

**FLOOD WARNING SIMULATION  
PROJECT ID: CEEN\_CPST\_05**

**by**

**FMA Engineering  
Jacob Anderson  
Justin Hunter  
Alma Meyer  
Taylor Porter**

**A Capstone Project Final Report**

**Submitted to**

**Dr. E. James Nelson  
BYU Hydroinformatics**

**Department of Civil and Construction Engineering  
Brigham Young University**

**April 11, 2022**

## Executive Summary

**PROJECT TITLE:** FLOOD WARNING SIMULATION  
**PROJECT ID:** CEEEn\_CPST\_05  
**PROJECT SPONSOR:** BYU Hydroinformatics  
**TEAM NAME:** FMA Engineering

Our design is a flood forecast response tool to help emergency responders learn how to use various flood forecasting and impact tools to make educated decisions before a flood event. This is presented in the form of a game or simulation to be used to train decision-makers and emergency responders. Several tools included in or related to the game were developed by or made available to us by the Hydroinformatics research lab. These tools include a global streamflow forecasting model, a flood impact web application, satellite flood maps and methods for creating them, flood impact scripts, a previously created simple flood response game, and existing flood forecasting tools. This game can be relevant to any area, but we worked with decision makers from SERVIR hubs in the Hindu-Kush-Himalaya (HKH), Mekong, and Amazon regions to guide development. The setting of the game is Piura, Peru, where severe flooding in March 2017 caused considerable damage. The final deliverables of the project are saved online as a HydroShare resource to facilitate sharing with decision-makers. These deliverables include different game formats including a paper version, intended to be printed out and distributed in a group setting, a PowerPoint presentation to accompany the paper version of the game, and a VBA enabled Excel file with an automated version of the game. Work was conducted on the campus of Brigham Young University from November 2021 through April 2022. Dr. Nelson intends to use this simulation with groups of emergency responders and local decision makers as soon as later this month to teach them about global forecasting tools and start conversations about flood forecasting, flood response actions, and flood mitigation strategies.

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## Introduction

The main goal of the project was to design and build a flood response and flood impact simulation or game. The game will be used throughout the world to teach local decision makers and emergency personnel about available global streamflow forecasting tools, such as GEOGloWS, flood mitigation measures, and the possible impact of large flood events in underprepared regions. The game will serve as a teaching tool, but also as a conversation starter to get these individuals talking about what can be done in their areas to predict and prepare for flood events, mitigate flood damage and loss of life, and respond to floods as they happen.

There was a lot of preliminary work that needed to be done before design and development of the game or simulation could begin. The first couple of months of working on the project were spent doing extensive research on flood early warning systems, potential tools and resources that could help with the project, and data sources. Not every tool or resource that was researched wound up being incorporated into the project or into the game, but this process was important and helped define the overall purpose and format of the game.

Some tools or resources that did bear fruits include flood impact scripts written by Evan Smith, a past graduate student in the Hydroinformatics Lab, a simple flood response game created a few years ago, and a method for creating flood maps using SAR satellite imagery. The flood impact scripts called for local population data, agricultural data, and local infrastructure data.

It was determined early on that Piura, Peru would be the focus area for the game. Piura experiences periodic flooding and wound up being an excellent place to start. After looking at past flooding in the area, it was determined that a flood event in 2017 would be suitable to model the simulation after.

Streamflow forecasts for the days before and after the flood were obtained from GEOGloWS global streamflow forecast caches. These forecasts were used to create flood maps for the event and allowed us to have hydrographs of the streamflow forecast in the game. The flood impact scripts allowed us to calculate the actual impact of a flood event of a certain magnitude. Population data was obtained from WorldPop, agricultural data was obtained from Croplands, and infrastructure data was obtained from OpenStreetMap. This data was then used in the impact script, along with the flood maps obtained via SAR imagery methods, to calculate affected crop areas, populations, and infrastructure.

This process was incorporated into the simulation. Flood maps and hydrographs are displayed during the game and players are tasked with responding to the forecasts with a variety of prevention, mitigation, and response measures to try to adequately respond to an impending flood event. Scores are calculated based on the damage incurred by the flood event and the benefit provided by a player’s actions.

The game operates with a variety of assumptions and limitations. One assumption is that any hectare of cropland which gets flooded is considered as 50% lost. Another assumes no loss of life. The game also incorporates some flood response measures, but there are many others which could be undertaken in a real scenario to predict, prevent, or respond to damage from flooding outside of what was included in the game. Cost and benefit values for damage and preventative measures are based on real data but are still just estimates. Some of these assumptions and limitations for the game are necessary to balance the gameplay and ensure a worthwhile experience. Others are inherently part of the uncertain nature of flooding and damages from floods.

Designing a game that runs smoothly for players and teaches the players something valuable was a difficult endeavor. Dr. Nelson hopes that the game will help foster more interest and trust in GEOGloWS global streamflow forecasts and that over time decision makers and emergency personnel will use these tools to foresee flood events before they happen. This foresight will allow them to have more time to prepare and prevent loss of life and property in their communities. The game has the potential to increase awareness of GEOGloWS and to eventually help save lives and property in flood-prone areas throughout the world.

## Schedule

Team meetings occurred weekly on Thursdays from September 2021 through April 2022. Meetings with sponsor occurred biweekly on Thursdays from September 2021 through April 2022.

Monday, November 22 <sup>nd</sup> .....	Statement of Work submitted
Wednesday, March 30 <sup>th</sup> .....	Complete Final Poster
Thursday, March 31 <sup>st</sup> .....	Game trial run with lab group
Tuesday, April 4 <sup>th</sup> .....	Complete Final Version of Game
Monday, April 11 <sup>th</sup> .....	Complete Final Report

## **Assumptions & Limitations**

We made several assumptions during the development of this game. The corresponding limitations were necessary to create a scenario simple enough to play a game, but they do make the game less realistic in some ways. These assumptions include:

- Any crop flooded is considered 50% ruined.
- Assume no loss of life.
- Realistic flood response actions are included in the game, but not all possibilities are accounted for.
- Cost and benefit values are estimates based on real data but have been optimized for smooth gameplay.
- Cost and benefit values will also vary depending on local conditions.

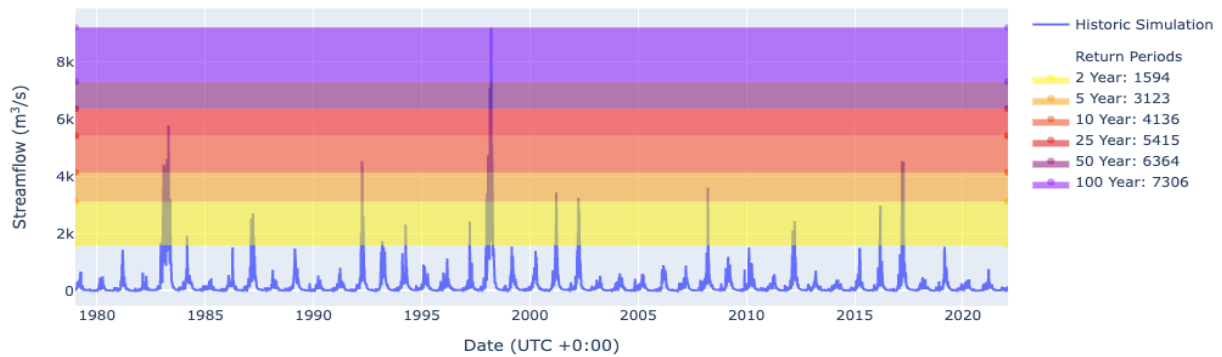
The game also has certain limitations where the simulation is simplified from reality. For example, the game sets a target date for each flood, and players are only concerned with the flooding that occurs on that day. In a real scenario, emergency response personnel would be concerned about any flooding on any given day. However, this simplification had to be made for the game to be simple enough to play as a short introduction to a training meeting.

## **Design, Analysis & Results**

The design of the game included gathering data from the various hydrologic modeling and mapping tools available to us, researching economic impact; development of the game procedures, materials, and rules; analysis of game performance by playing it in a test environment; and revising the game based on feedback from the trial run.

First, the global hydrologic model produced by GEOGloWS ECMWF (<https://geoglows.ecmwf.int/>) was used to get streamflow data for the Piura, Peru region. Several streams in the area were considered as the focus of the game, but one section that runs directly through downtown Piura was chosen. As shown in Figures 1 and 2, the historical forecast showed large streamflow values in March 2017, so we decided to focus on that flood event.

Historic Streamflow Simulation  
Reach ID: 9043566



Return Periods for Stream 9043566.0 (m<sup>3</sup>/s)

2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
1594.87	3123.9	4136.25	5415.36	6364.28	7306.19

Figure 1. 30-year historic streamflow simulation for Piura, Peru. High flows are seen during the year 2017.

Historic Streamflow Simulation  
Reach ID: 9043566

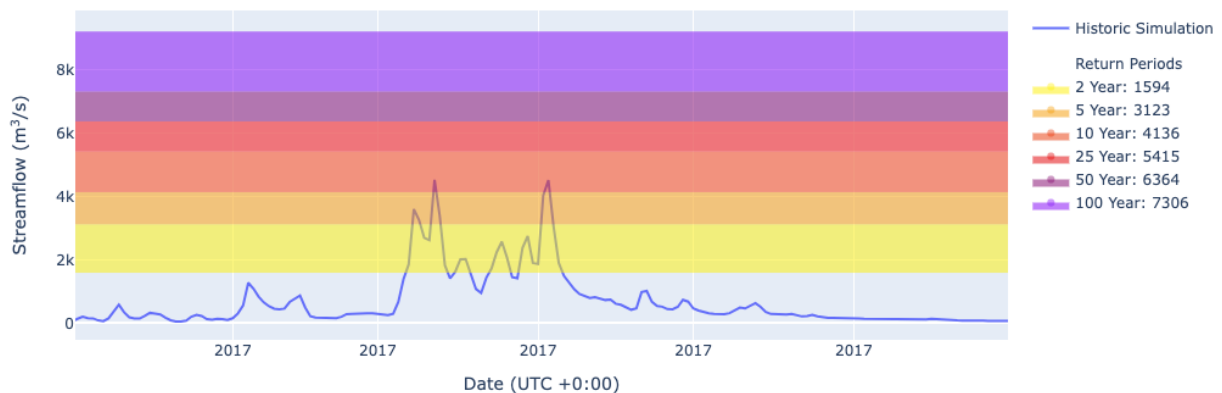


Figure 2. Historic simulation flows in Piura during 2017.

The forecasts, as well as bias corrected forecasts, for this time period were then obtained to be used in the game. Figure 3 shows an example forecast graph from the GEOGloWS ECMWF Streamflow Viewer.

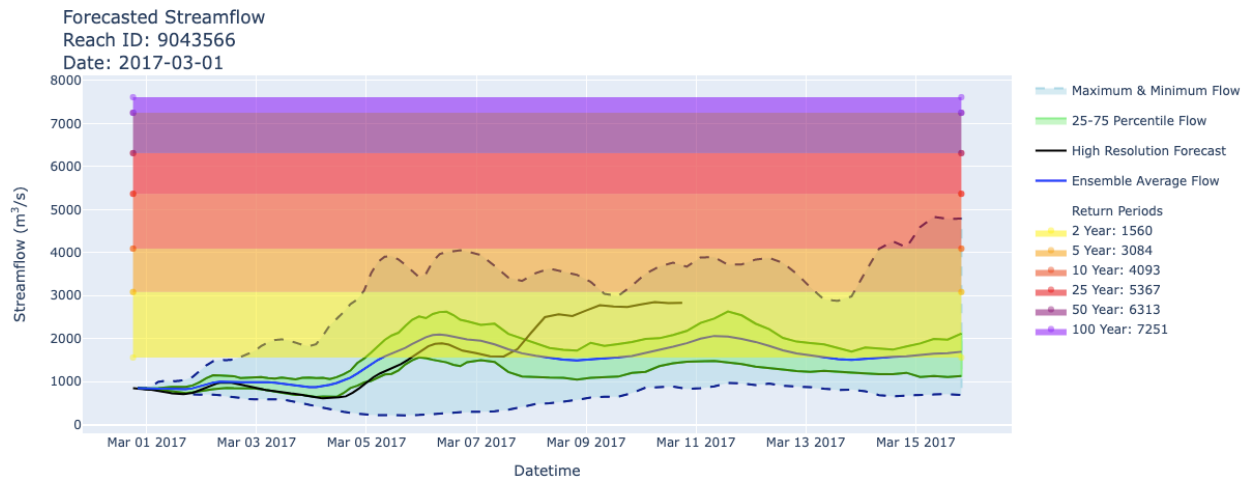


Figure 3. GEOGloWS ECMWF forecast from March 1st, 2017 for the river in Piura, Peru.

In order to simplify gameplay, we reduced the number of return periods to only include the 2-, 25-, and 100-year return periods. These return period thresholds were also adjusted to facilitate more variety in the outcome of the floods for the two rounds of the game. Figure 4 shows an adjusted forecast graph as seen in the final game. The target day is also indicated with a vertical line.

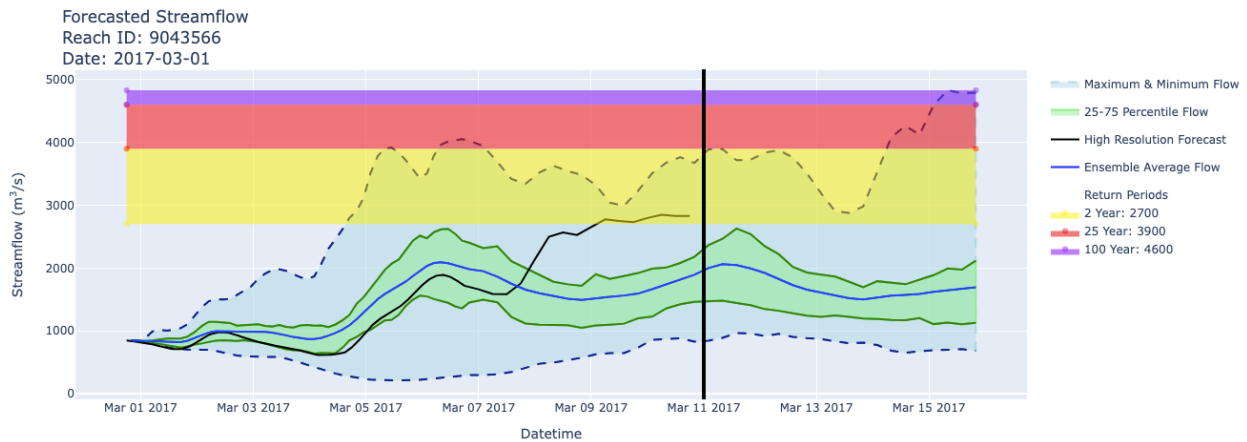


Figure 4. Adjusted GEOGloWS ECMWF streamflow forecast.

After obtaining the streamflow forecast data and graphs, we generated flood maps using Google Earth Engine (<https://earthengine.google.com/>) and the HYDRAFloods python package (<https://servir-mekong.github.io/hydra-floods/>). Sentinel-1 SAR data was

processed to generate a water map at the time of the floods, and then permanent water was masked out to get the flood map. This map was then processed in ArcGIS Pro to generate approximate 2-, 25-, and 100-year return period maps, shown in Figure 5, to correlate with our streamflow return periods.

**2-Year Flood**



**25-Year Flood**



**100-Year Flood**



*Figure 5. 2-Year, 25-Year, and 100-Year flood maps used in the game.*

To make the game as realistic as possible, we used an impact that correlated to the three flood maps. This script calculated the population displaced, agriculture flooded or washed out, and buildings or amenities within the flooded area. Evan Smith wrote a python script as part of his master's thesis (<https://scholarsarchive.byu.edu/etd/9362/>) that generated a flood impact as a function of input data and a flood map. Many of the python packages used are not common. To install them all, a conda environment was created. The command conda forge was used for the most difficult packages. Once the packages were installed and data input, the script ran smoothly. Minor changes were made to the output for readability of results and ease of finding files. The script was also edited to show the flood map once it was loaded. This allowed debugging to take place faster if any obvious errors were shown on the map. Any future users of the script should note that it takes a tremendous amount of processing power. For a flood the size of the 25-yr flood we used, the script takes around 35 minutes to run on an above average machine. Flood maps that are too large can run for over 48 hrs without completing the analysis.

After the flood impact python script was run, we then assigned economic value estimates to each impact to get an idea of the cost associated with each flood magnitude. Many hours of research went into finding accurate estimates of the flood impacts, and while this was a noble cause, we found that flood impact predictions are inherently hard to make. That being said, with the research we collected we used reasonable estimates of values that would facilitate learning about flood response. The economic values may not be entirely accurate, but the purpose of the game is to educate people about available flood response resources and not try to be a perfect representation of reality. The economic impacts, costs, and benefits are shown in the game's reference tables, included in the appendix. The economic values do help game players understand how flood response works financially. For example, choosing to

evacuate the population in the earliest time frame, which is ten days before a flood event, is more expensive because there is more risk involved. If people are moved and no event happens, that is an expense that did not need to be spent and costs the confidence of the people as well. Each value in the game has meaning and should cause the players to consider actual thought processes that would occur during a flood event.

Work was done to create a game worksheet and an accompanying excel scoresheet for automatic scoring during gameplay. With the basis of an actual flood event in Piura, Peru, this game gives decision makers a real-life example of what could happen in the event of a flood and will spark important conversations in meetings around the world relating to flood response.

## **Related Issues**

Our project was directly related to public health and safety. The flood response game that we created aims to educate decision makers and emergency response personnel throughout the world. It can help them get to know tools that can predict floods and prevent damage and loss of life from flooding in their communities. Knowing how to retrieve and interpret streamflow forecasts from GEOGloWS as well as what flood response actions are appropriate or feasible and when to take them is incredibly important. By educating others on these topics our project is helping to protect lives, crops, housing, and local infrastructure in flood-prone communities.

Our project is also related to welfare and social, global, and cultural factors. Flooding often affects poorer communities more severely than wealthier areas. Poorer populations may have no other option than to live in flood plains or other exposed areas. Some of the actions that players may take in the flood response game include warning and educating the populace as well as evacuating endangered individuals. Playing our game may help protect at risk populations if floods are predicted and prepared for more effectively. Flooding also impacts less developed nations and cultures more severely. Our tool strives to increase awareness of flooding and possible flood mitigation and response actions in these areas. In this way it has the potential to help disadvantaged populations and less developed nations specifically because they tend to be affected by flooding more than others.

The environment also has a role in our project. Preventing damage from floods and controlling and predicting flooding can also protect our waterways. Knowing when and

where flooding will occur is important and can allow for preparations to be made which can protect water from being contaminated. Protecting crops and infrastructure is also environmentally beneficial because new infrastructure won't need to be constructed and crops and all the resources that went into growing them won't go to waste.

Economic factors were also an important part of our project. Predicting and preparing for floods, as well as mitigating and preventing damage from floods, can save a lot of money. Our game strives to teach that investing in flood mitigation measures and even longer-term preventative measures can save money in the long run as damage from flooding is prevented. These savings from investments in flood prevention and response can help fuel developing economies in countries that suffer from flooding and protect their infrastructure and agricultural assets.

## **Lessons Learned**

We encountered many challenges over the course of this project. Some of the most important challenges include combining elements of past work done by other students and researchers, finding good data, manipulating data to suit our needs, VBA collaboration, and building a realistic game.

It was difficult to incorporate so many different pieces of code and past work into our project. We had access to Python scripts written by past graduate students, an older flood simulation game, bias corrected streamflow data, and cached GEOGloWS forecasts. It was difficult to incorporate all these things in a way that made sense while also creating something new and unique. In the end we were able to bring everything together in a way that felt realistic and new while also saving ourselves some time by using resources that already existed. We overcame this challenge by establishing a vision early on for what our game needed to look like and then using our available tools as needed to achieve that vision.

Finding good data and manipulating it to suit our needs was difficult. We had to get our data into the right formats and from the right sources to be able to use some of the Python code that we used to calculate flood impacts. We also had to do this for the specific geographical area that we were concerned with which was a different area than had been studied when the original Python scripts were written. We overcame this challenge by carefully studying our data sources and researching ways of manipulating the data the suit our needs.

VBA Collaboration was a challenge. We decided to build a VBA version of our game, but quickly discovered that it was difficult to collaborate on a single macro enabled excel workbook. The key to overcoming this challenge was communication and making sure that everyone working on the notebook knew its status and knew what needed to be done.

Building a realistic game was also a challenge. We overcame this challenge by reaching out to more knowledgeable people and getting their input on what flood response actions were realistic or appropriate for our game. We wanted to make sure that our players were able to make decisions that they would realistically make in a real situation and that the game and the decisions felt somewhat real to them.

## **Conclusions**

As a result of developing the flood response game, as a team, we have learned the process behind flood response and how using technology and past hydrologic models can help inform decisions. We have also seen how needed research efforts are to be able to communicate ideas from the engineering world to decision makers around the world. Our project blended international relations, engineering, and communications, as we brought together hydrograph forecasts, flood maps and flood impact python scripts, advice from officials, finances, local customs, and engineering ideas. The game we developed takes all these aspects and creates a real-life scenario that will facilitate discussion about how to better respond to the imminent threat of floods during training events. We have confidence that this flood response game will be a helpful tool to further educate people worldwide about how to respond to floods. In fact, Dr. Jim Nelson, our mentor for this project, is currently travelling in South America using this game to educate and talk to people about flood forecasts.

Work could continue with this project by adapting the game to different regions in the world. Right now, the game is only set up and optimized for Piura, Peru but adapting the game for regions such as the Mekong, Africa, or Himalaya's would make this tool more relevant for audiences in these regions. Also, further optimization of the VBA version of the game could be beneficial to take the game to the next level.

## **Recommendations**

The serious game, in either its paper or VBA versions, can serve as an excellent item for introducing individuals to the resources available to them and starting conversations about floods, preparation, and unique circumstances in a region. The hydrographs and flood maps can easily be generated for any area in the world, allowing the game to be adapted for any audience. In addition, the process of working with the flood impact script and displaying the data will soon become easier and more user-friendly with the Flood Impact Mapping app that is currently being developed within the Hydroinformatics lab.

**Appendix A**

Resume: Jacob Anderson .....16  
Resume: Justin Hunter .....17  
Resume: Alma Meyer .....18  
Resume: Taylor Porter .....19  
Flood Forecast Response Game Printout.....20

# JACOB ANDERSON

1565 N. University Ave, Provo, UT 84604 · (509) 412-5495

[jmanderson005@gmail.com](mailto:jmanderson005@gmail.com)

<https://www.linkedin.com/in/jacob-anderson-5549b51b5>

## EDUCATION

2017 – 2022

**BRIGHAM YOUNG UNIVERSITY, B.S. CIVIL ENGINEERING** (expected in 2022)

Focus: Hydrology

GPA: 3.37

Relevant Coursework: Computational Methods (VBA), Computational Linear Algebra (Python), CAD, Linear Algebra, Fluid Mechanics, Global Leadership, Engineering Applications of GIS (ArcGIS Pro)

## WORK EXPERIENCE

**AUGUST 2021 - PRESENT**

**TEACHING/RESEARCH ASSISTANT, BRIGHAM YOUNG UNIVERSITY**

Led 2 lab sessions for 55 students in CE 414 Engineering Applications of GIS

Taught GIS principles one on one to students

Maintained organization of grades and other class functions

**JUNE 2020 – AUGUST 2021**

**TECHNICAL STUDENT INTERN, PACIFIC NORTHWEST NATIONAL LAB**

GUI development with tkinter in Python

Developed skills using Git, Github, and Linux Virtual Machines

Created user-friendly applications for data viewing in PFLOTRAN

**JANUARY 2018 – JUNE 2021**

**STUDENT PRODUCTION ENGINEER, BYUTV**

Installation and maintenance of RTS radio system within Broadcasting Building

Maintained 15 4k cameras and \$15 million production truck

Led groups of 15 in successfully and efficiently setting up for TV productions

## SKILLS

- Python, Numpy, Scipy
- CAD, Revit
- Tkinter GUI Framework, Github, Linux, Git
- ArcGIS Pro
- VBA in Excel
- Fluent in Spanish

## ACCOMPLISHMENTS

- Member of ASCE and Phi Eta Sigma
- Recipient of the Foreign Language Area Studies Scholarship
- Two-year Ecclesiastical Mission to Guatemala
- Eagle Scout Award from Boy Scouts of America
- American Legion State Title with MVP Pitcher Honors

# Justin A. Hunter

(303) 350-7652 • justinhunter303@gmail.com  
www.linkedin.com/in/justinhunter-1

## EDUCATION

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- Brigham Young University – Ira A. Fulton College of Engineering** May 2018 – Apr 2022  
*Civil and Environmental Engineering* Provo, UT
- GPA 3.85 / 4.00
  - *BYU Scholarship*, Academic
  - ASCE, AREMA, and ITE Member
  - Language Certificate: Portuguese, Advanced Level
- University of Oregon** Jun 2015 – Jan 2016  
Eugene, OR
- GPA 4.00 / 4.00
  - Outside Linebacker for the Oregon Ducks football team

## EXPERIENCE

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- Bowen Collins & Associates** Starting May 2022  
*Incoming Water Resources EIT* Draper, UT
- Professional water, wastewater, site civil, structural, mapping/GIS, and environmental services
- BYU Hydroinformatics Lab** Apr 2020 – May 2022  
*Research Assistant* Provo, UT
- Created resources to help others understand and interact with the National Water Model
  - Managed the BYU Hydroinformatics Lab's website (hydroinformatics.byu.edu)
  - Contributed to hydroinformatics research alongside graduate students and faculty members
  - Used web programming and computer modeling to develop web applications and other online resources
- BYU Civil and Environmental Engineering Department** Sep 2020 – May 2021  
*Geomatics Teaching Assistant* Provo, UT
- Taught 40+ students in ArcGIS Pro lab sessions
  - Explained concepts relating to GIS software, surveying, GPS, data manipulation, etc.
  - Assisted students in finding and interpreting spatial data
  - Conducted test reviews and office hours to help students learn course material
- Pleasant Grove City** Oct 2019 – Aug 2020  
*Engineering Intern* Pleasant Grove, UT
- Frequently used Esri software, Bluebeam, and Civil 3D
  - Mapped utilities in ArcGIS Online for a city of 40,000 people
  - Reviewed permits and created bond estimates for city developments
  - Visited construction sites for ongoing projects with engineering staff
- BYU Independent Study** Jan 2019 – Oct 2019  
*Quality Control Inspector* Provo, UT
- Maintained and designed high school and university online courses
  - Worked with a team to solve problems and fix coding errors and bugs in over 500 courses
  - Coordinated with instructors, students, course designers, and customer service representatives
  - Assisted in transitioning courses across different learning management systems

## AWARDS, CERTIFICATIONS, SKILLS, LEADERSHIP, SERVICE, AND INTERESTS

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- Awards: 2<sup>nd</sup> Place ITE Mountain District Conference Kell Competition, 2<sup>nd</sup> Place Rocky Mountain Conference ASCE Blue Sky Innovation Contest, Eagle Scout Award
- Certifications: EIT certification (FE Exam passed in April 2022)
- Skills: ArcGIS, Civil3D, HTML, CSS, VBA, Python, SQL, JavaScript, Microsoft Office, Bluebeam, QGIS
- Leadership: Rock Canyon High School Football Captain, ASCE Blue Sky Innovation Contest Team
- Service: Voluntary representative of the LDS Church in Ceará, Brazil from Feb. 2016 to Feb. 2018
- Interests: Hiking, snowboarding, fitness, science fiction, board games, professional sports

# Alma Meyer

PHONE (509) 867-6789 • EMAIL [almajean14@gmail.com](mailto:almajean14@gmail.com) • URL [www.linkedin.com/in/meyer-alma](http://www.linkedin.com/in/meyer-alma)

## EDUCATION

- B.S. Civil Engineering** June 2022  
*Brigham Young University* Provo, UT
- 3.87 GPA
  - Programs: ArcGIS Pro; QGIS; Python; Microsoft Excel, VBA; Autodesk Civil3D, Revit
  - Relevant Courses: Engineering Applications of GIS, Hydraulic Engineering, Environmental Chemistry, Technical Communication
  - Assisted two Civil Engineering underclassmen with resumes, class schedules, etc. as a mentor (2021)
  - Manage website and help organize activities for Women in Civil Engineering club (2021-present)

## WATER RESOURCES EXPERIENCE

- Hydroinformatics Research Lab Assistant** April 2020-Present  
*BYU Department of Civil and Environmental Engineering* Provo, UT
- Published article in *Open Water Journal* on a python script written for NASA SERVIR to use in predicting algae blooms in Lake Atitlán, Guatemala; presented at 2021 GEO Symposium
  - Compared observed and forecasted data during Eta and Iota hurricanes and Storm Ida to improve streamflow forecast models
  - Developed skills in python, data science, and GIS applications

## RESEARCH & QUALITY CONTROL EXPERIENCE

- Organic Chemistry Lab Assistant** May 2019-Aug 2019  
*Masaryk University* Brno, Czech Republic
- Developed a method to synthesize a specific phospholipid for use in cancer research
- Data Administration Intern** Dec 2016-May 2017  
*Wagstaff Applied Technologies* Spokane Valley, WA
- Verified accuracy and completeness of quality control documents for glove boxes being manufactured for nuclear research facilities

## LEADERSHIP EXPERIENCE

- Chemistry 105 Teacher's Assistant** Sep 2019-Apr 2020  
*BYU Department of Chemistry and Biochemistry* Provo, UT
- Taught about 35 students twice a week, led 6 test reviews, held office hours, and graded tests
  - Wrote lesson plans and created teaching tools to supplement lectures
- Voluntary Representative** May 2017-Dec 2018  
*Church of Jesus Christ of Latter-Day Saints* Czech Republic
- Coordinated with 80 volunteers throughout Czech Republic and Slovakia to achieve our goals
  - Achieved fluency in Czech language through daily study and communication with native speakers
  - Trained three new volunteers on their responsibilities and purpose

## EXTRACURRICULAR & VOLUNTEER

- Enjoy long-distance trail running and backpacking
- Played violin with BYU University Orchestra, and sang with the University Chorale and A Cappella club

# Taylor Porter

(615) 602-0380 • tayp555@gmail.com • <https://www.linkedin.com/in/taylor-porter-621a37167/>

## EDUCATION

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### Brigham Young University

Dec 2022 (Expected Graduation Date)

Bachelor of Science: Civil Engineering

Provo, UT

- 3.13 GPA
- Y-Serve: Goodwill Bikes – Executive Director

## EXPERIENCE

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### Central Utah Water Conservancy District

Jun 2020 - Present

*Lead Intern: Asset Management*

Orem, UT

- Received 4 merit-based pay increases to elevate my hourly rate from \$13.50/hr to \$18.00/hr
- Promoted to 'Lead Intern' and given additional responsibilities after 15 months work experience
- Awarded 'Intern of the Month' twice (in a department with 9 interns)
- Spent 200 + hours automating projects and managing databases using Python and SQL
- Assisted in training 8 interns by conducting weekly trainings on topics related to ongoing work
- Reviewed third-party cost estimation for future infrastructure replacement for 12 facilities
- Worked with District staff to write and approve 20 technical documents
- Reviewed over 20 construction submittals and assisted in project management responsibilities
- Assisted District and Bureau of Reclamation employees in the inspection of dams, pipelines, and tunnels
- Populated and maintained an asset registry database (3,200+ manually entries)
- Audited over 80 operation and maintenance work orders
- Worked with GIS analysts to create over 70 redlines identifying corrections to District mapping services
- Participated in 49 field visits associated with data acquisition, inspections, and project management

### California Department of Transportation

May 2016

*Volunteer*

Fresno, CA

- Performed lab tests and calculations on soil compaction and concrete cores
- Compiled cost estimation reports for records and contractor
- Accompanied engineers in the field for inspection and problem solving

### Brigham Young University

Jun 2019-Apr 2020

*Teaching Assistant: Geomatics*

Provo, UT

- Taught 70 students how to use ArcGIS pro
- Taught students how to use a total station and perform surveying calculations
- Communicated with professor and students concerning any issues that arose

## ADDITIONAL WORK & VOLUNTEER EXPERIENCE

---

### Various Farms

Jun 2011-Aug 2014

*Farm Hand*

Victor, ID

- Operated and repaired equipment; learned how if previous experience was lacking
- Consistently moved 2 miles of irrigation pipe by hand (twice a day)
- Completed any task necessary for farm operation

### Church of Jesus Christ of Latter-day Saints

Jul 2016-Jul 2018

*Full-time Representative*

Tempe, AZ

- Conducted trainings, organized travel, solved interpersonal quarrels, trained new people
- Provided community service to people and organizations in 12 areas of southwest AZ

## ACHIEVEMENTS/SKILLS

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- Python, SQL, VBA, ArcGIS Pro, Microsoft Office, technical writing
- Familiar with: AutoCAD, Revit, HTML, R
- Eagle Scout Award

# Flood Forecast Response Game

## Reference Tables

### Cost of Protection

Actions	Lead Time									
	10 days	9 days	8 days	7 days	6 days	5 days	4 days	3 days	2 days	1 day
Pre-position	\$25,000	\$30,000	\$35,000	\$37,500	\$40,000	\$45,000	\$50,000	-	-	-
Sandbag	\$30,000	\$35,000	\$40,000	\$45,000	\$50,000	\$55,000	\$60,000	\$65,000	-	-
Warn	\$45,000	\$32,000	\$29,000	\$26,000	\$23,000	\$20,000	\$22,000	\$25,000	\$30,000	\$40,000
Evacuate	\$100,000	\$95,000	\$85,000	\$80,000	\$75,000	\$70,000	\$65,000	\$60,000	\$90,000	\$120,000

### Benefit of Protection

Action	Type	2-Year	25-Year	100-Year
Pre-position Resources	Mitigation	\$0.00	\$7,000,000	\$14,000,000
Place Sandbags	Mitigation	\$0.00	\$6,500,000	\$13,000,000
Warn Populace	Response	\$0.00	\$6,000,000	\$12,000,000
Evacuate	Response	\$0.00	\$10,000,000	\$20,000,000

### Flood Damage

No flood	2-Year	25-Year	100-Year
\$0	\$344,520	\$48,504,460	\$81,397,990

**Total Damage = Flood Damage - Benefit of Protection**

**Total Cost = Cost of Protection**

# Flood Forecast Response Game Scoresheet

Group #: \_\_\_\_\_

## Decision Table

Actions		Lead Time										
		10 days	9 days	8 days	7 days	6 days	5 days	4 days	3 days	2 days	1 day	
Round 1	Pre-position									-	-	-
	Sandbag										-	-
	Warn											
	Evacuate											
Round 2	Pre-position									-	-	-
	Sandbag										-	-
	Warn											
	Evacuate											

## Balance Table

Flood Events	Round 1	Round 2
Benefit of Protection		
Cost of Protection		
Flood Damage		
<b>Total Damage</b>		
<b>Total Cost</b>		

$$\text{Total Damage} = \text{Flood Damage} - \text{Benefit of Protection}$$

$$\text{Total Cost} = \text{Cost of Protection}$$