



# Optimizing Traffic Using Artificial Intelligence and Advanced Camera Sensors



**Chris McMasters**

Chief Information Officer

**Aaron M. Cox, P.E., P.M.P.**

Senior Engineer – Traffic Engineering

9/29/2021

# Strategic Plan Survey Results

## Top Weaknesses of the City

Traffic	Homelessness	Things to Do
<ul style="list-style-type: none"> <li>• Traffic (45%)                             <ul style="list-style-type: none"> <li>• Traffic tied to overdevelopment (3%)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Homeless (36%)</li> </ul>	<ul style="list-style-type: none"> <li>• Activities (17%)                             <ul style="list-style-type: none"> <li>• More restaurants (8%)</li> <li>• More recreation, entertainment</li> </ul> </li> </ul>

### Economy

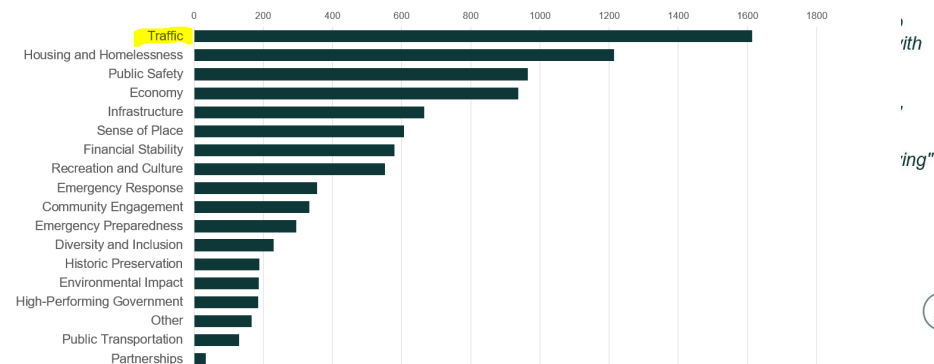
- Business
- L
- L
- C
- t
- I
- Jobs (5)
- L

### Parks

- Parks (
- U
- F
- M

What are you CONCERNED about?

Priorities in Rank Order



# Strategic Goal 3: Sound Infrastructure

## GOAL: SOUND INFRASTRUCTURE

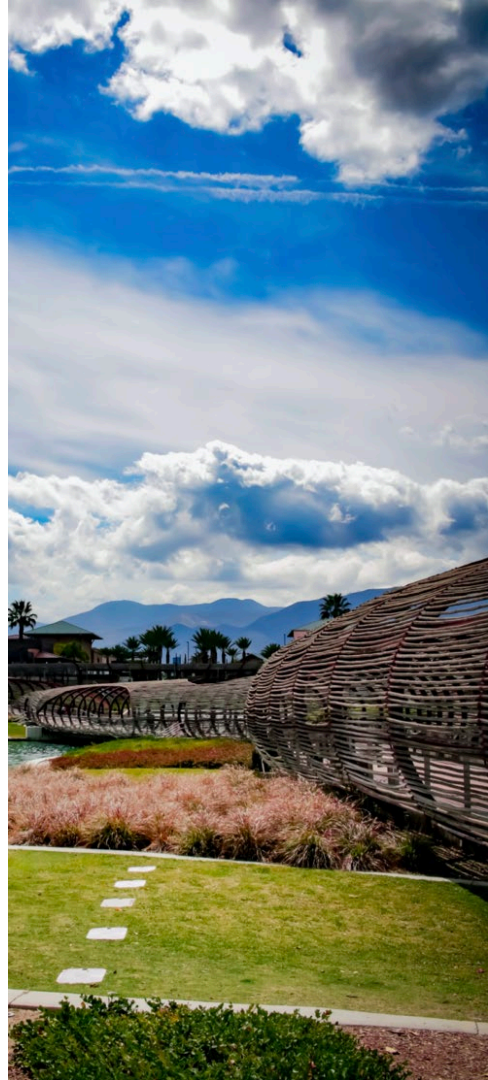
### **Reduce Negative Impacts of Traffic: Reduce traffic congestion and optimize traffic flows.**

- Develop long-term multi-modal transportation plan for traffic improvements, mitigation efforts, and expansion of alternative transportation options (including bicycle and pedestrian) to reduce reliance on fossil fuels.
- Modernize traffic cameras and explore utilization of Artificial Intelligence with traffic cameras to optimize traffic flows and improve responsiveness of traffic lights.
- Advocate with Riverside County Transportation Commission (RCTC) and the State for transportation improvements that impact congestion within Corona.
- Continue efforts to embrace mixed-use developments that would place housing within walking distance of commercial centers and public transportation.



# What We're Asking For:

- Investment into Artificial Intelligence based traffic Algorithms and Hi-Definition detection cameras that are compatible with the ATMS Master Plan and Public Safety
- Invest in a City-Wide (AI driven) Traffic Data Dashboard
- Invest in City synergies that rely on Traffic Infrastructure



# What is 'AI'?



# What is AI?

“The capability of a machine to imitate intelligent human behavior” – Merriam Webster

\* Broadly defined, intelligence is the capacity to acquire knowledge and apply it to achieve an outcome; the action taken is related to the particulars of the situation rather than done by rote (repetition).



# AI vs Traditional Programming

**Traditional**

**Data**

If (X = 1) do Y  
If (X = 2) do Z  
If (X = 3) do W...

**Output / decision**

**Artificial Intelligence**

**Data**

**Process the data**

**Build a model**

For every "new" data  
item, ask the model

**Get Prediction(s)**

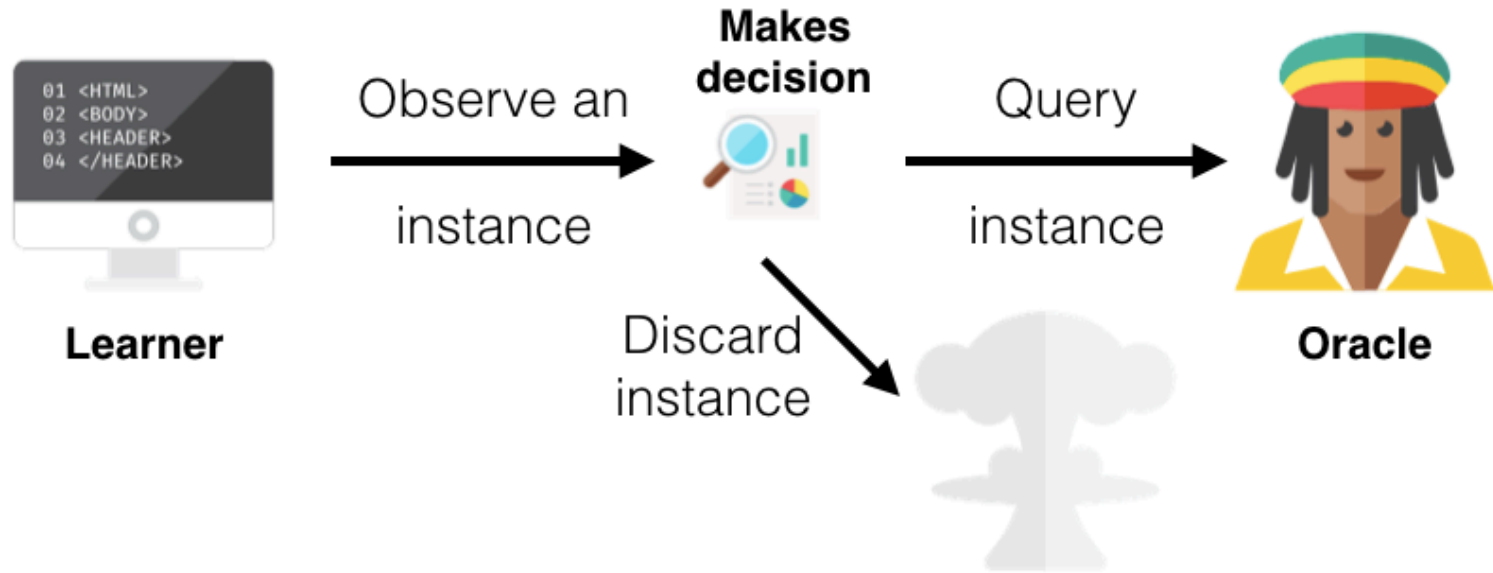
# Data is Key

- The **learning** aspect of AI programming focuses on acquiring data and creating rules for how to turn data into actionable information. The rules, called algorithms, provide computing systems with step-by-step instructions on how to complete a specific task.
- The **reasoning** aspect involves AI's ability to choose the most appropriate algorithm, among a set of algorithms, to use in a particular context.
- The **self-correction** aspect focuses on AI's ability to progressively tune and improve a result until it achieves the desired goal.





# AI: Passive vs Active



# Applications of...



Source: <http://www.govtech.com/civic/GT-September-Automation-Beyond-the-Physical-AI-in-the-Public-Sector.html>

# Types of Traffic Signal Control

## 1. Pre-timed

→ Downtown & Central Business Districts

## 2. Actuated , “Free” , “On Demand”

→ Off Arterial, Remote, Residential Intersections

## 3. Coordinated by time of day

→ Major Arterials, High Volume Corridors

→ Studied and Retimed every 1-3 years

## 4. Traffic Responsive

→ Series of Coordination Plans, Logic

## 5. Traffic Adaptive (AI)

→ Retimed in real-time

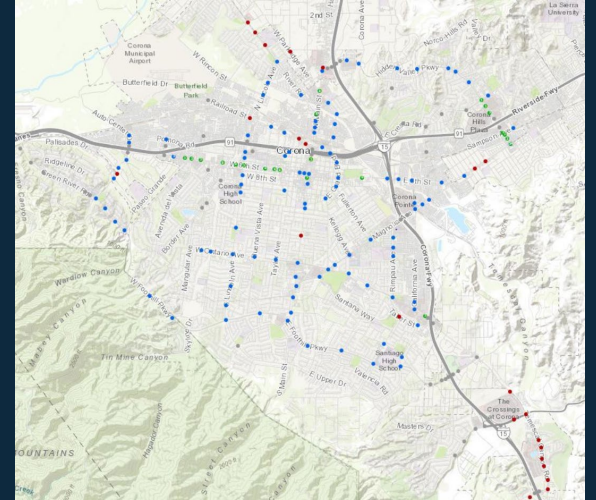
→ Less than 5% of US Signals operate adaptively

Corona utilizes Actuated and Coordinated modes



# ATMS Master Plan

City of Corona's Advanced Traffic Management System (ATMS)



# City of Corona - ATMS

What we are currently working on:

## → **Traffic Management Center Upgrades**

- Video Wall Replacement
- Consolidation of traffic systems into 1 interface (ATMS, DMS, CCTV, etc)
- Hired Assistant Traffic Engineer with significant TMC operation experience

## → **Traffic Monitoring CCTV System Upgrades CIP**

- Replacing legacy CCTV systems
- Upgrading to HD digital cameras
- Integrate into City Unified Surveillance System (City IT Coordination)





# City of Corona - ATMS

What we are currently working on:

- **ATMS Phase 3:** Project Extends communications and signal control to:
  - **Ph. 3A:** Westerly to Green River/91 Fwy area and Easterly to El Cerrito / Interstate 15. Creates fully interconnected corridor.
  - **Ph. 3B:** River Road to Norco City Limits
  - **Ph. 3C:** Update existing network infrastructure and traffic surveillance cameras.
  - 80% Funded – Construction to begin 2022
  - Traffic Engineering Reviewing 90% Plans



# City of Corona - ATMS

What we are currently working on:

→ **Foothill Corridor Signal Interconnect Improvement CIP**

- Updating Traffic Signal Controllers to ATC 6.25 Specifications
- Updating Network Interconnect Equipment
- Replacement of legacy ATMS to industry leading Centrac's ATMS
- Project Limits – Green River/Serfas Club to Foothill/California





# What Does it all Mean?



# Laying Foundation for Future Capabilities

- ATC Traffic Controllers
- High Speed Fiber Network
- Cutting Edge Traffic Management System
- SR-91 to I-15 Interconnected Corridor on Green River / Foothill.
- Connected Vehicle Ready

Enables Traffic Engineering to leverage AI with Advanced Traffic Algorithms, and Connected Vehicle technology



Three vertical bars of different colors (light green, dark blue, and yellow) are positioned on the left side of the slide.

# Compatible Solutions to Optimize Traffic

# Types of Solutions

## Traffic Data Dashboards

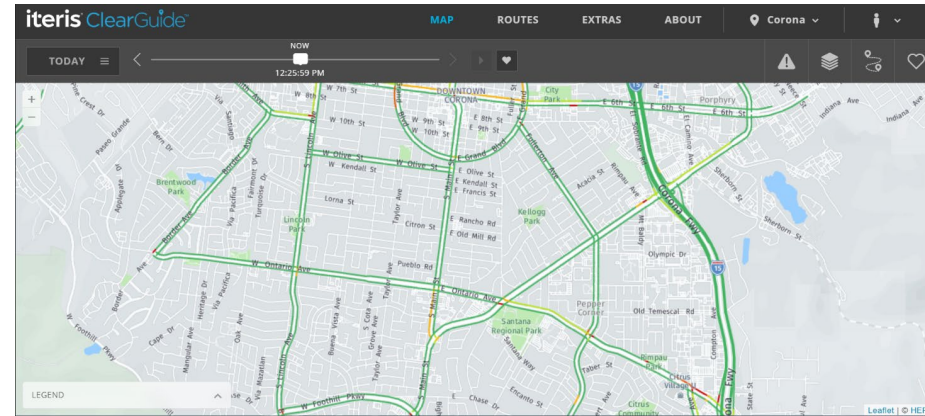
- City-wide live and historic traffic data (travel times, congestion levels, incidents, etc.).
- Systems utilize 3<sup>rd</sup> party data sources
- City Roads and Freeway Data

## Advanced Traffic Algorithms

- Traffic network-wide data collection and processing using AI in the cloud.
- Traffic timing evaluated continuously and creates signal timing recommendations.
- Hi-Resolution data to make traffic decisions

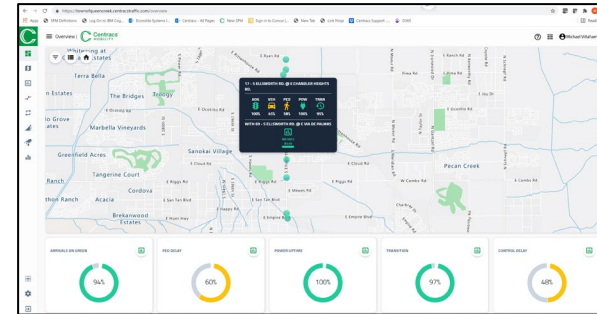
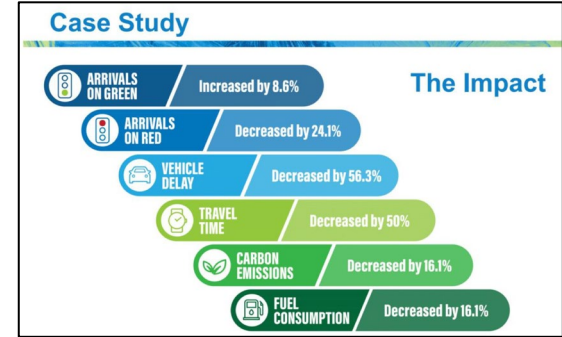
# Traffic Data Dashboard: Iteris Clearguide APMS

- Arterial Performance Management System (APMS)
- Citywide Data Dashboard
- Operates independently of existing systems
- Uses third party data sources
- **Includes Freeway Data**



# Advanced Traffic Algorithms: Centrac's Mobility + Edaptive Modules

- Compatible with Centrac's ATMS system and Controllers procured under Foothill Pkwy Interconnect Improvement CIP
- Can be deployed System-wide
- 10 Observations per Second Data Collection (BIG DATA!!)
- Statistical Analysis with AI in the cloud to provide Traffic Signal Timing recommendations
- Optimizations can be implemented in real time
- Powerful traffic engineering metrics to evaluate system performance (Signal Performance Measures - SPM)
- Module has built in diagnostics to alert staff that there are issues.



## Edaptive

Centrac's *Edaptive* is the next-generation in adaptive signal control, optimizing cycle, offset and splits in real-time. It is built upon Econolite's latest cloud-based Centrac's SPM and revolutionary Pattern Optimizer solutions.

# What is Required to Implement?

## Traffic Data Dashboard:

- No Capital costs
- Web-Based
- Approximately \$50k / year Subscription
- Minimal remote setup by vendor
- WAZE-Corona partnership can be integrated into Clearguide APMS





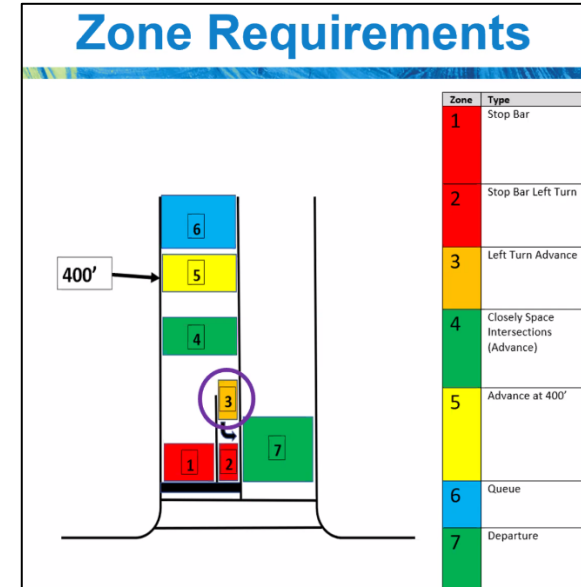
# What is Required to Implement?

## Edaptive Signal Control:

- Upfront Costs:
  - Hi-Definition Vehicle Detection Camera Systems [Zones 1,2,3,4,7] **\$25,000 / Intersection**
    - Has Data-logging capabilities for pedestrian counts, vehicle classifications, turning movement counts, etc.
    - Can be Integrated into City Unified Surveillance System
  - Magnetomer "Puck" Advanced Detection for high-speed arterial approaches **\$15-\$20,000 / Intersection** [Zone 5,6]
    - \*Only required on high speed approaches or where roadway curvature does not allow line of sight from HD Cameras  
Example: West Foothill Parkway Extension
  - Advanced Traffic Controller **\$3,500 / Intersection**
  - Initial Configuration for Intersections **\$2,500 / Intersection**



City of Anaheim – Disneyland Area



Detection Zones Required

## Adaptive Signal Control:

- [illegible]



# How Do We Know It's Working?

## Internal Performance Metrics:

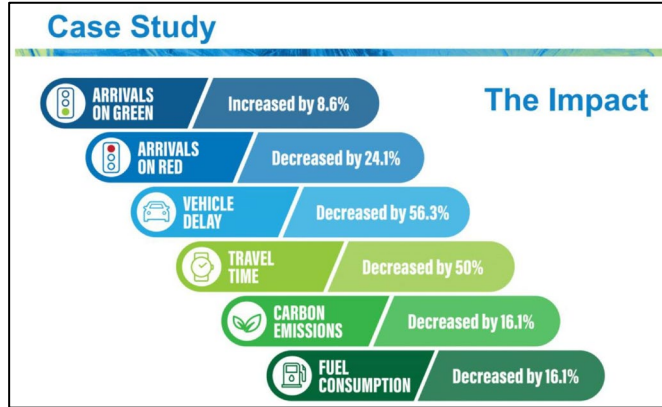
- Arrivals on **Green** (ROG)
- Arrivals on **Red** (ROR)
- Purdue Coordination Diagram
- Vehicle Delays
- Volumes
- Volume / Capacity
- Before/After Comparisons

## Check With Data Dashboard:

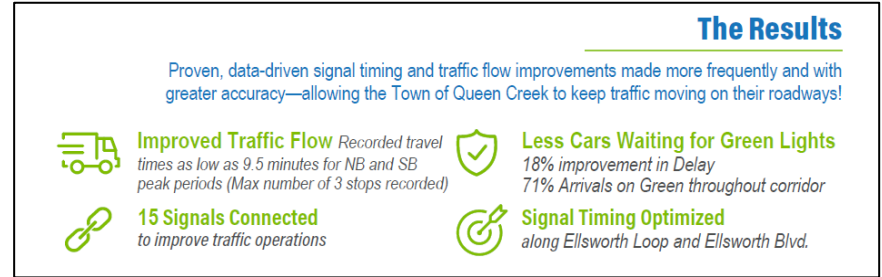
- Average Speed
- Delays
- Heat Map
- Travel Times
- Compare to Historical Data

# What Improvements in Traffic Flow Can be realized?

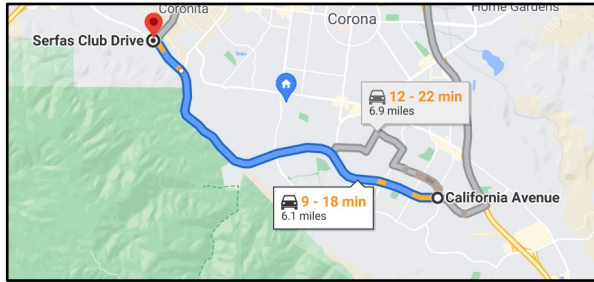
- Oahu, Hawaii



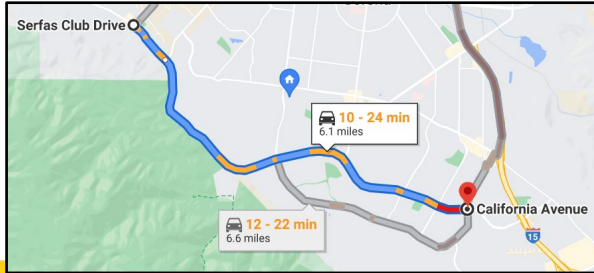
- Queen Creek, Arizona



# Green River / Foothill Corridor is an Excellent candidate for Edaptive



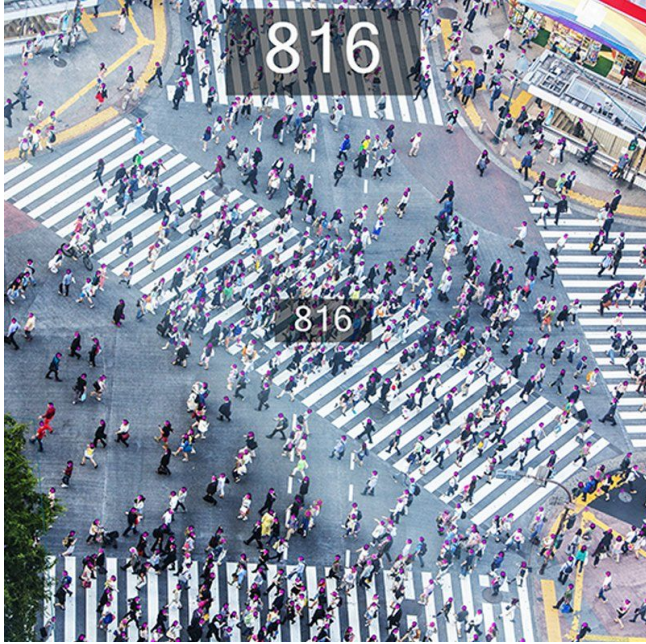
AM Westbound Peak Hours



PM Eastbound Peak Hours

- Highly Variable travel times (Greater than 2x average during Peak)
- Highly influenced by variations in freeway flow
- High volumes = Big impacts and potential improvements
- Highly Variable School traffic at both ends of corridor

# Potential Synergies



- **HD Cameras**
  - Augment Public Safety Abilities
  - Monitor Pedestrian and Bicycle Traffic
  - Parks and Trailhead Usage
  - Facility Capacities
- **WAZE Integration**
  - Leverage existing partnership with WAZE

Three vertical bars of different colors (light green, dark blue, and yellow) are positioned on the left side of the slide.

# Options for Consideration



# Option 1: Status Quo

- Continue to follow industry best practices and operate traffic signals in Free and Coordinated Modes
- Commence yearly timing studies to update coordination patterns
  - FHWA recommends retiming every 3-5 years!
- Check timing effectiveness with floating car surveys
  - Staff drives corridor multiple times and records data
- Reactive approach to traffic concerns

## Pros

- No capital expenditures
- Follows current industry practices

## Cons

- Significant staff time required currently to complete studies
- Slow reaction to changes in traffic
- Slow process to verify effectiveness
- ATMS Ph. 3 funding gap leaves important locations disconnected from TMC

# Option 2: One Corridor (Green River Foothill) Edaptive + Citywide Traffic Dashboard

- Invest in Artificial Intelligence based signal control system with 20 HD vehicle detection camera systems
- Fill 20% Funding Gap on ATMS P3 Project to complete network connections to West and East termini of corridor
- Deploy end-to-end proof of concept corridor from Green River/SR-91 to EL Cerrito/I-15 (20 Intersections)
- Measure effectiveness of changes with integrated performance metrics and traffic data dashboard.
  - Expand reach of Edaptive or decline to renew yearly agreement
- **Cost:** \$1.6 Million and \$85,000 yearly. Implementation over 1 Year

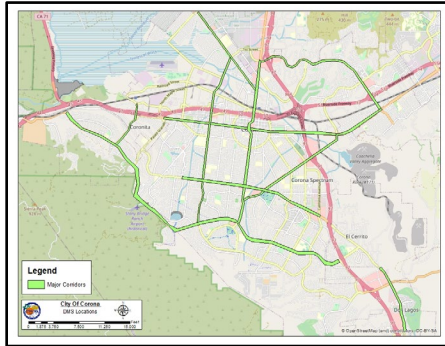
## Pros

- Exceeds industry best practices
- Real-time adjustments to signal timing on Green River/Foothill
- Improved travel times, less delays
- Fills ATMS P3 funding gap bringing connection to ~90% of City
- Reduced staff time in completing timing studies
- Performance metrics of signal timing and travel time
- Detailed Citywide traffic data available for making decisions

## Cons

- Capital Cost
- Recurring Costs
- Schedule (1 Year)
- Staff time to implement
- Benefits of Traffic-AI only in one area of City

# Option 3: Citywide Major Arterial Corridor Edaptive + Citywide Traffic Dashboard



Invest in Artificial Intelligence based Edaptive signal control system on ALL major Arterials: (129 Signals)

- Main St
- Hidden Valley / McKinley
- Lincoln Ave
- Foothill / Green River / El Cerrito
- Magnolia
- Sixth St
- Ontario Ave
- Auto Center Drive
- River Rd
- Temescal Canyon Rd

**Cost:** \$6 Million initially and \$250,000 yearly. Implementation over 3 Years

## Pros

- Exceeds industry best practices
- Citywide improvements in travel time and delays
- Real-time adjustments to traffic timing on all major arterials
- Fills ATMS P3 funding gap bringing connection to ~90% of City
- Reduced staff time in completing timing studies
- Performance metrics of signal timing and travel time
- Detailed Citywide traffic data available for making decisions

## Cons

- Capital Cost
- Recurring Costs
- Schedule (3 Years)
- Staff time to implement

# Staff Recommendations

## Dual facet approach:

- Implement City-wide Traffic Data Dashboard
- Implement AI based “Edaptive” Signal Control Citywide on all Arterials
- Rollout Edaptive in phased approach



# Summary + Recommendation

	Good	Better	Best (Recommended)
	Option 1 Status Quo	Option 2 One Corridor (Green River Foothill) Edaptive + Citywide Traffic Dashboard	Option 3 Citywide Major Arterial Corridor Edaptive + Citywide Traffic Dashboard
Intersections Optimized with Artificial Intelligence and HD Detection Cameras	0	20	129
Capital Investment	\$0	\$1.6M	\$6M
Yearly Fees	\$0	\$80,000	\$250,000

# QUESTIONS?



951-736-2266



Traffic.Eng@CoronaCA.gov



www.CoronaCA.gov





[www.CoronaCA.gov](http://www.CoronaCA.gov)

