Engineering Transformations of the New York Canal System and Long-Term Environmental and Public Health Implications.

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Introduction

Three rivers, the Hudson, Mohawk, and Passaic, drained much of northeastern United States. The lands adjacent to these rivers were low-lying bottomlands that flood with the seasons, unconstrained by human structures.

In the last century, the New York Canal System has become an economic engine as humans reengineered the rivers by creating canals and channels and their bottomlands with extensive systems of levees, locks and dams, floodwalls, and reservoirs.

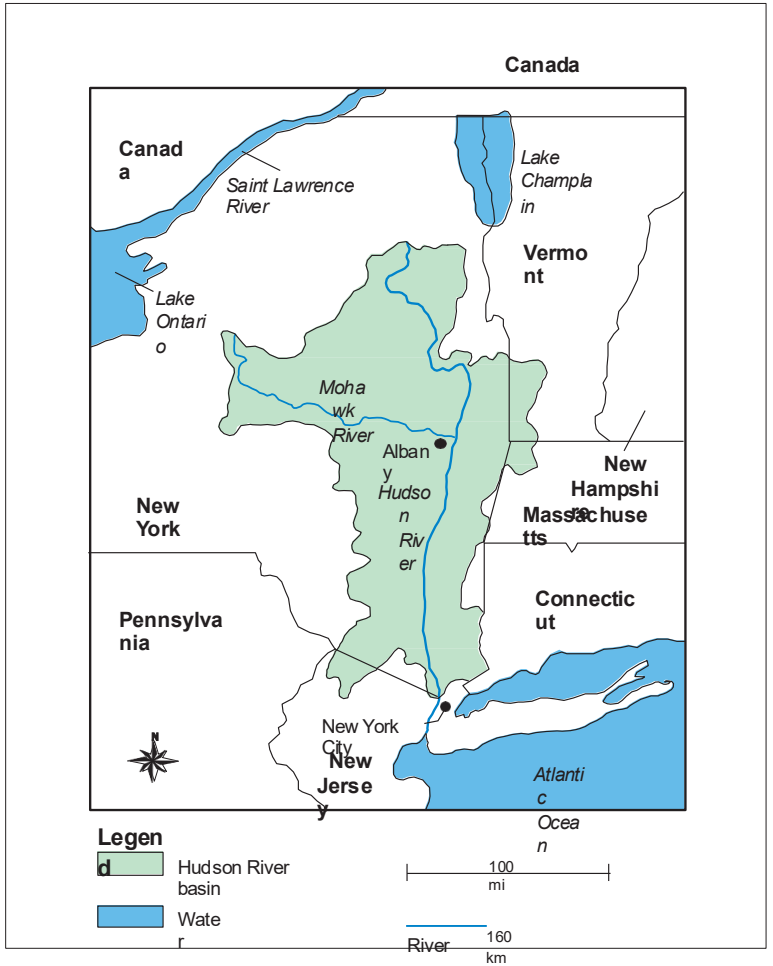


Figure 1. The Hudson and Mohawk River basin in the State of New York, United States.

The primary objectives of this article are:

To examine the complex and ever-changing Hudson, Mohawk, and Passaic River landscapes and their systems.

Review historical impacts of climate, chemical and industrial manufacturing, channel construction, economic and population growth, pollution and efforts to manage waterways with engineered structures.

Make recommendations on future management to protect soil and water resources and facilitate social, economic, and ecosystem balance.

Case Study 1. Hudson River

The Hudson River with its abundant water supply and capacity to transport raw materials and finished goods, fueled the Industrial Revolution of the 1800s.

Settlements and industries along the Hudson River valley flourished, creating jobs, expanding communities, bringing economic prosperity to the northeast region and the United States.



Figure 2. The confluence of the Hudson River (background) and the Mohawk River (far right), and the Erie Canal (front and center) near Troy, New York.

Two General Electric (GE) capacitor manufacturing plants were built at Fort Edward and Hudson Falls, New York, on the Hudson River north of Albany and used PCBs from 1947 to 1977 in their production processes.

In its wake, an era of industrial pollution (PCBs) that left an ugly mark on the river celebrated for its beauty and pristine waters.

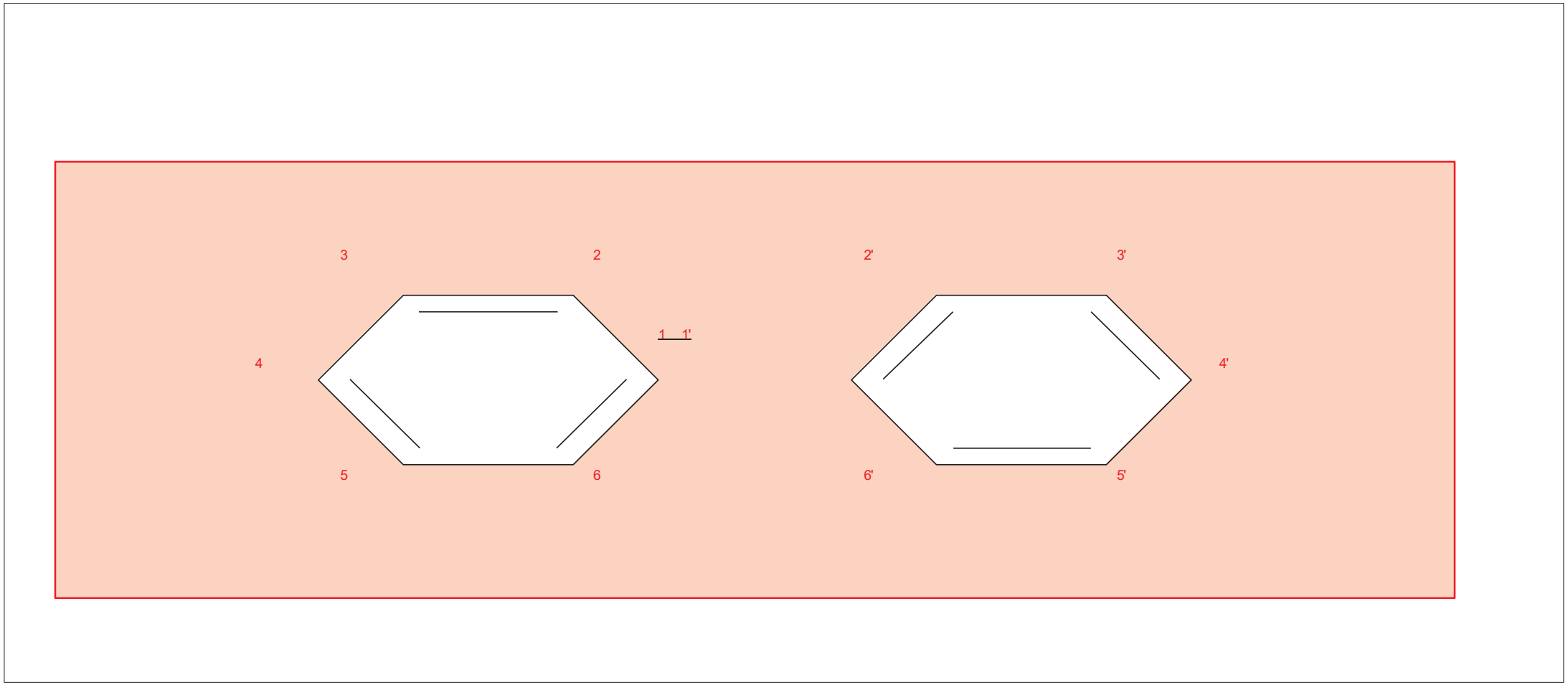


Figure 3. Biphenyl molecule with the numbering system. In polychlorinated biphenyls (PCBs) some or all of the 10 hydrogens (attached to carbon atoms numbers 2 to 6 and 2’ to 6’) are substituted with chlorines, thereby creating groups of chlorinated compounds (congeners).

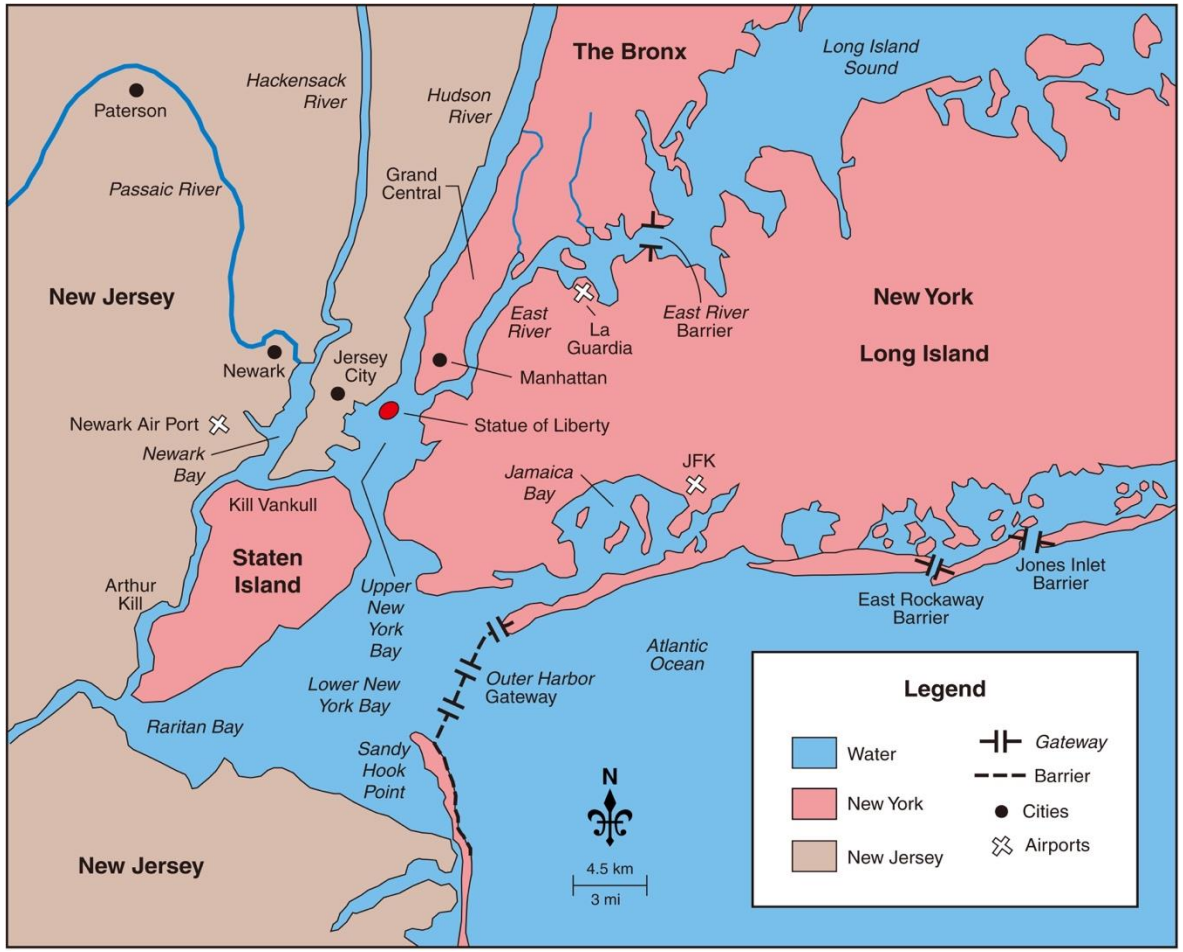


Figure 4. Passaic River, a 27 km dioxin hotspot near Newark, New Jersey and flows into Newark Bay, Hudson River and the Atlantic Ocean. Published with copyright permission from Editor of Open Journal of Soil Science. Map created by Mic Greenberg.

Recreational fishing of the Hudson was banned from 1976 to 1995, and a fish consumption advisory continues in effect in the contaminated reach.

Over 90% of ducks tested in 2008 downstream of the GE plants but above the Hudson tidal river influence exceeded the US Food and Drug Administration 3.0 mg m–1 tolerance level for PCBs in fatty tissues.

In 1984, the USEPA designated 322 km of the Hudson River a PCB Superfund Site”.



Figure 5 Recreational fishing boats on the lower Hudson south of the Troy Federal Dam. A fish advisory remains in effect with cautions against eating them.

In its wake followed an era of industrial pollution (PCBs) that left an ugly mark on the river celebrated for its beauty and pristine waters.

In 1984, 321 km of the Hudson River was classified by the US Environmental Protection Agency (USEPA) as the Hudson River PCBs Superfund site—one of the largest in the country.

Under the oversight of USEPA, billions of industrial and governmental dollars are spent to clean up waste sites and the Hudson River.

Case Study 2. New York State Canal System

During the last century, the New York State Canal System has become an economic engine as humans reengineered the rivers by creating canals and channels and their bottomlands with extensive systems of levees, locks and dams, floodwalls, and reservoirs.

The New York Canal System was dug through the upland from the Mohawk River to Lake Erie and Lake Ontario.

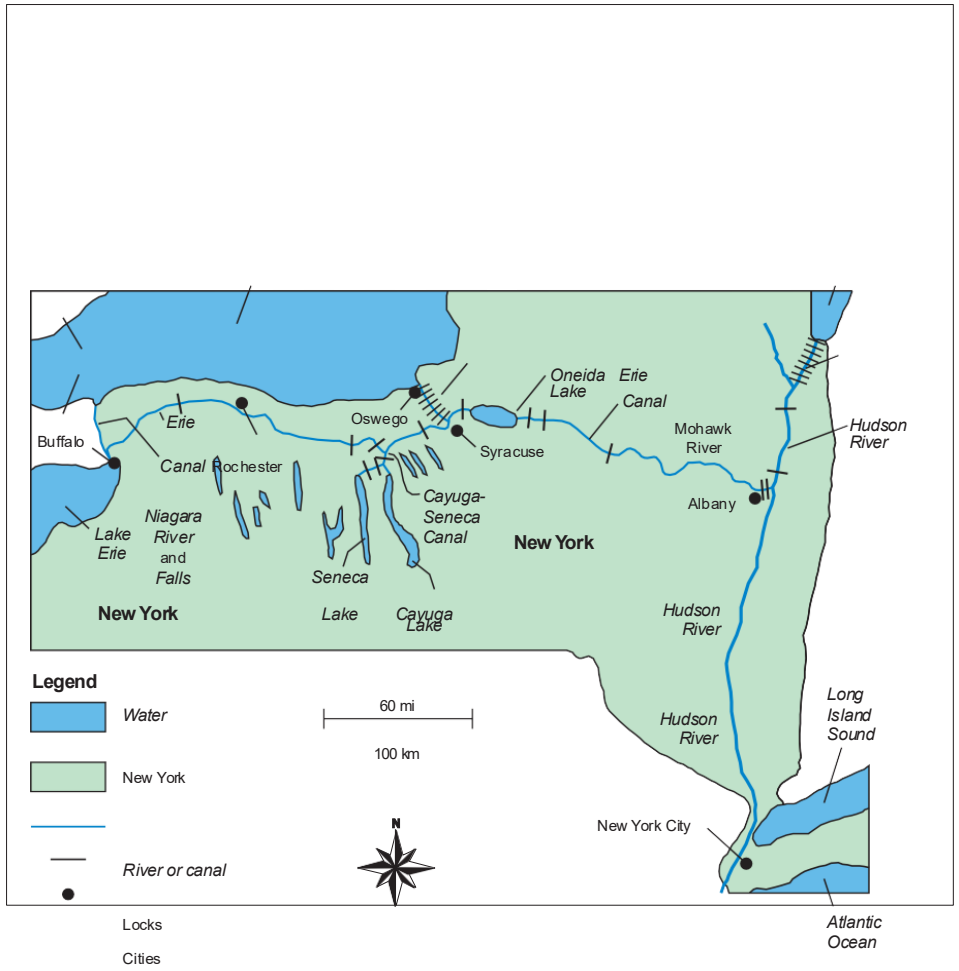


Figure 6. The New York State Canal System (built and enlarged 1817 to 1880) runs west-east from Buffalo on Lake Erie to Albany where it meets the Hudson River. At Albany the canal system runs north-south, connecting the headwaters of the Hudson to Lake Champlain by canal and flowing south to the mouth of the Hudson River, the port of New York on the Atlantic Ocean.

The New York Canal System was dug through the upland from the Mohawk River to Lake Erie and Lake Ontario.

A channel, Kill Van Kull, was dredged and deepen from the Newark Bay to the New York Bay to connect the Passaic and Hudson Rivers.



Figure 7. The New York State Canal System gates are closed at Palmyra Lock 29 creating slack water in the foreground as canal boats approach the lock from the east.



Figure 9. A view of East Kill Van Kull. Photo Credit: Jim Henderson



Figure 8. Ships waiting in New York Bay to enter the Kill Van Kull. Photo Credit: Jasmile.

In the 1950s, Diamond Alkali began to manufacture Agent Orange. Diamond Alkali workers stated in court testimony that they were exposed to Agent Orange by-product dioxin TCDD.

These workers claimed that the factory floors in the 1950s and 1960s were so slick with spilled and leaking Agent Orange and dioxin TCDD that it was treacherous to walk on them.

In 1983, sampling of soils and sediments by the State of New Jersey and US Environmental Protection Agency (USEPA) near 80 Lister Avenue in Newark and in the Passaic River revealed high levels of dioxin TCDD.

There were also high levels of PCBs and Hg because of the manufacture of the other chemical products.

In 2001, the USEPA, in partnership with New Jersey and other federal agencies, cleaned up the Lister Avenue manufacturing site.

The building was torn down and hauled to a landfill, and the site became a gravel parking lot; the dioxin-contaminated soil was removed and incinerated.



Figure 10. Gravel parking lot of the former Diamond Alkali Company. The dioxin conta- minated building was torn down and contaminated building materials were placed in a landfill. The contaminated soil was incinerated. The former chemical plant site was on the Passaic River bank. The site was made into a gravel parking lot. Published with copyright permission from Editor of Open Journal of Soil Science.

However, the chemical pollution of the pristine Passaic River waters left a 27-kilometer dioxin hot spot. The cancer-causing dioxin attached to the sediments as it flowed towards the Atlantic Ocean via Arthur Kill and the Kill Van Kull channels.

A chemical company called Diamond Alkali manufactured the herbicide, Agent Orange, for use as a defoliant during the Vietnam War at its Newark facility on the Passaic River.

However, the lesser-told story is the environmental and human health impacts on the chemical plant workers who manufactured Agent Orange at seven locations in the United States and one site in Canada.

The chemical plant workers and their families are continuing to live with the consequences of the early 1960s US government and military decision to use tactical herbicides during the Vietnam War.

These workers were exposed to dioxin TCDD during the chemical manufacturing process.



Figure 12. The North American locations of the eight Agent Orange chemical manufacturing plants, the primary Agent Blue chemical manufacturing site and the two Ports on the Gulf of Mexico where tactical herbicides were loaded on ocean-going ships. Map created by Cruz Dragosavac.

Medical doctors were able to determine dioxin TCDD caused chloracne and cancers in chemical plant workers. In March of 2016, a remedy for the contaminated sediment of the lower Passaic River was chosen.

The removed dredge material was dewatered and transported by barge to a sediment-permitted processing facility on the banks of the Passaic River and Newark Bay for disposal.



Figure 15. Deeping the Kill Van Kull channel to 17 m. USACE dredge brings up debris from bedrock broken by dynamite. Photo Credit: Bob King.

The estimated cost was US$1.38 billion. Cleanups for the remainder of Newark Bay and lower Passaic River are still being planned.

The USEPA estimated the cost of the cleanup and natural resource restoration of the lower 27 km of the Passaic River and Newark Bay to be US$12 billion.

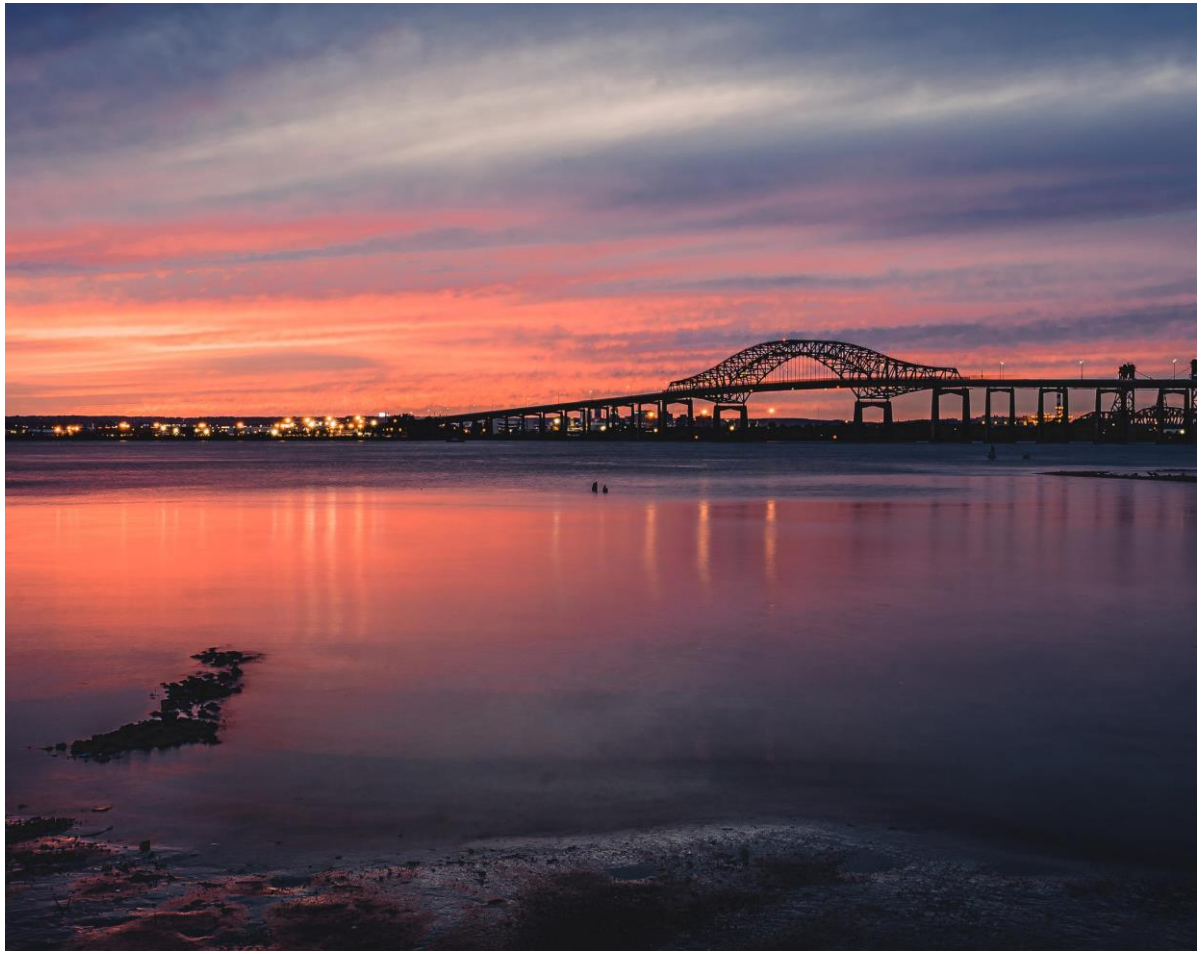


Figure 11. View of the Bayonne Bridge from Newark Bay at sunset. Photo Credit: istock.