TECHNICAL MEMORANDUM

Date:	September 7, 2016
To:	Victoria Wilson, A.C.
From:	Amber Raynsford, PLA, GISP
TWC Project Number:	111103
Project Name:	Energize Eastside Tree Impact Assessment

Subject: Methodology for Vegetation Impact Analysis

Vegetation within a utility corridor that has transmission line(s) with an operational voltage of more than 200 kV must be managed in a way that meets federal requirements. The fines/penalties for having a power outage related to vegetation growing into a 230 kV transmission line can be substantial. To ensure compliance with the NERC standard, PSE allows vegetation with a mature height of no greater than 15 feet within the *wire* zone. For evaluation purposes, the same vegetation requirement was applied to the *managed* right-of-way (ROW) zone. The area outside of the managed ROW, but still within the legal ROW is subject to select clearing of trees that pose a risk of damaging the line.

The wire zone is the area measured 10 feet away from the outermost conductor(s) in a static position, whereas the managed ROW zone is the area that extends roughly 16 feet from the outside of the transmission wires in their static position.

The vegetation impact assessment used GIS analysis to evaluate the tree inventory data and the preliminary transmission line design to assess the number of trees that would likely require removal within a specific route. The steps of the analysis are provided below.

Tree Inventory

The inventory methodology used to map and locate trees varied along the various proposed routes for the Energize Eastside project, depending on the segment, jurisdiction, topography, and land use type along the proposed alignment. A summary of study area acres is presented in Tables 1 and 2. The tree and vegetation inventory methodology and boundaries of the study area are described in detail in The Watershed Company (TWC) Jurisdiction and Segment reports.

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Table 1. Study Area by EIS Segment

EIS Segment	Acres in Study Area
Segment 1 / Redmond	25.4
Segment 2 / Bellevue North	27.2
Segment 3 / Bellevue Central	139.6
Segment 4 / Bellevue South	108.3
Segment 5 / Newcastle	18.5
Segment 6 / Renton-King County	49.8
Richards Creek Substation	7.8
Total	**376.6** ac

Table 2. Study Area by Segment and Route

EIS Segment	Existing Easemnt	Bypass 1	Bypass 2	Willow 1	Willow 2	Oak 1	Oak 2	Richards Creek Substn
Segment 1 / Redmond	25.4	-	-	-	-	-	-	-
Segment 2 / Bellevue North	27.2	-	-	-	-	-	-	-
Segment 3 / Bellevue Central	34.3	87.5	86.4	-	-	-	-	-
Segment 4 / Bellevue South	-	-	-	38.0	32.7	46.6	58.6	-
Segment 5 / Newcastle	18.5	-	-	-	-	-	-	-
Segment 6 / Renton-King Co	49.8	-	-	-	-	-	-	-
Richards Creek Substation	-	-	-	-	-	-	-	7.8
Total	**155.2 ac**	**87.5 ac**	**86.4 ac**	**38.0 ac**	**32.7 ac**	**46.6 ac**	**58.6 ac**	**7.8 ac**

The tree inventory acreage was determined using the following methodology. For the existing easement (EIS Segments 1, 2, 5 and 6 and portions of EIS Segments 3 and 4), the approximately 100-foot-wide legal ROW is assumed to be the project boundary. All area within those limits is included. The acreage calculation includes all parcels along the ROW, regardless of whether access was granted to the arborist or survey field crews. Acreage for the portions of EIS Segments 3 and 4 that are outside of the existing easement generally consists of the road ROW plus the 30-foot-wide strip extending outward from either side of the road ROW where both sides of the street were inventoried. If only one side of the street was inventoried, only the ROW plus one 30-foot strip was included in the acreage calculation.

Data Compilation

Tree locations used in this analysis were obtained and compiled from survey, GPS, and digitization using high-resolution imagery. Surveyed locations were collected by two survey firms, APS Survey & Mapping (APS) and David Evans Associates (DEA). This information was provided to TWC as tables containing surveyor-assigned point number, latitude and

longitude coordinates, and surveyors' field notes. Surveyors captured the physical tree tag numbers, which were placed in the field by TWC arborists during the tree inventory. Where possible, the surveyors also collected tree type information and approximate diameter at breast height (DBH).

Tree Point Mapping and Data Set Compilation

Surveyed tree locations were mapped as geospatial points using the coordinate data and then merged with the associated geospatial data associated with each point. Once compiled, the full set of tree points was spatially joined to County parcel geometry. Each point (tree) was assigned a unique identification number generated from a concatenation of tree tag and ten-digit parcel number.

Using the unique identification number, mapped tree points were joined to the arborist's master tree inventory table that contained detailed information for each tree, including DBH, species, observed height, maximum potential height, canopy radius, condition/health, and arborist's field notes. Maximum potential height values were assigned by species according to best available resources for mature vegetation growth. This was necessary to identify non-compatible species. The resultant dataset provides the location and detailed attribute information for all inventoried trees within the study area.

Vegetation Impact Analysis

The impact analysis was conducted by placing the tree points on a georeferenced base map and overlaying the proposed conductor and pole alignments establishing the wire and managed ROW zones or areas. Impact areas were defined by PSE as: wire zone, managed right-of-way (ROW), legal ROW, pole buffer area, and proposed access roads. Geometry for impact areas were obtained from multiple sources in AutoCAD format, then translated into ArcGIS polygon data to facilitate overlay with geospatial point data. Survey data for the existing alignments were provided by APS and DEA. Geometry for the prospective corridor alignments was provided by PSE. Proposed access road alignments were provided by PSE in ArcGIS shape file format. Pole buffer areas, defined as the area within a 12-foot buffer of proposed pole locations, were derived from the proposed pole geometry in the AutoCAD data provided by PSE.

Next, using a series of spatial queries, tree points were classified as occurring within or outside of the designated impact areas for each corridor alignment. Then, within each zone, select-by attribute queries were used to identify records that met the criteria for removal. Removal criteria are listed below.

Removal Criteria

- Remove all dead and dying trees.

- Remove all trees within the legal ROW and outside of the managed ROW with a maximum potential height exceeding 70 feet.
- Remove all trees within the proposed wire zone and managed ROW with a maximum potential height exceeding 15 feet.

Limitations

During the field inventory stage, 38 properties containing a portion of a proposed pole alignment were wholly or partially inaccessible to arborist and/or survey field crews. Tree locations on these properties may not have been captured completely and/or detailed inventory data may not have been collected.

Several surveyed records were not attributed with a physical tree tag number. To rectify unnumbered point data, surveyed points were analyzed against the mapped parcel data and arborist's master tree inventory table, which recorded parcel numbers. Using the surveyors' notes, high-resolution aerial imagery, and arborists' notes and recollection, unnumbered points were matched with physical tree tag numbers to the extent feasible.

Further, some errors, such as typographical or duplicate values, were present in the notes fields. These errors were rectified based on the best judgement of the analyst through review of the data, documentation, and imagery. Considering these limitations, it is possible that some tree tags numbers may be incorrectly assigned, which may affect the vegetation impact summary calculations and mapped results.

Where the surveyors' point location could not be matched with the arborists' detailed tree inventory data, records were excluded from the vegetation impact analysis study set. The tables below describe the data set composition by source, summary of issues affecting the study set, and presents a breakdown of the total records by EIS segment and jurisdiction.

Table 3. Summary of Source Data for Tree Point Locations

Source	Total Number of Records
Surveyed tree locations (APS)	6,108
Surveyed tree locations (DEA)	487
GPS points (TWC)	417
Digitized tree locations (TWC)	3,949
Total Tree Point Locations Gathered	**10,961**

Table 4. Summary of Point Issues Affecting the Study Set

Issue Description	Number of Records Impacted	Effect on Vegetation Impact Analysis
Inaccessible Parcel: Tree is located on a parcel where access was granted to the surveyor, but was not extended to TWC field crews. Data point lacks detailed attribute information, including species, DBH, and maximum potential height.	265	Included in Vegetation Impact Analysis; maximum potential height not considered in tree removal
Out of scope: Tree is located outside of 100-foot inventory corridor or did not meet the criteria for inventory (e.g. maximum potential height less than 15 feet). Tree location may be surveyed or some inventory data collected.	790	Removed from Vegetation Impact Analysis study set

Table 5. Summary of Tree Inventory Data in Vegetation Impact Analysis by EIS Segment

EIS Segment	Total number of records included in study set
Segment 1 / Redmond	779
Segment 2 / Bellevue North	829
Segment 3 / Bellevue Central	3,778
Segment 4 / Bellevue South	3,365
Segment 5 / Newcastle	370
Segment 6 / Renton-King Co	621
Richards Creek Substation	429
Total	**10,171**

Table 6. Summary of Tree Inventory Data in Vegetation Impact Analysis by Jurisdiction

Jurisdiction	Total number of records included in study set
Bellevue	8,401
King County	14
Newcastle	370
Redmond	779
Renton	607
Total	**10,171**

In addition, the scale of the impact area boundaries drawn in AutoCAD is unknown. Therefore, mapped impact areas may not align with the planned real-world layout of proposed corridor facilities. Ground-truthing of these results may reveal that some trees appearing in or out of a mapped impact area are incorrect. Furthermore, as impact area

geometries were translated from AutoCAD into ArcGIS, some geometric refinements were necessary to address gaps and other issues, which could affect the accuracy of the analysis results.

As of the draft date of this memorandum, the Vegetation Impact Analysis is underway. This methodology describes a process that is still in development. This memo will be updated and expanded as the analysis progresses to reflect the methods and source data employed and to describe the limitations that could affect analysis results.