Undergraduate Thesis Prospectus

Mitigation of Stormwater Runoff from Ivy and Emmet Street Redevelopment Site

(technical research project in Civil Engineering)

Climate Change: Fossil Fuel Companies' Responses

(STS research project)

by

Allyson Beaubien

October 31, 2019

technical project collaborators:
Joe Dunleavy
Charlie Haywood
Andrew Spaziani

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

signed: _____ date: _____

approved: _____ date: _____
Peter Norton, Department of Engineering and Society

approved: _____ date: _____
Teresa Culver, Department of Civil Engineering

General Research Problem

How has human development impacted the environment and its natural processes?

To many, development is a sign of progress. Construction of new facilities and roadways is a constant, continuous cycle in both rural and urban areas, but such projects impact the local environment. In her Commencement Address to Scripps College (1962), Carson attributes the dumping of radioactive wastes into the sea and waging "war on organisms" to the point of extinction to man's conquest of nature. Climate change now threatens the world. Since the 19th century the average temperature of the Earth has risen 1.62^{o}F, and ice sheets in Greenland and the Antarctic have decreased in mass. In the past century sea levels rose 8 inches (NASA, 2019c). Human development is changing the environment and the very processes that keep mankind alive.

Mitigation of Stormwater Runoff from Ivy and Emmet Street Redevelopment Site

How can stormwater runoff from the redevelopment site near the intersection of Ivy and Emmet Street be mitigated?

The project department is Civil Engineering and my capstone advisor is Teresa Culver, Associate Professor in Civil Engineering. In this team capstone with fellow Civil Engineering students Joe Dunleavy, Charlie Haywood, and Andrew Spaziani, the project goals include designing a site layout and an onsite stormwater system that can serve as a gateway to the University of Virginia grounds. To manage stormwater, environmental effects and flood risks must be evaluated. The performance of the design will be explored under climate change conditions.

During the design of a project, stormwater management is a primary concern regarding both quality, the amount of pollutants, and quantity, the volume of runoff leaving the site. Site

development increases the impervious land cover, thus worsening the volume and peak flow of runoff as well as the pollutant loadings. The Energy Independence and Security Act (EISA), section 438, requires redevelopment to either maintain or reduce the pre-development runoff (Congress, 2007). Pollutants found in urban runoff include nutrients, such as phosphorus and nitrogen, which can collect in bodies of water and lead to eutrophication when excessive algae growth depletes the dissolved oxygen in the water. Suspended solids and trace metals are other pollutants which have an adverse effect on aquatic life. Flooding is another concern after redevelopment in which "pavement will fail or be undermined, structures will be water damaged, landscaping and other improvements not used to inundation will be damaged" (Virginia DCR, 1999). Stormwater management is a necessary part of design in order to avoid such undesirable impacts to the environment.

The Ivy and Emmet Street intersection is located at the entrance to the University of Virginia and serves as a cross-road between North Grounds and Central Grounds. Currently it consists of a mixture of undeveloped land surrounding a natural stream, residential and retail spaces. The vision as outlined in the University of Virginia's 2030 Strategic Plan is an "open grounds…designed to be welcoming to members of the UVA community, the surrounding communities, and visitors to grounds." The design is envisioned to include the three nexuses of Creativity, Democracy, and Discovery achieved through the inclusion of academic buildings centered around these ideals (University of Virginia, 2019). Without such a project this parcel of land would continue to serve as an unconnected, separate unit dividing the University of Virginia grounds.

AutoCAD Civil 3D, a civil design software, will be used to design the site layout, topography, and erosion and sediment control plans. GIS data of existing site conditions has been

provided for use in design. The Virginia Runoff Reduction Method (VRRM) will be utilized to determine the performance of chosen stormwater management systems to ensure compliance with volume and water quality regulations. Storm Water Management Model (SWMM) will be used to model both preliminary and post development site hydrology for 1, 2, 10, and 100-year storm events.

Upon completion of the project, a site layout design plan along with Virginia Runoff Reduction Method worksheets showing stormwater compliance and hydrological modeling to compare both before and after redevelopment conditions will be submitted. The Best Management Practices (BMPs) used to control stormwater will be included in a separate proposal along with a cost estimate and schedule. These components will comprise our design for consideration by the University of Virginia in the redevelopment of the project site.

Climate Change: Fossil Fuel Companies' Responses

How have fossil fuel companies responded to evidence and public pressure regarding dangerous climate change?

Since 1880, the global ocean and land temperature has increased an average 0.13^{o}F each year; 2014-2018 were the five warmest years on record (NOAA, 2019). The share in the atmosphere of carbon dioxide, a greenhouse gas, has increased steadily every year. In September 2005 the level of CO_2 was at 380 ppm, and presently, in September 2019, its level has risen to 412 ppm. In the Arctic, the sea ice is shrinking while sea levels are continuing to rise (NASA, 2019a). Major sources of carbon dioxide emissions include the burning of fossil fuels such as coal and oil (NASA, 2019b). The evidence of anthropogenic climate change is clear, but the question remains of what is being done to stop it.

Ayling and Gunningham (2015) analyzed the divestment movement and its strategies to push investors to withdraw from fossil fuel stocks and turn to climate-friendly alternatives. They found that the movement's confrontational strategies and planned, high-profile events attracted significant attention, and that its complex aims were less about achieving actual divestment than raising public attention to climate change. The researchers do not consider the impact of this raised awareness on fossil fuel companies. Nasiritousi (2017) examined the climate change rationales for the 10 largest oil and gas companies in the world. She analyzed their climate change activities and found active engagement by many in governance to influence policymakers and introduce energy efficient mitigation measures, but to various degrees. Effective climate change action was scarce. Her focus was on governance activities of fossil fuel companies, not to the impact of public pressure on their response.

Exxon Mobil claims it is reducing climate change risks through policy, stakeholder engagement, climate risk oversight, and climate change research (Exxon Mobil, 2018). Chevron's Chairman of the Board and Chief Executive Officer, Michael K. Wirth, states in his chairman's letter that Chevron is "managing climate risks to our business and taking on new opportunities to reduce greenhouse gas emissions and develop lower-carbon energy" (Chevron, 2019). Shell Oil claims its goals include sustainability and that it has a plan to "increase transparency around the topic of climate change." The company recently committed to setting short-term targets to reduce the Net Carbon Footprint (Shell, 2018). A top shareholder of Exxon Mobil, BlackRock, recognizes the financial impacts of climate and sustainability risks and states it "manages one of the largest renewable power funds" and claims that it supports a transition to low-carbon energy (BlackRock, 2019).

Lastly, the global movement #FridaysForFuture, inspired by Greta Thunberg, led to protests calling for action on global warming. In a speech to Congress, Thunberg called for "governments, political parties and corporations [to] grasp the urgency of the climate and ecological crisis." She demanded steep cuts in carbon dioxide emissions (Thunberg, 2019).

References

Ayling, J. & Gunningham, N. (2015). Non-state governance and climate policy: the fossil fuel divestment movement. *Climate Policy*, *17*(2), 131-149. http://dx.doi.org/10.1080/14693062.2015.1094729. Google Scholar.

BlackRock. (2019). Investors Underappreciate Climate-Related Risks in Their Portfolios – BlackRock Report. https://www.blackrock.com/corporate/newsroom/press-releases/article/corporate-one/press-releases/investors-underappreciate-climate-related-risks-in-their-portfolios

Carson, R. (1962). Commencement Address. *Scripps College Bulletin*, *36*(4), 5-11.

Chevron. (2019). Chairman's Letter. In *Update to Climate Change Resilience: A Framework for Decision Making* (1). https://www.chevron.com/-/media/shared-media/documents/update-to-climate-change-resilience.pdf

Congress. (2007). Energy Independence and Security Act of 2007. https://www.govinfo.gov/content/pkg/BILLS-110hr6enr/pdf/BILLS-110hr6enr.pdf

Exxon Mobil. (2018). Engaging on climate change policy. https://corporate.exxonmobil.com/en/community-engagement/sustainability-report/managing-risks-of-climate-change/engaging-on-climate-change-policy#effectiveClimateChangePolicy

NASA. (2019a). National Aeronautics and Space Administration. Carbon Dioxide. https://climate.nasa.gov/vital-signs/carbon-dioxide/

NASA. (2019b). National Aeronautics and Space Administration. The Causes of Climate Change. https://climate.nasa.gov/causes/

NASA. (2019c). National Aeronautics and Space Administration. Climate Change: How Do We Know. https://climate.nasa.gov/evidence/

Nasiritousi, N. (2017). Fossil fuel emitters and climate change: unpacking the governance activities of large oil and gas companies. *Environmental Politics, 26*(4), 621–647. https://doi.org/10.1080/09644016.2017.1320832. Google Scholar.

NOAA. (2019). National Oceanic and Atmospheric Administration. State of the Climate: Global Climate Report for Annual 2018. https://www.ncdc.noaa.gov/sotc/global/201813

Shell. (2018). Leading investors back Shell's climate targets. https://www.shell.com/media/news-and-media-releases/2018/leading-investors-back-shells-climate-targets.html

Thunberg, G. (2019). Greta Thunberg: I Have a Dream That the Powerful Will Take the Climate Crisis Seriously. *The Independent*. https://www.independent.co.uk/voices/greta-thunberg-congress-speech-climate-change-crisis-dream-a9112151.html

University of Virginia. (2019). A Good and Great University: The 2030 Plan. https://strategicplan.virginia.edu/The2030Plan.201908.pdf

Virginia DCR. (1999). "Department of Conservation and Recreation." Virginia Stormwater Management Handbook. https://www.deq.virginia.gov/Portals/0/DEQ/Water/Publications/HndbkVolumeI.pdf