ENVIRONMENTAL STUDY FOR ARROWHEAD PROJECT
Project ID: CEEn-2017CPST-002

by

MWM Engineering
Josh Gibbons
Daniel Wells
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Capstone Final Report

Submitted to

Bob Tandler

Fritzi Realty

Department of Civil and Environmental Engineering
Brigham Young University

April 18, 2018

Executive Summary

PROJECT TITLE: Environmental Study for Arrowhead Project
PROJECT ID: CEEn-2017CPST-002
PROJECT SPONSOR: Bob Tandler
TEAM NAME: MWM Engineering

The Arrowhead Center Development Project is a research endeavor for the Arrowhead building and surrounding site, owned by Fritzi Realty and located in Spanish Fork, Utah. The overall project has been broken up into various components, and MWM Engineering researched and developed ideas regarding the environmental aspects of the site. The aspects being considered primarily include the environmental impact the project will have on the site and water resource needs. In preparation for this report, MWM Engineering examined the site itself, existing documents/studies of the project, and public works information from Spanish Fork City and the federal government. MWM gathered information from the research, coordination from the other research teams, and desires from the project sponsor.

MWM Engineering is committed to providing quality service to Fritzi Reality as we work with the other teams from BYU to develop creative and efficient solutions for the Arrowhead Center Development Project.

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Introduction

Purpose

The purpose of this report is to present MWM Engineering's findings regarding the environmental study and water resource needs of the project. It discusses potential environmental challenges and what further studies will need to be performed by qualified professionals. It also discusses the water resource needs for the site, namely culinary water, sanitary sewer, and storm water.

Background

The Fritzi Realty property is divided into 4 different parcels. Parcels 1, 2, and 4 are currently undeveloped. Parcel 3 is currently occupied by a large warehouse and being rented out as industrial space. The Arrowhead project looks at using these parcels for both residential and commercial use. MWM Engineering's portion assesses how this project will affect the environment and the utility demands.

Scope

For each of the four parcels, analyze what impact any development will have on the environment. In addition, determine the utility requirements of the development. These findings will be discussed in this report.

Objectives

MWM Engineering seeks to fulfill their scope through the following objectives:

- Review and compile existing environmental documents.
- Determine which environmental documents need to be updated.
- Determine possible environmental surveys that need to be completed.
- Determine the utility requirements of the given land uses.

Schedule

Table 1: Schedule of Activities

DATE	EVENT
10/20/17	Kickoff meeting
10/30/17	Submit proposal to BYU
11/15/17	Submit proposal to Fritzi Reality
11/20/17	Perform site visit; begin reviewing environmental and utility information
11/27/17	Brainstorm session
12/1/17	Submit monthly report
12/11/17	Review ideas, create action plan for further research
12/22/17 - 1/5/18	*Holiday break*
1/8/18	Submit monthly report
1/11/18	Team meeting
1/29/18	Submit monthly report
2/8/18	Meeting with Stanley Consultants
2/15/18	Team meeting
2/26/18	Submit monthly report
3/5/18	Submit 50% report
4/2/18	Submit monthly report
4/12/18	Sponsor presentation
4/12/18	CEEn seminar presentation
4/12/18	Present poster to ASCE CUB
4/18/18	Submit final report

Assumptions & Limitations

Some of the major assumptions made involve water resources. The first main assumption made was that culinary water lines will reach the project location and provide adequate water pressure. In other words, the Spanish Fork City will have the infrastructure needed to adequately cover the project's water resource needs outside the project boundaries.

It is assumed that the amount of sewage generated per household/business is 80% of the culinary water used. This value was given by professional engineers at Stanley Consultants.

In the new storm drainage calculations, several assumptions regarding the soil curve number, number of sumps, and allowable storm discharge were made. These are discussed further in the "Storm Water" section below.

The largest limitation we came across was the minimal knowledge we had prior to this project in water resources and environmental engineering. One of the biggest factors that helped us become informed on these topics was talking with experienced professionals in those fields.

Design, Analysis, & Results

Environmental

As shown in Table 1, the MWM Engineering team met with Stanley Consultants in their office on February 8, 2018 with Rick Black, Principal Environmental Planner and Greg S. Thomas, PE. They provided valuable direction for environmental and water resource needs for the project. Among their comments, they suggested the assumption that the utilities outside the project were sufficient to handle any planned development. They suggested several environmental studies that could be conducted, including a wetlands survey, a federal NEPA analysis, and/or a cultural resource survey.

One test that was performed was done using the Information for Planning and Consultation location explorer provided by the U.S. Fish and Wildlife Service, also known as an IPaC resource list. This area has probability to be home to threatened or endangered wildlife including birds, fish, and certain types of plant life. It is permissible to build in the area if none of these birds are nesting in the area when construction starts. If there are signs of the birds already living there, then construction in the area will possibly be stalled until the birds vacate the nests. Figure 1 shows the breeding season and probability of presence for some of the possible protected birds that may be found in the Fritzi Realty properties.

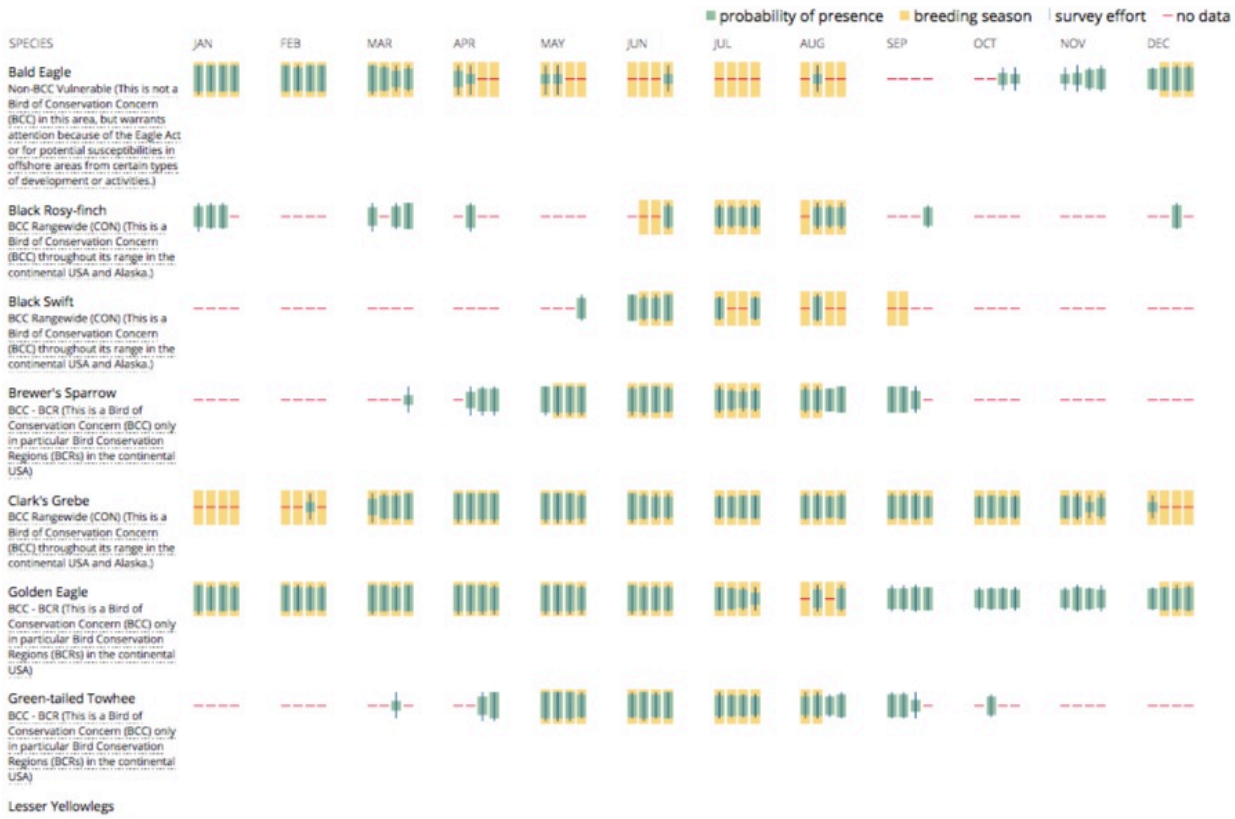

Figure 1: IPaC bird list.

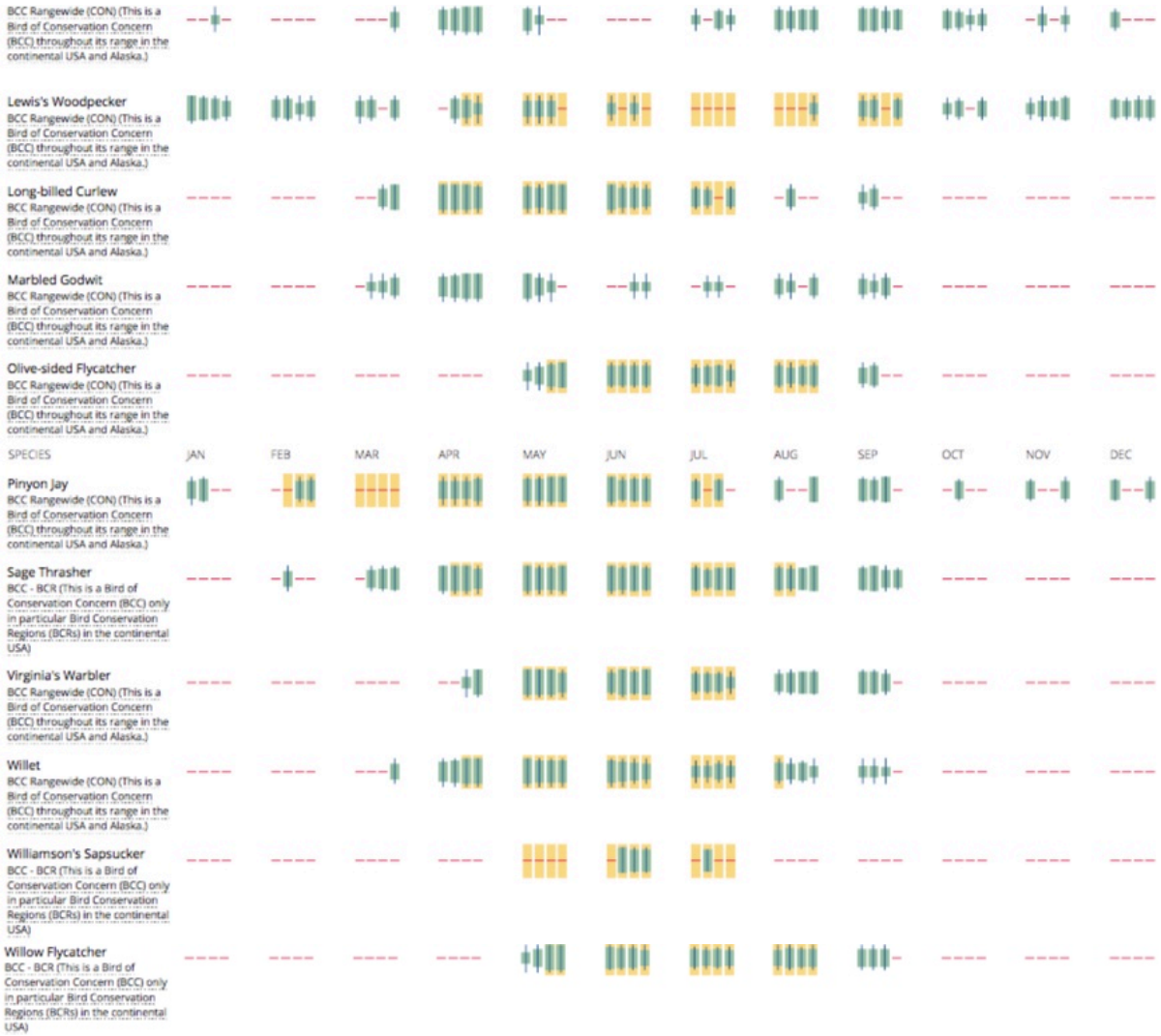

Figure 1: IPaC bird list (continued).

The property is also in the historical range where the June Sucker, an endangered fish, is known or believed to live. The portion of the Spanish Fork River that runs near the eastern part of the property could very well be a home for these fish. As the endangered status assumes, development around this area should not be treated lightly. Any work being done close to the stream should have a plan to avoid disturbing the stream or surrounding life.

Figure 2: June Sucker.

There is also concern about building close to a possible wetland. From a previous [DW1]study done on this site, it was determined by the U.S. Army Corps of Engineers that a protected wetland does not exist on this property. This study, however, was done more than five years ago and needs to be redone.

There is a strong possibility that the immediate area surrounding the river along the eastern parcels could possibly be in a flood plain. From a previous [DW2]study performed by FEMA, it was learned that Parcel 1 indeed contains areas within the 100-year flood plain. An earlier study[DW3] stated that most of that area was in the flood plain but was amended by the current analysis using more detailed modeling. Precautions should still be taken in determining the type and amount of development in this area, as well as attaining the proper insurance to protect against flooding. This study was also done more than five years ago, therefore it does need to be redone.

Being so close to a source of water, this area has an abundance of plant life. Among the many plants in the area, there is a high probability that the Jones cycladenia and the Ute ladies'-tresses exist, which are both considered threatened. MWM Engineering did not identify any present on the four parcels after an initial inspection. This can be misleading as there are many factors that go into defining the existence of these plants. Ute ladies'-tresses grow in seasonally moist soils and meadows near lakes and streams. One reason they are hard to identify is they only flower for a brief period of time, so most people have not had any interaction with them. Not only do they flower for only a short time, they may not even flower every year. A professional survey should be performed to determine the possible existence of these plants.

Figure 3: Ute Ladies Tresses

Lastly, there is most likely materials containing asbestos and lead within the structures on this site. They should be sampled, documented, and disposed of in the proper manner. According to instructions from the sponsor, this was not to be an area of focus for this project.

Water Resources

While reviewing the utilities that will service the Fritzi Reality property, MWM Engineering determined to focus primarily on culinary (drinking) water, sanitary sewer, and storm sewer. Other water utilities such as untreated irrigation or industrial graywater sewer are not analyzed in this report.

Culinary Water

During the meeting with Stanley Consultants, Mr. Thomas provided direction on sources for water resource demands. The Utah Division of Drinking Water provides information on culinary water requirements and how much is needed. For residential areas, 800 gallons per day (gpd) is required for each household. For the commercial portion of the project, 500 gpd is needed for each public restroom.

In calculating our demands for culinary water and sanitary sewer, the preliminary parcel layouts from both Fritzi Reality and the overall capstone group were used. With the Fritzi Reality layout, 240 residential connections are planned, resulting in a demand of 192,000 gpd of culinary water. The overall capstone group's layout requires 70 residential connections and 24 commercial connections, requiring 68,000 gpd.

Southeast of the primary Arrowhead warehouse, a culinary water well exists. In 2006, Desert Rose Environment, LLC analyzed the irrigation and well water rights of Fritzi Realty. They indicated that Fritzi Realty owned 2.25 cfs of ground water rights, equaling 1630.7 ac-ft per year. However, Desert Rose Environment warns that "Utah law states that if a water right is not used for a period of five years then the water right reverts to the public." On the Spanish Fork City GIS webpage, they indicate the well is owned by Spanish Fork City on a 4,600 sq-ft property. If Fritzi Realty currently owns the water rights, they may be sold to the city to service the land development. This is an area for further investigation.

Sanitary Sewer

The sewage created is assumed to be 80% of the amount of culinary water needed, the percentage coming from the meeting with the Stanley Consultants engineers. This means that the residential areas create 640 gpd per household and the commercial areas create 400 gpd per public restroom.

It was calculated that the Fritzi Reality layout would need to be designed to accommodate 153,600 gpd of sewage. The overall capstone group plans would need to be designed to accommodate 54,000 gpd. According to code in Utah the minimum diameter size of a sanitary sewer main is 8". This 8" pipe is sufficient to accommodate both sets of plans. With this knowledge we were able to come up with two recommendations on how to tie the new sanitary sewer mains into the existing system.

The first recommendation, shown in Figure 4, is to connect Parcels 1 and 2 into the neighborhood just south west of the Arrowhead Trail and SR-198 junction. This connection will require an 8" main. Easements would also need to be acquired to cross both SR-198 and Arrowhead trail. An easement will also need to be acquired from H & P PROPERTIES LLC to cross their property to tie into the existing sanitary sewer system. For Parcels 3 and 4, MWM

Engineering proposes working with W.W. Clyde to tie into their proposed sewer system for their development.

Figure 4: Proposed utility layout – first recommendation.

The second recommendation involves crossing the river at the location shown in Figure 5. This recommendation serves as a backup plan if our first recommendation is not possible due to unforeseen circumstances. All the parcels would connect into the 24" sanitary sewer main north of the property and across the river. To cross the river a permit will need to be acquired to delineate the Spanish Fork River during placement. A permit will also need to be acquired from the EPA to run sanitary sewer under the river. An easement will need to be acquired from Mark A. Mckell to cross his property and tie in to the existing sewer. For this a 12" pipe is recommended to adequately service all four parcels.

Figure 5: Proposed utility layout – second recommendation.

Storm Water

In 2006, LEI Consulting Engineers and Surveyors, Inc. performed storm drainage calculations for Parcels 1, 2, and 3. They determined the storage needs for the parcels during 25-year and 100-year storms. Scans of their results are found in Appendix B. Following their template and using the same rainfall intensity data, a storm drainage calculation was performed for parcel 4. Since LEI combined Parcels 2 and 3 for their 100-year storm analysis, an additional analysis was performed for each parcel individually. The results provided by LEI are provided in Table 2, and the newly calculated results in Table 3.

Table 2: LEI Storm Drainage Calculation Results

	Storm Type	Sump Storage (cf)	Runoff Volume (cf)	Detention Storage Required (cf)
Parcel 1	25-Year	0	3732	3732
	100-Year	0	5080	5080
Parcel 2	25-Year	3144	3022	-122
Parcel 3	25-Year	14148	13978	-173
Parcels 2&3	100-Year	17292	13967	-3325

Table 3: New Storm Drainage Calculation Results

	Storm Type	Sump Storage (cf)	Runoff Volume (cf)	Detention Storage Required (cf)
Parcel 2	100-Year	3144	7246	798
Parcel 3	100-Year	14148	18129	3981
Parcel 4	25-Year	7074	6507	-567
	100-Year	7074	8358	1284

There are several critical assumptions to note while reading the Table 3 calculations. First, Parcel 4 was assumed to have a similar land type to parcel 3. Therefore, the weighted curve number was computed to be the same rounded value, 0.35. Next, the number of sumps in Parcel 4 was based on the same ratio of sumps per square foot in Parcel 3, resulting in an estimated nine sumps for Parcel 4. Additionally, the allowable storm drainage discharge was assumed to be zero, save for Parcel 2, which was kept at 1.84 cfs for the 100-year storm, the same value LEI used for the Parcel 2 25-year storm. Changing the amount of runoff allowed into the city system will result in dramatic changes in the storage requirements.

With these assumptions, we see that the sumps of Parcel 4 should hold the runoff generated in a 25-year storm, but not in a 100-year storm. It is also observed that the 100-year storms in parcels 2 and 3 sum to 4779 cf storage needed. The LEI sum for this storm is -3325 cf, indicating no storage needed. This may be due to LEI allowing 7.24 cfs into the city system, where the assumption for the new calculations was that 0 cfs would be allowed. Verification of LEI's calculations could be an area of additional research.

The current plans from Fritzi Realty include playground areas in Parcels 1 and 2. These could double as detention basins during major storm events. However, Parcels 3 and 4 do not include plans for any public areas or detention basins. The excess runoff shown in the 100-year storm in parcel 4 will need to be housed in additional sumps or carried by the city storm system. Otherwise, detention basins should be installed.

Lessons Learned

The biggest challenge faced was a lack of knowledge in the areas of environmental and water resource engineering. None of the team members plan on specializing in either of these areas of civil engineering, so the previous experience was extremely limited. What helped most in overcoming this was meeting with Rick Black and Greg Thomas of Stanley Consultants. They provided direction and an outline of what needed to be accomplished. Engineers, especially young and inexperienced ones like MWM Engineering, can seek help from engineers with more experience. Although outside help was eventually sought, more specific help earlier on would have been beneficial. This could have positively impacted the project in many ways. As members of MWM engineering we unsuccessfully discussed over and over how to reach the targets for this project for the first few weeks. We will undoubtedly utilize our resources with much more haste in the future.

In the learning process, multiple available resources were discovered for quickly identifying potential environmental concerns. These include the prior sources referenced, such as the IPaC resource list, preliminary wetland survey, and public government data. The most effective resources were still the people with whom connections were built.

Conclusions and Recommendations

In summary, environmental and water resource limitations should not hinder future development of the Arrowhead Project if the proper care is taken moving forward. From the research of existing water resources in Spanish Fork, the utilities should be adequate to handle the addition of the Fritzi Realty development. Note, none of the findings in this report are official or in any way binding, meaning all the information provided needs to be reviewed and stamped by a professional environmental and water resource engineer with the correct qualifications to perform the studies. The final decision on existence and impacts to the wetlands may be subject to regulations under Section 404 of the Clean Water Act and must be studied by the U.S. Army Corps of Engineers District. All environmental studies performed on the site that are 5 years or older need to be redone.

Appendix A – Résumés

Josh Gibbons

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EDUCATION

Master of Science, Brigham Young University; Provo, UT – April 2018
- Performing research with Utah DOT regarding intersection safety
- Serving as President of BYU ITE student chapter

Bachelor of Science, Brigham Young University; Provo, UT – April 2017
- 3.77 GPA
- Civil Engineering; ACTFL Spanish Certificate
- Member of ASCE and ITE

WORK EXPERIENCE

Transportation Engineer Intern, Hales Engineering; Lehi, UT – April 2016-Present
- Complete traffic impact studies, parking studies, and safety studies for clients in both the private and public sector
- Assist in the development of transportation master plans and estimating travel demand using QRS II modeling software
- Create a new company website to improve marketing efforts

Research Assistant, Brigham Young University; Provo, UT – July 2015-Present
- Work with a team of students and faculty researching traffic and safety for the Utah Department of Transportation
- Use VBA code in Microsoft Excel to automate data manipulation processes to save client several hours of time
- Write a manual with clear instructions of how to use the Excel spreadsheets

Project Engineer Intern, Okland Construction; Lehi, UT – August 2014-August 2015
- Managed the digital plans of over 10 projects on site including hyperlinks, revision updates, and historical plan sets
- Lead a structural and architectural takeoff worth over $250,000

SKILLS & ABILITIES

Proficient in Synchro/SimTraffic, AutoCAD, Microstation, and Bluebeam Revu

Highly skilled in VBA coding in Microsoft Excel

Trained in Cube and QRS II travel demand modeling software

Strong problem-solving and analytical skills

Spanish Language – Read, write, and speak fluently

OTHER EXPERIENCE

BYU ITE Student Chapter Officer
- Secretary: April 2016 – April 2017
- Chapter President: April 2017 – Present

LDS Church Mission to Oaxaca, Mexico – March 2011-April 2013
- Led up to 20 other missionaries at a time in leadership positions
- Worked in mission office organizing dozens of new member records

Extra-curricular Activities
- Team captain of high school cross country team
- Taught piano lessons to 10 students and performed in several piano concerts

735 N 400 E #21
Provo, Utah 84606

Daniel Clark Wells

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Summary of Qualifications

- Bachelor of Science degree — Civil and Environmental Engineering
- Internship — 22 months with BYU Physical Facilities Planning Dept.
- FE Exam — will take in April 2018

Education

Bachelor of Science — Civil and Environmental Engineering — Expected December 2018
Brigham Young University — Provo, UT

- Minor: Mathematics
- GPA: 3.73
- Notable classes: Capstone, Soil Mechanics, Hydrology, Intro. to Transportation Eng., Technical Communication

Associate of Arts — General Education — June 2012
Pierce College — Puyallup, WA

- Graduated top 5%; GPA: 3.98

Work and Volunteer Experience

Civil Engineering Intern — Apr 2016 – Present
BYU Physical Facilities Planning Dept.
Provo, UT

- Maintained AutoCAD Civil 3D 560-acre campus maps
- Assisted with design and survey of over 2 dozen projects
- Used Trimble survey equipment to shoot over 9400 points

Conference Assistant and Community Service Assistant — Apr 2015 – Apr 2016
BYU Residence Life
Provo, UT

- Performed secretarial duties and night security roves
- Prepared over 60 rooms weekly for guest use

Hired Hand — Oct 2014 – Dec 2014
Summerville, SC

- Worked 48,000 sq. ft. property with manual labor

Volunteer Representative — Oct 2012 – Oct 2014
The Church of Jesus Christ of Latter-day Saints
Nashville, TN

- Coordinated with local church and community leaders
- Trained new volunteers; managed teams of 6–8 volunteers

Other Involvement

BYU ITE Student Chapter — Activities Officer — 2016 – Present
BYU ASCE Student Chapter — Committee Member — 2015 – Present
BYU A Cappella Club — Tenor — 2015 – 2016
Boy Scouts of America — Eagle Scout Award — 2012

Kyle Moncur

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Provo, UT 84606
Cell Phone: (801) 989 - 7254
kmoncur7@gmail.com

Education:

- BRIGHAM YOUNG UNIVERSITY, 2011 – 2012, 2014 – Present
  Civil Engineering (B.S. Completion Date: 2018)
  Provo, UT 84602
  GPA: 3.0
  Field specific classes included those in Auto-Cad, Revit, transportation and structural design courses.
- DAVIS HIGH SCHOOL
  High Honors Graduate, 2011

Experience:

- Undergraduate Research Assistant (September 2017-Present)
  Brigham Young University – Civil Engineering
- Jacobsen Construction Company (May 2014 – September 2017)
  Skilled Laborer
  Have been in charge and managed up to 10 other workers on job sites. Directed them to completion of the tasks required that day. Organized everyone into great working teams so time was never wasted and the work was done as quickly and efficiently as possible.
- Served a 2-year mission for the Church of Jesus Christ of Latter-day Saints in Washington from May 2012 - May 2014.
- Jakes Radiator and Air Conditioning (Summer 2010)
  Handy Man, Cleaned and replaced radiators.
  Began learning and shadowing the lead technicians but by the end of my time I was working alone. I was able to do this because of my quick learning skills and ability to cope with changing surroundings and new situations.

Interests:

- Triathlons, cycling, basketball, golf
  Through all sports I have learned to work well with others to help each other achieve goals.

Awards/achievements:

- Completed multiple triathlons including the St. George half ironman
  Compete on the BYU Triathlon Team. The experiences I have had on the team have allowed me to manage the growth in myself and even in some ways the growth of the team. This sport has positively affected my character in many areas such as drive, passion, dedication, work ethic, responsibility, hitting deadlines/goals, etc.
- Eagle Scout, Boy Scouts of America (February 2009)

References upon request

Braxton Kurt Miller

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Phone: 435-669-3819
millbraxton@gmail.com

Education

2013/Present **Student-** Brigham Young University
- Major: Civil and Environmental Engineering

Certifications
- WAQTC (Concrete)
- Soil Reduction and Density Testing
- Level 1 Inspector

Work History

Aug. 2014/Present **Stanley Consultants**

I have worked as a Level one inspector on various job locations throughout the state of Utah. I have worked on High Risk Rural Road jobs overseeing traffic sign installation, intersection widening projects, mill and fill projects, and virgin roads requiring large amounts of earthwork.
- Quality Assurance/Quality Control
- Review Plans and Standard Drawings
- Monitoring Progress

June 2013/Aug. 2013 **Landmark Engineering and Testing**

At Landmark I work as a lab technician. I ran tests on soils and concrete in order to determine if certain soils are acceptable for use in construction and whether or not the concrete is strong enough for its intended purpose. I am also a runner, which requires me to occasionally visit the job sites and pick up asphalt, soil, and concrete samples.
- Quality Assurance/Quality Control

Summer/Fall 2010 **Stanley Consultants**

While working for Stanley Consultants I had the opportunity to work on multiple job sites testing and inspecting concrete, soils, and asphalt. I had to work whenever the contractor worked causing me to work long hours and in adverse conditions.
- Quality Assurance/Quality Control

Extra Curricular

Dec. 2010/Dec. 2012 **LDS Mission, Lyon France Mission**

I had the opportunity to go on a proselyting mission to the south of France. While there I was able to serve the people, learn how to speak the French language, and gained valuable leadership experiences.
- Leadership Experience

References : Available Upon Request

Appendix B – LEI Storm Drainage Calculation Scans

Consulting Engineers and Surveyors, Inc.
3302 N. Main, Spanish Fork, UT 84660 (801)798-0555

Storm Drainage Calculations

Fritzi Subdivision

Parcel A
Storm Drainage

Date: November 17, 2006
Project #: 2006-1082
Prepared By: CJP
Revisions:

Design Criteria

Intensity Table:	Spanish Fork	
Return Period:	25	year
Allowable Discharge:	0.20	cfs/Ac

Storm Drainage Sumps

Sump Diameter:	5.00	ft		
Sump Depth:	10.5	ft		
Infiltration Rate:	10.00	in/hr	Source:	Estimate to be verified
Infiltration per Sump:	0.128	cfs		
# Sumps	0			

Allowable Discharges

Storm Drain Discharge:	1.83	cfs	
Sump Infiltration:	0.00	cfs	
Other Discharge:	0.00	cfs	Source:
Total Discharge:	*1.83*	*cfs*	

Weighted "C" Value

Surface Type	*Area (sf)*	*"C" Value*	*C*A*
Roof/Pavement	135,839.0	0.85	115,463
Landscape/Open Space	263,458.4	0.10	26,346
Other	0.0	0.00	0
Totals	399,297.4		141,809
Weighted "C" Value		*0.36*	

Drainage Calculations

Duration	Intensity	Runoff C	Area	Rainfall	Accumulated Flow	Allowable Discharge	Discharge	Required Storage
min	*in/hr*		*Ac*	*cfs*	*cf*	*cfs*	*cf*	*cf*
5.0	2.64	0.36	9.17	8.59	2,578	1.83	550	2,028
10.0	2.04	0.36	9.17	6.64	3,985	1.83	1,100	2,885
15.0	1.74	0.36	9.17	5.66	5,098	1.83	1,650	3,448
30.0	1.20	0.36	9.17	3.91	7,032	1.83	3,300	3,732
60.0	0.76	0.36	9.17	2.47	8,907	1.83	6,600	2,307
120.0	0.48	0.36	9.17	1.56	11,251	1.83	13,200	-1,949
180.0	0.38	0.36	9.17	1.24	13,361	1.83	19,800	-6,439
360.0	0.27	0.36	9.17	0.88	18,986	1.83	39,600	-20,614

Maximum Storage Requirement: *3,732*

Pipe Storage Capacities

	Pipe 1	*Pipe 2*	*Pipe 3*	*Pipe 4*
Pipe Lengths:				
Pipe Diameter:				
Pipe Storage:	0	0	0	0
Total Pipe Storage:				*0*

Sump Storage Capacities

Sump Storage: 0 cf

STATE OF UTAH
GREGORY D. MAGLEBY
No. 189844
REGISTERED PROFESSIONAL ENGINEER
11/27/06

Page 1 of 2

Catch Basin Storage Capacities

Catch Basin Area:	0	sf
Average Depth:	0	ft
Number Catch Basins:	0	
Catch Basin Storage:	*0*	*cf*

Detention Basin Design

Storage Requirement:	3,732	cf
Allowable Depth:	1.50	ft
Water Surface Area (top):	5,000	sf
Surface Area (bottom):	2,500	sf
Additional Volume:		cf
Detention Volume:	*5,625*	*cf*

Source:
DETENTION ADEQUATE

Orifice Design

Orificed Flow:	1.83	*cfs*
Orifice Head:	3.50	*ft*
Required Orifice Diameter:	*6.01*	*in*

Notes / Details

1- Rainfall intensity criteria is based on the average of KOVO and SF Powerhouse stations as provided by Spanish Fork City.
2- A stream alteration permit will be required from Utah State.
3- Pond sized for the 100 yr. storm event.\

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Consulting Engineers and Surveyors, Inc.
3302 N. Main, Spanish Fork, UT 84660 (801)798-0555

Storm Drainage Calculations

Fritzi Subdivision

Parcel A
Storm Drainage

Date: November 17, 2006
Project #: 2006-1082
Prepared By: CJP
Revisions:

Design Criteria

Intensity Table:	Spanish Fork	
Return Period:	100	year
Allowable Discharge:	0.20	cfs/Ac

Storm Drainage Sumps

Sump Diameter:	5.00	ft		
Sump Depth:	10.5	ft		
Infiltration Rate:	10.00	in/hr	Source:	Estimate to be verified
Infiltration per Sump:	0.128	cfs		
# Sumps	0			

Allowable Discharges

Storm Drain Discharge:	1.83	cfs	
Sump Infiltration:	0.00	cfs	
Other Discharge:	0.00	cfs	Source:
Total Discharge:	*1.83*	*cfs*	

Weighted "C" Value

Surface Type	*Area (sf)*	*"C" Value*	*C*A*
Roof/Pavement	135,839.0	0.85	115,463
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Totals	399,297.4		141,809
Weighted "C" Value		***0.36***	

Drainage Calculations

Duration	Intensity	Runoff C	Area	Rainfall	Accumulated Flow	Allowable Discharge	Discharge	Required Storage
min	*in/hr*		*Ac*	*cfs*	*cf*	*cfs*	*cf*	*cf*
5.0	3.12	0.36	9.17	10.16	3,047	1.83	550	2,497
10.0	2.46	0.36	9.17	8.01	4,805	1.83	1,100	3,705
15.0	2.08	0.36	9.17	6.77	6,094	1.83	1,650	4,444
30.0	1.43	0.36	9.17	4.66	8,380	1.83	3,300	5,080
60.0	0.91	0.36	9.17	2.96	10,665	1.83	6,600	4,065
120.0	0.58	0.36	9.17	1.89	13,595	1.83	13,200	395
180.0	0.47	0.36	9.17	1.53	16,525	1.83	19,800	-3,275
360.0	0.33	0.36	9.17	1.07	23,205	1.83	39,600	-16,395

Maximum Storage Requirement: *5,080*

Pipe Storage Capacities

	Pipe 1	*Pipe 2*	*Pipe 3*	*Pipe 4*
Pipe Lengths:				
Pipe Diameter:				
Pipe Storage:	0	0	0	0
Total Pipe Storage:				*0*

Sump Storage Capacities

Sump Storage: 0 cf

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Catch Basin Storage Capacities

Catch Basin Area:	0	sf
Average Depth:	0	ft
Number Catch Basins:	0	
Catch Basin Storage:	*0*	*cf*

Detention Basin Design

Storage Requirement:	5,080	cf
Allowable Depth:	1.50	ft
Water Surface Area (top):	5,000	sf
Surface Area (bottom):	2,500	sf
Additional Volume:		cf
Detention Volume:	*5,625*	*cf*

Source:
DETENTION ADEQUATE

Orifice Design

Orificed Flow:	1.83	*cfs*
Orifice Head:	3.50	*ft*
Required Orifice Diameter:	*6.01*	*in*

Notes / Details

1- Rainfall intensity criteria is based on the average of KOVO and SF Powerhouse stations as provided by Spanish Fork City.

2- A stream alteration permit will be required from Utah State.

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Storm Drainage Calculations

Fritzi Subdivision

Parcel B
Storm Drainage

Date: November 17, 2006
Project #: 2006-1082
Prepared By: CJP
Revisions:

Design Criteria

Intensity Table:	Spanish Fork	
Return Period:	25	year
Allowable Discharge:	0.20	cfs/Ac

Storm Drainage Sumps

Sump Diameter:	5.00	ft		
Sump Depth:	10.5	ft		
Infiltration Rate:	10.00	in/hr	Source:	Estimate to be verified
Infiltration per Sump:	0.128	cfs		
# Sumps	4			

Allowable Discharges

Storm Drain Discharge:	1.84	cfs
Sump Infiltration:	0.51	cfs
Other Discharge:	0.00	cfs
Total Discharge:	*2.35*	*cfs*

Source:

Weighted "C" Value

Surface Type	*Area (sf)*	*"C" Value*	*C*A*
Roof/Pavement	137,214.0	0.85	116,632
Landscape/Open Space	262,666.8	0.10	26,267
Other		0.00	0
Totals	399,880.8		142,899
Weighted "C" Value		***0.36***	

Drainage Calculations

Duration	Intensity	Runoff C	Area	Rainfall	Accumulated Flow	Allowable Discharge	Discharge	Required Storage
min	*in/hr*		*Ac*	*cfs*	*cf*	*cfs*	*cf*	*cf*
5.0	2.64	0.36	9.18	8.66	2,598	2.35	705	1,893
10.0	2.04	0.36	9.18	6.69	4,015	2.35	1,410	2,605
15.0	1.74	0.36	9.18	5.71	5,137	2.35	2,115	3,022
30.0	1.20	0.36	9.18	3.94	7,086	2.35	4,230	2,856
60.0	0.76	0.36	9.18	2.49	8,975	2.35	8,460	516
120.0	0.48	0.36	9.18	1.57	11,337	2.35	16,919	-5,582
180.0	0.38	0.36	9.18	1.25	13,463	2.35	25,379	-11,916
360.0	0.27	0.36	9.18	0.89	19,132	2.35	50,758	-31,626

Maximum Storage Requirement: *3,022*

Pipe Storage Capacities

	Pipe 1	*Pipe 2*	*Pipe 3*	*Pipe 4*
Pipe Lengths:				
Pipe Diameter:				
Pipe Storage:	0	0	0	0
Total Pipe Storage:				*0*

Sump Storage Capacities

Sump Storage: 3,144 cf

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Catch Basin Storage Capacities

Catch Basin Area:	0	sf
Average Depth:	0	ft
Number Catch Basins:	0	
Catch Basin Storage:	*0*	*cf*

Detention Basin Design

Storage Requirement:	-122	cf
Allowable Depth:		ft
Water Surface Area (top):		sf
Surface Area (bottom):		sf
Additional Volume:		cf
Detention Volume:	*0*	*cf*

Source:
DETENTION ADEQUATE

Orifice Design

Orificed Flow:		*cfs*
Orifice Head:		*ft*
Required Orifice Diameter:		*in*

Notes / Details

Rainfall intensity criteria is based on the average of KOVO and SF Powerhouse stations as provided by Spanish Fork City.

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Storm Drainage Calculations

Fritzi Subdivision

Parcel C
Storm Drainage

Date: November 17, 2006
Project #: 2006-1082
Prepared By: CJP
Revisions:

Design Criteria

Intensity Table:	Spanish Fork	
Return Period:	25	year
Allowable Discharge:	0.00	cfs/Ac

Storm Drainage Sumps

Sump Diameter:	5.00	ft		
Sump Depth:	10.5	ft		
Infiltration Rate:	15.00	in/hr	Source:	Estimate to be verified
Infiltration per Sump:	0.193	cfs		
# Sumps	18			

Allowable Discharges

Storm Drain Discharge:	0.00	cfs	
Sump Infiltration:	3.47	cfs	
Other Discharge:	0.00	cfs	Source:
Total Discharge:	*3.47*	*cfs*	

Weighted "C" Value

Surface Type	*Area (sf)*	*"C" Value*	*C*A*
Roof/Pavement	386,679.6	0.85	328,678
Landscape/Open Space	790,614.0	0.10	79,061
Other	0.0	0.00	0
Totals	1,177,293.6		407,739
Weighted "C" Value		***0.35***	

Drainage Calculations

Duration	Intensity	Runoff C	Area	Rainfall	Accumulated Flow	Allowable Discharge	Discharge	Required Storage
min	*in/hr*		*Ac*	*cfs*	*cf*	*cfs*	*cf*	*cf*
5.0	2.64	0.35	27.03	24.71	7,413	3.47	1,041	6,373
10.0	2.04	0.35	27.03	19.10	11,457	3.47	2,081	9,376
15.0	1.74	0.35	27.03	16.29	14,658	3.47	3,122	11,537
30.0	1.20	0.35	27.03	11.23	20,218	3.47	6,244	13,975
60.0	0.76	0.35	27.03	7.11	25,610	3.47	12,488	13,123
120.0	0.48	0.35	27.03	4.49	32,350	3.47	24,975	7,375
180.0	0.38	0.35	27.03	3.56	38,415	3.47	37,463	953
360.0	0.27	0.35	27.03	2.53	54,590	3.47	74,925	-20,335

Maximum Storage Requirement: *13,975*

Pipe Storage Capacities

	Pipe 1	*Pipe 2*	*Pipe 3*	*Pipe 4*
Pipe Lengths:				
Pipe Diameter:				
Pipe Storage:	0	0	0	0
Total Pipe Storage:				*0*

Sump Storage Capacities

Sump Storage: 14,148 cf

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Catch Basin Storage Capacities

Catch Basin Area:	0	sf
Average Depth:	0	ft
Number Catch Basins:	0	
Catch Basin Storage:	*0*	*cf*

Detention Basin Design

Storage Requirement:	-173	cf
Allowable Depth:		ft
Water Surface Area (top):		sf
Surface Area (bottom):		sf
Additional Volume:		cf
Detention Volume:	*0*	*cf*

Source:
DETENTION ADEQUATE

Orifice Design

Orificed Flow:		*cfs*
Orifice Head:		*ft*
Required Orifice Diameter:		*in*

Notes / Details

Rainfall intensity criteria is based on the average of KOVO and SF Powerhouse stations as provided by Spanish Fork City.

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Storm Drainage Calculations

Fritzi Subdivision

Parcels B&C (100yr)
Storm Drainage

Date: November 17, 2006
Project #: 2006-1082
Prepared By: CJP
Revisions:

Design Criteria

Intensity Table:	Spanish Fork	
Return Period:	100	year
Allowable Discharge:	0.20	cfs/Ac

Storm Drainage Sumps

Sump Diameter:	5.00	ft		
Sump Depth:	10.5	ft		
Infiltration Rate:	12.50	in/hr	Source:	Estimate to be verified
Infiltration per Sump:	0.161	cfs		
# Sumps	22			

Allowable Discharges

Storm Drain Discharge:	7.24	cfs	
Sump Infiltration:	3.53	cfs	
Other Discharge:	0.00	cfs	Source:
Total Discharge:	*10.77*	*cfs*	

Weighted "C" Value

Surface Type	*Area (sf)*	*"C" Value*	*C*A*
Roof/Pavement	523,893.6	0.85	445,310
Landscape/Open Space	1,053,280.8	0.10	105,328
Other		0.00	0
Totals	1,577,174.4		550,638
Weighted "C" Value		***0.35***	

Drainage Calculations

Duration	Intensity	Runoff C	Area	Rainfall	Accumulated Flow	Allowable Discharge	Discharge	Required Storage
min	*in/hr*		*Ac*	*cfs*	*cf*	*cfs*	*cf*	*cf*
5.0	3.12	0.35	36.21	39.44	11,832	10.77	3,232	8,600
10.0	2.46	0.35	36.21	31.10	18,658	10.77	6,465	12,193
15.0	2.08	0.35	36.21	26.29	23,664	10.77	9,697	13,967
30.0	1.43	0.35	36.21	18.08	32,538	10.77	19,394	13,144
60.0	0.91	0.35	36.21	11.50	41,412	10.77	38,788	2,624
120.0	0.58	0.35	36.21	7.33	52,788	10.77	77,575	-24,787
180.0	0.47	0.35	36.21	5.94	64,165	10.77	116,363	-52,198
360.0	0.33	0.35	36.21	4.17	90,104	10.77	232,726	-142,622

Maximum Storage Requirement: *13,967*

Pipe Storage Capacities

	Pipe 1	*Pipe 2*	*Pipe 3*	*Pipe 4*
Pipe Lengths:				
Pipe Diameter:				
Pipe Storage:	0	0	0	0
Total Pipe Storage:				*0*

Sump Storage Capacities

Sump Storage: 17,292 cf

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Catch Basin Storage Capacities

Catch Basin Area:	0	sf
Average Depth:	0	ft
Number Catch Basins:	0	
Catch Basin Storage:	*0*	*cf*

Detention Basin Design

Storage Requirement:	-3,325	cf
Allowable Depth:		ft
Water Surface Area (top):		sf
Surface Area (bottom):		sf
Additional Volume:		cf
Detention Volume:	*0*	*cf*

Source:
DETENTION ADEQUATE

Orifice Design

Orificed Flow:		*cfs*
Orifice Head:		*ft*
Required Orifice Diameter:		*in*

Notes / Details

1- Rainfall intensity criteria is based on the average of KOVO and SF Powerhouse stations as provided by Spanish Fork City.

2- Calculations include the areas for both parcels B and C for the 100 yr event. Parcel C handles the 25 yr. storm without any overflow discharge and the 100 yr. event with a 0.20 cfs/ac discharge. The overflow from parcel C will pass through parcel B to the existing 24" culvert in Arrowhead Trail.