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FINAL DELIVERABLE

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Community Partners	Camp Courageous, Maquoketa River Watershed Management Authority, Iowa DNR

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Camp Courageous
Storm Water Quality
Final Report

Submitted To: Camp Courageous

December 17th, 2021

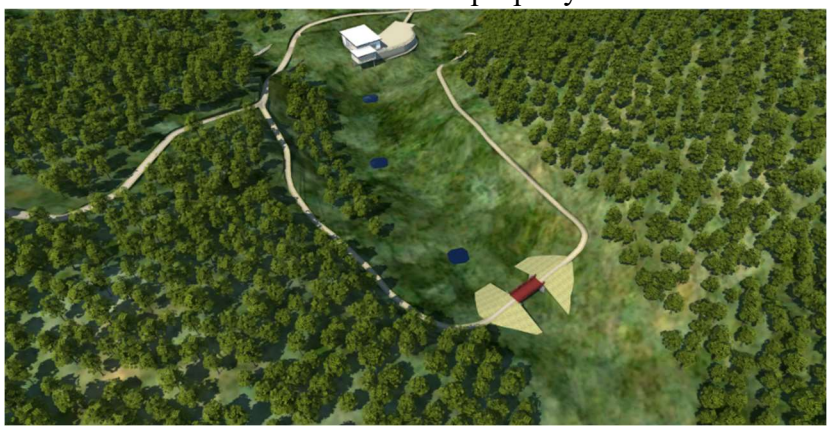
IOWA™
CIVIL & ENVIRONMENTAL
ENGINEERING

Prepared by: Duncan Szpara, Daniel Zirtzman, Kyle Jenkins

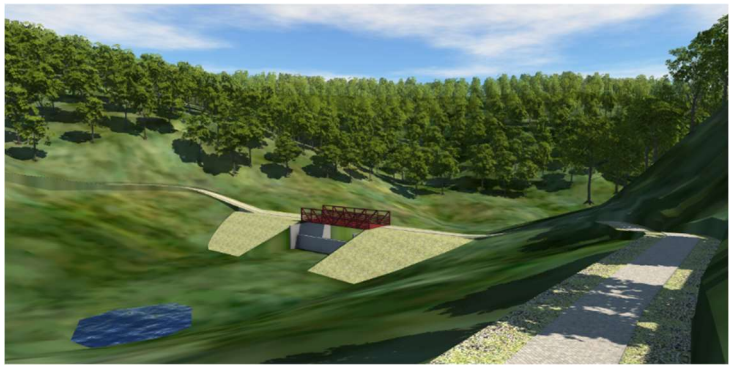
Table of Contents

Section I Executive Summary

Camp Courageous is a camp located east of Monticello, Iowa that caters to special needs individuals of all ages. The property sits on four hundred acres of land and operates with about one hundred staff in 33 buildings. The camp recently has purchased an area north of 190th St. The newly acquired land will incorporate new trails, a nature center, and a showcase of water management control. Our team was tasked with assisting Camp Courageous in becoming an environmental leader by proactively managing the quality of their storm water runoff. Our team has performed numerous site visits to determine the path and steps that Camp Courageous can take to effectively reduce pollutants from runoff, reduce erosion, increase habitat growth, and improve storm water quality overall. Our team recommends six methods of storm water control that should be put in place. The first of these recommendations is a small dam located on the north side of the property. The dam will effectively slow down storm water control peak flow events. Moreover, the dam will improve the water quality downstream of the dam.



The second method that should be put in place on the camp's property are sediment traps. A sediment trap is a pollutant settlement area that slows down storm water with the use of riprap to allow for sediment and pollutants to settle out. Our project team believes this is a good option for Camp Courageous to put in place near the north side of its property to capture and slow down pollutants coming from the northern farm fields. The additional methods recommended by the team would be the utilization of rock, wooden, and sock sleeve check dams. The use of these check dams can stabilize tributary slopes and slow down storm water velocity. Moreover, some of the check dams can be put in place by Camp Courageous with the efforts of volunteers and camp staff. The sixth and final method for storm water quality would be the use of habitat pools. Putting permanent pools along the main north stream would allow for sediment to filter out as it heads downstream as well as aid in natural habitat growth. These pools can be strategically placed near the education center so that campers may see wildlife. With the installation of permanent pools, we also recommend specific plants and vegetative cover that can be put in place around the pools to promote habitat growth as well as filter out pollutants. With these design recommendations, our project team has also coordinated with the other project groups to ensure that all the projects are interconnected. The trail group will link up with our stream crossing and the dam feature will be in view of



the education center. The estimated cost of all recommendations is broken down below. The largest cost of the project is the dam, which is broken down to be $193,800, sock sleeve check dams $1,500 each, rock check dams are estimated to be $3,400 each, the wood check dams are estimated to be $2,000 each, sediment traps are estimated to be $14,000, habitat pools are estimated to be $9,000. Additional costs such as the prefabricated bridge is $44,000 and the habitat cost is estimated to be $23,000. Lastly, the total site grading is estimated to be $80,000. The total cost of the project comes out to be $368,700 without the cost of engineering.

Section II Organization Qualifications and Experience

Daniel Zirtzman

Duncan Szpara, Project Manger

Kyle Jenkins

Duncan is the project manager and has a focus in civil and environmental practice, Daniel has a focus of civil and environmental practice, and Kyle has a focus of civil and environmental practice as well. Duncan brings to the team class experience in hydrology, fluvial geomorphology, and water resources engineering. Kyle has work experience in flood analysis, led the bulk of calculations, and conducted habitat planning. Daniel has brought extensive knowledge of Civil 3D, InfraWorks, and ArcGIS to this project. In previous classes the team have focused on the discussion of water management and erosion control. This coursework encompassed software knowledge of ArcGIS, HEC-RAS, Civil 3D, and EPANET.

Section III Design Services

Project Scope

We have been selected to help Camp Courageous be proactive leaders in the management of their storm water quality. Camp Courageous asked our project team to not only improve storm water quality but also to promote habitat growth, coordinate with other project groups, and to showcase water management techniques.

Our team has designed six storm water management features that Camp Courageous can implement on its property. These features include a dam along the main stream with a bridge crossing, a sediment trap design for the northern stream boundary, wooden check dams, rock check dams, sock sleeve check dams, and habitat pools. Design sheets are provided for all designs done by the project team and outside resources. All designs are to address camp courageous concerns with pollutants, erosion, and habitat growth. All the designs outlined are a result of numerous site visits with Camp Courageous staff, NRCS engineers, and DNR engineers as well as our professors here at the University of Iowa.

For all three check dams, we have designed cross section views to show the design and construction requirements in order to build them. With the wooden design, we have chosen design materials that Camp Courageous can pick up from a local hardware store such as Home Depot or Menards. The rock check dam will require larger equipment to move the Class E riprap to the designed site. The use of rock check dams and sock sleeve check dams vs wood check dams are ultimately down to the client with our given recommendations. Wooden check dams are a reliable option for slopes and tributaries that are semi stable whereas rock check dams are an option for recommended tributaries with more serious erosion. Sock sleeve check dams are recommended as an affordable option that is easy for volunteers to implement on the camp's property. We reached out to Filtrex to get a cost estimate and recommended design based on the property topography. Sock sleeves work by rooting themselves into the soil and help stabilize slopes. This potentially will be able to help erosion control on the camps property and be installed slowly over time.

Next, we designed a dam. To do this, we determined the amount of water discharge during the 100-year flood for this area and based our design on best management practices for the state of Iowa. This design of a dam does not create permanent detention of water behind it. It will only accommodate water during peak flow events and then eventually the water will filter out through groundwater.

Habitat pools were also designed in conjunction with the dam. These habitat pools are designed to hold water during rainfall events but do not retain water permanently. These potholes are to be installed with additional vegetation to increase and reinforce natural habitat growth for Camp Courageous native species. Vegetation types has been carefully considered to encourage habitat

growth for native species on the camps property as well as to filter out pollutants that will flow through. These vegetation types have been outlined in the appendix.

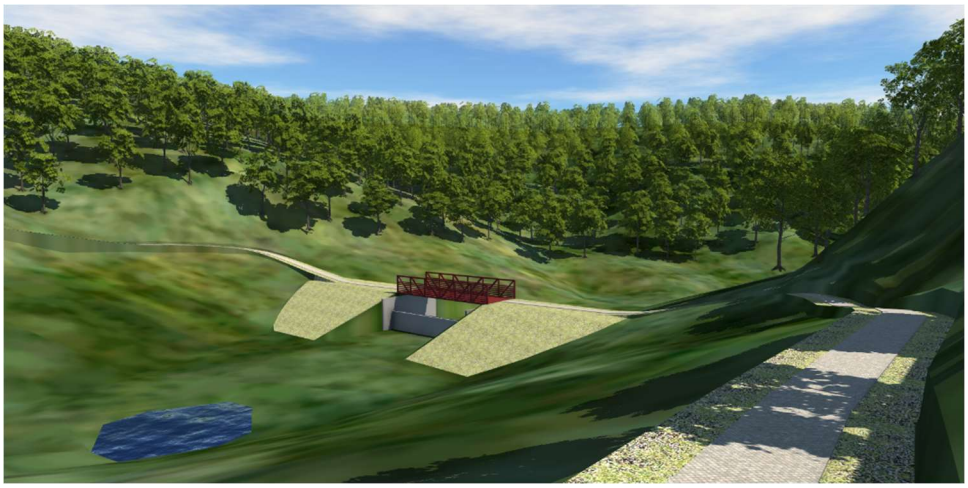


Fig.1: Proposed Dam

Finally, we designed a sediment trap in Civil 3d based on a habitat pool design and sediment trap design outlined by the Illinois Urban Manual. Sediment traps were selected as part of the overall design for Camp Courageous since they can effectively reduce nitrate pollution that comes off the northern farms that border camp courageous.

Work Plan

The team completed numerous tasks broken down in the Gantt chart found in Appendix C. To summarize the chart, starting late August we began with preliminary steps for Camp Courageous to get as much information about the site as possible. Our group performed several site visits and utilized geospatial tracking to get an early picture of where our site would be located. We also began coordinating with other project teams early in the project to ensure that each project would be intertwined. Moving on throughout the timeline of the project, we created numerous alternate solutions that we put forward for Camp Courageous to look at. Our project team was then able to narrow down to six designs which we and the camp felt would improve storm water quality, display water management practices, and create the best experience for the camps visitors. The total design for the project was estimated to take two months to get final designs completed for Camp Courageous. To split up this design, our project team broke down tasks to ensure we were tackling multiple things at once. Daniel conducted the ArcGIS geospatial processing and most of the 3D site design while Kyle researched habitats and created a landscape plan as well as performed necessary calculations for the designs. Duncan aided in any way he could with other tasks while also doing design work in Civil 3D and coordinating with the other groups weekly to ensure continuity of each group's goals and the client's vision for the site. Each group member worked to connect these designs to one another and add them to the master Civil 3D to highlight where these designs are located. The final part of this project consisted of putting together a poster and presentation for the client along with the final design sheets. Once these were completed, we ran through practice presentations with the class to straighten any loose ends.

Section IV Constraints, Challenges, and Impacts

Constraints

Distance to rock: Our solutions were limited due to the rock that is on-site. The distance to bedrock made designing habitat pools especially difficult. Except for using dynamite, the grading and expansion of the site would be difficult to accomplish due to cost and feasibility of terrain.

Space/Location: The location and spacing of the design sites were a constraint due to construction access difficulties. The site has many ridges, trees, and slopes. Access to certain locations on site would be extremely difficult to accomplish for most heavy machinery options.

Challenges

Time: It will take time to fund the project and get access to the proposed construction sites. Additionally, acquiring the appropriate permits would constrain the project as well. Moreover, time was a challenge for this project since there were many designs. This put everything on a fast-paced time crunch.

Pictured Rocks Indian Bluffs Cave: Indian bluffs cave sits underneath part of Camp Courageous property as well as Pictured Rocks State Park. Since this cave runs under the property, we had to ensure our designed sites would not interfere with the cave and the natural habitat that it provides to the species of bats that live there.

Societal Impact within the Community

The surrounding community would benefit from all the erosion control methods designed. This is demonstrated by the improved runoff and reduced pollutants that run into the Maquoketa River and the surrounding area. Furthermore, the addition of the other projects would attract visitors and thus bring about increased understanding of how water management practices work in general and specifically for Jones County as well. All work and design will be limited to the Camp Courageous property.

Section V Alternative Solutions That Were Considered

Sites Locations

Multiple design site locations that we felt would provide a beneficial impact to the storm water quality on Camp Courageous property were considered throughout the course of this project. The location of the dam relative to the trails and the education center are shown below in Fig.1:

Fig. 2: Combined Sites with Dam Location Highlighted

The only alternates that were not pursued from the early project meetings was the use of grass/sodding to reduce pollutants on the property and the outlet pipe. The other notable change was moving the location of the dam further North to ensure it was not visible from Pictured Rocks road. This was done due to the client's concerns about visitors from the neighboring property climbing onto the property to view the water features available.

By moving the dam upstream, this resulted in a better view from the Cultural Education Center which would be placed upstream of the dam. Both the Storm Water Quality group and the Cultural Education Center group agreed that it would be difficult to put the water feature at the original proposed location, thus it was agreed to move it further upstream.

Outlet Pipe

For one of our proposed storm water management devices, a dam, we initially had planned to insert a drop inlet upstream of the dam. This drop inlet would let water drain at a controlled rate downstream of the dam and stop large debris from entering the chute. However, small

debris could still work its way into the tube causing maintenance headaches. Thus, we abandoned the outlet pipe and instead went with the design of a dam with a weir.

South Side Improvements

Initially, the client had asked us to consider installing water management features on the North side and South side of the property since they had erosion issues on both sides. While investigating the South side, we concluded that due to property boundaries and steep terrain, it would prove extremely difficult to design a feature that would permit construction access while not encroaching on property boundaries. Moreover, concerns were raised about the magnitude of the workload. It was concluded that it would be best to solely focus on the North Side of the property.

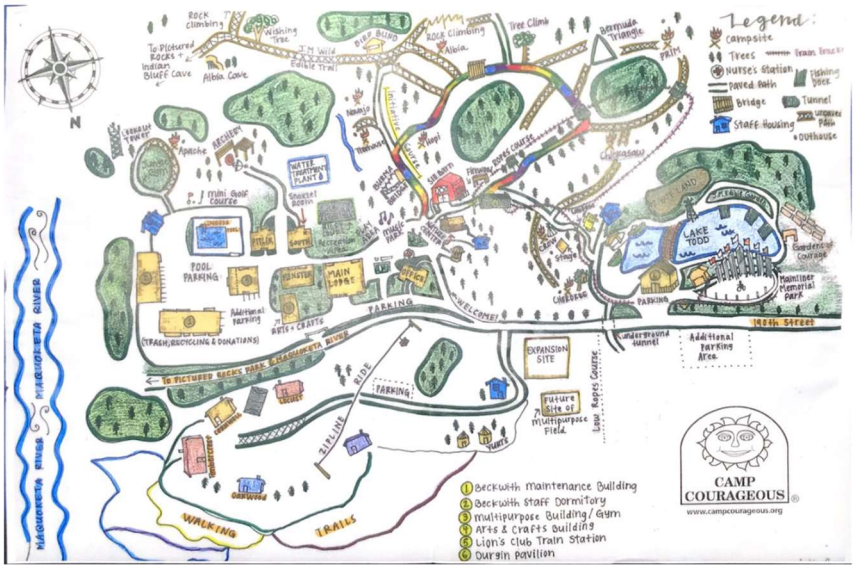


Fig. 3: Camp Map with Attractions

However, to resolve some of the erosion issues on the South side, we instead recommend water management devices for the camp such as check dams and sock sleeve slope stabilizers that do not require large machinery to be used. This way Camp Courageous could still decrease the erosion occurring on their property and could enlist volunteers to do it as well.

Section VI Final Design Recommendations

The final design, as previously stated, consists of six recommended storm water improvement features that will aim to improve the water quality, showcase water management practices, and increase habitat on Camp Courageous property. These recommendations are put forward with prior coordination with the other project teams.

Habitat Pool

To size the pools, we followed Integrated Stormwater Management manual[1].Following the steps provided in the manual, we determined that our volume for the habitat pool should be 900 ft^3. For a 4'-6' foot depth, this translates to a pool diameter of 15'.

Material Selection

For the habitat pool to hold the water to clean storm water discharge and provide water to wildlife, the pool is recommended to be lined with a clay liner. Moreover, the distance to bedrock will need to be determined by doing appropriate soil testing of the site to determine the feasibility of these pools holding water.

Additional Recommendations

To measure the change in nitrate concentration as well as other pollutants, we recommend using Lamotte GREEN Program water testing kits. These testing kits can test for eight parameters such as nitrates, phosphates, coliform bacteria, PH, as well as others. This is a very affordable option to test and track water quality throughout the year on the property, we recommend inspecting habitat pools at least once a year and maintaining them every three years.

Dam

To size the dam appropriately, we designed the dam to a 100-year flood event. With this design parameter, we sized it to be 28 feet in length and have a height of five feet. With a 100-year flood event, the maximum discharge that our designed dam could accommodate would be 360 cfs. The goal of this dam will be to temporarily detain water during a peak flow event and improve downstream water quality. Moreover, this dam will serve as a point for the Trail group to cross the stream as well as a showcase for the Cultural Education Center group. In order to fully design the product of the dam, an engineering firm with a valid PE must be hired. According to the Iowa DNR, for dams of 5 feet or more, a valid PE must design the dam.

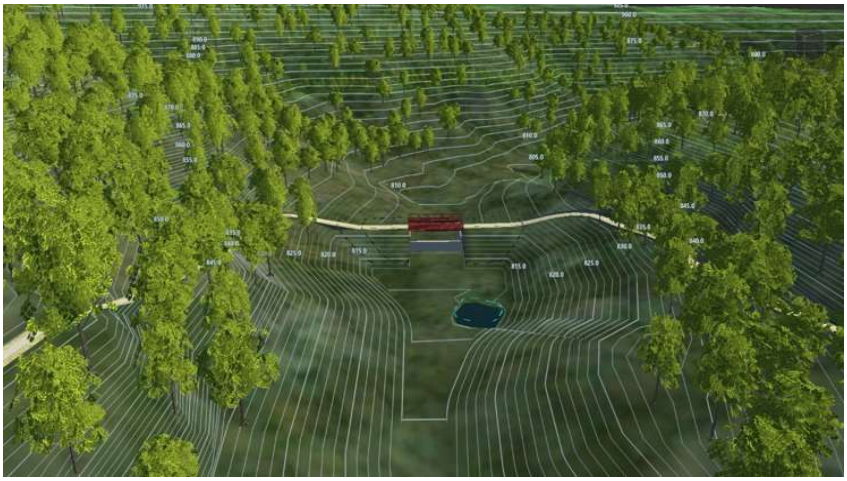


Fig.4: Dam Design with Contours

Sediment Trap

For the design of the sediment trap, we followed the Kentucky DOT recommendation. As outlined in their design standards, the traps are to be 4’ deep with a minimum of 2’ deep and have a 2H:1V bank slope. Moreover, these traps are to be 15’x15’ to accommodate the drainage area of the stream. These sediment traps are to be maintained every three years and inspected yearly. The main goal of sediment traps is to settle out sediment. The secondary benefits of using sediment traps are that it reduces total phosphorous, total nitrates, heavy metals, floatables, and oil and grease. To protect the traps from erosion and to increase detention time, the traps are to be lined with riprap around the edges. Riprap is to be lined downstream of the inlet and be half the circumference of the sediment trap. To allow for sediment to settle out, we recommend using clay as a liner that will allow water to filter out through the riprap and clay slowly. The volume of excavation for clay is calculated to be 90 CY.

Wooden Check Dams

Wooden check dams were designed to be built with materials from local lumber yards. The boards for the wooden check dams are to be 2”x8” dimensional lumber. We recommend using treated lumber. All wooden check dams to be installed are to be 3 feet tall and must be inserted 18” deep into side slopes per design standards. Moreover, wooden check dams will be supported every 4 feet with metal poles. Poles are to have 2” diameters and be 8’ long. These poles are to be driven into earth equal distance as the height of the check dams as shown in the design sheet. These check dams are to be drilled with bore holes as shown in the design drawings. The use of bore holes is to allow low flows to pass through the check dam without overtopping. Check dams are to be reinforced on the downstream side with sock stabilizers to prevent undercutting and erosion in overflow events. This feature is to be installed mid-way up the tributaries where storm water velocities are moderate.

Material Selection

Material was selected based of accessibility for Camp Courageous and what material would have the proper strength for withstanding storm water flow. We decided to go with 2”x8”

treated dimensional lumber that can be found at a Home Depot. Moreover, we have also selected the material for the reinforcing poles to be a rust resistant galvanized steel pole. These are to be 8’ in length and 2” in diameter.

Estimated Quantity

The estimated quantity for the wood is twenty-two 2”x8’ oak boards. The quantity of boards was determined by estimating a standard tributary width of 56 feet and a height of 3’.

Rock Check Dams

Rock check dams are to be constructed with Class E riprap. The check dams are to be 4 feet in height and run from side slope to side slope. Installation will require use of heavy-duty equipment and is not recommended to be installed by volunteers. This method is to be installed where storm water velocity is highest. This will be located at the bottom of the tributaries. This method will also be effective in reducing the sediment that flows out of the tributaries and preventing niche points from moving up the tributaries. Class E riprap was selected for this design per Iowa DOT design standards. This material is best for resisting storm water flows and is an affordable option. This material can be found at local rock quarries.

Estimated Quantity

Sizing of rock check dams in per a linear foot. These dam widths will vary between tributaries. We chose to do the cost estimate and quantity based of a standard tributary width that we found on site which was 56’ in width. This led our project team to estimate quantity of 68 tons of rip rap to accommodate for a 4’ tall check dam.

Sock Sleeve Check Dam

Sock Sleeve Check Dams were designed to be constructed by volunteers or camp staff. This design measure is easy to put in place in the tributaries on Camp Courageous property. The design for these sleeves were done with the assistance of the company Filltrex. With the recommendations of Filltrex, we designed these check dams to consist of six sock sleeves that fill the width of any tributary chosen. The estimated quantity and cost is based off a standard width for a tributary which is 56’. Filltrex recommended that the sock sleeves be 12” in diameter to be suitable for tributaries that are higher up. Moreover, this design is to be staked every four feet to ensure that the sleeves have adequate time to root themselves into the ground. The stakes that are recommended for use would be 1 ½" X 48” wooden stakes.

Habitat

In addition to creating soil erosion devices, we've provided plant recommendations for the surrounding area. One of the main goals of this project is to create habitat for the local wildlife in the area. To do this we researched several diverse plant types consistent with the moisture and sunlight conditions in the area[6]. A summary of all suggested plant varieties is found below:

Table 1: Plant Varieties

Long Beaked Sedge	Green Milkweed
Elderberry Plant	Cut-Leaved Toothwort
Indian Grass	Early Sunflower
Pennsylvania Sedge	Woodland Blue Phlox
Prairie Wild Rose	Marsh Marigold

One of the options we've recommended above is Elderberry Plant. Elderberry plant is a plant that grows edible berries which attracts deer and pollinators alike. Two plants will be placed close to the proposed trail system so that visitors may observe closely the wildlife that is grazing there. Not only that, but elderberry has many health benefits as well. Different meals can be made with elderberries which is beneficial since Camp Courageous can have visitors interact with the environment.

Another feature of the proposed habitat plan is the implementation of Indian Grass and Early Sunflowers. These plant species have a unique ability that allows them to absorb contaminants present in water, also known as Phytoremediation. We've designed the landscape plan so that these plants surround the channel to maximize their benefit to the water. It will result in cleaner clearer water not only for Camp Courageous but for the Maquoketa River as well.

The additional plants found in the summary table were selected due to their ability to attract wildlife and to have varying bloom times throughout the year. Rather than have all plants bloom in one month, we've carefully selected these to bloom throughout the year. This way visitors can appreciate the vegetation throughout the year.

Section VII Engineer's Cost Estimate

The cost estimate is for the construction of the designs put forward by our project team. This cost includes materials, labor, and contingency costs. We estimate the cost for all construction and installation to be $368,700. The largest cost of the project is the dam, which is estimated to be $193,800, sock sleeve check dams are estimated to be $1,500 each, rock check dams are estimated to be $3,400 each, the wood check dams are estimated to be $2,000 each, sediment traps are estimated to be $14,000, habitat pools are estimated to be $9,000. Additional costs such as the prefabricated bridge is $44,000 and the habitat cost is estimated to be $23,000. Lastly, the total site grading is estimated to be $80,000. All costs are excluding the engineering cost.

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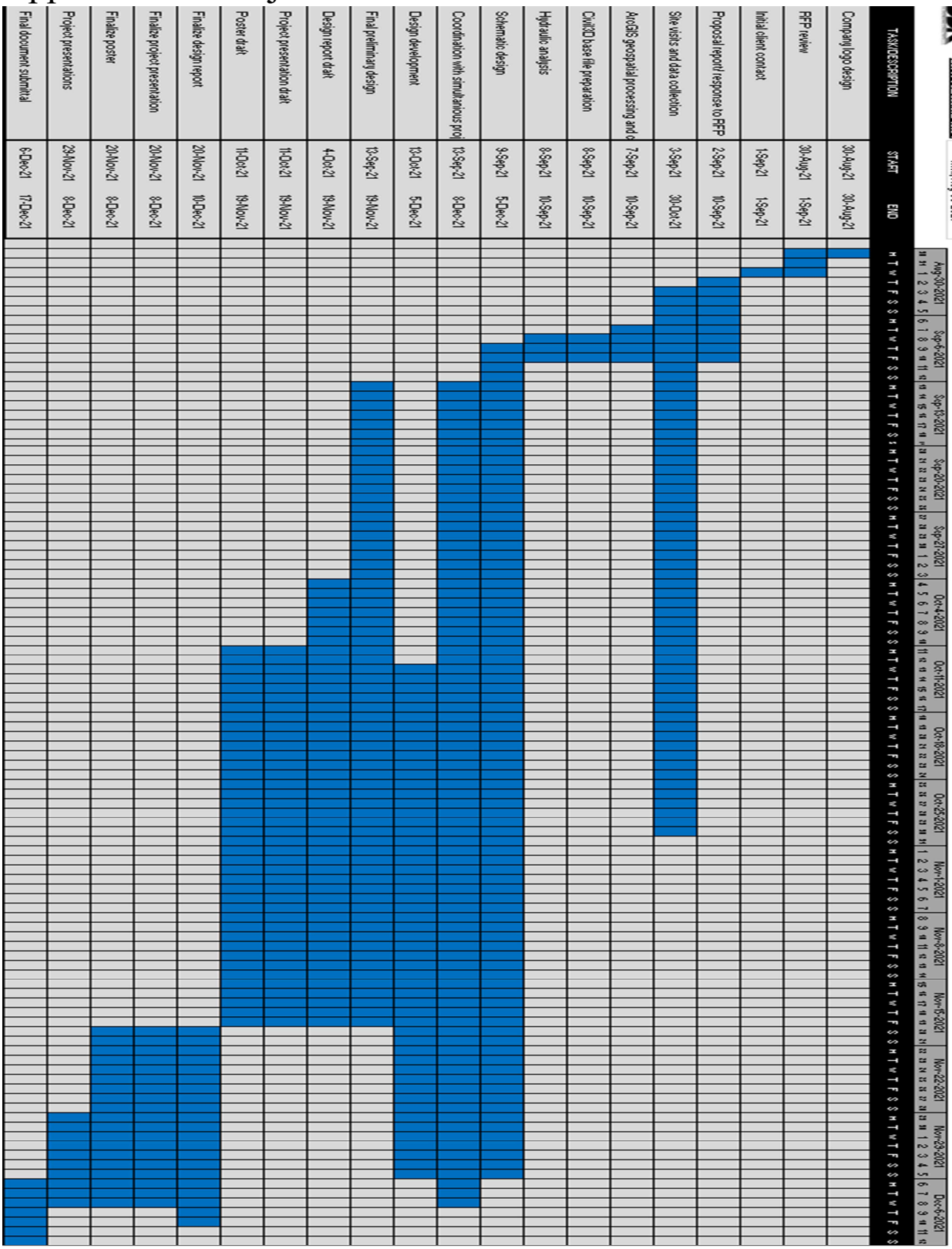
Appendix B – Project Schedule



Appendix C - Design Renderings and Models

Autodesk Infraworks is a 3D rendering software that was used to combine the education center, access road, trail system, and storm water quality features along with existing Camp Courageous infrastructure to get a better visualization of how the projects work together on site.