THESIS PROJECT PORTFOLIO

River Water Treatment in Chennai: Producing Drinking Water by Reverse Osmosis and Biocrude Oil by Hydrothermal Liquefaction

(Technical Report)

The Response to Nestlé's Water Appropriation in California

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring, 2022

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TABLE OF CONTENTS

Water scarcity is one of the most significant environmental dilemmas that our society faces. Population growth and socioeconomic development are expected to increase water demand, both industrial and domestic, by 50-80% over the next three decades. This demand, in addition to the difficulty to distribute water equitably throughout the world, puts some areas in critical danger. In 2016, two thirds of the global population suffered from water scarcity for one month of the year. Access to water is recognized by the United Nations as a human right, and when that water is taken away it can provide for serious ramifications for health and safety of communities. The inequitable access of water poses a significant threat to the sustainable growth of human society. The question then arises: How can equitable access to safe drinking water be improved? The two papers within this thesis portfolio address this question from both technical and sociotechnical viewpoints.

Due to abnormal rain patterns and pollution of local water sources, the city of Chennai in south India has faced from severe water scarcity. The water originally was sourced from rivers that flow through the city, which have been polluted due to industrial waste. In the technical section of this portfolio, a plant was designed to treat the water from the Cooum river that flows through Chennai. The plant is designed to intake 13,300 m^3 of water from the Cooum River to provide 10,052 m^3 of clean drinking water to Chennai every day. The level of water production is expected to accommodate the water needs of approximately 230,000 people every day or 1% of the city's daily water needs. The process also takes advantage of the sewage in the Cooum River to produce a biocrude oil via an industrial scale hydrothermal liquefaction (HTL) reactor. This biocrude oil will help power some of the plant reducing operating costs. The plant shows overall profit for almost every year when HTL is included in the design. With an internal rate of return (a marker for investment health) of 34.01%, the investment in HTL shows promise

through economic analysis. After designing this plant, the design team recommends that both HTL and the drinking water treatment aspects of the plant be implemented.

The sociotechnical thesis in this portfolio regards water scarcity from the perspective of holding corporations accountable. Water is supplied in many ways, with corporations extracting fresh water from reservoirs and aquifers. These corporations must pay for this right, and in extracting fresh water must abide by laws to not disrupt related systems. Large corporations, including Nestlé Waters North America (now BlueTriton), have recently come under scrutiny for "drying up" creeks and harming local groundwater, all while not paying for the water they are extracting. Drying up creeks directly affects the wildlife around the extraction site and depletes groundwater, supply normally used for irrigation or drinking water. The California State Water Board failed to enact any legislative changes to hold corporations accountable for unethical extraction practices like this.

The paper addresses the case of Blue Triton and the California State Water Board through the lens of collaborative governance, a concept in political science used by environmental groups. The paper looks at the case through criteria set in literature regarding collaborative governance to see what information can be extracted from the case for the future of holding corporations accountable in this way. The criteria did not match the case studied, showing how collaborative governance could have provided for more concrete changes. For the future of environmental boards, collaborative governance should be integrated into policymaking. More opportunities for collaboration in regulatory boards is vital for the success of their investigations and work. Education regarding collaborative governance, both for public environmental regulatory agencies as well as for the public who are trying to challenge unethical practices, could be a major step in the right direction for consensus-based decision making.

The research conducted in the theses within this portfolio provide a basis for tackling certain aspects of the water scarcity problem our planet is facing. The technical research gave a foundation for building a reverse osmosis filtration plant in India, offsetting the energy required using a hydrothermal liquefaction process. Though this work provided a lot of substance, the research did not provide lots in terms of distribution of water to the city of Chennai after the plant produces it. The plant also requires lots of supplemental biomass from other areas, as the biomass from the river does not suffice for the energy the HTL reactor is meant to produce. The sociotechnical work gave a framework for analyzing responses from environmental regulatory boards using collaborative governance. This thesis showed interesting yet obvious results. The case did not match the criteria set by Ansell & Gash regarding collaborative governance, even after a literature search through multiple investigative documents. In the future, when analyzing cases using collaborative governance, other criteria should be added into the analysis. Ansell & Gash look further than the six criteria that define a successful collaborative governance body and look at factors that matter to collaborative governance but do not define it. These factors would be interesting to look at, especially for regulatory boards that claim they do abide by the definition for collaborative governance. The results of both projects proved to be quite rewarding, showing some serious promise for understanding how we look at water scarcity both by making water filtration methods more efficient and by giving insight into regulatory board responses to unethical extraction of water.