THE UNIVERSITY OF IOWA
IOWA INITIATIVE
FOR SUSTAINABLE COMMUNITIES

FINAL DELIVERABLE

Title	Bellevue Residential Site Development
Completed By	Keya Xu, Qichen Wang, Kalley Matzen, Christian Norena
Date Completed	December 2019
UI Department	Department of Civil & Environmental Engineering
Course Name	CEE:4850:0001 Project Design & Management
Instructor	Richard Fosse
Community Partners	City of Bellevue, Jackson County Economic Alliance

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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Land Development

For Bellevue, Iowa

INNOVATIVE INFRASTRUCTURE

THE UNIVERSITY OF IOWA
College of Engineering

PREPARED BY
Innovative Infrastructure – Land Development Division

Keya Xu
Qichen Wang
Kalley Matzen
Christian Norena

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Section I: Executive Summary

The city of Bellevue has recently been experiencing an increase in need for housing development space and is quickly running out of lots available for development within the boundaries of the city. For this reason, the Jackson County Economic Alliance and Bellevue's Economic & Tourism Association inquired about nearby lots in order to expand the city. These organizations found and purchased Parcel 010829101020000 for land development purposes. An aerial view photo of the property can be viewed below in Figure 1. The land development plan consists of largely residential and a limited amount of commercial properties. The residential lots will consist of single family, multifamily, and universally designed residences.

Figure 1: Parcel for development is outlined in red

This 50-acre parcel is located parallel to HWY 52, south of Bellevue State Park Nelson Unit, north of Bellevue State Park Dyas Unit Campground, and west of the Mississippi River in Bellevue, Iowa. The parcel of land is surrounded by beautiful scenery on all sides. To the east of property, located only short distance away, is the Mississippi River. On all remaining side of the property are stunning bluffs covered in tree foliage. These features allow for beautiful views no matter which direction a person is facing. Currently, the parcel is used for agricultural purposes but provides for an optimal location for this development in the upcoming years.

While the land and topography are ideal for land development, there are more technical issues to consider. Currently, the city's water and sanitary sewer system stops short of the site. Extending the water and wastewater system can be quite costly causing the remaining portions of the project to be restrained to a stricter budget. An example of this is implementing the construction of the design in phases. Phases are generally a more expensive option in the long run but are a good option for projects that are cost constrained. This allows for the clients to save and earn money before taking on more investments into the project.

When the land was originally obtained it was to be designated for industrial use. For that reason, along with known Native American presence, the organizations commissioned an archaeological company to investigate the land. The investigation found two artifacts believed to have been part of a Late Woodland home which is enough information to have it registered with National Regulation of Historical Sites. The archaeological company suggested that no development happen within 100 feet. The final design is aimed at avoiding disturbing this area. Although the design is set to not disturb this area, Innovative Infrastructure would like to express that while

construction of the site is occurring, if more prevalent artifacts are found, it could stall and greatly delay the construction of the project – due to the need for archeologists to come in and do a more extensive study of the area.

The demographics of the community of Bellevue are reflective of the rural areas of the state of Iowa. The majority of the community identifies as Caucasian and the average age of the population is around 45. Because the population is aging, the city expansion project will provide sufficient housing options for the seniors who wish to maintain their independence without needing to maintain a large home. The city expansion project will also aim to create an environment appealing to young adults and families so that they will wish to move there and develop roots within the community; not only bettering their own lives, but the lives of others around the community. Because Bellevue is located only 30 minutes south of Dubuque, the city expansion project is hoping to attract commuters to the area as well.

All previous factors were taken into consideration when considering the design of the land development portion of the city expansion project. All elements relevant to the design and needs of the client were taken into consideration, and two design options were presented to the client. In both designs our recommendation was to place the multifamily units, which will likely be several floors high, closest to the HWY 52. Because the property lies close to the Mississippi River, the high stories of buildings may be able to capitalize on the views of the river, whereas if single family units were in this area, they would likely not rise high enough to be able to see over the foliage in the surrounding properties. The single family units were placed further back within the parcel to capitalize on the bluffs surrounding the property. If the multifamily buildings with three or four stories were to be placed further back in the lot, they would likely restrict the view of the bluffs for other housing options.

In the design, we envision multifamily buildings with space for either apartments or condos on the upper stories and the lowest floor would provide the opportunity for commercial space. The commercial space in both developments was designed to be limited because we do not wish to take away from the current revitalization of the historic downtown in Bellevue. Our vision for the commercial space in the land development includes the following: a gym, small convivence store, and space for a physical therapy office. Another possible option for the parcel would be to include a daycare facility to accommodate the younger families who will reside within the property.

On October 22nd, 2019 two options were presented to our clients and members of the Bellevue Housing Task Force. Alternative 1 can be seen in Figure 2 on the right. This option contained a higher amount of dwelling units overall with a total count of 320, but it contained a high number of apartment and commercial units. During the phasing of the project it would provide availability of all lot types. Alternative 2 can be viewed in Figure 3 on the following page. This lot contained fewer dwelling units than alternative 1, but did consist of more single family

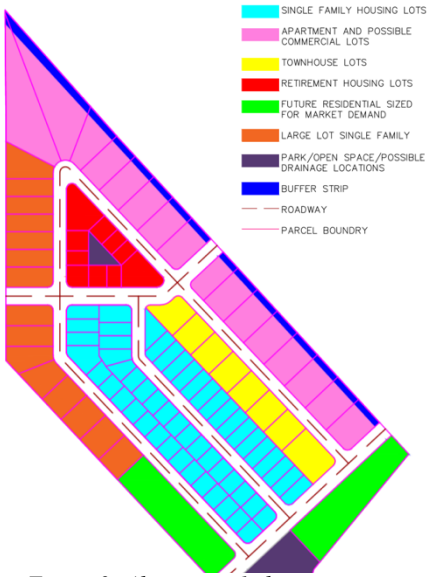

Figure 2: Alternative 1 shown to clients on 10/22/19

homes, rather than apartment complexes. It also contained much fewer large family lots, than with the prior alternative. This site also contained several cul-de-sacs within the property.

The clients chose to do a combination of the two presented alternatives. The street alignment of Alternative 1 was kept, a larger park was added to the middle of the lot, and lot definitions were altered within the street alignment. Additionally, another space for storm water was added at the top portion of the parcel. This allowed for a much better use of space at northernmost portion of the parcel. The final layout of the parcel for the project can be seen on the next page in Figure 4.

Figure 3: Alternative 2 shown to clients on 10/22/19

After working with our clients, we felt this was what they had described and provided the most opportunity for growth within the community and the city expansion project. The lot comprises of a high number of single family lots, both smaller sized lots and larger lots. This provides ample space for the community and families to grow. The universally designed housing provides options for independent senior living and the possibility of daycare. The multifamily housing provides cheaper housing options for those who cannot afford a single family home. The design of the parcel is inclusive and should be able to provide housing options to all people to be included in the Bellevue community.

This parcel contains two arterial roads with 80 feet of right of ways and local streets with 60 feet of right of ways. The appropriate water main and sewer line extensions are located throughout the property. Both water and sanitary sewer lines were designed to have 8 inch pipes. Offsite improvements were also included, these include the water main, sanitary sewer, and trail extensions. The utilities for the extensions been sized to 18 inches for both the water main and sanitary sewer by keeping the surrounding properties in mind with respect to whether or not they would be developed in the future or the properties across the highway would like to join the city's water service. Together, these designs combine to create one cohesive parcel with the Stormwater Division of Innovative Infrastructure.

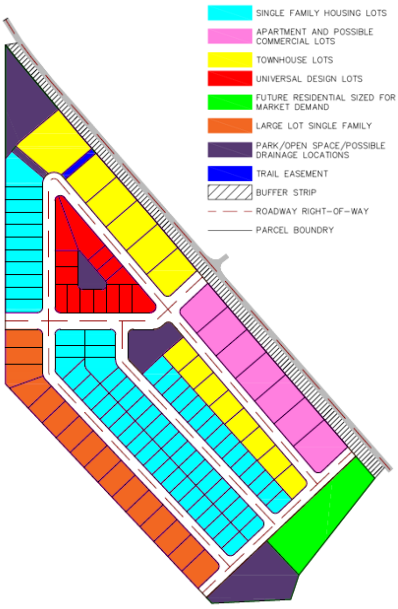

Figure 4: The final parcel layout

With the conclusion of our design, we have included our final report, presentation, poster, and a set of construction drawings. Overall, the estimated total construction costs for the city expansion project are $4,981,00. This includes the design for all specifications listed. This results in the price per square foot being about $3.40. The prices for each lot ranges from $24,000 for the single family lots to the $101,000 for the multifamily lots. Here at Innovative Infrastructure, we are proud to have designed the city expansion project and to have been able to provide the client with something they and their community will be able to enjoy for many years and many generations to come.

Section II: Organization Qualifications and Experience

Organization Information:

Innovative Infrastructure – Land Development Division
University of Iowa – Civil and Environmental Engineering – Iowa City, Iowa

Project Manager: Kalley Matzen
Email: kalley-matzen@uiowa.edu
Phone: 641-420-1100

Team Members:

All team members are seniors enrolled in the civil and environmental engineering program at the University of Iowa and the senior capstone design class. The senior engineering capstone class allows the students at the University of Iowa to implement the knowledge they have gained over the past four years and create purposeful solutions for various communities around Iowa. Our team, the Land Development Division within Innovative Infrastructure, is diverse. We have students from diverse backgrounds and various disciplines within the civil engineering department itself. A breakdown of our team members and a brief introduction to each is provided below. A more in-depth breakdown of each member's specialties and credentials can be found in the Appendix.

Kalley Matzen:

Kalley is the project manager of the Innovative Infrastructure – Land Development Division and an environmental engineering student. Because Kalley is the project manager, she led the team, ensured organization throughout the project (within our division and also with the stormwater division), led the team on the offsite improvement designs, and also managed the report, poster, and presentation design.

Kalley is from a small town in Iowa called Manly and graduated in 2015 from Central Springs High School. For the past two years, Kalley has been employed under University of Iowa faculty member, Dr. Craig Just, and has been working in his research lab focusing on drinking water in developing nations. In previous classes she has also designed prototype phytoremediation systems for wastewater treatment in small communities. Phytoremediation consists of the use of plants to remove harmful constituents from the soil or water.

Christian Norena:

Christian is the text editor for the Land Development Division. He has worked together with Keya to ensure graphics and text are correct and are able to represent data well. Christian led the design of the site layout for this project as well as the drawings.

Christian is majoring in civil engineering with a minor in business administration. He has had an internship with the City of Cedar Rapids where he became familiar with construction in Iowa and the standards that should be followed. Christian also had an internship with SmithGroup, an architecture and engineering firm, where he was able to learn the process in which plans are

created and all the items that are included in construction documents. Along with internship experience, he has had class experience with road design, specifically connecting a secondary road to a highway while following Iowa DOT standards. He also created a drainage plan for a parking lot in Civil 3D.

Qichen Wang:

Qichen is the technology support of the Land Development Division and a civil engineering student. His responsibilities included creating and maintaining an online storage for all documents used and produced by the team and was the go-to person for all computer and other technology needed for execution of the project. Qichen also led the design of the roads and utilities within the property.

Qichen is a civil engineering major, and his main focus area within civil engineering is structures. He has experience with analysis of road performance and with the use of fiber mechanisms for corn stalk fiber asphalt mixture. He has also studied topology and wind tower optimization.

Keya Xu:

Keya is the graphic editor of the Land Development Division within the Innovative Infrastructure – Land Development Division and is a civil engineering major. Her responsibility was to coordinate and prepare all the graphics in reports and discuss editing decision with text editor Christian. She and Christian will present the final editing decision to all the team members and eventually determine the most appropriate format and style of the report. Keya led the design of the pavement thickness and the selection of construction material. Keya also assisted the

For the past two years, Keya has taken several important structural courses at the University of Iowa. During this time, she has gained knowledge of the basic concept of construction and is planning to go to graduate school to further her studies of structural engineering.

Section III: Design Services

Project Scope

The Project consists of the following scope of services:

1. Engineering design services:
    a) Develop two site plan options.
    b) After the client's selection the following were produced:
        - Final site layout
        - Roadway design
        - Site sanitary sewer & water main plan
        - Site detail sheet
    b) Site grading, erosion control plan, and stormwater management were designed by the Stormwater Division of Innovative Infrastructure and seamlessly integrated into the development plan.
    c) Submit final plans to City for review and approval.
    d) Attend any necessary meetings with Client and City to review concepts.
    e) Email clients regularly with updates.

f) Develop a design report and construction plans for above mentioned items per City of Bellevue's standards and requirements.
g) Determine requirements for archaeological data
h) Provide recommendations for future developments – including basic trail route and utility extensions

The scope of services DOES NOT include:

1. Construction staking
2. Easement plats
3. Specifications
4. Bid documents
5. Environmental data
6. Land Surveying

Work Plan

Every successful engineering project must begin with a good plan. In order to complete a successful project, the Land Development Division implemented the use of a Gantt chart to keep from falling behind in the tasks that were necessary for a completed project. The Gantt chart used can be seen below in Figure 5. Figure 5 describes the Gantt data in numerical and visual form. Each task has the person who was responsible for it included as well as the dates that it was worked on.

Land Development: Bellevue, Iowa

TASK NAME	START DATE	END DATE	START ON DAY	DURATION (WORK DAYS)	PROJECT LEAD	PERCENT COMPLETE
Client Contact						
Contact Client	8/26	8/30	0	5	Kalley	100%
Phone Call with Client	8/30	9/3	4	5	Kalley	100%
Site Visit	9/3	9/10	8	8	Kalley	100%
Powerpoint with client alternatives	10/9	10/21	44	13	All	100%
Present Design Alternatives to Clients	10/22	10/22	57	1	All	100%
Preliminary Proposal Report and Presentation						
Initial Three Design Options	9/7	9/13	12	7	Kalley	100%
Societal Impacts	9/7	9/13	12	7	Keya & Qichen	100%
Challenges	9/7	9/13	12	7	Christian	100%
Draft of Designs						
Draft of Report	10/14	11/22	49	40	Kalley	100%
Update Report with Final Drawing, Design Information, & Cost E	10/14	11/22	49	40	Kalley	100%
Cost Estimate	11/17	11/22	83	6		100%
Draft of Project Drawing Set	9/14	11/22	19	70	Christian	100%
Layout	9/20	11/22	25	64	Christian	100%
Road Cross Section	10/22	11/22	57	32	Keya	100%
Offsite Improvemnents	10/22	11/22	57	32	Kalley	100%
Sanitary Sewer & Water Main	10/30	11/22	65	24	Qichen	100%
Notes Pages	10/30	11/22	65	24	Christian	100%
Title Sheet	11/3	11/22	69	20	Christian	100%
Draft of Presentation	9/20	11/22	25	64	Kalley	100%
Include All Important Information Based on Design	10/31	11/22	66	23	All	100%
Draft of Poster	9/20	11/22	25	64	Kalley	100%
Include Important Information to Understand Project	10/31	11/22	66	23	Kalley	100%
Final Designs						
Final Presentation	11/23	12/2	89	10	Qichen	100%
Updates from Draft	11/23	12/2	89	10	All	100%
Client Presentation	11/23	12/9	89	17	Keya	100%
Present To Clients in Bellevue - 12/9 & 4:30	12/2	12/9	98	8	All	100%
Final Project Drawing Set	11/23	12/13	89	21	Christian	100%
Update any flaws from draft of drawings	11/23	12/13	89	21	All	100%
Final Poster	11/23	12/13	89	21	Kalley	100%
Update any flaws from draft of the poster	11/23	12/13	89	21	All	100%
Final Report	11/23	12/13	89	21	Kalley	100%
Update any flaws from draft of report	11/23	12/13	89	21	All	100%

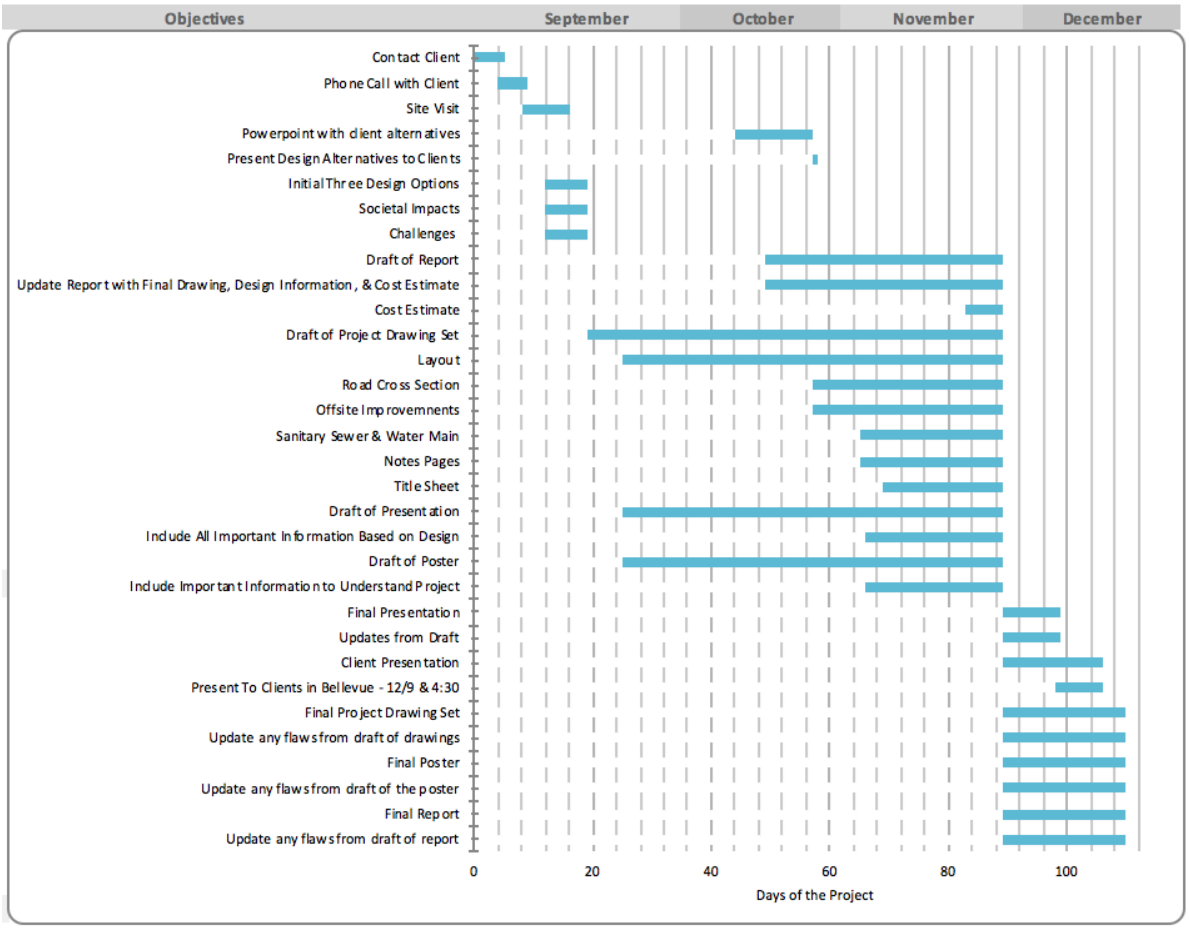

Figure 5: Gantt chart displaying important tasks, who was responsible for them, and the important dates in which they needed to be completed

Section IV: Constraints, Challenges, and Impacts

Constraints

All projects come with their own set of unique constraints. When working with the land development of a parcel in Bellevue, some extra precaution was taken due to the possibility of Native American presence. The eastern areas of Iowa near the Mississippi are well known for having been home to many Native Americans in the past thousands of years. The evidence of this can clearly be seen in landmarks such as the Effigy Mounds, which are just a short drive north of Bellevue. The Effigy Mounds are a National Monument of the United States where the Native Americans who called that area home buried one or more of their deceased in mounds in the shape of animals. Because of the presence of Native Americans is so well known in that area, the community organizers had sought out an archaeology report.

According to the archaeology report completed by Wapsi Valley Archaeology, Inc., three archaeological sites were identified. One of these three sites located in the north eastern portion of the parcel, referred to 13JK332 in the archaeology report, was found to contain two prehistoric

features that were interpreted as the remains of a Late Woodland house. These findings are considered significant and eligible for the National Register of Historic Places. The Archaeology, Inc. recommended avoidance for a 100-foot buffer area around this site. The recommended buffer can be viewed in Figure 12 in the Appendix portion of the report. The Wapsi Valley Archaeology recommended that the land not be constructed on. However, it is not required by law or regulation to avoid this area. (Part 6: The National Register of Historic Places, n.d.). Because of there is not a law regulating this, our site layout includes construction in this area. The Land Development Division would, however, like to caution our clients to be aware of this potential issue. If more significant artifacts are come across during construction, the project could be halted or stalled for an undetermined time. A further archaeological study would likely be necessary before construction could be continued.

Time and scope are also significant constraints to consider when designing projects. The clients have requested that the project be designed to be developed over 10 – 20 years. Thus, the phases were designed to fit this scope with the big picture kept in mind. While there was no defined time frame for this project, Innovative Infrastructure aimed to create designs that are feasible and seamless to implement. This should ensure ease for the client and a reduction in total project construction time.

Challenges

As with most projects, there is a budget that must be taken into consideration and abided to. The design of the land development has taken phasing into consideration. Because Bellevue has already invested a large sum of money into the project and is expected to invest a significant amount of money to extend sewer and water lines to the property, phases were designed to be the best choice to implement the project. Phasing helps keep the immediate cost to the client lower. The chosen phases are described in more detail within the final design portion of the report.

The land has been utilized for agricultural purposes for all recent history, so a possible challenge that could arise for construction is the presence of drainage tiles on the property. These drainage tiles can alter the path of water flow which can cause problems if the location of the drainage tiles is not known. If drainage tiles are present, it could potentially cause a delay in construction due to having an unknown factor pop up that was not originally accounted for.

When considering a development near a water feature, one must always consult FEMA (Federal Emergency Management Agency) maps. The parcel itself is located outside of FEMA's 2010 100 and 500 year floodplain maps. However, the floodplains defined in FEMA's maps are close to the property. This generally means there is a limited risk of flooding, but the area is not immune to flooding. With climate change accelerating changes in weather patterns, a close eye should be kept on the parcel to ensure that when the FEMA maps do update, the floodplain does not cross into an essential part of the parcel. Currently, however, avoiding the floodplain should not be an issue. In the future this may change, and the design will take this into consideration. The current FEMA 2010 map can be seen in the Appendix as Figure 13.

Another challenge with the property is planning for future development in surrounding areas. The land to the west of the property is currently used for agricultural purposes, but the owner has expressed some interest in selling the land eventually. Because there is potential for development

in the property to the west, considerations must be made to allow for accessibility to the land if it is developed in the future. This includes designing for connecting road access as well as water and wastewater line accessibility.

A unique challenge to this project in particular is the presence of a small cabin to the west of the property. In the finished design for the parcel, access to the cabin for the owner does continue, so the owner will be able to reach it. The cabin owner will have access through the southernmost road in the final design. During the phasing process, the owner will continue to have access as is established currently.

While designing the route for the bike trail connecting from the existing bike path, down to the parcel of land in the city expansion project, a few challenges arose. The only feasible route for the bike path is to follow along the west side of Highway 52. The first known challenge is that the current owner of the land that is needed for the route is the State Park of Bellevue. While the trail is designed for recreational purposes, there may be regulations or permits that need to be obtained in order to alter the land that is within the State Park of Bellevue. We recommend to our clients that they start this process soon in order to ensure that there are no future issues or time constraints due to regulations or permits. There are also varying distances of the right of way according to Beacon for properties along the route. When the trail does into further design, a surveying crew should ensure these property distances so the proper easements can be obtained, if necessary. Once the property rights are known, the trail can be properly designed.

Another challenge for the offsite trail design is the steep bluff next to the route by the State Park of Bellevue. This bluff does not allow for much room for the trail. This area may require retaining walls to be built in order comply with regulations involving allowable slopes and clearances on either side of the trail. This could add additional costs to the construction of the trail. When the trail gets taken further into the design phase, this should be taken into consideration.

Annexation of the city into non-connecting properties is another potential challenge we would like to ensure that the client is aware of. Annexation requires approval from the state of Iowa, and recently the state has not been very approving of extending city lines to properties which do not connect with existing city lines. Beginning this process early will help the client ensure that their project will be able to be completed.

The final challenges include the extension of the sanitary sewer lines. During the construction of the sanitary sewer extension, access to the wastewater treatment plant must be maintained. Currently, there is only one road allowing access to the property. The sewer lines have been designed to follow along this road, so the road will be out of service. This wastewater treatment plant is on the lower side of a bluff and on the opposite of the railroad tracks. Because of this it is difficult to maintain access. We suggest that a temporary rudimentary road be built to maintain access to the plant. This may involve clearing trees and an easement from the railroad company or a temporary creek crossing to the north of the wastewater treatment plant. As the extension of the sanitary sewer lines goes further into the design phase, the access for the road should be designed as well. Because the sanitary sewer must cross the railroad tracks in order to reach the property, boring under the tracks will be likely. This can be costly and will require easements

from the railroad company. It is recommended that our clients being the easement process early to ensure access from the railroad company. Additionally, our recommended route for the sanitary sewer passes a cemetery. Cautions must be taken during construction and during the design phase so that the construction does not disturb this area.

Societal Impact within the Community and State of Iowa

The population in Bellevue was 2,191 at the time of the 2010 census and the communities need for housing is increasing. Currently the city is developing about 10 lots per year. However, there are only about 20 lots left, leaving only about 2 years for development before they run out of lots. For this reason, the community looked into expanding their city limits. Bellevue currently is limited on the types of housing that are available. The community currently consists of 81% single family homes and has minimal multifamily housing options. These options are broken down in Table 1 below. One way to attract younger people and families would be to offer more rentable housing. Often young professionals do not have the finances set up to purchase a home and renting is their only option. Multifamily complexes are also optimal for the aging population of Bellevue. As people grow older, they tend to not wish to have as much house or lawn to maintain but do still wish to maintain their independence. An independent senior living facility would be a great option for those with that mentality. Apartments would also be suitable for seniors wishing to live independently.

Table 1: Housing Type within Bellevue

Bellevue		
Housing Type	Number	Percentage
Total	986	-
Single Family	802	81%
Multiple Unit & Apartment	64	6%
Mobile Home	74	8%
Condominium	42	4%
Townhouse	4	0%

It is also important to continue to offer diverse options of housing so that all people will be able to continue to have suitable housing options. In Jackson County, 45% of renters live below the poverty line. Therefore, they likely cannot afford to purchase a home making a rentable property their only option. Providing that option ensures community development and growth to be able to allow residents to afford housing and save for the future. The implementation of this project will provide many different housing options. Thus, hopefully satisfying the needs of the community. By providing options for lower income families, this should help lower income families find a place to call home.

Bellevue is located approximately 30 minutes south of Dubuque, Iowa. This short commute combined with reasonable housing prices allows for a significant number of residents to commute back and forth from Bellevue to Dubuque. A large portion of employees in Jackson County commute from somewhere outside of the county. Bellevue, along with Jackson County, has seen a slight decline in employment over the past 10 years, but long term it has been

relatively constant. Between 2000 and 2010, Jackson County's unemployment rate declined faster than the national average and has been closer to the State of Iowa rate. By providing housing within the city expansion project for Bellevue, it may encourage people to stay here and generate employment within the area. This could cause economic growth not only for the community but for the state of Iowa.

Bellevue is located along the Mississippi River and sees a significant amount of tourism. There is also a state park located in the bluffs near the city which attracts many people. The attractions within the city allow for a high amount of people to travel in and out of the city. By extending the biking trail, it will likely cause more attraction to the area. Providing economic benefits to the community and the state of Iowa.

Our proposed project has the possibility of extending its reach outside of the development. Because the water main and sanitary sewer will be extending south to the parcel, the properties in the rural development across Highway 52 will have the opportunity to connect to these lines if they so choose. Currently, these properties are all on private wells and septic tanks. Extending the water main and sanitary sewer to these properties could generate revenue for the city as a way to recuperate the costs of extending the lines. The residents of the properties in the rural subdivision would then not have to worry about unexpected expenses from septic tank failure, well problems, or water quality issues. The utilities extended to their homes would be under EPA guidelines and safer for the residents. The cost of extending water and sanitary utilities to these properties is not included in the detailed cost estimate later in the report.

Section V: Considered Alternative Solutions

Initial Design

In Innovative Infrastructure – Land Development Division's first design concepts we had ideas for alternatives but knew that there should be elements that remained consistent throughout the alternatives. The following describes several concepts we wanted to be available in all alternatives.

Placing the multifamily homes on the east portion of the lot, closest to the highway, is the recommended design layout no matter what the consistency of other properties is. The preference of the layout is due to the surrounding landscape and foliage. To the east of the property is the Mississippi River. From ground level, one is not able to see the river over the foliage on the lots to the east. Because multifamily homes are likely to be three or four stories high, the thought is that they may reach high enough to capitalize on the view of the river. However, if the buildings are not able to reach high enough to see over the foliage, there are still stunning views on the remaining sides of the property because it is surrounded by bluffs on the remaining sides. So, the multistory building would still be able to view those if the river view is not obtainable. Placing the multifamily building closest to the road will also allow for the remaining residential homes to be able to view the bluffs unrestrictedly. If the multistory buildings were to be placed on the west side of the lot, the views would most likely be blocked for all remaining homes.

In all design scenarios, we also envision a multifamily building with either apartments or condos on the upper stories and on the lowest floor providing room for commercial space. Our vision for the commercial space in the land development includes: a gym, a small convivence store, and a

physical therapy location to accommodate the aging population. The commercial space in all options of the developments will be limited because we do not wish to take business away from the current revitalization of the historic downtown in Bellevue.

Secondary Design

As we progressed through the design process, it quickly became clear, that only two design options were logical options. The basis for these designs are based on what the single family and multifamily options consisted of – such as townhouses and apartments for multifamily and large and small lots for single family. Focusing on these allowed for a more complete layout.

In both options the arterial streets had a 80' right of way and local streets had a 60' right of way. Both options also contained space in the southernmost corner to allow room for the Stormwater Division's stormwater management design. The options also contained a similar design for the independent senior living area. Because of the triangular shape at the top of the parcel, a triangle was created in the middle of the top portion of parcel. This area is the location for the independent senior living for both options. Placed in the middle of these units is a greenspace for a park, garden, or something similar. Another common feature is the future development space. No lot type was designed in this region. This was to allow the clients to be able to choose in the future which type of lot has the highest demand.

Secondary Site Layout Design Option 1:

The first parcel design option presented to the clients consisted of two arterial roads connecting to Highway 52 and extending through the parcel towards the future development plots and also allowing for access to the neighbor's cabin through the southernmost road. The local streets consisted of three roads running parallel with Highway 52. Inside the parcel, it was heavily aimed towards apartment and commercial space. The entirety of the properties closest to Highway 52 were all defined as apartment and commercial space. Most of the space towards the west side of the parcel was sized for large family lots. In the center portion of the lot, it consisted mainly of single family and a row of townhouses. In total, there were 320 dwelling units available for this parcel configuration. An image of this site layout can be seen to the right in Figure 6.

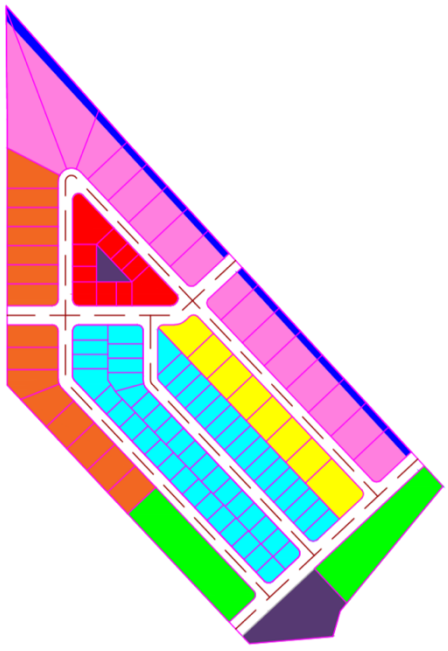

Figure 6: Alternative 1 presented to client on 10/22/19

Secondary Site Layout Design Option 2:

The second parcel layout that was developed differed from the first alternative. This parcel contained several cul-de-sacs and had a different street layout. At the northernmost portion of the parcel, a cul-de-sac was positioned there to allow to access to the northern point. Cul-de-sacs were also positioned in the southern portion and along the western portion. The internal street structure also varied, due to there being another road running east and west. This time the road was a local road and not an arterial road. The amount of large lots in this option greatly diminished and single family lots increased. The land paralleling Highway 52 consisted fairly evenly between townhouses and apartment and commercial space. In total, this parcel design allowed for 275 dwelling units. This can be seen in better detail in Figure 7 to the right.

Figure 7: Alternative 2 presented to client on 10/22/19

Offsite Improvements - Trail, Water Main, and Sanitary Sewer Extensions

Two options were presented to the clients for bike trail and water main and sanitary sewer extensions. The first option was to have the bike trail continue along the west side of Highway 52 until it reached the appropriate location to enter the parcel and head to a park. The water main follow along the road leading out from the wastewater treatment plant and cross the highway there and continue underneath the trail route until it reached the parcel. The sanitary sewer line would continue along with this route – maintaining its required distance from the water main.

The second option was to have the trail cross Highway 52 when able to – there were restraints due to the bluffs – and run the trail on the Eastern portion of Highway 52 until it reached the location to enter the parcel and head to a park within the parcel. The water lines would follow along the road leaving the wastewater treatment plant and follow along the trail route until they all needed to cross the highway. The purpose of this route would be to take advantage of the wasted space between the ditch of Highway 52 and the railroad that runs along the highway.

Street and Sidewalk Widths

Local streets and sidewalks are allowed some variation within what size they are allowed to be. For a local street, the width of the street could either be 26’ or 28’. The sidewalk could either be 4’ or 5’. One benefit of having a larger local road is, that they will have more room for street parking. It is also easier to change your design decision from 28’ to 26’ if it were to be chosen later on, than to go from 26’ to 28’. The benefit of a 5’ sidewalk vs a 4’ sidewalk is that if two wheelchairs were to meet on the sidewalk, they could both continue without one having to wait in a driveway for the other to pass. It also allows for more comfortability and family friendly activities, such as pushing a stroller, while utilizing the sidewalk. These alternatives were presented to the clients for their decision.

Section VI: Final Design Results

Final Site Layout Design

After the presentation to the clients on October 22nd, 2019, a site plan layout was developed that implemented a combination of the two previous site plans. It maintained the roadways of Alternative 1 because it did not include cul-de-sacs, which can make it difficult for snowplows to clear the roads. It also changed some of the potential zoning, since clients was expressed that large lot single family is preferred and that more single family lots should be included in the first phase because of the current demand for ten lots a year. The final design layout includes 250 dwelling in total.

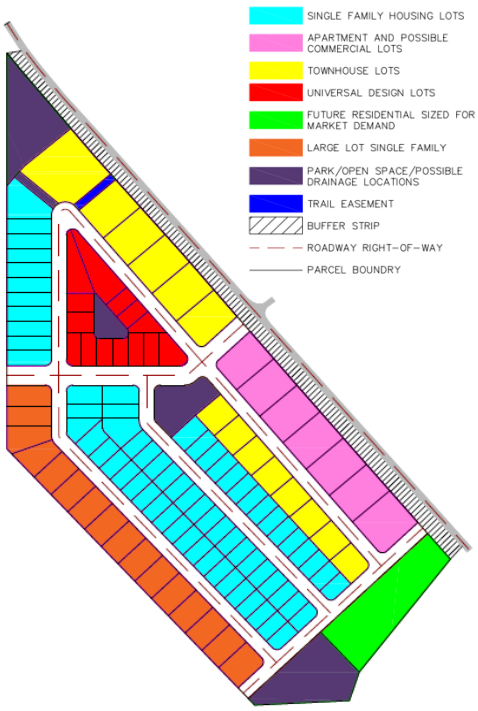

Figure 8: Final site layout design

When completing the design, it was expressed that there should be a minimum of width of 80 ft for single family lots instead of a width of 60 ft, since the zoning ordinance is being updated. However, the client expressed interest in the 60 ft wide lots believing it would allow for more affordable lots and therefore, staying competitive within the market. This could help sell more lots and provide a more diverse community. This site is designed for lots with a width of 60 ft, but this can be altered easily in the future to be 80 ft or a combination of the two. There are also multiple large single family lots available towards the west side of the development on the right in Figure 8. These lots have a width of 80 ft and are deeper lots.

The north east corner is now townhouses instead of apartment buildings, and the north west lots are now regular-sized single family instead of large lot single family. The south corner is now the only area listed for future residential now because the large lots were extended down to take up the entire length of the west side. While this southern portion is the only portion marked as undefined for future development, any portion can be changed if it is not included within the first phase of the design.

The middle section of the northern portion of the lot is designated for universally designed buildings. A universally designed building is designed to be ADA (Americans with Disabilities Act) compliant. This includes design structures such as having a doorknob as a lever and not knob. Our vision for this area is to provide space for independent senior living as well as a space for a potential daycare. We feel these would both fill the needs of the community. As the population is aging, the seniors would have a place to live as well as the younger millennial generation with young children would be provide with a place to take their children that would be very close to home.

There a few things that appeared in this layout that were not in the alternatives presented to the clients. The most immediate is the portion in the northern corner of the lot. This has been changed to house a stormwater structure. As the stormwater division further developed their design it became apparent that they required more area. This location was chosen as an appropriate location for the structure. Because this structure was added to this area, an access

road is needed to be able to access the structure for maintenance, so a small strip was taken to allow for vehicle access to the region. Another addition is the easement near the previously mentioned stormwater structure. This easement is for an additional trail entrance into the property. This does two things: the first being it allows the people who reside in the northern portion of the property to not need to back track in order to access the trail. It also allows access for the utility extensions to enter the property.

Offsite Improvements –Trail, Water Main, and Sanitary Sewer Extensions

The offsite improvements include a very basic design for the water main, sanitary sewer, and bike trail extension. These elements are not designed further due because they are outside of our scope of services and because of their importance to community's health we recommend more experienced professionals should fully design these. However, a basic route and pipe size has been determined for each. In Figure 8 below, an aerial photo the proposed routes can be viewed.

The water main is assumed to extend south from the current city limits from the bridge due to there not being any water lines extended across the bridge. Further design should ensure the actual location of the current water main in order to extend it. Calculations based on the recommendations by SUDAS (Sections 4B-1and 4C-1) allowed for the sizing of the pipes. The offsite portion of the water main diameters are based on the current estimate of the parcel, existing rural subdivision, and potential future subdivision's population size.

The same occurs as well for the sanitary sewer lines. They are sized based on our current knowledge of the area's population, but it is subject to change as more knowledge is obtained. The sanitary sewer lines will be extended from the current wastewater treatment plant. This is located south of town, but north of the parcel. Based on our current knowledge of the land elevation, the sanitary sewer is designed to be able to operate without a lift station. We believe it is possible to do without a lift station, but more information is needed. A full land survey completed by a surveying team would provide much more accurate data than the LIDAR data used for our design. The sanitary sewer lines will also cross railroad tracks. Easements are necessary to be obtained and horizontal boring will likely need to occur to be able to design the pipes to run underneath the tracks.

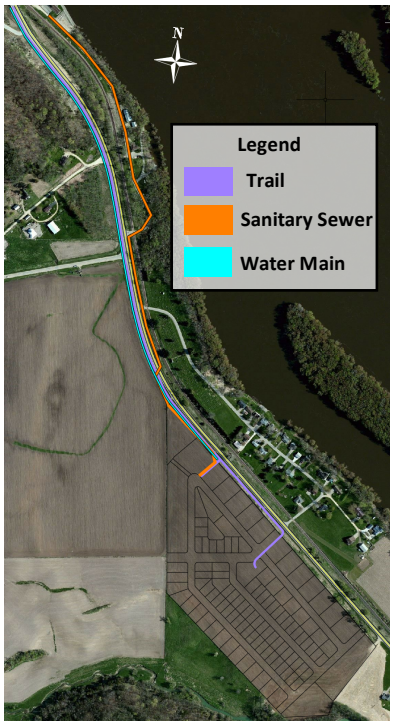

Figure 9: Aerial view of the offsite improvements. Note: pipe diameters have been exaggerated for visibility

It is recommended that the water main and sanitary sewer lines be put in place approximately a year before the trail is constructed to allow the ground to settle. Thus, preventing damage to the trail and the ground shifts. After the ground has settled, the trail system can be put into place. It is designed to be constructed out of PCC, be 10 ft wide and 6 in thick, as well as have two feet of clear zones on either side of the trail. Near the beginning of the extension is a large bluff. This could require the use of retaining walls along this portion.

Road Design

The roads within the parcel are designed to specifications based on Iowa Statewide Urban Design and Specifications (SUDAS) Design Manual Chapter 5 (Iowa, 2019) Roadway Design. A step-by-step process for determining the approximate mixture criteria was utilized in selecting the criteria for the pavement mixture that will best satisfy the project demands and limitations. Current equivalent single axle load (ESAL) and estimated cumulative ESALs over a 20 -year period and the regional climate conditions were the primary consideration. Current annual average daily traffic (AADT), percent of trucks utilizing the roads, and percent of annual population growth rate were selected based on the location of project on Iowa DOT database. ESAL analysis as shown in Table 5 in Appendix. Estimated cumulative ESALs over a 20 -year period and current AADT provide the options for the selection of asphalt pavement mixture in Table 6 in the Appendix.

The selected HMA mixture design level of the road is ≤ 0.3M. The normal soil in Iowa has in situ Californian Bearing Ratio (CBR) value of 1 to 3. In order to attain a soil strength of CBR of 3, a subgrade of at least 12 inches of mechanically compacted soil with a minimum of 95% accuracy should be used. Standard proctor policy density was necessary. The Iowa DOT uses a MR value of 3000 to 3500. The value is reasonably close to the value used in this section for a CBR of 3 when adjusted for seasonal variations. The flexible pavement thicknesses of local and arterial street are shown in Tables 7 and 8 in Appendix.

The right-of-way for the local street was designed to be 60 ft and 80 ft for the arterial street. This allows for wider streets to handle to higher use for the arterial streets. The local streets are sized to allow for street parking on both sides of the road. 5 feet sidewalks are also designed to be placed within this right of way. There is also space for a car to be parked in between the sidewalk and the street.

Utilities designed with this project include sanitary sewer, storm sewer and water main utilities. These must be aligned properly with the street to ensure no crossing or issues if the utilities were to fail. The cross section of the layout for the street profile can be seen below in Figures 10 and 11.

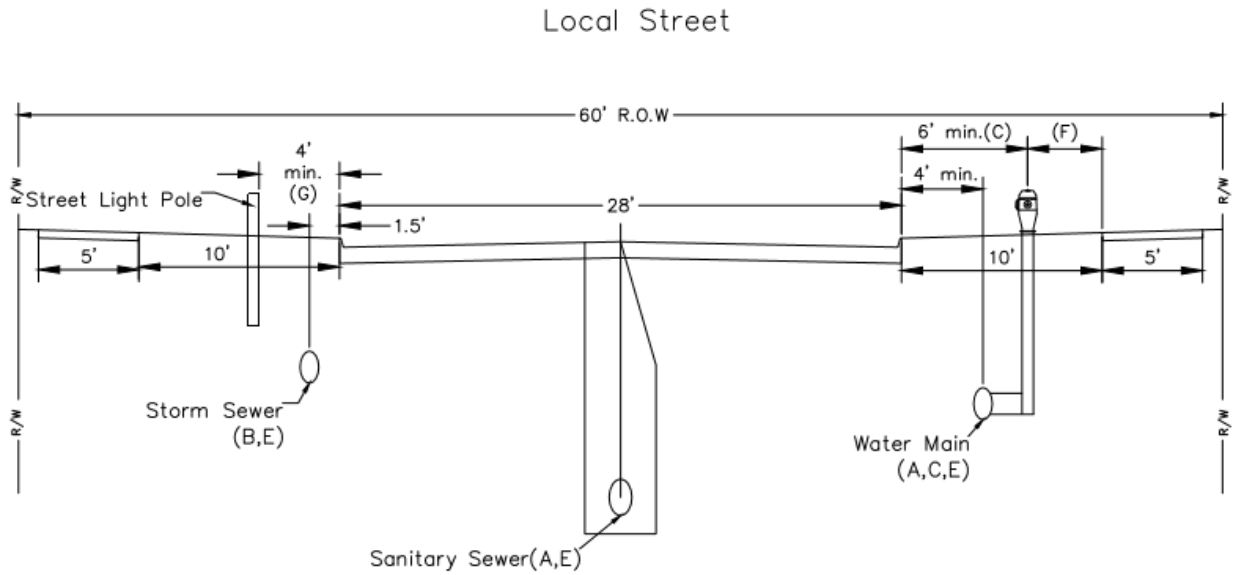

Figure 10: Urban Utility Location in Local Street

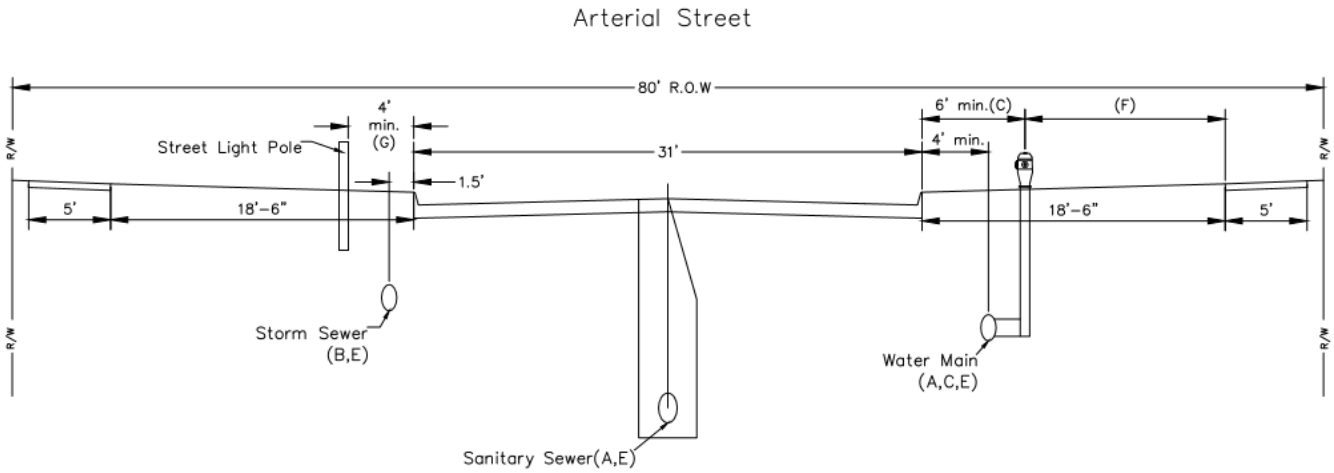

Figure 11: Urban utility location in arterial street

Water Main and Sanitary Sewer Design

The diameter of the sanitary Sewer was sized to be 8-inches of PVC. The sanitary Sewer system is gravity driven. This reduces costs and also prevents the possibility of pressurized sewage spilling out of the pipes if an issue were to occur. The sanitary sewer was designed to be deep enough to serve basements and with a minimum slope of 0.4%. They should be at least 8 ft below the ground surface while still being able to service basements. This prevents them from being frozen in the freeze-thaw cycle of the soil. Therefore, the starting station of each sanitary sewer has 8ft depth. Horizontal separation of gravity sewers from water mains shall be 10 feet and the top of a sewer main is at least 18 inches below the bottom of the water main. This information was referred from the Iowa SUDAS Design Manual Chapter 3 Sanitary and Sewer.

The water mains will be constructed out of 8-inch PVC within the parcel. This system is pressurized and follows the slopes of the road. Fire Hydrants within the parcel are placed at the high and low points of each street. Another fire hydrant is added if the distance between low point fire hydrant and high point fire hydrant exceed 400 feet. A 200-psi valve is installed at every intersection. More detailed information about valves can be referred from the Iowa SUDAS Design Manual Chapter 4 Water Mains.

Phasing

The site has also had phasing designed. This will allow for the project to be completed in a cost effective manner. The phasing outline can be seen to the right in Figure 12. Each phase provides various housing options. Allowing for options for people who are looking to build and buy homes. The phasing should meet the needs of the community.

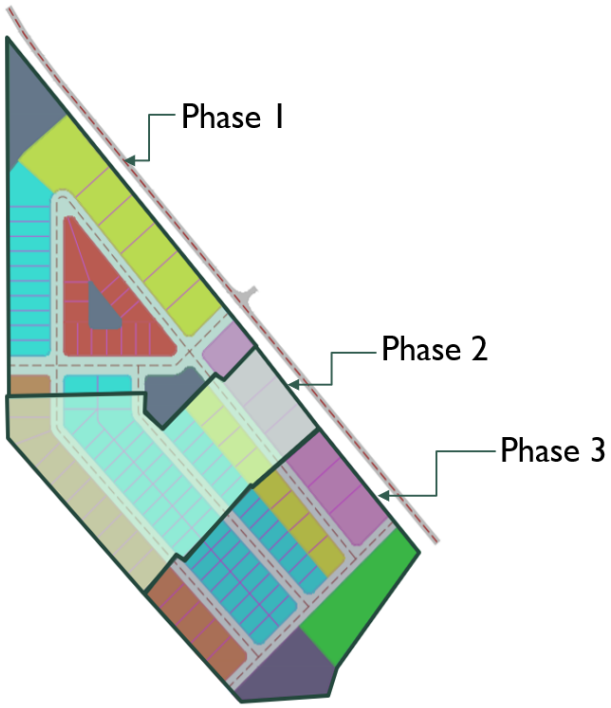

Figure 12: The phasing for the final parcel design

Section VII: Engineer's Cost Estimate

Included in Table 2 below is the cost estimate and breakdown for the design of the land development project. The major required components of the project are listed in the first column. These include site grading, land development, onsite utilities, and offsite utilities. The second contains a further break down of the costs based on the item that is constructed under each component. The quantities of each item are multiplied to produce a final total cost. The 2019 RS Means books were the main resource used to estimate the prices of each item needed for construction of this project. Other resources include the Iowa Department of Natural Resources for the cost estimation of the tree seedlings for the buffer strip. In 2019 Jackson County was eligible for free tree seedlings from the State Forestry. We hope this will continue into the future, if Jackson County is not still eligible for free tree seedlings when the trees for this project are required to be planted, the State Forestry is still a good resource. Then the tree seedlings would likely only be around $2 for each.

Table 3 below gives an overall cost estimate including the stormwater portion of the project. Included in this total cost estimate for the land development portion is a 25% contingency. This

is higher than a typical contingency due to the incomplete design of the offsite utilities. We wanted to provide an estimate which could include the cost of any potential items that were not included in the basic design we provided. This also helps include any costs missing in the site grading due our lack of a full land surveying data. We used LIDAR data which may not be as accurate as a survey of the land done by a crew.

Table 2: Displays the total cost estimation for the land development portion of the project

System	Item	Quantity	Unit	Unit Price	Total
Site Grading	Rough Site Grading	80800	C.Y.	$4.20	$339,360
	Grade Subbase - Roadways	21840	S.Y.	$0.55	$12,012
	Grade Subbase - Sidewalks	3900	S.Y.	$1.55	$6,045
	Erosion Control	1	LSUM	$6,000	$6,000
	Seeding	6534	LBS	$6.00	$39,204
	Buffer Strip - Tree Seedlings	~45	Ea.	$0	$0
Land Development	Local Road - 7" HMA	7545	US Ton	$68.50	$516,833
	Arterial Road - 10" HMA	3875	US Ton	$65.50	$253,813
	Curb & Gutter	7445	L.F.	$17	$126,565
Onsite Utilities	Water Main - PVC 8"	7500	L.F.	$18.35	$137,625
	Sanitary Sewer - PVC 8"	6500	L.F.	$48	$312,000
	Manholes	24	Ea.	$2,525	$60,600
	Fire Hydrants	20	Ea.	$967	$19,340
	Valves	27	Ea.	$2,500	$67,500
Offsite Material Estimation	Water Main - 18" Ductile Iron	4300	L.F.	$95	$408,500
	Fire Hydrants	10	Ea.	$967	$9,240
	Valves	5	Ea.	$1,050	$5,644
	Sanitary Sewer - 18" RCP	3715	L.F.	$88	$326,920
	Sanitary Sewer - Bored & Jacked	$100	L.F.	$650	$65,000
	Manholes	10	Ea.	$2,525	$25,250
	Trail - 6" PCC	57570	S.F.	$6.10	$351,177
	Access Road - 6" Chip Seal Gravel	3900	S.Y.	$0.80	$3,120
	Access Road - 8" Gravel Base	1210	US Ton	$17	$20,576
				Total	**$3,112,323**

Table 3: Displays the total cost summary including the stormwater costs

Land Development Portion	$3,112,000
Contingency (25%)	$778,000
Engineering & Administration (15%)	$467,000
Total Stormwater Project Cost	**$624,000**
Total Land Development Project Cost	**$4,357,000**
Total City of Bellevue Expansion Cost	**$4,981,000**

Section VIII: Appendix

Design Calculations

Offsite sizing calculations for the water main and sanitary sewer:
This sizing utilizes the method as recommended by SUDAS. Rate is calculated by multiplying the total people per lot by 100. These rates were summed to find a total rate. The offsite rates were determined by estimations. The total number of lots were summed and an average of three people were assumed to live in each home. The potential future subdivisions were sized by assuming approximately the same population density as the current parcel. The area was compared with the parcel's to determine how many people were assumed to live there. Both the onsite and offsite utilities were then combined for a total of approximately 376,000 gallons per day. This value was then converted into cubic feet per second where it could be translated using the chart provided in SUDAS to determine the pipe diameter. This also took the roughness coefficient based on the material of the pipe into consideration and the average slope of the pipe. For sanitary sewer the diameter was determined to be 18".

The water main required one extra step. Because the water main is pressurized, must provide water in emergency circumstances, and is mainly used during the day it requires a calculation based on peak flow. The following equation was used to determine the peak rate.

$$Peak\ Flow = Avg.Daily\ Demand * \frac{7}{Population^{0.167}}$$

The peak flow determined was approximately 665,000 gallons per day. This value along with the manning's coefficient sized the pipe to be 18" as well.

Table 4: Water main and sanitary sewer diameter size calculations

Onsite Extensions					
Lot Type	Estimated People Per Lot	Number of Lots	Total People Per Lot Type	Rate	Unit
Single Family	3	88	264	26,400	gpd
Apartment/Commercial	30	7	210	21,000	gpd
Independent Senior Living	9	14	126	12,600	gpd
Townhouse	12.5	14	175	17,500	gpd
Future - Assume Mix	6.8	10	68.125	6,813	gpd
Total People	3756		Total Rate	84,313	gpd
			Total Rate	0.1305	ft^3/s

Offsite Extensions			
Lot Type	Estimated Rate (gpd)	Estimated Rate (ft^3/s)	Approx. People Per Subdivision
Existing Subdivision	9,600	0.0149	96
Potential Future Subdivision 1	179,046	0.2771	1790
Potential Future Subdivision 2	102,676	0.1589	1027
Total	291,322	0.4508	2913

Combined Total Rate	Peak Rate	Unit
375,634	665,085	gpd
0.5813	1.0292	ft^3/s

References

Cook, W. J. (n.d.). *Preserving Native American Places.* Indian Land Tenure Foundation.

East Central Intergovernmental Association. (2015). *Housing Needs Assessment Jackson County, Iowa.*

Iowa, S. o. (2019). *Iowa Statewide Urban Design and Specifications (SUDAS).*

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Tables and Figures

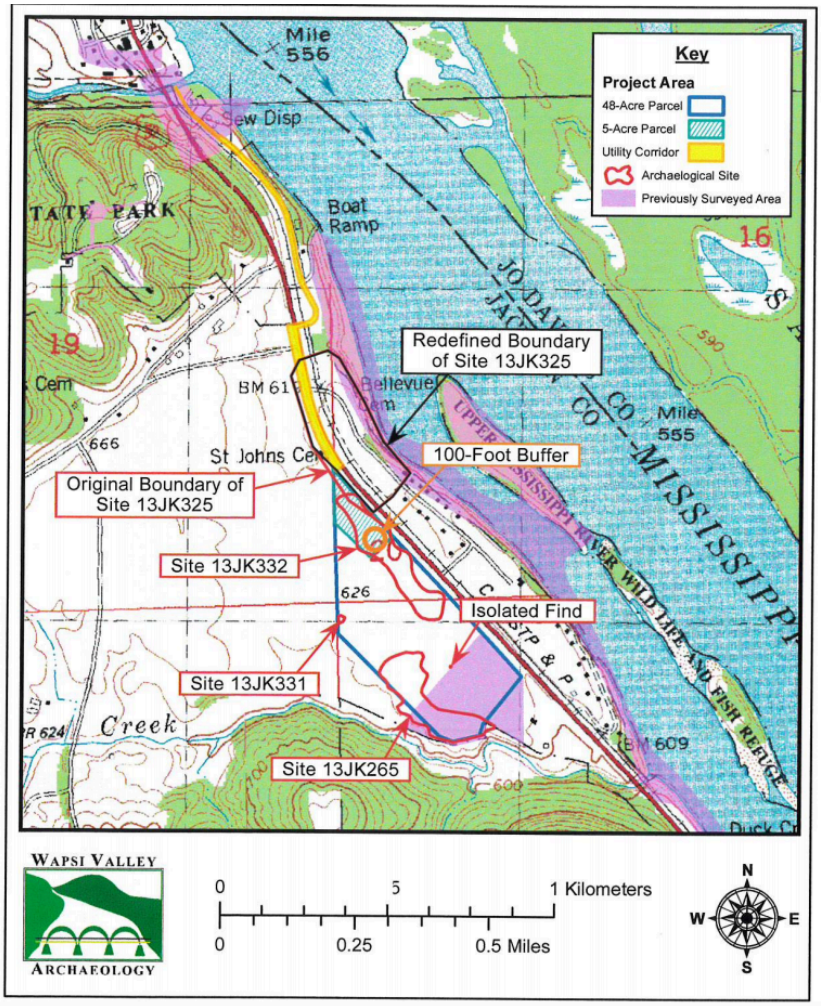

Figure *12*: Archaeological findings map completed by Wapsi Valley Archeology. More details available in Section IV - Constraints

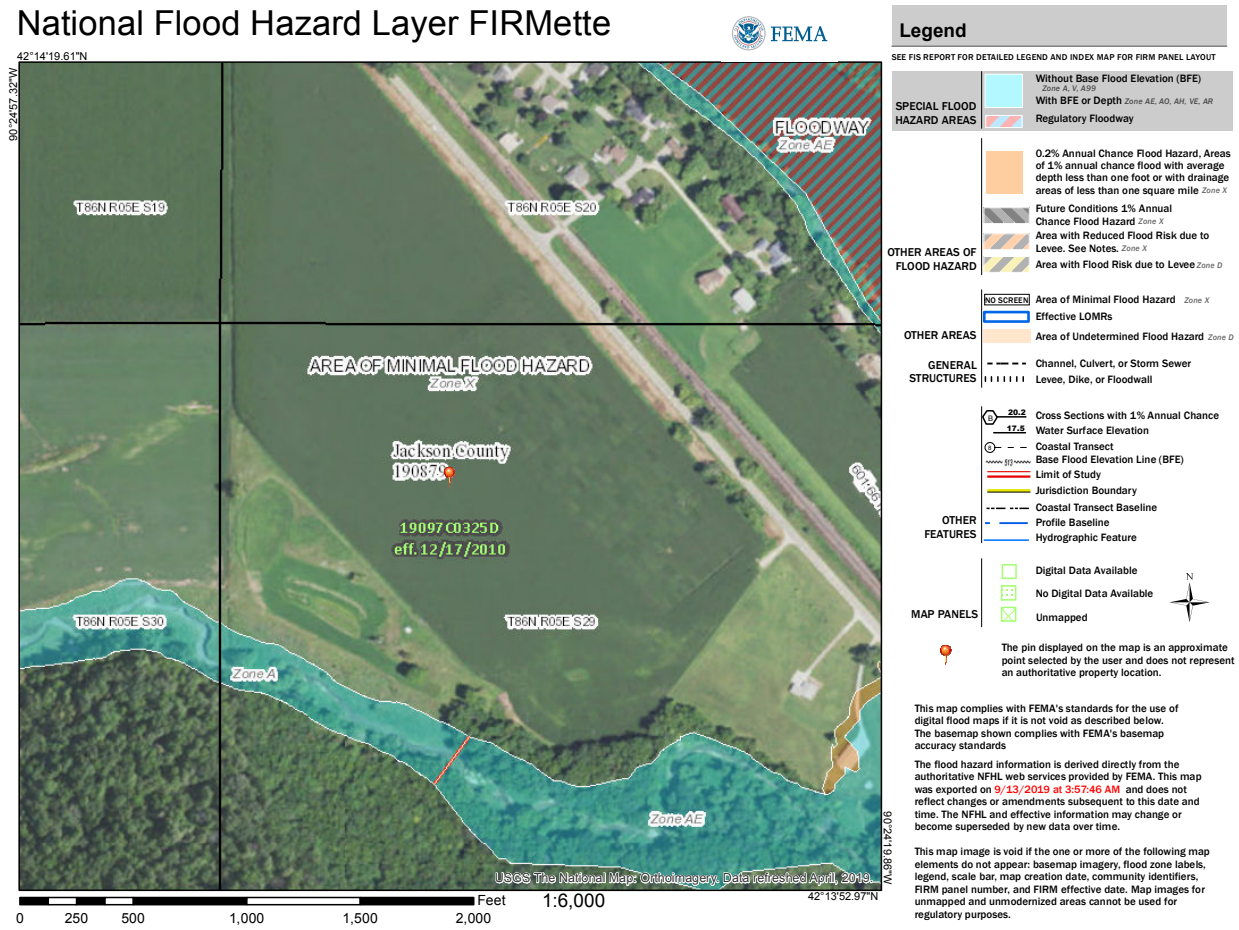

Figure *13*: FEMA 2010 Map - More Details in Section IV - Challenges

Table 5: ESAL cumulative traffic load summary statics)

ESAL (cumulative traffic load summary statistic)		
design AADT	5708	Veh/day
Truck Percent	4	%
Truck mix type	A	
ESAL	12840	
growth factor	22	
CBR	3	
Given: Current AADT	5709	
Percent Trucks	4	%
Percent Annual Growth Rate	1	%
Design period	20	years
Base Year Design ESALs	20552.4	ESALs
Growth Factor	22	
Compute ESAL20	452152.8	ESALs

Table 6: Asphalt pavement options - SUDAS

Asphalt Pavement Mixture Selection (SUDAS 5D-1)			
Step	**Task**		
1	**Given: Current AADT**	**5709**	
	Percent Trucks	**4**	**%**
	Percent Annual Growth Rate	**1**	**%**
	Design period	**20**	**years**
2	**Base Year Design ESALs**	**20552.4**	**ESALs**
	(from Section 5F-1,Table 5F-1.08)		
3	**Growth Factor**	**22**	
4	**Compute ESAL20**	**452152.8**	**ESALs**
5	**Select HMA mixture design level**		**<=0.3M**

Table 7: Recommended thickness for flexible pavement for local roads - SUDAS

CBR	3						5					
ESAL/ Subbase	Natural	4" Granular	6" Granular	8" Granular	10" Granular	12" Granular	Natural	4" Granular	6" Granular	8" Granular	10" Granular	12" Granular
300,000	8.5	7	6.5	6*	6*	6*	8*	6	6*	6*	6*	6*
500,000	9.5	8	7	6.5	6*	6*	8	6.5	6*	6*	6*	6*
750,000	10	8.5	7.5	7	6	6*	8.5	7	6	6*	6*	6*
1,000,000	10	8.5	8	7.5	6.5	6	8.5	7	6.5	6*	6*	6*
1,500,000	11	9.5	8.5	8	7	6.5	9	7.5	7	6	6*	6*
2,000,000	11	9.5	9	8.5	7.5	7	9.5	8	7.5	6.5	6	6*
3,000,000	12	10.5	9.5	9	8	7.5	10	8.5	8	7	6.5	6*

Table 8: Recommended thickness for flexible pavement for arterial road - SUDAS

CBR	3						5					
ESAL/ Subbase	Natural	4" Granular	6" Granular	8" Granular	10" Granular	12" Granular	Natural	4" Granular	6" Granular	8" Granular	10" Granular	12" Granular
1,000,000	12	11	10	9.5	8.5	8	10.5	9	8	7.5	6.5	6
1,500,000	13	11.5	10.5	10	9	8.5	11	9.5	9	8	7.5	6.5
2,000,000	13.5	12	11	10.5	10	9	11.5	10	9	8.5	8	7
3,000,000	14	12.5	12	11	10.5	9.5	12	10.5	10	9	8.5	7.5
4,000,000	---	13	12.5	11.5	11	10.5	12.5	11	10.5	9.5	9	8
5,000,000	---	13.5	13	12	11.5	10.5	13	11.5	11	10	9.5	8.5
7,500,000	---	---	13.5	13	12	11.5	13.5	12	11.5	10.5	10	9.5
10,000,000	---	---	---	13.5	13	12	14	12.5	12	11.5	10.5	10
12,500,000	---	---	---	14	13.5	12.5	---	13	12.5	11.5	11	10
15,000,000	---	---	---	---	13.5	13	---	13.5	12.5	12	11.5	10.5
17,500,000	---	---	---	---	14	13	---	14	13	12.5	11.5	11
20,000,000	---	---	---	---	---	13.5	---	14	13.5	12.5	12	11

Table 9: Recommended lift thickness for flexible pavement - SUDAS

Design $ESAL_{20}$ (Millions)	Layer Designation	Lift Thickness[3]			Mix Size[1]	Bid Item Designation	Binder Content[2]
		min	*rec*	*max*			
≤ 0.3	Surface	1.5	1.5	2.5	1/2"	Low Traffic (LT)	6.00
	Intermediate	1.5	1.5	3			
	Base	1.5	3	4.5			
0.3 to 1.0	Surface	1.5	1.5	2.5	1/2"	Standard Traffic (ST)	6.00
	Intermediate	1.5	1.5	3			
	Base	1.5	3	4.5			
1.0 to 10.0	Surface	1.5	2	2.5	1/2"	High Traffic (HT)	6.00
	Intermediate	2	2.5	3	3/4"		5.50
	Base	3	4	4.5	1"		5.25

[1] The Common mix size is shown. When other mix sizes are used, the minimum lift thickness also changes (see Section 5D-1, C, 6, b).
[2] These values are for estimating quantities only. The actual asphalt binder content is established in the approved job mix formula.
[3] Some lift thickness values in this guide may conflict with traffic control or allowable compaction criteria.

Table 10: Design of pavement for the parcel

Road Type	CBR	$ESAL_{20}$	Subbase	Thickness for Flexible Pavement
Local Road	3	452153	6" Granular	7"
Arterial Road	3	452153	6" Granular	10"