The University of Iowa
IOWA INITIATIVE
FOR SUSTAINABLE COMMUNITIES

FINAL DELIVERABLE

Title	Lee County - Chatfield Park Campground Upgrades Engineering & Design
Completed By	Robert Aunan, Samuel Dumford and Adam Lev
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UI Department	Civil & Environmental Engineering
Course Name	Senior Design - CEE:4850:0001
Instructor	Paul Hanley
Community Partners	Keokuk Chamber of Commerce, Lee County Conservation

This project was supported by the Iowa Initiative for Sustainable Communities (IISC), a community engagement program at the University of Iowa. IISC partners with rural and urban communities across the state to develop projects that university students and IISC pursues a dual mission of enhancing quality of life in Iowa while transforming teaching and learning at the University of Iowa.

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RAS Engineering Solutions

UNIVERSITY OF IOWA

DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING

Project Design & Management

(CEE:4850:0001)

Chatfield Campground Upgrades

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Dear Director Nathan Unsworth,

We at RAS Engineering Solutions are excited to be able to submit you and the Lee County Conservation workers with the design solutions for the Chatfield Campground Upgrades project. The report contains design solutions and construction pricing, plan sets are attached separately. We wanted to thank you for the opportunity to work with you and Lee County.

Robert Aunan, Project Manager

RAS Engineering Solutions

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Section I Executive Summary

The following design report is submitted by RAS Engineering Solutions a part of the University of Iowa Senior Design class spring of 2020 directly for the Chatfield Campground Upgrades. RAS Engineering solutions is comprised of Robert Aunan, Adam Lev, and Sam Dumford. Robert is a Civil Engineer graduating May 2020, while Adam and Sam are both Environmental Engineers graduating May 2020. RAS Engineering qualification and experience can be found in Section II.

The proposed scope for Lee County and the Chatfield Campground Upgrades is detailed in the Section III. The general scope details that the client receives a design report, plan sheets, and a cost estimate for the construction of the project. RAS Engineering Solutions also presented the project to the client. The specifics of the project scope include a new sanitary system design, including two septic tanks and leach fields, functioning for the newly proposed shower-house/bathroom area and to give individual hook-ups at each campsite for RV's to utilize. The campgrounds will also receive a design for a trail connecting the camping area to a lake southeast of the site. The rest of the project scope includes a pavilion shelter area for guests and new water line hook ups at selected sites that otherwise do not have water. A more specific work plan can be found in Section III and a Gantt chart in Appendix C.

The constraints of the Chatfield Campground all lead back to that the campground itself sits on small bluff and the designs need to be confined to the current area it sits on. Besides the trail, the rest of the project scope needed to be carefully analyzed to successfully design the clients wants. Challenges surrounding the sanitary system design were to properly follow guidelines since there is a lake directly southeast of the campsite, and carefully designing adequate septic tanks and leach fields with the amount of space given. The trail design's challenging aspect was abiding to design guidelines while still using the naturistic feel of the bluff the campsite sits on. The impact this project has on the surrounding society is that it can give the public a safe area to camp and in turn give life back to campgrounds.

The design of the septic system was decided to be split into two separate systems for multiple reasons. The first being the lack of space available to have one large leach field. The topography and location of brush on site made it so that it would not be possible to have one large leach field but there would be enough space to have two smaller and separately located leach fields. The next factor would be cost, and in general it is cheaper to have two smaller septic tanks then one large one that adds up to the same total capacity. RAS Engineering Solutions used Iowa Administrative Code (IAC) Chapter 69 for sizing guidelines for all the septic tanks, leach fields, and collection system.

The collection systems is comprised of the North System collecting wastewater from the shower house as well as 9 camp sites. And the South System collecting wastewater from 11 camp sites. Both collection systems flow by gravity down gradient that stays in the 1-5% guidelines by the IAC towards their respective septic tank. For the North System there is two lines of 4-inch schedule 40 PVC pipes that will feed into a tee and out into a 6-inch schedule 40 PVC pipe. This 6-inch pipe then leads into the septic tank. The South System also has two 4-inch schedule 40

PVC pipes that will feed into a tee and out into a 6-inch schedule 40 PVC pipe that feeds into the septic tank. All the piping networks as well as the septic tank and leach field is under the frost line which in Southeastern Iowa is approximately 40 inches deep.

It was found that the North Field needs a septic tank with the capacity of 3,250 gallons and the South System needs a septic tank with the capacity of 2,250 gallons. The North System has a leech field design made out of fine sand that is 58.75X’43’ and 3 feet deep where the South System will need a leech field also made out of fine sand that is 41.25X’43’ and 3 feet deep.

Seven sites were newly connected to drinking water and one site to electricity. Existing drinking water pipe locations are not known as they are quite old. These pipes are likely placed on the inside of the main path and tie into each camping spot, but this is not known for sure. These existing pipes were accounted for when it came to the placement and depth of the septic piping system design. The connections were done by using the existing underground utility map provided and putting in underground conduits to connect the sites. The existing underground map is not 100% accurate so it will not be until excavation begins will there be certainty on where the tie ins to existing utilities can take place.

A trail was designed that runs from the back of the campgrounds winding down the steep terrain, crossing a stream, and ending near the lake east of the campgrounds. This trail was designed following the National Parks Services Standards for Trail Construction for Rural Natural Trails. Because this is a camping site the aesthetic of the site is quite important. The trail navigated though the back end of the site to minimize disturbances to the surrounding aesthetic and maintain proper slope. The trail was designed to be made of 3/8” crushed stone. Due to an existing stream that drains the campgrounds a stormwater culvert was designed following the Iowa SUDAS to allow the trail to pass over the stream without disrupting the drainage. This culvert was designed for a 500-year storm event since it is expected that debris overtime could hinder the culverts ability to pass through water. A single barrel 15” diameter circular concrete culvert with a square edge entrance with a headwall is the design and will successfully perform for the needed flow of water. There is also a suggested grate for the intake of the culvert, this is detailed in Section VI and can be comparison shopped.

RAS Engineering Solutions were able to obtain architectural drawings from Romtec Design services that would allow to successfully complete this stage of the shower-house and pavilion area engineering details. The shower-house is proposed to have a wood truss roof system with wood sheathing and asphalt shingles. The walls of the shower house is proposed to be 8” thick CMU block with mortar joints and grouted solid. A foundation design was done by RAS Engineering solutions for the shower-house following the 2015 IBC and the Simplified Design of Foundations book. This foundation design is an unreinforced strip footing 14” wide and 8” deep. The pavilion area is a 20’x17’ concrete slab with an overhead pavilion sitting on it. The current overhead pavilion is from GazeboCreations.com and can be comparison shopped. The column to slab connection for the pavilion will need to be designed further in later engineering phases.

RAS Engineering Solutions used the RS Means Cost Handbook to appropriately cost the Chatfield Campgrounds Project. The total cost of the Chatfield Campground Upgrades is $275,550. This price includes cost of material, labor, equipment, overhead and profit, contingencies and engineering fees shown in Table VII.1 Engineers Cost Estimate. RAS Engineering Solutions decided to add an 8% markup for engineering fees and a 10% markup for contingencies. This cost estimate is broken up into subsections, with line numbers, descriptions, and individual markups.

Section II Organization Qualifications and Experience

Section II-A: Name of Organization

RAS Engineering Solutions

Section II-B: Organization Location and Contact Information

Location: 3100 Seamans Center for Engineering Arts and Sciences, Iowa City, Iowa, 52242.

Contact Information: Robert Aunan, Project Manager.

Email: robert-aunan@uiowa.edu

Section II-C: Organization and Design Team Description

RAS Engineering Solutions is a design orientated firm comprised of students from the University of Iowa Engineering school graduating this upcoming May of 2020. The team is comprised of Robert Aunan, Samuel Dumford and Adam Lev. Robert is studying Civil Engineering with a focus area in civil practice. Robert took the lead on the Civil Engineering Design aspects of the project. Samuel and Adam are both studying Environmental Engineering and took control of the Environmental Design aspects of the project.

Section II-D: Description of Experience with Similar Projects

Robert Aunan has Civil Engineering experience dating back to 2015. Robert started off by working as a laborer for local construction companies specifically working with concrete. After this he was able to gain a municipal internship with the town of Barrington, Il, a suburb of Chicago. There he worked directly with the city engineer and the land development office. Robert gained experience with residential concerns and engineering firms doing work in town. From the summer of 2019 to present Robert has been a construction engineer intern with HR Green. There he has experience with construction projects involving sanitary sewer, storm sewer, and water main replacement and planning. His experience always ranges to utility work and new road and bridge construction. Robert's schoolwork at the University of Iowa has consisted of transportation projects and traffic projects using Auto CAD Civil 3-D and Arc GIS.

Adam Lev has had a variety of roles in the field of environmental engineering including consulting, manufacturing, and government work. He has been interning for Stanley Consultants since May of 2019 where he has assisted in designing drinking/wastewater piping systems, stormwater discharge systems, and checked industrial facility environmental compliance. During his senior year Adam was a TA for a fluid mechanics class which helped him teach and better understand the field of fluid flow. With this experience he is confident in his abilities to understand the physical, biological, and regulatory requirements when it comes to designing a septic system for Chatfield park.

Sam Dumford has worked multiple roles in engineering offices. Working as a civil engineering intern for 6 months with HBK Engineering, he utilized AutoCAD daily to develop plats and worked to develop and design numerous parks in the Cedar Rapids area. Along with AutoCAD, he has familiarity in HEC-RAS floodplain modeling and ArcGIS. Along with technical competencies in those programs, he also has experience handling numerous files in an orderly manner. Last summer, as the Stormwater Technician for the City of Coralville, organizing, inspecting, and reviewing permitted construction sites were major parts of the job. In addition to the organizational skills learned, he is also more familiar with how proposed designs work when implemented in the real world, and common troubles that come from proposed designs.

Section III Design Services

Section III-A: Project Scope

General Scope:

The Chatfield Campground Upgrades project is designed to meet all the client's objectives. All the design work specified by the client is done by following applicable laws, codes and design regulations. With the completion of the design work the client will receive a design report detailing all design services completed along with a construction services estimation. The client will also receive plan sets for the Chatfield trail, sanitary system with leach field and septic tank, and for the shower-house / pavilion shelter area. RAS Engineering Solutions will also give a presentation to the client detailing the design report, plans sheets and final recommendations.

Sanitary System with Septic Tanks and Leach Field Scope:

RAS Engineering Solutions has designed a sanitary collection system for all 20 camp sites with septic tanks and leach fields, and tie in a newly constructed shower-house. These have been properly sized to not only handle the full capacity of the site if full but also comply Iowa Administrative Code (IAC) Chapter 69 for sizing guidelines for all the septic tanks, leach fields, and collection system.

Trail and Culvert Scope:

The Chatfield Campground has asked to see the incorporation of a trail connecting their campgrounds to a nearby lake east of the site. The trail is designed to connect the two areas following the National Parks Services Standards for Trail Construction for Rural Natural Trails. Due to the site and geography of the land the trail is designed to cross a stream that drains the campgrounds towards the lake due east. This trail crosses the stream, via culvert system, without disrupting the stream and in turn the drainage of the campgrounds. This culvert is designed following the Iowa SUDAS.

Shower House / Pavilion Scope:

Design alternatives were explored in order to bring a shower house and rest room to the campground site. The added site includes appropriate plumbing that is part the sanitary system design. The site also has appropriate water main connections along with electricity. The shower-house will serve the campground users as a place to shower and or use the rest room during their campground stay. RAS Engineering Solutions were able to obtain architectural drawings from Romtec Design services to aid this stage of the design process. The architectural drawings along with the RAS Engineering Solutions selected design materials and foundations designs were used to meet the client's current needs and for construction price estimation. The foundation design follows the 2015 IBC and the Simplified Design of Foundations book. The Chatfield Campground Upgrades project also includes a pavilion shelter area design using the same tactics of acquiring architectural drawings from Romtec Design services to aid this stage of the design process.

Electric / Water Scope:

Multiple camp sites at The Chatfield Campground currently do not have access to drinking water or electricity. Underground connections building off the existing utility lines were designed to connect these said sites to the utilities they needed.

Section III-B: Work Plan

The method of implementing a work plan for the Chatfield Campground Upgrades was done via Gantt Chart for the project. The Gantt chart is attached in Appendix C and shows the major tasks, the Engineer competing the task, and the duration. To begin the project, RAS Engineering Solutions took a site visit to gain knowledge on the site. Following the visit, we were able to draw up the current site plan, including camping sites, water and electric lines, and the restroom. During this time, we also gathered site specific GIS information and soil data. As a team we devoted 40 hours to this. The client specified the want of removing specific campsites to make room for the Leach Field, and to improve the functionality of the campgrounds. Robert then was able to create a proposed site plan for the campgrounds with said removed sites. The proposed campsite site plan had 10 hours tasked for it. Overall, the preliminary and current sit plan work took place during mid to late February totaling 15 days.

After the preliminary and current site plan work was completed Robert started the design of the Chatfield trail and culvert for the draining stream. This design for the trail took place from late February through the end of March. After the trail and designed for the campground the culvert design then began. The culvert design took place during first week of April. The design of the trail and culvert took 41 days and had 100 hours devoted to it.

After the site layout had been plotted in Excel, Sam was able to add sanitary hook up points were added to each camp site and connected as a pipe network. The structure insertion elevation and pipe slopes were manipulated to adhere to Iowa DNR regulations. Once the shape and diversion of flow was selected for each network, septic tank and leach field sizing could take place. Creation of the pipe network took 35 days to complete with 120 hours of work to accomplish it.

Once a rough outline of the pipe network was laid out it was found that it would be difficult to fit one large leach field onto the site seeing that there was limited space available. The decision was then made to split the septic system into two separate systems. First the soil quality, groundwater level, and bedrock level were analyzed. Then the sizing of the system was designed in accordance to IAC Chapter 69. Lastly the system would need to be put together in CAD as well as plan and section views to be presented. The design of the septic tanks and leach fields where completed by Adam taking 70 hours and 29 days

Sam oversaw the preliminary designs to add water and electric to the sites at the camp that needed it. This included water to 5 camp sites, the old bathroom, the new shower-house and electric to the new shower-house. The preliminary design of utilities took approximately 5 hours to complete.

Robert took the design tasks for the shower house and pavilion shelter area. These tasks were grouped together due to the similarities and challenges that the design work would bring. This specific design work started during the first week of April and continued throughout the month. Robert put forth a total of 23 days and 40 hours to complete the needed design work.

The design report itself was composed by all of RAS Engineering Solutions' Engineers. The three Engineers started the report in mid-April and had to be flexible with giving enough time to the on-going design work, but not lack on the quality of the design report itself. The report writing carried into the beginning of May totaling 18 days. Between the Engineers on the RAS Engineering Solutions team a total of 50 hours was devoted to the report. Between the three engineers at RAS Engineering Solutions a total of 435 hours was devoted to the Chatfield Campground Upgrades.

Section IV Constraints, Challenges and Impacts

Section IV-A Constraints:

There were several constraints we considered as design criteria. When it comes to the shower-house as well as the pavilion area is that they must be able to be viewed from the street. The pavilion area is also be an open design for better visibility. This is because the local areas have crime problems and if these structures were not in easy to view areas then it will lend itself to being vandalized and attracting vagrancy.

Another constraint was the area, footprint, and aesthetic of the site when it came to the placement of improvements. The campground is surrounded by heavy brush and woods which is part of the appeal to patrons. The campground also sits on what can be described as a small bluff. We can’t simply clear large swaths of trees and brush because being surrounded by vegetation is a desired attribute of camp sites. Trees provide a natural wind shield, a since of privacy, and a real feeling of the outdoors. This is a constraint because it limits the amount of space we had to work with when it comes to putting in a leech field, shower-house, and pavilion area.

Section IV-B Challenges:

Improper soil saturation in the leach fields can lead to improperly treated water entering the nearby lake. This challenge was answered by properly sizing two smaller leach fields and using the campgrounds more water-resistant soils. The challenges with the trail connecting the campgrounds to the nearby lake mainly involved terrain. The challenge of the trail is that there is a high/steep and short drop off at the end connecting to the lake. Utilizing a specifically designed path for the trail made it a feasible layout. The southeast half of the trail is designed to cross a small stream that has made its way from draining parts of the campgrounds. The stream is very small but is important for the campgrounds, using a culvert system was ultimately chosen to leave the stream as undisturbed as possible.

Existing drinking water pipe locations are not known as they are quite old. These pipes are likely placed on the inside of the main path and tie into each camping spot, but this is not known for sure. These existing pipes were accounted for when it comes to the placement and depth of the septic piping system being designed.

Section IV-C: Societal Impact within the Community and/or State of Iowa

Chatfield Park is one of the last parks in the area to be renovated. Currently, surrounding parks that have received upgrades are increasing in visitors while Chatfield has seen a decline in visitation. The area around Chatfield Park can be considered an "At Risk" area. With renovations to the park, it is hopeful that the area will promote a family friendly camping experience. Design goals include improving the campgrounds features while still maintaining the feeling of immersion in the woods. The improved campgrounds will provide an inviting atmosphere that will increase the use of Chatfield Park for the residents and visitors of Lee County.

Section V Alternative Design Options

Section V-A: Septic System Leach Field Alternative

In order to mitigate maintenance costs, safety, and time, all drain field options that were considered did not require power to run. This removed aerated tanks, drip distribution, and pumped mounds from consideration. Due to the topography of the campsite, it was unexpected that a pump would be needed as the site's slope is conducive to a gravity fed system. Additionally, evapotranspiration will not be considered as the climate in Lee County is not adequately hot or arid. After limiting design alternatives, the major drain field options are traditional gravel filtration, gravel-less chamber systems, sand filtration, and a constructed wetland.

Gravel filtration is the method conventionally used in residential homes. In this method, effluent from the septic tank is piped into shallow trenches and filtered through stone that treats effluent from attached growth and is then further treated as it percolates through the soil. A geofilm is placed over the trenches so contaminants do not enter or leave the leach field from above the trenches. Gravel filtration has a very large land footprint demand.

Gravel-less chamber filtration has become more popular in recent years. Rather than trenches with gravel, the septic effluent is transported through synthetic material that is open to the soil below. From the chamber, the effluent percolates through the soil and is treated by microbes. Because the chambers are typically impermeable, a geofilm is not needed above the filtration system. While easier to install and relatively cheap, their footprint is relatively similar to that of gravel filtration systems.

A sand filtration system is similar in design to conventional systems, but instead of microbes in the native soil treating the effluent, treatment is done in a lined sand area. Typically, PVC lined or in a concrete box, effluent can be gravity fed or pumped through the sand filtration system. Because it is closed off from the environment, collection piping is required at the bottom of the lined area. Treated water can be discharged after sand filtration or released to a different drain field option for further remediation. If it is a standalone structure, the sand filter requires less land than gravel or chamber filtration.

The final consideration is a constructed wetlands treatment system. This method mimics the microbial treatment observed in a natural wetland and allows for significantly higher detention time of the septic effluent in treatment. While treatment is impressive, there are numerous flaws for Chatfield Park. All other drain field methods are done underground and away from the campers. Additionally, the land space requirement is quite large, and Chatfield's topography may not be flat enough for a wetland structure. Lastly, wetlands do not properly operate in the winter months due to drastically slowed microbial processes in the cold. Currently, Chatfield is not used in the winter but with potential plans to expand or expected demand growth after renovations, limiting the winter months from use is not beneficial.

The selected alternative for Chatfield Park was to use a sand filter. This was because the soil that is present at Chatfield consists of a large percentage of clay. This high clay soil will not allow water to percolate through the leach field in order to be sufficiently treated and not run the risk of backing up. Sand is a cheap but effective option to use for the construction of the leach field and would be beneficial due to the limited space available at the park.

Section V-B: Trail Material

The design alternatives involving the trail are mainly the choices between materials. The main three materials used for trails are gravel, asphalt, and concrete. Gravel's strongest pro is that it is the most cost-effective material. Other notable pros are that is looks more natural in the campground area and that it is easy to install. Cons of gravel start with future maintenance that may be needed to keep the trail in good standing. The heaviest weighing con when it comes to gravel is that it is very hard to meet ADA standards. The next possible material is asphalt. When asphalt is initially installed is it very good looking and provides smooth surfaces, it is also cheaper than concrete. The downsides of asphalt are that there is high maintenance needed to fix cracks in the surface, it typically needs to be completely overlaid every seven-ten years. Also, it has low structural strength and is an impervious surface. The last possible material would be concrete. Concrete is the best surface in terms for meeting ADA requirements for long time periods. Other pros of concrete include its longevity, normally double the lifespan of asphalt, is strong against flooding and durable in steep sloped areas and is the strongest structural material for the trail. Cons of concrete as the trail material are mainly that it is the most expensive material and the least natural looking. Ultimately, gravel was chosen for the trail. This is because following the National Parks Services Standards for Trail Construction for Rural Natural Trails is a crucial design aspect of the trail. Without these standards the trail conception may be non-existent. Following these guidelines call for gravel and will maintain the campgrounds rural feel.

Section V-C: Shower-House Construction

When weighing all the different alternatives for construction of the shower-house the deciding factors are cost, structural integrity, effectiveness, and looks. The roof design started with a flat or pitched roof, and then carried in into a steel or wood truss system. The outer part of the roof design considerations was the type of sheathing to use, such as wood or OSB (Oriented Strand Board Decks). Another roof design area explored was the type of roof shingles which ultimately came done to asphalt or manufactured wood shingles. The different type of wall construction materials used for the shower-house came down to CMU block or wood construction. Different types of foundation designs were also explored to best aid the final choice of what the shower-house walls would be constructed of. While designing the shower-house multiple different make ups of materials were considered to give of most cost-effective option while meeting the needs of the client. The pavilion area's main design alternative is the overhead pavilion itself. This will heavily affect the looks and price of the pavilion area. It was decided that the shower-house will have a wood truss system, with wood sheathing and asphalt shingles. The walls will be comprised of 8" thick CMU walls with mortar joins and grouted solid. The foundation is designed to be an unreinforced strip footing. The overhead pavilion is a steel gable gazebo that is prefabricated.

<u>Section VI Final Design Details</u>

<u>Sanitary System with Septic Tanks and Leach Field Design:</u>

Existing plans of where the existing utilities were overlaid on aerial photos of the site were given to RAS engineering Solutions to start creating the design upgrades. The sites that did not have utility hook ups (including the to be constructed shower-house) were connected to the network. This was important do to do first to make sure the sanitary system would maintain proper distance from drinking water pipes The design of the septic system and leach field/filtration of sanitary waste complies with the USEPA and Iowa DNR standards for septic and private sewage disposal systems. This entails Chapters 68 & 69 of the IDNR Administrative Code along with Large Capacity Septic System guidelines set by the USEPA. Sanitary sewer pipe shall be laid between 3 and 8 feet of depth, favoring the deeper end of the range to avoid current electric and water utilities that are in place. Additionally, the gravity fed network must have a sufficient slope to work, between 1% and 5%. The design was made for the maximum number of pipes to have a 2% slope. Pipe slopes and insertion depths can be seen in sheets 2 and 3 of the Sanitary System and Utility Plan set. For the North System there is two lines of 4-inch schedule 40 PVC pipes that will feed into a tee and out into a 6-inch schedule 40 PVC pipe. This 6-inch pipe will then lead into the septic tank. The South System also has two of 4-inch schedule 40 PVC pipes that will feed into a tee and out into a 6-inch schedule 40 PVC pipe that feeds into the septic tank. All these piping networks as well as the septic tank and leach field are under the frost line which, in Southeastern Iowa, is approximately 40 inches deep.

After the collection system was created it was clear that it would be difficult to fit one large leach field with the limited free space available. Clearing trees and brush was not desired since the aesthetic of the site is wanted to be maintained as much as possible. The decision was then made to split the septic system into two separate systems for multiple reasons. The first being the lack of space available to have one large leach field. Second, topography and location of brush on site made it so that it would not be possible to have one large leach field but there is space to have two smaller and separately located leach fields. And lastly, the cost in general is cheaper to have two smaller septic tanks then one large one that adds up to the same total capacity. The design process started first with checking different attributes of the site such as soil quality, groundwater level, and bedrock level would need to be analyzed. Then the sizing of the system would need to be designed in accordance to IAC Chapter 69. The sanitary systems is comprised of the North System collecting wastewater from the shower house as well as 9 camp sites. And the South System collecting wastewater from 11 camp sites. Using Appendix A of chapter 69 of the IAC it was determined that each site produces 75 gallons of wastewater and the shower-house produces 25 gallons of wastewater per site that uses it. This was found from the difference between a "campground site with hookup" listed at 75 gpd and a "site with central bath" listed at 100 gpd. Once the flows for each of the sites had been calculated (1175 gpd for the North System and 825 for the South System) the sizing of the septic tank and the leach field began. A hydraulic retention time of 2.7 days was selected as it is between 2 and 3 days per industry standard. The sizes of the tanks were rounded up to the nearest factor of 250. It was found that the North Field needed a septic tank with the capacity of 3,250 gallons and the South System needed a septic tank with the capacity of 2,250 gallons. Because of the sizing being closer to the minimum design standard for volume being twice the daily maximum inflow the four tanks will likely need to be cleaned out every two years. A more detailed report of the design and sizing of these tanks can be found in Appendix H.

The current soil quality for a leech field was found to be poor in the area so soil needs to be brought in and used for the leach field construction. Fine sand was decided to be used for a combination for affordability and its hydrologic soil properties. It was calculated that an area of 588 square feet was needed for the North System and an area of 413 for the South System. 4" diameter perforated HDPE pipe would run along the top of the leach fields and allow water to percolate down into the sand see sheets 4 and 5 of the Sanitary System and Utility Plan set for more details. The North System will need a leach field made out of fine sand that is 58.75X'43' and 3 feet deep where the South System will need a leech field also made out of fine sand that is 41.25X'43' and 3 feet deep. The effluent from the leach field will need to be periodically tested because of the systems proximity to surface water. The effluent of this system will need to meet NPDES General Permit No. 4 limits. The effluent would be tested by a monitoring well adjacent to the down gradient side of the leach field. This is sampling a 4-inch well casing going 7 feet into the ground with proper screening to be able to take water in to be sampled. This system must be sampled no less than twice a year at six month intervals for Carbonaceous Biochemical Oxygen Demand, E. Coli, and Total Suspended Solids.

<u>Electric/Water:</u>
Due to limited knowledge about the existing underground utilities, precise design depths could not be created. Preliminary plans for the utility upgrades were drawn into the site plan but pipe networks were not created for the water pipes and electric conduits. Preliminary design for the utilities is designed to be below the frost line but above the sanitary collection with as few points of vertical intersection as plausible. This will minimize any potential risk of infiltration from the sanitary pipes into the drinking water.

<u>Trail Design:</u>

The design of the trail follows the National Park Services standards for trail construction. This design guide was chosen due to the rough terrain that surrounds the campgrounds that cannot be avoided. Within the National Park Services handbook for trail design and construction is chapter 4, standards for trail construction, and the specific design standards followed are for rural and roaded natural trails. A footprint design of the trail is shown in the Trail Plan set sheet number 1. The path of the trail was chosen due to meeting max slope percentages needed following the National Park Services standards for trail construction. These general standards are shown in Appendix E Table E.1 and is a table from the National Park Services standards for trail construction. It can be seen in Trail Plan set's plan and profile sheets, sheets 2-5, that the trail's vertical profile adheres to the design standards for the needed max slope percentages. Meeting these slope percentage standards mainly dictates the location of the trail. Meeting the vertical slope percentages of the National Park Services design standards was the deciding factor of where the trail is placed and its exact path. Many locations and paths were examined in order to meet the design standards, and the final path chosen deemed to be the best for the campgrounds. The location of the trail gives the campgrounds a true wooded feel, the trail gently winds down to the lake front and successfully provides a connection between the campgrounds and the lake. Following the National Park Services standards for trail construction for a rural/roaded natural trail it is specified that the trail will need to be composed of native or stabilized aggregate. This will not only meet the needed design specifications, but it will give the trail the true natural path that goes along with camping and hiking.

<u>Trail Culvert Design:</u>

The trail needs to overcome a stream that is draining the campgrounds. A culvert solution was designed to let the trail cross over the stream. The culvert design follows the Iowa Statewide Urban Design and Specifications (SUDAS). Specifically, the culvert design follows Chapter 3 sections 3 and 4. A calculation sheet for the culvert design needs is attached in Appendix F Table F.1. The calculations concluded that the peak flow of the catchment area that the culvert will be design for is 3.78 cfs. The culvert is designed for the .88-acre catchment area during a 500-year storm event. The 500-year storm event was chosen as the design event to help accommodate the possible buildup of debris and soil in the culvert. This catchment area is shown in Appendix F, Figure F.2. Using the calculations performed in Figure F.1, a flow model calculation sheet was made using the Hydraflow Express tool within AutoCAD Civil 3D, this model is shown in Appendix F, Table F.3. This calculation model shows that even during a peak storm event that no water will over top the culvert and overflow onto the trail. The Hydraflow Express Tool shows that a single barrel 15" diameter circular concrete culvert with a square edge entrance with a headwall will successfully perform for the needed flow of water. An inlet grate is recommended for the culvert and is currently from drainagesoluitons.com, the specific grate can comparison shopped for price and specific wants.

Shower-House/Pavilion Design:

The first step of the design of the shower-house and pavilion shelter was the location of the two areas. Ultimately, the location shown in shower-house and Pavilion plans sheet 2, was chosen as the safest placement for the two areas. Having the shower-house and pavilion area away from the road and close to the other campsites is best way to have a safe and private experience. We also decided to separate the two areas by the already placed roadway to create a more private area for the shower-house users.

It was decided to design a shower-house that also served as a rest room for the users. Knowing the needs of client and campgrounds made it possible to use Romtec Design services to obtain architectural drawings for the shower-house. RAS Engineering Solutions were able to reach out to campers of Iowa to gather what they most wanted out of a shower house. Using these suggestions RAS Engineering Solutions saw it best fit to implement the separate walled off areas each having their out exterior door for the shower-house. This detail can be seen in Shower-House and Pavilion plans sheet 3. The shower-house to designed to sit on a 28x20 foot concrete slab having plumbing, water, and electricity ran to the area. The roof will be designed as a wood truss system having wood sheathing and asphalt shingles. This provides essential structural needs while being cost effective. The walls will be 8-inch-thick CMU blocks with mortar joints and grouted solid. RAS Engineering Solutions also designed an appropriate footing for the shower-house. The foundation design was done by following the 2015 International Building code to find the appropriate load combinations and values, and the Simplified Design of Building Foundations Book for an unreinforced strip footing. It was determined that the design load is 1540 lb/ft, the max allowable soil pressure is 1500 psf, and the concrete design strength being 2000 psi. A calculation sheet following these steps can be found in Appendix H Figure H.1 shower-house Foundation calculation Sheet. These steps determined that a 8-inch thick by 14-inch-wide strip footing foundation will provide adequate support for the shower-house. A detailed drawing is shown Shower-House and Pavilion plans sheet 4.

Similar to the shower-house design RAS Engineering Solutions were able to use Romtec Design services for the architectural drawings for the pavilion area. The section is designed to sit on a 20'x17' concrete slab, shown in Shower-House and Pavilion plans sheet 6. The overhead pavilion is currently selected as a prefabricated structure from GazeboCreations.com, this is intended to be delivered to the work site. Currently the overhead pavilion is connected to the concrete slab via a bracket system. The connection should be explored more in detail during the next engineering to phase to ensure a capable connection. Lastly, as part of the pavilion cost estimate shown in Section VII, RAS Engineering Solutions included a seating option for the pavilion to be 4 park style picnic tables. This is a suggestion by RAS Engineering Solutions but can easily be interchanged.

Section VII Engineer’s Cost Estimate

RAS Engineering Solutions developed a preliminary construction cost estimation that includes cost of material, labor, equipment, overhead and profit, contingencies and engineering fees shown in Table VII.1 Engineers Cost Estimate. RAS Engineering Solutions decided to add an 8% markup for engineering fees and a 10% markup for contingencies. The total cost of the Chatfield Campground Upgrade’s is estimated at $275,550. This cost is broken down into subsections of trail, pavilion, sanitary system with septic tank and leach field, added electric and water, and shower-house. This general breakdown is shown at the top of Table VII.1. The cost estimate then breaks each subsection down into individual line items with descriptions for the client's needs. The cost estimating was done using RS Means Cost Handbooks and inflated from their 2011 costs to current 2020 costs. The pavilion cost estimating was done using 2020 pricing, and the shower-house cost estimating was done using a square footage multiplier.

Table VII.1 Engineers Cost Estimate

Chatfield Campground Upgrades Cost Estimate

RAS ENGINEERING SOLUTIONS

Subsections:	Cost
Trail	$89,000.00
Pavilion	$27,500.00
Sanitary System with Septic Tank and Leach Field	$51,500.00
Added Electric and Water	$3,050.00
Shower-House	$104,500.00
PROJECT TOTAL	$275,550.00

	Line Number	Description	Quanty	Unit	Extended Total	Extended Total O&P	Engineering Fees	Contingincies	Total
Trail	311110100260	Clearing and Grubbing , dense bursh, including stumps, clear and grub	5	Acre	$30,625.00	$37,500.00	$3,000.00	$3,750.00	$44,250.00
	312216103310	Excavated or borrow, loose cubric yards, small excavation job, 8 CY truck	40	Hr	$2,960.00	$3,840.00	$307.20	$384.00	$4,531.20
	312216103310	Fine grading, slopes, steep , finish grading	11073	S.Y.	$1,882.41	$2,436.06	$194.88	$243.61	$2,874.55
	312216140000	3/8" Crushed Stone	491	C.Y.	$14,239.00	$16,203.00	$1,296.24	$1,620.30	$19,119.54
	312216103100	Fine grading, select gravel, 6" deep, hand grading, including compaction	981	S.Y.	$2,158.20	$3,266.73	$261.34	$326.67	$3,854.74
	334213130530	Concrete Culverts, headwall concrete, precast, 30 degree skewed wingwall, 15" diametere pipe, 20'	1	Ea.	$2,100.00	$2,450.00	$196.00	$245.00	$2,891.00
	334213130530	Round 15" Steel Grate	1	Ea.	$112.00	$16.80	$1.34	$1.68	$19.82
							Trail Subsection Total:		$77,521.03
					2011 to 2020 inflation		Trail Subsection Total:		$88,954.52
Pavilion	312216130452	Excavated or borrow, loose cubric yards, small excavation job, 8 CY truck	5	Hr.	$425.00	$550.00	$44.00	$55.00	$649.00
	312216130456	crushed limstone	25	C.Y.	$1,250.00	$1,375.00	$110.00	$137.50	$1,622.50
	312216130460	Fine grading, select gravel, 6" deep, hand grading, including compaction	48	S.Y.	$125.00	$184.00	$14.72	$18.40	$217.12
	312216130464	Concrete	25	C.Y.	$3,250.00	$3,575.00	$286.00	$357.50	$4,218.50
	312216130468	Concrete finishing, bull float and manual float	440	S.F.	$235.00	$348.00	$27.84	$34.80	$410.64
	312216130472	16' x 20' All Steel Gable Rectangular Savannah Pavilion	1	Ea	$15,000.00	$16,500.00	$1,320.00	$1,650.00	$19,470.00
	312216130476	6' pressure treated, steel fame picnic tables	4	Ea	$440.00	$484.00	$38.72	$48.40	$571.12
						2020 pricing	Pavilion Subsection Total:		$27,158.88

Sanitary System with Septic Tank and Leach Field								
333613100180	Utility Septic Tank and Effulent Wet Wells, Sepitc tanks precast concrete, 4,000 gallon, excludes excavation piping	1	Ea	$6,290.00	$6,960.50	$556.84	$696.05	$8,213.39
333613100140	Utility Septic Tank and Effulent Wet Wells, Sepitc tanks precast concrete, 2,500 gallons excludes excavation piping	1	Ea	$2,747.00	$3,118.50	$249.48	$311.85	$3,679.83
333613101000	Utility Septic Tank and Effulent Wet Wells, Sepitc tanks distribution boxes, concrete, 7 outlets, excludes excavation piping	2	Ea	$231.00	$283.00	$22.64	$28.30	$333.94
333613102800	Utility Septic Tank and Effulent Wet Wells, Sepitc tanks crushed stone 3/4", excludes excavation or piping	80	C.Y.	$3,691.00	$4,236.00	$338.88	$423.60	$4,998.48
332113108340	Public Water Supply Wells, wells domestic water, well screen assembly, slotted PVC, 4" diameter	7	L.F	$164.00	$193.90	$15.51	$19.39	$228.80
333113253080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipes, fittings, bends or elbows, 6" diameter, SDR 35, excludes excavation or backfill	2	Ea.	$101.00	$119.40	$9.55	$11.94	$140.89
333113253040	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipes, fittings, bends or elbows, 4" diameter, SDR 35, excludes excavation or backfill	31	Ea.	$1,481.80	$2,134.35	$170.75	$213.44	$2,518.53
333113252000	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipes, B & S, 20' lengths, 4" diameter, excluded excavation or backfill	7	Ea.	$44.17	$56.63	$4.53	$5.66	$66.82
333113252080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipes, B & S, 20' lengths, 6" diameter, excluded excavation or backfill	88	Ea.	$379.28	$511.28	$40.90	$51.13	$603.31
333113203000	Public Sanitary Utility Sewerage Piping, piping HDPE Corrugated Type S with watertight gaskets, 4" diameter, excludes excavation or backfill	240	L.F.	$765.60	$1,068.00	$85.44	$106.80	$1,260.24
312316142300	Excavating, chain trencher, utility trench, common earth, 40 H.P., 6" wide, 60" deep	1890	L.F.	$1,890.00	$2,457.00	$196.56	$245.70	$2,899.26
312323131300	Backfill, bulk, up to 300' haul, dozer backfilling	1335	L.C.Y	$1,735.50	$2,122.65	$169.81	$212.27	$2,504.73
312232142340	Bulk Fine Sand For Leach Field	478	C.Y.	$11,950.00	$14,620.00	$1,169.60	$1,462.00	$17,251.60
				Sanitary System with Septic Tank and Leach Field Subsection Total:				$44,699.83
		2011 to 2020 inflation		Sanitary System with Septic Tank and Leach Field Subsection Total:				$51,292.56

Added Electric and Water								
312316142300	Excavating, chain trencher, utility trench, common earth, 40 H.P., 6" wide, 60" deep	657	LF	$657.00	$854.10	$68.33	$85.41	$1,007.84
331113252120	Water supply distribution piping, piping polyvinyl chloride, clas 150, 2" diameter	597	LF	$764.16	$1,026.84	$82.15	$102.68	$1,211.67
337119151030	Electrical underground ducts and manholes, PVC, conduit with coupling, 1" diameter, sc	60	LF	$151.80	$202.20	$16.18	$20.22	$238.60
331113264940	60-1/2"L Frost Proof Yard Hydrant	5	Ea.	$165.00	$165.00	$13.20	$16.50	$194.70
					Electric & Water Subsection Total:			$118,401.52
			2011 to 2020 inflation		Electric & Water Subsection Total:			$3,044.07

* Shower-House section cost estimating done via a square footage method

Shower-House		Cost Per S.F	Extended Total	Extended Total O&P	Engineering Fees	Contingincies	Total
312316221001	Standard Foundations						
312316221010	Strip footing, concrete, reinforced, load 11.1 KLF, soil bearing capacity 6 KSF, 12" deep x 24" wide	$6.97	$3,903.20	$4,293.52	$343.48	$429.35	$5,066.35
312316221019	spread footings, 3000 PSI concrete, load 50K, soil bearing capacity 6 KSF, 3' - 0" square x 12" deep	$0.20	$112.00	$123.20	$9.86	$12.32	$145.38
312316221037	Slab on Grade						
312316221046	Slab on grade, 4" thick, non industrial, non reinforced	$4.46	$2,497.60	$2,747.36	$219.79	$274.74	$3,241.88
312316221064	Floor Construction						
312316221073	Wood column, 6" x 6", 20' x 25' bay, 12' unsupported height, 72 BF/MSF, 40 PSF total allowable load	$0.06	$33.60	$36.96	$2.96	$3.70	$43.61
312316221082	Wood beam, 3 - 2 x 14, Douglas Fir No. 2, 243 lbs/LF @ 18' span	$0.08	$44.80	$49.28	$3.94	$4.93	$58.15
312316221100	Roof Construction						
312316221109	Wood roof truss, 2' OC, 60' span, 4:12 pitch, 1' overhang, 5/8" sheathing, 1x8 fascia, R30 insulation	$8.06	$4,513.60	$4,964.96	$397.20	$496.50	$5,858.65
312316221127	Roof Coverings						
312316221136	Roofing, asphalt flood coat, gravel, base sheet, 3 plies 15# asphalt felt, mopped	$2.70	$1,512.00	$1,663.20	$133.06	$166.32	$1,962.58
312316221145	Gravel stop, aluminum, extruded, 4", mill finish, .050" thick	$1.90	$1,064.00	$1,170.40	$93.63	$117.04	$1,381.07
312316221163	Exterior Walls						
312316221172	Cement stucco, 5/8" thick, 2 coats on regular CMU, 8" x 8"x 16"	$28.11	$15,741.60	$17,315.76	$1,385.26	$1,731.58	$20,432.60

312316221190	Exterior Doors						
312316221199	Door, aluminum & glass, without transom, full vision, double door, hardware, 6'-0" x 7'-0" opening	$0.57	$319.20	$351.12	$28.09	$35.11	$414.32
312316221208	Door, steel 18 gauge, hollow metal, 1 door with frame, "A" label, 3'-0" x 7'-0" opening x5	$4.03	$11,284.00	$12,412.40	$992.99	$1,241.24	$14,646.63
312316221226	Partitions						
312316221235	Metal partition, 5/8"fire rated gypsum board face, no base,3 -5/8" @ 24" OC framing, same opposite face, no insulation	$2.53	$1,416.80	$1,558.48	$124.68	$155.85	$1,839.01
312316221253	Fittings						
312316221262	Toilet partitions, cubicles, ceiling hung, stainless steel x2	$0.33	$554.40	$609.84	$48.79	$60.98	$719.61
312316221280	Ceiling Finishes						
312316221289	Acoustic ceilings, 3/4" fiberglass board, 24" x 48" tile, tee grid, suspended support	$4.39	$2,458.40	$2,704.24	$216.34	$270.42	$3,191.00
312316221307	Plumbing Fixtures						
312316221316	Water closet, vitreous china, bowl only with flush valve, wall hung	$5.35	$2,996.00	$3,295.60	$263.65	$329.56	$3,888.81
312316221325	Urinal, vitreous china, stall type	$0.36	$201.60	$221.76	$17.74	$22.18	$261.68
312316221334	Lavatory w/trim, vanity top, PE on CI, 19" x 16" oval x2	$2.67	$2,990.40	$3,289.44	$263.16	$328.94	$3,881.54
312316221343	Service sink w/trim, PE on CI, corner floor, 28" x 28", w/rim guard x2	$0.52	$582.40	$640.64	$51.25	$64.06	$755.96
312316221352	Water cooler, electric, wall hung, dual height, 14.3 GPH	$0.72	$403.20	$443.52	$35.48	$44.35	$523.35
312316221370	Domestic Water Distribution						
312316221379	Electric water heater, commercial, 100< F rise, 120 gal, 36 KW 147 GPH	$1.75	$980.00	$1,078.00	$86.24	$107.80	$1,272.04
312316221397	Energy Supply						
312316221406	Commercial building heating system, fin tube radiation, forced hot water	$10.76	$1,506.40	$1,657.04	$132.56	$165.70	$1,955.31
312316221424	Standpipes						
312316221433	Wet standpipe risers, class III, steel, black, sch 40, 4" diam pipe, 1 floor	$0.74	$414.40	$455.84	$36.47	$45.58	$537.89
312316221451	Electrical Service/Distribution						
312316221460	Service installation, includes breakers, metering, 20' conduit & wire, 3 phase, 4 wire, 120/208 V, 200 A	$6.38	$3,572.80	$3,930.08	$314.41	$393.01	$4,637.49
312316221469	Feeder installation 600 V, including RGS conduit and XHHW wire, 200 A	$4.15	$2,324.00	$2,556.40	$204.51	$255.64	$3,016.55
312316221478	Switchgear installation, incl switchboard, panels & circuit breaker, 400 A	$7.37	$4,127.20	$4,539.92	$363.19	$453.99	$5,357.11
312316221496	Lighting and Branch Wiring						
312316221505	Receptacles incl plate, box, conduit, wire, 2.5 per 1000 SF, .3 watts per SF	$1.71	$957.60	$1,053.36	$84.27	$105.34	$1,242.96
312316221514	Wall switches, 1.0 per 1000 SF	$0.27	$151.20	$166.32	$13.31	$16.63	$196.26
312316221523	Miscellaneous power, to .5 watts	$0.14	$78.40	$86.24	$6.90	$8.62	$101.76
312316221532	Central air conditioning power, 4 watts	$0.57	$319.20	$351.12	$28.09	$35.11	$414.32
312316221541	Fluorescent fixtures recess mounted in ceiling, 1.6 watt per SF, 40 FC, 10 fixtures @32watt per 1000 SF	$5.14	$2,878.40	$3,166.24	$253.30	$316.62	$3,736.16
					Shower-House Subsection Total:		$90,780.04
			2011 to 2020 inflation		Shower-House Subsection Total:		$104,169.09

Section VIII Proposal Attachments

Appendix A – Tasks Form

Appendix B – Client Information and work products

Appendix C – Gannt Chart

Appendix D – RAS Engineering Solutions Work Experience

Appendix E – Trail Design

Appendix F – Culvert Design

Appendix G – Septic Tank and Leach Field Design

Appendix H – Shower-House Foundation Design Calculation Sheet

Appendix A: Tasks Form

UNIVERSITY OF IOWA

DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING

Project Design & Management

(CEE:4850:0001)

RFP # 13-spring2020

Chatfield Park Campground Upgrades

Tasks Form

Bidder's Organization Name:

RAS Engineering Solutions

Task Name	Task Hours
Task 1: Preliminary Work	40
Task 2: Current Site Plan	10
Task 3: Sanitary System	120
Task 4: Septic Tank and Leach Field	70
Task 5: Trail and Culvert	100
Task 6: Shower-House	20
Task 7: Pavilion	20
Task 9: Electric and Water work	5
Task 10: Design Report	50
TOTAL BILLABLE HOURS	435

Appendix B: Client Information and Work Products

Contact

Nathan Unsworth

Lee County Conservation Director nunsworth@leecounty.org

Location:

Lee County, IA Work products:

Site design is to be completed in Civil 3D. The design is to be generated and shown in plan and cross section views and rendered in 3D. The final plan drawings are to be used to generate a plan set that is printable both electronically and on paper*.

The site drawings shall include as a minimum the following elements:

Site Location

Construction boundaries

Existing and future facilities/improvement locations

Existing and final grading (cut and fill requirements)

Sanitary septic system design is to be completed in an appropriate software package and shown in plan and cross section views. The design shall conform to all state and local regulations pertaining to on-site wastewater treatment and disposal.

The design may include as a minimum the following elements: Foundations

Foundation wall

Floor Slab

Walls

Roof beams/trusses

Doors and windows located and sized

Lintels and / or beams above openings in walls.

Utility entrance (Water supply, Wastewater, Electrical supply)

Drawings

Drawing Size. All drawings of a single project must be a uniform standard size, as designated by

the

American National Standards Institute (ANSI). The following are related sheet sizes: Related Sheet Sizes

(A) 8.5" x 11" 220 mm x 280 mm

(B) 11" x 17" 280 mm x 430 mm

(C) 17" x 22" 430 mm x 560 mm

(D) 22" x 34" 560 mm x 860 mm

(E) 34" x 44" 860 mm x 1120 mm

Drawing Lettering. Lettering on drawings must be legible when drawings are reduced to half size and when they are printed as PDF. This applies to concept and design development drawings.

Drawing Scale. All drawings will be produced with metric drawing scales which are always expressed in nondimensional ratios. Scales should also be illustrated graphically on the drawings. Scale of drawings should be appropriate for high resolution and legibility to include half-size reduced copies.

There are nine preferred base scales: 1:1 (full size), 1:5, 1:10, 1:20, 1:50, 1:100, 1:200, 1:500, 1:1000. Three others have limited usage: 1:2 (half size), 1:25, 1:250. Floor plans should be drawn at 1:100 (close to 1/8-inch scale).

CAD Standards. The National CAD/CIFM Standards should be obtained via the internet. These guidelines should be followed for all CAD drawing formatting

Dimensioning. US Customary Units are the unit of measurement to appear on documents for building plans and details for all disciplines.

Appendix C: Gantt Chart

Chatfield Campground Upgrades

RAS ENGINEERING SOLUTIONS

Robert Aunan
Sam Dumford
Adam Lev

TASK NAME	ASSIGNED TO	START DATE	FINISH DATE	DURATION (Days)
Preliminary Work	All	2/3/20	2/7/20	4
Current Site Plan	Robert Aunan Sam Dumford	2/10/20	2/21/20	11
Sainitary System	Sam Dumford Adam Lev	2/24/20	4/13/20	49
Septic Tank and Leach Field	Sam Dumford Adam Lev	3/17/20	4/15/20	29
Trail	Robert Aunan	2/24/20	4/5/20	41
Shower-House	Robert Aunan	4/5/20	4/17/20	12
Pavillion Shelter	Robert Aunan	4/13/20	4/24/20	11
Electric and Water work	Sam Dumford	4/13/20	4/30/20	17
Design Report	All	4/13/20	5/8/20	25

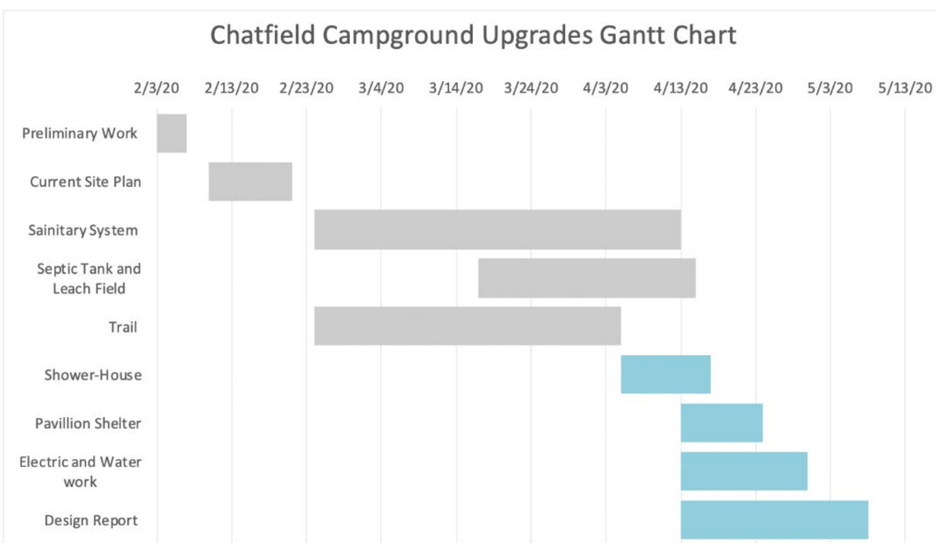

Figure C.1 Project Gannt Chart

Appendix E: Trail Design

Table E.1 National Parks General Design Requirements for Trail Construction

Standards (desired)	ROS Class			
	Urban	Rural and Roaded Natural	Semiprimitive	Primitive
Tread Width Hiking Segments Accessible Segments	 48" 60"	 24" 36"	 18" 28"	*
Clearing Width (each side of tread))	24"	12" (WIDNR-24")	12"	*
Clearing Height (min.)	10'	8' (WIDNR-10')	8'	*
Slope(max.sustained) Hiking Segments Accessible Segments	 10% 5%	 10% 8%	 15% 12%	*
Slope (max.) Hiking Segments Accessible Segments	 15% for 100' 8% for 30'	 20% for 100' 10% for 50'	 30% for 100' 10% for 50'	*
Cross Slope (max)	3%	5%	8%	*
Other Accessible Segment Standards Passing Spot Int.-max Rest Area Interval-max	 N/A 1200'	 600' 1200'	 1200' 1/2 mile	 N/A N/A
Surfaces	Asphalt. Concrete. Stabilized-aggregate. Screening(1). Wood Chip. Sod.	Native. Wood Chip(2). Stabilized-aggregate. Screening(1).	Native	Native
Accessible Surfaces	Asphalt. Concrete. Stabilized-aggregate.	Asphalt. Stabilized-aggregate.	Native. Stabilized-aggregate.	Native

Appendix F: Culvert Design

Culvert Deisgn

The following Calculations follow Iowa SUDAS chapter 3 section 3 and 4

Total Catchment Area: .88 acres

Group D Soils at 100 year occurance interval

	Land Uses	Weight	Catchment Area (acres)	C	Weighted Average C:	0.2836
	Gravel	0.5	0.091	0.0455		
Undeveloped Surface	Flat	0.2	0.088	0.0176		
	Avergae	0.25	0.35	0.0875		
	Steep	0.38	0.35	0.133		
		Total:	0.88 acres			

Flow rate **Q Calc** Q= CIA

Area	A	0.88 acres	Time of Concentration :	2.49 * value from AutoCAD Civil 3D, Catchment Area tools
Runoff Coeffiecent	C	0.29		
Rainfall Intensity	I, 500	14.8 in/hr	* Rainfall intensity from Iowa SUDAS chapter 3 section 3	
	I,5	6.58 in/hr		
	Q=	3.77696 cfs	max	
	Q=	1.679216 cfs	min	

Flow values used for Hydraflow Express, Culvert Design tool within AutoCAD Civil 3D

Figure F.1 Culvert Design Calculation Sheet

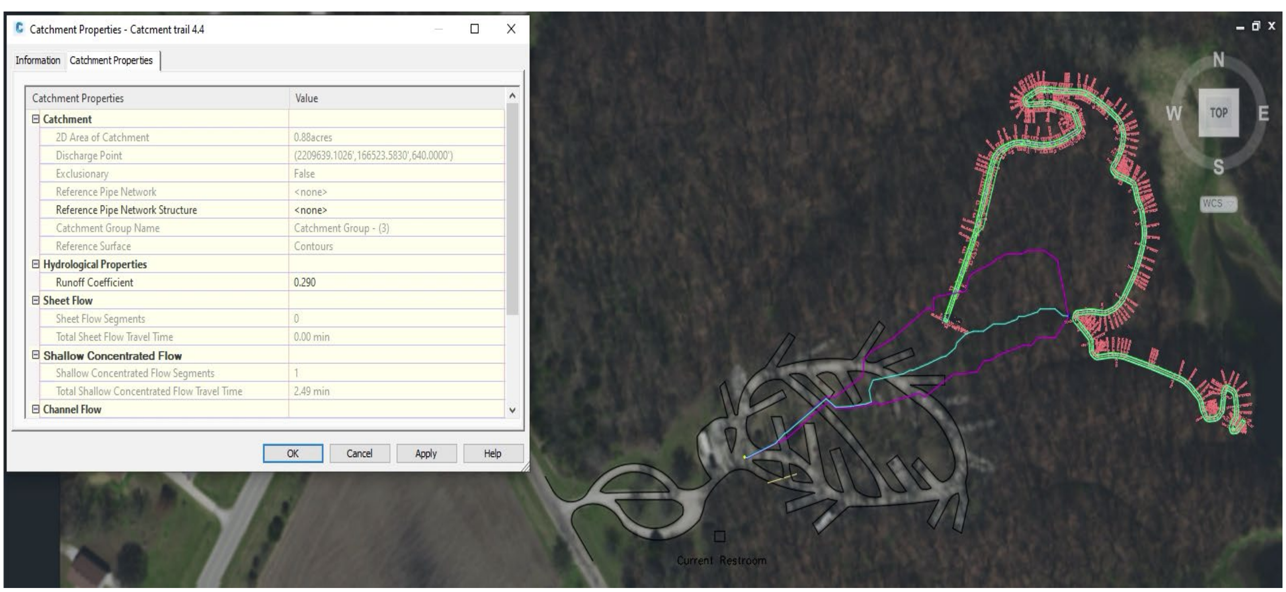

Figure F.2 Culvert Design Catchment Area

Table F.3 Culvert Performance Results

Culvert Performance Reuslts

Q			Veloc		Depth		HGL			
Total (cfs)	Pipe (cfs)	Over (cfs)	Dn (ft/s)	Up (ft/s)	Dn (in)	Up (in)	Dn (ft)	Up (ft)	Hw (ft)	Hw/D
0.25	0.25	0	0.34	2.07	8.66	2.32	637	637	637	0.18
0.5	0.5	0	0.64	2.5	9.15	3.3	637	637	637	0.27
0.75	0.75	0	0.91	2.79	9.53	4.06	637	637	637	0.35
1	1	0	1.17	3.03	9.86	4.71	637	637	638	0.41
1.25	1.25	0	1.42	3.23	10.14	5.29	637	637	638	0.47
1.5	1.5	0	1.65	3.41	10.41	5.81	637	637	638	0.52
1.75	1.75	0	1.88	3.58	10.65	6.3	637	638	638	0.57
2	2	0	2.1	3.73	10.88	6.76	637	638	638	0.62
2.25	2.25	0	2.31	3.88	11.09	7.18	637	638	638	0.67
2.5	2.5	0	2.52	4.01	11.3	7.59	637	638	638	0.71
2.75	2.75	0	2.73	4.14	11.49	7.98	637	638	638	0.76
3	3	0	2.93	4.27	11.68	8.35	637	638	638	0.81
3.25	3.25	0	3.12	4.4	11.85	8.71	637	638	638	0.85
3.5	3.5	0	3.32	4.52	12.03	9.05	637	638	638	0.9
3.75	3.75	0	3.51	4.64	12.19	9.38	637	638	638	0.94

Appendix G: Septic Tank and Leach Field Design

North Septic System

Step 1: Estimate the wastewater volume generated on a daily basis, Q_{in}. Appendix A

Estimates of Non-household Domestic Sewage Flow Rates (Iowa Administrative Code (IAC) CHAPTER 69 PRIVATE SEWAGE DISPOSAL SYSTEMS: Appendix A, p 31)

9 Sites with a bathhouse will fall under "campground site with hookup" of 75 gpd which is 675 gpd

Because " Site with central bath" of 100 gpd/site which is 25 gpd/site more then the usual and there will be 20 sites using this shower house we must add an additional 25*20 = 500 gpd

1175 gpd of waste water inflow

Step 2: Calculate required tank volume. Select a minimum retention time, R_t. Under ordinary conditions (i.e., with routine maintenance pumping) a tank should be able to provide two to three days of retention time.

$V_t = Q_{in} * R_t$

69.8(2)b

"Other domestic waste systems. In the event that an installation serves more than a 6-bedroom home or its equivalent, or serves a facility other than a house and serves the equivalent of fewer than 16 individuals on a continuing basis, approval of septic tank capacity and design must be obtained from the administrative authority. Minimum septic tank liquid-holding capacity shall be two times the estimated daily sewage flow"

A retention time of 2-3 days is standard practice.

Step 3: Check the Effective Retention Time. You need to check that the retention time is at least 24 hours, assuming that the tank is 1/2 filled with solids. Therefore, the effective volume is 1/2 of total tank volume.

$V_e = V_t * 1/2$

Rmin = Ve /Qin

If R_{min} < 24 hrs then increase the tank volume

Assuming 2.7 days of retention would give

$V_t = Q_{in} * R_t$

$V_t = 1175 \text{ gpd} * 2.7 \text{ days}$

$V_t \approx 3250 \text{ gallons}$

$V_e = V_t * 1/2$

$V_e = 3250 * 1/2$

$V_e \approx 1625 \text{ gallons}$

Rmin = Ve /Qin
$R_{min} = 1625 / 1175$

$R_{min} = 1.383$ days (this is over 1.0 so it is satisfactory)

Step 4: Check minimum liquid-holding capacity. The minimum septic tank liquid-holding capacity shall be two times the estimated daily sewage flow (CHAPTER 69. 567—69.8(455B)-b).

hmin = Vt > 2 * Qin

$h_{min} = V_t \ / 2 * Q_{in} = 1$

$h_{min} = 3250 > 2 * 1175$

$h_{min} = 3250 > 2350$

Step 5: Find a manufacturer for preliminary material cost. Search on-line for typical costs for a tank that meets your needed volume. For example, https://sheaconcrete.com/products/precast-concreteresidential-septic-tanks#septic-tanks.

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Prices based on 30 mile radius of plant and do not include sales tax.

Residential Septic Tanks / Holding Tanks / Pump Chamber:

Capacity	Regular	H-20	Length	Width	Height	Invert In	Outlet
500 Gal (5x5)	$665.00	$875.00	5'-0"	5'-0"	5'-6"	52"	52"
500 Gal (Low profile)	$665.00	$875.00	8'-0"	5'-2"	3'-3"	27"	25"
1000 Gal	$815.00	$1,145.00	8'-0"	5'-2"	5'-8 '	55"	52"
1250 Gal	$945.00	$1,235.00	10'-0"	5'-0"	5'-8"	56"	53"
1500 Gal	$1,105.00	$1,520.00	10'-6"	5'-8"	5'-8"	55"	52"
2000 Gal	$1,835.00	$2,355.00	12'-0"	6'-6"	5'-8"	55"	52"
2500 Gal	$2,340.00	$3,310.00	12'-10"	6'-10"	6'-5"	62"	59"
3000 Gal	$2,880.00	$3,945.00	12'-5"	7'-0"	7'-9"	83"	80"

3250 Gallons needed so two 1250 gallon tanks would be most effective

Leach (drainage) Field

Step 1: Obtain soil characteristics. Use the USGS soil survey (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx) and check well driller soil logs in the area (https://www.iihr.uiowa.edu/igs/geosam/map) to obtain hydrologic soil group and soil texture class. Use the Iowa Storm Water Management Manual for estimate of infiltration rate (SWMM Chapter 5, Table C5-S1-1).

Soil Texture = Sand

Hydrologic Soil Group = A

Design Infiltration Rate (in/hr) = 8.27

Table C5-S1- 1: Hydrologic soil properties classified by soil texture

Soil texture class	Hydrologic soil group	Effective water capacity (C_w) (in/in)	Minimum infiltration rate (*f*) (in/hr)	Effective porosity, θe (in^3/in^3)
Sand	A	0.35	8.27	0.025 (0.022-0.029)
Loamy sand	A	0.31	2.41	0.024 (0.020-0.029)
Sandy loam	B	0.25	1.02	0.025 (0.017-0.033)
Loam	B	0.19	0.52**	0.026 (0.020-0.033)
Silt loam	C	0.17	0.27	0.300 (0.024-0.035)
Sandy clay loam	C	0.14	0.17	0.020 (0.014-0.026)
Clay loam	D	0.14	0.09	0.019 (0.017-0.031)
Silty clay loam	D	0.11	0.06	0.026 (0.021-0.032)
Sandy clay	D	0.09	0.05	0.200 (0.013-0.027)
Silty clay	D	0.09	0.04	0.026 (0.020-0.031)
Clay	D	0.08	0.02	0.023 (0.016-0.031)

**Minimum rate: soils with lower rates should not be considered for infiltration BMPs

Source: Rawls et al., 1982

Step 3: Calculate the minimum required area for leachate field. Obtain design hydraulic loading rate, H_l, that matches the soil texture (IAC Chapter 69:69.9(2) Table IIIb). $A_l = Q_{in} / H_l$

Use Fine sands

$A_l = 1175 / 0.5$

$A_l = 588$ square feet

Table IIIb

Maximum Soil Loading Rates Based Upon Soil Evaluations in Gallons per Square Foot per Day ($gal/ft^2/day$) for Septic Tank Effluent. Values in ( ) are for secondary treated effluent.

Soil Texture	Single Grain	Massive	Structure Granular, Blocky, or Prismatic			Platy	
			Weak	Moderate	Strong	Weak	Moderate to Strong
Coarse sand and gravel	1.2 (1.6)	X	1.2 (1.6)	X	X	1.2 (1.6)	X
Medium sands	0.7 (1.4)	X	0.7 (1.4)	X	X	0.7 (1.4)	X
Fine sands	0.5 (0.9)	X	0.5 (0.9)	X	X	0.5 (0.9)	X
Very fine sands*	0.3 (0.5)	X	0.3 (0.5)	X	X	0.3 (0.5)	X
Sandy loam	X	0.3 (0.5)	0.45 (0.7)	0.6 (1.1)	0.65 (1.2)	0.4 (0.6)	0.3 (0.5)
Loam	X	0.4 (0.6)	0.45 (0.7)	0.5 (0.8)	0.55 (0.8)	0.4 (0.6)	0.3 (0.5)
Silty loam	X	NS	0.4 (0.6)	0.5 (0.8)	0.5 (0.8)	0.3 (0.5)	0.2 (0.3)
Clay loam	X	NS	0.2 (0.3)	0.45 (0.7)	0.45 (0.7)	0.1 (0.2)	0.1 (0.2)
Silty clay loam	X	NS	0.2 (0.3)	0.45 (0.7)	0.45 (0.7)	NS	NS

Step 2: Calculate the width of trench. Select the linear loading rate, LL_r, that best fits the limiting condition on site from table VI-4. Use the hydraulic loading rate obtained previously. Add 1.5 to result to account for perimeter trench width to obtain total width.

$W_E = LL_r / H_l$

$W_T = 1.5 + W_E$

Use Sand and/or gravel layer

$W_E = 10 / 0.5\ (0.9)$

$W_T = 1.5 + W_E$

$W_T = 1.5 + 20$

$W_T = 21.5$

South Septic System

Step 1: Estimate the wastewater volume generated on a daily basis, Q_{in}. Appendix A

Estimates of Non-household Domestic Sewage Flow Rates (Iowa Administrative Code (IAC) CHAPTER 69 PRIVATE SEWAGE DISPOSAL SYSTEMS: Appendix A, p 31)

11 Sites with a bathhouse will fall under "campground site with hookup" of 75 gpd which is 825 gpd

825 gpd of waste water inflow

Step 2: Calculate required tank volume. Select a minimum retention time, R_t. Under ordinary conditions (i.e., with routine maintenance pumping) a tank should be able to provide two to three days of retention time.

$V_t = Q_{in} * R_t$

69.8(2)b

"Other domestic waste systems. In the event that an installation serves more than a 6-bedroom home or its equivalent, or serves a facility other than a house and serves the equivalent of fewer than 16 individuals on a continuing basis, approval of septic tank capacity and design must be obtained from the administrative authority. Minimum septic tank liquid-holding capacity shall be two times the estimated daily sewage flow"

A retention time of 2-3 days is standard practice.

Step 3: Check the Effective Retention Time. You need to check that the retention time is at least 24 hours, assuming that the tank is 1/2 filled with solids. Therefore, the effective volume is 1/2 of total tank volume.

$V_e = V_t * 1/2$

Rmin = Ve /Qin

If R_{min} < 24 hrs then increase the tank volume

Assuming 2.7 days of retention would give

$V_t = Q_{in} * R_t$

$V_t = 825$ gpd * 2.7 days

$V_t \approx 2250$ gallons

$V_e = V_t * 1/2$

$V_e = 2250 * 1/2$

$V_e \approx 1125$ gallon

Rmin = Ve /Qin
$R_{min} = 1125 / 825$

$R_{min} = 1.364$ days (this is over 1.0 so it is satisfactory)

Step 4: Check minimum liquid-holding capacity. The minimum septic tank liquid-holding capacity shall be two times the estimated daily sewage flow (CHAPTER 69. 567—69.8(455B)-b)$h_{min} = V_t * 1/2 > 2 * Q_{in}$

$h_{min} = V_t \;\; / \; 2 * Q_{in} \; = 1$

$h_{min} = 2250 > 2 * 825$

$h_{min} = 2250 > \; 1650$

Step 5: Find a manufacturer for preliminary material cost. Search on-line for typical costs for a tank that meets your needed volume. For example, https://sheaconcrete.com/products/precast-concreteresidential-septic-tanks#septic-tanks.

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Residential Septic Tanks / Holding Tanks / Pump Chamber:

Capacity	Regular	H-20	Length	Width	Height	Invert In	Outlet
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1000 Gal	$815.00	$1,145.00	8'-0"	5'-2"	5'-8 '	55"	52"
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1500 Gal	$1,105.00	$1,520.00	10'-6"	5'-8"	5'-8"	55"	52"
2000 Gal	$1,835.00	$2,355.00	12'-0"	6'-6"	5'-8"	55"	52"
2500 Gal	$2,340.00	$3,310.00	12'-10"	6'-10"	6'-5"	62"	59"
3000 Gal	$2,880.00	$3,945.00	12'-5"	7'-0"	7'-9"	83"	80"

2250 Gallons needed so one 1000 gallon tank and one 1250 gallon tank would be most effective

Leach (drainage) Field

Step 1: Obtain soil characteristics. Use the USGS soil survey (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx) and check well driller soil logs in the area (https://www.iihr.uiowa.edu/igs/geosam/map) to obtain hydrologic soil group and soil texture class. Use the Iowa Storm Water Management Manual for estimate of infiltration rate (SWMM Chapter 5, Table C5-S1-1).

Soil Texture = Sand

Hydrologic Soil Group = A

Design Infiltration Rate (in/hr) = 8.27

Table C5-S1- 1: Hydrologic soil properties classified by soil texture

Soil texture class	Hydrologic soil group	Effective water capacity (C_w) (in/in)	Minimum infiltration rate (f) (in/hr)	Effective porosity, θe (in^3/in^3)
Sand	A	0.35	8.27	0.025 (0.022-0.029)
Loamy sand	A	0.31	2.41	0.024 (0.020-0.029)
Sandy loam	B	0.25	1.02	0.025 (0.017-0.033)
Loam	B	0.19	0.52**	0.026 (0.020-0.033)
Silt loam	C	0.17	0.27	0.300 (0.024-0.035)
Sandy clay loam	C	0.14	0.17	0.020 (0.014-0.026)
Clay loam	D	0.14	0.09	0.019 (0.017-0.031)
Silty clay loam	D	0.11	0.06	0.026 (0.021-0.032)
Sandy clay	D	0.09	0.05	0.200 (0.013-0.027)
Silty clay	D	0.09	0.04	0.026 (0.020-0.031)
Clay	D	0.08	0.02	0.023 (0.016-0.031)

**Minimum rate: soils with lower rates should not be considered for infiltration BMPs

Source: Rawls et al., 1982

Step 3: Calculate the minimum required area for leachate field. Obtain design hydraulic loading rate, H_l, that matches the soil texture (IAC Chapter 69:69.9(2) Table IIIb). $A_l = Q_{in} / H_l$

Use Fine sands

$A_l = 825 / 0.5$

$A_l = 413$ square feet

Table IIIb
Maximum Soil Loading Rates Based Upon Soil Evaluations in Gallons per Square Foot per Day ($gal/ft^2/day$) for Septic Tank Effluent. Values in ( ) are for secondary treated effluent.

Soil Texture	Single Grain	Massive	Structure Granular, Blocky, or Prismatic			Platy	
			Weak	Moderate	Strong	Weak	Moderate to Strong
Coarse sand and gravel	1.2 (1.6)	X	1.2 (1.6)	X	X	1.2 (1.6)	X
Medium sands	0.7 (1.4)	X	0.7 (1.4)	X	X	0.7 (1.4)	X
Fine sands	0.5 (0.9)	X	0.5 (0.9)	X	X	0.5 (0.9)	X
Very fine sands*	0.3 (0.5)	X	0.3 (0.5)	X	X	0.3 (0.5)	X
Sandy loam	X	0.3 (0.5)	0.45 (0.7)	0.6 (1.1)	0.65 (1.2)	0.4 (0.6)	0.3 (0.5)
Loam	X	0.4 (0.6)	0.45 (0.7)	0.5 (0.8)	0.55 (0.8)	0.4 (0.6)	0.3 (0.5)
Silty loam	X	NS	0.4 (0.6)	0.5 (0.8)	0.5 (0.8)	0.3 (0.5)	0.2 (0.3)
Clay loam	X	NS	0.2 (0.3)	0.45 (0.7)	0.45 (0.7)	0.1 (0.2)	0.1 (0.2)
Silty clay loam	X	NS	0.2 (0.3)	0.45 (0.7)	0.45 (0.7)	NS	NS

Step 2: Calculate the width of trench. Select the linear loading rate, LL_r, that best fits the limiting condition on site from table VI-4. Use the hydraulic loading rate obtained previously. Add 1.5 to result to account for perimeter trench width to obtain total width.

$W_E = LL_r / H_l$

$W_T = 1.5 + W_E$

Use Sand and/or gravel layer

$W_E = 10 / 0.5\ (0.9)$

$W_T = 1.5 + W_E$

$W_T = 1.5 + 20$

$W_T = 21.5$

Table VI-4. Linear Loading Rates Based on Limiting Conditions

	Linear Loading Rate Range (gpd/linear ft)	
Limiting Condition	**Conservative Value**	**Space-Limited Value**
Solid bedrock	3	4
Impermeable soil layer	3	4
Seasonal high water table	3	4
Semi-permeable soil layer	5	6
Fractured compacted till	5	6
Creviced or fractured bedrock	8	10
Sand and/or gravel layer	8	10

Step 4: Calculate the total length of pipe.

$L_T = Q_{in} / LL_r$

$L_T = 825 / 10$

$L_T = 82.5$

Because of area constraints we are choosing 1 trench

Step 5: Calculate the width and length of drainage field. Set the number of trenches you want that limits the maximum length to 100 ft (IAC Chapter 69 - 69.9(3).b)

Number of trenches = L_T / 100 (round up to nearest whole number)

Width = W_T * Number of trenches

Length = L_T / Number of trenches

Width = 21.5 * 2

Width = 43 ft

Length = 82.5 / 2

Length = 41.25

Step 6: Layout the septic system on site plan. Follow setback requirement in Table I (IAC Chapter 69: 69.3(2) Table I)

Appendix H: Shower-House Foundation Design Calculation Sheet

Unreinforced Strip Footing			
Footing design laod		1540	lb/ft
Wall thickness for design		8	in
Maximum allowable soil pressure		1500	psf
Concrete design strength	f'_c	2000	psi
Footing thickness	h =	8	in
Footing weight		100	lb/ft^2
Usable soil pressure		1400	lb/ft^2
Required width	w =	13.2	in
rounded	w =	14	in
Actual soil pressure		1320	lb/ft^2
Cantilever distance for wall face		3	in
Soil force on cantilever	F =	330	lb
Cantilever moment	M =	495	lb -in
Section modulus	S =	128	in^2
Max bending stress	f =M/S	3.9	psi
Allowable stress	fc = 1.6sqrt(f'_c)	72	psi
Is Max bending stress < Allowable stress?		Satisfactory	
Shear stress	vc =	3	psi
Allowable shear stress	1.1sqrt(f'_c)	49	psi
Is Shear stress < Allowable shear stress?		Satifactory	
Min transverse reinforcing	0.0015 * h*w	0.168	in^2

Figure H.1 Shower-House Foundation Calculation Sheet