

Appendix C

Technical Memoranda

TO: Jon Holan, Community Development Director, City of Forest Grove, Oregon
COPIES: File
FROM: Lindsey Kuipers, Vista Planning
DATE: June 7, 2011
SUBJECT: Housing Density and Needs for the David Hill Urban Reserve

Introduction

This memo documents existing conditions and regulatory considerations, and offers recommendations for future housing density and need in the David Hill Urban Reserve (DHUR).

In 2007, the Oregon Legislature approved Senate Bill 1011 which enabled Metro and the three metropolitan counties to designate areas outside the current urban growth boundary (UGB) best suited for accommodating urban development as “urban reserves.” The reserve designations remain in effect for 50 years. According to Senate Bill 1011, one of the main criteria for land chosen as an urban reserve is sufficient land within the designated areas that is suitable for a range of housing types (Oregon Legislative Assembly, 2007).

Regulatory Framework

Planning for residential development within the DHUR is guided by several local, county, regional, and state requirements. Among them are *Title 11: Planning for New Urban Areas* of Metro’s Urban Growth Management Functional Plan, the City of Forest Grove Comprehensive Plan Update, and the State of Oregon Land Conservation Development Commission (LCDC). Relevant considerations from each of these are discussed below.

Planning for New Urban Areas, Metro Code, Chapter 3.07, Title 11

Title 11 provides long-range planning guidance for areas brought into the UGB to ensure that they are “urbanized efficiently” and attempt to contribute to mixed-use, walkable, transit-friendly communities. As it specifically relates to housing, Title 11 states that a concept plan should:

- *Consider actions necessary to achieve. . . a range of housing of different types, tenure and prices addressing the housing needs in the prospective UGB expansion area in the context of the housing needs of the governing city, the county, and the region if data on regional housing needs are available, in order to help create economically and socially vital and complete neighborhoods and cities and avoiding the concentration of poverty and the isolation of families and people of modest means (3.07.1110 (B)(1)(c))*
- *Show the general locations of any residential, commercial, industrial, institutional and public uses proposed for the area (3.07.1110(C)(1))*

Currently, Title 11 does not include specific density requirements for concept planning areas. However, prior to the 2011 updates to Title 11, the density requirements were set at 10 dwelling units per acre.

In August 2010, Metro released *Making a Great Place: Growth Management Assessment* that included a recommendation on urban and rural reserves. It assumed that UGB expansions will develop with a more compact efficient form in response to market demands and policy and investment choices over the 50-year reserve timeframe (Metro, 2010). This document includes an assumed average density of 15 units per net buildable acre while allowing for variations over time and across different geographies. This assumption was based on the fact that urban reserve areas were originally sized using 15 units per net buildable acre.

City of Forest Grove Comprehensive Plan Update

In August 2009, the City of Forest Grove prepared a draft document on statewide planning Goal 10 as part of the City of Forest Grove's Comprehensive Plan Periodic Review process (City of Forest Grove, 2009b). The City of Forest Grove is currently updating its Comprehensive Plan, therefore the draft Goal 10 document will serve as the most current information regarding housing density in Forest Grove. The document provides target densities for residential zones (see Table 1).

TABLE 1
Zoning Classifications and Target Densities

Zoning Classification	Target Density
Suburban Residential	1.00 dwelling/net acre
Single Family Residential	4.35 dwellings/net acre
Single Family Residential	6.22 dwellings/net acre
Single Family Residential	8.70 dwellings/net acre
Multifamily Residential Low	12.00 dwellings/net acre
Multifamily Residential High	20.28 dwellings/net acre

Source: Comprehensive Plan Periodic Review Draft Goal 10 Housing Element Update, City of Forest Grove, August 2009.

State of Oregon Land Conservation Development Commission

At the state level, the LCDC requires cities to do the following (Oregon Revised Statutes [ORS] 197.295 – ORS 197.314 [2009]):

- Provide the opportunity for at least 50 percent of new residential units to be attached single-family housing or multiple-family housing
- Provide for an overall density of eight or more dwelling units per net buildable acre

Existing Conditions

Over half the urban reserve (167 acres) contains natural constraints, or features that are less desirable for development such as slopes of 25 percent or more, existing forest or woodlands, wetlands, and water quality management areas. Natural constraints are shown on Figure 1. Areas not identified as having natural constraints, and thus deemed most suitable for development, equate to 150 acres, or approximately 47 percent, of the DHUR.

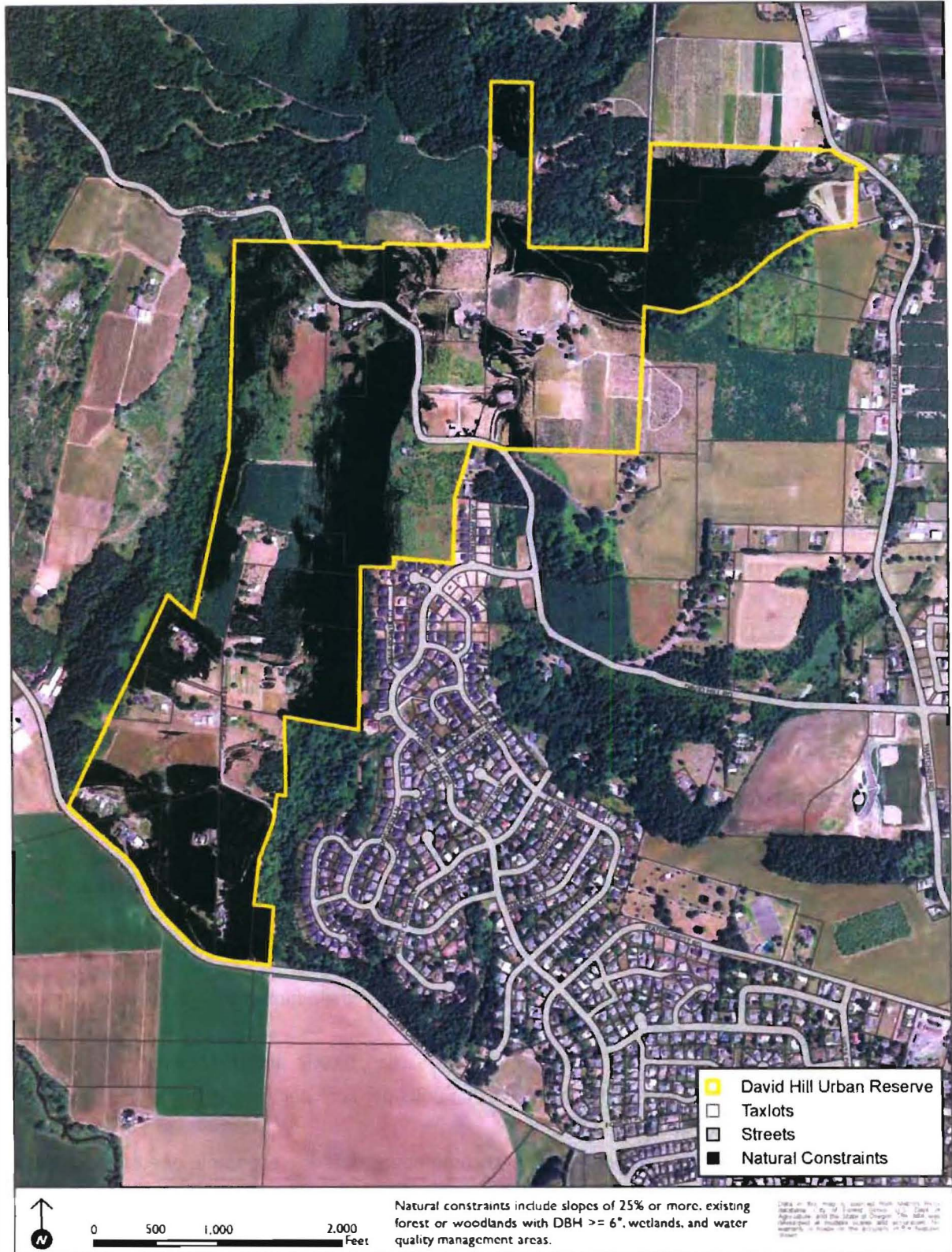


FIGURE 1
Natural Constraints

Over the next 30 years, the City of Forest Grove is projected to experience a 47 percent population increase (City of Forest Grove, 2010). The most recent long-term analysis of Forest Grove's employment and housing needs, the *2060 Economic Opportunities Analysis* (EOA), dated April 2011, is based on the *Long-Term Urban Employment and Residential Land Needs Analysis* conducted in 2008. According to the 2011 EOA, Forest Grove has an estimated 7,768 existing dwelling units currently within the city limits. Based upon future population projections, the city will need to add 15,260 dwelling units over the next 50 years to accommodate future growth. The City of Forest Grove estimates that existing vacant land and redevelopable land within the current UGB allows for an estimated 4,700 additional dwelling units (see Table 2). Thus, 10,560 dwelling units are needed over the next 50 years.

TABLE 2
Vacant Residential Parcels and Estimated Housing Development Capacity

Zoning	Designation	Net Buildable Acreage	Potential Units Accommodated
R-10	Low Density Residential	120.00	523
R-7	Low Density Residential	104.50	650
R-5	Low Density Residential	40.20	350
RML	Medium Density Residential	29.90	374
RMH	High Density Residential	69.55	1,424
FD-10	FD-10 Residentially Designated	115.20	693
	Redevelopment/Infill		686
Totals/Averages		497.30	4,700

Source: City of Forest Grove, *Growth Capacity Analysis*, 2011

The City of Forest Grove's *Buildable Lands Analysis* shows that 784 acres of land within the city limits could support additional development (City of Forest Grove, 2009a).

Recommendations

Given the significant challenges to development posed by the natural constraints shown on Figure 1, the City of Forest Grove should explore the possibility that existing buildable lands within Forest Grove may be better suited to absorb some of the density otherwise required within the DHUR.

In addition, it is recommended that the DHUR:

- Provide a diverse range of needed housing types, including single-family, attached, and multi-family
- Locate types of housing appropriate to the topography
- Include a mix and intensity of uses that support pedestrian, bicycle, and transit where possible
- Aim for an average density of 10 to 12 dwelling units per acre per Title 11 and other concept plans recently approved in Washington County
- Reevaluate the needed housing units to accommodate differing economic needs and population projections
- Site housing to maintain viewsheds for both housing within the DHUR and for those looking up into it

References

City of Forest Grove. 2011a. *2060 Economic Opportunities Analysis*. April.

City of Forest Grove. 2011b. *Growth Capacity Analysis*.

City of Forest Grove. 2010. Profile & Demographics: Area Economic Profile. <http://www.forestgrove-or.gov/city-hall/profile-a-demographics-area-economic-profile.html>.

City of Forest Grove. 2009a. *Buildable Lands Analysis*.

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Metro. 2010. *Making a Great Place: 2010 Growth Management Assessment*. August.

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Oregon Legislative Assembly. 2007. Senate Bill 1011. 2007 Regular Session. http://library.oregonmetro.gov/files/senate_bill_1011.pdf. June.

Washington County. 2010. *Community Development Code*. Article III, 300-3.3. <http://www.co.washington.or.us/LUT/Divisions/CurrentPlanning/Code/community-development-code.cfm>. November.

TO: Jon Holan, Community Development Director, City of Forest Grove, Oregon
COPIES: File
FROM: Ryan Michie
DATE: June 7, 2011
SUBJECT: Natural Resource Areas for the David Hill Urban Reserve

Introduction

This memo documents the current natural resource policy, regulatory framework, and the existing natural resource conditions, and provides recommendations for the David Hill Urban Reserve (DHUR).

Data and Methodology

All water features, floodplains, and building footprints were identified using Metro's Regional Land Information System (RLIS) database. Land elevations, slopes, and vegetation information were primarily derived from Light Detection and Ranging (LiDAR) data collected for the Oregon Department of Forestry (Watershed Sciences, 2007). Additional information was collected through site visits, orthophotos, and feedback from local residents and community members during the public outreach process. Data was processed and analyzed using a geographic information system (GIS) and further refined based on public feedback and site visits.

Regulatory Framework

Relevant regulations for environmental considerations include *Title 11: Planning for New Urban Areas* of Metro's Urban Growth Management Functional Plan, The City of Forest Grove's Development Code, and Clean Water Services' *Design and Construction Standards*.

Planning for New Urban Areas, Metro Code, Chapter 3.07, Title 11

Title 11 (Metro, 2011) provides long-range planning guidance to ensure that areas brought into the urban growth boundary (UGB) are "urbanized efficiently" and that natural ecological systems and important natural landscape features are protected. As it specifically relates to natural resources, Title 11 states that a concept plan should:

- *Consider actions necessary to achieve. . .protection of natural ecological systems and important natural landscape features (3.007.1110(B)(1)(g))*
- *Show water quality resource areas, flood management areas and habitat conservation areas that will be subject to performance standards under Titles 3 and 13 [of the Urban Growth Management Functional Plan](3.007.1110(C)(5))*

City of Forest Grove Development Code, Chapter 10.5

New urban development in the DHUR will be required to meet Article 5 of the City of Forest Grove's Development Code Chapter 10.5 (2009) which includes special provisions and design standards for natural resources areas and the protection of trees. The intent of these provisions is described below.

- *To protect and improve the following functions and values that contributes to fish and wildlife habitat in urban streamside areas: (1) Microclimate and shade; (2) Stream-flow moderation and water storage; (3) Bank stabilization, sediment and pollution control; (4) Large wood recruitment and retention and channel dynamics; and (5) Organic material sources. (10.05.005(A))*
- *To protect and improve the following functions and values that contributes to upland wildlife habitat in new urban growth boundary expansion areas: (1) Large habitat patches, (2) Interior habitat, (3) Connectivity and proximity to water; and (4) Connectivity and proximity to other upland habitat areas. (10.05.005(B))*
- *The trees of Forest Grove, a reminder of the City's namesake, offer historic, aesthetic, spiritual, social, environmental and monetary values to the community. This section of the Code establishes guidelines, a legal framework, and authority for the community forestry program. The intent of this section is to enhance the quality of life in Forest Grove by promoting good stewardship that will ensure the continued health of the community forest. (10.5.100)*

Generally, the City of Forest Grove's Development Code references Clean Water Services' *Design and Construction Standards* as the baseline performance standard for identification and protection of streams, wetlands, and water quality. These design standards were used to identify and map natural resource protection areas in the DHUR. Additional guidance and direction was provided by community feedback received during the public involvement process.

Existing Conditions

Floodplains

The DHUR contains no 100-year Federal Emergency Management Agency (FEMA) floodplains. However, the Gales Creek 100-year floodplain abuts the DHUR's southern border along Gales Creek Road.

Habitat Conservation Areas

Habitat conservation areas were mapped by Metro and adopted by the City of Forest Grove into Article 5, Chapter 10.05.005(C) of the city's Development Code. Areas classified as riparian class I- II and upland class A and B generally represents the same areas identified as forest/woodland with a DBH greater than or equal to 6 inches (which corresponds to a tree height of approximately 48 feet) are shown in Figure 1. Water quality management areas, which are also protected, are shown in Figure 2 (see the Streams and Vegetated Riparian Corridors section for more information).

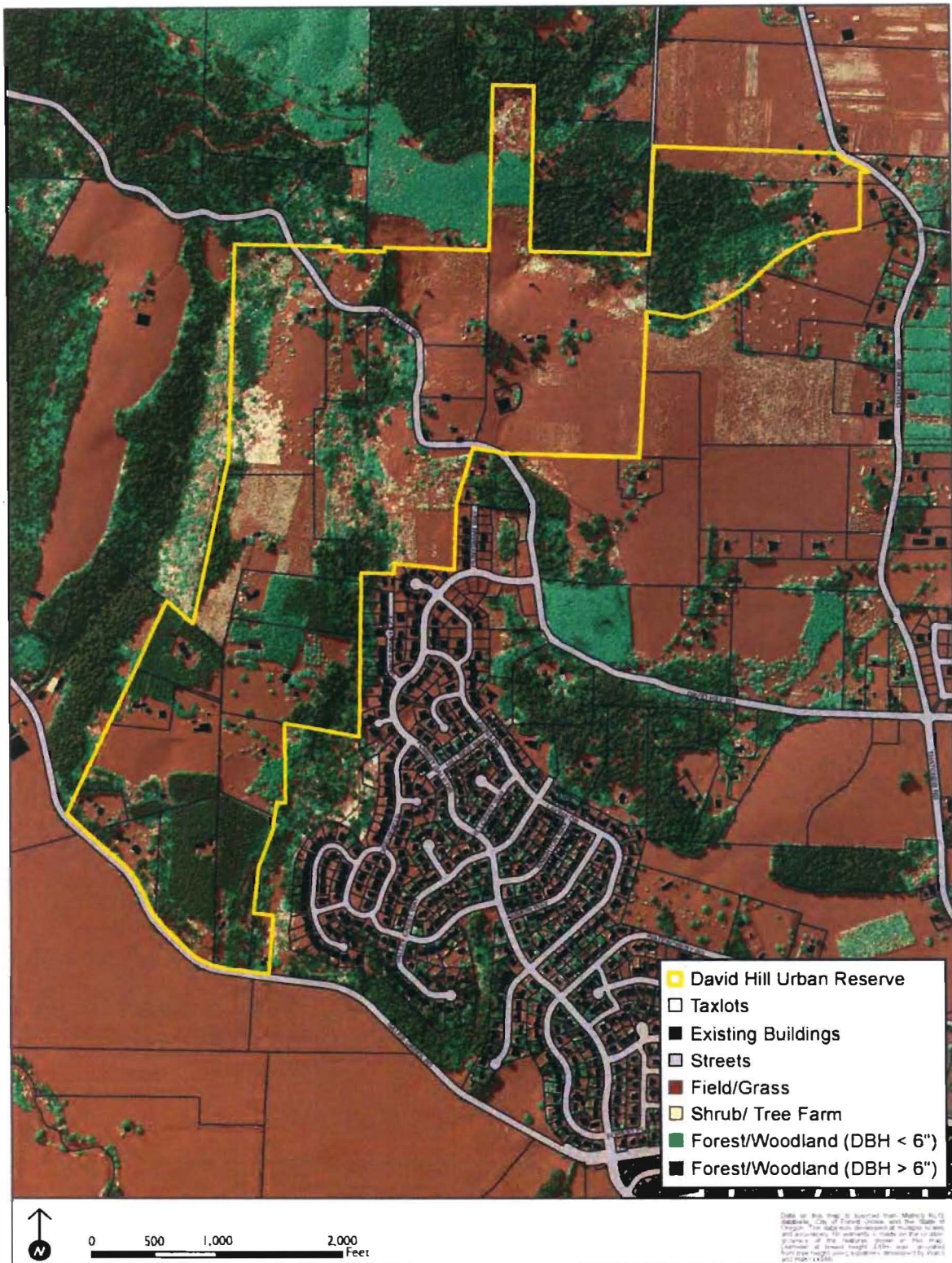


FIGURE 1
Existing Vegetation (2007)

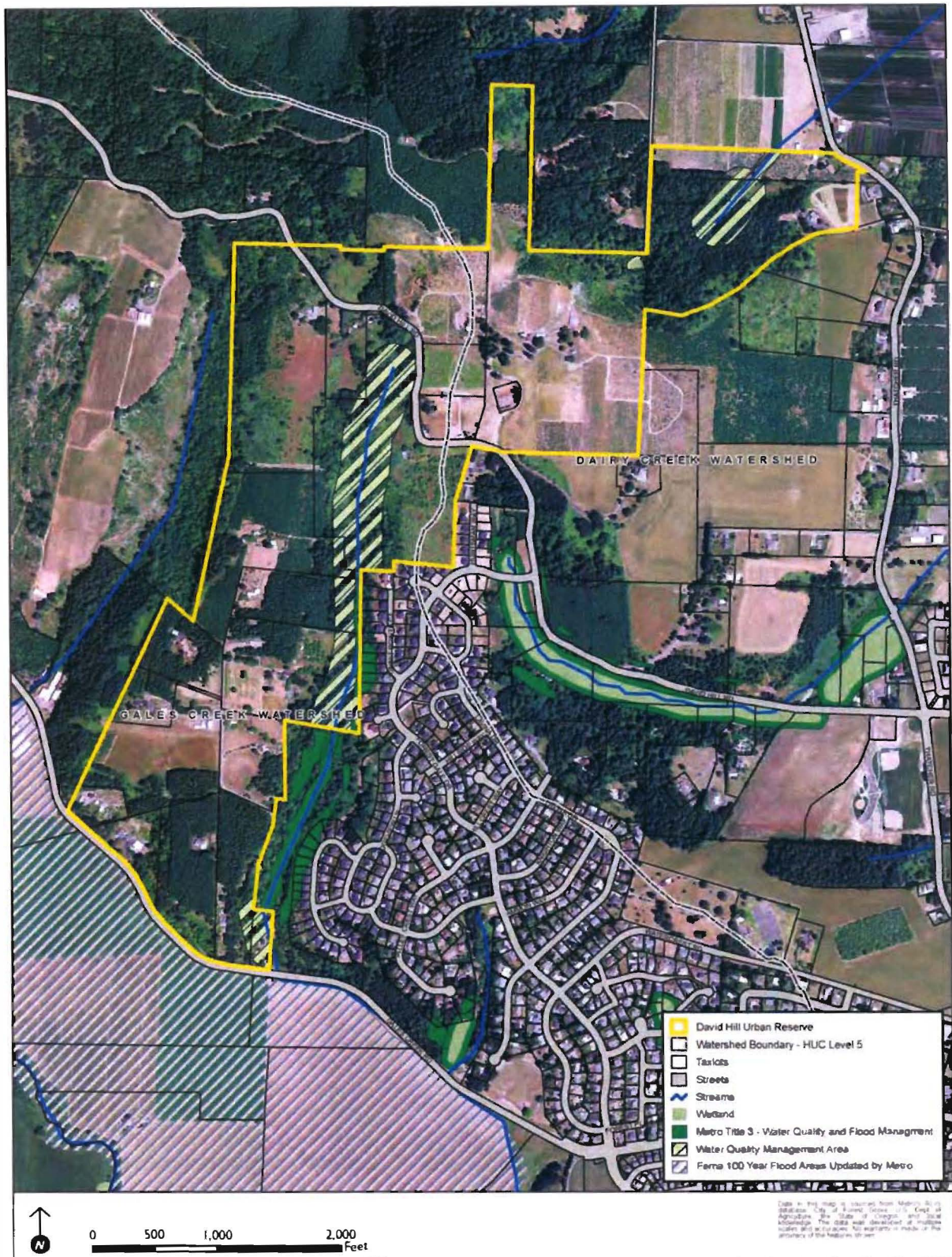


FIGURE 2
Streams and Wetlands

Steep Slopes and Landslide Prone Areas

The DHUR is composed of eastern and southern facing moderate to steep sloping hills. The steepest slopes are in the ravines along the stream corridors and to the north and east along David Hill Road. Metro and Clean Water Services' policies define steep slopes as those greater than or equal to 25 percent. Approximately 97.5 acres, or 31 percent, of the study area contains steep slopes where development could be a risk for landslide or debris flows. Figure 3 shows the topography and percent slope in the DHUR.

Figure 4 shows landslide hazard zones as developed by the Oregon Department of Geology and Mineral Industries (IMS-22). Note that the map is based on a limited amount of data and cannot serve as a substitute for site-specific investigations by qualified practitioners. Only two landslide hazard areas were identified with the DHUR - an area just off Gales Creek Road in the south and another in the northern portion. However, one property owner identified a small landslide in the ravine near the tributary to Gales Creek.

Streams and Vegetated Riparian Corridors

The DHUR is located in Tualatin River Subbasin and the Gales Creek and Dairy Creek watersheds. Two unnamed and intermittent, but mapped, streams originate from the reserve (see Figure 2). The south flowing stream henceforth will be referred to as the tributary to Gales Creek and the north flowing stream will be the tributary to Dairy Creek. The tributary to Gales Creek drains approximately 25 acres near the center of David Hill Road at its upstream end and flows to the southern urban reserve boundary at Gales Creek Road where it drains up to 198 acres. The tributary to Dairy Creek originates near the center of the far northeastern section of the reserve. It drains approximately 24 acres at its upstream reach and 64 acres downstream at the northwestern urban reserve boundary near Thatcher Road.

A total of 33.5 acres, approximately 11 percent of the DHUR, were identified as water quality management areas (see Figure 2). Approximately 1 acre of Title 3 water quality management areas were identified using the RLIS database. Other areas were identified using Clean Water Services *Design and Construction Standards* (2007) (shown in Table 1). The areas adjacent to the streams range from 50 to 99 acres. According to the Clean Water Services standards, the streams require vegetated corridors that range between 25 and 200 feet, depending upon the slope of the adjacent area. Because many of the slopes are greater than or equal to 25 percent (see Figure 3), most of the vegetated corridor buffer around the streams is 200 feet.

TABLE 1

Clean Water Services Design Standards for Vegetated Corridor Width Adjacent to Intermittent Streams

Sensitive Area Type	Width Slope <25%	Width Slope ≥25%
< 10 acres	0 feet	0
≥10 to <50 acres	15 feet	Variable from 50 to 200 feet
≥50 to <100 acres	25 feet	Variable from 50 to 200 feet
≥100 acres	50 feet	Variable from 50 to 200 feet

Source: Clean Water Services *Design and Construction Standards*, Section 3.03.01, Table 3-1

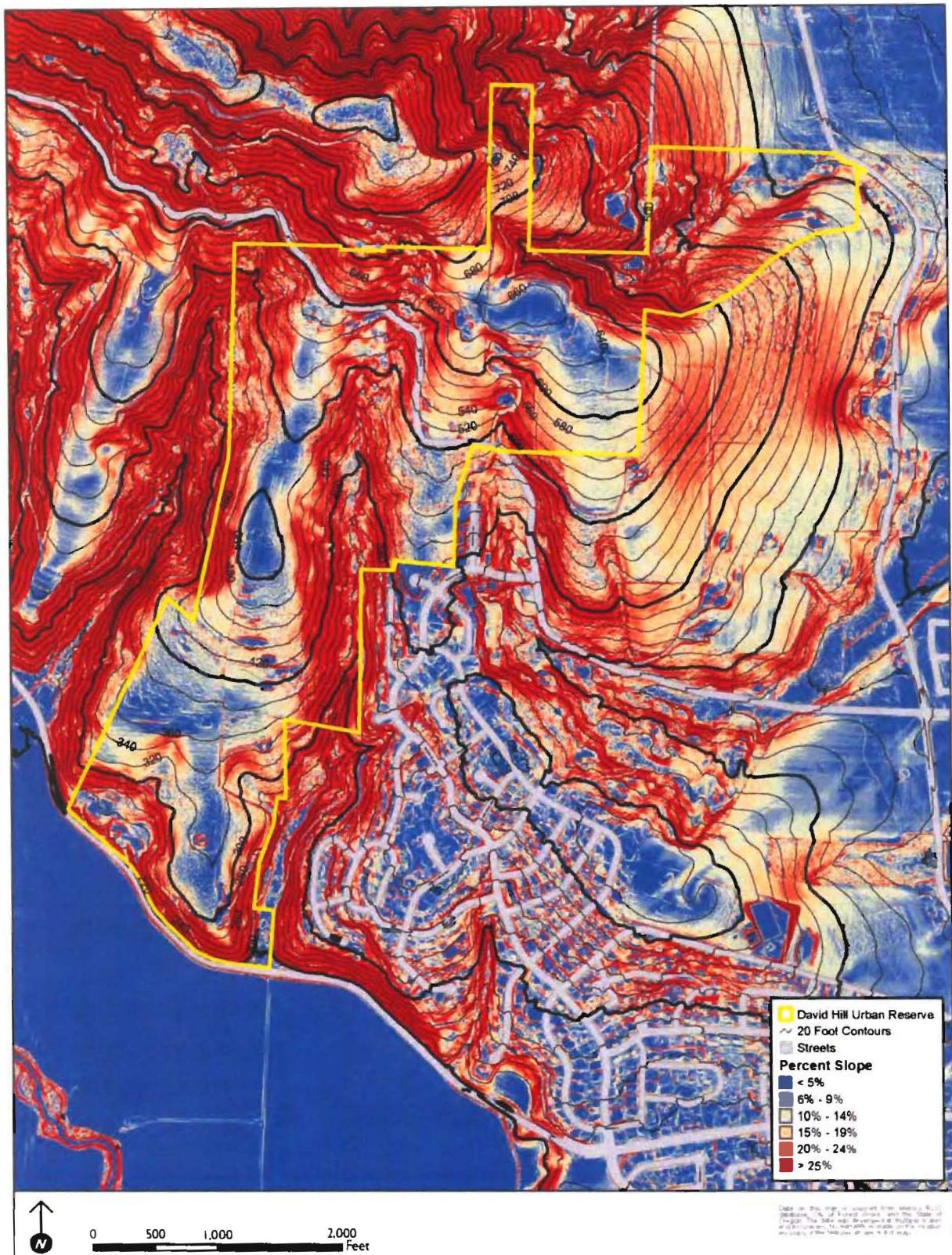


FIGURE 3
Topography and Percent Slope

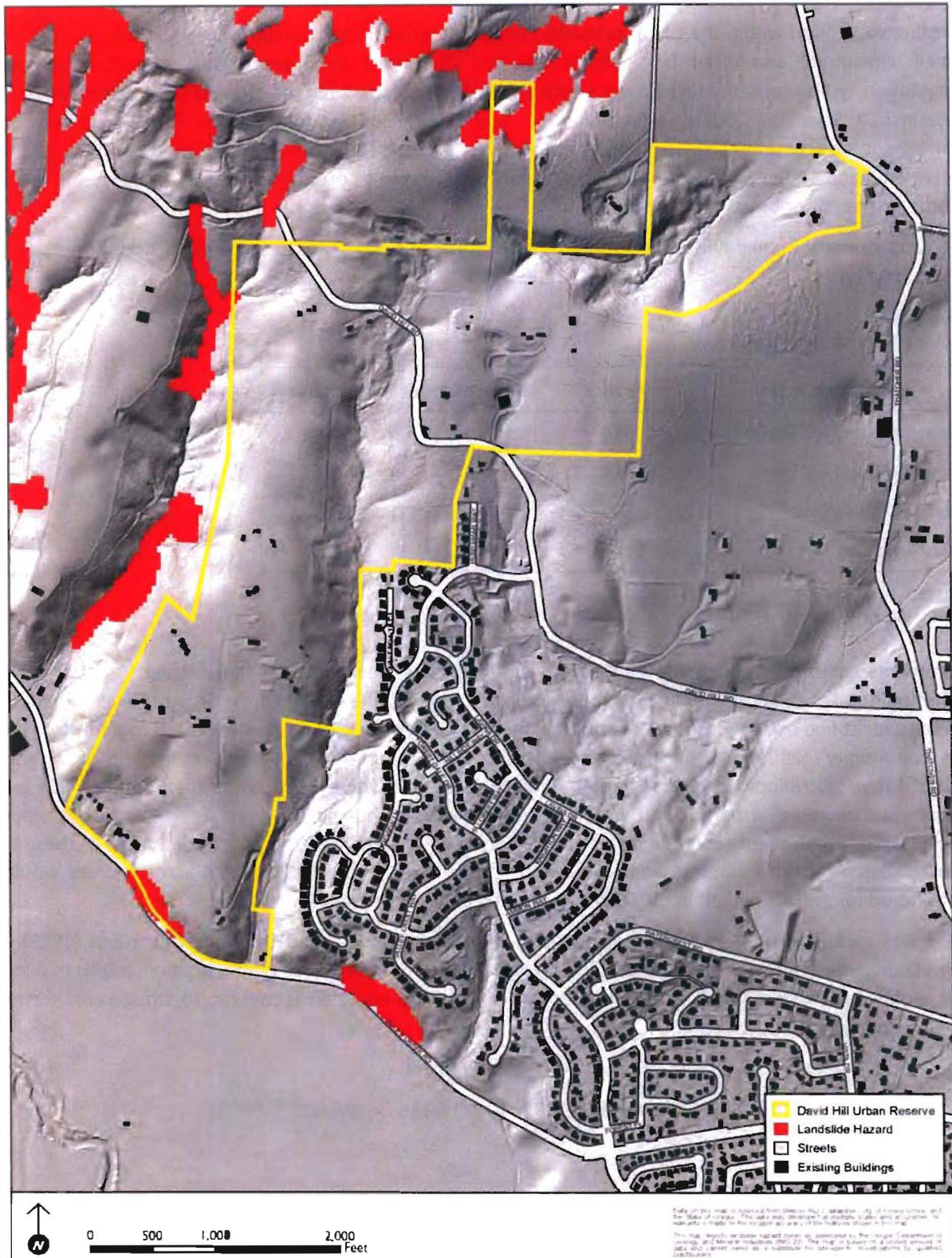


FIGURE 4
Landslide Hazard

Vegetation

Existing vegetation within the DHUR primarily consists of young mixed conifer/hardwood forests, tree farms, small agricultural and other horticultural activities. The most prevalent conifer species is Douglas-fir. Vegetation types were identified using LiDAR technology collected for the Oregon Department of Forestry (Watershed Sciences, 2007). Vegetation type was categorized by tree height. Forest/woodland types correspond to vegetation greater than or equal to 15 feet, tree farm/shrub types correspond to vegetation between 4 and 14 feet, and grass/field is less than 4 feet. Buildings or other built infrastructure was removed from the analysis prior to classification.

The approximate breakdown of vegetation is shown in Table 2. Figure 1 shows the distribution of existing vegetation types.

TABLE 2
Existing Vegetation in the DHUR

Vegetation Type	Acres	Percentage of Urban Reserve
Forest/Woodland < 6" DBH	44.0	14
Forest/Woodland ≥ 6" DBH	68.4	22
Tree Farm (small)/Shrub	35.0	11
Grass/Field/Road	1,11.5	53

Notes:

DBH = diameter breast height

Comments collected through the public involvement process revealed that the existing forest is a valued community asset and is an important natural landscape feature. The City of Forest Grove's Development Code has also identified existing trees as "historic, aesthetic, spiritual, social, environmental and monetary values to the community" (2009). Existing trees are generally protected from removal under Article 5 of the City of Forest Grove's Development Code Chapter 10.05 (2009). Trees with a DBH greater than or equal to 6 inches require a tree removal permit and with some exceptions, cannot be removed. For the concept planning process, trees that might require a tree removal permit are shown in Figure 1. Provided none of these trees are harvested for timber before annexation into Forest Grove, approximately 68.4 acres of trees would be considered for protection within the DHUR. This represents 22 percent of the total reserve.

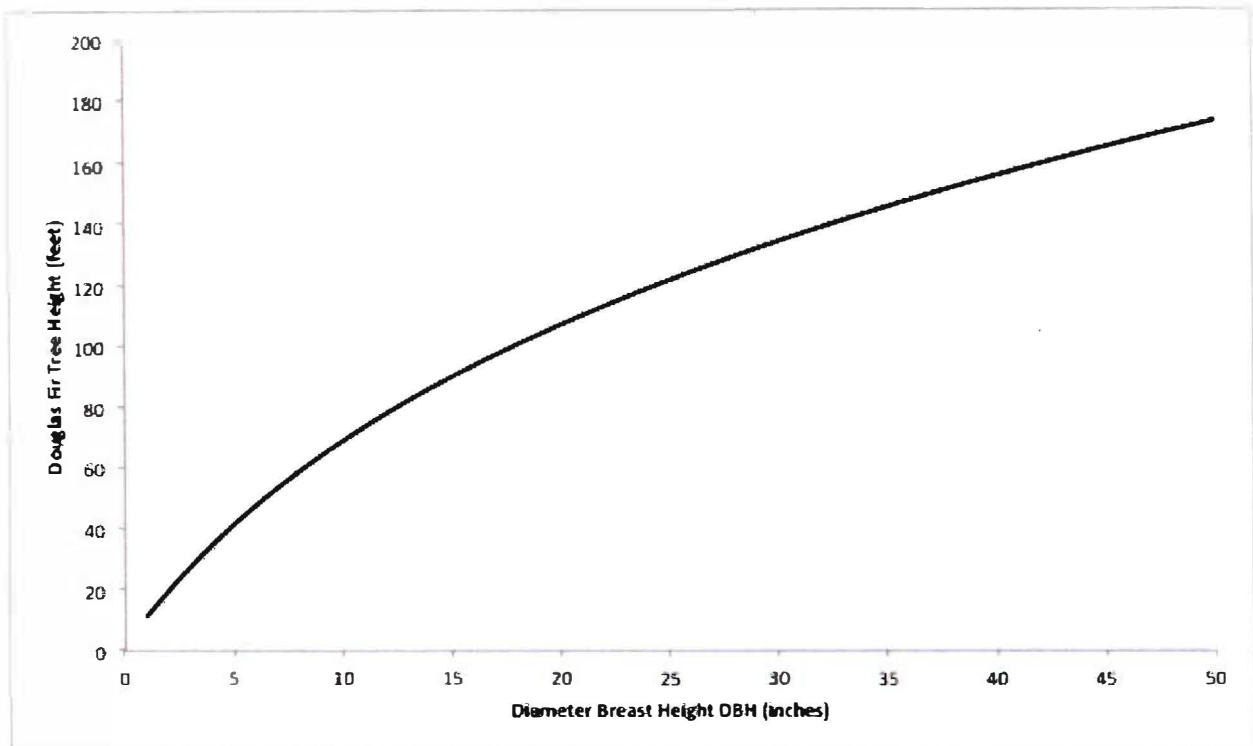
DBH was identified using a regression equation (Equation 1) developed by Wang and Hann (1988). The regression curve (shown in Figure 5) predicts tree height based on DBH. Using this equation, a DBH of 6 inches corresponds to a tree height of approximately 48 feet. The equation is specific to Douglas-fir, the most prevalent conifer in the DHUR.

Equation 1

$$Height = e^{(7.04524 + 5.16836 \times DBH^{-0.253869})}$$

FIGURE 5

Regression Equation Predicting Douglas-fir Tree Height as a Function of Diameter Breast Height (DBH)



Wetlands

There are no documented wetlands in the DHUR, although a local landowner noted a seasonal wet spot (vernal pool) near the headwaters of the tributary to Dairy Creek. The wetland is visible in aerial photos and the location is depicted on Figure 2. Based on its small size, a 50-foot buffer is required around this feature according to Clean Water Services' *Design and Construction Standards* Section 3.03.01, Table 3-1 (2007).

Figure 6 shows the overlay of all the natural constraints mentioned above.



FIGURE 6
Natural Constraints

Recommendations

To protect natural ecological systems and important natural landscape features, the following actions are recommended.

- Minimize development in areas identified as forest/woodland vegetation with DBH greater than or equal to 6 inches shown on Figure 1 for habitat conservation areas and as important natural landscape features
- Restrict development in water quality management areas as identified on Figure 2
- Conduct a wetland survey to investigate the vernal pool identified on Figure 2
- Minimize landslide hazards by restricting development in areas with slopes greater than or equal to 25 percent
- Place development, roads, and utility infrastructure in such a way as to minimize tree removal
- Consider using small groupings of individual trees or existing tree farms for parks, maintaining rural character, or other desired community assets such as shielding new development from view, buffering noise, and providing opportunities for trails and open space.
- Revise the Forest Grove Development Code to require geotechnical analysis of potential development sites in the DHUR with slopes of 10 percent or greater to understand landslide hazard and maintain consistency with Forest Grove's current Comprehensive Plan

References

- City of Forest Grove. 2009. Development Code. <http://www.forestgrove-or.gov/city-hall/community-development-planning-zoning-information.html>. March 9.
- Clean Water Services. 2007. *Design and Construction Standards*, R&O 07-20. <http://www.cleanwaterservices.org/PermitCenter/DesignAndConstruction/DandCTable.aspx>. June.
- Metro. 2011. *Metro Code, Chapter 3.07, Title 11: Planning for New Urban Areas*. Effective December 31, 2011, January 13, 2011, and December 16, 2010.
- Wang, Chao-Huan and David W. Hann. 1988. "Height-Diameter Equations for Sixteen Tree Species in the Central Western Willamette Valley of Oregon." Research Paper 51, Forest Research Lab, College of Forestry, Oregon State University. January.
- Watershed Sciences. 2007. *LiDAR Remote Sensing Data Collection: Department of Geology & Mineral Industries, Oregon Department of Forestry, Puget Sound LiDAR Consortium*. November 14.

TO: Jon Holan, Community Development Director, City of Forest Grove,
Oregon
COPIES: File
FROM: Joseph Shearer
DATE: June 7, 2011
SUBJECT: Parks and Trails in the David Hill Urban Reserve

Introduction

This memo documents the existing conditions and regulatory framework and provides recommendations relating to parks and trails within the David Hill Urban Reserve (DHUR).

Regulatory Framework

Relevant regulations for parks and trails include *Title 11: Planning for New Urban Areas* of Metro's Urban Growth Management Functional Plan, The City of Forest Grove's *Parks, Recreation & Open Space Master Plan*, and the City of Forest Grove's *Community Trails Master Plan*.

Title 11 provides long-range planning guidance for areas brought into the urban growth boundary (UGB) to ensure that they are "urbanized efficiently" and attempt to contribute to mixed-use, walkable, transit-friendly communities. As it specifically relates to parks and open space, Title 11 (Metro, 2011) states that a concept plan should:

- *Consider actions necessary to achieve. . . Well-connected systems of streets, bikeways, parks, recreational trails and public transit that link to needed housing so as to reduce the combined cost of housing and transportation (3.007.1110(B)(1)(e))*
- *Consider actions necessary to achieve. . . A well-connected system of parks, natural areas and other public open spaces (3.007.1110(B)(1)(f))*
- *Show the general locations of proposed sewer, park and trail, water and storm-water systems (3.07.1110(C)(2)(a))*

The Forest Grove *Parks, Recreation & Open Space Master Plan* (2002) sets the following standards of service:

- Neighborhood parks and school-parks should be set at 1.5 acres per 1,000 population, with a one-third-mile service area radius.
- Community parks and school-parks should be set at 4.0 acres per 1,000 population, with a 1-mile service area radius. An additional community park should be developed to meet future population needs and ensure geographical accessibility to all residents.
- Open space/greenway should be set at 13.0 acres per 1,000 population.



The Forest Grove *Community Trails Master Plan* (2007) established a plan for a regional system of trails throughout Forest Grove, including elements that pass through or near the DHUR (see Figure 1). The regional footpath, the Western Connection, is planned by Metro and will follow approximately along the western edge of the current UGB. The project is identified in the City's Transportation System Plan and will extend from David Hill Road south to Ritchey Road. The project is scheduled for completion in 2017.

Existing Conditions

The City of Forest Grove Parks and Recreation Department currently provides and maintains 357 acres of parkland and open space within the city limits to meet the daily leisure needs of residents. Approximately 85.5 acres are active park space and the remainder is open space, natural areas, or greenways. Forest Grove residents have access to nine parks, an aquatic center, and a skateboard park. No parks currently exist within the DHUR (see Figure 2).

The City of Forest Grove's *Parks, Recreation & Open Space Master Plan* (2002) establishes definitions for the following park types:

- **Community Parks** – large parks that provide active and passive recreational opportunities for all city residents. They are large enough to accommodate large group activities (i.e., Lincoln Park)
- **Natural Resource Areas** – areas that enhance the livability and character of a community by preserving natural amenities and open space (i.e., Fernhill Wetlands)
- **Neighborhood Parks** – parks intended to meet day-to-day recreational needs of the surrounding neighborhood (i.e., Bard Park, Hazel Sills Park, Rogers Park, and Talisman Park)

Thatcher Park, at the corner of David Hill Road and Thatcher Road is a 25-acre community park of sufficient size and proximity to serve the future residents of the DHUR.

The City of Forest Grove also benefits from greenways and natural areas acquired through Metro's Greenspaces program. These areas (such as Gales Creek Natural Area, Hagg Lake Greenway, and Upper Tualatin Greenway) contribute significant open space in and around Forest Grove, and have the potential to accommodate trails and interpretive areas which would increase opportunities and resources for passive recreation.

The City of Forest Grove also maintains 6 to 7 miles of paved trails and approximately 2 miles of natural surface trails. None of these trails currently exist within the DHUR.

The City of Forest Grove Department of Parks and Recreation has started the process of adding a section of trail in Thatcher Park. This section of trail is a 3,000-foot natural surface trail built in cooperation with several community volunteers who worked on design and alignment.

No formal pedestrian trails or bicycle paths/lanes exist within the DHUR area.

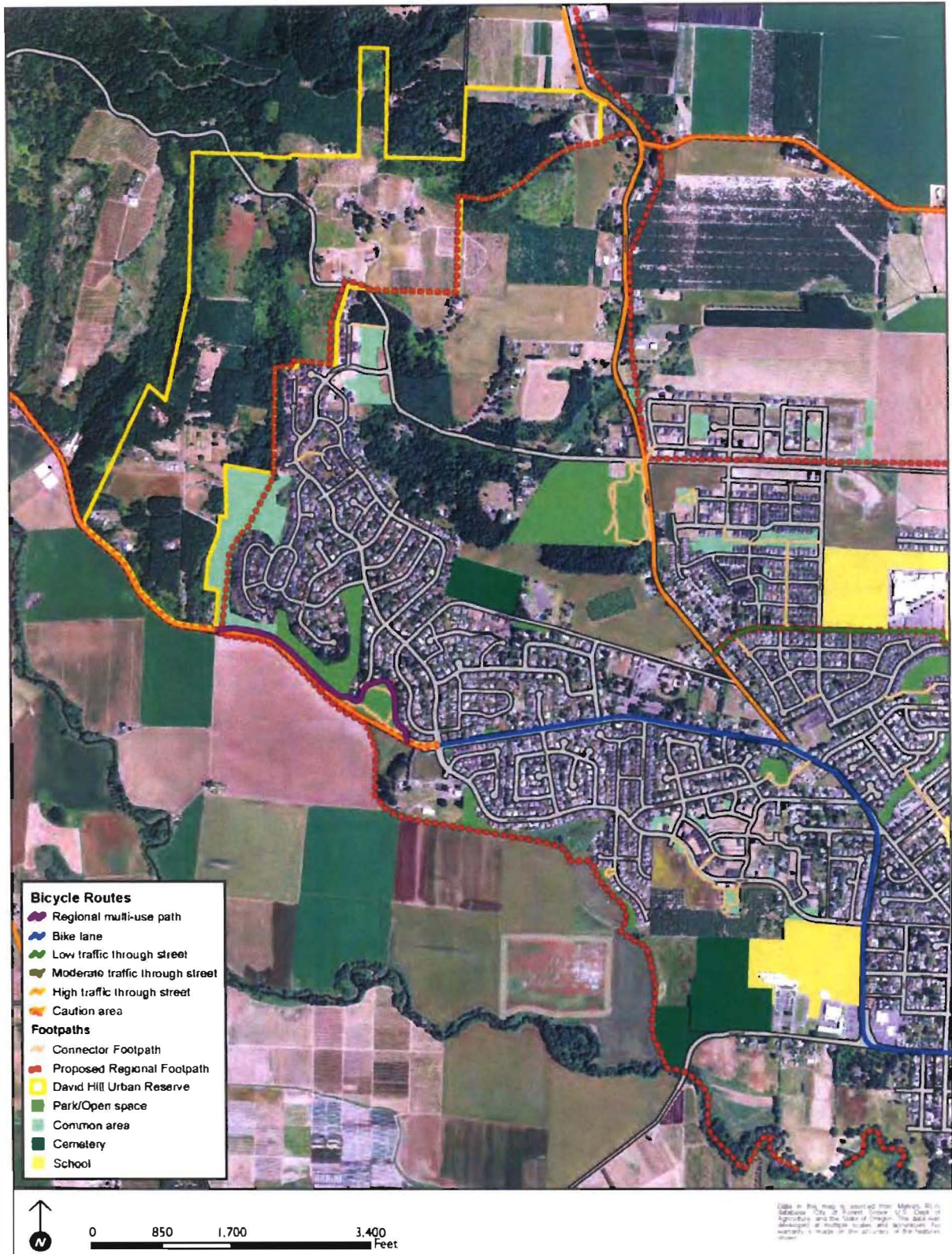


FIGURE 1
Bicycle Routes and Footpaths

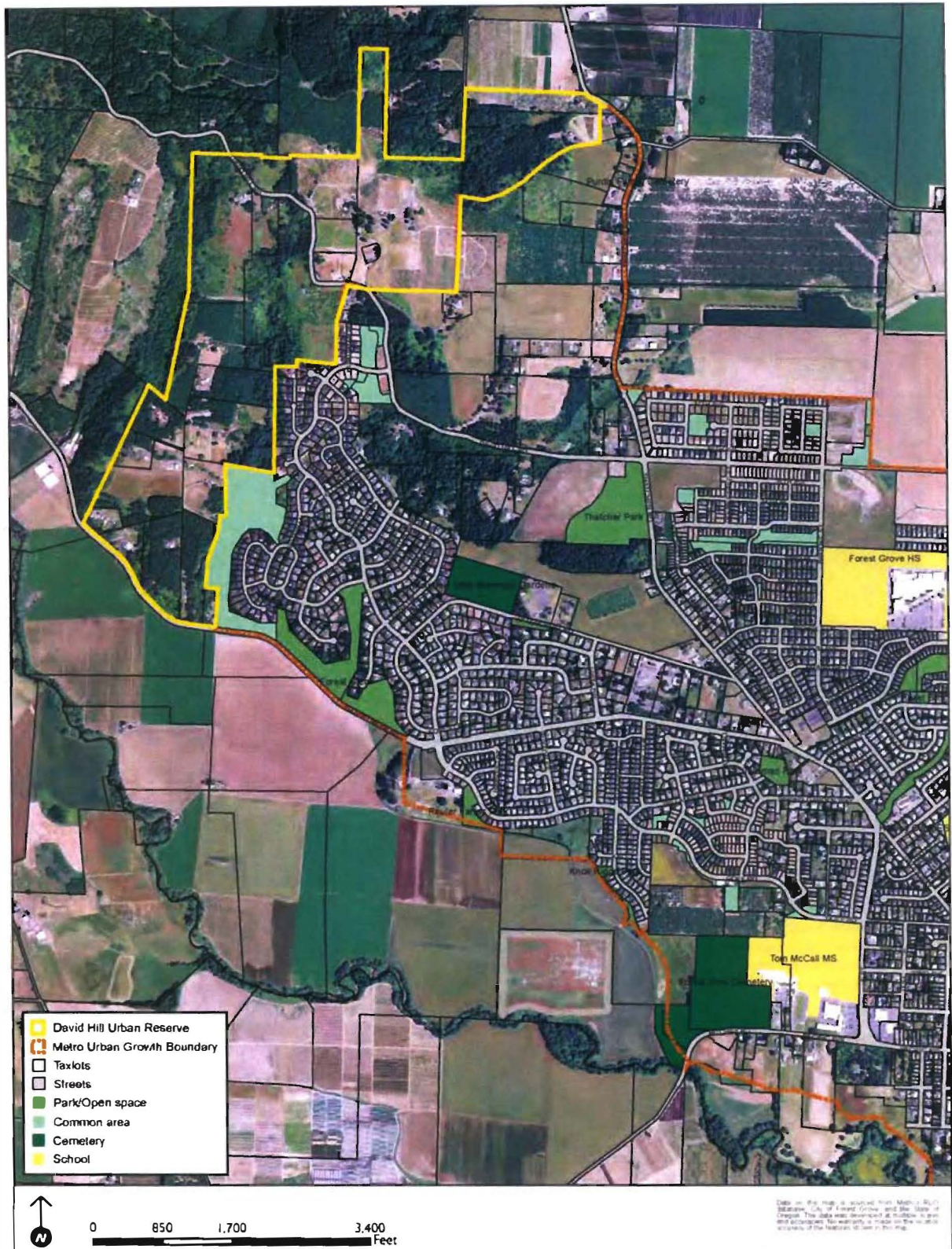


FIGURE 2
Parks and Greenspaces

Recommendations

Land uses within the DHUR should utilize parks and open space to help balance the rural character of the David Hill area with the small town urban character of the City of Forest Grove. Parks and open space can also be implemented to preserve and protect natural resource areas and views. Finally, opportunities to implement the existing *Community Trails Master Plan* can help provide for safe, connected, multi-modal travel opportunities. A robust system of trails running through the DHUR provides members of the community with additional transportation choices and recreation benefits.

The following items are recommended for consideration when planning parks, open space, and trails for the DHUR:

- Meet or exceed Forest Grove *Parks, Recreation & Open Space Master Plan* (2002) standards of service based on population projections within the DHUR (assuming 2.68 people per dwelling unit)
- Implement plans for the regional trail system where they abut or penetrate the DHUR
- Incorporate potential DHUR parks into future Parks Master Plan updates to ensure funding through System Development Charges (SDCs)
- Established a neighborhood park in the DHUR

References

City of Forest Grove. 2007. *Community Trails Master Plan*. October.

City of Forest Grove. 2002. *Parks Master Plan*. May.

DKS Associates. 2010. *Forest Grove Transportation System Plan*. August.

Metro. 2011. *Metro Code, Chapter 3.07, Title 11: Planning for New Urban Areas*. Effective December 31, 2011, January 13, 2011, and December 16, 2010.

TO: Jon Holan, Community Development Director, City of Forest Grove, Oregon
COPIES: File
FROM: Misty Schymtzik, Vista Planning
DATE: June 7, 2011
SUBJECT: Storm and Surface Water Considerations for the David Hill Urban Reserve

Introduction

This memo documents the storm and surface water considerations and offers recommendations for the David Hill Urban Reserve (DHUR). These considerations include managing storm and surface water to protect water quality and natural resources, and to protect built areas from flooding and ponding during storm events. Issues to be addressed include drainage, conveyance, and incorporating storm and surface water management into the landscape of the DHUR.

Regulatory Framework

Relevant regulations for storm and surface water include *Title 11: Planning for New Urban Areas* of Metro's Urban Growth Management Functional Plan, the City of Forest Grove Development Code, and Clean Water Services' *Design and Construction Standards* and *Low Impact Development Approaches Handbook*.

Planning for New Urban Areas, Metro Code, Chapter 3.07, Title 11

Title 11 provides long-range planning guidance to ensure that areas brought into the UGB are "urbanized efficiently" and that natural ecological systems and important natural landscape features are protected (Metro, 2011b). As it specifically relates to storm and surface water management, Title 11 requires that a concept plan should:

- *Consider actions necessary to achieve. . .protection of natural ecological systems and important natural landscape features* (3.007.1110(B)(1)(g))
- *Show the general locations of proposed sewer, park and trail, water and storm-water systems* (3.07.1110(C)(2)(a))
- *Be coordinated with the comprehensive plans and land use regulations that apply to nearby lands already within the UGB* (3.007.1110(C)(5))

City of Forest Grove Development Code

The City of Forest Grove's Development Code Chapter 10.8 has several provisions relevant to storm and surface water management for the DHUR. These are detailed below.

- Modifications to land within the Forest Grove city limits are “encouraged to integrate. . .habitat-friendly development practices” which minimize hydrological impacts (10.8.315, Table 8-1)
- The use of pervious surfaces is encouraged (Section 10.8.605D).
- *Where public storm sewer lines are proposed, drainage swales and other open drainage facilities may be used with the approval of the City Engineer (10.8.605E).*
- Stormwater drainage systems must be “separate and independent” of sewer systems. In addition, if possible, surface water should not intercede on intersections or flood streets (10.8.635A).
- Lastly, drainage facilities should be large enough to accommodate upstream drainage (10.8.635C).

Clean Water Services Guidance

The DHUR will be annexed into Clean Water Services’ Service District Boundary once development occurs that includes stormwater and sanitary services. The Clean Water Services *Design and Construction Standards* (2007) sets minimum regulations for development in regard to storm and surface water management systems.

Existing Conditions

The DHUR is located at the northwestern corner of Forest Grove and extends along the northwestern edge of the Urban Growth Boundary (UGB) northeast and southwest of David Hill Road. The northeastern edge of this area extends to Thatcher Road and the southwestern boundary extends to Gales Creek Road. The DHUR is approximately 317 acres.

The DHUR is currently zoned for agriculture or forestry as are the areas to the immediate north, west, and south of the urban reserve. These areas are outside the Forest Grove city limits and the UGB. Developments, which are within both the Forest Grove city limits and the UGB, border the DHUR along its southeastern border.

Over half the urban reserve (167 acres) contains natural constraints, or features that are less desirable for development such as slopes of 25 percent or more, existing forest or woodlands, wetlands, and water quality management areas. Natural constraints are shown on Figure 1. Areas not identified as having natural constraints, and thus deemed most suitable for development, equate to 150 acres, or approximately 47 percent, of the DHUR.

Average annual rainfall for the City of Forest Grove is 44.58 inches (City of Forest Grove, 2010).

Floodplains

The DHUR contains no 100-year Federal Emergency Management Agency (FEMA) floodplains. However, the Gales Creek 100-year floodplain abuts the DHUR’s southern border along Gales Creek Road.

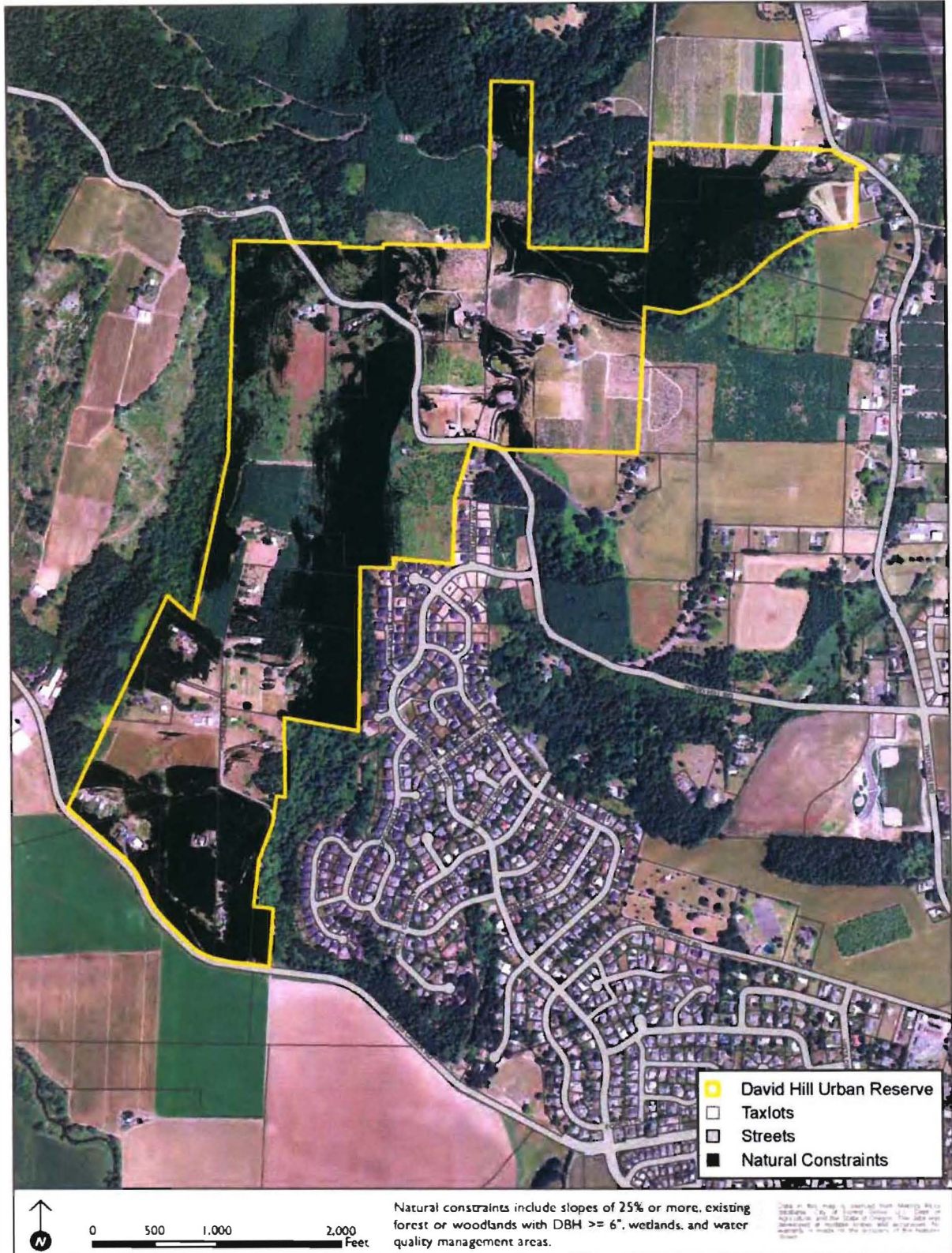


FIGURE 1
Natural Constraints

Population and Built Structures

The urban reserve is currently sparsely populated, with 16 currently occupied units, and minimal built environment. Impervious areas consist of the paved section of David Hill Road, buildings such as homes and barns, and the David Hill Reservoir.

Soils

Eight major soil types are in the DHUR (USDA, 2010). The primary soil unit is Laurelwood silt loam which underlies approximately 75 percent of the total urban reserve (see Table 1). The Natural Resources Conservation Service (NRCS) rates these soils types as having very limited septic tank absorption based on evaluations between 24 and 60 inches deep. True absorptions ability may vary based on the underlying soils.

TABLE 1
Soil Types in the DHUR

Soil Type	Acres in DHUR	Percentage of DHUR
Cornelius and Kinton silt loams, 2 to 7 percent slopes	0.5	0.2
Cornelius and Kinton silt loams, 7 to 12 percent slopes	9.1	2.9
Cornelius and Kinton silt loams, 12 to 20 percent slopes	7.8	2.5
Cornelius and Kinton silt loams, 20 to 30 percent slopes	12.1	3.8
Cornelius and Kinton silt loams, 30 to 60 percent slopes	0.7	0.2
Helvetia silt loam, 7 to 12 percent slopes	2.4	0.8
Jory silty clay loam, 12 to 20 percent slopes	8.1	2.6
Jory silty clay loam, 30 to 60 percent slopes	3.1	1.0
Laurelwood silt loam, 3 to 7 percent slopes	46.5	14.7
Laurelwood silt loam, 7 to 12 percent slopes	57.2	18.1
Laurelwood silt loam, 12 to 20 percent slopes	60.0	19.0
Laurelwood silt loam, 20 to 30 percent slopes	39.3	12.4
Laurelwood silt loam, 30 to 60 percent slopes	33.2	10.5
McBee silty clay loam	2.4	0.8
Melbourne silty clay loam, 2 to 7 percent slopes	7.2	2.3
Melbourne silty clay loam, 12 to 20 percent slopes	11.4	3.6
Melbourne silty clay loam, 30 to 60 percent slopes	10.7	3.4
Saum silt loam, 30 to 60 percent slopes	3.4	1.1
Wapato silty clay loam	1.5	0.5

Steep Slopes

The DHUR is composed of eastern and southern facing moderate to steep sloping hills. The steepest slopes are in the ravines along the stream corridors and to the north and east along David Hill Road (see Figure 2). Metro and Clean Water Services' policies define steep slopes as those greater than or equal to 25 percent (Metro 2011a; Clean Water Services, 2007). Approximately 97.5 acres, or 31 percent, of the study area contains steep slopes which could be a risk for landslide or soil erosion (Clean Water Services, 2009). In addition, steep slope and slide prone areas are not advisable for certain low impact development approaches (LIDA) to managing stormwater (Clean Water Services, 2009).

Stormwater Flow and Existing Infrastructure

Stormwater generally flows downslope (see Figure 2 for slopes). The DHUR contains no existing built of natural stormwater management infrastructure. Existing and planned stormwater infrastructure in the areas of the DHUR is shown on Figure 3.

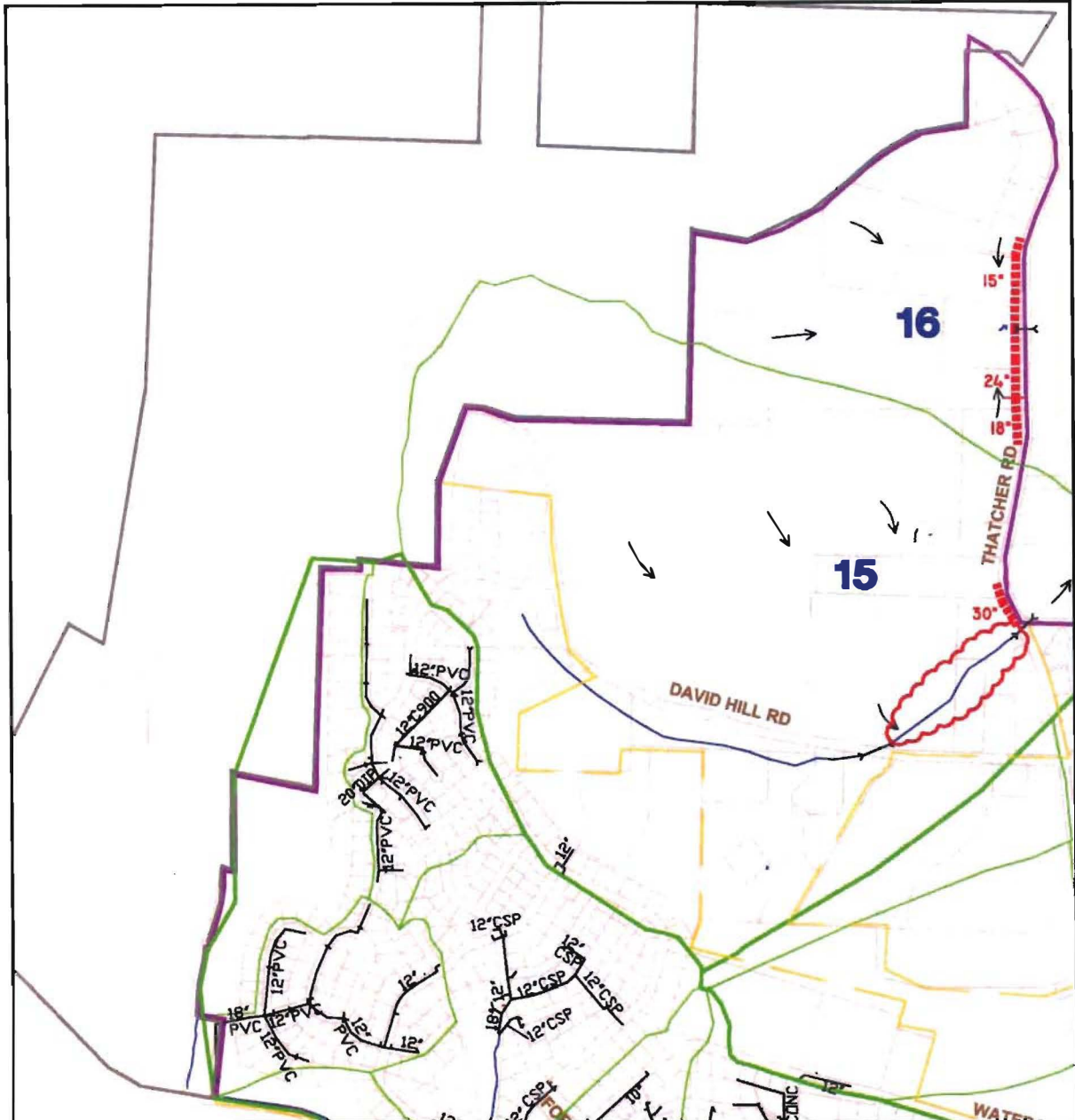
Streams and Water Quality Management Areas

The DHUR is located in Tualatin River Watershed and the Gales Creek and Dairy Creek subwatersheds. Two unnamed and intermittent, but mapped, streams originate from the reserve (see Figure 4). The upstream end of the southflowing stream begins near the center of David Hill Road and flows to the southern urban reserve boundary at Gales Creek Road. The northflowing stream originates near the center of the far northeastern section of the reserve and flows to the northwestern urban reserve boundary near Thatcher Road.

A total of 33.5 acres, approximately 11 percent of the DHUR, were identified as water quality management areas (see Figure 4). Approximately 1 acre of Title 3 water quality management areas were identified using Metro's RLIS database. Other areas were identified using Clean Water Services *Design and Construction Standards* (2007; Section 3.03.01, Table 3-1). Because many of the slopes are greater than or equal to 25 percent, most of the water quality management buffers around the streams are 200 feet (see Figure 2).

Vegetation

Existing vegetation within the DHUR primarily consists of young mixed conifer/hardwood forests, tree farms, small agricultural and other horticultural activities. The most prevalent conifer species is Douglas-fir. Vegetation types were identified using LiDAR technology collected for the Oregon Department of Forestry (Watershed Sciences, 2007). Vegetation type was categorized by tree height. Forest/woodland types correspond to vegetation greater than or equal to 15 feet, tree farm/shrub types correspond to vegetation between 4 and 14 feet, and grass/field is less than 4 feet. Buildings or other built infrastructure was removed from the analysis prior to classification.



Legend

	STREET		MINOR BASIN	ABBREVIATIONS CONC: CONCRETE CSP: CORRUGATED STEEL PIPE DIP: DUCTILE IRON PIPE FM: FORCE MAIN PVC: POLYVINYL CHLORIDE PIPE RCP: REINFORCED CONCRETE PIPE
	EXISTING PIPE (SIZE, MATERIAL)		MAJOR BASIN	
	PROPOSED CIP		CITY LIMITS	
	STREAM RESTORATION		UGB	
	APPROXIMATE BORDER OF DAVID HILL (URBAN) RESERVE		FLOW PATHS	
			1989 MASTERPLAN BASIN DESIGNATION	

FIGURE 3

Existing Stormwater Infrastructure and Planned Improvements

Source: City of Forest Grove Stormwater Masterplan Update (Kennedy/Jenks, 2007)

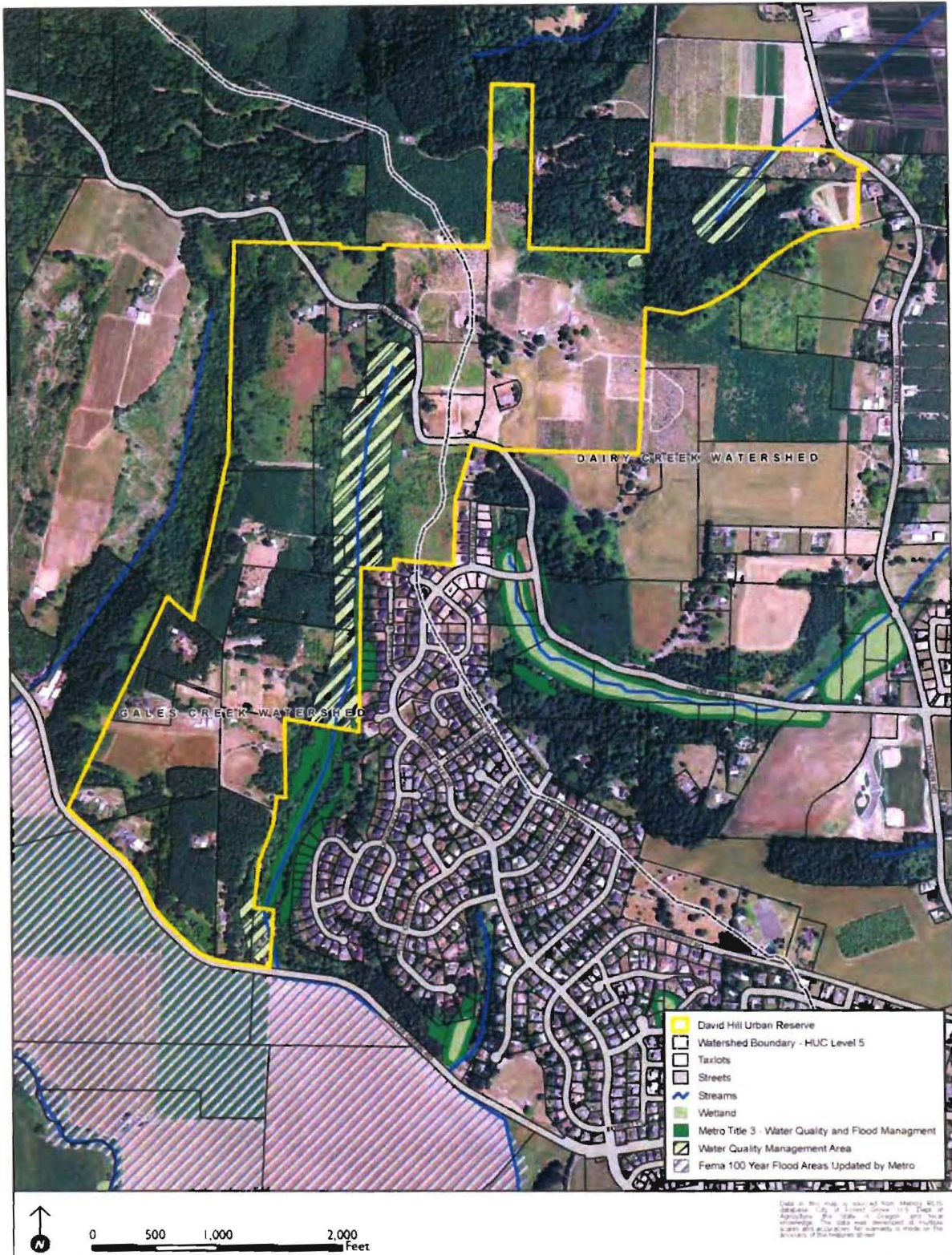


FIGURE 4
Streams and Wetlands

The approximate breakdown of vegetation is shown in Table 2. Figure 5 shows the distribution of existing vegetation types.

TABLE 2
Existing Vegetation in the DHUR

Vegetation Type	Acres	Percentage of Urban Reserve
Forest/Woodland < 6" DBH	44.0	14
Forest/Woodland ≥ 6" DBH	68.4	22
Tree Farm/Shrub	35.0	11
Grass/Field/Road	1,11.5	53

Notes:

DBH = diameter breast height

Existing trees are generally protected from removal under Article 5 of the City of Forest Grove's Development Code Chapter 10.05 (2009). Trees with a diameter breast height (DBH) greater than or equal to 6 inches require a tree removal permit and with some exceptions, cannot be removed. For the concept planning process, trees that might require a tree removal permit are shown on Figure 5. Provided none of these trees are harvested for timber before annexation into Forest Grove, approximately 68 acres, or 22 percent, of the urban reserve would be considered for protection.

Best Management Practices

Storm and surface water management occurs on three levels: site, street, and regional. Site refers to areas expected to develop. Street is roadways and public street rights-of-way. Regional refers to stormwater management facilities that service the greater DHUR area.

Site

Managing storm and surface water include reducing or eliminating the possibility of contact with pollutants at the source. Low impact development applications (LIDA) such as bioswales, rain gardens, ecoroofs, and pervious surfaces encourage water quality and infiltration and help manage the quantity and quality of stormwater (Clean Water Services, 2009).

Street

Impervious areas such as streets often collect items from non-point sources which pollute stormwater such as oil and antifreeze from cars, trash, and soil. LIDA stormwater facilities such as swales, flow-through planters, and infiltration planters can be located adjacent to roadways adjacent to the sidewalk area, a curb extension, or planter strip to help manage runoff and resulting pollution (Clean Water Services, 2009).

The public ROW can also collect and convey runoff to a stormwater management facility.

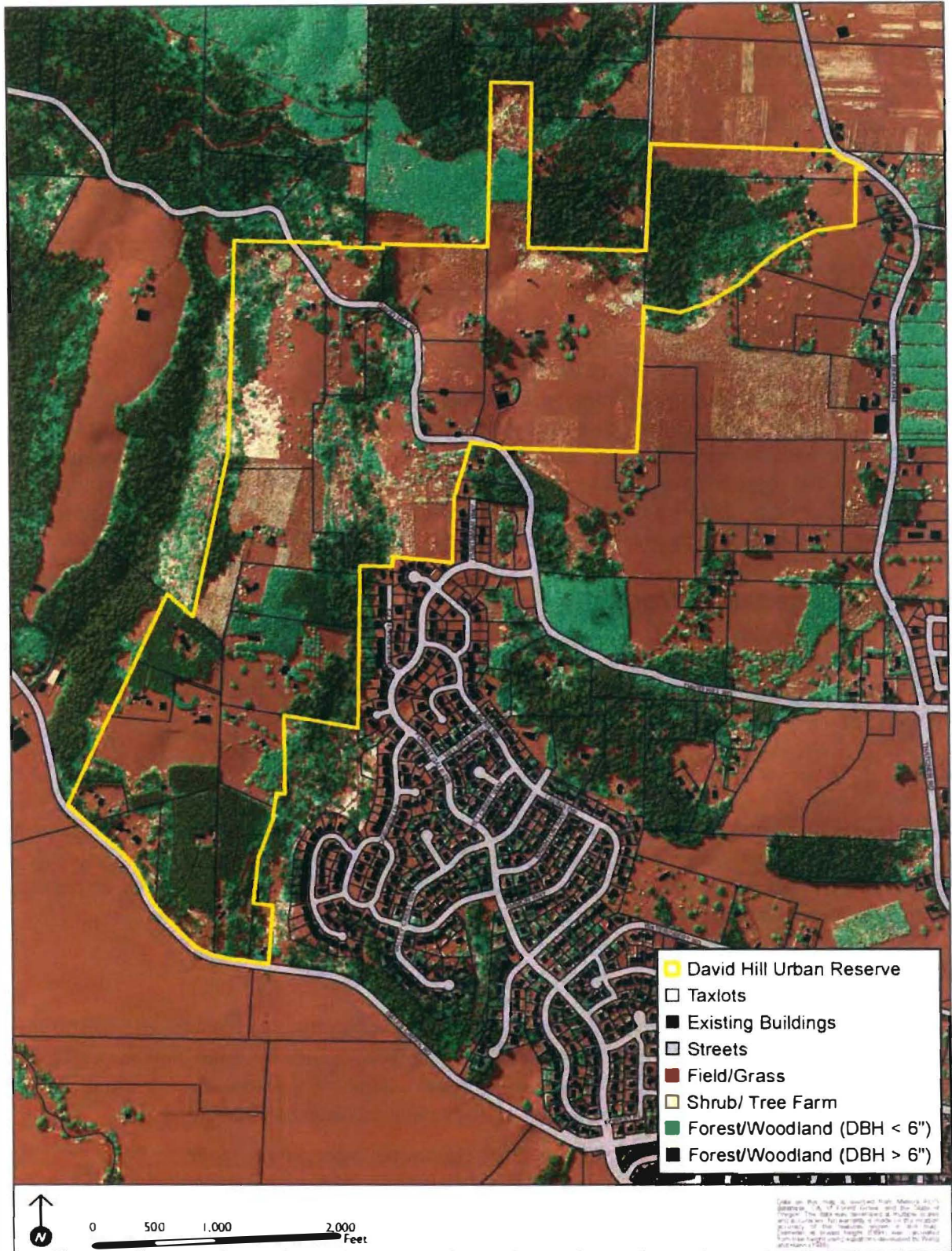


FIGURE 5
Existing Vegetation (2007)

Regional

Regional stormwater facilities may also be used in conjunction with LIDA facilities to provide water quality treatment. The abovementioned water quality facilities are the final treatment before stormwater discharges to a natural drainage system.

Recommendations

Much of the topography of the DHUR consists of steep slopes. In addition, the high clay content in the soil presents issues with infiltration or water percolating through the soil. The LIDA facilities require ongoing maintenance to ensure they are functioning as designed.

To best manage storm and surface water to protect natural ecological systems and important natural landscape features, the following items are recommended:

- Create a maintenance plan with a regular maintenance routine.
- Use LIDA in conjunction with conventional water quality facilities throughout the urban reserve to manage runoff on individual sites and the street ROW. LIDA should be designed and constructed according to Clean Water Services *Design and Construction Standards* and the LIDA Handbook.
- Limit impervious development/infrastructure wherever possible.
- Explore the possibility of incorporating storm and surface water management with parks and open spaces.
- Explore the possibility of using porous surfaces for roadways and sidewalks to reduce runoff and environmental impacts.
- Site built infrastructure in public ROWs for efficiency and economic concerns.
- Conduct a site evaluation to validate soil ratings developed by the NRCS.

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MEMORANDUM



TO: Jon Holan, Community Development Director, City of Forest Grove, OR
COPIES: File
FROM: Krissy Hostetler
DATE: June 7, 2011
SUBJECT: Transportation Elements for David Hill Urban Reserve

Introduction

This memo documents existing conditions and regulatory considerations, presents conclusions, and offers recommendations for future transportation elements in the David Hill Urban Reserve (DHUR) area. The purpose of this memo is to document the opportunities, constraints, and design tools related to transportation that maximizes the efficiency of existing and future infrastructure and minimizes the impacts of future urbanization of the DHUR.

Existing Conditions

Roads

The DHUR consists of 317 acres located at the northwest corner of the City of Forest Grove and extends along the northwestern edge of the Urban Growth Boundary (UGB) northeast and southwest of David Hill Road. The northeastern edge of the urban reserve is bordered by Thatcher Road and the southwestern boundary extends to Gales Creek Road. The reserve is characterized by rolling hills with slopes ranging from less than 5 percent to greater than 25 percent. Over half the urban reserve (167 acres) contains natural constraints, or natural features that are less desirable for development such as slopes of 25 percent or more, existing forest or woodlands, wetlands, and water quality management areas.

A single, two-lane public road, David Hill Road, bisects the DHUR. The section of David Hill Road within current city limits is under city jurisdiction. The pavement condition for this section is rated “good” (City of Forest Grove, 2010) and the current posted speed limit is 25 miles per hour (mph). Outside of current city limits and within the DHUR, David Hill Road is under Washington County jurisdiction. This section of the road is only partially paved and lacks urban standards such as curbs, gutters, and sidewalks.

David Hill Road is classified as a collector and traverses diagonally across the reserve from the southeast to the northwest. According to the 2010 *Forest Grove Transportation System Plan* (TSP), the collector street functional classification is to:

Provide both access and circulation within residential and commercial/industrial areas...and penetrate residential neighborhoods, distributing trips from the neighborhood and local street system (Chapter 8, pg. 8-2).



In its updated Transportation System Plan (TSP), the City of Forest Grove explains that roadway functional classification is used to define the degree of connectivity for a particular roadway and is not a determinate for traffic volume, road size, or urban design (City of Forest Grove, 2010).

A David Hill Road extension study area specifically studying north-south and east-west travel connections northwest of Forest Grove city limits is identified in the Washington County *2020 Transportation Plan* (Policy 10, pg. 35) and is listed in the 2010 Forest Grove TSP. This study area includes a project to extend David Hill Road from Thatcher Road to Highway 47. It was originally scheduled to be completed by 2009 (City of Forest Grove, 2010). However, to date, this extension has not been completed. Although this project is outside the boundaries of the DHUR, it may impact the future westbound average daily traffic volumes through the urban reserve.

Other roads connected to the DHUR are Gales Creek Road in the south and Thatcher Road in the northeast. Both roads are classified as arterials and are under Washington County jurisdiction. Their pavement conditions are rated as “good” and the current posted speed limit for both roads is 40 mph.

Unimproved private rural roads (mostly gravel or dirt) exist throughout the DHUR and serve as driveways for the residents. Two prominent unimproved roads exist in the DHUR:

- Creekwood Place extends approximately 3,000 feet north from Gales Creek Road. The road is privately owned by the Jarrell family which oversees maintenance.
- An unnamed road extends north approximately 1,900 from David Hill Road and winds around the David Hill Reservoir to a cell phone tower north of the reservoir.

The intersection of Gales Creek Road and Creekwood Place was identified in Washington County’s Safety Priority Index System (SPIS). The SPIS is used to identify existing hazardous intersections for potential safety improvements. The Gales Creek/Creekwood Place intersection ranked 77th out of 276 intersections for receiving safety enhancements.

See Figure 1 for Streets, Roads, and Driveways in the DHUR.

Transit

No transit lines exist within the DHUR. However, TriMet’s 57 bus line does serve the City of Forest Grove. A crude network analysis shows the nearest bus stop from the DHUR is approximately 2.8 miles at Pacific Avenue and A Street (measured from either the intersection of Gales Creek Road and Creekwood Place or David Hill Road and Forest Gale Drive). A recently awarded Transportation Growth Management (TGM) grant authorized a feasibility study to evaluate and design a potential station community for a possible light rail line. The study area is located near the intersection of Oak Street and Pacific Avenue, approximately 4 miles east of the DHUR within in the city limits.

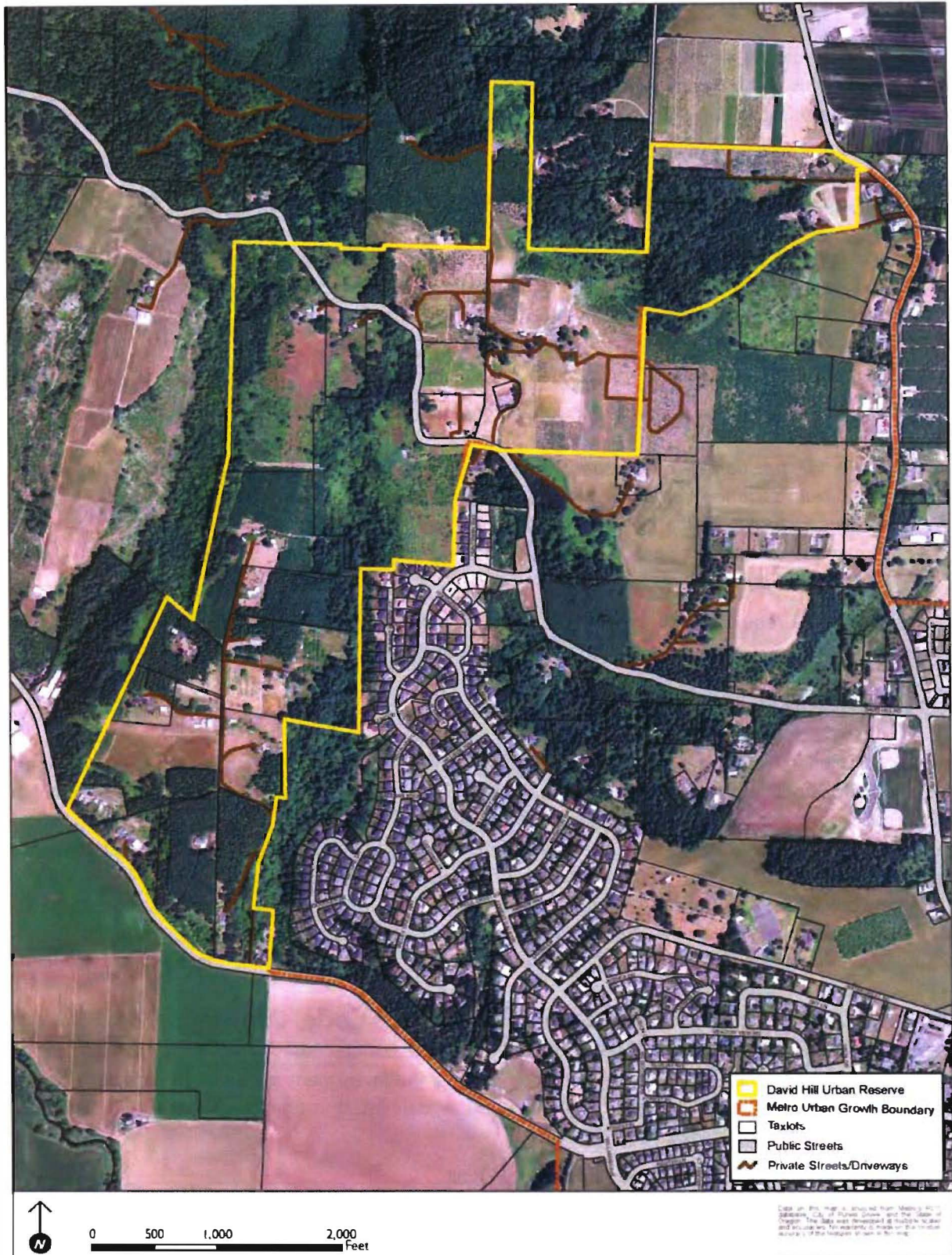


FIGURE 1
Streets, Roads, and Driveways

Regulatory Framework

Planning for residential development within the DHUR is guided by several local, county, and regional requirements. This section highlights the most relevant transportation guidance. It begins with the regional perspective, including Metro and Washington County policies, followed by City of Forest Grove policy guidance.

Planning for New Urban Areas, Metro Code, Chapter 3.07, Title 11

Title 11: Planning for New Urban Areas of the Metro Urban Growth Management Functional Plan (Metro, 2011) provides long-range planning guidance to ensure that areas brought into the UGB are urbanized efficiently and attempt to contribute to mixed-use, walkable, transit-friendly communities. As it specifically relates to transportation, Title 11 requires that a concept plan provide:

- *Well-connected systems of streets, bikeways, parks, recreational trails and public transit that link to needed housing so as to reduce the combined cost of housing and transportation (Title 11, 3.07.1110 (B)(1)(e))*
- *The mode, function, general location, and proposed connections to existing systems of any proposed state transportation facilities, arterials facilities, regional transit and trail facilities and freight intermodal facilities (Title 11, 3.07.1110 (C)(2)(b))*
- *The proposed connections of these systems and facilities, if any, to existing systems (Title 11, 3.07.1110 (C)(2)(c))*

In addition, Title 11 requires that a concept plan “be coordinated with the comprehensive plans and land use regulations that apply to nearby lands already within the UGB” (Title 11, 3.07.1110 (C)(6)).

2035 Regional Transportation Plan

The 2035 Regional Transportation Plan (RTP) is an outcomes-based planning framework which serves as Metro’s regional functional plan for transportation. It is in line with the Oregon Transportation Planning Rule (TPR) requirements for consistency with the Oregon Transportation Plan, state modal and facility plans, and the Oregon TPR. Chapter 2.5 addresses regional system concepts and policies for different components of the regional transportation system. Areas of interest for developing a transportation plan for the DHUR include community building, designs for a well-connected network of complete streets that prioritize pedestrian and bicycle access, and stormwater management and natural resource protection. Chapter 6.7 of the RTP addresses local implementation for the RTP and contains the requirements for meeting the functional plan.

Regional Transportation Functional Plan, Metro Code, Chapter 3.08

The Regional Transportation Functional Plan (RTFP) establishes an outcomes-based framework and includes policies, objectives and actions that direct future planning and investment decisions to consider economic, equity, and environmental objectives. It implements the goals listed in Chapter 2.3 of the 2035 RTP. The principal performance objectives of the RTFP are

- Improving public health, safety, and security for all
- Attracting jobs and housing to downtowns, main streets, corridors, and employment areas
- Creating vibrant, livable communities

- Sustaining the region's economic competitiveness and prosperity
- Maximizing use of the existing transportation system
- Completing the transportation system for all modes of travel to expand transportation choices
- Increasing use of the transit, pedestrian, and bicycle systems
- Ensuring equity and affordable transportation choices
- Improving freight reliability
- Reducing vehicle miles traveled and resulting emissions
- Promoting environmental and fiscal stewardship and accountability

Title 1 of the RTFP addresses transportation system design, including streets, transit, pedestrian, bicycle, and freight. Specific requirements for new residential and mixed-use developments greater than 5 acres include:

The map shall identify street connections to adjacent areas to promote a logical, direct and connected system of streets and should demonstrate opportunities to extend and connect new streets to existing streets, provide direct public right-of-way routes and limit closed-end street designs consistent with subsection E. (Section 3.08.110(D))

Additional requirements for developments requiring new streets include:

If proposed residential or mixed-use development of five or more acres involves construction of a new street, the city and county regulations shall require the applicant to provide a site plan that:

- 1. Is consistent with the conceptual new streets map required by subsection D;*
- 2. Provides full street connections with spacing of no more than 530 feet between connections, except if prevented by barriers such as topography, rail lines, freeways, pre-existing development, leases, easements or covenants that existed prior to May 1, 1995, or by requirements of Titles 3 and 13 of the UGMFP;*
- 3. If streets must cross water features protected pursuant to Title 3 UGMFP, provides a crossing every 800 to 1,200 feet unless habitat quality or the length of the crossing prevents a full street connection;*
- 4. If full street connection is prevented, provides bicycle and pedestrian accessways on public easements or rights-of-way spaced such that accessways are not more than 330 feet apart, unless not possible for the reasons set forth in paragraph 3;*
- 5. Provides for bike and pedestrian accessways that cross water features protected pursuant to Title 3 of the UGMFP at an average of 530 feet between accessways unless habitat quality or the length of the crossing prevents a connection;*
- 6. If full street connection over water features protected pursuant to Title 3 of the UGMFP cannot be constructed in centers as defined in Title 6 of the UGMFP or Main Streets shown on the 2040 Growth Concept Map, or if spacing of full street connections exceeds 1,200 feet, provides bike and pedestrian crossings at an average of 530 feet between accessways unless habitat quality or the length of the crossing prevents a connection;*
- 7. Limits cul-de-sac designs or other closed-end street designs to circumstances in which barriers prevent full street extensions and limits the length of such streets to 200 feet and the number of dwellings along the street to no more than 25; and*

8. *Provides street cross-sections showing dimensions of right-of-way improvements and posted or expected speed limits. (Regional Transportation Functional Plan, 3.08.110(E))*

2020 Washington County Transportation Plan

Policy 1 of the 2020 Washington County Transportation Plan (2002) aims to provide a multi-modal transportation system that supports county and city land uses and makes progress toward achieving the following 2040 Regional Non-Single Occupant Vehicle mode share targets prescribed in the RTP:

- 45 to 55 percent in regional centers, town centers, main streets, light rail station areas and corridors
- 40 to 45 percent in industrial and employment areas, inner and outer neighborhoods and for intermodal facilities

These mode share targets are reiterated in Forest Grove's updated TSP.

The Roadway Elements Policy 6, *Roadway System Policy*, of the 2020 Washington County Transportation Plan requires that all roadway systems perform at minimum operating standards for given locations. See Table 1 for minimum acceptable motor vehicle performance measures.

In addition, Policy 6 references Metro's *Creating Livable Streets: Street Design Guidelines for 2040* (2002) handbook as acceptable design guidelines for Washington County. The contents of this handbook are further described in the *Recommendations* section of this memo. To ensure a safe roadway system that is accessible for all modes of travel and across all functional classifications, access management standards are set by the Washington County Community Development Code. Functional classification design parameters are shown in Table 2.

Table 1
Washington County Motor Vehicle Performance Measures

Maximum Volume to Capacity (V/C) Ratio Standards, and Deficiency Areas

Location ²	AM/PM Peak Two-hour Period			
	Target ¹ Performance Measures ³		Acceptable ¹ Performance Measures ³	
	First Hour ⁴	Second Hour ⁴	First Hour ⁴	Second Hour ⁴
Regional Centers				
Town Centers	.99	.9	.99	.99
Main Streets	(E)	(D)	(E)	(E)
Station Communities				
Other Urban Areas	.9	.9	.99	.9
	(D)	(D)	(E)	(D)
Rural Areas	.9	.9	.9	.9
	(D)	(D)	(D)	(D)

¹ For development review purposes, these performance standards will be used in assessing safety improvements. For plan amendment purposes, if a plan amendment is predicted to exceed the acceptable performance standard, the performance on applicable facilities will not be allowed to deteriorate further, and mitigation may be necessary. For project development purposes, these performance standards will be used to evaluate conditions beyond the transportation plan's planning horizon, as appropriate.

² For location reference see 2040 Growth Concept Design Types Map.

³ Vehicle performance shall be determined by using volume to capacity ratios. Volume to Capacity equivalencies to LOS are as follows: LOS C = V/C of 0.8 or lower; LOS D = V/C of 0.81 to 0.9; LOS E = V/C of 0.91 to 0.99. Further discussion of vehicle performance is provided in the Technical Appendix.

⁴ First Hour is defined as the highest hour of the day. Second hour is defined as the hour following the first hour.

⁵ For location reference see the Deficiency Area Map. Deficiency areas do not affect development review, but apply for planning purposes. Not all placeholder projects in study areas solved the predicted problems; it is anticipated that further study will address the issues.

Source: Washington County 2020 Transportation Plan (2002), Table 5, Roadway Element, Policy 6-11, pg. 15

Table 2
Washington County Functional Classification Design Parameters

Roadway Classification	Lanes ¹	Bike Lanes ²	Max. ROW ³	Max. Paved Width ³
Principal Arterials & Arterials ³	7	Yes	122 Feet	98 Feet
	5	Yes	98 Feet	74 Feet
	3	Yes	90 Feet	50 Feet
	2	Yes	90 Feet	48 Feet
Collectors ^{3,4}	5	Yes	98 Feet	74 Feet
	3	Yes	74 Feet	50 Feet
	2	Yes	74 Feet	50 Feet
Special Area Collectors ³	3	Yes	62 Feet	46 Feet
	2	Yes	40 Feet	34 Feet
Neighborhood Routes	2	No	60 Feet	36 Feet
Special Area Neighborhood Routes ⁵	2	No*	44 Feet	38 Feet
Commercial/Industrial	4	No	70 Feet	50 Feet
	3	Yes	64 Feet	50 Feet
	2	No	64 Feet	34 Feet
Special Area Commercial Streets ⁴	4	No*	70 Feet	64 Feet
	3	No*	58 Feet	52 Feet
	2	No*	46 Feet	40 Feet
Locals	24' Travel Way	No	50 Feet	32 Feet
Special Area Local Streets ⁵	16' Travel Way	No	38 Feet	32 Feet

* While these facilities do not include bike lanes, they do include wide travel lanes of 14 feet due to constrained right-of-way width – see Footnotes 2 and 5.

Notes:

¹ The maximum number of travel lanes that can be built without a plan amendment is identified on the 'Road Lane Numbers' map in the Transportation Plan. This plan-level decision establishes the transportation system capacity necessary to adequately serve future travel demands identified in the plan. The number of lanes required to accommodate turning movements at intersections and interchanges will be determined through traffic analysis conducted during the transportation project development process. This project-level decision identifies physical improvements necessary at or near intersections and

interchanges to safely and efficiently move toward attaining the system capacity identified in the Plan. Improvements may include turn lanes and auxiliary lanes adjoining the traveled roadway to accommodate weaving, merging, speed changes, or other purposes supplementary to through traffic movement. Auxiliary lanes to address spot area capacity and safety needs may extend between intersections (including interchanges) and beyond an intersection. Opportunities for public involvement at the transportation project development level are provided as defined in Washington County's adopted Transportation Project Development Public Involvement Guidelines (R&O 93-124, August 25, 1993). Additional opportunities for public participation are available as provided by Article VII of the Community Development Code.

² Bikeways are required on all urban Collectors and Arterials, including Special Area Collectors. Six-foot wide, striped and stenciled bike lanes shall be constructed along these urban facilities except where special constraints exist: in these areas, 14-foot wide, outside travel lanes may be used and transitioned back to six foot bicycle lanes when the constraint ends. Outside of the UGB, refer to the Bicycle System map to determine which facilities are intended to have bikeways. These bikeways may be a minimum of four-foot wide paved shoulders.

³ Maximum right-of-way and pavement widths identified here are, as a rule, the maximum that can be built on roadway segments without an amendment to the Transportation Plan. However, plan amendments will not be required when it is determined during the project development or development review processes that these maximums should be exceeded to accommodate topography or project-level refinements associated with wider than standard pedestrian facilities; bus pullouts; on-street parking; project impact mitigation measures; and intersection, interchange or other project features identified as necessary for safe, efficient operation of the planned transportation system. All intersections along Arterials and Collectors shall be planned to include right-of-way necessary for turn lanes within 500-feet of intersections, based on a 20-year analysis of intersection needs. Actual right-of-way requirements may be less than the maximums specified in the table based on roadway characteristics and surrounding land uses. On two and three lane urban Collectors, right-of-way may be reduced to 60 feet and maximum paved width may be reduced to 36 feet through the land development or project development processes when there is a finding that a turn lane is reasonably unlikely to be needed based on anticipated future development and traffic analysis. Acquiring adequate right-of-way is important to avoid unnecessary and costly future roadway system improvement impacts. Efforts should be made to specifically define project/roadway right-of-way requirements during the project and/or land development processes in order to avoid acquiring excess right-of-way, however (by performing the traffic safety and access analysis necessary to determine whether a center turn lane is needed, for instance). In rural areas, the maximum right-of-way for Collectors shall be 60-feet. Opportunities for public involvement at the transportation project development level are provided as defined in Washington County's adopted Transportation Project Development Public Involvement Guidelines (R&O 93-124, August 25, 1993). Article VII of the Community Development Code identifies land use standards, public notice and public involvement provisions and appeal opportunities that are provided in the Land Use Permitting Process.

⁴ On those Arterials and Collectors designated on the 'Regional Street Design Overlay' map as 'Boulevards', 'Boulevard Intersections' or 'Streets', or located within identified 'Pedestrian Districts' on the Pedestrian System Map, sidewalk widths and other design features such as planter areas shall be determined based on the applicable standards in the Community Plans, Community Development Code.

⁵ 'Special Area' streets (Collector, Neighborhood, Commercial or Local classifications) are shown on the 'Special Area Street Overlay Maps'. Special Area Local Streets are also designated in the appropriate Community Plans and/or by the Community Development Code. Additional Special Area Neighborhood Routes and Special Area Local Streets may be designated using the development review process. Special Area Street designs will be determined via the development review process. While Special Area Commercial Streets do not include striped bicycle lanes, they shall include wide travel lanes of 14 feet to accommodate bicycle use. For Special Area Collectors, in addition to the right-of-way, a nine-foot minimum utility/sidewalk easement shall be dedicated on each side of the right-of-way. For Special Area Local streets, in addition to the right-of-way, a ten-foot minimum utility/sidewalk easement shall be dedicated on each side of the right-of-way. For Special Area Alleys, additional right-of-way may be required as part of development review.

Source: 2020 Washington County Transportation Plan (2002), Table 6, Roadway Element, Policy 6-11, pg. 35

Washington County Community Development Codes

Code standards are adopted to protect the health, safety, and welfare of the public by preventing incompatible land uses from being established next to one another. The requirements and standards within the Community Development Code are used to determine whether or not a proposed development can be approved in its proposed location and what applicable conditions should be applied. The standards within the Community Development Code are based on a collection of standards including Oregon State Statutes, Oregon State Administrative Rules, and ordinances adopted by the Board of County Commissioners. Specific articles and subsections within the Community Development Codes that address access management and should be considered for transportation planning within the DHUR include:

- Article IV Development Standards
 - 408, Neighborhood Circulation
 - 409, Private Streets
 - 410, Grading and Drainage
- Article V Public Facility & Service Requirements

These articles provide guidelines to ensure development which supports safe and connected transportation options for pedestrians, bicyclists, and public transit users. The articles discuss optimal number of connections and distances between intersections to promote multi-modal connectivity. Guidance for coordinating site plans with Emergency Medical Service personnel is provided. Slope constraints related to transportation facilities and guidance for grading plans are provided.

2010 Forest Grove Transportation System Plan

The City of Forest Grove updated its TSP in August 2010 to reflect amendments and additions to state and regional policies and regulations. The key updates to the TSP goals and policies include Metro street connectivity spacing standards, Metro and Oregon Department of Transportation (ODOT) mobility standards and Metro 2040 vehicle occupancy goals to reduce single-occupant vehicle trips. The City's TSP now lists 10 transportation goals with subsequent policies and actions for specific measurement and implementation. As this TSP was drafted and updated in accordance with higher level regional and state transportation plans, policies, and regulations, it is assumed that developing a transportation plan for the DHUR in line with the goals, policies, and actions of the City's TSP will also meet all regional and state standards. The most relevant policies and actions from the City's 10 transportation goals include:

- **Goal 1, Policy a. Provide a citywide network of safe and convenient walkways and bikeways that are integrated with other transportation modes and regional destinations.**
 - *Action: The City will develop new and improved pedestrian routes with ultimate goal of a complete 'pedestrian grid' in Forest Grove.*
- **Goal 2, Policy a. Enhance street system connectivity wherever practical and feasible.**
 - *Action: Establish design criteria and implementing ordinances to enable the connection of streets identified on the plan as funds are available and new development or redevelopment opportunities arise. Exceptions will be given where connections are prevented by topography, barriers such as railroads, expressway or pre-existing development, or environmental constraints.*
 - *Action: The City will develop a local and neighborhood street system with a preferred spacing of no more than 530 feet, between elements of the City street network.*

- *Action: The City will develop a walkway route system with a preferred spacing of no more than 330 feet, between elements of the City pedestrian network.*
- **Goal 4, Policy a. Maintain the livability of Forest Grove through proper location and design of transportation facilities.**
 - *Action: Design streets and highways to respect the characteristics of the surrounding land uses, natural features and other community amenities.*
- **Goal 6, Policy a. Streets should be designed to support their intended users.**
 - *Action: A primary emergency response route system shall be developed for roadways within Forest Grove in coordination with the local Fire District. Appropriate traffic calming guidelines for these routes shall be developed in coordination with the local Fire District and other local emergency service providers.*
- **Goal 6, Policy d. Promote context-sensitive transportation facility design, which fits the physical context, responds to environmental resources, and maintains safety and mobility.**
 - *Action: Amend their street design standards to allow for options related to storm drainage design on city facilities. These 'green street' design options would be subject to the review and approval of the City Engineer.*

City of Forest Grove Development Code, Chapter 10.8

The City of Forest Grove Development Code describes development and improvement standards for the city. The section of particular relevance to the DHUR is Section 10.8.6 which discusses public improvements. The standards and regulations outlined in this section aim to ensure safe and efficient vehicle and pedestrian travel through standard implementation of public infrastructure including streets. Minimum rights-of-way and street widths are discussed in Section 10.8.615 and shown in Table 3.

The code explains that the decision-making body determines the width of a street for new development after considering numerous factors. These include its functional classification, anticipated traffic generation, bicycle and sidewalk requirements, drainage and slope impacts, and emergency vehicle access. In addition, the code also addresses standards and regulations related to slopes and stormwater drainage, both of which are prevalent issues for the DHUR as well as bicycle network design and accommodation.

The above documents are consistent with each other, and ultimately reflect and comply with the overarching Oregon TPR. To comply with the Oregon TPR, each city must adopt a TSP which complies with both the state TSP and Metro's RTP. The goals of the Oregon TPR are to:

- Reduce dependence on the automobile and the number of people driving alone
- Establish a stronger connection between land use and transportation planning

Table 3
City of Forest Grove Street Standards

Street Classification	Minimum R.O.W. Width	Minimum Roadway Width
Major Arterial	90-96 feet	52-64 feet
Minor Arterial	66 feet	40 feet
Residential Collector	66 feet	40 feet
Local Industrial	66 feet	40 feet
Local Street	58 feet	32 feet
Local Street	54 feet	28 feet [1]
Local Street	50 feet	24 feet [2]
Local Street	50 feet [3]	15 feet [4]
Neighborhood Route	54 feet	28 feet [7]
Cul-de-sac	58 feet	32 feet
Circular end of cul-de-sac	55 feet (radius)	42 feet (radius)
Cul-de-sac	50 feet	24 feet [5]
Circular end of Cul-de-sac	40 feet (radius)	34 feet (radius) [6]
Alley	15 feet	12 feet

Notes

[1] These streets shall not exceed 330 feet in length for any one segment. Each end of the segment shall connect to an existing or planned street with a minimum roadway width of 32 feet. Fire hydrants shall be placed at one-third intervals along the street segment. Driveways shall be placed in a manner to provide queuing space to allow for adequate traffic passage including emergency vehicles.

[2] These streets shall not exceed 330 feet in length for any one segment or the length needed to traverse a wetland or natural resource area. Each end of the segment shall connect to an existing or planned street with a minimum roadway width of 32 feet. Fire hydrants shall be placed at one-third intervals along the street segment. On-street parking is permitted on one side only.

[3] Street right-of-way may be reduced if approved by the City Engineer to preserve natural features, crossing a wetland or natural resource area or where construction of a full-width street would result in excessive cut-and-fill due to existing topography.

[4] One-way traffic only; no on-street parking permitted. One-way streets may be permitted only to preserve natural features or where the construction of a full-width street would result in excessive cut-and-fill due to existing topography as determined by the City Engineer.

[5] No on-street parking permitted.

[6] Sidewalks permitted adjacent to curb.

[7] On-street parking permitted on one side only.

Source: City of Forest Grove Development Code (2009), Chapter 10.8.6, Table 8-8, pg. 55

Best Practices

The latest transportation innovations and best practices of today may likely become standard practice by the time a concept plan for DHUR is implemented. To that end, best practices and latest innovations in transportation planning should be incorporated to the fullest extent possible. Best practices to consider are discussed below.

Emergency Medical Services Provision

In the past, planning for emergency medical service (EMS) provision was overlooked in transportation plans. From Goal 6 of the Forest Grove TSP, it is clear that EMS is considered an important element of the transportation system. Best practices exist which integrate emergency response needs with local transportation planning and traffic calming measures. The Tualatin Valley Fire and Rescue department has implemented "Emergency Response Friendly" traffic calming policies that establish coordination and planning between local agencies and the emergency service district. This coordinated effort aims to accomplish transportation goals and traffic calming measures without negatively impacting emergency response times or

routes. The policy discusses a “toolbox” which lists ways to successfully manage minimum roadway widths, roundabouts, and speed humps.

Road Placement

The hilly topography of the DHUR will present a challenge for all future development. Best practices suggest that future residential roads built through the area should aim to follow contour lines to the extent it is practical and financially feasible.

Public Transit

The Institute of Traffic Engineers (ITE) offers general guidelines for determining viable public transit provision. Generally, higher density areas offer greater options for providing public transit. Table 4 provides an overview of these guidelines. Because of the topography and natural constraints in the DHUR, there are limited options to allow for higher densities. For example, the existing development southeast of the DHUR is currently not served with public transit at densities of approximately four dwelling-units per net acre.

Table 4
Density and Population Guidelines for Public Transit Provision

	Frequency	Density (DU/AC)	Gross Population Density	Concentration of Non- Residential Floorspace
Local Bus Service	1/hr	4 to 5	3K to 4K / sq-mi	5 to 8 million square feet
Intermediate Service	1/30min	7	5K to 6K / sq-mi	8 to 20 million square feet
Frequent Service	~1/10min	15	10K / sq-mi	20 to 50 million square feet

Source: Institute of Traffic Engineers as referenced by Thomas Jefferson Planning District Commission (2011) online at <http://www.tjpd.com/transportation/report.asp?docID=24>

Street Design

Metro’s Creating Livable Streets: Street Design Guidelines for 2040

(Text from Metro’s website: <http://www.metro-region.org/index.cfm/go/by.web/id=26334>)

This handbook provides specific tools that complement strategies and policies identified in the RTP and the 2040 Growth Concept. Street design elements such as sidewalks, crosswalks, bikeways, street trees, landscaping that separates the sidewalk from the street, street lighting, bus shelters and corner curb extensions provide a safer environment that can slow traffic and encourage walking, bicycling and transit use. Specific design considerations addressed in the handbook, include:

- How streets can be retrofitted and upgraded with pedestrian-oriented amenities to promote walking, bicycling, and the use of transit
- How to ensure that pedestrian improvements do not preclude reasonable truck and bus movement at major intersections and that truck and bus improvements do not inhibit pedestrian movement
- How streets should integrate bikeways
- How site access along regional arterials with continuous commercial or mixed-use development can be controlled to improve safety, function, and appearance
- How to make tradeoffs between regional street design elements where right-of-way constraints limit desired design elements

Green Streets: Innovative Solutions for Stormwater and Stream Crossings

(Text from Metro's website: <http://www.oregonmetro.gov/index.cfm/go/by.web/id=26335>)

Metro's Green Streets handbook describes stormwater management strategies and illustrates street designs with features such as street trees, landscaped swales, and special paving materials that allow infiltration and limit runoff. The handbook also provides guidance on balancing the needs of protecting stream corridors and providing access across those streams.

Particular chapters and sections of interest are:

- Chapter 5 Design Solutions - particularly Section 5.3 covering maintenance tradeoffs of green street design solutions, and Section 5.4 discussing swale/basin vegetation
- Chapter 6 Designing Major Streets
- Chapter 7 Planning New Neighborhoods - especially Section 7.3 covering stream channel crossings considerations for street network design

From its mission statement, the tools within the *Green Streets* handbook promote the following:

- Viewing the public right-of-way (ROW) and urban runoff from streets as a human extension to the natural stream system and its ecology
- A street system designed to protect, and attempt to mimic, the natural hydrology of the area and protect streams from the adverse impacts of urban stormwater runoff
- Minimizing the negative effects of stream crossings
- Maximizing tree canopy coverage first by protecting existing forests and trees, and second by planting large street trees with wide-spreading canopies that are long-lived
- A level of neighborhood and street connectivity that promotes walking, bicycling and transit use, and reduces the demand to further expand major streets
- Stormwater treatment, attenuation and infiltration facilities that are integrated into the open spaces of a community, and treat stormwater as a resource and not a hazard
- Alternative street and infrastructure designs that are cost-effective
- Balance multiple policy objectives regarding transportation requirements and natural resource protection

Recommendations

The transportation system within the DHUR should allow for safe, connected, multi-modal travel opportunities. It is important to recognize the long-term impacts of a transportation system and to ensure that any proposed transportation system through the DHUR allows the opportunity to make transportation choices. Based on the existing conditions and regulatory framework, the following items should be considered when planning a transportation system specifically for the DHUR.

- Establish road networks with no higher than a neighborhood collector functional classification to offer adequate mobility through the DHUR and access to other destinations. Street calming measures should be considered to maintain slower traffic speeds
- Design neighborhood collector ROWs in accordance with City of Forest Grove Development Codes to allow for comfortable travel of all modes
- Conduct traffic impact analysis and capacity-based needs studies to determine the following items:

- Optimum street alignment if any development occurs in the southern part of the urban reserve, and to determine the necessity of installing a traffic signal and lower speed zone along Gales Creek Road to facilitate left-turn movements out of the DHUR
- Optimal placement of additional east-west streets connecting the DHUR to Thatcher Road and Purdin Road
- Evaluate the viability of extending public transit into the DHUR
- Involve emergency response personnel in the transportation planning process for the DHUR
- Incorporate best management practices for transportation planning as much as possible

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TO: Jon Holan, Community Development Director, City of Forest Grove, Oregon
COPIES: File
FROM: Misty Schymtzik, Vista Planning
DATE: June 7, 2011
SUBJECT: Water and Sewer Considerations for the David Hill Urban Reserve

Introduction

This memo documents and provides recommendations for the water and sewer considerations for the David Hill Urban Reserve (DHUR). These considerations include future quantity needs, facility siting, and conveyance/infrastructure.

Regulatory Framework

Relevant regulations for environmental considerations include *Title 11: Planning for New Urban Areas* of Metro's Urban Growth Management Functional Plan, the City of Forest Grove Development Code, and state regulations including those of the Oregon Department of Environmental Quality (DEQ).

Planning for New Urban Areas, Metro Code, Chapter 3.07, Title 11

Title 11 provides long-range planning guidance to ensure that areas brought into the UGB are "urbanized efficiently" and that natural ecological systems and important natural landscape features are protected (Metro, 2011b). As it specifically relates to water and sewer, Title 11 requires that a concept plan should:

- *Consider actions necessary to achieve. . .protection of natural ecological systems and important natural landscape features (3.007.1110(B)(1)(g))*
- *Show the general locations of proposed sewer, park and trail, water and storm-water systems (3.07.1110(C)(2)(a))*
- *Be coordinated with the comprehensive plans and land use regulations that apply to nearby lands already within the UGB (3.007.1110(C)(5))*

City of Forest Grove Development Code

The City of Forest Grove's Development Code (2009) contains several provisions relevant to water and sewer considerations for development. These include the following:

- Section 10.8.630 requires that water facilities be installed to serve new developments and to connect to existing mains in accordance with the Comprehensive Plan, and the City's Master Water Plan (City of Forest Grove, 2009). This would include any new development in the DHUR once it is brought into the Forest Grove city limits.

- Section 10.8.625 requires that all new developments connect to sanitary sewers in accordance with CWS' *Design and Construction Standards*, the Comprehensive Plan, and the City's Master Sewer Plan. This would include any new development in the DHUR once it is brought into the Forest Grove city limits.

Other Relevant Regulations

All water systems must comply with the Oregon Drinking Water Quality Act, as detailed in Oregon Drinking Water Quality Act, Oregon Administrative Rules (OAR) 333-061 (HDR, 2010).

Sewer system design must comply with DEQ sewer design guidelines and OAR 340-052-0020, its updates, and all local ordinances.

Existing Conditions

The DHUR is located at the northwestern corner of the City of Forest Grove and extends along the northwestern edge of the Urban Growth Boundary (UGB) northeast and southwest of David Hill Road. The northeastern edge of this area extends to Thatcher Road and the southwestern boundary extends to Gales Creek Road. The DHUR is approximately 317 acres.

The DHUR is currently zoned for agriculture or forestry as are the areas to the immediate north, west, and south of the urban reserve. These areas are also outside the Forest Grove city limits and the UGB. Developments, which are within both the Forest Grove city limits and the UGB, border the DHUR along its southeastern border.

Over half the urban reserve (167 acres) contains natural constraints. Natural constraints are natural features that are less desirable for development such as slopes of 25 percent or more, existing forest or woodlands, wetlands, and water quality management areas. Natural constraints are shown on Figure 1.

Areas not identified as having natural constraints, and thus deemed most suitable for development, equate to 150 acres, or approximately 47 percent, of the DHUR.

The DHUR is currently sparsely populated, with 16 currently occupied units. Average annual rainfall in the City of Forest Grove is 44.58 inches (City of Forest Grove, 2010a).

Water

Residents of the DHUR currently obtain their water from wells. Well owners are responsible for needs associated with the wells including maintenance, pumps, and pipes.

The City of Forest Grove belongs to the Joint Water Commission (JWC), a joint operation for the treatment, transmission, and storage of municipal and industrial water owned by the member agencies of the Cities of Forest Grove, Hillsboro, and Beaverton, and the Tualatin Valley Water District. Residents of Forest Grove receive their water from the City.

A 1-million-gallon reservoir which serves the needs of the city is located on David Hill Road within the DHUR. The City's Municipal Code requires properties to be annexed to receive water from the City, thus residents of the DHUR currently have no access to water in the reservoir. In addition, the reservoir currently has insufficient water pressure to serve the DHUR. Figure 2 shows the locations of current water lines and the David Hill Reservoir.

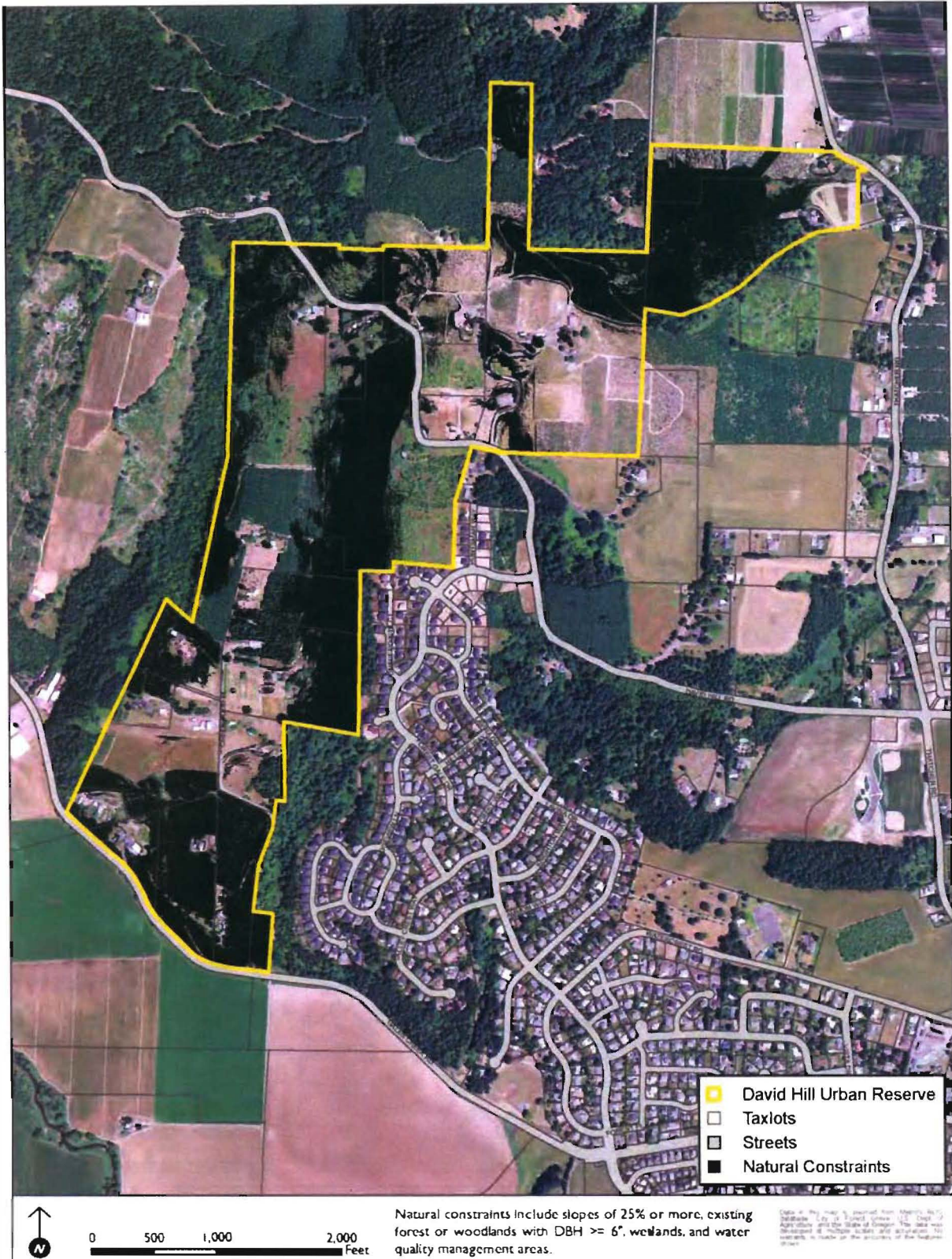


FIGURE 1
Natural Constraints

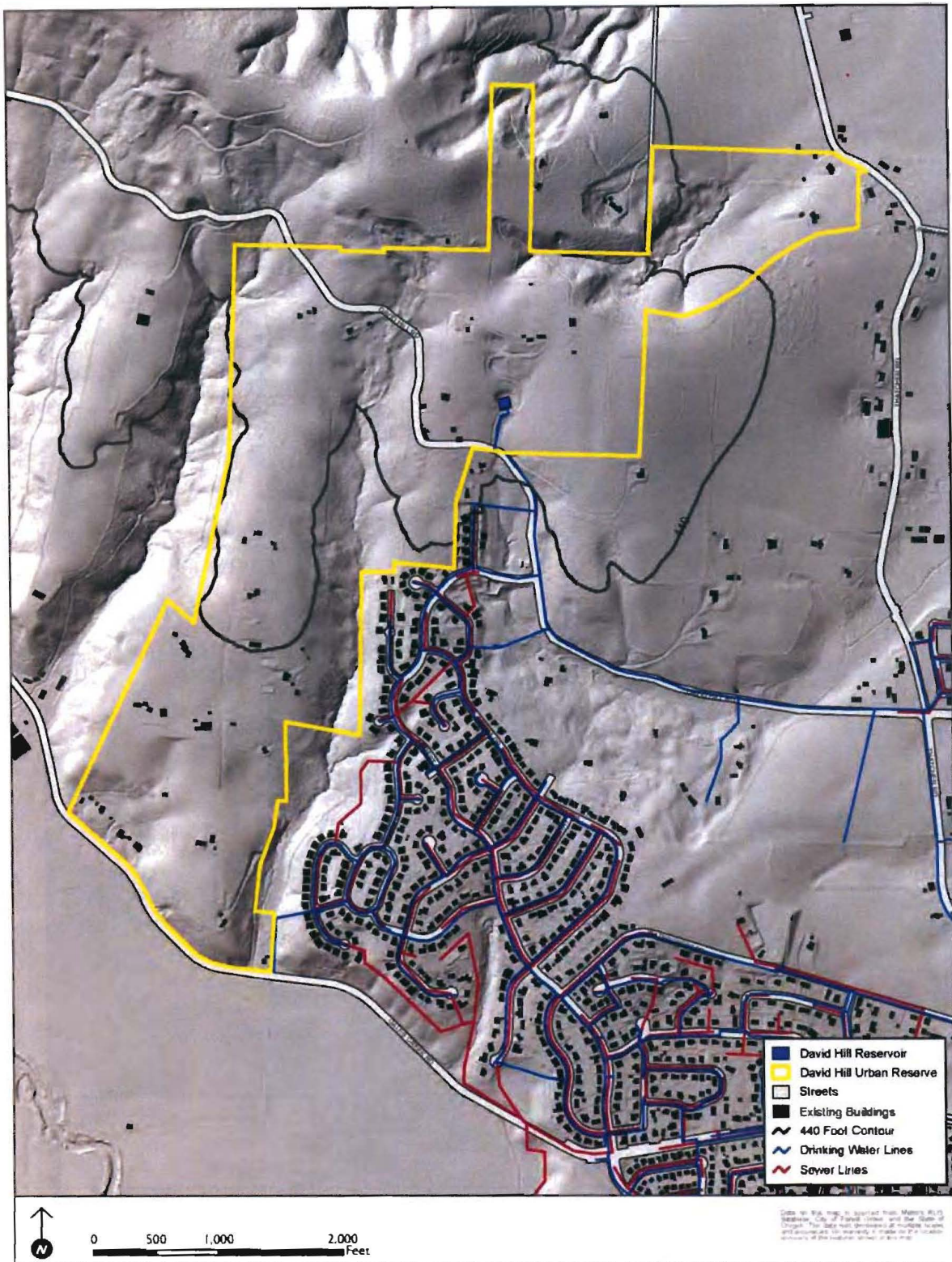


FIGURE 2
Water and Sewer Lines

City water is fed to the developments along the southeastern border of the DHUR through a system of pipes. However, these developments are separated from the DHUR by a stream corridor, Metro Title 3 water quality management areas, and a small ravine with slopes of greater than 25 percent. These constraints would likely limit the extension of water lines into the DHUR.

Elevations in the DHUR range from 200 feet to 760 feet. The majority of the DHUR is at elevations greater than 440 feet. Because of issues with pressure, water cannot be supplied through the City's current system. However, a reservoir and associated infrastructure is proposed in the area of the DHUR to meet future pressure and storage needs of the city and possible development in the DHUR (HDR, 2010).

The *2010 Water Master Plan* (HDR, 2010) recommends a Capital Improvements Program that includes a new 10-inch pipe. The pipe will extend from the current pipe along David Hill Road and continue along David Hill Road through the DHUR. No new water lines are currently planned to extend along Thatcher Road to the northeastern segment of the DHUR or along Gales Creek Road to reach the southern border of the DHUR. See Figure 3.

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The closest existing water lines are that along David Hill Road that ends just before the DHUR and those in the developments along the southeastern border of the DHUR. However, these developments are separated from the DHUR by a stream corridor, Metro Title 3 water quality management areas, and a small ravine with slopes of greater than 25 percent. These constraints would likely limit the extension of these water lines into the DHUR.



FIGURE 3. Proposed Water Lines

Source: 2010 Water Master Plan, Figure 7-1 (HDR, 2010)

Sewer

Sanitation needs are served in the DHUR by individual septic tanks. Owners are responsible for needs associated with the septic tanks including maintenance, pumps, and pipes.

Areas within the city limits and Clean Water Services' (CWS) District boundary may be served by sewer lines provided by the City of Forest Grove.

According to the Sanitary Sewer Master Plan, new pipes are planned along David Hill Road and Thatcher Road, though neither will reach the borders of the DHUR (Kennedy/Jenks, 2007). The closest existing sewer lines are those in the developments along the southeastern border of the DHUR. However, these developments are separated from the DHUR by a stream corridor, Metro Title 3 water quality management areas, and a small ravine with slopes of greater than 25 percent. These constraints would likely limit the extension of these sewer lines into the DHUR. Figure 4 shows the proposed sewer lines.

Recommendations

The primary issues for providing water and sewer service to the DHUR concern natural constraints, available supply and storage, site elevation, and extension of existing infrastructure.

In general, the City of Forest Grove has sufficient water supply and water rights to meet needs through approximately 2045 (HDR, 2010).

Connecting the reserve to the existing sewer system will require building infrastructure. Placing this infrastructure in the public right-of-way (ROW), usually within roadways, will require acquiring ROW. Topography such as steep slopes and the ravine separating the DHUR from the neighboring developments could make connecting to those water and sewer lines both difficult and expensive.

In light of the natural constraints, topography, and economics, the following items are recommended:

- Plan in accord with the Water and Sanitary Sewer Master Plans, City of Forest Grove Comprehensive Plan, and land uses on nearby lands within the UGB.
- Develop the proposed reservoir and associated infrastructure
- Consider the siting and size of the proposed reservoir to ensure water supply and distribution to the DHUR
- Evaluate the economics of extending infrastructure along Gales Creek Road and up into the reserve from Gales Creek Road.
- Use existing and planned infrastructure as much as possible.
- Run infrastructure in public ROW as much as possible.



FIGURE 4. Proposed Sewer Lines around the DHUR

Source: Sanitary Sewer Master Plan (Kennedy/Jenks, 2007)