INDUSTRIAL ZONING & EMPLOYMENT DENSITY: A MISSED CONNECTION?

STUDY

This study explores the density and composition of employment within industrial zones in a sample of five Oregon cities.

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Abstract

This study explores the density and composition of employment within industrial zones in a sample of Oregon cities. Employment densities are particularly important in Oregon because they are used in the calculation of land needs, ultimately influencing urban growth boundary expansions. This study uses the mapping and analysis software ArcGIS to explore employment density; combining tax lot, zoning, and geo-located Quarterly Census of Employment and Wages data.

This study finds that median employment densities are relatively consistent across cities of different sizes, despite differences in employment sector composition. This study also quantifies employment density by employment sectors, again finding that median employment densities are relatively consistent, with a few exceptions. When employment is categorized as either industrial or commercial, this study finds that considerable commercial employment exists on industrial lands. Lastly, this study reviews economic opportunities analyses for the five study cities, noting the variety of methods jurisdictions use to calculate employment densities, and ultimately land needs.

Based on these findings, this study concludes that Oregon industrial planning land use laws are working as intended and that jurisdictions do take advantage of the multiple methodologies allowed to them for conducting land needs assessments. Furthermore, cities should be cognizant of how non-industrial uses on industrial lands may influence land needs assessments as well as the undue influence singular, large employers may have on sector composition and overall employment density. Lastly, cities may want to reconsider the methodology they use in estimating land needs as continued mixing of uses in industrial zones may make accurate estimations more difficult.

Introduction

Employment densities are useful measures that can serve a variety of purposes in local government land use planning. Employment densities can be used to measure economic health, efficiency of land use, and can influence transportation and housing decisions and investment locations. Employment densities are particularly important in Oregon because of the state's unique land use and planning laws.

Oregon has 19 statewide planning goals, two of which, goals 14 and 9, are fundamental to this study. Under goal 14, cities are required to establish urban growth boundaries (UBGs). UGBs define the extent of urbanizable land (inside the UGB) and separate it from largely agricultural and natural lands (outside the UGB). UGBs are periodically assessed to determine if they contain a sufficient amount of land to accommodate increased population and employment growth. A city may expand its UGB if forecast land needs exceed current land supply.

Goal 9 relates to economic development and requires cities to provide an adequate amount of land to realize economic growth and opportunities. To determine if they have enough land, cities compare the amount of employment land they have available to future employment land needs. Future land needs are based on estimated job growth over a 20 year planning period. Cities convert estimated job growth to land need by applying employment density numbers.

Thus, the employment density numbers a city uses have very real implications related to the amount of land allocated, or not allocated, to employment. Cities use multiple employment densities to reflect real differences in employment that occur across zones. For example, employment density in a central business district with multi-story office buildings and mixed use areas will typically be higher than employment density in a heavy industrial area with large warehouses. Much of this work is contained within a city's economic opportunities analyses (EOA). If the EOA determines there is not a sufficient supply of land for forecast employment growth, the UGB may be expanded.

An understanding of employment densities in industrial zones, both in and outside of Oregon, is becoming increasingly important in light of recent industrial trends. One, as manufacturing becomes progressively more automated employment densities may drop. Relatedly, there may be less emphasis on providing city services, such as water and sewer, to these areas if work is fully automated. Two, technology is increasingly cutting down on the noise, pollution, and other negative externalities that traditionally exiled heavy industrial uses to the cities' fringe and created impetus for separating industry from other uses. Three, warehouses and distribution centers are attempting to locate closer to population centers to decrease delivery times. Four, many large cities are experiencing increased pressure to convert industrial areas into mixed use, residential, and commercial zones. Five, and unique to just a handful of states, is the proliferation of the marijuana industry, components of which occupy industrial land.

These trends suggest that cities would do well to expand their understanding of employment and businesses in industrial zones. A more thorough understanding of uses and employment in

industrial zones will allow cities to better align their decision making with economic development goals, housing goals, transit investments, and equity concerns.

Purpose and Methods

Industrial lands have long been a topic of interest in cities and current trends have highlighted the importance of such areas. From encroachment of other uses to evaluating which industrial lands should be converted, recent research has focused on quantifying the unique characteristics that define industrial lands. Quantifying these characteristics, such as employment density, allows jurisdictions to more effectively plan for future industrial land needs. Planning for industrial lands is especially relevant in Oregon, where cities are mandated by state law to provide an adequate amount of industrial lands for employment purposes.

An understanding of employment densities on industrial lands can thus be beneficial to cities, and Oregon cities in particular. In Oregon employment densities play a crucial role in estimating land needs and ultimately UGB expansion. Given this, it is somewhat surprising that the state does not provide more detailed or prescribed guidelines concerning how employment density should be used in EOAs.

Despite this ambiguity and the renewed interest in industrial lands, the subject of industrial employment densities has received scant attention in academic literature. This report seeks to fill part of this knowledge gap by focusing on industrial employment densities in five Oregon cities: Eugene, Bend, Albany, McMinnville, and Canby. Specifically, this study asks about employment densities in industrial zones, employment densities within sectors in industrial zones, and the sector composition of industrial zones. The report also explores how study cities arrived at the employment density numbers they use in their EOAs (though not all EOAs use employment density to estimate land needs) and compares those density figures to the numbers found in this study.

Questions are answered using a combination of tax lot, zoning, and Quarterly Census of Employment and Wages (QCEW) data provided by the Oregon Department of Employment. The spatial analysis and mapping tool ArcGIS is used for the majority of this work. A more detailed discussion on methodology in located in Appendix A.

Context for Industrial Land Planning in Oregon

As referenced earlier, Oregon has a unique land use planning system that is guided by 19 statewide planning goals. This section describes how Oregon's state mandated planning laws apply to industrial lands in more depth. There are four terms related to industrial land planning that are best to define at the outset of this section.

Employees per acre (EPA): The number of employees divided by the acreage of the tax lot on which employment occurs. EPA is one measure of employment density. In this study employment density refers to EPA.

Square feet per employee (SFE): The amount of physical space in square feet that is needed by an employee. SFE represents the square footage of built structure needed per employee, not square footage of land. SFE needs vary by job type. In the context of this study, SFEs are used to convert employment forecasts to building space needs.

Floor area ratio (FAR): The percentage of an office or industrial site that is covered by the building footprint. In the context of this study, FARs are used to convert building SFE needs to land needs.

Industrial use / Industrial: Note that the following definition is taken verbatim from Oregon administrative rules chapter 660 division 38.

Employment activities including, but not limited to, manufacturing, assembly, fabrication, processing, storage, logistics, warehousing, importation, distribution and transshipment, and research and development, that generate income from the production, handling or distribution of goods or services, including goods or services in the traded sector, as defined in ORS 285A.010.

"Industrial use" means NAICS Categories 11, 21, 22, 23, 31, 32, 33, 42, 48, and 49. These are land uses that generally require significant space for indoor or outdoor production or logistics.

Planning for Employment Lands in Oregon

Under goal 9, cities in Oregon are required to provide opportunities for economic development. Specifically, goal 9's purpose is "to provide adequate opportunities throughout the state for a variety of economic activities vital to the health, welfare, and prosperity of Oregon's citizens"[1], this largely takes the form of planning for sufficient employment lands.

Oregon administrative rule 660-009 lays out the requirements for implementing goal 9. Under this rule, cities must conduct economic opportunities analyses (EOAs). EOAs are technical documents that compare the projected demand for employment land to the existing supply of employment land over a 20 year time horizon.[2] EOAs break employment land demand down into two types, land for industrial employment and land for other employment. EOAs follow the generalized steps below. A slightly different version the same process with associated Oregon administrative rules is shown in Figure 1.

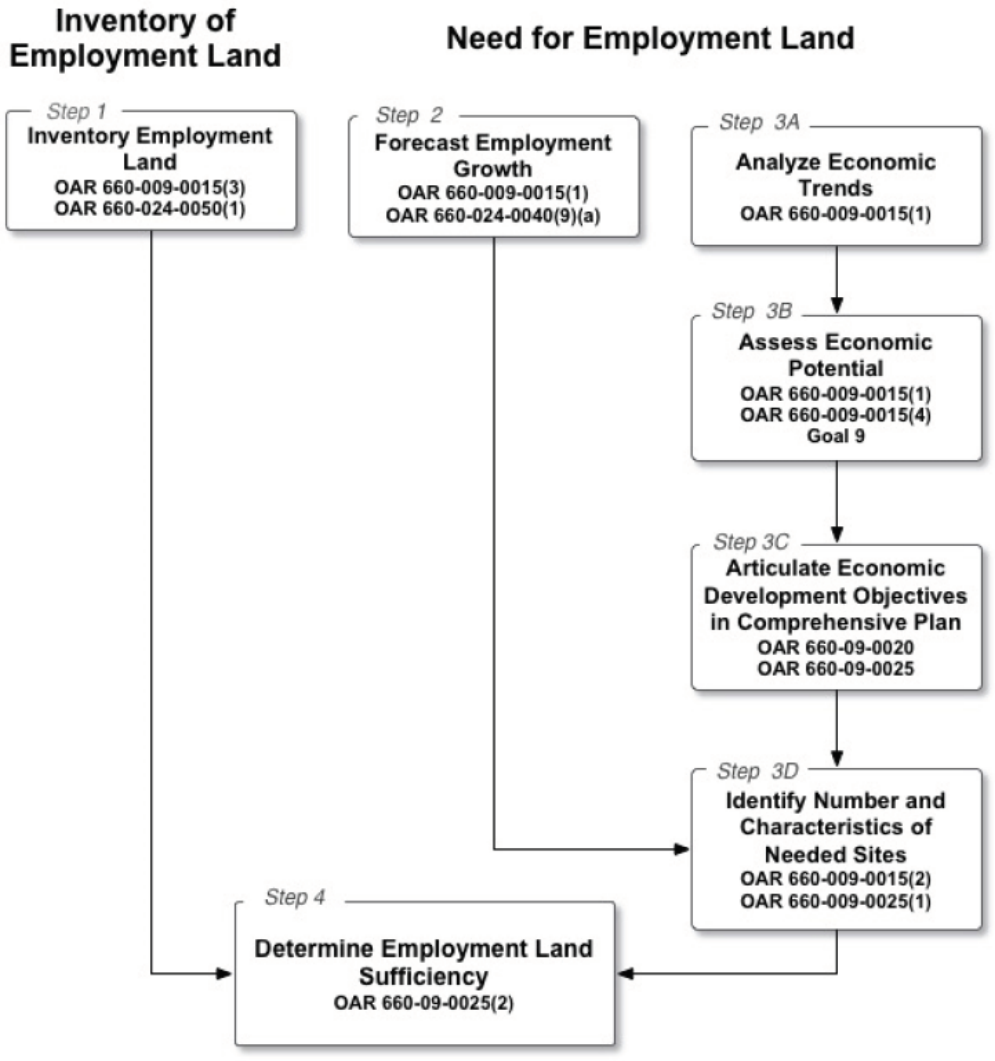
1) Review national, state, regional, county, and local trends to estimate industrial and other employment growth. Estimates are typically based on employment forecasts from the Oregon Employment Department.
2) Identify the number and type of land sites needed to accommodate estimated employment growth. This includes specific site sizes, special site requirements such

[1] Oregon Department of Land Conservation and Development, Oregon's Statewide Planning Goals and Guidelines, Goal 9: Economic Development, OAR 660-015-0000(9).
[2] Oregon Department of Land Conservation and Development, Chapter 660 Division 9 Oregon Administrative Rule 660-009.

as proximity to transportation, and other characteristics affecting the needed land supply.

3) Inventory current industrial and other employment land sites that are suitable for new employment. Inventory takes into consideration developmental constraints such as protected habitat areas, topography, and infrastructure restrictions that further limit the amount of available suitable employment land.
4) Assess community economic development potential given current employment land availability and estimated employment land needs.
5) Develop policy recommendations to further guide city toward economic development goals. Recommendations may include capital improvements programming, tax incentives, and UGB expansion to accommodate forecast employment land demand.

Figure 1. Assessing Employment Land Needs



Source: ECONorthwest, Eugene Economic Opportunities Analysis, 2012, p. 60

Converting Forecasted Employment to Land Demand

The portion of an EOA most pertinent to this study is how the EOA converts forecasted employment growth to land demand. The Oregon Department of Land Conservation and Development's (DLCD) Industrial and Other Employment Lands Guidebook describes two ways to conduct EOAs, basic and advanced.

Under the "basic approach", land demand can be estimated on one of four ways, as seen in Table 1. Method one, using an employees per acre (EPA) figure, is most relevant to this study. Once EPAs are obtained, cities combine densities with forecast employment to back calculate the amount of land needed to accommodate the expected new jobs.

Table 1. Basic Methods for Estimating Land Demand

Method	Description
1. Employee per acre (EPA) ratio	Assumes a specific employment density, expressed in employees per acre. At the simplest level, the method uses an aggregate EPA ratio for all new employment. Requires both a current employment estimate and an employment forecast.
2. Population/developed land ratio	Uses the number of developed industrial and other employment acres per 1000 persons and extrapolates it to the planning horizon using the local population forecast.
3. Employment/developed land ratio	Uses the number of developed industrial and other employment acres per 1000 employees and extrapolates it to the planning horizon using the local population forecast. Requires both a current employment estimate and an employment forecast.
4. Expert consultation	Relies on the expertise of local developers, business leaders and others to estimate land needs.

Source: Oregon Department of Land Conservation and Development, *Industrial and Other Employment Lands Guidebook*

The Guidebook provides some basic figures for employee densities; "typical employment densities per net acre range from 8 - 12 jobs for industrial; 14 - 20 jobs for commercial; and 6 - 10 jobs for institutional/other jobs"[3], noting also that employment density varies by and within industries.

The second, "advanced approach", lays out additional ways to estimate land demand, both based on methods in the basic approach but expanded upon somewhat. Unlike the basic approach, the advanced approach methods require access to ArcGIS and detailed economic data. The fist method involves EPAs, but instead of using assumed EPAs as is done in the basic EOA approach, EPAs are calculated for the specific city and averaged by industry or land use

[3] Oregon Department of Land Conservation and Development, Industrial and Other Employment Lands Guidebook, 2005, p. 2-11

type. The second method is a variation of method three from Table 1, it applies assumptions of building square feet per employee (SFE) needs to the employment forecast to estimate total building space needed to accommodate forecasted employment growth. Building space estimates are then translated to acres of land by applying assumptions of building floor area ratios (FARs). SFEs and FARs can be based on similar studies elsewhere or calculated for the jurisdiction. Nelson's Planner's Estimating Guide is another source for SFE and FAR estimates. The Guidebook notes that the SFE/FAR method tends to yield greater densities than those found under the EPA methodology and suggests that this may be because FAR assumptions for a single lot are not easy to sustain over a larger area.

The Guidebook does not contain any more detailed information on estimating land needs than what is described here. The goal 9 administrative rules offer additional guidance, but not substantially more than is provided by the Guidebook.

Previous Work

Spatial and temporal patterns of employment have long been of interest to planners.[4] For a long time the areas with greatest densities of jobs were central business districts (CBDs), with their combination of office, commercial, and service jobs. More recent changes in development patterns and transportation options have given rise to new suburban employment centers.[5] CBDs, in combination with suburban employment centers, suggest a polycentric pattern of employment densities, as oppose to the traditional monocentric CBD pattern.[6] Recent research on employment density has expanded from locating employment dense areas to include accurately mapping changing spatial and temporal employment trends, the relationship between employment density, transportation and residential areas, as well as how agglomerations of industries influences density.[7]

Compared to the amount of literature on employment density in CBDs and suburban areas, employment densities of industrial lands have received scant attention. However, the importance of industrial lands, more generally, has become a renewed topic of interest. Industrial employment densities are innately tied to industrial lands and the industries that locate there. An understanding of employment densities helps paint a picture of the current status of industrial lands within a specific jurisdiction. Below, I discuss some of the leading research on industrial lands. Much of this work centers around the need to better understand unique characteristics of industrial lands so threats of conversion to other uses can be accurately addressed.

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[4] McMillen, D., and McDonald, J., Suburban Subcenters and Employment Density in Metropolitan Chicago, 1996

[5] McMillen, D., and McDonald, J., A nonparametric analysis of employment density in a polycentric city, 1997

[6] Redfearn, C., The topography of metropolitan employment: Identifying centers of employment in a polycentric urban area, 2007

[7] Nagle, N., Geostatistical smoothing of areal data: Mapping employment density with factorial kriging, 2010; Sanchez, T., The Connection Between Public Transit and Employment, 2007; Weitz, J., and Crawford, T., Where the Jobs Are Going: Job Sprawl in U.S. Metropolitan Regions, 2001–2006, 2012

Assessing Industrial Lands: Common Approaches from Practitioners

Howland, using Prince George's County, MA as a study area, recognizes the pressure that growing residential, office, and retail sectors can place on conversion of industrial zoned lands when industrial employment growth has slowed.[8] The research team creates a methodology for planning and setting priorities for industrial land conversion, identifying excess industrial land that could be converted with the least drawbacks. Howland's team uses employment density, among other factors, in creating categories of industrial lands.

In conducting their research, the team identifies a number of important qualities exhibited by industrial lands including the jobs they provide (relatively high paying for lower levels of required education), the housing of activities that are crucial to government operation (waste hauling, constructions, recycling), the housing of activities that are essential to other sectors of the economy (warehousing, printing, high technology manufacturing), and the relatively low-cost space they provide for startups.

Similar to Howland, a study conducted by Lester, Kaza, and Kirk looks into factors that support conversion of industrial lands and the associated tradeoffs in Cook County, IL and Mecklenburg County, NC.[9] They make note of two national trends that have recently elevated the discussion of industrial lands: 1) the return of manufacturing to the U.S. as higher labor cost abroad and strong demands have improved the competitiveness of U.S. based manufacturing, and 2) increased demand for urban living (by conversion of industrial lands). Their conversion framework includes whether or not industrial protection policies are in place and measures of economic competitiveness of industries and firms, among others. The study concludes by suggesting "that planners need a more nuanced approach to industrial land preservation." [10]

Chapple, in her work on industrial land and jobs, describes how industrial zones shape firm relocation and expansion in the San Francisco Bay area.[11] She too, notes the pressure cities with strong real estate markets come under to rezone industrial land for residential and commercial use. She states that rarely is the decision to rezone "grounded in an understanding of business dynamics, particularly rates of job creation on industrial land."[12] Chapple finds that industrial zones play a significant role in firm expansion, allowing firms to "spill over" into available space in large buildings. This point is highlighted when industrial zones are compared to office buildings; industrial spaces have the ability to shift between horizontal and vertical organization and can more easily add and subtract employees.

Dempwolf, noticing the increasing number of cities and counties conducting industrial land use studies (ILUS) in the past decade, conducted a review of over 20 ILUSs from across the U.S. with

[8] Howland, M., Planning for Industry in a Post-Industrial World, 2010
[9] Lester, T., Kaza, N., and Kirk, S., Making Room for Manufacturing: Understanding Industrial Land Conversion in Cities, 2013
[10] Ibid, p. 305
[11] Chapple, K., The Highest and Best Use? Urban Industrial Land and Job Creation, 2014
[12] Ibid, p. 300

the aim of developing a composite framework for future ILUSs.[13] Dempwolf found that many jurisdictions conduct ILUSs is response to increasing demand for conversion of industrial land or to identify which industrial lands are most fit for conversion. He found that methodology and other aspects of ILUSs varied widely but notes many of the same imperatives for protecting industrial land found in other studies: their support of other mixed use and residential areas, their proximity to customers that strengthens that support, and their sensitivity to rent levels.

Of particular pertinence to this study is Dempwolf's framework for future ILUSs. The framework suggests sections on employment characteristics, employment clusters, and workforce development needs (among others), all of which relate to industrial employment densities. Dempwolf ultimately concludes that ILUSs provide sound reasons for protecting industrial land and that ILUS findings can help improve planning and regulation of industrial land in the future.

A study conducted by Leigh and Hoezel also explores industrial areas, specifically how smart growth initiatives tend to overlook and undervalue industrial zones.[14] The authors compare industrial land preservation policies from 13 cities, including Portland, OR, with ten popular smart growth publications. The researchers find a clear disconnect between smart growth publications and local economic development initiatives related to industrial land, the implication being that smart growth has overlooked and undervalued industrial land. They note that even Portland, with its state mandated policy to provide adequate industrial lands, has faced conflict related to adding industrial areas. That this conflict has come from those wanting to preserve prime agricultural land from industrial uses is not surprising, though it forces other tradeoffs between industrial land and smart growth related infill and conversion. In conclusion, the authors state that smart growth and industrial interests do not have to be at odds with each other, but that the benefits and tradeoffs of each much be recognized. For industrial lands, trade-offs can include good-paying jobs and economic activities that contribute to a diverse, innovative, and resilient economic base. For infill and conversion land, tradeoff include increased residential and commercial space and potentially higher property taxes for the city.

As illustrated by Leigh and Hoezel, even Oregon cities, with state mandated planning for industrial lands, are not exempt from the challenges that regulating and planning for industrial areas brings. Whether cities are considering rezoning because of encroaching uses, stagnant industrial growth, or want to better understand and plan for increased industrial economic growth, an understanding of the costs and benefits of their decisions is necessary. Employment density is one part of that cost benefit analysis.

[13] Dempwolf, C., An Evaluation of Recent Industrial Land Use Studies: Do Theory and History Make Better Practice? 2010

[14] Leigh, N., and Hoelzel, N., Smart Growth's Blind Side, 2012

Research Questions

To better understand the characteristics of employment densities and how cities are estimating land demand within their EOAs, the following questions were asked of five Oregon cities (Table 2).

1) What are the measures of center and interquartile range of employment densities within industrial zones?
2) What are the measures of center and interquartile range of employment densities within sectors (two-digit NAICS codes[15])?
3) What is the composition of employment by NAICS sector within industrial zones?
4) What methods do cities use to calculate employment density in their EOAs and how do city EPAs compare to EPAs found in this study?

Table 2. Select Oregon Cities and 2012 Metrics

City	Acres within UGB	Population	Number of Jobs	Population/Employment
Eugene	34,464	156,222	86,266	1.8
Bend	21,285	77,063	40,459	1.9
Albany	13,894	50,239	20,663	2.4
McMinnville	7,535	32,092	13,565	2.4
Canby	3,476	15,770	5,604	2.8

Population source: American Community Survey 5-Year Estimates, Table DP05. Area source: Oregon Spatial Data Library. Employment source: Oregon Employment Department 2012 QCEW data

Results

The following section displays and describes the results of this study beginning with measures of center and interquartile range (difference between the 25th percentile and the 75th percentile) of employment densities. Employment densities by sectors are discussed next, followed by composition of employment by sector and employment type. The final portion or the results section is devoted to review of selected cities EOAs.

Employment Densities – All Industrial Lands

Median employment densities for industrial zones range from a low of 8.3 in Albany to a high of 12.2 in Canby, aggregate median employment density is 9.9, as seen in Table 3. Mean employment density is higher than median employment density for all cities, mean employment is indicated by an "X" in Figure 2. On average, the mean employment density is 7.9 points higher than the median, indicating a skewed distribution towards higher employment densities. The skewed distribution may be attributed in part to aggregate reporting of QCEW data from a single, central office location when in actuality places of employment are scattered. Alternatively, there may be just a few outlier businesses with truly high employment densities, pulling the mean employment density up.

[15] A list of North American Industry Classification System (NAICS) sector codes is in Appendix B.

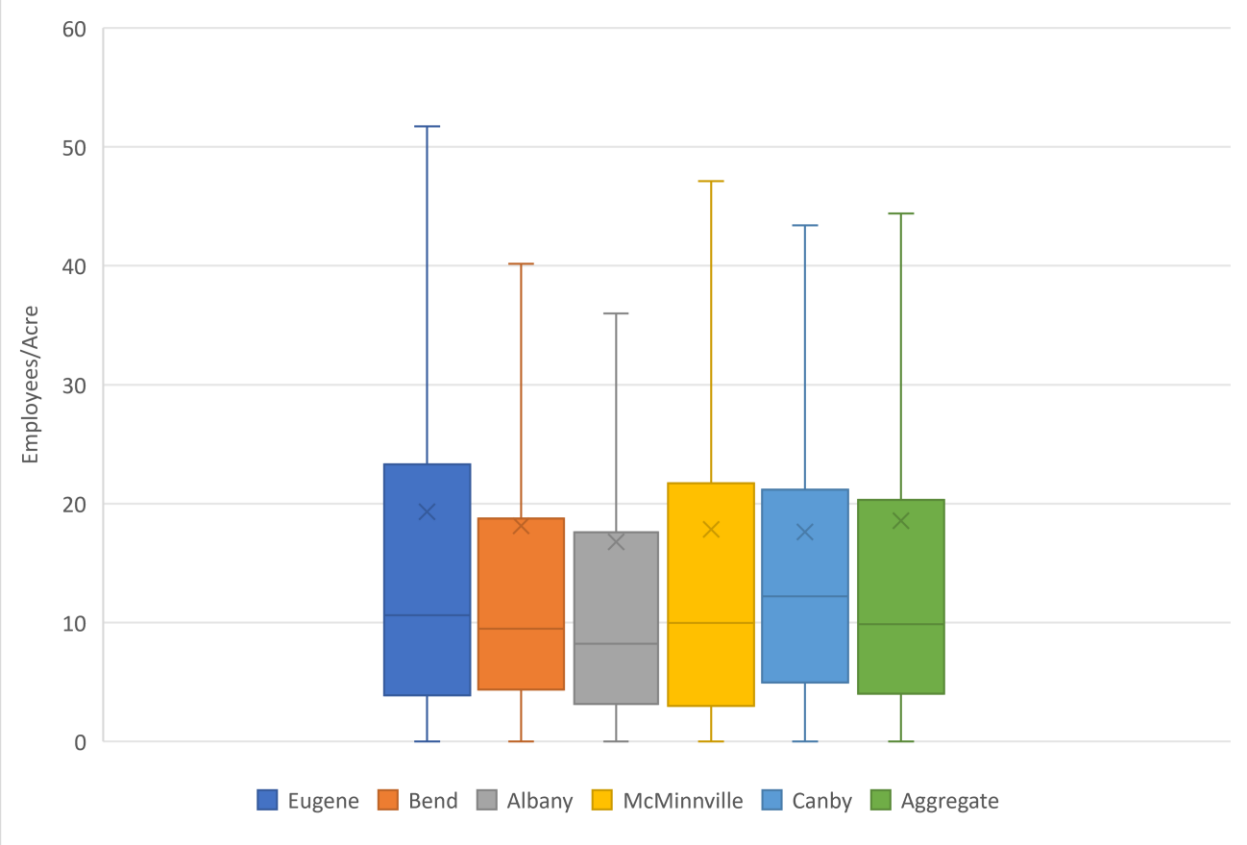
Examining employment density outliers in Eugene, it appears that most of the 36 data points are truly employment dense businesses, though there is evidence of misreporting for the data point with the very highest employment density.

Employment density interquartile range (IQR) is rather large, particularly for Eugene and McMinnville. The larger IQRs of these two cities indicate more variable employment densities within the cities. This is not that remarkable for Eugene, the largest of the cities, but is somewhat more surprising in McMinnville. It's possible both Eugene and McMinnville have a more diverse use of industrial space, creating a larger range of employment densities, than do the other cities.

Table 3. Employment Density Measures (EPA) of select Oregon Cities

	Eugene	Bend	Albany	McMinnville	Canby	All case study cities
Mean	19.4	18.2	16.9	18.1	18.0	18.6
Median	10.7	9.5	8.3	10.3	12.2	9.9
IQR	19.4	14.4	14.6	19.0	16.4	16.3

Figure 2. Industrial Employment Densities by City



Employment Density by Sector

Employment densities by sector are calculated for sectors that have sample sizes of 24 or more across all cities. Taking the construction sector as an example, that means there are 122 industrial zoned tax lots containing a single QCEW point and the business represented by that QCEW point is in the construction sector. Limiting this data set to only those tax lots with single QCEW data points considerably decreased the sample size, as seen in Table 8 of Appendix A.

Median employment density across the seven sectors is fairly consistent, falling between 7.1 and 11 with the exception of the real estate and rental and leasing sector (EPA of 2.2) and the administrative support sector (EPA of 20.3), as seen in Table 4. Median employment density for the real estate sector may be low in part because realtors are classified as contract workers and not included as employees in QCEW reporting. Employment density for the administrative sector is relatively high for most of the 25 samples, suggesting the sector is more employee dense by nature of the work.

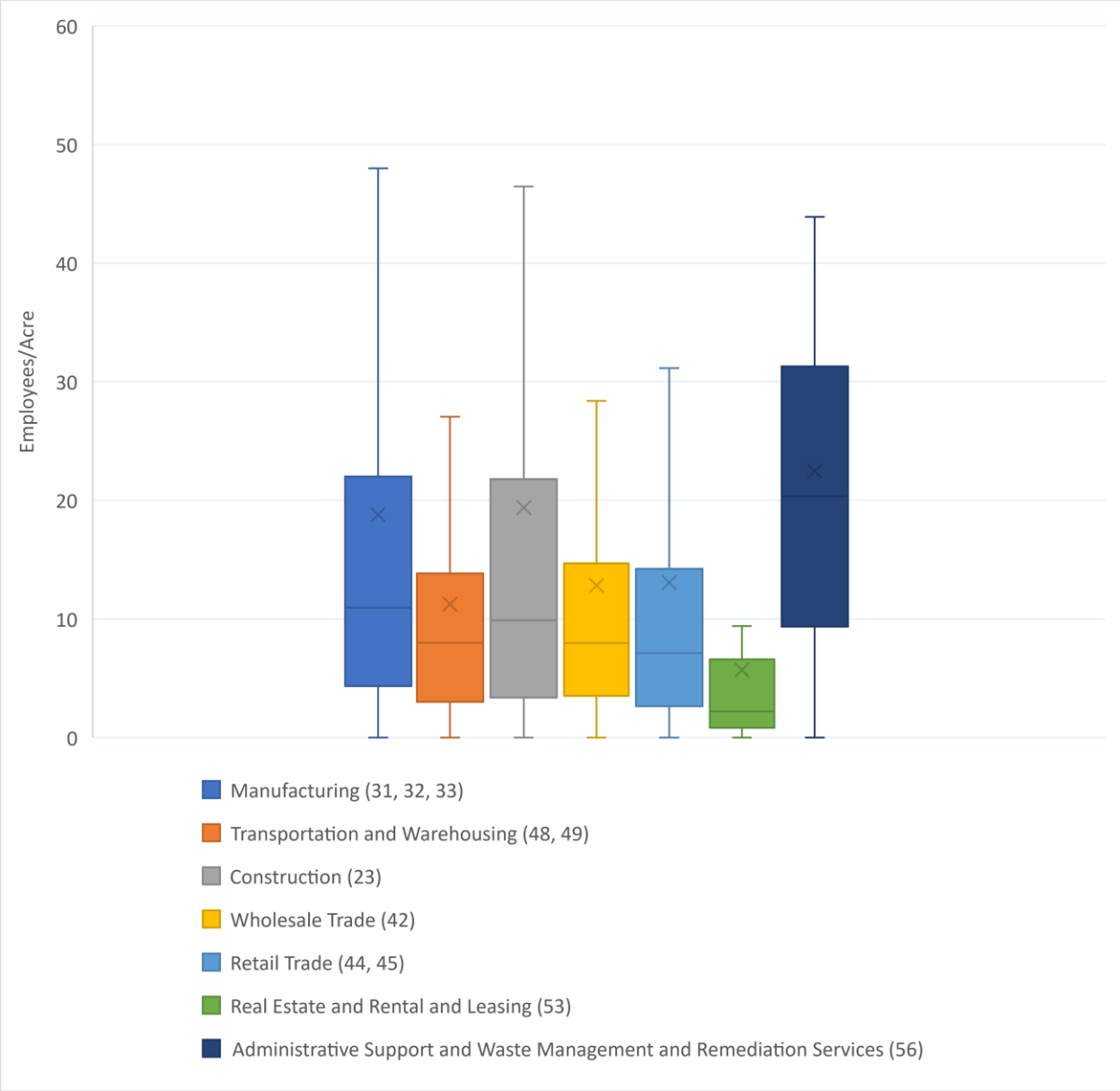
All sectors display a higher mean employment density than median employment density, this may be due to aggregate business reporting in QCEW data or a few truly employment dense businesses in each sector. Examining the five highest density lots in the construction sector (four located in Eugene), it appears that employment densities are being accuracy reported (not aggregated). However, it should be noted that the construction businesses examined perform contract work, which does not require substantial physical business space if employees are consistently out on job sites. When the four highest density lots in the manufacturing sector (also in Eugene) are examined, evidence of aggregate reporting for two of the businesses is found. Hence it may be a combination of employment dense business and aggregate reporting pulling employment density means up, though employment dense businesses appear more likely based on the examination of outlier data point in Eugene discussed in the previous section.

Employment density IQR is around 11 for three of the seven sectors. IQR was lower for the real estate sector and higher for the construction, manufacturing, and administrative support sectors. The higher IQRs of these three sectors, best seen in Figure 3, indicate more variable employment densities within the sectors. This is further underscored by the examination of outlier data point in Eugene; the two sectors best represented among the 36 outlier data points are the manufacturing sector with 11 data points and the construction sector with eight data points.

Table 4 Employment Density Measures (EPA) of select NAICS Sectors

Sector (NAICS codes)	Mean	Median	IQR	Sample size
Manufacturing (31, 32, 33)	18.8	11.0	15.7	217
Transportation and Warehousing (48, 49)	11.2	8.0	10.8	34
Construction (23)	19.4	9.9	18.4	122
Wholesale Trade (42)	12.8	8.0	11.1	132
Retail Trade (44, 45)	13	7.1	11.6	65
Real Estate and Rental and Leasing (53)	5.7	2.2	5.8	24
Administrative Support and Waste Management and Remediation Services (56)	22.5	20.3	22.0	25

Figure 3: Employment Density by select NAICS Sector



Composition of Employment by Sectors

Total employment on industrial land is broken down by sector for each city and in aggregate, results are displayed in Figure 4. To increase readability only the top four employment sectors for each city are displayed. For most cities, close to 50% of employment in industrial zones is in the manufacturing sector (NAICS 31, 32, 33). The exception to this is Bend, where manufacturing account for 22% of employment. Much of Bend's employment is concentrated in the "other" sector category. In Bend this includes the information sector (NAICS 51, 8%), finance and insurance (NAICS 54, 7%), administrative and support and waste management and remediation services (NAICS 56, 7%), and public administration (NAICS 92, 7%).

Wholesale trade and construction came in as the sectors with the second and third most employment in all cities except Albany and McMinnville. The transportation and warehousing sector is also a top employment sector in all cities except Eugene, where the sector accounts for 5% of employment.

Both Albany and McMinnville have substantial employment in sectors that did not "break" the top four employment sectors in other cities. In Albany this is the administrative and support and waste management and remediation services sector (NAICS 56, 11%). There are 11 businesses in this sector with a total employment of 472 among them all, though the two largest businesses account for 61% of the employment in the sector. In McMinnville these are the health care and social assistance (NAICS 62, 19%) and management of companies and enterprises (NAICS 55, 4%) sectors. Similar to what is seen in Albany, the health care and social assistance sector is made up of only 15 businesses with a total employment of 654 among them, the largest business accounting for 84% of the employment in the sector. The management of companies and enterprises sector consists of five business and 63 employees, the largest business accounting for 68% of the employees.

Figure 4. Composition of Employment by Sectors by City

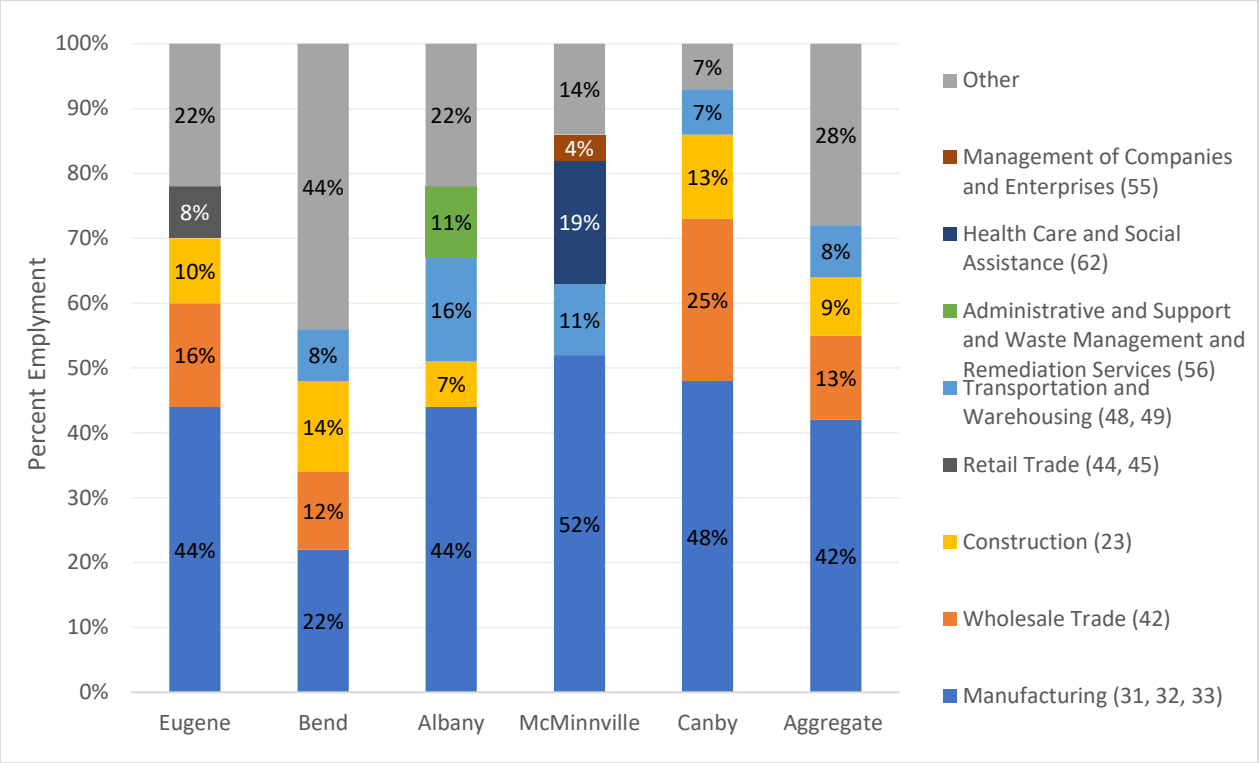
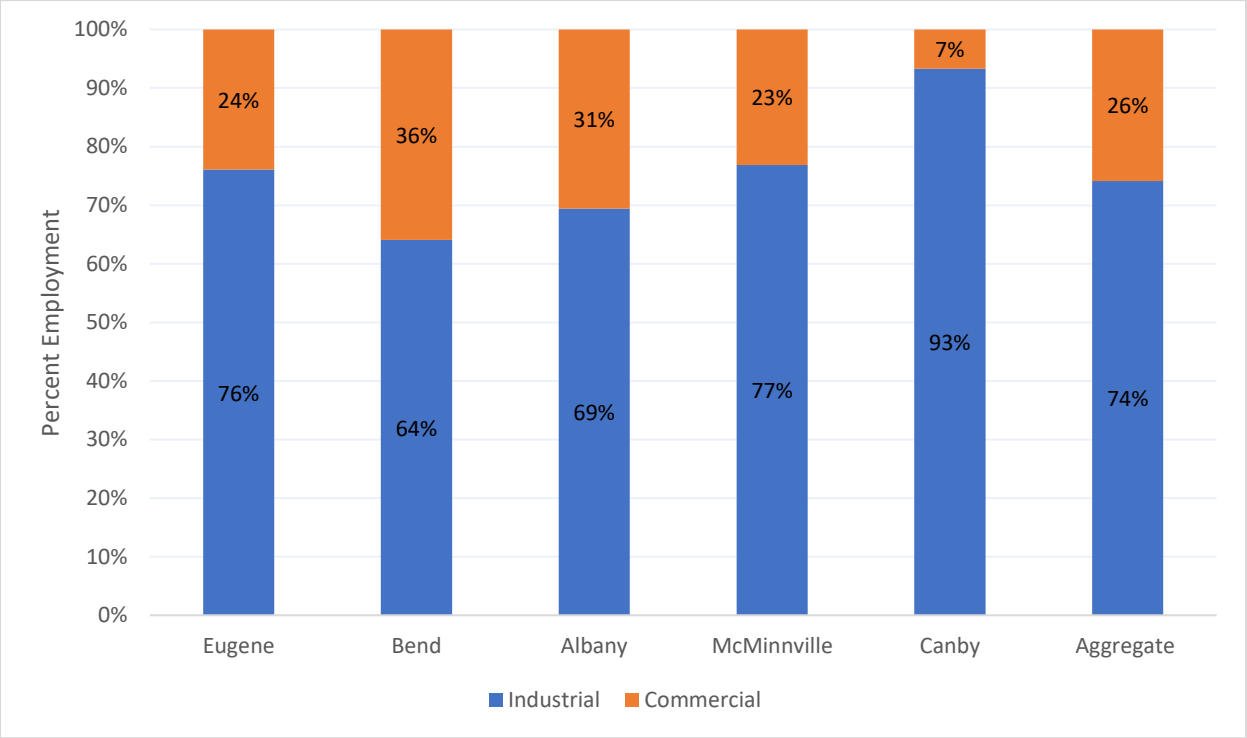


Figure 5 displays the same employment data from industrial zones but broken down by "industrial" and "commercial" uses as defined by division 38 (Simplified Urban Growth Boundary Method) of chapter 660 (Land Conservation and Development Department) of Oregon's administrative rules. Under the division 38 definition, "commercial" use means office, retail, institutional, and public employment land uses that generally do not require significant indoor or outdoor space. "Industrial" use refers to manufacturing, assembly, fabrication, processing, storage, warehousing, distribution, and research and development among other employment types; these uses typically require significant indoor or outdoor space.[16]

As seen in Figure 5, commercial employment accounts for between a quarter and a third of all employment in industrial zones in most cities, Canby being the exception. There is considerable non-industrial employment in industrial zones.

[16] Under division 38 commercial use NAICS sectors include 44, 45, 51, 52, 53, 54, 55, 56, 61, 62, 71, 72, 81, 92, and 99. Industrial use NAICS sectors include 11, 21, 22, 23, 31, 32, 33, 42, 48, and 49.

Figure 5. Composition of Employment by Industrial and Commercial Use



Economic Opportunities Analyses: Discussion and Comparison

EOAs were obtained for Eugene (2017), Bend (2016), Albany (2020, draft form), and McMinnville (2020, draft form). Canby is in the beginning stages of conducting their first EOA. To substitute for Canby's lack of an EOA, EOAs from two similarly sized cities were examined, Cornelius (2007) and The Dalles (2017). Each EOA is examined to determine how the city obtained the employment density numbers used to estimate industrial land needs. Where appropriate, employment densities used in the EOAs are also compared to employment densities found in this study.

Eugene

Eugene's most recent EOA is contained within the larger Envision Eugene/Employment Land Supply Study that was published in 2017. The EOA was prepared by the consulting firm ECONorthwest. The EOA addresses Eugene's employment trends and land demand for the 2012 to 2032 planning period. Eugene arrives at their industrial employment density figures by calculating employment density for a sample of five industrial zoned areas totaling 1,191 acres. Employment densities for industrial sample sites range from 3.3 to 16.7 employees per acre. Eugene's EOA uses QCEW data from 2006 to calculate employment density for sample areas, presented below in Table 5.

Comparing employment densities from Eugene's EOA and this study, there are some differences, particularly in the Light-Medium Industrial zones. The employment density for Light-Medium Industrial zones is calculated in the Eugene EOA as 16, while this study calculates 11. These differences, however, are difficult to interpret in light of the different data sets,

Eugene's EOA uses 2006 data while this study uses 2012 data. Between these two dates the U.S. economy also underwent considerable upheaval in the form of the Great Recession (2007-2009). Despite these temporal differences, the overall industrial zone employment densities are similar, 13 for the Eugene EOA and 11 for this study.

Table 5. Eugene EOA Employment Densities (EPA)

	Heavy Industrial	Light-Medium Industrial	Industrial Overall
Eugene EOA (2006 data)	8	16	13
This Study (2012 data)*	10	11	11

Sources: ECONorthwest Eugene Economic Opportunities Analysis and original research
* Median employment density

Bend

Bend's most recent EOA was published in 2016 and prepared by ECONorthwest and Angelo Planning Group. A discussion of the employment densities used in the EOA, however, is located in the 2016 Bend Urbanization Report. The Urbanization Report describes the densities as being calculated "through a GIS analysis of employment lands and geo-coded employment data from the Oregon Employment Department", similar to this study. The city summed the acreage of developed land by general plan designation then calculated the total non-shift employees on the land and divided the two numbers to arrive at employment density. The Urbanization Report does not directly state the year of the data used to calculate employment densities, however a memorandum attached to the report indicates that data may be from 2006.
Table 6, below, shows the employment densities calculated by Bend and in this study. Employment densities calculated in this study are lower than those calculated by Bend across both industrial zoning designations. Like Eugene, differences in employment densities are difficult to attribute give the different data sets and changes in the economy.

Table 6. Bend EOA Employment Densities (EPA)

	Industrial Light	Industrial General	Industrial Overall
Bend EOA (possibly 2006 data)	11	15	NA
This Study (2012 data)*	9	12	10

Sources: Bend Urbanization Report and original research
* Median employment density

Albany

Albany's most recent EOA, from March 2020, is available in draft form. The EOA was prepared by Angelo Planning Group and Johnson Economics. Albany calculates the amount of land needed for future employment by allocating expected employment growth into standard building typologies (office, institutional, general industrial, warehouse, retail, etc.) and then applying a "typical space needed per employee" (also known as square feet per employee, SFE) number to each building typology. The demand for space is converted into a demand for acreage using an assumed floor area ratio (FAR) that varies across building typology. The SFE and FAR assumptions provide estimates of job densities per acre, Albany's "implied density". Albany does not specify where they obtained information on distribution of employment by building typology, SFEs, or FARs outside of stating their source as "Johnson Economics, Oregon Employment Department". Based on the source description and discussion of SFE and FAR

assumptions, it is unlikely that the SFEs and FARs used in Albany's EOA are derived from empirical analysis.

A comparison between Albany's "implied densities" and the employment densities found in this study is difficult because Albany calculates employment density by building use typology. To accommodate for this, Table 7 shows the employment density calculated for NAICS sectors that are most likely to be located in the building topologies identified in Albany's EOA. Building typologies are limited to those that would likely be found in industrial zones, as seen here.

Building Typology: General Industrial

- Constructions (NAICS 23)
- Manufacturing (NAICS 31, 32, 33)
- Information (NAICS 51)

Building Typology: Warehouse

- Utilities (NAICS 22)
- Wholesale (NAICS 42)
- Transportation and warehousing (NAICS 48, 49)

Table 7. Albany EOA Employment Densities (EPA)

	General Industrial (NAICS 23, 31, 32, 33, 51)	Warehouse (NAICS 22, 42, 48, 49)
Albany EOA (unknown data)	21	8
This Study (2012 data)*	9	7

Sources: Albany Draft Economic Opportunity Analysis and original research
* Median employment density

The comparison of employment densities by building typology, while not entirely direct, showcases very different employment densities for the general industrial building typology but similar employment densities for the warehouse building typology. A more detailed analysis of Albany's methodology would need to be conducted to fully understand the differences in employment densities, though this brief introduction to Albany's methodology highlights one of the methods cities use to calculate land demand.

McMinnville

Like Albany, McMinnville's most recent EOA, from February 2020, is in draft form. The EOA was prepared by ECONorthwest. The EOA calculates industrial employment density in two different ways. The first method involves identifying all developed industrial designated lots (as described in McMinnville's buildable lands inventory) and number of employees associated with each lot. The number of employees is then divided by the lot's acreage to arrive at an employment density figure. This methodology produces an industrial employment density of ten. The EOA uses 2017 QCEW data from the Oregon Employment Department. The EOA notes that while this approach provides a reasonable indication of employment density, not all employment in industrial areas is classified as industrial employment, potentially skewing the "industrial" employment density.

The second method used to calculate employment density involves selecting representative sample areas and calculating employment densities for just those areas, as was done in Eugene's EOA. Using this methodology resulted in an employment density of 11. Limitations regarding this method are detailed as well, primarily the danger of sample areas not being able

to provide information on employment densities across the entirety of McMinnville. Ultimately, the McMinnville EOA used an industrial employment density of 11 for their calculations. The EOA employment density is very similar to the median employment density calculated in this study, 10.3.

Canby

The city of Canby is currently in the very beginning of drafting their first EOA, proposals were due to the city this past March. In light of this, two similarly sized cities, Cornelius (2012 population of 12,575) and The Dalles (2012 population of 13,537), with readily available EOAs are reviewed.[17] EOAs are reviewed strictly as examples of how smaller jurisdictions calculate employment densities and land needs.

Cornelius's most recent EOA was published in 2017 and prepared by PNW Economics. Similar to Albany, Cornelius's EOA uses SFEs to estimate total industrial space demand and then applies FAR assumptions to arrive at total industrial land demand in acres. The EOA notes that SFEs for industrial employment vary much more widely than office employment space requirements. The EOA uses a different SFE for each employment sector that needs industrial land (constructions, manufacturing, wholesale, etc.). FAR assumptions are also unique to each sector. SFE and FAR figures are attributed to "PNW Economics based on regional project experience and Urban Land Institute national averages". Unlike Albany, the Cornelius EOA does not provide "implied densities" of employees per acre.

The Dalles's most recent EOA was published in 2007 and prepared by ECONorthwest. This EOA does not calculate employment density, instead it makes assumptions about average employment density and applies those numbers to determine land demand. In describing this methodology, the EOA states that "There are few empirical studies of the number of employees per acre, and these studies report a wide range of results. Ultimately the employees/acre assumptions reflect a judgment about average densities and typically reflect a desire for increased density of development."[18] Cornelius ultimately uses an industrial employment density of ten, an educated guess that aligns very well with the aggregate median employment density calculated in this study, 9.9.

All Cities Summary

In reviewing EOAs from these six jurisdictions, it becomes apparent that cities are taking advantage of the multiple land demand methodologies allowed by the DLCD Guidebook. Bend calculates employment density in a similar fashion to this study, through GIS analysis of employment lands and geo-coded employment data. Eugene and McMinnville both use a sampling approach, calculating employment densities on an employees per acre basis for a few representative areas and applying those numbers to forecast employment. The Dalles's EOA uses employment density figures that are essentially educated guesses (and very similar to the median employment densities found in this study).

[17] American Community Survey 5-Year Estimates, Table DP05

[18] ECONorthwest, City of The Dalles: Economic Opportunities Analysis, 2007. P. 64

Albany and Cornelius do not calculate employment density on an employees per acre basis. Instead these two cities use average space square footage requirements per employee to estimate total industrial space demand and then apply floor area ratio assumptions to arrive at total industrial land demand in acres.

Conclusions and Take-aways

Employment density in industrial zones is consistent across cities. The median and mean employment densities for all five of the cities examined in this study are relatively stable. City size, ranging from a high of 156,000 in Eugene to a low of 16,000 in Canby, does not appear to influence employment density. This could be interpreted as a sign that Oregon's industrial land planning guidelines are being applied consistently and producing consistent results. A city with either much lower of much higher industrial employment density could signify a lack (or inefficient use) of industrial land or need for more industrial land. Oregon's state planning laws try to prevent such misallocation of land, from this study it appears the laws are working as intended.

- **Take-away:** Laws regarding allocation of industrial lands are working as intended and should be maintained by the State.

Sector level employment density in industrial zones is more variable then city level industrial employment density, but still relatively consistent, with exceptions. This study found that median employment density for the seven best represented sectors in industrial zones is fairly consistent between seven and eleven EPA. Exceptions to this finding are the real estate and administrative support sectors, which have much lower and higher employment densities, respectively.

- **Take-away:** Industrial employment density is relatively consistent across most sectors; this can make estimating land demand easier. Cities, however, should take note of those sectors that do not follow this general pattern and their contribution to total employment.
- **Take-away:** Assigning an average or median employment density number to a zone may allow cities to essentially "balance out" the higher and lower employment densities of specific sectors. This take-away supports DLCD's Guidebook suggestion of applying a single employment density number to a zone or planning designation.

There is considerable employment density variability within some sectors, as indicated by larger IQRs. Employment density IQR for the construction, manufacturing, and administrative support sectors was 50% to 100% higher than other sectors, indicating more variable employment densities within these sectors.

- **Take-away:** Cities should remain cognizant of within sector employment density variability when conducting land needs assessments.

A few large employers can visibly change the sector make up of a jurisdiction. Most cities had a similar mix of "top" employment sectors on industrial lands. Two cities, however, stood apart from this group; Albany and McMinnville both have high levels of employment in sectors that are not well represented in other cities. In both cities, most of the employment in these sectors came from just one or two large businesses.

- **Take-away:** A few large employers in sectors that do not typically contribute much employment in industrial zones can substantially change the sector employment "mix" of a city, especially in smaller cities. Cities should be cognizant of the undue influence such singular, large employers may have on density and employment, particularly when approximating employment trends.

Considerable non-industrial use employment exists on industrial lands. In four of the five cities examined nearly a quarter to a third of employment in industrial zones is considered "non-industrial" under Oregon's administrative rules.

- **Take-away:** Cities need to account for the percentage of non-industrial employment that takes place (and consumes land) in industrial zones when estimating industrial land needs. If EOAs fail to account for non-industrial uses, they may risk under allocating land to industrial employment.

There are considerable differences in how cities estimate industrial land needs. DLCD's Guidebook outlines multiple methods cities can use to estimate land needs. Methods include estimating, calculating, and sampling EPA, using population/developed land ratio, relying on expert consultations, and using SFE and FAR figures (both calculated and estimated). This study found that jurisdiction take advantage of the "menu" of approved methodology in conducting their EOAs. Eugene and McMinnville use a sampling EPA method, Bend calculates EPA city wide, and The Dalles relies upon estimated EPA. Albany and Cornelius both used the SFE/FAR methodology.

- **Take-away:** Cities take advantage of the "menu" of estimating land needs methodologies, keep these options available.

More mixed-use zoning may complicate land needs assessments. Land demand analyses may become more difficult if industrial (and other) zones allow an increase of uses.

- **Take-away:** Cities, particularly those with mixed use zones or lots of acceptable uses, may need to consider adopting a land demand methodology or a non-industrial employment factor that accounts for non-industrial employment locating in industrial zones. Inclusion of a non-industrial employment factor in DLCD's Guidebook would acknowledge that a certain percentage of industrial land will be used for non-industrial purposes. Albany's distribution of employment by building typology is reminiscent of form-based codes and provides food for thought on new land demand methodologies.

Future Work

There will undoubtably be work on industrial lands completed in the future, especially considering the industrial zone tends discussed at the beginning of this study. This study brings to light the multitude of ways cities calculate employment densities (or related figures) when conducting EOAs. Albany and Cornelius use SFEs and FARs to calculate land needs. Future research could look deeper into that methodology and compare it to the methodology used by cities like Eugene, Bend, and McMinnville, who took EPA based approaches. Broadening the scope of future research to include other states, it would be interesting to compare the EPA found in Oregon cities to comparably sized jurisdictions in states with different (or no) requirements for provision of industrial land.

The recent COVID-19 pandemic has also opened new avenues concerning employment density research. Employees in commercial sectors are working from home and will continue to do so, at least in part, for the foreseeable future. Commercial businesses, aware of this trend and conscience of expenditures, are increasingly floating the idea of permanently closing or consolidating physical offices.[19] Unlike commercial business, industry and manufacturing cannot operate remotely and may require additional space to comply with social distancing guidelines. Future studies could explore the extent and intensity of shifting employment centers during and following the pandemic. Shifts in employment centers would have consequences related to property tax income, transportation investments, and location of businesses, such as restaurants, that rely on neighboring employment centers for income.

[19] Haag, M. Manhattan Faces a Reckoning if Working from Home Becomes the Norm, 2020

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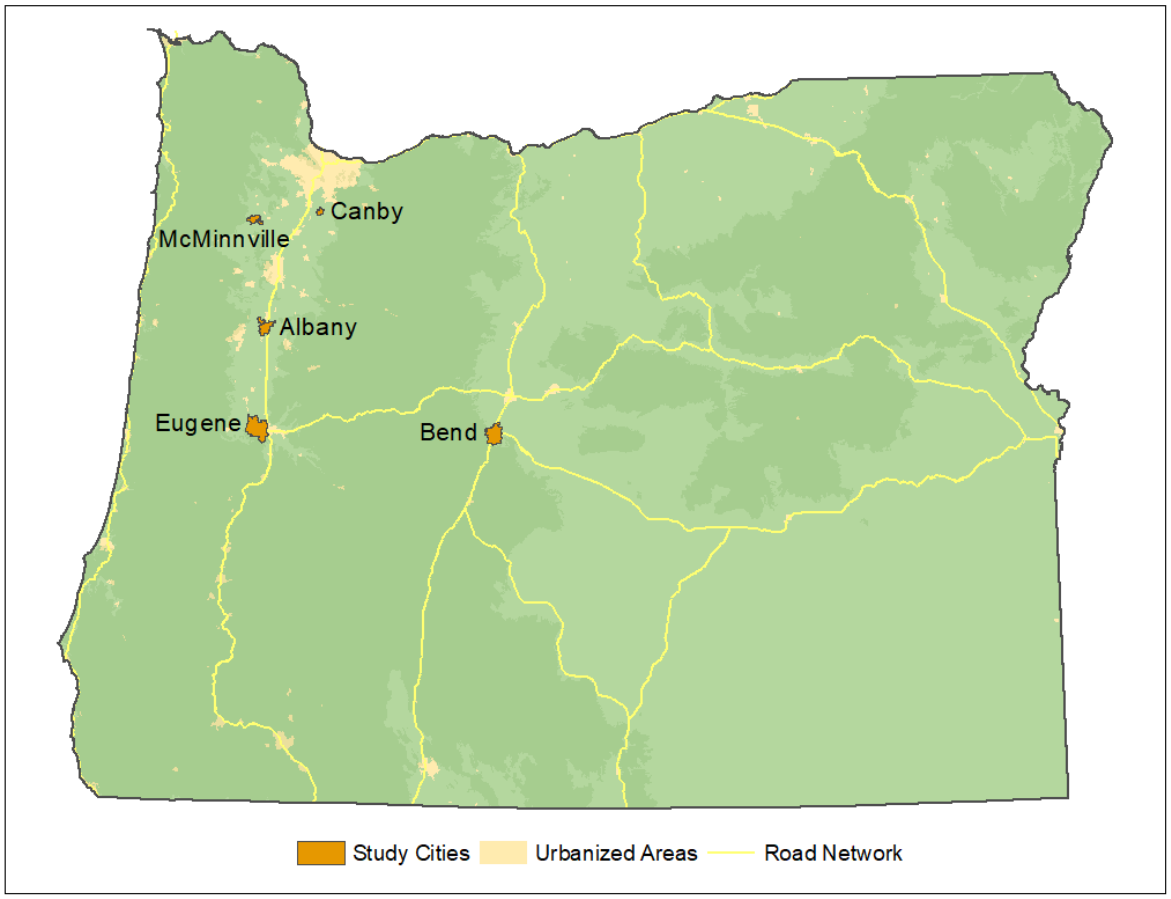
Appendix A: Detailed Methodology

Data on employment densities is not readily available at the tax lot level for Oregon cities. Hence, employment densities had to be calculated by combining geo-located QCEW data from the Oregon Department of Employment with zoning and tax lot data from city and county websites. Employment densities in this study are calculated as number of employees per tax lot acreage. Much of the initial work was done using ArcGIS 10.6.1, a geographic information systems software. Resulting data was then pulled into Microsoft Excel for further analysis. Below, I detail more fully city selection, data used, and briefly explain how I manipulated primary data sources to answer study research questions. I also touch on data limitations.

City Selection

Two factors greatly influenced city selection. The first is the availability of GIS zoning and tax lot data, which is not readily available for all cities, the second is city population size. To get a feel for how employment densities may or may not change with city size, a range of city sizes was used. Selected cities are spread throughout the western half of the state, as seen in Figure 6.

Figure 6. Selected Oregon Cities



Source: Oregon Spatial Data Library

Primary Data Sources

Oregon Department of Employment QCEW database (2012) - This database contains individual, geo-located QCEW data points for all businesses located in Oregon. A sampling of the data for each business includes average number of employees, quarterly pay, North American Industrial Classical System (NAICS) two-digit sector code, business name, and business street address. Crucial to this report, the QCEW data also includes the latitude and longitude of each business's physical location. While readily available at the aggregate county level, data at the individual business level is not available to the public for confidentiality reasons. Obtaining business level data requires signing of a Commitment to Confidentiality release. The release includes stipulations on sharing data in individual businesses or data that would easily allow identification of individual business. This study utilizes 2012 QCEW data that was already in hand from prior work related to Oregon House Bill 2245 and land use efficiency.[20]

City zoning and tax lots data - City zoning and tax lot data were obtained from city and county websites. McMinnville is the exception to this, as those data is not publicly available but were already in hand from prior work. PDFs of each city's zoning map are located in Appendix C.

Data Manipulation

Question 1: Employment Densities within Industrial Zones - To answer this question QCEW data are spatially joined to city zoning data, imbuing QCEW data points with the underlaying zoning designation. City tax lot data are then spatially joined to QCEW data points with industrial zoning designations, imbuing tax lots with QCEW data. Some tax lots contain more than one QCEW point, in these instances the employment of the two points is added together to get the total employment of the tax lot.

Following the second spatial join, total employment of the lot is divided by lot acreage to arrive at the tax lot's employment density. The resulting attribute table is brought from the GIS application into Excel to calculate measures of center and interquartile range.

Question 2: Employment Densities within Sectors – A subset of the same final data set from question one is used to examine sector specific employment densities within industrial zones. Tax lots with more than one QCEW point are removed as these tax lots are associated with different sectors, confounding sector specific density calculations. Data from tax lots with single QCEW data points are brought from the GIS application into Excel to calculate employment density measures of center and interquartile range. The number of tax lots drops notably for each city during this process, as shown in Table 8.

[20] University of Oregon Community Service Center Department of Planning, Public Policy and Management, Analysis of Land Use Efficiency in Oregon Cities, 2015.

Table 8. QCEW Distribution within Tax Lots

City	Eugene	Bend	Albany	McMinnville	Canby	Total
Total industrial tax lots	518	304	133	71	50	1076
Tax lots with 1 QCEW point	382 (74%)	188 (62%)	96 (72%)	52 (73%)	38 (76%)	757 (70%)
Tax lots with ≥ 2 QCEW points	136 (26%)	116 (38%)	37 (28%)	19 (27%)	12 (24%)	319 (30%)

Question 3: Composition of Employment by Sectors - To answer this question a process similar to that of question one is used. QCEW data are first given underlying zoning attributes, but instead of joining that data to tax lots, industrial zoned QCEW data points are aggregated based on two-digit NAICS codes and employment within each sector is summed.

Question 4: Employment Densities in EOAs, Discussion and Comparison - Answering this question does not require extensive GIS work, instead it requires obtaining a copy of each city's most recent economic opportunities analysis (EOA). EOAs are obtained for Eugene, Bend, Albany, and McMinnville. Canby is in the process of developing their first EOA, so EOAs from two similarly sized cities, Cornelius and The Dalles, are examined instead. Each EOA is examined to determine how the city used (or didn't use) employment density to estimate industrial land needs. Where appropriate, comparisons are also made between employment densities used in the EOAs and the employment densities calculated in this study.

Data Limitations

There are a number of data limitations associated with this research. The age and accuracy of QCEW data are the most evident data limitations. Aggregate reporting of business data also complicates employment density calculations. Lastly, the lack of temporal alignment between tax lot, zoning, and EOAs, while not overly problematic, is important to be aware of.

While it is difficult to estimate how much the state of industrial employment has changed since 2012 (date of QCEW data used in this study), it has likely shifted somewhat due to increasing automation, changes in market competitiveness, changes in consumer expectations, and wider economic fluctuations. Hence, the information on industrial employment presented in this study, such as composition of NAICS sectors, may not be as representative of current conditions as would be liked.

The accuracy of geolocated QCEW data points in another limiting factor. The Oregon Department of Employment collects information on the physical address of business. Physical addresses are geo-coded using GIS and each business is assigned a latitude and longitude. This study uses these assigned latitude and longitude to determine which zone and tax lot a business is located in. Geo-coding is not a completely precise process, as a result some QCEW points do not accurately depict the physical location of a business. The Oregon Department of Employment speaks to this issue in the user's guided associated with the 2012 QCEW data.

QCEW GIS files contain precision values for each data point, most of the industrial zoned data point locations are precise within +/- ten feet (97% in Eugene, 78% in Bend, 98% in Albany, 80% in McMinnville, and 91% in Canby). While small, this +/- ten feet can result in data points being placed in adjoining tax lots or in streets, limiting analyses. Despite this limitation, the QCEW remain the best available data for this study's purposes.

The aggregate reporting of business data is also problematic for employment density calculations. Aggregate reporting happens when businesses that operate at multiple locations report total employment in just one location, such as the business's headquarters. Reporting in aggregate erroneously increases the employment density at the businesses headquarters and decreases employment density at other locations. This study attempts to compensate for aggregate reporting by including more robust measures of center, such as median employment density.

The lack of temporal alignment between data, while not overly problematic, is also important to be aware of. This study relies on readily available data (GIS tax lot and zoning layers, EOAs). In doing so it forgoes an ideal temporal alignment of data. As an example, Albany's tax lot GIS layer was last updated in 2019, the zoning layer in 2018, and the EOA in 2020 (draft form). Part of the lack of alignment is due to the very nature of planning, different jurisdictions operate on different timelines, each updating and refining data and plans when needed. The lack of temporal alignment is mitigated to some degree by the typically slow pace of land use change, allowing us to still draw useful conclusions from this study.

Appendix B: North American Industry Classification System

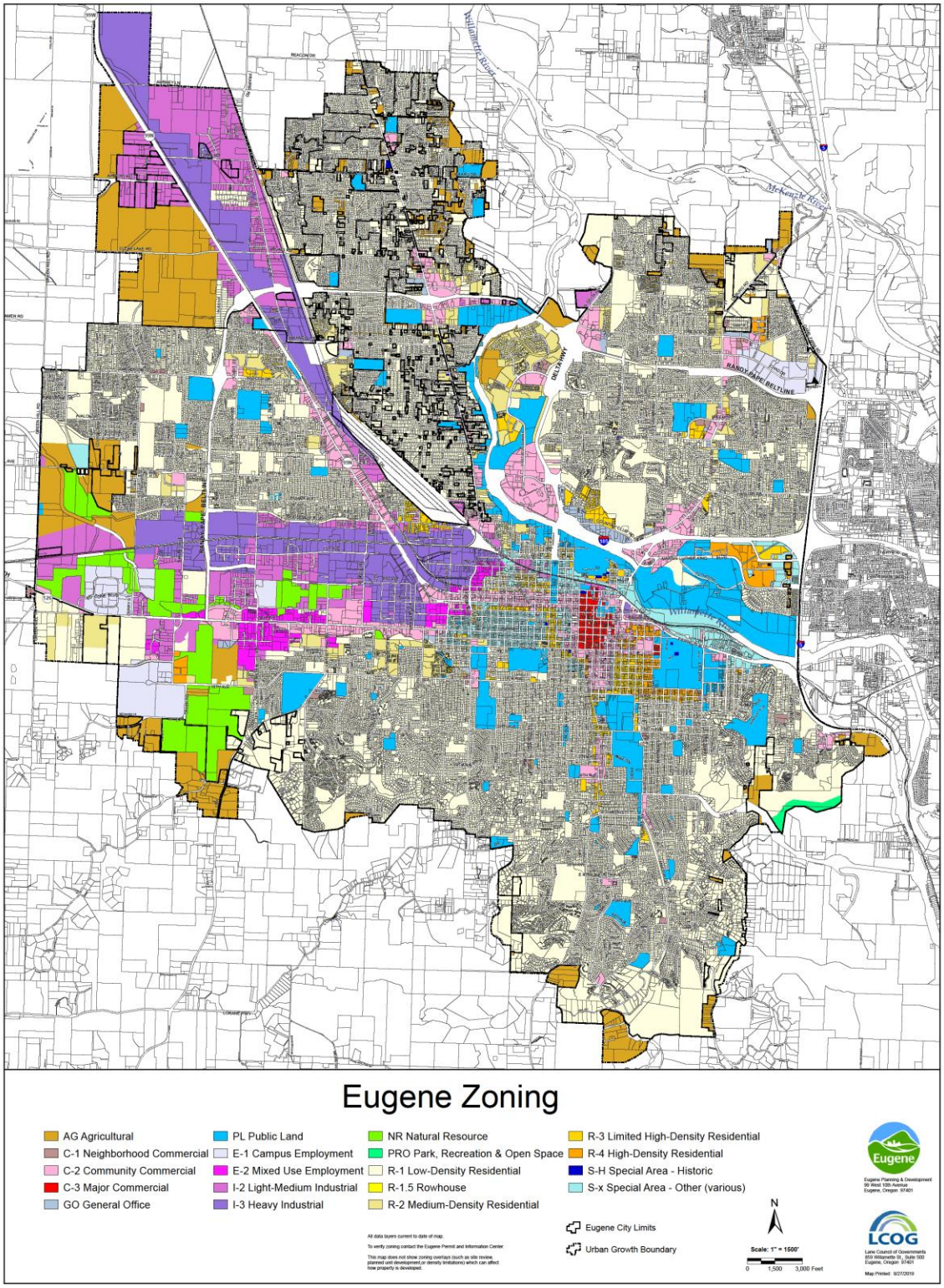
The table below shows the sector number and description of the 2012 North American Industry Classification System (NAICS).

Table 9: NAICS sectors and descriptions

Sector	Description
11	Agriculture, Forestry, Fishing and Hunting
21	Mining, Quarrying, and Oil and Gas Extraction
22	Utilities
23	Construction
31-33	Manufacturing
42	Wholesale Trade
44-45	Retail Trade
48-49	Transportation and Warehousing
51	Information
52	Finance and Insurance
53	Real Estate and Rental and Leasing
54	Professional, Scientific, and Technical Services
55	Management of Companies and Enterprises
56	Administrative Support and Waste Management and Remediation Services
61	Educational Services
62	Health Care and Social Assistance
71	Arts, Entertainment, and Recreation
72	Accommodation and Food Services
81	Other Services (except Public Administration)
92	Public Administration

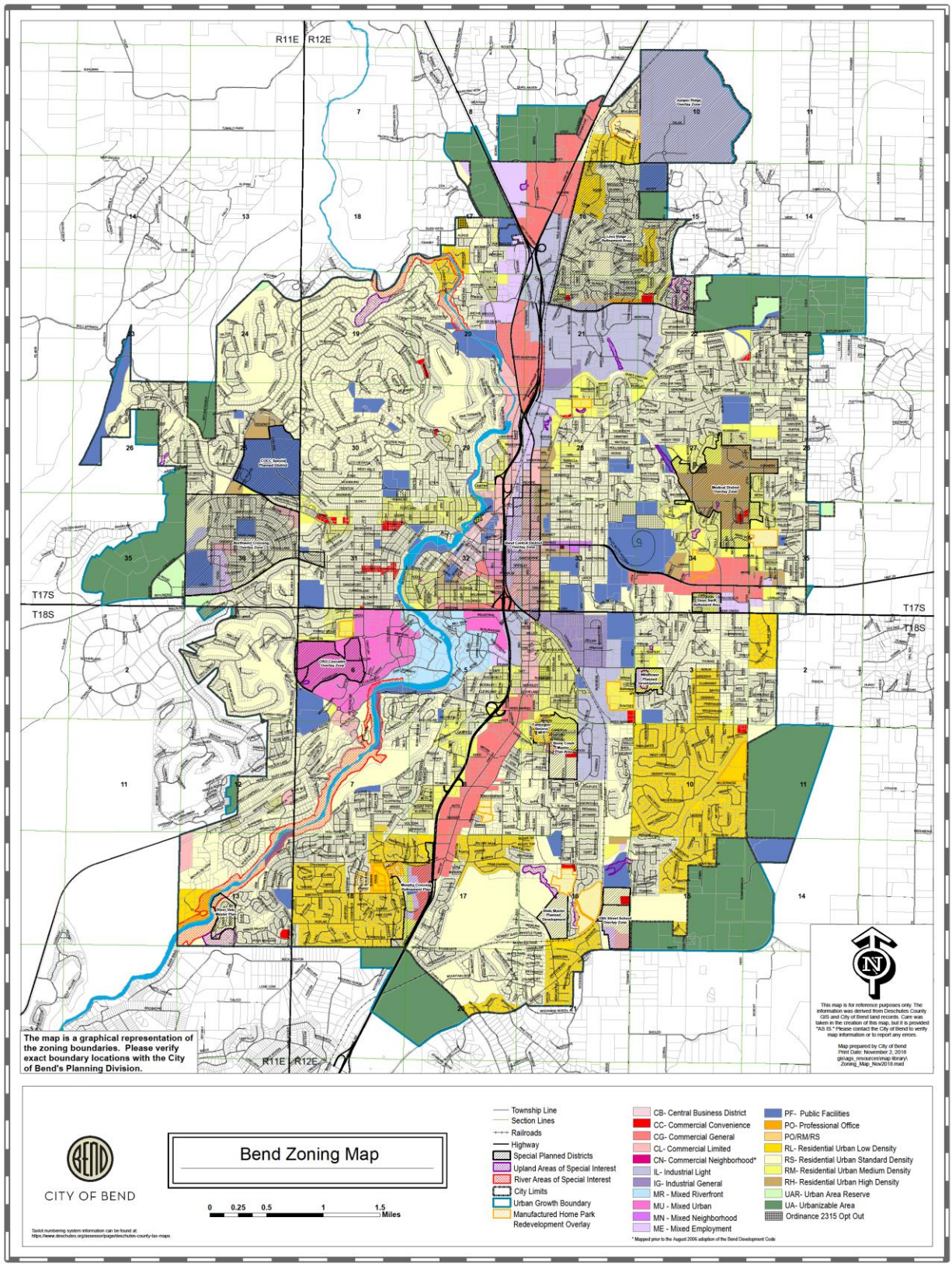
Appendix C: Zoning Maps

Figure 7. Eugene, OR Zoning Map



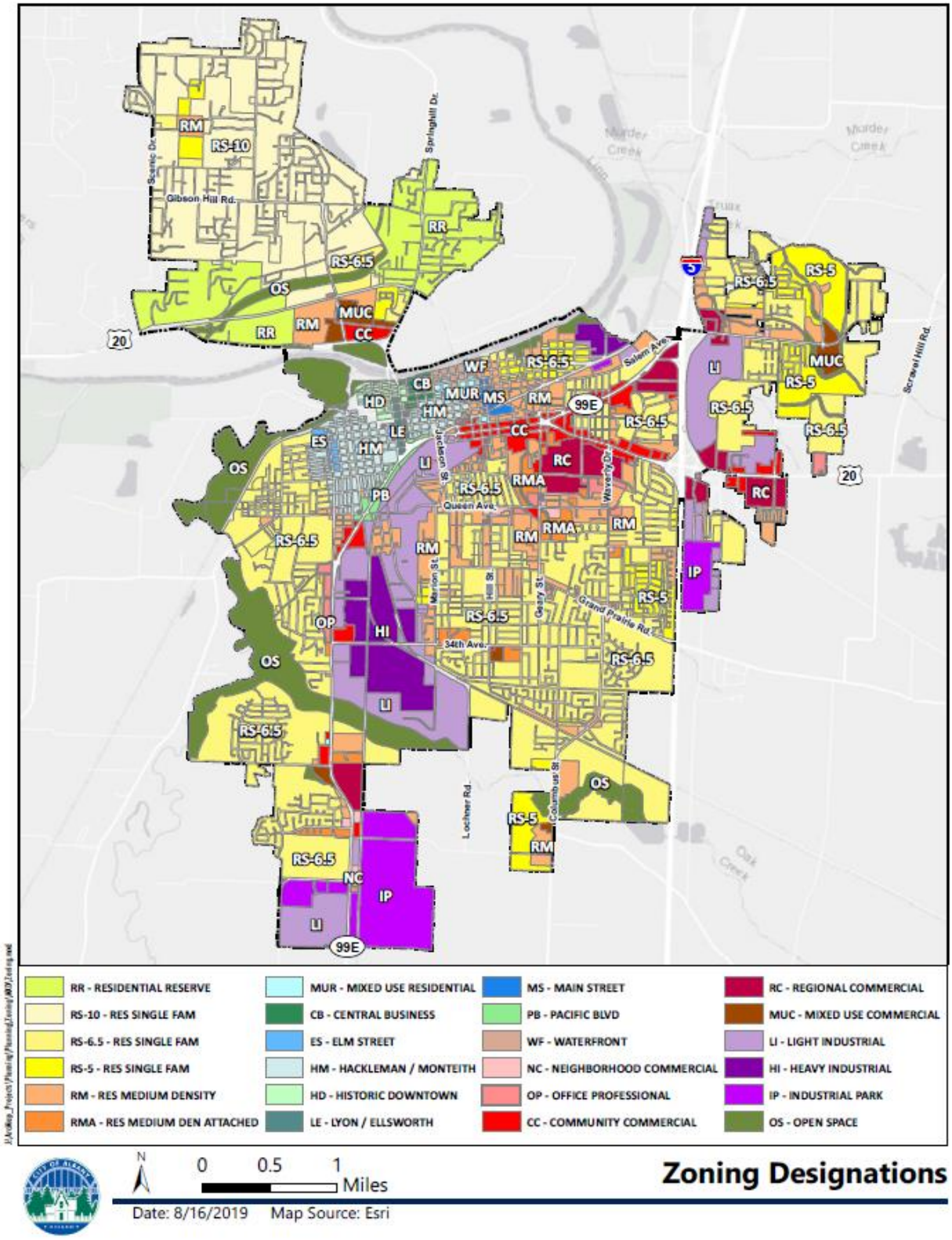
I-2: Light-Medium Industrial (bright pink), I-3: Heavy Industrial (purple)

Figure 8. **Bend, OR Zoning Map**



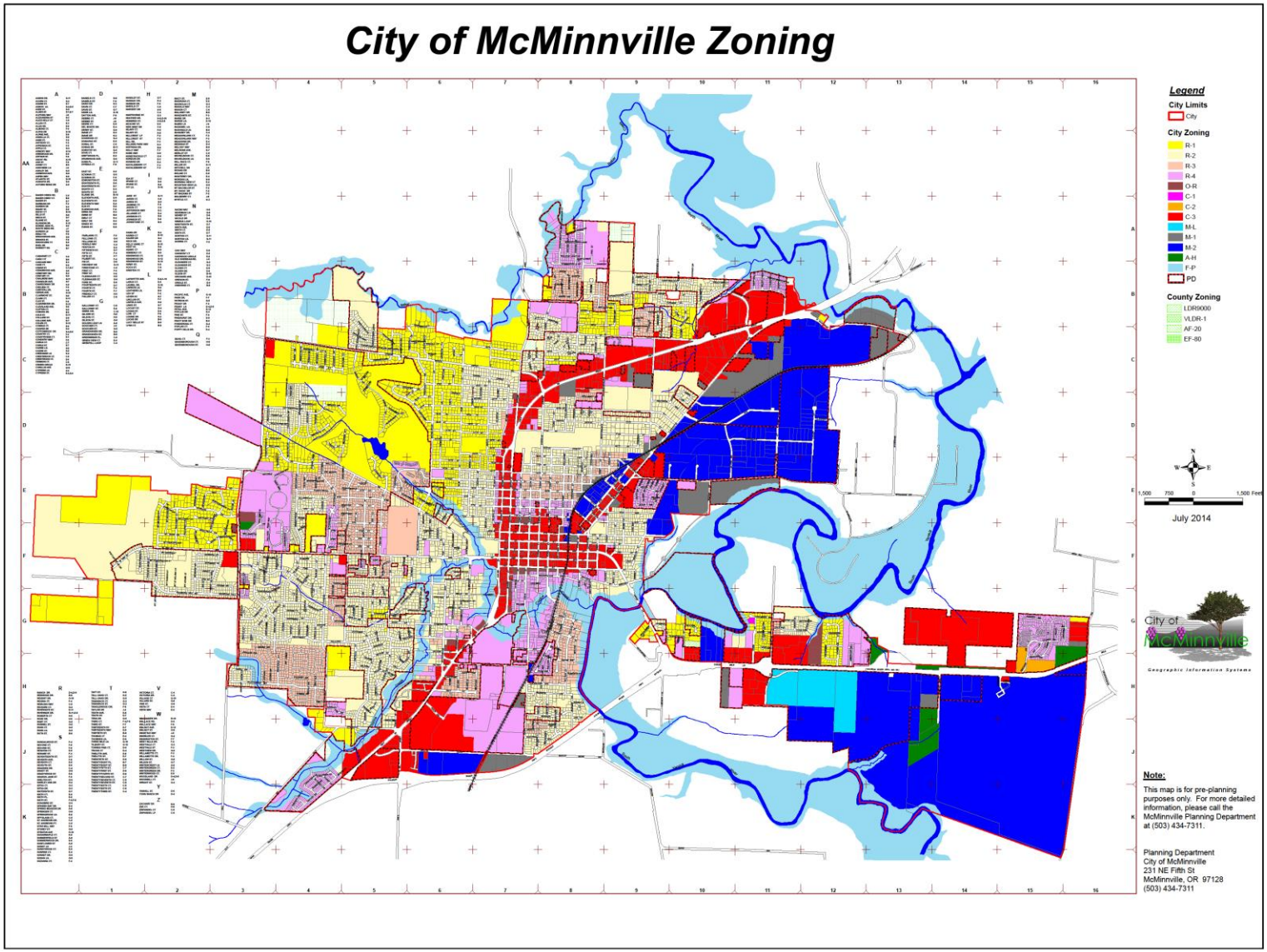
IL: Industrial Light (muted light purple), IG: Industrial General (muted purple)

Figure 9. **Albany, OR Zoning Map**



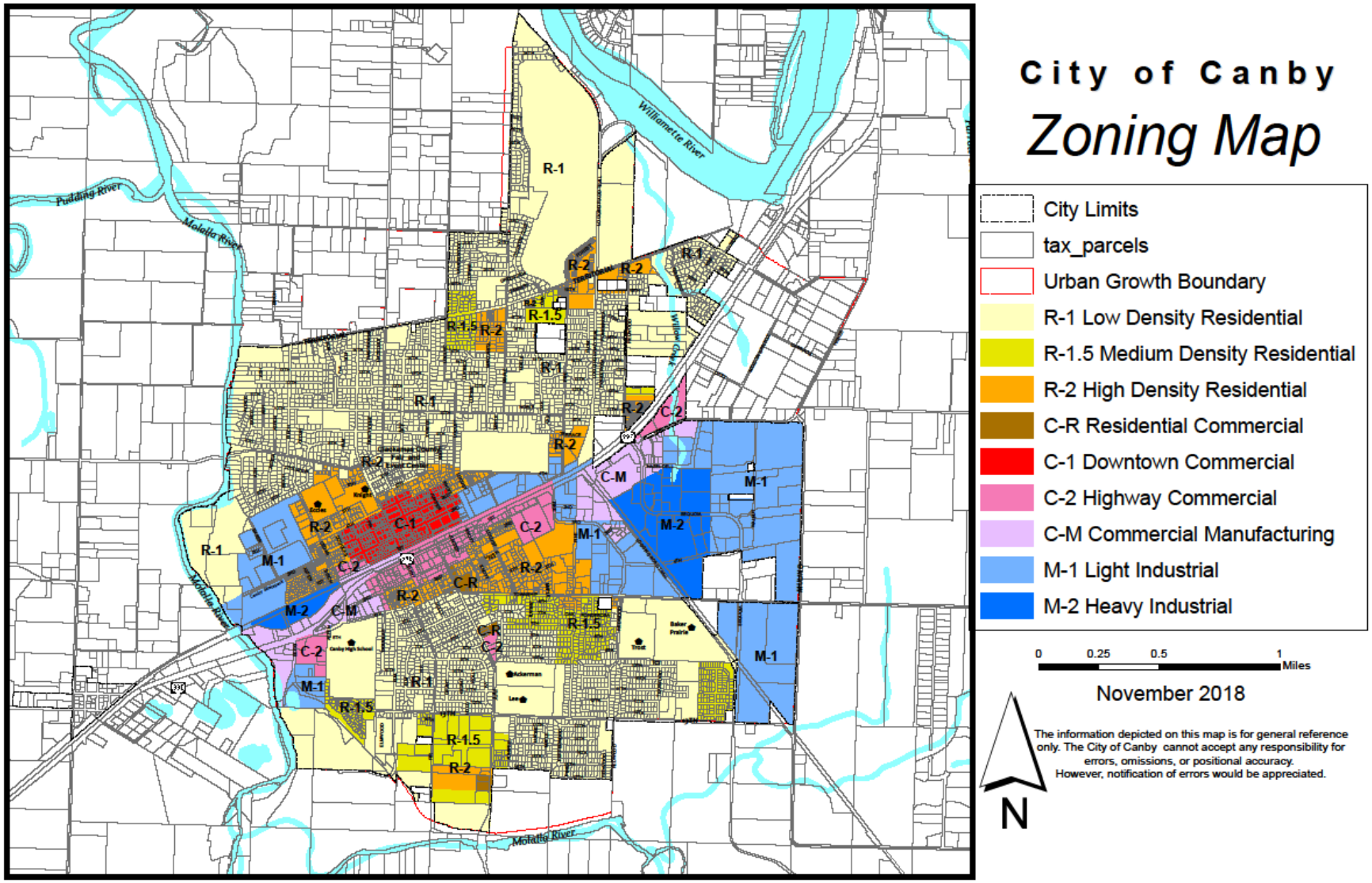
LI: Light Industrial (light purple), HI: Heavy Industrial (dark purple), IP: Industrial Park (bright purple)

Figure 10. McMinnville, OR Zoning Map



M-L: Limited Light Industrial (aqua), M-1: Light Industrial (grey), M-2: General Industrial (royal blue)

Figure 11. Canby, OR Zoning Map



M-1: Light Industrial (light blue), M-2: Heavy Industrial (blue)