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Refill Report – Measuring Past Refill Rates and Forecasting Future Refill

Economic & Land Use Forecasting Measurement Program

December, 2011

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Suzanne Flynn

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SUMMARY

Definitions and Background

We define "refill" as a combination of two types of real estate development. These are infill development and redevelopment. The former real estate development occurs on developed land without a previous improvement being demolished. On the other hand, redevelopment occurs on developed land where the land is made usable by demolishing a preexisting structure. For our purposes we combine the two and simply call the process "refill".

How do we measure refill? The key here is the term *measurement*. We measure infill and redevelopment that has actually taken place in the past. The lynchpin in this process has been the existence of the RLIS system (Regional Land Information System) fully implemented in 1995. This GIS information system categories all tax lots within an area approximating the urban extent of Clackamas, Multnomah and Washington Counties as developed or vacant. This classification manually audited each year is accompanied with a number of tax assessor, air photo, building permit, etc. data files that provide full information about the status of each tax lot beginning with the 1996 fiscal year.

Periodically beginning in 1997 we review recent building permits for new construction[1] and ask the simple question: was the tax lot on which the development occurred considered developed prior to construction? If the answer is yes, the development is classed as refill. If no, the development is classed as vacant. As detailed in both the residential and nonresidential sections, the actual work procedures are substantially more complicated then the above explanation implies. Nevertheless, the explanation provides an apt summary of what the work effort amounts to.

Taken at the simplest level the above procedure yields for a given year the number of units built on land RLIS considered already developed and the number of units built on land RLIS considered vacant. Hence for the time period 2001 – 2006 we can say that 35 - 45% of all residential units were constructed on land that RLIS already considered developed or that between 2001 and 2007 50 - 60% of all commercial new square footage occurred on developed land.

So why is the "refill rate" important? These data document the amount of residential and nonresidential growth that the Metro Region accommodates without using vacant land. If the refill rate were always 100%, the Region could grow without increasing in physical size. Conversely, if the refill rate were 0%[2], all growth would be accommodated by vacant, green field sites at the urban edge. Since the Metro 2040 Plan and all subsequent policy statements strongly back the most compact urban form and increased densities, knowing the refill rate and the economics underlying trends in the refill rate are of utmost interest and importance to all levels of Metro staff and policy makers.

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[1] This is strictly true for residential development. As detailed in the nonresidential section the procedures for nonresidential development are substantially more complicated.

[2] It is possible to have a negative refill rate where existing buildings are being abandoned and demolished and replaced with new structures on vacant, green field sites at the urban edge. Many North American cities experienced this phenomenon in the 60's and 70's and some continue to experience this trend at present though the counter trend of increasing central development on developed land is the predominant case.

Knowing past refill rates is vital knowledge and indeed Metro is required to measure it as part of the 5 year periodic review process as well and measurements of densities, lot sizes and land consumption for several classes of real estate. However, measuring past performance while a necessary and vital starting point, is not sufficient for comprehensive MetroScope analysis of Metro's 2040 plans. More to the point, we need estimate and validate future Metro refill capacity and incorporate that data into the MetroScope scenario evaluations. This leads to another use of the data; namely, statistical prediction of those tax lots experiencing development and separation of that prediction into development on vacant, infill development of redevelopment. The point of the statistical analysis is to be able to assess the long run (40 or more years) refill capacity of the Metro region at the present time.

We conclude the introductory section of the Refill Report with a short results summary. The remainder of the Refill Report contains the detailed Residential Refill Report and the Non-residential Refill Report. The final section includes an explanation of the economics of redevelopment and a report on progress to date towards estimating and validating methods of forecasting future Metro refill capacity.

Results Summary

Below we depict refill rates for both residential and nonresidential development. The residential rate (Figure One) depicted over time from a series of 4 studies shows a range of 18% to 42%. The data from year 2000 on understate the refill rate by roughly 5% (23% to 47%). After our latest study we learned that all of the mixed use redevelopment in the Pearl District was carried as nonresidential mixed use permits and the number of residential units was not listed until 2005 – 2006. Subsequently we estimated the upwards of 500 – 2000 multi-family units per year were not included in the original counts. Without exception these mixed use permits occurred on already developed land.

Figure One: Residential Refill Summary

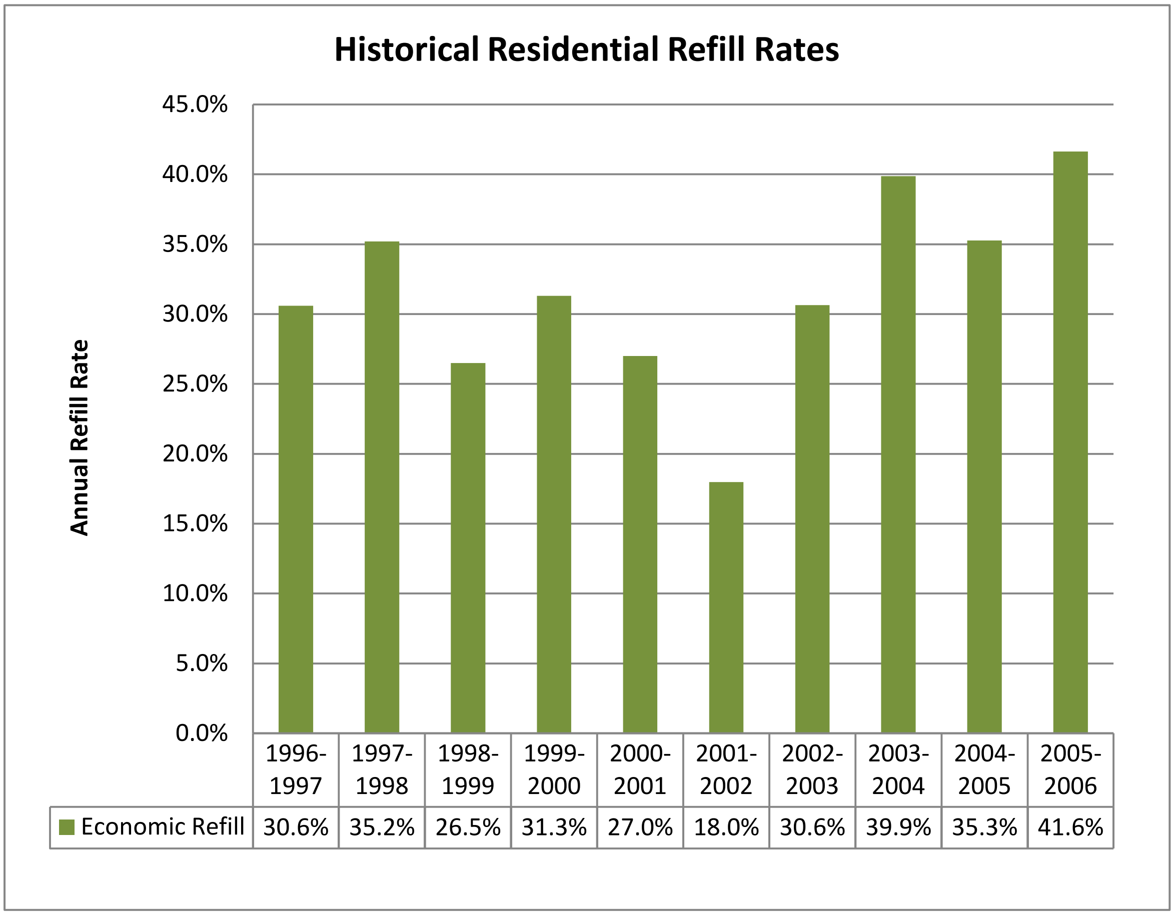
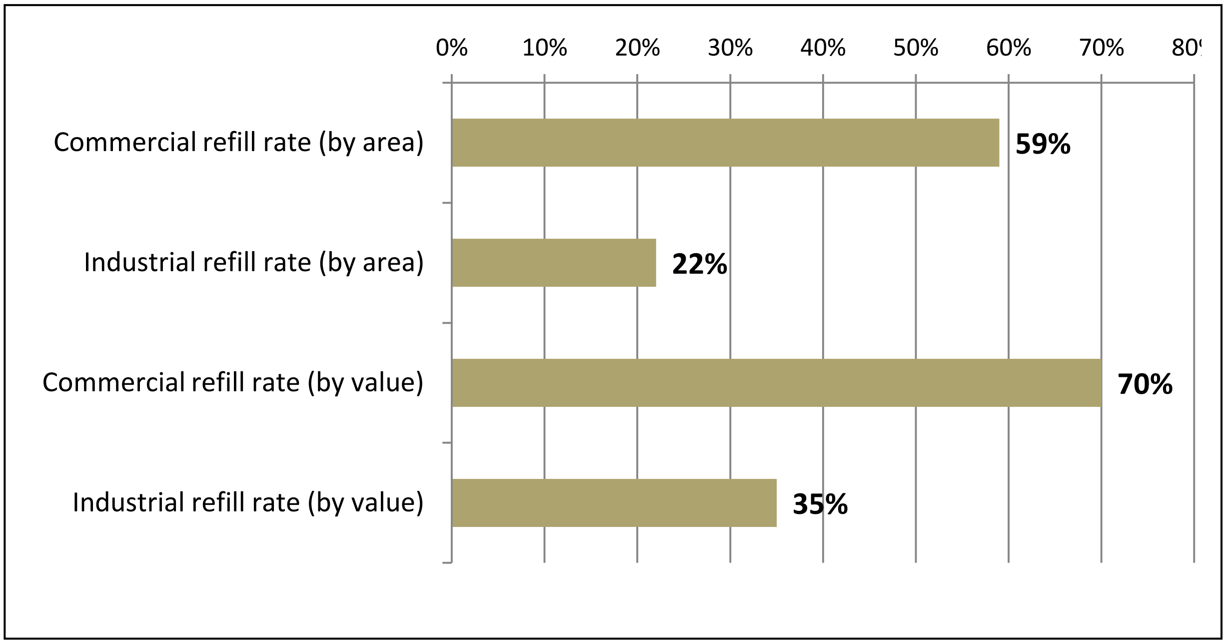


Figure Two below presents the summarized nonresidential refill data for the period 2001 – 2007. The data are not sufficiently dense to allow meaningful year to year comparisons so we present only the data for the entire period. Unlike residential development nonresidential development is not self-evident in interpretation. A given permit may simply amount to a new roof or it may add significant square footage to existing facilities. On the other hand it may be a restaurant remodel as part of a tenant improvement. Consequently, we seldom repeat the nonresidential study which requires careful and time consuming manual audits to determine eligible building permits and measurement of capacity added.

The summary data in Figure 2 indicate that well over 50% of commercial development occurs on already developed land. In Figure 2 the numbers are 59% when measured by square footage and 70% when measured by value of permit. Conversely, industrial development is much less likely to occur on developed land; 22% measured by square footage and 35% when measured by value. Essentially, building at higher density on already developed land incurs greater cost and so refill permits tend to have a higher value than building on vacant land. Significantly, industrial development for a number of reasons prefers to use vacant lands predominately located at the urban periphery in favor of refill lands located more within the Region's central areas.

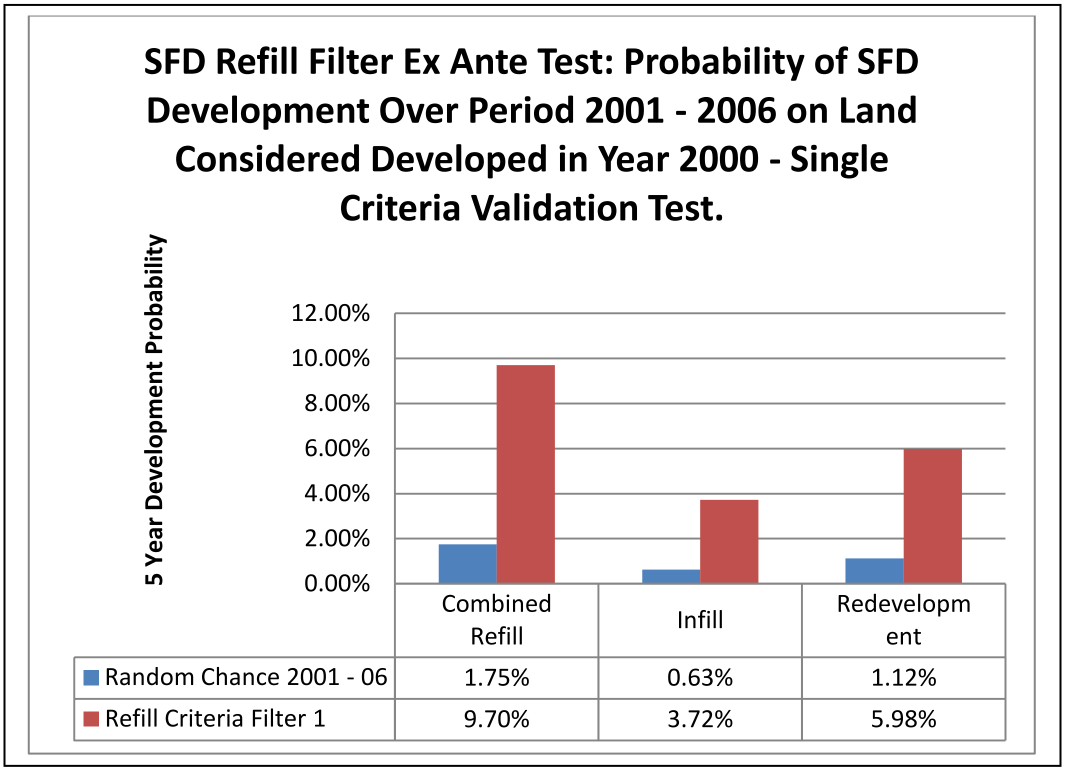
Figure 2: Nonresidential Refill Rate Summary 2001 - 2007



So what are the policy implications of Figures One and Two? We presently have updated 2040 Plan guidelines that limit UGB expansion to roughly 15,000 acres through the first 30 years of the plan and some options of the Green House Gas scenario analysis would preclude UGB expansion altogether. At some point virtually all of the existing vacant land within the present UGB will be developed. At that point all additional growth of the Metro region inside the UGB occurs as refill. In other words the refill rate for residential and nonresidential will be 100%. By way of comparison we presently know of no "regions" that have 100% refill but there are numerous central cities such as San Francisco, Vancouver BC, the Borough of Manhattan in NY, etc. where all additional growth can be considered refill. Accurately measuring and tracking the refill rates and relating the resultant trends to the underlying real estate demand, supply and price behavior is important for our modeling and by extension our policy assessments.

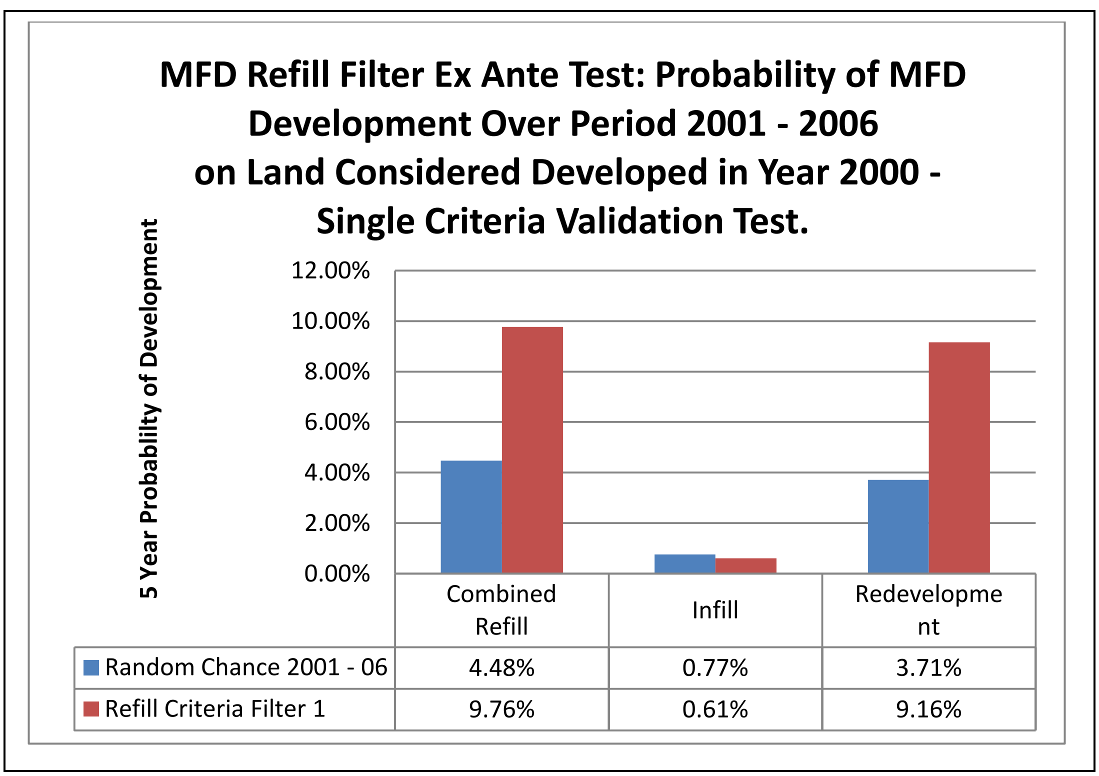
In our third section we begin to address the even more challenging task of moving from measurement of past refill events to forecasting the future level of refill. Here we are limited to information generated from present assessor files and supplemental information gleaned from RLIS data for each tax lot within the Metro Region. Our primary task is to evaluate whether our present tax lot criteria using assessor information provides an improvement over random guessing. A secondary but eventually even more important task is to develop criteria that will improve the accuracy of our refill capacity forecast. Figures 3 and 4 taken from Section Three provide a graphic synopsis of our statistical results to date for residential refill.

Figure 3: Refill Filter Criteria for SFD are 5 Times Better than “an Average Guess”.



	Combined Refill	Infill	Redevelopment
Random Chance 2001 - 06	1.75%	0.63%	1.12%
Refill Criteria Filter 1	9.70%	3.72%	5.98%

Figure 4: Refill Filter Criteria for MFD Double Your Chances of Correctly Selecting MFD Refill Tax Lots.



	Combined Refill	Infill	Redevelopment
Random Chance 2001 - 06	4.48%	0.77%	3.71%
Refill Criteria Filter 1	9.76%	0.61%	9.16%

Figures 3 and 4 point out that our present methods of identifying future refill tax lots provide an improvement over just knowing the average per 5 year period and then guessing. The filter criteria look much better if one assumes you know nothing about the rate and simply make a random choice. However, we have chosen to evaluate our present efforts using more conservative evaluation criteria. As detailed in Section Three, using more variables available in RLIS greatly increases our ability to identify MFD refill lots.

Report Organization Notes

The following Report is organized into three self-contained sections each researched, compiled and written by different research teams at different times. Suffice to say the only continuous reference system is the page numbering system and Table of Contents. Figures, Tables and other graphics along with Appendices and references are specific to a particular section. Consequently, the first figure in any section will be listed as “Figure One”. Likewise, Appendices and references are attached to the Section to which they refer.

SECTION ONE: REPORT ON RESIDENTIAL REFILL

Background

What is residential refill?

Refill is composed of two types of development: redevelopment and infill. Redevelopment means demolishing an existing structure to build a new dwelling. An example of redevelopment would be tearing down an old house to build four townhouses in its place. Infill means building on land that is classified as developed, but does not require tearing down an existing structure to build a new one. For example, a homeowner owns a half acre lot with one house built on it and the lot is classified as developed in RLIS. Zoning allows the lot to be split into two lots so the homeowner divides the property and builds a second house on the vacant land. This is infill because the original house is still standing.

What is the refill rate?

The "refill rate" is the percentage of new dwelling units that are built on land that is already considered to be developed, instead of on vacant land. It is important to note here that we are comparing the number of refill units to the total of all new units built over a particular time period. So the refill rate is a proportion of new development, not a proportion of some land base.

Why is the refill rate important?

The subject of residential refill is significant in terms of legal and policy contexts. Metro accounts for a "refill" factor when estimating the residential land supply available within the Urban Growth Boundary per the requirements of O.R.S. 197.296 and 197.301. For instance, if the residential refill rate is estimated at 20% and Metro's 20-year growth is assumed to be 215,000 dwelling units, this means 20% of 215,000 units (43,000) will be built on land Metro considers previously developed. If the refill rate were 100%, all residential development would occur on developed land and Metro would require no additional vacant land for housing. Conversely, if the refill rate were 0%, all future residential development would require vacant land. Clearly, estimates of the present residential refill rate and projections of its future value strongly influence calculations of how much residential land will need to be included within the Urban Growth Boundary.

How is the refill rate used?

The focus of this study is the historical refill rate over the period from 2001 to 2006. Building permit data, information about the regional land inventory, aerial photographs and site visits are used to identify where refill is actually happening on the ground. This historical information can help to inform assumptions about future refill rates. However, these historical rates may not be exactly the same as the refill rates that are assumed for projections of future housing needs.

The residential refill rate may be higher or lower in the future than the rate observed over the study period, for several different reasons. As shown in this study, the mix of single family and multi-family dwelling units can have an impact on the refill rate, with a higher share of multi-family development generally pushing the refill rate higher. The residential refill rate is also strongly tied to economic cycles, where lower economic growth is usually correlated with lower refill rates and vice versa. The assumed refill rate for the current UGR is slightly higher than the recent historical trend, as the effects of a constrained land supply, increased multi-family development and better economic growth are expected to push the rate higher over the next 20 years.

INTRODUCTION

This report presents the fourth residential refill study conducted by Metro for the Portland area. Residential refill describes any new dwelling units that are built on land that are considered to be already developed, in the form of either redevelopment or infill. The "refill rate" is the percentage of new dwelling units that are built on land that is already considered to be developed, instead of on vacant land. Historical refill rates are important because they help to inform Urban Growth Report (UGR) assumptions about future refill rates, and those assumptions have a significant impact on assessments of future land needs for residential use. These studies are generally conducted every three to five years to examine the historical residential refill rate by looking at actual residential development in the recent past. The most recent prior refill study collected data from 1997 to 2001 and found an average residential refill rate of 30.4% for the period. The current study collected data from 2001 to 2006 and estimated an average residential refill rate of 33.0% over the five year period with wide variation from year to year.

METHODS

Definitions

Building permit data were used to identify new dwelling units built in the region over the period from 2001 to 2006. In order to identify each permit as being infill, redevelopment or occurring on vacant land, these classifications are defined as follows:

- <u>Vacant</u>: Residential development (denominated in dwelling units) on a taxlot, or portion of a taxlot, that is identified in the Regional Land Inventory System (RLIS) as vacant and has never had any development on it. This land is generally at least 90% vacant and the historical records show no evidence of any prior development.
- <u>Infill</u>: Residential development on land without a pre-existing physical structure where Metro considers the taxlot to be developed. For example, a homeowner owns a half acre taxlot with one house built on it and RLIS classifies the whole lot as developed. Zoning allows the property

to be split into two smaller lots, so the homeowner divides the property and builds a second house on the vacant land. This is infill because the original house is still standing.

- Redevelopment: Same as above except that there was an existing structure at the site of the new development at some point in the past. An example of redevelopment would be tearing down an existing house to build four townhouses in its place. Another example would be building condos on a lot where the existing structure had been torn down years earlier and the land remained vacant for a period of time before being redeveloped.

Infill and redevelopment are combined to measure total refill, or any development that occurs on previously developed land. These definitions result in what is referred to as the "economic" refill rate. Refill is defined and measured differently in the UGR so a comparison is provided in Appendix A between the refill rate discussed throughout this report and the refill rate used in the UGR.

Procedures

The new dwelling units that were identified in the permit data were classified into one of the three definitions above (vacant, infill or redevelopment) using a series of procedures. First, the new dwelling unit permits were divided into single family (SFD) and multi-family (MFD) for analysis. In order to reduce the workload required by the classification process, the SFD permits were sampled at a rate of one in five using geographic weights to ensure a representative distribution across the region. The pool of SFD permits is fairly homogenous as most SFD permits represent a single dwelling on a single residential lot. By contrast, every MFD permit was evaluated, since there are fewer permits of this type and each multi-family development is unique in type, number of units and lot size. The SFD sample findings were then scaled by five so that the tables in this report represent the proper distribution of SFD to MFD units.

For both subsets, SFD and MFD, the following steps were taken:

1. Geo-code the permit based on address and find the taxlot that it falls on.
2. Check the Regional Land Information System (RLIS) database and aerial photos both before and after the date of the permit to classify the development as vacant, infill or redevelopment.
3. If these steps could not clearly identify the type of development, a site visit was conducted to try to classify the permit into the most appropriate category.

The following three figures show some examples of how these types of development were identified using the geo-coded permit location, tax lots from RLIS and aerial photographs before and after the development. More examples and descriptions can be found in Appendix B.

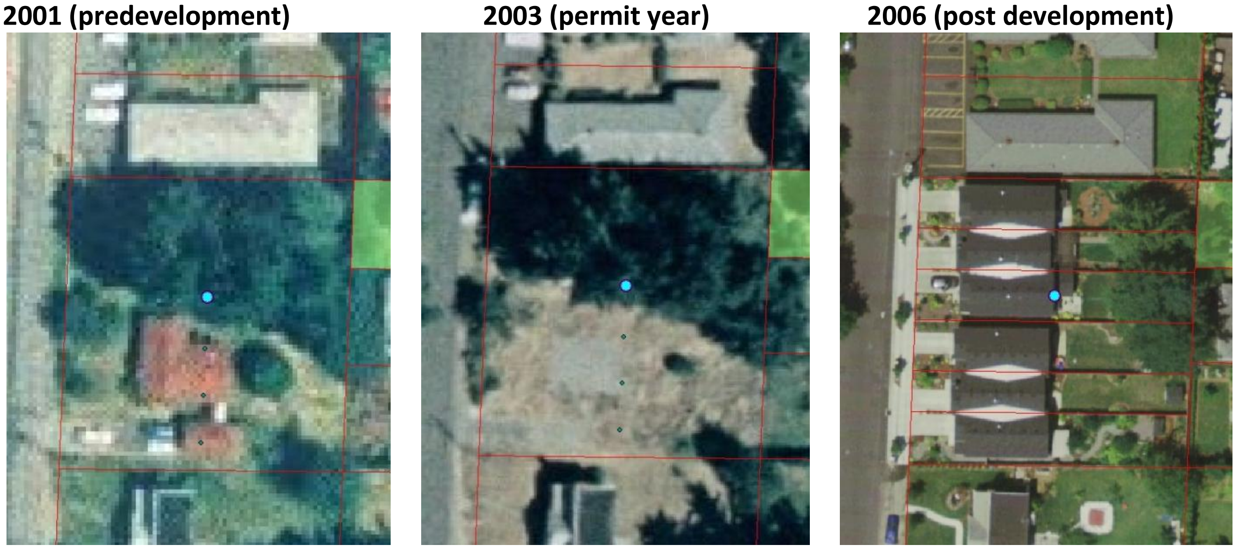
Figure 1. Example of building permit identified as infill development

Predevelopment **Post development**

The predevelopment image on the left indicates that a large tax lot was likely divided into three smaller lots. (The pre-subdivision taxlot is not shown.) The building permit (indicated by a blue dot) is for a new house on the back lot, which was vacant prior to the permitted development. This is considered infill because the larger lot was previously developed but building the new house did not require tearing down any existing structures.

Figure 2. Example of building permit identified as redevelopment

2001 (predevelopment) **2003 (permit year)** **2006 (post development)**



The predevelopment images from 2001 and 2003 show that an existing structure was torn down at some point and the land remained vacant for a period of time before it was subdivided and redeveloped at a higher density, as shown in the 2006 image.

Figure 3. Example of vacant and redevelopment on the same lot

Predevelopment

Post development

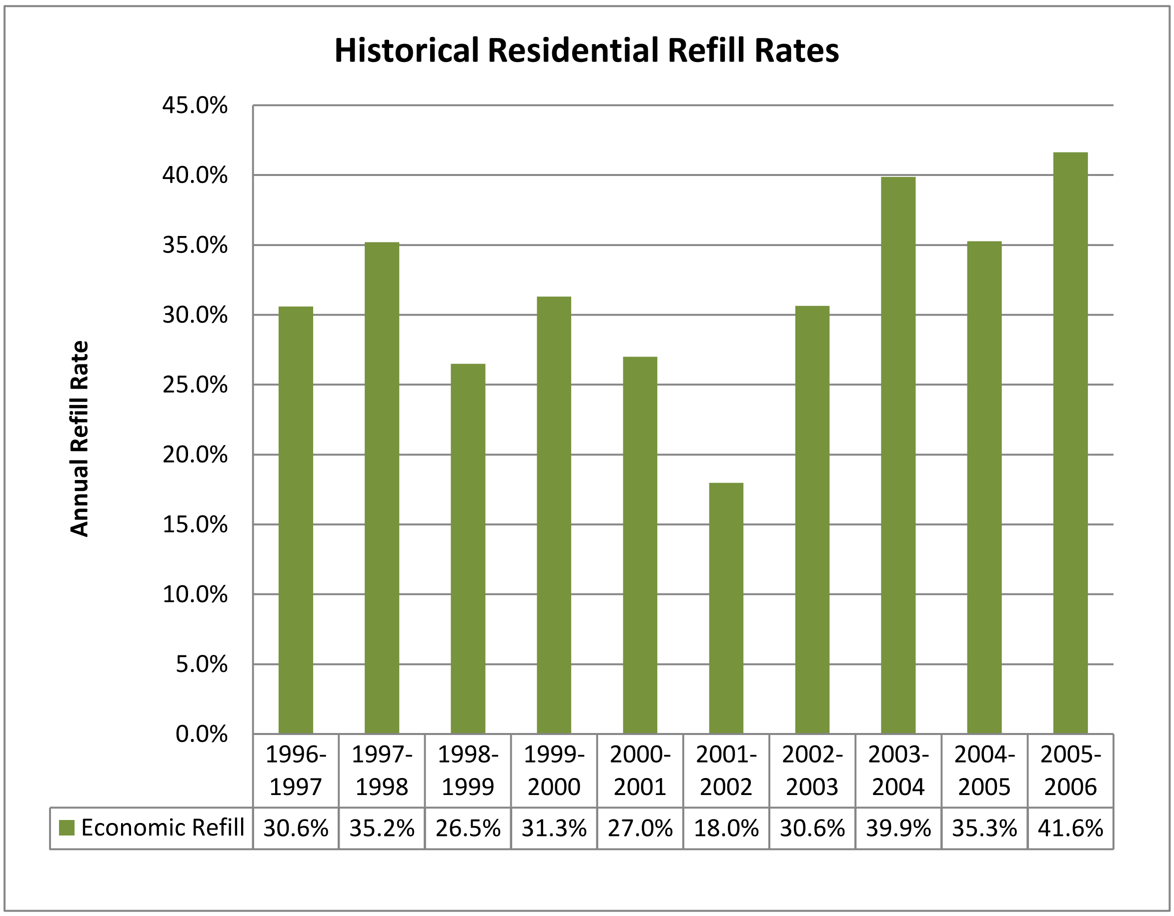
The predevelopment image shows that the left half of the lot was classified as vacant (indicated by the green overlay) while the right half was developed. The subdivision that occurred on the green area would be considered development on vacant land. The subdivision on the right side of the lot required the removal of the existing structure, and would be classified as redevelopment.

Results

Regional Results

Results from the current study (2001-2002 to 2005-2006) and the most recent prior residential refill study (1996-1997 to 2000-2001) are shown in Figure 4. From 2001 to 2006, the annual residential refill rate ranged from a low of 18.0% in the first year to a high of 41.6% in the final year. The overall refill rate for the five year period was 33.0%, compared to 30.4 % for the previous five years.

Figure 4. Historical economic refill rate



Multifamily developments accounted for about 39% of new dwelling units built from 2001 to 2006 while single family dwellings made up 61% of new residential units (Table 1). The refill rate for multifamily dwelling units was much higher than single family, at 46% compared to 25%. Accordingly, the overall residential refill rate is sensitive to the proportional distribution of MFD and SFD development. If the long term share of multifamily dwelling units compared to single family dwellings were higher in the future than that observed over the study period, we could expect a higher overall residential refill rate. If the multifamily share were lower, we would expect a lower overall residential refill rate over the long term. Table 2 shows the impact that various proportional allocations of multifamily and single family dwelling units might have on the residential refill rate in the future, given the current MFD and SFD refill rates.

Table 1. Distribution of new dwelling units by permit type

Dwelling Unit Type	Total Units	Proportion of Development	Vacant Units	Refill Units	Refill Rate
Multi Family	16,940	39%	9,170	7,770	45.9%
Single Family	26,515	61%	19,945	6,570	24.8%
Total	43,455	100%	29,115	14,340	33.0%

Table 2. Theoretical impact of shares of MFD and SFD development on the overall residential refill rate

Proportion multifamily	Proportion single family	Refill Rate
20%	80%	29%
30%	70%	31%
40%	60%	33%
50%	50%	35%
60%	40%	37%

Subarea Results

The subarea data for MFD permits in Table 3 show a wide range of refill rates throughout the region. The City of Portland accounted for nearly half of all new MFD units from 2001 to 2006 and 71.5% percent of those were refill units. The highest MFD refill rate occurred in Oregon City – Milwaukie, at 87.8%, however this subarea accounted for less than 1% of MFD development. The overall MFD refill rate of 45.9% was driven largely by the MFD development observed in Portland.

Table 3. New multi-family dwelling units from 2001-2006, by subarea

MFD combined jurisdictions (2001-2006)[3]	MFD Vacant Units	MFD Refill Units	MFD % Refill
Oregon City - Milwaukie	19	137	87.8%
Portland	2,287	5,740	71.5%
Gresham - Troutdale - Fairview - Wood Village	797	681	46.1%
Forest Grove - Cornelius	51	39	43.3%
Hillsboro	1,818	691	27.5%
Beaverton	931	282	23.2%
Lake Oswego - West Linn	57	16	21.9%
Clackamas Unincorp - Happy Valley - Wilsonville	432	62	12.6%
Washington County Unincorp	2,107	93	4.2%
Tualatin - Tigard - Sherwood - King City	671	29	4.1%
Totals	9,170	7,770	45.9%

Note: Jurisdictions with fewer than 500 new dwelling units will exhibit much more variability than jurisdictions with more than 1,000 units.

The City of Portland also exhibited a high refill rate for single family dwellings, as shown in Table 4. More than 21% of new SFD permits were issued in Portland and 53.2% of those were considered refill. The lowest SFD refill rate was observed in the Tualatin - Tigard - Sherwood - King City area. The area accounted for about 13% of new single family dwelling units with a refill rate of 10.4%.

[3] These subareas were defined based on the availability of the building permit data. The building permits are classified by the issuing jurisdiction, so these jurisdictions were collapsed down to larger subareas for this report.

Table 4. New single family dwelling units from 2001-2006, by subarea

SFD combined jurisdictions (2001-2006)	SFD Vacant Units	SFD Refill Units	SFD % Refill
Portland	2,625	2,980	53.2%
Lake Oswego - West Linn	550	235	29.9%
Hillsboro	3,435	1,010	22.7%
Clackamas Unincorp - Happy Valley - Wilsonville	1,755	400	18.6%
Washington County Unincorp	3,825	870	18.5%
Forest Grove - Cornelius	655	115	14.9%
Beaverton	1,200	200	14.3%
Oregon City - Milwaukie	875	135	13.4%
Gresham - Troutdale - Fairview - Wood Village	1,960	270	12.1%
Tualatin - Tigard - Sherwood - King City	3,065	355	10.4%
Totals	19,945	6,570	24.8%

Note: Jurisdictions with fewer than 500 new dwelling units will exhibit much more variability than jurisdictions with more than 1,000 units.

Figures 5 and 6 are illustrative examples of how refill rates vary across the region and how they might change in the future given a particular set of assumptions. These maps are based on a Metroscope scenario that uses the same assumptions that were used for the current Residential UGR. The simulation results shown here assume mid-range growth, which obviously falls between the low and high growth scenario results presented in the UGR. A detailed description of the scenario assumptions can be found in the Residential UGR.

Figure 5 compares the historical MFD refill rates observed from 2001 to 2006 with the Metroscope projected MFD refill rates for 2005 to 2030. Multifamily dwelling refill rates are generally expected to increase across the region, potentially reaching an overall MFD refill rate of nearly 70% for the region given current policies. This change is largely driven by a lack of infrastructure on newly urbanized land within the projected time period as well as increasing demand for dwelling units closer to the city center and other concentrations of jobs, retail and services. Changing demographics and preferences are increasing the housing demand in existing urban areas, where development is already fairly dense. Accordingly, new dwelling units in these areas must be created through refill development, and multifamily dwellings are particularly well suited for this purpose. Oregon City – Milwaukie is the only subarea where the future MFD refill rate is expected to fall in comparison to the historical data. However, since so little MFD development occurred for the subarea from 2001 to 2006 the estimated historical MFD refill rate of 87.8% should be interpreted with caution. The MFD refill rate is expected to increase dramatically in the Lake Oswego – West Linn area, from 21.9% to 79.9% since the model is anticipating no new vacant land for MFD development in this area by 2030.

Figure 5. Comparison of historical and projected multifamily dwelling refill rates by subarea

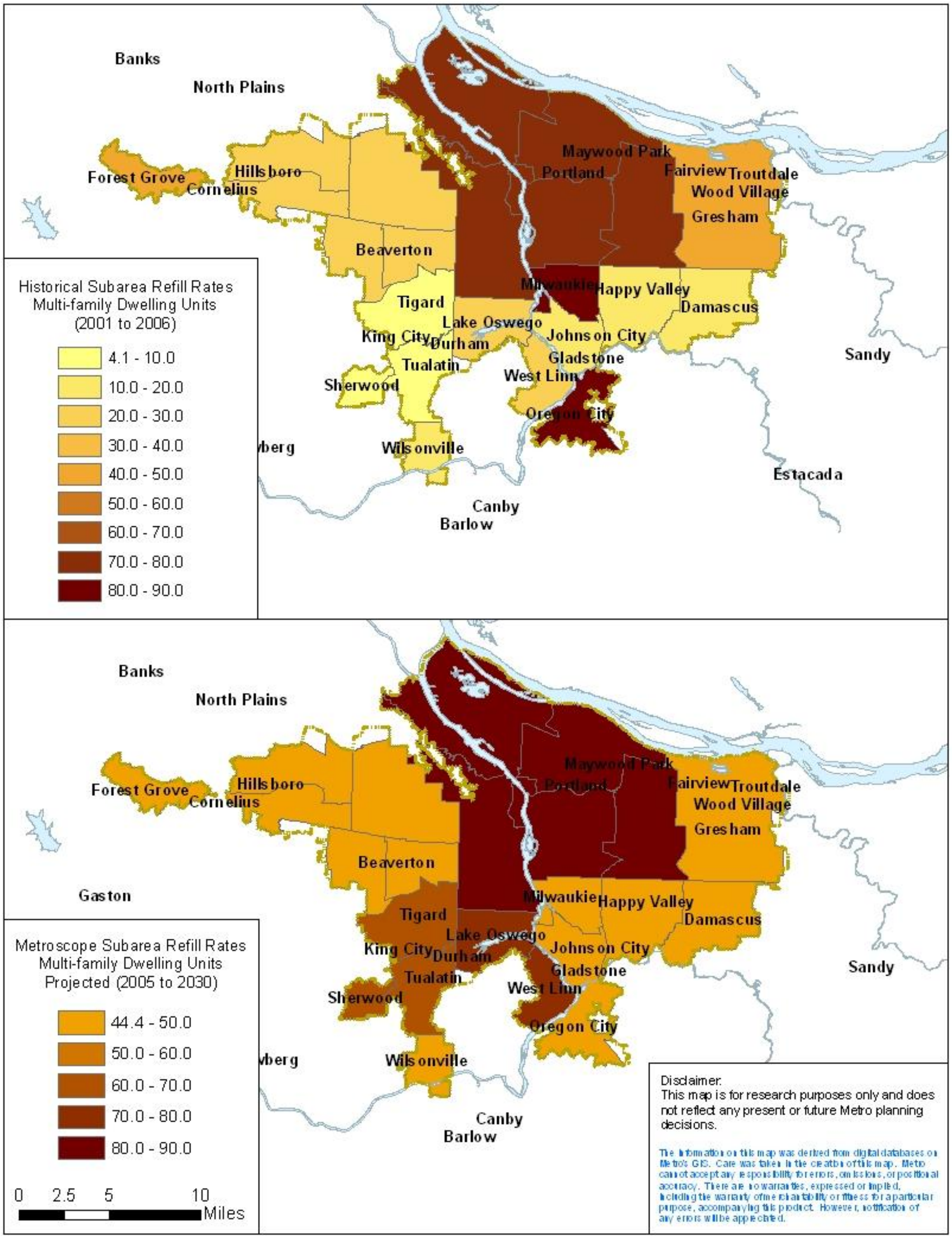
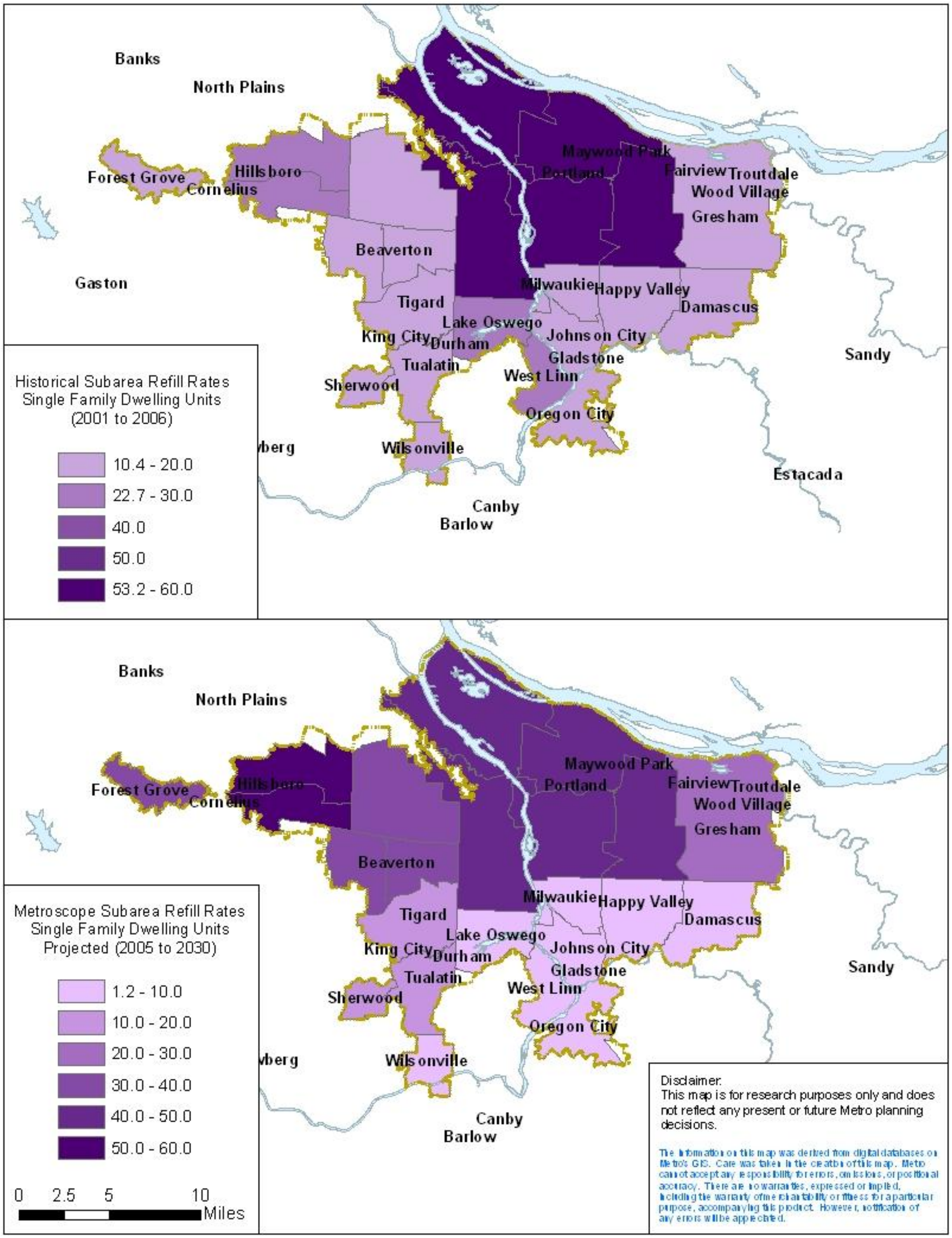


Figure 6 compares the historical SFD refill rates observed from 2001 to 2006 with the Metroscope projected refill rates for 2005 to 2030. The future expectations for SFD refill are more varied than for MFD, with both increases and decreases in the subarea SFD refill rates across the region. In five of the nine subareas the SFD refill rate is expected to increase, with the largest increases projected to occur in the Beaverton, Hillsboro and Forest Grove – Cornelius areas. In four subareas, (Portland, Lake Oswego - West Linn, Oregon City - Milwaukie and Clackamas Unincorporated – Happy Valley – Wilsonville), the SFD refill rate is expected to fall over the period 2005 to 2040. However, this decline is not so much an indication that refill is going to slow down significantly as it is an indication that refill in these areas is expected to shift more toward multifamily instead of single family development. In fact, in these four subareas, multifamily dwelling units are projected to account for between 82% and 92% of the refill residential development in terms of units.

The overall residential refill rate is expected to increase in most subareas in the region. The two exceptions are Clackamas Unincorporated – Happy Valley – Wilsonville, where refill is projected to decline from 17.4% to 11.6%, and Lake Oswego – West Linn, where refill is projected to decline from 29.3% to 9.4%. These results are consistent with the land supply situation in the region and the assumptions for land availability and UGB expansions used for this scenario. In places like the city of Portland, existing vacant supply is being used up and little additional vacant land is anticipated in the area over the forecast period. Vacant land within the current UGB and new UGB additions are expected to become available in areas adjacent to the Clackamas Unincorporated – Happy Valley – Wilsonville and Lake Oswego – West Linn subareas, based on the land availability assumptions used for the UGR. Single family development is projected to take place on new vacant land in these areas, which reduces the residential refill rate. These UGB and land availability assumptions may change with the designation of urban and rural reserves, which would produce different scenario results.

Figure 6. Comparison of historical and projected single family dwelling refill rates by subarea



UGR Refill vs. Economic Refill

UGR Refill:

Some prior refill studies, and the Urban Growth Report (UGR), have relied on a "UGR" definition of refill and the resulting refill rates. This definition was driven by the need for a technical definition of refill in terms of the Regional Land Information System (RLIS) that did not require any value judgments. UGR infill and redevelopment are defined as follows:

- <u>Infill</u>: Residential development (denominated in dwelling units) on a parcel without a pre-existing physical structure where Metro considers the parcel developed in the fiscal year (or years) prior to the fiscal year for which the building permit is issued. For instance a single family residential building permit issued between July 03 and June 04 for a parcel classed as developed in RLIS as of June 30, 2004 would be classified as infill provided no previous structure occupied it.
- <u>Redevelopment</u>: Same as above except that a structure or the identifiable remains of a structure were visible on the parcel in the fiscal year prior to the issuance of the residential building permit.

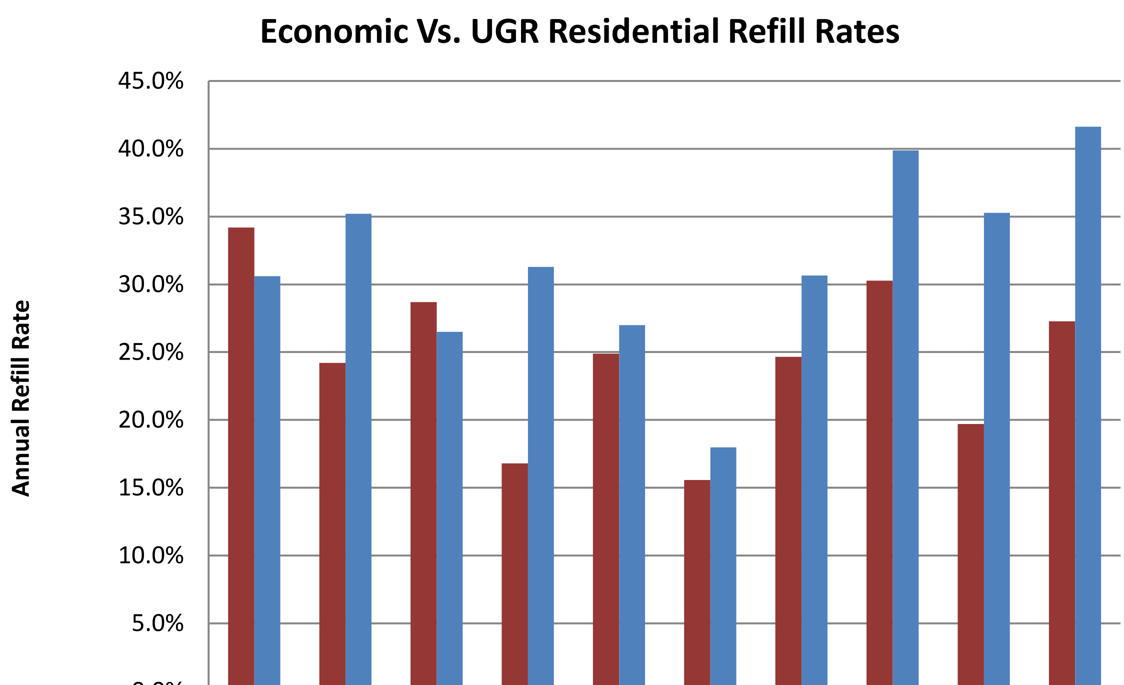
Economic Refill:

By virtue of reducing the classification exercise to a 99.9% mechanical operation, a limited number of building permits are classified in a fairly counter-intuitive fashion using these definitions. In order to address this issue, an "economic" classification system was developed that is more accurate from an economic and historical urban development perspective. For example, in some fast growing suburban subdivisions on vacant land, a few building permits are assigned to parcels that Metro had classed as developed in the previous year. Since these parcels are no longer in the vacant land inventory, they are properly classed as infill in a legal sense. While consistent with the RLIS accounting framework, this classification is somewhat misleading in an economic sense and would be classified as development occurring on vacant parcels according to the economic definition of refill. Conversely, in some instances on developed land, buildings are demolished and the land held vacant for a number of years. In many of those instances RLIS detects the vacant land and restores it to the vacant land inventory. Subsequently, when the land is redeveloped it is accounted for as development on vacant land according to the land accounting system. From an economic and historical perspective it is clearly redevelopment and would be classified as such under the economic definition of refill.

It is important to note that though these refill rates look different numerically, the net impact of using one over the other is nil, because they are used with two different land accounting systems. The UGR refill rate is used in conjunction with RLIS, which returns land to the vacant land inventory if an existing structure is torn down and the land remains vacant for a period of time. The economic refill rate is used with a land inventory that classifies previously developed land to be developed, even if the land was scraped clean and remained vacant for several years before being redeveloped. This type of inventory will have a higher proportion of developed land than RLIS, so naturally the associated refill rate is usually slightly higher. Which refill rate is used depends on which land accounting system is being used, however the two systems are perfectly consistent and great care is always taken not to double count any type of land or development in either case. Both measures are still in use because the land use forecasting model Metroscope relies on the economic refill rate and the associated land inventory, while we are legally required to report refill rates in terms of RLIS for the UGR.

Figure 7 compares historical UGR and economic refill rates and clearly indicates that the two measures have diverged in recent years. The five year average UGR refill rate for 1996 to 2001 was 26.5% and the average economic refill rate was 30.4%. For 2001 to 2006, the average UGR refill rate was 23.5% and the average economic refill rate was 33.0%. So between the two periods, the average UGR refill rate declined by 3 percentage points and the average economic refill rate increased by 2.6 percentage points.

Figure 7. Ten year comparison of economic and UGR refill rates



	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006
UGR Refill	34.2%	24.2%	28.7%	16.8%	24.9%	15.6%	24.7%	30.3%	19.7%	27.3%
Economic Refill	30.6%	35.2%	26.5%	31.3%	27.0%	18.0%	30.6%	39.9%	35.3%	41.6%

This gap between the different measures of refill can largely be attributed to how redevelopment is identified under the two systems. From 2001 to 2006, redevelopment accounted for about 77% of observed refill. For 2005-2006, nearly half of the SFD units identified as economic redevelopment were classified as UGR vacant and almost a third of MFD units classified as economic redevelopment were called UGR vacant. In most cases this is because the redevelopment took place on land where the prior existing development was torn down years before the site was redeveloped, and so it was returned to the vacant lands inventory in RLIS but not in Metroscope's land accounting system. Using the UGR definition of refill leads to sensitivity to the timing of observations, which is one of the shortcomings of the UGR refill rate in comparison to the economic refill rate. For example, if an existing house was torn down in January 2006, then an aerial photograph from July 2005 would show the lot as developed and an aerial photograph from July 2006 would show the lot as vacant. If a building permit for a new house were filed for the lot in June 2006, it would be classified as UGR redevelopment. On the other hand, if the permit was filed in August 2006, it would likely be classified as occurring on vacant land according to RLIS. There is no meaningful difference between the developments that would occur under these two hypothetical permits, so to classify them differently makes no economic sense. The economic definitions of infill and redevelopment tend to classify development more consistently than the UGR definitions.

Urban renewal areas are a significant driver of redevelopment, so increased urban renewal activity could contribute to this discrepancy between the UGR and economic refill rates. Currently, urban renewal areas account for about 8.3% of acreage within the UGB while nearly 36% of MFD units classified as redevelopment were built in urban renewal areas from 2001 to 2006. Almost 63% of these redevelopment MFD units were misidentified as occurring on vacant land using the UGR definition of refill. By contrast, about 23% of redevelopment MFD units outside of urban renewal areas were misidentified as vacant development.

APPENDIX A: Classifying development as vacant, infill or redevelopment

This section describes, in detail, the steps to classify building permit data into both an economic refill category and a UGR refill classification.

1. Review Taxlot, Vacant Land and Photo Layer for the year prior to the building permit. Use the following definitions to identify the permit as vacant, infill or redevelopment.

2. Definitions

    a. **UGR Vacant** is development on a taxlot that is designated as vacant in RLIS prior to the date the building permit is issued. A portion of a taxlot may also be considered vacant in RLIS if it meets the following criteria:

        i. The entire taxlot is at least one acre in size

        ii. Zoning would allow for the creation of a new lot

        iii. There is at least half an acre of undeveloped land on the taxlot

    If the land is considered vacant in RLIS, then new development would be considered UGR vacant regardless of whether it is located on a fully vacant taxlot or the vacant portion of a partially developed taxlot.

    b. **UGR Refill** is a term that includes UGR Infill and UGR Redevelopment, defined below:

        i. **UGR Infill** is the addition of dwelling units to a developed taxlot while preserving the existing structure. By definition, UGR infill should only occur on taxlots that are smaller than one acre since development on larger taxlots would properly be considered development on partially vacant land.

        ii. **UGR Redevelopment** is the removal of existing structures and replacement with a net increase in dwelling units. If existing structures are removed years prior to the redevelopment, the land may be returned to the RLIS vacant land inventory, in which case the new development would be classified as occurring on vacant land.

    c. **Economic Vacant** is development on a taxlot that has <u>never</u> been developed. Once developed, the taxlot (or developed portion, if the tax lot is large) is permanently removed from the economic vacant category, even if it is subsequently cleared of improvements.

    d. **Economic Refill** is a term that includes Economic Infill and Economic Redevelopment, defined below:

        i. **Economic Infill** is building additional dwelling units on a lot that is not considered vacant in RLIS, without the removal of an existing building. If the land where the permit is located is classified as vacant in RLIS (even if only a portion of the taxlot is vacant), the development is not considered Economic Infill.

ii. **Economic Redevelopment** is the removal of existing structures and replacement with a net increase in dwelling units. Economic redevelopment includes taxlots that were at one point developed but were cleared and held vacant for years prior to redevelopment (regardless of whether RLIS returns them to the vacant lands inventory.)

Using these definitions, each building permit receives an economic classification (vacant, infill or redevelopment) and a UGR classification (vacant, infill or redevelopment). There are two reasons that a building permit might receive different classifications under the two systems. The first reason is the conceptual difference between the definitions above, particularly in how redevelopment is identified. However, discrepancies between UGR and economic classifications may also arise from mistakes (or inconsistencies) in how land is classified in RLIS, as some of the examples in this section will show.

Other notes:

3. When recording lot sizes for building permits, the new lot size is used if the property was subdivided.

4. Parking lot conversion is considered redevelopment since something was there prior to the building permit being issued.

Examples

1. In the pictures below, the old lot is partially vacant (as identified by the green shading). The blue dot shows the location of a permit application on the vacant portion of the land. This is an example that shows development on vacant land on a partially vacant lot. The permit identified by the blue dot would be considered UGR Vacant and Economic Vacant.

Before

After

2. UGR Redevelopment/Infill and Economic Redevelopment/Infill – In regards to the tear down of a SFD and the rebuilding of skinny houses in its place, if the permit falls on the house itself it would be classified both UGR and Economic Redevelopment. However, if the permit falls on the vacant yard it would be classified UGR Infill and Economic Infill.

Before | After

3. In this picture the blue dot falls on property that should have been classified as partially vacant in RLIS. Since it was not, the blue dot would be considered UGR Infill and Economic Vacant. This is an example of a discrepancy that arises due to an error in RLIS. The pink dots on the green space are on land that was properly identified as partially vacant and would be considered both UGR and Economic Vacant.

4. The blue dot below shows UGR Infill, because the taxlot was not considered vacant in RLIS but building a new house did not require the teardown of an existing structure. Since the lot is in a fully developed neighborhood, it may have been overlooked in the vacant lands inventory and never returned to UGR Vacant status. Since there are no existing buildings visible in previous year photos, it was classified as Economic Vacant for this study.

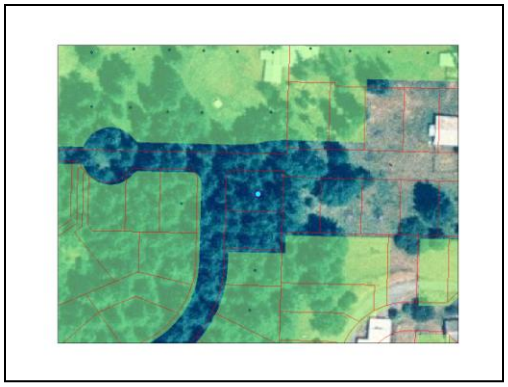
   This example is a judgment call that depends on the context of the lot and building permit under consideration. This lot looks like it might have been part of the developed lot next to it before it was sold off for a new house. In that case, it would be considered Economic Infill because it was part of a developed lot and there was less than half an acre of vacant land available for development. In the future, this type of example would more likely be classified as Economic Infill, however development of this type was consistently classified as Economic Vacant for this study.

   Pre-Development

   Post-Development

5. Below is another example of how errors can influence the classification of a building permit. This is UGR Infill, Economic Vacant due most likely to surveyor error when checking new development status. The lot with the blue dot on it was probably deemed developed along with the surrounding developing lots before its individual permit was approved. Or it may have been missed in the vacant land layer update.

1996



Pre-Development

Post-Development

6. The following photos show a case where the existing lot is a partially vacant lot, with an existing house that also gets redeveloped. The blue dot on the left is UGR and Economic Vacant, on a partially vacant lot. The blue dot on the right side shows development that is both UGR and Economic Redevelopment. It is possible that another building permit not on the site of the original house, but not on the green vacant land area, could be considered both UGR and Economic Infill.

Pre-Development

Post-Development

7. This is an example of UGR Redevelopment (due to an error in RLIS) and Economic Redevelopment. The blue dot shows the address of the building permit. The year the building permit was issued, 2003, the lot was empty (but not considered vacant), however the 1996 photo shows that there was a house on the lot. This is considered Economic Redevelopment because there once was a building on the lot, even though a significant amount of time passed between the tear down and the replacement (approximately 7 years). More correctly the lot should have been assessed as a vacant lot on the green vacant lot layer in 2003. Then this building permit would correctly be considered UGR Vacant, Economic Redevelopment.

1996

2003 – Permit year

Post Development

8. With condos, the permit may not divulge how many units the application is for, and when geocoded, the permit address will not link to a specific address. General rules created for consistent evaluation are as follows:

When looking at the permit description for the pink dots, each states that the permit is for a five unit condo development. So it can be assumed that each permit is for an entire row of condos. If there is not a description like that, an educated guess can be made by checking the permit value (in these cases, between $400,000 & $500,000), and then checking Portland maps for sale price of an individual condo ($180,000). Because of the higher permit cost (which is based on estimated construction cost), one can assume the permit was for a row of condos.

For instances like the blue dot above, where there is no apparent connection to a specific condo or group of condos, the best reference is to look at surrounding examples. Several things to compare are

1. The permit value – Review the permit value for one of the pink dots. If the blue dot value is comparable, it is most likely the same situation.

2. Street names – Look to see if the street names changed. In the blue dot case, the permit was for the old street name before the development changed a street name. Once this was established, it was easier to find a corresponding house number, and thus the corresponding row of condos.

Data Sources

Regional Land Information System (RLIS) and other data collected and/or maintained by Metro:

- Current and historical taxlots
- Current and historical aerial photographs
- Vacant lands
- Streets

Construction Monitor (http://www.constructionmonitor.com/):

- Building permit data available by subscription service

SECTION TWO: REPORT ON NON-RESIDENTIAL REFILL

This report presents the second non-residential refill study conducted by Metro for the Portland metropolitan area. The goals of this study are to determine the non-residential refill rate for the period 2001 – 2007, with a particular focus upon the following:

- The amount and percentage of non-residential building permit value placed on land that Metro considered developed in 2000;
- The amount and percentage of non-residential square footage placed on land Metro considered developed in 2000; and

What is Refill?

Non-residential refill is a term that captures two types of activity: redevelopment and infill. Infill construction (Figure 2) is on land previously classified as developed, but which does not require demolition of an existing structure. Infill may result from dividing developed parcels or from building on land which is used for parking. Redevelopment (Figure 3) is construction that occurs after demolition of an existing structure on land also previously classified as developed. These categories are contrasted with development on land previously classified as vacant (Figure 4).

The **non-residential refill rate** is the percentage of new construction for commercial and industrial purposes that occurs on land already classified as developed with respect to the total new construction for commercial and industrial purposes in the same time period. The refill rate can be measured in number of buildings, total square feet of construction, or in permit value. The refill rate does **not** refer to a proportion of the land base subject to infill or redevelopment.

Why is the Refill Rate Important?

The refill rate is directly connected to Metro's ability to determine how much non-residential land needs to be included within the Urban Growth Boundary. When estimating the land supply available, Metro takes into account the refill rate (per the requirements of O.R.S. 197.296 and 197.301).

The non-residential refill rate is also important in examining the relationship between new physical capacity and employment. Further, the impact on employment capacity due to non-residential refill can vary widely. Some types of building alterations may yield substantial increases in employment capacity (for example, new buildings or additions), whereas other alterations (i.e. external remodels, parking lot construction) may add no capacity at all.

Figure 8. Infill Development Example

2004

2010

Figure 9. Redevelopment Example

2006

2008

2010

Figure 10. Vacant Land Development Example

2004

2008

METHODOLOGY

The basic methodology for determining the refill rate is through reviewing building permits and determining how much, if any, new building square footage resulted from each building permit. These permit records are then consolidated to show the total amount of new square footage on vacant versus developed lands and for industrial versus commercial uses.

Source Data

Building permit data acquired through commercial sources is the base unit of analysis and is the source of the term "Permit Audit" coined to describe the non-residential refill research process. Metro has a master tabular database of building permits for the metro region of 275,000 records. This master set contains residential and non-residential records for the years 1998 to 2008. This file includes both "pending" and "approved" permits as well as records outside of the Metro region (e.g. Salem, Oregon, Yamhill County, etc.). The permit records were geocoded at the Data Research Center; Appendix A provides an analysis of the geocoding quality.

The permit records are consistently attributed with permit date and value. Other data, such as owner information, square footage, development units, and development description are provided but are inconsistently populated. Further, the development descriptions fluctuate from being highly specific (such as providing establishment names) to generic (such as providing an establishment type) to being non-descriptive entirely. These attributes were used to help determine location and type of development where available, but are not reliable as a basis of analysis.
Permits were selected for audit based on the likelihood that they would add physical capacity and not simply signal a change in use. Permits were selection for evaluation if they met all of the following criteria:

- Permits with a class of "Commercial"
- Permit with a status of "Approved"
- Permits with a square foot value of greater than 1,000
- Permit with a value of greater than $1,000,000 if the description indicates a tenant improvement or remodel
- Permit with a value of greater than $50,000 if the description indicates an addition
- Permit with a value of greater than $100,000 when tenant improvement, remodel, or addition is not indicated
- Permit with a date of between January 2001 and December 2007

The resulting set included 3,624 building permits for evaluation. During the audit process, development was detected that was attributed to 53 permits not included in the selected set. During the analysis, 314 records were removed because they were outside the area of available data (243 records), determined to be duplicate permits (37 records), or the permit location could not be determined (34 records), thus the net number of reviewed permits was 3,363.

Of the 3,363 original permit records, only records meeting the following criteria were used to calculate refill rates:

- Those records inside the UGB boundary, AND
- Those records with new capacity (having new buildings and/or additions) AND
- Those records that have commercial or Industrial activity.

Based on these criteria, a subset of 1,740 records was used for the refill rate analysis.

Supporting GIS data for the permit audit included:

- In-house aerial imagery for the years 1994, 1996, and 2000 through 2010.
- RLIS layers including Tax lots, Streets, Vacant, Buildings, and Multi-Family Housing.

Other sources consulted for this project included:

- Internet mapping sources including, Google Maps, Google Streetview, and Bing Maps
- News outlets including OregonLive, *The Oregon Daily Journal of Commerce*, and *The Portland Business Journal*
- Developer and project websites

Workflow

The permit audit process followed the following workflow for each permit:

- **Determine actual location of the permit record**. Many of the permits did not geocode to the location of the building being constructed or altered. Permit information such as site address, owner, and description were used to determine the true location.
- **Determine "pre-permit" conditions.** The year 2000 tax lots and aerial imagery are for the year before the permit is used as the primary go-to source for determining pre-permit conditions.
- **Determine "post-permit conditions**. The year 2010 tax lots and aerial imagery for the year after the permit year are used to determine the conditions resulting from the permit.

The final permit audit data provided is listed in Table 5**.Detailed descriptions and data capturing rules are provided in Appendix A. In the case of multiple permits issued for the same site, all new capacity will be assigned to a primary permit, usually the one with the**

largest payment value. Related permits for site development or tenant finish are related to the primary permit, but not included in the refill rate analysis.

Table 5. Primary Permit Audit Data Collected

Data Collected	Description
Pre-development Vacant/Developed Status	Two types of pre-development status are collected: **GIS Vacant** and **Economic Vacant**
Type of new capacity	This flag indicates the presence of a new building, and addition, or no new capacity.
New Square Footage	The total gross square footage is captured. For mixed-use developments, the net commercial square footage is also estimated.
Tear-down flag	This flag indicate whether there was a structure on site prior to development. This was not used in final refill rate calculation.
Type of activity on site	Flags for the type of development (e.g. industrial, commercial, or residential) are recorded for each permit.
Location Status	This flag shows whether the permit record is in the UGB, outside the UGB, or location is undetermined. Only records in the UGB were used in refill rate calculation.
Adjusted Permit Value	The value of the permit adjusted by the portion of the total square footage dedicated to commercial or industrial use.

FINDINGS

The 2001 – 2007 non-residential refill rate is calculated as the percentage of development that occurs on land that is classified as "Developed." Development is measured in two ways: based on total square footage and adjusted permit value.

2001 – 2007 Non-Res Refill Rate, measured by square footage

Using square footage as the measurement of development, the overall commercial refill rate is 59% while the overall industrial refill rate is 22%.

Table 6 and Table 7 present these rates for the region and by county. These differences are explained by two factors: number of permits issued and the relative size of developments.

There were more than twice as many commercial refill developments as commercial developments on vacant lands. This much larger number of permits offset the fact that the median new square footage for commercial development on vacant lands (13,246 sq ft) was somewhat larger than the median square footage for similar refill development (8,419 sq ft).

In contrast, the much lower refill rate for industrial development reflects the fact that while the industrial permits were equally distributed between vacant and developed lands, the median new square footage size for vacant industrial development (36,160 sq ft) was much larger than the median square footage for vacant refill development (9,801 sq ft). Figure 5 provides an example of the very large industrial structures on vacant lands seen in this time period.

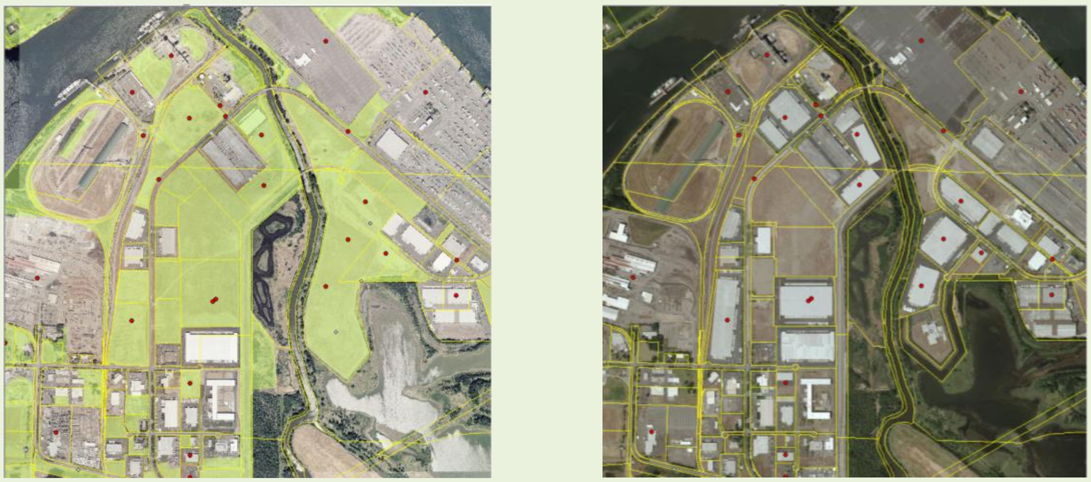
Table 6. 2001 – 2007 Commercial Refill rate, measured by square footage

County	Economic Vacant Status	Total Square Feet	Percentage	Number of Records
Clackamas	Developed	3,958,608	65%	189
	Vacant	2,164,073	35%	63
Multnomah	Developed	8,933,769	73%	436
	Vacant	3,349,401	27%	110
Washington	Developed	5,848,183	43%	310
	Vacant	7,665,478	57%	221
All counties combined	*Developed*	*18,720,560*	*59%*	*935*
	Vacant	*13,179,252*	*41%*	*394*

Table 7. Industrial Refill rate, measured by square footage

County	Economic Vacant Status	Total Square Feet	Percentage	Number of Records
Clackamas	Developed	836,358	28%	39
	Vacant	2,127,917	72%	42
Multnomah	Developed	2,129,515	19%	121
	Vacant	9,050,783	81%	110
Washington	Developed	1,118,979	28%	49
	Vacant	2,948,733	72%	52
All counties combined	*Developed*	*4,084,852*	*22%*	*209*
	Vacant	*14,127,433*	*78%*	*204*

Figure 11. Industrial Development north of Portland’s Rivergate area



2000 2010

Much industrial development occurred on large tracts of vacant land. The new structures in this

2001 – 2007 Non-Residential Refill Rates, by permit value

The 2001-2007 refill rate measured by permit value was 70% for commercial development and 35% for industrial development. These values are presented for the region and by county in Table 8 and Table 9. This value-based commercial rate 11 percentage points higher than the square footage based rate. Similarly, the value-based industrial rate is 13 percentage points higher than the square footage based rate. The higher refill rate for permit value may, in part, be explained by the types of developments seen during the study period.

Many of the highest-value refill commercial structures included large institutional refill developments at OHSU, the Oregon Convention Center, new hospital structures, and numerous additions to educational institutions from primary schools to universities.

In contrast, common examples of significant commercial vacant development during the study period included retail and office development at Cascade Station, Happy Valley Town Center, or the streets of Tannasbourne. There was a small number of institutional developments on vacant land, the most notable being the Coffee Creek and Wapato correctional facilities Assuming that the institutional developments have more specialized requirements, these developments may be by nature of higher value than standard retail or office development.

Table 8. 2001 – 2007 Commercial Refill rate, measured by permit value

County	Economic Vacant Status	Total Value*	Percentage	Number of Records
Clackamas	Developed	$410,875,415	78%	189
	Vacant	$119,280,743	22%	63
Multnomah	Developed	$811,365,130	77%	436
	Vacant	$237,783,926	23%	110
Washington	Developed	$389,705,619	53%	310
	Vacant	$347,936,374	47%	221
All counties combined	*Developed*	*$1,611,946,164*	*70%*	*935*
	Vacant	*$705,001,043*	*30%*	*394*

Table 9. 2001 – 2007 Industrial Refill rate, measured by permit value

County	Economic Vacant Status	Total Value*	Percentage	Number of Records
Clackamas	Developed	$27,588,858	29%	39
	Vacant	$67,209,097	71%	42
Multnomah	Developed	$129,515,465	36%	121
	Vacant	$230,128,843	64%	110
Washington	Developed	$35,234,559	39%	49
	Vacant	$56,106,913	61%	52
All counties combined	*Developed*	*$192,338,882*	*35%*	*209*
	Vacant	*$353,444,853*	*65%*	*204*

APPENDIX A: COLLECTED PERMIT AUDIT DATA

1. Vacant/Developed Status

There are two Vacant/Developed statuses recorded for each permit. The **Economic Vacant** flag is the primary attribute collected to determine the refill rate**.** This flag counts as Developed land that has had any development, regardless of the status of the land in RLIS Vacant lands inventories. The data collection phase also distinguishes between two types of vacant lands (described in Table 10); however these variations are grouped together as "vacant" for purposes of calculating refill rate.

Table 10. Economic Vacant Flag Criteria

Economic Vacant Flag	Real-World Conditions
Vacant	No signs of previous development on property AND Parcel is not primarily in a built-up area
Vacant - Infill	Parcel is primarily in a built up area Parcel has no signs of previous development
Developed	Signs of previous development on site

A second status, **GIS Vacant,** is a flag that indicates whether the building of the development is on land coded as vacant in the 2000 Vacant lands layer. Values for this flag can be "Vacant," or "Developed." Figure 6 and Figure 7 show examples of both the **Economic Vacant** and **GIS Vacant** flags.

A small number of records are marked in opposite "Developed" or "Vacant" categories for the two vacant statuses because of the difference in definitions. Table 11 shows a cross tabulation of the **Economic Vacant** versus **GIS Vacant** for 1,742 permits with new capacity used to estimate refill rates. The majority of these differences are attributed to permits for locations that were classified as vacant in the 2000 inventory, but in which there was previous development (see Figure 8 and Figure 9 for examples.)

Figure 12. Development on Vacant-Infill land

2000

2010

The GIS Vacant status for this permit is “Vacant;” the Economic Vacant Flag for this development

Figure 13. Development Spanning Vacant and Developed Lands

2000

2010

The GIS Vacant status for this permit is “Developed;” the Economic Vacant Flag for this

Table 11. GIS Vacant versus Economic Vacant Cross tabulation

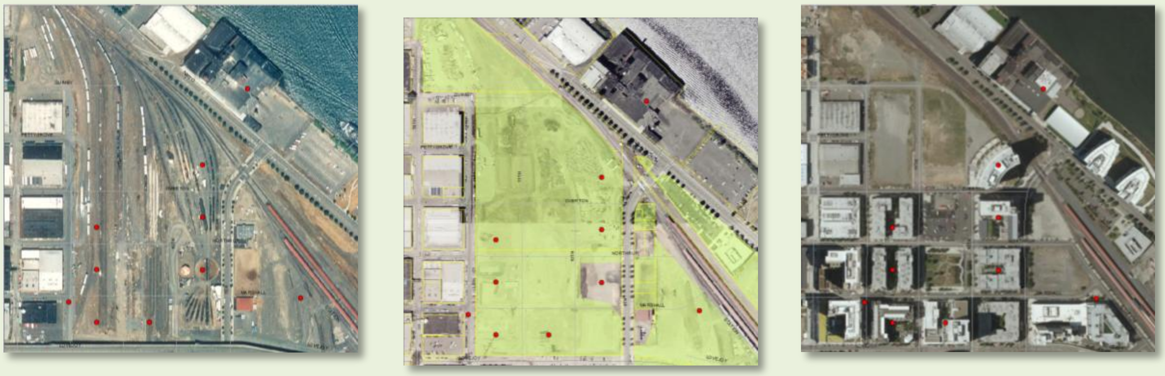
		GIS Vacant		
		Developed	Vacant	*Total*
Economic Vacant	Developed	1,102	42	*1,144*
	Vacant – Greenfield	2	450	*452*
	Vacant – Infill	1	145	*146*
	Total	*1,105*	*637*	*1,742*

Figure 14. Redeveloped Land classified as GIS Vacant

1996 2000 2010

The GIS Vacant status for this permit is “Vacant;” the Economic Vacant Flag for this development is “Developed” because there is evidence of previous development

Figure 15. Redeveloped Land classified as GIS Vacant in the Perl District



1996 2000 2010

Much of the redevelopment of the Perl district that occurred in the time-frame of this study

2. Type of New Capacity

The **New Capacity** field indicates whether the permit has resulted in a new structure, an addition to an existing structure, a non-building type structure, or no visible development. Table 12 provides a description of these flags and the number of occurrences of each in the total dataset. Figure 10 shows an example of new capacity through addition. For the refill rate calculation, only permits with “New building” or “Addition” are considered.

Table 12. New Capacity Flag Criteria

New Capacity Flag	Real-World Conditions	Number of Records
New Building	An observable, stand-alone new building is on the site. Note that the small number of records that result in new buildings and additions are coded as “New Building.”	1,475
Addition	An addition is observed on a pre-existing building on the site.	400

Non-building structure	The permit refers to the following types of structures: - Pump houses - Mechanical coverings - Parking structures - Grading or site development - Electrical substations - Bus or MAX shelters These types are commonly identified in the permit description text itself.	421
No visible development	There is no observable new capacity on the site.	1,068
N/A	Records not evaluated (location unknown or outside UGB).	313

Figure 16. New Capacity Through Addition

2000

2010

The observed addition on the south side of this building yields to a New Capacity flag of "Addition."

3. New Square Footage

New square footage is estimated for each permit that has new capacity. The square footage is estimated as the area of the building footprint multiplied by the number of stories in the structure. Special cases in estimating square footage include:

- For **mixed-use** residential & commercial development, only the commercial share of the square footage is captured. The commercial portion is presumed, in all cases, to be the building footprint itself and is not factored by additional stories.
- The square footage estimate is not decreased by any area of a whole or partial **tear down** on the site.

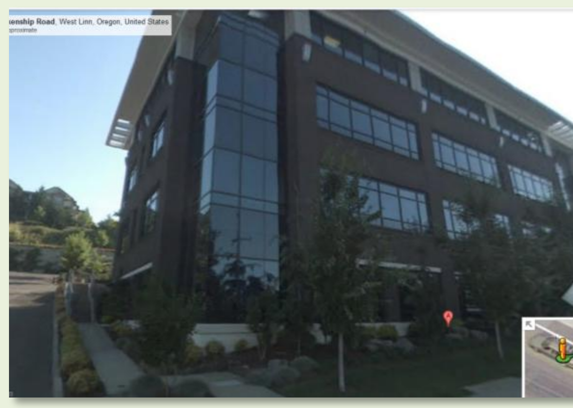
- For **additions**, only the new area is recorded.

The estimate for the building footprint may be derived from either the area of the RLIS Buildings layer or the area of a polygon drawn over the aerial imagery. The estimate for the number of stores in the structure drives from Google Streetview and Bing Bird's Eye View. Where possible, the height of the building in the RLIS Buildings layer is used to support the reasonableness of the number of stories estimate.

Note that the square footage estimated using this method will be much larger than what would be provided by an assessor's office or as a statement of net leasable area. Thus, the square footage resulting from the Permit Audit process cannot be used in conjunction with other estimates. Instead, it is a consistent method by which to compare only records within the audit process itself.

Figure 17. Estimation of permit square footage

2010 Aerial Imagery



2011 Google Streetview

The building footprint for this permit is 18,851 square feet and there are 4 stories in the building. Thus, square footage for this permit is recorded as 75,404.

4. Teardown Flag

The teardown flag is a binary flag indicating whether the site of development had a structure torn down prior to the development associated with the permit under review. This includes both entire structures and partial tear-downs. The teardown flag is not used in calculating the refill rate, but is captured as an auxiliary attribute for database checking.

Figure 18. Teardown prior to development

2000 2010

5. Activity Type

Activity type is captured for two reasons. First, refill rates are calculated separately for "commercial" versus "industrial" development. Additionally, a finer grain detail of activity type is captured to facilitate linking of permit records to employment databases in subsequent project steps. The detail and general activity types are described in Table 13.

Permits may be coded to multiple activity types. For example, mixed-use developments are coded as "commercial" and "residential." Activity types are researched through the permit description, tax lot information, and Google searches.
Common special cases of categories that ARE included in the refill rate include:

- Mixed-use commercial/residential
- Care and custodial facilities such as assisted living, nursing homes, correctional institutions
- Home businesses, including care facilities

Common special cases that ARE NOT included in the refill rate include:

- College dormitories: These are coded as Institutional and Residential and are not considered in the refill rate analysis
- Pool houses or community buildings on residential developments
- Public housing (unless mixed-use with a retail establishment on-site)

- Park buildings

Table 13. Description of permit activity types

Detail Activity Type	General Activity Type	Examples
Commercial	Commercial	Development with a retail presence. Includes shops, banks, restaurants, car dealerships, churches, gas stations, day-care, auditoriums, etc.
Office	Commercial	Services or offices. Includes medical offices, hospitals, business services. Light industrial not coded as industrial falls in this category.
Institutional	Commercial	Schools, colleges, civic offices, correctional facilities
Care Facilities	Commercial	Nursing homes, assisted living, other types of group quarters.
Industrial	Industrial	Sites with 2010 Tax lot use classified as of Industrial
Residential	Not Considered	Residential housing that are not group quarters
Other	Not Considered	None of the above categories; most commonly parks and recreational spaces.

6. Location Status

The location status of permits indicates the location of the permit with respect to the Urban Growth Boundary. Table 14 describes the location status flags used and provides the number of occurrences of each flag in the database. For the refill rate calculation, only permits with the value "In UGB" were used.

Table 14. Location Status

Location Status Flag	Real-World Conditions	Number of Records
In UGB	The location for the permit is known and it is in the 2010 UGB boundary.	3,299
Out of UGB, but evaluated	The location for the permit is known and it is outside the 2010 UGB boundary. Source material was available for the permit and audit information was collected.	63
Out of UGB, not evaluated	The permit geocoded to a location outside of the 2010 UGB boundary. Source material was not available for the permit and audit information was not collected.	244
Location Unknown	The location of the permit could not be determined because of errors or ambiguities in the permit site address or description.	34
False Records	Permits deemed to be duplicates or for development that was never completed	37

7. Adjusted Permit Value

Permit value is an attribute of the permit records themselves. **Adjusted Permit Value** is a calculated field that pro-rates the total permit value by the percentage of the square footage that is for commercial development. Thus, the adjusted permit value is only different from the actual permit value for the records that have mixed residential/commercial uses.

8. Other Supporting Information

Where applicable, the **number of residential units** is collected for residential building permits with new capacity. This data is derived from the permit records themselves (development units), from the RLIS Multi-Family Housing Inventory, or from web searches related to the development itself.

Long-string **comments** are collected for permits to track development type or unusual information that may be helpful in QA and review.

A **link to the Building layer** for each permit is used to capture the true location of the development.

APPENDIX B. PERMIT DATABASE GEOCODING ANALYSIS

Summary

Errors in the permit database geocodes include failure to determine the site location for a permit record or matching the permit record to an inaccurate location. Geocoding error rates in the permit database depend on how errors are defined, but generally an evaluation of the data reveals that:

- 3% - 7% of the permit records fail to geocode
- 4% - 14% of the permit records geocode to an inaccurate location

Reasons for geocoding errors of both types include:

- Errors in the permit address information including typos or standardization problems;
- errors or ambiguity in address locator data;
- changes in real-world address patterns between the time the permit was recorded and when the permit was geocoded.
- A small number of these errors have the potential to be corrected through changes in the geocoding process (for example, by using different locators or pre-processing the permit addresses). Most of the errors detected, however, cannot be resolved without intensive manual evaluation.

Geocoding Error evaluation

Geocoding Accuracy and the Permit Audit Process

A commercially available tabular database of building permits for the metro area was used as the basis for the non-residential refill rate analysis. The location for each permit was assigned through a systematic geocoding process at Metro's Data Resource Center. The geocoding process attempts to correctly assign a location to each permit using address information while limiting "false positive" address matches.

There is a risk that errors in the geocodes of the permit record database can introduce errors to the accuracy of the non-residential refill rate analysis: geocoding failures lead to permits that cannot be evaluated and a failure to detect development; assignment of inaccurate locations may lead to erroneous permit evaluations.

Additionally, because the audit process is essentially a manual verification of the geocoding accuracy of a 2% subset of the full permit database, an assessment of the database geocoding accuracy and error patterns can help inform what types of projects would benefit from using the permit database and how the database could be improved.

Evaluation Method

Evaluation of the goodness of permit locations includes assessing the match rate and the accuracy rate. The match rate is gathered from the output results of the geocoded permit file itself; this is evaluated for all permit records.
In contrast, the accuracy rate is evaluated through a comparison of the geocoded location and the location of the development for each permit recoded as part of the manual permit audit process. This evaluation is only conducted on the subset of records selected for the non-residential refill rate audit and for which a development location was found.

Matching Rates

The overall geocoding match rate of the permit database is very high. Table 15 shows the geocoding match rate for the full permit database, including both residential and non-residential permit records. This full database also includes records for counties outside the Metro area.

Table 15. Geocoding Match Rate

Permit Database	Total Number of Records	Matched Records	Percent Matched
Full Permit Database			
• All records	278,258	258,280	93%
• 3-County region records	179,072	174,141	97%
Non-residential Refill Records			
• All records	3,677	3,565	97%
• 3-County region records	3,670	3,558	97%

While 7% of the full database records do not successfully geocode with the current process, many of these records are outside of the Metro area. For example, the full database includes 17,000 records for Salem, OR and 14,000 records for Vancouver, WA. When only records in Clackamas, Multnomah, and Washington counties are evaluated, the geocoding failure rate is only 3%.

Geocoding Error Patterns

Patterns of errors for permit database geocodes include the broad categories:

- Failure to match to a correct location because of errors in the permit site address information.

- Failure to match to a correct location because of changes in address information between the time the permit was recorded and when the permit was geocoded.
- Failure to match to a correct location because of errors or ambiguity in address locator data.

Examples of Geocoding Errors Due to Errors in the Permit Database

1. Permit Database Error: Typos in site address information

Many geocoding errors result from typos in the number or name portion of the address in the permit record itself. Errors in the number portion are likely not detectable or correctable without intensive manual review. Detection of errors in the name portion is possible by comparing the permit street names to a list of known street names in each jurisdiction.

Typos in the street type and directional quadrant are also observed. There are 50 unmatched occurrences of permits with the string " sst" and " ddr"; a selected sample of these geocoded successfully when the street type was corrected.

Table 16. Examples of permit record address errors

Permit Address	Real Address	Geocoding Result
8770 SW Scoffins St	**8700** SW Scoffins St	Segment level match w/ score of 88
2935 NE Halsey	**21935** NE Halsey	Address Unmatched
1422 N **Lomard** St	1422 N **Lombard** St	Address Unmatched
11883 SW **Hel** St	11883 SW **Itel** St	Address Unmatched
1624 NW Lovejoy **sst**	1624 NW Lovejoy **St**	Address Unmatched
10652 NE Holman **sst**	10652 NE Holman **St**	Address Unmatched

2. Permit Database Error: Extraneous information in site address

Many permit records contain building or suite information in the site address. This does not always lead to a geocoding failure, but it does appear to be the reason for a number of unmatched records. In the full permit file, there are 434 matched occurrences with the string "Bldg" and 184 unmatched occurrences of the string "Bldg. "

Table 17. Examples of extra information in address field errors

Permit Address	Real Address	Geocoding Result
14500 N Lombard St **Bldg A**	14500 N Lombard St	Address Unmatched
239 N Sumner St **Bldg 12**	239 N Sumner St	Address Unmatched

3. Permit Database Error: Site address truncated

A small number of unmatched records were observed with truncated Site Address fields. The following two patterns account for about 25 missing records.

Table 18. Examples of truncated address information

Permit Address	Real Address	Geocoding Result
12931 Happy Valley Town **Ce**	12931 Happy Valley Town **Center Dr**	Address Unmatched
16037 SW Upper Boones Ferry **R**	16037 SW Upper Boones Ferry **Rd**	Address Unmatched

4. Permit Database Error: No address information

Over 4000 permit records have no site address information. This includes and address recorded with null or empty values and with ambiguous information ("Right of Way" or "Not Assigned Yet"). Some of these records include a tax lot identifier, however most are not geocodable.

5. Permit Database Error: Address standardization problems

Many common names are abbreviated in the permit records. There are dozens of unmatched variations of the Beaverton Hillsdale Highway, the Historic Columbia River Highway, Tualatin Valley Highway, Martin Luther King Boulevard, Happy Valley Town Center Drive, and Upper & Lower Boones Ferry Roads. Similarly, the interpretation of the street "Park Way" as "Parkway" (incorrect street name and type) resulted in 37 unmatched records alone.

Table 19. Examples of permit database standardization errors

Permit Address	Real Address	Geocoding Result
8205 SW **Bvtn Hillsdale** Hwy	8205 SW **Beaverton Hillsdale** Hwy	Address Unmatched
36023 **Historic Columbia R** Hwy	36023 E **Columbia River** Hwy	Address Unmatched
10164 SW **Parkway**	10164 SW **Park Way**	Address Unmatched

Examples of Geocoding Errors Due to Real-world Address changes

1. Real-world Address Changes: Systemic changes in addressing pattern

Changes in addressing scheme were detected in Sherwood (2005), Hillsboro (2003), and Tualatin (2002). Permits entered prior to the change-over year are unmatched when using the current locators. Sherwood has the most extensive changes; Hillsboro and Tualatin only had changes on larger arterials passing through several jurisdictions. There were 323 unmatched permits in these towns prior to each transition.

Table 20. Examples of system changes in addressing patterns

Permit Address	Real Address	Geocoding Result
380 Oregon St	15677 SW Oregon St	Address Unmatched
23105 SW Tualatin Valley Hwy	6577 SW Tualatin Valley Hwy	Address Unmatched
855 N Sherwood Blvd	21907 SW Sherwood Blvd	Address Unmatched

2. Real-World Address Changes: Development prior to address assignment

It was observed during the audit process that when lots were newly divided or developed, the development site often did not have a physical address at the time the permit was issued. In many of these cases, the address of the pre-divided lot or adjacent lot was with the same owner was entered as the permit site. The resulting permits are matched to an incorrect but nearby tax lot. Correcting the geocodes location of these permits through automated means is unlikely.

Table 21. Examples of development prior to address assignment

Permit Address	Real Address	Geocoding Result
37208 SW Florence Ln	7206 SW Florence Ln	Address matched with score of 100% to wrong parcel.
 2000 imagery & tax lots	 2010 imagery & tax lots	The cyan dot in each image shows geocoded permit location of for development on the subdivided parcel.

Geocoding Errors Due to Ambiguity or Errors in Address Source Data

- Address Data Errors: Large Campuses & Adjacent Lots

Development which occurred on sites comprised of multiple tax lots are the most common source of “inaccurately geocoded” error records. In these cases, the tax lots may have the same address, so the geocode may match a tax lot distant from the actual development.

This error was observed on both mid-scale developments and large multi-building campuses (e.g. high schools, shopping centers, hospitals, etc). Additionally, permits for large campuses may be issued with a central headquarters address as the site address instead of the building where development has occurred.
Because these records geocode to the general area of development, they are not considered severe. However, the presence of this pattern can yield problems in attempting to associate permit records to a specific tax lot or building.

Figure 19. Examples of real-world address ambiguity

14 permits for development on various buildings at OHSU all geocoded to one of two central locations highlighted in red in the image.

The permit for this development geocoded to the lot with the red dot instead of the lot with the primary development. In this example, the lots are reasonably compact and thus the geocode is not very far from the development location. In other cases observed, the geocode location can be quite far from the development because the lot sizes are much larger.

3. Address Locator Errors: Errors in locator data

The permit file was largely geocoded using the MAF_2008_Q2 locator using address information from 2008 tax lots A small number of permits were observed in which the permit address failed to geocode or geocoded to an inaccurate location. Manually matching of these records, however, using the current RLIS_MAF_juris_city locator, did match to the correct location. The difference in these cases can be traced to changes (presumably corrections) from the 2008 tax lots to the current tax lots. The number of these errors is estimated to be very low, however the error can be easily resolved geocoding with a current locator.

Figure 20. Examples of error in locator data

The highlighted permit geocoded to a street-level match because the 2008 tax lot file had an error in the site address. The permit matches the 2010 tax lot file and correctly geocodes with the current locator file.

Geocoding Evaluation Recommendations

Evaluation of the geocoding errors in the permits database reveals that these errors result from both problems in the permit database, problems with address data, and real-world address changes or ambiguity. Ambiguity in real-world addresses due to large or adjacent tax-lots is the most common cause of geocodes to a location that is not "on" the development site at the building or tax-code level. These errors are largely not resolvable. A smaller number of errors associated with unmatched permit records could be resolved through changes to the geocoding process:

- A small number of records which are now unmatched could potentially be match with additional pre-processing to filter for known street name errors (e.g. typos, and standardization errors.) The match improvement from this effort is estimated at roughly 500 to 1,000 records, or less than 1% improvement.

- A small number of older permit records which are now unmatched could be matched by using geocoding locator files created for the date of the permit records. The match improvement from this effort is estimated at a maximum of 300 records, or less than .1% improvement.
- A small number of records which are not now unmatched or inaccurately geocoded could be improved by geocoding to a current address locator to capture tax lot site address corrections. The match improvement from this effort is estimated to be a few dozen records, or less than .1% improvement.

SECTION THREE: REPORT ON VALIDATING FUTURE REFILL CAPACITY ESTIMATES

Introduction

The first two sections of the study move the discussion of infill and redevelopment from the arena of planner speculation and conjecture to actual verifiable measurement. However, knowing what we have done in the past, is not the equivalent of knowing what we are able to do in the future. This brings us to the subject of the third section; namely measuring and estimating future refill capacity. Estimating future refill capacity consists of obtaining information to better understand two issues. These are:

1. What levels and what percentage of the region's future growth should we expect to be satisfied by refill?
2. What conditions and policies vary the share of development occurring as refill and how might this share be increased or decreased?

As presently, implemented in MetroScope at the very start of a 35 year forecast, we provide as initial conditions both the development capacity of land that we regard as vacant and land that is presently developed but that we expect to have infill or redevelopment sometime in the 35 year period. The issues are how do we make this assessment and how might the actual measurement data better inform us in making a forecast of refill capacity?

TIMING OF INFILL AND REDEVELOPMENT – THEORY AND PRACTICE

Before explaining our present procedures and discussing how those procedures can be improved in the future we need to provide a wider research perspective concerning the subject of refill. Redevelopment and infill are well understood theoretically and fit neatly into the timing of real estate development paradigm. Stated in verbal terms, refill occurs when:

> The value of the land on which the improvement is located assuming its most economic use exceeds the net present value of the property in its current use.

The verbal definition is short and on the face of it fairly easy to comprehend. However, digging deeper into the definition produces a few questions that require more explanation. For instance, how do we determine the most economic use of land and just what does net present value of property mean? Figure One below provides an graphic explanation of how this works.

Figure One: Graph of Refill Timing

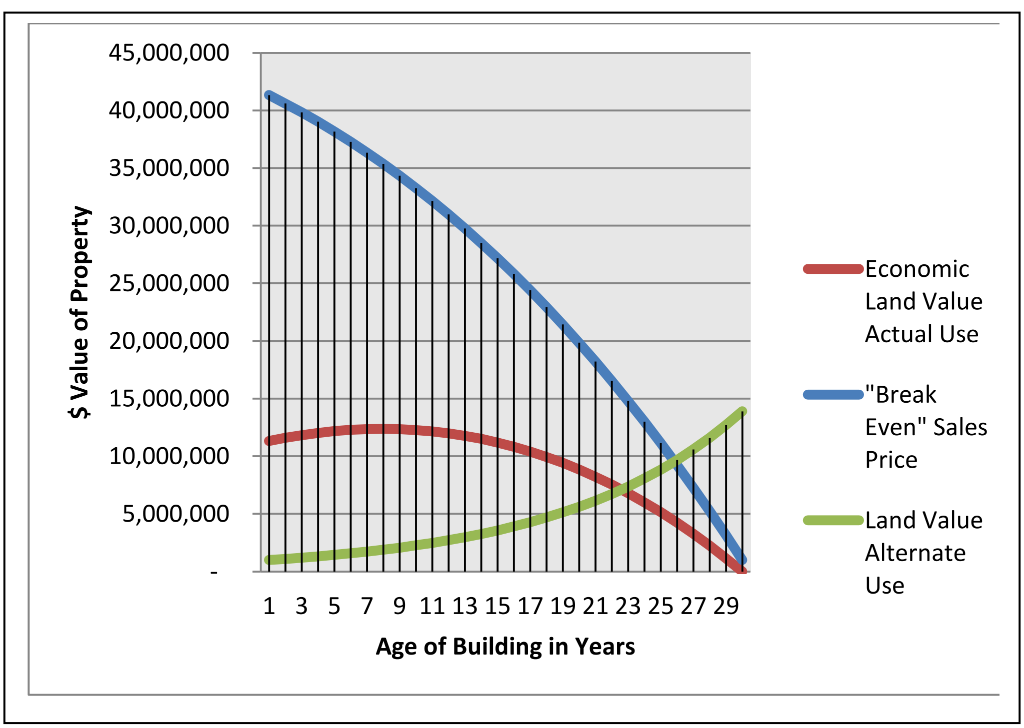


Figure One displays 3 lines that change over the 30 year life span of a building that becomes operational (starts earning revenue) in year 1[4]. The most important line is the "break even" sales price. Simplified a bit this value includes the economic value of the land (the net present value of all operating profits in any given year) and the unrecovered capital investment in the building. For our example in Figure One in year one this amount is 42 million $ which includes 30 million $ for the unrecovered capital cost of the building and about $12 million in future net earnings. By the start of year 30 the "break even" price has dropped to about 1 million $ which represents the level of the unrecovered capital investment.

The "economic land value" of the actual use line represents the net present value of net profits valued in each year of the building's life. For instance the economic land value in year 2 is about 11.5 million $ and it rises to about 12. 5 million $ by year 7 since decreasing interest on invested capital increases the cumulative value of net operating revenues even though building life is 23 years instead of 30 years[5]. However, by year 10 of the building life the net present value of future earnings decreases toward 0$ by the end of the 30 year building life.

The final trend line is that of the land value of the site in the most economic alternative use.[6] Here we simply presume an alternative use that over time increases the land value at a rate of 9.5% per year. We note that this line crosses the land value line at year 23 of the building's life. If the site were vacant, at that point it would be profitable to convert the site to the alternative use. However, the site still has an improvement on it that embodies the existing use and the owner would not sell at the land value price. It takes another 3 years (year 26) for the alternative value to exceed the break- even price. At that point it makes economic sense for the current land lord to sell the property as he would receive more in sales value than the unrecovered capital cost plus net present value of future revenue. In our very hypothetical example year 26 of the 30 year building life is when the land would convert to another use.

Once one gets comfortable with the accounting conventions, the above example becomes fairly intuitive. However, is it of much help for the real world estimation of future refill capacity? Unfortunately, the answer is not much help at all. Consider such an approach to be applied to the region's roughly 125,000 non single family tax lots. The first problem we would encounter is establishing the economic life of any particular building stock; even very old stock. Unlike our proforma example, building stock rarely embodies one unique use; usually buildings

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[4] Table 1 in the Appendix to this Section provides more accounting details of the data depicted in Figure One.

[5] Future net earnings are discounted from the year at which you are making the valuation. Hence, in year 1 the net earnings in year 29 are divided by 1.035 to the 29th power. In year 7 earnings in year 29 are divided by 1.035 to the 22nd power.

[6] This economic status is usually referred to as "highest and best" use and it many cases tax assessors are required to value the land in terms of its "highest and best" use. How this is accomplished in any comprehensive and consistent way remains another issue.

are adaptable for a range of uses. Consequently, most building stock accommodates several if not many uses over its lifespan. Indeed, in areas dominated by an older stock of vintage buildings most of the building investment comes in the form of alterations and tenant improvements rather than new or capacity additions. What this means that unlike our example buildings always have some value and as a consequence their life spans are indeterminate.

A second complication even more vexing than the first, is the severe limit on our ability to determine the economic land value associated with "highest and best" use. Even if we as our example implies estimate the land value associated with the most profitable alternative use; what value will we assume for the next tax lot? And the next? Intuitively, we would expect the market demand for any given use to be fairly limited in any particular time period. Assuming a highest and best use land value for a particular tax lot is one thing; making that same assumption for hundreds if not thousands of tax lots is totally different.

Figure Two below illustrates what the assessor is more often to do given the real world difficulties in estimating values that economic theory takes as given.

Figure Two: What the Assessor is Likely to Report

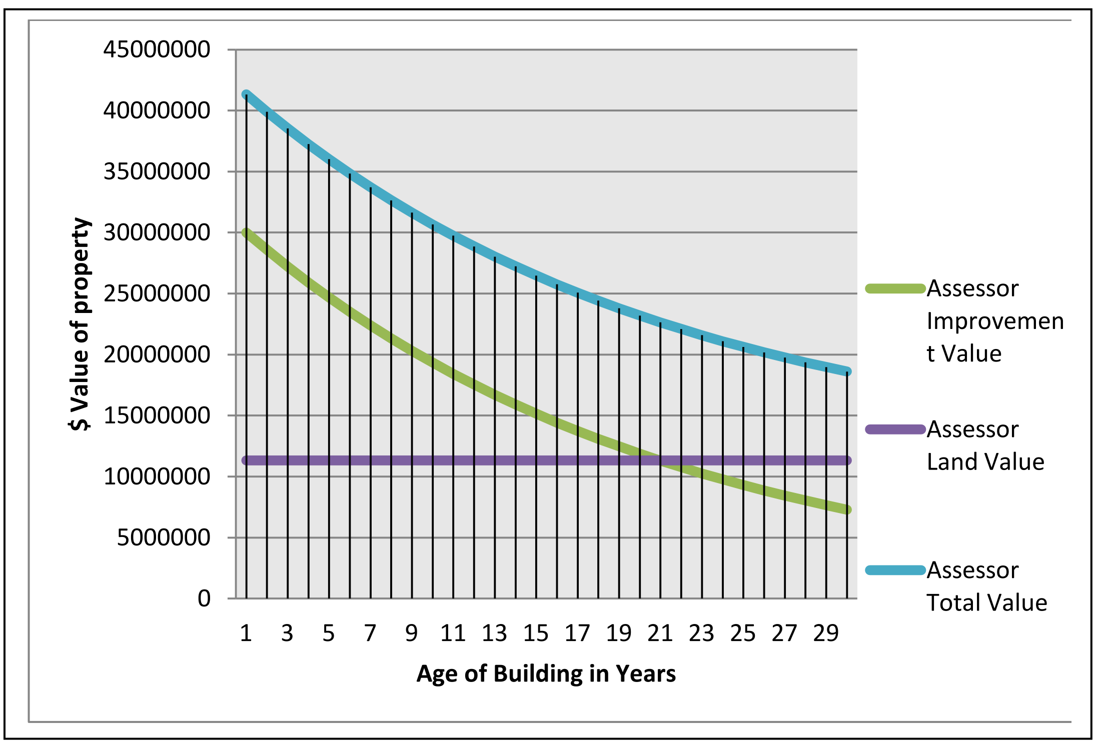


Figure Two presents a substantially different picture than the theoretical graph. Here the time of redevelopment is not determined at all. Though by year 30 of the building's life the land value exceeds the improvement value, total value is almost 20 million $ with both land and building totaling 10 million $ apiece. In short, refill is not a determined quantity as theory would have it; rather it appears to be a statistical quantity requiring calibration and verification against actual refill events.

Finally, we need step back and make clearer why assessor data and appropriate interpretation of assessor data are important in the first place. In a word, the assessor data are our only source of consistent, regularly published, public records of the economic conditions of every tax lot within the Metro Region. We have no other way of assessing the likelihood that developed or vacant land will be developed in the future. What we are faced with then is constructing a statistical surrogate of the theoretical result of Figure One using data available from assessor records.

MEASURING AND VALIDATING OUR REFILL SELECTION CRITERIA

Our first and indeed our present efforts at estimating refill potential from assessor records has involved an ad hoc "filter" approach to evaluating tax lots. In sum the "refill filter" involves testing on qualifying tax lots[7] each tax lots zoning, size, improvement value, land value, etc. against a set of qualifying criteria. An example of filter criteria applied to each tax lot is shown in Figure Three.

Figure Three: Example of Refill Filter Values

New SRZ	Lot Size	Bldg. Value	Land Value
SFR1	x		
SFR2	x		
SFR3	x		
SFR4	x		
SFR5	0.49	125,000	35,000
SFR6	0.37	125,000	35,000
SFR7	0.37	125,000	35,000
SFR8	0.34	125,000	35,000
SFR9	0.34	125,000	35,000
SFR10	0.29	125,000	35,000
SFR11	0.29	125,000	35,000
SFR12	0.23	125,000	35,000
SFR13	0.14	125,000	35,000
SFR14	0.12	125,000	35,000
SFR15	0.11	125,000	35,000
SFR16	0.11	125,000	35,000
MFR1	0.49	200,000	50,000
MFR2	0.49	200,000	50,000
MFR3	0.49	200,000	50,000
MFR4	0.49	200,000	50,000
MFR5	0.4	200,000	50,000
MFR6	0.35	200,000	50,000
MFR7	0.3	200,000	50,000
MUR1	0.249	120,000	35,000
MUR2	0.249	120,000	35,000
MUR3	0.249	120,000	35,000

[7] The first step is to exclude ... operty, etc. and any other tax lots whose attributes do ...

Figure Three provides an example of the filter values for some of the zoning categories for Multnomah County. For instance, for Multnomah County for zoning category MFR1, we would include in the refill supply anylot larger than .49 acres that had an improvement value less than $200,000 and a land value of greater than $50,000. For the filter criteria lot sizes, improvement values and land values vary by County and zoning type throughout the region. We also include Clark County in the filter criteria.

Up to this point, validation of the refill criteria has been very informal. Mostly, validation has involved mapping out all tax lots selected using the criteria and visually comparing the results to a map of areas where we know refill has occurred. Far more desirable is a statistical study that determines if our criteria provide an improvement over a random guess and by how much. Moreover, a statistical study provides an opportunity to improve the filter and incorporate more useful criteria.

Our previous efforts at statistical validation have been frustrated due to a lack of a reliably measured dependent variable. In order to conduct a statistical analysis we required data over a sufficient period on which tax lots experienced infill, redevelopment, or underwent no change. Only after the 2009 residential refill study did we acquire sufficient tax lot development records to be able to classify residential data into developed on vacant, developed on infill and developed on redevelopment for SFD and MFD units.

At this juncture we should point out that the statistical research continues beyond testing and extending the filter for single family and multi-family development. As reported in the 2nd Section, we now have data on nonresidential development and will be incorporating those results as well. Secondly, our present efforts have been directed toward discriminating between developed land that is likely to experience refill and developed land that is likely to remain unchanged. Our future work will be extended to provide supply side based statistical models using nested or mixed logit that will model the development decision and then the decision to choose vacant or developed land. For the moment, it is worth repeating that the present analysis limits itself to determining the future refill capacity of the Metro Region.

To perform the statistical analyses, we arrived at a set of 4 multinomial logit regressions on the set of developed lots in the Portland Metro UGB for single family housing and multi-family housing. To perform the tests we assembled the tax lot data as follows:

1. For both SFD and MFD we included all those tax lots on which we recorded either infill or redevelopment for the period 2001 – 2006.

2. For both SFD and MFD we included a sample of developed tax lots on which no development had been observed. To obtain an approximation of the true ratio of developed tax lots with refill to developed tax lots with no refill we used the NLOGIT WGHT option to adjust the frequencies of developed tax lots without refill. In addition we used the WGHT option for MFD to account for multiple units on one tax lot based on actual unit counts for refill lots and average units per lot for developed lots not experiencing refill.
3. We tested our "refill filter" criteria for each housing type. What this means is that for each SFD and MFD lot we compared by zone type in the year 2000 the lot size, the improvement value and the land value. If the tax lot satisfied each of the 3 filter criteria, it was coded with a 1; if it failed any of the 3 criteria it received a 0. This test was performed for both SFD and MFD.
4. We then tested the same data base using the individual lot size, improvement value, land value and several other variables available for each tax lot within the RLIS data base. Likewise this test was performed for both SFD and MFD.

Tabular results for first SFD and then MFD for the refill filter are presented below in Figures Four and Five.

Figure Four: Multinomial Logit Results for MFD Refill Filter

Variable Name	Coefficient Value	Coefficient "T Value"
Constant (Infill)	-6.237	-27.036
Refill Filter =1 (Infill)	2.235	3.516
Constant (Redevelopment)	-5.052	-39.520
Refill Filter=1 (Redevelopment)	3.764	17.654

N=9914; McFadden Pseudo R-squared=.76; NOBLD=1

Figure Five: Multinomial Logit Results for SFD Refill Filter

Variable Name	Coefficient Value	Coefficient "T Value"
Constant (Infill)	-6.181	-18.492
Refill Filter=1(Infill)	3.992	7.654
Constant(Redevelopment)	-5.534	-22.866
Refill Filter=1 (Redevelopment)	3.819	9.418

N=4444;McFadden Pseudo R-squared = .92; NOBLD=1

Without undue elaboration the results in Figures Four and Five establish that the refill filters currently in use are valid selectors for future refill sites. However, the tests do not establish whether the filter criteria are optimum or whether better GIS based criteria may be developed. Also, we should point out that the pseudo R-squared values are greatly inflated by the very high percentage (95 - 98%) of developed lots that experienced no change. In a word, if you just guess no development (NOBLD), you will be right almost all the time.

Figures Six and Seven below provide a more useful test of the efficacy of the present refill filter criteria. Here we characterize our measurement of the efficacy of the refill filter criteria in intuitively more plausible ways. In these cases we answer the question of how much better off are we using the filter than just making a random guess? The refill filter may not be as nifty as Dudley Doright's extra keen decoder ring, but is it better than nothing?

Figure Six: SFD Filter Criteria Improve Your Chances of Guessing on Refill

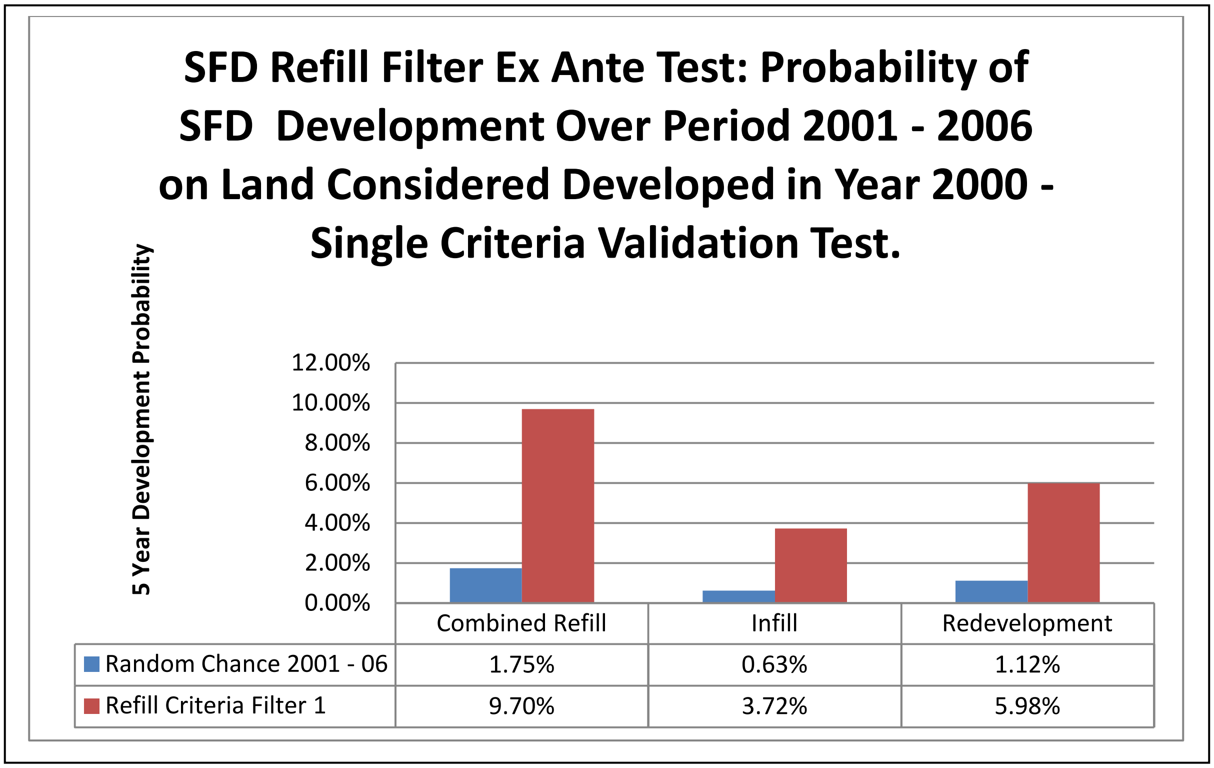
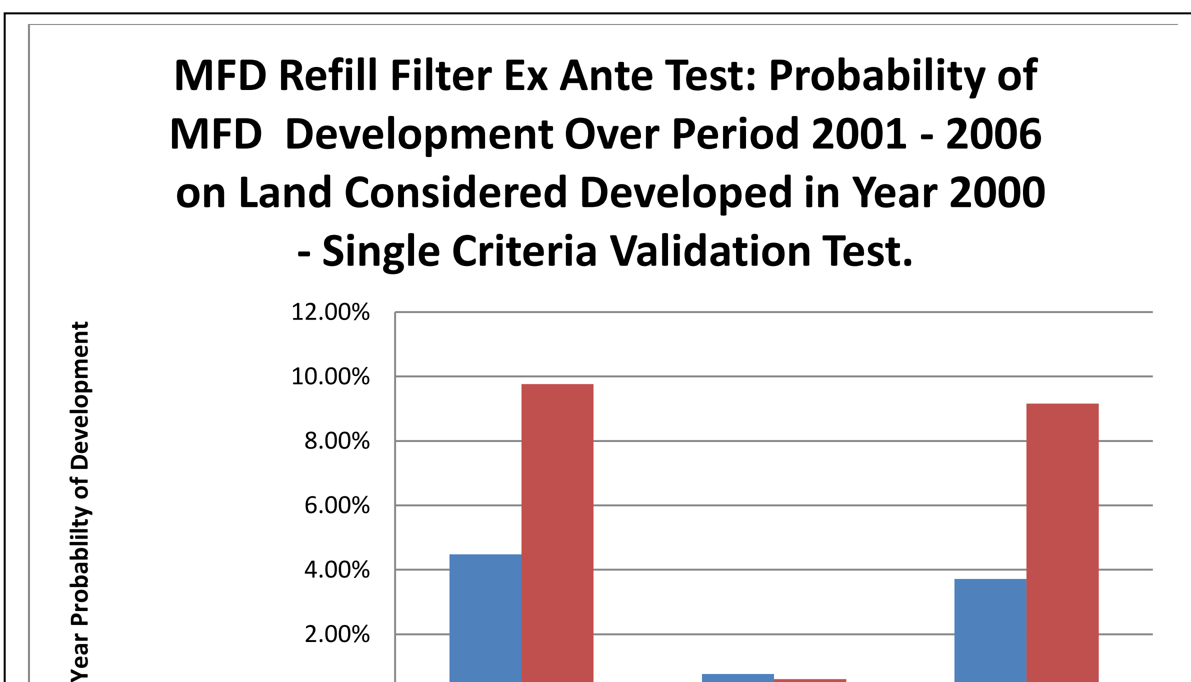


Figure Seven: MFD Chances of Refill Selection Increase with Filter Criteria



Keep in mind as well that we are performing an "ex ante" test; meaning that we are using only the information available in assessor records as of the year 2000 to estimate whether a particular developed tax lot experienced refill in the period 2001 – 2006. Moreover, for the null model we are assuming that the chooser knows the mean probability but has no access to the filter information.

In Figure Six for SFD we note that in the first column our random chance of a particular developed tax lot (zoned SFD) experiencing a refill event amounted to 1.75%; 0.35% per year. Conversely, 98.25% of the time nothing would happen; in other words if you just guessed nothing every time, your score would be 98.25; certainly an A. The real issue is would you do better were you equipped with a refill filter tax lot detector? As the first column in Figure Six attests, you would be right guessing refill almost 10% of the time versus only 1.75% of the time if you did not have one.

Figure Seven repeats the same calculations for MFR as were done for SFR above. The major difference is that not surprisingly the random chance of a MFR refill event on a developed lot over the 2001 – 2006 period is 4.5%[8]; 0.9% per year; about 2.5 times the SFR rate. Like SFR the MFR data indicate that overall having the filter doubles your chances of choosing correctly from 4.5% to 9.8%. However, all the improvement occurs in the redevelopment class; the filter does not help identify infill lots at all and in fact operates a little worse.

To this point we have statistically substantiated that using the filter criteria provides a 2 – 5 fold increase over randomly guessing based on the regional average rate. This finding by itself provides a mild accolade to our efforts to date. However, it begs the question of can we reformulate the assessor data, combine it with other appropriate RLIS data and do substantially better? We need also add the proviso that our list of variable arguments is constrained by the requirement that they be generated in the future by MetroScope or that they can be assumed

[8] The tax lot denominator in this instance was all developed lots less SFR and Industrial as of 2000. The interpretation is clouded somewhat because MFR and Commercial zoning was almost entirely switched to Mixed – Use zoning over the 2001 – 2006 period. Consequently, the number of lots on which MFR could occur was materially increased.

as policy instruments to be tested. Experience makes it worth repeating that retrospective exercises in statistical analyses oftentimes yield results that fit the existing data very well but depend wholly on surrogate variables that cannot be forecast.

Figures Eight and Nine below present the logit results for MFD and SFD refill.

Figure Eight: MFD Refill Selection Improves with More Variables

Variable Name	Coefficient Value	Coefficient "T Value"
Constant (Infill)	-10.869	-11.267
ACRES (Acres above criteria=1)	3.619	6.471
BLDGVAL(Below refill criteria=1)	2.061	3.504
LANDVAL(Above refill criteria=1)	0.463	0.676
COM (Zone commercial in 2000=1)	4.151	4.172
IND (Zone industrial in 2000=1)	3.625	3.187
MF (Zone multi-family in 2000=1)	2.799	3.231
UA- Units per acre allowed 2000	0.012	0.575
URANSCOR(Nghqlty&urbanrenew)	5.059	5.231
VACRATE(%vacant acres ¼ mile)	0.038	0.471
Constant(redevelopment)	-10.979	-17.020
ACRES (Acres above criteria=1)	3.145	10.310
BLDGVAL(Below refill criteria=1)	2.392	5.961
LANDVAL(Above refill criteria=1)	1.913	3.953
COM (Zone commercial in 2000=1)	5.359	9.166
IND (Zone industrial in 2000=1)	5.908	9.241
MF (Zone multi-family in 2000=1)	0.468	0.954
UA- Units per acre allowed 2000	0.084	7.278
URANSCOR(Nghqlty&urbanrenew)	2.415	3.704
VACRATE(%vacant acres ¼ mile)	-0.348	-0.659

N=9914, Pseudo R-squared = .86, NOBLD=1

Figure Nine: SFD Refill Selection Improves Slightly with More Variables

Variable Name	Coefficient Value	Coefficient "T Value"
Constant (Infill)	-7.851	-10.620
ACRES (Acres above criteria=1)	3.728	7.181
BLDGVAL(Below refill criteria=1)	1.973	2.161
Constant (Redevelopment)	-6.920	-14.324
ACRES (Acres above criteria=1)	3.857	9.649
BLDGVAL(Below refill criteria=1)	1.444	3.135

N=4444, Pseudo R-squared = .93, NOBLD=1

Figure Eight reports the logit results for MFR. In this case including more RLIS available arguments substantially increases the selection power of the refill filter. In the multi-variable tests we entered each filter criteria separately to examine the relative importance of lot size, improvement value and land value to the overall filter effectiveness. We also included the generalized zoning shown in RLIS as of the year 2000 (SFD-MUR omitted), the regulatory maximum capacity in year 2000, location inside an urban renewal area interacting with an index of neighborhood quality and the percentage of vacant land within ¼ mile of the tax lot.

Apparent in Figure Eight is that for the existing filter criteria for MFD most of the explanatory power comes from the lot size (ACRES) and building value criteria. Land value adds little or nothing to the discriminating power of the filter criteria for MFD. This outcome is fairly consistent with the hypothetical graph depicted in Figure Eight which indicated assessor data was unlikely to estimate land value in terms of alternative uses even when the total real estate value was accurately estimated.

Generalized Metro zoning in the year 2000 is also instructive. Both commercial and industrial zoning were far more useful than was MFR zoning. This reflects the observation that as of the year 2000 most of the locations and particular sites most favorable to MFR development were occupied by other uses. The widespread rezoning of centers and corridors to mixed use zoning after the year 2000 should be credited with at least enabling the market to sort out the most efficient uses. Continued conversion of restrictive nonresidential zone types to mixed use zoning (MUR and MUE) can only produce additional land use benefits.

Allowable units per acre in the year 2000 had no effect on MFR infill selection but was helpful for redevelopment. The relative levels of vacant, alternative tax lots also had no effect perhaps owing to the difficulty of properly measuring this variable as most vacant tax lots occur in SFR zones that exclude MFR development. Outside of zoning our major policy variable to be tested was the effect of inclusion in an urban renewal zone and neighborhood quality. As noted in Figure Eight, the variable was helpful for determining both infill and redevelopment lots. However, we need be dutiful and point out the high likelihood of endogeneity problems with this variable. Inclusion within an urban renewal area by definition means the tax lots have been selected with the intention of redevelopment. In addition a high neighborhood score means the area, other things equal, sustains a high demand price. Local officials seeing a strong market in an area earmarked for redevelopment are expected to promote conversion of existing uses into new development. Consequently, interpreting this variable should be undertaken with great caution.

Figure Nine presents similar results for SFR. For SFR we started with a variable list similar to that for MFR. However, we discovered few of our presently measured variables conferred much in the way of additional explanation beyond the filter criteria. For SFD only lot size and low valued improvements provided much explanation of whether a developed lot experienced a refill event over the period 2001 – 2006. In this instance the assessor’s land value meeting the filter criteria provided no additional explanation at all so we dropped it.

As noted earlier the NLOGIT software uses the Log(0) convention as the null model in determining R-Square and the variance of the regression estimate. We prefer the convention that the null model presumes knowledge of the mean as is typical for ordinary least squares estimation. As in the filter tests we simply graphed the increase in likelihood having the regression information produced versus a random guess based on the mean.

Figure Ten: Having Multi-variable Criteria Produces a 19 Fold Increase in Discriminatory Power

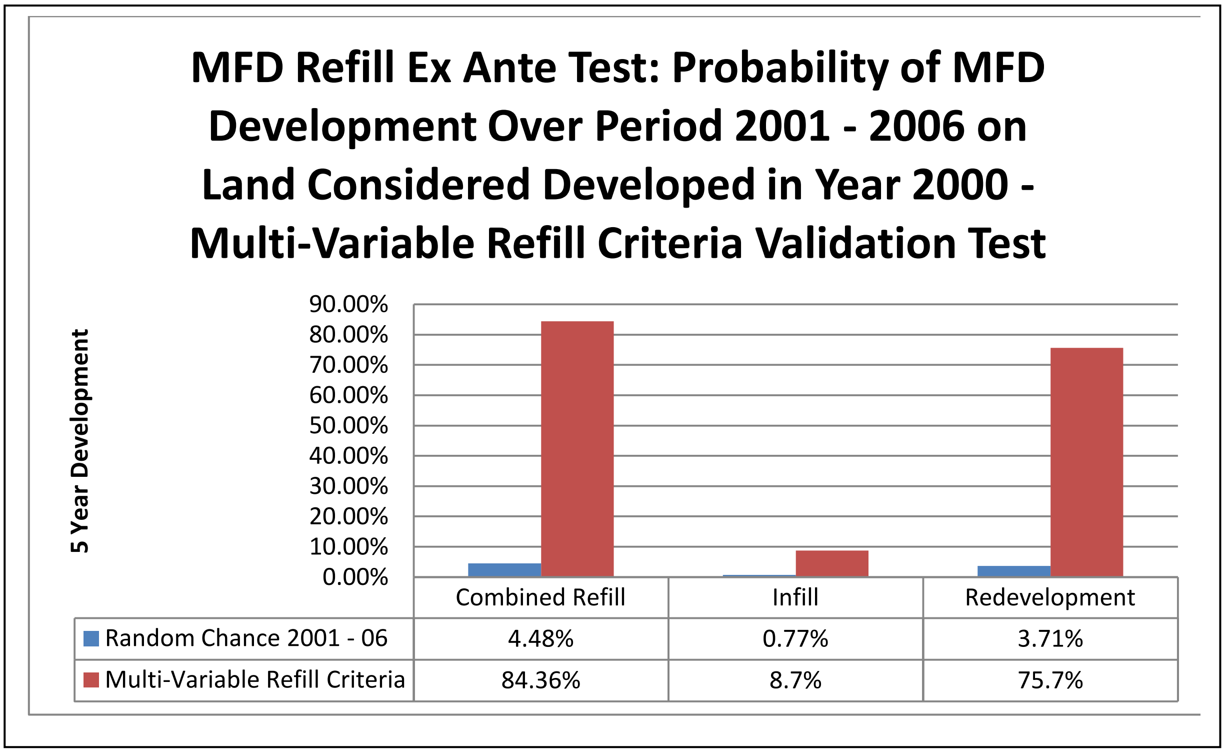
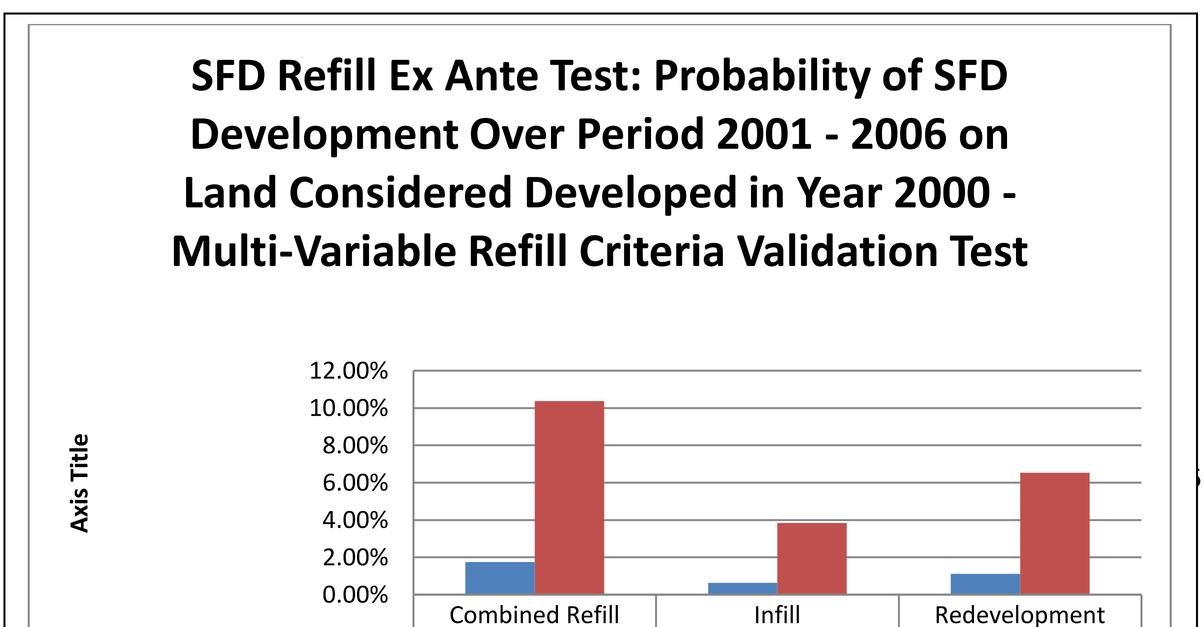


Figure Eleven: For SFD Multi-variable Criteria Produce Little Gain Over Filter Criteria



Figures Ten and Eleven reveal marked contrasts between MFD and SFD in regard to refill estimation. For MFD our ability to estimate refill capacity from assessor and RLIS data is greatly increased using multi-variable criteria. For SFD almost the opposite is the case. Using multi-variable criteria we find that the only identifiable and useful preexisting lot characteristics are having a large lot with a cheap structure on it. Using the criteria we experience for SFD a 6 fold increase over random chance. For MFD the criteria increase our discriminatory power almost 19 fold.

RESULTS SUMMARY

To summarize the three sections of the Refill Report, the software, data bases and knowledge systems necessary to identify tax lots likely to infill or redevelop over the next 20-40 years constitutes a critical ability underpinning our endeavors to maintain the smallest possible urban growth boundary. To obtain and master this ability the Refill Report documents that we have made impressive progress; moving from being able to identify and measure past refill to focusing on the determinants of future refill. Certainly, as growth continues and the Metro Region continues to fill up, we shall move from simply measuring and forecasting to more proactive research that points to policies necessary to increase refill levels without undue real estate price increases. Some of the results reported here for MFD refill already point in that direction. Certainly, the widespread rezoning of commercial and industrial properties to mixed use has been and will continue to be very helpful.

APPENDIX A- PROFORMA TABLE ON HOW REFILL TIMING WORKS

TABLE ONE: IDEALIZED REDEVELOPMENT TIMING PROFORMA

Year	Annual Revenue	Capital Cost Recovery (Depreciation)	Interest	Operating Cost	Total Annual Cost	Total Net Revenue	Economic Land Value Actual Use	Unrecovered Capital Cost	"Break Even" Sales Price	Land Value Alternate Use
1	4,000,000	1,000,000	2,250,000	750,000	4,000,000	-	11,326,070	30,000,000	41,326,070	1,000,000
2	4,000,000	1,000,000	2,100,000	772,500	3,872,500	127,500	11,599,294	29,000,000	40,599,294	1,095,000
3	4,000,000	1,000,000	2,025,000	795,675	3,820,675	179,325	11,832,008	28,000,000	39,832,008	1,199,025
4	4,000,000	1,000,000	1,950,000	819,545	3,769,545	230,455	12,023,467	27,000,000	39,023,467	1,312,932
5	4,000,000	1,000,000	1,875,000	844,132	3,719,132	280,868	12,172,918	26,000,000	38,172,918	1,437,661
6	4,000,000	1,000,000	1,800,000	869,456	3,669,456	330,544	12,279,603	25,000,000	37,279,603	1,574,239
7	4,000,000	1,000,000	1,725,000	895,539	3,620,539	379,461	12,342,761	24,000,000	36,342,761	1,723,791
8	4,000,000	1,000,000	1,650,000	922,405	3,572,405	427,595	12,361,622	23,000,000	35,361,622	1,887,552
9	4,000,000	1,000,000	1,575,000	950,078	3,525,078	474,922	12,335,417	22,000,000	34,335,417	2,066,869
10	4,000,000	1,000,000	1,500,000	978,580	3,478,580	521,420	12,263,369	21,000,000	33,263,369	2,263,222
11	4,000,000	1,000,000	1,425,000	1,007,937	3,432,937	567,063	12,144,700	20,000,000	32,144,700	2,478,228
12	4,000,000	1,000,000	1,350,000	1,038,175	3,388,175	611,825	11,978,630	19,000,000	30,978,630	2,713,659
13	4,000,000	1,000,000	1,275,000	1,069,321	3,344,321	655,679	11,764,375	18,000,000	29,764,375	2,971,457
14	4,000,000	1,000,000	1,200,000	1,101,400	3,301,400	698,600	11,501,153	17,000,000	28,501,153	3,253,745
15	4,000,000	1,000,000	1,125,000	1,134,442	3,259,442	740,558	11,188,179	16,000,000	27,188,179	3,562,851
16	4,000,000	1,000,000	1,050,000	1,168,476	3,218,476	781,524	10,824,669	15,000,000	25,824,669	3,901,322
17	4,000,000	1,000,000	975,000	1,203,530	3,178,530	821,470	10,409,841	14,000,000	24,409,841	4,271,948
18	4,000,000	1,000,000	900,000	1,239,636	3,139,636	860,364	9,942,916	13,000,000	22,942,916	4,677,783
19	4,000,000	1,000,000	825,000	1,276,825	3,101,825	898,175	9,423,116	12,000,000	21,423,116	5,122,172
20	4,000,000	1,000,000	750,000	1,315,130	3,065,130	934,870	8,849,668	11,000,000	19,849,668	5,608,778
21	4,000,000	1,000,000	675,000	1,354,583	3,029,583	970,417	8,221,806	10,000,000	18,221,806	6,141,612
22	4,000,000	1,000,000	600,000	1,395,221	2,995,221	1,004,779	7,538,768	9,000,000	16,538,768	6,725,065
23	4,000,000	1,000,000	525,000	1,437,078	2,962,078	1,037,922	6,799,801	8,000,000	14,799,801	7,363,946
24	4,000,000	1,000,000	450,000	1,480,190	2,930,190	1,069,810	6,004,162	7,000,000	13,004,162	8,063,521
25	4,000,000	1,000,000	375,000	1,524,596	2,899,596	1,100,404	5,151,115	6,000,000	11,151,115	8,829,556
26	4,000,000	1,000,000	300,000	1,570,333	2,870,333	1,129,667	4,239,938	5,000,000	9,239,938	9,668,364
27	4,000,000	1,000,000	225,000	1,617,443	2,842,443	1,157,557	3,269,924	4,000,000	7,269,924	10,586,858
28	4,000,000	1,000,000	150,000	1,665,967	2,815,967	1,184,033	2,240,378	3,000,000	5,240,378	11,592,610
29	4,000,000	1,000,000	75,000	1,715,946	2,790,946	1,209,054	1,150,623	2,000,000	3,150,623	12,693,908
30	4,000,000	1,000,000	-	1,767,424	2,767,424	1,232,576	-	1,000,000	1,000,000	13,899,829

Figure A: Sometime in Year 26 It is More Profitable to Sell the Property for Development in an Alternative Use.