves easily across local and regional zones, human and nonhuman bodies, and atmospheric, terrestrial, and marine ecologies. Global weather patterns and distribution infrastructures shape its circulation, yet its material effects depend greatly on local conditions.

Artists, activists, and humanities scholars face the same difficulties in mediating hydrologic changes, and it is perhaps for this reason that digital platforms, which offer different rubrics of scale and movement, have been widely adopted. In the last decade, digital projects have tracked the pollution of rivers and lakes, the water shortages of cities around the world, and the struggles over blue gold.[1] For some, digital media are an outreach mechanism, a tool that can circulate ecological messages more widely than traditional means of communication. For others, digital systems offer a new way to access, generate, or mobilize data that will alter environmental politics and scientific practice. Mobile phone–based applications, including *NextDrop*, *WaterQuality*, and *CreekWatch*, crowdsource information about local water systems and at times make it accessible to affected communities. Digital media's databases and algorithms also afford possibilities for the remixing of aquatic archives and narratives.

Many of these projects, which ultimately seek to use digital media to create a more sustainable hydrosphere, share key techniques

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and epistemological orientations with the digital humanities (DH). Data visualization platforms, time-line applications, and geographic information systems are used to display a large body of information and to locate patterns indiscernible in a single text or location. Enabling users to shift between variables and navigate between linked sets of content, they facilitate nonlinear and nonintuitive encounters with data. The content of these platforms is often open-access, the purpose being to disseminate information beyond a field of specialists, and multidimensional, broadening the scale and scope of possible analysis. Although they diverge in their object of study, ecological digital media and DH projects are invested in digital technologies' capacity both to reconfigure informational resources and to facilitate new extractions of meaning.

This capacity is generated by what I call the resource operations of digital media. Both in software and in industrial extraction, *operation* signifies a formalized process that produces value from individual inputs. At the same time, *operation* is used to describe the system that organizes such processes, whether it is a mining operation or the operating system of a computer. Nadia Bozak and Shane Brennan have each used the concepts of the resource image and the resource data file, respectively, to highlight the extraction of natural resources needed for media production and distribution. The term *resource operation* draws attention to the ways that computational and logistical operations entail the definition of inputs and thus the reduction of the material world to a set of resources. In natural resource operations, nonhuman materialities are distilled into a standing reserve for human use. Digital humanities projects transform texts into online resources, recast the relation between scholarly work and financial resources, and reorient the humanities in regard to institutional support. In other words, the operations of the digital humanities alter the resource potential of texts, knowledge, and people. Many have observed that this effect has helped integrate humanities research into neoliberal systems of exchange and value.

In the case of ecological digital platforms such as *Growing Blue* and *Aqueduct*, which connect disparate sources of data, give new actors access to water supply data, and collectively map the emerging water crisis, the systems' operations produce natural resources as informational resources. As Stacy Alaimo has observed of many Anthropocene visualizations, in these platforms the human spectator is dislocated from the material world and situated as an abstract force whose geological agency (in this case, hydrologic agency) is enacted in their manipulations of the virtual landscape (*Bodily Natures* and *Protest*). When social and cultural factors are included, they are often treated as variables, discrete factors that will affect or be affected by the supply of water. Through an analysis of these projects below, I highlight the ways in which ecological digital projects, as they encode nature as a resource that can be operationalized by algorithmic systems, depend on nature's separation from the messiness of culture.

There is a fundamental tension between the operation of such platforms and environmental humanities research, which has interrogated and complicated the boundaries between culture and nature, between human and animal, and between bodies and the environments in which they are enmeshed. Recent work in ecocriticism has reconceptualized the agencies that extend across the human and more-than-human world, tracing how ecological phenomena are constituted through the intra-actions rather than interactions of discrete entities. Scholars such as Stefan Helmreich, Melody Jue, and John Durham Peters have argued that water is not only a lively materiality but also a medium. Coursing through infrastructures, landscapes, and all forms of life, it both transmits and transforms other elements. By the time "it reaches our faucet in the form of potable water," Ma-

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ria Kaika observes, "it is neither purely natural nor purely a human construction" (6). As the environmental humanities have well documented, the reduction of generative matter and transformative elements into resources underwrites the expansion of capitalism, enables privatization, and causes scarcity.

In the emerging ecological digital humanities, resource operations are extended beyond discourse to an array of nonhuman forces. Such projects, if they are to draw from existing scientific data sets, run the risk of bounding the messy, complex materiality of water in ways that segment it from culture. In order to operationalize water, they might, as many "big data for sustainability" projects do, turn it into a natural resource and an informational resource, as amenable to capitalist production and privatization as to environmentalist action. But a critical orientation can counter this dominant paradigm, allowing water's material agencies, its mediating functions, and its intra-actions with cultural processes to inflect the operations themselves. In this essay I discuss three projects that offer other models for resource operations. *Good Water: Walkerton* and *Waterlife* encode water in a database in ways that foreground its ability to exceed the bounds of classification and disrupt the functions to which it is subjected. *#clusterMucks* uses digital techniques to render the complexities of water systems through a series of affective, multimodal compositions, situating both water and algorithms as material means by which human and nonhuman worlds are entangled. These three projects, using digital systems to model water as a powerful agent for connecting, combining, and mediating culture, undermine the procedural management of water as a natural resource.

Stress, Scarcity, Security

In the early 2010s, several interactive maps forcefully communicated the global water crisis. *Growing Blue*, a "data-driven water resource," launched a tool that color-codes countries on a global map according to the vulnerability of their water supply. Each is given a water stress level, which relates the human withdrawal of water from the area to the water's natural availability. The United States, with a level of 0.499, is light orange. India, assigned a level of 0.967, is dark red. Each variable—the water used by municipal systems, by agriculture, and by industry; the quality, reliability, and replenishment of water supplies—can be individually mapped. The *Aqueduct: Water Risk Atlas* provides a similar map but has a wider range of variables, including severity of drought, occurrence of flooding, and the percentage of the population without access to water resources (fig. 1). Both these visualizations are color-coded to indicate levels of threat and framed in discourses of security and risk.

These maps and the data that they assemble have been integrated into calls for environmental conservation and sustainable development. *Aqueduct* was recently used to call attention to the effect of fracking, which requires millions of gallons of water, on already stressed areas. The tool was also used by Toyota to conduct an analysis of its water usage in North America and develop conservation efforts. Both the *Growing Blue* and *Aqueduct* visualizations were aggregated from massive data sets and launched by partnerships of nongovernmental organizations, representatives from a range of industries, and academics and research institutes. *Aqueduct* includes data generated by Coca-Cola, and the Aqueduct Alliance that supported the project was founded by General Electric and Goldman Sachs. The projects increased awareness of the global water crisis but are being used extensively by companies to design smarter business practices and better organize their supply chains. As a reporter from the *Wall Street Journal* noted, a company like Nike might use such visualizations to assess if its factories, which produce "water-intensive

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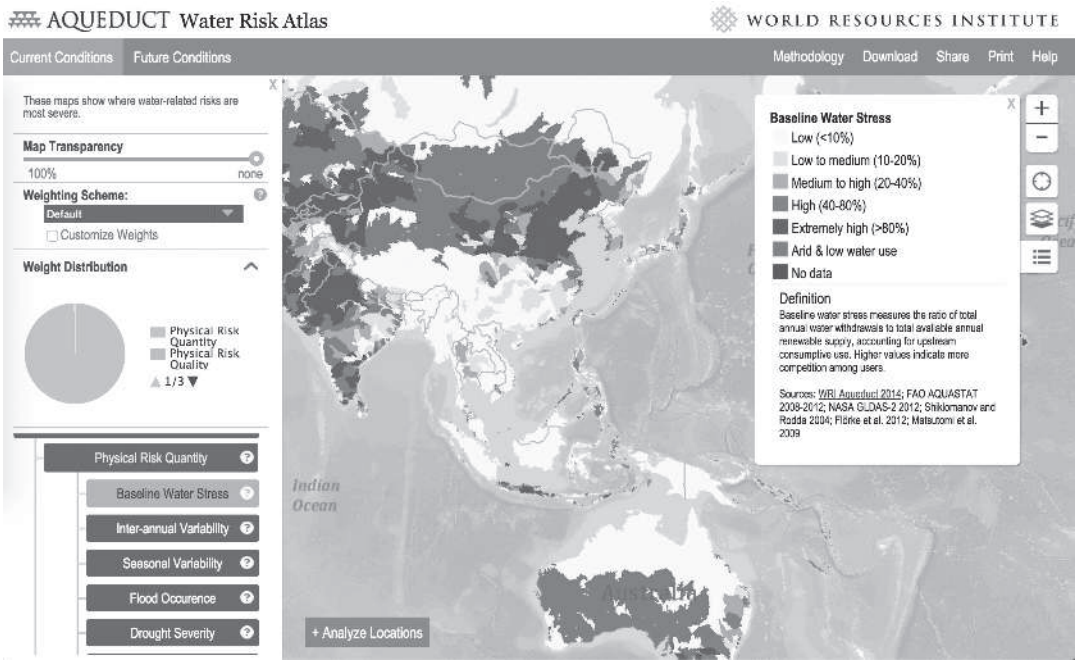


FIG. 1 *Aqueduct* indicates water stress levels around the world.

cotton," will be affected by drought (Davidson). And he points out bluntly, "There can also be ways for investors to benefit from water scarcity."

These projects' openness to both exploitation and conservation is underwritten by the ways water is encoded in their algorithmic operations. Take, for example, the key index of both projects, water stress. Water stress is often used in scientific studies, and the data gathered to compute it precedes the production of either visualization. It is a rendering of the hydrosphere in capitalist terms: the ratio of the human use of water to the natural supply of water. In the *Aqueduct* project, use is termed "withdrawal" and is the result of a function that computes gross domestic product, population, irrigated areas, and power production, among other indicators (Gassert et al. 5). In turn, supply, termed "available blue water," is calculated as the water that flows into a catchment area, its volume subtracted by upstream consumptive uses and runoff (7). Although the operations that process this data are complex, it is clear that ideas of resource scarcity and risk are not only demarcated through aesthetic choices and framing but also encoded in the definition of the system's inputs and data.

In order to create a legible diagram of the hydrosphere in a state of crisis, water has to be input as a natural resource both separate from culture and located geographically. Calculating withdrawal requires that a boundary be drawn between human use and the many ways that water might be distributed through environments to support human and nonhuman life. Human use, as it is calculated on the basis of population, assumes a human subject with standardized water needs and the ability to access it. Boundaries must be drawn between polluted and unpolluted waters, along national borders and watersheds, but they are not drawn between corporate and individual users. Distinctions (or lack of distinctions) that encode assumptions about human use are necessary to produce a numerical value that can be calculated in these operations, correlated with color, and used to articulate a striated world of differential resource availability. It is this register of difference that legitimates the framing of "water security" as

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the ability of a population to "safeguard" its resources (United Nations 1).

Other mapping systems, though explicitly oriented toward environmentalist practice, rely on similar resource operations. The Resource Investment Optimization System is an open-source tool designed to improve water management. It enables users to input data about their management priorities and creates an investment map on the basis of these priorities. The Nature Conservancy's *Urban Water Footprint*, released in 2014, maps water stress in relation to potential natural solutions, such as reforestation and fossil fuel reduction. Like *Growing Blue* and *Aqueduct*, these maps presuppose a certain calculability of water as an entity that can be graphed and manipulated. They allow investors and environmental conservationists to model, through the manipulation of variables, where water can and should be managed.

Cecilia Chen, Janine MacLeod, and Astrida Nemanis's observation proves apt in these water crisis visualizations: "[U]ndergirded by anthropocentric logics of efficiency, profit, and progress, waters are all too often made nearly invisible, relegated to a passive role as a 'resource,' and subjected to containment, commodification, and instrumentalization" (3). In such projects, the transformative abilities of water and the complexities of engagement and corporeal exchange are absent. Any understanding of how water and its pollutants are differentially experienced across bodies or cultures is precluded, and a globally interconnected system is bounded. The digital visualizations instead, through their very operations, help make water scarce. As Greg Garrard notes, scarcity "is not simply an objective fact about the natural world, but a function of the will and means of capital: the purposes that guide production, and the technologies that facilitate it" (31). Technologies, including digital visualizations such as *Growing Blue* or *Aqueduct*, that harness big data for sustainability are inevitably part of this process.

Water Is . . .

Growing Blue and *Aqueduct* rely on a standardized definition of what water is: a natural resource that will be uniformly consumed across a population and that can be clearly separated from toxins and pollutants. *Good Water: Walkerton* disrupts these assumptions. Of all the digital media projects discussed here, it best mirrors the methods of digital humanities. It visualizes a set of keyword searches for the terms *good water*, *safe water*, *chlorine*, and *taste* in 20,000 pages of transcripts of an inquiry into the contamination of the water supply of Walkerton, Ontario, which left seven residents dead and thousands sick. *Good Water: Walkerton* uses a fairly simple screen display, in which text blocks, each an excerpt from the transcript, move from the bottom of the screen to the top.

Even though *good water* and *safe water* are markers used to determine what parts of the transcript are shown on the screen, the textual fragments speak to the contradictory understandings of good or safe water. An excerpt from Ken Prehogan's testimony reads, "[S]afe water was being provided in the context, in the sense that nobody was getting sick." A few moments later, another testimony states, "Yeah, I think that's consecutive coliform counts and that, yes, is an unsafe water condition." Safe water is understood both in terms of its effects on bodies (water is safe if it does not make people who drink it sick), and in terms of analytic tests: the presence or absence of chlorine, E. coli, and other indicators determine its safety. The searches for the keyword *taste* reveal similar discrepancies between town members' abilities to determine water quality by taste and the state's regulations. Taste, of course, is subjective: "One person's swampy taste and smell is not another person's." As the text scrolls on, the conceptions of water quality multiply, making it clear that the phrases used to define text selections actually have diverse and conflicting meanings.

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Good Water: Walkerton, like many digital humanities projects, turns a set of documents, and in particular a selection of fragments from them, into a resource that can improve our understanding of water contamination. Instead of casting the lack of good water as a crisis of natural resource availability, the project foregrounds the failure to standardize good and safe water, showing that water takes on different meanings in different embodied contexts. The project works with "a suspicion rather than celebration of the reliability of database textual markers as guarantors of meaning, particularly when that meaning concerns tacitly and corporeally held knowledge" (*Good Water*). It cultivates suspicion not only about the definitions of consumable water but also about the computational operations for which these definitions are created: whether the state-supported tests of safe water or the algorithms that order the project's material itself.

The 2009 interactive documentary *Waterlife* differs from *Good Water: Walkerton* in form—it is a multimodal piece that uses text, images, video, and sound—but likewise rejects any clear-cut division between human beings and their environment. At first the project tells "the story of the last great supply of fresh drinking water on earth," framing water as a scarce resource, not unlike *Aqueduct* and *Growing Blue*. Both the interactive site and the associated feature-length film describe how the lakes are losing water every year, how invasive species are wreaking havoc on the ecosystem, how chemical contaminants are pervasive throughout the water supply, and how an array of human and nonhuman beings are suffering the consequences. "No matter where we live, the Great Lakes affect us all," the opening to the Web site tells us.

Yet *Waterlife* does not locate water as a variable that can be statistically mapped and rationally manipulated apart from the forms of life it interweaves. The project models water as an element that flows through and connects human and nonhuman systems, not as a resource that can be contained in a database. The central interface of the project is a map of the Great Lakes. Instead of projecting the lakes in terms of their resource potential or lack of it, this map is composed of images, each a screenshot from the film (fig. 2). In the top left-hand corner, a short text reads in white, "Water is." When the user hovers over it, twenty-three words appear below—"everything," "chemicals," "bottled," "shipping," "evaporating," "action," and so on. When the user clicks on a word, a new graphic constellation appears. The lakes transform into a seahorse (for "Water is invasive species") or into an icon of a trash can (for "Water is waste"). The individual media elements, like the waters that they represent, are fluid, adopting a new orientation in relation to each aquatic entanglement. In this way, even as the project focuses on a delimited place, the shifting of "Water is" destabilizes what the user encounters as water.

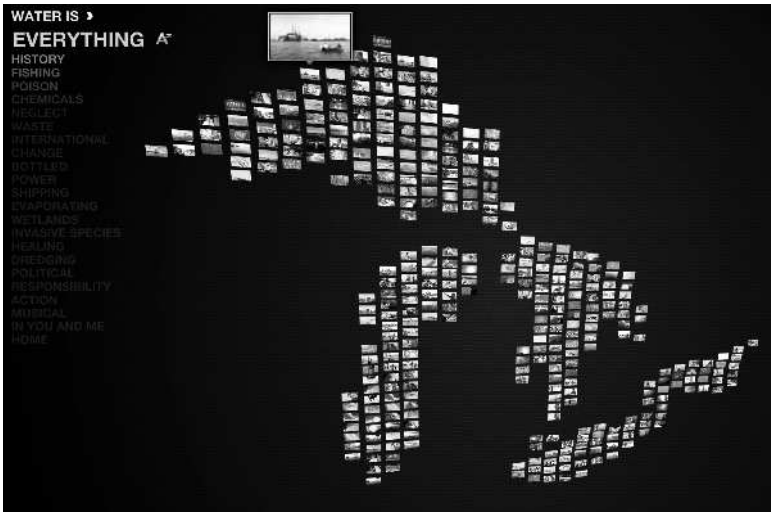


Fig. 2 *Waterlife* shows that "water is everything."

This destabilization happens not only through the juxtaposition of multiple definitions on the screen but also in the system's operations. In the project's technical configuration, water is not a variable that the

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user can manipulate. Rather, the screenshots themselves are the discrete elements that catalyze changes in the project's visual landscape and orient the user to water's transformative qualities. When the user clicks on any of the images that compose the Great Lakes, the cluster of images becomes mobile again, dispersing and floating around the screen, suggesting the movement of diving into the sea. The user moves among moments of encounter, short facts, narratives, and oral testimonies, each of which correlates to one of the "Water is" indicators on the left. For example, when "Water is everything" is selected, a pixelated image of a drinking glass on the edge of a dock comes into view. The text narrates, "A whole new class of chemicals, from pharmaceuticals to industrial chemicals, is showing up in our water." A voice-over says, "We don't know if they have any effect on human health." In the glass, small bright dots bounce. Dragging one's mouse over these dots brings up the names of the chemicals and their sites of production.

The narrative in this and other segments of *Waterlife* fosters a sense of transcorporeality, "of being immersed within incalculable, interconnected material agencies that erode even our most sophisticated modes of understanding" (Alaimo, *Bodily Natures* 17). The user is alerted to the fact that the spread of chemicals is pervasive, and yet their effects are unclear. In the glass, chloroform, mercury, and triclosan take the place of water molecules. Both composition and agencies here are uncertain and in flux—they are neither reduced to a single cause of harm nor remediable through capitalist means. In other video segments we see massive container ships that pollute the Great Lakes and water levels lowered because of climate change.

The sense of transcorporeality is enacted at the operational level as well, through the design of the movements of elements. While the recoloring of the landscape in *Growing Blue* and *Aqueduct* is a direct reflection of the user's choice to view water resources and produces a sense of mastery and management of such resources, the images in *Waterlife* are mobile, dispersed, and their movement exceeds the user's manipulations. Viewers are enfolded in the flow of images unraveling and reintegrating; water and media both connect and transform. Here, images, sound, and text are the discrete and manipulable resources and are operationalized in movements that reflect water's distinct material capacities.

#clusterMucks, Jamie Skye Bianco's iterative and performative documentation of toxic landscapes, also uses images, video, and text as resources for algorithmic operations. *#saltNsea* tracks the slowly evaporating waters of California's Salton Sea, the dramatic algae blooms that lead to massive fish die-offs, the endangered birds that stop at toxic wetlands on their migratory routes, and the industrial irrigation of the area to support the growth of organic foods. The disappearing sea poses a threat not only to the animals that inhabit it but also to the residents of Los Angeles, whose air will be contaminated by hydrogen sulfide swept toward the coast from the Imperial Valley. *#bottlesNbones* focuses on Dead Horse Bay, where the remains of horse rendering, the late-nineteenth-century trash of New York City, and the detritus of Hurricane Sandy all commingle on the city's shores. Like *Waterlife*, *#saltNsea* and *#bottlesNbones* do not map sites of ecological devastation in their entirety; rather, they assemble an inventory of objects, images, sound, and video that evoke the entanglement of human and nonhuman agencies.

Bianco terms her method algoRhythmic, and for each iteration or performance of *#clusterMucks* she creates an algorithm that organizes materials from the inventory. Included in this database are quotations from theorists, attempts to grapple with and explain *materiality*. For one performance, given at the Society for Literature, Science, and the Arts conference in Dallas in 2014,

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she brought the bottles and desiccated bones of fish, horses, and birds from the Salton Sea and Dead Horse Bay. Behind her, images and video from the two sites are overlaid with key words from theoretical texts in the new materialisms, feminist materialism, and object-oriented theory. At one point, she reads a quotation from Isabelle Stengers: "It is eliminating, dissolving away, all reasons to resist the redefinition of humans as a piece of engineering that can be understood by algorithms, and modified at will." Behind her an image of a degrading steel seawall on the Dead Horse Bay coast, juxtaposed with the word "matter," cuts to an image of blue Styrofoam among collapsed branches, with the word "anthropocene" in the upper left-hand corner. The displacement of these elements from their original contexts and their reordering by an algorithm produces new conceptual and aesthetic connections. Human trash and other forms of nonhuman matter are intermingled. The blue of the water gives way to the blue of the Styrofoam, the brown rods of the seawall to brown sticks. This sequence might lead the viewer to ask what remains after substances, human and nonhuman, have been engineered for algorithmic operations.

Several minutes later, Bianco quotes Claire Colebrook: "The task of theory is to take this form or Idea of difference—that we begin not with substances or subjects but potentialities for problematic relations." The video behind her is a close-up of encrusted dead fish and bird feathers. A plastic bin of the same dried fish matter is passed around the room. "Inventory" is written on the screen. The inventory of *#clusterMucks* is a set of resources, mobilized in these algorithmic operations toward the critique of the engineering of the world as data and the reduction of nature to a set of substances. As Melody Jue has argued, this is a database inspired by water, one that spills out around the edges, that rusts and transforms its elements instead of fixing them in a grid. The nonhuman world and the water that is present throughout much of the video exceed the designations they are given and become a way for viewers to thread together the fragmented landscape, to begin to articulate connections between ecological catastrophe on both coasts of the United States.

In their review of connections among ecocriticism, environmental history, and the environmental humanities, Hannes Bergthaller and his coauthors write, "The value of the environmental humanities, we suggest, lies precisely in their resistance to such bottom-line imperatives and to the allure of the 'cutting edge'" (265). This statement encapsulates a key tension between the environmental humanities and the digital humanities, a field that often makes use of cutting-edge technologies and massive data sets. Drawing from these data sets, whether generated through crowdsourcing or scientific labor, digital ecological projects all too often rely on distinctions between human and nonhuman worlds that neatly segregate messy and entangled materialities. We must look critically at the resource operations at work in order to avoid reproducing natural resources as informational resources that can be used in the interests of environmental management and capital. Instead, let us turn to projects that incorporate such a critical orientation in their very design. *Good Water: Walkerton*, *Waterlife*, and *#clusterMucks* offer other models for digital media's resource operations, ones that attend to the materiality of the environment, reflect on these environments' ability to exceed their engineering, and envision the entanglements of human and more-than-human worlds.

Note

1. See, for example, *Waterlife*; *Water, CA*; *A Hundred Gallons*; *Over Water under Fire*; *Aqueduct*; *Water Blues, Green Solutions*; *Los Angeles Aqueduct Digital Platform*.

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