Memorandum

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From: Cadeo Group and SBW

Date: March 31, 2020

Subject: TO30: OLSA Phase 3 Findings Summary (Deliverable 3b)

This memo summarizes the key findings from third phase (TO30) of the Bonneville Power Administration's (BPA) Outdoor Lighting Stock Assessment (OLSA) research, which took place between September 2019 and March 2020.

Introduction

BPA launched OLSA to improve the region's understanding of the outdoor lighting stock in the Pacific Northwest. While previous residential, commercial, and industrial-specific regional stock assessments led by the Northwest Energy Efficiency Alliance provided insight into select outdoor lighting segments, significant outdoor lighting segments—most notably street and roadway lighting—remained largely unresearched. BPA sought to fill this regional information gap, beginning with a scoping study in June 2017 (Phase 1) and a pilot of OLSA's online and in-field data collection protocols in December 2018 (Phase 2).

Methodology

Phase 3 of OLSA focused on completing the team's remaining online survey of 2,000 regional census blocks, which began in Phase 2. The team originally selected the 2,000 blocks in Phase 1 using a stratified random sampling approach, based on "brightness" of each block (determined using satellite luminosity data for the entire region).

To survey sampled blocks, the team used a custom built, project-specific web-based data collection tool. The custom tool leveraged and integrated geographic data from Google and Bing, as well as publicly available census block data and aggregated, third-party tax assessor data. Collectively these data, through the interface of the web-based data collection tool, allowed the team to remotely (and cost efficiently) survey sampled blocks for relevant outdoor lighting.

Specifically, the team used the online survey to 1) identify sites within sample blocks with OLSA lighting for future phone or onsite data collection, and 2) count observable streetlights to inform a regional streetlighting estimate.

OLSA Sites

Per the study definitions created as part of Phase 2, an "OLSA site" is an area of common operation indicated by shared entrances from a named road, buildings with similar architectural features, shared

parking, connecting walkways or vehicle paths, or enclosing walls/fences that fall into one of 18 identified OLSA site types listed in Table 1.

Table 1. OLSA Site Types

Agriculture and fisheries	Manufacturing	Power generation, water supply, waste and water treatment
Bulk storage (tanks and silos)	Military Bases	Rail/bus stations
Cemetery	Mining, gas/oil extraction	Residential <= 3 stories with common
Courthouse	Park/open space	Residential >3 stories
Data center	Parking	Stadiums
Jail, prison, asylum	Ports (air and water)	Mixed

As noted above, the purpose of identifying OLSA sites was to develop a list of sites that BPA could use in the future, if desired, as a recruitment list for phone or onsite data collection of the site's outdoor lighting. To enable this potential next step, the team collected detailed contact information for each identified OLSA site (e.g., name, phone, e-mail, company website).

Counting Streetlights

The team used the tool's street view function to virtually "walk" the streets within each sampled block and identify (by dropping a geo-located pin within the tool on the image of the streetlight) all streetlights on named streets. It is important to note that the unit of analysis is the number of lamps associated with each streetlight. For example, the team would drop single pin for a streetlighting pole with a single lamp, but two pins for a pole with two streetlamps attached to it. The tool automatically counted the identified streetlights within each block.

Results

In total, the team identified 1,503 OLSA sites. Table 2 provides a breakdown of these 1,503 sites by OLSA site type. As noted above, this pool of identified OLSA sites can serve as the sampling frame should BPA move forward with future OLSA data collection efforts.

Table 2. Identified OLSA Sites by Type

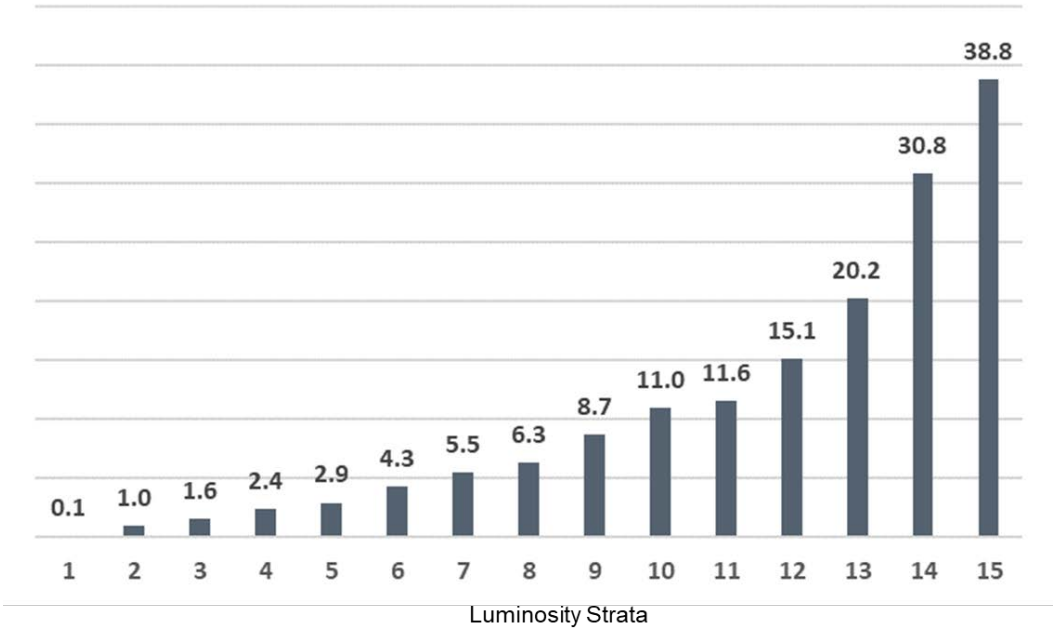
Site Type	Sites Identified
Manufacturing	419
Park/open space	294
Residential <= 3 stories with Common	235
Power generation, water supply, waste and water treatment	135
Ports (air and water)	98
Agriculture and fisheries	94
Bulk storage (tanks and silos)	65
Residential > 3 Stories	36
Cemetery	25

Mixed	20
Jail, prison, asylum	17
Mining, gas/oil extraction	17
Military bases	16
Parking	11
Stadiums	10
Courthouse	4
Rail/bus stations	4
Data center	3
Grand Total	**1,503**

The team also identified a total of 26,453 streetlights when surveying the sampled census blocks. The average number of streetlights per block (when the block contained at least one streetlight) was 17.4, while the average across all cataloged blocks is 11.1.

There was a wide range of streetlights among sampled blocks, with many rural blocks not having any streetlights while one sampled block alone had 594 identified streetlights. Overall, the team identified a higher average number of streetlights in "brighter" blocks (i.e., block in a higher satellite luminosity stratum) as shown in Figure 1.

Figure 1. Average Streetlights by Luminosity Strata



The table below outlines how the team extrapolated these strata-specific streetlight counts to develop an estimate of **785,756** total streetlights in the region.

The extrapolation approach is relatively straightforward; the team multiplied the average number of streetlights per sampled block in each stratum (e.g., 11.0 for Stratum 10) by the total number of regional blocks in that luminosity stratum (e.g., 4,848 for Stratum 10). Summing the product of these stratum-

specific extrapolations yields an estimate of the total number of streetlights in all non-all-water census blocks in the Pacific Northwest.

As evident in the table below, the overall precision of the regional estimate of 785,756 streetlights is 6% at the 90% confidence level, which means the actual number of streetlights in the region is between 736,467 and 835,046.

Table 3. Summary of Regional Streetlight Estimate

Strata	Total Regional Census Blocks	Sampled Census Blocks	Observed Streetlights	Observed Streetlights /Block	Extrapolated Regional Streetlights	Standard Error	Precision at 90% Confidence	Min Estimate	Max Estimate
1	337,846	54	4	0.1	25,026	17,527	115%	-	53,857
2	34,999	34	33	1.0	33,970	8,287	40%	20,337	47,602
3	49,976	87	138	1.6	79,272	8,776	18%	64,836	93,708
4	43,601	137	323	2.4	102,797	10,381	17%	85,720	19,873
5	23,274	113	331	2.9	68,174	7,330	18%	56,117	80,232
6	20,012	143	619	4.3	86,625	8,221	16%	73,102	100,149
7	13,819	146	797	5.5	75,437	7,281	16%	63,459	87,414
8	9,920	153	966	6.3	62,632	6,894	18%	51,291	73,973
9	7,083	159	1,379	8.7	61,431	7,308	20%	49,409	73,453
10	4,848	158	1,736	11.0	53,267	5,438	17%	44,321	62,212
11	3,385	160	1,849	11.6	39,118	3,344	14%	33,617	44,619
12	2,270	155	2,337	15.1	34,226	3,065	15%	29,183	39,268
13	1,366	141	2,851	20.2	27,620	2,704	16%	23,172	32,069
14	738	122	3,753	30.8	22,703	1,940	14%	19,511	25,894
15	347	238	9,232	38.8	13,460	809	10%	12,129	14,791
Total	**553,484**	**2,000**	**26,348**	**13.2**	**785,756**	**29,963**	**6%**	**736,467**	**835,046**

In addition to estimating the total number of streetlights in the region, the team also developed an estimate of the region's streetlighting technology mix (i.e., what percent of streetlights are LED, HID, etc.?). The team developed streetlighting technology mixes, by state and census urban/rural designation, using a combination of streetlighting data received through records request to regional jurisdictions and a review of online press releases announcing LED retrofits. The team estimated separate technology mixes by state and urban/rural designation in recognition that streetlights are owned/managed differently across state and city lines.

As evident in Table 4, the team estimates that approximately two-thirds of the region's streetlights are LED. In general, the LED market share is significantly higher in Oregon and Washington, driven by large-scale, city-wide LED retrofits in metropolitan areas like Seattle and Portland.

Table 4. Streetlight Technology Mix by State and Urban/Rural Designation

	Urban		Rural		Overall	
State	**HID**	**LED**	**HID**	**LED**	**HID**	**LED**
ID/MT	73%	27%	84%	16%	73%	27%
OR	21%	79%	27%	73%	21%	79%
WA	32%	68%	45%	55%	33%	67%
Total	**32%**	**68%**	**54%**	**46%**	**33%**	**67%**