Wildland Urban Interface Report

City of Bellingham

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Submitted to:

City of Bellingham, Public Works Dept.
Natural Resources Division

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1.0 Introduction

The City of Bellingham contracted Diamond Head Consulting (DHC) to assess existing forest conditions as part of Phase 1 (Assessment) of the City's Urban Forestry Management Plan (UFMP) effort. This report describes the methodology and results for one of the plan's tasks, the **wildland urban interface analysis.** This task required mapping wildland urban interface area and the forest fuel types in Bellingham. The International Wildland Urban Interface Code defines the wildland urban interface as "that geographical area where structures and other human development meets or intermingles with wildland or vegetative fuels."

This report provides a brief literature review of wildfire risk in the Pacific Northwest and a description of methodology and findings for:

- Wildland urban interface, which was mapped using Washington State's draft wildland urban interface areas for the state in 2019. DHC reviewed these results and provided feedback to the City and Washington State on their accuracy. The state is currently reviewing and updating this wildland urban interface layer therefore the map used in this report is a draft.
- Fuel types, which were classified using USDA National Fire Danger Rating system for defining fuel models that represent different vegetation types. The International Wildland Urban Interface Code further groups the fuel types into fuel load categories of light, medium, or heavy fuels. The forest inventory data was used to assign fuel types and fuel load, which are mapped in this report and were included in the forest structure GIS layer provided to the City.

2.0 Literature Review

Wildfire is an endemic natural and cultural disturbance in the forests of the Pacific Northwest. Over the past 14,000 years, fire has catalyzed ecological change within forests during periods of marked climate change (Crausbay, Higuera, Sprugel, & Brubaker, 2017). The coniferous, needle-bearing trees common in the landscape carry more flammable resins and less leaf moisture than their broadleaved counterparts. The City's temperate climate, ample rainfall, and geologically young soils create the perfect growing conditions to produce large trees and dense foliage. This high productivity results in accumulations of fuels for wildfire to consume (Morgan, Bagley, McGill, & Raymond, 2019). A history of effective fire suppression has contributed to fuel load accumulations in the Pacific Northwest. This effect is more pronounced east of the Cascades in dry forests where historic fire return intervals were shorter (Haugo, et al., 2019; Halofsky, Conklin, Donato, Halofsky, & Kim, 2018).

The amount of fuel is one side of the "fire triangle" – fuel, oxygen, and heat – the three ingredients that allow a wildfire to start and spread. While the wet, maritime climate of the region controls fire potential for much of the year, the prevalent dry summer conditions present a window during which the threat of a wildfire is real and considerable (Halofsky, Conklin, Donato, Halofsky, & Kim, 2018; Agee, Wright, Williamson, & Huff, 2002).

The trend of increased area burned by wildfires along with higher fire suppression costs has been documented across North America (Marlon, 2012). This can be in part attributed to climate change, which is contributing to hotter and drier weather in the spring and summer. This is causing vegetation to grow earlier, dry out faster, and remain dry for a longer period (Hope, McKenney, Pedlar, Stocks, & Gauthier, 2016). Since 1985, it is estimated that 50% of the increase in the area burned by wildfire in the western United States is due to human caused climate change (Abatzoglou & Williams, 2016). Worldwide, the length of the fire season has increased by 19% from 1979 to 2013.

Climate change is influencing this risk of wildfire by increasing tree morbidity and mortality. This has increased the quantity of fuel within forests, and caused extended periods of drought and high temperatures, which offer increased opportunities for wildfire ignition and spread (Flannigan, et al., 2016; Abatzoglou & Williams, 2016). The period during which weather will support fire spread, or the fire season, is projected to lengthen because of decreased summer precipitation and hotter average temperatures (Halofsky, Peterson, & Harvey, 2020; Littell, et al., 2010). Historically, wind events coming from the east during the dry season have been associated with the most extreme wildfire conditions and largest, most destructive fires (Halofsky, Conklin, Donato, Halofsky, & Kim, 2018; Cramer, 1957). During these events, relative humidity can quickly drop, providing any small ignition with a ready supply of warm, dry air (Morgan, Bagley, McGill, & Raymond, 2019). The 2020 Labor Day fires throughout Washington were an example of strong, dry winds which drove the rapid expansion of multiple wildfires. Research is ongoing by the Washington State Department of Natural Resources (WDNR) and US Forest Service (USFS) on the impacts of climate change on wildfire regimes in the forests west of the Cascades.

The extensive research being caried out to project the impacts of climate change on wildfire frequency and severity has mostly focused on landscape-scale effects that are easier to predict compared to site-specific impacts (Morgan, Bagley, McGill, & Raymond, 2019). In practice, the risk to life and property is strongly influenced by smaller-scale patterns of development, development regulation within the wildland urban interface, the location and condition of vegetation and forests in proximity to homes, and the overall strategic risk and emergency planning in place at the state and local levels (Ager, Kline, & Fischer, 2015).

The variety of biophysical and social components of wildfire risk was distilled by USFS and Portland State University researchers into “archetypes of community wildfire exposure”, which are intended to help planners and land managers guide public investments to improve wildfire risk within threatened communities in or adjacent to National Forests (Evers, Ager, Nielsen-Pincus, Paliologou, & Bunzel, 2019). This research underscores the inherent risk of low to moderate density “intermixed” development, which describes a pattern of urbanization where homes and neighborhoods are broadly scattered within a matrix of wildland vegetation and where half of estimated wildfire exposure occurs (USDA and USDI, 2001; Martinuzzi, et al., 2015).

Despite an increasing volume of research on the complexity of social-ecological and emergency management, there are still many unanswered questions about the impacts of wildfire. It remains unclear how climate change will affect the frequency and intensity of wind events during periods of summer drought. Additionally, low perceived risk in forests west of the Cascades, such as those in Bellingham, has meant there are fewer examples of successful interface fuel management and community wildfire planning projects.

The effectiveness of wildfire risk mitigation strategies is strongly influenced by fuel loading and characteristics. The types of fuel treatments that are being successfully implemented elsewhere may not be suitable in Bellingham. Local universities, Washington State Department of Natural Resources, and the USFS are collaborating on a research agenda to improve the understanding of wildfire dynamics and wildfire management west of the Cascades. The state legislature is examining ways to improve the technical resources available to communities related to forest management through the Department of Natural Resources, which has been mapping wildland urban interface areas in Washington. The International Wildland Urban Interface Code is a tool that several communities in Washington have adopted to ensure building and construction regulations and wildfire protection requirements for new developments are aligned with the level of wildfire hazard in the wildland urban interface.

The Code addresses factors that are known to reduce wildfire hazard, including road design, construction materials, water supply and the creation of defensible spaces. In order to apply the Code, a community must have defined and mapped the wildland urban interface and fuel types in their jurisdiction.

3.0 Methodology

3.1 Identifying the Wildland Urban Interface

A wildland urban interface mapping dataset was created in 2019 by the Washington State Department of Natural Resources (WDNR) - Wildfire & Forest Health Divisions in consultation with the USFS Rocky Mtn Research Station. The Department was required by State Bill 6109 to map the wildland urban interface in Washington State. This purpose of this mapping was to promote the adoption of county-based building codes that will help mitigate wildfire risk. The wildland urban interface depicts areas of Washington where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.

The International Wildland Urban Interface Code defines the wildland urban interface as "*that geographical area where structures and other human development meets or intermingles with wildland or vegetative fuels*." The USFS defines the wildland urban interface as "*an area close to or intermingled with forests and grasslands, with at least one home per 40 acres*."

Although not defined in the wildland urban interface code there are three recognized components that are considered when defining the wildland urban interface including human presence, wildland vegetation characteristics and buffer size.

The wildland urban interface polygons identified by the WDNR include two categories:

1. Intermix = Areas with at least one structure per 40 acres and wildland vegetation > 50% and not overlap water
2. Interface = Areas with at least one structure per 40 acres and are within 2.414 km (1.5mi) of areas with >= 75% wildland vegetation and not overlap water

The minimum housing density used for defining intermix and interface areas was consistent with that used by the USFS (Martinuzzi, et al., 2015) and defined in the Federal Register (Federal Register Notice, 2001). Intermix and interface polygons were ranked by structure density from very low to high. The flowchart in Appendix 1 offers a detailed breakdown of the role of structure density and fuel/vegetation cover in defining the wildland urban interface areas. Wildland urban interface mapping does not portray wildfire risk. The wildland urban interface mapping is an input to determining wildfire risk. Wildfire risk assessment often incorporates, but is not limited to, fuel types, slope/aspect terrain models and fire weather variables.

Figure 1 depicts the draft wildland urban interface mapping created in 2019 by the WDNR. The interface area polygons identified were created based on the WDNR definitions for Intermix and Interface defined above. DHC reviewed the mapping in relation to building structure data provided by the City and identified several new subdivisions and high density developments that were not included in the State's wildland urban interface mapping. Feedback was provided to WDNR on the accuracy of the wildland urban interface map and it is currently being refined for subsequent updates from the State. An update that will consider Bellingham's most recent building structure dataset is expected in the Fall of 2021.

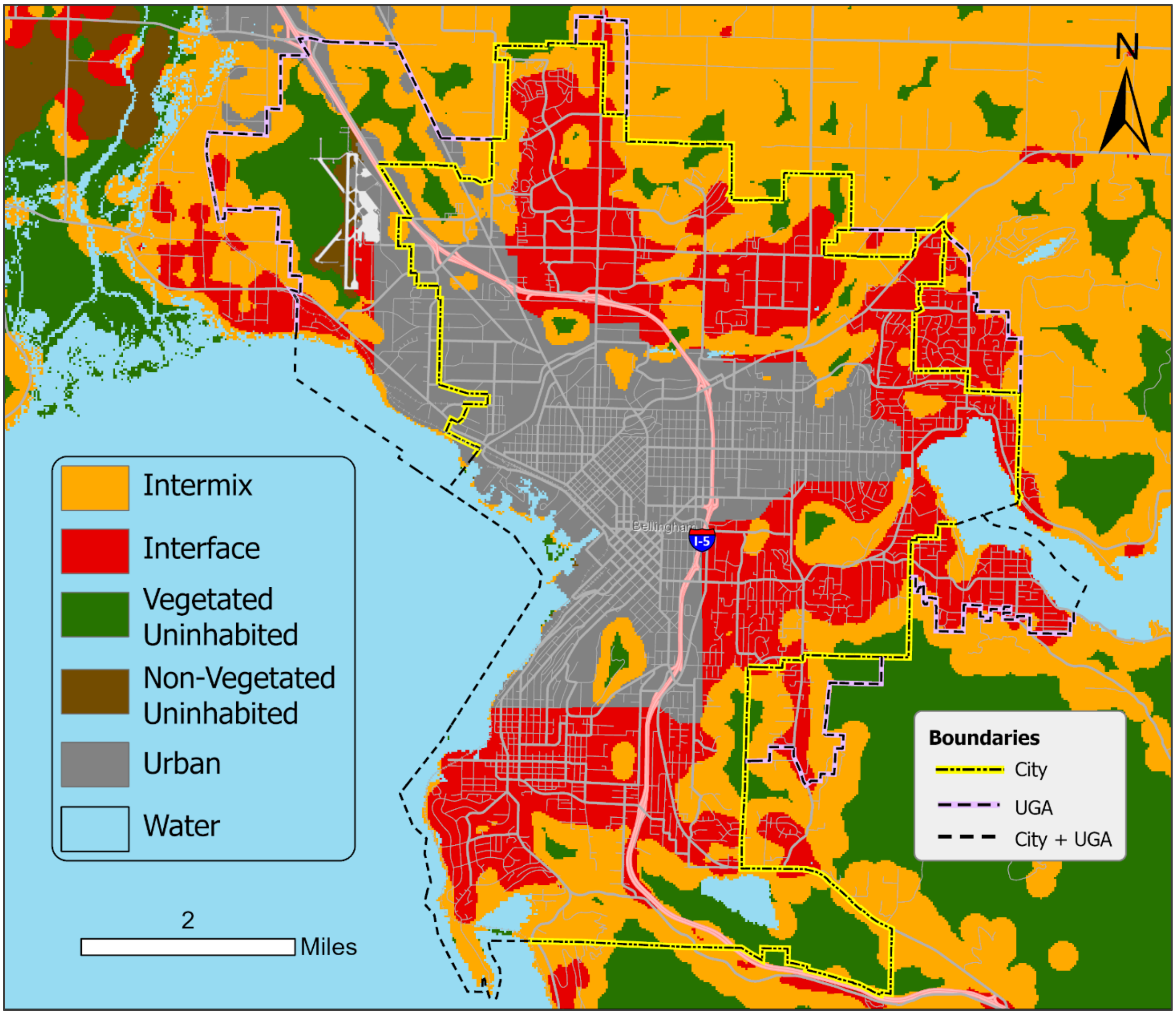

Figure 1 – DRAFT Wildland Urban Interface mapping by Washington State covering the City of Bellingham

3.2 Fuel Types

Fuel types were assigned to the City's forested areas using the USDA National Fire Danger Rating System (NFDRs) fuel models. The NFDRS fuel models are based on composition of deciduous and coniferous species, forest structure and fuel loading characteristics. The International Wildland Urban Interface Code (the Code) groups the NFDRS fuel models into light, medium and heavy fuels. The Code then uses those fuel types, along with slope and critical fire weather frequency, to define fire hazard severity. Fire hazard severity then determines the special building and construction regulations and fire protection requirements that should apply in wildland urban interface areas. DHC classified Bellingham's forested areas into NFDRS fuel models and assigned them as light, medium and heavy fuels. This section describes the fuel typing methodology and results.

Fuels were classified based on the DHC's forest structure analysis (Diamond Head Consulting, 2021) and ground truthing to collect fuel and forest structure data at 35 plots in September 2020 and March 2021. DHC's analysis of forest structure in Bellingham identified three relevant fuel models:

- **FUEL MODEL R:** This fuel model represents hardwood areas after the canopies leaf out in the spring. It is provided as the off-season substitute for Fuel Model E, which is used when hardwoods are leafless. It should be used during the summer in all hardwood and mixed conifer-hardwood stands where more than half of the overstory is deciduous.
- **FUEL MODEL H:** The short-needled conifers (white pines, spruces, larches, and firs) are represented by Fuel Model H. In contrast to Model G fuels, which are dense conifer stands with heavy litter accumulations, Fuel Model H describes a healthy stand with sparse undergrowth and a thin layer of ground fuels. Fires in the H fuels are typically slow spreading and are dangerous only in scattered areas where the downed woody material is concentrated.
- **FUEL MODEL G**: Fuel Model G is used for dense conifer stands where there is a heavy accumulation of litter and down woody material. Such stands are typically over mature and may also be suffering insect, disease, and wind or ice damage—natural events that create a very heavy buildup of dead material on the forest floor. The duff and litter are deep and much of the woody material is more than three inches in diameter. The undergrowth is variable, but shrubs are usually restricted to openings. Types to be represented by Fuel Model G are hemlock-Sitka spruce, coastal Douglas fir, and wind thrown or bug-killed stands of lodgepole pine and spruce.

Model R was the most common fuel type due to the prevalence of deciduous and mixed deciduous forest in the city (Figure 2). Most mature conifer dominated stands in Bellingham were classified as Model H and were generally uniform stands with a single storied canopy separated from the surface fuels by a large gap. Fire behavior can be high in these forests but typically only under extreme fire weather. The USFS created a national NFDRS fuel model map[1], which classified most of the fuels in the Pacific Northwest as Fuel Model G, which will more often support high intensity crown fires. DHC's assessment based on LiDAR and orthophoto analysis as well as field visits did not concur with the results of the national study. In Bellingham, Model G was relatively rare and assigned mostly to younger, dense conifer stands.

[1] The NFDRS Fuel Model Map was accessed from the US Forest Service's Wildland Fire Assessment System website: https://www.wfas.net/index.php/nfdrs-fuel-model-static-maps-44

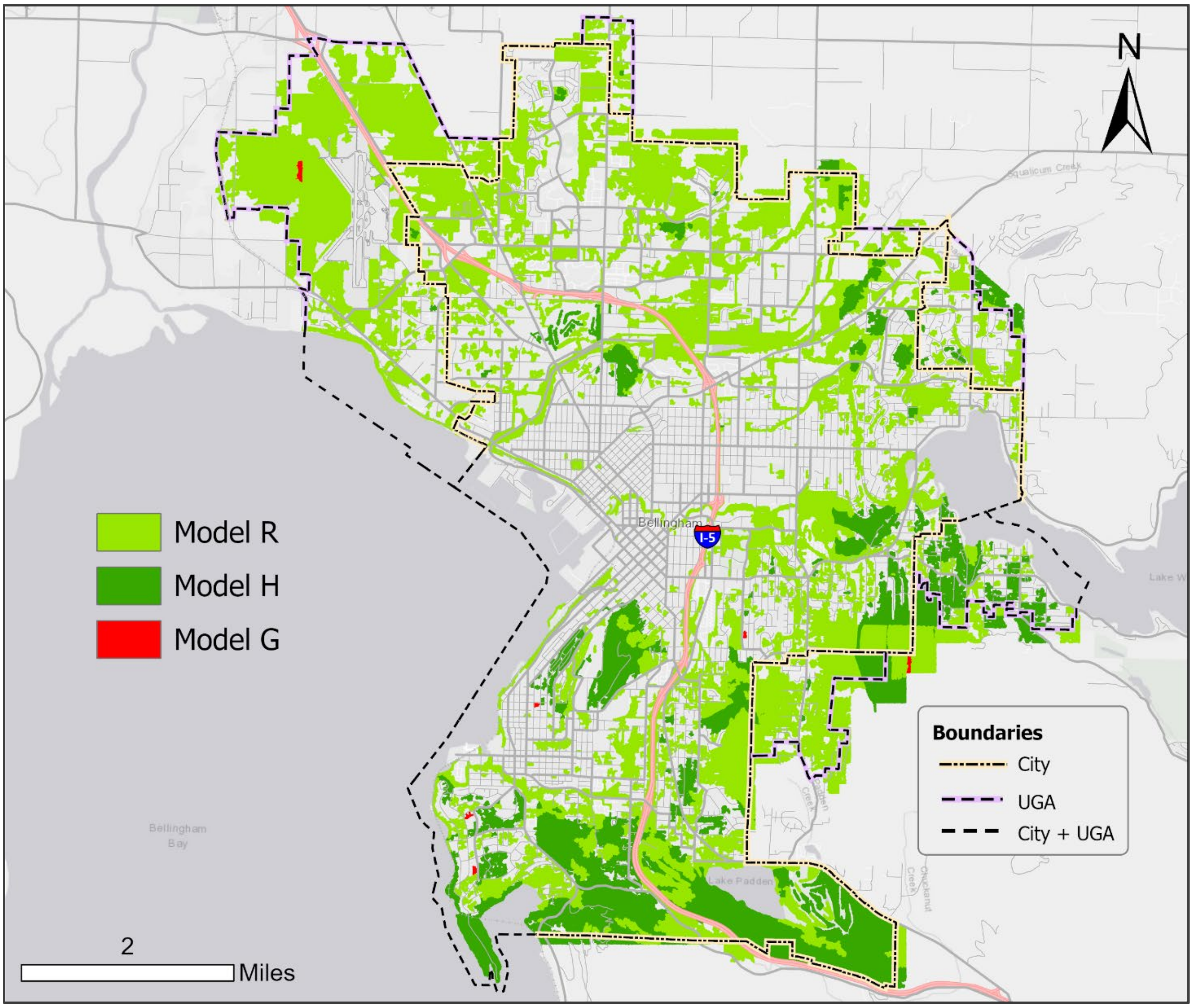

Figure 2 – Fuel types in the City of Bellingham based on the Wildland Urban Interface Code

3.3 Defining Fuel Loading

The 2018 Wildland Urban Interface Code classifies the NFDRS fuel models into three fuel loads:

- **FUEL, HEAVY**. Vegetation consisting of round wood 3 to 8 inches (76 to 203 mm) in diameter. Applies to Fuel Models **G**, I, J, K and U.
- **FUEL, LIGHT**. Vegetation consisting of herbaceous plants and round wood less than 1/4 inch (6.4 mm) in diameter. Applies to Fuel Models A, C, E, L, N, P,**R** and S.
- **FUEL, MEDIUM**. Vegetation consisting of round wood 1/4 to 3 inches (6.4mmto 76 mm)in diameter. Applies to Fuel Models B, D, F, **H**, O, Q and T.

Fuel loads in Bellingham forests were estimated based on ground truthing results from 35 plots completed in September 2020 and March 2021, which was then generalized for each forest successional stage and type (deciduous/coniferous/mixed) mapped in the forest structure analysis (Diamond Head

Consulting, 2021). Figure 3 maps these three fuel loads in Bellingham. Most of Bellingham's forest is classified as light fuel or medium fuel with only isolated fragments of heavy fuels. Field assessments confirmed that these assigned fuel loading levels were consistent with the forest conditions in Bellingham.

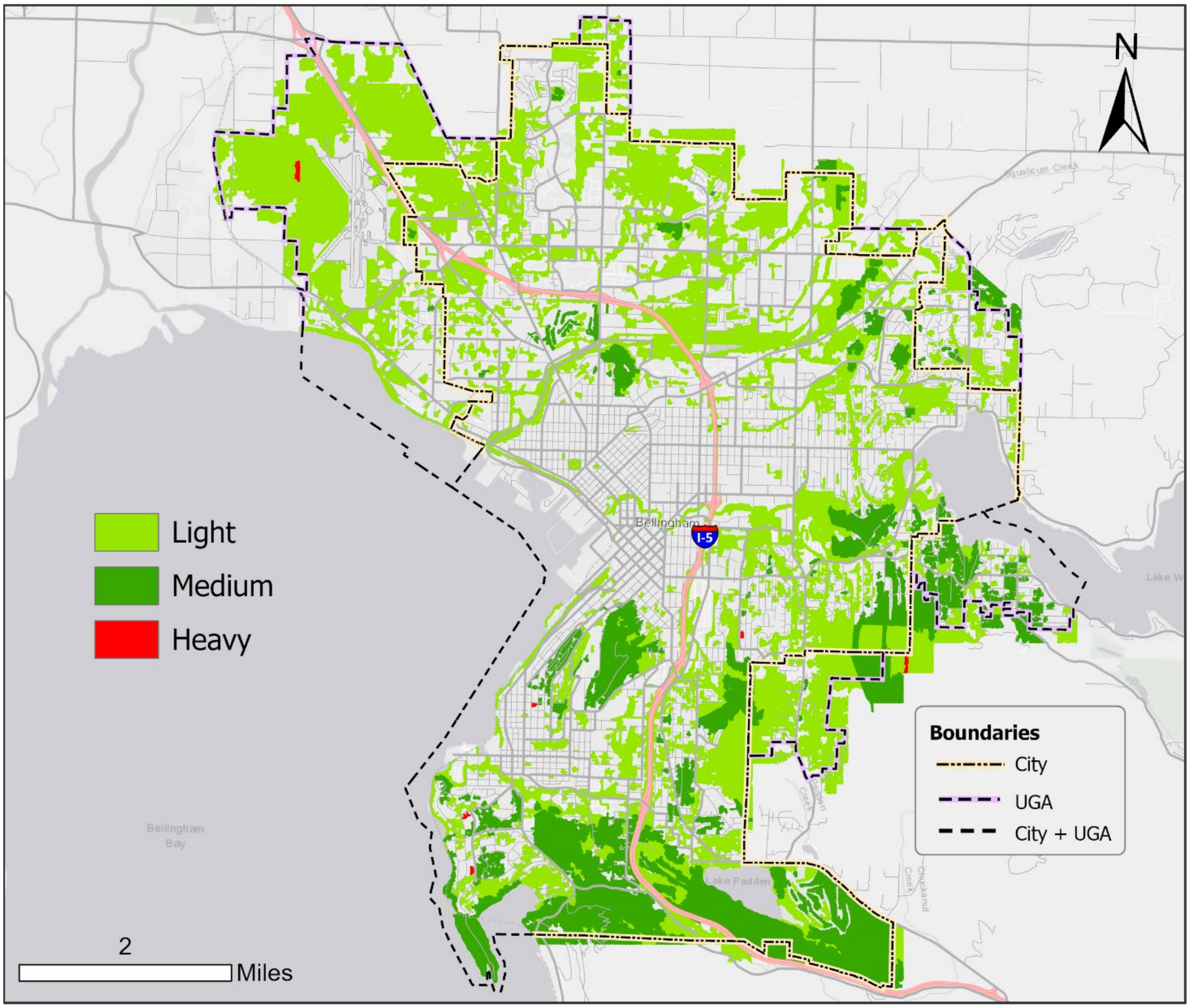

Figure 3 – Fuel loading in the City of Bellingham based on the predominant fuel types present

4.0 Conclusion

Research suggests that the increase in area burned by wildfire and the lengthening fire season in the western United states is caused by climate change. The combination of warmer, drier summers, declining tree health and increasing development in the wildland urban interface has the potential to increase wildfire hazard in Pacific Northwest communities. Low to moderate density "intermix" development, where homes are scattered within wildland vegetation are particularly vulnerable to wildfire. Tools such as wildland urban interface mapping by the Washington State Department of

Natural Resources and the Wildland Urban Interface Code are being used by several communities in Washington to manage the risk wildfire poses to new development.

Bellingham's wildland urban interface was mapped by the Washington State Department of Natural Resources in 2019. This draft mapping product identified areas of intermix and interface in Bellingham and is expected to be updated in 2021. Based on site-specific data, most fuel types in Bellingham have a light to medium fuel loading based on the composition of deciduous and coniferous species, forest structure and fuel loading characteristics. Once finalized, the wildland urban interface mapping could be used in combination with fuel type mapping to identify areas of moderate to extreme fire hazard severity in Bellingham according to the Wildland Urban Interface Code.

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Appendix 1 - State of Washington wildland urban interface mapping process