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)

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

Lead authors: Gerard C.S. Mildner, Ph.D.
Jerald Johnson, AICP
Robert Trapa, M.Eng.

Research Team Jeff Horwitz
Alexander Wallace
Trevor Wright

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.

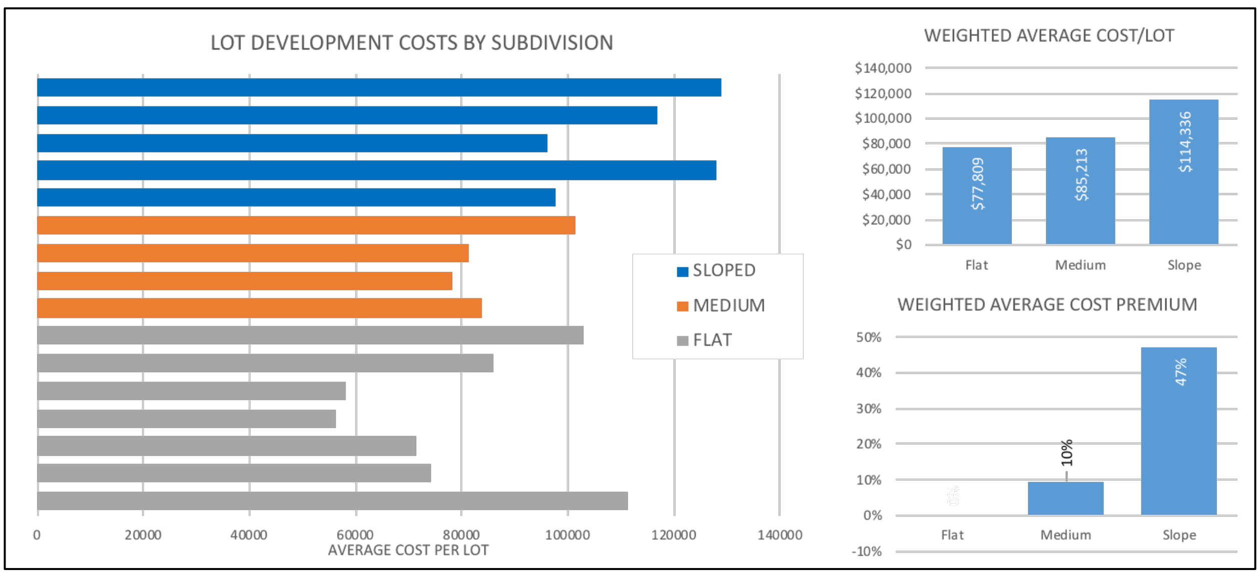
## Data Sets and Analysis

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**



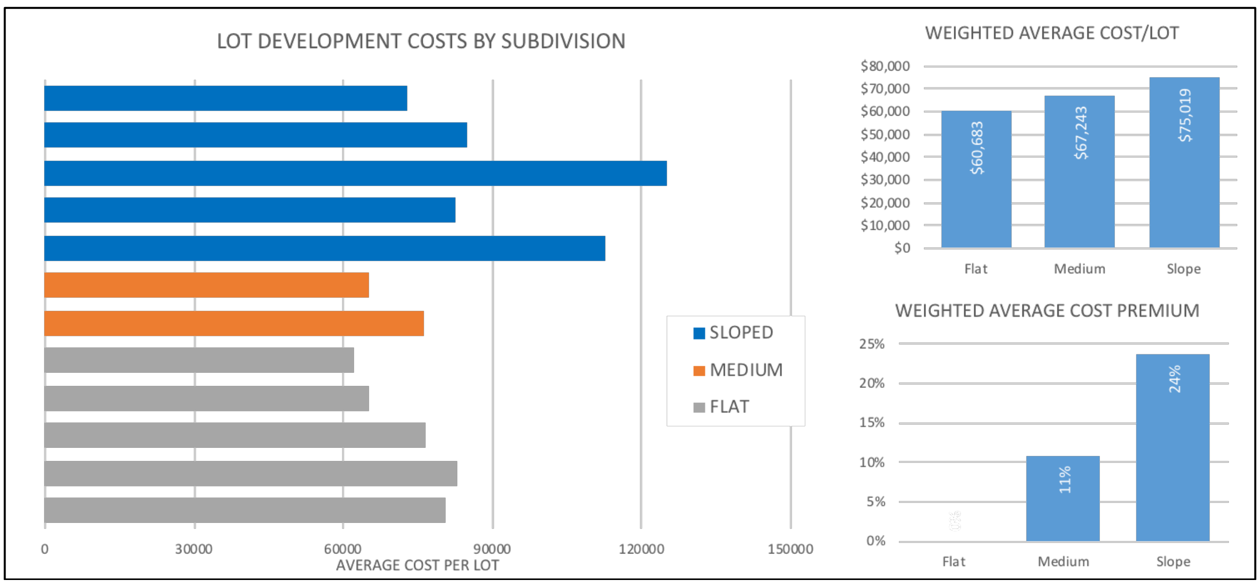

Data set #2 consists of 12 case studies of single family developments built by four separate developers. Five of these developments were built on steeply sloped land, two were built on moderately sloped land, and five were built on flat land. The mean per lot infrastructure costs for steeply sloped land, 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.

Section 1 Conclusions

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.

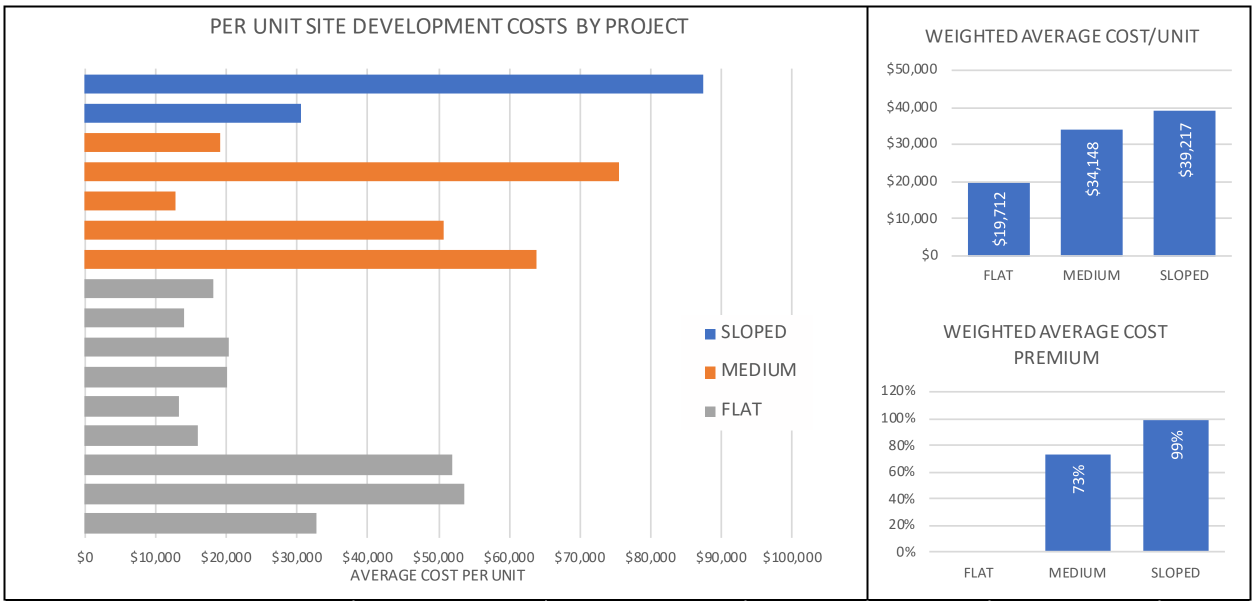
In addition to gathering cost data, some supplemental work involved analyzing potential sites for development in McMinnville in order to determine soil anatomy. Gathering this information will ideally provide a convenient file of basic soil information for each site for future reference. Upon looking 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.

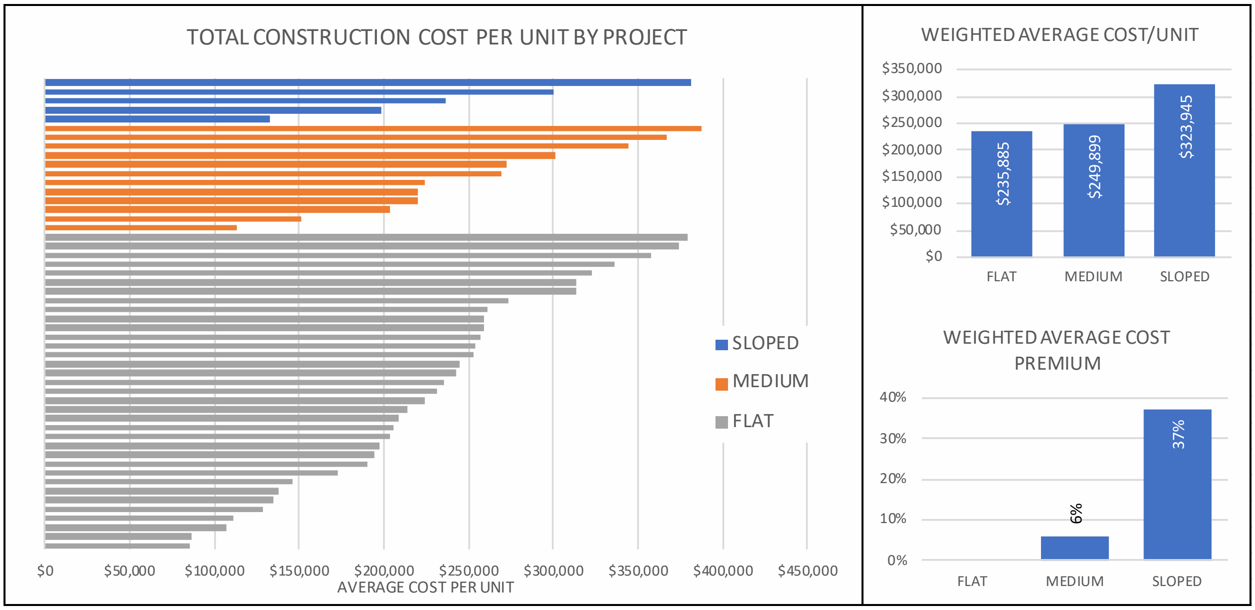
From this data, we found nine observations with mild or no slope (0-4%), five observations with moderate slope (5-9%), and two observations with steep slopes (10% or higher). From these observations, we computed the weighted average site development cost and found the steep sites required $39,217, the 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

**Gerard C.S. Mildner** is an Associate Professor Real Estate Finance at Portland State University and the Academic Director at the PSU Center for Real Estate. He has a bachelor's degree from the University of Chicago and a Ph.D. in Economics from New York University.

**Jerald Johnson** is a principal with Johnson Economics and an Adjunct Instructor in Real Estate at Portland State University. He has bachelor degrees in Architectural Design and Economics and a Master of Urban Planning from Portland State University.

**Robert C. Trapa** is a Senior Vice President with Bremik Construction in Portland and an Adjunct Instructor in Urban Studies and Planning at Portland State University. He has a Master's degree in Engineering Management from Montana State University

**Jeff Horwitz** is a Master degree candidate in Real Estate Development from Portland State University and is the RMLS Student Fellow with the Center for Real Estate. He has a Master degree in Urban Planning and Policy from the University of Illinois at Chicago.

**Alexander Wallace** is a Master degree candidate in Real Estate Development from Portland State University and is an SCS Student Fellow with the Center for Real Estate. He has a bachelor's degree in Law from the University of Stirling in Scotland.

**Trevor Wright** is a Master degree candidate in Real Estate Development from Portland State University and is an SCS Student Fellow with the Center for Real Estate. He has a bachelor's degree in History from the University of Oregon.

JACOBS

| | |
|---|---|
| **Subject** | **Serviceability Analysis** |
| **Project Name** | City of McMinnville, Oregon – UGB Remand Infrastructure Serviceability Analysis |
| **Attention** | City of McMinnville, Oregon |
| **From** | Jacobs Engineering<br>Thomas C. Walsh, PhD, PE; Kristi Steiner, PE; Neha Rathi, PE |
| **Reviewed** | Shad Roundy, PE |
| **Date** | October 30, 2020 |

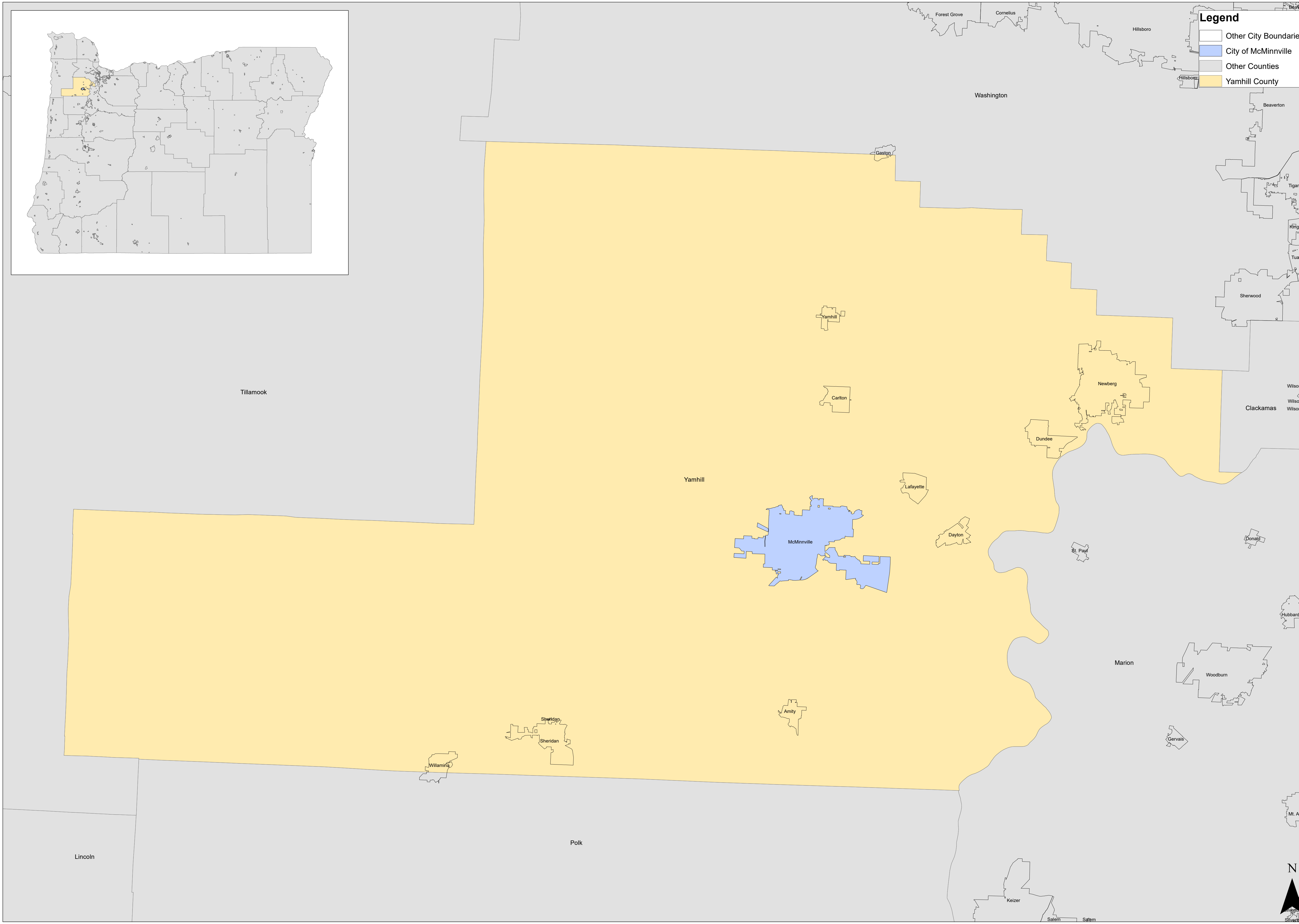
## Background

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. 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 the Land Conservation and Development Commission (LCDC). 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 2006 submittal 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. After the appeal hearing, the City paused the update to 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.

In 2018, the City began to examine its long-range population and employment forecasts and related urban land needs. Because economic conditions had drastically slowed growth and development, the 2018 review indicated a similar need for residential capacity as defined in the 2006 DLCD submittal. 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**.




Inset Image: State of Oregon, with county and city boundaries outlined.

**Figure 1 - Study Area**

0 1.25 2.5 5 7.5 10 Miles

A summary of the candidate 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** |
| BB | Booth Bend Road | 40.2 | Out | Exception |
| BR | Brentano Lane | 91.8 | Out | Exception |
| EA | East of Airport | 493.4 | Out | Resource |
| 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 |
| NBC | North of Baker Creek | 118.7 | Out | Resource |
| 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 |
| WR | Westside Road | 35.0 | Out | Exception |
| **Total** | | **3,885** | **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, sewer, stormwater and transportation infrastructure. The evaluation presented in this document includes a review of infrastructure serviceability of the candidate expansion areas shown in **Figure 1** and **Table 1**.

## Assumptions

The water, sewer, or transportation models used for the analysis were provided by the following entities:

- Water Distribution – McMinnville Water and Light (MWL)
- Sewer – City of McMinnville and Jacobs Engineering
- Transportation – Yamhill County model for the City of McMinnville (VISUM)
- Storm – Not modeled

Water supply, water treatment, wastewater treatment, and treated wastewater discharge services were excluded from the evaluation.

Information for water, sewer, stormwater, and transportation infrastructure related to the models and planned system improvements was reviewed in the following planning documents:

- Water
  - *McMinnville Water & Light – Water Master Plan* (October 2011)
- Sewer
  - *Collection System Available Capacity Mapping* (April 30, 2019)
  - *Sanitary Sewer Master Plan Updates – Conveyance System Master Plan* (October 2008)
- Stormwater
  - *Storm Drainage Master Plan* (April 2009)
- Transportation
  - *City of McMinnville – Transportation System Plan* (May 2010)

## 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

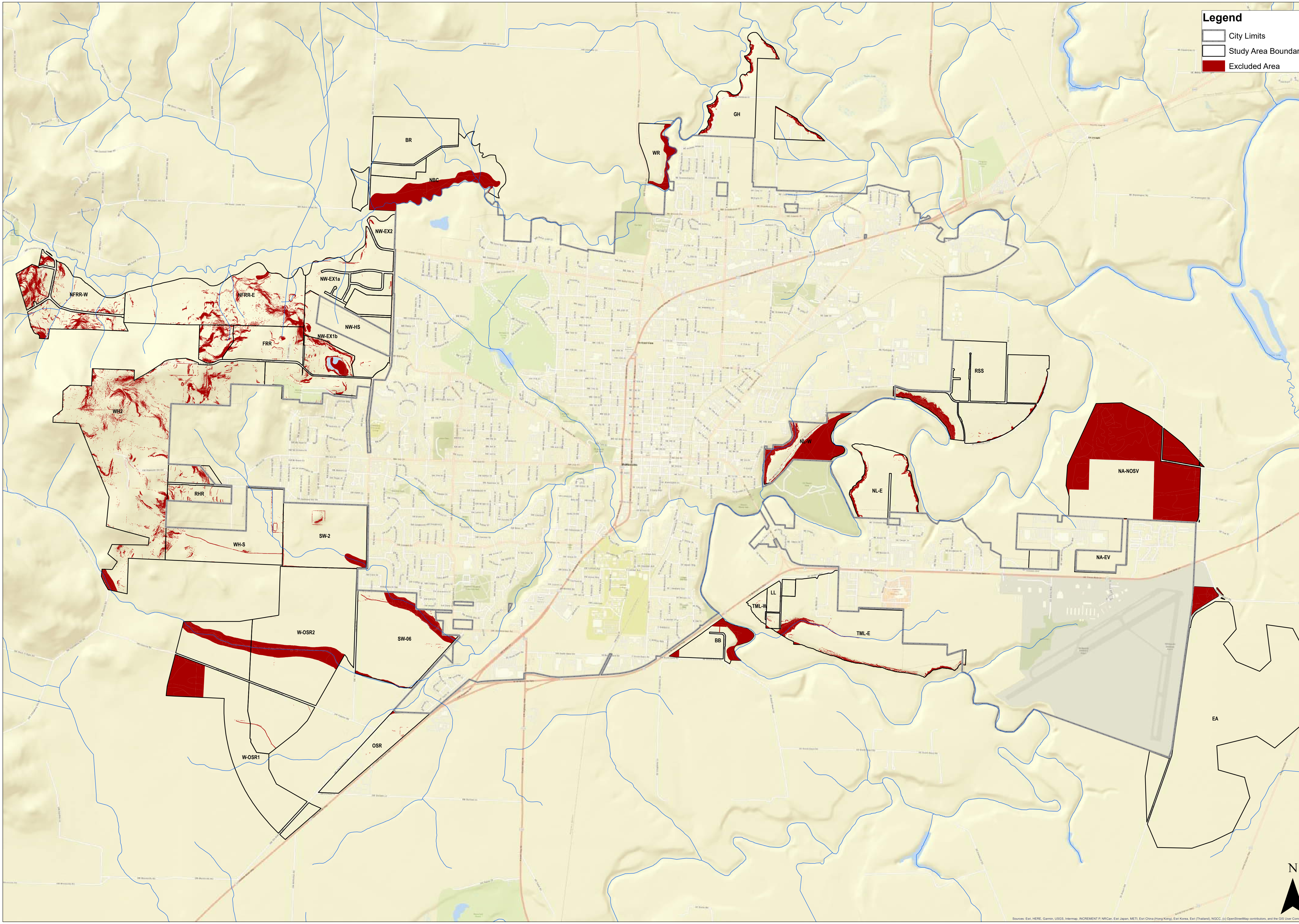
City staff provided mapping and background data for areas of exclusion, which encompassed the following topographic (i.e., physical) datasets:

- 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 646 acres, or roughly 17 percent of the total study area (3,885 acres). This results in a buildable area of 3,239 acres, with 3,182 acres serving residential uses and 57 acres serving commercial uses.




Map reflects study areas and concepts, as of 10/8/2020.

**Figure 2 - Exclusion Results by Expansion Area**

## Serviceability Evaluation

### Approach

The serviceability analysis considered scoring of infrastructure concepts for servicing candidate expansion areas. Constructability hazards were excluded by the City and removed as part of the excluded lands. Thus, buildable lands had already accounted for these hazards.

#### Hazards

Hazards were accounted for and excluded from the buildable lands analysis completed by the City for expansion areas.

#### Concepts

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

***Water***

Concepts required to service the water needs of the expansion areas included pressure zone topographic breaks, storage requirements, pumping requirements, and distribution backbone piping throughout the study area. The existing pressure zone (Zone 1), which has a service range of 0-feet to 250-feet elevation, is well established for expansion with reservoirs and infrastructure currently in place. New Pressure Zones (2 thru 6) were identified using a service range of 60 pounds per square inch (psi), or 138-feet for each zone with Zone 2 138 feet above Zone 1, Zone 3 138 feet above Zone 2, etc. The MWL Water Distribution Master Plan (October 2011) identifies plans for pumping and storage infrastructure to service Pressure Zone 2. Serviceability is increasingly challenging for Pressure Zones 3 through 6, due to additional pumping and storage requirements at higher elevations. These concept types are identified in order of increasing challenge relative to serviceability:

- Pressure Zone 1 only (excellent/very good - good, service is easy),
- Pressure Zone 2 (fair, service is moderately easy),
- Above Pressure Zone 2 (poor - very poor, service is moderate to very challenging),

***Sewer***

Sewer service concept were identified for each candidate expansion area. The concept types are listed below in order of increasing challenge for serviceability:

- Short length local gravity extension (good, easy to serve).
- Intermediate length gravity extension (good to fair, moderately easy to serve),
- Long gravity extension (fair, moderately challenging to serve),
- Regional/service area pump station (fair to poor, challenging to serve), and
- Long gravity extension & regional pump station (poor, very challenging to serve)

***Stormwater***

The stormwater assessment of candidate expansion areas considered potential runoff based on the National Resource Conservation Service (NRCS) Curve Number method including the range presented below in order of increasing challenge for serviceability:

- Curve Number < 60 (indicating less runoff generated; good, easier to serve),
- 60-70 (good to fair),
- 70-80 (fair),
- 80-90 (fair to poor), and
- Curve Number > 90 (indicating more runoff generated; poor, more challenging to serve)

***Transportation***

The assessment of transportation concepts for expansion areas considered both the existing and future planned infrastructure, including the following in order of increasing challenge for serviceability:

- Connected through multiple existing access points, < 10% slopes, within < 1/4 mile to planned transit network, lower new trips per buildable acre and available capacity downstream roads (very good and easy to serve)
- Connected through a major road, < 15% slopes, within < 1/2 mile to planned transit, < 1000 new trips per buildable acre and almost at capacity downstream roads (fair)
- Needs new roads to access, >= 15% slopes, requires 1 to 2 miles of route extension, higher than 1000 new trips per buildable acre and oversaturated downstream roads (poor, more challenging to serve)

## Application Relative to Infrastructure Systems

The results of the concept serviceability evaluation were completed for each infrastructure component, including: sewer, stormwater, water, and transportation. Conceptual serviceability was scored according to the range and descriptions listed in the previous sections. 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.

***Sewer***

Sewer scores and concepts are visually presented in **Figure 3A** and **Figure 3B** (attached at end of document).

***Water***

Water scores and concepts are visualized in **Figure 4A** and **Figure 4B** (attached at end of document).

***Transportation***

Transportation scores and general service concepts along with City's street classifications are visually presented in **Figure 5** (attached at the end of document).

***Composite***

A composite score was calculated for each expansion area to aid in ranking of the infrastructure needs relative to one another, with weighting applied. This composite score was weighted by area and is presented in **Table 3**. The stormwater score weight is minor due to its negligible impact to the overall, or composite, score. Expansion areas where transportation systems were not specifically analyzed have been given a score of "NA" and weighting is only based on water, sewer, and stormwater scores.

## 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) | |
| Sewer | 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 1 & 2 | > Zone 2 | | 0.333 |
| Stormwater | Land Cover/ Curve Number Concept | <60 | 60-70 | 70-80 | 80-90 | >90 | <0.001 |
| Transportation | New Road or upgrade to existing road (Local or Arterial/ Collector) | Connect to existing road | N/A | Connect to upgrade required road | N/A | Needs new road | 0.083 |
| | New Roads | Needs new local roads | N/A | Needs new collector and local roads | N/A | Needs new arterial, collector and local roads | 0.083 |
| | Emergency Connection/ Alternate Routes | Multiple roads access | N/A | Collector or local access | N/A | Local or one road access only | 0.067 |
| | Slopes | < 10% | N/A | < 15% | N/A | >= 15% | 0.033 |
| | Transit Accessibility | < 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 | 0.033 |
| | New Trips generated in peak hour | <= 500 | N/A | <= 1,000 | N/A | > 1,000 | 0.017 |
| | Downstream congestion levels | Available: V/C <=90 | N/A | Saturated: V/C <=100 | N/A | Over-capacity: V/C > 100 | 0.017 |

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

| Study Area | Public Facilities - Water | Public Facilities - Sewer | Public Facilities - Stormwater | Transportation | Composite |
|---|---|---|---|---|---|
| ***Exception Areas*** | | | | | |
| Riverside South | 3.0 | 2.0 | 2.0 | 3.0 | **3** |
| Redmond Hill Road | 1.0 | 3.0 | 2.0 | 3.0 | **2** |
| Fox Ridge Road | 1.0 | 2.0 | 2.0 | 3.0 | **2** |
| 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 | 1.0 | 1.0 | 2.0 | 1.0 | **1** |
| Booth Bend Road | 3.0 | 2.0 | 2.0 | NA | **2** |
| Brentano Lane | 3.0 | 1.0 | 2.0 | NA | **2** |
| Westside Road | 3.0 | 2.0 | 2.0 | NA | **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 | 2.0 | 3.0 | 2.0 | 2.0 | **2** |
| West Hills-2 | 1.0 | 2.0 | 2.0 | 1.0 | **1** |
| N of Fox Ridge-East 1 | 3.0 | 1.0 | 2.0 | 1.0 | **2** |
| N of Fox Ridge-East 2 | 2.0 | 1.0 | 2.0 | 1.0 | **1** |
| NW-Ext 1a (Northern) | 3.0 | 2.0 | 2.0 | 3.0 | **3** |
| NW-Ext 1b (Southern) | 2.0 | 2.0 | 2.0 | 3.0 | **2** |
| 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** |
| East of Airport | 3.0 | 1.0 | 2.0 | NA | **2** |
| North of Baker Creek | 3.0 | 1.0 | 2.0 | NA | **2** |

## Feasibility of Inclusion and Service

Additional consideration for favorable service concepts for water, sewer, and transportation systems included the following:

- Concepts that incorporate contiguous priority lands,
- Concepts without environmental implications (e.g., limited impact to stream and environmental corridors), and
- Concepts that coincide with planned Capital Improvement Projects (CIPs)

## Available Downstream Capacity Evaluation

An evaluation of the downstream infrastructure was completed for sewer and water systems as described below.

### Sewer

For the downstream capacity evaluation, the City's hydraulic model was used to simulate dry weather flow conditions as well as wet weather flow conditions with the new developments and the 5-year frequency design storm. 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 flow 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)

A velocity criterion of 6 feet per second (fps) was applied when evaluating force mains. Pump stations were evaluated for firm pumping capacity (largest pump out of service).

**Table 4**, below, presents descriptions of sewer concepts and sewer downstream impacts for each candidate expansion area. Color coding is applied separately for and as a function of the costs per buildable acre for both the local and downstream results.

**Table 4 – Wastewater Infrastructure System Descriptive Scores & Notes**

| Study Area | Score | Feasibility | Pump Required | Upstream Contributions | Local Descriptive Score | Downstream Impacts Descriptive Score |
|---|---|---|---|---|---|---|
| ***Exception Areas*** | | | | | | |
| Riverside South | 2.0 | 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 | 3.0 | 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 | 2.0 | 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 | 1.0 | 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 | 3.0 | 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 | 1.0 | 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. |
| Booth Bend Road | 2.0 | Is bounded on the east by an environmental corridor (i.e., South Yamhill River); the study area contains a portion of excludable area (i.e., non-buildable) along its entire west edge and in the east corner. | Yes | No | Loading via local gravity service to a local pump station at the lowest point in the study area "BB", directly west of South Yamhill River; this concept requires a local pump station to pump to the existing gravity system at manhole "I-10-49". | 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. |
| Brentano Lane | 1.0 | Two portions of an environmental corridor (i.e., stream) run through the study area. | Yes [NW-EX2] | No | Loading via local gravity service to intersection with NW Hill Rd; Loading via gravity along NW Hill Rd (shared with NBC) to the proposed NW-EX2 pump station, which discharges to the existing system at manhole "F-5-35" | 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. |
| Westside Road | 2.0 | Is bounded on the east, south, and north-east corner by an environmental corridor (e.g., Baker Creek); NW Westside Rd passes over Baker Creek | Yes | No | Loading via local gravity service to a local pump station at the lowest point in the study area "WR", directly west of Baker Creek; this concept requires a local pump station to pump to the existing gravity system at manhole "I-4-25B". | The downstream system is pumped once, through RSPS. Downstream existing infrastructure experiences capacity issues east of NE Lafayette Avenue as it transfers flows to RSPS. |

**Table 4 – Wastewater Infrastructure System Descriptive Scores & Notes (cont.)**

| Study Area | Score | Feasibility | Pump Required | Upstream Contributions | Local Descriptive Score | Downstream Impacts Descriptive Score |
|---|---|---|---|---|---|---|
| ***Resource Areas*** | | | | | | |
| NA-EV | 3.0 | 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 | 1.0 | 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 | 1.0 | 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 | 2.0 | 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 | 2.0 | 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) | 3.0 | 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 gravity 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 | 3.0 | 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 | 3.0 | 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) --> SW 06 --> system | 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. |

**Table 4 – Wastewater Infrastructure System Descriptive Scores & Notes (cont.)**

| Study Area | Score | Feasibility | Pump Required | Upstream Contributions | Local Descriptive Score | Downstream Impacts Descriptive Score |
|---|---|---|---|---|---|---|
| W of Old Sheridan-2 | 3.0 | Subdivided 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 the 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 | 3.0 | 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 | 2.0 | 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 | 1.0 | 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 | 1.0 | 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) | 2.0 | 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) | 2.0 | There are at least two environmental corridors/crossings (i.e., streams) within the subdivided sub-areas NW-EX1b_NW-EX1-1 & NW-EX1b_NW-EX1-3) | Yes; NW-EX-1 for NW-EX1b_NW-EX1-1 & NW-EX1b_NW-EX1-3 | 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 "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). | 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 2 | 2.0 | 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 | 2.0 | 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. |

**Table 4 – Wastewater Infrastructure System Descriptive Scores & Notes (cont.)**

| Study Area | Score | Feasibility | Pump Required | Upstream Contributions | Local Descriptive Score | Downstream Impacts Descriptive Score |
|---|---|---|---|---|---|---|
| Grandhaven-W | 2.0 | 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. |
| East of Airport | 1.0 | Neither contains nor passes through environmental corridor (i.e., stream); however, it is adjacent to the McMinnville Municipal Airport | Yes | No | Loading via local gravity to the low point within the study area located just south of SE Cruickshank Rd; this concept requires a local pump station to pump to the existing gravity system at manhole "N-10-2" on the south side of Hwy 18. | The downstream system is pumped four times, through 3MILELN#3 & 3MILELN#2 & 3MILELN#1 & RSPS. Existing downstream capacity issues. |
| North of Baker Creek | 1.0 | Is bounded on the south by an environmental corridor (e.g., stream); environmental corridors (x2) run north to south through the eastern portion of the study area; the entire southern portion of the study area is identified as excluded lands (i.e., non-buildable). | Yes [NW-EX2] | No | Loading via local gravity service to intersection with NW Hill Rd; Loading via gravity along NW Hill Rd (shared with BR) to the proposed NW-EX2 pump station, which discharges to the existing system at manhole "F-5-35" | 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. |

### Water

For the downstream capacity evaluation, MWL's hydraulic model (EPANet) was used to simulate buildout demands plus expansion area demands under the future maximum day demand (MDD) + fire flow demand scenario. Deficiency criteria was established with both pressure (pressures greater than 20 psi under fire flow conditions) and velocity (velocities greater than 6 fps). Impacts to the water distribution system were assessed as a function of the following seven scenarios, which considered not only expansion area demands loaded to the east and the west of the South Yamhill River but also by pressure zone, including:

- Scenario 1 – Base (no additional demands)
- Scenario 2 – West side of the river, Pressure Zone 1 Demands
- Scenario 3 – West & East side of the river, Pressure Zone 1 Demands
- Scenario 4 – West & East side of the river, Pressure Zones 1 & 2 Demands
- Scenario 5 – West & East side of the river, Pressure Zones 1, 2 & 3 Demands
- Scenario 6 – West & East side of the river, Pressure Zones 1, 2, 3 & 4 Demands
- Scenario 7 – West & East side of the river, Pressure Zones 1, 2, 3, 4 & 5+ Demands

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 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 quantitative and descriptive scores relative to the breakdown of pressure zones by expansion area. Color coding is a function of primarily the pressure zones present within the expansion area, with the following logic applied:

- Score = 1 (Very Poor), Red: Pressure Zones above Pressure Zone 1 & 2
- Score = 2 (Fair), Yellow: Pressure Zones 1 & 2 only
- Score = 3 (Excellent/Very Good), Green: Pressure Zone 1 only

**Table 5 – Water Infrastructure System Descriptive Scores & Notes**

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

**Transportation**

The transportation system feasibility and downstream 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.

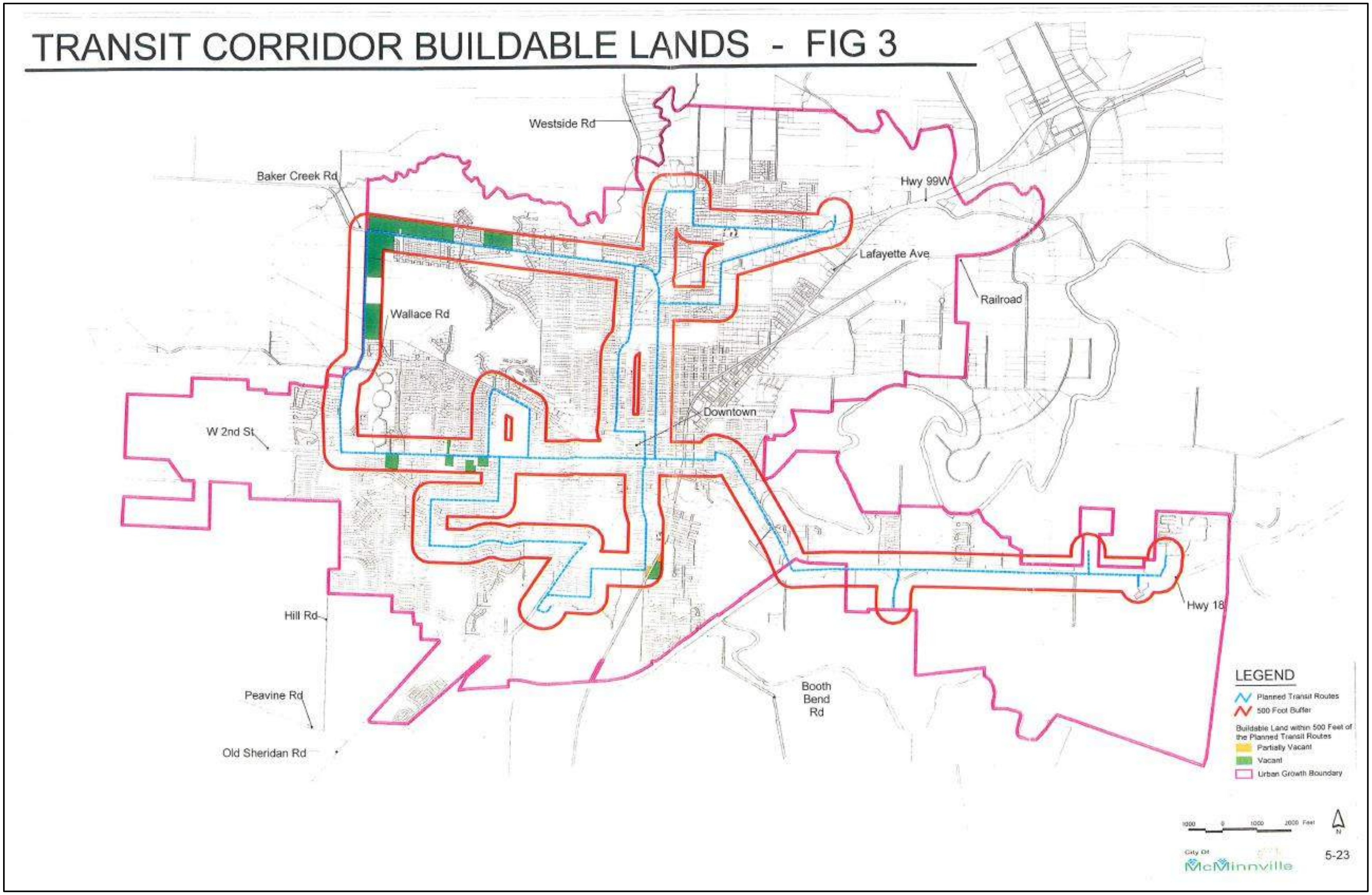
The location of the candidate expansion areas relative to the City's existing roadway network was used to evaluate each area for the following criteria, including:

- 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

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 and presented below as **Figure 6**. The further the transit services were located, the lower the candidate area scored on its evaluation.

**Figure 6 – Transit Corridor Buildable Lands**



Based on the planned dwelling units and commercial area provided by the City, the number of new trips generated during the afternoon (PM) peak hour by each expansion area was estimated using trip rates estimated based on the *Yamhill County model for the City of McMinnville (VISUM)*. The following trip rates were used:

- PM peak hour trips per dwelling unit = 1.03
- PM peak hour trips per employee = 0.16
    - Building area for commercial developable area was estimated using probable Floor Area Ratio (FAR), which indicates the ratio of gross building square footage permitted on a parcel to net square footage of the parcel, from *Socioeconomic Build-out Projections Assumptions & Methodology, County of Riverside, CA*
        - Commercial Retail and Office = 0.29 FAR
        - Commercial Tourist = 0.25 FAR
    - Number of Employees for the commercial development was estimated using Square Feet (SF)/Employee factor, that indicates the number of square feet of the building space per employee, from *Socioeconomic Build-out Projections Assumptions & Methodology, County of Riverside, CA*
        - Commercial Retail and Office = 400 SF/Employee
        - Commercial Tourist = 500 SF/Employee

For the available downstream capacity, the *Transportation System Plan* (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 *Transportation System Plan (Exhibit 3-9)* was used to determine available capacity and is presented below as **Figure 7**.

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

**Figure 7 – 2023 PM Peak Hour V/C (Transportation System Plan, May 2010)**

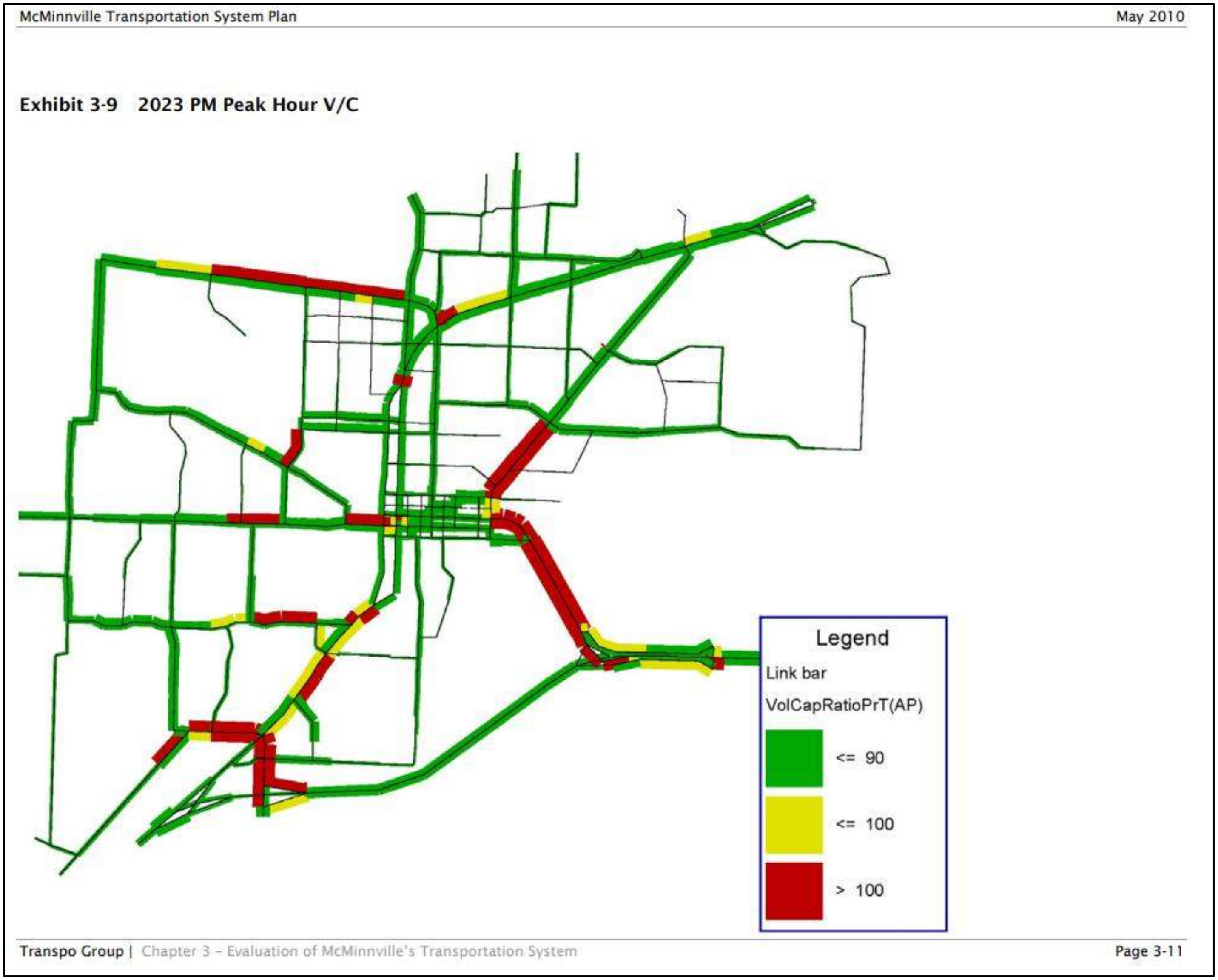


**Table 6 – Transportation Serviceability Descriptive Scores and Downstream Impact Notes**

| Study Area | Score | Descriptive Score | Downstream Impact |
|---|---|---|---|
| ***Exception Areas*** | | | |
| Riverside South | 3 | 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 | 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 | 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 | 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 | 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 | 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 |
| Booth Bend Road | NA | NA | NA |
| Brentano Lane | NA | NA | NA |
| Westside Road | NA | NA | NA |
| ***Resource Areas*** | | | |
| NA-EV | 3 | 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 | 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 | 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 |

**Table 6 – Transportation Serviceability Descriptive Scores and Downstream Impact Notes (cont.)**

| Study Area | Score | Descriptive Score | Downstream Impact |
|---|---|---|---|
| Norton Lane East | 2 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 |

**Table 6 – Transportation Serviceability Descriptive Scores and Downstream Impact Notes (cont.)**

| Study Area | Score | Descriptive Score | Downstream Impact |
|---|---|---|---|
| NW-Ext 1b (Southern) | 3 | 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 | 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 | 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 | 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 |
| East of Airport | NA | NA | NA |
| North of Baker Creek | NA | NA | NA |

## Cost Analysis

A planning-level cost analysis was completed for each system and candidate expansion area. Capital costs were evaluated for local service concepts and downstream impacts. Costs were summarized on a per acre and per unit basis to better compare each expansion area. Cost evaluations utilize Class 5 budget estimates as established by the *American Association of Cost Engineers* (AACE). This estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end and +30 to +100 percent on the high end. The following assumptions were used for the cost analysis.

For sewer infrastructure, unit costs included the following:

- Local Force main Cost - $30 per inch-diameter per linear foot (LF), assuming:
  - Peak Dry + Wet Weather Flow conditions and a velocity criterion of six (6) fps
- Local Gravity Pipeline Cost - $40 per inch-diameter per LF, 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 per gallons per minute (gpm) firm capacity, assuming
  - Peak Dry + Wet Weather Flow conditions (5-year frequency storm)
- Downstream Pump Station Cost - $1,000,000 per cubic feet per second (cfs) firm capacity

For water infrastructure, unit costs included the following:

- Local Storage Costs - $2,500,000 per million gallons (MG) 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 per gpm firm capacity (multiplied as a function of service to zones above Pressure Zone 2)[1]
- Downstream Transmission Main Cost - $35 per inch-diameter per LF, assuming:
  - MDD conditions plus 1,000 gpm of fire flow and a velocity criterion of 6 fps

The local and downstream water costs, per expansion area, are presented in **Table 7**. The local and downstream sewer 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 a function of grouping the cost per buildable acre (dollars per buildable acre) results into three primary classes to yield High (Red), Medium (Yellow), and Low (Green) costs for each infrastructure system. These costs and color-coding breakdowns are presented as follows:

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

- Water
  - Local - average = $8,604; maximum = $29,267; minimum = $4,558
    - High: > $11,550
    - Medium: $5,657 - $11,550
    - Low: < $5,657
  - Downstream - average = $3,127; maximum = $10,209; minimum = $71
    - High: > $4,690
    - Medium: $1,564 - $4,690
    - Low: < $1,564
- Sanitary
  - Local - average = $35,737; maximum = $103,426; minimum = $2,815
    - High: > $51,480
    - Medium: $19,993 - $51,480
    - Low: < $19,993
  - Downstream - average = $49,815; maximum = $182,206; minimum = $29,077
    - High: > $67,841
    - Medium: $31,790 - $67,841
    - Low: < $31,790

**Table 7 – 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 |
| Booth Bend Road | $0.11 | $1,621 | $5,944 | $0.01 | $103 | $379 |
| Brentano Lane | $0.55 | $1,543 | $6,627 | $0.04 | $103 | $444 |
| Westside Road | $0.09 | $1,649 | $5,767 | $0.01 | $103 | $361 |
| ***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 |
| East of Airport | $4.22 | $1,397 | $8,709 | $4.94 | $1,638 | $10,209 |
| North of Baker Creek | $0.65 | $1,414 | $8,433 | $0.05 | $103 | $616 |
| **Total** | **$31.04** | | | **$11.56** | | |

**Table 8 – Sewer 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 |
| Booth Bend Road | $0.73 | $11,061 | $40,556 | $0.52 | $7,930 | $29,077 |
| Brentano Lane | $2.01 | $5,585 | $23,983 | $3.06 | $8,537 | $36,660 |
| Westside Road | $0.89 | $15,526 | $54,294 | $2.97 | $52,104 | $182,206 |
| ***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 | $1.37 | $11,874 | $74,809 | $1.02 | $8,821 | $55,575 |
| Grandhaven-E | $2.40 | $5,656 | $35,632 | $3.74 | $8,821 | $55,575 |
| Grandhaven-W | $8.97 | $2,972 | $18,521 | $26.19 | $8,682 | $54,107 |
| East of Airport | $1.66 | $3,641 | $21,723 | $3.15 | $6,903 | $41,181 |
| North of Baker Creek | $1.37 | $11,874 | $74,809 | $1.02 | $8,821 | $55,575 |
| **Total** | **$70.06** | | | **$141.13** | | |

For transportation infrastructure, unit costs included the following:

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

A planning-level cost analysis, only for comparative purposes was completed for transportation concept for the candidate expansion area. The Capital cost estimations were based of geographically estimated miles of new roadways that would be needed to serve the new development. The cost estimates are only the pavement cost and does not include costs associated with curb/gutter, curb ramps, sidewalks, bike lanes, striping/ signing, planters, etc. Capital costs for pavement were estimated based on information on American Road & Transportation Builders Association (ARTBA) from Florida DOT. The transportation costs estimate would need to be refined at design phase, to include the details from Master Plans per expansion area and the impacted roadways downstream.

The local transportation costs per expansion area, are presented in **Table 9**. The table presents the total local transportation costs, as well as cost per buildable acre, per expansion area. Similar to the water and sewer infrastructure cost color-coding, the following ranges were used:

- Transportation - average = $34,652; maximum = $82,000; minimum = $11,000
    - High: > $48,712
    - Medium: $20,592 - $48,712
    - Low: < $20,592

**Table 9 – Transportation Infrastructure System Cost (Local)**

| Study Area | Total ($million) | Cost/Buildable Area ($/acre) |
|---|---|---|
| ***Exception Areas*** | | |
| Riverside South | $1.67 | $13,000 |
| Redmond Hill Road | $1.00 | $43,000 |
| Fox Ridge Road | $2.34 | $36,000 |
| Lawson Lane | $0.78 | $72,000 |
| Old Sheridan Road | $0.78 | $21,000 |
| N-Fox Ridge - West | $3.91 | $67,000 |
| Booth Bend Road | NA | NA |
| Brentano Lane | NA | NA |
| Westside Road | NA | NA |
| ***Resource Areas*** | | |
| NA-EV | $1.23 | $31,000 |
| Three Mile Lane East | $2.79 | $15,000 |
| Three Mile Lane West | $0.67 | $82,000 |
| Norton Lane East | $1.67 | $25,000 |
| Norton Lane West | $0 | $0 |
| SW I (SW 06) | $2.34 | $20,000 |
| SW II | $2.34 | $20,000 |
| W of Old Sheridan-1 | $3.46 | $16,000 |
| W of Old Sheridan-2 | $3.24 | $11,000 |
| West Hills-South | $2.34 | $21,000 |
| West Hills-2 | $5.47 | $15,000 |
| N of Fox Ridge-East 1 | $4.58 | $78,000 |
| N of Fox Ridge-East 2 | $3.01 | $27,000 |
| NW-Ext 1a (Northern) | $1.00 | $31,000 |
| NW-Ext 1b (Southern) | $2.23 | $33,000 |
| NW-Ext 2 | $0.78 | $52,000 |
| Grandhaven-E | $0.78 | $43,000 |
| Grandhaven-W | $1.67 | $25,000 |
| East of Airport | NA | NA |
| North of Baker Creek | NA | NA |

## Recommended Urban Growth Expansion and Serviceability

Based on the outcomes of serviceability analysis and other criteria, the City has recommended the following expansion areas (either in whole or as a portion) and comprehensive plan designations, including:

- Booth Bend Road (BB) - Urban Holding, Floodplain
- NA-EV - Commercial
- NW-Ext 1b (Southern) (NW-EX1b) - Urban Holding
- Norton Lane West (NL-W) - Industrial, Floodplain
- Old Sheridan Road (OSR) - Urban Holding
- SW I (SW-06) - Urban Holding, Floodplain
- SW II - Urban Holding, Floodplain
- West Hills-South (WH-S) - Urban Holding
- W of Old Sheridan-2 (W-OSR2) - Urban Holding, Floodplain

The following summary is provided for water, sewer, and transportation serviceability based on the recommended expansion.

### Water Infrastructure System

The expansion areas chosen all have scores of 3.0 (excellent/very good) and are served by Pressure Zone 1, with the exception of the West Hills-South and NW-Ext 1b (Southern) areas. These areas are identified with a score of 2.0 (fair), since Pressure Zone 2 is included in these areas. Deficiencies have been identified and are included in **Figure 8**, located at the end of this TM.

To service the chosen expansion areas the following costs are anticipated using the Class 5 planning estimates, including:

- Local Costs - $8.0 million and an average cost of $9,190 per buildable acre
- Downstream Costs - $3.2 million and an average cost of $3,876 per buildable acre

### Sewer Infrastructure System

The recommended expansion areas have scores between 2.0 and 3.0 (average of 2.67, fair to good), with those areas scoring lower because of new local pump station requirements (e.g., Booth Bend Road, Norton Lane West, and NW-Ext 1b [Southern]). In addition to those areas that require local pumping, all expansion areas rely on local gravity pipeline extensions. Downstream impacts include improvements to existing pump stations, including (listed in decreasing order of number of times identified as a deficiency):

- Raw Sewage Pump Station (RSPS) - impacted by all expansion areas
- Cozine Pump Station - impacted by all expansion areas except NL-W and NA-EV

- Cozine Acres Pump Station - impacted by expansion areas SW I (SW-06), WH-S, OSR, and W-OSR2
- Three Mile Lane #3 Pump Station (3MILELN#3) - impacted by expansion area NA-EV
- Three Mile Lane #2 Pump Station (3MILELN#2) - impacted by expansion area NA-EV
- Kathleen Manor Pump Station (KATHLN) - impacted by expansion area SW II

Significant improvements are also required to downstream gravity interceptors as shown in **Figure 9**, attached at the end of this TM. Downstream gravity interceptors serving Old Sheridan Road, Booth Bend Road, SW I (SW-06), and NA-EV are located in stream and environmental corridors. Interceptor improvements may require environmental permitting and restoration. Alternate routing of parallel gravity infrastructure improvements may be considered to minimize construction through environmental corridors.

To service the chosen expansion areas, the following costs are anticipated using the Class 5 planning estimates, including:

- Local Costs - $9.4 million and an average cost of $15,936 per buildable acre
- Downstream Costs - $45.7 million and an average cost of $53,696 per buildable acre

**Transportation Infrastructure System**

The expansion areas chosen have scores between 2.0 and 3.0 (average of 2.6, fair to good). Areas with lower scores require connections to existing roads, are limited by single access for emergency service, do not have planned transit services within one mile, include higher trips generation, or require connections to downstream congested roadways. These lower scoring areas include Norton Lane West, W of Old Sheridan-2 (W-OSR2), and West Hills-South (WH-S).

Downstream impacts for the selected areas may impact traffic in common locations, including: Highway 18, SR-18 (to the airport), Three Mile Lane (to town; to the airport), Old Sheridan Road, Pacific Highway, SW 2nd Street (through town), SW Fellow Street (through town), and NW Wallace Road (to town). Booth Bend Road was not assessed for transportation serviceability.

The traffic to and from the airport from all the chosen expansion areas, except the NA-EV and Booth Bend Road, would have impact on SE Three Mile Lane. The SE Three Mile Lane which is expected to be congested and overcapacity in future based on **Figure 7**, and the additional new trips from these expansion areas would send additional traffic to this road. There is a proposed interchange at SE Three Mile Lane and Highway 18 in future along with new collector road that would run east-west parallel to Highway 18, but these improvements would not address the congestion on SE Three Mile lane from the town to new interchange. Additional capacity analysis and improvements should be investigated to address the congestion on SE Three Mile Lane.

The SW 2nd Street, SW Fellow Street, SW Old Sheridan Road, Pacific Highway W, and Highway 18 are expected to be congested and at capacity in future based on **Figure 7**. This would take traffic from chosen expansion areas on the west, to and through the town.

An additional westbound lane for SW 2nd Street, and additional turn lanes on the SW Old Sheridan Road are planned in the future that might help with relieving the future background congestion as well as new trips from the new expansion areas. The capacity analysis for SW 2nd Street and SW Old Sheridan Road should still be revisited to plan the improvements accordingly.

The capacity analysis for SW Fellow Street and Pacific Highway W should be included in the next Transportation System Plan as these two roads are expected to have higher number of new trips from the chosen expansion areas.

To service the chosen expansion areas, the following costs are anticipated using the Class 5 planning estimates, including:

- Local Costs - $14.5 million and an average cost of $22,429 per buildable acre
- Downstream Costs - Not calculated

See **Figure 10** for expansion areas and downstream impacts to the transportation system (attached at end of document).


Map reflects study areas and concepts, as of 10/8/2020.

**Figure 3A - Preliminary Concepts of the Sewer System**

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


Map reflects study areas and concepts, as of 10/8/2020.

**Figure 3B - Preliminary Scoring of the Sewer System**

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


Map reflects study areas and concepts, as of 10/8/2020.

**Figure 4A - Preliminary Concepts of the Water System**


Map reflects study areas and concepts, as of 10/8/2020.

**Figure 4B - Preliminary Scoring of the Water System**

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


Map reflects study areas and concepts, as of 10/8/2020.

**Figure 5 - Preliminary Concepts & Scoring of the Transportation System**

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


Map reflects study areas and concepts, as of 10/8/2020. Deficient pipes are identified when flagged under Scenario 2 (PZ1, west of river) and under Scenario 3 (PZ1, west/east). See TM for details and results.

**Figure 8 - Final Water System Concepts & Deficiencies**


Map reflects study areas and concepts, as of 10/8/2020.
Call-outs identify pump stations & pipes identified as deficient with color-coding (red, orange). See TM for results.

**Figure 9 - Final Sewer System Concepts & Deficiencies**

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


Map reflects study areas and concepts, as of 10/8/2020.

**Figure 10 - Traffic Flow and Impacts on the Transportation System**