Growing McMinnville
MINDFULLY

McMinnville Growth Management and Urbanization Plan, 2003 – 2023

City of McMinnville
Remand Order 12-WKTASK-001814

REFERENCE MATERIALS

December, 2020

Attachment 3

- Portland State University (PSU): Impact of Slope on Housing Development Costs (Attachment 3a)
- Jacobs Engineering: Serviceability Analysis, McMinnville UGB Study Areas, October 2020 (Attachment 3b)
- GeoTech Report (Attachment 3c)

Attachment 3a

Impact of Slope on Housing Development Costs

A report by the Center for Real Estate
Portland State University
For the City of McMinnville, Oregon

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One of the tenets of the Oregon land use planning system is that cities will develop within urban growth boundaries (UGBs), protecting farmland, forest land, and open space, and that those boundaries will maintain land supplies representing 20 years of population and economic growth. Within the real estate and urban planning professions, these definitions have been widely debated, with some arguing that urban development can become more dense and existing UGBs can support much greater densities, extending the protections on agricultural land and open space, with others arguing that dense development can only be supported by sufficient rents and prices and that the assumed carrying capacity of the land is less than it would appear.

The City of McMinnville, Oregon asked the Portland State University research team to investigate the impact of slope on housing development within its UGB. The city is located within the Willamette Valley and much of the land within its UGB has slope and other topographic constraints that require significant contouring, site stabilization, and infrastructure improvements in order to be developed. These additional site preparation costs add to the cost of developing the sloped parcels within the UGB, requiring premium selling prices and rents in order for the development to be feasible. And when these higher price points cannot be achieved, many of these parcels remain undeveloped and do not add to the effective 20-year land supply that the state statutes promise. Moreover, the yield of housing units per acre is greatly reduced when significant slope exists, as buildings need to have less mass and greater separation to avoid the problems of stormwater runoff and landslides.

These cost barriers create urgent problems for the development of affordable housing. Affordable housing requires low site preparation costs, as well as public subsidy, in order to meet the needs of low-income households within the community. When affordable housing developers submit applications for subsidy funds, they are often (correctly) judged by the cost of construction per housing unit. When site preparation costs are high, affordable housing developers won't be able to submit competitive grant applications.

In this report, we will segment the discussion by focusing first on the impact of slope on single-family housing development, followed by the impact of slope on market-rate, multi-family development, and then by the impact on affordable multi-family development. Data for the project comes from examples throughout the Willamette Valley, supplemented by construction cost information at a national level.

1. Single-Family Development
2. Market-Rate Multi-Family Development
3. Affordable Multi-Family Development
4. Conclusion

Section 1: Single Family Development and Sloped Land

As part of the update to its comprehensive land use plan, the City of McMinnville sought to understand the additional cost of developing land on sites with varying slope and soil conditions. This section of the report examines the additional cost associated with building single family home developments on varying slopes. This section of the report will evaluate the effects of building on flat (0-4% gradient), moderate (5-9% gradient), and steep slopes (10% gradient and up) in terms of construction issues, the cost of infrastructure construction, home value, and yield of homes in a given development.

To do this, developers and engineers were interviewed. Additionally, this section examines two separate data sets that seek to answer the questions above. The first data set consists of 16 single family developments in the Willamette Valley built by a developer located in Washington County. The second data set consists of 12 case studies of single family developments in the Willamette Valley on varying slopes built by four distinct developers.

Construction Issues Related to Building on Sloped Land

There are several common construction-related issues that builders experience when building on sloped land. The most prominent issues that developers and engineers referred to were earthwork, including removing soil and building retaining walls, and storm water management. All of the people interviewed agreed that building on flat ground was less expensive than building on slopes; and when building on slopes, it is less expensive to build on a downhill lot (where the slope goes down from the front to the back of the home) than it is to build on an uphill lot.

One developer in Clackamas County estimated that downhill lots were, “20% to 25% more expensive” to develop than flat lots, while uphill lots were, “25% to 30% more expensive” than flat lots. A developer in Washington County mentioned that the value of a downhill lot is, “33% less than flat lots”, while uphill lots could be as much as, “40% less” valuable. One reason for the difference is that it is easier to build foundations downhill than it is to carve them out of an uphill slope. It is also easier for a builder to move soil and rock downhill, away from the street – in order to make a lot flatter – than it is to move soil and rock uphill, toward the street.

Another earthwork issue related to sloped land, according to a project engineer from Multnomah County, is that sloped land has not experienced erosion and sedimentation as much as flat land has. Because of this, there is often less topsoil on sloped land, and the soil and rock that remains is often more dense than the soil on flat land. This makes it more expensive to excavate soil on slope than soil on flat land, for example.

In addition to physically moving earth, creating retaining walls and terracing requires extra labor and materials. One common way to build a retaining wall is using boulders. According to a project engineer in Marion County, when retaining walls and terraces start to exceed four feet in height, a builder can no longer use boulders for retaining walls and must use steel-reinforced concrete. The project engineer estimated that the additional cost of boulders was around $25/square foot, and the additional cost of steel-reinforced concrete could range anywhere from $50/square foot to $75/square foot.

Another construction issue that most of the developers brought up was the issue of storm water management. On sloped land, storm water runoff must be managed to avoid flooding and landslides. According to a developer in Washington County, it is also more difficult to do so on sloped land because, unlike a flat development, there are no natural land features to retain the storm water. This developer, who was working on a steeply sloped development, had to install an underground water retention feature connected to a water treatment system by a pipe that was seven feet high and 190 feet long. According to the project engineer in Marion County, although the cost of treating water is similar on sloped and flat developments, the initial capital expense is much greater for sloped projects.

The yield of homes might also be considered a construction issue because of the infrastructure required to build homes on slope. In certain situations, homes must be single loaded on one side of the street if slopes are too great. Also, lots that are built on sloped land tend to be bigger to offset the effect of slope. In a sampling of 16 single family developments from a developer in Washington County with 328 total lots, the mean (average) lot size for homes on steeply sloped, moderately sloped, and flat developments were 4,800, 4,625, and 3,843 square feet, respectively. The median lot size for the same sample set were 4,500, 4,250, and 2,900 square feet, respectively. Five of these developments were built on steeply sloped land, four were built on moderately sloped land, and seven were built on flat land.

There were also a few minor issues that developers noted with some frequency. One of these issues was the expense of building road and sidewalk features to ADA accessibility standards. ADA standards require that all new developments have flat intersections, as well as sidewalks and curb cuts at gradients 8.3% or less. A developer in Multnomah County said that the most expensive part of ADA accessibility was ensuring that intersections are flat. Of course, many developers also recognized the importance of aligning a project's construction schedule to avoid working on any key steps in the process during the rainy season in the Willamette Valley.

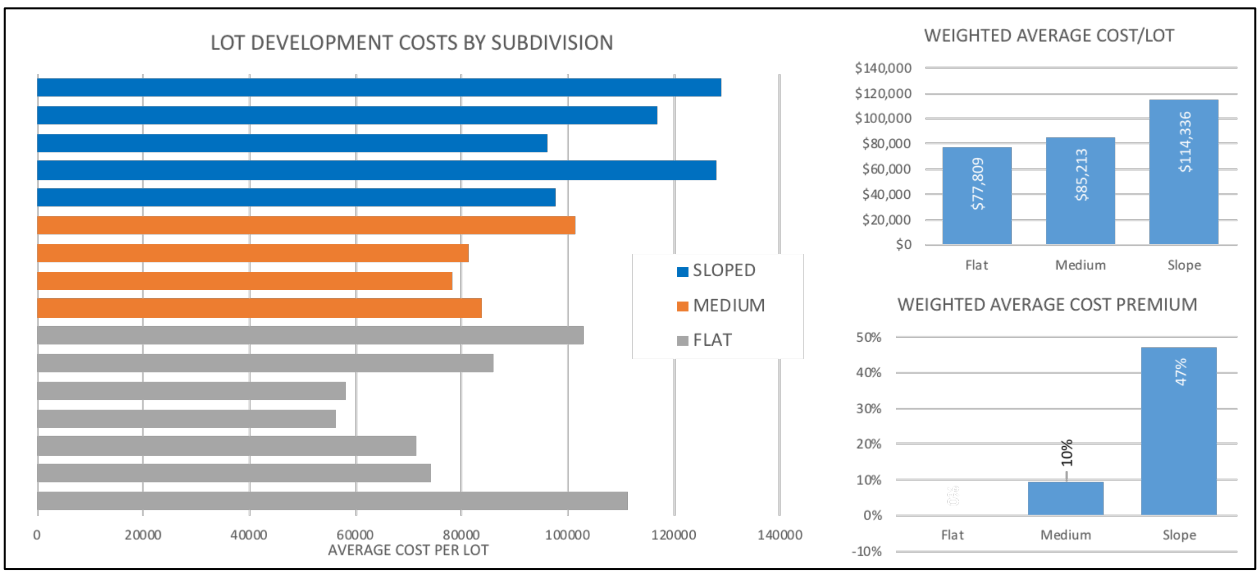
Data Sets and Analysis

This section will draw upon two separate data sets to evaluate the effect of slope on infrastructure construction costs and home value. Data set #1 consists of 16 single family developments with 328 total lots, which were built throughout the Willamette Valley by a developer based in Washington County. Five of these developments were built on steeply sloped land, four were built on moderately sloped land, and seven were built on flat land. As discussed in the previous section, this data set illustrated that as slope increases, the yield of lots in a given development decreases. It will also show that as slope increases, infrastructure construction costs increase.

The mean infrastructure costs per lot for steeply sloped, moderately sloped, and flat developments in this data set was $114K, $86K, and $80K, respectively. Further, the median infrastructure costs per lot were $117K, $83K, and $74K, respectively. While the difference in infrastructure costs per lot between flat developments and moderately sloped developments is relatively small, the difference in costs between moderately sloped and steeply sloped developments appears to be approximately $28K to $34K per lot, based on the mean and median, respectively. The disparity becomes even larger when comparing steeply sloped and flat developments. In this case, the mean and median suggest that the difference is approximately $34K to $43K.

The following graphic summarizes total lot development costs by subdivision in this data set, broken out by degree of slope. The weighted average premium (adjusting for subdivision size) was 10% for a medium sloped property vis-à-vis a flat site, increasing to a 47% premium for a sloped site.

SUMMARY OF DATA SET #1



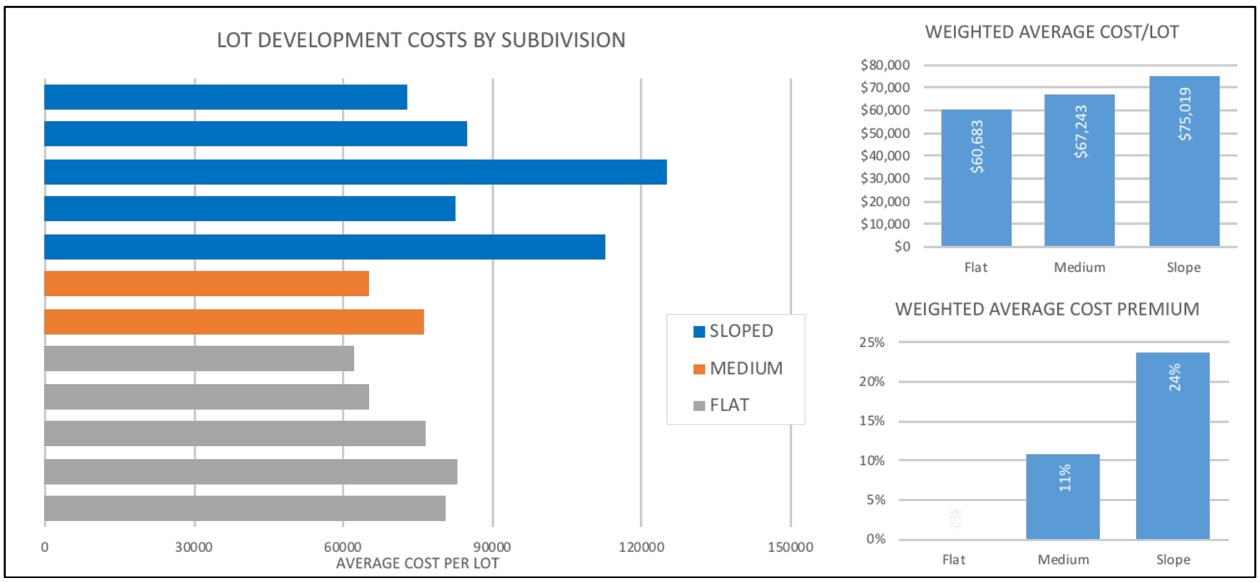
Data set #2 consists of 12 case studies of single family developments built by four separate developers. Five of these developments were built on steeply sloped land, two were built on moderately sloped land, and five were built on flat land. The mean per lot infrastructure costs for steeply sloped land, moderately sloped, and flat developments were $82K, $69K, and $62K, respectively. The median per lot infrastructure costs for these developments was $75K, $69K, and $63K, respectively. In terms of this data, the mean per lot infrastructure cost for steeply sloped developments was $13K higher than moderately sloped developments, and $20K higher than flat developments. The median infrastructure cost for steeply sloped developments was $6K higher than moderately sloped developments and $12K higher than flat developments.

Three of the homes in data set #2 were built by a developer who builds luxury homes and were all over $1.0 million. One of these was built on slopes of 10% to 25%, and homes in this development range in value from $1.1 to $1.3 million. The two other luxury developments were built on flat land, and the home values in these developments range from $1.15 to $2.2 million.

The remaining nine developments in data set #2 have homes that range from $348K to $685K. Of these developments, four were built on steeply sloped land, two were built on moderately sloped land, and three were built on flat land.

The lot development costs by subdivision in this data set show a similar pattern to those in the first data set, with the weighted average development cost per lot increasing as slope increases. In this case, the cost premium for a medium slope was 11%, while a higher sloped lot had a premium of 24%. While the differential was somewhat lower in percentage terms, it remains significant.

SUMMARY OF DATA SET #2



The homes built on steeply sloped land ranged from $360K to $685K, the homes on moderately sloped land ranged from $420K to $620K, and the homes built on flat land were $348K to $635K. When looking at the higher end of these ranges, it appears that developments on steeply sloped land have the homes with the highest values; however when looking at the low end of these ranges, it appears that homes on moderately sloped land have the homes with the highest values. Based on this information, it is difficult to say how sloped land affects the resale value of homes.

<u>Section 1 Conclusions</u>

The purpose of this section was to evaluate the effects of building single family developments on flat, moderately, and steeply sloped land in terms of construction issues, the cost of infrastructure construction, and home value. The main construction issues posed by building homes on sloped land were earthwork, water management, and reduced yield of homes on a given development. In terms of the cost of infrastructure and home value, there are other variables that were not taken into account such as the soil quality, materials used in construction, and the varying expenses of building in different jurisdictions. While there is evidence that building luxury homes on sloped land decreases the value of those homes, it cannot be said conclusively what the effect developing sloped land has on home value. Based on the information gathered in this report, it can conclusively be said that as slope increases, infrastructure construction costs increase significantly.

Increased lot development costs directly impact housing prices, as homebuilders purchasing lots will need to recover those costs. The typical lot accounted for 26% of final home price for all sales recorded in the Portland metropolitan area in 2019.[1] While there is a great deal of variability between subdivisions due to differences in achievable pricing by market and land purchase price, it is common for a developer to increase their pricing by a ratio of roughly four to one to recover the additional costs and maintain their margins. The two data sets evaluated indicate a cost premium for a sloped site of between $14,300 to $36,500 per lot. Assuming that the lot price remains at 26% of home price, this would indicate an increase in home prices of between $55,000 and $140,000 per unit.

It should be noted that the final home price is a function of what the market will bear, and the loaded cost of the lot is also a function of the purchase price of the undeveloped property. As a result, these ratios may vary significantly on an individual development basis. To the extent that the market can support higher final home prices, this additional value will typically be reflected in transferred lot price. The incremental increase in costs is therefore more easily dealt with in markets that can support higher home prices, with more affordable housing less capable of absorbing these costs. While sloped sites (up to 20-25%) can be successfully developed for higher end housing, they are unlikely to have the capacity to meet the full pricing spectrum of detached housing demand.

[1] New Home Trends, MetroStudy

Section 2: Market-Rate Multi-Family Development and Sloped Land

The research team interviewed professionals at local real estate construction firms to learn about the challenges of constructing apartment projects on sloped sites. Sloped site development often results in a project incurring additional costs and extended schedules. Development impacts include complications with overall site logistics, installation of site utilities, water retention ponds, erosion control measures, site retaining walls, and more complex stepped building foundations.

Site logistics often hamper excavation since earthmoving equipment cannot easily access the sits. For example, sloped sites may require track mounted excavators rather than bulldozers and scrapers. In addition, concrete may be required to be pumped rather than deposited by a standard chute method and aggregate fill may need to be deposited by conveyor rather than using a typical dump truck deliver method.

Surface water runoff during construction, especially during the fall and winter rainy seasons, requires additional silt fencing, temporary water retention ponds, straw waddles and hay bales as well as diligent maintenance of these temporary erosion control systems. Additionally, as these sites are developed, terraced retaining wall systems are erected for end-user accessibility and most often building structure foundation walls are taller and have more robust waterproofing systems applied in order to keep subsurface water from entering the buildings.

Sloped site development may also require complex and costly deep utility trench excavation and shoring systems. Onsite lift stations are possible, but the pump and control equipment needed for these lift stations is costly and requires regular maintenance.

Typical development costs for no slope sites range from $16 - $25 per square foot. On moderately sloped sites, those less than a 10% slope, cost impacts can increase the project site development costs by as much as 30%. Consequently, the cost increase for the site development of a moderately sloped, a 5-acre parcel may range between $1,045,000 - $1,634,000.

On steep sloped sites (those greater than 10%), cost impacts can easily increase the project site development costs by 50% or more. As a result, cost increases for site development on a steep sloped 5-acre parcel may range between $1,742,000 - $2,723,000.

Data Sets and Analysis

To better understand the underlying development costs on sloped sites, we reached out to numerous, local general contractors, design firms, and developers to develop two data sets that looked at site development costs and total construction costs. By contacting these various firms, we gathered detailed information on market-rate, multi-family development projects in and around the Portland metropolitan area. In particular, we looked for the timeline of the project (using either the bid date or the completion date), the slope grade of each project, the total development cost of each project in a lump sum, and the site-specific development costs removed from the total project cost.

Seeking cost information for multi-family developments in the Portland metropolitan area from private firms proved to be difficult. Much of this information is confidential and important to maintaining a competitive business, so attempting to extract this information for outside research purposes was difficult. Even more difficult was getting in contact with the right personnel from each firm. Many of these firms were very busy, and the work required to extract this data is essentially extra, unpaid work for these firms. As such, in the process of gathering the data, we were unable to obtain some of the key pieces of information outlined above due to time constraints.

Another aspect of this process was converting development costs to present-day dollars in order to better compare the different developments. In this sense, it required finding the original dollar costs of each project and then adjust those costs for inflation using an inflation index dedicated to construction costs. In some cases, the providers of the data adjusted the costs to present-day dollars for convenience, but they used a different index than the one that was chosen for the project (the Seattle ENR City Cost Index). This inconsistency required going back and extracting the original data in order to adjust it with the same index as the other projects.

For example, one contractor provided data on completed multi-family development but was unable to extract site-specific development costs due to time constraints. Wherever possible, we attempted to fill in gaps for the key information pieces. One set of data did not provide site-specific slope grades, which required us to locate each project and determine slope grade using various mapping software.

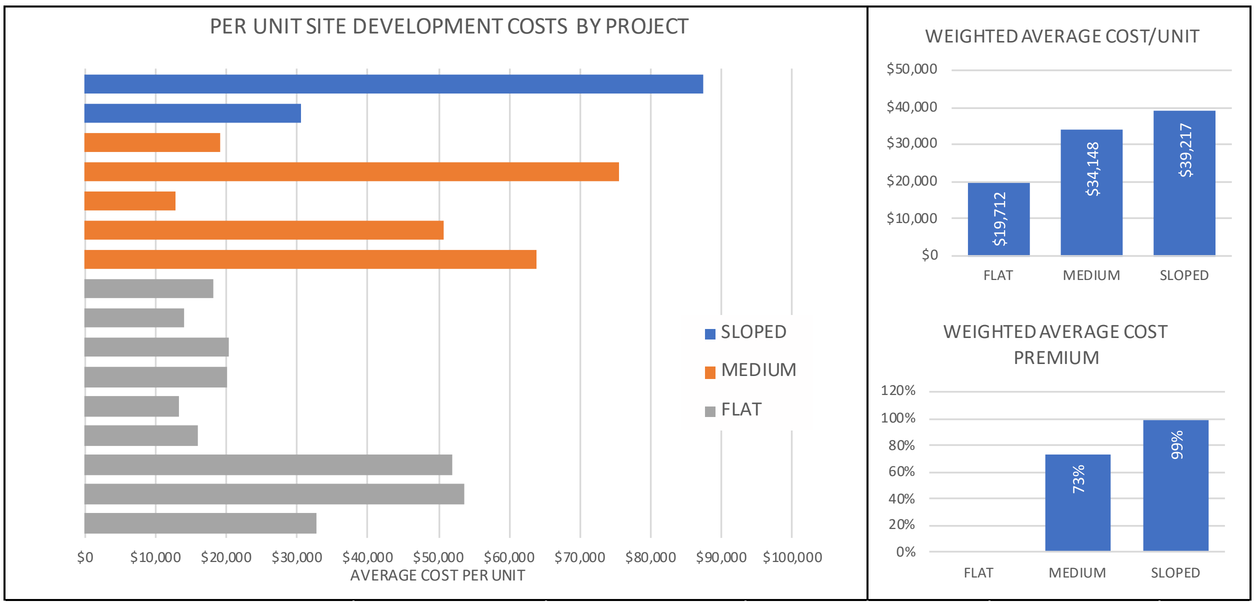
In addition to gathering cost data, some supplemental work involved analyzing potential sites for development in McMinnville in order to determine soil anatomy. Gathering this information will ideally provide a convenient file of basic soil information for each site for future reference. Upon looking further into the soil anatomy to determine foundation requirements specific to each site, we determined that a truly useful opinion of value on foundation requirements can only be derived by an actual on-site analysis in order to get a full understanding of the soil conditions. However, researching general foundation and soil conditions, we managed to come to a general conclusion on the viability of the development on the potential sites.

After putting the data together on development project costs, the data was sorted according to three categories: 1) Site Development Cost/Site Area; 2) Total project construction cost/Site Area; 3) Total Project Cost/Unit.

Upon sorting the data based on these units of comparison, projects with numbers that grossly exceeded the average number range of the data set were thrown out to better focus the comparison between the most similar projects. After examining the reduced data set, we found significant variation in costs, both between the categories based upon slope, as well as within those categories, given the wide variation in location, unit size, and construction type.

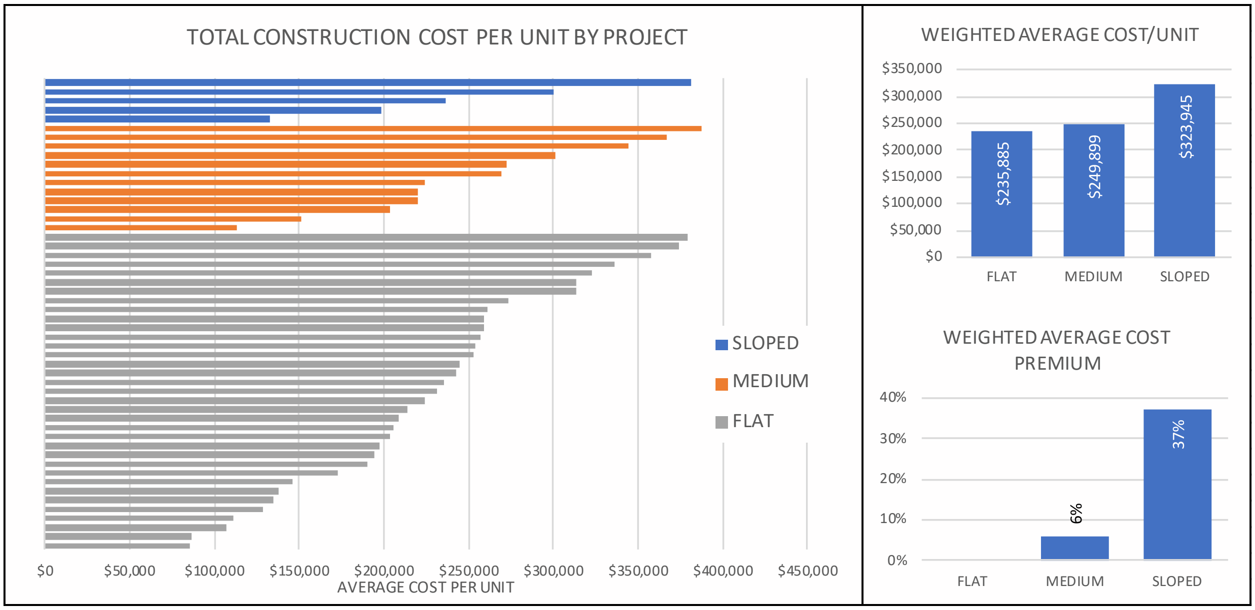
From this data, we found nine observations with mild or no slope (0-4%), five observations with moderate slope (5-9%), and two observations with steep slopes (10% or higher). From these observations, we computed the weighted average site development cost and found the steep sites required $39,217, the moderate sloped sites, $34,418, and the mild/no slope sites $19,712. Put differently, moderate slopes added 73% to site development costs relative to flat sites, and highly sloped sites increased site development costs by 99%.

SUMMARY OF DATA SET #3



The research team had more information on total project costs, with five projects built on highly sloped sites, twelve projects built on moderate slopes and thirty-five projects built on mild slopes or flat sites. From these observations, we computed the average project cost per unit weighted by the number of units and found development costs of $323,945 per unit for highly sloped sites, $249,899 for moderately sloped sites, and $235,885 for mild slope or flat sites. Put differently, the total project cost per unit of moderate sloped sites required a 9% premium over mild slope or flat sites, and highly sloped sites required a 37% cost premium over mild slope or flat sites.

SUMMARY OF DATA SET #4



As can be seen from the table above, there are many more multi-family development projects that are built on sites with little slope. While there are construction strategies for handling slope, those strategies are expensive and those sites either require a premium rent or remain undevelopable. For that reason, sloped sites are often overlooked in favor of easier-to-develop sites with mild or no slope.

<u>Section 2 Conclusions</u>

Slope and terrain remain a barrier for market rate developers. As discussed above, construction firms need to employ expensive construction techniques to excavate sites. Concrete often needs to be pumped uphill, and aggregate may require conveyor systems to deliver material where its needed. Construction firms will need more extensive retaining walls and terracing to keep their sites stable. Installing utilities and other infrastructure is also a complication with slope sites, including the management of storm water runoff and retention.

Section 3: Affordable Housing and Sloped Land

The goal of this section was to determine if sloped sites had an impact on construction and development costs of affordable housing. To collect the information required for analysis, outreach began to affordable housing developers based in Oregon, with specific focus on projects built along the corridor of I-5 from Portland to Eugene. Oregon Housing and Community Services provided some starting data on projects around Oregon, and Home Forward, as well as the Housing Development Center, each provided projects in their pipeline or those that they had finished fairly recently. Other affordable developers provided data on several projects, though often neglecting to share full development or construction costs due to privacy concerns or an unwillingness to scour through their old projects for those that featured slope.

Nearly every affordable housing developer did not internally differentiate or specify their projects that were built on sloped sites, and it was often first-hand knowledge of a specific site that led to information being shared. Notably, many affordable housing developers stated outright that they do not build on sloped sites, or that developing on a sloped site is a very rare phenomenon, as it is assumed that slope would bring an additional cost to development. This posed an interesting problem for the analysis in terms of being able to collect data on sloped sites, where few appeared to exist. Additionally, several developers were willing to offer quotes for the analysis based upon conditions of anonymity:

> "What we all already know, it's a lot cheaper to build on flat land rather than steep slope."

> "There is an additional cost burden which sloped sites cause for such projects."

As the project was a comparison of costs based upon slope, information was collected on projects built both on sloped and flat sites as well as the gradient each site featured. Using the data provided by OHCS as a starting template, projects were defined by their location, the year they were finished, their square footage, and the total number of units in each development. Dollar amounts for total construction and development costs for each project were collected. These costs were then adjusted for inflation based upon the year they were built and using the Seattle ENR City Cost Index to bring their costs up to their value in 2020 dollars. These adjusted totals were then used to calculate construction and development costs based upon the site area, as well as total project cost per unit.

Once data was collected, an analysis was conducted to establish the impact sloped sites had on affordable housing development costs versus those built on flat sites. The data collected revealed that as slope increased, sites that featured a 20% slope gradient or above reflected higher development costs (between 40-50%) in comparison to the project's construction costs. Sites with less slope - those with 7.5% gradient or below - saw little to no impact on their development costs in comparison to sites built on flat ground. Additionally, sites that featured any gradient of slope tended to have slightly higher development costs per square foot than flat sites. Sites built more recently, those within the last 2 years as well as those currently in development, tended to feature higher costs overall regardless of their slope.

Section 4: Overall Conclusions

Land is an essential component of real estate development, and there is much variety in the quality of sites. Historically, cities developed near water ports and railroad lines, both of which tend to accommodate or require flat sites. Development tends to follow river valleys and expensive uphill transportation is avoided. As regions become congested, developers are often left to consider sloped sites, given the tendency of flat sites to be already developed. And in Oregon, our land use planning system encourages greater consideration of sloped sites inside urban growth boundaries, as the lack of available flat sites causes land prices to rise.

The research team was able to find a mix of single-family and multi-family development projects that were built on a variety of slopes. For single family development, slope sites require terracing that involves boulders or retaining walls with steel-reinforced concrete, so that individual homeowners can have relatively flat yards. In addition, slope sites require excavation and moving earth with expensive equipment. And the development of water retention ponds is complicated by sloped land, sometimes requiring underground piping systems and pumps.

In addition to interviewing construction firms and single-family development companies, we constructed two data sets to measure the impact of these additional expenses on development costs. We found that adding slope to the site led to an increase in development costs by 10% to 47% and subdivision development costs rising between 11% and 24%, depending upon the severity of the slope. These increases in development costs lead to higher prices for homeowners. And the added complexity of development on sloped sites also leads to smaller yields of housing units for a given acreage of the site. That may result in a lower density of housing units per acre, or unless achievable prices are high, no development at all.

For multi-family development, the construction challenges are magnified due to the weight of the buildings and the greater risk of settlement and landslides. We found additional problems resulting from waterproofing basements from subsurface water. Delivery of concrete and aggregate often require pumps and conveyor systems, respectively. And sloped sites experience greater challenges with water runoff and the construction of water retention systems.

Professionals in the industry advised us that moderate sloped sites could result in additional costs of $1.0 million to $1.6 million for a 5-acre site, and steep slopes would result in additional costs of $1.7 million to $2.7 million for such a site. To assess this question further, the team constructed two data sets of recently built apartment projects, adjusting those cost figures for inflation. We found an increase in site development costs ranging from 73% to 99%, depending upon whether the slope was moderate or high, leading to overall construction costs to rise between 6% and 37%, respectively.

These increases in costs create particular challenges for affordable housing developers, who depend upon a variety of funding sources and don't have the reserves to obtain and land bank flat sites for future development. Moreover, they are not able to capture the premium rents that development on sloped sites require. Given these challenges, cities need to insure a robust supply of relatively flat land to encourage the development of affordable housing.

The Research Team

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Subject	**Serviceability Analysis**
Project Name	City of McMinnville, Oregon – UGB Remand Infrastructure Serviceability Analysis
Attention	City of McMinnville, Oregon DJ Heffernan
From	Jacobs Engineering Thomas C. Walsh, PhD, PE; Shad Roundy, PE; Kristi Steiner, PE; Neha Rathi, PE
Date	October 15, 2020

Background

The City of McMinnville (City) has been working to both update its Comprehensive Land Use Plan (Comp Plan) and expand its urban growth boundary (UGB) since the 1990's.

In 2003, the City submitted an updated Comp Plan to the Oregon Department of Land Conservation and Development (DLCD) and the Land Conservation and Development Commission (LCDC). The City had been working on the plan for nearly five years. After review, the Comp Plan was sent back to the City with guidance to correct deficiencies identified by both the DLCD and outside interests, including 1000 Friends of Oregon. The City made changes to the 2003 Comp Plan and, after an expanded planning process in January of 2006, submitted an amended Comp Plan to DLCD. In September of 2006, LCDC approved the updated Comp Plan, which included the addition of 1,188 acres of land to the UGB. These lands were comprised of a mix of not only rural exception land, which is not a protected resource land, but also resource farm land, which is a protected resource land. Most of the additional land was added to meet residential land needs.

The approval was appealed by 1000 Friends of Oregon and others to the Oregon Court of Appeals (Court). In 2011, after a series of appeal hearings, the Court remanded the Comp Plan back to LCDC and the City for additional analysis on the land added to the UGB. The Court's decision outlined a process to use in conducting the follow-up UGB analysis. By this time, however, the City had exhausted its planning resources and elected to suspend work on the Comp Plan. An ordinance was passed that "unwound" the adopted Comp Plan and UGB, which effectively returned the City to its acknowledged plan from the 1980's. The City has been working under that plan since.

In 2018, the City began to examine its long-range population and employment forecasts and related urban land needs. That analysis indicated that in spite of the elapsed time since the 2001 land needs analysis, the City's needs had not changed significantly because economic conditions had drastically slowed growth and development. The City has reviewed the Court's 2011 order and is now moving forward with an evaluation of the land supply deficiencies.

An overview of the City and candidate expansion areas is shown in **Figure 1**.

Figure 1 – Study Area

<<Insert PDF with Study Areas>>

A summary of the UGB expansion areas is presented in **Table 1**, including the total acreage, UGB status, and other details.

Table 1 – UGB Expansion Areas

UGB Expansion Areas				
Area	**Name**	**Size (Acres)**	**UGB Status**	**Area Details**
FRR	Fox Ridge Road	145.7	In	Exception
GH-E	Grandhaven-E	19.5	Out	Resource - Higher Quality
GH-W	Grandhaven-W	67.9	Out	Resource - Higher Quality
LL	Lawson Lane	18.1	Out	Exception
NFRR-E1	N of Fox Ridge-East 1	60.7	Out	Resource - Lower Quality
NFRR-E2	N of Fox Ridge-East 2	128.5	Out	Resource - Lower Quality
NA-EV	NA-EV	40.2	Out	Resource - Lower Quality
NA-NOSV	NA-NOSV	279.0	Out	Resource - Lower Quality
NFRR-W	N-Fox Ridge - West	116.3	Out	Exception
NL-E	Norton Lane East	81.5	Out	Resource - Higher Quality
NL-W	Norton Lane West	61.4	Out	Resource - Higher Quality
NW-EX1a	NW-Ext 1a (Northern)	78.2	Out	Resource - Higher Quality
NW-EX1b	NW-Ext 1b (Southern)	72.5	Out	Resource - Higher Quality
NW-EX2	NW-Ext 2	15.5	Out	Resource - Higher Quality
NW-HS	NW - High School	42.0	In	Resource - Lower Quality
OSR	Old Sheridan Road	54.5	Out	Exception
RHR	Redmond Hill Road	43.6	In	Exception
RSS	Riverside South	192.3	In	Exception
SW-06	SW I (SW 06)	158.0	Out	Resource - Higher Quality
SW-2	SW II	120.1	Out	Resource - Higher Quality
TML-E	Three Mile Lane East	201.7	Out	Resource - Higher Quality
TML-W	Three Mile Lane West	9.0	Out	Resource - Higher Quality
W-OSR1	W of Old Sheridan-1	231.4	Out	Resource - Lower Quality
W-OSR2	W of Old Sheridan-2	313.8	Out	Resource - Lower Quality
WH2	West Hills-2	431.9	Out	Resource - Lower Quality
WH-S	West Hills-South	122.3	Out	Resource - Lower Quality
Total		**3,105**	**N/A**	**N/A**

Purpose

The purpose of this analysis is to provide professional engineering services to augment the planning record on an objective basis regarding the serviceability of candidate urban study areas from the 2006 Comp Plan as it relates to the water, wastewater, and transportation infrastructure.

Assumptions

No detailed updates or calibration of the hydraulic models were completed under this work. Water supply, water treatment, wastewater treatment, and wastewater discharge are excluded from the evaluation. Further, wastewater systems exclude consideration of local, 8-inch sewers and wet weather flow reduction. These have already been analyzed in system master plans and are anticipated to serve present and future urban residents regardless the direction the City grows.

McMinnville Water and Light (MWL) will be expanding their treatment capacity, including supply, on the east side of the City.

[Include transportation assumptions – transit map limitations, etc.]

Statutory and Rule Framework

For reference, the applicable rules and statutory requirements for analyzing urban expansion study areas are those that were in effect in 2003. These are listed as follows:

- **Statewide Land Use Planning Goal 14 – Urbanization** – Note that the Goal and its related administrative rule in OAR 660-024 were amended after the 2003 Comp Plan was adopted. The applicable regulatory framework for the remand analysis is the version of the Goal and rule that was in effect in 2003.

- **ORS 197.298** – This statute regulates how urban growth boundaries are to be evaluated for expansion and the priorities for considering land that may be added. In particular, ORS 197.298(3)(b) establishes that higher priority land may only be excluded for consideration due to a serviceability constraint if there is a "topographical or physical" barrier to the extension of public facilities. ORS 197.298(3)(c) states that lower priority land may be included in a UGB to provide services to higher priority lands.

- **ORS 197.295(1) [now, ORS 197.286]** – Buildable land is defined in this law, as "lands in urban and urbanizable areas that are suitable, available and necessary for residential uses…includ[ing] both vacant land and developed land likely to be redeveloped."

- **OAR 660-011** – This rule includes definitions for the public facilities that may be considered in the evaluation of urbanizable land. Of importance to the subject review are water, sanitary sewers, and transportation facilities.

Non-Developable, or Exclusion, Lands Evaluation

City staff provided mapping and background data for areas of exclusion, which encompassed the following topographic (i.e., physical) datasets:

- Steep slopes: This includes areas where slopes either meet or exceed 25 percent
- Floodplains: This includes areas with a (i.) Code A = one percent chance of flooding and 26 percent of flooding over the life of a 30-year mortgage and (ii.) Code AE = the base floodplain where base flood elevations are provided
- Floodways: Identifies the channel of a river or other watercourse and the adjacent land areas must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height
- Wetlands: This includes areas where water covers the soil or is present either at or near the surface of the soils all year or for varying periods of time during the year.
- Conservation lands: This includes a delineation of the easements established to respect conservation areas.

This data provided an estimation of non-developable lands (i.e., exclusion) and developable lands prior to the serviceability analysis. Slope information was provided by the City as polygons converted from LiDAR data. The remainder of the datasets were provided as polygon shapefiles.

Exclusion of Lands

The following figure, **Figure 2**, presents the excluded lands for candidate expansion areas. The total excluded area for the candidate expansion areas is approximately 545 acres, or roughly 18 percent of the total study area (3,105 acres). This results in a buildable area of 2,560 acres, with 2,503 acres serving residential uses and 57 acres serving commercial uses.

FIGURE 2 - EXCLUSION RESULTS BY EXPANSION AREAS

Serviceability Evaluation

Approach

The serviceability, integrating hazards and constructability components, of each expansion area was incorporated into an analysis following the determination of the developable, or inclusion/exclusion, status. With this data, Jacobs identified the feasibility of developing candidate areas for infrastructure by scoring. This resulted in the elimination of lands from consideration by accounting for both the physical (topographic) constraints and constructability constraints, including: liquefaction susceptibility, landslide risk, wildfire risk, and rock excavation (i.e. soils data). These hazards are further defined below.

Hazards

For the purposes of this remand analysis, the following definitions were applied to hazard data when assessing the constructability of candidate areas.

Liquefaction susceptibility is the relative risk an area has to liquefaction during an earthquake. This includes a numeric range of values (1-5) with 1 being no risk and 5 being the most severe. The source of this data was the Oregon Department of Geology and Mineral Industries, or DOGAMI, via the City.

Landslide risk is the risk associated with an area's exposure to landslide. This includes a numeric range of values (0-6) with 0 being no risk and 6 being the most severe. The source of this data was DOGAMI, via the City.

Wildfire risk is identified as the overall likelihood of a wildfire on highly valued resources and assets, such as critical infrastructure, developed recreation, housing unit density, seed orchards, sawmills, historic structures, timber, municipal watersheds, vegetation condition, and terrestrial and aquatic wildlife habitat. This risk also reflects the susceptibility of resources and assets to wildfire of different intensities, and the likelihood of those intensities. The source of this data was DOGAMI, via the City.

Rock excavation was determined by using both hydrologic soils data (e.g., depth to bedrock) and geology data (e.g., rock type). Rock excavation was defined as any areas where depth to bedrock was within five (5) feet of the surface. The source of this data was DOGAMI, via the Consultant.

Concepts

The conceptual approaches are unique to each infrastructure system and are outlined below.

Water

Assessment of the concept required to service the water needs of the expansion areas incorporated the potential pressure zones, storage requirements, and distribution backbone piping throughout the study area. The pressure zones were based upon the existing pressure zone (Zone 1), which has a service range of 0-ft to 250-ft. Zones were identified using a service range of 60 psi, or 138-ft, building upon the existing Zone 1 service area. These zones were allowed to go all the way up to Zone 6, as a function of the elevations present in the candidate expansion areas; however, in reality, service will likely not be considered above Zone 2.

Wastewater

An initial assessment of expansion areas focused on the service concept required to feasibly bring the area into the UGB. These concepts included the following:

- Short length local gravity extension,
- Intermediate length gravity extension,
- Long gravity extension,

- Long gravity extension & regional pump station, and
- Regional/service area pump station

Stormwater

The stormwater-based assessment of expansion areas focused on the land cover (i.e., curve number) associated with feasibly bringing the area into the UGB. These concepts included the following ranges of curve numbers:

- Curve Number < 60 (indicating less runoff generated)
- 60-70
- 70-80
- 80-90
- Curve Number > 90 (indicating more runoff generated)

Transportation

The assessment of transportation concepts for expansion areas considered both the existing and future planned infrastructure, including:

- New road or upgrade to existing road
- Local road or extension of existing road
- Emergency connections/ alternate access
- Transit Accessibility
- New trips in the peak hour, and
- Downstream capacity and congestion level

Application Relative to Infrastructure Systems

The results of the serviceability evaluation were completed separately for each infrastructure component, including: wastewater, water, and transportation. Scoring was weighted for the developable and serviceable areas, as per **Table 2**. Initial results for the serviceability analysis relative to each infrastructure system and concepts are presented below.

Wastewater

Wastewater scores are visually presented below in **Figure 3**.

Water

Water scores are visualized in **Figure 4**.

Transportation

Transportation scores are visually presented in **Figure 5**.

Composite

A composite score was calculated for each expansion area to aid in ranking of the infrastructure needs relative to one another. This composite score was weighted by area and is presented in **Table 3**.

Table 2 – Rating (Score) Criteria & Weighting

Rating (Score) Criteria & Weighting							
Concept	Details	Rating (Score)					Weight
		Excellent / Very Good (3)	Good (2.5)	Fair (2	Poor (1.5)	Very Poor (1)	
Hazard	Liquefaction Susceptibility	Low	N/A	Moderate	N/A	High	N/A
	Landslide Risk	Low	N/A	Moderate	N/A	High	N/A
	Wildfire Risk	Low	N/A	Moderate	N/A	High	N/A
Wastewater	Service Concept	Short Length Local Gravity Extension	Intermediate Length Gravity Extension	Long Gravity Extension	Long Gravity Extension & Regional Pump Station	Regional/ Service Area Pump Station	0.333
Water	Service Concept	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5+	0.333
Stormwater	Land Cover/ Curve Number Concept	<60	60-70	70-80	80-90	>90	<0.001
Transportation	Service Concept	Connect to existing road	N/A	Connect to upgrade required road	N/A	Needs new road	0.25
	New Road or upgrade to existing road (Local or Arterial/ Collector)	Needs new local roads	N/A	Needs new collector and local roads	N/A	Needs new arterial, collector and local roads	0.25
	New Roads	Multiple roads access	N/A	Collector or local access	N/A	Local or one road access only	0.2
	Emergency Connection/ Alternate Routes	< 10%	N/A	< 15%	N/A	>= 15%	0.1
	Slopes	< 1/4 mile to planned transit route	N/A	>1/4 Mile to planned transit route	N/A	Route extension required - 1 to 2 miles	0.1
	Transit Accessibility	<= 500	N/A	<= 1,000	N/A	> 1,000	0.05
	New Trips generated in peak hour	Available: V/C <=90	N/A	Saturated: V/C <=100	N/A	Over-capacity: V/C > 100	0.5

FIGURE 3 - WASTEWATER RESULTS

FIGURE 4 - WATER RESULTS

0 1,250 2,500 5,000 7,500 10,000 Feet

N

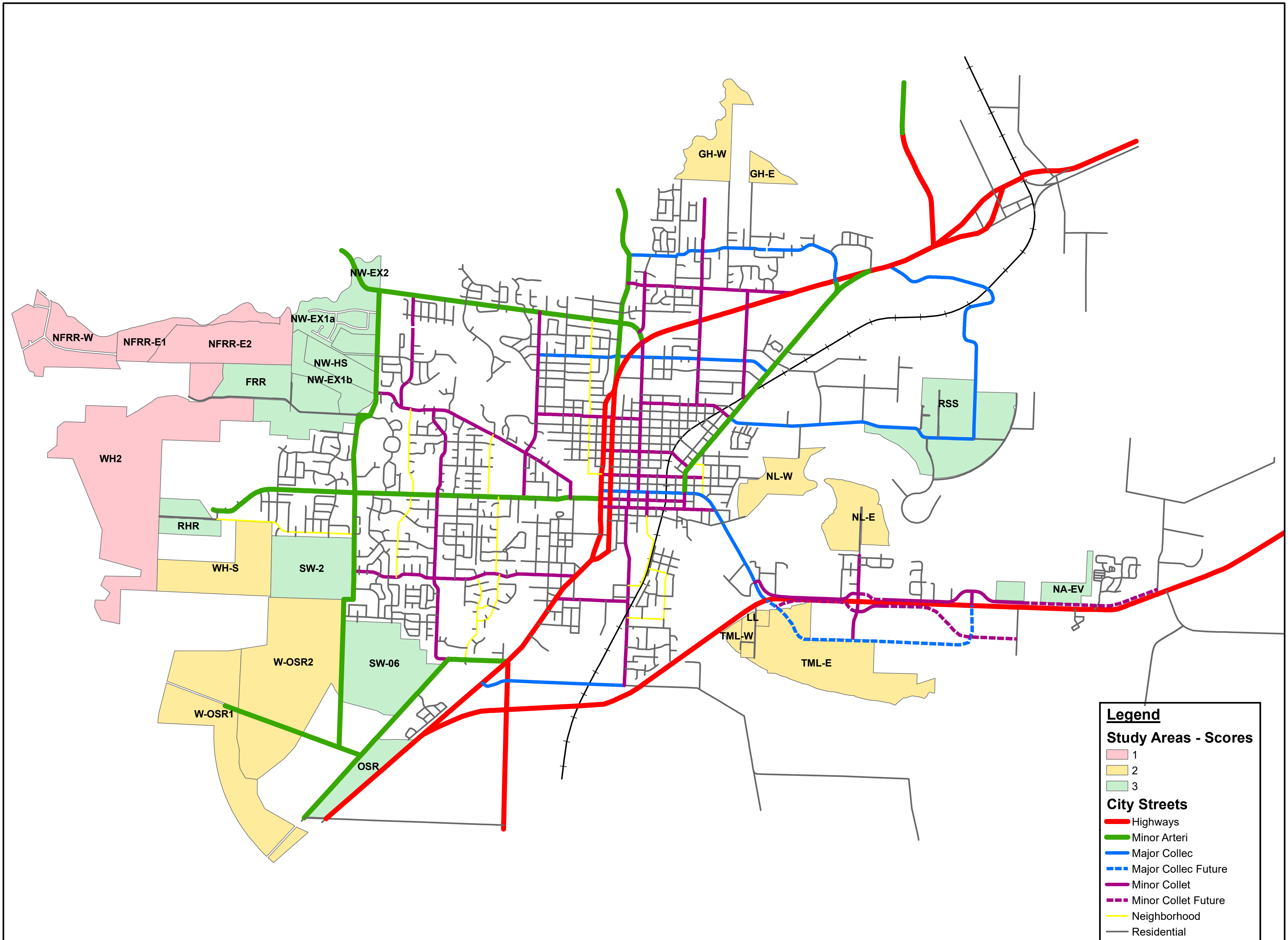

FIGURE 5 - TRANSPORTATION RESULTS

Table 3 – Composite Results (Color-Coding by Score)

Study Area	Public Facilities - Water	Public Facilities - Wastewater	Public Facilities - Stormwater	Transportation	Composite
Exception Areas					
Riverside South	3.0	2.0	2.0	3.0	**3**
Redmond Hill Road	3.0	3.0	2.0	3.0	**3**
Fox Ridge Road	3.0	2.0	2.0	3.0	**3**
Lawson Lane	3.0	1.0	2.0	2.0	**2**
Old Sheridan Road	3.0	3.0	2.0	3.0	**3**
N-Fox Ridge - West	3.0	1.0	2.0	1.0	**2**
Resource Areas					
NA-EV	3.0	3.0	2.0	3.0	**3**
Three Mile Lane East	3.0	1.0	2.0	2.0	**2**
Three Mile Lane West	3.0	1.0	2.0	2.0	**2**
Norton Lane East	3.0	2.0	2.0	2.0	**2**
Norton Lane West	3.0	2.0	2.0	2.0	**2**
SW I (SW 06)	3.0	3.0	2.0	3.0	**3**
SW II	3.0	3.0	2.0	3.0	**3**
W of Old Sheridan-1	3.0	3.0	2.0	2.0	**3**
W of Old Sheridan-2	3.0	3.0	2.0	2.0	**3**
West Hills-South	3.0	3.0	2.0	2.0	**3**
West Hills-2	2.0	2.0	2.0	1.0	**2**
N of Fox Ridge-East 1	3.0	1.0	2.0	1.0	**2**
N of Fox Ridge-East 2	3.0	1.0	2.0	1.0	**2**
NW-Ext 1a (Northern)	3.0	2.0	2.0	3.0	**3**
NW-Ext 1b (Southern)	3.0	2.0	2.0	3.0	**3**
NW-Ext 2	3.0	2.0	2.0	3.0	**3**
Grandhaven-E	3.0	2.0	2.0	2.0	**2**
Grandhaven-W	3.0	2.0	2.0	2.0	**2**

Feasibility of Inclusion and Service

A matrix of the developable and serviceable water, wastewater, and transportation systems by candidate expansion area and scenario was established to identify recommendations for the UGB expansion. Further weighting of the areas was applied as a function of the resource quality (e.g., high and low), with higher quality lands being less desirable to develop than lower quality. Additional considerations include:

- Concepts that incorporate contiguous priority lands
- Concepts without environmental implications (e.g., within a stream corridor)
- Concepts that coincide with planned Capital Improvement Projects (CIPs)

Available Capacity Evaluation

The available capacity of the infrastructure systems was completed using the most recent hydraulic models provided by the City, for wastewater, and McMinnville Water and Light (MWL), for water. The following subsections provide more detail on the capacity evaluations relative to the wastewater and water infrastructure systems.

Wastewater

For the available capacity evaluation, the City's hydraulic model (Innovyze InfoSWMM) was used to simulate existing dry weather flow conditions as well as existing and buildout wet weather flow conditions with the new developments. For peak dry weather flow, the deficiency criterion is based on a maximum flow depth to pipe diameter ratio of 0.8. For peak wet weather flow, surcharging of manholes is allowed with a minimum freeboard of 2-feet from maximum water surface to manhole rim. The following values were assumed to quantify loading for each candidate area, including:

- 150 gallons per day (gpd) per dwelling unit
- Dry weather peaking factor = 1.8, where
  - Peak Dry Weather Flow = 270 gallons per unit per day
- Peak infiltration & inflow (I&I) rate = 2,500 gallons per acre per day (gpad)

For the existing system evaluation, the additional flow from the candidate expansion areas was added to existing flows in the model at respective manholes. Local pipe capacity was evaluated assuming existing 8-inch local sewers are constructed at a minimum slope (0.4 ft/100 ft) and a Manning's pipe roughness coefficient of 0.013. A velocity criteria of 6 feet per second (fps) was applied when sizing forcemains in conjunction with estimated slopes and loading.

Table 4, below, presents the descriptive scores, as a function of feasibility, for both the local and downstream impacts associated with each expansion area and its sanitary sewer concept.

Water

For the available capacity evaluation, MWL's hydraulic model (Innovyze InfoWater) was used to simulate existing demands under the maximum day demand scenario. The following values were assumed to quantify the demands for each candidate expansion area, including:

- Persons per household = 2.54
- Average Day Demand (ADD) demand per dwelling unit = 150
- Peaking factor for ADD to Maximum Day Demand (MDD) = 2.3
  - Where MDD = 345 gallons per unit per day
- Peaking factor for MDD to Peak Hour Demand (PHD) = 4.0

Table 5 presents the descriptive scores for each expansion area. Color coding is a function of the water system serviceability score.

Table 4 – Wastewater Infrastructure System Descriptive Scores & Notes

Study Area	Feasibility	Pump Required	Upstream Contributions	Local Descriptive Score	Downstream Impacts Descriptive Score
Exception Areas					
Riverside South	Neither contains nor passes through environmental corridor (i.e., stream)	Yes; RSS PS	No	Loading via local gravity service to local pump station at lowest point in study area; pumped to existing gravity system at manhole "L-6-2"; Concept employs local gravity conveyance and a service area pump station that discharges to the existing gravity system.	The downstream system is pumped once, through RSPS. Enters existing gravity system close to RSPS and, therefore, has little impact on portion of system with available capacity
Redmond Hill Road	Neither contains nor passes through environmental corridor (i.e., stream)	No	Yes; WH-2-4 --> RHR-2/-3/-4/-5	Subdivided study areas (RHR-2 through RHR-5) loading via local gravity service to existing gravity system at manhole "D-8-6"; study area RHR-1 loading via local gravity service to existing gravity system at manhole "D-9-2"; Concept employs local gravity conveyance to the existing gravity system.	The downstream system is pumped twice, through COZINE PS & RSPS. Downstream existing infrastructure passes through environmental corridors (i.e., creek); System requires capacity upgrades in the downstream interceptor.
Fox Ridge Road	Subdivided study areas (FRR-2 through FRR-7) neither contain nor pass through environmental corridors (i.e., streams), with the exception of FRR-1	FRR-1 gravity to NFRR-E-2 and, ultimately, NW-EX-1 PS; FRR-2 through FRR-7 = No	No	FRR-1 loading via local gravity service to NFRR-E-2 and, ultimately, gravity service to NW-EX-1 PS, and pumped to existing gravity system at manhole "F-5-28"; FRR-2 through FRR-7 loading via local gravity service to existing gravity system: FRR-2 loads to manhole "E-7-9", FRR-3/-4/-5 load to manhole "F-7-79", FRR-6 loads to manhole "E-7-11", FRR-7 loads to manhole "F-7-83"; Concept employs local gravity conveyance to the existing gravity system for subdivided study areas (FRR-2/-3/-4/-5/-7); Concept for FRR-1 employs gravity conveyance to downstream proposed infrastructure and, ultimately, a regional pump station (NW-EX-1).	The downstream system is pumped twice, through COZINE PS & RSPS. Downstream existing infrastructure passes through environmental corridors (i.e., creek); System requires capacity upgrades in the downstream interceptor. just north and parallel to Wallace Rd.
Lawson Lane	Does not contain environmental corridor (i.e., stream); however, contributes flow downstream to pump station that requires pumping over an environmental corridor (i.e., bridge crossing)	Yes; TML-E (north)	No	Loading via local gravity service to local pump station at lowest point in study area "TML-E", north of the creek/ditch; this concept requires a bridge to cross the river and connect in to existing infrastructure; pumped to existing gravity system at manhole "J-8-58"; Concept employs local gravity conveyance to downstream proposed infrastructure, and, ultimately, a regional pump station (TML-E).	The downstream system is pumped twice, through 3MILELN#1 & RSPS. Despite being pumped, wastewater enters the existing gravity system close to RSPS and, therefore, has little impact on portion of system with available capacity
Old Sheridan Road	Neither contains nor passes through environmental corridor (i.e., stream)	No	Yes; W-OSR1_W-OSR-2 & W-OSR2_W-OSR-2 --> OSR	Loading via local gravity service to existing gravity system at manhole "F-12-2"; Concept employs local gravity conveyance to the existing gravity system.	The downstream system is pumped three times, through COZINEACRES & COZINE PS & RSPS. Downstream existing infrastructure passes through environmental corridors (i.e., creek); System requires capacity upgrades in the downstream interceptor. Alternate routes may be considered for gravity interceptor improvements to avoid portions of the environmental corridor.
N-Fox Ridge - West	Contains at least two environmental corridors/crossings (i.e., stream) within its study area	Yes; NW-EX-1	No	Loading via local gravity service to north of study area; loading transferred downstream through long gravity extension to NW-EX-1; Concept employs local gravity conveyance to downstream proposed infrastructure and, ultimately, a regional pump station (NW-EX-1).	The downstream system is pumped twice, through COZINE PS & RSPS. Downstream existing infrastructure passes through environmental corridors (i.e., creek); System requires capacity upgrades in the downstream interceptor including segments just north and parallel to Wallace Rd.
Resource Areas					
NA-EV	Neither contains nor passes through environmental corridor (i.e., stream)	No	No	Loading via local gravity service to existing gravity system at manhole "N-10-1" for study area NA-EV-1 and manhole "M-10-9" for study area NA-EV-2; Concept employs local gravity conveyance to the existing gravity system.	The downstream system is pumped four times, through 3MILELN#3 & 3MILELN#2 & 3MILELN#1 & RSPS. Higher per acre cost due to the smaller buildable area (relative to "NA-NOSV") despite being

					subject to similar downstream gravity system capacity issues and requiring multiple pumping scenarios.
Three Mile Lane East	Contains environmental corridor (i.e., stream) within its study area; therefore, requires service to north and south portions (bisected by stream/ditch)	Yes; TML-E (north)	No	Loading from north of creek is serviced via local gravity service to local pump station at lowest point in study area "TML-E", north of the creek/ditch; this concept requires a bridge to cross the river and connect in to existing infrastructure; pumped to existing gravity system at manhole "J-8-58"; south portion of TML-E = ???; Concept for the (1) North portion of the TML-E study area employs local gravity conveyance to a proposed regional pump station (TML-E), and (2) South portion of the TML-E study area...	The downstream system is pumped twice, through 3MILELN#1 & RSPS. Despite being pumped, wastewater enters the existing gravity system close to RSPS and, therefore, has little impact on portion of system with available capacity
Three Mile Lane West	Does not contain environmental corridor (i.e., stream); however, contributes flow downstream to pump station that requires pumping over an environmental corridor (i.e., bridge crossing)	Yes; TML-E (north)	No	Loading via local gravity service to local pump station at lowest point in study area "TML-E", north of the creek/ditch; this concept requires a bridge to cross the river and connect in to existing infrastructure; pumped to existing gravity system at manhole "J-8-58"; Concept employs local gravity conveyance to downstream proposed infrastructure and, ultimately, a regional pump station (TML-E).	The downstream system is pumped twice, through 3MILELN#1 & RSPS. Despite being pumped, wastewater enters the existing gravity system close to RSPS and, therefore, has little impact on portion of system with available capacity
Norton Lane East	Neither contains nor passes through environmental corridor (i.e., stream)	Yes; NL-E	No	Loading via local gravity service to local pump station at lowest point in study area; pumped to existing gravity system at manhole "K-9-19"; Concept employs local gravity conveyance and a service area pump station that discharges to the existing gravity system.	The downstream system is pumped twice, through 3MILELN#1 & RSPS. Enters existing gravity system close to RSPS and, therefore, has little impact on portion of system with available capacity
Norton Lane West	Contains environmental corridor (i.e., stream) along west boundary of study area, but does not impede the development of the majority of this study area	Yes; NL-W	No	Loading via local gravity service to local pump station at lowest point in study area; pumped to existing gravity system at manhole "K-7-1"; Concept employs local gravity conveyance and a service area pump station that discharges to the existing gravity system.	The downstream system is pumped once, through RSPS. NA
SW I (SW 06)	Contains environmental corridor (i.e., stream) along north-east boundary of study area, but does not impede the development of the majority of this study area; Assume can service area north of creek with existing gravity network to north and service area south of creek with proposed local gravity to existing gravity network	No	Yes; W-OSR2_W-OSR-4 --> SW 06	Loading via local gravity service to existing gracity system at manhole "F-11-1" for area south of creek (north-east corner of SW 06); Concept employs local gravity conveyance to existing gravity system.	The downstream system is pumped three times, through COZINEACRES & COZINE PS & RSPS. Downstream existing infrastructure passes through environmental corridor (i.e., creek). System requires capacity upgrades in the downstream interceptor. Alternate routes may be considered for gravity interceptor improvements to avoid portions of the environmental corridor.
SW II	Contains at least one environmental corridors/crossings (i.e., stream) within the subdivided study area portion "SW II-1" (designated by north/south of the creek)	No	Potentially; WH-2-5 --> WH-S --> SW II-1 (South)	Loading via local gravity service to existing gravity system at the following manholes for sub-divided areas: SW II -1 (split north/south of creek) to manholes "F-9-76" (North) and "F-10-18" (South); SW II-2 to manhole "F-9-69"; SW II-3 to manhole "E-9-9"; Concept employs local gravity conveyance to existing gravity system, though SW II-1 is split by the creek.	[SW-2_SW-2-1] - The downstream system is pumped three times, through KATHLN & COZINE PS & RSPS. [SW-2_SW-2-2/SW-2_SW-2-3] - The downstream system is pumped twice, through COZINE PS & RSPS. Downstream existing infrastructure passes through environmental corridor (i.e., creek); System requires capacity upgrades in the downstream interceptor. Alternate routes may be considered for gravity interceptor improvements to avoid portions of the environmental corridor.
W of Old Sheridan-1	Contains at least two environmental corridors/crossings (i.e., stream) within its study area; W-OSR1_W-OSR-1 is bisected by creek corridor, splitting loading to north and south of creek	No	Yes; WH-2-1 --> W-OSR1_W-OSR-1 (north of creek) --> W-OSR2_W-OSR-1 (north of creek) -->	Loading via local gravity service to downstream local gravity service systems, as follows: (1) North of creek: WH-2-1 to W-OSR1_W-OSR-1 to W-OSR2_W-OSR-1 to SW 06 to existing gravity system at manhole "F-11-1"; (2) South of creek: W-OSR1_W-OSR-1 to W-OSR2_W-OSR-1 to existing gravity system at manhole "F-12-1"; (3) W-OSR2_W-OSR-2 to OSR to existing gravity system at manhole "F-12-2"; Concepts employ local gravity conveyance to existing gravity system.	The downstream system is pumped three times, through COZINEACRES & COZINE PS & RSPS. Downstream existing infrastructure passes through environmental corridor (i.e., creek). System requires capacity upgrades in the downstream interceptor. Alternate routes may be considered for gravity interceptor improvements to avoid portions of the environmental corridor.

			SW 06 --> system		
W of Old Sheridan-2	Area W-OSR2_W-OSR-1 contains at least one environmental corridor/crossing (i.e., stream); the remainder do not	No	Yes; (1) WH-2-5 --> WH-S --> W-OSR2_W-OSR-3, (2) WH-2-1 --> W-OSR1_W-OSR-1 --> W-OSR2_W-OSR-1	Loading via local gravity service to existing gravity system at the following manholes for sub-divided areas: W-OSR2_W-OSR-1: "F-12-1", W-OSR2_W-OSR-3: "F-10-10"; W-OSR2_W-OSR-2: loading via local gravity service to downstream local gravity service in study area W-OSR1_W-OSR-2; and, W-OSR2_W-OSR-4: loading via local gravity service to downstream local gravity service in study area SW 06 and, ultimately, manhole "F-11-1" in th existing gravity system; Concepts employ local gravity conveyance to existing gravity system.	The downstream system is pumped three times, through COZINEACRES & COZINE PS & RSPS. Downstream existing infrastructure passes through environmental corridor (i.e., creek). System requires capacity upgrades in the downstream interceptor. Alternate routes may be considered for gravity interceptor improvements to avoid portions of the environmental corridor.
West Hills-South	Contains at least two environmental corridor/crossing (i.e., stream) within its study area; located mostly within the north-east corner of the study area	No	Yes; WH-2-5 --> WH-S	Loading via local gravity service to downstream local gravity service in study area "W-OSR2_W-OSR-3" to existing gravity system at manhole "F-10-10"; Concept employs local gravity conveyance to proposed downstream gravity conveyance that, ultimately, discharges to the existing gravity system.	The downstream system is pumped three times, through COZINEACRES & COZINE PS & RSPS. Downstream existing infrastructure passes through environmental corridor (i.e., creek). System requires capacity upgrades in the downstream interceptor. Alternate routes may be considered for gravity interceptor improvements to avoid portions of the environmental corridor.
West Hills-2	Contains minor environmental corridor/crossing (i.e., stream), only in small corner of south-west portion of WH-2-1	Yes; WH-2-2 to NW-EX-1 PS (via NFRR-E2 --> gravity); None required for WH-2-1/-3/-4/-5/-7	WH-2-7 --> WH-2-2	Loading via local gravity service to existing gravity system for the following subdivided areas: (1) WH-2-3 to manhole "D-8-9", (2) WH-2-4 to manhole "D-8-6" but shares cost with RHR-2/-3/-4/-5; loading via local gravity service to proposed local gravity infrastructure for the following subdivided areas: (3) WH-2-1 to W-OSR1-W-OSR-1 to W-OSR2_W-OSR-1 to existing manhole "F-11-1"; (4) WH-2-2 to NFRR-E2 to gravity service to regional pump station (NW-EX-1 PS) to existing manhole "F-5-28"; (5) WH-2-5 to WH-S to existing manhole "F-10-10"; Concepts employ local gravity conveyance to (1) existing gravity system (WH-2-3/-4), and (2) proposed downstream gravity conveyance (WH-2-1/-2).	[WH2_WH-1/WH2_WH-5] - The downstream system is pumped three times, through COZINEACRES & COZINE PS & RSPS. [WH2_WH-3/WH2_WH-4/WH2_WH-2/WH2_WH-7] - The downstream system is pumped twice, through COZINE PS & RSPS. Downstream existing infrastructure passes through environmental corridors (i.e., creek). System requires capacity upgrades in the downstream interceptor. Alternate routes may be considered for gravity interceptor improvements to avoid portions of the environmental corridor.
N of Fox Ridge-East 1	Contains at least two environmental corridors/crossings (i.e., stream) within its study area	Yes; NW-EX-1	No	Loading via local gravity service to north of study area; loading transferred downstream through long gravity extension to NW-EX-1; Concept employs local gravity conveyance to proposed downstream gravity system and, ultimately, a regional pump station (NW-EX-1 PS).	The downstream system is pumped twice, through COZINE PS & RSPS. Downstream existing infrastructure passes through environmental corridors (i.e., creek). System requires capacity upgrades in the downstream interceptor just north and parallel to Wallace Rd.
N of Fox Ridge-East 2	Contains at least three environmental corridors/crossings (i.e., stream) within its study area	Yes; NW-EX-1	Yes; WH-2-2 --> FRR-1 --> NFRR-E2	Loading via local gravity service to north of study area; loading transferred downstream through long gravity extension to NW-EX-1; Concept employs local gravity conveyance to proposed downstream gravity system and, ultimately, a regional pump station (NW-EX-1 PS).	The downstream system is pumped twice, through COZINE PS & RSPS. Downstream existing infrastructure passes through environmental corridors (i.e., creek). System requires capacity upgrades in the downstream interceptor just north and parallel to Wallace Rd.
NW-Ext 1a (Northern)	There is at least one environmental corridor/crossing (i.e., stream) within the subdivided sub-area NW-EX1a_NW-EX1-1)	Yes; NW-EX-1 for NW-EX1a_NW-EX1-1	Yes; NW-EX1b_NW-EX1-1, NW-EX1b_NW-EX1-3, & NW-HS_NW-HS-1	Loading via local gravity service to: (1) NW-EX1a_NW-EX1-1 --> gravity service along north of study area --> NW-EX1-1 PS --> existing manhole "F-5-28"; (2) NW-EX1a_NW-EX1-4 --> existing manhole "F-5-23"; Concepts employ local gravity conveyance to (1) existing gravity system (NW-EX1a_NW-EX1-4), and (2) proposed gravity downstream gravity system, ultimately discharging to regional pump station at NW-EX-1 (NW-EX1a_NW-EX1-1).	The downstream system is pumped twice, through COZINE PS & RSPS. Downstream existing infrastructure passes through environmental corridors (i.e., creek). System requires capacity upgrades in the downstream interceptor just north and parallel to Wallace Rd.
NW-Ext 1b (Southern)	There are at least two environmental corridors/crossings (i.e., streams) within the	Yes; NW-EX-1 for NW-	No	Loading via local gravity service to: (1) NW-EX1b_NW-EX1-1 --> NW-EX1a-NW-EX1-1 --> NW-EX1-1 PS --> existing manhole "F-5-28"; (2) NW-EX1b_NW-EX1-2 --> existing manhole	The downstream system is pumped twice, through COZINE PS & RSPS. Downstream existing infrastructure passes through

	subdivided sub-areas NW-EX1b_NW-EX1-1 & NW-EX1b_NW-EX1-3)	EX1b_NW-EX1-1 & NW-EX1b_NW-EX1-3		"F-6-13"; (3) NW-EX1b_NW-EX1-3 --> NW-EX1a-NW-EX1-1 --> NW-EX1-1 PS --> existing manhole "F-5-28"; and, (4) NW-EX1b_NW-EX1-4 --> existing manhole "F-6-23"; Concepts employ local gravity conveyance to (1) existing gravity system (NW-EX1b_NW-EX1-2/-4), and (2) proposed gravity downstream gravity system, ultimately discharging to regional pump station at NW-EX-1 (NW-EX1b_NW-EX1-1/-3).	environmental corridors (i.e., creek). System requires capacity upgrades in the downstream interceptor just north and parallel to Wallace Rd.
NW-Ext 2	Neither contains nor passes through environmental corridor (i.e., stream)	Yes; NW-EX-2	No	Loading via local gravity service to local pump station at lowest point in study area; pumped to existing gravity system at manhole "F-5-35"; Concept employs local gravity conveyance and a service area pump station (NW-EX 2) that discharges to the existing gravity system.	The downstream system is pumped twice, through COZINE PS & RSPS. Downstream existing infrastructure passes through environmental corridors (i.e., creek). System requires capacity upgrades in the downstream interceptor just north and parallel to Wallace Rd.
Grandhaven-E	Neither contains nor passes through environmental corridor (i.e., stream)	Yes; GH-E	No	Loading via local gravity service to local pump station at lowest point in study area; pumped to existing gravity system at manhole "I-3-47"; Concept employs local gravity conveyance and a service area pump station (GH-E) that discharges to the existing gravity system.	The downstream system is pumped once, through RSPS. Downstream existing infrastructure passes through at least three environmental corridors; Downstream existing gravity interceptor, within the Fairgrounds Basin, requires capacity upgrades.
Grandhaven-W	Contains environmental corridor (i.e., stream) at two points within the study area; can avoid crossings by connecting to "J-4-90"	Yes; GH-W	No	Loading via local gravity service to local pump station at lowest point in study area; pumped to existing gravity system at manhole "J-4-90" for minimal environmental implications, else connect to existing gravity system at manhole "J-3-4"; Concept employs local gravity conveyance and a service area pump station (GH-W) that discharges to the existing gravity system.	The downstream system is pumped once, through RSPS. Downstream existing infrastructure passes through at least three environmental corridors; Downstream existing gravity interceptor, within the Fairgrounds Basin, requires capacity upgrades.

Table 5 – Water Infrastructure System Descriptive Scores & Notes

Study Area	Feasibility
Exception Areas	
Riverside South	Zone 1 Only
Redmond Hill Road	Zone 1 - 12%; Zone 2 - 83%; Zone 3 - 5%
Fox Ridge Road	Zone 1 - 18%; Zone 2 - 76%; Zone 3 - 6%
Lawson Lane	Zone 1 Only
Old Sheridan Road	Zone 1 Only
N-Fox Ridge - West	Zone 1 - 49%; Zone 2 - 48%; Zone 3 - 3%
Resource Areas	
NA-EV	Zone 1 Only
Three Mile Lane East	Zone 1 Only
Three Mile Lane West	Zone 1 Only
Norton Lane East	Zone 1 Only
Norton Lane West	Zone 1 Only
SW I (SW 06)	Zone 1 Only
SW II	Zone 1 Only
W of Old Sheridan-1	Zone 1 Only
W of Old Sheridan-2	Zone 1 Only
West Hills-South	Zone 1 - 93%, Zone 2 - 7%
West Hills-2	Zone 1 - 3%, Zone 2 - 19%, Zone 3 - 46%, Zone 4 - 22%, Zone 5 - 9%, Zone 6 - <1%
N of Fox Ridge-East 1	Zone 1 Only
N of Fox Ridge-East 2	Zone 1 - 72%, Zone 2 - 28%
NW-Ext 1a (Northern)	Zone 1 Only
NW-Ext 1b (Southern)	Zone 1 - 99%, Zone 2 - 1%
NW-Ext 2	Zone 1 Only
Grandhaven-E	Zone 1 Only
Grandhaven-W	Zone 1 Only

Transportation

The transportation system feasibility and capacity evaluation were done based on existing and future planned roadways, planned transit, potential development; and existing and forecasted traffic congestion on the City's roadway networks.

The location of the candidate expansion areas relative to the City's existing roadway network was used to evaluate each area for the following criteria -

- New road or upgrade to existing road
- Local road or extension of existing road
- Emergency connections/ alternate access

The usability of the potential roads connecting the candidate areas was evaluated based on slopes in each area. The higher the slope lesser favorable the roads would be for pedestrians, bicyclists and emergency vehicles.

Accessibility to existing and planned transit service was determined based on the "Transit Corridor Buildable Lands - Figure 3" provided by the City. The further the transit services were the lower the candidate area scored on its evaluation.

Based on the planned dwelling units and commercial area provided by the City, the number of new trips generated by each candidate area were estimated. These new trips were calculated using trip rates estimated based on the Yamhill County model for the City.

For the available downstream capacity, the City's Transportation System Plan (TSP) published in May 2010 was used to understand existing and future forecasted traffic congestion on the City's roadway network. The volume to capacity information in the TSP was used to determine available capacity.

Table 6 presents the descriptive scores for each expansion area. Color coding is a function of the transportation system serviceability score.

Table 6 – Transportation Serviceability Descriptive Scores and Downstream Impact Notes

Study Area	Scores	Descriptive Score	Downstream Impact
Exception Areas			
Riverside South	3.0	Requires local roads and connection to existing transportation network, multiple access for emergency services and connected to major roadway	Impacts traffic downstream on the already congested NE Lafayette Ave through the town and the Three Mile Lane connecting to the Airport
Redmond Hill Road	3.0	Requires local roads and connection to existing transportation network, multiple access for emergency services and connected to major roadway	Impacts traffic downstream on the east-west SW 2nd St corridor to the town and the Three Mile Lane connecting to the Airport
Fox Ridge Road	3.0	Requires local roads and connection to existing transportation network, multiple access for emergency services and within 1/2 mile of transit network	Impacts traffic downstream on the east-west SW 2nd St corridor through the town and the Three Mile Lane connecting to the Airport
Lawson Lane	2.0	Requires upgrade to existing access roads, do not have multiple access for emergency services and downstream roadway network is at capacity and would need upgrades to serve the new trips	Impacts traffic on Three Mile Lane connecting to the downtown and SR 18 to the Airport
Old Sheridan Road	3.0	Requires local roads and connection to existing transportation network, multiple access for emergency services and connected to major roadway	Impacts traffic on the north-south Highway 18 through the town and SR 18 connecting to the Airport
N-Fox Ridge - West	1.0	Requires connection with current transportation network at a longer distance, do not have multiple access for emergency services, have medium slopes and no planned transit service	Impacts traffic downstream on the east-west SW 2nd St corridor through the town and the Three Mile Lane connecting to the Airport
Resource Areas			
NA-EV	3.0	Requires local roads and connection to existing transportation network, multiple access for emergency services and within 1/4 mile of transit network	Impacts traffic on the east-west corridor on Three Mile Lane to the town
Three Mile Lane East	2.0	Requires new roadways to connect to existing network and do not have multiple access for emergency services; but have transit services within 1/4 mile	Impacts traffic on Three Mile Lane connecting to the downtown and SR 18 to the Airport

Three Mile Lane West	2.0	Requires upgrade to existing access roads, do not have multiple access for emergency services and downstream roadway network is at capacity and would need upgrades to serve the new trips	Impacts traffic on Three Mile Lane connecting to the downtown and SR 18 to the Airport
Norton Lane East	2.0	Requires connections to existing roads, do not have multiple access for emergency services and downstream roadway network is at capacity and would need upgrades to serve the new trips	Impacts traffic on Three Mile Lane connecting to the downtown and SR 18 to the Airport
Norton Lane West	2.0	Requires connection to existing roads, do not have multiple access for emergency services and downstream roadway network is at over-capacity would need upgrades to serve the new trips	Impacts traffic on Three Mile Lane connecting to the downtown and SR 18 to the Airport
SW I (SW 06)	3.0	Requires local roads and connection to existing transportation network, multiple access for emergency services and connected to major roadway	Impacts traffic on Old Sheridan Road and Pacific Highway connecting to the downtown and SR 18 to the Airport
SW II	3.0	Requires local roads and connection to existing transportation network, multiple access for emergency services and connected to major roadway	Impacts traffic downstream on the east-west SW 2nd St corridor through the town and the Three Mile Lane connecting to the Airport
W of Old Sheridan-1	2.0	Requires upgrade to existing access roads, do not have multiple access for emergency services and no planned transit service within 1 mile	Impacts traffic on Old Sheridan Road and Pacific Highway connecting to the downtown and SR 18 to the Airport
W of Old Sheridan-2	2.0	Requires connection to existing roads, do not have multiple access for emergency services and no planned transit service within 1 mile	Impacts traffic on Old Sheridan Road and Pacific Highway connecting to the downtown and SR 18 to the Airport
West Hills-South	2.0	Requires upgrade to existing access roads, do not have multiple access for emergency services and no planned transit service within 1 mile	Impacts traffic downstream on the east-west SW 2nd St corridor through the town and the Three Mile Lane connecting to the Airport
West Hills-2	1.0	Requires connection with current transportation network at a longer distance, do not have multiple access for emergency services, have high slopes and no planned transit service within 1 mile	Impacts traffic downstream on the east-west SW 2nd St corridor through the town and the Three Mile Lane connecting to the Airport
N of Fox Ridge-East 1	1.0	Requires connection with current transportation network at a longer distance, do not have multiple access for emergency services, have medium slopes and no planned transit service	Impacts traffic downstream on the east-west SW 2nd St corridor through the town and the Three Mile Lane connecting to the Airport

N of Fox Ridge-East 2	1.0	Requires connection with current transportation network at a longer distance, do not have multiple access for emergency services, have high slopes and no planned transit service	Impacts traffic downstream on the east-west SW 2nd St corridor through the town and the Three Mile Lane connecting to the Airport
NW-Ext 1a (Northern)	3.0	Requires local roads and connection to existing transportation network, multiple access for emergency services, connected to major roadway and within 1/4 mile of transit network	Impacts traffic on NW Baker Creek Road to downtown and Three Mile Lane to the Airport
NW-Ext 1b (Southern)	3.0	Requires local roads and connection to existing transportation network, multiple access for emergency services and within 1/2 mile of transit network	Impacts traffic on NW Baker Creek Road to downtown and Three Mile Lane to the Airport
NW-Ext 2	3.0	Requires local roads and connection to existing transportation network, multiple access for emergency services and within 1/4 mile of transit network	Impacts traffic on NW Baker Creek Road to downtown and Three Mile Lane to the Airport
Grandhaven-E	2.0	Requires upgrade to existing access roads, do not have multiple access for emergency services and no planned transit service within 1 mile	Impacts traffic on Pacific Highway to downtown and SR 18 to the Airport
Grandhaven-W	2.0	Requires upgrade to existing access roads, do not have multiple access for emergency services and no planned transit service within 1 mile	Impacts traffic on Pacific Highway to downtown and SR 18 to the Airport

Cost Analysis

A planning-level cost analysis was completed for each concept relative to not only the infrastructure system but also the candidate expansion area. Capital costs were also calculated for the downstream impacts resulting from each scenario and expansion area. Costs were estimated for both the local (i.e., expansion area) and downstream (i.e., system-wide) scales based on the following assumptions and unit costs.

For the wastewater infrastructure, unit costs included the following:

- Local Forcemain Cost - $30/inch/linear feet, assuming:
  - Peak Dry + Wet Weather Flow conditions and a velocity criteria of six (6) fps
- Local Gravity Cost - $40/inch/linear feet, assuming:
  - Peak Dry + Wet Weather Flow conditions and sized using full flow capacity with Manning's Equation for full pipe flow (roughness coefficient, n, of 0.013)
- Local Pump Station Cost - $2,500/gpm firm capacity, assuming
  - Peak Dry and Wet Weather Flow conditions
- Downstream Pump Station Cost - $1,000,000/cfs firm capacity
  - If no forcemain, apply a factor = 1.15

For the water infrastructure, unit costs included the following:

- Local Storage Costs - $2,500,000/million gallons of storage
  - This assumes the following:
    - Fire Flow Volume = 3,000 gpm for a total of three (3) hours
    - Equalization Volume = 25 percent of MDD for a total of 24 hours
    - Emergency Volume = 100 percent of MDD for a total of 24 hours
    - Total Storage Volume = Fire Flow Volume + Equalization Volume + Emergency Volume
- Local Pump Station Cost - $4,000/gpm firm capacity (multiplied as a function of service to zones above Pressure Zone 2)[1]
- Downstream Transmission Main Cost - $35/inch/linear feet, assuming:
  - MDD conditions plus 1,000 gpm of fire flow and a velocity criteria of six (6) fps

The local and downstream wastewater costs, per expansion area, are presented in **Table 7**. The local and downstream water costs, per expansion area, are presented in **Table 8**. These tables also present costs on a per dwelling unit and per buildable acre basis. Color coding is based on the standard deviations and average values for the per buildable acre results.

For transportation infrastructure, unit costs included the following:

- New roadway costs - $2,231,965/mile
  - This assumes that any new road would be an undivided, 2-lane rural road with 5'-wide paved shoulders.

[1] Pressure Zone 2 is multiplied by a value of 1.0; Pressure Zone 3 is multiplied by a value of 2.0; Pressure Zone 4 is multiplied by a value of 3.0; Pressure Zone 5 is multiplied by a value of 4.0; and, Pressure Zone 6 is multiplied by a value of 5.0.

A planning-level cost analysis was completed for transportation concept for the candidate expansion area. Capital costs were estimated based on information on American Road & Transportation Builders Association (ARTBA) from Florida DOT.

The local transportation costs and the cost range, per expansion area, are presented in **Table 9**. The local transportation costs, per expansion area, are presented as cost per buildable acre.

Table 7 – Wastewater Infrastructure System Costs (Local & Downstream)

Study Area	Local Costs			Downstream Capital Costs		
	Total ($million)	Per Dwelling Unit ($/DU)	Per Buildable Acre ($/acre)	Capital ($million)	Per Dwelling Unit ($/DU)	Per Buildable Acre ($/acre)
Exception Areas						
Riverside South	$4.51	$8,163	$35,101	$4.50	$8,142	$35,009
Redmond Hill Road	$1.56	$19,150	$67,026	$0.99	$12,209	$42,733
Fox Ridge Road	$4.54	$19,956	$69,846	$2.87	$12,613	$44,147
Lawson Lane	$1.12	$24,053	$103,426	$0.32	$6,798	$29,233
Old Sheridan Road	$0.55	$4,266	$14,932	$1.62	$12,649	$44,273
N-Fox Ridge - West	$2.47	$12,163	$42,569	$2.10	$10,356	$36,244
Resource Areas						
NA-EV	$0.68	$2,813	$11,269	$3.08	$12,834	$51,422
Three Mile Lane East	$2.84	$2,442	$15,385	$6.19	$5,325	$33,544
Three Mile Lane West	$0.45	$8,788	$55,366	$0.28	$5,325	$33,544
Norton Lane East	$2.08	$4,982	$31,388	$2.22	$5,325	$33,544
Norton Lane West	$0	$0	$0	$0	$0	$0
SW I (SW 06)	$0.34	$415	$2,815	$6.62	$8,209	$55,651
SW II	$1.16	$1,600	$10,078	$7.40	$10,234	$64,473
W of Old Sheridan-1	$4.59	$3,398	$21,408	$11.58	$8,570	$53,989
W of Old Sheridan-2	$3.06	$1,715	$10,805	$15.28	$8,570	$53,989
West Hills-South	$1.02	$1,483	$9,342	$5.91	$8,570	$53,989
West Hills-2	$12.18	$7,651	$32,898	$16.71	$10,495	$45,128
N of Fox Ridge-East 1	$1.77	$4,805	$30,274	$2.58	$7,016	$44,198
N of Fox Ridge-East 2	$2.17	$3,069	$19,333	$4.97	$7,016	$44,198
NW-Ext 1a (Northern)	$1.79	$8,691	$54,755	$1.44	$7,016	$44,198
NW-Ext 1b (Southern)	$2.31	$5,444	$34,294	$3.04	$7,173	$45,192
NW-Ext 2	$0.88	$6,563	$58,800	$0.78	$5,776	$51,754
Grandhaven-E	$1.37	$11,874	$74,809	$1.02	$8,821	$55,575
Grandhaven-W	$2.40	$5,656	$35,632	$3.74	$8,821	$55,575
Total	**$55.81**			**$105.23**		

Table 8 – Water Infrastructure System Costs (Local & Downstream)

Study Area	Local Costs			Downstream Capital Costs		
	Total ($million)	Per Dwelling Unit ($/DU)	Per Buildable Acre ($/acre)	Capital ($million)	Per Dwelling Unit ($/DU)	Per Buildable Acre ($/acre)
Exception Areas						
Riverside South	$0.70	$1,263	$5,420	$0.30	$542	$2,329
Redmond Hill Road	$0.30	$3,666	$12,799	$0.01	$64	$226
Fox Ridge Road	$0.80	$3,517	$12,309	$0.02	$97	$339
Lawson Lane	$0.06	$1,261	$5,420	$0.05	$1,041	$4,474
Old Sheridan Road	$0.17	$1,302	$4,558	$0.07	$542	$1,896
N-Fox Ridge - West	$0.54	$2,656	$9,295	$0.05	$268	$937
Resource Areas						
NA-EV	$0.31	$1,274	$5,104	$0.25	$1,041	$4,169
Three Mile Lane East	$1.40	$1,203	$7,576	$1.21	$1,041	$6,555
Three Mile Lane West	$0.06	$1,203	$7,576	$0.05	$1,041	$6,555
Norton Lane East	$0.50	$1,203	$7,576	$0.43	$1,041	$6,555
Norton Lane West	$0	$0	$0	$0	$0	$0
SW I (SW 06)	$0.96	$1,194	$8,093	$0.44	$542	$3,672
SW II	$0.87	$1,203	$7,576	$0.39	$542	$3,413
W of Old Sheridan-1	$1.63	$1,203	$7,576	$0.73	$542	$3,413
W of Old Sheridan-2	$2.14	$1,203	$7,576	$0.97	$542	$3,413
West Hills-South	$0.92	$1,338	$8,428	$0.35	$503	$3,166
West Hills-2	$10.84	$6,806	$29,267	$0.03	$17	$71
N of Fox Ridge-East 1	$0.44	$1,203	$7,576	$0.20	$542	$3,413
N of Fox Ridge-East 2	$1.22	$1,725	$10,866	$0.28	$390	$2,459
NW-Ext 1a (Northern)	$0.25	$1,203	$7,576	$0.11	$542	$3,413
NW-Ext 1b (Southern)	$0.51	$1,215	$7,652	$0.23	$539	$3,394
NW-Ext 2	$0.16	$1,166	$10,444	$0.07	$542	$4,854
Grandhaven-E	$0.14	$1,203	$7,576	$0.06	$542	$3,413
Grandhaven-W	$0.51	$1,203	$7,576	$0.23	$542	$3,413
Total	**$25.42**			**$6.53**		

Table 9 – Transportation Infrastructure System Costs

Study Area	Cost/Buildable Area ($/acre)	Cost Range
Exception Areas		
Riverside South	$13,000	Low
Redmond Hill Road	$43,000	Medium
Fox Ridge Road	$36,000	Medium
Lawson Lane	$72,000	High
Old Sheridan Road	$21,000	Low
N-Fox Ridge - West	$67,000	High
Resource Areas		
NA-EV	$31,000	Medium
Three Mile Lane East	$15,000	Low
Three Mile Lane West	$82,000	High
Norton Lane East	$25,000	Low
Norton Lane West	$0.00	$0
SW I (SW 06)	$20,000	Low
SW II	$20,000	Low
W of Old Sheridan-1	$16,000	Low
W of Old Sheridan-2	$11,000	Low
West Hills-South	$21,000	Low
West Hills-2	$15,000	Low
N of Fox Ridge-East 1	$78,000	High
N of Fox Ridge-East 2	$27,000	Low
NW-Ext 1a (Northern)	$31,000	Medium
NW-Ext 1b (Southern)	$33,000	Medium
NW-Ext 2	$52,000	Medium
Grandhaven-E	$43,000	Medium
Grandhaven-W	$25,000	Low

Results and Recommendation

Local and downstream analyses yield the feasibility of each expansion area as a function of the criteria established earlier in the TM.

[results and recommendations to be added]


GH
NW-EX2
NFRR-W
NFRR-E
NW-EX1a
NW-HS
NW-EX1b
FRR
WH2
RHR
WH-S
SW-2
W-OSR2
SW-06
W-OSR1
OSR
RSS
NL-W
NL-E
NA-NOSV
NA-EV
TML-W
LL
TML-E
DRAFT
10/15/2020
Legend
Sanitary Sewer
Gravity
Force
Sewer Concept Area
Serviceability Concept
Short Length Local Gravity Extension
Intermediate Length Gravity Extension
Long Gravity Extension
Long Gravity Extension and Regional PS
Regional Pump Station
Service Area Pump Station
Routing Concept
Gravity Concept
Pumped Concept
N
0
1,250
2,500
5,000
7,500
10,000 Feet


NFRR-W
NFRR-E
NW-EX2
NW-EX1a
NW-HS
NW-EX1b
FRR
WH2
RHR
SW-2
W-OSR2
SW-06
W-OSR1
OSR
GH
RSS
NL-W
NL-E
NA-NOSV
NA-EV
TML-W
LL
TML-E
DRAFT
10/15/2020
Legend
Water Distribution
Water Main
Proposed Water Connection
Water Pressure Zones
Zone 1
Zone 2
Zone 3
Zone 4
Zone 5
Zone 6
Zone 7
0
1,250
2,500
5,000
7,500
10,000 Feet
N