Virginia Tech Transportation Institute

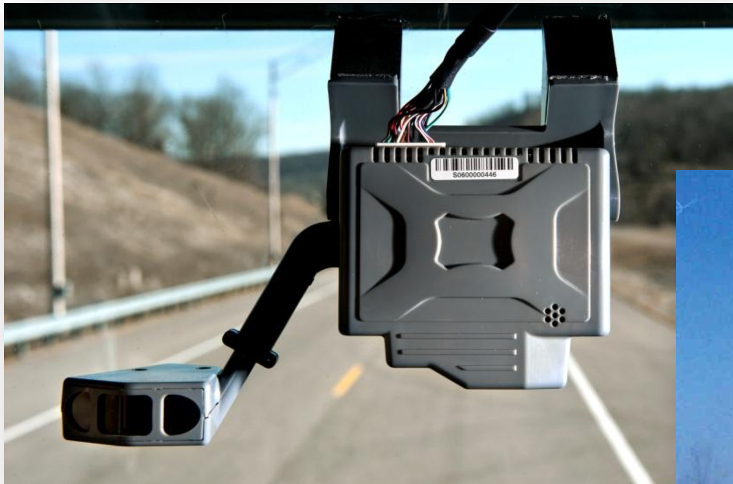
Background

- VTTI was established in August 1988 by agreement between US DOT and the University Transportation Centers Program
- We focus on Safety and Efficiency in the entire transportation Infrastructure
- Largest university-level research center at Virginia Tech
  - Approximately 400 faculty, staff and students working on over 200 projects
  - $80 Million Awarded
  - $40 Million in Annual Expenditures
  - Largest supporter of both undergraduate and graduate students

Center for Infrastructure Based Safety Systems (CIBSS)

- Specializes in research dealing with safety issues involving the built transportation environment
- Including roadway and vehicle lighting, delineation, signage, roadway geometry, other transportation structures

Unique Capabilities

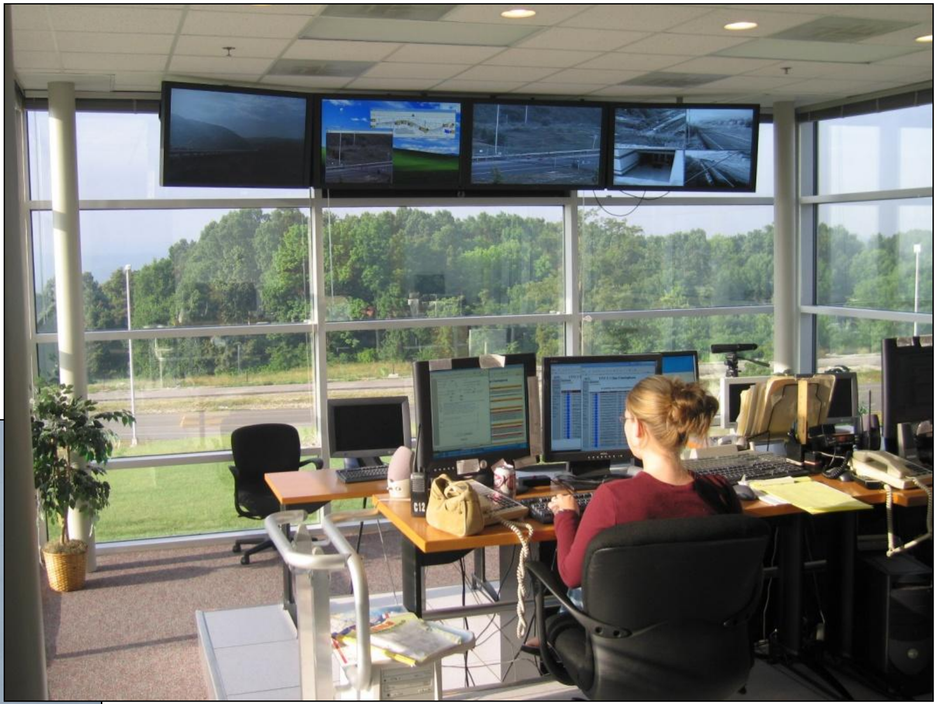


Instrumentation Systems

The Virginia Smart Road

The Virginia Smart Road

- Advanced Control Room
- Weather capabilities



- Variable Lighting Systems
- Pavement Testing

Experimental Lighting Testbed

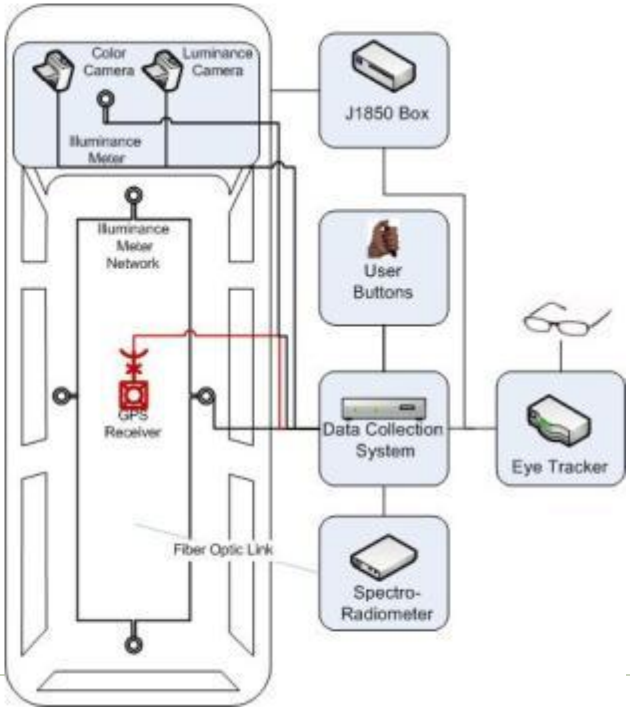
- Three luminaires
  - HPS
  - LED
    - 3500K
    - 6000K
  - Metal Halide
  - White HPS
- Variable Bracket Height
- Full Dimability and individual control

Lighting Measurement Systems

- Mobile Measurement Systems
  - CCD based photometry
  - Illuminance
  - Color
  - User inputs

Equipment

- External
  - Novatel GPS device mounted at the center of the vehicle
  - Illuminance Meter Grid
    - Four weatherproof heads mounted horizontally on the roof of the vehicle in the center of the wheel path



- Internal
  - Illuminance Meter
    - One mounted vertically inside the windshield
  - Luminance Camera
    - VTTI-developed luminance camera to monitor the entire scene
    - Luminance is derived from a calibration procedure performed on each camera
  - Color Camera
    - 1280x960 RGB FireWire camera
  - J1850 box
    - Returns vehicle information from internal vehicle CAN network
  - Spectroradiometer
    - Ocean Optics HR4000
    - Measures spectral information through a fiber optic link to a cosine or sphere collector on vehicle roof
  - Buttons
    - Small push buttons mounted in vehicle to capture human response events
  - Eye Tracker
    - Arrington Research Binocular Eye Tracking System

System Layout

Variations on a Theme

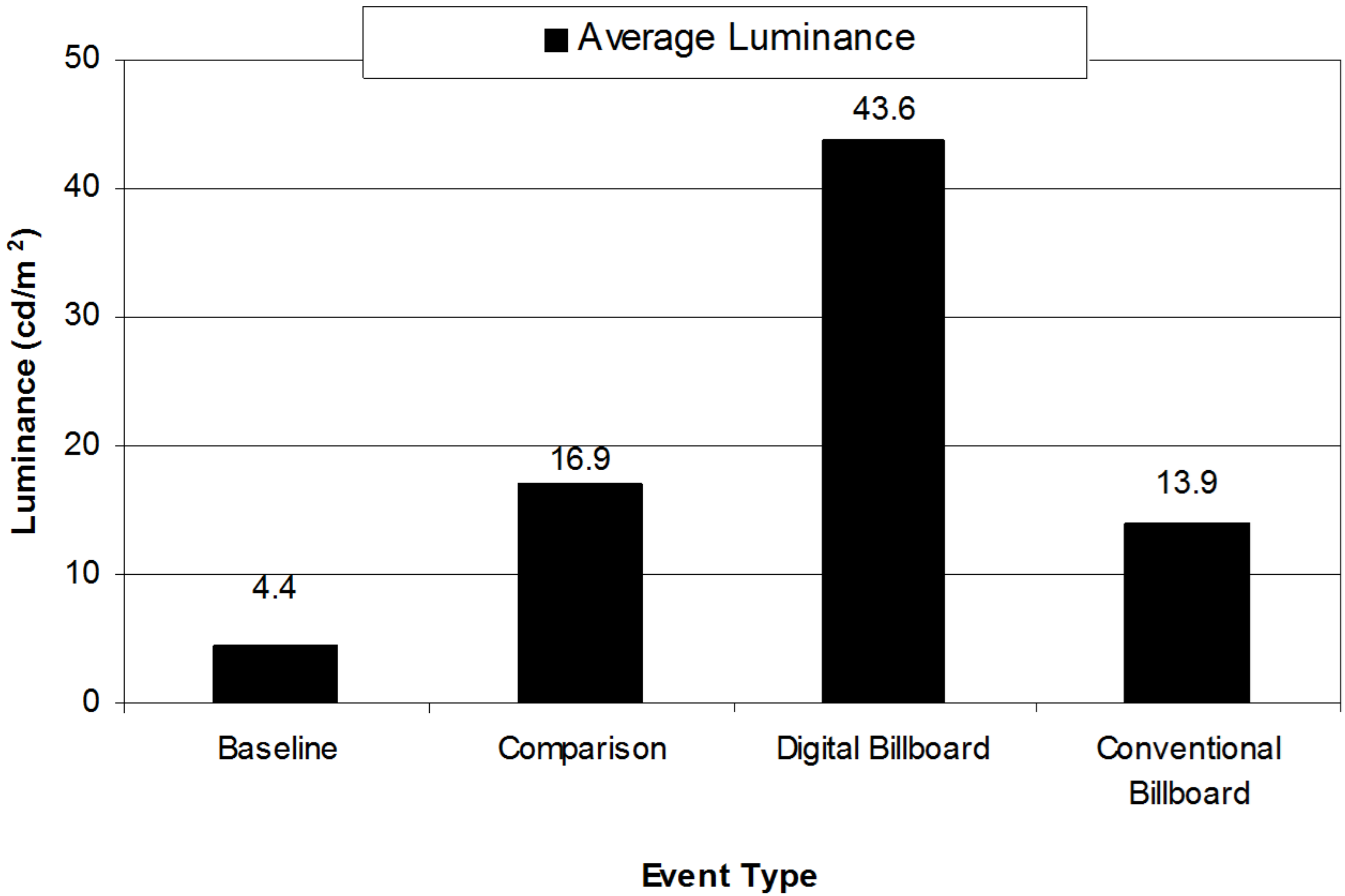
- Robot based lighting measurement
  - Vertical and Horizontal measurement
- Public vehicle lighting monitoring

After Data Collection: GIS Lighting Overlay

Selected CIBSS Projects

- Spectral Effects of Light Sources
  - Mesopic
  - Color Contrast
- Adaptive Lighting
- Airport Parking Lot Lighting
- Sign Lighting Requirements
- LED Performance Evaluations
- Solid State Lighting Implementation
  - Seattle, Anchorage, San Diego, San Jose, DC
- National Surface Transportation Safety Center of Excellence
  - Visibility in Roundabouts
  - Lighting in Fog
  - Lighting in Rain
  - Bicycle Visibility
- Connected Vehicle UTC
  - Just in Time Lighting Possibilities

Average Billboard Luminance



Adaptive Lighting

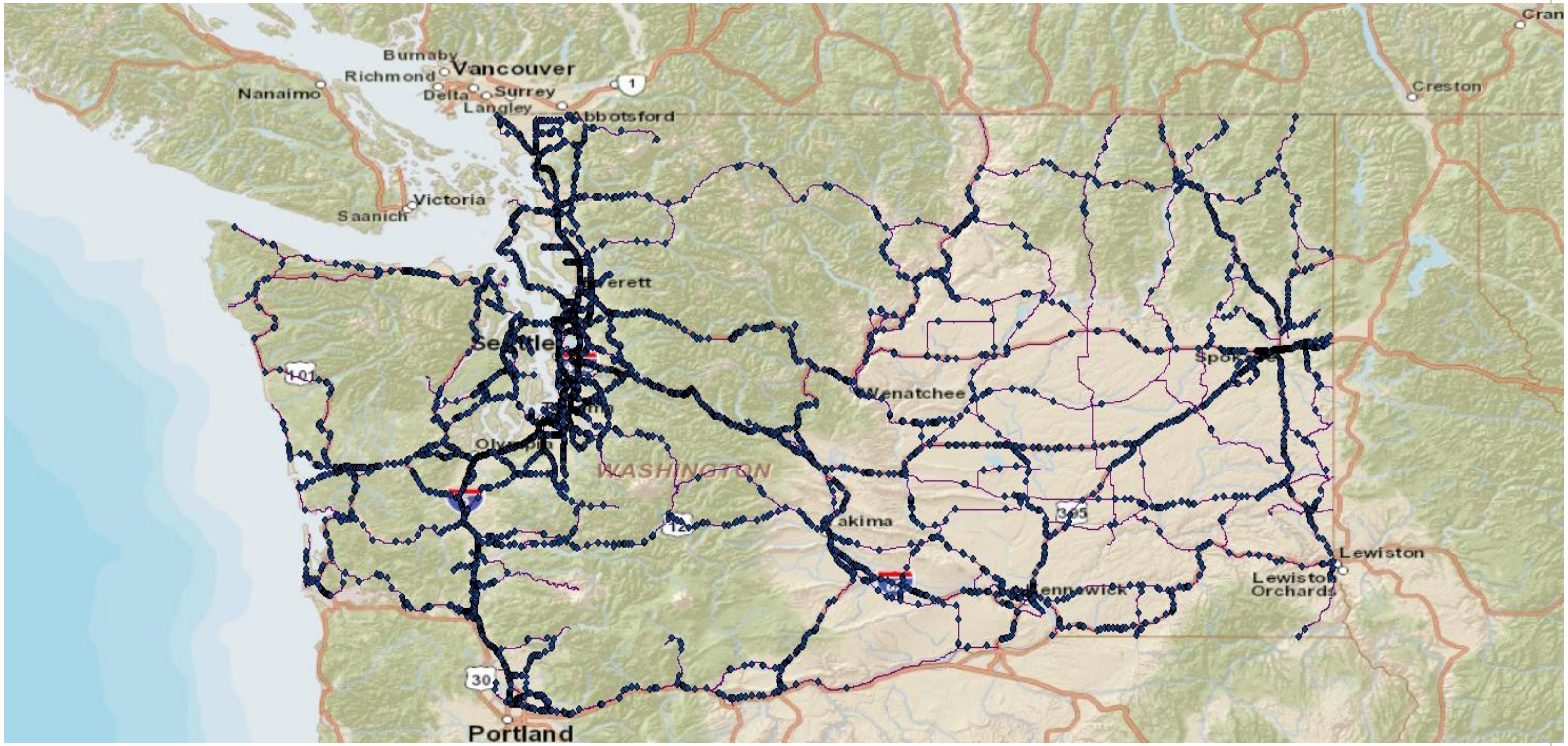
- With the advent of new control and ballast technology we have the ability to adapt a roadway lighting system to the needs of the environment.
  - Traffic Volume
  - Weather
  - Lighting Condition
  - Pedestrian Usage
- Consider it as managing your lighting level as an asset

Why Adapt? Energy Usage

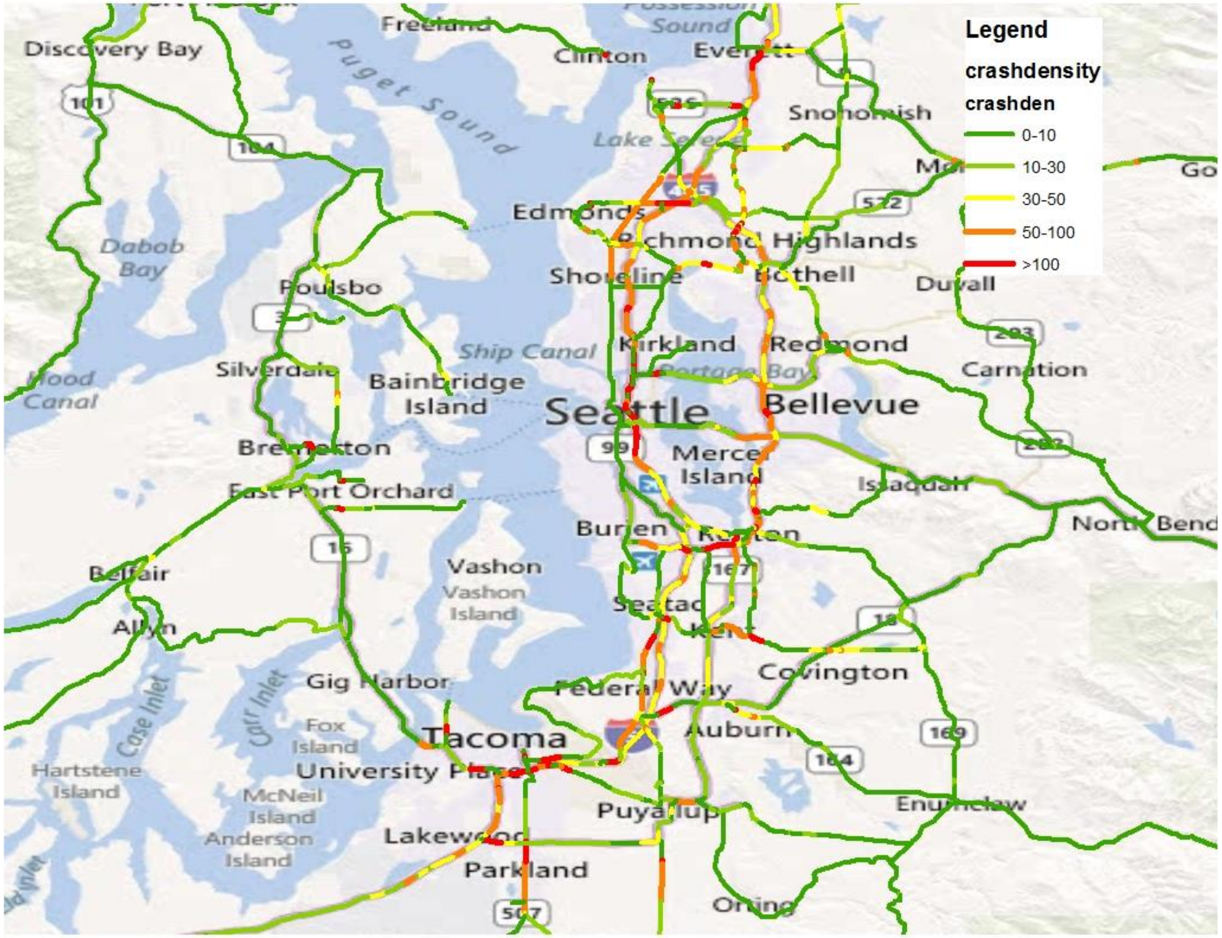
- In 2001:
  - It was estimated that there are 72 929 000 outdoor lighting fixtures in the US
  - Consuming 57.35 Twh of Electricity
  - Costing $5.9 Billion in energy usage each year
- Potential to reduce energy usage by 25%
  - 50% diming, 50% of the time
  - $1.49 Billion Savings = $20 per luminaire per year
- Sliding Scale
  - Install Solid State
    - 50% power reduction * 25% Adaptive Savings
    - 12.5% saving for Adapting = $10 per luminaire

Washington

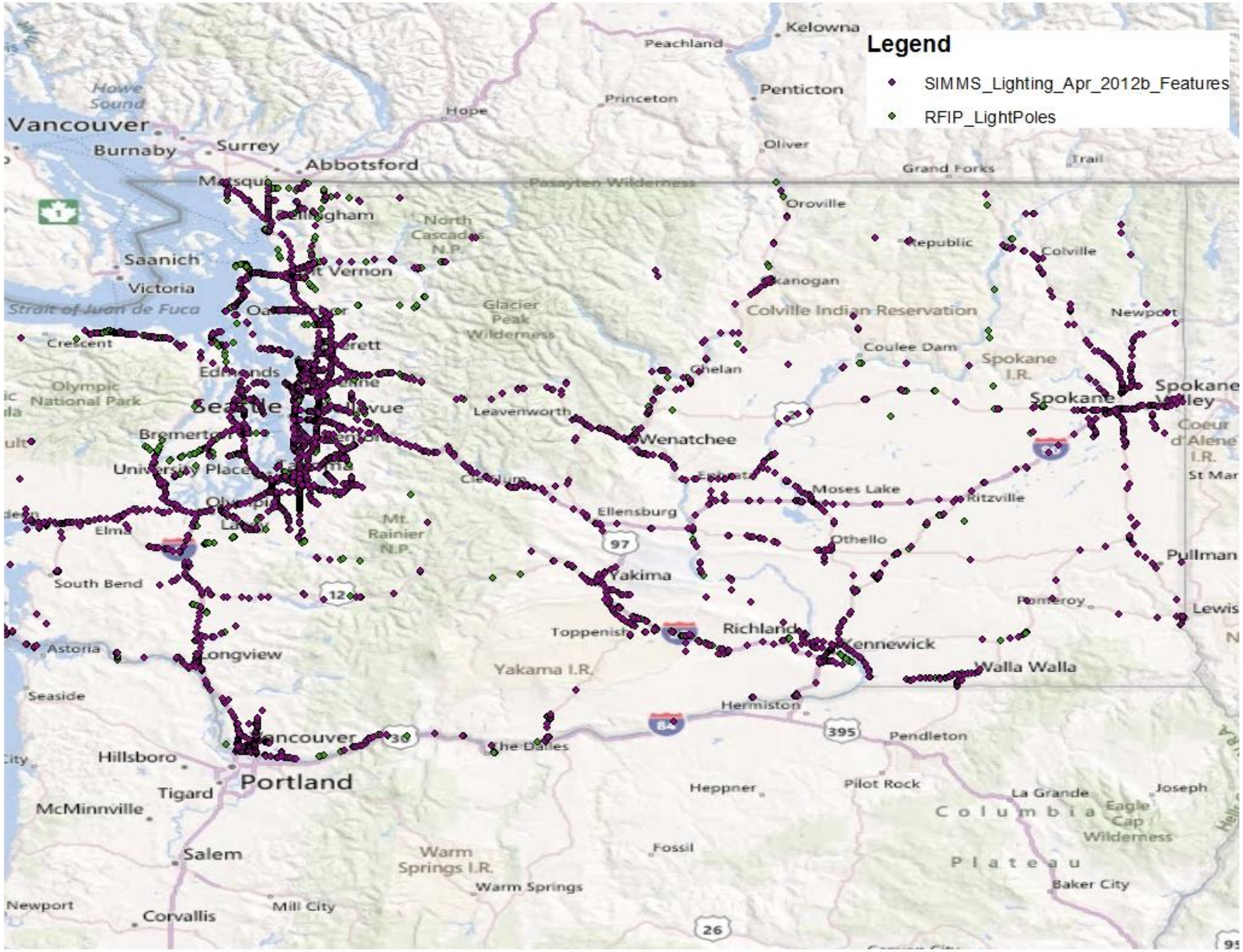
Washington Year (Currently Showing 2008 Night Time Crashes)



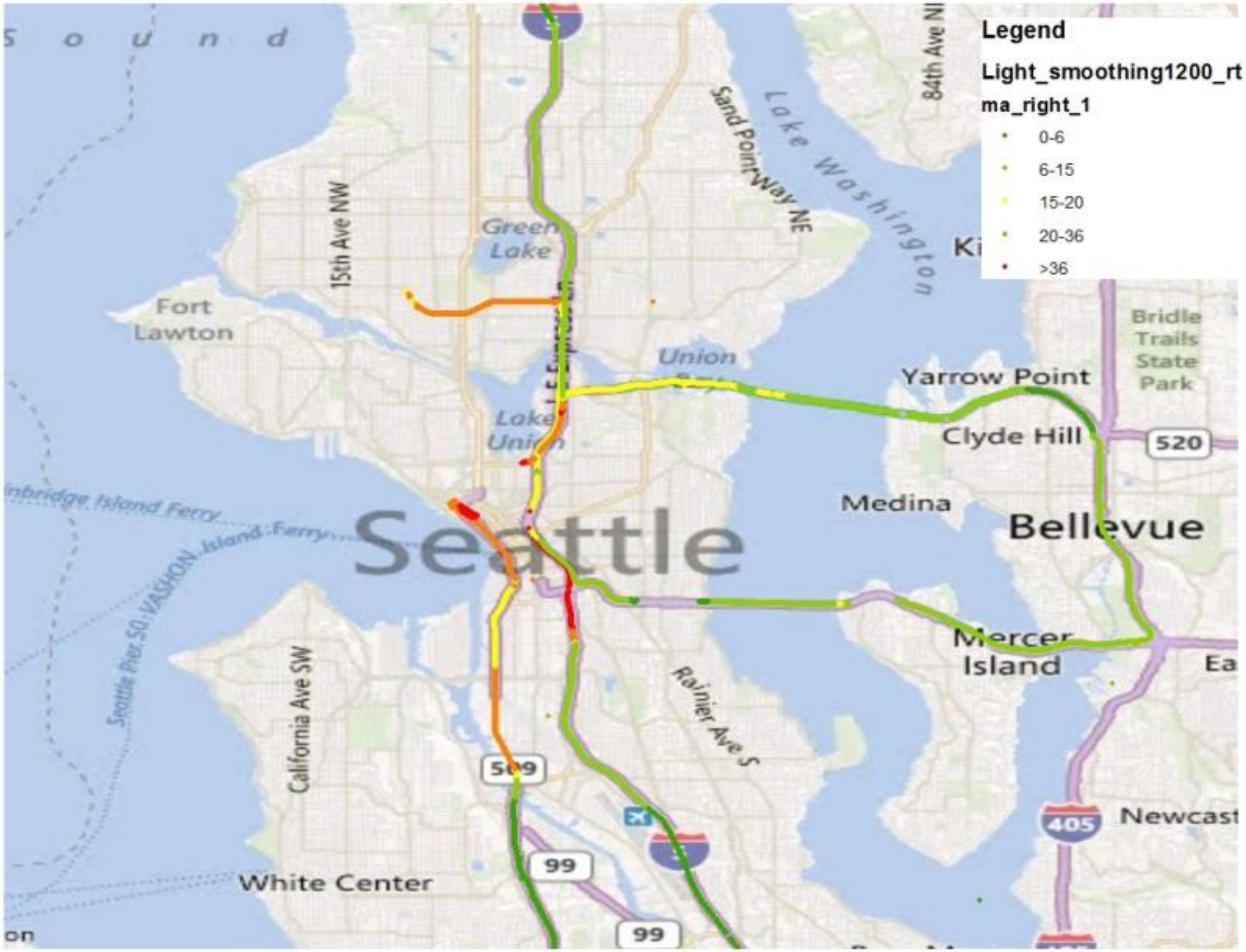
Crash Density per Mile



Light Pole Locations



WA Lighting Data Collection



Analysis

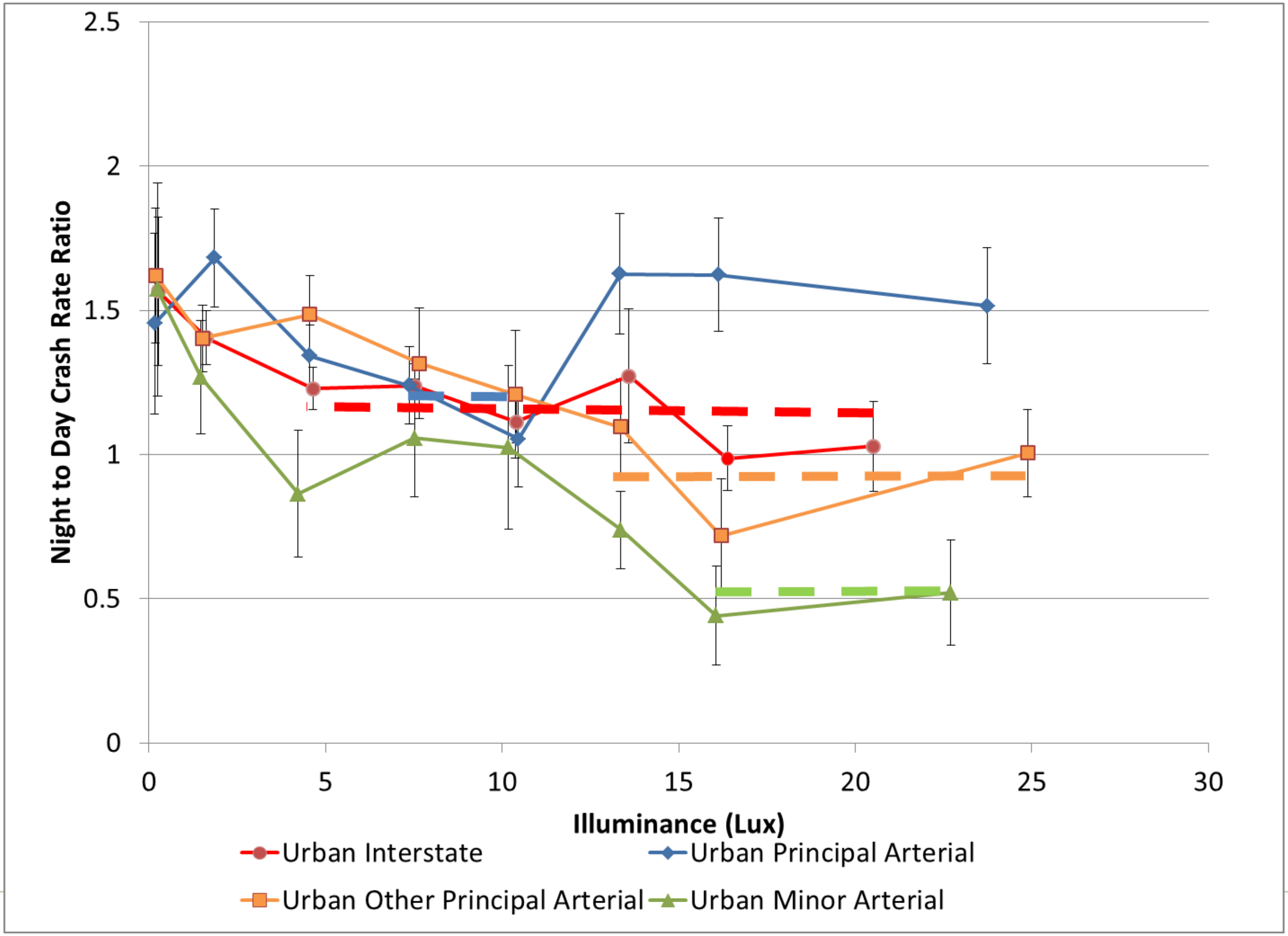
$$Crash\ Rate_{Day} = \frac{Crash\ occured\ during\ day\ time}{Day\ time\ average\ traffic\ volume * length\ of\ segment}$$

$$Crash\ Rate_{night} = \frac{Crash\ Occured\ during\ night\ time}{Night\ time\ average\ traffic\ volume * length\ of\ segment}$$

The night-to-day crash rate ratio (NDCRR) was calculated as:

$$Night - to - DayCrash\ Rate\ Ratio = \frac{Crash\ Rate_{night}}{Crash\ Rate_{Day}}$$

Lighting Impact by Functional Class



Roadway Classification

Parameter	Options	Criteria	Weighting Value
Speed	Very High	> 60 mph	1
	High	> 50 mph	0.5
	Moderate	> 40 mph	0
Traffic Volume	Very High	> 10000 ADT Equivalent	1
	High	> 7500 ADT Equivalent	0.5
	Moderate	> 5000 ADT Equivalent	0
	Low	> 2000 ADT Equivalent	-0.5
	Very Low	<2000 ADT Equivalent	-1
Median	No		1
	Yes		0
Intersection / Interchange Density	High	>1 per mile	1
	Moderate	> .25 / Mile	0
	Low	< .25 per mile	-1
Ambient Luminance	High	Background > 1 cd/m^2	1
	Moderate	Background > .5 cd/m^2	0
	Low	Background < .5 cd/m^2	-1
Guidance	Good		0
	Poor		0.5

Roadway Lighting Levels

Class =5 - (Total of Factors)

Design Values

Class	Average Luminance	Max Uniformity Ratio	Max Uniformity Ratio	Veiling Luminance Ratio
H1	1	3	5	0.3
H2	0.8	3.5	6	0.3
H3	0.6	3.5	6	0.3
H4	0.4	3.5	6	0.3

Concept of Adaptability for Airport Operations

- Apron Lighting
  - Consider each aircraft stand as an adaptive area
  - Individual Control of each of gates
    - Adapt based on usage (suggestions only)
      - 50 lux for fueling
        - » Could be supplemental on service vehicle lighting
      - 25 lux for service
      - 10 lux for Parking or pushback
        - » Reduction of glare from the lighting system for the pilots
      - 5 lux for parked aircraft or overnight parking
        - » Security only

Questions?