

Analysis Metric:

WATER
& SOIL

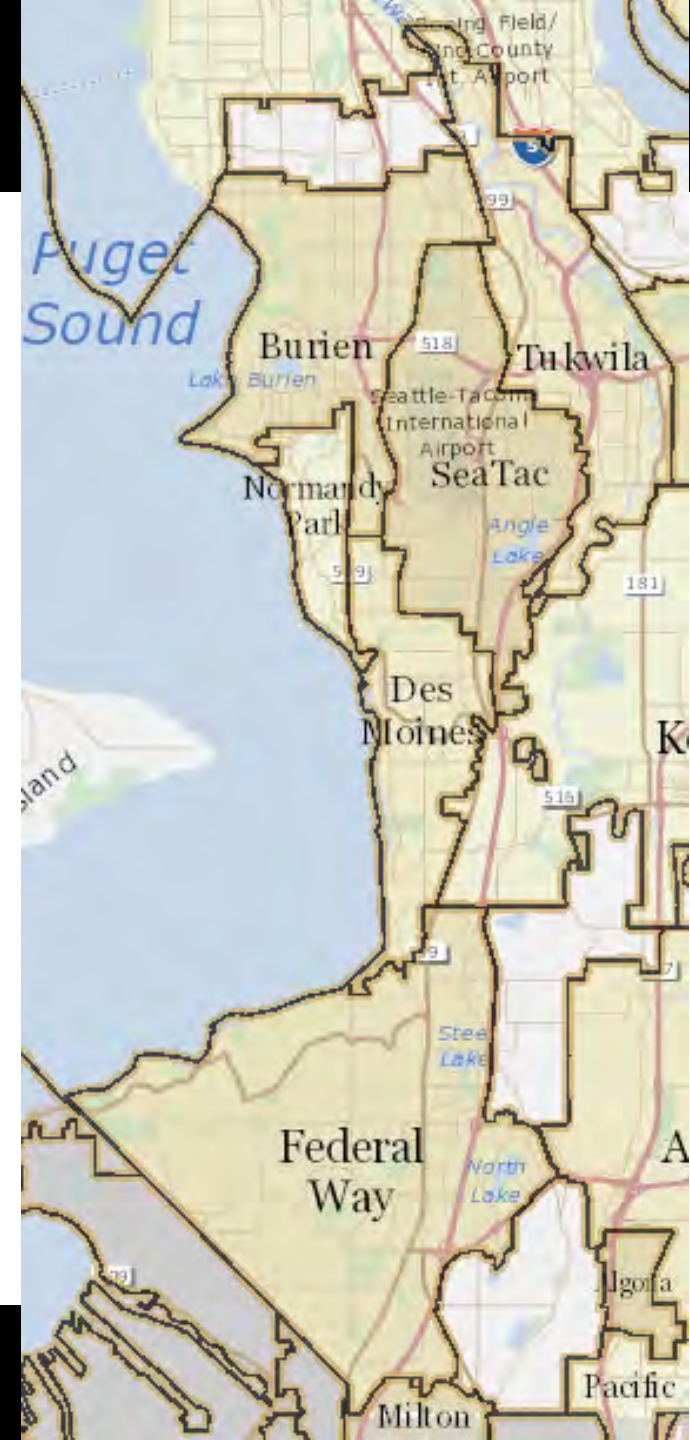
Presenter:

Carol Shestag
Senior Geologist



Project Objective and Study Area

- **Objective:** Collect and analyze data to identify overall changes in land use, vegetation cover, wetlands, water quality, and soil chemical quality over time from 1997 to present with focus on the years 1997, 2009, and 2018 (as the data allow).
- Study area includes Seattle-Tacoma International Airport and the cities of Burien, Des Moines, Federal Way, Normandy Park, Seatac, and Tukwila.



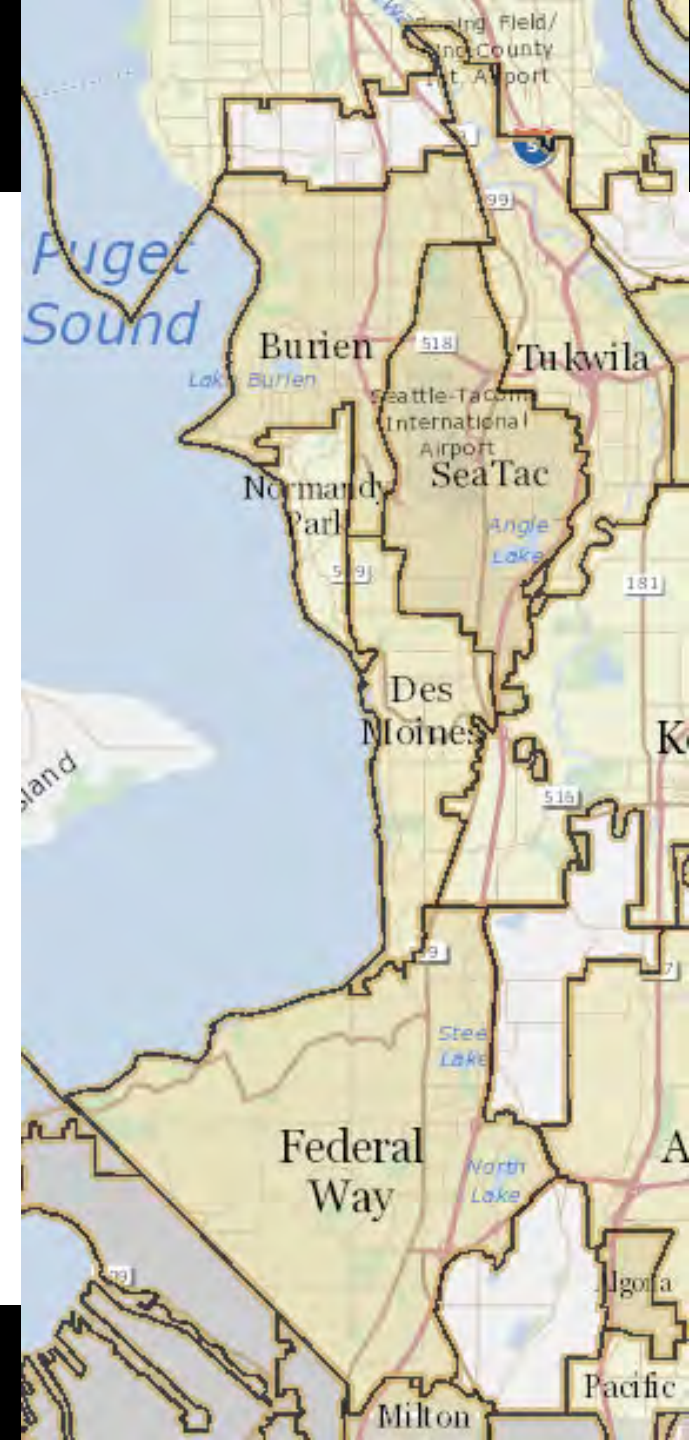
Project Challenges

- Effects from the airport on surrounding communities are both **DIRECT** and **INDIRECT**.
- **DIRECT** effects are those with an obvious source of input coming straight from the airport property
 - Wastewater and stormwater exiting airport property
 - Airport development and expansion
- **INDIRECT** effect are those with a secondary or less obvious source of input
 - Metals and pollutants from airplane exhaust settling in waters and soils
 - Noise or light disturbances affecting wildlife



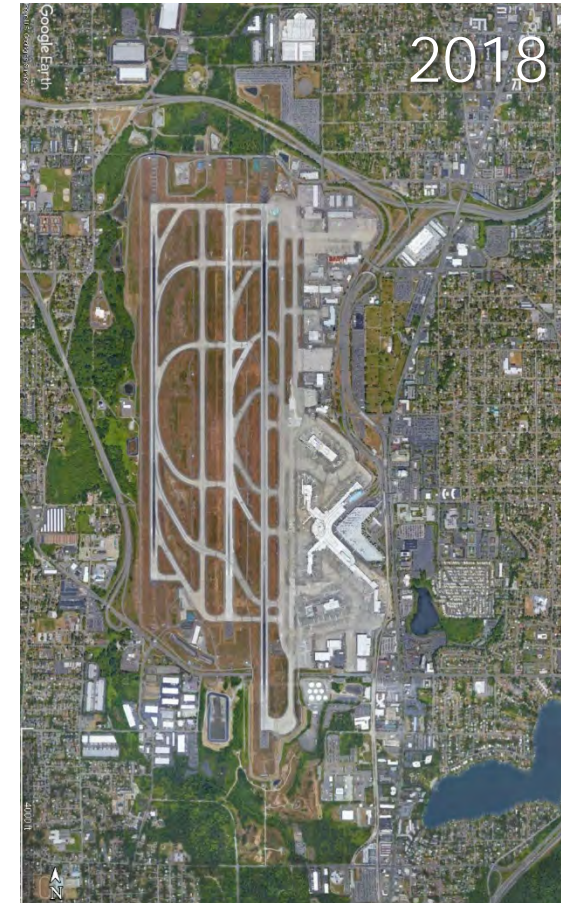
Project Challenges

- Because the study area is in a highly urbanized area, **INDIRECT** effects are extremely difficult to isolate to simply one source (ie., the airport).
- Additionally, over the past 20 years, many laws and ordinances have been put into effect, increasing efforts to identify and protect natural resource areas:
 - Growth Management Act in 1990.
 - Shoreline Management Act in 1996.
 - Prompted cities and counties to develop Critical Areas Ordinances, officially designating wetlands, streams, and buffers.
 - Endangered Species Act listing of Chinook in 2005, and Steelhead in 2007.



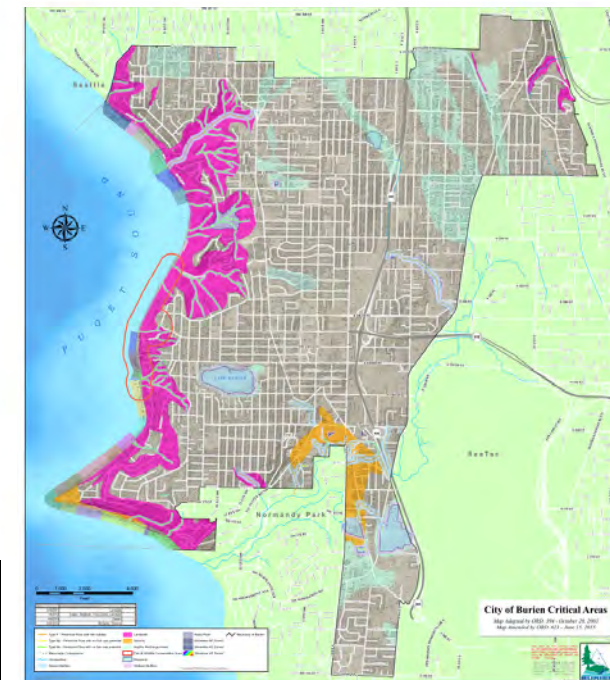
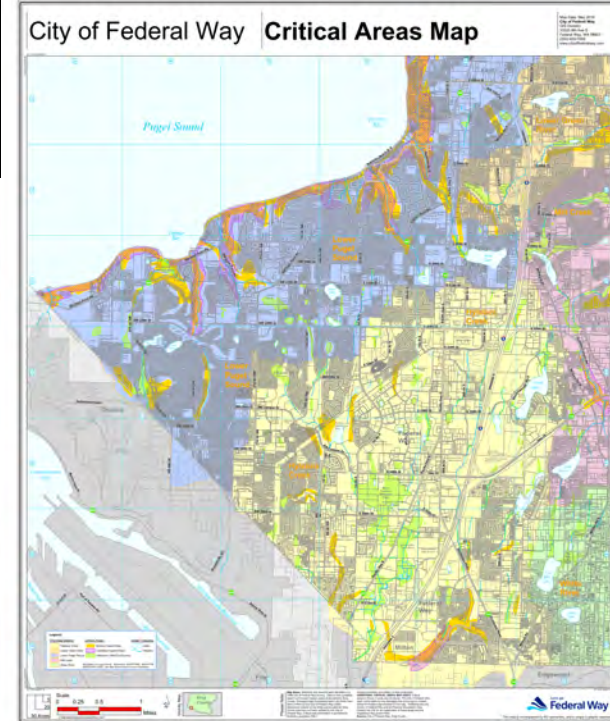
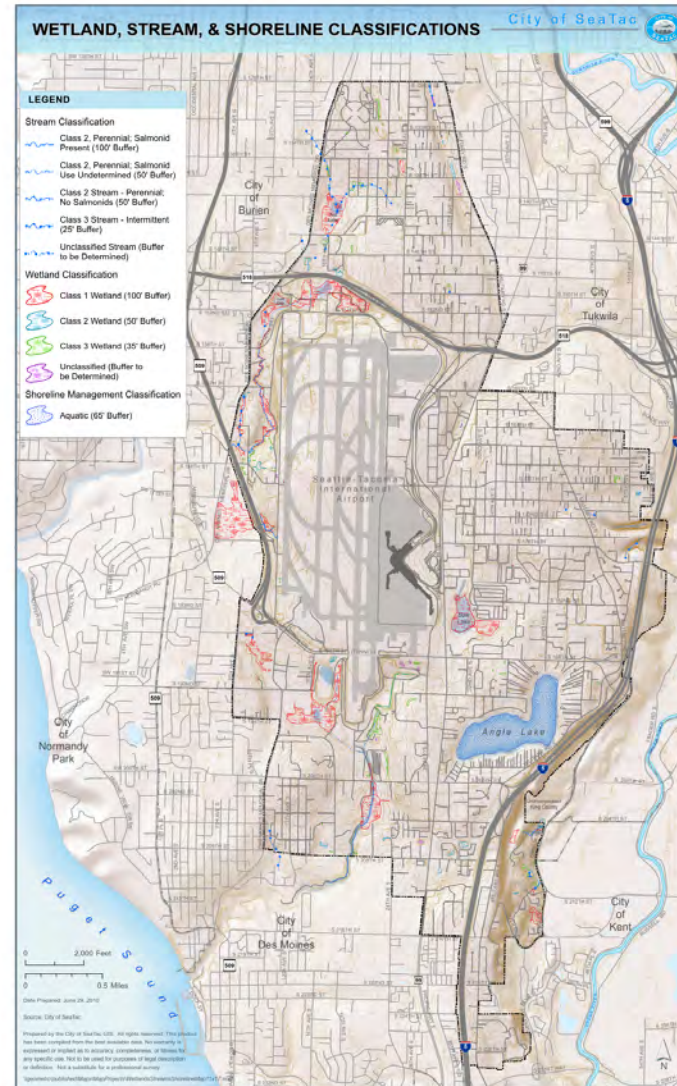
Orthographic Images Over Time

- We have compiled a series of orthographic images of the airport and municipalities over time (1990, 2002, 2004, 2006, 2007, 2009, 2012, 2016, and 2018)
- Looking for land use changes



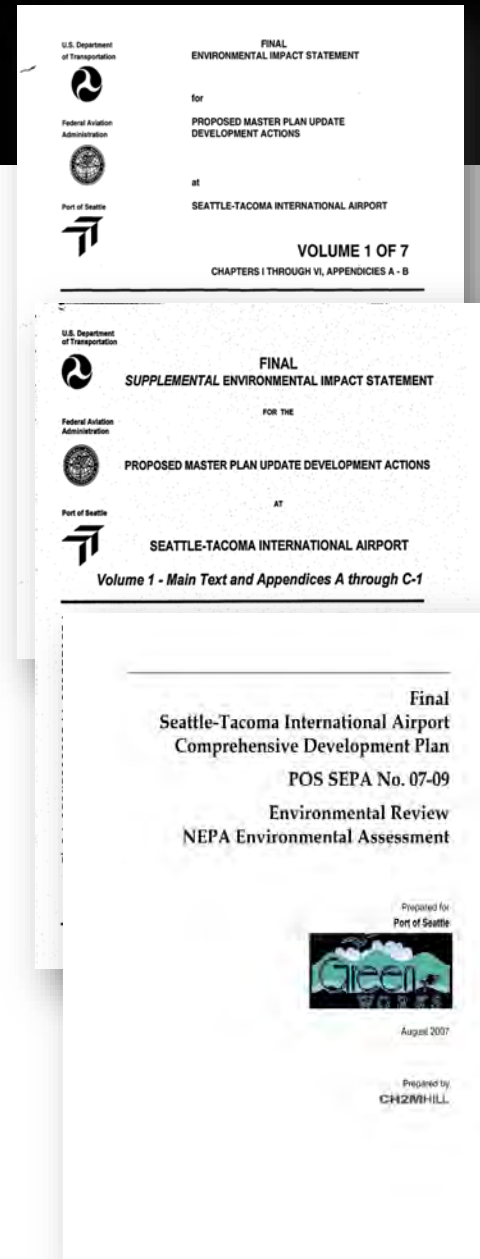
Data Collected from the Six Surrounding Cities

- Geographic Information System (GIS) data for critical areas from the cities of Burien, Des Moines, Federal Way, Normandy Park, Seatac, and Tukwila.
- **Data Review In-Progress:** Field pH, temperature, and dissolved oxygen measurements associated with fish mortality surveys.
- None-to-very-little water quality/chemical analytical data available from the cities (indicate they have none to share).



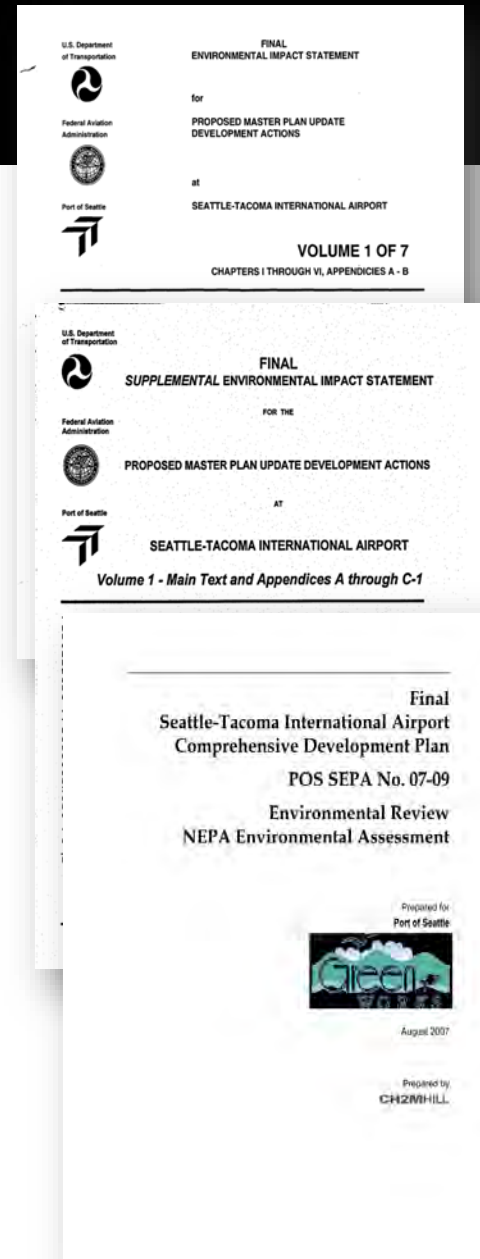
Data from Port of Seattle

- Port provided three environmental documents:
 - 1996 Master Plan Environmental Impact Statement (EIS);
 - 1997 Master Plan Supplemental EIS; and
 - 2007 Comprehensive Development Plan.
- These documents have no to very little water or soil quality analytical data. State and Federal Water Quality Standards/Guidelines are provided in numerous places with accompanying mitigation procedures to be implemented to meet those Standards/Guidelines



Data from Port of Seattle

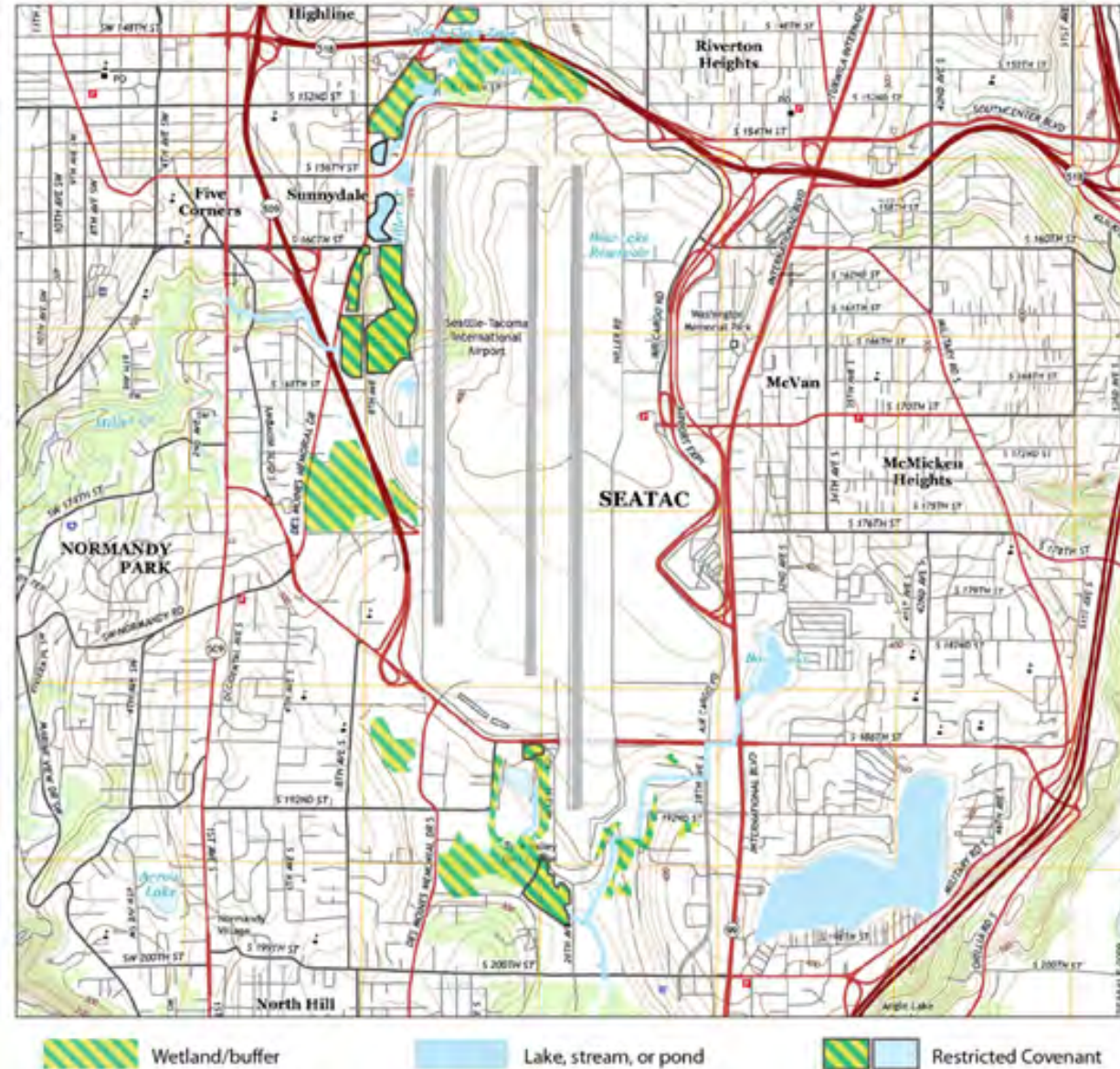
- Port provided two mitigation/monitoring reports (both dated 2018 with one regarding streams & the other regarding wetlands). A Groundwater Study is forthcoming.
- Port retrofitted their stormwater system in 2005 and 2010/2011 with additional upgrades in 2015/2016. Based on National Pollutant Discharge Elimination System (NDPES) data reviewed to date, there have been little discharge exceedances and none that have triggered regulatory agency corrective action.



2018 Sustainable Airport Master Plan (SAMP)

Technical Memorandum No. 8

- Technical Memorandum No. 8 (Environmental Overview) gives a summary of conditions and information.
- Approximately 88 acres of contiguous wetland, stream, and buffer mitigation exists on airport property that is permanently protected by restrictive covenants.

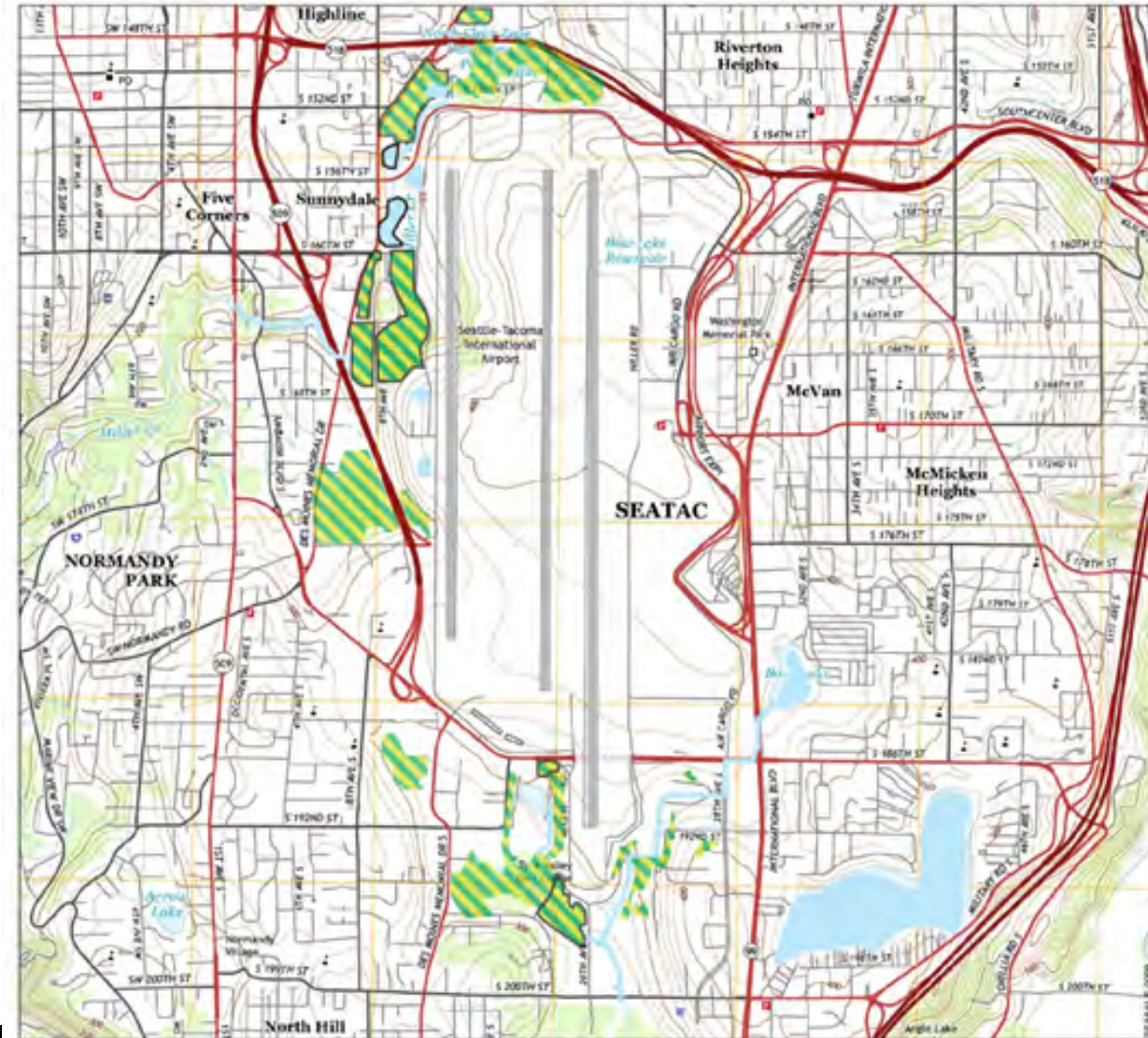


Source: Port of Seattle.

2018 Sustainable Airport Master Plan (SAMP)

Technical Memorandum No. 8

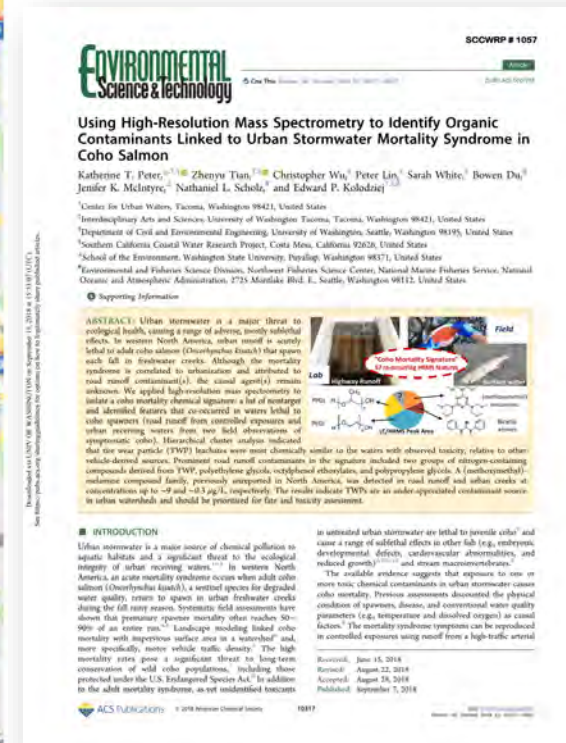
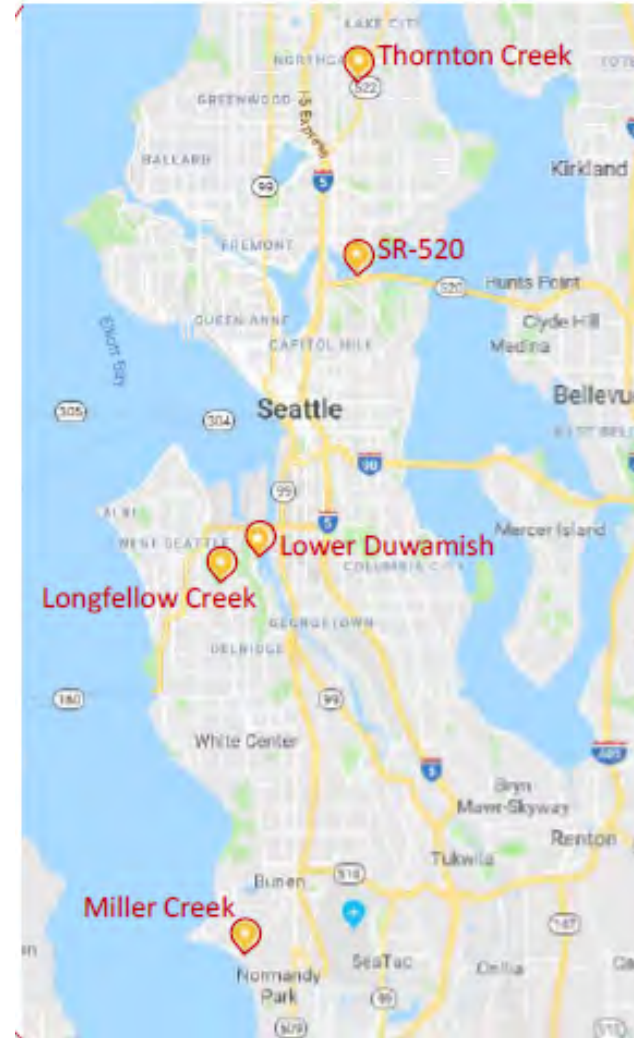
- Technical Memorandum No. 8 contains no water or soil quality/chemical analytical data but notes “Des Moines Creek violations of dissolved oxygen, bacteria, and copper” and “notes violations of copper and zinc for Miller Creek in the immediate Airport vicinity”.



Source: Port of Seattle.

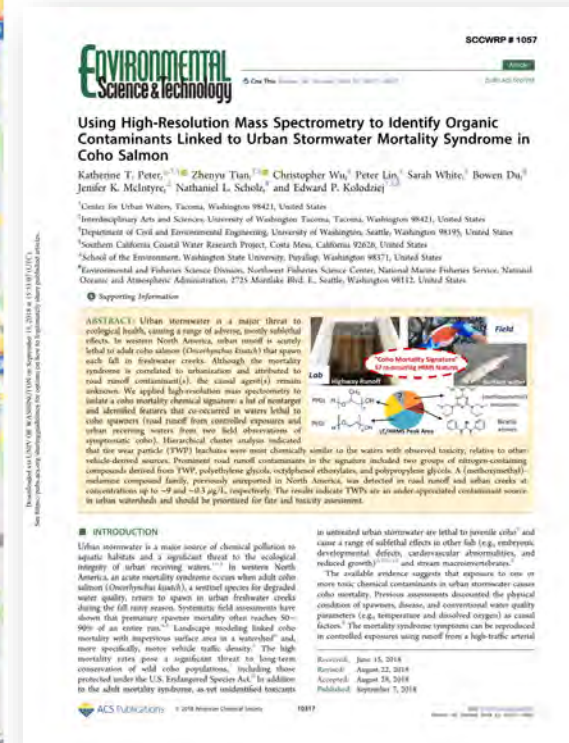
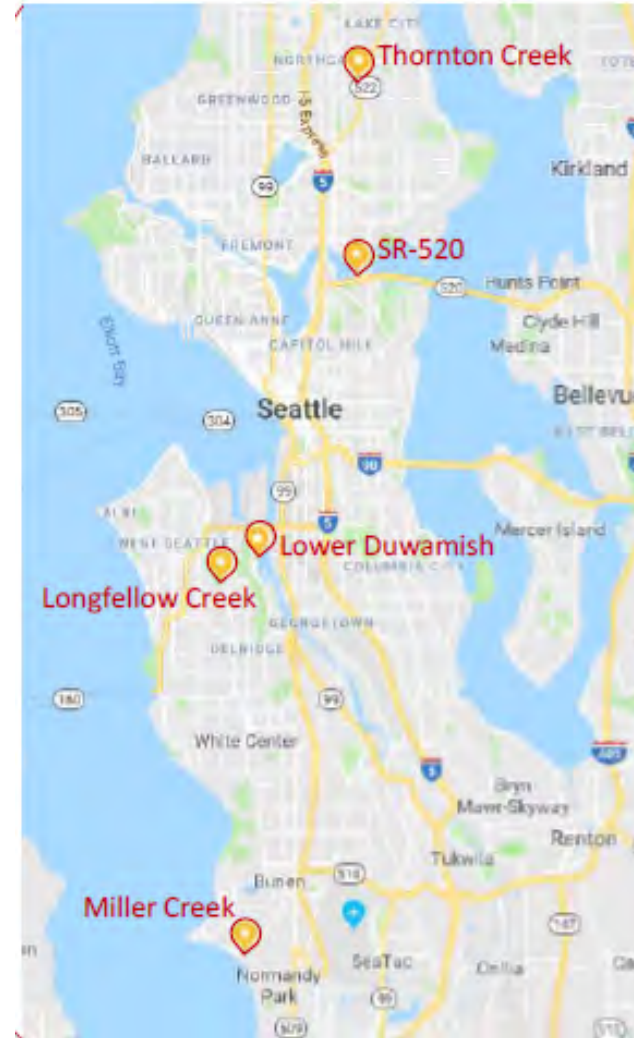
Ongoing University of Washington HRMS Study

- Ongoing High-Resolution Mass Spectrometry (HRMS) water quality study in **Miller Creek**: “deep dataset focused on understanding what is going on during [fish] mortality events...focused on tire rubber compounds and roadway runoff [from Highway 520 near UW], and [UW] did sample above and below the area where airport runoff enters the creek.”



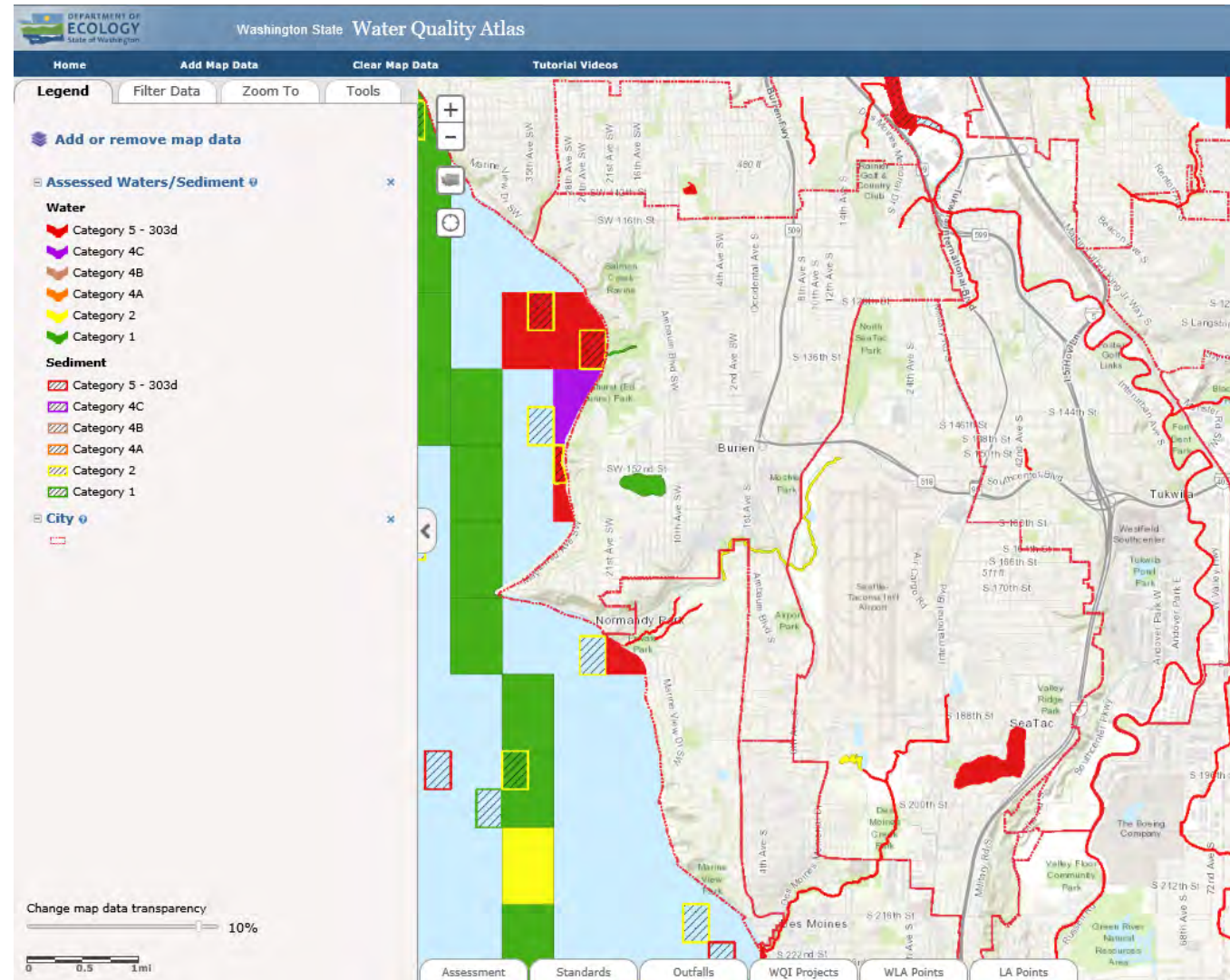
Ongoing University of Washington HRMS Study

- Results show “the highway is a more significant source of chemicals to the creek relative to the airport.” (ref: personal communication, Edward Kolodziej; Sept. 24, 2019).
- Formal manuscripts in progress; not available until April 2020 or likely later.
- UW library – water and soil quality searches at or near the airport have resulted with no additional or available reports, studies, or databases.



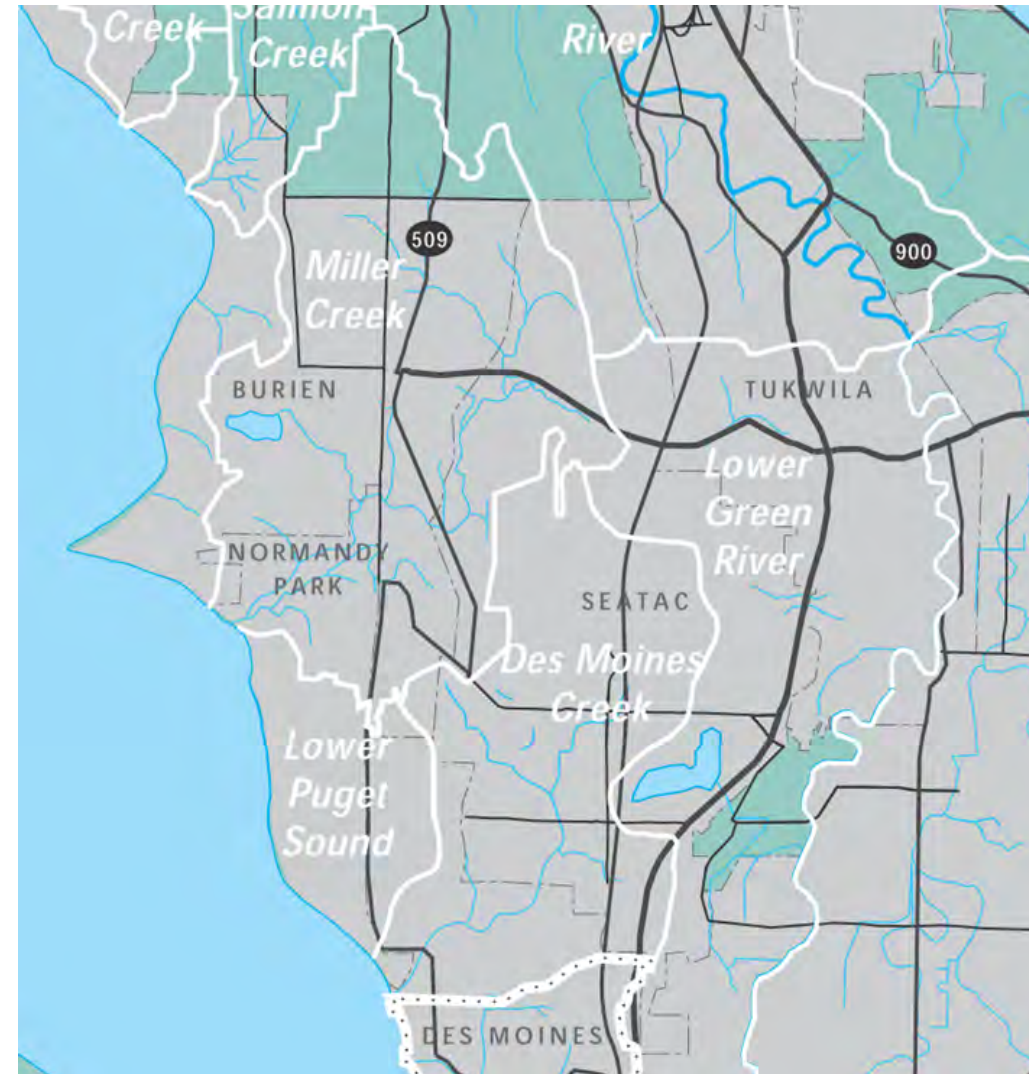
Data from Washington Dept. of Ecology

- Water and soil quality data being reviewed includes:
 - Department of Ecology’s Water Quality Atlas Map
<https://fortress.wa.gov/ecy/waterqualityatlas/map.aspx>
 - Department of Ecology’s Environmental Information Management System
<https://apps.ecology.wa.gov/eim/search>
 - Department of Ecology’s Toxic Cleanup Program (TCP)
<https://apps.ecology.wa.gov/gsp/SiteSearchPage>



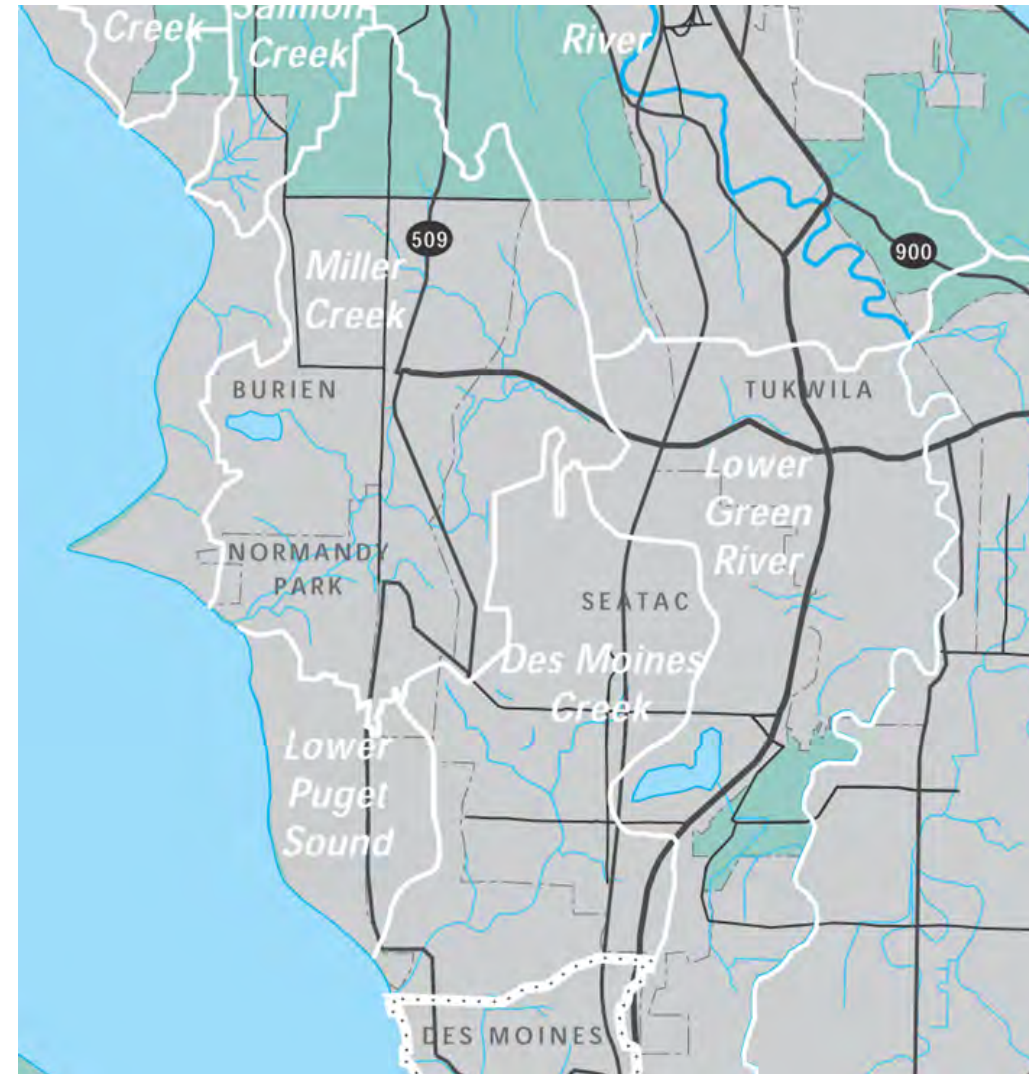
Data from Washington Dept. of Ecology

- Many sampling sites and studies (one-time, one-location) – limited ongoing data collected.
 - a) King County Streams Sediment Monitoring Program (includes two sites on Des Moines Creek, only from 2008)



Data from Washington Dept. of Ecology

- b) Copper and Zinc Levels in Des Moines, Massey, and McSorley Creeks, King County (Dept of Ecology, December 2008)
 - concentrations of both metals during storm events (beginning in 1995) were high and often exceeded acute water quality standards in Des Moines Creek.
 - Several sites; data from 1995-1999, 2001, and 2008-2010.
- c) Statewide River and Stream Ambient Monitoring (mostly related to fish passage data and/or salmon counts)
 - Most streams have data, but type & amount of data variable



2017 Ecology Study: Copper and Zinc in Urban Runoff, Phase 1

Potential Pollutant Sources & Release Rates

- The CuZn study area was located in the lower Woodland Creek watershed primarily within the City of Lacey but also in a portion of Thurston County
- Area was selected because:
 - It reflects the land use in other Puget Sound urban areas.
 - Area size is manageable, allowing for comprehensive review of potential Cu and Zn sources.
 - Location is logistically convenient for unpredictable stormwater monitoring schedule.

Copper Sources



From Bookter (2017), Publication No. 17-03-018

2017 Ecology Study: Copper and Zinc in Urban Runoff, Phase 1

- **Copper** – The primary sources of copper are vehicle brake wear, roofing materials, parking lots, treated lumber, building siding, and vehicle exhaust.

Copper Sources

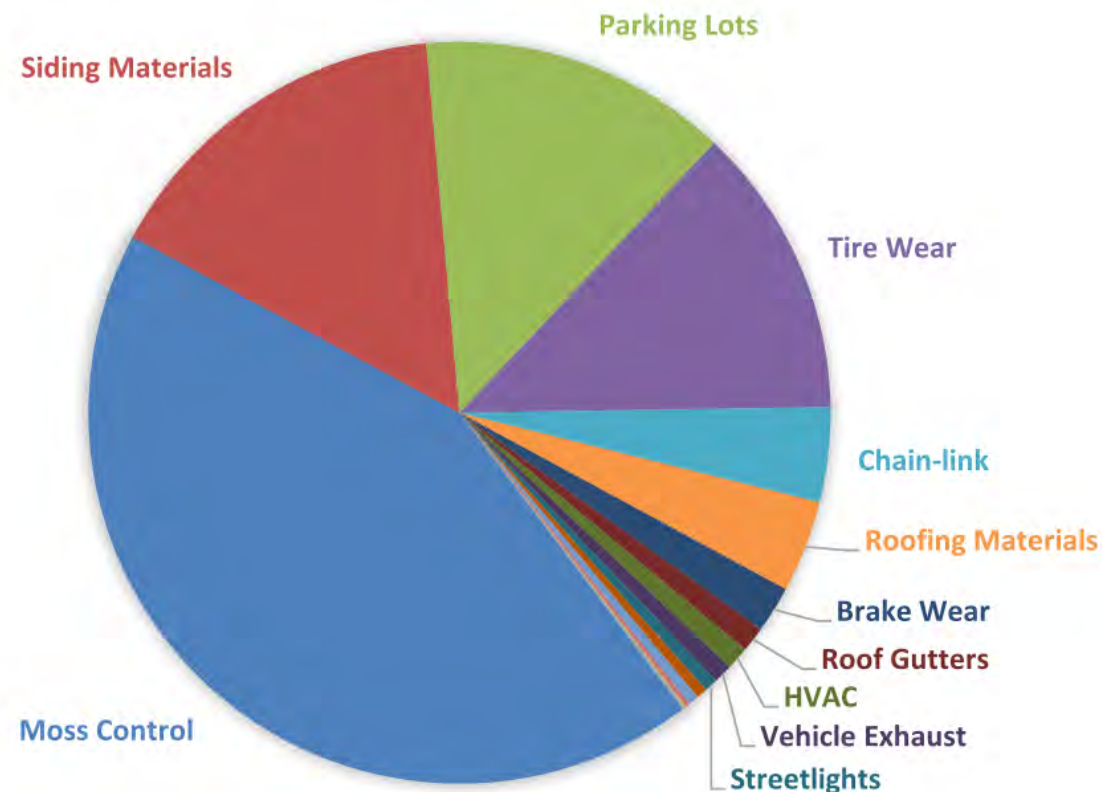


From Bookter (2017), Publication No. 17-03-018

2017 Ecology Study: Copper and Zinc in Urban Runoff, Phase 1

- **Zinc** – The main sources of zinc are moss control products, building siding, parking lots, vehicle tire wear, chain-link fence, roofing materials, and vehicle brake wear.
- The sources with the most uncertain loading values are roofing materials, parking lots, and metal salvage operations.

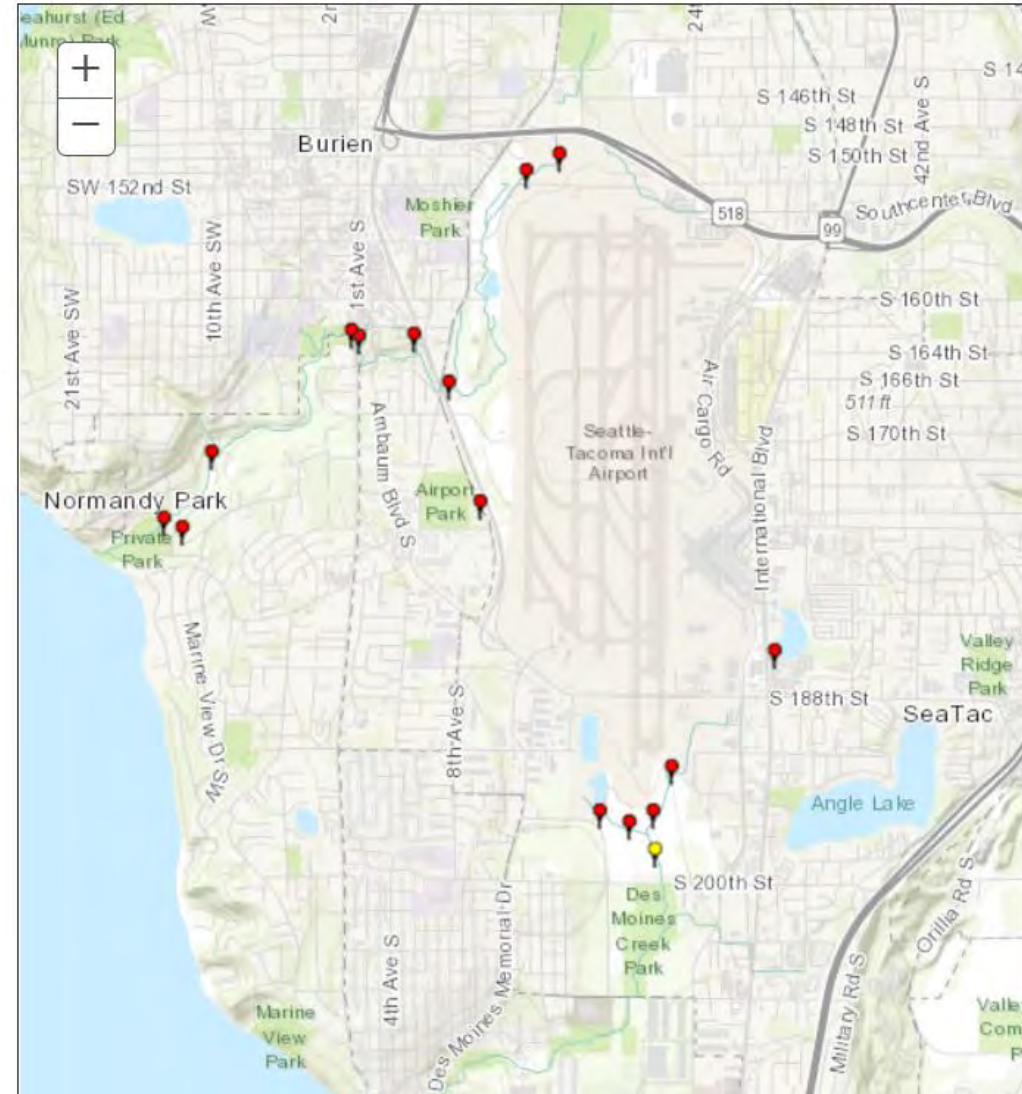
Zinc Sources



From Bookter (2017), Publication No. 17-03-018

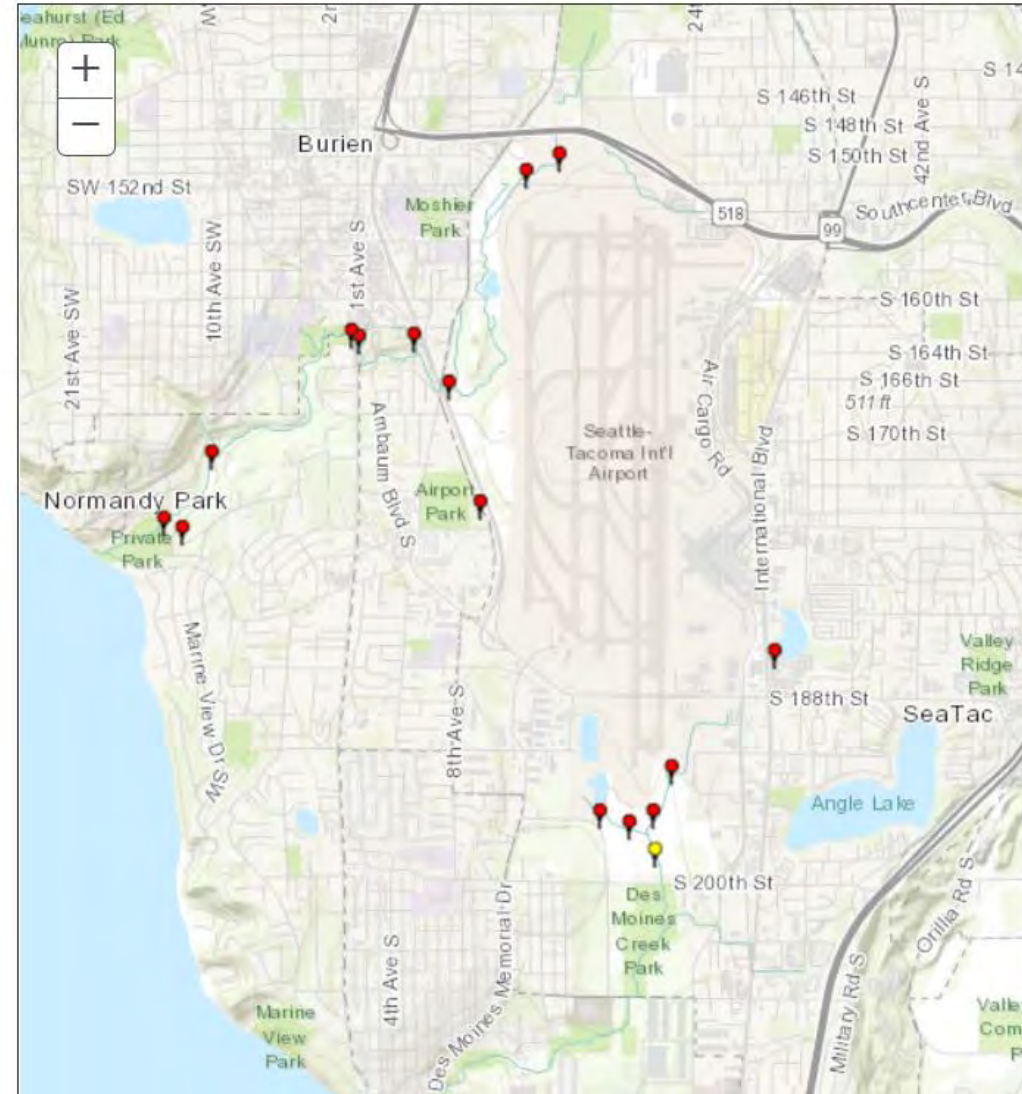
King County Hydrologic Information Center

- Multiple stream flow stations on Miller, Walker, and Des Moines Creeks
- Most only measure stream flow (velocity &/or volume).
- Some sites (three or more) measure basic field water quality parameters (pH, dissolved oxygen, and temperature) from 1996 to present (similar to & overlapping City data).



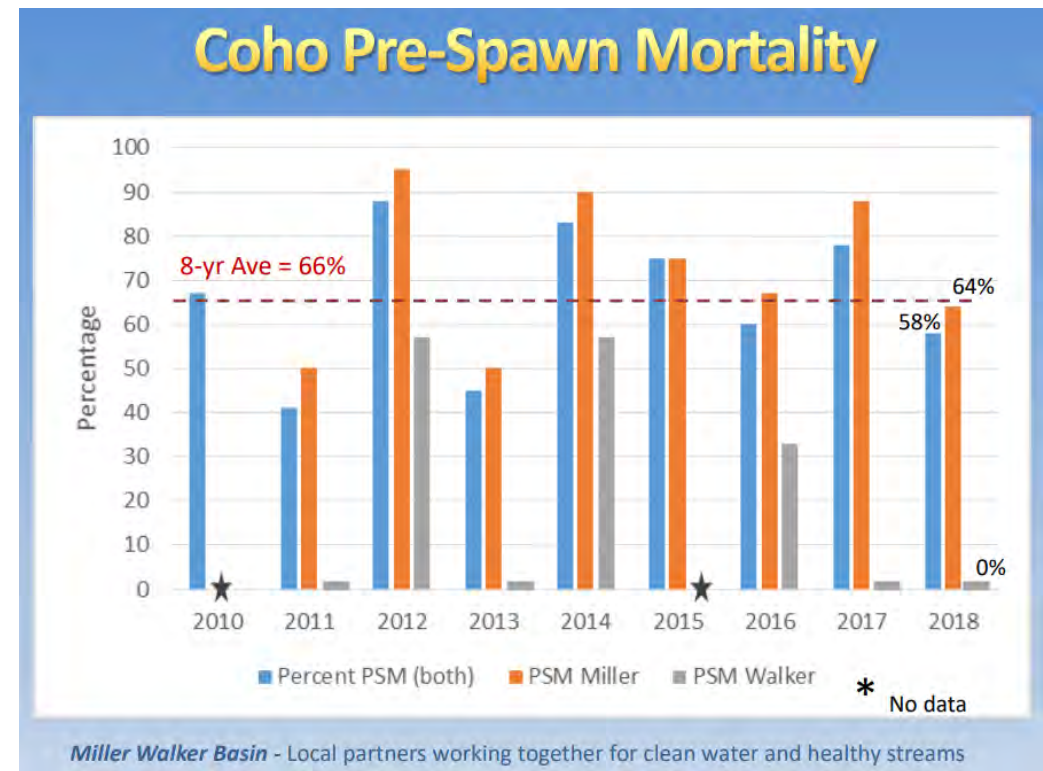
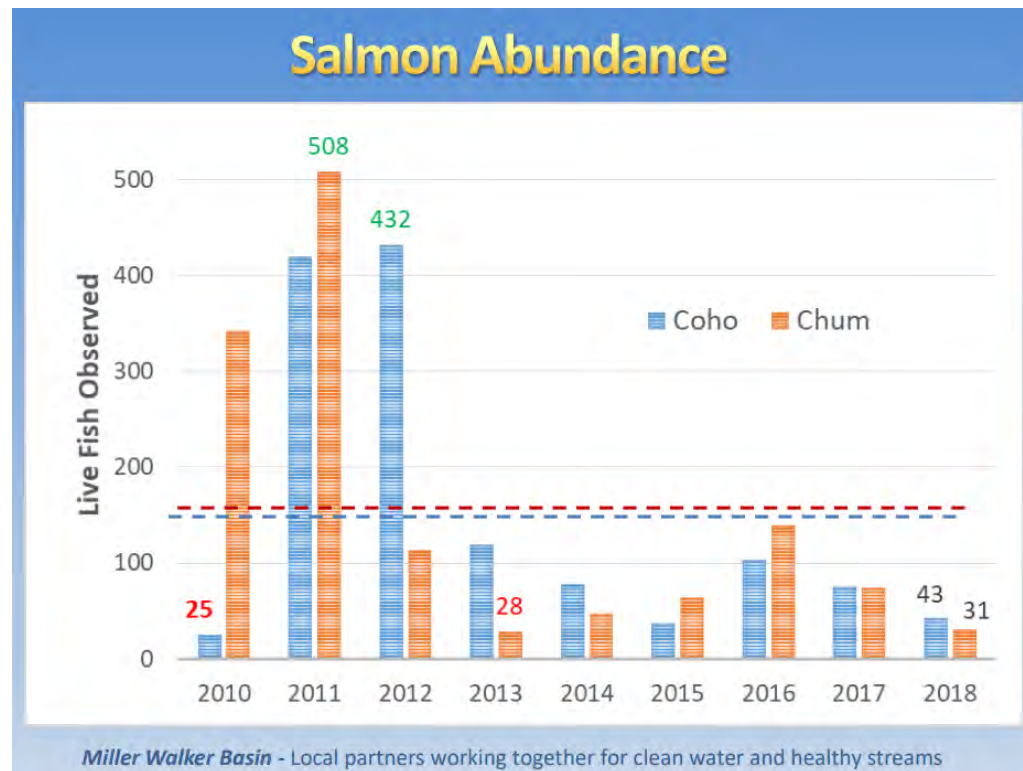
King County Hydrologic Information Center

- A few sites measure other or additional water quality parameters (turbidity, total dissolved solids [TDS], a few metals).
- Very limited to no hydrocarbon data to evaluate potential airport operational impacts (such as 1. fuels, deicing fluids, engine maintenance chemicals which can also originate from non-airport sources).



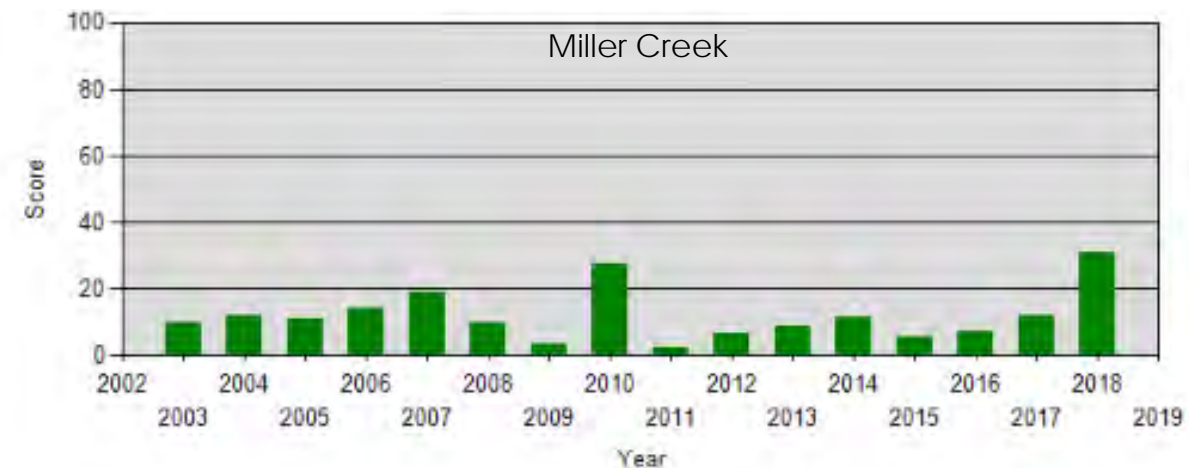
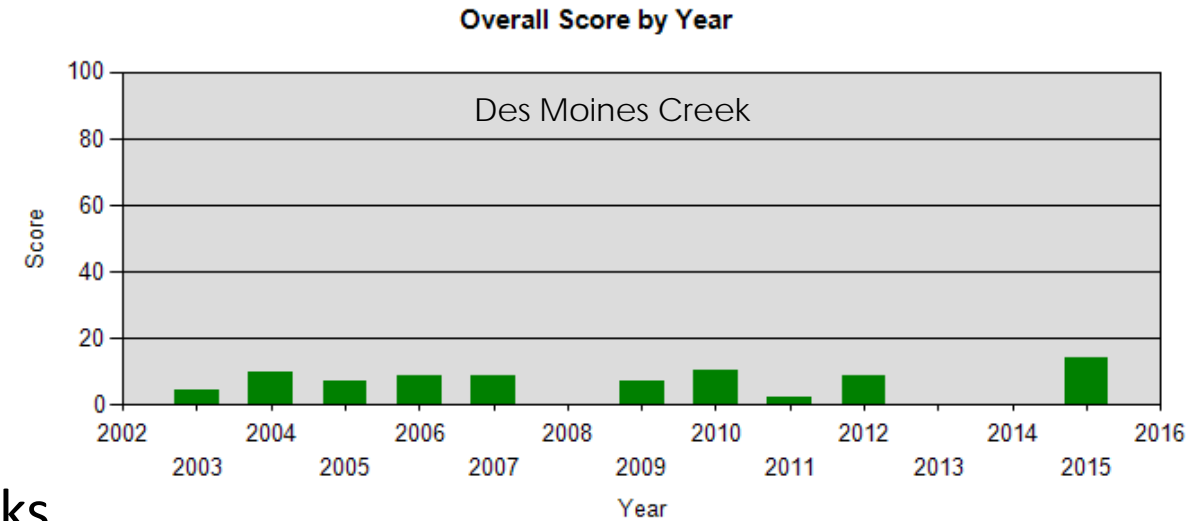
Data from King County: Community Salmon Investigation (CSI)

- Salmon Data on Miller and Walker Creeks from citizen volunteer stewardship efforts; 2010-2018 salmon counts, pre-spawn mortality. This same trend is common throughout Puget Sound.



Data from King County: Puget Sound Stream Benthos* Database

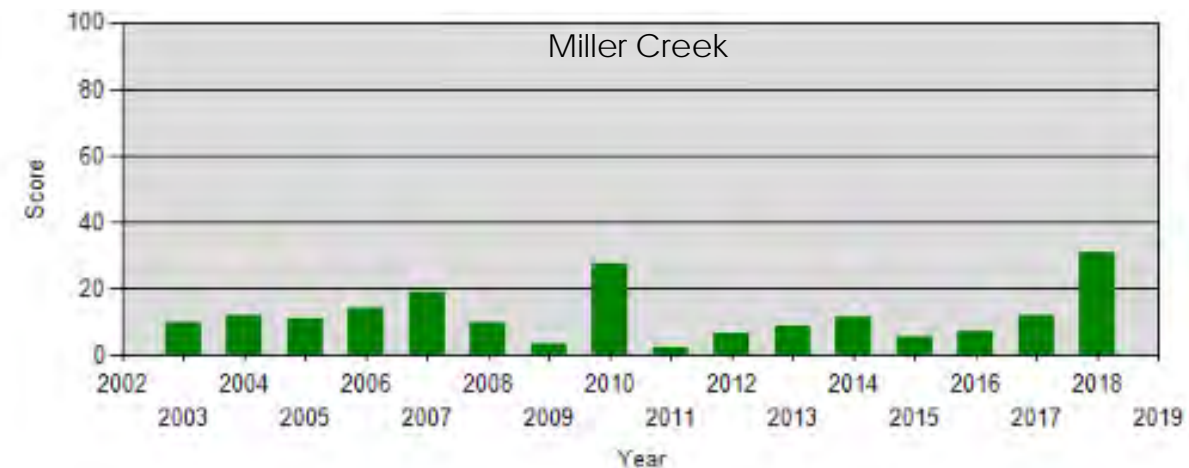
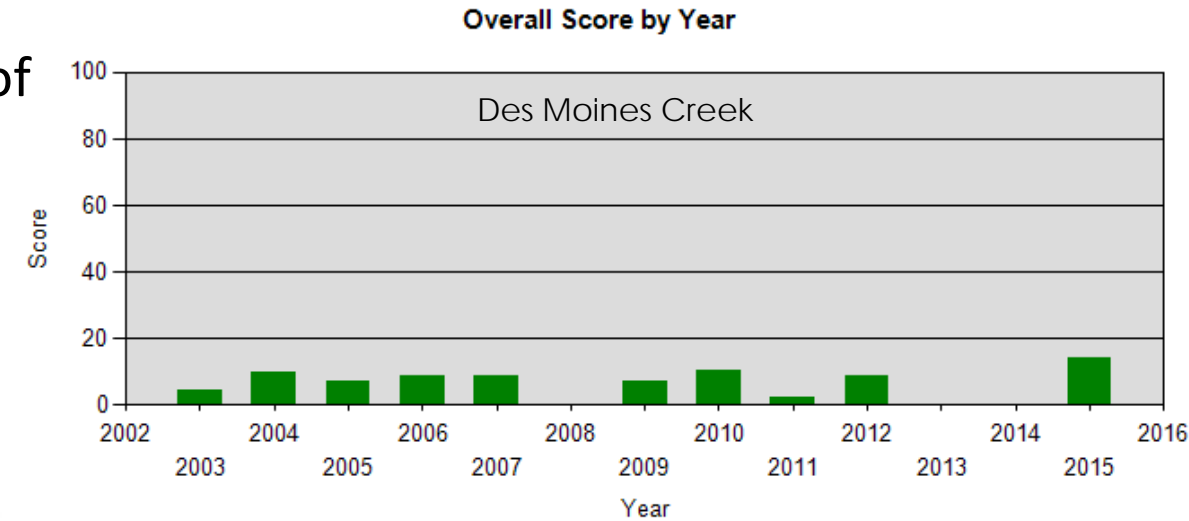
- Database of aquatic invertebrate (insects, snails, worms, etc.) data for stream health monitoring
- Important as fish food, as well often being a better indicator of water quality over time
- Data on Miller, Walker, and Des Moines Creeks indicate very low stream health.
 - Benthic Index of Biotic Integrity (B-IBI) is a calculated index of 10 different metrics that produces a score with a range of 0 to 100.
 - High Score = healthy stream
 - Low Score = impacted stream
 - Most samples under 20.



* Benthos = "bottom dwelling", i.e., invertebrates living on or in the streambed.

Data from King County: Puget Sound Stream Benthos* Database

- Majority of samples collected in lower extent of streams, not in upstream reaches near airport
- Therefore streams also effected by roads, residences, businesses (i.e, high urban effects)



* Benthos = "bottom dwelling", i.e., invertebrates living on or in the streambed.

Additional Studies and Anecdotal Information

- Anecdotal information from citizens notes a concern with particulate matter in the air negatively impacting landscaping, trees, grass, gardens, etc.
- No studies or data have been located in our Study Area that address this concern (Athens, Greece; Delhi, India; Poland; LAX & Santa Barbara, Calif have studies that look at soils in and next to airports; identification of nearby land use not included)
- A specific local study would need to be conducted to identify specific pollutants in these particles, determine whether they could be identified from the airport specifically, and then determine presence in soils or on plant surfaces.

TRANSPORTATION RESEARCH RECORD 1517

Evaluating Particulate Emissions from Jet Engines: Analysis of Chemical and Physical Characteristics and Potential Impacts on Coastal Environments and Human Health

KARLEEN A. BOYLE

The results of this study suggest that the range of size of particulate emissions from some jet engines clusters below 1.5 μm and that the emissions contain heavy metals. Therefore, jet exhaust particulates (JEPs) have the potential to adversely affect both the environment and human health. Little is known about the particulate component of jet engine emissions. Baseline physical and chemical data on JEPs were obtained to evaluate their potential effects on the environment. Particles collected from the exhaust stream of two types of jet engines were examined using scanning electron microscopy. Analysis indicated that 100 percent of the particles collected were below 1.5 μm in size. Particles in this size range can penetrate to the alveoli of human lungs. Chemical analyses of jet engine exhaust were conducted in an attempt to identify chemical fingerprints that would distinguish aviation emissions in the environment from other anthropogenic emissions. Certain heavy metals, especially vanadium, were found in jet exhaust and may be useful chemical fingerprints. Analysis of JP-5 fuel standards revealed a suite of alkylbenzene hydrocarbons, which may also aid in fingerprinting aviation emissions. Sediment samples taken at coastal wetlands near airports indicated the presence of the same heavy metals as those found in jet exhaust samples. Field sites exposed to higher volumes of air traffic contained higher levels of sediment heavy metals, supporting the hypothesis that aerial deposition of heavy metals is occurring in areas near some airports.

The aviation industry has committed substantial resources to studying and reducing the adverse environmental impacts of its activities. Most notably the problems of jet noise abatement and control of airport runoff have been addressed. Increased attention is being paid to jet engine emissions as airlines continue to upgrade their fleets to achieve full Stage 3 compliance with the 1990 Airport Noise and Capacity Act; concerns over emissions are not confined to noise, however. The latest challenge facing both the aviation industry and its regulatory agencies is to address the air pollution generated by air traffic. Until recently commercial air traffic had been mostly exempt from regulatory control of emissions. This is likely to change because the level of public concern about environmental and health issues remains high and many regions around the world are enacting more stringent air quality regulations.

Current fuel consumption as a result of aviation is 180 million tons annually (1). Airlines operating out of the five commercial air-

ports in the Los Angeles Basin produce 28 tons of emissions daily. Three-fourths of this amount comes from airplanes, the remainder from ground support equipment (2). Fuel consumption is expected to increase. The International Civil Aviation Organization (ICAO) projects a 65 percent increase in aviation fuel consumption between 1990 and 2010 (1). Because of the predicted increases, pressure for further regulation of aviation emissions is also increasing. A recent meeting of ICAO's Committee on Aviation Environmental Protection resulted in a strong recommendation for increased stringency in the regulation of both noise and emissions from airports. In the United States, the recently proposed federal implementation plan of the Clean Air Act in California suggested instituting a sliding scale of reductions on aviation emissions beginning in 2001 (3). The plan proposed that airlines reduce emissions in the Los Angeles Basin by 35 to 45 percent by 2005 and that heavy fines, such as a fee of \$10,000 per ton of excess emissions, be levied against parties exceeding the standards. The plan's standards applied to both airplanes and ground support equipment operated by the airlines. The plan was not implemented because of a variety of economic and logistic considerations, but it appears highly probable that regulation of airline emissions will increase in the future. It is vital that information on the effects of aircraft emissions be collected so that future efforts to reduce their impact can be as productive as possible.

Changes in jet engine technology intended to reduce noise have led to changes in emission profiles. New lower-noise engines have reduced emissions of hydrocarbons (HC) and carbon monoxide (CO) but have increased nitrous oxide (NO_x) emissions. Such tradeoffs are often made when the reduction of specific emission components is pursued. Reductions in engine noise generally require increased fuel burn, which also increases engine emissions. This paradigm of tradeoffs in engine design makes it vital to collect data on the relative environmental impacts of the chemical components of jet engine exhaust. The data will allow priorities to be set for the regulation of the most damaging emissions and will help guide the development of new engine technologies. For this study, information was collected on a relatively unstudied component of jet engine exhaust—particulate emissions.

The operation of jet engines results in the release of HC, CO, NO_x, sulfur dioxide (SO₂), and particulate matter. Assessments of the impacts of engine emissions and considerations of methods of reduction have focused more on the pollutants CO, HC, and NO_x.

Department of Biology, University of California, Los Angeles, 405 Hilgard Avenue, Los Angeles, Calif. 90024-1606.

Additional Studies and Anecdotal Information

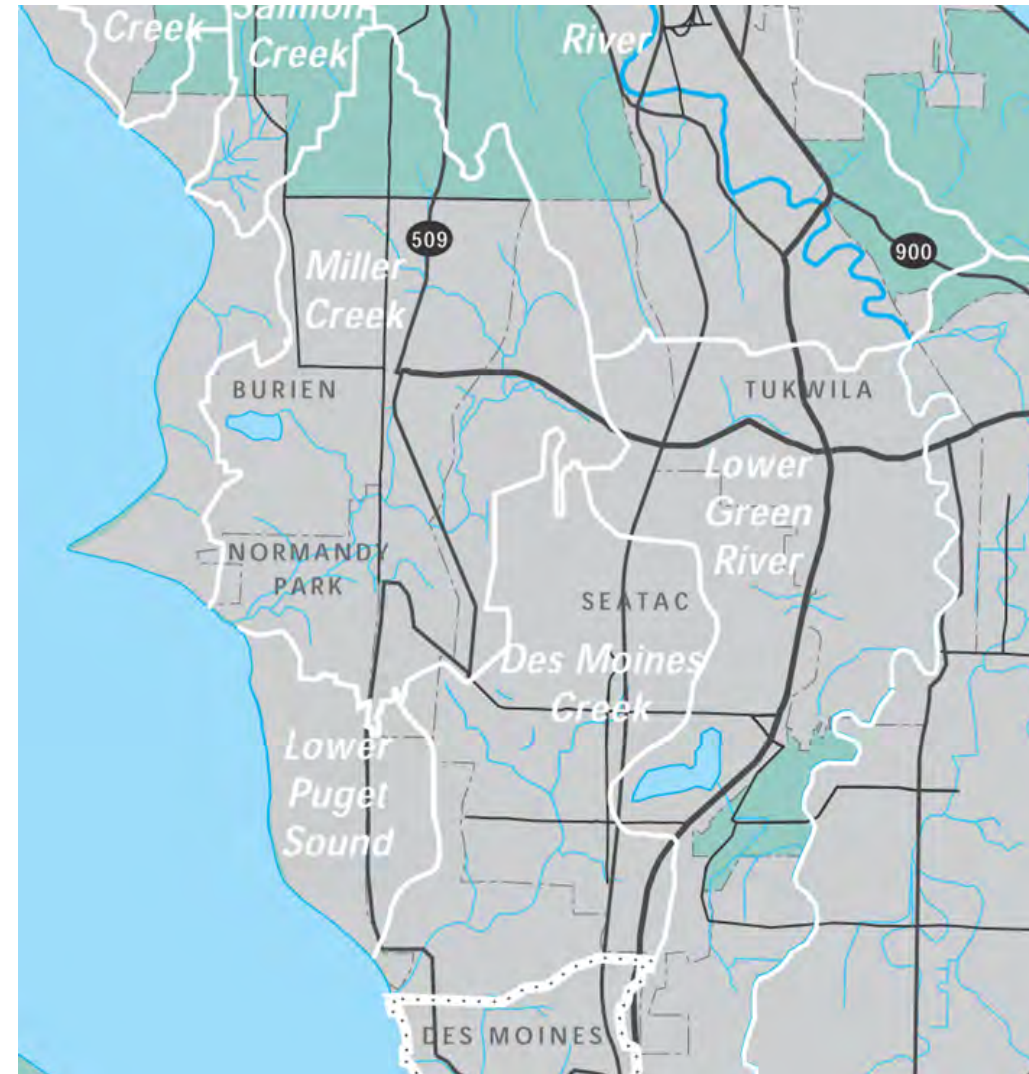
MOV-UP: Mobile Observations of Ultrafine Particles Study (University of Washington - <https://deohs.washington.edu/mov-mobile-observations-ultrafine-particles-study#outcomes>)

- Final report in December 2019.
- The study focuses on ultrafine PM concentrations within 10 miles of the airport in the directions of aircraft flight.
- Does not address human health impacts.
- Does not address impacts to plants, water, soils.



Next Steps – Data Evaluation

- **Geographic Information System (GIS)** – analyze layers for wetlands, streams, and soils data.
- **National Pollutant Discharge Elimination System (NPDES):**
 - Analyze discharge monitoring reports to isolate the airport’s outfall data
 - Identify most relevant water quality parameters with the best data series over time.
 - Existing data reveals a few permit exceedances but no required significant regulatory agency corrective actions.
- **Groundwater Study** (from the Port of Seattle) – to be reviewed when it is received.



Analysis Metric:

LIGHT

Presenter:

Seth Ely, MIES
Senior Lighting Designer



Satellite Analysis of Light Emissions

Sea-Tac
Airport

Layer options

Base map
Aerial imagery

Lights layer opacity: 75 %

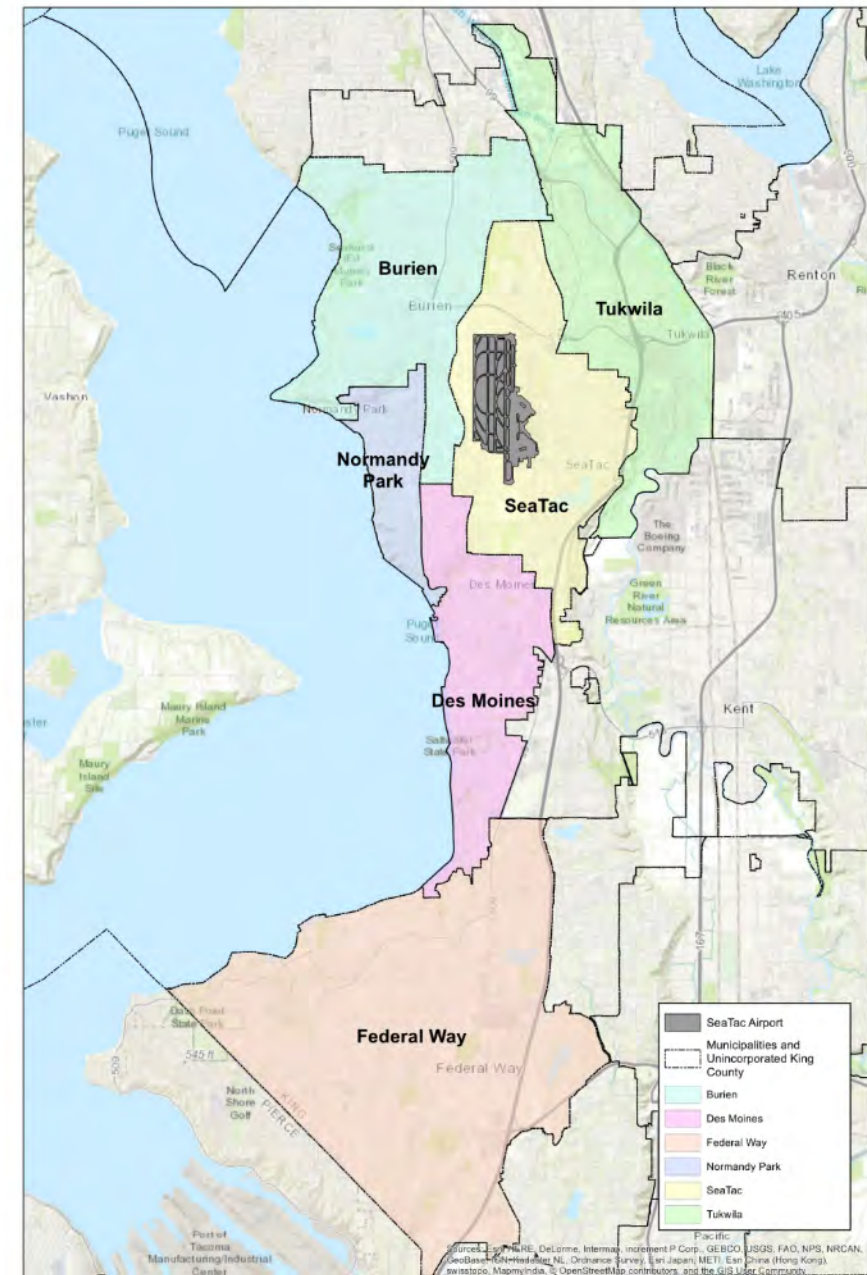
Lights layer style
Rainbow

- 2017 Nov (npp)
- 2017 Dec (npp)
- 2018 Jan (npp)
- 2018 Feb (npp)
- 2018 Mar (npp)
- 2018 Apr (npp)
- 2018 May (npp)
- 2018 Jun (npp)
- 2018 Jul (npp)
- 2018 Aug (npp)
- 2018 Sep (npp)

Analysis of Electric Light Conditions

Categories of Electric Lighting Conditions

- Skyglow
- Potential Glare Conditions



Analysis of Electric Light Conditions

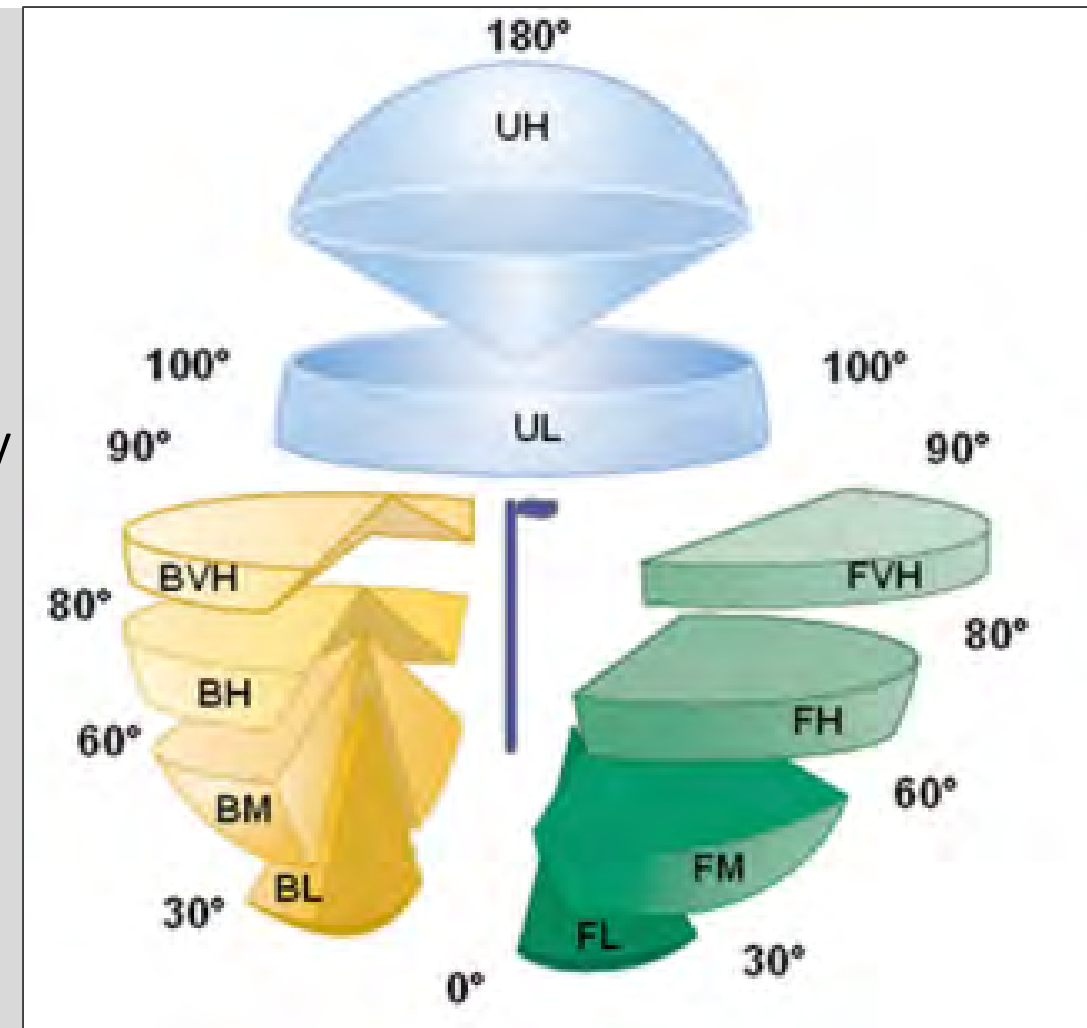
Skyglow –

results from

- electric light sources
- reflected from illuminated surfaces

Light fixture classifications identify fixtures that may create more skyglow.

- BUG Rating
 - Backlight
 - Up-light
 - Glare



Analysis of Electric Light Conditions

Skyglow –

results from

- electric light sources
- reflected from illuminated surfaces
- Lighting Controls can reduce light levels when spaces are not occupied



Relationship between Light and Health

- Sleep Cycle (Circadian Rhythm)
- Potential Glare Conditions
- Ecological Impacts

Analysis of Electric Light Conditions

Ongoing Research

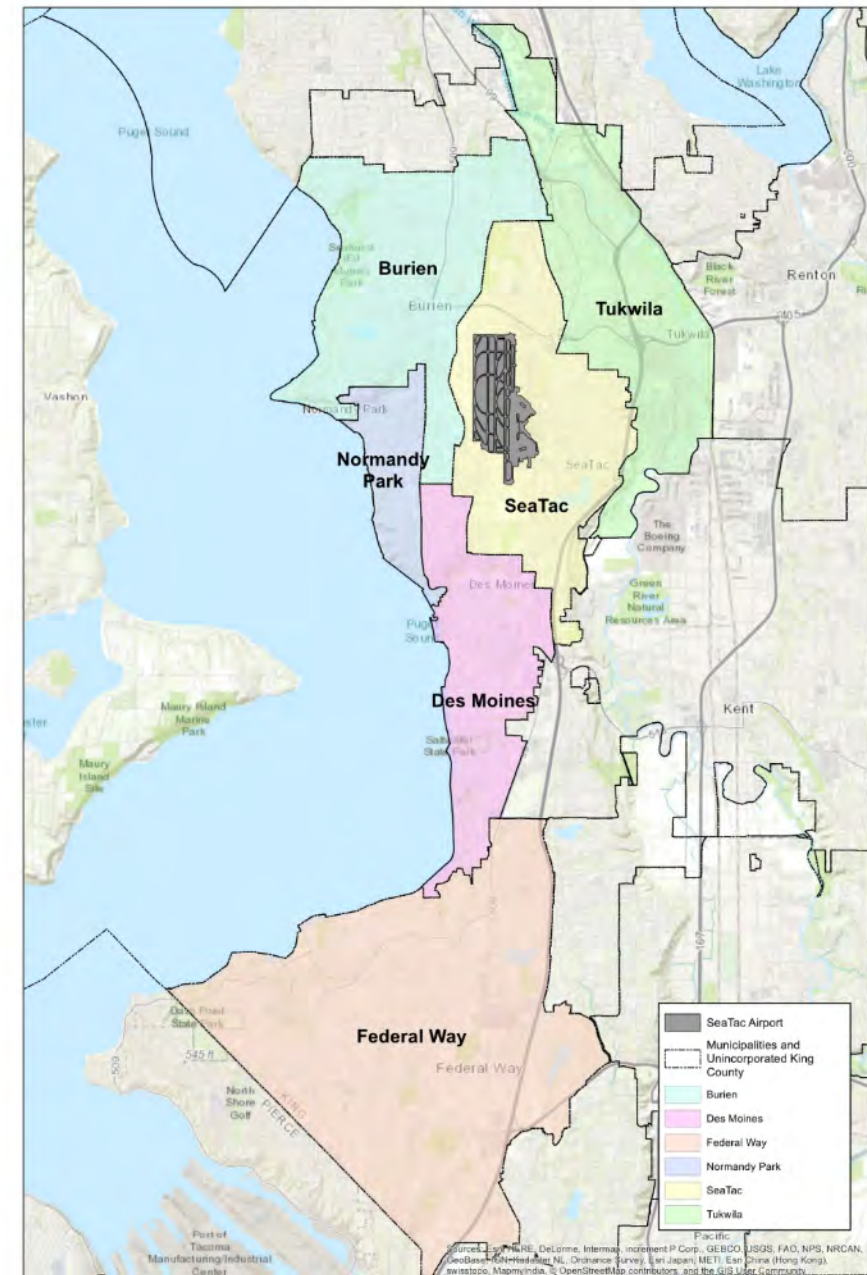
Relationship between light and human health

- Brainard, G – Thomas Jefferson University
- Bullough, J – Rensselaer Polytechnic Institute
- Figueiro, M – Rensselaer Polytechnic Institute
- Nietz, J – University of Washington
- Rea, M – Rensselaer Polytechnic Institute
- Soler, R – BIOS

- **Rensselaer Polytechnic Institute**
<https://www.lrc.rpi.edu/programs/lightHealth/research.asp>
- **University of California, Davis**
<https://cltc.ucdavis.edu/research/outdoor-lighting>

Review of Lighting Conditions

- **Light Pollution**
 - Compare changes in light pollution
 - Airport
 - Neighboring Communities
 - Central Puget Sound Region
- **Field Observations**
 - North Loop Road
 - Rental Car Facility
- **Terminal Apron Lighting**
 - Ongoing Updates



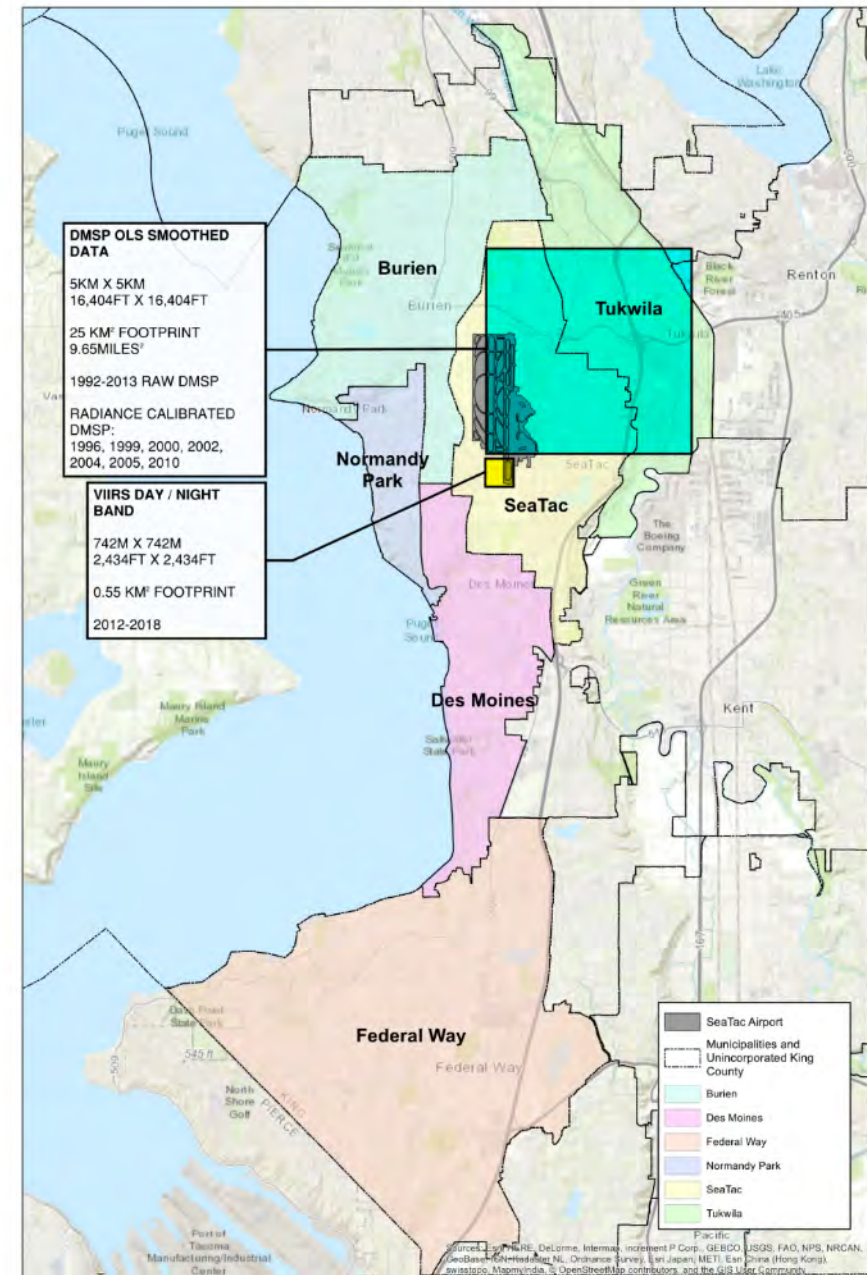
Satellite Analysis of Light Emissions

From 1992 to 2013, data comes from the Operational Linescan System of the Defense Meteorological Satellite Program (DMSP) satellites.

- **Qualitative**
- **Low Resolution**
- **Radiometrically calibrated data produced for select years: 1999 and 2010 Reviewed**

From 2012 to the present, data comes from the Day/Night Band of the Visible Infrared Imaging Radiometer Suite instrument (VIIRS DNB).

- **Quantitative**
- **Higher Resolution**



Satellite Analysis of Visible Light Emissions (Light Pollution)

Variations in light emissions may vary from 15% to 20% due:

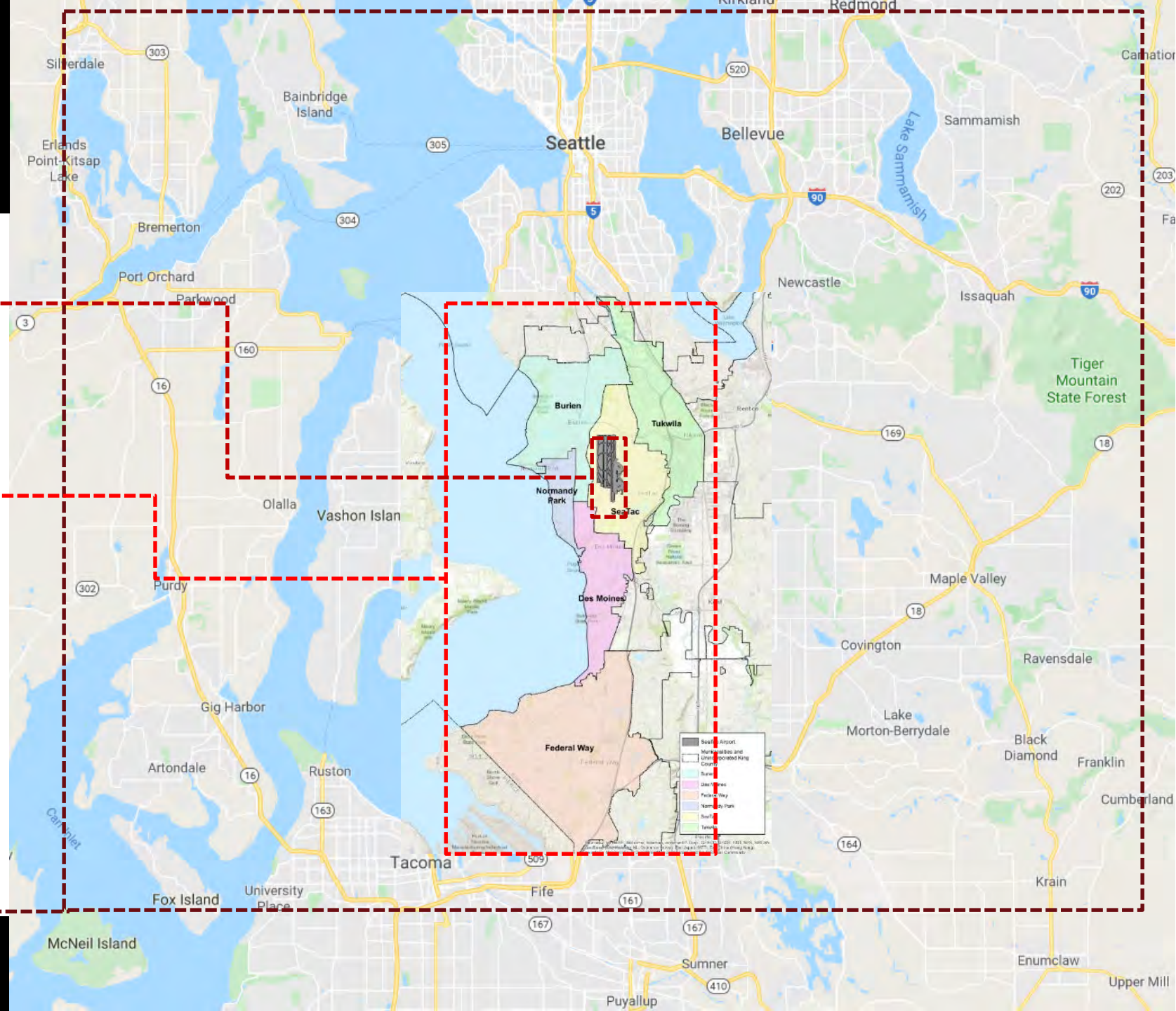
- Imaging Angle
- Time Of Night
- Seasonal Vegetation
- Atmospheric Conditions - Aerosol
- Changes In Sample Area For Composites
- Changes Imaging Sensor
- The Presence Or Absence Of Moonlight
- Temporary Electric Lighting
- Electrical Blackouts And Disasters
- Actual Changes In Permanently Installed Lighting

Satellite Analysis of Light Emissions

Area of Review
Sea-Tac Airport

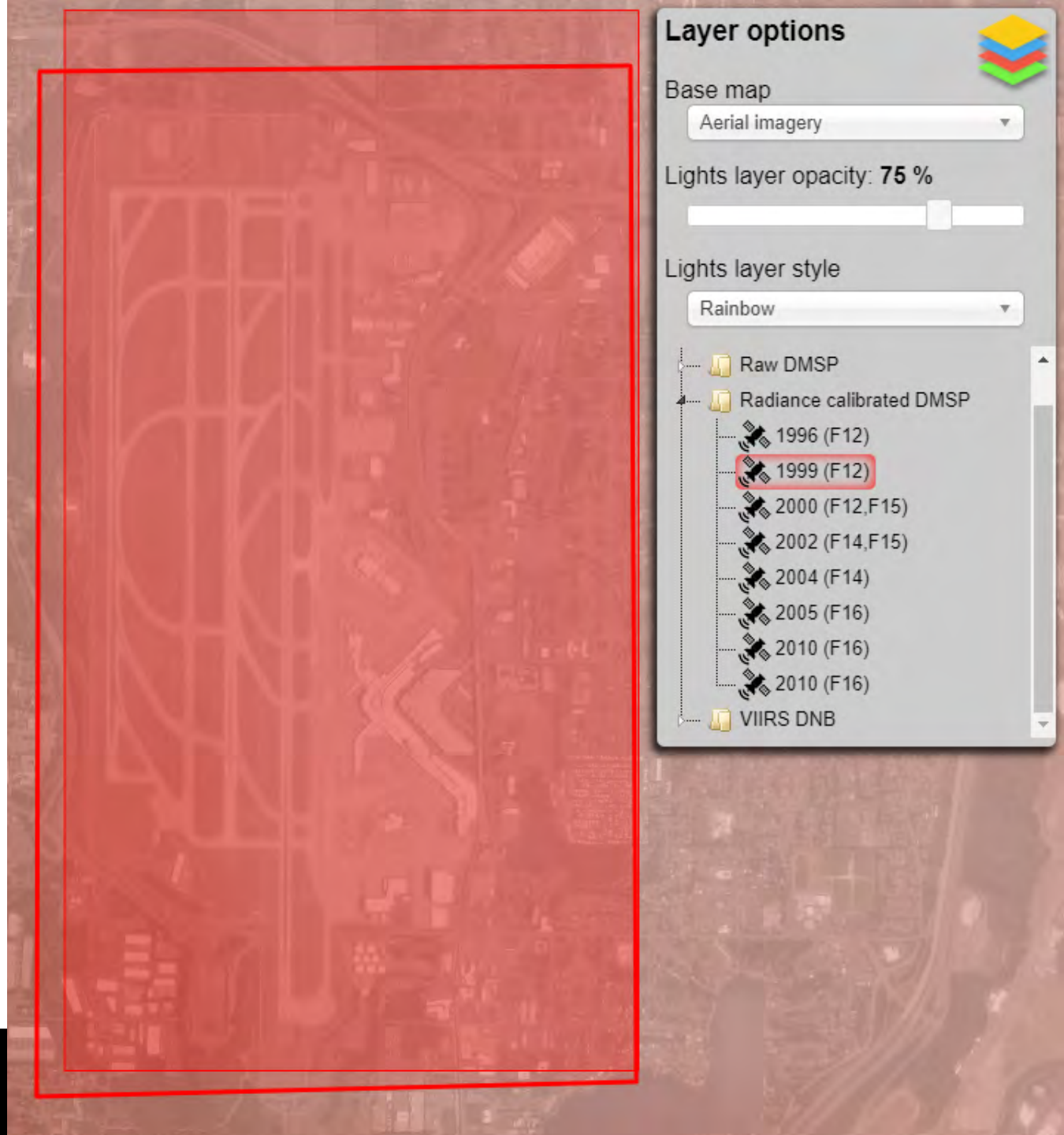
Area of Review
Communities

Area of Review
Central Puget Sound
Region



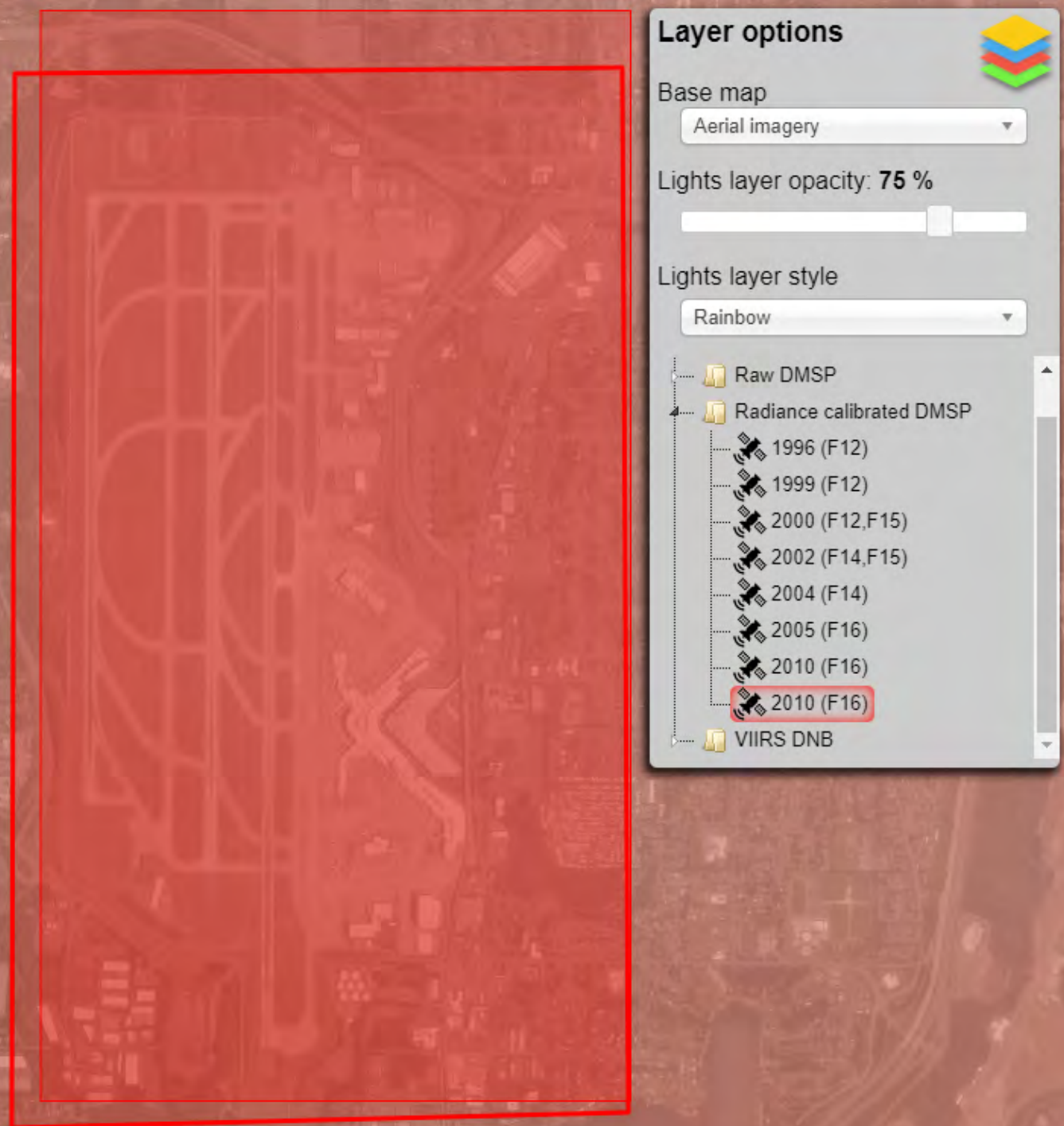
Satellite Analysis of Light Emissions

Area of Review
Sea-Tac Airport



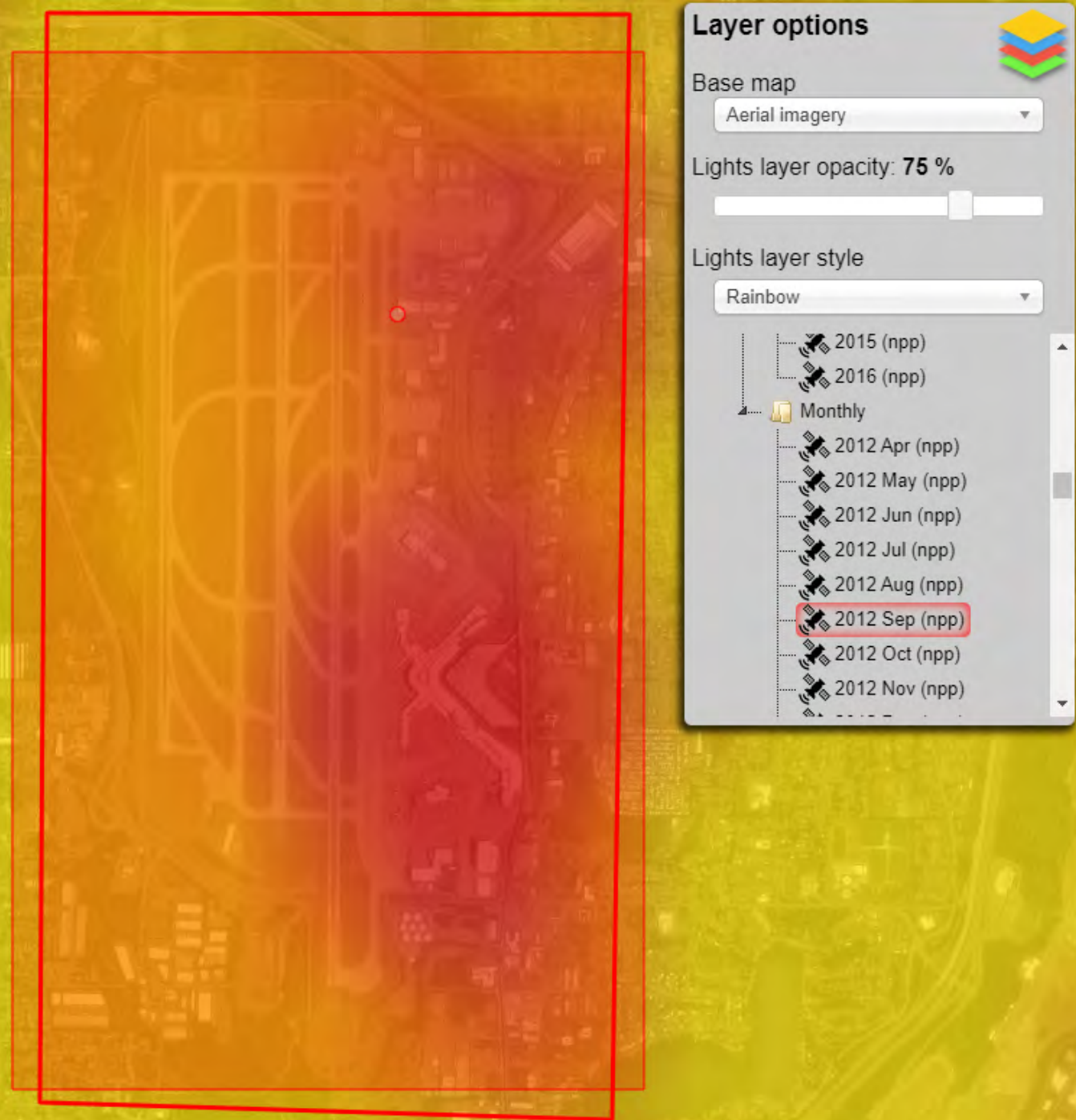
Satellite Analysis of Light Emissions

Area of Review
Sea-Tac Airport



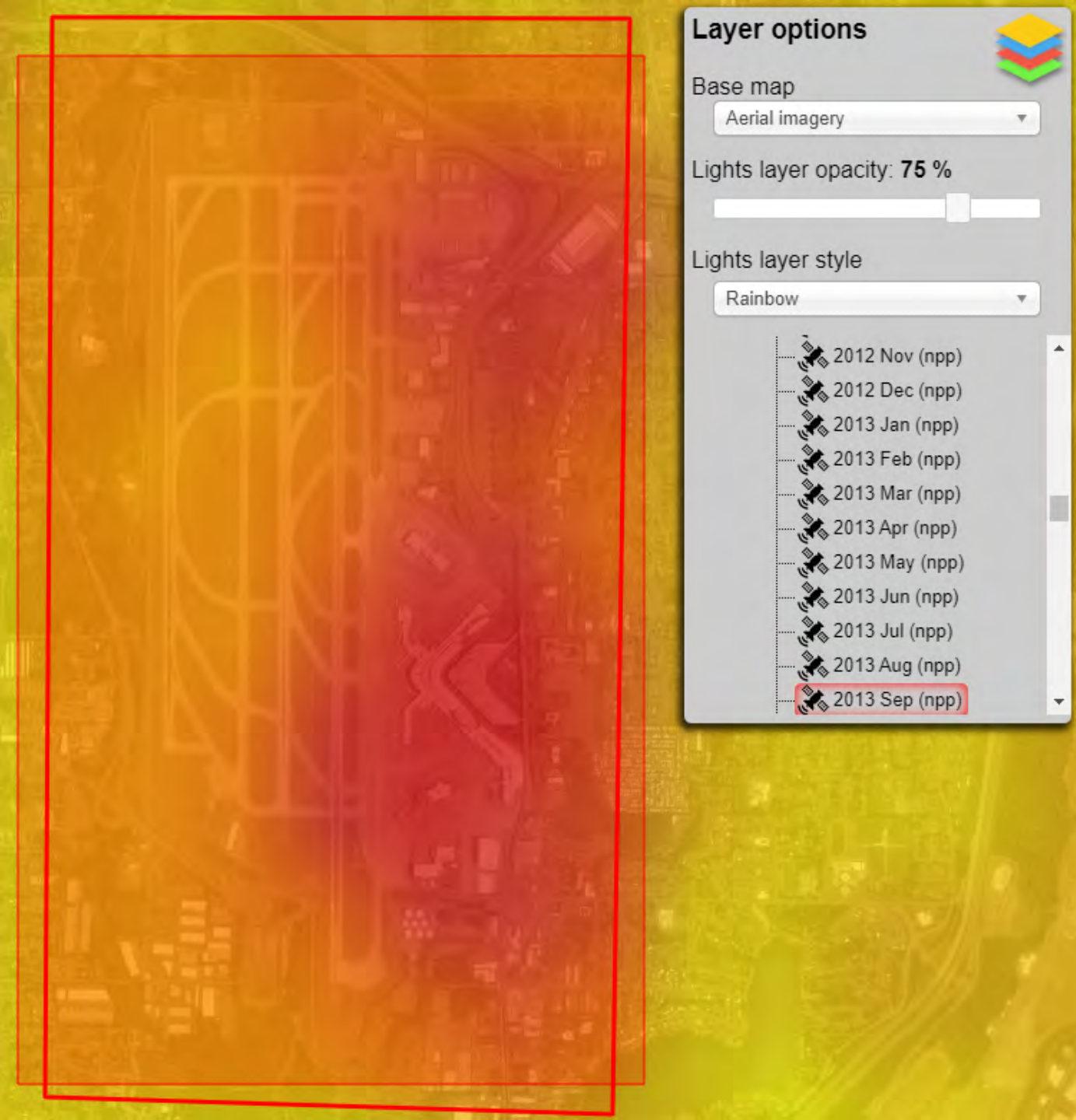
Satellite Analysis of Light Emissions

Area of Review
Sea-Tac Airport



Satellite Analysis of Light Emissions

Area of Review
Sea-Tac Airport



Satellite Analysis of Light Emissions

Area of Review
Sea-Tac Airport



Layer options

Base map
Aerial imagery

Lights layer opacity: 75 %

Lights layer style
Rainbow

- 2014 Jun (npp)
- 2014 Jul (npp)
- 2014 Aug (npp)
- 2014 Sep (npp)
- 2014 Oct (npp)
- 2014 Nov (npp)
- 2014 Dec (npp)
- 2015 Jan (npp)
- 2015 Feb (npp)
- 2015 Mar (npp)
- 2015 Apr (npp)

Satellite Analysis of Light Emissions

Area of Review
Sea-Tac Airport



Layer options

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Aerial imagery

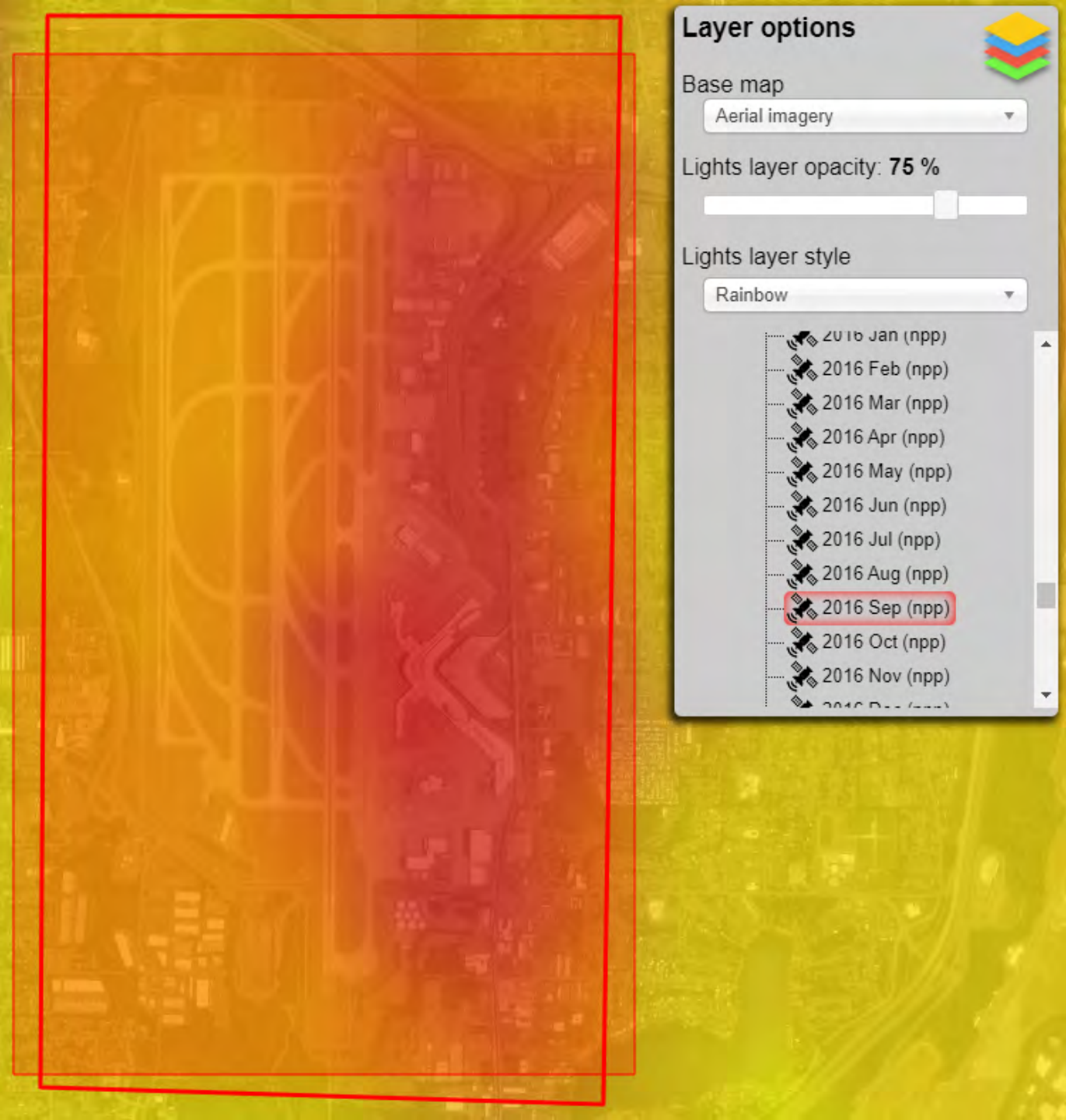
Lights layer opacity: 75 %

Lights layer style
Rainbow

- 2015 Apr (npp)
- 2015 May (npp)
- 2015 Jun (npp)
- 2015 Jul (npp)
- 2015 Aug (npp)
- 2015 Sep (npp)
- 2015 Oct (npp)
- 2015 Nov (npp)
- 2015 Dec (npp)
- 2016 Jan (npp)
- 2016 Feb (npp)

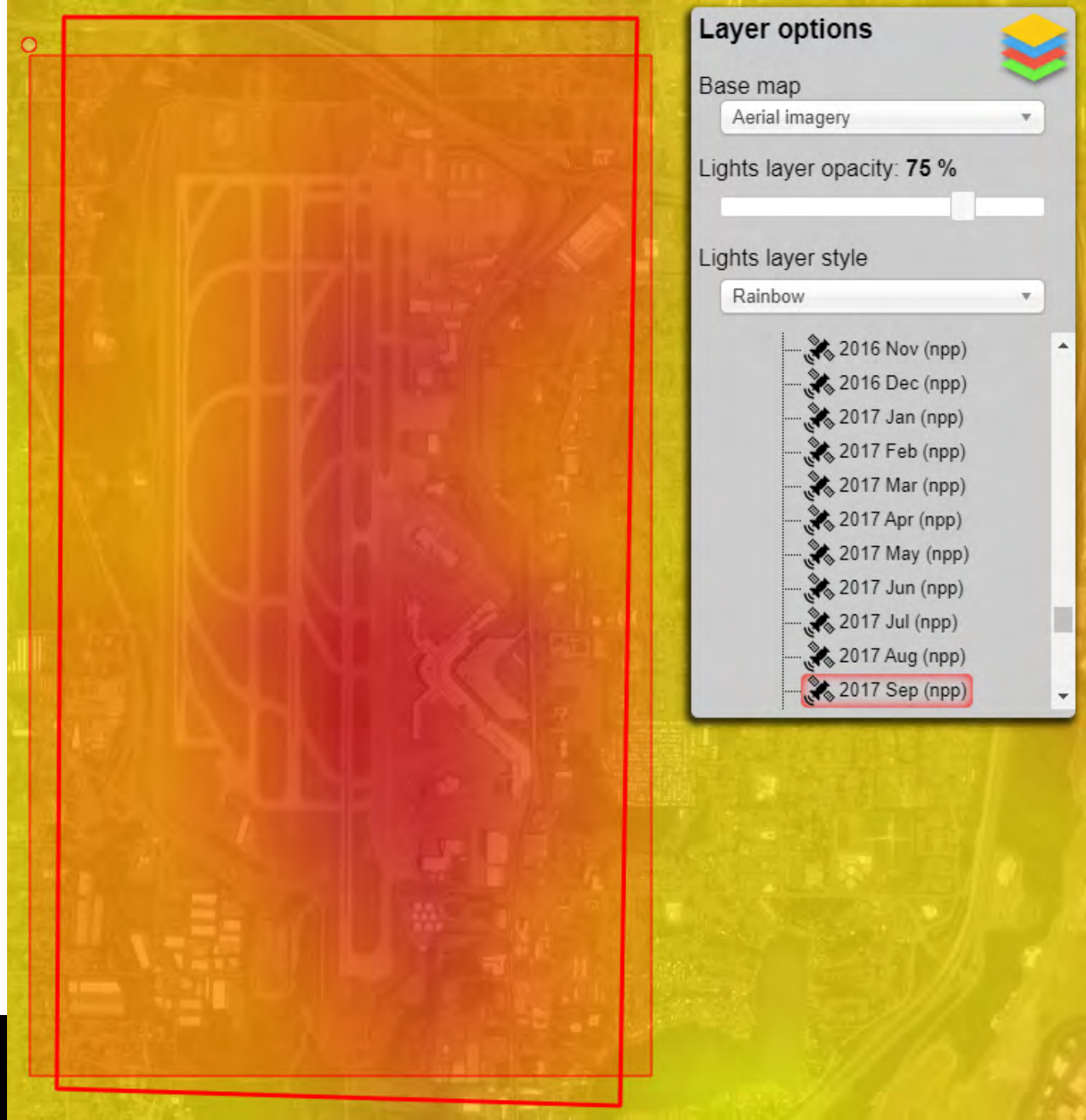
Satellite Analysis of Light Emissions

Area of Review
Sea-Tac Airport



Satellite Analysis of Light Emissions

Area of Review
Sea-Tac Airport



Satellite Analysis of Light Emissions

Area of Review
Sea-Tac Airport



Layer options

Base map
Aerial imagery

Lights layer opacity: 75 %

Lights layer style
Rainbow

- 2018 Feb (npp)
- 2018 Mar (npp)
- 2018 Apr (npp)
- 2018 May (npp)
- 2018 Jun (npp)
- 2018 Jul (npp)
- 2018 Aug (npp)
- 2018 Sep (npp)
- 2018 Oct (npp)
- 2018 Nov (npp)
- 2018 Dec (npp)

Satellite Analysis of Light Emissions

Area of Review
Communities

Sea-Tac
Airport

Layer options

Base map
Aerial imagery

Lights layer opacity: 75 %

Lights layer style
Rainbow

- 2011 (F18)
- 2012 (F18)
- 2013 (F18)
- Radiance calibrated DMSP
 - 1996 (F12)
 - 1999 (F12)
 - 2000 (F12,F15)
 - 2002 (F14,F15)
 - 2004 (F14)
 - 2005 (F16)
 - 2010 (F16)

Satellite Analysis of Light Emissions

Area of Review
Communities

Sea-Tac
Airport

Layer options

Base map
Aerial imagery

Lights layer opacity: 75 %

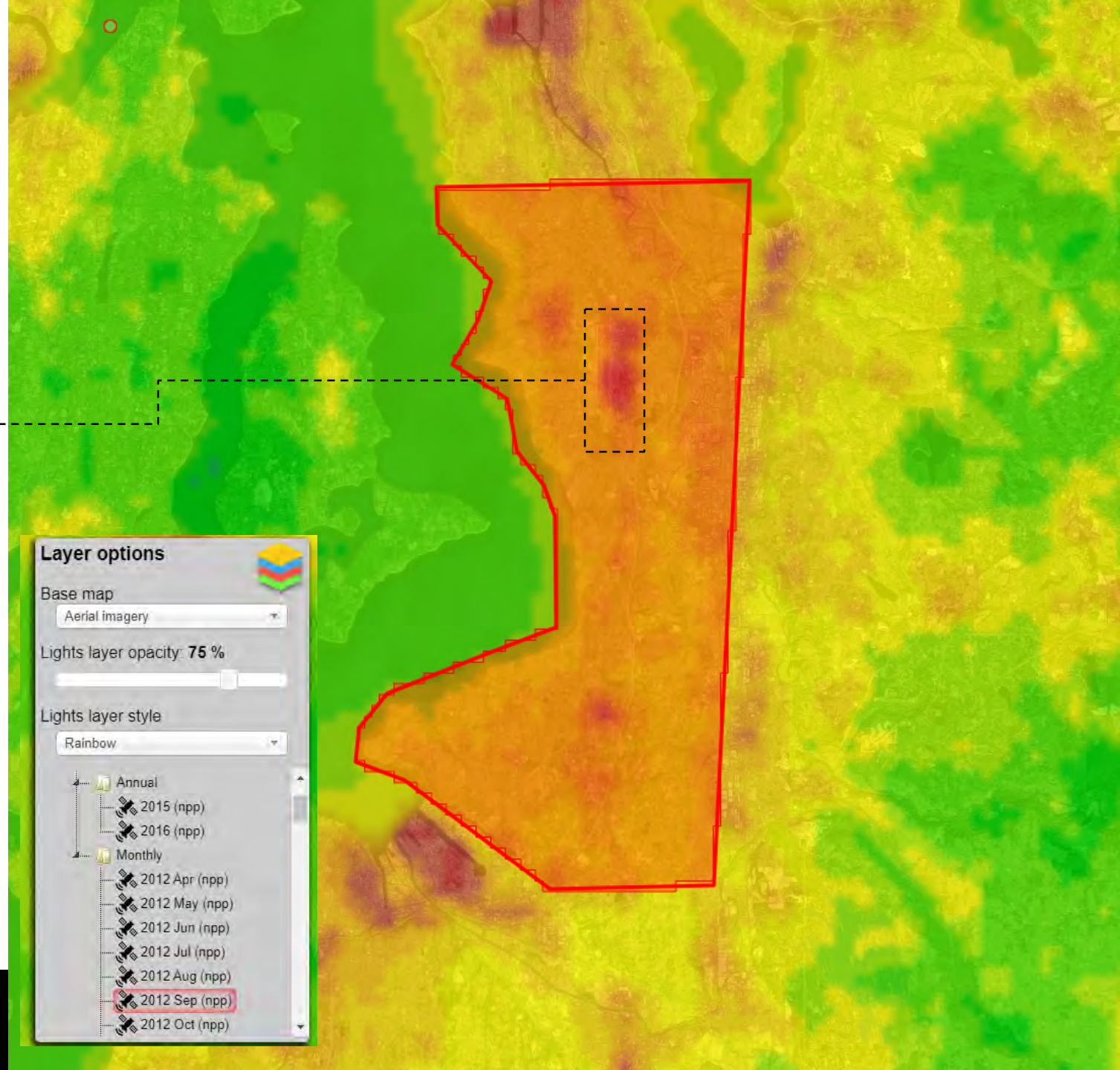
Lights layer style
Rainbow

- 1996 (F12)
- 1999 (F12)
- 2000 (F12, F15)
- 2002 (F14, F15)
- 2004 (F14)
- 2005 (F16)
- 2010 (F16)**
- 2010 (F16)
- VIIRS DNB
 - Annual
 - 2015 (npp)

Satellite Analysis of Light Emissions

Area of Review
Communities

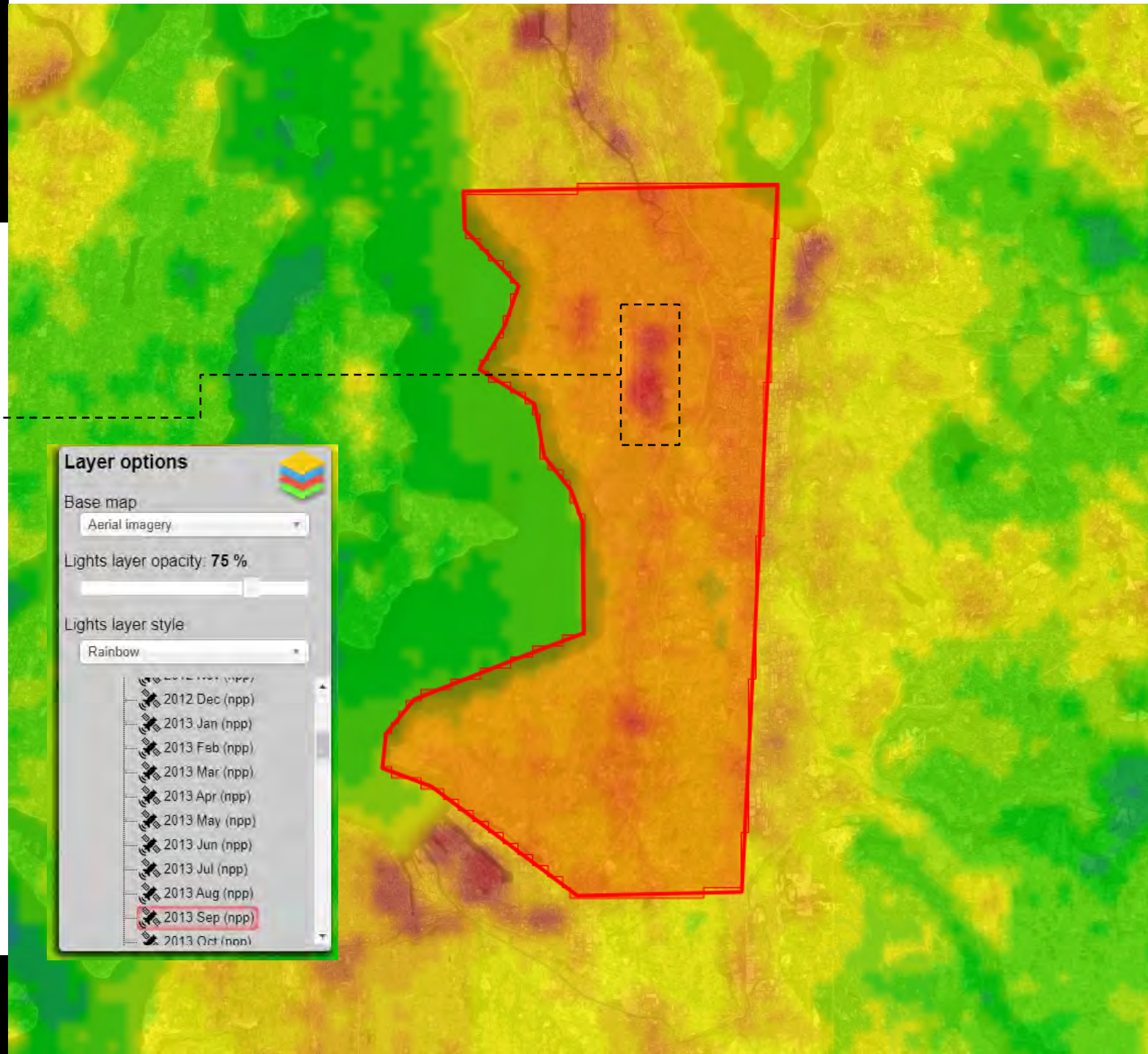
Sea-Tac
Airport



Satellite Analysis of Light Emissions

Area of Review
Communities

Sea-Tac
Airport



Layer options

Base map
Aerial imagery

Lights layer opacity: 75 %

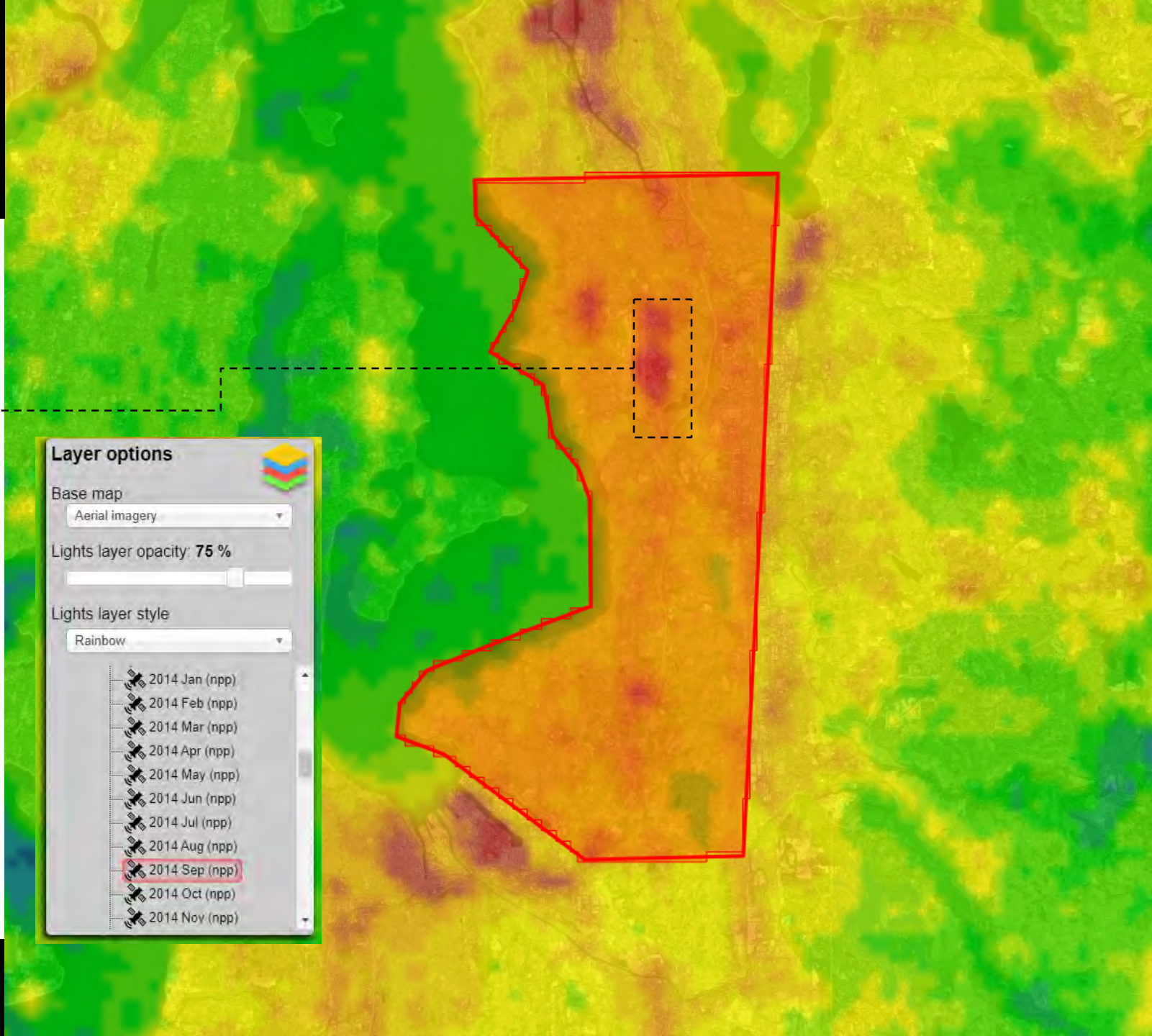
Lights layer style
Rainbow

- 2012 Dec (npp)
- 2013 Jan (npp)
- 2013 Feb (npp)
- 2013 Mar (npp)
- 2013 Apr (npp)
- 2013 May (npp)
- 2013 Jun (npp)
- 2013 Jul (npp)
- 2013 Aug (npp)
- 2013 Sep (npp)
- 2013 Oct (npp)

Satellite Analysis of Light Emissions

Area of Review
Communities

Sea-Tac
Airport



Layer options

Base map
Aerial imagery

Lights layer opacity: 75 %

Lights layer style
Rainbow

- 2014 Jan (npp)
- 2014 Feb (npp)
- 2014 Mar (npp)
- 2014 Apr (npp)
- 2014 May (npp)
- 2014 Jun (npp)
- 2014 Jul (npp)
- 2014 Aug (npp)
- 2014 Sep (npp)**
- 2014 Oct (npp)
- 2014 Nov (npp)

Satellite Analysis of Light Emissions

Area of Review
Communities

Sea-Tac
Airport

Layer options

Base map
Aerial imagery

Lights layer opacity: 75 %

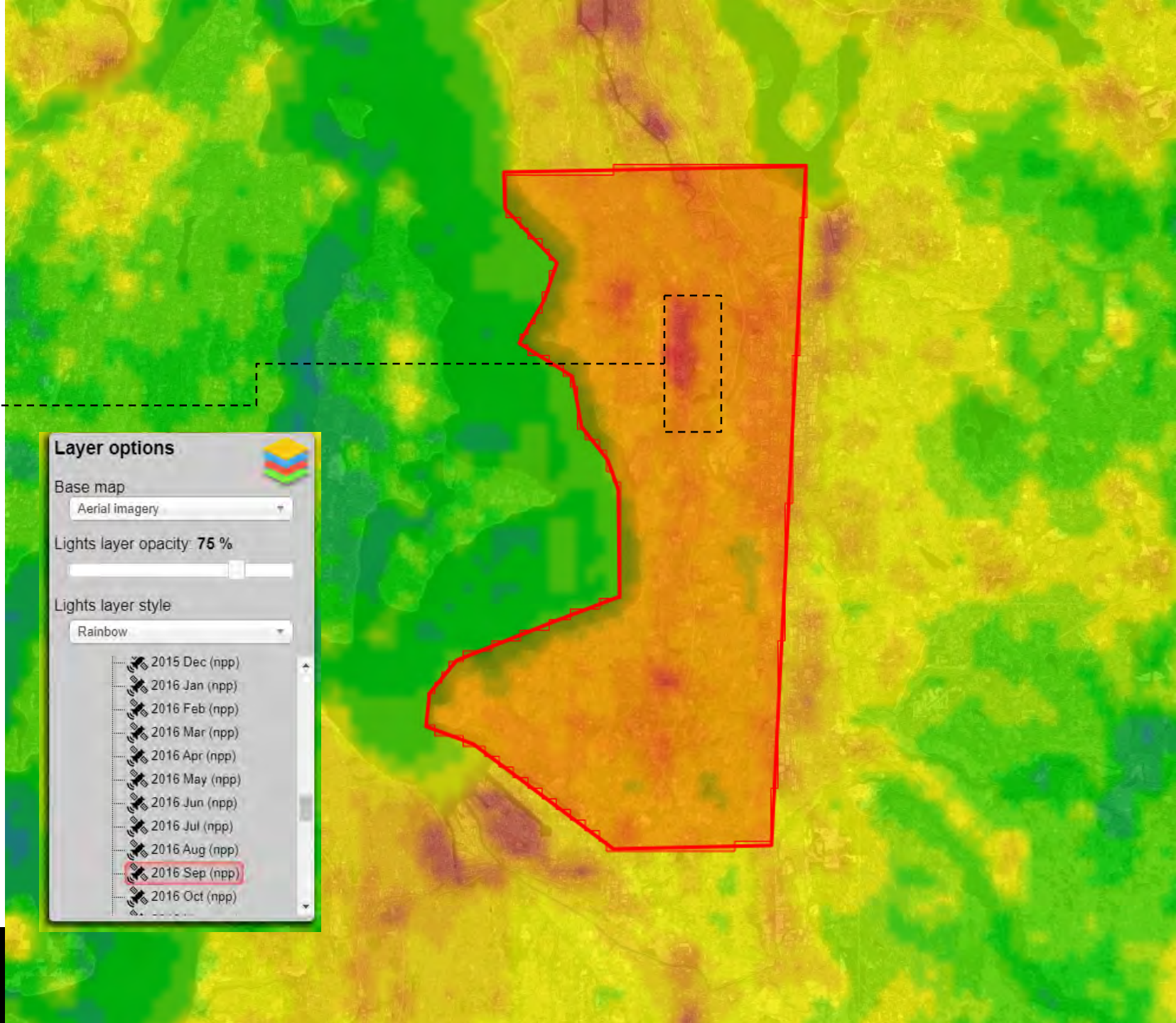
Lights layer style
Rainbow

- 2015 Jan (npp)
- 2015 Feb (npp)
- 2015 Mar (npp)
- 2015 Apr (npp)
- 2015 May (npp)
- 2015 Jun (npp)
- 2015 Jul (npp)
- 2015 Aug (npp)
- 2015 Sep (npp)**
- 2015 Oct (npp)
- 2015 Nov (npp)

Satellite Analysis of Light Emissions

Area of Review
Communities

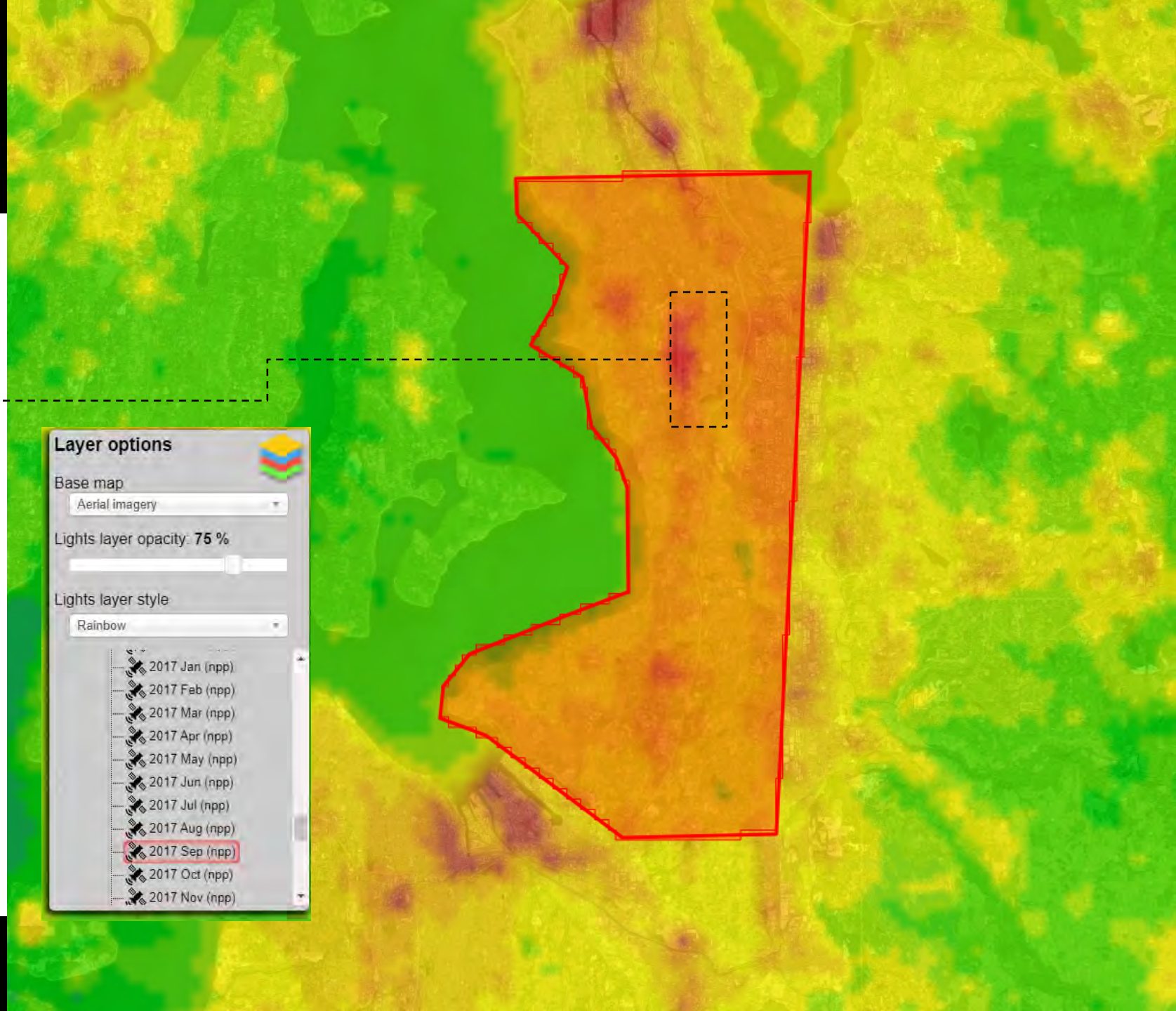
Sea-Tac
Airport



Satellite Analysis of Light Emissions

Area of Review
Communities

Sea-Tac
Airport



Layer options

Base map
Aerial imagery

Lights layer opacity: 75 %

Lights layer style
Rainbow

- 2017 Jan (npp)
- 2017 Feb (npp)
- 2017 Mar (npp)
- 2017 Apr (npp)
- 2017 May (npp)
- 2017 Jun (npp)
- 2017 Jul (npp)
- 2017 Aug (npp)
- 2017 Sep (npp)
- 2017 Oct (npp)
- 2017 Nov (npp)

Satellite Analysis of Light Emissions

Area of Review
Communities

Sea-Tac
Airport

Layer options

Base map
Aerial imagery

Lights layer opacity: 75 %

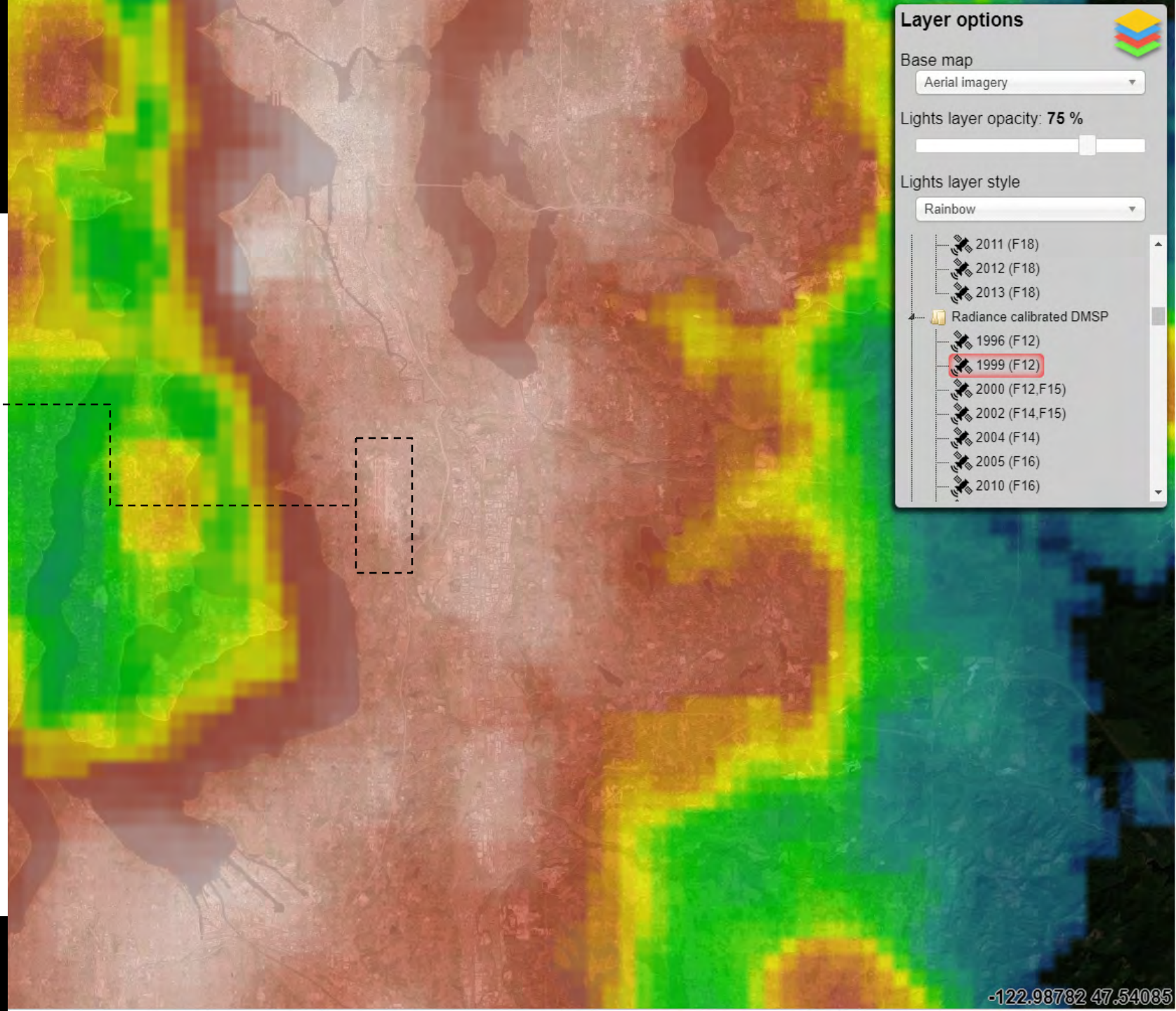
Lights layer style
Rainbow

- 2017 Nov (npp)
- 2017 Dec (npp)
- 2018 Jan (npp)
- 2018 Feb (npp)
- 2018 Mar (npp)
- 2018 Apr (npp)
- 2018 May (npp)
- 2018 Jun (npp)
- 2018 Jul (npp)
- 2018 Aug (npp)
- 2018 Sep (npp)

Satellite Analysis of Light Emissions

Area of Review
Communities

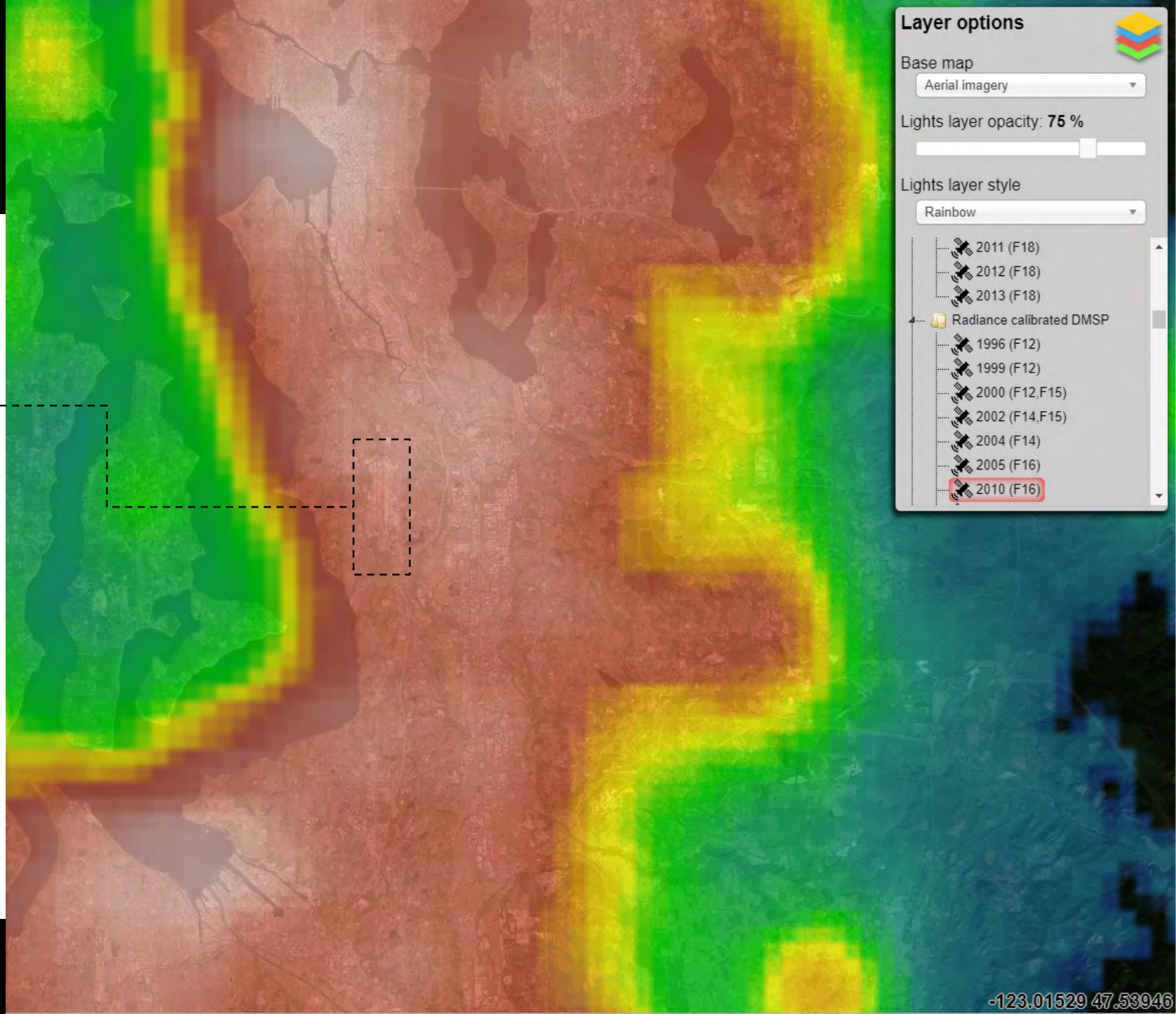
Sea-Tac
Airport



Satellite Analysis of Light Emissions

Area of Review
Communities

Sea-Tac
Airport



Satellite Analysis of Light Emissions

Area of Review
Communities

Sea-Tac
Airport

Layer options

Base map
Aerial imagery

Lights layer opacity: **75 %**

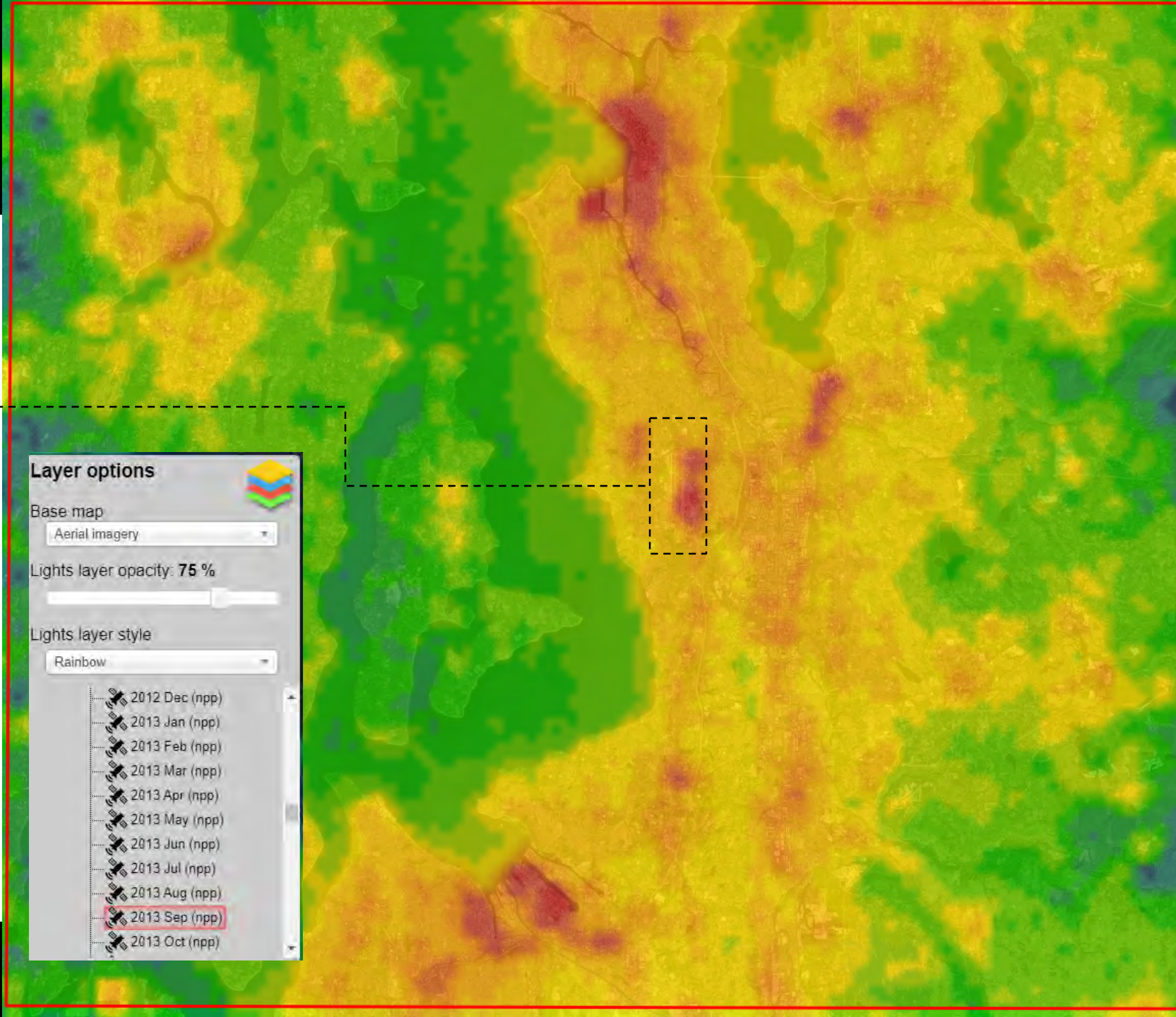
Lights layer style
Rainbow

- 2012 Apr (npp)
- 2012 May (npp)
- 2012 Jun (npp)
- 2012 Jul (npp)
- 2012 Aug (npp)
- 2012 Sep (npp)
- 2012 Oct (npp)
- 2012 Nov (npp)
- 2012 Dec (npp)
- 2013 Jan (npp)
- 2013 Feb (npp)

Satellite Analysis of Light Emissions

Area of Review
Communities

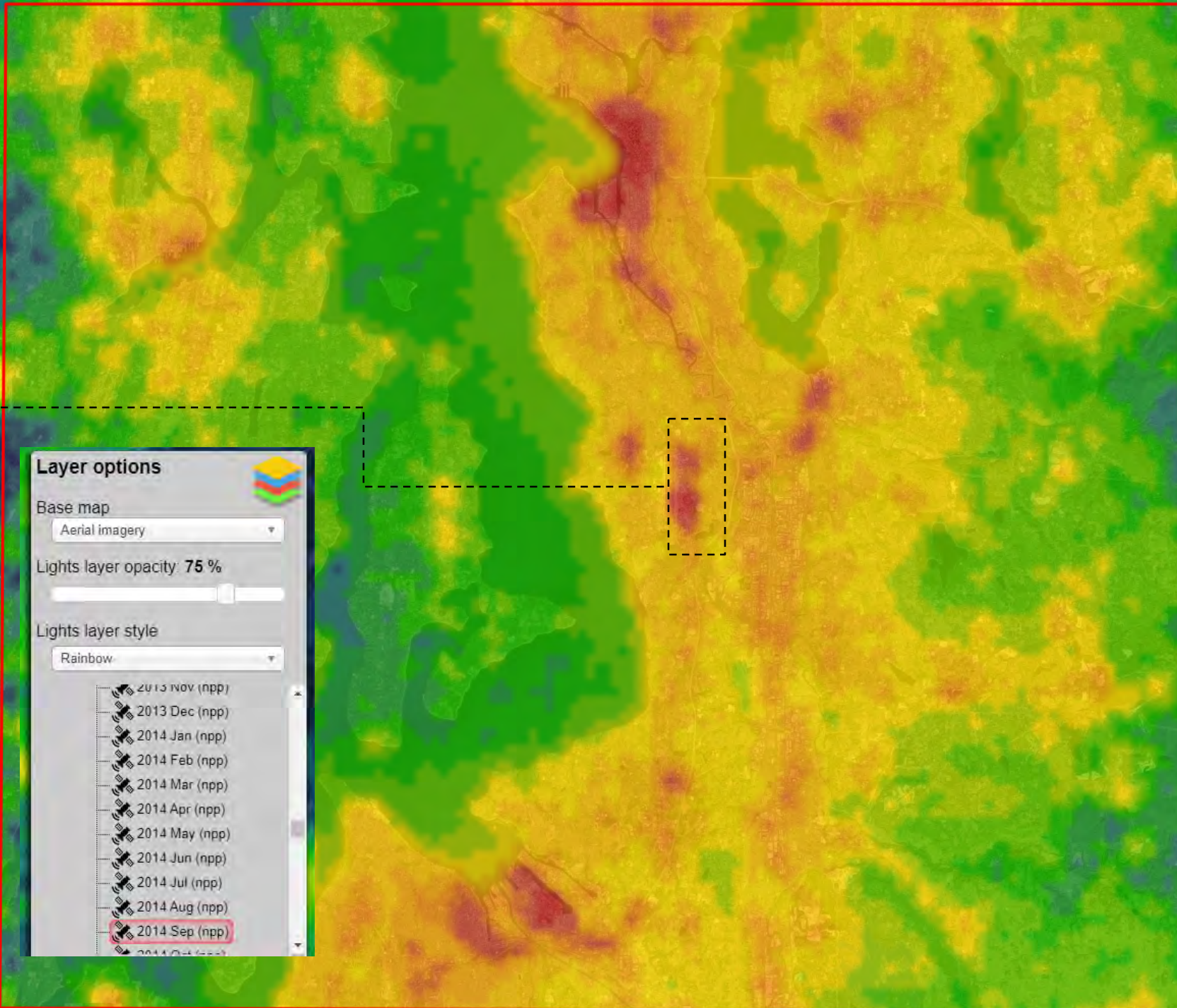
Sea-Tac
Airport



Satellite Analysis of Light Emissions

Area of Review
Communities

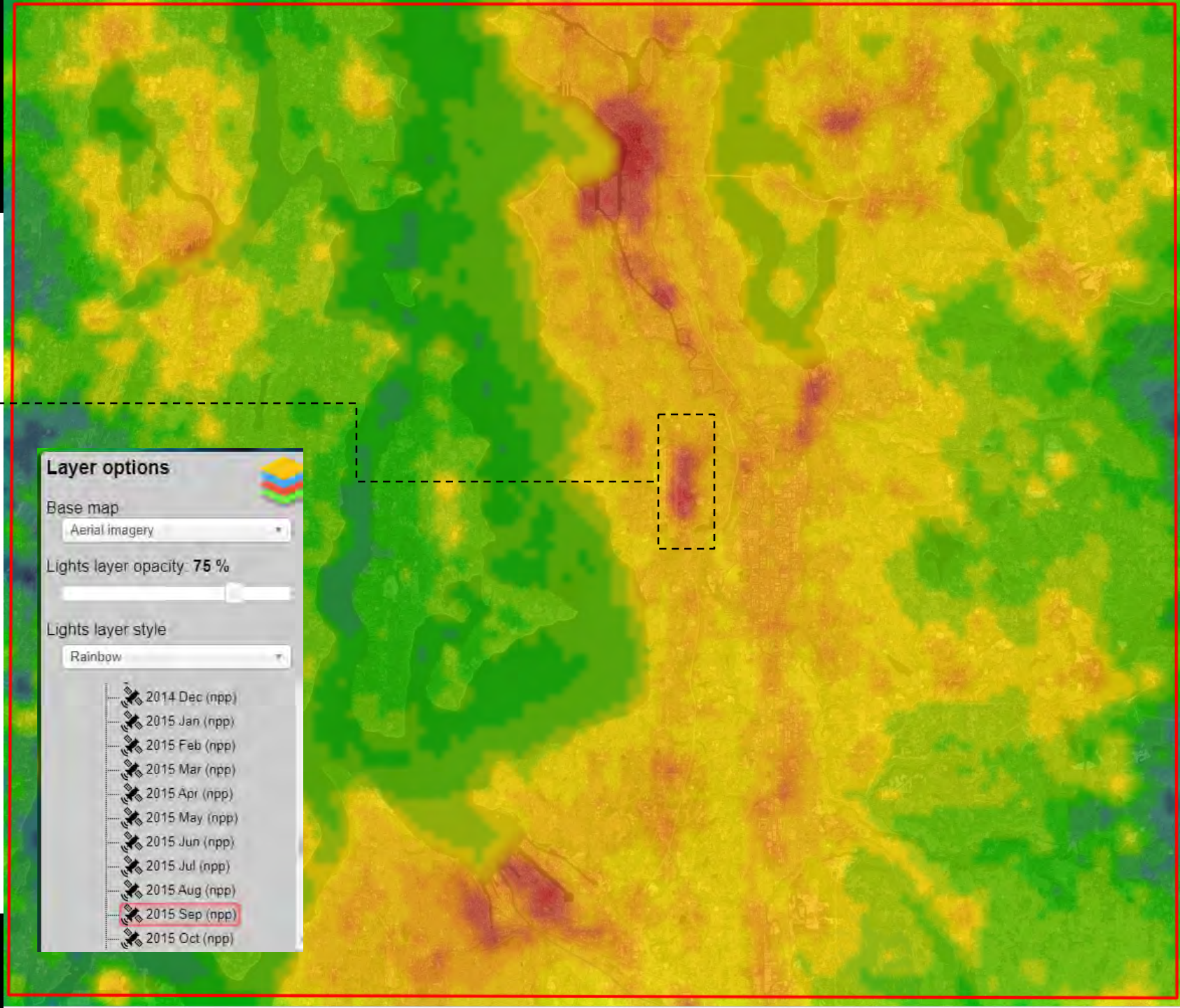
Sea-Tac
Airport



Satellite Analysis of Light Emissions

Area of Review
Communities

Sea-Tac
Airport



Satellite Analysis of Light Emissions

Area of Review
Communities

Sea-Tac
Airport

Layer options

Base map
Aerial imagery

Lights layer opacity: **75 %**

Lights layer style
Rainbow

- 2015 Dec (npp)
- 2016 Jan (npp)
- 2016 Feb (npp)
- 2016 Mar (npp)
- 2016 Apr (npp)
- 2016 May (npp)
- 2016 Jun (npp)
- 2016 Jul (npp)
- 2016 Aug (npp)
- 2016 Sep (npp)
- 2016 Oct (npp)
- 2016 Nov (npp)

Satellite Analysis of Light Emissions

Area of Review
Communities

Sea-Tac
Airport

Layer options

Base map
Aerial imagery

Lights layer opacity: 75 %

Lights layer style
Rainbow

- 2017 Jan (npp)
- 2017 Feb (npp)
- 2017 Mar (npp)
- 2017 Apr (npp)
- 2017 May (npp)
- 2017 Jun (npp)
- 2017 Jul (npp)
- 2017 Aug (npp)
- 2017 Sep (npp)
- 2017 Oct (npp)
- 2017 Nov (npp)

Satellite Analysis of Light Emissions

Area of Review
Communities

Sea-Tac
Airport

Layer options

Base map
Aerial imagery

Lights layer opacity: 75 %

Lights layer style
Rainbow

- 2018 Jan (npp)
- 2018 Feb (npp)
- 2018 Mar (npp)
- 2018 Apr (npp)
- 2018 May (npp)
- 2018 Jun (npp)
- 2018 Jul (npp)
- 2018 Aug (npp)
- 2018 Sep (npp)
- 2018 Oct (npp)
- 2018 Nov (npp)
- 2018 Dec (npp)

Satellite Analysis of Light Emissions

Area of Review
Sea-Tac Airport

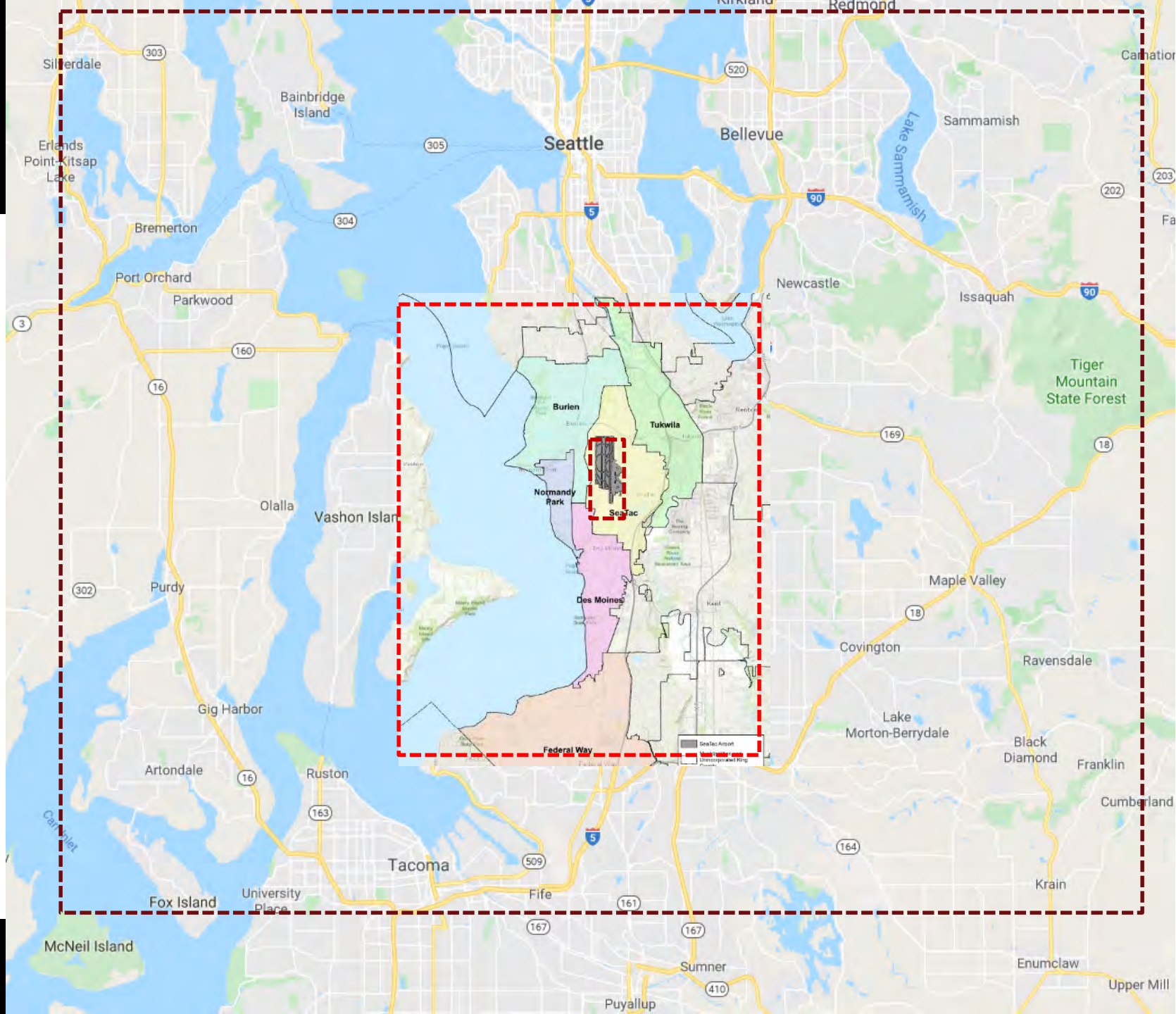
Δ : 1.30% Increase Per year

Area of Review
Communities

Δ : 0.51% Increase Per year

Area of Review
Central Puget Sound
Region

Δ : 0.31% Increase Per year



Satellite Analysis of Light Emissions

Area of Review
Sea-Tac Airport

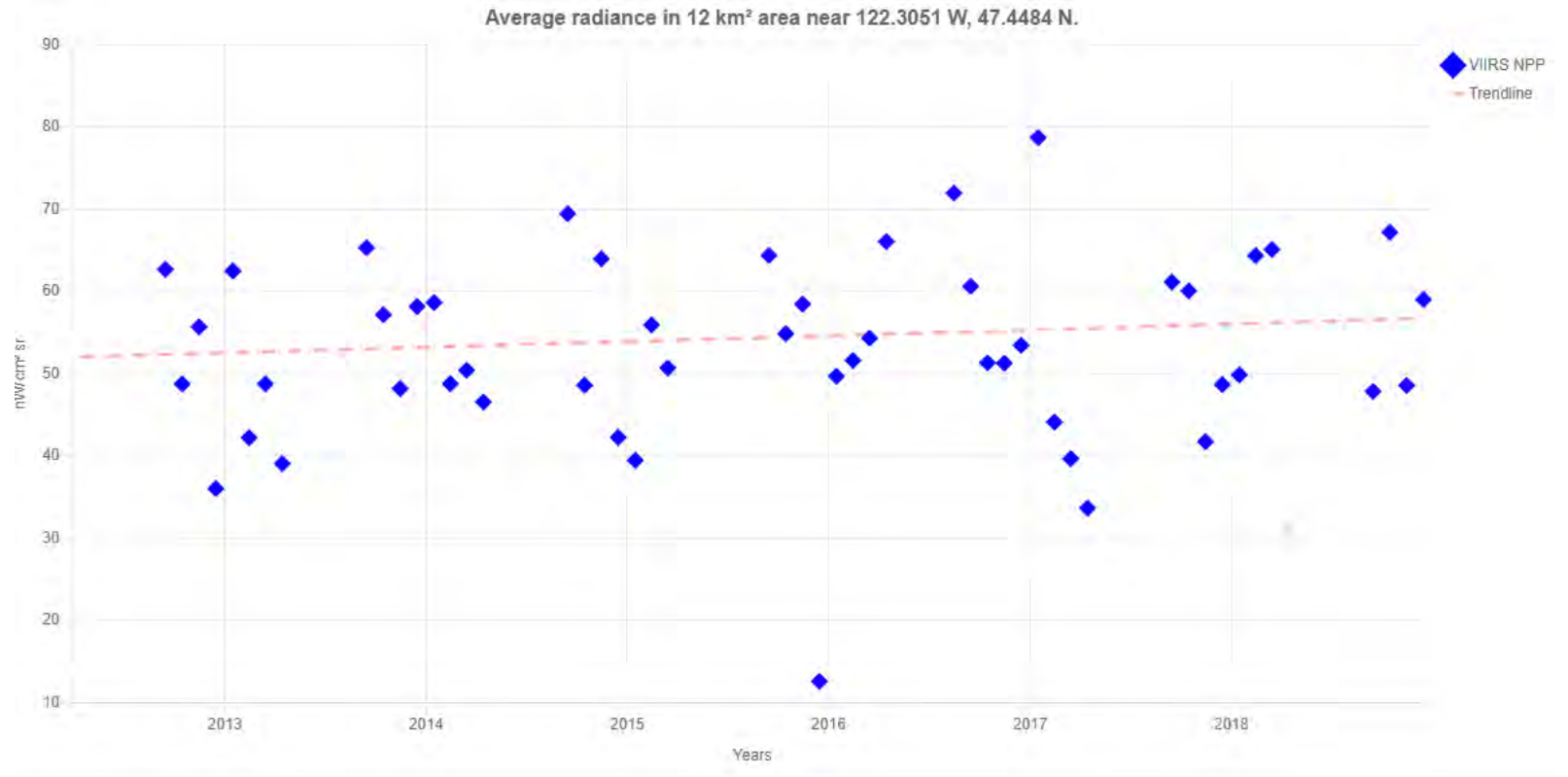
Δ : 1.30% Increase Per year

Area of Review
Communities

Δ : 0.51% Increase Per year

Area of Review
Central Puget Sound
Region

Δ : 0.31% Increase Per year



Satellite Analysis of Light Emissions

Area of Review
Sea-Tac Airport

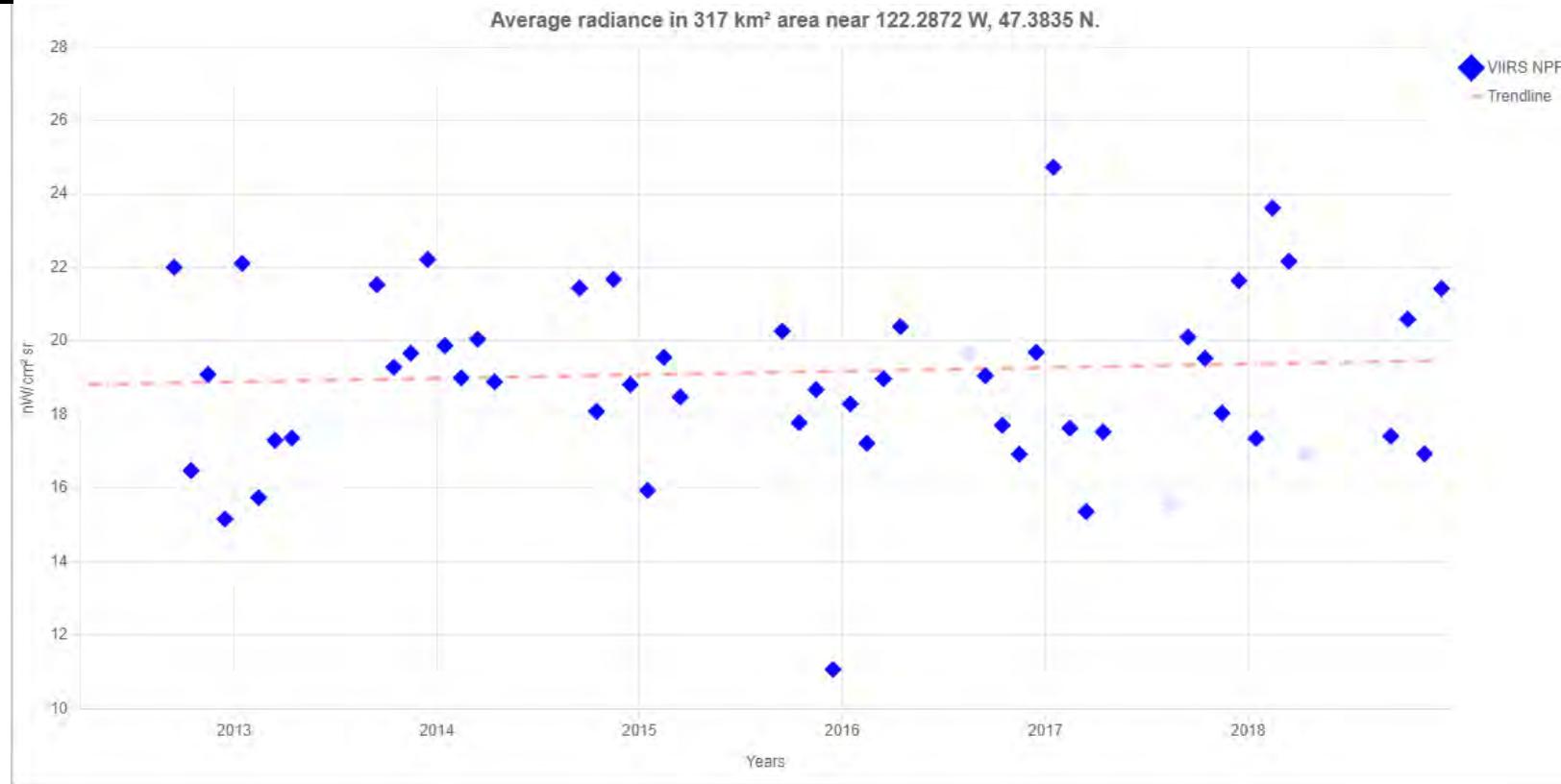
Δ : 1.30% Increase Per year

Area of Review
Communities

Δ : 0.51% Increase Per year

Area of Review
Central Puget Sound
Region

Δ : 0.31% Increase Per year



Satellite Analysis of Light Emissions

Area of Review
Sea-Tac Airport

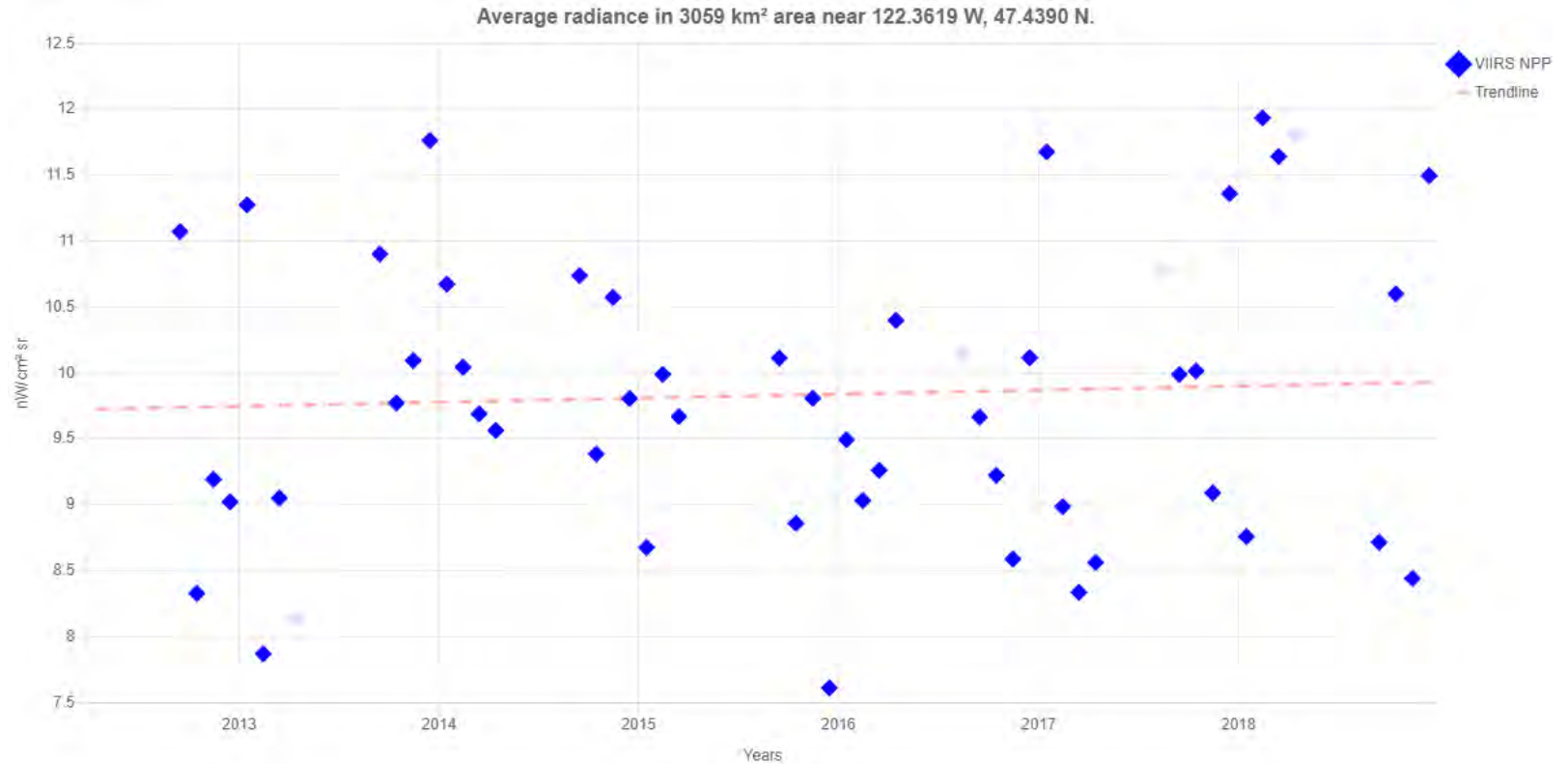
Δ : 1.30% Increase Per year

Area of Review
Communities

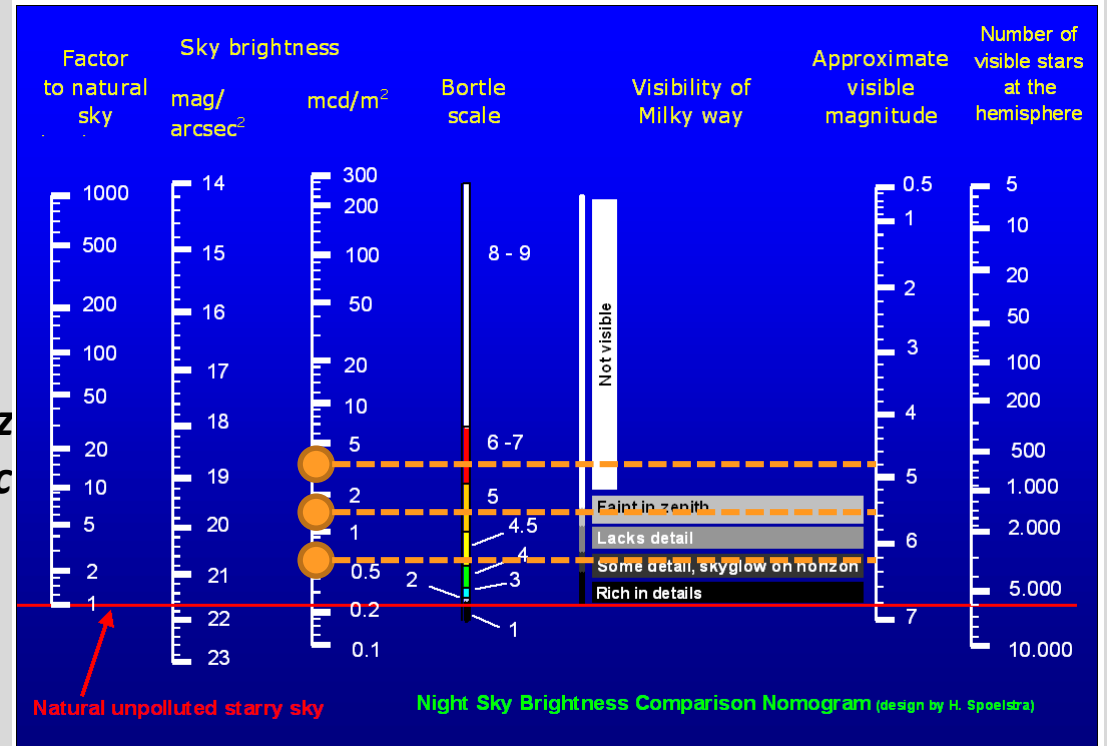
Δ : 0.51% Increase Per year

Area of Review
Central Puget Sound
Region

Δ : 0.31% Increase Per year



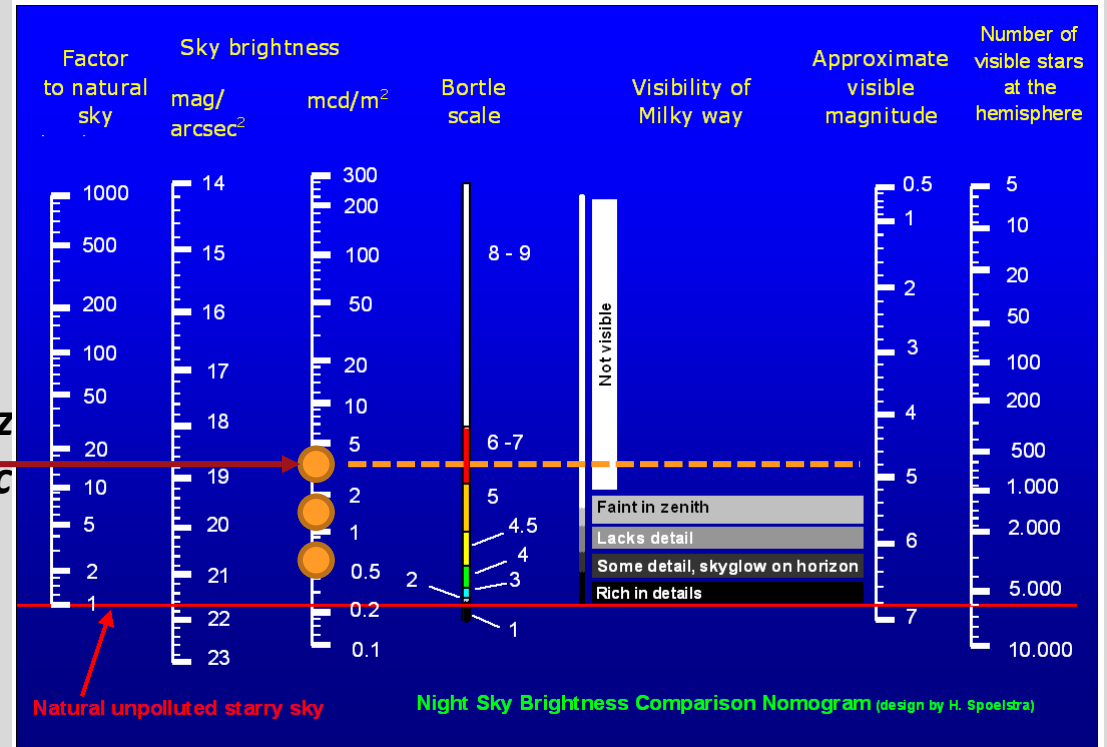
Satellite Analysis of Visible Light Emissions (Light Pollution)



Satellite Analysis of Visible Light Emissions (Light Pollution)



Sea-Tac Airport



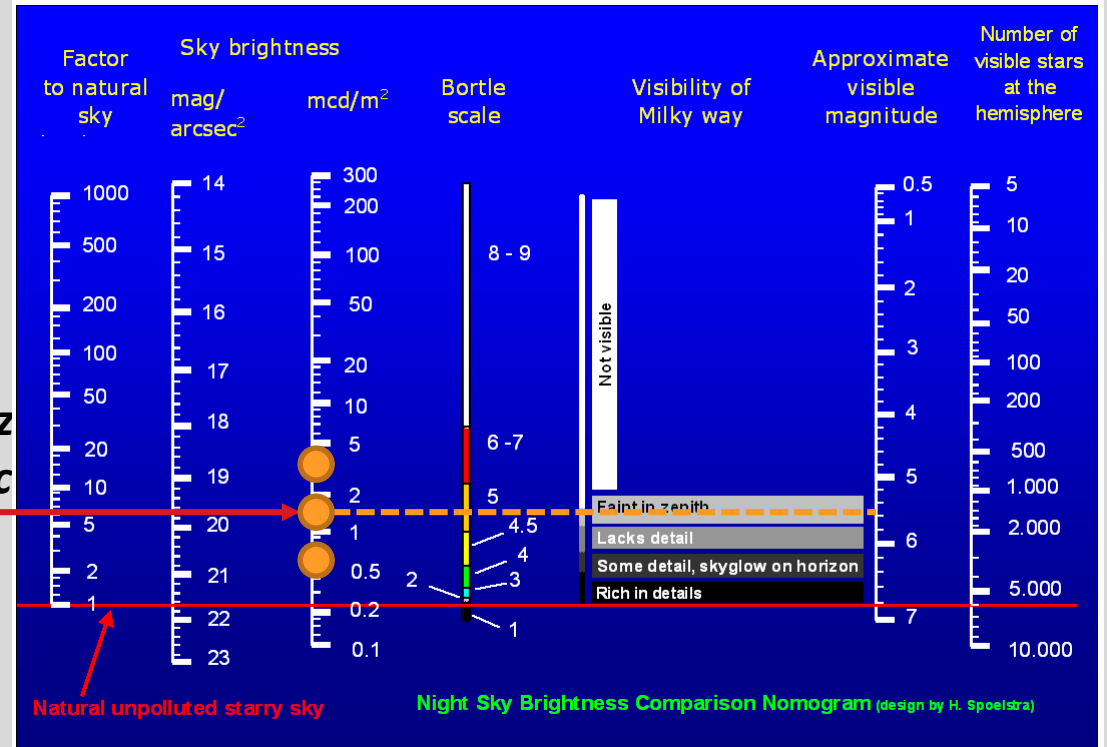
Natural unpolluted starry sky

Night Sky Brightness Comparison Nomogram (design by H. Spoelstra)

Satellite Analysis of Visible Light Emissions (Light Pollution)



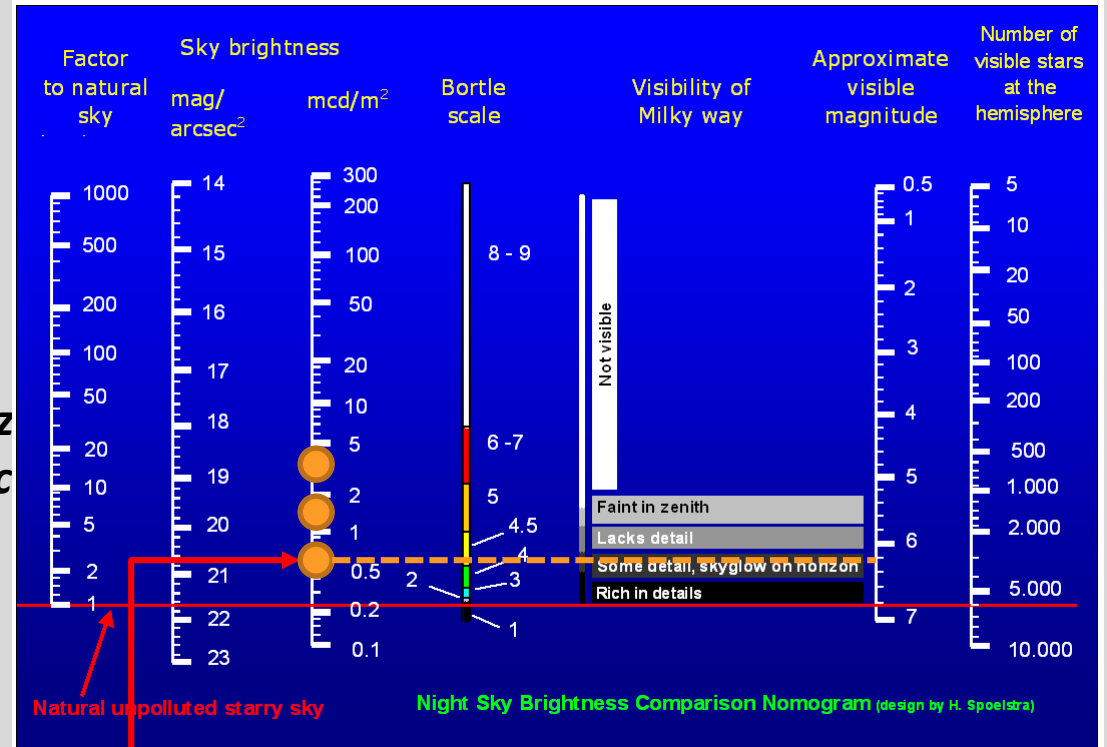
Surrounding communities



Natural unpolluted starry sky

Night Sky Brightness Comparison Nomogram (design by H. Spoelstra)

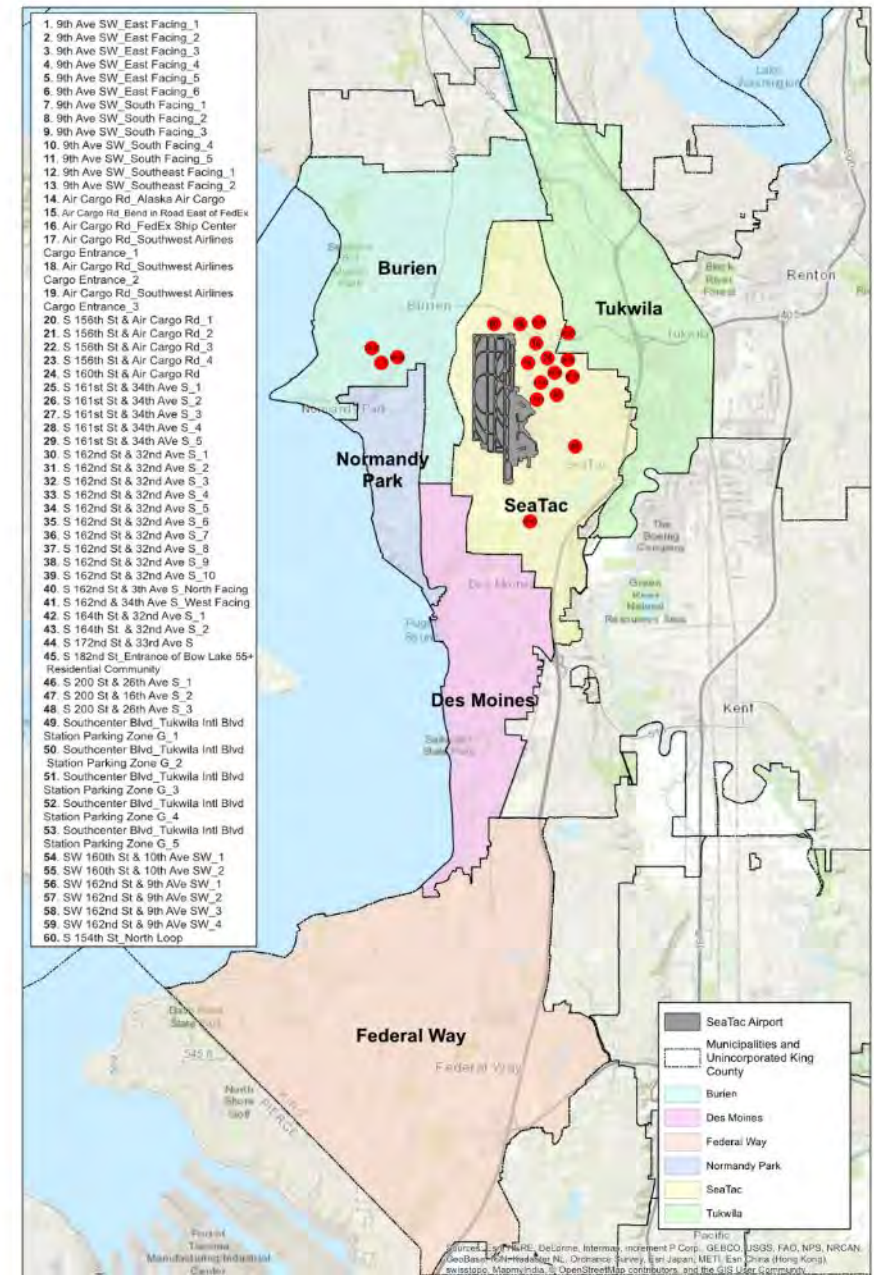
Satellite Analysis of Visible Light Emissions (Light Pollution)



Central Puget Sound Region

SURVEY OF NIGHTTIME ELECTRIC LIGHT CONDITIONS

ON SITE REVIEW OF NIGHTTIME CONDITIONS



SURVEY OF NIGHTTIME ELECTRIC LIGHT CONDITIONS



S 164th ST & 32th Ave S,
facing North



S 162th ST & 32th Ave S,
facing North



S 164th ST & 34th Ave S, facing Northwest

SURVEY OF NIGHTTIME ELECTRIC LIGHT CONDITIONS



SW 162nd ST & 9th Ave SW, Facing East



SW 162nd ST & 9th Ave SW, Facing East

SURVEY OF NIGHTTIME ELECTRIC LIGHT CONDITIONS

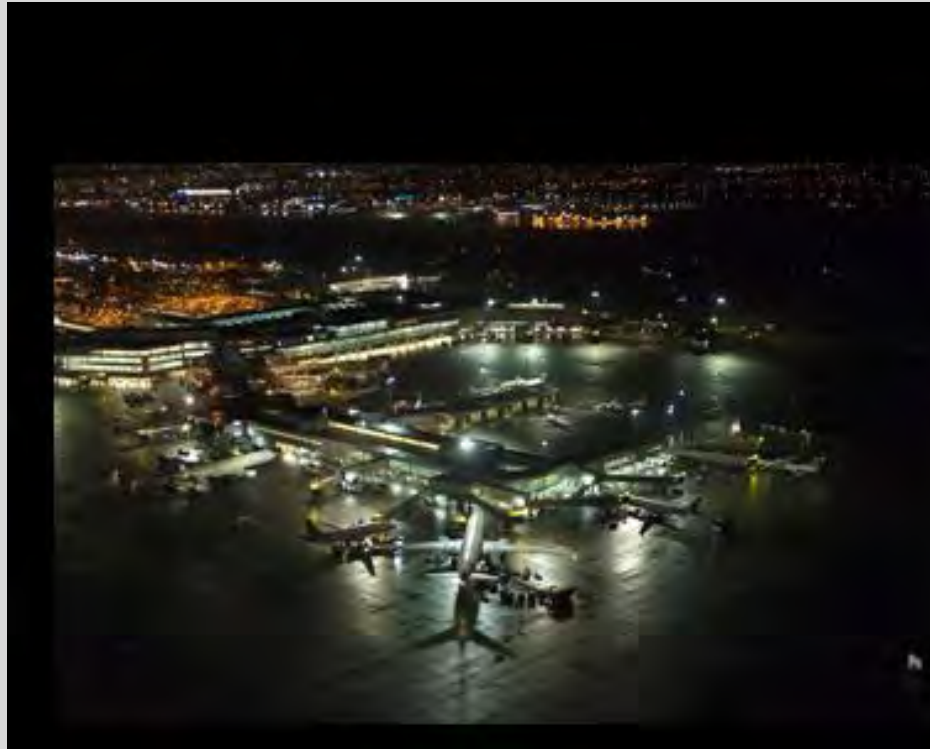
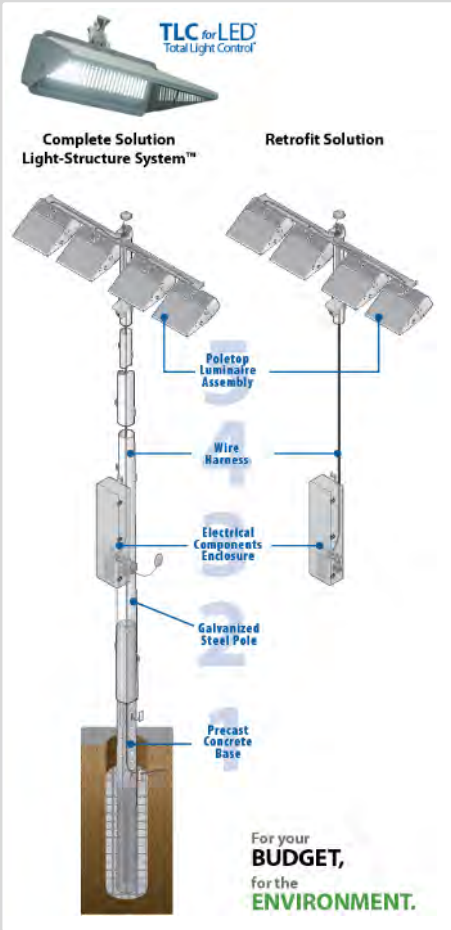


Airport Expressway



Air Cargo Road

UPDATES TO APRON LIGHTING



Metal Halide light sources - limited control of uplight and glare potential

Vancouver International Airport



LED sources - minimize uplight and glare potential

Analysis Metric:

SOCIO- ECONOMIC INDICATORS

Presenter:

Anne Ricker, Principal and
Managing Director



Socio- Economic Impacts

■ Social Impacts

- Public Safety
- Public Health

■ Demographic Impacts

- Education
- Employment
- Housing
- Income

■ Economic Impacts

- Property Performance (by type)
- Development Activity

- Cost of Development
- Business Concentrations
- Policy Direction and Support
- Financial Climate

■ Fiscal Impacts

- Municipal Revenue by Source
- Land Use Mix
- Cost of Services
- Incentive Offerings
- Capacity for Growth

Public Safety: Violent Crime Index

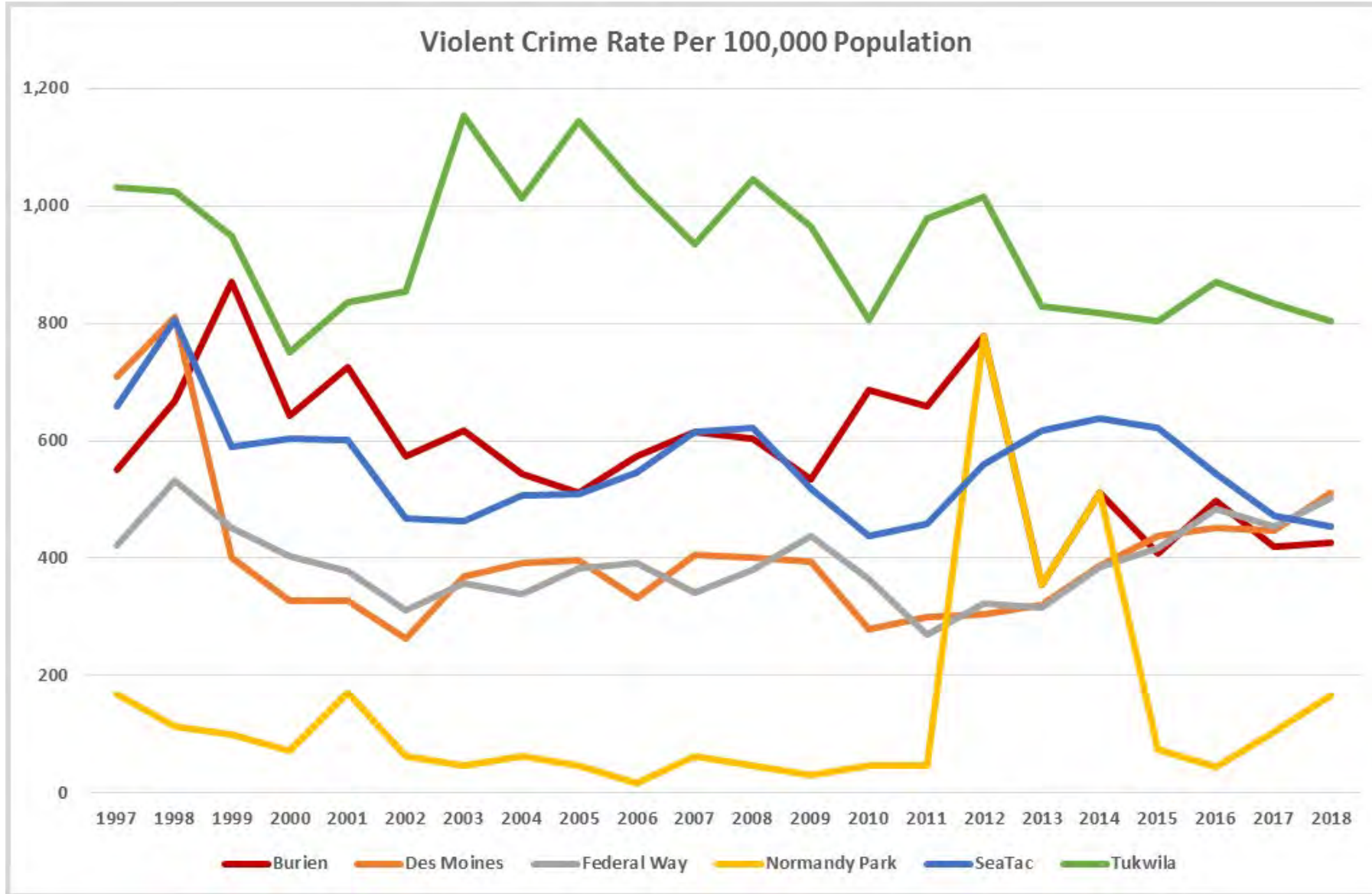
1997 - 2018

1,200

Violent Crime Rate Per 100,000 Population

600

0



Tukwila

Federal Way

Des Moines

SeaTac

Burien

Normandy Park

Burien Des Moines Federal Way Normandy Park SeaTac Tukwila

Public Safety: Property Crime Index

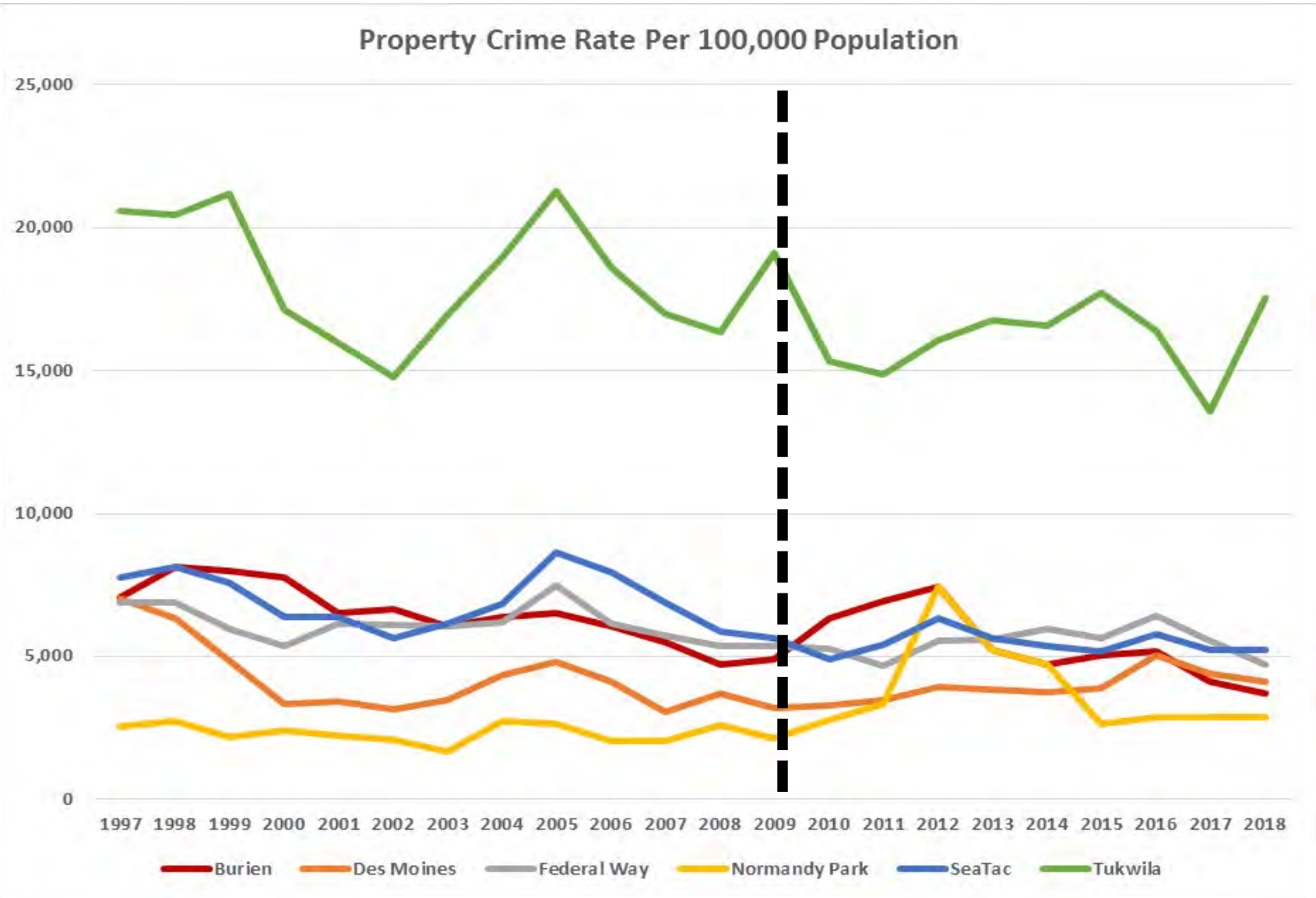
1997 - 2018

25,000

15,000

0

Property Crime Rate Per 100,000 Population



Tukwila

SeaTac

Federal Way

Des Moines

Burien

Normandy Park

Public Safety: Motor Vehicle Theft Index

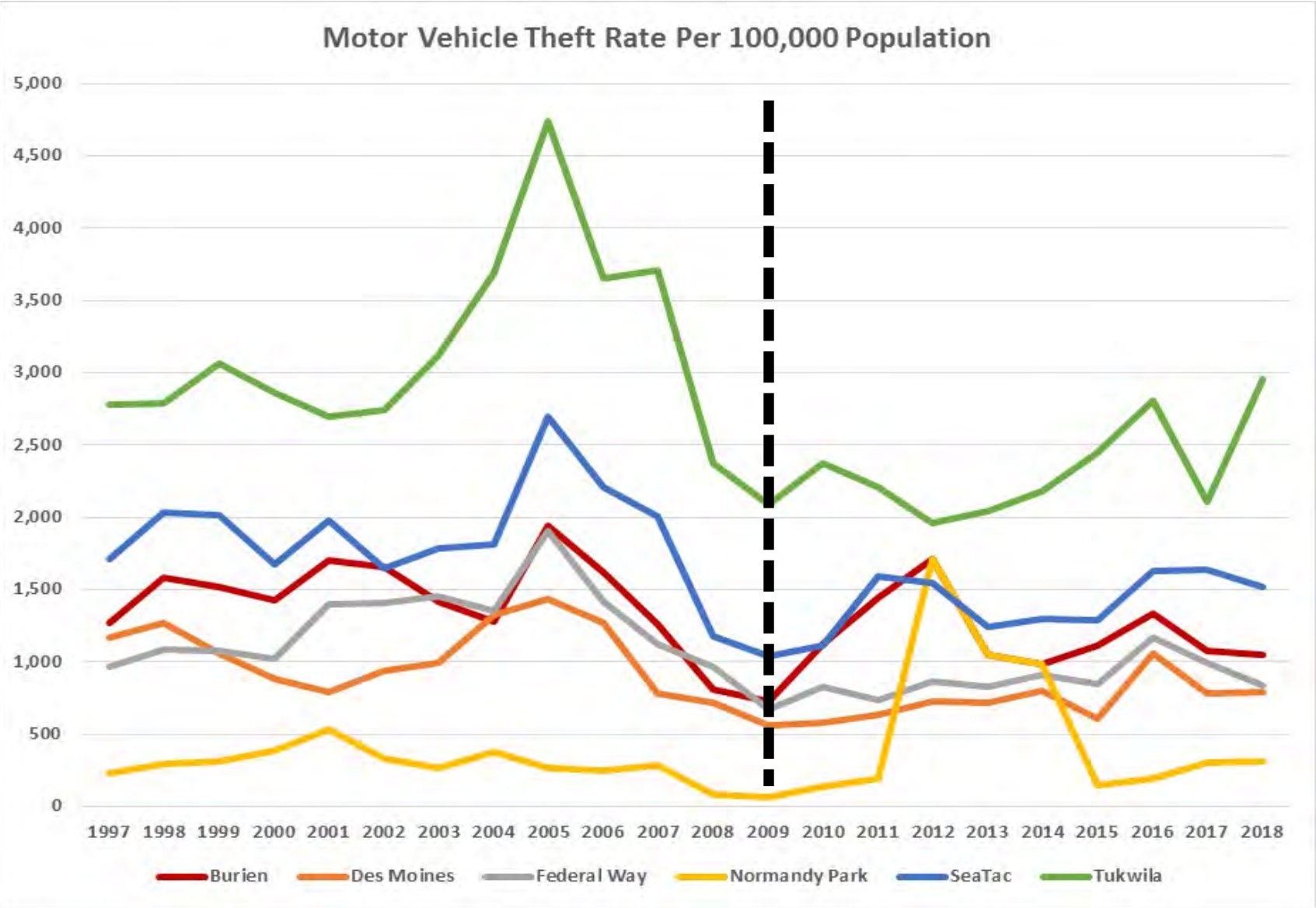
1997 - 2018

5,000

2,500

0

Motor Vehicle Theft Rate Per 100,000 Population



Tukwila

SeaTac

Burien

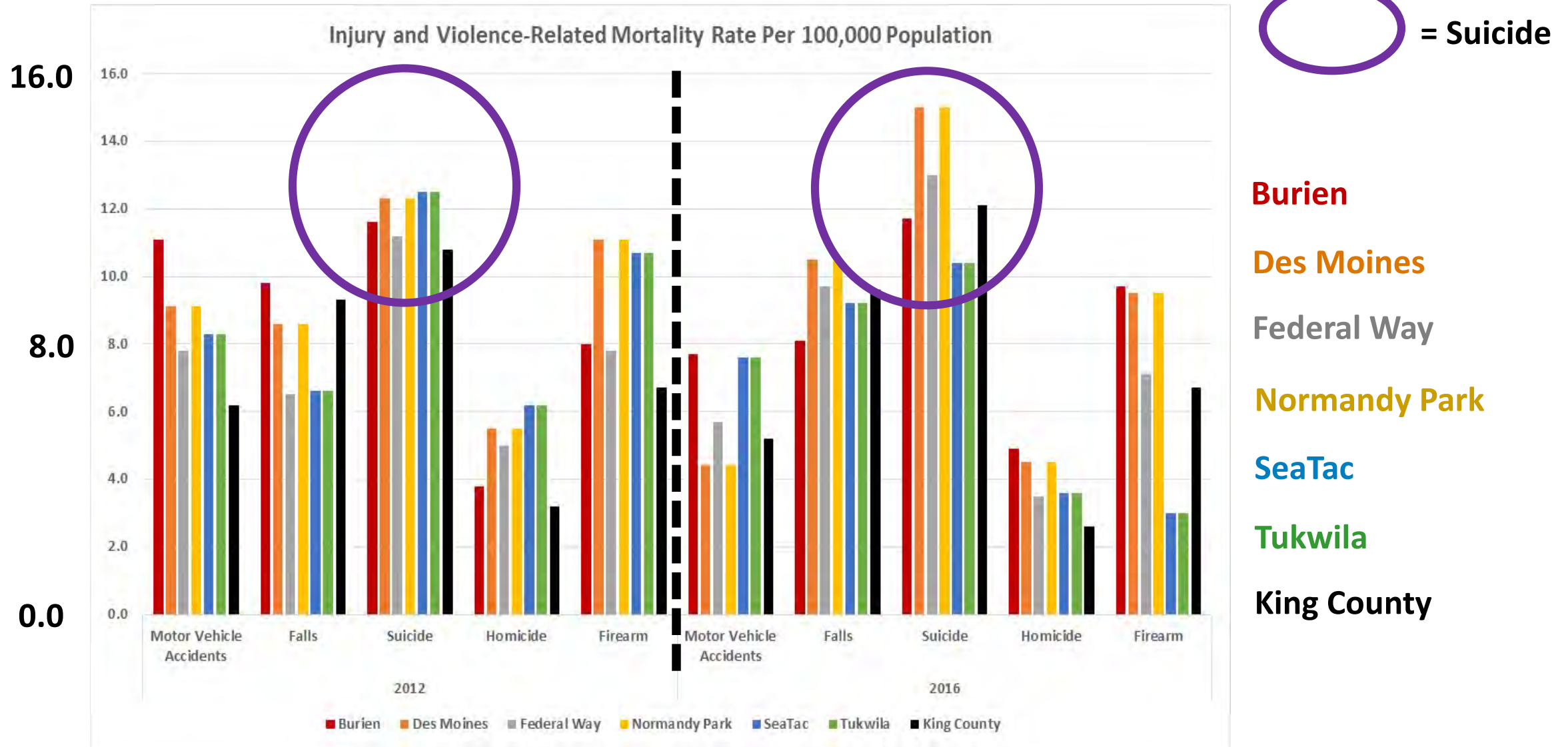
Federal Way

Des Moines

Normandy Park

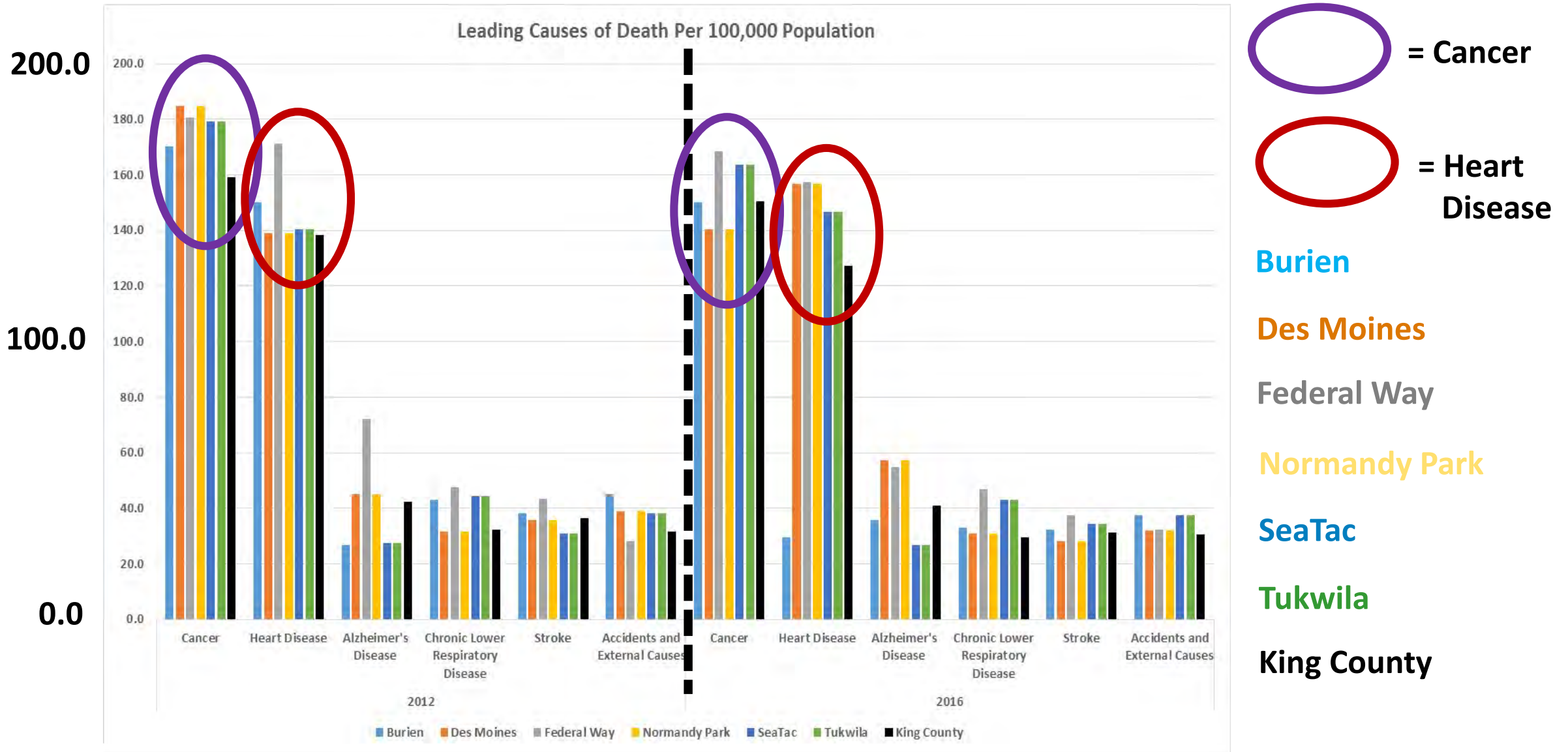
Public Safety: Injury and Violence-Related Mortality

2012 & 2016



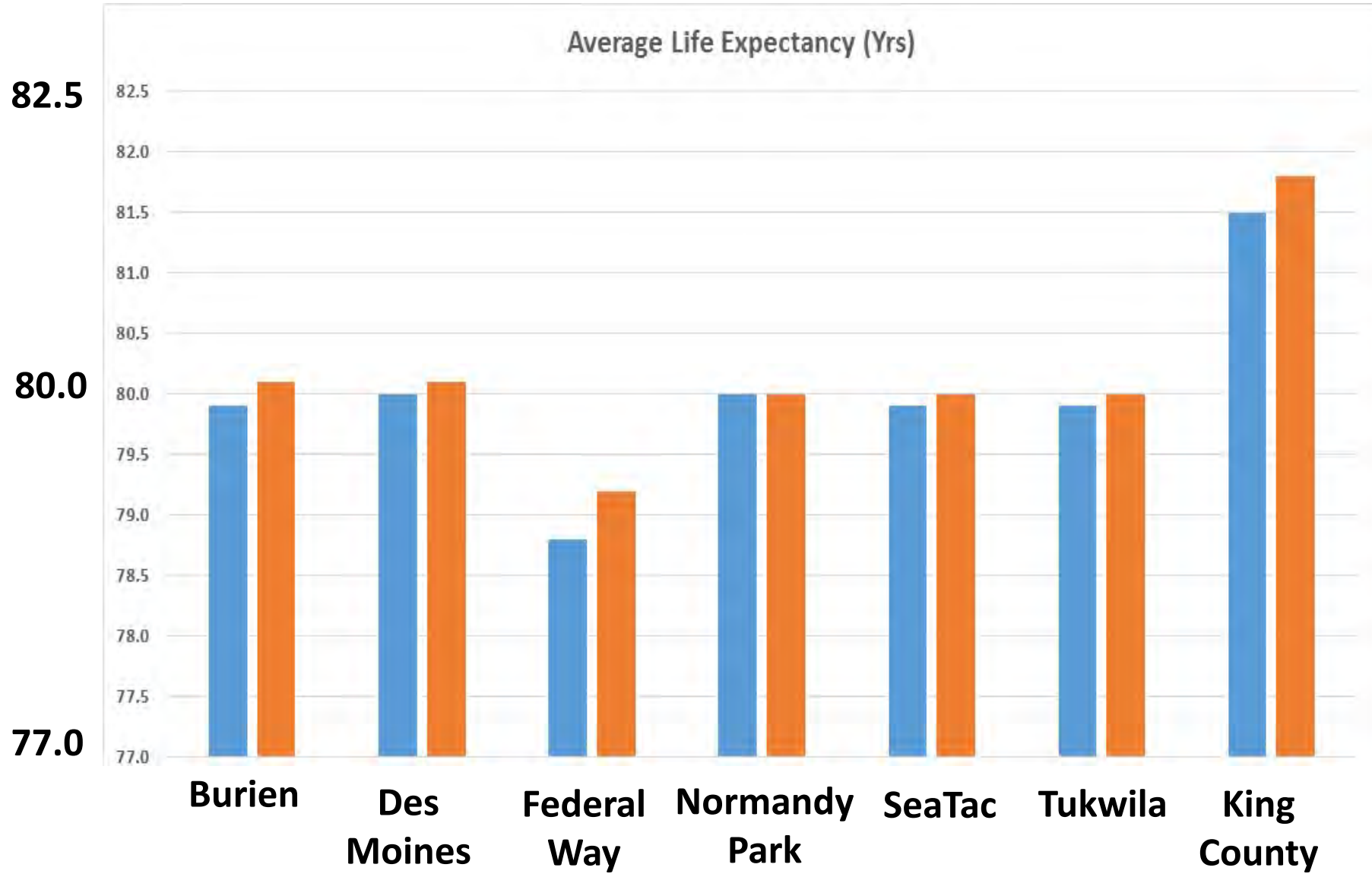
Public Health: Leading Causes of Death by Illness



2012 & 2016



Public Health: Average Life Expectancy (years)

2012 & 2016

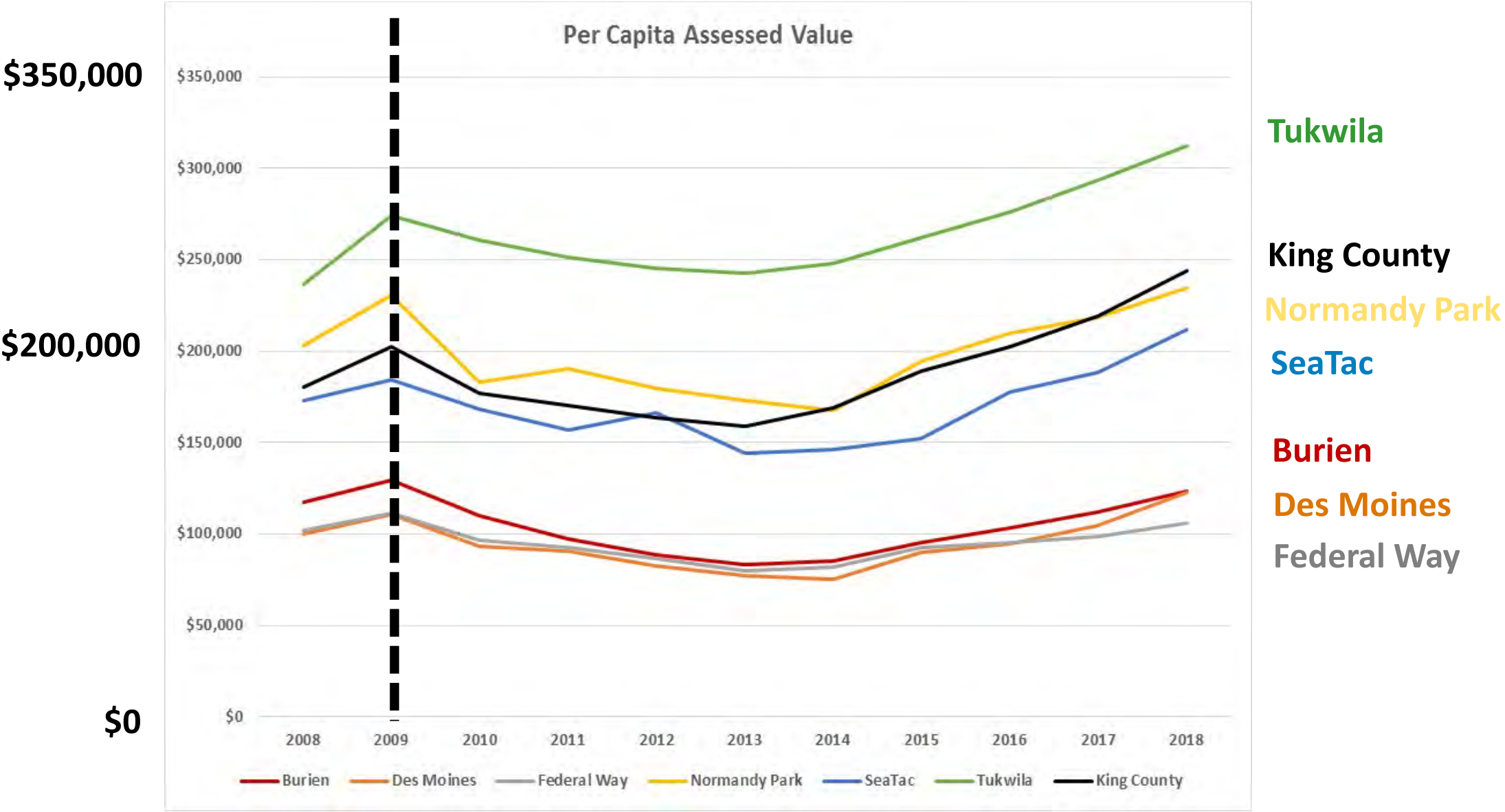


 = 2012
 = 2016

City	2012	2016
Burien	37.5	37.5
Des Moines	37.3	41.2
Federal Way	34.9	35.9
Normandy Park	48.4	49.8
SeaTac	35.2	34.3
Tukwila	32.7	34.1
King County	37.1	37.2

Property Performance: Per Capita Assessed Value

2008 - 2018



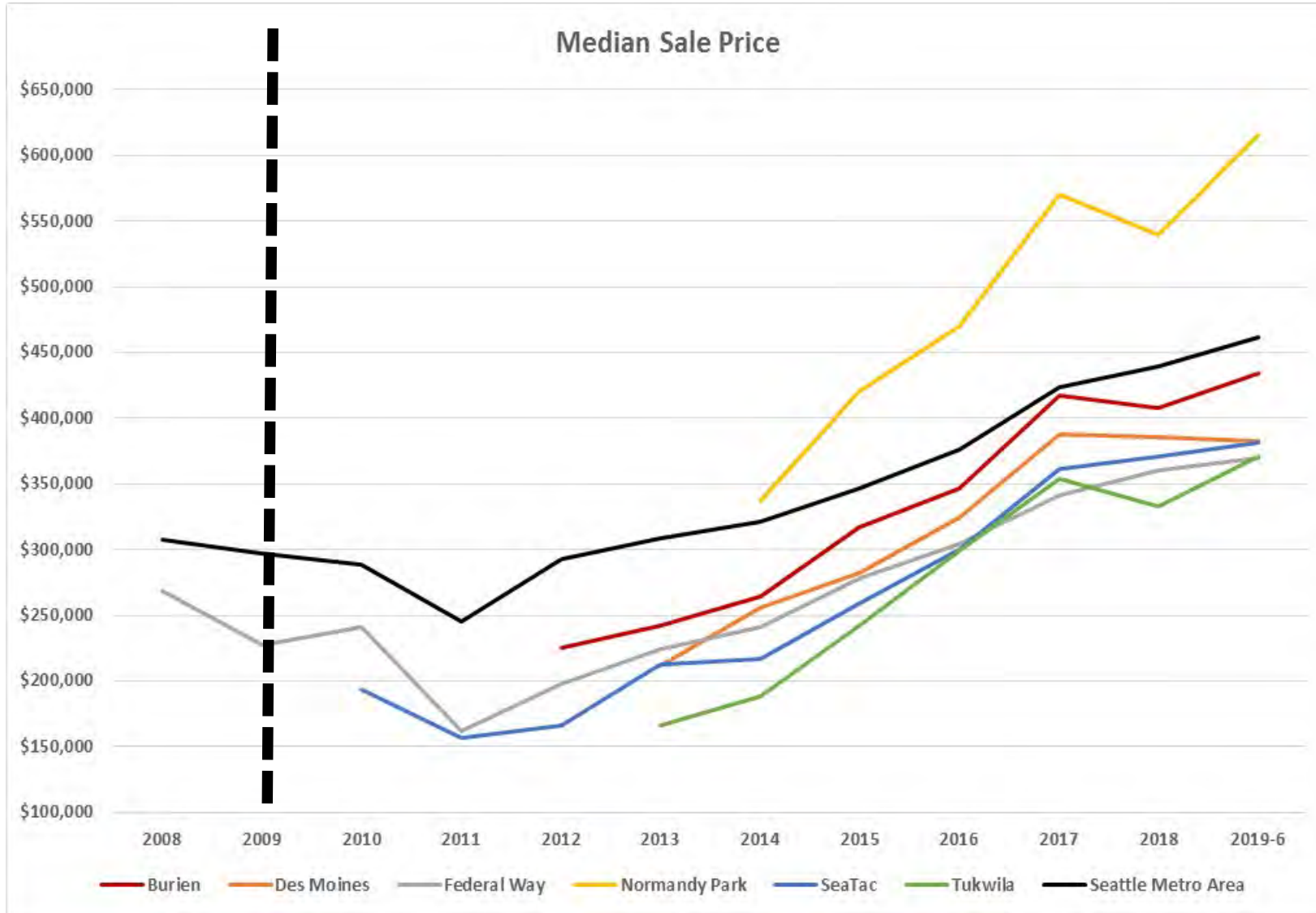
Property Performance: Median Home Price

2008 - 2018

\$650,000

\$400,000

\$100,000



Normandy Park
\$539,100 (2018)

Seattle MSA

Burien

Des Moines

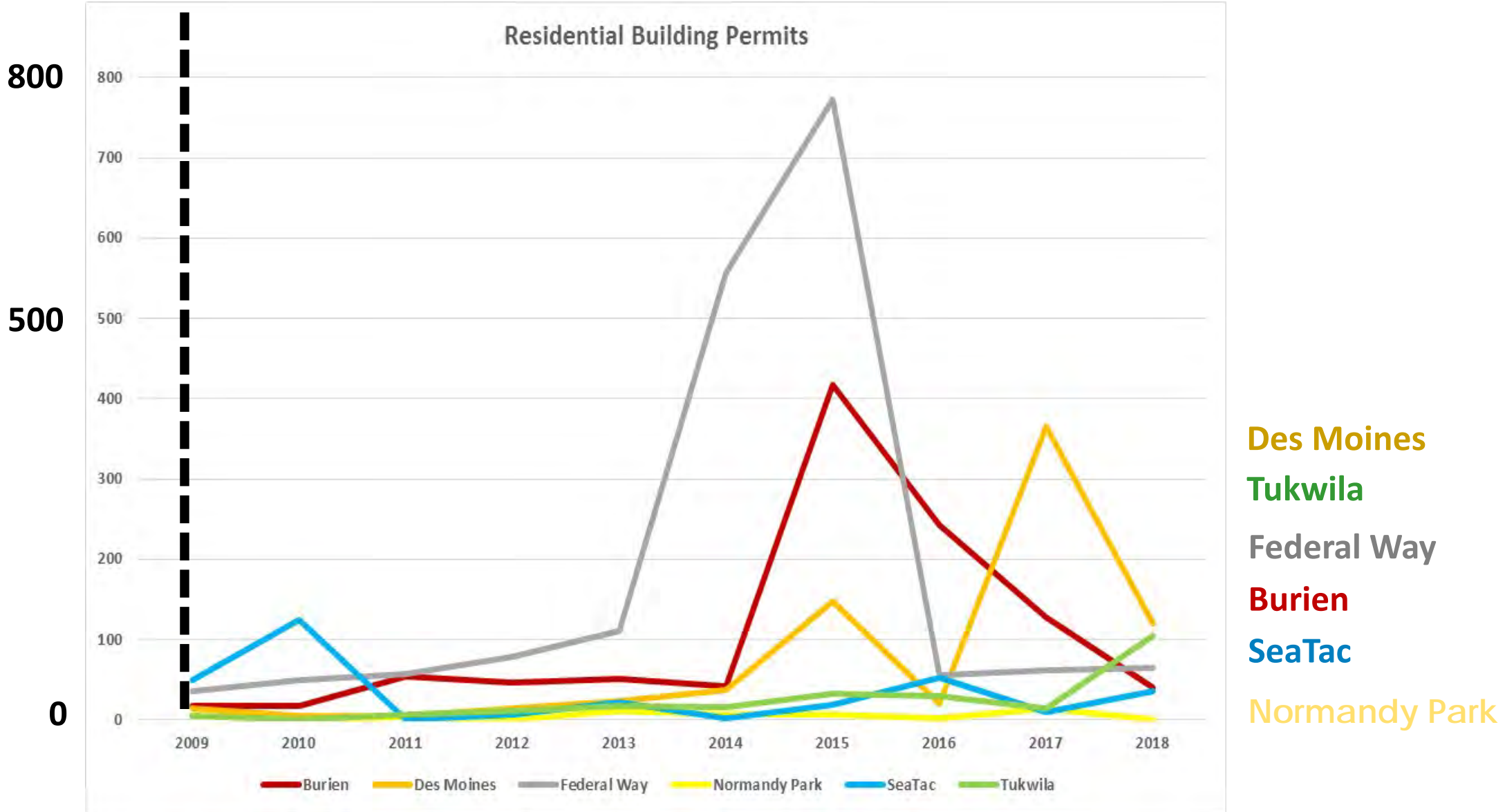
SeaTac

Federal Way

Tukwila

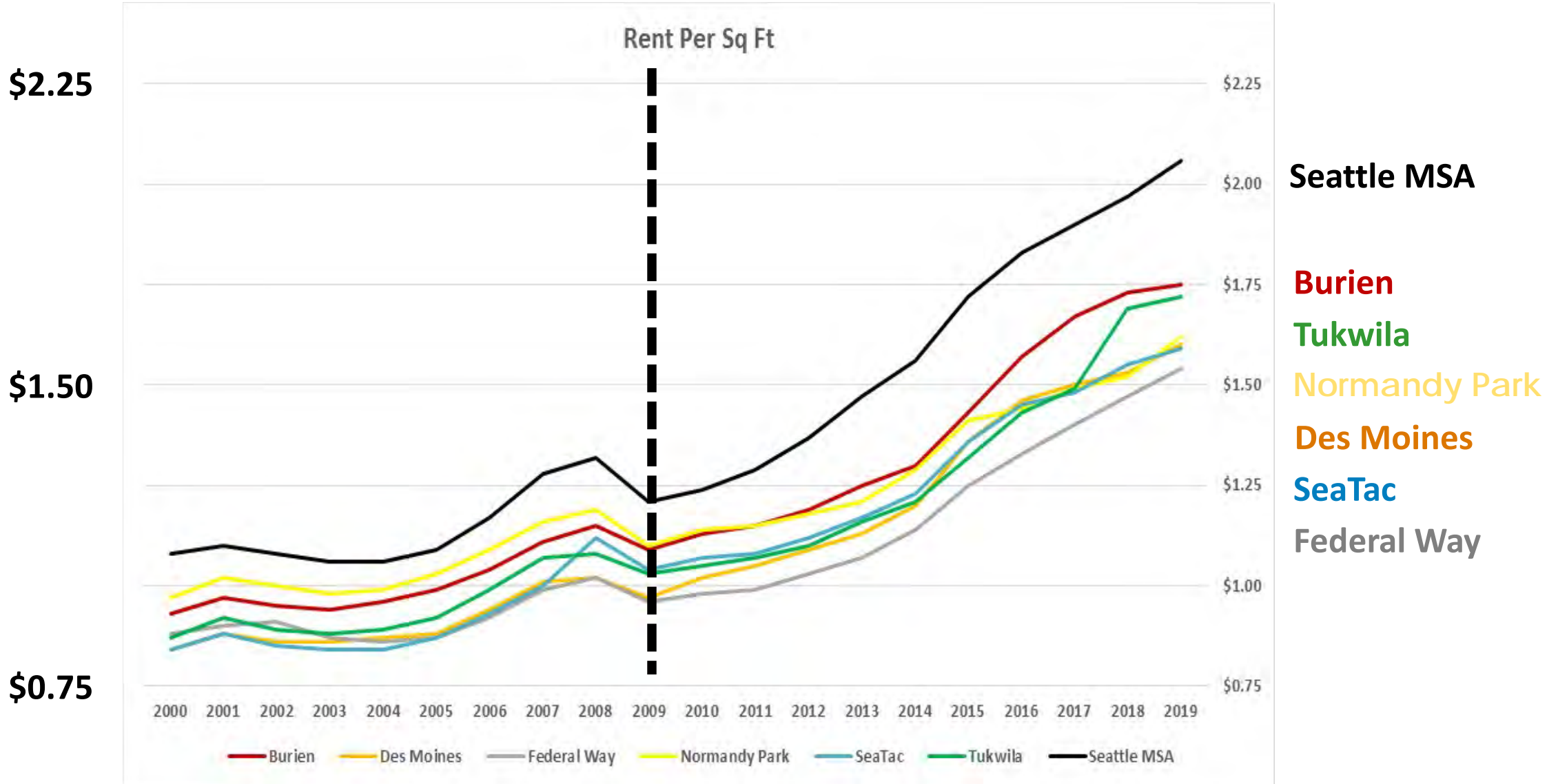
Property Performance: Residential Building Permits

2009 - 2018



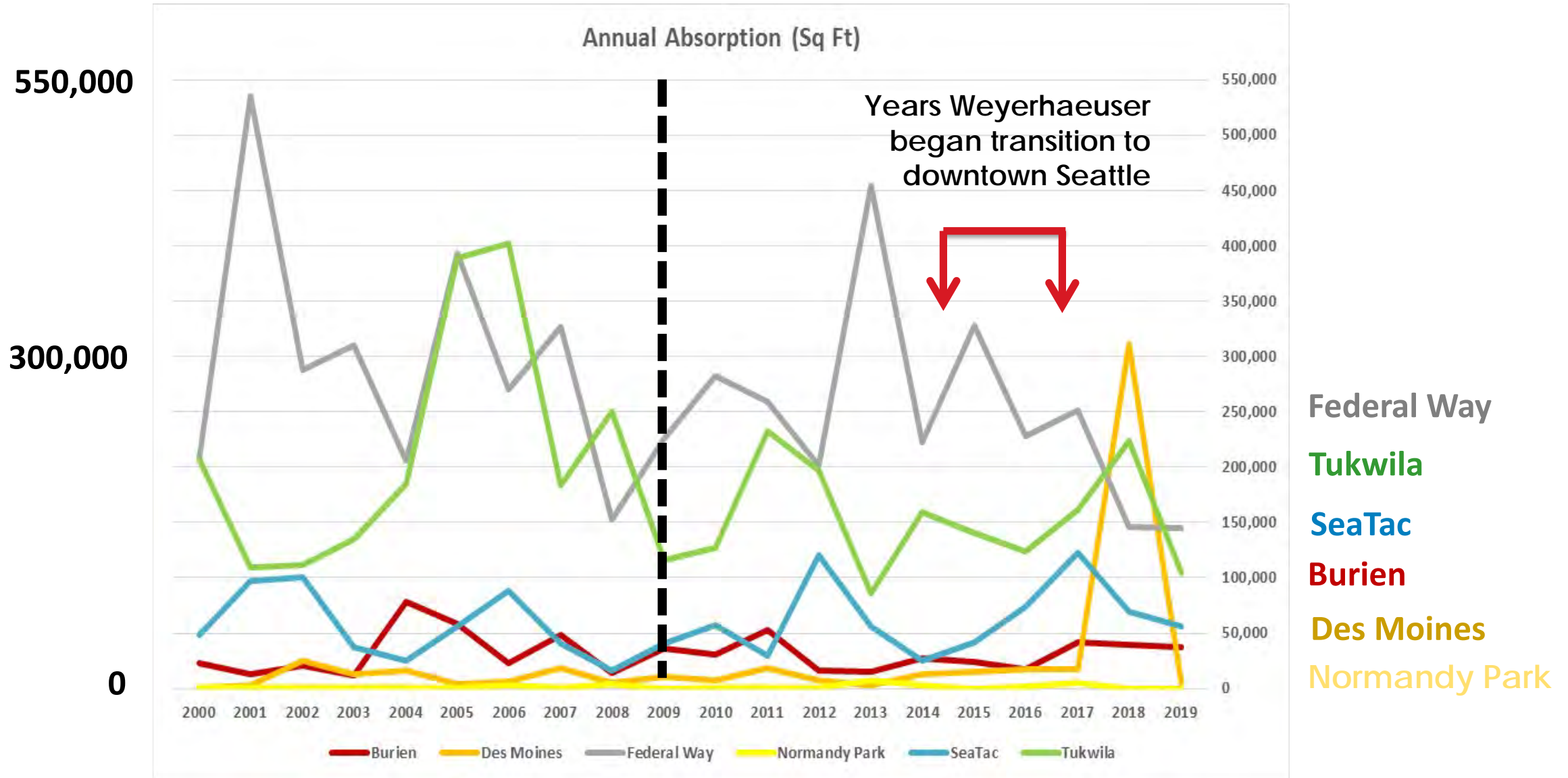
Property Performance: Multifamily Rents

2000 - 2019



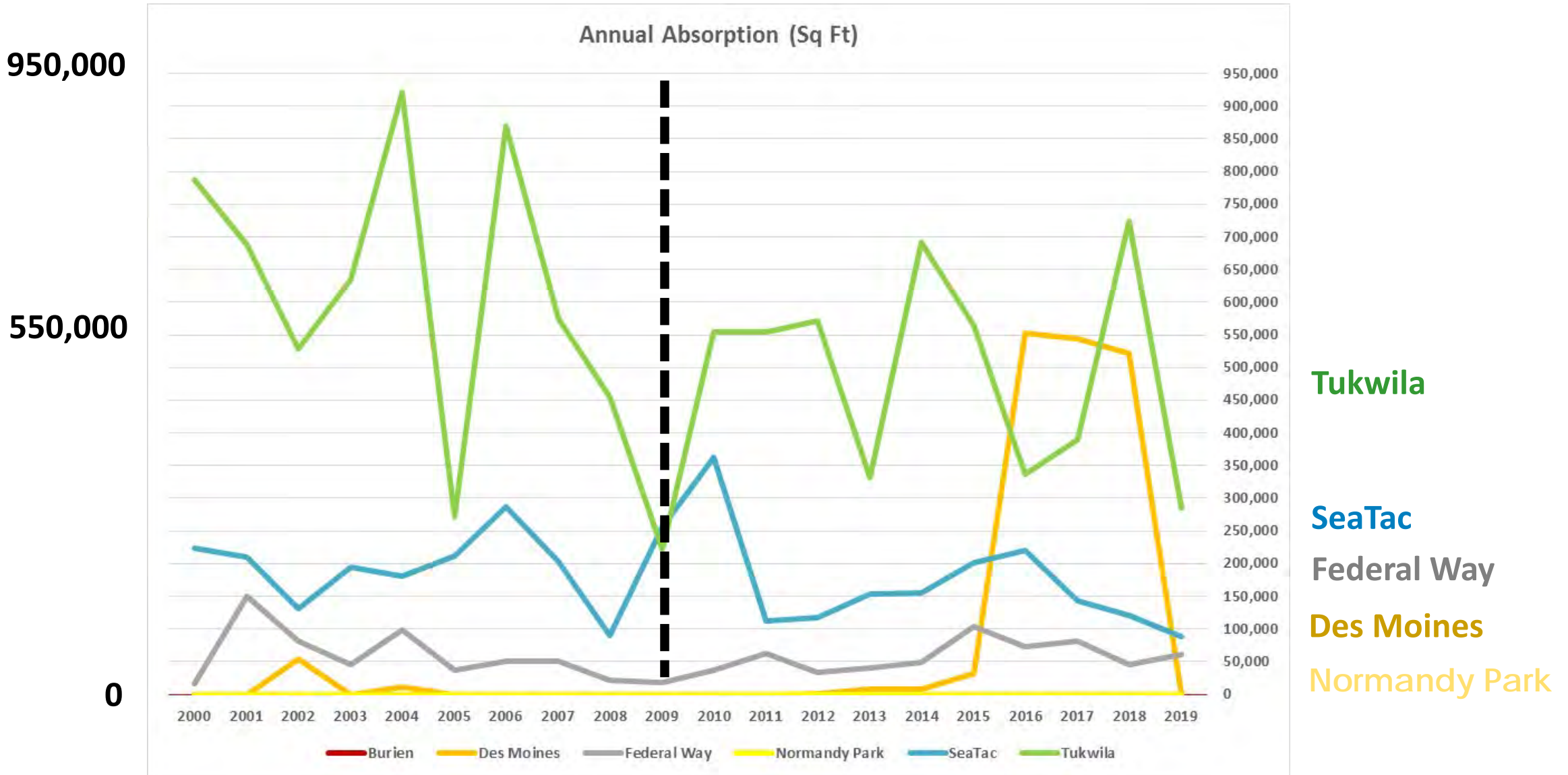
Development Activity: Office Absorption

2000 - 2019



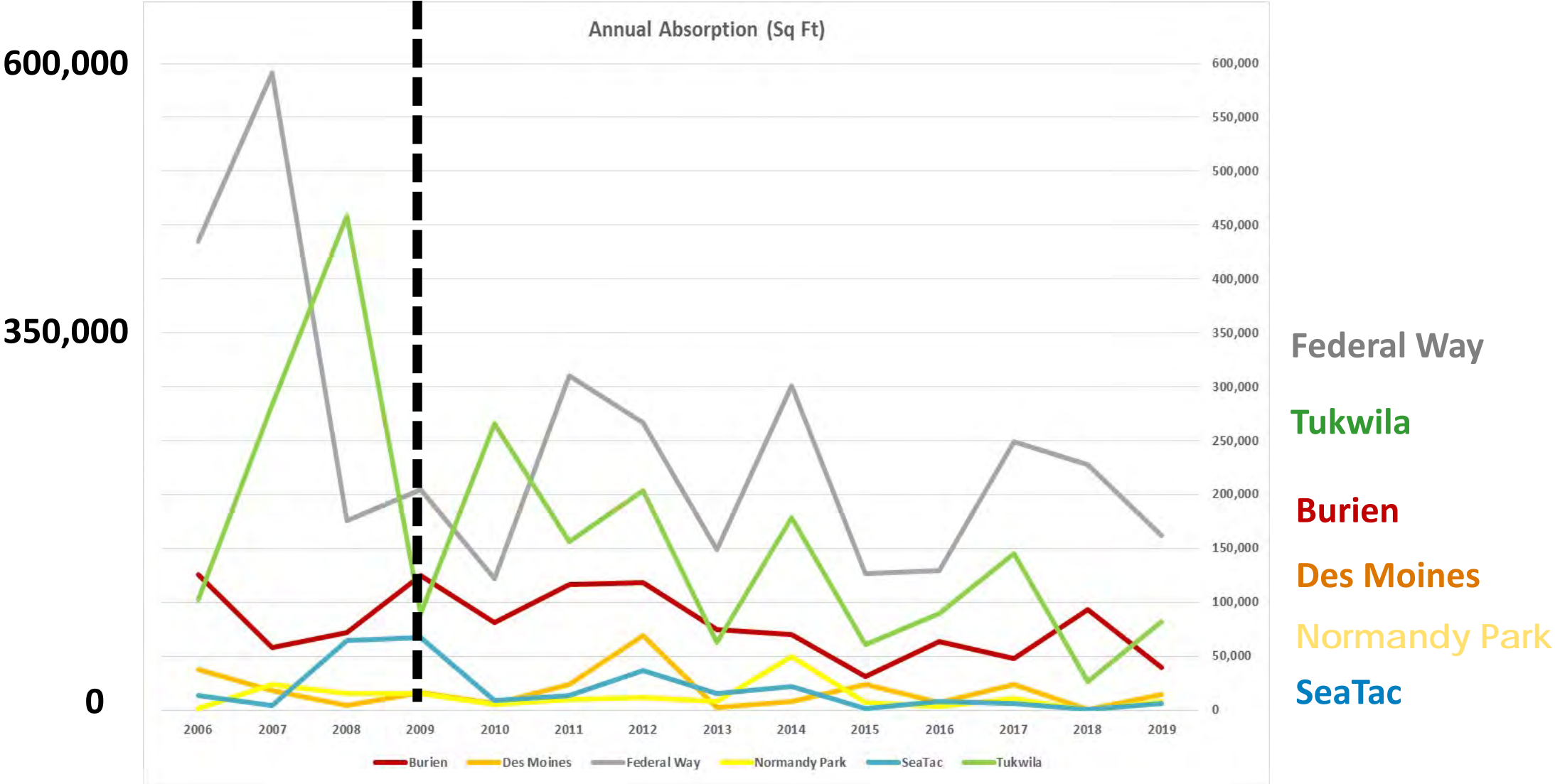
Development Activity: Industrial Absorption

2000 - 2019



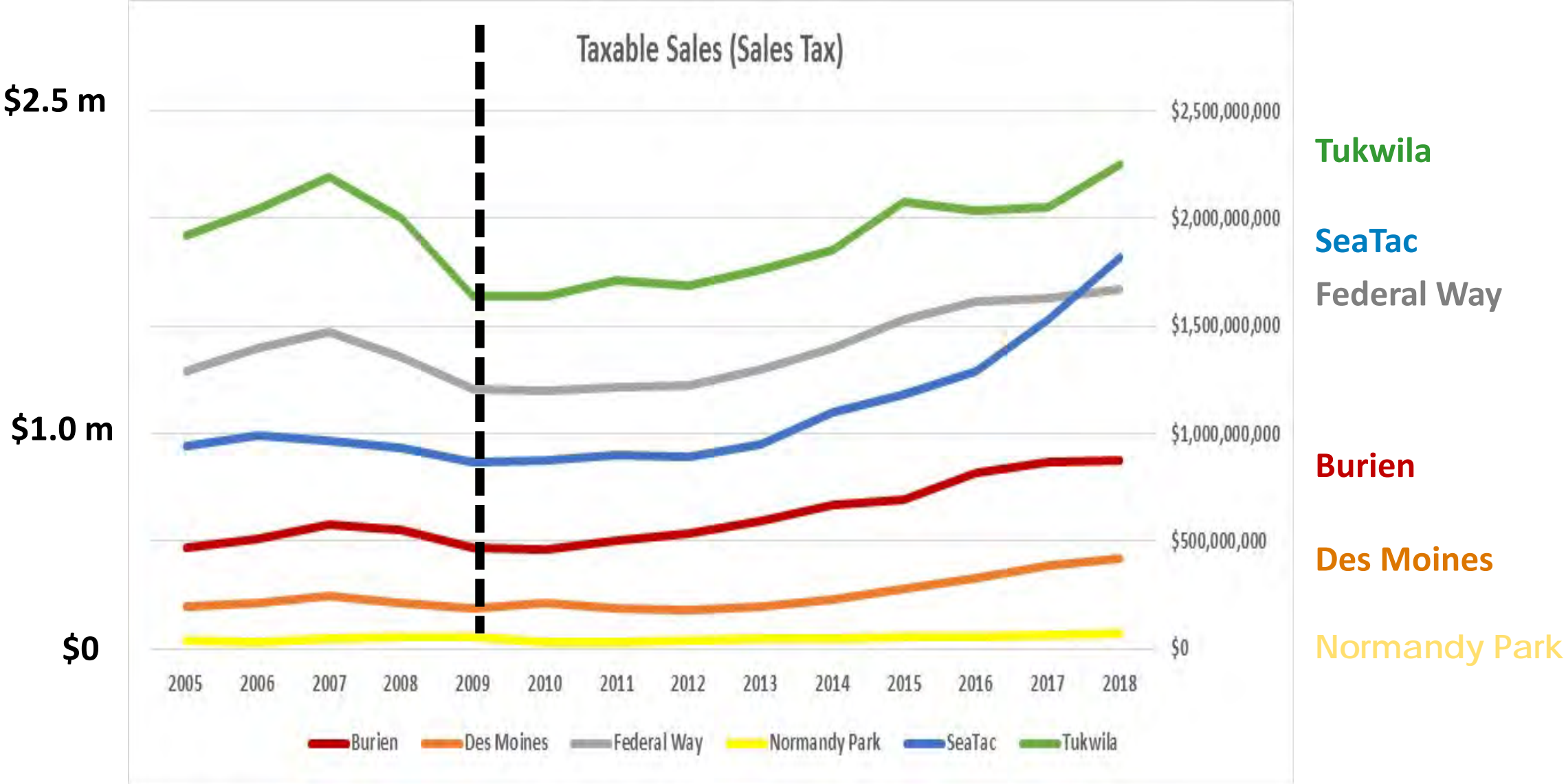
Development Activity: Retail Absorption

2006 - 2019



Fiscal Impact : Taxable Sales

2005 - 2018



Next Steps

- Fill in missing data for relevant years or timeframes
- Identify timeframe for significant airport activities
- Cross-reference information with other indicator categories
- Isolate airport-specific impacts
- Determine indicators that warrant mapping | visual representation