ECOVILLAGE

DESIGN REPORT

May 10th, 2024

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CEE:4850 Project Design & Management

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Section I. Executive Summary

We are pleased to present our design solutions to the Scotch Grove Steering Committee. The following report outlines the design of an Ecovillage centered at 11726 Co Rd E17, Scotch

Grove, Iowa. The site has been configured to provide three new homes, as well as the inclusion of two existing structures on the property. This report has been prepared by a team of civil engineering students from The University of Iowa. The four-member team consists of Tyler Mroz, Evan Wulfekuhle, Abbagail Evans, and Angela Mrksic. The members all have experience in civil engineering site design and construction which were gained during their time at The University of Iowa, engineering internships, and training under professional civil and construction engineers.

The existing property consists of two parcels separated by the red dotted line seen in Figure 1.1, the first being commercially zoned to the south, including structures one through four. The second parcel is the primary residential development area for the proposed village, with existing structures five through nine.

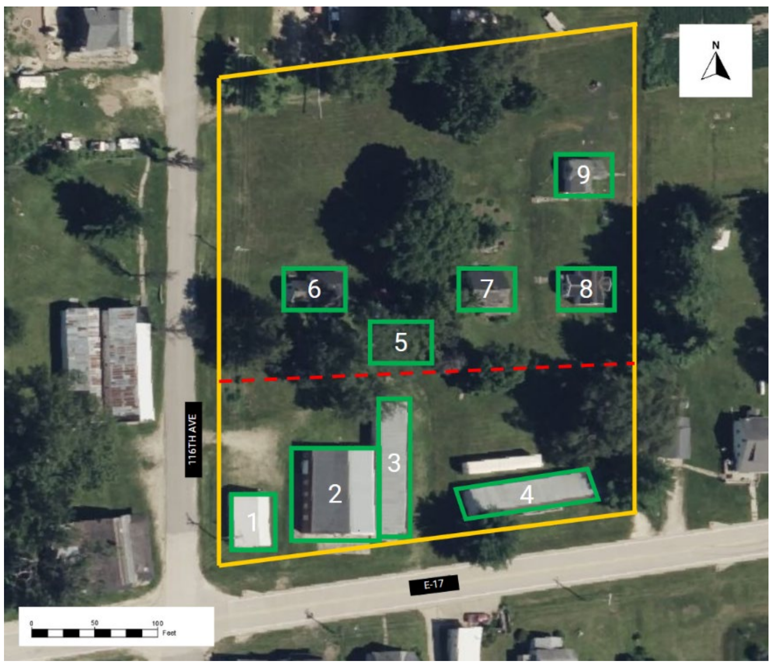


Figure 1.1: Existing site conditions

The existing buildings on the commercial side of the property were established in 1899-1935 and are considered historic per the National Register of Historic Places in 2014. All four buildings centered around 11735 Co Rd E17 will remain as they are on the property. As for the buildings on the north portion of the project, structures five, six, and seven will be demolished. These structures are recommended for removal, as we observed issues no longer feasible to resolve. The detached garage, marked five, appears to have asbestos siding which will require special attention for demolition and disposal. Structures eight and nine on the east side of the village will remain and be incorporated into the proposed development.

Due to the lack of public water and sewers in Scotch Grove, we were presented with significant design challenges. Due to regulatory standards, the use of septic systems and a private well required more space per home than a typical urban development. This space is necessary for the septic systems to function properly and to protect the water quality in the private well in case of leakage or failures. Compounded, these factors contributed to a recommended design that contains fewer homes than desired by the client. Because of this, we have created two fundamental design options. The first option (Figure 1.2) has a lower density that we believe satisfies the regulatory requirements for septic systems and private wells. The second option (Figure 1.3) has a higher density that aligns with the client's vision for this project, but it would need to rely on wastewater technology that is beyond the scope of our work. Furthermore, this option would require additional public hearings and meetings with county resources. A possible compromise may have to be made to establish a density both the client and the county are satisfied with. In the event of this challenge, we recommend the client to either adopt the low-density plan or remove homes one-by-one from the high-density option. Our design and cost estimates are crafted based on the low-density option (Figure 1.2), aligning with county codes and standards while navigating challenges posed by regulations that limit the client's vision. These challenges, as previously stated, are primarily rooted in setback requirements for houses, wastewater management, well water considerations, and the desired density of homes per acre of land. To achieve the desired house density, the client is required to submit extensive documentation to the Jones County Land Use Office and participate in a public hearing with the Planning and Zoning Commission, with the ultimate decision resting with the Board of Supervisors. Through dialogue with the County, it has been determined that the low-density plan, with each home having its own address, is the most viable option likely to gain approval within the regulatory framework. Despite creating a design layout for a high-density option (Figure 1.3), requested by the Scotch Grove steering committee, these limitations further emphasize the delicate balance between design goals and regulatory compliance in this project.

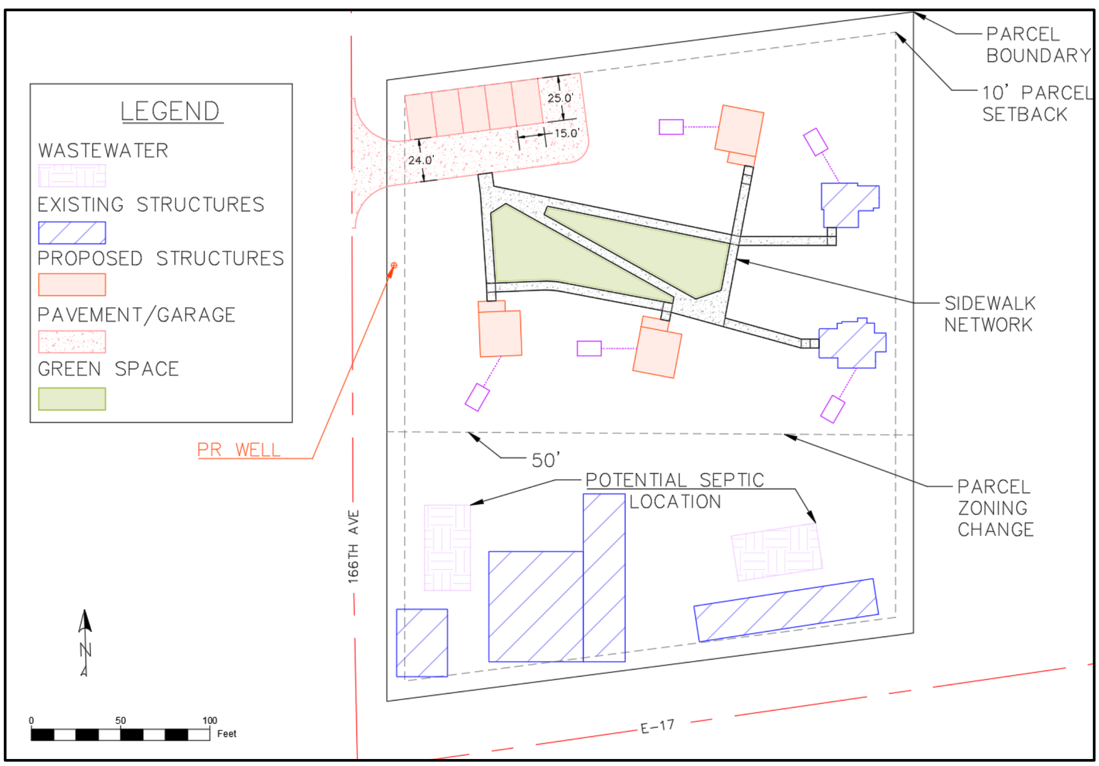


Figure 1.2: Low-density site plan

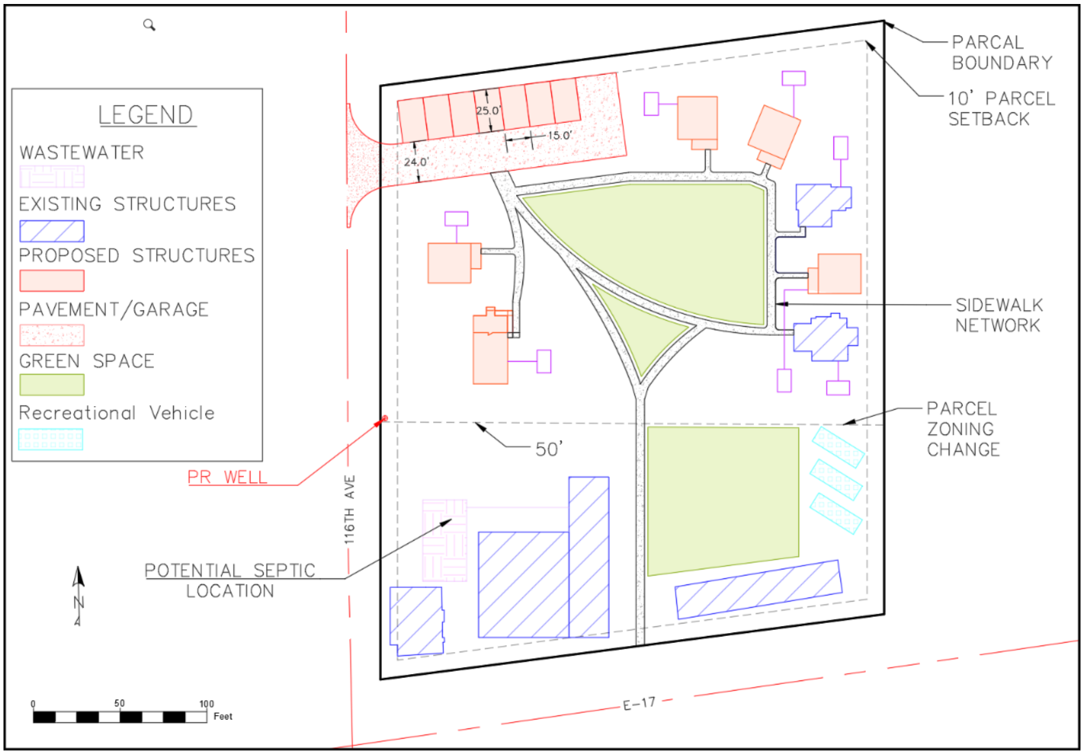


Figure 1.3: High-density site plan

The cost estimate has been broken into cost of site construction and home construction. The total construction cost for the site has been estimated at $254,000. The total construction cost for the homes has been estimated at $178,000 per unit. A contingency of 15% was used for the site construction estimate due to many of the existing conditions being unknown. For the home construction estimate, a contingency of 10% was applied to account for changing conditions, footprints, and uncertainty in subsurface conditions. Iowa Department of Transportation bid tabs were utilized to obtain a weighted average for the cost of construction. For all square foot costs, such as the detached garage structure and the home estimates, Gordian's 2019 Square Foot Costs with RSMeans data book was used. For all demolition estimating, Gordian's 2018 Heavy Construction Costs with RSMeans data book was utilized. This includes the foundation, septic systems, well connection, and the homes themselves. We recommend P.C. concrete for the garage and driveway area. This creates a single material mobilization for both the sidewalks and the garage and driveway area, which will be most cost effective. Rehabilitation of the existing structures shall be designed and estimated separately by a professional in their respective field.

To conclude, the designed development combines thoughtful planning, sustainable design, and strategic financial analysis to create a vibrant and economically viable village. With careful consideration of environmental impact, infrastructure design, and housing strategies, the project aims to meet both county regulations and community needs while fostering a sustainable and inclusive living environment, thus creating an Ecovillage. With the team's expertise, dedication, and collaborative approach, we hope to have helped create a visionary design that reflects the aspirations and values of Scotch Grove's residents and steering committee while fostering growth for generations to come.

Section II. Organization, Qualification, and Experience

Organization and Design Team Description:

The design team is comprised of civil engineering students at the University of Iowa in the capstone design class. Below is who the design team consists of, each design team role, their focus areas, and the area each specialized in for this project:

Abbagail Evans: Project manager, structures, mechanics, and materials, lead role - drinking water and structures

Angela Mrksic: Report production, civil engineering practice, lead role - environmental and impacts

Tyler Mroz: Technical support, transportation, lead role - wastewater and cost estimation

Evan Wulfekuhle: Report production, management, lead role - grading and details

Section III. Design Services

Many of the planned design services were completed for this project. The others were either adapted or dropped due to new information received. The noteworthy changes are explained in detail below.

Key Changes:

- A feasibility report was not made for the Scotch Grove Ecovillage, because one was already put together in 2022 by Seelman Landscape Architecture. The feasibility report from 2022 is still in line with the client's vision for Ecovillage. Because of this, a new feasibility report was not created.
- Three conceptual designs were proposed, however, the number increased to four to give the client more options.
- The alternatives were narrowed down to two options: high density and low density. This was done to allow the client more flexibility when it came to having a design that aligns with their goals, and one that is more aligned with the county's standards/restrictions.
- Due to time constraints and regulatory restrictions, construction drawings were completed for the low-density option only.
- The sidewalk system is ADA compliant except for the stairs leading up to the garden houses. The steep incline could be remedied by building a new, lower foundation under the garden houses.

Below is a description of the tasks completed for the site.

1. Preliminary Planning:

- Examined topography, soil conditions, and existing environmental conditions.
- Evaluated the local zoning regulations, land use restrictions, and building codes.
- Discovered permit process for a new well.

2. Conceptual Design:

- Explored sustainable design principles including tree conservation, eco-friendly sanitary sewers, and Grasscrete.
- Developed four conceptual designs, each having a list of pros and cons, based on input from the stakeholders and the feasibility outcomes. After meeting with the client, the designs were narrowed down to two options. One being the client's preferred alternative and the other being a design that the county would be more likely to approve.
- Refined the two options and made a list of pros and cons for each of them along with a recommendation for which one to choose and why.
- Created a master plan for the preferred alternative that included land use allocation, sidewalk layout, green spaces, and building placement.

3. Environmental Impact:

- Identified concerns located on or near the site including a buried gas tank, asbestos, and high nitrogen in the ground water.
- Proposed mitigation measures to the client.
- Completed an analysis of the local water resources and flood plains.

- Developed a plan to preserve most existing structures and add them to the natural features of the area.

4. Infrastructure Design and Engineering:

- Researched information on Coco-Filters which would be used for treatment of the wastewater.
- Obtained sizing data on the Coco-Filters. This data included the pipes needed to transport the wastewater from the structures to the Coco-Filters, and the pipes needed to transport the discharge.
- Obtained data on the existing well which will need to be removed and sealed.
- Obtained sizing data on the new well, which would need to be installed.
- Included a list of sustainable practices such as rainwater runoff collection and Grasscrete, which can be incorporated into the infrastructure's design to enhance the natural environment.
- Designed the sidewalks to follow accessibility standards, promoting an ADA-friendly design apart from the stairs leading up to the garden houses, which had to be installed due to the slope of the site.

5. Architectural Design and Housing Plans:

- Obtained blueprints for proposed tiny homes, with a mix of ADA compliant, non-ADA compliant, one-bedroom, and two-bedroom units.
- Provided a list of energy-efficient features that can be incorporated on site to benefit the community.

6. Housing:

- Placed tiny homes in locations that optimize their ability to be used as Airbnb's for daily-weekend rentals, long term renting options for starter or empty nesters, and/or be able to be sold along with the lots that they are on at market rates.

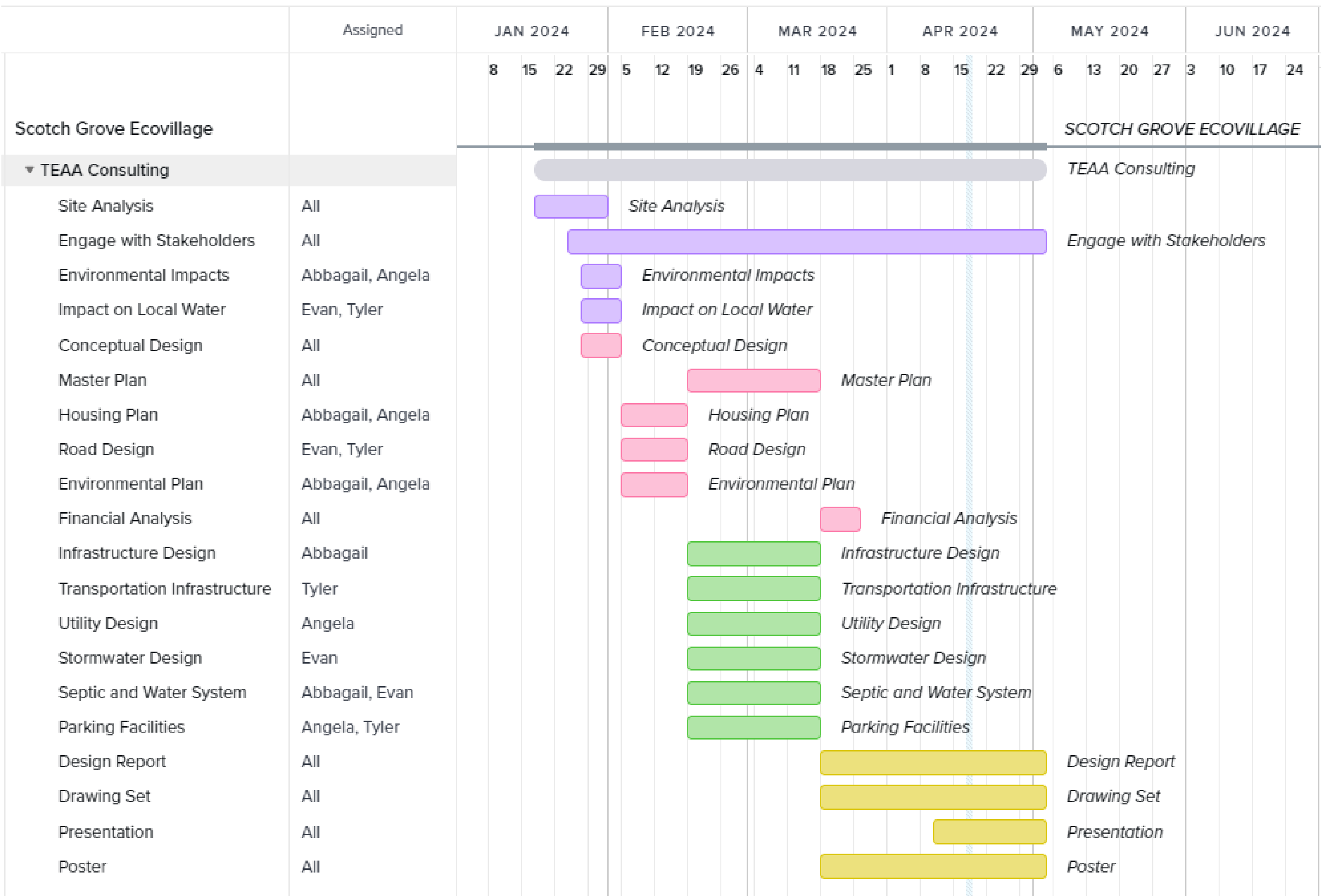
7. Transportation Planning and Connectivity:

- Thoroughly planned design and geometry of transportation infrastructure, including driveways, sidewalks, and communal spaces.
- Environmentally friendly detached parking facilities for Scotch Grove Ecovillage visitors and residents, which include extra space for storage and with ADA sizing in mind.

8. Prepared Work Products for Client:

- Design Report
- Construction Drawings for the Low-Density option
- Poster for the High-Density option
- PowerPoint Presentation on High-Density option, with common design elements

Work Plan:



Section IV. Constraints, Challenges, and Impacts

Constraints

Throughout the design process, various constraints were faced. These ranged from wastewater to public safety. One of the first constraints discovered was that the property would have to be split up into individual 911 addresses to ensure that emergency services would have access to each home on-site. The difficulty of having to split the property into individual 911 addresses is the arrangement of keeping each parcel responsible for their own septic tank, coco box, and discharge of wastewater. Breaking the existing land into multiple parcels will require more permit and regulatory costs. The client expressed the importance of incorporating specific existing structures into the design. Structures five, six, and seven will be demolished, and the remaining structures will remain. All alternatives presented follow the client's vision of including these structures. As a result, we recommend the client seek improvements for these homes which would have to be worked on during construction and the design process.

The septic system also had requirements that could not be changed. The Linn County Environmental Health Specialist described these requirements. The requirements include that there must be one 1250 gal/day septic tank per dwelling, any tanks over 1500gal/day would trigger DNR approval, all tanks need to have a ten-foot offset from structures and property lines, and the septic tank cannot be underneath proposed roadways or any structures. The drinking water system also faced constraints. Environmental services tested the existing well on the proposed Scotch Grove development property, and it was found that it was beyond its life. The Environmental Services recommended a new well be drilled and constructed.

Challenges

One of the greatest challenges faced in the Scotch Grove Ecovillage project was the size limitations of the site. The size of the development is approximately three acres, with the northern parcel being less than half of that. The objective included fitting approximately six lots, a walk-in garage, treehouses, and a community space onto the site. With the existing trees and buildings reducing the remaining land to approximately 1.1 acres, spacing played a key factor throughout the design process. Due to the project being a rural development there was not an existing sewer system to connect to. Because of this, other options were explored. A new private well will be installed as the town does not have any water infrastructure in place that the community would be able to tap into. The high-water table of the site also presented many challenges. As a result, primary and secondary wastewater treatment systems were a concern. The Linn County Environmental Health Specialist advised that concrete boxes be explored for wastewater systems due to the high-water tables.

To proceed with the design process, zoning had to be considered. To meet the client's vision regarding the density of the site, the zoning process was investigated and is as follows. The client will work towards changing the parcel's zoning from "Residential" to "Planned Development". The application process is detailed in Chapter three, page forty-one, of the Jones County Zoning Ordinance. Once the proper documentation is submitted to the Land Use Office, it will go before the Planning and Zoning Commission for a public hearing. If it passes at the public hearing, it will then proceed to the Board of Supervisors. If the preliminary plan is approved, the next step is to develop the final plan. The Land Use Administrator for Jones County recommended being as precise as possible throughout the application process.

Societal Impacts

According to the United States Census Bureau, Scotch Grove has a population of around 350. It has been steady in population between 2011 and 2022, with a peak population of 464 in 2019. Scotch Grove's priority is to maintain its rich history while introducing additions to help the community grow. The addition of residential units, transportation infrastructure, and community spaces will aid in the growth of the community.

Referencing the Scotch Grove feasibility report, the community frequently discussed the abundant history of the Scotch Grove area. This ensures any new infrastructure is designed with historical considerations in mind. Inspecting the Scotch Grove census report further revealed that in Scotch Grove's 113 households, the average persons per household is 2.7. The addition of tiny homes into our Ecovillage will attract single families, which aligns with the average household. The tiny homes target this group and will promote population growth for Scotch Grove.

The introduction of a community garden provides residents with the opportunity to cultivate fresh produce locally. Alongside this, the establishment of communal greenspaces encourages outdoor recreation and fosters a sense of community bonding. Additionally, the utilization of coconut husks serves as a renewable and biodegradable alternative for various purposes, minimizing waste and environmental impact. Implementing these components not only enhances environmental resilience but also promotes a more sustainable way of life for residents, fostering a healthier and more vibrant community.

The success of this project could be a blueprint for future developments in the community and in surrounding communities. As the first of its kind in the area, it draws attention from neighboring towns and beyond, positioning Scotch Grove as a pioneer in sustainable living.

Section V. Alternative Solutions That Were Considered

Various design alternatives were generated to meet the client's needs for the Scotch Grove Ecovillage project. The client had expressed incorporating some of the existing structures into the design. As a result, all alternatives were generated with this requirement.

Multiple septic system options were considered. Initially, a mound system was explored. Following conversations with the Linn County Environmental Health Specialist, it was discovered that it would be a very difficult process. All mound systems must be individually engineered and approved at a county or state level. This system is expensive, and not very common in the area. As a result, the size of the site led to this option not being feasible. A leech field was also explored. Further conversations with the Linn County Environmental Health Specialist revealed it was impossible to do on site. The soil is not sufficient for a leech field which led to it not being feasible. Ultimately, septic tanks with coco filters were determined to be the best option. Because of the high-water table, coco boxes would discharge water to the surface. The water is fully clean at this point; therefore, a benefit of these systems is that they could discharge straight to future gardens on the site. This method can be done at a local level, with no engineering or state approval, which helps meet the client's vision.

Being represented as an Ecovillage, it was extremely important to incorporate sustainable features and aspects of design into our ideas. An example of this is the use of the Ecoflo Coco Filters. This wastewater treatment system offers an environmental benefit that extends far beyond conventional treatment approaches. The utilization of coconut husks as a natural filtering medium holds efficiency and waste reduction. Coconut husks, a byproduct of the coconut industry, are abundantly available and renewable, diminishing the need for factory-created filtration media derived from non-renewable concepts and resources. The biodegradability of coconut husk ensures slim to no ecological impact, as they decompose naturally after their lifespan within the filtration system. They hold a life of twelve to fifteen years, before being replaced with a new husk media. Moreover, the Ecoflo Coco Filter significantly reduces energy consumption and carbon emissions associated with wastewater treatment. Unlike conventional treatment plants reliant on mechanical aeration and chemical dosing, Ecoflo Coco Filter operates primarily through passive processes, requiring minimal energy input. This results in reduced operational costs and environmental footprint, making Ecoflo Coco Filter an economically sustainable choice for such a rural setting in Scotch Grove. Additionally, the treated effluent produced by Ecoflo Coco Filter complies with stringent regulatory standards made by the Iowa DNR and local counties, safeguarding water resources and surrounding ecosystem integrity. By effectively removing contaminants and pathogens from wastewater streams, Ecoflo Coco Filter mitigates the risk of waterborne diseases and ecosystem degradation, enhancing public health and environmental quality in not only Scotch Grove, but also all the surrounding areas.

When deciding what to name the project, the client had the option of either “Scotch Grove Pocket Neighborhood” or “Scotch Grove Ecovillage”. Sustainability and community were two main drivers in the design, which led the client to choose “Scotch Grove Ecovillage”. To implement elements of an ecovillage, the common green space was key. The greenspaces on the site were explored, and it was concluded that some existing trees would be used for treehouses.

To meet the client’s needs regarding the number of homes on the site, and to get county approval, numerous zoning options were explored. After multiple conversations with county officials, it was concluded that a zoning change of the Northern portion of the site from “Residential” to “Planned Development” and keeping the Southern portion “Commercial” would provide the highest chance of county approval.

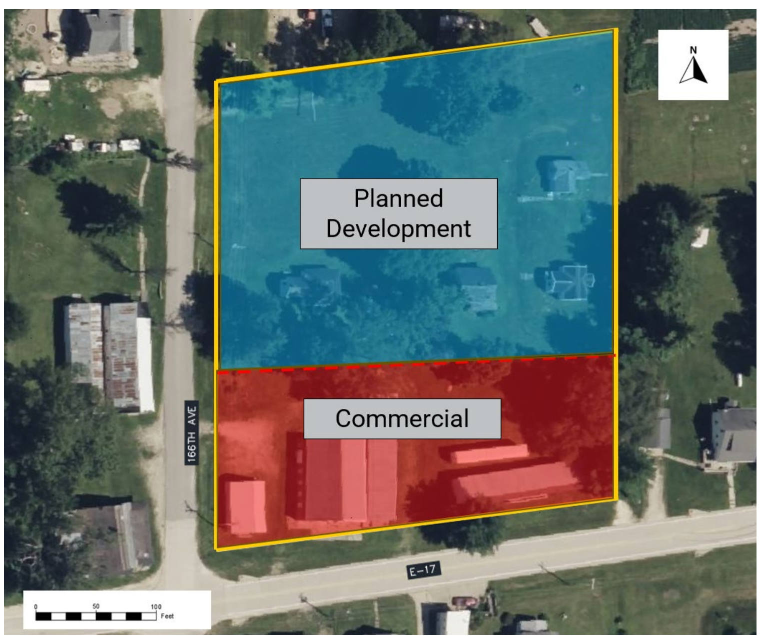


Figure 5.1: Proposed Land-Use Zoning for the site

After considering the concepts described, two final design alternatives were provided to the client using Civil3D. The first alternative is a “high density” option. The benefits of this alternative are aligning with the client’s vision of more homes on the property and providing a bigger boost to the Scotch Grove community. Drawbacks of this alternative include potentially needing to build a public well off-site, the county may not approve this density without a municipal sanitary sewer system, and additional flow for septic. The second alternative is a “low density” option. The benefits of this alternative are a greater chance of being approved by the county, potentially using a private well on-site, and more green space. A drawback is that the number of units falls short of vision for the project.

Concepts that were explored but could not be implemented due to the time constraint of the project timeline:

- Using commercial building #2 as a community space
- Using commercial building #3 as apartments
- Using the Northern portion of commercial building #3 as a bathroom/shower area for RVs
- Off-site public well that provides service to the grocery store South of the site
- Grasscrete as an eco-friendly pavement option
- Using 20’ containers that are onsite for growing gardens, outdoor showers, or a bathhouse
- Solar panels on the roofs of the homes and the garage structure
- Recreational uses for the greenspace

Section VI. Final Design Details

Wastewater

Premier Tech's Ecoflo CocoFilter is a package wastewater treatment system that harnesses the natural filtration capabilities of coconut husk fragments to purify wastewater sustainably. This section provides an in-depth analysis of the Ecoflo CocoFilter system, diving into its components, mechanisms, and application for the Scotch Grove Ecovillage. Wastewater treatment is a pivotal aspect of modern sanitation infrastructure, essential for safeguarding public health and preserving environmental integrity. However, traditional treatment methods often come with drawbacks, including high energy consumption, chemical usage, and large footprints. Premier Tech's Ecoflo CocoFilter embodies a shift in wastewater treatment, offering a sustainable alternative grounded in nature's own purification mechanisms, bundled into one “package” treatment.

Regarding wastewater treatment, each dwelling requires a 1250-gallon/day septic tank per Iowa Legislative Document 567-69.8(455B). These tanks must be ten feet away from structures and property lines per Iowa Legislative Document 567-69.3. Enclosing tanks in concrete was considered due to the high-water table. Ecoflo’s polyethylene PACK option can service areas with up to a five-foot water table (Figure 6.1).

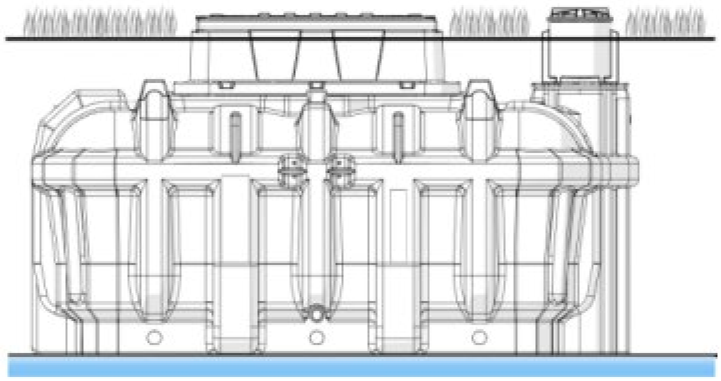


Figure 6.1: Seasonal High Groundwater (SHGT) levels to respect for Ecoflo installation

We recommend ordering the PACK option without a concrete box as it will not be necessary. Ecoflo Coco Filter 4.1 PACK option (see Figure 6.2 and 6.3) also provides secondary wastewater treatment, Coco boxes (coconut husk filters) are the preferred choice. These filters treat septic tank effluent and could gravity discharge. Spacing is critical for multiple addresses, and the discharge location must be one hundred feet from private wells. All added offsets and spacing requirements can be found in Figure 6.5.

Model	Ecoflo® Coco Filter 4.1 PACK option	
Hydraulic capacity	750 US gal/d (2,870 L/d)	
Actual volume of the primary/septic tank	1,250 US gal (4,750 L)	
Effluent filter in the primary/septic tank	Polylok PL-122	
Mode of discharge	Gravity	Pumped
Type of bottom	Watertight	Watertight
Length (A)*	13'4" (4,050 mm)	
Width (B)*	8'2" (2,485 mm)	
Height (C)*	5'10" (1,770 mm)	
Inlet invert height (D)*	4'4" (1,285 mm)	
Inlet invert height (E)*	1'7" (485 mm)	
Outlet invert height (Fg and Fp)*	1¾" (44 mm)	3'9" (1,140 mm)
Weight** (including internal components and filtering medium)	2,070 lb (940 kg)	2,090 lb (950 kg)
Factory-set dosage volume	---	35 US gal. (135 L)
Maximum dosage volume	---	200 US gal (755 L)
Retention volume (between the bottom of the containment tank and the bottom of the filtering medium)	---	350 US gal. (1,325 L)

Figure 6.2: Ecoflo PACK specifications

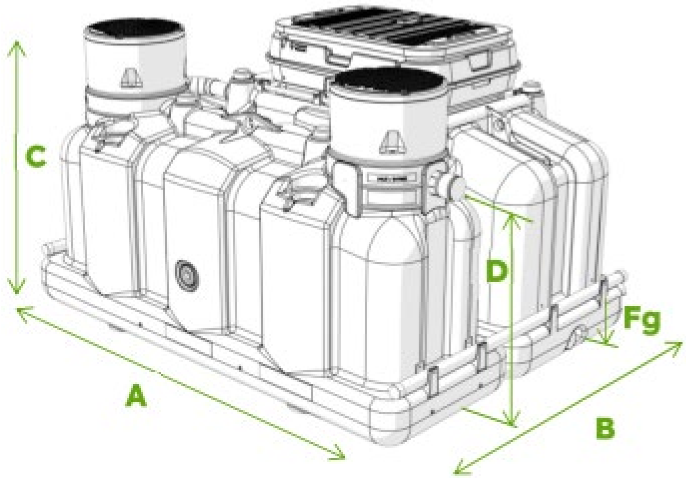


Figure 6.3: Ecoflo PACK specifications drawing

At the heart of the Ecoflo CocoFilter system lies an engineered arrangement of components designed to optimize wastewater treatment efficiency. Central to its operation is the filtering medium, composed of coconut husk fragments sourced from renewable coconut plantations. These husks display exceptional adsorption properties, effectively capturing suspended solids, pathogens, and organic contaminants present in wastewater streams. Encased in a polyethylene containment unit, the husks create a long contact time between the wastewater and the biofilm-rich surface of the coconut husk fragments, enhancing treatment efficiency.

Upon entry into the system, raw wastewater undergoes preliminary treatment, allowing larger solids to settle out, thereby reducing the load on later treatment stages. As the wastewater permeates through the coconut husk fragments, organic pollutants are degraded by microorganisms inhabiting the husks. While this occurs, adsorption mechanisms help the removal of contaminants, such as heavy metals and pharmaceutical products.

Once waste has been processed through the Ecoflo PACK, it is to be routed to a discharge location meeting all specifications. Provided below in Figures 6.4 and 6.5 are visual representations of the Ecoflo installation.

Figure 6.4: View of an Ecoflo Coco Filter – PACK option treatment system (gravity discharge)

Reference Point	Polyethylene Ecoflo Coco Filter
Bottom of a talus, surplus backfill (A)	13 ft
Parking area (B)	13 ft
Vehicle or object weighing more than 500 lb (C)	13 ft
Retaining Wall (D)	13 ft
Finished landscaping vs base of Ecoflo lid (E)	2 in

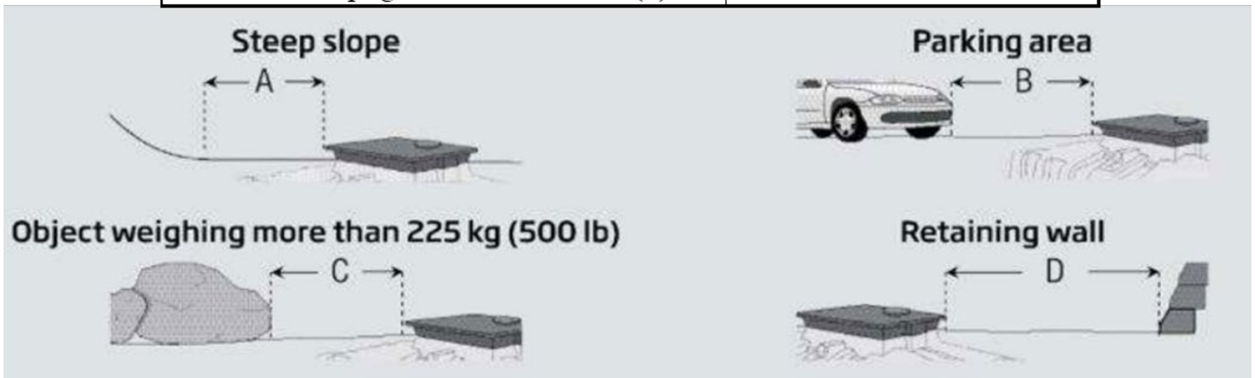


Figure 6.5: Minimum distances to be maintained per specifications

Water Service

A single private well will serve all dwellings. The existing well needs replacement due to its age. Private well spacing requirements include fifty feet from septic tanks and one hundred feet from discharges. The Scotch Grove Ecovillage project combines thoughtful zoning, innovative wastewater treatment, and well construction to create a sustainable and harmonious community. Detailed planning and adherence to guidelines are essential for successful implementation.

To size the private well, information was used from surrounding wells in the area taken from the Iowa Geological Survey. The depths of the surrounding wells were taken into consideration when approximating the depth needed for the private well. The nominal diameter for the pipe was found by using Indiana's Department of Health, due to it having the most accessible information. The Central Valley Flood Protection Board held typical prices for drilling wells across the country. This was used to estimate the cost to drill the new well.

Stormwater

To evaluate existing stormwater conditions versus proposed development conditions, Iowa codes were followed. The process entailed a thorough examination of several factors. Understanding the pertinent regulations and guidelines on stormwater management and land development in Iowa was essential. Gathering data on existing conditions, including land use, topography, soil types, and drainage patterns, served as the foundation for the assessment. To perform all these computations, StreamStats and WinTR-55 were utilized. StreamStats provided access to hydrological data such as streamflow statistics and watershed boundaries, while WinTR-55, a hydrological model, estimated stormwater runoff and peak discharge rates based on input data such as land use, soil types, and rainfall data.

First, StreamStats was used to delineate the subbasin for the Ecovillage. After delineation, a report was generated to achieve the values needed for the NRCS Water Lag Method Using USGS StreamStats for Iowa (See Appendix A). These necessary values include drainage area, mean basin slope computed from 10 m DEM, percentage of cultivated crops and hay, classes 81 and 82, from NLCD 2011, percentage of developed (urban) land from NLCD 2011 classes 21-24, average percentage of impervious area determined from NLCD 2011 impervious dataset, percentage of area of Hydrologic Soil Type A, B, C, and D from SSURGO. The existing and post-development curve number was approximated using the NRCS Weighted Curve Number method (Figure A.3 and A.5). Finally, the existing and post-development time of concentration was found by the NRCS Watershed Lag Time of Concentration with Measured Flow Length method (Figure A.3 and A.5).

Second, WinTR-55 was used to estimate flood peaks in both the existing site and the proposed Ecovillage. WinTR-55, a widely used hydrological model, offered valuable insights into the impact of land use changes on flood characteristics. By analyzing the existing site conditions and proposed alterations, including changes in land cover, topography, and impervious area, we aimed to quantify potential shifts in flood peak magnitudes. This comparative analysis provided crucial data for informed decision-making using the previously calculated curve number and time of concentration. Through WinTR-55 simulations, a Type II design storm with Jones County rainfall data was analyzed. The events simulated were the 2, 5, 10, 25, 50, and 100-year rainfall events. Refer to Figure A.4 and A.6 for WinTR-55 hydrograph peak values in cubic feet per second (cfs).

The comparison between existing and proposed conditions involved analyzing both the StreamStats and WinTR-55 factors like peak discharge rates, runoff volumes, and potential flood risks associated with the proposed development. This comparison ensured compliance with Iowa codes and regulations regarding stormwater management and environmental protection. If adverse impacts are found, mitigation measures such as green infrastructure or stormwater management facilities may be necessary. After analyzation, we concluded that the proposed development only increased impervious area by approximately five percent. This is not enough impact to warrant additional stormwater management practices. Table A.7 shows the full percent increase for each rainfall event. To help mitigate runoff and capture some of the stormwater on our site, we also recommend the installation of rain gardens or box gardens in the green space. These will help hold stormwater in and foster growth of plants, food, or herbs. Additionally, rain barrels are recommended for the individual homes to utilize.

The evaluation of the site stormwater runoff involved a comprehensive assessment of the site's topography and drainage conditions. Through careful analysis, it was determined, as depicted in Figure 6.6 below, that the water movement across the site occurs primarily as "sheet flow." This means that water flows evenly across the surface without concentrating into defined channels or causing significant erosion. Consequently, it was concluded that no further action is required to deliberately divert stormwater runoff throughout the site. However, it is noted that specific stormwater diversion measures will be implemented on a house-by-house basis to ensure effective management and minimize any potential localized impacts. This approach acknowledges the unique characteristics of each property while maintaining overall stormwater management objectives.

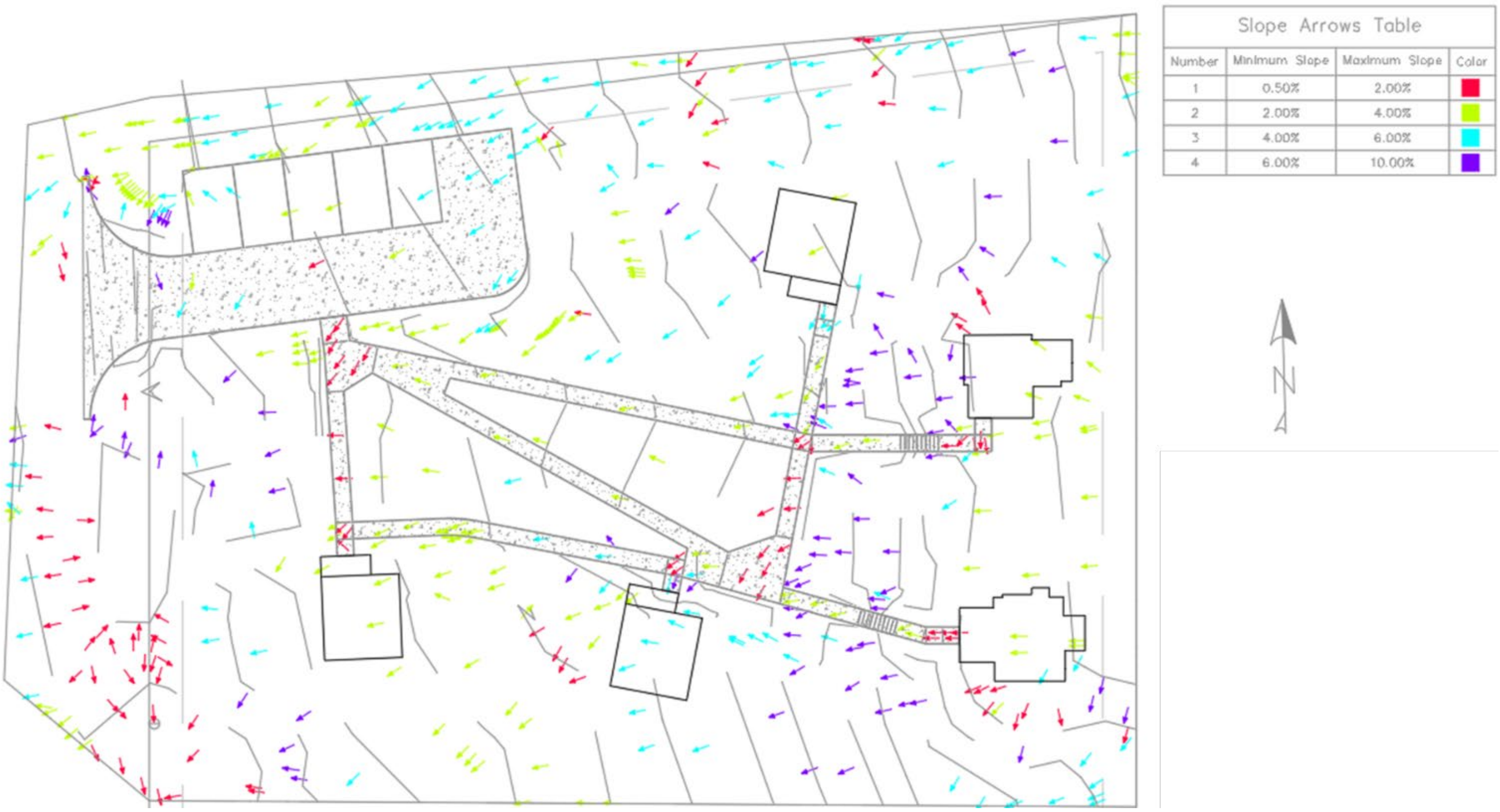


Figure 6.6: Slope arrow overlay on site for stormwater runoff

Limited space

The central "common space" has been designed to allocate use by all properties in the location. In this area, room was left for the existing trees to be used as tree houses per the client's request. There will also be room to plant gardens and any other use that comes to fruition. With so much of the site and walkways being publicly shared an HOA is going to have to be established to bear the cost when maintenance is required. Another route would be for the owners to maintain possession of the property and take on all expenses. Each property has been parceled as required by the county 911 operator.

Existing structures

The existing buildings on the commercial side of the property were established from 1899 to 1935 and are considered historic per the National Register of Historic Places in 2014. All four buildings centered around 11735 Co Rd E17 will remain as they are on the property.

As for the buildings on the north of the project, structures five, six, and seven will be demolished. These structures are recommended for removal, as we observed issues no longer feasible to resolve. The detached garage, marked five, appears to have asbestos siding which will require special attention for demolition and disposal. Structures eight and nine on the east side of the village will remain and be incorporated into the proposed development.

ADA Consideration

When designing the sidewalks, a standard five-foot-wide walkway with near direct paths to each individual house was used. Knowing the clientele in the area, it was vital to ensure that the grades of all the sidewalks would be up to ADA standards.

The sidewalk grades were designed to limit cross slope to 2%, and to limit a longitudinal slope to under 8.25% for ADA considerations. In all turning spaces, slope cannot exceed 2% in any direction. This was achieved throughout the sidewalk network with a couple of exceptions. These exceptions include the existing structures located at the top of the ridge. Achieving an ADA compliant solution would have been costly and unnecessary, considering the houses themselves are not ADA compliant. The solution was to design two staircases leading to the houses. This design was done using section 9080.101 of the Statewide Urban Design and Specification (SUDAS) Specification Manual. See drawing sheet S.02 and S.04 for more information on the implemented sidewalk and stair design respectively. The new parking area will also be ADA accessible based on the standards from SUDAS. Extra space in each of the parking garages will be provided to be used for storage space by individuals occupying the tiny homes.

Site Plan

The site plan features one driveway that connects to 116th Ave on the northwest side of the site and pulls into a five-stall shared garage. The driveway is a 24-foot-wide aisle with 24' radius curb returns. There is a turnaround area if the driveway is used accidentally. The width will accommodate service vehicles, and emergency vehicles to travel through. With there being such little pavement, it was decided to specify reinforced PCC with a depth of 6" (more details can be seen on sheet B.01). Asphalt was considered, however further analysis found that it would be too costly for such a small area. A stall garage is to be built on the PCC drive. This has been sized to allow ADA vehicles to have the space they need in accordance with Section 8B-1 of the Statewide Urban Design and Specifications (SUDAS) Design Manual. Additionally, it has a secondary purpose of acting as storage area for the homes as it is oversized.

Section VII. Engineer's Cost Estimate

Unit costs for all items on the estimate were obtained in accordance with Iowa Department of Transportation bid tabs, Gordian's 2019 Square Foot Costs with RSMeans data, and Gordian's 2018 Heavy Construction Costs with RSMeans data. Using Autodesk Civil3D to generate volume takeoffs, as shown in Appendix A, a quantity was assigned to each unit. The project has been divided into two separate cost estimates: a site estimate, and a home estimate. These were split up to allow the client easier estimation depending on the density of the Ecovillage. The site estimate was divided into four main sections: demolition, earthwork, pavement & sidewalk, and garage. The home estimate used Gordian's 2019 Square Foot Costs with RSMeans data to get an estimate of cost per square foot of home built for the project. Cost implications for property division were considered but were not included in the home estimate. Rehabilitation of the existing structures were not included in the home estimate and shall be designed and estimated separately by a professional in their respective field. Specific costs and quantities were estimated for each section and can be found below in Figure 7.1.

Utilizing values from five- and six-year-old resources creates extra assumptions and calculations. To project values in both Gordian books, construction cost indices were used. Indexes are used to adjust costs over time for the effects of inflation. An index already compounds annual percent to prevent the error of adding annual percents. To move cost from some point in time to some other point in time, the index for year desired to move to is divided by the index for the year to move cost from. Specifically, Construction Analytics provides a record of RSMeans index inputs at a national level to calculate a proper multiplier. Shown below is an example formula used to calculate the multiplier for values projecting from 2018 and 2019 in accordance with Figure A.1 in Appendix A.

$$MULTIPLER = \frac{TO}{FROM}$$

Figure 7.1 below shows the site cost estimate. Note that the detached garage item within Figure 7.1 was considered unit cost. This was found by extrapolating the costs found in the Gordian 2019 Square Foot Costs with RS Means data book, a linear forecast was calculated to achieve this (see Figure A.2 in Appendix A). Once the total cost of each item was calculated, the total site construction cost of the project was calculated with a 15% contingency. Figure 7.2 has the estimated value of each proposed home on the project. This estimate includes a 10% contingency due to changing conditions, footprints, and uncertainty in subsurface conditions upon construction. All project costs were rounded according to the RSMeans rounding standards, which can be found in Figure B.1 in Appendix B. The estimated site construction cost for this project came to $254,000, and the home estimate was determined to be $178,000 per unit.

ITEM	UNIT	UNIT COST	QUANTITY	COST
DEMOLITION				
CLEARNING AND GRUBBING	[ACRE]	$5,434.48	0.22	$1,200.00
STRUCTURE DEMO / REMOVAL	[UNIT]	$12,740.66	2	$25,500.00
GARAGE DEMO / REMOVAL	[CF]	$0.69	6912	$4,775.00
SILT FENCE	[LF]	$1.78	260	$465.00
EARTHWORK				
EXCAVATION - CLASS 10	[CY]	$4.36	156	$680.00
BACKFILL	[CY]	$47.99	66	$3,175.00
TOP SOIL - STRIP, SALVAGE AND SPREAD	[CY]	$6.17	103	$635.00
SEEDING AND FERTILIZING	[ACRE]	$1,043.85	1.31	$1,375.00
SELECTED TREE & SHRUBBERY	[LUMP]	$2,120.90	1	$2,125.00
PAVEMENT & SIDEWALK				
SIDEWALK, P.C. CONCRETE, 5 IN.	[SY]	$64.93	400.0	$26,000.00
DRIVEWAY, REINFORCED P.C. CONCRETE, 6 IN.	[SY]	$84.35	666.9	$56,500.00
CLASS A CRUSHED STONE	[CY]	$39.91	208.1	$8,300.00
CULVERT, CORRUGATED METAL ENTRANCE PIPE, 24 IN. DIA.	[LF]	$60.04	43	$2,575.00
APRONS, METAL, 24 IN. DIA.	[EACH]	$478.26	2	$955.00
GARAGE				
DETATCHED 5 CAR GARAGE, AVERAGE, WOOD	[UNIT]	$86,636.16	1	$86,500.00
SUBTOTAL	$220,760.00			
CONTINGENCY, 15%	$33,100.00			
TOTAL COST	**$254,000**			

Figure 7.1: Final site cost estimate.

ITEM	UNIT	UNIT COST	QUANTITY	COST
ONE BED, ONE BATH WITH KITCHEN HOME	[SQFT]	$213.81	1740	$372,000.00
ECOFLO® COCO FILTER 4.1 PACK OPTION	[UNIT]	$25,000.00	5	$125,000.00
PRIVATE WELL	[LF]	$50.00	80	$4,000.00
SANITARY SEWER GRAVITY MAIN, TRENCHED, POLYVINYL CHLORIDE PIPE (PVC), 4 IN.	[LF]	$71.51	100	$7,150.00
WATER MAIN, TRENCHED, POLYVINYL CHLORIDE PIPE (PVC), 2 IN.	[LF]	$117.20	452	$53,000.00
ITS TRACER WIRE	[LF]	$1.62	552	$895.00
SUBTOTAL	$562,045.00			
CONTINGENCY, 10%	$56,000.00			
TOTAL COST	**$618,000**			

Figure 7.2: Final home cost estimate excluding the garden homes' rehabilitation.

Section VIII. Appendices

Appendix A. Calculations and Reports

CONSTRUCTION ANALYTICS INDEX BASE YR SET TO 2019 = 100	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CA NONRESIDENTIAL BLDGS	**84.0**	**87.1**	**90.6**	**95.5**	**100.0**	**102.4**	**110.8**	**124.2**	**130.9**	**136.5**	**141.8**
Turner Index actual cost	81.6	85.5	89.8	94.9	100.0	101.8	103.7	112.1	118.7	123.4	128.4
Rider Levett Bucknall Index Actual Cost	82.2	86.7	90.6	94.8	100.0	103.5	108.5	117.3	125.4	130.4	135.6
Mortenson avg 6 cities nonres bldg	85.1	88.1	91.1	97.8	100.0	101.9	118.2	131.6	135.8	141.3	146.9
PPI Industrial Bldg actual cost	87.5	88.0	90.4	94.6	100.0	102.8	109.5	133.9	142.9	150.0	154.5
PPI Warehouse Bldg actual cost	88.0	89.4	92.0	95.2	100.0	101.6	111.6	143.0	148.3	154.2	158.8
PPI School Bldg actual cost	88.0	88.8	90.6	94.5	100.0	102.3	106.9	124.4	131.8	138.4	142.5
PPI Office Bldg actual cost	88.5	89.9	91.9	95.7	100.0	102.2	109.8	132.5	143.4	152.0	156.6
PPI Health Care Bldg actual cost	90.3	90.8	92.1	96.0	100.0	102.2	108.3	126.9	134.6	141.3	145.6
PPI Concrete Contractor actual cost	83.2	86.7	89.8	94.0	100.0	101.8	110.2	129.6	131.3	141.8	146.1
PPI Roofing Contractor actual cost	93.1	94.4	96.6	97.5	100.0	103.2	110.3	131.1	148.4	163.3	168.2
PPI Electrical Contractor actual cost	88.3	90.2	91.5	95.6	100.0	102.6	108.0	122.7	131.3	137.9	142.0
PPI Plumb/HVAC Contractor actual cost	90.7	89.6	91.3	95.2	100.0	100.7	105.6	119.6	128.1	134.5	138.5
Ready Mix Concrete Input	87.6	90.9	93.8	97.7	100.0	102.5	106.5	117.4	130.5	135.8	141.2
Fabricated Str Mtl Products Input	89.7	89.1	91.1	97.5	100.0	97.7	119.4	152.6	152.2	158.3	164.6
RS Means Index Inputs Natn'l	88.7	89.9	92.1	96.4	100.0	101.9	111.1	124.2	127.5	136.9	142.4
ENR BCI Index Inputs	89.9	92.0	95.0	98.1	100.0	102.4	112.7	127.0	132.5	136.5	140.6
PPI Inputs to NONRES BLDGS	87.9	86.4	89.8	96.0	100.0	100.2	118.7	137.4	137.0	141.8	146.7
CA INFRASTRUCTURE composite	**91.0**	**89.5**	**91.4**	**96.1**	**100.0**	**99.5**	**107.7**	**125.9**	**132.0**	**137.0**	**141.8**
FHWA Hiway Index NHCCI	88.3	86.4	87.1	93.3	100.0	99.9	107.2	135.2	148.8	154.0	159.4
I H S UCCI Pipeline, LNG	103.8	92.9	95.1	99.5	100.0	94.5	103.3	114.2	120.2	125.0	130.0
I H S DCCI Refinery, Petrochemical	92.6	89.2	93.1	98.0	100.0	97.0	106.0	118.0	118.0	122.7	127.6
BurRec Roads & Bridges	90.7	91.4	94.1	97.5	100.0	100.7	107.8	119.7	124.2	127.9	131.8
BurRec Dams & Pumping Plants	90.6	91.8	94.0	97.0	100.0	100.7	106.0	117.6	123.9	127.6	131.4
BurRec Distribution Pipelines STEEL	93.0	94.2	96.0	97.9	100.0	100.2	106.0	118.2	121.8	125.4	129.2
CA RESIDENTIAL	**83.5**	**87.4**	**92.2**	**96.6**	**100.0**	**104.5**	**119.1**	**137.7**	**141.2**	**145.9**	**151.2**
US Cen Bur NEW Homes Lasperyes	84.8	89.1	93.7	96.9	100.0	104.0	116.1	135.3	138.4	143.9	149.7
S&P/Case Shiller HomePrice NATIONAL	82.0	86.3	91.8	96.5	100.0	105.9	123.7	142.0	145.6	148.5	152.9
PPI Residential Inputs +Labor	88.7	87.6	90.6	97.7	100.0	102.4	121.1	136.4	132.9	136.8	140.9
All data updated to Q4'2023 where available		**All future forecast by Construction Analytics**						**edzarenski.com**			

$$Index = \frac{TO}{FROM}$$

For 2018 to 2025: $\frac{142.4}{96.4} = 1.477$ COSTS IN BOOK TO BE MULTIPLIED BY 1.477

For 2019 to 2025: $\frac{142.4}{100} = 1.424$ COSTS IN BOOK TO BE MULTIPLIED BY 1.424

Figure A.1: Construction Analytics' index projection factor and calculations.

RESIDENTIAL **Modifications/Adjustments/Alternatives**

Garages *

(Costs include exterior wall systems comparable with the quality of the residence. Included in the cost is an allowance for one personnel door, manual overhead door(s) and electrical fixture.)

Class	Type: Detached			Attached			Built-in		Basement	
	One Car	Two Car	Three Car	One Car	Two Car	Three Car	One Car	Two Car	One Car	Two Car
Economy										
Wood	$18,467	$28,175	$37,884	$14,279	$24,532	$34,241	$-1984	$-3968	$1851	$2550
Masonry	24,997	36,348	47,699	18,366	30,261	41,611	-2786	-5572		
Average										
Wood	20,232	30,384	40,536	15,383	26,080	36,232	-2201	-4401	2109	3067
Masonry	25,136	36,521	47,907	18,452	30,382	41,768	-2803	-4465		
Custom										
Wood	22,565	34,631	46,697	17,507	30,276	42,341	-3144	-2944	3096	5039
Masonry	27,465	40,762	54,060	20,573	34,573	47,871	-3746	-4148		
Luxury										
Wood	25,210	39,236	53,262	19,809	34,538	48,565	-3256	-3169	4184	6693
Masonry	32,653	48,551	64,449	24,467	41,068	56,966	-4170	-4997		

*See the Introduction to this section for definitions of garage types.

# of Cars	Cost
1	$20,232.00
2	$30,384.00
3	$40,536.00
4	$50,688.00
5	**$60,840.00**

"= FORECAST.LINEAR(x, known_y's, known_x's)"

Figure A.2: Five car detached garage cost.

NRCS Water Lag Method Using USGS StreamStats for Iowa

StreamStats Basin Characteristics

DRNAREA	BSLDEM10M		LC11CRPHAY	LC11DEV	LC11IMP		SSURGOA	SSURGOB	SSURGOC	SSURGOD
(mi^2)	(%)		(%)	(%)	(%)		(%)	(%)	(%)	(%)
0.0758	4.24		62.5	37.7	9.76		0	80.4	1.58	18

Approximate NRCS Weighted Curve Number

		0	80.4	1.58	18	99.98		
Landuse	*Area (%)*	*CN-A*	*CN-B*	*CN-C*	*CN-D*	*CN*	*A*CN*	*Land Use/Land Cover*
Crops	62.5	71	80	87	90	81.9	5119.4	Row crops: SR+CR: Poor
Impervious	9.76	98	98	98	98	98.0	956.5	Impervious Areas
Grassland	27.74	39	61	74	80	64.6	1792.7	Open Space: Good Condition
Sum	100					*CN*	78.7	

NRCS Watershed Lag Time of Concentration (Measured Flow Length)

L	*L*	*S*	*Y*	t_l	t_c	t_c
(mi)	(ft)	(in)	(%)	(h)	(h)	(min)
0.23	1214	2.709	4.24	0.19	0.313	18.8

Figure A.3: Curve number and time of concentration calculations for existing conditions.

```
TMM                          Sr. Design - Ecovillage

                                Jones County, Iowa

                          Hydrograph Peak/Peak Time Table

 Sub-Area         Peak Flow and Peak Time (hr) by Rainfall Return Period
 or Reach          2-Yr       5-Yr      10-Yr      25-Yr      50-Yr     100-Yr
Identifier        (cfs)      (cfs)      (cfs)      (cfs)      (cfs)      (cfs)
             (hr)       (hr)       (hr)       (hr)       (hr)       (hr)
-----------------------------------------------------------------------------------
SUBAREAS
Site              48.27      99.49     131.79     181.37     225.08     272.02
           12.09      12.08      12.08      12.09      12.07      12.07


REACHES

OUTLET            48.27      99.49     131.79     181.37     225.08     272.02
```

Figure A.4: WinTR-55 peak flow, existing conditions.

NRCS Water Lag Method Using USGS StreamStats for Iowa										
StreamStats Basin Characteristics										
DRNAREA	BSLDEM10M		LC11CRPHAY	LC11DEV	LC11IMP		SSURGOA	SSURGOB	SSURGOC	SSURGOD
(mi^2)	(%)		(%)	(%)	(%)		(%)	(%)	(%)	(%)
0.0758	4.24		62.5	37.7	14.76		0	80.4	1.58	18
Approximate NRCS Weighted Curve Number										
		0	80.4	1.58	18	99.98				
Landuse	*Area (%)*	*CN-A*	*CN-B*	*CN-C*	*CN-D*	*CN*	*A*CN*	*Land Use/Land Cover*		
Crops	62.5	71	80	87	90	81.9	5119.4	Row crops: SR+CR: Poor		
Impervious	14.76	98	98	98	98	98.0	1446.5	Impervious Areas		
Grassland	22.74	39	61	74	80	64.6	1469.6	Open Space: Good Condition		
Sum	100					*CN*	80.4			
NRCS Watershed Lag Time of Concentration (Measured Flow Length)										
L	*L*	*S*	*Y*	t_l	t_c	t_c				
(mi)	(ft)	(in)	(%)	(h)	(h)	(min)				
0.23	1214	2.445	4.24	0.18	0.297	17.8				

Figure A.5: Curve number and time of concentration calculations for proposed conditions.

```
TMM                         Sr. Design - Ecovillage

                               Jones County, Iowa

                        Hydrograph Peak/Peak Time Table

 Sub-Area        Peak Flow and Peak Time (hr) by Rainfall Return Period
 or Reach         2-Yr       5-Yr      10-Yr      25-Yr      50-Yr     100-Yr
Identifier       (cfs)      (cfs)      (cfs)      (cfs)      (cfs)      (cfs)
            (hr)       (hr)       (hr)       (hr)       (hr)       (hr)
----------------------------------------------------------------------------------
SUBAREAS
Site             55.17     108.40     141.24     192.40     236.57     283.64
           12.09      12.09      12.07      12.07      12.08      12.07


REACHES

OUTLET           55.17     108.40     141.24     192.40     236.57     283.64
```

Figure A.6: WinTR-55 peak flow, proposed conditions.

Storm Event	**Natural Condition Peak Flow [cfs]**	**Post-Developed Peak Flow [cfs]**	**Increase over Natural Conditions [%]**
2-year	48.27	55.17	14%
5-year	99.49	108.4	9%
10-year	131.79	141.24	7%
25-year	181.37	192.40	6%
50-year	225.08	236.57	5%
100-year	272.02	283.64	4%

Table A.7: WinTR-55 peak flow, development increase.

Figure A.8: StreamStats Report

Figure A.9: Volume Dashboard output from Civil3D grading surface.

Appendix B. Design Specification, Standards, and Guidelines

Iowa Statewide Urban Design and Specifications. (2023). Design Manual. Iowa Statewide Urban Design and Specifications

Gordian. (2019). 2019 Square Foot Costs with RSMeans data. RSMeans.

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DeBoer Tree Farm. (2024). Pricing Guide. DeBoer Tree Farm

Walmart. (2024). 8 in Boxwood Wintergreen Live Shrub with Full Sun-1 Piece. Walmart

Walmart. (2024). Van Zyverden Hosta Olive Bailey Langdon Bare Plant Root Full Shade Multi-Color. Walmart

Central Valley Flood Protection Board. (n.d.). EIS Attachment: Well Drilling Costs. Central Valley Flood Protection Board

Indiana Department of Health. (2024). Recommended Standards For Private Water Wells. Indiana Department of Health

Giant Industrial Supply. (2021). 5 in. x 20 ft. Schedule 40 PVC-DWV Plain End Pipe. Giant Industrial Supply

IIHR—Hydroscience & Engineering. (2024). Home - GeoSam. IIHR—Hydroscience & Engineering

Prices From	To	Rounded to Nearest
$0.01	$5.00	$0.01
5.01	20.00	0.05
20.01	100.00	1.00
100.01	1,000.00	5.00
1,000.01	10,000.00	25.00
10,000.01	50,000.00	100.00
50,000.01	Up	500.00

Figure B.1: RSMeans rounding standards.