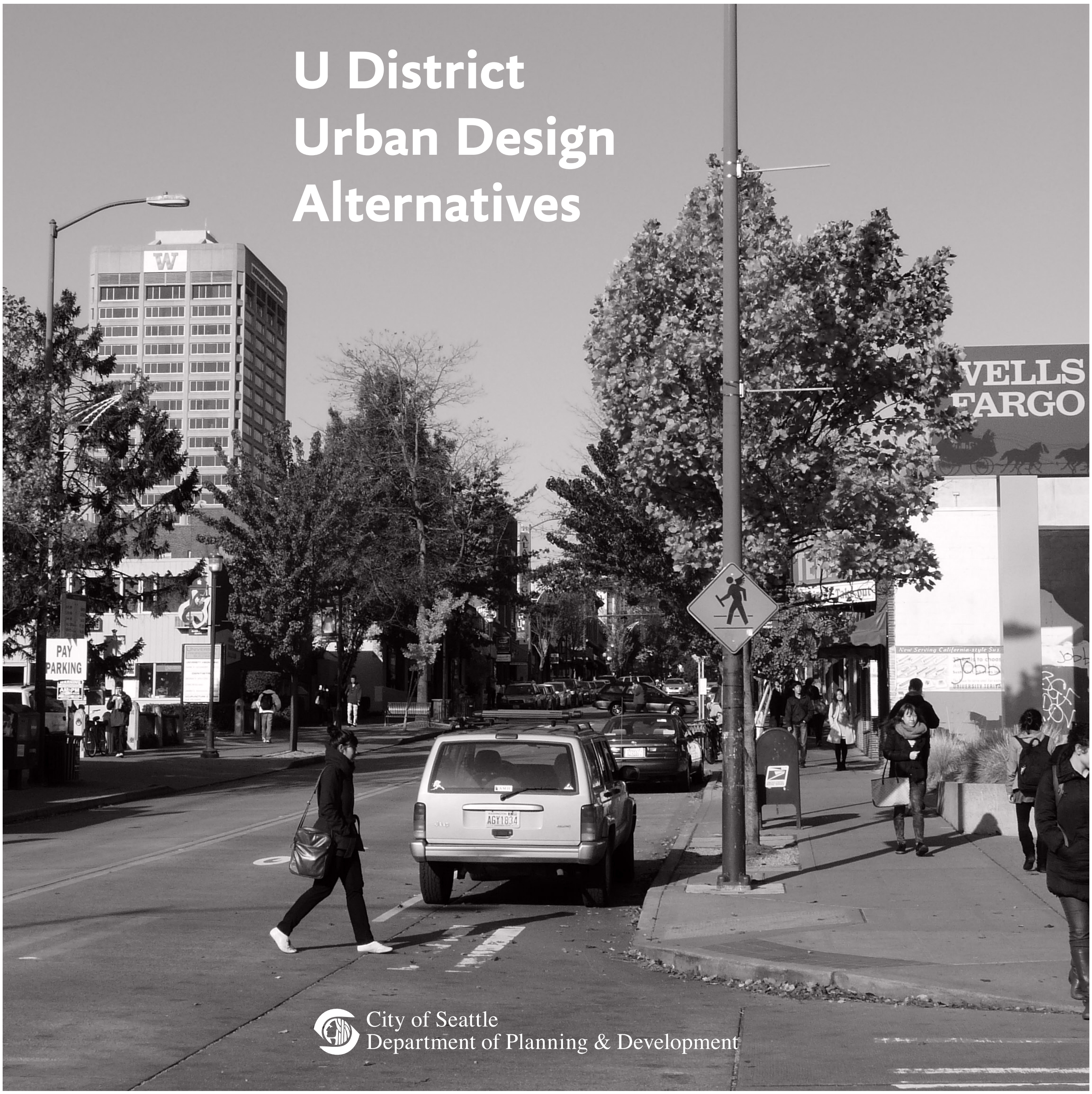
DRAFT
Environmental Impact Statement

Appendices

for the



U District
Urban Design
Alternatives

City of Seattle
Department of Planning & Development

April 24, 2014

FACT SHEET

1. SUMMARY

2. ALTERNATIVES

3. ANALYSIS

4. REFERENCES

APPENDICES

A. Distribution List

City of Seattle City Light
Attn: Laurie Hammack
SMT-28-22

City of Seattle City Light
SMT 3616

City of Seattle Dept. of Transportation
Tony Mazzella
SMT -39-00

City of Seattle Dept. of Parks and Recreation
Attn: Chip Nevins
PK-01-01

City of Seattle, DON, Historic Preservation Program
Attn: Sarah Sodt
SMT 17-00

City of Seattle Dept. of Transportation
Attn: Kristen Simpson
SMT -39-00

City of Seattle School District
Attn: Joseph Wolf
P.O. Box 34165, Mailstop 32-151
Seattle, WA 98124-1165

Seattle Emergency Management
Attn: Erika Lund
105 5th Ave S
Seattle, WA. 98104

Seattle Housing Authority
120 Sixth Avenue N.
Seattle, WA 98109-1028

SPU
Shannon Kelleher
SeaMuniTower 44th fl – SMT-49-00

King County Department of Natural Resources Parks Division
201 S. Jackson St. Ste 700
Seattle, WA 98104

King County Department of Natural Resources Parks Division
2040 84th Avenue SE
Mercer Island, WA 98040

King County Dept of Natural Resources
Attn: Bob Burns
201 S. Jackson St.
Seattle, WA 98104-3855

King County Dept. of Natural Resources
Attn: Karen Huber
201 S. Jackson Street
Seattle, WA 98104

King County Dept. of Design and Environmental Services
Attn: Stephanie Warden, Director
900 Oakesdale Ave. SW
Renton, WA 98055

King County Dept. of Public Health
Attn: Rosemary Bryrer
2124 Fourth Avenue, 4th Floor
Seattle, WA 98121

King County Dept. of Transportation
Attn: Harold Taniguchi
201 S. Jackson St.,
Seattle, WA 98104-3856

King County Dept. of Transportation
Attn: Kevin Desmond
201 S. Jackson St
Seattle, WA 98104-3856

King County Dept. of Transportation Roads & Eng.
201 S. Jackson Street
Seattle, WA 98104

King County Executive's Office
Attn: Carolyn Duncan
701 Fifth Avenue, Ste. 3210
Seattle, WA 98104

King County Housing and Community Development
Attn: Linda Peterson
821 Second Avenue, #500
Seattle, WA 98104

King County Land Use Services Division
900 Oaksdale Ave SW
Renton, WA 98055-1219

King County Metro Transit Environ Plng
Gary Kriedt
201 S JACKSON ST
MS KSC-TR-0431
SEATTLE WA 98104-3856

King County Regional Water Quality Committee
201 South Jackson Street
Seattle, WA 98104

Muckleshoot Indian Tribe
Attn: Planning staff
39015 172nd Ave. SE
Auburn, WA 98092-9763

Duwamish Tribe Cultural Resources
John Rasmussen
4717 W. Marginal Way SW
Seattle, WA 98106

Seattle Indian Services Commission
606 12th Avenue S.
Seattle, WA 98144

United Indians of All Tribes Foundation
PO Box 99100
Seattle, WA 98199

Seattle-King County Dept of Public Health
401 5th Av Suite 1300
Seattle, WA 98104

Puget Sound Clean Air Agency
1904 Third Avenue, Suite 105
Seattle, WA 98101

Puget Sound Regional Council of Governments
Attn: Ivan Miller
1011 Western Avenue, Ste 500
Seattle, WA 98104-1035

Sound Transit
Attn: Steve Kennedy
401 S. Jackson St.
Seattle, WA 98104

Wa State Dept of Ecology N.W. Regional Office
Attn: Bernard Jones
3190 160th Ave SE
Bellevue, WA 98008-5452

Wa State Dept of Natural Resources
Attn: Boyd Powers
PO Box 47015
Olympia, WA 98504-7015

Wa State Dept of Social & Health Services
Attn: Elizabeth McNagny
P.O. Box 45848
Olympia, WA 98504-5848

WA State Dept of Transportation/Urban Planning Office Attn: Tom Washington
401 2nd Av S Suite 300
Seattle, WA 98104

Wa State Dept. of Health
Attn: Kelly Cooper
PO BOX 47820
OLYMPIA, WA 98504-7822

Wa. State Dept. of Transportation
PO BOX 330310
SEATTLE WA 98133-9710

Department of Ecology Northwest Regional Office
Attn: Rebecca Padgett
3190 - 160th Ave. SE
Bellevue, WA 98008-5452

Wa. State Dept. of Ecology
SEPA Unit
P.O. Box 47703
Olympia WA 98504-7703

Wa State Dept. of Fish & Wildlife
1775 12th Ave NW Suite 201
Issaquah WA 98027

Wa State Dept. of Fish & Wildlife
600 Capitol Way N.
Olympia, WA 98501-1091

Wa. State Dept. of Transportation
Attn: Thomas Noyes
401 Second Ave. S., Suite 300
Seattle, WA 98104-2887

Wa State Dept. of Fisheries Habitat
SEPA Coordinator
PO Box 43155
OLYMPIA WA 98504

Wa State Dept. of Health
PO BOX 47820
OLYMPIA, WA 98504-7822

Wa. State Dept. of Transportation
Attn: Barbara Ivanov
PO Box 47322
Olympia, WA 98504-7322

Department of Archaeology & Historic Preservation
1063 S. Capitol Way, Suite 106
Olympia, WA 98501

Wa State Dept. of Community Development
Attn: Nancy Ousley
906 Columbia St. SW.
Olympia WA 98504-2525

Wa. State Dept. of Transportation
Attn: John White
999Third Avenue, Suite 2424
Seattle, WA 98104

Wa. State Dept. of Transportation
Environmental Affairs Office
P.O. Box 47331
Olympia, WA 98504

U.S. Department of Commerce
Economic Development Admin.
915 2nd Av Room 1856
Seattle, WA. 98174

U.S. Dept of Housing & Urban Development,
Attn: John Myers
909 First Avenue, Ste 200
Seattle, WA 98104-1000

U.S. Dept Of Fish & Wildlife EIS Reviews
16018 Mill Creek Blvd.
Mill Creek, WA 98012

U.S. Dept. of Fish & Wildlife Service
510 Desmond Drive SE, Ste. 102
Lacey, WA 98503

US EPA Regional Office SEPA Review Section
1200 Sixth Avenue
Seattle, WA 98101

B. Capacity Methodology

Zoned Development Capacity

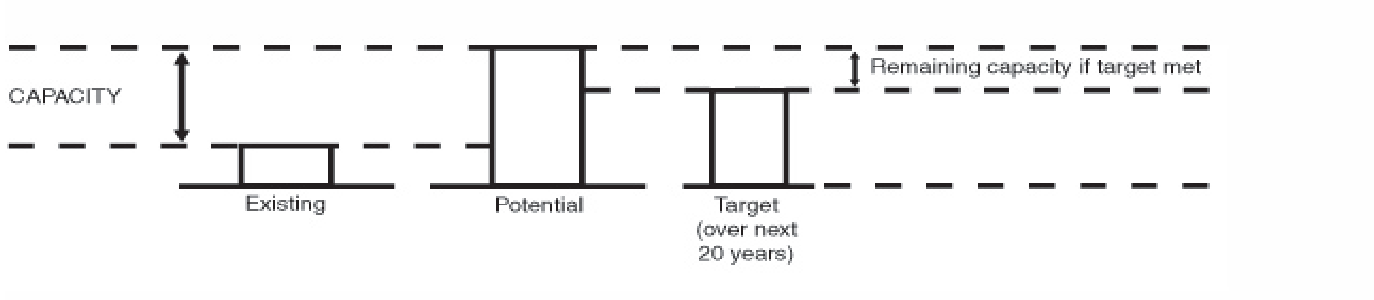
The Department of Planning and Development uses a development capacity model. This model estimates the amount of new development that could be built in the City by comparing existing land uses, housing units and commercial square feet to what could be built under current or proposed zoning. The difference between potential and existing development yields the capacity for new development. This capacity is measured as the number of housing units, the amount of commercial square feet and the number of potential jobs that could be added.

Evaluation of each of the EIS alternatives and their potential impacts references two distinct measures – planning estimates for growth and development capacity. The planning estimates for growth represents the assumed level of growth that will occur in the U District neighborhood by the year 2035. Development capacity represents the maximum level of development possible under each alternative with no effort to estimate the likely level of development that will actually occur. Development capacity is based on assumptions about how much land is redevelopable and the type of projects that could be developed under existing zoning. Below is a brief description of how capacity estimates are achieved and their relationship to planning estimates for growth.

Indefinite Time Period Covered by the Estimates

Development capacity is not a prediction that a certain amount of development will occur in some fixed time period. The capacity estimates do not include a time dimension because they do not incorporate any direct measurement of demand, which would help determine when parcels would be developed. Many parcels in the city today have zoning that allows for more development than currently exists on them, but not all of them are available or have a demand for development. Consider a single-family house in a commercial zone that is occupied by an owner who has no plans to sell. Some day that land will change hands and the new owner may be more willing to develop the parcel to its full development potential.

Aside from the relatively small number of parcels that have either active or pending development permits, there is no way to know when actual redevelopment will happen. For the purposes of determining development capacity, though, it is assumed within the model that development will eventually occur regardless of market forces. Therefore, development capacity is not a forecast and has no planning horizon. It is simply an estimate of the additional development that could occur under the current zoning regulations. This additional development could happen all in one year or not at all depending on the economy, attractiveness to development, or other market conditions. Capacity represents the amount of new growth that could be accommodated. The amount of growth that is expected to occur and that City policy intends to accommodate is established as the 20-year growth targets in the Comprehensive Plan.



Comparison of existing development to potential to expected, or target.

Development Capacity Analysis

The actual level of development activity that occurs is controlled by a variety of future factors, many of which are beyond our ability to predict or influence. These factors include such things as the future demand for a particular type of development (such as for townhouses, high-amenity multifamily or small-unit multifamily), whether the owner of any particular land is willing to sell or redevelop it, the financial feasibility of developing the land, and the intensity of development when it does occur. Other factors, such as the relative attractiveness of certain areas for living and commerce, and the relative densities allowed by the existing zoning, can cause some areas to be developed earlier or later than others. No one can predict with certainty the total effect of all these factors on the choices made by land developers.

These limitations notwithstanding, the City has created a model that identifies parcels that have the potential to develop and to estimate the amount of development that could occur. The two key determinants in this model are: 1) available land and 2) zoning. Available land refers to land that is either vacant or developed sufficiently below the potential allowed by the zoning to allow a significant increase in density if it were redeveloped. Zoning represents the rules to which new development must adhere including the uses and densities that are allowed.

In its simplest form, an estimate of capacity is the product of: 1) determining what land is available; 2) multiplying the area of that land by the future expected densities of development zoning allows; and 3) subtracting the existing development. The formulas below summarize the model process.

Potential Development =
Developable Land Area x Future Density Assumption

Development Capacity =
Potential Development - Existing Development

The City's development capacity estimate is the difference between the amount of development on the land today and the amount that could be built under the current zoning. On vacant land, we only need to estimate what the zoning would permit. For a parcel that already contains one or more buildings, the amount of development in those buildings is subtracted from the total that zoning would allow.

Availability of Land for Development

The first task is to determine the land that is available for development. Seattle's capacity model excludes a number of parcels from the calculations based on ownership, use or zoning. For instance, all parcels owned by a public entity—federal, state, county, city, school district, port district—are excluded from the calculations. Parcels used for cemeteries, public and private schools, churches, nursing homes, boarding houses, military bases, public utilities, railroads, hospitals, libraries, law enforcement and that contain landmark structures are excluded. All of the land within the major institution overlay (MIO) is excluded; the jobs and housing units that institutions may provide are determined by each institution's master plan and are counted over and above the capacity. In addition, some parcels are excluded based on specific knowledge of unique circumstances.

No land is excluded to represent additional rights-of-way or other public purposes because Seattle's street system is nearly completely laid out, and most facilities to satisfy public purposes are already in place to the point that no significant quantity of land now within private parcels will be needed for these uses. Nor was land excluded from the calculations because of critical area designations (except for parcels that are shown as creeks or streams) since the City's critical areas ordinance does not prohibit development on critical areas and allows clustering to enable the property developer to achieve the same densities on the developable portion of the parcel as would be allowed on the entire parcel.

Parcels not in the categories listed above are considered available for development. Subsequently their development status is determined through a comparison of existing development to potential future development and classified as developed, vacant, or redevelopable.

Future Density Assumptions

To determine the number of potential housing units or commercial floor area that could be developed on each parcel, two assumptions are made: 1) the density of housing units to be built, and 2) a floor area ratio (FAR) to determine the commercial floor area that could be built. Table 1 below shows the equations for calculating potential housing and floor area using the density assumptions.

Residential	Commercial
Potential Housing Units = Developable Land Area ÷ Expected Square Feet per Unit	**Potential Building Floor Area = Developable Land Area x Expected Floor Area Ratio**

Table 1.

For those zones where the Land Use Code defines maximum density limits, the capacity estimates have, in past practice, assumed that those maximums would be achieved on the parcels that developed. However, examination of historical permitting data has shown that those maximums are not actually being achieved in all zones. Moreover, not all of Seattle's zones have prescribed minimum or maximum density limits, requiring an analysis to make a best-guess of what densities would be achieved.

An analysis of the actual densities that have resulted from development in each different zone from 1996-2005 has led to the creation of a set of "expected" density assumptions. These density assumptions are revised every five years as part of the City's reporting under the Buildable Lands program mandated by the Growth Management Act and are used in capacity analysis related to the Comprehensive Plan. Alternatively, maximum density assumptions, or the maximum densities a zoning category allows, can be used to examine "build-out" scenarios where appropriate.

Determination of What Land Will Redevelop

In a built city such as Seattle, where nearly every parcel already has some building or improvement on it, new buildings often come as redevelopment i.e., expansion or replacement of existing buildings. A developer's decision to demolish and replace an existing building - one that may be generating revenue for its owner - involves many considerations, such as whether the land is owned outright, how much revenue the current building brings in, how much it would cost to demolish and replace it, and how much revenue a new structure could generate. There is no way to know about these considerations for all the parcels in the city today, let alone for five or 20 years into the future.

In place of such detailed knowledge, the City uses three different measures to identify parcels likely to redevelop depending on the type of zone: 1) *residential development ratio* - the existing residential units compared to potential residential units, 2) *commercial development ratio* - existing building floor area compared to potential floor area; and 3) *improvement to land value ratio* - the value of buildings and other improvements on a parcel compared to its land value.
The assumption for assessing developability is that the value of the ratio measure is inversely proportional to the tendency to develop - that is the lower the ratio the higher the probability that the parcel will redevelop. In practice for capacity determination, developability of a parcel is determined by comparison of the appropriate ratios with a predetermined threshold value.

The *residential development ratio* is a straightforward indication of whether a parcel will redevelop. The basic assumption is that over time property owners will attempt to maximize the value of their property by maximizing the number of residential units that can be rented or sold on that property. However, if the number of units currently on-site is close to the total number of potential units that could be developed on the site, the cost of building additional units would exceed the revenue that can be generated by building new units. Therefore in residential zones, a ratio of existing units to total potential units is used to determine if a site is likely to be redeveloped at some point in the future. This measure is called the Development Ratio using Units (DR:UNITS in the model) and is used for single-family and multi-family zones.

The number of potential units on a site is based on the assumed densities. See the discussion labeled "Future Density Assumptions" below for a description of how these densities are selected.

Development Ratio:Units = Existing
Units / Potential Housing Units

The *commercial development ratio* is similar to residential except that it compares the above-ground building square footage of the existing buildings to the potential floor area. This ratio is called the Development Ratio using Square Feet (DR:SQFT) and is used for commercial, neighborhood commercial and Seattle-mixed zones.

Development Ratio:Sqft =
Existing Building Square Feet / Potential Building Square Feet

To determine the *improvement to land value ratio* (ILR), the City relies on data from the King County Assessor. Appraisers in the Assessor's office assign two monetary values to a given parcel – one for the land and one for the improvement (structures) on the site. The value of land is an indication of the demand for that land in its "highest and best" use. For vacant land, different values may be assigned to different parcels for a variety of reasons, including that those parcels are inherently more desirable because of location or physical features, or because they are zoned for higher development potential. Similarly, in the case of developed parcels, a land value that is higher than the structure value often indicates that more intense use of the land is possible. This measure is used for downtown and industrial zones.

Improvement to Land Value Ratio = Existing Building Values / Parcel Land Value

Again, one cannot know precisely at what point a particular parcel is likely to redevelop, but an analysis of parcels that have been redeveloped in Seattle over the past ten years has provided guidance for the development of thresholds of existing development compared to potential development below which parcels are more likely to redevelop.

Residential/Commercial Split in Mixed-Use Zones

Seattle's commercial zones are primarily intended to provide locations for commercial uses, e.g., retail shops, offices and restaurants. However, the Land Use Code also allows residential uses in these zones. Analysis of permitting data has informed assumptions about the "split" between residential and commercial development in a mixed-use project in the commercial zones. These splits are represented as percentages of the type of use that, in aggregate for a zone, actually occurred. For example, in a C2-40 zone about 80% of development is commercial and 20% is residential, as opposed to an NC3/R-40 zone where development is about 80% residential.

It is important to note that the split of residential and commercial space applies across a broad area, and may not be relevant on a site-by-site basis. Any particular site or small area may be developed with residential, mixed-use or commercial uses, depending on the market. For the capacity estimates, results derived from the following three assumptions are provided to present a range of potential development in these zones: 1) all development is commercial, 2) all development is residential and 3) all development is mixed according to observed proportions expressed as the following:

Total Development in Mixed-Use Zones = (Potential Housing Units x Percent Residential) + (Potential Building Floor Area x Percent Commercial)

University District Land Capacity Analysis: Assumptions

<u>Assumptions</u>

- 1 housing unit/850ft^2 of residential development and 1 job/300ft^2 of commercial development.
- In residential zones, 100% of new development will be residential. In commercial and mixed zones, 50% of new development will be residential and 50% will be commercial.
- FAR by zone (from existing zoning code except for the Mixed zones)

ZONE		Alt 1 / Alt 2	Outside SAO		Inside SAO	
			No Action Res	No Action Com	No Action Res	No Action Com
Residential	LR1	1.2	1.2	-	1.2	-
	LR2	1.3	1.3	-	1.3	-
	LR3	2	2	-	2	-
	MR	4.25	4.25	-	4.25	-
Commercial or Mixed	C1 65	4.25	4.25	4.25	4.75	4.75
	NC2 40	3	3	3	3.25	3.25
	NC2P 40	3	3	3	3.25	3.25
	NC2 65	4.25	4.25	4.25	4.75	4.75
	NC2P 65	4.25	4.25	4.25	4.75	4.75
	NC3 65	4.25	4.25	4.25	4.75	4.75
	NC3P 65	4.25	4.25	4.25	4.75	4.75
	NC3 85	6	6	6	6	6
	NC3P 85	6	6	6	6	6
	SM 125 (Mixed 125)	6 on lots > 15,000ft^2 8 on lots ≤ 15,000ft^2	-	-	-	-
	SM 160 (Mixed 160)	8 on lots > 15,000ft^2 10 on lots ≤ 15,000ft^2	-	-	-	-
	SM 240 (Mixed 240)	9 on lots > 15,000ft^2 11 on lots ≤ 15,000ft^2	-	-	-	-
	SM 340 (Mixed 340)	11 on lots > 15,000ft^2 12 on lots ≤ 15,000ft^2	-	-	-	-

FACT SHEET
1. SUMMARY
2. ALTERNATIVES
3. ANALYSIS
4. REFERENCES
APPENDICES

C. Scoping Summary

CITY OF SEATTLE
DEPARTMENT OF PLANNING AND DEVELOPMENT

U District Urban Design EIS
Scoping Summary

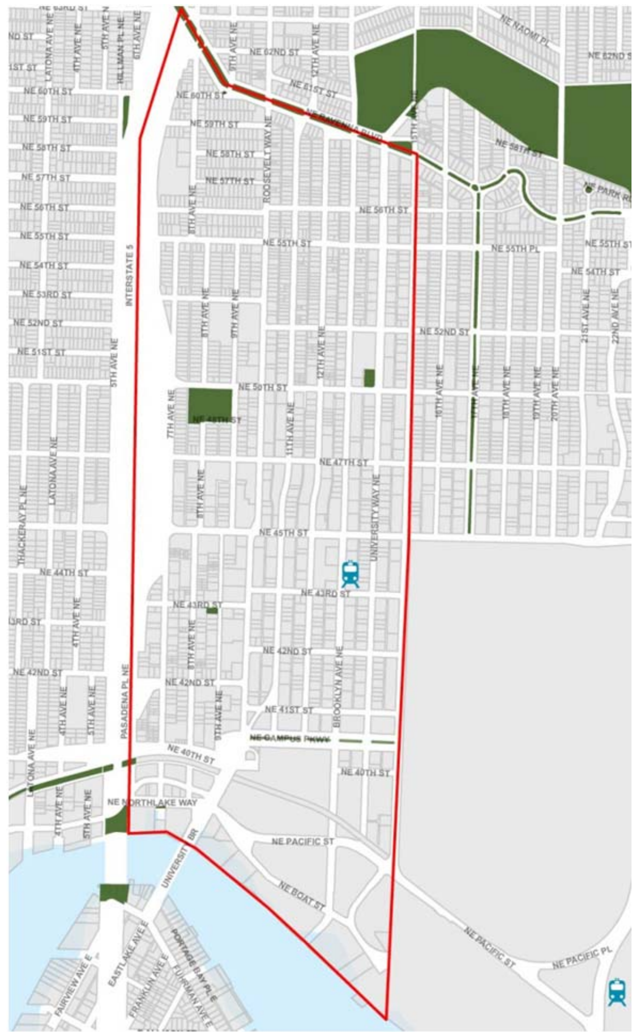
October 29, 2013

I. Introduction

The City of Seattle is preparing an Environmental Impact Statement (EIS) to evaluate potential significant environmental impacts associated with possible zoning changes in the U District study area. The study area is bounded by Portage Bay on the south, NE Ravenna Boulevard on the north, Interstate 5 on the west and 15th Avenue NE on the east (see Vicinity Map).

The City is considering amendments to the Land Use Code (Seattle Municipal Code Title 23) to allow greater height and density in the U District Planning Area, along with design standards and programs for neighborhood amenities. The proposal is based on a lengthy public stakeholder process that addressed land use, urban design, transportation and other topics related to the urban character of the U District planning area. The legislative action, if taken, would apply within the U District planning area.

Alternatives to be addressed in the EIS include *No Action*, or continued growth under current development patterns and Land Use Code standards; and two *action alternatives* that will consider growth under different development patterns and Land Use Code standards. Both action alternatives will evaluate increased allowable height and density for residential and commercial development within the planning area.



Vicinity Map

II. EIS Scoping

Scoping is the process of identifying the elements of the environment to be evaluated in an EIS. Scoping is intended to help identify and narrow the issues to those that are significant. Scoping includes a public comment period so that the public and other agencies can comment on key issues and concerns. Following the comment period, the City considers all comments received and determines the scope of review for the environmental analysis.

The City of Seattle issued a Determination of Significance/ Scoping Notice for the U District proposal on September 5, 2013 and made it available to the public through a variety of methods (see Attachment 1). The Scoping Notice states that the EIS will consider potential impacts associated with land use, housing, aesthetics, historic preservation, parks/open space, transportation, public services, and utilities.

Through the Scoping Notice, the City invited public and agency comment on the proposal, alternatives and elements of the environment to be considered in the EIS. The scoping period was originally scheduled to close on October 7, 2013, but based on citizen request, the comment period was extended to October 9, 2013. On September 24, 2013, the City held a public scoping meeting at the University Heights Community Center. A total of 72 people signed in at this meeting and 21 people spoke at the meeting. A meeting summary is contained in Attachment 2.

After the scoping meeting, DPD received 29 letters and emails addressing a variety of issues and concerns. All comments are summarized in Section III (Table of Comments) in this Scoping Summary. All letters and emails, as well as the written comments received at the scoping meeting, may be reviewed with advance notice (contact dave.laclergue@seattle.gov).

Following an analysis of scoping comments and available information, the City made two changes to the description of the proposal and alternatives:

1. Maximum building height. As described in materials at the September 24 public meeting and on the City's project website, Alternative 2 was described as allowing the highest potential building heights, up to 300 feet in the core. Comment from the Seattle Planning Commission suggested a higher maximum building height for this alternative, up to 420 feet. In addition, review of the existing UW Tower, the tallest building in the study area, determined that the building height is 340 feet. For these reasons, the City concluded that it is appropriate to increase the maximum building height for consideration under Alternative 2 to 340 feet in the core.

2. Comprehensive Plan amendments. In the Determination of Significance, the proposal is described as potential amendments to the Land Use Code, along with design standards and programs for neighborhood amenities. Upon further review of the proposal, the City has determined that amendments to the Comprehensive Plan may also be incorporated to ensure continued consistency between policies and regulations. Therefore, amendments to the Comprehensive Plan are added as potential element of the proposed action.

There were no other changes to the EIS scope or alternatives.

III. Table of Comments

The following table summarizes comments by EIS element/topic, together with the City's response to comments.

EIS Topic	Comments	Response
Scoping Process	▪ Will you consider comments from the scoping process? ▪ Have you already completed studies of the different scenarios?	The City reviewed and recorded all comments we received during the scoping period. We are finalizing the descriptions of the alternatives now that the scoping process is complete, with consideration of the comments we received. Aside from initial data gathering, detailed analysis did not begin until after scoping.
Alternatives	▪ What does No Action (current zoning) look like? ▪ Allow height bonuses for residential development only ▪ Consider modest height increases in southwest area of U District, where terrain slopes down to water ▪ Evaluate impacts of allowing more highrise development ▪ Allow building heights up to 340' and 420' ▪ Consider heights over 125' on the Ave ▪ Consider change to LR2 zoning on Roosevelt Avenue ▪ Evaluate lidding I-5 between 45th and 50th ▪ Consider Seattle Mixed zoning in the UW potential "Innovation Zone" along I-5. ▪ Consider downzones in conjunction with increased heights to preserve existing single family areas. What concessions can the neighborhood expect from the action alternatives? ▪ Is the DEIS looking at the same growth projection for all alternatives? ▪ Where does the EIS discuss UW growth projections? ▪ Do not immediately identify a preferred alternative ▪ Make the U District Square an essential element of the preferred alternative	The EIS will consider impacts related to different height and density scenarios. Under Alternative 1, the tallest buildings would be between 125- and 160-feet in height. Under Alternative 2, the tallest buildings would be between 240- and 340-feet in height. Alternative 3 is the No Action (existing zoning) alternative. Other elements, such as an I-5 lid, a plaza, or other specific measures to mitigate impacts are not included as part of the alternatives, but may emerge through the environmental analysis and identification of potential mitigating measures in the Draft EIS. A visual model of all three alternatives is being developed as part of the environmental analysis and images from this model will be included in the Draft EIS. The EIS will be looking at the same growth projection for all three alternatives. An increase of approximately 3,900 housing units and 4,800 jobs is assumed under each alternative. The Draft EIS will not identify a preferred alternative.
Housing	▪ Retain opportunities for single family housing ▪ Preserve existing single family homes ▪ Create Single Family/Low Rise Preservation zones in single family areas	Consideration of housing impacts will include a review of affordability, potential diversity of housing types, impacts on existing single family residential areas. The needs of students and permanent residents will be reviewed.

EIS Topic	Comments	Response
	▪ Design alternatives to attract families and permanent residents ▪ Require a minimum amount of 2 and 3 bedroom units about certain development size thresholds ▪ Focus on affordable and low-income family housing ▪ Include in zoning changes a requirement to accommodate people/families at all income levels ▪ Improve enforcement of rental housing regulations to reduce conflicts between neighbors. ▪ Limit microhousing to south of 45th ▪ Provide for affordable and low-income housing in U District ▪ Multi-family Tax Exemption – what happens after 12 years?	
Employment	▪ Encourage zoning that will encourage a diversity of employers ▪ Consider growth projections of UW employees ▪ Consider ways to protect the existing businesses on the Ave.	Consideration of employment impacts will incorporate UW growth projections and will address employment diversity.
Transportation	▪ Impact of increased traffic for all three alternatives ▪ Conduct full level-of-service analysis for all alternatives ▪ Base analysis on actual mode splits, not goals ▪ Plan now for good connections between transit modes ▪ What are plans to allow bicycle commuting around transit station? ▪ Consider bus integration at the light rail station ▪ Consider extension of the streetcar system to NE 65th Street. ▪ Pursue design and development of a streetcar to serve the neighborhood ▪ Consider mid-block pedestrian crossings ▪ Base parking analysis on how people actually behave, not goals ▪ Split the RPZ into two zones to separate high density and	The transportation analysis will include consideration of all modes of travel, parking and safety. The analysis will be based on existing traffic counts, transit usage, existing pedestrian and bicycle activity, and available on- and off-street parking data. Future trip generation will be estimated based on amount of projected development at a block level of geography. 2035 transportation forecasts will be estimated and the operations of the transportation system under future conditions will be analyzed. Based on this information, impacts and recommended mitigating measures will be identified.

EIS Topic	Comments	Response
	lower density development ▪ Consider "over parking" high rise buildings ▪ Plan for car ownership and off-street parking ▪ Acknowledge that residents in buildings with no off-street parking still own cars	
Open Space	▪ Additional open space needed ▪ Include a thorough review of how existing open space does or does not meet Comprehensive Plan goals. Project the "open space deficit" into future growth. ▪ Consider planned U Heights open space and existing UW campus in open space analysis ▪ Include/consider public plaza/centralized public space at the future light rail station location ▪ Identify funding for central public square ▪ Proposed zoning changes will intensify need for central square and for ease of pedestrian movement in vicinity of transit station ▪ Consider using a small lot for a Japanese style garden ▪ Impact of a lid over I-5 between 45th and 50th Streets ▪ Benefits of reconnecting Wallingford/Greenlake with the U District ▪ Consider crime and antisocial behavior impacts of open space areas	The open space analysis will include an inventory of existing and planned facilities within and immediately surrounding the study area, documentation of adopted open space standards and the extent to which the study area does or does not meet these standards under each alternative. Potential mitigation to address identified impacts will be described, but the EIS will not include a detailed implementation strategy for any particular improvement.
Land Use	▪ Evaluate impacts of height and density in study area and more broadly in adjacent neighborhoods, including potential for conversion of low-rise to mid- and high-rise development ▪ Evaluate potential impact of proliferation of 300-foot office tower development ▪ Evaluate ways to assure that height bonuses apply only to residential development ▪ Consider mechanisms to assure increased height and density around light rail station do not result in increased development pressure throughout the neighborhood	The land use patterns analysis will include a description of the development pattern, character and scale of development in the study area and surrounding area. The land use analysis will include a review of compatibility of the alternatives with the existing and planned land use patterns and will identify potential conflicts. The analysis will include a review of livability, focused particularly on streetscape character and pedestrian connections. Mitigating measures to address identified significant impacts will be identified. The land use analysis will include a review of consistency of the proposal with pertinent state, regional and local plans,

EIS Topic	Comments	Response
	▪ Consider design issues related to ST station ▪ Consider pertinent plans and policies ▪ Evaluate the distribution of adverse impacts among other Urban Centers ▪ Consider zoning tools to guarantee a mix of uses	policies and regulations.
Economic Analysis	▪ Identify economic benefit of increased heights ▪ Include detail economic analysis of different zoning/density options, including the market for high-rise buildings in the area	The EIS does not include an economic analysis of the alternatives. As described in WAC 197-11-448, SEPA anticipates that the general welfare, social and economic aspects of policy options will be considered in the weighing future decisions, but an EIS is not required to evaluate all of the possible considerations of a decision. Rather it focuses on environmental impacts and is expected to be used by decision-makers in conjunction with other relevant considerations and documents. With respect to economic analysis, the City has conducted a market analysis for the U District study area focused on whether high-rise development is likely to be financially feasible over a time period extending to 2035. This report is available at this link: http://www.seattle.gov/dpd/cs/groups/pan/@pan/documents/web_informational/dpds022258.pdf
Aesthetics	▪ Visual context, neighborhood context, height, bulk and scale Impacts of high rises on area views ▪ Preference for tall and narrow buildings over short and squat buildings ▪ Preference for a variety of building types rather than one dominant type. ▪ Do not allow towers to block sun at street level and create wind canyons ▪ Decreased sun on open spaces and public areas ▪ Focus on first 30 feet of buildings – design features for walkability, U District character ▪ Consider extensive landscaping, importance of trees in an	The visual analysis will include consideration of area context, neighborhood character and height, bulk and scale. The analysis will include development of a visual model that will allow street level and aerial perspectives of the existing conditions and all three alternatives. The model will be used to study the effect of sun and shadow at specific street-level locations and important public spaces as established in the City's specific environmental policies, SMC 25.05.675.

EIS Topic	Comments	Response
	urban environment. ▪ Do not allow mid-block pedestrian overpasses	
Schools	▪ Include analysis of educational need, including childcare, preschool, K-8, and after-school activities ▪ Identify means to provide a neighborhood elementary school	The analysis of schools will include a review of existing facilities and capacity, forecast demand under the alternatives and potential impacts. For any significant impacts, proposed mitigation will be identified, but detailed consideration of how to provide a school does not fit within the EIS scope.
Police and Emergency Services	▪ Drug and crime activity on the Ave ▪ Impacts of high rise development on crime ▪ High rise results in increased pressure on public safety and emergency responders. How will upper floors be served? ▪ Increased personal danger and health risks associated with a natural disaster or prolonged power outage ▪ Address location of UW Police Department/SPD joint facility for enhanced police support	Police and emergency response services will include a review of existing facilities and capacity, forecast demand under the alternatives and potential impacts. For any significant impacts, proposed mitigation will be identified. The specific needs and challenges to serving high rise development will be discussed.
Historic Character	▪ Historic integrity of retail core from along University Way from Campus Parkway to 50th ▪ Leave the retail core alone ▪ Consider preservation program along The Ave.	The historic resources analysis will describe the historic context for the planning area, including key development periods, trends, and land use history patterns. The analysis will include a comparison of former and existing development patterns and properties with the proposed alternatives to understand potential impacts. Based on identified impacts, opportunities to preserve and rehabilitate historic properties and areas will be identified.
Noise	▪ Increased urban noise levels	The existing acoustic environment in the study area is typical of a mixed use urban setting. The Seattle Noise Control Code (Seattle Municipal Code Chapter 25.08) is applicable to the construction and operation of all development proposed as part of the project. The Noise Code sets levels and durations of allowable daytime/nighttime operational noise and daytime construction noise. These limits are based on the zoning of the source and receiving properties. Because the proposed uses under any of the alternatives would be consistent with existing uses, no significant impacts to noise levels, as defined in the

EIS Topic	Comments	Response
		Seattle Noise Code, are anticipated.
Air quality	▪ Evaluate long-term air quality issues associated with increased density	The EIS will consider potential greenhouse gas impacts associated with future growth under each alternative development scenario. With respect to specific types of pollutants, the Seattle area is in an attainment management area for ozone, particulate matter and carbon monoxide. Because future potential growth levels do not exceed growth anticipated in regional growth projections from the Puget Sound Regional Council, no significant adverse air quality impacts are anticipated. However, depending on the nature of future site-specific development, mitigation may be necessary to address site-specific impacts associated with construction. This mitigation will be identified and required as part of future project-level review.
Urban Design Framework	▪ Numerous comments on specific aspects of the Urban Design Framework	Comments on the Urban Design Framework express individual preferences, ask questions about future implementation and identify specific concerns. It is anticipated that these issues will be addressed in the public review process of potential policy and regulatory actions that will follow the EIS process. The EIS is intended to provide information that will help inform this future process, but it will not cover every concept included in the Urban Design Framework.
Funding	▪ Evaluate cost of infrastructure improvements ▪ Identify feasible funding methods to meet capital facility needs	To the extent that information is available, the EIS will identify planning level cost estimates for capital facilities that are identified as potential mitigating measures.
Miscellaneous	▪ Sound Transit is detached from the neighborhood ▪ Impacts of development prior to adoption of new standards ▪ Coordinate between any historic preservation programs and the City's earthquake retrofit policies – each will affect the other.	As noted previously, the EIS is intended to consider impacts related to different height and density scenarios. Concerns over coordination with Sound Transit with respect to planning for the future station are noted but outside the scope of this EIS. Similarly, specific implementation issues, such as retrofits for earthquake safety and development impacts associated

EIS Topic	Comments	Response
		with timing of new standards, will be considered in the future public review process of potential policy and regulatory actions that will follow the EIS process. The EIS is intended to provide information that will help inform this future process.

Attachments

1. Determination of Significance and Scoping Notice
2. Scoping Meeting Summary

DETERMINATION OF SIGNIFICANCE
AND REQUEST FOR COMMENTS ON SCOPE OF EIS

Description of proposal: The City of Seattle is proposing amendments to Land Use Code (Seattle Municipal Code Title 23) to allow greater height and density in the U District Planning Area, along with design standards and programs for neighborhood amenities. The proposal is based on a lengthy public stakeholder process that addressed land use, urban design, transportation and other topics related to the urban character of the U District Planning Area. The legislative action, if taken, would apply within the U District Planning Area.

Alternatives to be addressed in the EIS include *No Action*, or continued growth under current development patterns and Land Use Code standards; and two *action alternatives* that will consider growth under different development patterns and Land Use Code standards. Both action alternatives will evaluate increased allowable height and density for both residential and commercial development within the Planning Area.

Proponent: City of Seattle

Location of proposal: The U District Planning Area is bounded by Interstate 5 on the west, 15th Avenue NE on the east, NE Ravenna Boulevard on the north and Portage Bay on the south. The majority of the Planning Area is located within the University Community Urban Center.

Lead agency: City of Seattle

EIS Required. The lead agency has determined this proposal is likely to have a significant adverse impact on the environment. An environmental impact statement (EIS) is required under RCW 43.21C.030 (2)(c) and will be prepared. Once they are prepared, a draft EIS and technical appendices will be available for review at our offices.

The lead agency has identified the following areas for discussion in the EIS:

The EIS will consider potential impacts associated with land use, housing, aesthetics, historic preservation, parks/open space, transportation, public services, and utilities.

Scoping. Agencies, affected tribes, and the public are invited to comment on the scope of the EIS. You may comment on alternatives, mitigation measures, probable significant adverse impacts, and licenses or other approvals that may be required. The methods and deadlines for providing comments are:

1. Provide written or verbal comment at the public scoping meeting scheduled for:

Tuesday, September 24, 2013
5:30 to 7:00 pm
University Heights Community Center
5031 University Way NE
Seattle WA 98105

2. Mail written comments to the Responsible Official at the address below or email comments to Dave.LaClergue@seattle.gov. Comments may also be faxed to (206)233-7883. The City must receive comments by 5:00 pm on October 7, 2013 for the comments to be considered.

Responsible official: Diane Sugimura, Director
Department of Planning and Development
700 5th Ave, Suite 2000
PO Box 34019
Seattle, WA 98124-4019

Signature: (signature on file) Date: 8/26/2013

Diane Sugimura, Director, Department of Planning & Development

There is no agency appeal.

U DISTRICT EIS SCOPING PUBLIC MEETING

September 24, 2013

Meeting Overview

On September 24, 2013, the City of Seattle hosted a public SEPA scoping meeting for the U District Urban Design EIS. The meeting provided information about the EIS process, draft zoning alternatives, and topics to be considered in the EIS. It also included information about how prior planning work in the U District community.

The meeting was held at the University Heights Community Center (5031 University Way NE) and featured an open house, presentation and public comment period. A total of 72 participants signed in at the meeting. The agenda was as follows:

5:30 – 6:00	Open House	The open house included informational stations about the project with project team staff available to meet one-on-one with interested persons to discuss questions and comments. Display materials and handouts from the open house are available at the link noted below this table.[1]
6:00 – 6:30	Presentation	Marcia Wagoner, Studio 3MW, opened the presentation with a welcome and introductions of the project team. Dave LaClergue, City of Seattle, and Deborah Munkberg, Studio 3MW, presented information on the U District planning process, EIS process, preliminary alternatives and environmental topics proposed for consideration in the Draft EIS. Questions and answers about the project were addressed as part of the presentation. Slides of the presentation are available at the link noted below this table.[1]
6:30 – 7:30	Public Comment	Following the presentation, public comment was invited. All comments received are summarized below.

1. http://www.seattle.gov/dpd/cityplanning/completeprojectslist/universitydistrict/

Staff Participants

City of Seattle

Dave LaClergue
Susan McLain
Ryan Moore

Tony Mazzella

Consultant Team

Chris Breiland, Fehr & Peers
Leah Ephrem, Hewitt
Jessica Hartmann, Studio 3MW
Deborah Munkberg, Studio 3MW
Morgan Shook, BERK
Marcia Wagoner, Studio 3MW

Public Comment

A total of 21 persons provided verbal comments, summarized below. Some of these comments were supplemented by written material, available for review with advance notice (contact dave.laclergue@seattle.gov).

Peter Steinbrueck

- Supporter of the U District Square concept
- Need for parks and open space in the district (EIS should include existing and future deficits)
- Parks should be appropriately located near population densities (near new transit center)
- Need a better location for the farmer's market
- Need a plaza at future Link light rail University Station
- Need a rigorous independent analysis for where to locate public space
- Need diversity of housing stock
- Need a heart to the district

Steve Wilkins

- Supporter of the U District Square concept
- Study how existing Urban village zoning can accommodate increases in pop and employment
- Study of how to allow taller buildings within station walkshed and ensure access to sunlight
- Put utilities and storage facilities underground for the transit center
- Study how land use is expressed in the current plans
- Public space should be at the heart of the project
- Evaluate the use of development fees
- Need more schools and social services in the district to serve the increasing population

Cory Crocker

- Supporter of the U District Square concept
- Create a vibrant walkable community
- Advocate of the "urban living room" (i.e., Barcelona) with lively street culture in shared public spaces
- Concentrate development around public transit
- District currently has a deficit of public open space – study the scale, location and quality of the needed public open space

John Bennett

- Supporter of the U District Square concept
- Plan for a large central common open space as part of the transit station which allows for lots of flexible events to be held (farmer's markets, festivals, etc.) – 1/3 to 1/2 the area of a full city block and well connected to the Ave and transit station
- Bring a sense of social appreciation to the new transit station

Doug Campbell

- EIS should address quality issues not quantity issues (quality of life in the District)
- Put properly sized and safe public spaces in the right location
- Need better retail core and elementary school(s)

- Without a strong core we (the District) cannot support a quality neighborhood
- Explore qualitative characteristics of the District
- Options should focus on how to create permanent long-term residents in the community

Phil Thiel (read by Peter Steinbrueck)

- Study convenient pedestrian interchanges between different modes – connections and access
- Create opportunities for commuter convenient services adjacent to transit
- Address the need for better existing and future open space
- Allow public open space to be an integral part of everyday public life within the District
- Enhance the availability and quality of social public events (like farmer's markets, street fairs, festivals, etc.)

Dennis Christianson

- Strong interest in the nine core block area around the station
- Standards should be designed to encourage tall, slim buildings as in Vancouver, including changing fire code requirements to allow a smaller core
- Difference in the public space of a horizontal versus vertical buildings
- Should remember that parts of each of the alternatives are appropriate to different areas of the district

John Fox

- Why are we doing this at all? The answer provided (not a question of adding growth but how growth will be added) is just an attempt to substantially increase density in this neighborhood
- District is on pace to exceed our growth targets – cited that the neighborhood has met 75% of 2004 growth target.
- EIS is about upzoning the neighborhood and bears no relationship to what the neighborhood needs – it's a blueprint for gentrification
- District needs an affordable housing stock
- Supporter of the status quo option (No Action option)
- Look at vulnerability to change assessment
- The increased density would change the community for the worse

Matt Fox

- Supporter of the U District Square concept
- This study is heading us towards more 300' buildings like the Safeco Tower
- EIS scoping should include a worst case scenario that reflects the largest possible build out – what is to stop the worst of both worlds from spreading (current code and increased height areas)
- Additional trips generated by the UW should be considered as well as the transportation impacts of development
- What about a fourth option that calls for downzoning to maintain current development?

Barbara Quinn

- We should have an elementary school that is walkable to everyone projected to live here

Jorgen Bader

- GMA makes the Comp Plan the center for controlling development

- We should focus on the vision for the character of the neighborhood, then discuss building heights, zoning, etc.
- Need more open space
- Consider incentive zoning to create amenities
- Written material submitted and included as Attachment 3

Tom Cullen

- We don't want high rise, downtown Seattle in the U District
- Alternatives are unfriendly to seniors
- If we're not planning for an increase in parking how are we planning for more families?
- Don't need housing for the people who come and leave throughout the day (RapidRide)
- Where do the population and employment projections come from?
- Don't consider the light rail riders as new commuters, they're just going to shift from other modes.
- Need public toilets in the District

Barbara Green

- Lights at the incoming park at the University Heights Community Center are a huge safety concern and should be included in the park

Brendan Coleman

- Pay attention to guiding principle #5 in the Urban Design Framework: welcome a diversity of residents
- What happens if the new housing is all studios and 1 bedroom apartments? This kind of housing doesn't bring a diversity of people to the District but we need a diversity of people to support a diversity of businesses and housing

Kenny Hancock

- Supporter of existing zoning and low-rise character of the District/Ave. The existing character is not compatible with highrise.

Mark Griffin

- Need more density around the Ave but the District really needs more diversity of housing stock (2, 3+ bedrooms) to get families
- Tune down the micro-housing
- Put a cap between 45th and 50th to reconnect the neighborhood
- Add different employers to the area (not just the UW) to provide a diversity of jobs

Carl Wolfer

- How much density is enough?
- 300' towers will wipe out the reasons people came to the U District
- Supports the no growth option
- Should preserve the character and affordability of the housing stock – don't "yuppify" the neighborhood
- Currently a lack of open space
- We should embrace the U District Square concept

Sharon Dunn

- Take into account several dimensions of the public space, public safety, social concerns
- How are we addressing the homeless and the character of the open space
- Concerns about existing safety issues and neighbor conflicts around University Playfield.
- Need a quality of life and safety in the District

Nancy Bocheck

- The 1998 Neighborhood Plan brought enough capacity for growth in the neighborhood.
- Supports the no growth option without the height increases
- Current zoning accommodates the anticipated growth
- Examine the affordability of housing – students can't even afford to live here anymore

Kent Wills

- Supports open space where the station is going to be located
- Open space should be in the center and not the outskirts/edge of the District
- Support low-income (not the same as affordable) housing to allow those who work here to live here

Jan Hudson

- How are we incorporating the City's earthquake retrofit policies into the planning effort
- Need for public toilets, especially in the business core

D. Transportation Calculations

Appendix D-1: Parking

This appendix provides more information on the parking analysis completed for this document.

Seattle Parking Requirements

City of Seattle Department of Planning & Development Director's Rule 11-2012 defines criteria that allow for developments without parking, or qualify for a 50 percent required parking reduction if the site is within walking distance of frequent transit service (FTS).

Seattle Municipal Code 23.54.015.A-C has no minimum required parking for all land uses, except hospitals, if it is located within an urban center, or is within an urban village and is within 1,320 feet of frequent transit service (defined in SMC 23.84A.038). A 50 percent reduction in required parking is allowed in multifamily and commercial zones, except for hospitals, if it is located within 1,320 feet of frequent transit service (SMC 23.54.020.F).

The urban center village boundary and areas within 1,320 feet of frequent transit service are mapped in Figure D3.5- 1.

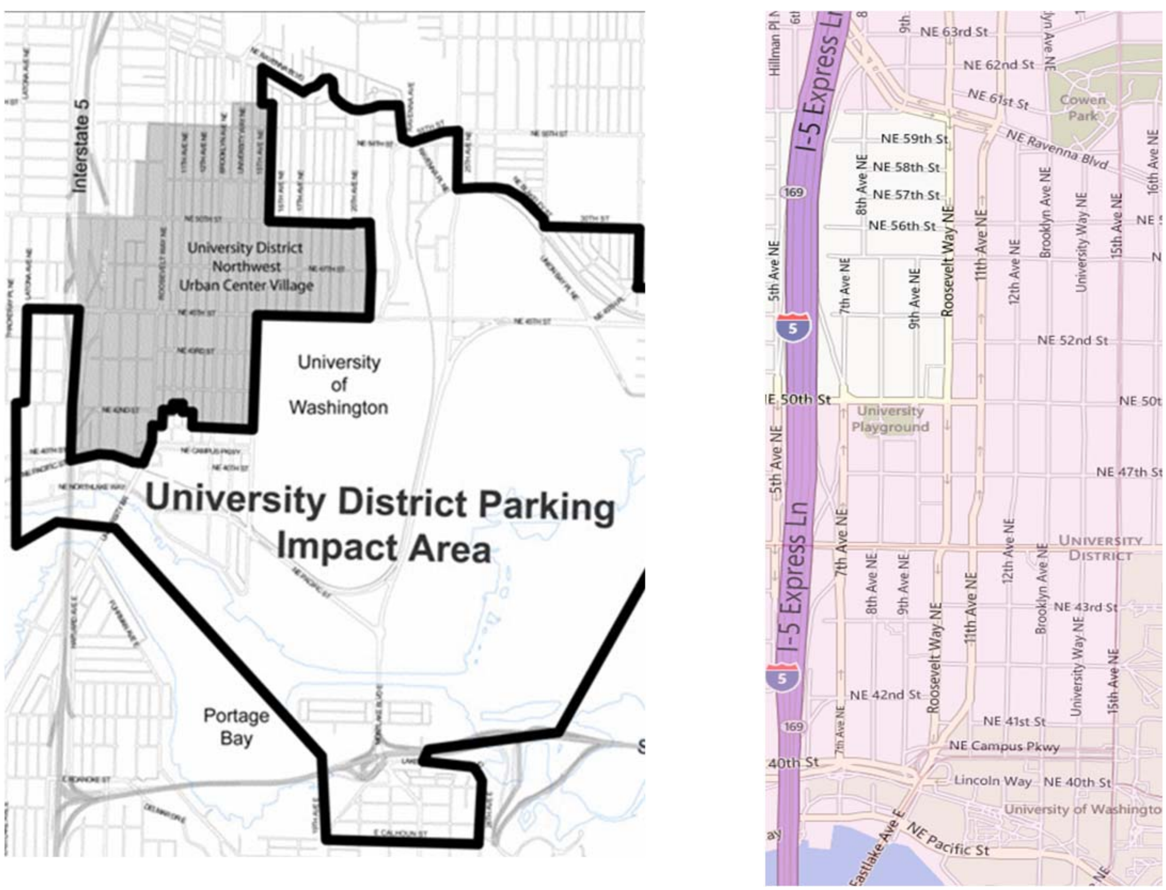


Figure D3.5- 1. Map of the U District Urban Center Village and Frequent Transit Service areas.
Source: *City of Seattle, Seattle Municipal Code 23.54.015, Seattle DPD, Frequent Transit Service Areas, http://web1.seattle.gov/dpd/maps/dpdgis.aspx*

The majority of the study area falls within either an urban center or the Major Institution Overlay to the south. Minimum requirements are set forth for the Major Institution Overlay in Section 23.54.016.13. The maximum number of spaces provided for the Major Institution is not allowed to exceed 135 percent of the minimum requirement without approval through administrative or Council review. Although no parking is required by the City Municipal Code for the majority of the study area (outside the Major Institution Overlay), parking is usually supplied.

Table D3.5- 1 summarizes the on-street parking facilities on major arterials within the study area. The list outlines the general parking facilities and is not exhaustive, as there are dedicated loading zones to serve businesses and other smaller parking restrictions. Under the Paid heading "N/A" indicates that it is unpaid parking, and under the Time Limit heading, "N/A" indicates it is not time restricted parking. A "Y" under Peak Hour Restrictions indicates that parking is not allowed during the peak hours (generally 7 AM – 9AM and 3 PM – 5 PM).

Table D3.5-1. On-Street Parking Facilities

Street	From	To	Paid	Time Limit	Peak Hour Restrictions
Roosevelt Way NE	University Bridge	NE 50th St	$1.50	4-hr	
Roosevelt Way NE	NE Campus Parkway	NE 50th St	$1.50	4-hr	
Roosevelt Way NE	NE 50th St	NE Ravenna Blvd	N/A	1 or 2-hr	Y
11th Ave NE	NE 41st St	NE 43rd St	N/A	N/A	Y
11th Ave NE	NE 43rd St	NE 50th St	$1.50	4-hr	
11th Ave NE	NE 50th St	NE Ravenna Blvd	N/A	2-hr	Y
University Way NE	NE Pacific St	NE 50th St	$2.00	2-hr	
University Way NE	NE 50th St	NE Ravenna Blvd	N/A	2-hr	
15th Avenue NE	NE Pacific St	NE 40th St	$2.00	2-hr	
15th Avenue NE	NE 40th St	NE 45th St	$2.00	2-hr	Y
15th Avenue NE	NE 45th St	NE 50th St	$1.50	4-hr	Y
15th Avenue NE	NE 50th St	NE Ravenna Blvd	N/A	N/A	Y
NE Ravenna Blvd	I-5	NE Ravenna Blvd	N/A	2-hr	
NE 50th St	None				
NE 45th St	None				
NE Campus Parkway	11th Ave NE	12th Ave NE	$1.50	4-hr	
NE Campus Parkway	University Way NE	15th Ave NE	$2.00	2-hr	
NE Pacific St	I-5	8th Ave NE	N/A	1 or 2-hr	
7th Ave NE	NE 42nd St	I-5 Off-ramp	N/A	N/A	
7th Ave NE	NE 45th St	NE 53rd St	N/A	2-hr	
Brooklyn Ave NE	NE Pacific St	NE 45th St	$2.00	2-hr	
Brooklyn Ave NE	NE 45th St	NE 50th ST	$1.50	4-hr	
Brooklyn Ave NE	NE 50th St	Ravenna Blvd NE	N/A		
NE Ravenna Blvd	8th Ave NE	15th Ave NE	N/A	2-hr	

Table D3.5-1. On-Street Parking Facilities					
Street	**From**	**To**	**Paid**	**Time Limit**	**Peak Hour Restrictions**
NE 47th St	7th Ave NE	Roosevelt Way NE	N/A	1 or 2-hr	
NE 43rd St		Brooklyn Ave NE	$1.50	4-hr	
NE 43rd St	Brooklyn Ave NE	15th Ave NE	$2.00	2-hr	
NE 42nd St	7th Ave NE	9th Ave NE	N/A	N/A	
NE 42nd St	9th Ave NE	Roosevelt Way NE	N/A	2-hr	
NE 40th St (north section)	I-5	Pasadena Place NE	N/A	N/A	

Appendix D-2: Roadway Operations Analysis.

This appendix provides additional information on the methods used for the roadway operations analysis.

Roadway Arterial Network

Table D3.5-2 shows the 26 study corridors evaluated in the transportation analysis. Most corridors were evaluated for auto, freight, and transit, although some were only evaluated for auto/freight or transit. Note that auto/freight and transit corridors were chosen to mirror each other, but vary in their extents because auto/freight segments break at intersections while transit segments break at the nearest bus stop.

TABLE D3.5-2. STUDY CORRIDORS

ID	Road	Segment	Auto & Freight Study Corridor	Transit Study Corridor
1	NE Ravenna Blvd	8th Ave NE to 15th Ave NE	✓	
2	NE 50th St	Latona Ave NE to 5th Ave NE	✓	
3	NE 50th St	5th Ave NE to Roosevelt Way NE	✓	
4	NE 50th St	Roosevelt Way NE to 15th Ave NE	✓	
5	NE 45th St	Latona Ave NE to 5th Ave NE	✓	✓
6	NE 45th St	5th Ave NE to Roosevelt Way NE	✓	✓
7	NE 45th St	Roosevelt Way NE to 15th Ave NE	✓	✓
8	NE 45th St	15th Ave NE to Montlake Blvd NE	✓	
9	NE 40th St	2nd Ave NE to 9th Ave NE	✓	✓
10	NE Campus Pkwy	Roosevelt Way NE to 15th Ave NE		✓
11	NE Pacific St/NE Northlake Way	6th Ave NE to 15th Ave NE	✓	✓
12	NE Pacific St	15th Ave NE to Montlake Blvd NE	✓	✓
13	7th Ave NE	NE 42nd St to NE 45th St		✓
14	Roosevelt Way NE	NE Ravenna Blvd to NE 50th St	✓	✓
15	Roosevelt Way NE	NE 50th St to NE 45th St	✓	✓
16	Roosevelt Way NE	NE 45th St to NE Campus Pkwy	✓	✓
17	University Bridge	NE Campus Pkwy to Fuhrman Ave E	✓	✓
18	11th Ave NE	NE Ravenna Blvd to NE 50th St	✓	✓
19	11th Ave NE	NE 50th St to NE 45th St	✓	✓
20	11th Ave NE	NE 45th St to NE Campus Pkwy	✓	✓
21	University Way NE	NE Ravenna Blvd to NE 50th St		✓
22	University Way NE	NE 50th St to NE 45th St		✓
23	University Way NE	NE 45th St to NE Pacific St		✓
24	15th Ave NE	NE Ravenna Blvd to NE 50th St	✓	✓
25	15th Ave NE	NE 50th St to NE 45th St	✓	✓
26	15th Ave NE	NE 45th St to NE Pacific St	✓	✓

Source: Fehr & Peers, 2013.

The following provides additional descriptions of arterials not listed in the transportation chapter.

7th Avenue NE is a minor arterial running from NE 40th Street to NE 50th Street. It is one lane in each direction from NE 40th to NE 42nd Street. Between NE 42nd Street and NE 53rd Street, the roadway becomes a one-way local street with two northbound lanes of traffic and one lane of on-street parking. North of NE 53rd Street, 7th Avenue NE reverts to two-way operations and the road ends at NE 55th Street. The roadway is signalized at NE 42nd Street, NE 45th Street, and NE 50th Street. The land use along the corridor is predominantly apartment buildings south of NE 50th Street and single family homes north of NE 50th St. Parking is allowed on the west side of the street north of NE 42nd Street to the northbound I-5 off-ramp. North of NE 45th Street parking is available with a 2-hour limit and no parking between 6 PM and 12 AM except with a residential zone permit. Between NE 53rd Street and NE 55th Street there is unrestricted parking.

Brooklyn Avenue NE is a collector arterial with one lane in each direction. There is a bicycle lane from Pacific Street to south of Grant Lane. The roadway is signalized at Campus Parkway, NE 45th Street, and NE 50th Street. All other intersections are 4-way stop controlled. On-street paid parking on both sides of street along most of corridor at an hourly rate of $2.00 for up to two hours (or three hours maximum after 5 PM) from 8 AM to 8 PM south of NE 45th Street. North of NE 45th Street to NE 50th Street paid parking is available at an hourly rate of $1.50 for up to four hours maximum from 8 AM to 8 PM. North of NE 50th Street unpaid parking is available for two hour time limit from 7 AM to 6 PM except for Restricted Zone Permits (RPZ). Land use along the corridor is primarily residential apartment buildings, with some restaurants and grocery stores.

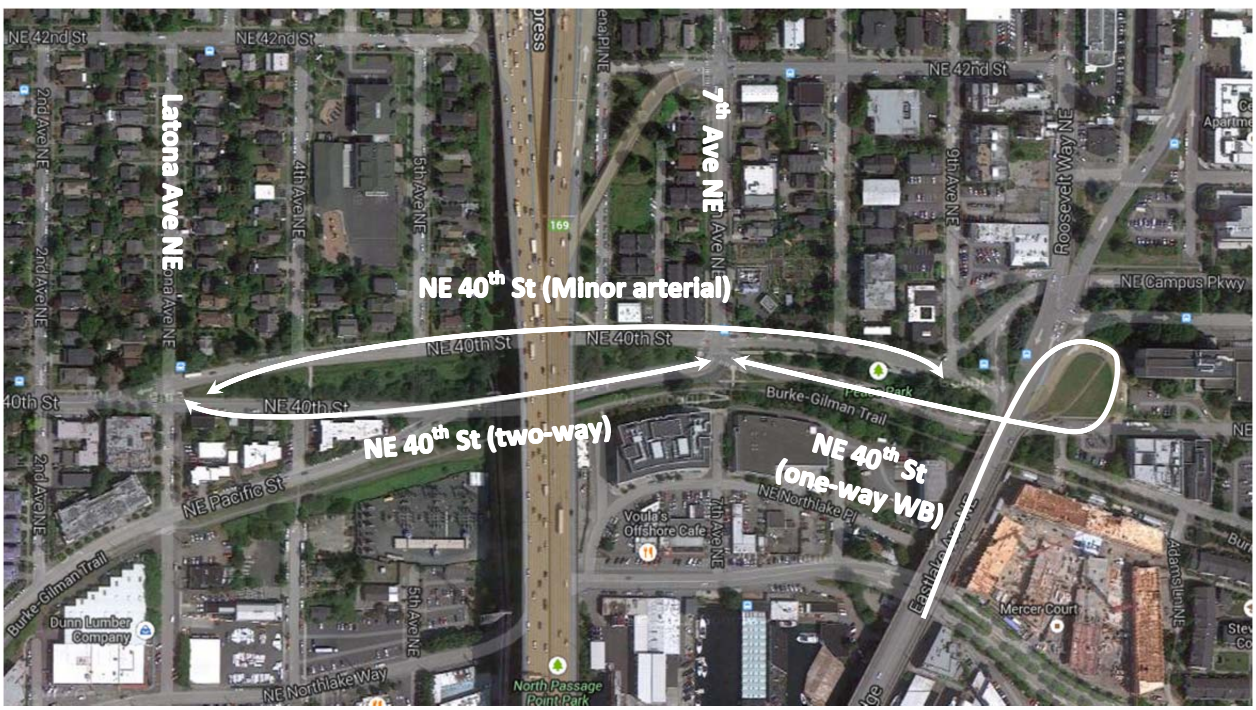
NE 47th Street between Roosevelt Way to 15th Avenue NE is a collector arterial with one travel lane in each direction. With the exception of a signal at 11th Avenue NE, NE 47th Street is four-way stop controlled at intersections. From 7th Ave NE to Roosevelt Way NE there is unrestricted or one or two hour time limited unpaid parking from 7 AM to 6 PM. From Roosevelt Way NE to 15th Avenue NE paid parking is an hourly rate of $2.00 for up to two hours (or three hours after 5 PM) from 8 AM to 8 PM. There are generally apartment buildings and housing on this corridor.

NE 43rd Street is classified as a collector arterial between Roosevelt Way NE and 15th Avenue NE. It has one travel lane of travel and one paid parking lane in each direction. It is signalized at 11th Avenue NE, University Way NE, and 15th Avenue NE. The remaining intersections are either side-street or four-way stop controlled. West of Brooklyn Ave NE on street parking has an hourly rate of $1.50 for up to 4 hours from 8 AM to 8 PM. East of Brooklyn Ave NE on street parking rate changes to $2.00 for up to two hours (or three hours after 5 PM) from 8 AM to 8 PM. East of Roosevelt Way NE, the corridor has a mix of residential and commercial uses.

NE 42nd Street is classified as a principal arterial between 7th Avenue NE at the terminus of the I-5 express lanes ramp and Roosevelt Way NE. It has one lane of traffic in each direction with unrestricted on-street unpaid parking on both sides of street. Two-hour time limited unpaid parking from 7 AM to 6 PM except for Residential Permit Zones is from 9th Avenue NE to Roosevelt Way NE. Apartment buildings is the predominant land use along this corridor.

NE 40th Street is a minor arterial from I-5 to Roosevelt Way NE with one travel lane and bicycle sharrow in each direction. There is unpaid unrestricted parking west of Pasadena Place NE. This roadway is generally residential west of Roosevelt Way NE and has UW facilities, restaurants, or retail east of Brooklyn Avenue NE.

There is another local NE 40th Street to the south of this minor arterial accessible for vehicles traveling northbound on the University Bridge and headed to the area west of the University Bridge towards I-5 via a one-way loop ramp, as seen below. This local street is one-way westbound from the ramp to 7th Ave NE and also has bicycle lanes in both the westbound and eastbound direction. From 7th Ave NE to Latona Ave NE, where both streets merge together, this road is two-way operational with one lane in each direction and no bicycle lanes.



Map of NE 40th St in the U District. Source: Google Maps, 2013.

Speed and Travel Time Thresholds

The 2010 Highway Capacity Manual (HCM) defines level of service (LOS) thresholds for speed along urban streets. LOS is a concept used to describe traffic operations by assigning a letter grade of A through F, where A represents free-flow conditions and F represents highly congested conditions.

Since speed is the inverse of travel time, these thresholds can be communicated in terms of travel time as shown in **Table D3.5-**. In simple terms, if you are traveling at half the free-flow speed, your travel time will be twice that of the free-flow travel time.

Table D3.5-3. LOS Thresholds for Travel Speeds and Travel Time

LOS	Speed Thresholds – Percent of Free-Flow Speed	Travel Time Thresholds – Ratio between PM Peak Hour Travel Time and Travel Time at Free-Flow Speed
A	>85%	<1.18
B	>67-85%	1.18 to <1.49
C	>50-67%	1.49 to <2.0
D	>40-50%	2.0 to <2.5
E	>30-40%	2.5 to <3.33
F	≤30%	≥3.33

Source: *Highway Capacity Manual 2010*, Transportation Research Board.

Free-Flow Travel Time Adjustments

The HCM criteria were developed for segments between intersections, rather than including intersections. In general, the corridors used in this study span multiple blocks and thus incorporate the delay experienced at intersections. Therefore, adjustments to the free-flow travel time were made based on the number of signalized intersections to account for the number of mid-segment intersections and to more accurately represent observed conditions.

The Difference Method

To reduce model error, a technique known as the difference method was applied for traffic volumes and travel times. Rather than take the direct output from the 2035 model, the difference method calculates the growth between the base year and 2035 models, and adds that growth to an existing count or travel time. For example, assume a road has an existing travel time of 1.5 minutes. If the base year model showed a travel time of 1.6 minutes and the future year model showed a travel time of 2.0 minutes, 0.4 minutes would be added to the existing travel time for a future expected travel time of 1.9 minutes.

Vehicle Miles Travelled

The impact threshold for auto and freight travel is based on the percentage of vehicle miles travelled (VMT) that occur on study segments operating at LOS F. VMT on each segment is calculated as the product of the PM peak hour volume and the length of the segment. The proportion used to identify impacts is the ratio of the VMT on LOS F study segments to the total VMT on all study segments. An example is shown below for the No Action Alternative. Of the total 11,834 VMT on the study segments, 2,239 (18.9 percent) occurs on segments operating at LOS F.

Table D3.5-4. No Action Alternative – VMT Operating on LOS F Segments

ID	Road	Segment	LOS		VMT (Volume x Length in Miles)		VMT Operating on LOS F Segment	
			NB/EB	SB/WB	NB/EB	SB/WB	NB/EB	SB/WB
1	NE Ravenna Blvd	8th Ave NE to 15th Ave NE	E	E	210	205	0	0
2	NE 50th St	Latona Ave NE to 5th Ave NE	C	F	110	162	0	162
3	NE 50th St	5th Ave NE to Roosevelt Way NE	B	C	180	278	0	0
4	NE 50th St	Roosevelt Way NE to 15th Ave NE	D	A	185	218	0	0
5	NE 45th St	Latona Ave NE to 5th Ave NE	E	D	100	98	0	0
6	NE 45th St	5th Ave NE to Roosevelt Way NE	E	D	240	324	0	0
7	NE 45th St	Roosevelt Way NE to 15th Ave NE	D	D	224	245	0	0
8	NE 45th St	15th Ave NE to Montlake Blvd NE	B	B	592	727	0	0
9	NE 40th St	2nd Ave NE to 9th Ave NE	D	F	144	196	0	196
10	NE Campus Pkwy	Roosevelt Way NE to 15th Ave NE						
11	NE Pacific St/NE Northlake Way	6th Ave NE to 15th Ave NE	D	B	346	403	0	0
12	NE Pacific St	15th Ave NE to Montlake Blvd NE	D	B	644	518	0	0
13	7th Ave NE	NE 42nd St to NE 45th St						
14	Roosevelt Way NE	NE Ravenna Blvd to NE 50th St		D		449		0
15	Roosevelt Way NE	NE 50th St to NE 45th St		F		231		231
16	Roosevelt Way NE	NE 45th St to NE Campus Pkwy		C		512		0
17	University Bridge	NE Campus Pkwy to Fuhrman Ave E	F	F	717	704	717	704
18	11th Ave NE	NE Ravenna Blvd to NE 50th St	C		454		0	
19	11th Ave NE	NE 50th St to NE 45th St	F		229		229	
20	11th Ave NE	NE 45th St to NE Campus Pkwy	E		454		0	
21	University Way NE	NE Ravenna Blvd to NE 50th St						
22	University Way NE	NE 50th St to NE 45th St						
23	University Way NE	NE 45th St to NE Pacific St						
24	15th Ave NE	NE Ravenna Blvd to NE 50th St	C	C	146	362	0	0
25	15th Ave NE	NE 50th St to NE 45th St	D	E	95	240	0	0
26	15th Ave NE	NE 45th St to NE Pacific St	C	C	379	514	0	0
				Total	**11,834**		**2,239**	

Appendix D-3: Transit Analysis

This appendix summarizes the transit travel time analysis presented in the transportation chapter.

Existing Conditions

OneBusAway Transit Travel Times

The OneBusAway Application Programming Interface (API) was utilized to query transit travel times from a real-time information feed from King County Metro, which uses GPS-tracking of their coaches. Transit arrival times to bus stops were collected every 90 seconds from 4 to 6 PM on two weekdays in Fall 2013. The difference in arrival times of transit vehicles to bus stops at each end of a study corridor were calculated to determine the transit travel time. All data points along each corridor were averaged to determine an average travel time for the corridor. The two-hour average was factored to approximate the PM peak hour, as determined by the auto volumes.

Transit Free-Flow Speed Adjustment

Free-flow speed was determined for transit corridors so that a level of service could be assigned. The same process as described for autos was used, with the addition of a transit adjustment factor to account for the slower travel speed and frequent stops made by buses. The transit adjustment factor was based on the ratio of the transit travel time data to the auto travel time data on equivalent segments. Ratios were calculated along key corridors including NE 45th Street, Roosevelt Avenue NE, 11th Avenue NE, and 15th Avenue NE. The travel times along the entire corridors were used, rather than the sub-segments. This was to resolve any study corridor length discrepancies between transit and auto travel times. While auto travel time runs were collected from intersection to intersection, transit travel times were between actual bus stop locations, which do not always line up with intersections.

The ratios of transit to auto travel times were then averaged to reach the final transit to auto travel time factor of 1.67. This factor was applied to the auto free-flow speed to determine the transit free-flow speed.

Future Conditions

Since transit operates in the same roadways as autos, the transit adjustment factor was applied to the auto travel times from the travel demand model to determine future year transit travel times. The difference method was also used as described in the auto section.

Appendix D-4: MXD Tool Trip Generation

This appendix contains detailed background information on the enhanced trip generation tool used for this analysis. **Attachment 1** is an article published as a Planning Advisory Service (PAS) memo by the American Planning Association (APA) in May 2013. The article, titled "Getting Trip Generation Right: Eliminating the Bias Against Mixed Use Development", provides additional information on the MXD tool.

MXD Tool

Traditional trip generation methodologies are not well suited to analyze either the existing or future conditions in the U District. These methods often take trip generation estimates from the Institute of Transportation Engineers (ITE) and factor the results using mode split data from a validated travel model, US Census Bureau, or engineering judgment. While traditional trip generation methods can account for the high share of non-auto modes in the City, they have limited ability to consider shifts in mode choice caused by major land use changes for the following reasons:

- Typical mode split adjustments tend to assume continuation of current trends and have limited responsiveness to changes in the land use and the built environment (e.g., increased density, increased mix of uses) or transportation system (e.g., improved pedestrian and bicycle connectivity, improved transit service).
- Mode split data are often derived from the US Census Bureau. As time passes, the mode split estimates may not be applicable given changes in development patterns and socioeconomic conditions.

The MXD model overcomes many of these shortcomings and explicitly accounts for how built environment variables, such as building forms, the mix of land uses (jobs/housing balance), densities, transit accessibility, and neighborhood connectivity, affect travel behavior and mode choice.

The MXD model was developed in cooperation with the US Environmental Protection Agency (EPA) and ITE. Over 200 mixed-use development sites across the United States were surveyed as part of the model development process and the model was validated using data from 16 independent mixed use sites. The MXD model was previously applied in the transportation analysis for the South Lake Union Height and Density Rezone EIS.

Model Validation

To ensure the accuracy of the MXD model, a set of 16 independent mixed use sites that were not included in the 239 initial model development MXD sites were tested to validate the model. Among the validation sites, use of the MXD model produced superior statistical performance when comparing the model results to observed data than are found when using traditional ITE methods. Specifically, the MXD model had a significantly lower root mean squared error (RMSE) and higher pseudo-R squared than traditional ITE methods when comparing estimated to observed external vehicle trips. Estimates from the ITE Trip Generation Handbook had an RMSE of 40 percent and pseudo-R squared of 0.58 (i.e., the ITE method only explains about 58 percent of the variability in external vehicle trips), modified estimates using ITE's traditional trip internalization techniques had an RMSE of 32 percent and pseudo-R squared of 0.73, whereas modified estimates using the MXD model had an RMSE of only 26 percent and pseudo-R squared of 0.82.

Trip Generation Tables

ITE gross trips are generally based on vehicle trip generation data from suburban development projects with very little transit, pedestrian, or bicycle trip generation. In this case, gross trips were estimated using the "Single Family Detached Housing – 210," "Apartment – 220," - "Shopping Center – ITE 820," "General Office – ITE 710," "General Light Industrial – 110," "Manufacturing – 140," and "University/College – 550," land use types. The MXD model estimates the number of internal trips and external trips made by auto, pedestrian, bicycle, and transit by calculating the probability that a gross ITE trip will use one of these alternative modes. When this calculation is made, the vehicle-trip is converted into a person-trip. The MXD model assumed an ITE average vehicle occupancy of 1.1 persons per vehicle. This means that one vehicle trip shifted to another mode becomes 1.1 person-trips. Therefore, the sum of the auto and non-auto trips will be greater than the ITE gross trips. Mode share must be calculated using the same unit of trips (i.e. vehicle-trips or person-trips). As shown in **Table D3.5-4**, the mode share is calculated after the conversion factor was applied to auto trips:

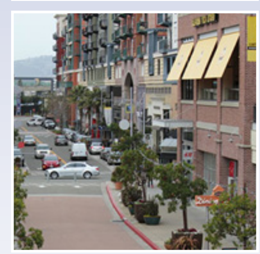
Table D3.5-4. Mode Split Calculations

	MXD OUTPUT			PERSON TRIPS				MODE SHARE		
Alternative	Auto Trips	Non-Auto Trips: Internal, Bicycle & Pedestrian	Non-Auto Trips: Transit	Person Trips Made by Auto (Assuming 1.1 Vehicle Occupancy)	Non-Auto Trips: Internal, Bicycle & Pedestrian	Non-Auto Trips: Transit	Total Person Trips	Auto Mode Share	Non-Auto Mode Share: Internal, Bicycle & Pedestrian	Non-Auto Mode Share: Transit
2015 Conditions	6,270	4,370	3,570	6,900	4,370	3,570	14,840	46.5%	29.4%	24.1%
No Action Alternative	7,010	6,660	6,180	7,710	6,660	6,180	20,550	37.5%	32.4%	30.1%
Alternative 1	6,840	6,760	6,250	7,520	6,760	6,250	20,530	36.6%	32.9%	30.4%
Alternative 2	6,880	6,740	6,240	7,560	6,740	6,240	20,540	36.8%	32.8%	30.4%

GETTING TRIP GENERATION RIGHT

Eliminating the Bias Against Mixed Use Development

By Jerry Walters, Brian Bochner, and Reid Ewing



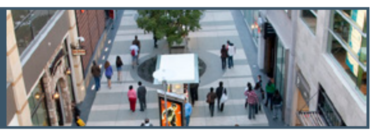
American Planning Association

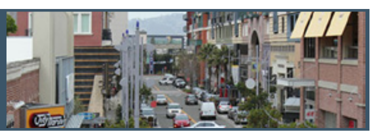
Making Great Communities Happen

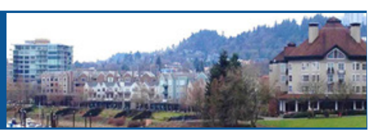
*Originally published as a PAS Memo by the American Planning Association (APA) in May 2013. PAS Memo is a bimonthly online publication of APA's Planning Advisory Service, a subscription service providing its members with the latest planning resources and customized research assistance. Learn more at **www.planning.org/pas/about/.***

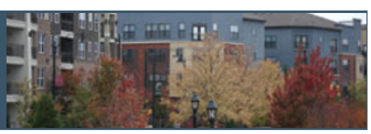
Photos in document courtesy of Fehr & Peers.

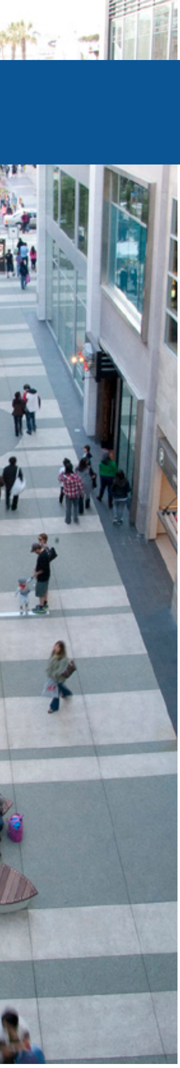
TABLE OF CONTENTS











When planners, developers, or traffic engineers conduct traffic impact analyses for proposed developments, they typically use the trip-generation data and analysis methods published by the Institute of Transportation Engineers (ITE) in its *Trip Generation* report and *Trip Generation Handbook*. However, standard traffic engineering practice does not account for project characteristics such as the mix and balance of land uses, compactness of design, neighborhood connectivity and walkability, infill versus remote location, and the variety of transportation choices offered. This can have significant implications when the project in question is a mixed use development.

The conventional methods used by traffic engineers throughout the U.S. to evaluate traffic impacts fail to account for the benefits of mixed use and other forms of lower-impact development. They exaggerate estimates of impacts and result in excessive development costs, skewed public perceptions, and decision maker resistance. These techniques overlook the full potential for internalizing trips through interaction among on-site activities and the extent to which development with a variety of nearby complementary destinations and high-quality transit access will produce less traffic. These effects can reduce the number of vehicle trips generated to a far greater degree than recognized in standard traffic engineering practice.

The ITE trip-generation data and analysis methods apply primarily to single-use and freestanding sites, which limits their applicability to compact, mixed-use, transit oriented developments (ITE 2004, 2012). The *Handbook* does include an approach based on limited data on mixed use developments, but only from six sites in Florida, not nearly enough to cover today's diverse mixed use developments across the United States.

It is important that planners and developers recognize the implications of using standard ITE trip generation data and methodologies for mixed use developments and use methods that more accurately estimate traffic generated by these projects. Commonly used methods unjustifiably favor types of development that consume greater resources and generate greater impacts, shifting our attention away from development forms and locations that stimulate higher levels of social interaction and benefit to established communities.

Researchers have attempted to analyze how a mix of uses in a compact, walkable project design affects trip generation and on-the-ground traffic impacts. In 2011, two major studies introduced methodologies for predicting traffic generation from mixed use development. The researchers on those studies have now collaborated to combine the advantages of both and provide, in this *PAS Memo*, an even more complete and reliable approach to measuring the benefits of such forms of development. Using this new approach, planners conducting trip-generation analysis for mixed use development projects will produce more accurate forecasts of traffic generation, which will allow more appropriate on-site design features and off-site mitigation measures.

The Problem with Conventional Traffic Impact Analysis

Traffic analysis is intended to inform planners, community members, and public officials of the most suitable planning features and infrastructure elements needed to support new development. However, the conventional methods were developed during an era when most new development was single use, stand alone, highway oriented, and suburban. Standard practices ascribe similar levels of impact to mixed-use, integrated, transit-oriented, and infill development, and consequently overlook the benefits of — and impose unreasonable obstacles to — appropriate planning and approval of such "smart growth" forms.

The standard analytic process used for planning, design, and impact analysis does not account for the degree to which well-designed mixed use development places shops, restaurants, offices, and residences in close proximity to one another, shortening internal trips between them and making more trips conducive to walking, biking, or riding transit. Such reductions in traffic and vehicle miles traveled reduce fuel consumption, greenhouse-gas and other emissions, and exposure of residents to passing traffic and the related threats to comfort, health, and safety. Reduced vehicular travel can also lessen the need to construct new or wider streets and highways, allowing communities to economize on infrastructure. Mixed use developments (MXD) also create opportunities for shared parking, which can reduce the number of spaces needed in parking lot and garage construction.

Traffic-Reducing Attributes of Mixed Use Development

Many of the attributes of lower-impact development can reduce traffic generation compared with conventional single-use suburban development forms:

Diverse land uses and activities can fill basic needs nearby, thereby reducing automobile travel. They allow for linkage of trips in multipurpose trip chains, with a single auto trip to an activity center followed by several short trips on foot. Mixed use sites also create the opportunity for shared parking, which in turn encourages multipurpose trips and reduces the tendency to make separate automobile trips from one destination to the next.

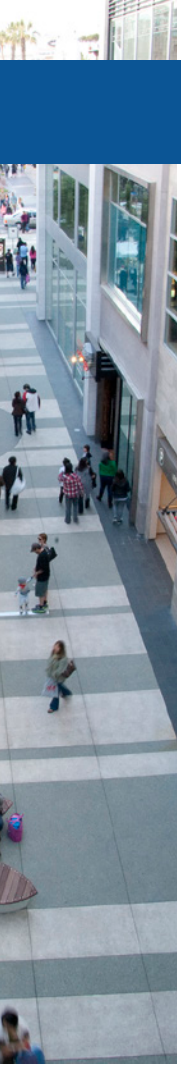
Higher densities and intensities of development provide opportunities for residents, employees, and visitors to circulate among larger numbers of businesses and activities by walking, bicycling, or making short trips by automobile. Higher concentrations of land use also support higher quality and higher-frequency transit service, offering tenants and visitors a viable alternative to driving. High land values and cost to provide parking also leads to higher parking prices, a disincentive to driving versus other available modes of travel.

Walkable urban design and interconnected streets generally reduce the perceived and real separation among destinations, encourage walking and cycling, and reduce the circuitousness and length of each trip.

Short distances to transit help make transit a viable alternative to the automobile and can create activity centers with sufficient street life, amenities, and walking connections where needs and entertainment can be accomplished without independent car trips.

Accessibility to complementary destinations outside the development reduces distances between jobs and housing, services and entertainment, and recreation, often making automobile travel unnecessary. Placed at infill locations, complementary new development that satisfies local needs can also reduce trip making by residents, employees, and shoppers in the surrounding community.

Socio-demographic compatibility can further reduce auto traffic to the extent that developments are designed to attract and accommodate residents with low auto ownership (through, for example, parking supply limits), low travel needs (based on, for example, family size,



fewer employed residents, lower income, or age range), or close affiliation with other project elements or surrounding land uses (linked, or simply compatible, jobs and residents).

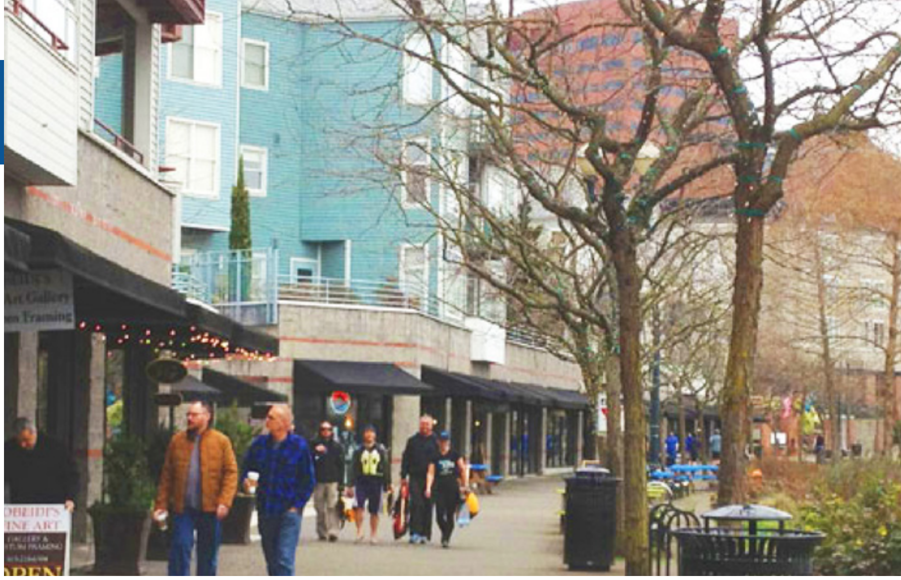
Scale of development affects feasibility for communities and employers to provide travel demand options and management services that can shift traveler modes from the auto to alternative modes of travel. Residents and businesses that self-select into such sites and settings are also often more amenable to travelling less or using alternatives to the automobile. Transportation demand management (TDM) programs are both more likely to be available and more likely to be successful in compact, central, transit-supported settings.

The danger of using traditional traffic-generation data based on single-use facilities is that it misrepresents the true traffic generation impacts of mixed use development. The consequences of miscalculating the benefits of mixed-use development may include unreasonable development cost, exaggerated impacts and mitigation responsibilities, skewed public perceptions, and decision maker resistance. This penalizes mixed use development proposals, often tipping the balance in favor of projects that offer fewer benefits and ultimately generate higher impacts. Denying "smart" forms of development does not reduce the overall market demand for housing and business, so the building disallowed ends up in other locations within the region, often in less accessible locations, at lower densities, and in less-mixed use configurations. The end result can be more traffic and higher regional vehicle-miles traveled than had the smart-growth development been approved.

Understandably, communities and public reviewers want to minimize the risk of unmitigated impacts. However, doing so through the application of overly conservative project evaluation criteria undermines the pursuit of other community values, such as vibrant neighborhoods with integrated development and activities that minimize the need to travel and the impacts produced by excessive unnecessary use of the automobile.

Conservative traffic-generation estimates have supply-side impacts, affecting design and cost of streets and parking. Within constrained sites, over design of traffic elements can limit the space available for revenue-producing land uses and increase other development costs. Development fee programs also rely heavily on traffic-generation estimates from the ITE *Trip Generation Manual*; this can lead to setting excessively high fee rates on mixed use development. Unquestioning use of the ITE data can unreasonably jeopardize a MXD project's approval, financial feasibility, and design quality.

Mixed use sites can take many forms, but all offer a diversity of uses in walkable settings. Oakland City Center BART (left); RiverPlace, Portland, Oregon (opposite page).



New Research Evidence for Mixed Use Development Trip Generation

Several hundred studies over the past 20 years have confirmed that the built environment affects travel generation (Ewing and Cervero 2010). Development features associated with reduced trip rates include a series of "D" variables: density, diversity of uses, design of urban environment, distance from transit, destination accessibility, development scale, demographics of inhabitants, and demand management. In the past three years, research has examined more directly the relative influence of each factor and their interactions and has sought to corroborate the research results through field verification. Organizations such as the U.S. Environmental Protection Agency and the National Academy of Sciences Transportation Research Board have sponsored several of the more reputable studies on the subject.

The Eight "D" Variables

The most advanced research has confirmed that trip rate reductions are quantifiably associated with the attributes of mixed use development, defined in terms of these characteristics of urban development patterns:

Density: dwellings, jobs per acre. Higher densities shorten trip lengths, allow for more walking and biking, and support quality transit.

Diversity: mix of housing, jobs, retail. A diverse neighborhood allows for easier trip linking and shortens distances between trips. It also promotes higher levels of walking and biking and allows for shared parking.

Design: connectivity, walkability. Good design improves connectivity, encourages walking and biking, and reduces travel distance.

Destinations: regional accessibility. Destination accessibility links travel purposes, shortens trips, and offers transportation options.

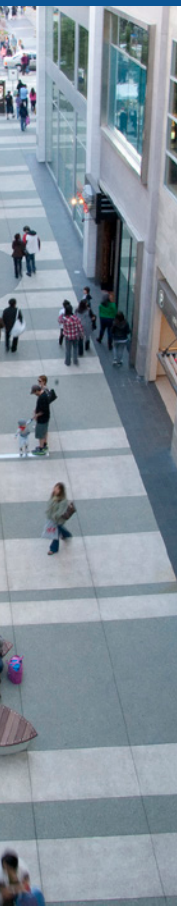
Distance to Transit: rail proximity. Close proximity to transit encourages its use, along with trip-linking and walking, and often creates accessible walking environments.

Development Scale: residents, jobs. Appropriate development scale provides critical mass, increases local opportunities, and supports transit investment.

Demographics: household size, income. Mixed use development allows self-selection by households into settings with their preferred activities and travel modes, allows businesses to locate convenient to clients, and supports a socioeconomic "fit" among residents, businesses, and activities.

Demand Management: pricing, incentives. Demand management ties incentives to the urban environment and allows alignment of auto disincentives with available alternate modes. It takes advantage of critical mass of travel resulting from density, diversity, and design.

A growing body of evidence indicates that these factors, individually or together, quantifiably explain the number of vehicle trips and vehicle-miles traveled for a development project and for a region as a whole. Each of the D factors influences traffic generation through a variety of mechanisms. There are also important interactions, both synergistic and mutually dampening, among the D factors that call for sophisticated techniques when quantifying the travel generation effects of different combinations proposed in any project or plan.



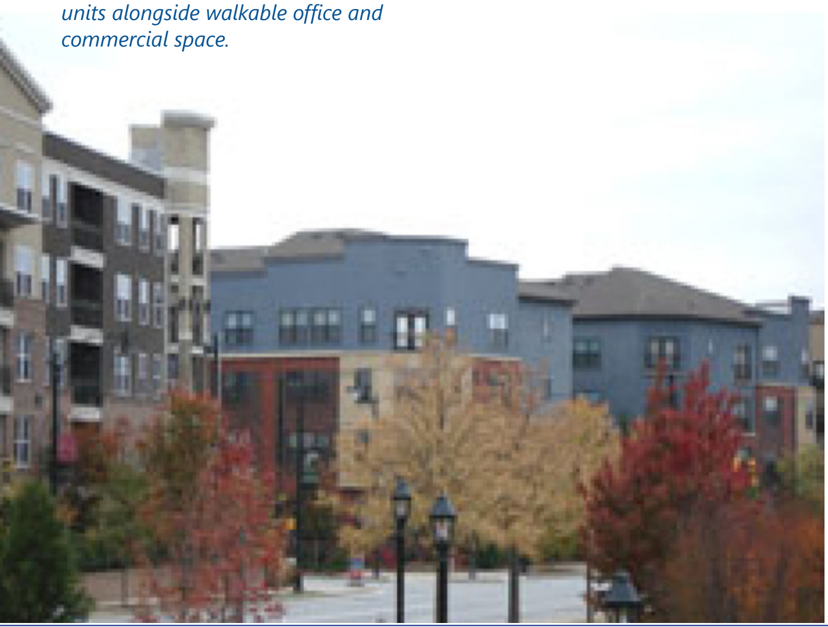
The Evidence that Conventional Methods Overstate MXD Impacts

Empirical evidence and research provides evidence that mixed-use, infill, and transit-oriented developments generate fewer external vehicle trips than equivalent stand-alone uses. A nationwide study sponsored by the U.S. EPA (Ewing et al. 2011) found statistical correlation between the D factors and increased trip internalization and increased walking and transit use. It further demonstrated, for 27 mixed-use development sites across the U.S., that:

1. On average, the sites' land uses would generate 49 percent more traffic if they were distributed among single-use sites in suburban settings, the situations to which the ITE *Trip Generation Manual* would apply.

2. The ITE *Handbook*, the current state-of-practice resource for estimating mixed use trip generation, would overestimate peak hour traffic by an average of 35 percent.

Atlantic Station offers residential units alongside walkable office and commercial space.



The following examples from recent studies demonstrate the degree by which such developments reduce traffic generation relative to what would be presumed under conventional traffic analysis methods.

Atlantic Station in Atlanta is a major mixed-use infill development located on a 138-acre former brownfield site in midtown Atlanta, connected by nonstop shuttle service to a MARTA metro rail station about a half-mile away. At the time it was studied, the development included 798 mid- and high-rise residential units, 550,600 square feet of office space, 434,500 square feet of retail space, a 101-room hotel, a restaurant, and a cinema.

For Atlantic Station, the "internal capture rate" (proportion of generated trips that remain internal to the site) is 15 percent in the morning peak hour and about 40 percent of evening peak-hour. Of the trips entering and leaving the site, between 5 and 7 percent use transit and another 5 to 7 percent walk or bicycle.

According to standard ITE trip-generation rates, were the Atlantic Station development elements located at single-use suburban sites, they would generate 37 percent more weekday traffic and 69 percent more PM peak traffic than actually counted at the centrally located, mixed use site.

RiverPlace in Portland is an award-winning mixed use waterfront development on a former brownfield within easy walking distance of downtown Portland, Oregon. Adjacent to the Tom McCall Waterfront Park, the site contains 700 residential units (condominiums and apartments), 40,000 square feet of office space, 26,500 square feet of small retail shops and restaurants, a 300-room hotel, and a marina, cinema, and athletic club. The waterfront walking environment conveniently links all of the activities within the development site and connects the site to the Portland central business district. Transit is also available at the site; the Portland Streetcar connects RiverPlace to downtown Portland and the greater Portland area.

RiverPlace (left) offers a mix of residential, office, and commercial uses on Portland's waterfront. Photo courtesy Fehr & Peers. Bay Street's walkable urban village (below) is designed on a Main Street theme.

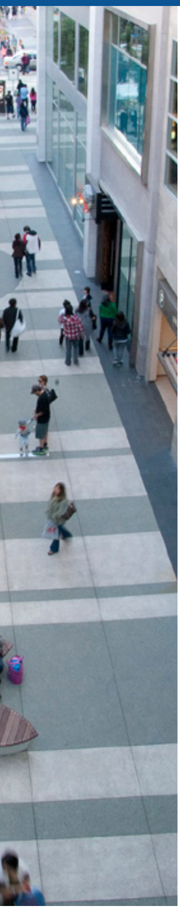
RiverPlace's internal capture rate is 36 percent. For internal and external trips combined, 40 percent are by walking and 5 percent by transit. These statistics are significantly higher than the regional averages of 15 percent of trips taken by walking and 2 percent by transit.

Bay Street in Emeryville is a vibrant, thriving recent redevelopment project in Emeryville, California, just outside San Francisco. The previously heavy-industrial area within and around Bay Street has undergone dramatic revitalization in the past two decades, and it now includes the headquarters of Pixar Studios and other businesses. Bay Street itself is a one-million-square-foot walkable urban village designed on a Main Street theme. It contains a major theater complex, hotel, and 382,000 square feet of fashionable retail shops (including an Apple Store) with 381 apartment units and offices above. The site is within walking distance of a Capitol Corridor commuter rail station and within a shuttle bus ride of BART metro rail.

Bay Street's daily traffic generation is about 41 percent less than the combined total that would be generated by similarly sized suburban shopping centers, theater complexes, residential uses, and office developments based on standard ITE trip rates for stand-alone land uses. It also generates 36 percent less daily traffic than would be estimated by traffic engineers applying the ITE *Handbook* and conventional analysis methods. In the PM peak hour, Bay Street traffic generation is 46 percent lower than would be generated by the same land uses scattered on individual suburban sites, and 41 percent lower than would be estimated by standard ITE traffic analysis.

New Models for Mixed Use Development Traffic Analysis

To address the shortcomings in conventional analysis methods, the National Cooperative Highway Research Program (NCHRP) and the U.S. EPA recently conducted significant research studies to improve quantification of the trip-reducing effects of mixed use development. Each study took a different approach: NCHRP undertook extensive visitor surveys and traffic counts at Atlantic Station and two mixed-use developments in Texas (Bochner et al. 2011), while EPA sponsored a nationwide study of more than 260 mixed use developments across the U.S. using regional travel survey data and verification traffic counts at a subset of the sites (Ewing et al. 2011). Using different analysis methods, each study developed a recommended approach to discounting traffic generation estimates to account for the mix of uses and other development characteristics. Each study represents a major advancement over conventional analysis methods.



NCHRP Report 684

National Cooperative Highway Research Program (NCHRP) Report 684, "Enhancing Internal Trip Capture Estimation for Mixed-Use Developments," analyzed internal-capture relationships of MXD sites and examined the travel interactions among six individual types of land uses: office, retail, restaurant, residential, cinema, and hotel. The study looked at three master-planned developments: Mockingbird Station, a single-block TOD in Dallas; Legacy Town C enter, a multiblock district in suburban Plano, Texas, containing fully integrated and adjacent complementary uses; and Atlantic Station (see above). It compared the survey results to those found in prior ITE studies at three Florida sites, Boca del Mar, Country Isles, and Village Commons, all containing a variety of land uses, though in single-use pods.

Based on traveler and vehicle counts and interviews, the study ascertained interactions among the six land-use types of interest and compared them with site characteristics. It then examined the percentage of visitors to each land-use type who also visited each of the other uses during the same trip. The study considered site context factors and described percentage reductions in sitewide traffic generation that might result from the availability of transit service and other factors.

Researchers then performed verification tests by comparing the analysis results to those available from ITE for three earlier studies at Florida mixed use sites. The validation confirmed that the estimated values were a reasonable match for actual counted traffic. The product of the study is a series of tables and spreadsheets that balance and apply the discovered use-to-use visitation percentages to the land uses within the project site under study. The interaction percentages are then used to discount ITE trip-generation rates and to reduce what would otherwise represent the number of trips entering and leaving the entire site.

EPA MXD

The U.S. EPA–sponsored 2011 report, "Traffic Generated by Mixed-Use Developments — A Six-Region Study Using Consistent Built Environmental Measures," investigated trip generation, mode choice, and trip length for trips produced and attracted by mixed use developments. Researchers selected six regions — Atlanta, Boston, Houston, Portland, Sacramento, and Seattle — to represent a wide range of urban scale, form, and climatic conditions. Regional travel survey data with geographic coordinates and parcel-level detail available for these areas allowed researchers to isolate trips to, from, and within MXDs and relate travel choices to fine-grained characteristics of these developments.

In each region, researchers worked with local planners and traffic engineers to identify a total of 239 MXDs that met the ITE definition of multi-use development. The MXDs ranged from compact infill sites near regional cores to low-rise freeway-oriented developments. They varied in size, population and employment densities, mixes of jobs and housing, presence or absence of transit, and locations within their regions. In total, the MXD sample for the six regions provided survey data on almost 36,000 trips.

The analysis found that one or more variables in each of seven D categories (see above) were statistically significant predictors of internal capture, external walking, external transit use, and external private vehicle trip length. Specifically, an MXD's external traffic generation was related to population and employment within the site (density); the relative balance of jobs and housing within the site and the amount of employment within 1 mile of the site (diversity); the density of intersections within the site as a measure of street connectivity (design); the presence of bus stops within a quarter mile or the presence of a rail station (distance from transit); employment within a mile of site boundaries and percentage of regional employment within 20 minutes by car, 30 minutes by car, and 30 minutes by transit (destination accessibility); the gross acreage of the development (development scale); and the average number of household members as well as household vehicle ownership per capita(demographics). The accuracy of the EPA MXD method was verified through traffic generation comparisons at 27 mixed-use sites across the U.S.

The EPA MXD product is a series of equations and instructions captured in a spreadsheet workbook. The methodology calculates the percentage reductions in ITE trip generation resulting from the national statistical analysis of seven D effects on internal trip capture, walking, and transit use. The spreadsheets produce reduced estimates of traffic generation on a daily basis and for peak traffic hours.

Combining the Approaches

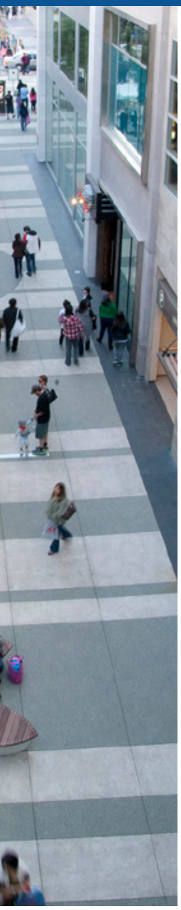
The NCHRP 684 method and EPA MXD method each derive from different research approaches and produce different methods of analyzing trip generation at mixed use developments. They focus on overlapping but not identical aspects of mixed-use development sites and their contexts and offer respective strengths and weaknesses in terms of factors considered and ease of application. Selecting which method to employ under different circumstances requires both a comparison of their capabilities as well as professional judgment of their respective strengths and weaknesses.

Report 684 includes a refined assessment of on-site land-use categories, specifically recognizing the roles of restaurants, theaters, and hotels within the site land-use mix, along with an adjustment to account for the spatial separations among individual land uses within the development site. It is directly useful for the evaluation of proposed development sites that are similar to the one or more of the three surveyed in Atlanta and Texas for the report. However, it is not responsive to factors such as regional location, transit availability, density of development, walkability factors, and the socio-demographic profile of site residents and businesses.

In contrast, the EPA MXD method accounts directly and quantitatively for these factors. However, while it accounts for the balances of retail, office, and residential development, it does not explicitly differentiate subcategories such as restaurants, theaters, and hotels. Furthermore, it requires the analyst to account for off-site development, including employment within a one-mile radius of the MXD and the number of jobs available within 30 minutes of the site.

To develop a method that captures the best of both sets of research findings, the authors of the two original studies decided to collaborate on an integrated method that recognizes the full array of on-site and context characteristics that contribute to traffic reduction and, through a focus on empirical verification, achieves greater accuracy than either method individually.

In developing the integrated approach, we compared the performances of the methods to actual traffic counts at a diverse group of mixed use developments in a variety of settings. The 27 verification sites were successful mixed-use development, exhibiting moderate to high levels of activity in terms of business sales, occupied residential units, property value, and household income, with average or above-average person trips, at the time of the survey. They included those studied for NCHRP 684, the sites used as the basis for the ITE *Trip Generation Handbook*, and others surveyed by Fehr & Peers, transportation consultants. Six of the 27 sites were located in Florida, and three were located in Atlanta and Texas. Three of these nine were nationally known examples of smart growth or transit-oriented development: Atlantic Station, Mockingbird Station, and Celebration, Florida. Six sites were located in San Diego County and were designated by local planners and traffic engineers in 2009 as representing a wide range of examples of smart growth trip generators in that region. The 12 remaining sites were MXD developments located elsewhere in California and in Utah, ranging from TOD sites (commuter rail and ferry) to conventional suburban freeway-oriented mixed use sites.



A New Approach: The MXD+ Method

The new analytical approach, the MXD+ method, combines the strengths of NCHRP 684 and EPA MXD. The authors sought to (1) address the fact that each method has strengths relative to the other, (2) create a method that is more accurate than either of the individual methods alone, and (3) reduce confusion among practitioners on which is the most appropriate method.

The proposed MXD+ method incorporates the underlying data sources and logic that the two methods share. It offers the ability to assess the effects of spatial separation of uses and recognition of more specific land-use categories and to consider the dynamic influences of local development context, regional accessibility, transit availability, development density and walkability factors, and the characteristics of residents.

To develop the preferred method, the authors experimented with different methods of integrating the two methods and arrived at a direct calibration approach. The appropriate combination of the results of the two individual methods was determined through regression analysis to identify the proportions that provided the best correlation with the traffic counted at the 27 validation sites. Table 1 presents results from the regression analysis, listing the proportions of the two methods found most effective at matching the traffic generation at the diverse set of mixed use validation sites. Weighting the results of the two individual analyses by the percentages in Table 1 and combining the results produces more accurate estimates of traffic generation and captures the effects of all of the site description variables included in the NCHRP and EPA methods.

TABLE 1 **OPTIMAL BLEND OF NCHRP 684 AND EPA MXD METHODS**

	AM PEAK TRAFFIC	PM PEAK TRAFFIC	AVERAGE DAILY TRAFFIC
NCHRP 684	10.1%	36.5%	n/a
EPA MXD	89.9%	63.5%	100%

The step-by-step method is as follows:

1. Apply the full EPA MXD methodology to predict external traffic generation as influenced by site development scale, density, accessibility, walkability and transit availability, resident demographics, and general mix of uses.

2. Apply the full NCHRP 684 method to capture the effects of detailed land-use categories, including hotel, theater, and restaurant, and the spatial separation of uses within small and medium sites.

3. Combine the results of the two methods in terms of percentages of trips remaining internal to the development site, using proportioning factors presented in the table above.

4. Apply adjustments to account for off-site walking and transit travel using the EPA MXD method.

5. Discount standard ITE traffic-generation rates by the percentages of internalization produced in step 3 and the percentage of walk and transit travel in step 4 to obtain the estimate of site- generated traffic.

TABLE 2 **COMPARISON OF THREE PRINCIPAL METHODS IN TERMS OF PROJECT CHARACTERISTICS CONSIDERED**	EPA MXD METHOD	NCHRP 684 METHOD	MXD+ METHOD
Project Characteristics Considered			
Density of Development	♦		♦
Diversity of Uses: Jobs/Housing	♦	♦	♦
Diversity of Uses: Housing/Retail		♦	♦
Diversity of Uses: Jobs/Services		♦	♦
Diversity of Uses: Entertainment, Hotel		♦	♦
Design: Connectivity, Walkability	♦	♦	♦
Design: Separation Among Uses		♦	♦
Destination Accessibility by Transit	♦		♦
Destination Accessibility by Walk/Bike	♦		♦
Distance from Transit Stop	♦		♦
Development Scale	♦		♦
Distance from Transit Stop	♦		♦
Development Scale	♦		♦
Demographic Profile	♦		♦
Data Needs (beyond Project Site Plan)			
Average Residents per Dwelling Unit	♦		♦
Average Autos Owned per Dwelling Unit	♦		♦
Nearby (1/4 mi) Bus Stops and Rail Stations	♦		♦
Jobs Within 1 Mile of Site	♦		♦
Jobs Within 30-Minute Transit Trip	♦		♦
Regional Employment	♦		♦
Located in CBD or TOD?	♦		♦
Site Development by Classification		♦	♦
Vehicle Occupancy Estimate		♦	
Mode Split Estimate		♦	

As Table 2 indicates, the MXD+ method improves traffic generation estimates by considering the full array of 12 site development and context characteristics shown to influence internal capture and mode share, while the individual methods consider only 5 to 8 factors each. Effects considered in MXD+ that are not included in the NCHRP 684 method include household size and auto ownership, site proximity to bus and rail stops, and accessibility to local and regional jobs. Effects considered in the NCHRP 684 method that do not appear in the EPA MXD method include specific land uses and proximity of interacting land uses to each other.

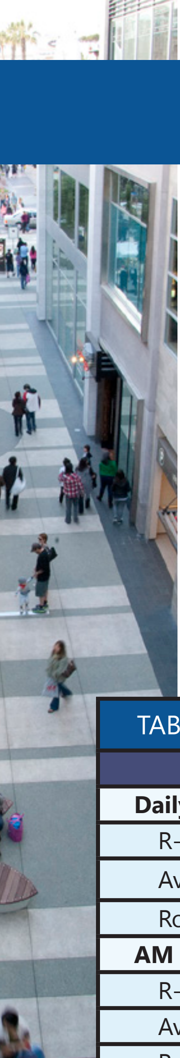


Table 3 presents the statistical performance of the MXD+ integrated method with the individual performance of the individual NCHRP 684 and EPA MXD methods. We compared the ability of each of the available methods to replicate the amount of traffic generated at the 27 validation sites in terms of statistical measures including percent root mean squared error, a metric used in the transportation field to evaluate model accuracy, and the coefficient of determination (or "R-squared"), which measures the ability of the analysis method to account for the variations in traffic generation among the 27 survey sites. For daily traffic generation, MXD+ is equivalent to the EPA MXD method, as the NCHRP 684 method does not address daily analysis. For peak hour traffic generation, MXD+ performs notably better than either of the individual methods.

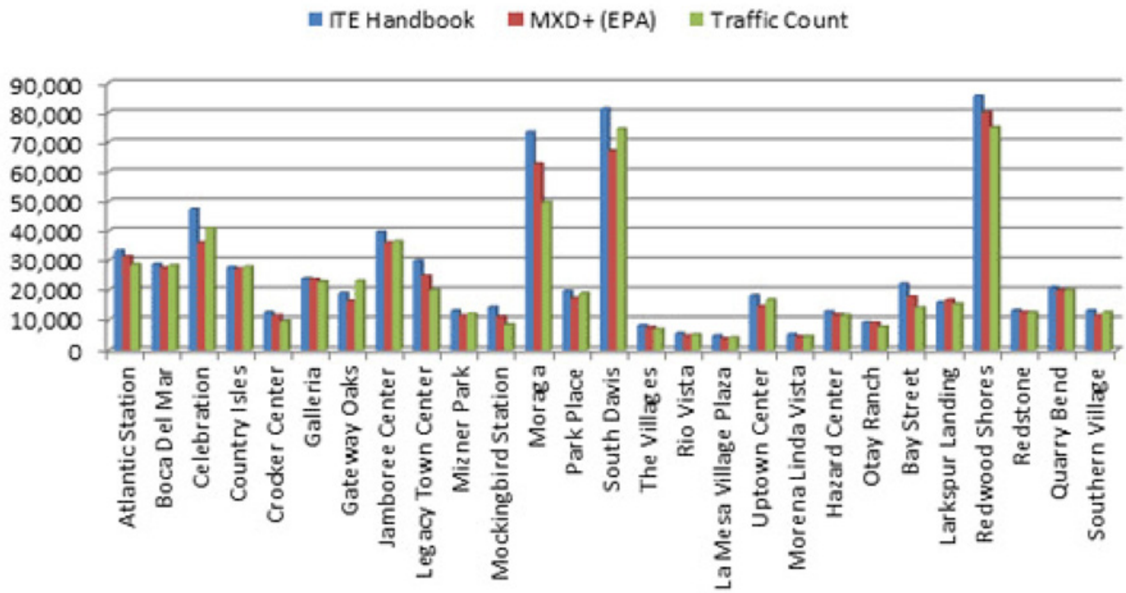
TABLE 3 **COMPARISON OF THREE PRINCIPAL METHODS IN TERMS OF PERFORMANCE AT VALIDATION SITES**

	EPA MXD METHOD	NCHRP 684 METHOD	MXD+ METHOD
Daily Traffic Generation			
R-squared	96%	89%*	**96%**
Average Error	2%	16%*	**2%**
Root Mean Square Error	17%	27%	**17%**
AM Peak Traffic Generation			
R-squared	97%	93%*	**97%**
Average Error	12%	30%	**12%**
Root Mean Square Error	21%	33%	**21%**
PM Peak Traffic Generation			
R-squared	95%	81%	**97%**
Average Error	8%	18%	**4%**
Root Mean Square Error	18%	36%	**15%**

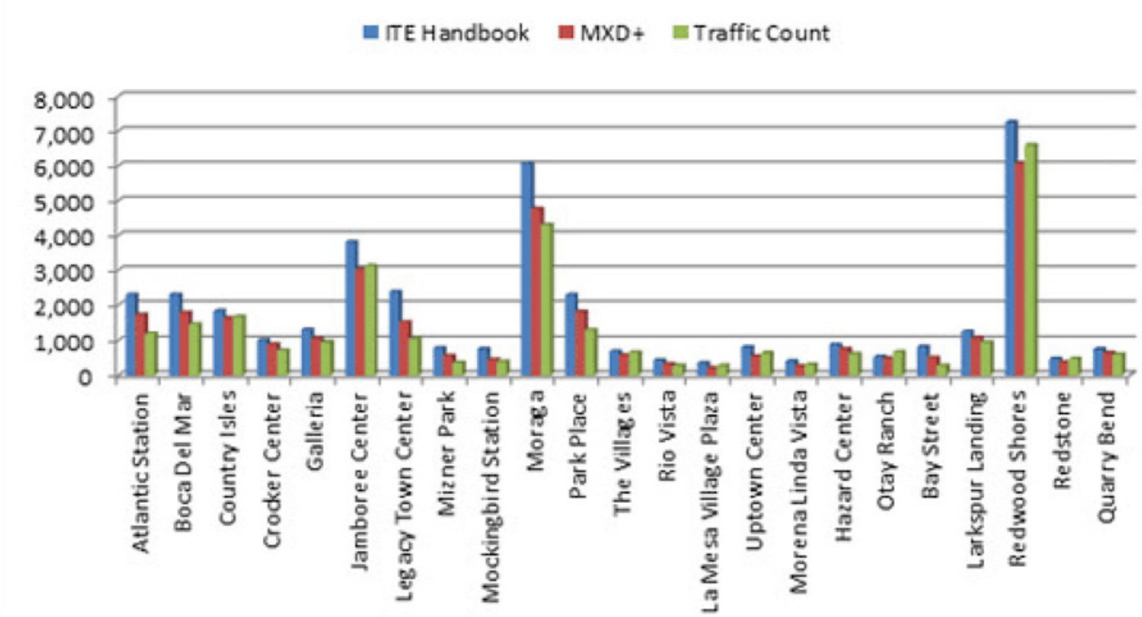
** ITE Handbook internalization statistics (NCHRP 684 method does not address daily trip generation)*

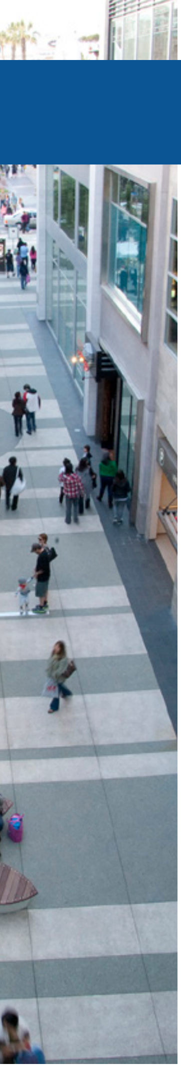
The graphs on the following page compare the performance of the MXD+ method to the ITE *Handbook* method at replicating traffic generation at the diverse group of mixed-use validation sites. Compared with the ITE *Handbook*, MXD+ method more accurately matches the amount of daily traffic actually counted at 20 of the 27 survey sites. In the AM peak hour, it is more accurate than the ITE Handbook at 21 of the 24 sites for which counts were available, and in the PM peak hour, MXD+ is more accurate than the ITE *Handbook* method at 23 of 25 sites.

DAILY TRAFFIC GENERATION COMPARISON OF ITE HANDBOOK & MXD+ METHODS

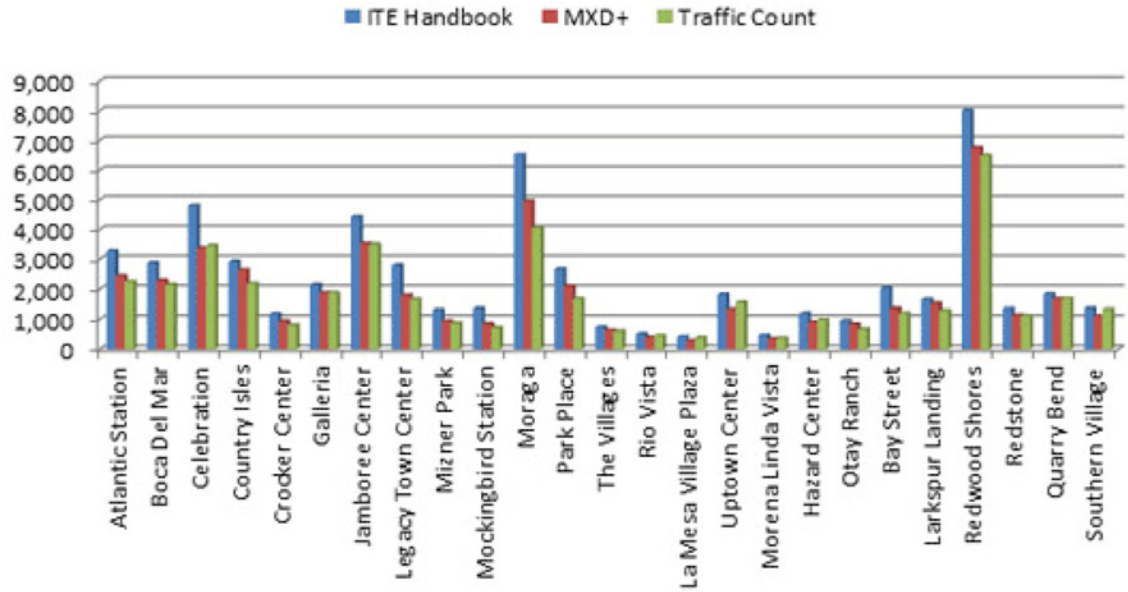


AM PEAK HOUR TRAFFIC GENERATION COMPARISON OF ITE HANDBOOK & MXD+ METHODS





PM PEAK HOUR TRAFFIC GENERATION COMPARISON OF ITE HANDBOOK & MXD+ METHODS



The MXD+ method explains 97 percent of the variation in trip generation among mixed-use developments, compared with 65 percent for the ITE *Handbook* method. On average, the *Handbook* overestimates AM peak traffic generation by 49 percent, compared with 12 percent for MXD+. For the PM peak hour, the ITE *Handbook* overestimates actual traffic by 35 percent. The MXD+ method reduces this to 4 percent, remaining slightly conservative and unlikely to understate impacts.

By combining and refining the two most advanced methodologies for estimating traffic generation for mixed-use development, the MXD+ method provides transportation planners and engineers a more accurate single approach that accounts for the most important factors that distinguish lower impact development from other forms. Doing so advances development planning and impact assessment beyond the practices that have, to date, unreasonably discouraged mixed-use development.

Recommendations for Planners

We recommend that planners adopt the latest methods for evaluating traffic generation of mixed use and other forms of smart growth, including infill and transit-oriented development. The MXD methods developed under the U.S. EPA multiregional study and the NCHRP 684 study on enhancing trip-capture estimation each represent substantial advances to the conventional practices previously available through ITE. Combining the two new methods, as described above, improves upon both individual methods. Tools for all three approaches are available for use through the references and resources listed below.

Traffic engineers are beginning to take notice of the new methods, but we expect that natural sluggishness in adopting new practices will continue to impose unfair penalties on mixed use and other forms of lower-impact development. We recommend activism on the part of all planners, development reviewers, and impact analysts on behalf of the more accurate MXD methods.

Immediate adoption of the improved methods will allow planners to account for a project's regional location, transit availability, density of development, walkability factors, and the characteristics of residents and businesses and on-site adjacencies of land uses including residential, office, retail, restaurants, theaters, and hotels. Accounting for these factors through the MXD+ method will achieve the highest levels of accuracy possible in estimating traffic impacts of mixed use development.

We recommend applying and promoting the MXD+ method for day-to-day project planning and performance-based site-plan refinement, impact analysis, and discretionary review. Doing so will eliminate what is presently a systematic bias in traffic analysis that favors single-use, isolated, suburban-style development.

Conclusion

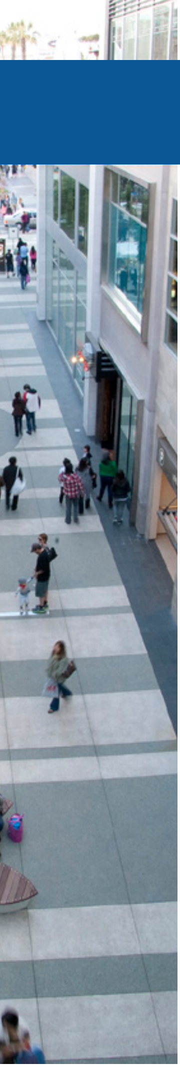
Standard traffic engineering practices are blind to the primary benefits of smart growth. A plan's development density, scale, design, accessibility, transit proximity, demographics, and mix of uses all affect traffic generation in ways unseen to prescribed methods. The Institute of Transportation Engineers (ITE) *Trip Generation Manual* and *Handbook* overestimate peak traffic generation for mixed-use development by an average of 35 percent. For conventional suburban stand-alone development, ITE rates portray the average for such sites; so hedging mixed-use analysis toward more conservative assumptions creates a systematic bias in favor of single-use suburban development.

ITE overestimation of traffic impacts reduces the likelihood of approval of mixed use and related forms of smart growth such as infill, compact, and transit-oriented development. Such overestimation escalates development costs, skews public perception, heightens community resistance, and favors isolated single-use development.

The methods of evaluating mixed use development described in this report represent a substantial improvement over conventional traffic-estimation methods. They improve accuracy and virtually eliminate overestimation bias, and they are supported by the substantial evidence of surveys and traffic counts at 266 mixed use sites across the U.S. The MXD+ analysis method explains 97 percent of the variation in trip generation among mixed use sites and all but eliminates the ITE systematic overestimation of traffic. We hope planners and other professionals will take advantage of the available spreadsheet tools listed below to help even the playing field between conventional development patterns and more sustainable, walkable, livable places.

About the Authors

Jerry Walters is a principal and sustainability practice leader with Fehr & Peers, transportation consultants. He has more than 30 years of experience in transportation planning, engineering, and travel forecasting and is a registered traffic engineer. Jerry developed project evaluation methods for the U.S. EPA study "Mixed-use Development and Vehicle Trips: Improving the Standard Estimation Methodology." He is a co-author of the book Growing Cooler – the Evidence on Urban Development and Climate Change (Urban Land Institute, 2008).



Brian S. Bochner is a senior research engineer at Texas Transportation Institute with over 40 years of experience in traffic engineering and planning. He is a certified professional traffic engineer, a professional traffic operations engineer and transportation planner, an affiliate with the Transportation Research Board, and past president and member of the International Board of Direction of the Institute of Transportation Engineers (ITE). His awards include Transportation Innovator, Texas Department of Transportation Research Program, and Transportation Engineer of the Year for the Texas Section of ITE.

Reid Ewing is a professor of city and metropolitan planning at the University of Utah, associate editor of the *Journal of the American Planning Association*, columnist for *Planning* magazine, and Fellow of the Urban Land Institute. His 2010 article, "Travel and the Built Environment: A Meta-Analysis," won the Best Article of the Year award from the American Planning Association, and his book, Best Development Practices (APA Planners Press, 1996), is listed by APA as one of the 100 essential planning books of the past 100 years.

References

Bochner, Brian, Kevin Hooper, Benjamin Sperry, and Robert Dunphy. 2011. *NCHRP Report 684: Enhancing Internal Trip Capture Estimation for Mixed-Use Developments*. Washington, D.C.: National Cooperative Highway Research Program, Transportation Research Board. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_684.pdf

Ewing, Reid, and Robert Cervero. 2010. "Travel and the Built Environment: A Meta-Analysis." *Journal of the American Planning Association* 76(3): 265–94. www.tandfonline.com/doi/abs/10.1080/01944361003766766

Ewing, Reid, Michael Greenwald, Ming Zhang, Jerry Walters, Robert Cervero, Lawrence Frank, and John Thomas. 2011. "Traffic Generated by Mixed-Use Developments — Six-Region Study Using Consistent Built Environmental Measures." *ASCE Journal of Urban Planning and Development* 137(3): 248–61. http://ascelibrary.org/action/showAbstract?page=248&volume=137&issue=3&journalCode=jupddm&isAuthorized=no

Institute of Transportation Engineers. 2012. *Trip Generation Manual*, Ninth Edition. www.ite.org/emodules/scriptcontent/orders/ProductDetail.cfm?pc=IR-016G

Institute of Transportation Engineers. 2004. *Trip Generation Handbook*, Second Edition. www.ite.org/emodules scriptcontent/orders/ProductDetail.cfm?pc=RP-028B

San Diego Association of Governments. 2010. *Trip Generation for Smart Growth: Planning Tools for the San Diego Region*. San Diego, Calif.: SANDAG. www.sandag.org/uploads/publicationid/publicationid_1500_11604.pdf

Walters, Jerry, Reid Ewing, and John Thomas Eary. 2013. "Getting Trip Generation Right -- How to Accurately Account for Impact Reduction Attributable to Mixed-Use and Related Forms of Sustainable Development." *National Association of Environmental Professionals Conference Proceedings*, April.

Additional Resources

Description, documentation, and spreadsheet tools for the NCHRP 684 method, Enhancing Internal Trip Capture Estimation for Mixed-Use Developments may be found at www.trb.org/Main/Blurbs/165014.aspx.

Description, documentation, and spreadsheet tools for the EPA MXD Trip Generation Tool for Mixed-Use Developments may be found at www.epa.gov/smartgrowth/mxd_tripgeneration.html.

Quick-response analysis tools for applying the EPA MXD method, the combined EPA /NCHRP method MXD+, and MXD in conjunction with analysis of vehicle-miles traveled, GHG emissions, and shared parking, Plan+, may be found at http://asap.fehrandpeers.com/tools/.

Appendix D-5: CAPCOA Research

This appendix contains background information on the California Air Pollution Control Officers Association (CAPCOA) research used as a basis for the mode shift estimates made to account for pedestrian and bicycle improvements in the baseline and mitigation scenarios. The MXD trip generation tool predicts mode share based primarily on land use and demographic information.

Research has found that the completion of a pedestrian access network results in a 0-2 percent reduction in VMT within the project site in an urban area. In addition, a 1 percent increase in bicycle mode share was found for each additional mile of bike lanes per square mile. **Attachment 2** contains the pedestrian network improvements and the on-site bike lane street design sections from the CAPCOA research report. The full report, Quantifying Greenhouse Gas Mitigation Measures, is available online at the following location: http://www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf

3.2 Neighborhood/Site Enhancements

3.2.1 Provide Pedestrian Network Improvements

Range of Effectiveness: 0 - 2% vehicle miles traveled (VMT) reduction and therefore 0 - 2% reduction in GHG emissions.

Measure Description:

Providing a pedestrian access network to link areas of the Project site encourages people to walk instead of drive. This mode shift results in people driving less and thus a reduction in VMT. The project will provide a pedestrian access network that internally links all uses and connects to all existing or planned external streets and pedestrian facilities contiguous with the project site. The project will minimize barriers to pedestrian access and interconnectivity. Physical barriers such as walls, landscaping, and slopes that impede pedestrian circulation will be eliminated.

Measure Applicability:

- Urban, suburban, and rural context
- Appropriate for residential, retail, office, industrial and mixed-use projects
- Reduction benefit only occurs if the project has both pedestrian network improvements on site and connections to the larger off-site network.

Baseline Method:

See introduction to transportation section for a discussion of how to estimate trip rates and VMT. The CO_2 emissions are calculated from VMT as follows:

$$CO_2 = VMT \times EF_{running}$$

Where:

VMT = vehicle miles traveled

$EF_{running}$ = emission factor for running emissions

Inputs:

The project applicant must provide information regarding pedestrian access and connectivity within the project and to/from off-site destinations.

Mitigation Method:

Estimated VMT Reduction	Extent of Pedestrian Accommodations	Context
2%	Within Project Site and Connecting Off-Site	Urban/Suburban
1%	Within Project Site	Urban/Suburban
< 1%	Within Project Site and Connecting Off-Site	Rural

Assumptions:

Data based upon the following references:

- Center for Clean Air Policy (CCAP) Transportation Emission Guidebook. http://www.ccap.org/safe/guidebook/guide_complete.html (accessed March 2010)
- 1000 Friends of Oregon (1997) "Making the Connections: A Summary of the LUTRAQ Project" (p. 16): http://www.onethousandfriendsoforegon.org/resources/lut_vol7.html

Emission Reduction Ranges and Variables:

Pollutant	Category Emissions Reductions[45]
CO_2e	0 - 2% of running
PM	0 - 2% of running
CO	0 - 2% of running
NOx	0 - 2% of running
SO_2	0 - 2% of running
ROG	0 – 1.2% of total

Discussion:

As detailed in the preferred literature section below, the lower range of 1 – 2% VMT reduction was pulled from the literature to provide a conservative estimate of reduction potential. The literature does not speak directly to a rural context, but an assumption was made that the benefits will likely be lower than a suburban/urban context.

Example:

N/A – calculations are not needed.

Preferred Literature:

[45] The percentage reduction reflects emission reductions from running emissions. The actual value will be less than this when starting and evaporative emissions are factored into the analysis. ROG emissions have been adjusted to reflect a ratio of 40% evaporative and 60% exhaust emissions based on a statewide EMFAC run of all vehicles.

- 1 - 2% reduction in VMT

The Center for Clean Air Policy (CCAP) attributes a 1% reduction in VMT from pedestrian-oriented design assuming this creates a 5% decrease in automobile mode share (e.g. auto split shifts from 95% to 90%). This mode split is based on the Portland Regional Land Use Transportation and Air Quality (LUTRAQ) project. The LUTRAQ analysis also provides the high end of 10% reduction in VMT. This 10% assumes the following features:

– Compact, mixed-use communities
– Interconnected street network
– Narrower roadways and shorter block lengths
– Sidewalks
– Accessibility to transit and transit shelters
– Traffic calming measures and street trees
– Parks and public spaces

Other strategies (development density, diversity, design, transit accessibility, traffic calming) are intended to account for the effects of many of the measures in the above list. Therefore, the assumed effectiveness of the Pedestrian Network measure should utilize the lower end of the 1 - 10% reduction range. If the pedestrian improvements are being combined with a significant number of the companion strategies, trip reductions for those strategies should be applied as well, based on the values given specifically for those strategies in other sections of this report. Based upon these findings, and drawing upon recommendations presented in the alternate literature below, the recommended VMT reduction attributable to pedestrian network improvements, above and beyond the benefits of other measures in the above bullet list, should be 1% for comprehensive pedestrian accommodations within the development plan or project itself, or 2% for comprehensive internal accommodations and external accommodations connecting to off-site destinations.

Alternative Literature:

Alternate:

- Walking is three times more common with enhanced pedestrian infrastructure
- 58% increase in non-auto mode share for work trips

The Nelson\Nygaard [1] report for the City of Santa Monica Land Use and Circulation Element EIR summarized studies looking at pedestrian environments. These studies have found a direct connection between non-auto forms of travel and a high quality pedestrian environment. Walking is three times more common with communities that have pedestrian friendly streets compared to less pedestrian friendly communities. Non-auto mode share for work trips is 49% in a pedestrian friendly community, compared to 31% in an auto-oriented community. Non-auto mode share for non-work trips is 15%, compared to 4% in an auto-oriented community. However, these effects also depend upon other aspects of the pedestrian friendliness being present, which are accounted for separately in this report through land use strategy mitigation measures such as density and urban design.

Alternate:

- 0.5% - 2.0% reduction in VMT

The Sacramento Metropolitan Air Quality Management District (SMAQMD) Recommended Guidance for Land Use Emission Reductions [2] attributes 1% reduction for a project connecting to *existing* external streets and pedestrian facilities. A 0.5% reduction is attributed to connecting to *planned* external streets and pedestrian facilities (which must be included in a pedestrian master plan or equivalent). Minimizing pedestrian barriers attribute an additional 1% reduction in VMT. These recommendations are generally in line with the recommended discounts derived from the preferred literature above.

Preferred and Alternative Literature Notes:

[1] Nelson\Nygaard, 2010. City of Santa Monica Land Use and Circulation Element EIR Report, Appendix – Santa Monica Luce Trip Reduction Impacts Analysis (p.401). http://www.shapethefuture2025.net/

Nelson\Nygaard looked at the following studies: Anne Vernez Moudon, Paul Hess, Mary Catherine Snyder and Kiril Stanilov (2003), Effects of Site Design on Pedestrian Travel in Mixed Use, Medium-Density Environments, http://www.wsdot.wa.gov/research/reports/fullreports/432.1.pdf; Robert Cervero and Carolyn Radisch (1995), Travel Choices in Pedestrian Versus Automobile Oriented Neighborhoods, http://www.uctc.net/papers/281.pdf;

[2] Sacramento Metropolitan Air Quality Management District (SMAQMD) Recommended Guidance for Land Use Emission Reductions. (p. 11) http://www.airquality.org/ceqa/GuidanceLUEmissionReductions.pdf

Other Literature Reviewed:

None

3.2.5 Incorporate Bike Lane Street Design (on-site)

Range of Effectiveness: Grouped strategy. [See LUT-9]

Measure Description:

The project will incorporate bicycle lanes, routes, and shared-use paths into street systems, new subdivisions, and large developments. These on-street bike accommodations will be created to provide a continuous network of routes, facilitated with markings and signage. These improvements can help reduce peak-hour vehicle trips by making commuting by bike easier and more convenient for more people. In addition, improved bicycle facilities can increase access to and from transit hubs, thereby expanding the "catchment area" of the transit stop or station and increasing ridership. Bicycle access can also reduce parking pressure on heavily-used and/or heavily-subsidized feeder bus lines and auto-oriented park-and-ride facilities.

Refer to Improve Design of Development (LUT-9) strategy for overall effectiveness levels. The benefits of Bike Lane Street Design are small and should be grouped with the Improve Design of Development strategy to strengthen street network characteristics and enhance multi-modal environments.

Measure Applicability:

- Urban and suburban context
- Appropriate for residential, retail, office, industrial, and mixed-use projects

Alternative Literature:

Alternate:

- 1% increase in share of workers commuting by bicycle (for each additional mile of bike lanes per square mile)

Dill and Carr (2003) [1] showed that each additional mile of Type 2 bike lanes per square mile is associated with a 1% increase in the share of workers commuting by bicycle. Note that increasing by 1 mile is significant compared to the current average of 0.34 miles per square mile. Also, an increase in 1% in share of bicycle commuters would double the number of bicycle commuters in many areas with low existing bicycle mode share.

Alternate:

- 0.05 – 0.14% annual greenhouse gas (GHG) reduction
- 258 – 830% increase in bicycle community

Moving Cooler [2], based off of a national baseline, estimates 0.05% annual reduction in GHG emissions and 258% increase in bicycle commuting assuming 2 miles of bicycle lanes per square mile in areas with density > 2,000 persons per square mile. For 4 miles of bicycle lanes, estimates 0.09% GHG reductions and 449% increase in bicycle commuting. For 8 miles of bicycle lanes, estimates 0.14% GHG reductions and 830% increase in bicycle commuting. Companion strategies assumed include bicycle parking at commercial destinations, busses fitted with bicycle carriers, bike accessible rapid transit lines, education, bicycle stations, end-trip facilities, and signage.

Alternate:

- 0.075% increase in bicycle commuting with each mile of bikeway per 100,000 residents

A before-and-after study by Nelson and Allen (1997) [3] of bicycle facility implementation found that each mile of bikeway per 100,000 residents increases bicycle commuting 0.075%, all else being equal.

Alternative Literature References:

[1] Dill, Jennifer and Theresa Carr (2003). "Bicycle Commuting and Facilities in Major U.S. Cities: If You Build Tem, Commuters Will Use Them – Another Look." *TRB 2003 Annual Meeting CD-ROM*.

[2] Cambridge Systematics. *Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions.* Technical Appendices. Prepared for the Urban Land Institute. http://www.movingcooler.info/Library/Documents/Moving%20Cooler_Appendix%20B_Effectiveness_102209.pdf

[3] Nelson, Arthur and David Allen (1997). "If You Build Them, Commuters Will Use Them; Cross-Sectional Analysis of Commuters and Bicycle Facilities." *Transportation Research Record 1578.*

Other Literature Reviewed:

None

Appendix D-6: Commute Trip Reduction Surveys

Commute Trip Reduction Surveys

Worksites with over 100 employees arriving in the morning commute are required to participate in the Washington State Commute Trip Reduction (CTR) Program. CTR worksites within the project area include the University of Washington-Seattle Main Campus, University Bookstore, and Seattle Children's at Roosevelt Commons. The 2011-2012 survey results are summarized in **Table D3.5-5,** and found that the three worksites generate 53,259 weekly trips to the area.

Drive alone goals have been set for the University Bookstore and the University of Washington-Seattle Main Campus. The results of the 2011-2012 surveys for each worksite found that the University Bookstore had attained its drive alone rate goal, while the University of Washington-Seattle Main Campus has not. Previous year's survey results for this worksite have shown a decreasing trend in drive alone trips however, from approximately 35 percent in 2007 to 34 percent in 2012. Seattle Children's at Roosevelt Commons did not have a set drive alone goal, and survey results were only available for the 2011-2012 year.

Table D3.5-5. Commute Trip Reduction Survey Reports in the U District

Worksite	SOV Goal	2011-2012 Mode Split (%)				
		SOV	HOV	TRANSIT	WALK	BIKE
University Bookstore	24	19	3	57	4	16
Seattle Children's at Roosevelt Commons	NA	32	12	34	6	3
University of Washington-Seattle Main Campus	32	34	10	34	9	5

Source: CTR Survey Reports, 2008-2012

Appendix D-7 Growth Management Act Concurrency

This section describes the evaluation to determine concurrency with Growth Management Act (GMA) concurrency standards.

Methodology

The Seattle Comprehensive Plan uses peak hour volume-to-capacity (v/c) ratios across designated screenlines to assess arterial LOS for GMA concurrency assessment. The v/c ratio is defined as the ratio of measured traffic volumes to calculated roadway capacity. V/c ratios measure vehicles that pass a given point during the peak hour and do not consider queuing. Since buses (the primary transit mode in the City currently) operate in the same roadways as general traffic, the City uses the same screenline analysis for transit. Within the vicinity of the study area, the Comprehensive Plan identifies two screenlines: the Ship Canal (University and Montlake Bridges) and I-5 (cross-streets immediately to the east of the freeway from the Ship Canal to NE Ravenna Boulevard). Figure D3.5-2 shows the screenline locations.

The screenline analysis was based upon methods outlined in the Department of Planning and Development Director's Rule 5-2009 which summarizes the 2008 traffic volumes and capacities at each of the City's screenlines. From this document, the capacities of the key facilities were determined and the v/c ratio was calculated using the recent traffic counts collected for this study.

Concurrency Standard

As previously described, the Seattle Comprehensive Plan uses v/c ratios across designated screenlines to assess arterial LOS. Each screenline is assigned a maximum acceptable v/c threshold. In the event a screenline's measurement approaches this threshold, the Comprehensive Plan calls for vehicular demand reduction strategies to be pursued before increasing capacity. **Table 3.5-6** displays the screenlines and their respective v/c thresholds.

TABLE 3.5-6. TRAFFIC IMPACT ANALYSIS AREA SCREENLINES

Screenline Number	Screenline Location Segment	LOS Standard (v/c Ratio)
5.16	Ship Canal – University & Montlake Bridges	1.20
13.13	East of I-5 – NE Pacific Street to NE Ravenna Boulevard	1.00

Source: Seattle Comprehensive Plan, 2005.

Screenline Ratios

Table 3.5-7 shows the peak hour v/c ratios for the relevant screenlines for the 2015 base year and each of the three 2035 scenarios.

TABLE 3.5-7. TRAFFIC IMPACT ANALYSIS AREA SCREENLINES				
Alternative	**Ship Canal – University & Montlake Bridges**		**East of I-5 – NE Pacific St to NE Ravenna Blvd**	
	NB/EB	**SB/WB**	**NB/EB**	**SB/WB**
2015	0.93	0.95	0.60	0.53
2035 No Action	1.14	1.15	0.63	0.59
2035 Alternative 1	1.15	1.16	0.62	0.59
2035 Alternative 2	1.14	1.16	0.63	0.59

Source: Fehr & Peers, 2013.

Neither of the screenlines is expected to exceed the LOS standard stated in the Comprehensive Plan under any of the 2035 scenarios.

E. Greenhouse Gas Worksheets

U District EIS - Existing Conditions (with VMT Tool)

Section I: Buildings

Type (Residential) or Principal Activity (Commercial)	# Units	Square Feet (in thousands of square feet)	Emissions Per Unit or Per Thousand Square Feet (MTCO2e) Embodied	Energy	Transportation	Lifespan Emissions (MTCO2e)	Lifetime Embody	Lifetime Energy	Average Building Life Span	Energy / yr	Embodied
Single-Family Home............................	717		98	672	0	552,093	70,147	481,946	57.9	8,325	0
Multi-Family Unit in Large Building	9115		33	357	0	3,556,001	298,900	3,257,100	80.5	40,437	0
Multi-Family Unit in Small Building	0		54	681	0	-	-	-	80.5	-	0
Mobile Home.......................................	0		41	475	0	-	-	-	57.9	-	0
Education		0.0	39	646	0	-	-	-	62.5	-	0
Food Sales		0.0	39	1,541	0	-	-	-	62.5	-	0
Food Service		0.0	39	1,994	0	-	-	-	62.5	-	0
Health Care Inpatient		0.0	39	1,938	0	-	-	-	62.5	-	0
Health Care Outpatient		0.0	39	737	0	-	-	-	62.5	-	0
Lodging		0	39	777	0	-	-	-	62.5	-	0
Retail (Other Than Mall)......................		966.5	39	577	0	595,332	37,419	557,914	62.5	8,920	0
Office		2,273.1	39	723	0	1,731,542	88,004	1,643,538	62.5	26,277	0
Public Assembly		0.0	39	733	0	-	-	-	62.5	-	0
Public Order and Safety		0.0	39	899	0	-	-	-	62.5	-	0
Religious Worship		0.0	39	339	0	-	-	-	62.5	-	0
Service		0.0	39	599	0	-	-	-	62.5	-	0
Warehouse and Storage		0.0	39	352	0	-	-	-	62.5	-	0
Other		126.4	39	1,278	0	166,495	4,894	161,601	62.5	2,584	0
Vacant		0.0	39	162	0	-	-	-	62.5	-	0
										86,542	0

Annual Energy Emissions....................	86,542
Annual Embodied Emissions...............	-
Annual Transportation, with VMT Tool..	72,173
Annual Project Emmisions:	**159,000**

2035 U District EIS (with VMT tool)

Section I: Buildings

			Emissions Per Unit or Per Thousand Square Feet (MTCO2e)					2035 Project Area	2035 Target growth		
Type (Residential) or Principal Activity (Commercial)	# Units	Square Feet (in thousands of square feet)	Embodied	Energy	Transportation	Lifespan Emissions (MTCO2e)	Average Building Life Span	Energy Emissions/ Year	Embodied Emissions/Year	Embodied Units	Embodied Square Feet (thousands of square feet)
Single-Family Home............................	975		98	672	0	750,755	57.9	11,320	-	0	
Multi-Family Unit in Large Building	13314		33	357	0	5,194,141	80.5	59,065	1,574	3866	
Multi-Family Unit in Small Building	0		54	681	0	-	80.5	-	-	0	
Mobile Home.......................................	0		41	475	0	-	57.9	-	-	0	
Education		0.0	39	646	0	-	62.5	-	-		
Food Sales		0.0	39	1,541	0	-	62.5	-	-		
Food Service		0.0	39	1,994	0	-	62.5	-	-		
Health Care Inpatient		0.0	39	1,938	0	-	62.5	-	-		
Health Care Outpatient		0.0	39	737	0	-	62.5	-	-		
Lodging		0	39	777	0	-	62.5	-	-		
Retail (Other Than Mall)......................		958.0	39	577	0	590,097	62.5	8,841	-		
Office		4,169.7	39	723	0	3,176,284	62.5	48,202	884		1428.3
Public Assembly		0.0	39	733	0	-	62.5	-	-		
Public Order and Safety		0.0	39	899	0	-	62.5	-	-		
Religious Worship		0.0	39	339	0	-	62.5	-	-		
Service		0.0	39	599	0	-	62.5	-	-		
Warehouse and Storage		0.0	39	352	0	-	62.5	-	-		
Other		90.6	39	1,278	0	119,264	62.5	1,851	-		
Vacant		0.0	39	162	0	-	62.5	-	-		
								129,279	2,458		

Annual Energy Emissions.................... 129,279
Annual Embodied Emissions............... 2,458
Annual Transportation, with VMT Tool..
No Action.................... 86,241
Alt 1.................... 84,401
Alt 2.................... 84,631

Annual Project Emmisions:
No Action.................... **218,000**
Alt 1.................... **216,000**
Alt 2.................... **216,000**

Version 1.7 12/26/07

King County Department of Development and Environmental Services
SEPA GHG Emissions Worksheet
Version 1.7 12/26/07

Introduction
The Washington State Environmental Policy Act (SEPA) requires environmental review of development proposals that may have a significant adverse impact on the environment. If a proposed development is subject to SEPA, the project proponent is required to complete the SEPA Checklist. The Checklist includes questions relating to the development's air emissions. The emissions that have traditionally been considered cover smoke, dust, and industrial and automobile emissions. With our understanding of the climate change impacts of GHG emissions, King County requires the applicant to also estimate these emissions.

Emissions created by Development
GHG emissions associated with development come from multiple sources:
- The extraction, processing, transportation, construction and disposal of materials and landscape disturbance (Embodied Emissions)
- Energy demands created by the development after it is completed (Energy Emissions)
- Transportation demands created by the development after it is completed (Transportation Emissions)

GHG Emissions Worksheet
King County has developed a GHG Emissions Worksheet that can assist applicants in answering the SEPA Checklist question relating to GHG emissions.

The SEPA GHG Emissions worksheet estimates all GHG emissions that will be created over the life span of a project. This includes emissions associated with obtaining construction materials, fuel used during construction, energy consumed during a buildings operation, and transportation by building occupants.

Using the Worksheet
1. Descriptions of the different residential and commercial building types can be found on the second tabbed worksheet ("Definition of Building Types"). If a development proposal consists of multiple projects, e.g. both single family and multi-family residential structures or a commercial development that consists of more than on type of commercial activity, the appropriate information should be estimated for each type of building or activity.

2. For paving, estimate the total amount of paving (in thousands of square feet) of the project.

3. The Worksheet will calculate the amount of GHG emissions associated with the project and display the amount in the "Total Emissions" column on the worksheet. The applicant should use this information when completing the SEPA checklist.

4. The last three worksheets in the Excel file provide the background information that is used to calculate the total GHG emissions.

5. The methodology of creating the estimates is transparent; if there is reason to believe that a better estimate can be obtained by changing specific values, this can and should be done. Changes to the values should be documented with an explanation of why and the sources relied upon.

6. Print out the “Total Emissions” worksheet and attach it to the SEPA checklist. If the applicant has made changes to the calculations or the values, the documentation supporting those changes should also be attached to the SEPA checklist.

Definition of Building Types

Type (Residential) or Principal Activity (Commercial)	Description
Single-Family Home..................................	Unless otherwise specified, this includes both attached and detached buildings
Multi-Family Unit in Large Building	Apartments in buildings with more than 5 units
Multi-Family Unit in Small Building	Apartments in building with 2-4 units
Mobile Home...	
Education	Buildings used for academic or technical classroom instruction, such as elementary, middle, or high schools, and classroom buildings on college or university campuses. Buildings on education campuses for which the main use is not classroom are included in the category relating to their use. For example, administration buildings are part of "Office," dormitories are "Lodging," and libraries are "Public Assembly."
Food Sales	Buildings used for retail or wholesale of food.
Food Service	Buildings used for preparation and sale of food and beverages for consumption.
Health Care Inpatient	Buildings used as diagnostic and treatment facilities for inpatient care.
Health Care Outpatient	Buildings used as diagnostic and treatment facilities for outpatient care. Doctor's or dentist's office are included here if they use any type of diagnostic medical equipment (if they do not, they are categorized as an office building).
Lodging	Buildings used to offer multiple accommodations for short-term or long-term residents, including skilled nursing and other residential care buildings.
Retail (Other Than Mall)............................	Buildings used for the sale and display of goods other than food.
Office	Buildings used for general office space, professional office, or administrative offices. Doctor's or dentist's office are included here if they do not use any type of diagnostic medical equipment (if they do, they are categorized as an outpatient health care building).
Public Assembly	Buildings in which people gather for social or recreational activities, whether in private or non-private meeting halls.
Public Order and Safety	Buildings used for the preservation of law and order or public safety.
Religious Worship	Buildings in which people gather for religious activities, (such as chapels, churches, mosques, synagogues, and temples).
Service	Buildings in which some type of service is provided, other than food service or retail sales of goods
Warehouse and Storage	Buildings used to store goods, manufactured products, merchandise, raw materials, or personal belongings (such as self-storage).
Other	Buildings that are industrial or agricultural with some retail space; buildings having several different commercial activities that, together, comprise 50 percent or more of the floorspace, but whose largest single activity is agricultural, industrial/ manufacturing, or residential; and all other miscellaneous buildings that do not fit into any other category.
Vacant	Buildings in which more floorspace was vacant than was used for any single commercial activity at the time of interview. Therefore, a vacant building may have some occupied floorspace.

Sources: ....

Residential 2001 Residential Energy Consumption Survey
Square footage measurements and comparisons
http://www.eia.doe.gov/emeu/recs/sqft-measure.html

Commercial Commercial Buildings Energy Consumption Survey (CBECS),
Description of CBECS Building Types
http://www.eia.doe.gov/emeu/cbecs/pba99/bldgtypes.html

Embodied Emissions Worksheet

Section I: Buildings

Type (Residential) or Principal Activity (Commercial)	# thousand sq feet/ unit or building	Life span related embodied GHG missions (MTCO2e/ unit)	Life span related embodied GHG missions (MTCO2e/ thousand square feet) - See calculations in table below
Single-Family Home................................	2.53	98	39
Multi-Family Unit in Large Building	0.85	33	39
Multi-Family Unit in Small Building	1.39	54	39
Mobile Home...	1.06	41	39
Education	25.6	991	39
Food Sales	5.6	217	39
Food Service	5.6	217	39
Health Care Inpatient	241.4	9,346	39
Health Care Outpatient	10.4	403	39
Lodging	35.8	1,386	39
Retail (Other Than Mall)..........................	9.7	376	39
Office	14.8	573	39
Public Assembly	14.2	550	39
Public Order and Safety	15.5	600	39
Religious Worship	10.1	391	39
Service	6.5	252	39
Warehouse and Storage	16.9	654	39
Other	21.9	848	39
Vacant	14.1	546	39

Section II: Pavement.............................

All Types of Pavement............................			50

	Columns and Beams	Intermediate Floors	Exterior Walls	Windows	Interior Walls	Roofs	Total Embodied Emissions (MTCO2e)	Total Embodied Emissions (MTCO2e/ thousand sq feet)
Average GWP (lbs CO2e/sq ft): Vancouver, Low Rise Building	5.3	7.8	19.1	51.2	5.7	21.3		
Average Materials in a 2,272-square foot single family home	0.0	2269.0	3206.0	285.0	6050.0	3103.0		
MTCO2e	0.0	8.0	27.8	6.6	15.6	30.0	88.0	38.7

Sources

All data in black text	King County, DNRP. Contact: Matt Kuharic, matt.kuharic@kingcounty.gov
Residential floorspace per unit	2001 Residential Energy Consumption Survey (National Average, 2001) Square footage measurements and comparisons http://www.eia.doe.gov/emeu/recs/sqft-measure.html
Floorspace per building	EIA, 2003 Commercial Buildings Energy Consumption Survey (National Average, 2003) Table C3. Consumption and Gross Energy Intensity for Sum of Major Fuels for Non-Mall Buildings, 2003 http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set9/2003excel/c3.xls
Average GWP (lbs CO2e/sq ft): Vancouver, Low Rise Building	Athena EcoCalculator Athena Assembly Evaluation Tool v2.3- Vancouver Low Rise Building Assembly Average GWP (kg) per square meter http://www.athenasmi.ca/tools/ecoCalculator/index.html Lbs per kg 2.20 Square feet per square meter 10.76
Average Materials in a 2,272-square foot single family home	Buildings Energy Data Book: 7.3 Typical/Average Household Materials Used in the Construction of a 2,272-Square-Foot Single-Family Home, 2000 http://buildingsdatabook.eren.doe.gov/?id=view_book_table&TableID=2036&t=xls See also: NAHB, 2004 Housing Facts, Figures and Trends, Feb. 2004, p. 7.
Average window size	Energy Information Administration/Housing Characteristics 1993 Appendix B, Quality of the Data. Pg. 5. ftp://ftp.eia.doe.gov/pub/consumption/residential/rx93hcf.pdf
Pavement Emissions Factors	

MTCO2e/thousand square feet of asphalt or concrete pavement	50 (see below)	

Embodied GHG Emissions……………………..Worksheet Background Information

Buildings
Embodied GHG emissions are emissions that are created through the extraction, processing, transportation, construction and disposal of building materials as well as emissions created through landscape disturbance (by both soil disturbance and changes in above ground biomass).

Estimating embodied GHG emissions is new field of analysis; the estimates are rapidly improving and becoming more inclusive of all elements of construction and development.

The estimate included in this worksheet is calculated using average values for the main construction materials that are used to create a typical family home. In 2004, the National Association of Home Builders calculated the average materials that are used in a typical 2,272 square foot single-family household. The quantity of materials used is then multiplied by the average GHG emissions associated with the life-cycle GHG emissions for each material.

This estimate is a rough and conservative estimate; the actual embodied emissions for a project are likely to be higher. For example, at this stage, due to a lack of comprehensive data, the estimate does not include important factors such as landscape disturbance or the emissions associated with the interior components of a building (such as furniture).

King County realizes that the calculations for embodied emissions in this worksheet are rough. For example, the emissions associated with building 1,000 square feet of a residential building will not be the same as 1,000 square feet of a commercial building. However, discussions with the construction community indicate that while there are significant differences between the different types of structures, this method of estimation is reasonable; it will be improved as more data become available.

Additionally, if more specific information about the project is known, King County recommends two online embodied emissions calculators that can be used to obtain a more tailored estimate for embodied emissions: www.buildcarbonneutral.org and www.athenasmi.ca/tools/ecoCalculator/.

Pavement
Four recent life cycle assessments of the environmental impacts of roads form the basis for the per unit embodied emissions of pavement. Each study is constructed in slightly different ways; however, the aggregate results of the reports represent a reasonable estimate of the GHG emissions that are created from the manufacture of paving materials, construction related emissions, and maintenance of the pavement over its expected life cycle. For specifics, see the worksheet.

Special Section: Estimating the Embodied Emissions for Pavement

Four recent life cycle assessments of the environmental impacts of roads form the basis for the per unit embodied emissions of pavement. Each study is constructed in slightly different ways; however, the aggregate results of the reports represent a reasonable estimate of the GHG emissions that are created from the manufacture of paving materials, construction related emissions, and maintenance of the pavement over its expected life cycle.

The results of the studies are presented in different units and measures; considerable effort was undertaken to be able to compare the results of the studies in a reasonable way. For more details about the below methodology, contact matt.kuharic@kingcounty.gov.

The four studies, Meil (2001), Park (2003), Stripple (2001) and Treolar (2001) produced total GHG emissions of 4-34 MTCO2e per thousand square feet of finished paving (for similar asphalt and concrete based pavements). This estimate does not including downstream maintenance and repair of the highway. The average (for all concrete and asphalt pavements in the studies, assuming each study gets one data point) is ~17 MTCO2e/thousand square feet.

Three of the studies attempted to thoroughly account for the emissions associated with long term maintenance (40 years) of the roads. Stripple (2001), Park et al. (2003) and Treolar (2001) report 17, 81, and 68 MTCO2e/thousand square feet, respectively, after accounting for maintenance of the roads.

Based on the above discussion, King County makes the conservative estimate that 50 MTCO2e/thousand square feet of pavement (over the development's life cycle) will be used as the embodied emission factor for pavement until better estimates can be obtained. This is roughly equivalent to 3,500 MTCO2e per lane mile of road (assuming the lane is 13 feet wide).

It is important to note that these studies estimate the embodied emissions for roads. Paving that does not need to stand up to the rigors of heavy use (such as parking lots or driveways) would likely use less materials and hence have lower embodied emissions.

Sources:
Meil, J. A Life Cycle Perspective on Concrete and Asphalt Roadways: Embodied Primary Energy and Global Warming Potential. 2006. Available: http://www.cement.ca/cement.nsf/eee9ec7bbd630126852566c40052107b/6ec79dc8ae03a782852572b90061b914/$FILE/ATTK0WE3/athena%20report%20Feb.%202%202007.pdf

Park, K, Hwang, Y., Seo, S., M.ASCE, and Seo, H. , “Quantitative Assessment of Environmental Impacts on Life Cycle of Highways,” Journal of Construction Engineering and Management , Vol 129, January/February 2003, pp 25-31, (DOI: 10.1061/(ASCE)0733-9364(2003)129:1(25)).

Stripple, H. Life Cycle Assessment of Road. A Pilot Study for Inventory Analysis. Second Revised Edition. IVL Swedish Environmental Research Institute Ltd. 2001. Available: http://www.ivl.se/rapporter/pdf/B1210E.pdf

Treloar, G., Love, P.E.D., and Crawford, R.H. Hybrid Life-Cycle Inventory for Road Construction and Use. Journal of Construction Engineering and Management. P. 43-49. January/February 2004.

Energy Emissions Worksheet

Type (Residential) or Principal Activity (Commercial)	Energy consumption per building per year (million Btu)	Carbon Coefficient for Buildings	MTCO2e per building per year	Floorspace per Building (thousand square feet)	MTCE per thousand square feet per year	MTCO2e per thousand square feet per year	Average Building Life Span	Lifespan Energy Related MTCO2e emissions per unit	Lifespan Energy Related MTCO2e emissions per thousand square feet
Single-Family Home.............................	107.3	0.108	11.61	2.53	4.6	16.8	57.9	672	266
Multi-Family Unit in Large Building	41.0	0.108	4.44	0.85	5.2	19.2	80.5	357	422
Multi-Family Unit in Small Building	78.1	0.108	8.45	1.39	6.1	22.2	80.5	681	489
Mobile Home...	75.9	0.108	8.21	1.06	7.7	28.4	57.9	475	448
Education	2,125.0	0.124	264.2	25.6	10.3	37.8	62.5	16,526	646
Food Sales	1,110.0	0.124	138.0	5.6	24.6	90.4	62.5	8,632	1,541
Food Service	1,436.0	0.124	178.5	5.6	31.9	116.9	62.5	11,168	1,994
Health Care Inpatient	60,152.0	0.124	7,479.1	241.4	31.0	113.6	62.5	467,794	1,938
Health Care Outpatient	985.0	0.124	122.5	10.4	11.8	43.2	62.5	7,660	737
Lodging	3,578.0	0.124	444.9	35.8	12.4	45.6	62.5	27,826	777
Retail (Other Than Mall)........................	720.0	0.124	89.5	9.7	9.2	33.8	62.5	5,599	577
Office	1,376.0	0.124	171.1	14.8	11.6	42.4	62.5	10,701	723
Public Assembly	1,338.0	0.124	166.4	14.2	11.7	43.0	62.5	10,405	733
Public Order and Safety	1,791.0	0.124	222.7	15.5	14.4	52.7	62.5	13,928	899
Religious Worship	440.0	0.124	54.7	10.1	5.4	19.9	62.5	3,422	339
Service	501.0	0.124	62.3	6.5	9.6	35.1	62.5	3,896	599
Warehouse and Storage	764.0	0.124	95.0	16.9	5.6	20.6	62.5	5,942	352
Other	3,600.0	0.124	447.6	21.9	20.4	74.9	62.5	27,997	1,278
Vacant	294.0	0.124	36.6	14.1	2.6	9.5	62.5	2,286	162

Sources

All data in black text — King County, DNRP. Contact: Matt Kuharic, matt.kuharic@kingcounty.gov

Energy consumption for residential buildings — 2007 Buildings Energy Data Book: 6.1 Quad Definitions and Comparisons (National Average, 2001)
Table 6.1.4: Average Annual Carbon Dioxide Emissions for Various Functions
http://buildingsdatabook.eren.doe.gov/
Data also at: http://www.eia.doe.gov/emeu/recs/recs2001_ce/ce1-4c_housingunits2001.html

Energy consumption for commercial buildings and Floorspace per building — EIA, 2003 Commercial Buildings Energy Consumption Survey (National Average, 2003)
Table C3. Consumption and Gross Energy Intensity for Sum of Major Fuels for Non-Mall Buildings, 2003
http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set9/2003excel/c3.xls

Note: Data in plum color is found in both of the above sources (buildings energy data book and commercial buildings energy consumption survey).

Carbon Coefficient for Buildings — Buildings Energy Data Book (National average, 2005)
Table 3.1.7. 2005 Carbon Dioxide Emission Coefficients for Buildings (MMTCE per Quadrillion Btu)
http://buildingsdatabook.eere.energy.gov/?id=view_book_table&TableID=2057
Note: Carbon coefficient in the Energy Data book is in MTCE per Quadrillion Btu.
To convert to MTCO2e per million Btu, this factor was divided by 1000 and multiplied by 44/12.

Residential floorspace per unit — 2001 Residential Energy Consumption Survey (National Average, 2001)
Square footage measurements and comparisons
http://www.eia.doe.gov/emeu/recs/sqft-measure.html

average lief span of buildings, estimated by replacement time method

	Single Family Homes	Multi-Family Units in Large and Small Buildings	All Residential Buildings	
New Housing Construction, 2001	1,273,000	329,000	1,602,000	
Existing Housing Stock, 2001	73,700,000	26,500,000	100,200,000	
Replacement time:	57.9	80.5	62.5	(national average, 2001)

Note: Single family homes calculation is used for mobile homes as a best estimate life span.
Note: At this time, KC staff could find no reliable data for the average life span of commercial buildings.
Therefore, the average life span of residential buildings is being used until a better approximation can be ascertained.

Sources:

New Housing Construction, 2001 **Quarterly Starts and Completions by Purpose and Design - US and Regions (Excel)**
http://www.census.gov/const/quarterly_starts_completions_cust.xls
See also: http://www.census.gov/const/www/newresconstindex.html

Existing Housing Stock, 2001 **Residential Energy Consumption Survey (RECS) 2001**
Tables HC1:Housing Unit Characteristics, Million U.S. Households 2001
Table HC1-4a. Housing Unit Characteristics by Type of Housing Unit, Million U.S. Households, 2001
Million U.S. Households, 2001
http://www.eia.doe.gov/emeu/recs/recs2001/hc_pdf/housunits/hc1-4a_housingunits2001.pdf

Transportation Emissions Worksheet

Type (Residential) or Principal Activity (Commercial)	# people/ unit or building	# thousand sq feet/ unit or building	# people or employees/ thousand square feet	vehicle related GHG emissions (metric tonnes CO2e per person per year)	MTCO2e/ year/ unit	MTCO2e/ year/ thousand square feet	Average Building Life Span	Life span transportation related GHG emissions (MTCO2e/ per unit)	Life span transportation related GHG emissions (MTCO2e/ thousand sq feet)
Single-Family Home..................................	2.8	2.53	1.1	4.9	13.7	5.4	57.9	792	313
Multi-Family Unit in Large Building	1.9	0.85	2.3	4.9	9.5	11.2	80.5	766	904
Multi-Family Unit in Small Building	1.9	1.39	1.4	4.9	9.5	6.8	80.5	766	550
Mobile Home...	2.5	1.06	2.3	4.9	12.2	11.5	57.9	709	668
Education	30.0	25.6	1.2	4.9	147.8	5.8	62.5	9247	361
Food Sales	5.1	5.6	0.9	4.9	25.2	4.5	62.5	1579	282
Food Service	10.2	5.6	1.8	4.9	50.2	9.0	62.5	3141	561
Health Care Inpatient	455.5	241.4	1.9	4.9	2246.4	9.3	62.5	140506	582
Health Care Outpatient	19.3	10.4	1.9	4.9	95.0	9.1	62.5	5941	571
Lodging	13.6	35.8	0.4	4.9	67.1	1.9	62.5	4194	117
Retail (Other Than Mall)............................	7.8	9.7	0.8	4.9	38.3	3.9	62.5	2394	247
Office	28.2	14.8	1.9	4.9	139.0	9.4	62.5	8696	588
Public Assembly	6.9	14.2	0.5	4.9	34.2	2.4	62.5	2137	150
Public Order and Safety	18.8	15.5	1.2	4.9	92.7	6.0	62.5	5796	374
Religious Worship	4.2	10.1	0.4	4.9	20.8	2.1	62.5	1298	129
Service	5.6	6.5	0.9	4.9	27.6	4.3	62.5	1729	266
Warehouse and Storage	9.9	16.9	0.6	4.9	49.0	2.9	62.5	3067	181
Other	18.3	21.9	0.8	4.9	90.0	4.1	62.5	5630	257
Vacant	2.1	14.1	0.2	4.9	10.5	0.7	62.5	657	47

Sources

All data in black text — King County, DNRP. Contact: Matt Kuharic, matt.kuharic@kingcounty.gov

people/ unit — Estimating Household Size for Use in Population Estimates (WA state, 2000 average)
Washington State Office of Financial Management
Kimpel, T. and Lowe, T. Research Brief No. 47. August 2007
http://www.ofm.wa.gov/researchbriefs/brief047.pdf
Note: This analysis combines Multi Unit Structures in both large and small units into one category;
the average is used in this case although there is likely a difference

Residential floorspace per unit — 2001 Residential Energy Consumption Survey (National Average, 2001)
Square footage measurements and comparisons
http://www.eia.doe.gov/emeu/recs/sqft-measure.html

employees/thousand square feet — Commercial Buildings Energy Consumption Survey commercial energy uses and costs (National Median, 2003)
Table B2 Totals and Medians of Floorspace, Number of Workers, and Hours of Operation for Non-Mall Buildings, 2003
http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set1/2003excel/b2.xls

Note: Data for # employees/thousand square feet is presented by CBECS as square feet/employee.
In this analysis employees/thousand square feet is calculated by taking the inverse of the CBECS number and multiplying by 1000.

vehicle related GHG emissions

Estimate calculated as follows (Washington state, 2006)_

56,531,930,000	2006 Annual WA State Vehicle Miles Traveled	
		Data was daily VMT. Annual VMT was 365*daily VMT.
		http://www.wsdot.wa.gov/mapsdata/tdo/annualmileage.htm
6,395,798	2006 WA state population	
		http://quickfacts.census.gov/qfd/states/53000.html
8839	vehicle miles per person per year	
0.0506	gallon gasoline/mile	
		This is the weighted national average fuel efficiency for all cars and 2 axle, 4 wheel light trucks in 2005. This includes pickup trucks, vans and SUVs. The 0.051 gallons/mile used here is the inverse of the more commonly known term “miles/per gallon” (which is 19.75 for these cars and light trucks).
		Transportation Energy Data Book. 26th Edition. 2006. Chapter 4: Light Vehicles and Characteristics. Calculations based on weighted average MPG efficiency of cars and light trucks.
		http://cta.ornl.gov/data/tedb26/Edition26_Chapter04.pdf
		Note: This report states that in 2005, 92.3% of all highway VMT were driven by the above described vehicles.
		http://cta.ornl.gov/data/tedb26/Spreadsheets/Table3_04.xls
24.3	lbs CO2e/gallon gasoline	
		The CO2 emissions estimates for gasoline and diesel include the extraction, transport, and refinement of petroleum as well as their combustion.
		Life-Cycle CO2 Emissions for Various New Vehicles. RENew Northfield.
		Available: http://renewnorthfield.org/wpcontent/uploads/2006/04/CO2%20emissions.pdf
		Note: This is a conservative estimate of emissions by fuel consumption because diesel fuel,
2205		with a emissions factor of 26.55 lbs CO2e/gallon was not estimated.
4.93	lbs/metric tonne	
	vehicle related GHG emissions (metric tonnes CO2e per person per year)	

average lief span of buildings, estimated by replacement time method	See Energy Emissions Worksheet for Calculations
Commercial floorspace per unit	EIA, 2003 Commercial Buildings Energy Consumption Survey (National Average, 2003) Table C3. Consumption and Gross Energy Intensity for Sum of Major Fuels for Non-Mall Buildings, 2003 http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set9/2003excel/c3.xls

Example VMT Tool Results for 2035 No Action

PM VMT By Speed Bin	No Action Alt	EMFAC	Daily tonnes
0-5 MPH	0	1,171.72	0.000424746
5-10 MPH	1,428	895.207	1.278529744
10-15 MPH	1,768	709.93	1.255213868
15-20 MPH	1,104	584.789	0.645366262
20-25 MPH	7,075	502.632	3.55611134
25-30 MPH	29,580	447.285	13.23087396
30-35 MPH	7,304	411.572	3.006238355
35-40 MPH	3,895	391.228	1.523958577
40-45 MPH	1,000	383.986	0.384048882
45-50 MPH	1,018	389.117	0.396201588
50-55 MPH	568	407.285	0.231296003
55-60 MPH	47,248	440.683	20.8212872
60-65 MPH	0	493.475	0
65-70 MPH	212	498.673	0.105905076
70+ MPH	227	506.806	0.114922464

TOTAL VMT	**102,428**

Total Daily Tonnes CO2e	245.0019947
Annual Tonnes	86,241

HH	14308
Jobs	15957
Service Population	45229
Daily VMT /person Estimate	18.11729405

PM Peak Period Pounds per person 2.26

FACT SHEET
1. SUMMARY
2. ALTERNATIVES
3. ANALYSIS
4. REFERENCES
APPENDICES

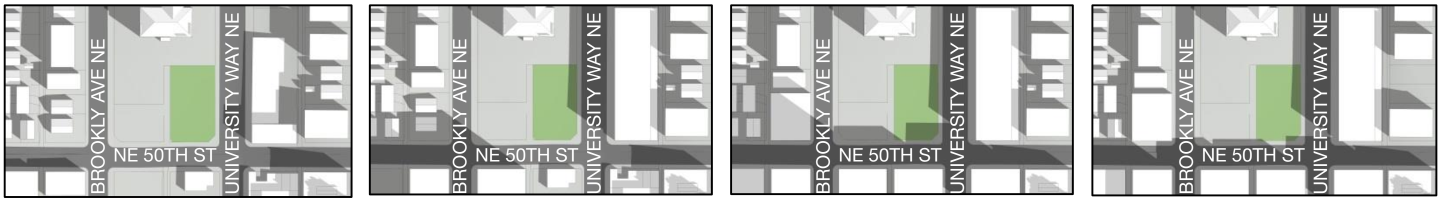
F. Shadow Impacts

Figure X

University Heights Open Space

September 21

9am

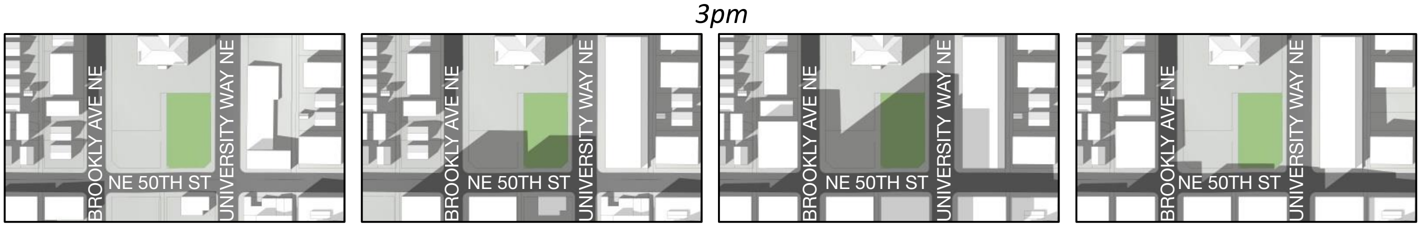


EXISTING ALT 1 ALT 2 ALT3

12 noon

EXISTING ALT 1 ALT 2 ALT3

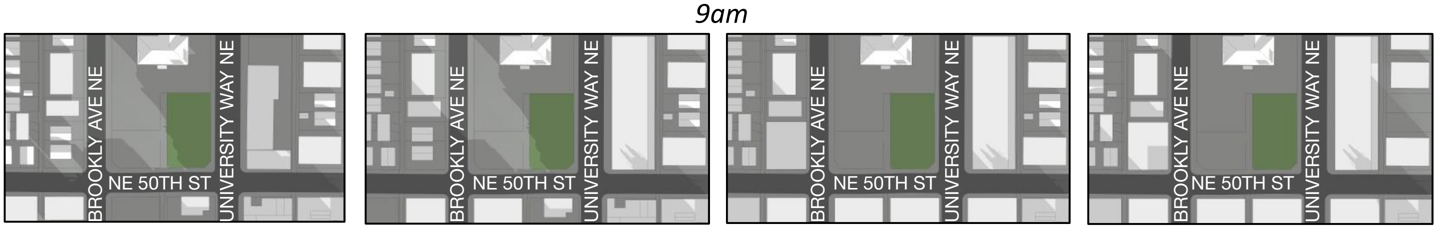
3pm



EXISTING ALT 1 ALT 2 ALT3

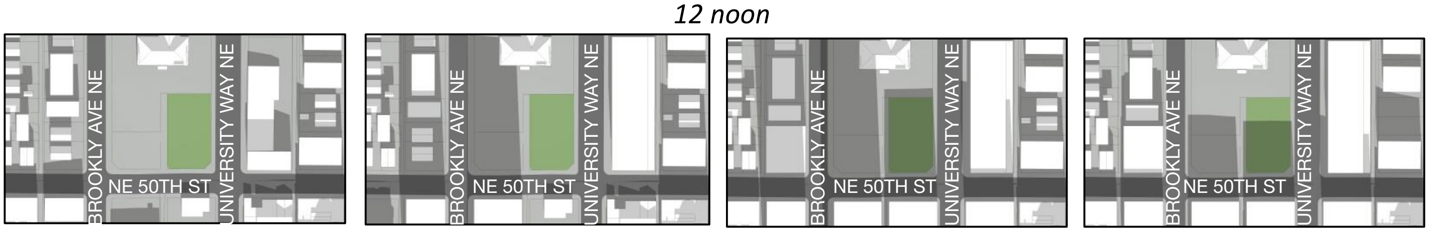
December 21

9am



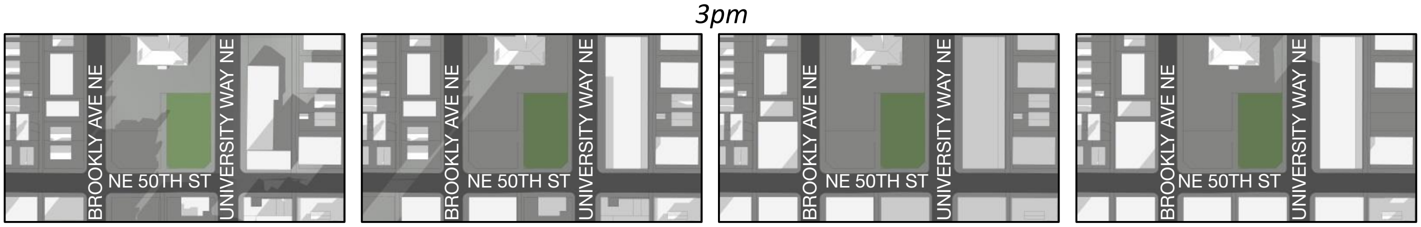
EXISTING ALT 1 ALT 2 ALT3

12 noon



EXISTING ALT 1 ALT 2 ALT3

3pm



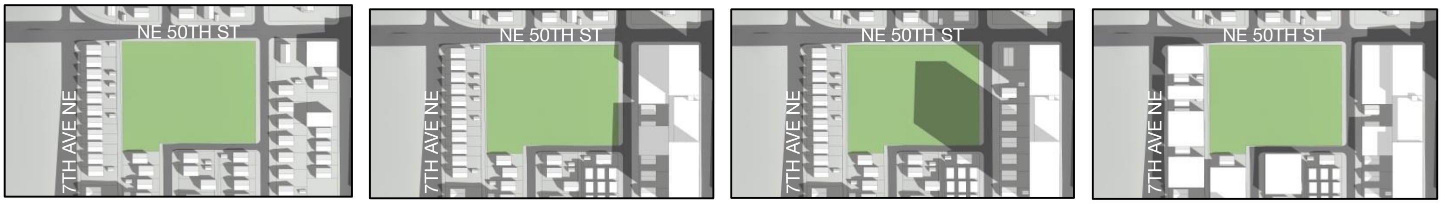
EXISTING ALT 1 ALT 2 ALT3

Figure X

University Playground

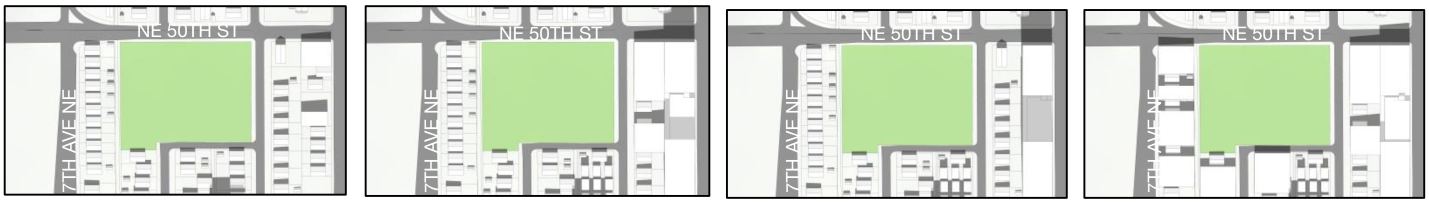
September 21

9am



EXISTING ALT 1 ALT 2 ALT3

12 noon



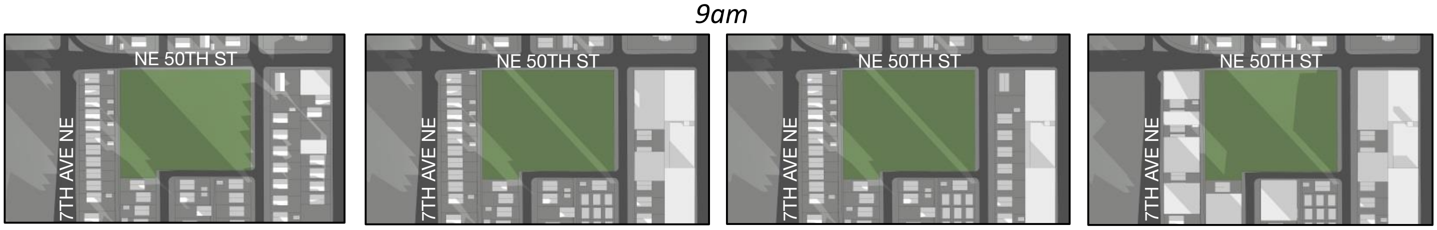
EXISTING ALT 1 ALT 2 ALT3

3pm

EXISTING ALT 1 ALT 2 ALT3

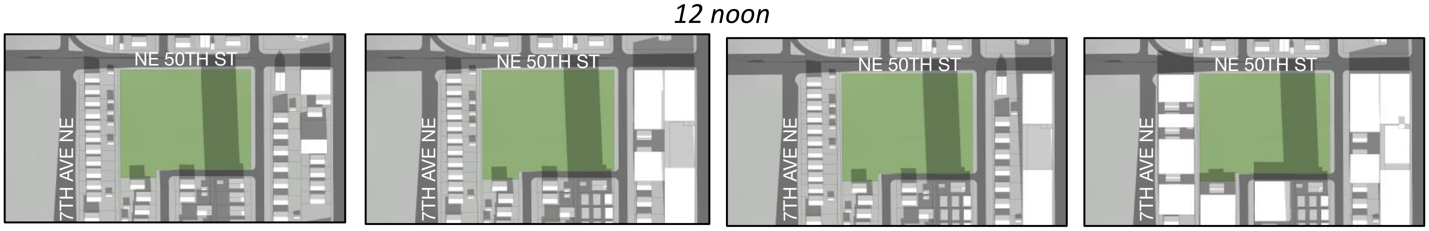
December 21

9am



EXISTING ALT 1 ALT 2 ALT3

12 noon



EXISTING ALT 1 ALT 2 ALT3

3pm

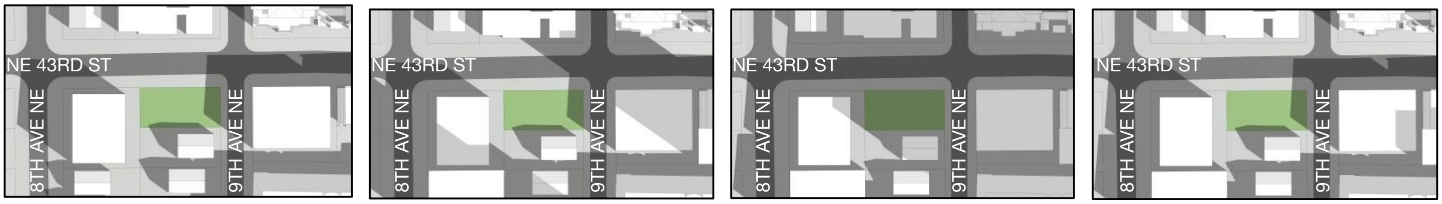
EXISTING ALT 1 ALT 2 ALT3

Figure X

Christie Park

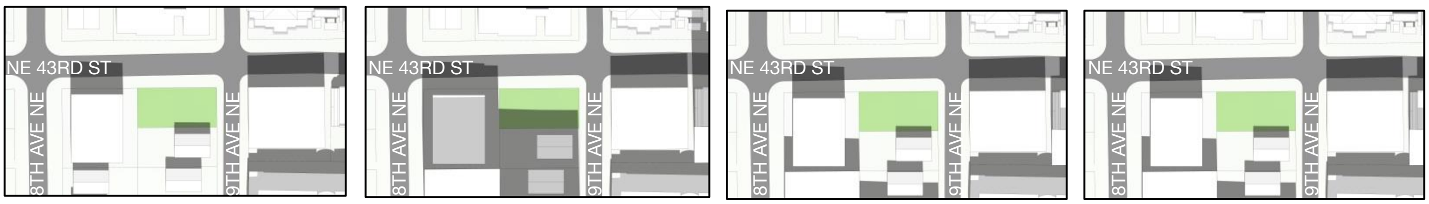
September 21

9am



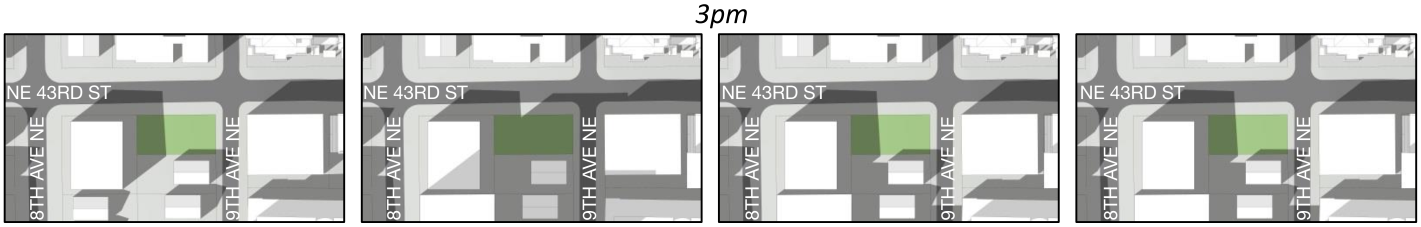
EXISTING ALT 1 ALT 2 ALT3

12 noon



EXISTING ALT 1 ALT 2 ALT3

3pm



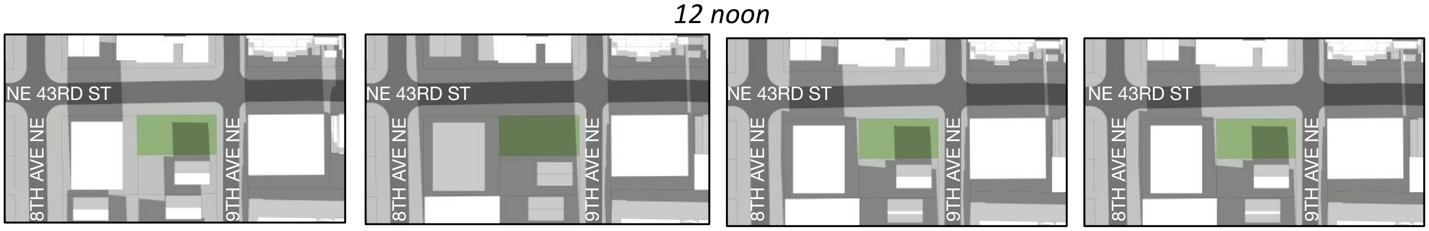
EXISTING ALT 1 ALT 2 ALT3

December 21

9am

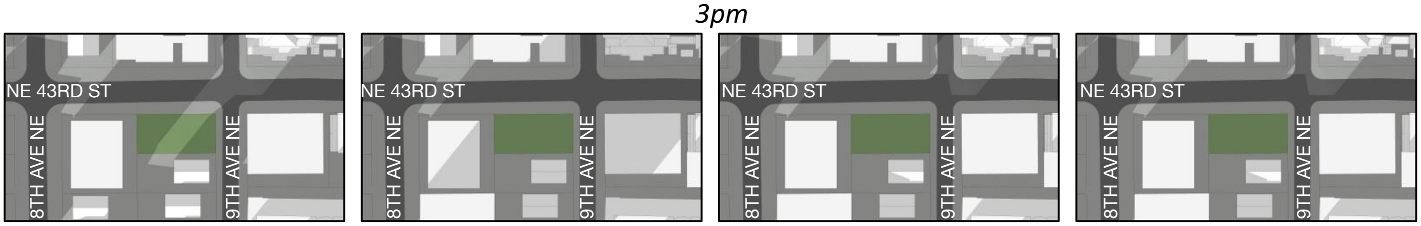
EXISTING ALT 1 ALT 2 ALT3

12 noon



EXISTING ALT 1 ALT 2 ALT3

3pm



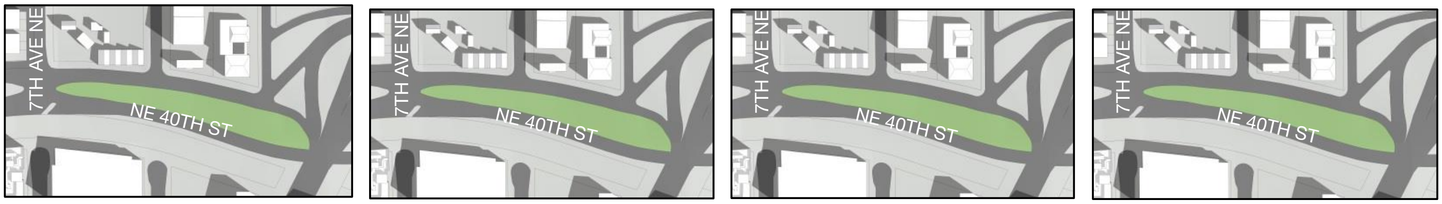
EXISTING ALT 1 ALT 2 ALT3

Figure X

Peace Park

September 21

9am



EXISTING ALT 1 ALT 2 ALT3

12 noon

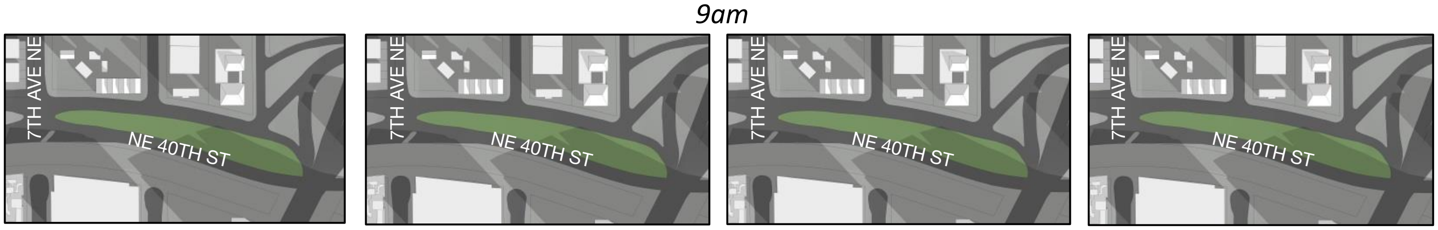
EXISTING ALT 1 ALT 2 ALT3

3pm

EXISTING ALT 1 ALT 2 ALT3

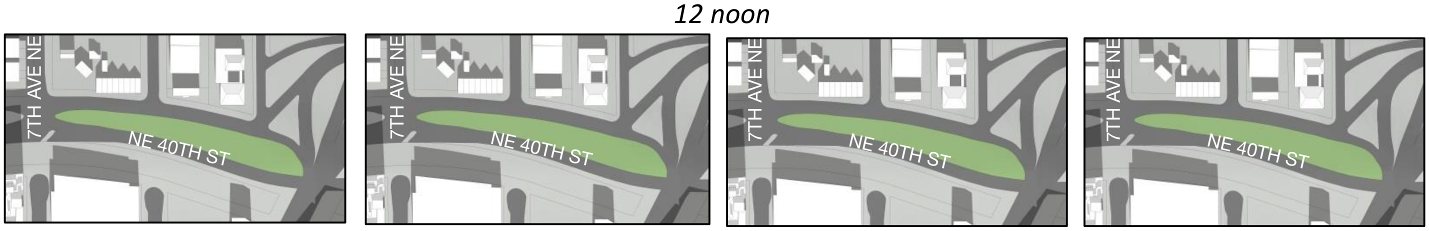
December 21

9am



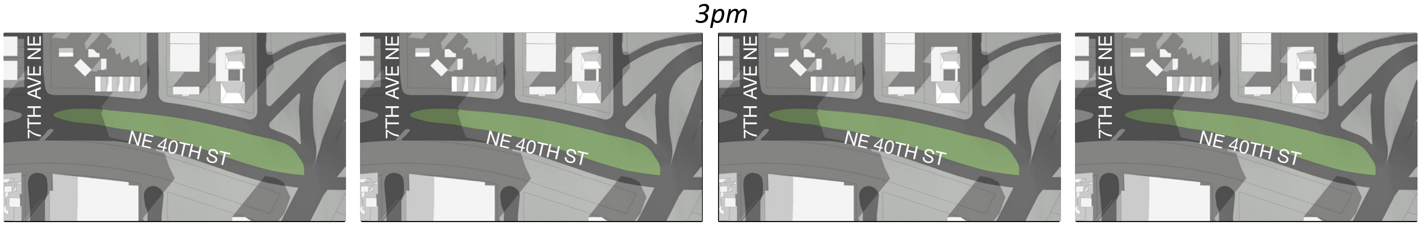
EXISTING ALT 1 ALT 2 ALT3

12 noon



EXISTING ALT 1 ALT 2 ALT3

3pm



EXISTING ALT 1 ALT 2 ALT3