Golder Associates

DRAFT TECHNICAL MEMORANDUM

Date: April 14 2015 **Project No.:** 1405198.005

To: Lisa Grueter **Company:** Berk Consulting

From: Dave Findley, LG, LEG

cc:

RE: CITY OF WOODINVIILLE LANDLSIDE HAZARD MAPPING-ADDITIONAL EVALAUTION

1.0 INTRODUCTION

This technical memorandum summarizes the results of additional geologic support activities that have been completed to support the update of the City of Woodinville's (City) Geohazard maps. This additional work was authorized by the City primarily to provide additional information regarding the Potential Landslide Hazard Areas map. The intended primary focus of field activity was to complete a surface reconnaissance of the Halsey property. A second field activity was related to a reconnaissance of a reported wetland/bog area (Hoven Bog) located near the Snohomish County / City of Woodinville boundary in the vicinity of NE 203rd Pl. and 164th Ave. NE

One of the intended elements of the additional study was a surface geomorphic and geologic reconnaissance of the Halsey property, an undeveloped parcel located on the west-facing slope of the Sammamish River valley and east of downtown Woodinville. However the City was unable to obtain right-of-entry. Therefore, field observations of the Halsey property were limited to observations from the public right-of-way.

This additional work reported herein, follows the submittal of draft Geohazard area maps prepared by Golder Associates Inc. for City review in mid-November 2014 (Golder Associates 2014). Subsequent to the submittal of the draft maps, presentations were made to the City Planning Commission and the City Council summarizing the Geohazard mapping update program. The City Council authorized this additional study to address questions raised by City Council members after the presentations. Questions raised during the presentations to the City Council focused on the landslide hazard status of the Halsey property and question regarding the compressible nature of foundation soil at Hoven Bog in Snohomish County and the potential for this bog area to extend across the County boundary into Woodinville.

In addition, we visited several field sites that were provided by interested Woodinville citizens and were accessible.

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2.0 BACKGROUND

The primary focus of this Technical Memorandum is the update of the Potential Landslide Hazard Areas map. As background, the City's municipal code, WMC 21.06.350 and .353, defines a Landslide and Landslide Hazard Areas as:

> **21.06.350** **Landslide.** Landslide: episodic downslope movement of a mass including, but not limited to, soil, rock or snow.
>
> **21.06.353** **Landslide hazard areas.** Landslide hazard areas: those areas in City of Woodinville subject to severe risks of landslides, including the following:
> (1) Any area with a combination of:
> (a) Slopes steeper than fifteen (15) percent,
> (b) Impermeable soils, such as silt and clay, frequently interbedded with granular soils, such as sand and gravel, and
> (c) Springs or ground water seepage.
> (2) Any area which has shown movement during the Holocene epoch, from 10,000 years ago to the present, or which is underlain by mass wastage debris from that epoch.
> (3) Any area potentially unstable as a result of rapid stream incision, stream bank erosion or undercutting by wave action,
> (4) Any area which shows evidence of or is at risk from snow avalanches.
> (5) Any area located on an alluvial fan, presently subject to or potentially subject to inundation by debris flows or deposition of stream-transported sediments.

Sections 1 and 2 under WMC 21.06.353 are the relevant paragraphs relative to the west-facing slope area east of downtown. The operative words are "...combination of: a) Slopes steeper than fifteen (15) percent" b) Impermeable soils, such as silt and clay, frequently interbedded with granular soils, such as sand and gravel and c) Springs or groundwater seepage."

Slopes steeper than fifteen (15) percent as defined in paragraph (a) section (1) are relatively straight forward and easily quantified with GIS topographic mapping from digital elevation models (DEM). These areas have been factored in the delineation of the draft Landslide Hazard Areas map.

Paragraph (b) of Section (1) relates to impermeable soils interbedded with granular soils. It has been our interpretation that the intent of this portion of the Landslide Hazard regulations is to capture the affect an important, specific regional geologic contact may have on landslide occurrence. This geologic contact is related to the boundary between underlying pre Vashon(pre-glacial) deposits and granular glacial advance outwash deposits associated with Vashon stade of the Fraser glaciation (the most recent glacial advance into the project area).

The pre Vashon deposits include the Transition Beds as mapped by Minard (1985) in the Woodinville area. These deposits are commonly dense as a result of having been overridden by the advancing Vashon glacial ice, and are composed of fine grained silt and clay, which exhibit lower permeability than the granular advance outwash that overlie them. The location of this contact is commonly where groundwater seeps and springs occur where the sloping ground surface intersects the contact. High groundwater seepage pressures may develop along the contact resulting in decreased soil strength and landslide activity. Many landslides in the Puget Sound lowland are located along, or in close proximity to this geologic contact.

The generally granular advance outwash deposits may have local thin beds of silt or clay and may have localized seasonal seepage occurring. These fine grained beds within the advance outwash are generally of limited lateral extent and are not considered a major contributor to slope instability and thus are not generally considered when addressing paragraph (b) of Section 1.

Paragraph (c) of Section 1 has to do with the occurrence of groundwater springs and seepage. This criterion is considered to primarily capture the occurrence of groundwater springs and seepage that may occur along the important contact between the low permeability, underlying pre Vashon deposits and the granular, advance outwash that has been previously discussed. It is recognized that groundwater springs and seepage may occur as groundwater perched along the top of dense impermeable lodgment till deposits in a slope faces or constructed cuts (particularly during the rainy season), but this is generally not considered a major contributor to slope instability due to the generally limited lateral extent of these perched conditions. In addition, water may pond on the ground surface during the wet rainy season as a result of the ground surface being underlain by shallow, low permeability lodgment till. Again, this type of situation is generally not considered a major contributor to slope instability.

Section 2 of WMC 21.06.353 captures areas where evidence of Holocene movement or evidence showing areas underlain by mass wasting deposits from the Holocene. The Holocene epoch, as considered in the Pacific Northwest, is the period of geologic time since the end of the Fraser glaciation, which was responsible for most of the glacial deposits in the Puget Sound region ended. The Holocene in the Puget Sound region extends from the end of Fraser glaciation in the Pleistocene to the present (essentially the last approximately 11, 700 years).

Also incorporated into the Potential Landslide Hazard Area Map is inclusion of any slope steeper than 40 percent. This attribute originates from the Geologically Hazardous areas designation in WMC Chapter 21.24 Development Standards-Critical Areas (21.24.290). A copy of the landslide hazard areas as defined in the Critical Areas Development Standards is attached. We note that the definitions of landslide hazard areas in WMC 21.06.353 and WMC 21.24.290 do not totally align. The 40 percent slope issue is an example and is addressed in 21.24.290 and not in the WMC 21.06.353. For clarity, it is recommended that disconnects such as this be addressed by the City.

3.0 METHODS OF STUDY

The additional landslide hazard mapping study included two primary activities: 1) review of selected, previous geotechnical reports supplied by the City, and 2) observations by Golder documented during the field reconnaissance.

3.1 Review of Geotechnical Reports

The following references were reviewed as supporting documents for the preparation of this technical memorandum

- Robinson Noble Report "Revised Geotechnical Engineering Brickyard Ridge Residential Development Woodinville, Washington for Brickyard Ridge, LLC," dated December 2013.
- Cornerstone Geotechnical, Inc. report "Preliminary Geotechnical Engineering Report Woodinville Plat Woodinville, Washington for Lee Livingston Phil & Mayrlin Stout," dated September 30, 2014.
- GeoEngineers report "Report, Geotechnical Engineering Services Proposed Halsey Subdivision Woodinville, Washington," dated February 4, 1991.
- GeoEngineers report "Report Addendum, Geotechnical Engineering Services Proposed Halsey Subdivision Woodinville, Washington," dated January 7, 1993

3.2 Field Reconnaissance

The field geomorphic and geologic reconnaissance activity was limited to the public right-of-way and King County property. The area of the reconnaissance focused on the west-facing slopes of the Sammamish River valley within the city limits. This reconnaissance activity was focused on refining the Landslide Hazard area map. One exception to this was the area located along the City of Woodinville-Snohomish County line in the vicinity of NE 203rd Place and 164th Ave. NE where a bog/wetland is located within Snohomish County and was thought to have possibly extended into the City of Woodinville city limits.

The purpose of the west-facing valley slope field reconnaissance was to evaluate the near-surface geologic conditions as it relates to the permeable soils overlying less permeable soils and the associated springs or seeps that often associated with this type of stratigraphic relationship (Sections 1 and 2 of the WMC 21.06.353). Field exposures on public property are very limited due to the urbanized residential nature of this area.

4.0 FIELD OBSERVATIONS AND ADDITIONAL DATA REVIEW

The following sections describe areas of the west-facing slope that were either visited in the field or additional geotechnical information was available and reviewed to provide some refinement to the Potential Landslide Hazard Areas map. These areas include the Halsey property, a King County green belt located between NE 178th Street on the north and NE 174th Street on the south, and a cut slope exposure located near NE 171st St. /143rd Pl NE. In addition, the area in the vicinity of NE 203rd Pl. and 164th Ave. NE in

Woodinville was visited to evaluate some City Council questions regarding the extent of the Hoven bog, located in Snohomish County, and whether the bog may extend into the City limits.

Additional review of the Halsey property was completed because of the recent interest in the parcel by the City and others. The King County green belt corridor was visited because it provides public access to a representative section along the slopes of the east side of the valley. The cut slope located east of the intersection of NE 171st Street and 143rd Pl. NE provides a rare opportunity to observe geologic conditions from a public right-of-way in the generally urbanized area.

4.1 Halsey Property

The Halsey property is located within the approximate northern half of the area delineated on the Potential Landslide Hazard Areas map as being possibly an old (pre-historic) landslide based on the geomorphic expression of the terrain. The Halsey property is bounded on the north by NE 185th Street and, on the east by 151st Avenue NE. The western boundary is formed by a southern projection of 148th Ave. NE in the vicinity of NE 184th Place to a King County Drainage Easement located 500 feet south of the intersection of NE 184th Place and 148th Avenue NE

The general area around the Halsey property had been identified in the previous geohazard landslide Hazard area map as a possibly an old landslide based solely on geomorphic expression on the Lidar imagery with no subsurface information. The geomorphic expression consists of an arcuate, irregular topographic scarp (break in slope) with subdued hummocky topography within the suspected landslide area. The subdued nature of the topographic expression of the area suggests it is an older, if it is indeed a landslide.

Our original estimate of the age of this landslide-like feature was possibly early Holocene. To say something is early, middle, or late Holocene implies a level of precision that is not warranted for a study of this level. To obtain absolute age dates would require the use of radiometric or other age data techniques on suitable samples. For the purpose of this Potential Landslide Hazard Areas map, we consider the area as at least pre-historic and not currently active.

Visual observations made from the public right-of-way of the Halsey area is vegetated by what appears to be mature, straight, second growth timber.

The GeoEngineers report (1993) for the Halsey property contains geologic logs from nine exploratory test pits that were excavated with a backhoe in 1991. Six of the nine test pits were excavated in the higher elevations (above elevation 375 feet) of the property in the vicinity NE 185th Street and 151st Ave. NE, in areas identified as Lots 1 through 7 for the proposed Halsey subdivision. These test pits are identified as TP-1 through TP-6, and TP-9. The other two test pits (identified as TP-7 and TP-8 were excavated in the

lower portion of the parcel (below elevation 350 feet). All of the test pits in the higher elevations (TP-1 through TP-6 and TP-9) encountered a veneer of topsoil and duff overlying what was identified as till. The lower elevation test pits (TP- 7 and TP-8) encountered dense, granular deposits composed of varying amounts sand, gravel, and cobbles. Though not identified geologically, the descriptions are consistent with what has been usually interpreted as advance outwash. It is noteworthy that no groundwater seepage was observed in either TP-7 or TP-8 even though the test pits were excavated in January during wetter portion of a year.

4.2 County Green Belt

This undeveloped, forested drainage trends roughly east-west and is located in the general area bounded by NE 178th Street on the north and NE 174th Street on the south. The upslope, eastern limits of the drainage is located near 154th Court NE and 143rd Ave. NE defines the lower western end of the drainage. Two areas of this drainage were reconnoitered. Access limitations dictated where entry was made. The upper reaches of the drainage were accessed off N E 178th Street between 149th Ave. NE 151st Way NE. Reference to the upper reaches of the drainage is generally those portions located above approximate elevation 260 feet. The lower reaches of the drainage were accessed from the King County easement extending from 174th Ave. NE to an approximate elevation of 250 feet. The lowest reach was accessed from 143rd Avenue NE (around elevation 120 feet.).

The upper reaches were evaluated by surface observations and shallow hand-dug scratch holes. The ground surface in the upper reaches appears to be underlain by fine sandy soils. Mature second growth coniferous tress appeared to be generally straight. No ponded water was observed even though morning rains had occurred hours before the field reconnaissance and no well-established active drainages were noted which suggest the subsurface soils are free draining. These observations are consistent with the upper reaches likely being underlain by advance outwash.

The middle reach that was accessed via the King County easement from 174th Ave. NE exhibited wetland type terrain with characteristic hydrophilic vegetation such as equisetum (hoarse tails), skunk cabbage, and standing water. This observation suggests a low permeability, confining stratigraphic layer is fairly shallow and likely represents fine grained soils (silt and clay) either glaciolacustrine sediments or fine grained pre-Vashon deposits that are of lower permeability and thus form a lower confining layer for vertical flow of groundwater resulting in the observed wetland.

The lower reaches was accessed off 143rd Ave.NE and a flowing creek was observed on the east side of 143rd Ave. NE that flows into a culvert and then into a storm water management facility located on the west side of 143rd Ave. NE. Exposures of dense, slightly oxidized, silty fine sand with little subangular to subrounded gravel clasts were noted. These deposits are clearly dense and over consolidated and form a

low permeable stratigraphic layer upon which the creek is flowing. These deposits are interpreted as either dense glaciolacustrine deposits or pre-Vashon sediments.

4.3 NE 171st St./143rd Pl NE Road Cut

This existing road cut is located along the north side of NE 171st Street and east of the intersection of NE 171st Street and 143rd Pl. NE. Most of the cut has been faced with a 5 to 6 feet high rockery. An outcrop of exposed natural soils is located off the east end of the rockery allowing visual observation. The exposed soils consisted of compact tom dense; non stratified deposits of silt and clayey silt with zones or pockets of matrix supported, medium to coarse gravel, and is locally oxidized. These deposits may be pre-Vashon in age and thus act as a low permeable layer relative to Section 1 (b) of WMC 21.06.353.

4.4 Hoven Bog area

The Hoven bog is located in Snohomish County, just north of the City limits in the vicinity of NE 203rd Pl. and 164th Ave. NE. A surface field reconnaissance was completed to evaluate ground surface conditions that could suggest that soft compressible soil and peat deposits associated with the bog could extend into the City limits and thus prompt revisions to the draft Potential Liquefaction Hazard Areas map or the Potential Problem Soils map. Field observations were limited to those from public right-of-way namely from 83rd Ave. NE and 243rd Street SE. No surface field indications of soft compressible soils or vegetation that is typically associated with bogs and wet lands were noted in this area. Additional review of Google Earth images were made as well. The vegetation observed on the Google Earth suggests a thin branch of the bog may extend into the City limits, located between 164th Ave. NE and 166th Ave. NE. This interpretation is based solely on the imagery and could not be verified in the field because of private property.

5.0 DISCUSSION

Revisions to the draft Potential Landslide Hazard Areas map have been made. The changes reflect the geologic interpretation resulting from the field observations and review of the additional geologic data from geotechnical reports. Change has been made to the permeable soil overlying impermeable soil relationship related to 1 (b) and (c) of WMC 21.06.353. The previous draft of the Landslide Hazard map was based largely on the location of the contact between the Transition Bed (as defined by Minard, 1985) and the overlying Vashon advance outwash. We are in general agreement with the mapped location of this contact on the west side of the valley and its relevance to the Potential Landslide Hazard Area delineation. The east side of the valley is not as clear cut. While Minard's contact may be accurate as mapped on the west side of the valley, there are clearly dense, hard fine grain deposits located along the base of the west-facing slopes of the valley. These deposits may be older pre-Vashon deposits that predate the Transition Beds mapped by Minard (1985) and form an erosional unconformity with the overlying granular Vashon advance outwash sediments. This stratigraphic relationship has the same effect of permeable deposits overlying

less permeable deposits as discussed in 1 (b) and (c) of WMC 21.06.353. This has resulted in moving this important stratigraphic relationship further to the east.

Based on our review of the subsurface information in the geotechnical report for the Halsey property (GeoEngineers 1991; 1993), this part of the suspected older landslide area would suggest in-place glacial stratigraphy e.g. dense lodgment till located near the crest and along the upland surface that overlies dense granular sandy advance outwash that extends to at least the bottom of the topographically defined drainage basin. No mention of landslide deposits or unusual geologic or groundwater conditions was noted in the GeoEngineers reports.

We completed a field visit to the northern city limit/Snohomish County area in the vicinity of NE 203rd Pl. and 164th Ave. NE where the Hoven bog was reportedly located. We observed the wetlands but these appear to be located entirely within Snohomish County. No surface indications were noted that would suggest that soft compressible soils associated with older bog areal limits extend into the Woodinville City limits. Shallow test pits or probing with a steel rod may be warranted to confirm the surface observations. Google Earth imagery shows vegetation that may represent wetland/bog type terrain extending into the City limits between 164th Ave. NE and 166th Ave. NE. However this could not be field verified because of private property access issues. No modifications to the Potential Problem Soil Map or the Potential Liquefaction Map were made in this area at this time.

GOLDER ASSOCIATES INC.

DRAFT

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Associate Geologist

DPW/km

6.0 REFERENCES

GeoEngineers. (1993). Report Addendum Geotechnical Services Proposed Halsey Subdivision Woodinville, Washington. January 7.

GeoEngineers. (1991). Report Geotechnical Engineering Services Proposed Halsey Subdivision Woodinville, Washington. February 4.

Golder Associates Inc. (2014). Technical Memorandum "City of Woodinville Geologic Hazards Areas and Critical Aquifer Recharge Areas". November 13.

Minard, James, P. (1985). Geologic Map of the Bothell Quadrangle, Snohomish and King Counties, Washington; United States Geological Survey, Miscellaneous Field Studies Map MF-1747.

City of Woodinville Municipal Code

ATTACHMENT

Attachment

Geologically Hazardous Areas from Critical Areas Development Standards (21.24.290)

21.24.290 Geologically hazardous areas – Designation.

(1) Geologically hazardous areas include areas susceptible to erosion, sliding, earthquake, or other geological events. Areas susceptible to one or more of the following types of hazards shall be designated as a geologically hazardous area:

(a) Erosion hazard;

(b) Landslide hazard;

(c) Seismic hazard;

(d) Other geological events including mass wasting debris flows, rock falls, and differential settlement.

(2) Designation of Specific Hazard Areas.

(a) Erosion Hazard Areas. Erosion hazard areas are those areas identified by the U.S. Department of Agriculture's Natural Resources Conservation Service or identified by a critical area special study as having a severe to very severe erosion potential.

(b) Landslide Hazard Areas. Landslide hazard areas are areas potentially subject to landslides based on a combination of geologic, topographic, and hydrologic factors. They include areas susceptible because of any combination of bedrock, soil, slope (gradient), slope aspect, structure, hydrology, or other factors. Examples of these may include, but are not limited to the following:

(i) Areas of historic failures, such as areas designated as quaternary slumps, earthflows, mudflows, lahars, or landslides on maps published by the U.S. Geological Survey or Department of Natural Resources;

(ii) Areas with all three of the following characteristics:

(A) Slopes steeper than 15 percent; and

(B) Hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock; and

(C) Springs or ground water seepage;

(iii) Areas that have shown movement during the Holocene epoch (from 10,000 years ago to the present) or that are underlain or covered by mass wastage debris of that epoch;

(iv) Areas potentially unstable because of rapid stream incision, stream bank erosion, and undercutting by wave action;

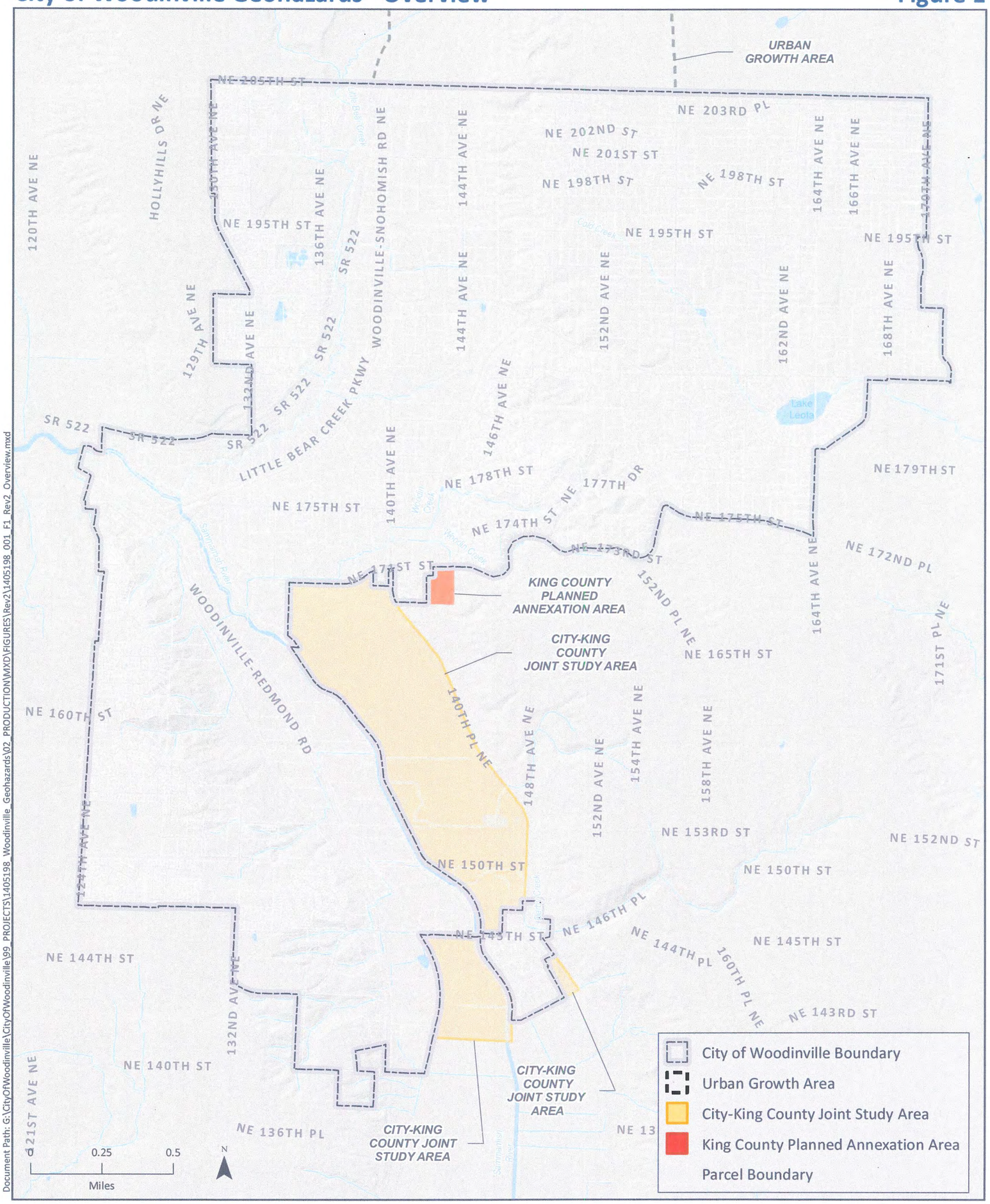
(v) Areas located in a canyon or on an active alluvial fan, presently or potentially subject to inundation by debris flows or catastrophic flooding; and

(vi) Any area with a slope of 40 percent or steeper and with a vertical relief of 10 or more feet except areas composed of consolidated rock. A slope is delineated by establishing its toe and top and measured by averaging the inclination over at least 10 feet of vertical relief.

(c) Seismic Hazard Areas. Seismic hazard areas are areas subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement, surface rupture, or soil liquefaction. (Ord. 375 § 3, 2004; Ord. 175 § 1, 1997. Formerly 21.24.210 – 21.24.300)

City of Woodinville Geohazards - Overview

Figure 1



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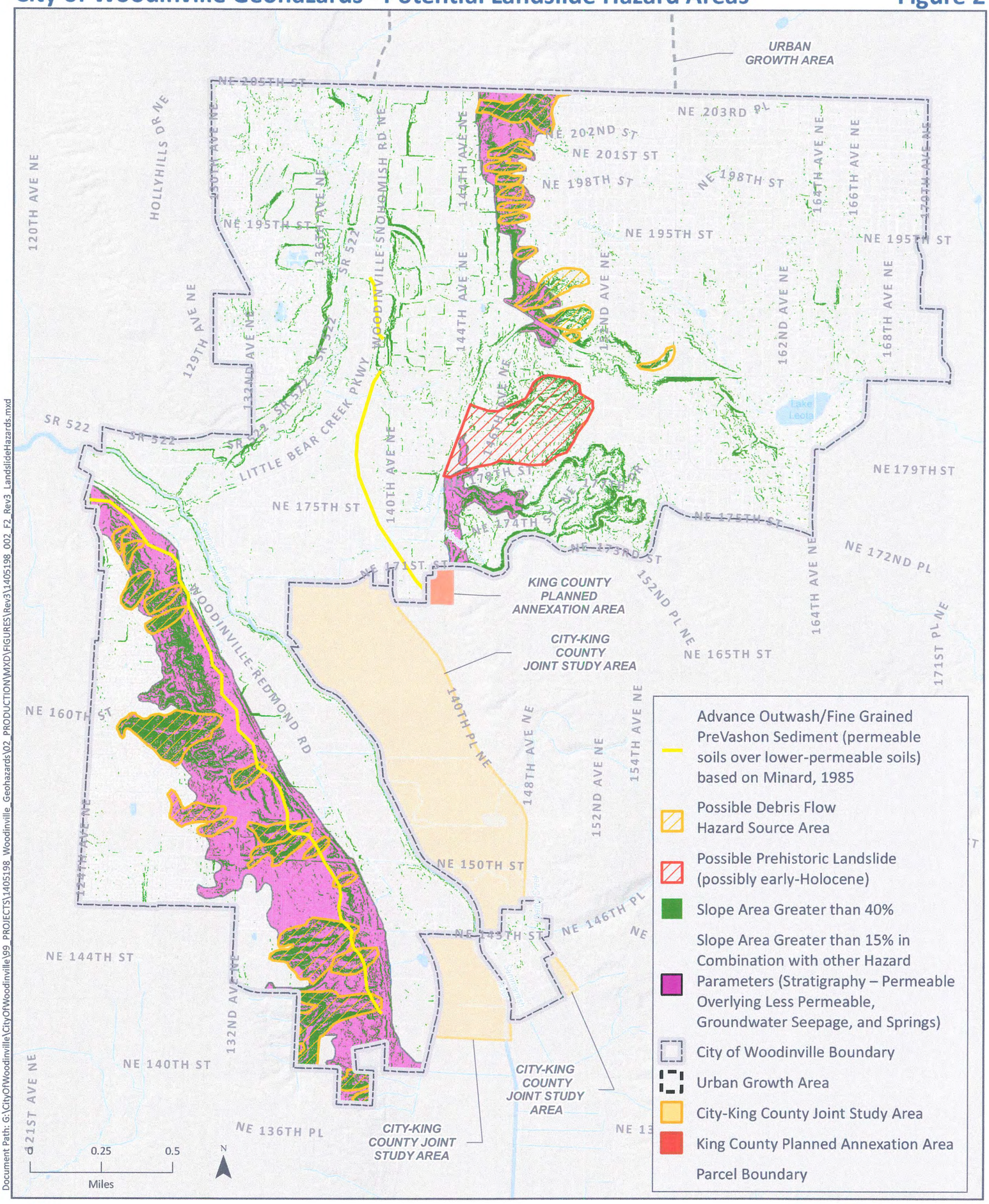
Date: April, 2015
Source: City of Woodinville, King County

Golder Associates

City of Woodinville Geohazards - Potential Landslide Hazard Areas

Figure 2



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Date: April, 2015
Source: City of Woodinville, King County, Washington DNR, Golder Associates Inc.

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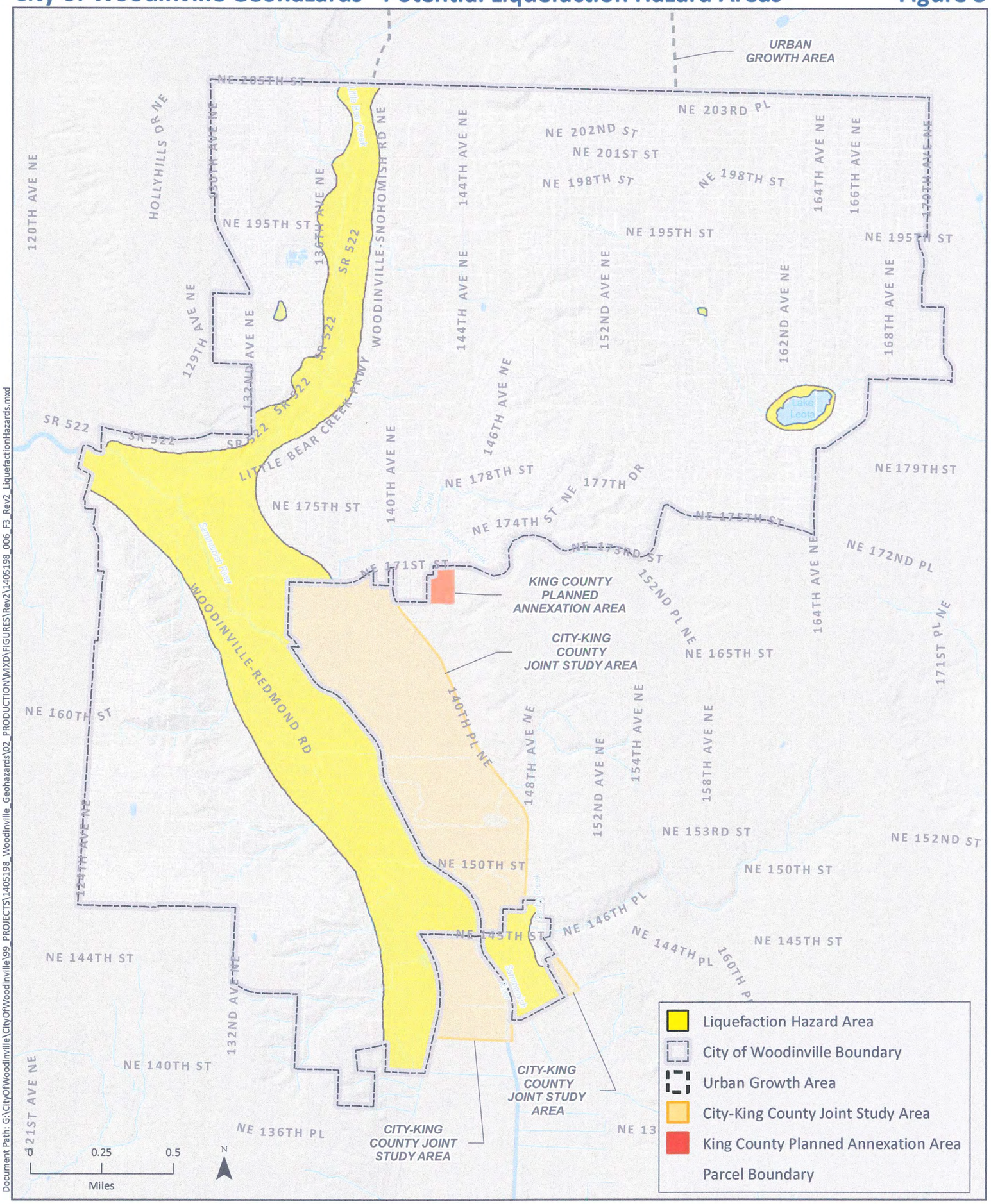
City of Woodinville Geohazards - Potential Liquefaction Hazard Areas

Figure 3



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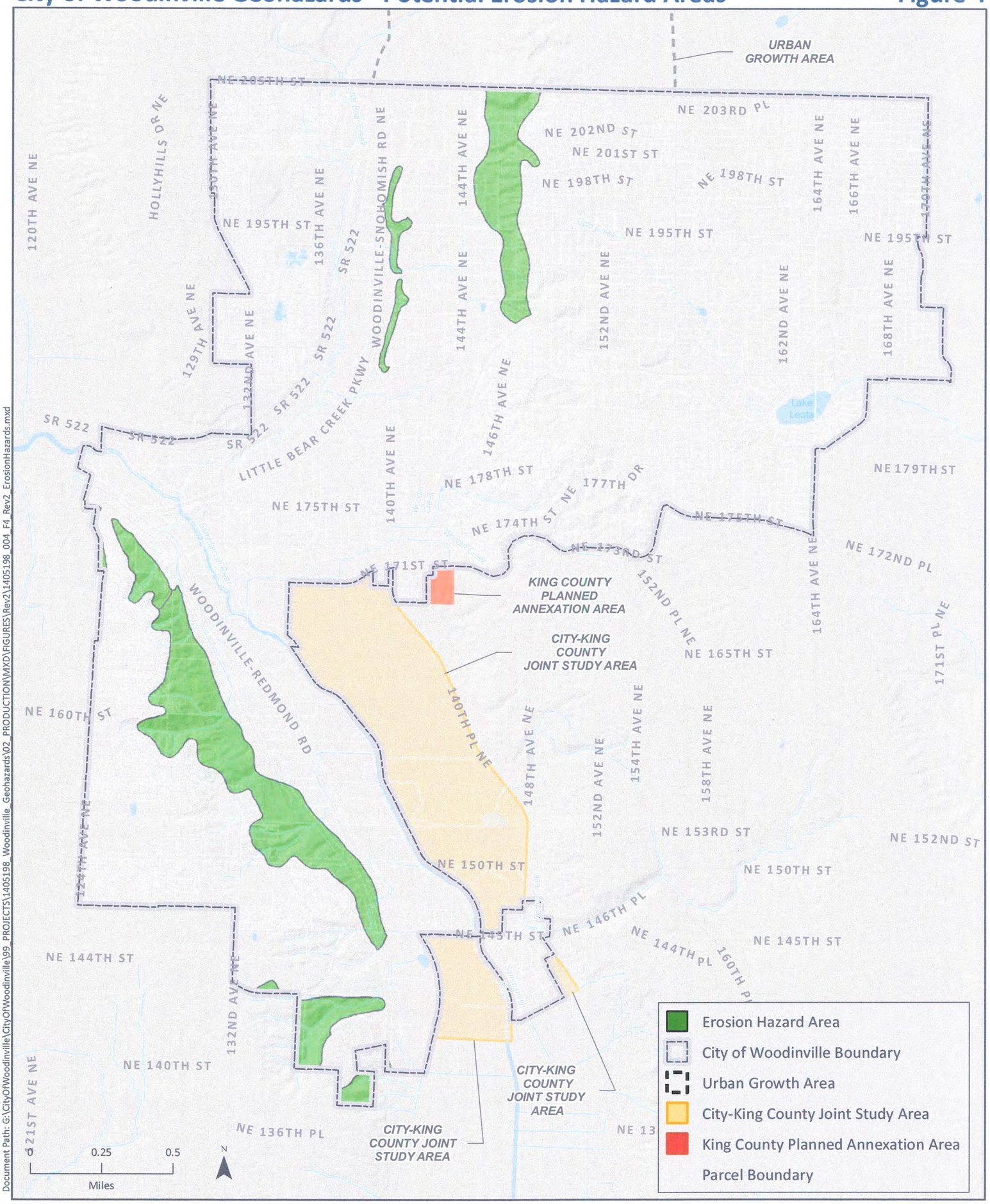
Date: April, 2015
Source: City of Woodinville, King County, Golder Associates Inc.

Golder Associates

City of Woodinville Geohazards - Potential Erosion Hazard Areas

Figure 4



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Date: April, 2015
Source: City of Woodinville, King County, U.S. Dept. of Agriculture - NRCS

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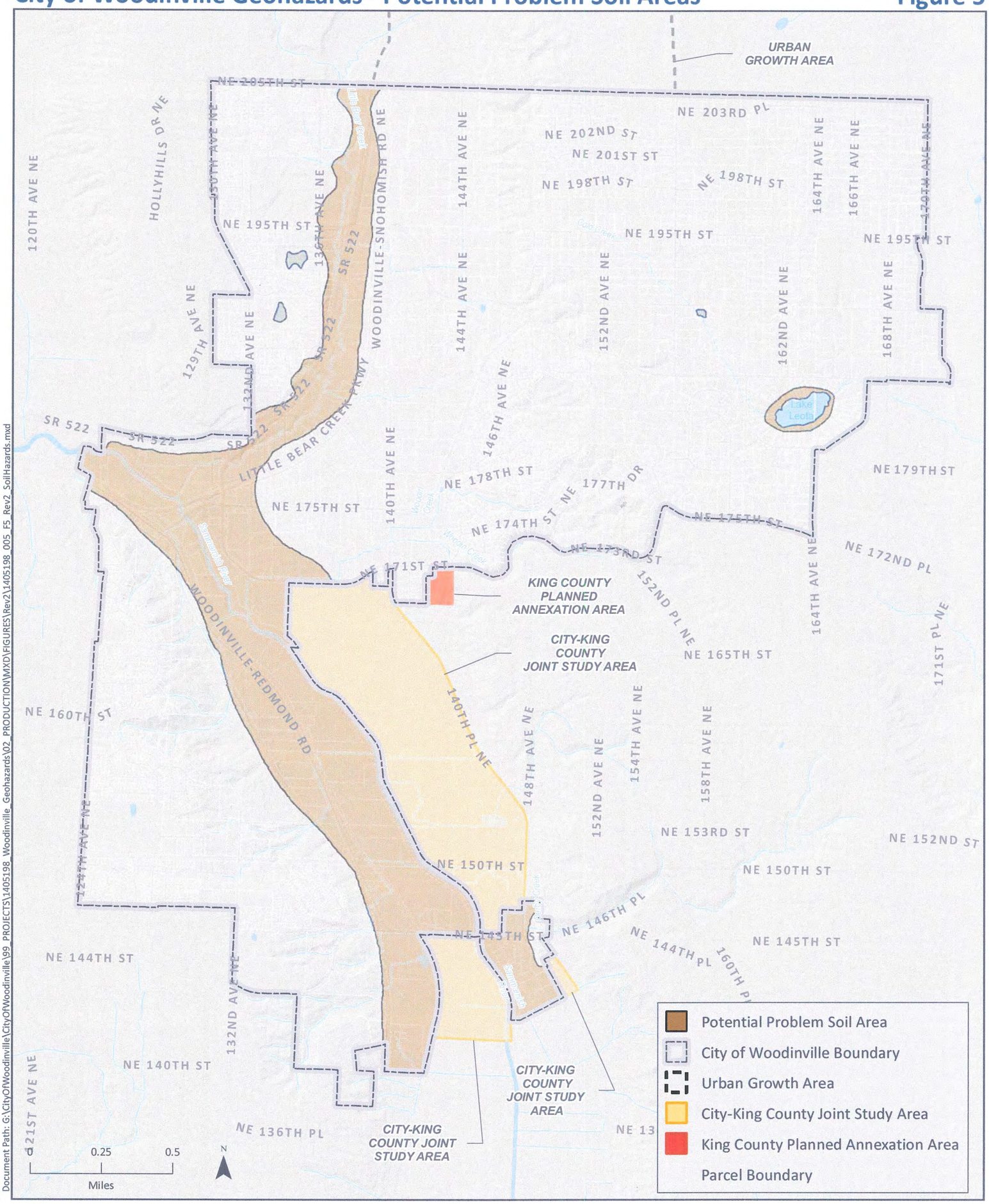
City of Woodinville Geohazards - Potential Problem Soil Areas

Figure 5



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Date: April, 2015
Source: City of Woodinville, King County, Golder Associates Inc.

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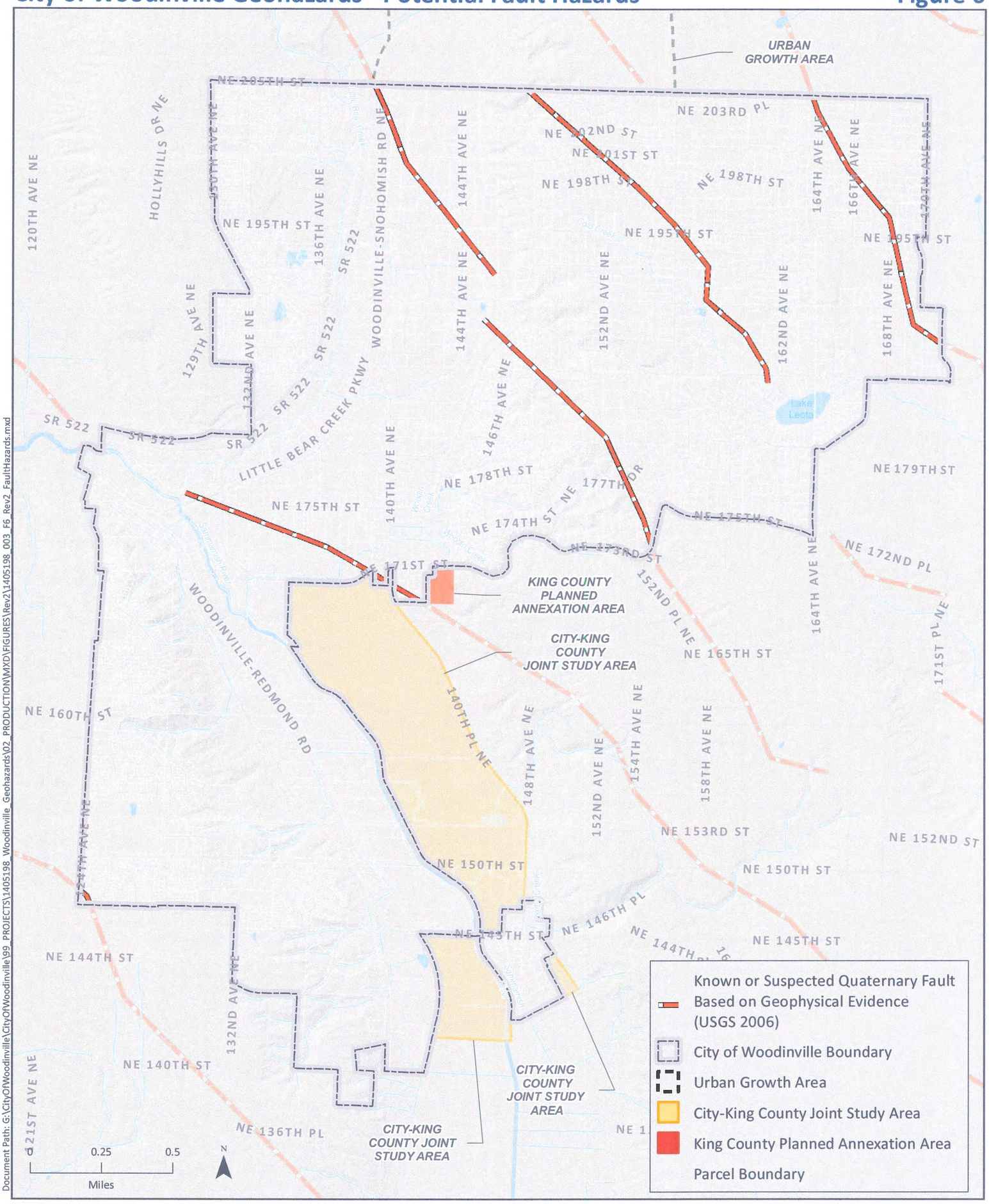
City of Woodinville Geohazards - Potential Fault Hazards

Figure 6



Date: April, 2015
Source: City of Woodinville, King County, Washington DNR

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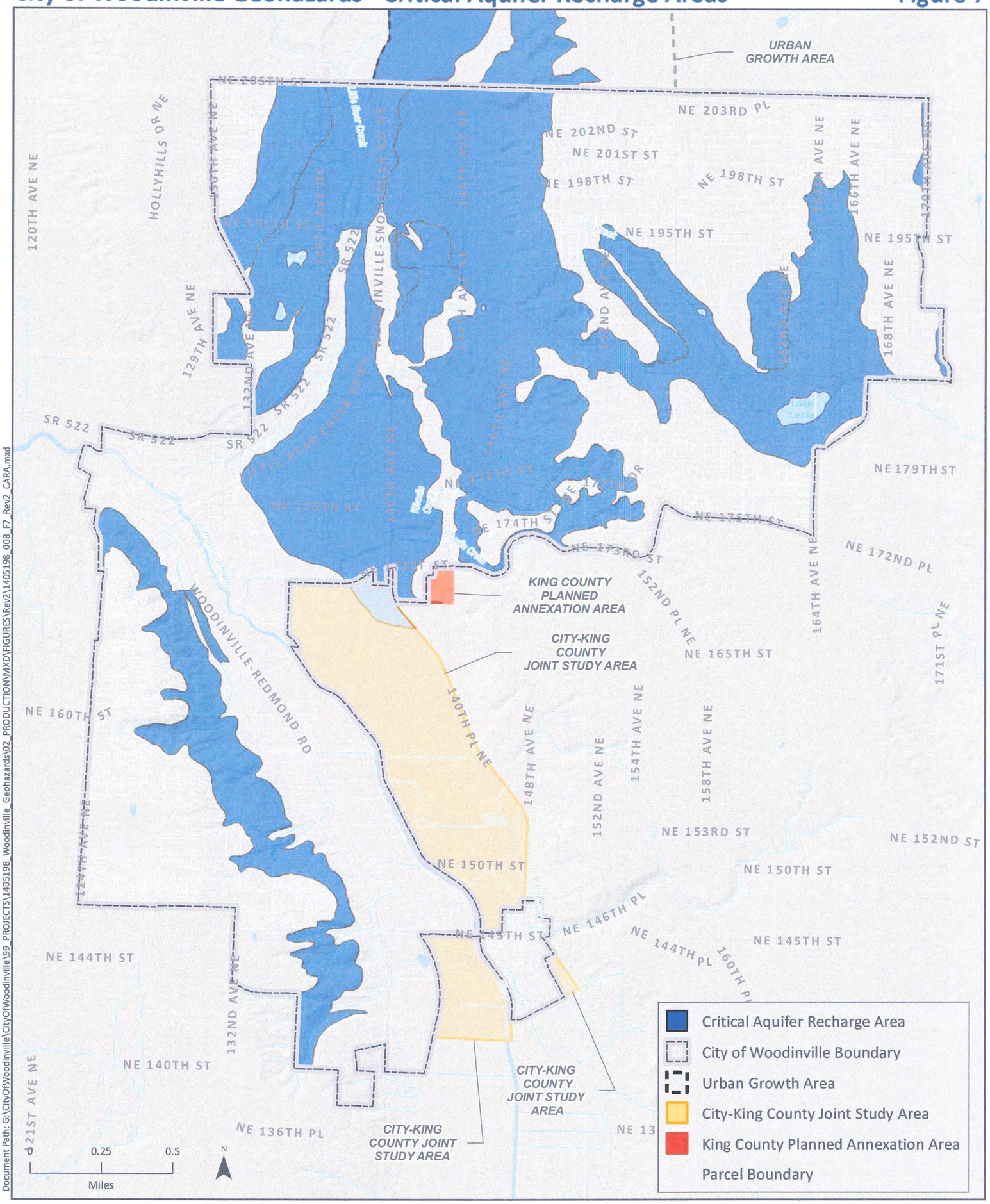
City of Woodinville Geohazards - Critical Aquifer Recharge Areas

Figure 7



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Date: April, 2015
Source: City of Woodinville, King County, The Watershed Company

Golder Associates