Task 2: Benefit Identification and Quantification

Cost-Benefit Analysis and Feasibility Study for the Acquisition of SR 133 from Coast Highway to El Toro Road

Laguna Beach, CA
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1 Introduction

The purpose of Task 2: Benefit Identification and Quantification is to provide a high-level overview of the potential benefits that may accrue to the City of Laguna Beach ("Laguna Beach" or "the City") if it is to acquire from the California Department of Transportation ("Caltrans") ownership of State Route 133 / Laguna Canyon Road. Section 2 provides an overview of benefit-cost analysis. Section 3 discusses potential infrastructure improvements that would be enabled by the acquisition of Laguna Canyon Road by the City. This section includes a description of each potential infrastructure improvement, the benefits that they could generate, the likelihood that the benefit would be realized, and the expected order of magnitude of the benefit. In Section 4, the potential benefits that may be generated are discussed in more detail, including, where applicable, discussion of documented "case studies" in which social, economic, or environmental benefits have been quantified for roadway improvements similar to those considered for Laguna Canyon Road. Finally, Section 5 provides a matrix summarizing the potential improvements considered for Laguna Canyon Road and the anticipated likelihood and magnitude of respective benefits generated by those improvements.

2 Benefit-Cost Analysis Overview

A benefit-cost analysis, or "BCA," calculates the benefits that are expected to accrue from a given investment project over a specified period, and compares these benefits to the anticipated costs of the project. For a given project under analysis, a BCA considers two theorized states or "conditions" of the world: a "No-Build" state in which the given project is not undertaken and conditions remain unchanged at their "status quo," and a "Build" state in which the given project is undertaken and conditions change correspondingly. Total benefits that can be attributed to the given project are all those outcomes that differ between the "Build" and "No-Build" scenarios. Benefits can be economic, social, behavioral, or environmental in nature, and can be considered either positive (socially desirable, such as a decrease in the cost of travel) or negative (socially undesirable, such as an increase in harmful vehicle emissions). For transportation projects, benefit categories often include project impacts such as reduced travel time or improved safety conditions; these benefits apply both to users and non-users of the facility affected by the project. Costs are also considered as the difference between the "Build" and "No-Build" scenarios, and include upfront "capital" costs of the project as well as ongoing "operations and maintenance" ("O&M") costs. A BCA values all cost and benefit categories in monetary terms, referencing valuation parameters developed by government, academic, or industry sources. Where costs or benefits cannot be quantified or monetized, they are assessed qualitatively.

Benefit-cost analysis is one of many tools that can be used to inform decisions about infrastructure investments. All else equal, the funding of projects that are found to generate a high ratio of total benefits to total costs would typically be considered an efficient allocation of limited resources. Many agencies, including Caltrans and the United States Department of Transportation (USDOT), consider benefit-cost analysis in

their decision-making processes and believe that BCAs can provide useful a benchmark from which to evaluate and compare potential transportation investments.

For the current project, benefit-cost analysis can assist the City in its assessment of the merits of the acquisition of Laguna Canyon Road, and in weighing potential benefits of the road's acquisition against the accompanying cost of roadway ownership. This Task 2 memorandum focuses on the benefits side of the BCA equation. Task 1 analyzes project costs, while Task 3 synthesizes benefits and costs.

3 Potential Improvements Enabled by Acquisition of Laguna Canyon Road

This section provides an overview of potential roadway or streetscape improvements that would be enabled by the City's acquisition of Laguna Canyon Road. While these improvements would be expected to generate benefits to roadway users and the community of Laguna Beach, they are unlikely to be implemented if Laguna Canyon Road continues under Caltrans ownership. By acquiring Laguna Canyon Road, the City would enable itself to implement these roadway and streetscape improvements in the future as it sees fit, without Caltrans involvement.

The potential improvements can be grouped into four categories: i) roadway design and traffic management, ii) corridor aesthetics and design opportunities, iii) roadway and utility integration, and iv) public transportation and carpooling improvements. The following section describes each potential roadway or streetscape improvement, explains how Caltrans ownership of Laguna Canyon Road is likely to prevent the improvements from being implemented, and lists the benefits that each improvement would be expected to generate. These benefits are further discussed in more detail in Section 4. Furthermore, this section provides categorizations of i) the expected likelihood that each potential roadway or streetscape improvement will generate its associated benefits, and ii) the anticipated magnitude of each benefit, if generated.

3.1 Roadway Design and Traffic Management

3.1.1 Road Striping and Lane Design

With ownership of Laguna Canyon Road, the City of Laguna Beach would exercise more control over roadway design decisions. One of the many improvements that the City would be able to implement is the optimization of roadway striping and lane widths.

Roadway striping and lane widths along Laguna Canyon Road are currently dictated by state-wide Caltrans standards. With control of the roadway, the City would be able to potentially adjust travel lane width, add or remove turn lanes, establish and/or optimize bicycle lanes, and generally stripe the roadway in the manner it deems fit.

Optimized lane widths are expected to generate the following benefits:

- **Safety Benefits**: Roadway striping is a significant contributor to roadway safety conditions. Lane width and lane striping influence driver behavior and travel speed,

while turn and bicycle lanes can be used to allow for safer travel movements, potentially decreasing the frequency and severity of crashes.

  - There is a low likelihood that optimized lane widths will generate safety benefits. If generated, the magnitude of safety benefits is also expected to be low.

- **Travel Ease and Comfort**: Beyond safety impacts, optimized road striping and lane design can improve the "feel" of the roadway for users of all modes, making travel along the corridor less stressful and more comfortable.

  - There is a medium likelihood that this infrastructure improvement will generate this category of benefits. If generated, the magnitude of travel ease and comfort benefits is also expected to be low.

3.1.2 Traffic Control Measures, Traffic Signals, and Speed Limits

In addition to roadway striping changes, the City of Laguna Beach would also be able to implement other traffic control and calming measures along Laguna Canyon Road. For example, ownership of the roadway would allow the City to adjust speed limits, change roadway signage, and implement traffic signals.

Caltrans currently will not allow additional traffic signals to be installed along Laguna Canyon Road. This practice can be an impediment to roadway safety and general travel conditions. With control over the roadway, the City would be able to install traffic signals to facilitate left turns across traffic on Laguna Canyon Road. This is especially relevant at intersections, where City roadways intersect the Caltrans roadway. By bringing all area roadways under the control of the City, focus will be established on the broad network of roadways, rather than more narrowly on the roadways controlled by each entity.

Traffic control measures, including traffic signals and speed limit adjustments, are expected to generate the following benefits:

- **Safety Benefits**: Traffic control and calming measures can improve roadway safety conditions and remove conflict points between vehicles.

  - There is a high likelihood that this category of roadway improvements will generate safety benefits, and these safety benefits are expected to be of high magnitude.

- **Travel Ease and Comfort**: Speed limit adjustments and signalized intersections can make travel along Laguna Canyon Road feel more orderly and controlled for both roadway users and neighbors.

  - There is a medium likelihood that additional traffic control measures will improve the ease and comfort of travel along Laguna Canyon Road, and these benefits are expected to be of medium magnitude.

- **Travel Time Savings**: Signalized intersections with controlled left turns can decrease travel times by preventing "bottlenecks." Alternatively, additional traffic control measures could increase average travel time and generate a "disbenefit" (or negative benefit).

- There is a medium likelihood that traffic control measures will affect travel time, and the magnitude of time savings benefits are expected to be low or possibly negative.

3.1.3 Crosswalks

With ownership of Laguna Canyon Road, the City of Laguna Beach would also gain control over decisions regarding the location and design of crosswalks and pedestrian crossing beacons.

For example, a crosswalk and a HAWK (High-Intensity Activated crossWalK) beacon currently exist at the Laguna College of Art and Design, allowing pedestrians to cross Laguna Canyon Road to access buildings on either side of the right-of-way. Decisions relating to this pedestrian crossing—or any other current or future crossings along the right-of-way—ultimately fall to Caltrans, the owner of the roadway. With the acquisition of Laguna Canyon Road, the City would be able to exercise its own judgement, in response to community input, as to the design and location of pedestrian crossings.

City control over crosswalks and pedestrian beacons would be expected to generate the following benefits:

- **Safety Benefits**: Laguna Canyon Road can be dangerous to cross on foot, with a few pedestrian fatalities in recent years. The implementation of crosswalks and crossing beacons can greatly improve safety conditions for pedestrians.
  - There is a high likelihood that this category of roadway improvements will generate safety benefits, and these safety benefits are expected to be of high magnitude.
- **Travel Ease and Comfort**: The implementation of crosswalks and pedestrian beacons can also improve general travel conditions for pedestrians beyond the increase in safety.
  - There is a high likelihood that improvement to pedestrian crossings will increase the travel ease and comfort of pedestrians, and these benefits are expected to be of high magnitude.
- **Increased Property Values**: Abutting property owners can potentially realize increased property values resulting from improved pedestrian access to their real estate.
  - The likelihood that City control of crosswalks and pedestrian crossings on Laguna Canyon will generate increased property values is low, and the magnitude of this benefit would be low if it were generated.
- **Travel Time Savings**: Changes to crosswalks along Laguna Canyon Road could slow traffic, leading to increased travel times.
  - There is a medium likelihood that crosswalk changes will increase travel time, generating a “disbenefit.”

3.1.4 Sidewalks

Similar to the case of crosswalks discussed above, the City would also be able to install or modify sidewalks along Laguna Canyon Road after the acquisition of the roadway. Under Caltrans ownership, the majority of Laguna Canyon Road does not feature adequate sidewalks, making the corridor hostile to pedestrians and those with mobility impairments. With control of the roadway, the City would be able to install or improve sidewalks where appropriate, as it sees fit.

City control over sidewalks along Laguna Canyon Road would be expected to generate the following benefits:

- **Safety Benefits**: Added or improved sidewalks can better separate pedestrians from vehicular traffic, improving safety conditions for pedestrians.
    - There is a medium likelihood that this category of roadway improvements will generate safety benefits. Safety benefits, if generated, are expected to be of high magnitude.
- **Travel Ease and Comfort**: Improved sidewalk conditions facilitate travel and generate benefits for pedestrians, and especially for individuals with mobility impairments. Changes to sidewalks along Laguna Canyon Road could also impact the aesthetics of the corridor.
    - There is a high likelihood that this category of roadway improvements will improve travel conditions, especially for individuals with mobility impairments. The expected magnitude of these benefits is high.
- **Recreation and Health Benefits**: Improved sidewalk conditions along Laguna Canyon Road can increase the amount of walking along the corridor, providing recreation and health benefits to those that decide to walk more or shift their behaviors to walking away from other modes.
    - There is a medium likelihood that sidewalk improvements will generate recreation and health benefits, and the expected magnitude of these benefits is low.
- **Increased Property Values**: As is the case for crosswalks and pedestrian crossing beacons, improved pedestrian access can increase the value of properties that abut Laguna Canyon Road.
    - The likelihood that sidewalk improvements will lead to increased property values is low, and the magnitude of this benefit is expected to be low if it is generated.

3.1.5 Shoulders

With control of Laguna Canyon Road, the City of Laguna Beach would also be able to widen shoulders along the roadway, where appropriate. Shoulders along the roadway are generally only two-foot wide in current conditions, leaving little room for cyclists or other non-motor vehicles, and the location of utility poles along the roadway further limits shoulder width. Shoulder asphalt conditions are also suboptimal in many locations, or shoulders are covered in dirt.

Widening or improving roadway shoulders would be expected to generate the following benefits:

- **Safety Benefits**: Wider, smoother shoulders can improve safety conditions along Laguna Canyon Road, especially for cyclists.
    - There is a high likelihood that improved shoulders will generate safety benefits, and these benefits are anticipated to be of medium magnitude.
- **Travel Ease and Comfort**: Beyond safety improvements, widened and improved roadway shoulders can also improve the ease and comfort of travel for cyclists along the roadway.
    - Improved shoulders have a medium likelihood to generate this category of benefits, and these benefits are anticipated to be of medium magnitude.

3.1.6 Driveways and Roadway Access Points

The current configuration of Laguna Canyon Road features numerous driveways and parking areas along the roadway. In some of these roadside parking areas, vehicles pull off of Laguna Canyon Road directly into parking spaces and subsequently back out of the spaces directly into traffic. Every driveway and parking space that directly accesses the roadway represents a potential vehicle conflict point, and parking spaces from which vehicles must back out into traffic are particularly dangerous.

With ownership of Laguna Canyon Road, the City of Laguna Beach would be in a position to coordinate with property owners to reduce the total number of driveways that access the roadway and better address the safety risks posed by “back out” parking spaces. Reconfiguring roadway access by, for example, consolidating driveways between neighboring properties could decrease safety risks along the roadway without impeding property access. Current property owners along Laguna Canyon Road have expressed interest in reconfiguring their access to the roadway; for example, the driveway of the Anneliese School currently accesses the east side of Laguna Canyon Road, but the school has plans to relocate its driveway so that it accesses the south side of El Toro Road instead. This planned reconfiguration demonstrates the value that existing property owners see in reducing or redesigning access points to Laguna Canyon Road. With ownership of the roadway, the City could encourage and implement additional reconfigurations of this variety.

The reconfiguration of driveways and access points would be a highly local process, requiring coordination among the parties that own the roadway and the abutting properties. The City of Laguna Beach is in a better position than Caltrans to oversee and implement this process, given the City’s stronger ties and relationships with area property owners. The City also controls the other smaller public streets and roads in the area, so any reconfiguration of intersections between those streets and Laguna Canyon Road would also be facilitated by the City’s ownership of all of the relevant roadways.

The reconfiguration of driveways and roadway access points is expected to generate the following categories of benefits:

- **Safety Benefits**: Relocated or consolidated driveways would reduce conflict points between vehicles travelling along Laguna Canyon Road and those entering or exiting the roadway. This safety benefit is particularly relevant to current “back out” parking spaces, as vehicles exiting these spaces have limited visibility and must come to a complete stop and reverse direction while located in the travel line.

  - There is an expected medium likelihood that City ownership of Laguna Canyon Road would lead to reconfiguration of driveways and access points that improve safety. If generated, these safety benefits are expected to be of a high magnitude.

- **Travel Ease and Comfort**: In addition to their potential safety benefits, reconfigured driveways and roadway access points would increase travel ease and comfort by making it generally easier and less stressful for vehicles to access Laguna Canyon Road.
  - The potential reconfiguration of driveways and roadway access points along Laguna Canyon Road is expected to generate this category of benefits with medium likelihood, and these benefits are expected to be of relatively low magnitude if generated.
- **Increased Property Values**: Quality and ease of roadway access is considered by the market in the determination of property valuation, and any improvement in roadway access would be viewed favorably by the market and result in increased property values.
  - As with the other benefit categories considered for this potential roadway improvement, it is expected with medium likelihood that property values will increase as a result of reconfigured roadway access. Where access is improved and property values do increase, this benefit is expected to be of a medium magnitude.

3.1.7 Bicycle Lanes

Laguna Canyon Road is a popular destination for cyclists. However, little consideration is paid to cyclists in the roadway's current auto-focused design. Cyclists who currently travel along Laguna Canyon Road are forced to travel primarily on the narrow or non-existent shoulder. With ownership of Laguna Canyon Road, the City could reconfigure the roadway to include dedicated cycling infrastructure where appropriate, including the possible addition of bicycle lanes.

To provide additional benefits, future bicycle lanes could be designed in such a way to also function as an emergency vehicle lane. Such a design would separate bicycles from motor vehicle traffic for the majority of the use of the bicycle lane, but also be wide enough to provide unobstructed emergency vehicle access as needed when the motor vehicle travel lanes are congested.

The reconfiguration of Laguna Canyon Road to include bicycle lanes, and especially bicycle lanes that can be used for emergency access, is expected to generate the following categories of benefits:

- **Safety Benefits**: Dedicated bicycle infrastructure would separate cyclists from motor vehicles, decreasing the risk of crashes and increasing safety conditions along the corridor.
  - There is a high likelihood that dedicated bicycle lanes will generate safety benefits of high magnitude.

- **Travel Ease and Comfort**: In addition to making the roadway safer for cyclists, dedicated bicycle lanes would also increase the ease and comfort of traveling along Laguna Canyon Road by bicycle.
    - There is also a high likelihood that this improvement will generate travel ease and comfort benefits of high magnitude.
- **Recreation and Health Benefits**: The improved safety conditions and increased ease and comfort of bicycle travel that would be generated by this infrastructure improvement would likely lead to an increase in bicycle travel on Laguna Canyon Road. This would directly provide recreation benefits for new cyclists, and additional exercise brought about by the changes would generate health benefits for residents and visitors.
    - Both the expected likelihood that this benefit will be generated and its expected magnitude are high.
- **Emergency Response Benefits**: Bicycle lanes that are designed for emergency vehicle access would allow first responders to bypass congestion and traffic obstruction as they respond to emergency situations. By their size and nature, bicycles are much better suited to yield and make room for passing emergency vehicles than cars or trucks. Improved emergency response time can potentially save lives, avert property damage, and generate significant societal benefits.
    - There is an expected high likelihood that bicycle lanes configured for emergency access will provide emergency response benefits, and the magnitude of this benefit is expected to be medium.
- **Increased Property Values**: Improved bicycle access along Laguna Canyon Road could increase visibility and accessibility for area business and residences, especially those that cater to cyclists. To the extent that bicycle access is valued by the market, these improvements would lead to increases in property values.
    - There is an expected medium likelihood that this improvement will result in increased property values, and this benefit if generated is expected to be of medium magnitude.
- **Emissions Reduction**: By encouraging bicycle travel, this roadway improvement could result in some degree of motor vehicle mileage being shifted to bicycle mileage. Each motor vehicle trip that is averted as a result of this “mode shift” would lead to a decrease in automobile emissions.
    - It is expected with high likelihood that the installation of bicycle lanes will decrease motor vehicle emissions as some motor vehicle trips are replaced by bicycle trips, but the expected magnitude of this benefit is low.

3.1.8 High-Occupancy Vehicle (HOV) or Restricted Access Lanes

Another roadway improvement that could be implemented by the City with ownership of Laguna Canyon Road is the establishment of restricted access lanes along the corridor. Some potential applications of restricted access lanes along Laguna Canyon Road include a seasonal shuttle bus or trolley lane, high-occupancy vehicle (HOV) lane, or restricted access lanes with special access for residents of Laguna Beach.

Establishment of a lane reserved for certain purposes or certain vehicles would benefit that designated form of vehicle or traffic, potentially incentivizing others to "shift" their travel patterns or behaviors in order to gain access to the restricted lane.

The establishment of HOV or restricted access lanes could generate the following benefits:

- **Travel Time Savings**: Restricted access lanes could reduce congestion for the designated vehicle type granted access, reducing travel times for qualifying drivers and passengers. A seasonal trolley lane, for example, would save time for trolley riders compared to motor vehicle users, and possibly induce drivers to become trolley riders in order to realize this time saving benefit. An HOV or restricted access lane could include special access for City residents.
    - Travel time savings are expected to result from the establishment of HOV or restricted access lanes with high likelihood, and the magnitude of these benefits is expected to be medium.
- **Emergency Response Benefits**: Any potential restricted access lane would likely be open to emergency vehicles, generating emergency response benefits.
    - Restricted access lanes are expected to generate emergency response benefits with medium likelihood, and the magnitude of this benefit is expected to be low.
- **Emissions Reduction**: Restricted access lanes that benefit high-occupancy vehicles or shuttles would dis-incentive single-passenger vehicle travel and incentivize public transportation or carpooling. This would be expected to decrease vehicle miles traveled, leading to a decrease in automobile emissions.
    - It is expected with medium likelihood that restricted access lanes will decrease motor vehicle emissions, but the expected magnitude of this benefit is low.

3.1.9 Reversible Lanes

An alternative configuration of Laguna Canyon Road that the City could implement with ownership of the roadway is one featuring reversible lanes. For example, a center reversible lane, replacing the current turn lane, could be configured to allow for travel heading into the City of Laguna Beach in the morning then reverse to allow for travel exiting Laguna Beach in the afternoon.

A reversible travel lane configuration for Laguna Canyon Road could provide the following benefits:

- **Travel Time Savings**: Changing the direction of the reversible travel lane throughout the day to match prevailing direction of traffic volume could reduce traffic congestion and save travel time.
    - There is a high likelihood that travel time savings will result from the implementation of reversible lanes, and the magnitude of this benefit is expected to be high.
- **Emergency Response Benefits**: By reducing traffic congestion along Laguna Canyon Road, reversible lanes could provide emergency response benefits similar to those provided by restricted access or HOV lanes.

  - It is expected with medium likelihood that reversible lanes will result in emergency response benefits, and magnitude of this benefit is expected to be low.

- **Emissions Reduction**: By reducing vehicle idle time and allowing for more consistent travel speed, the implementation of reversible lanes could reduce automobile emissions.
  - It is expected with medium likelihood that reversible lanes will result in a reduction in emissions, and the magnitude of this benefit is expected to be low.

3.2 Corridor Aesthetics and Design Opportunities

3.2.1 Street Trees

With ownership of Laguna Canyon Road, the City of Laguna Beach would gain control over landscaping elements along the roadway in addition to control over the roadway itself. One such landscaping element is the vegetation and street trees planted in the roadway median and on the edges of the right-of-way.

Under current Caltrans control, vegetation planted along Laguna Canyon Road must follow state standards governing tree size and type based on speed limits and other factors. These standards do not allow trees with relatively larger trunk diameters to grow along Laguna Canyon Road. With ownership of Laguna Canyon Road, the City would be free to plant trees that conform to local community and aesthetic standards.

City control over the planting of street trees along Laguna Canyon Road could generate the following benefits:

- **Travel Ease and Comfort**: More aesthetically pleasing street trees could increase the perceived trip quality of travel along Laguna Canyon Road.
  - There is a high likelihood that street trees will generate travel ease and comfort benefits, and the magnitude of these benefits is expected to be low.

- **Increased Property Values**: Landscaping improvements that beautify Laguna Canyon Road could make property along the corridor more desirable, leading to increased property values.
  - There is a medium likelihood that increased property values will result from changes to street trees along Laguna Canyon Road, generating an expected benefit of medium magnitude.

- **Carbon Sequestration**: Long-lived woody vegetation such as sycamores absorb carbon dioxide from the atmosphere and store it in solid form, combatting climate change.
  - There is an expected high likelihood that street trees along Laguna Canyon Road will sequester carbon, but the magnitude of this benefit is expected to be low.

- **Safety Benefits**: Larger or more plentiful street trees along Laguna Canyon Road could be crash hazards, decreasing the safety conditions of the roadway.

- There is an expected medium likelihood that street trees along Laguna Canyon Road will pose a safety hazard that generates safety "disbenefits."

3.2.2 Landscaping Elements and Materials

In addition to controlling the types and sizes of street trees along the corridor, the City would also gain control over other landscaping elements and materials. This would give the City latitude to select rural landscaping elements that maintain the natural look of the canyon, as opposed to the more manicured and curated variety of roadside landscaping featured in other communities of Orange County. As a state agency focused on transportation, Caltrans has little interest in the aesthetics of Laguna Canyon Road and is less responsive to community interests in this area than the City of Laguna Beach.

City control over landscaping elements and materials along Laguna Canyon Road would be expected to generate benefits similar to those associated with City control over street trees.

- **Travel Ease and Comfort**: More aesthetically pleasing landscaping along Laguna Canyon Road could increase the perceived trip quality of travel through the corridor.
  - There is a high likelihood that landscaping improvements will generate travel ease and comfort benefits, and these benefits are expected to be of medium magnitude.
- **Increased Property Values**: Landscaping improvements that beautify Laguna Canyon Road could make property along the corridor more desirable, leading to increased property values.
  - There is a medium likelihood that property values will increase as a result of changes to landscaping along Laguna Canyon Road, generating an expected benefit of medium magnitude.
- **Stormwater Runoff Mitigation**: Unlike paved surfaces, permeable surfaces such as soil and vegetation absorb stormwater, decreasing water runoff and flood risk.
  - Given the relatively confined scale of the landscaping improvements that would be implemented along Laguna Canyon Road, any stormwater runoff mitigation is expected to occur with low likelihood and to generate benefits of low magnitude.
- **Carbon Sequestration**: Roadside vegetation represents a natural source of solid carbon, and can play a part in sequestering carbon dioxide to combat climate change.
  - There is an expected low likelihood that landscaping elements and materials along Laguna Canyon Road will significantly sequester carbon as this type of vegetation is less woody and long-lived than street trees. The magnitude of this benefit is also expected to be low.

3.2.3 Fencing

Another specific design element that could be implemented along Laguna Canyon Road with City ownership is the installation of horse corral fencing, similar to that which existed

in the area in the 1930s and 1940s. This fencing could contribute the rural feel of the road.

The installation of horse corral fencing along Laguna Canyon Road would generate benefits similar to those associated with other corridor aesthetic improvements:

- **Travel Ease and Comfort**: More aesthetically pleasing fencing along Laguna Canyon Road could increase the perceived trip quality of travel through the corridor.
    - There is a high likelihood that fencing improvements will generate travel ease and comfort benefits, and these benefits are expected to be of medium magnitude.
- **Increased Property Values**: Fencing improvements along Laguna Canyon Road could beautify the corridor, increasing the desirability and value of neighboring real estate.
    - There is a medium likelihood that property values will increase as a result of changes to fencing along Laguna Canyon Road, generating an expected benefit of medium magnitude.

3.3 Roadway and Utility Integration

3.3.1 Undergrounding Of Utility Lines

With ownership of Laguna Canyon Road, the City of Laguna Beach would also be in the position to potentially oversee undergrounding of overhead utility distribution and sub-transmission lines that currently run along the corridor. Caltrans will not allow utility undergrounding along the Laguna Canyon Road within the travel lanes of the right-of-way, but with City ownership such an improvement would be a possibility.

The undergrounding of utility sub-transmission lines along the Laguna Canyon Road corridor could generate the following benefits:

- **Safety Benefits**: Relocating overhead utility lines to underground vaults would reduce the risk of vehicle collisions with utility poles. Underground electricity transmission lines also result in lower risk of injuries and fatalities caused by electrocution from downed power lines.
    - There is an expected high likelihood that undergrounded utility lines will generate safety benefits, and these benefits are expected be of a medium magnitude.
- **Travel Ease and Comfort**: Undergrounded utility lines are invisible to the public eye, resulting in an improved visual environment for Laguna Canyon Road.
    - Undergrounded utility lines are expected to result in travel ease and comfort benefits with medium likelihood, and the magnitude of this benefit category is expected to be low.
- **Wildfire Mitigation**: Overhead utility lines are a common cause of fire, and relocating electricity lines underground can reduce wildfire risk.

  - There is an expected low likelihood that undergrounding utility lines along Laguna Canyon Road will reduce wildfire risk, and the expected magnitude of this benefit is low.

- **Continuity of Utility Services**: Undergrounded utility lines are more protected from interruptions due to severe weather or surface collisions, improving the expected continuity of utility services.
  - There is a medium likelihood that improved continuity of utility service will be a benefit resulting from the undergrounding of utility lines, and the expected magnitude of this benefit is low.

3.3.2 Relocated Utility Cabinets and Transformers

In addition to undergrounding utility distribution and sub-transmission lines, the City of Laguna Beach would be able to locate any utility cabinets associated with new undergrounding projects within the right-of-way of Laguna Canyon Road with ownership of the roadway. Utility cabinets are currently located on the shoulders alongside Laguna Canyon Road, as Caltrans discourages utility infrastructure in the state-owned right-of-way.

The expected benefits of relocating utility cabinets and transformers are similar to those of utility undergrounding.

- **Travel Ease and Comfort**: Relocated utility infrastructure can be designed to be more aesthetically pleasing, increasing the quality of travel along Laguna Canyon Road.
  - The expected likelihood and magnitude of this benefit category are low.
- **Wildfire Mitigation**: Providing greater separation between utility infrastructure and potentially flammable vegetation can reduce wildfire risk.
  - There is a low likelihood that the relocation of utility infrastructure in the Laguna Canyon Road right-of-way, as opposed to outside of the right-of-way, will generate wildfire prevention benefits. The magnitude of these benefits are expected to be low.
- **Continuity of Utility Services**: Upgraded utility infrastructure relocated to more optimized locations can reduce the risk of interruptions to utility service.
  - Like the other benefit categories that could result from the relocation of utility infrastructure, the expected likelihood and magnitude of this benefit category are low.

3.4 Public Transportation and Carpooling

3.4.1 Shuttle Bus and Parking Lot

With ownership of Laguna Canyon Road, the City of Laguna Beach would be in a better condition to oversee improvements at parking lots and shuttle bus stops along the roadway. It can take significant amounts of time for vehicles to exit satellite parking facilities at times of high traffic and demand, especially for vehicles turning left. Caltrans

previously rejected a study to add signals at these parking facilities. With ownership of Laguna Canyon Road, the City could work to improve the interaction between shuttle buses, parking facilities, and general traffic along the roadway.

Shuttle bus and parking lot improvements are expected to yield the following benefits:

- **Safety Benefits**: Reducing conflict points between cars, buses, and pedestrians decreases the risk of crashes.
    - The expected likelihood of this benefit is low, while the benefit is expected to be of medium magnitude.
- **Travel Ease and Comfort**: Shuttle bus and parking lot improvements can ease travel by reducing driver, pedestrian, and bus rider frustration and dissatisfaction.
    - This benefit is expected to arise with medium likelihood, and the magnitude of this benefit is also expected to be medium.
- **Recreation and Health Benefits**: Improved parking lot and shuttle bus stops can facilitate beach access for area visitors and residents, providing recreational benefits.
    - There is a high likelihood that this benefit will be generated, and the expected magnitude of this benefit is low.
- **Travel Time Savings**: Improved traffic management at parking lots and bus stops can decrease traffic wait times, yielding travel time savings. Shuttle bus and parking lot improvements can also reduce vehicle volume and parking in downtown Laguna Beach, easing traffic and generating time savings in that area.
    - There is a high likelihood that improvements to shuttle bus stops and parking lots will generate travel time savings. The magnitude of these benefits is expected to be medium.
- **Reduced Transportation Costs**: Improvements to satellite parking facilities and shuttle bus pick-up and drop-off points can make the use of those services more appealing, inducing visitors to substitute away from more expensive transportation methods and parking locations.
    - This benefit is expected to result with medium likelihood from the proposed infrastructure improvement, and the magnitude of this benefit is also expected to be medium.

3.4.2 Transit Bus Stop and Route

The Orange County Transportation Authority (OCTA) 89 bus currently travels along Laguna Canyon Road with multiple stops between El Toro Road and its terminus at the Laguna Beach Bus Station. However, the majority of these stops do not have crosswalks and are difficult to legally and safely access on foot from both sides of the roadway. With ownership of Laguna Canyon Road, the City could work with OCTA to relocate and optimize bus stops, improving their accessibility, safety, and utility to bus riders.

Improvements to transit bus stops along Laguna Canyon Road are expected to generate the following benefits:

- **Safety Benefits**: In order to access many bus stops, passengers currently cross Laguna Canyon Road in areas without crosswalks. Optimizing the location of these bus stops can decrease safety risks.
    - Improving transit bus stops is expected to generate with medium likelihood to generate safety benefits, and these benefits are expected to be of medium magnitude.
- **Travel Ease and Comfort**: Improved bus stops will facilitate travel for bus riders.
    - This benefit is highly likely to be generated by bus stop improvements, and its magnitude is expected to be medium.
- **Travel Time Savings**: Optimized bus stop location can decrease travel times for bus riders by allowing them direct access to bus services closer to their origins or destinations.
    - This benefit is expected to be generated with medium likelihood and its magnitude is expected to be low.
- **Reduced Transportation Costs**: Optimized bus stops can induce some travelers to travel by bus instead of automobile, yielding transportation cost savings.
    - There is an expected medium likelihood that improved bus stops will generate transportation savings, and the expected magnitude of this benefit is low.

4 Potential Quantifiable Benefits of Roadway Improvements

This section provides a more detailed overview of the categories of benefits that the potential roadway improvements discussed in the previous section would be expected to generate. As previously discussed, the City's acquisition of Laguna Canyon Road would enable roadway and streetscape improvements that could generate these benefits. These benefits are not expected to accrue if Laguna Canyon Road continues under Caltrans ownership.

The following section describes each benefit category, the improvements that are expected to generate these benefits, and the accepted methodology or methodologies typically adopted to quantify and monetize these benefits. Where applicable, this section also discusses "case studies" in which the respective benefit was quantified or monetized for a roadway or streetscape improvement comparable to those evaluated for Laguna Canyon Road.

4.1 Safety Benefits

Safety benefits are generated as improved roadway conditions lower the likelihood of crashes, and this category of benefits is frequently monetized by multiplying the expected number of averted crashes by valuation parameters of crash severity based on the Economic Value of a Statistical Life (VSL). Safety benefits are expected to be generated with high likelihood by many of the potential roadway improvements under

consideration for Laguna Canyon Road. The magnitude of this benefit category is also expected to exceed that of any other category of benefits that would likely be generated along the corridor.

Safety benefits are expected to be generated as the following roadway improvements decrease the risk of traffic crashes:

- Roadway Design and Traffic Management
  - Optimized Road Striping and Lane Design
  - Traffic Control Measures, Signals, and Speed Limits
  - Crosswalks
  - Sidewalks
  - Shoulders
  - Reconfiguration of Driveways and Roadway Access Points
  - Bicycle Lanes
- Roadway and Utility Integration
  - Undergrounding of Utility Lines
- Public Transit and Carpooling
  - Shuttle Bus and Parking Lot Improvements
  - Transit Bus Stop and Route Improvements

Data provided by Caltrans shows that 847 documented vehicle crashes occurred along Laguna Canyon Road in the ten years from 2009 through 2018. These crashes involved 1,720 motor vehicles, 26 bicycles, and 21 pedestrians, and resulted in 469 injuries (including 22 cyclist and 16 pedestrian injuries) and 6 fatalities (including 3 pedestrian fatalities).

Published research demonstrates that roadway improvement projects similar to those under consideration for Laguna Canyon Road have delivered significant safety benefits in other settings. For example, research published by the National Cooperative Highway Research Program (NCHRP) analyzed approximately 1,000 sites across 14 different US cities where pedestrian hybrid beacons with advanced “yield” or “stop” markings and signs were installed. The results of this analysis found that the installation of such pedestrian crossing infrastructure reduces crash frequency by an average of 18 percent.[1] Other comparable research published by the Federal Highway Administration (FHWA) found a corresponding decrease in crash frequency of 28.8 percent.[2] Given the 21 pedestrian crashes and 3 pedestrian fatalities that occurred on Laguna Canyon Road over the last decade, improvements of this type could potentially avert as many as approximately 6 pedestrian crashes and approximately one fatality.

[1] *Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments*. Available at https://doi.org/10.17226/24627

[2] *Safety Effectiveness of the HAWK Pedestrian Crossing Treatment*. Available at http://www.cmfclearinghouse.org/study_detail.cfm?stid=196

Published research has also shown that separated bike lanes improve safety. Much of this research has been conducted in Canada, where one study in Montreal shows that bicyclists on roads with separated bike lanes had 28 percent less injury risk than those on comparable roadways without bicycle facilities. Other Canadian studies show that these safety benefits are most pronounced at non-intersection locations (at which particularly dangerous collision types such as hit-from-behind collisions are relatively more common), where the risk of injury decreases by 95 percent where bicyclists ride in separated bike lanes.[3] Implementing bicycle lanes along Laguna Canyon Road accordingly could be expected to avert between approximately 6 and 21 cyclist injuries over ten years.

The undergrounding of utility lines generates safety benefits in part by eliminating utility poles, which research shows pose a significant safety risk. Data provided by Caltrans shows 69 documented incidents in which motor vehicles collided with utility poles along Laguna Canyon Road from 2007 through mid-2019, including a collision that resulted in a fatality. By undergrounding utility transmission lines, this collision risk can be eliminated and a life could potentially be saved.

4.2 Improved Ease and Comfort of Travel

While of a relatively lesser magnitude than safety benefits, increased ease and comfort of travel is also expected to be a likely outcome of many of the potential improvement projects that would be enabled by the City of Laguna Beach's acquisition of Laguna Canyon Road. These benefits, also referred to as "journey quality" benefits, are expected to be potentially generated by nearly every roadway or streetscape improvement under consideration, including the following improvements:

- Roadway Design and Traffic Management
  - Optimized Road Striping and Lane Design
  - Traffic Control Measures, Signals, and Speed Limits
  - Crosswalks
  - Sidewalks
  - Shoulders
  - Reconfiguration of Driveways and Roadway Access Points
  - Bicycle Lanes
- Roadway Aesthetics and Design
  - Street Trees
  - Landscaping Elements and Materials
  - Fencing
- Roadway and Utility Integration

[3] *Bicyclist Safety on US Roadways: Crash Risks and Countermeasures*, pp 35-36. Available at https://www.ntsb.gov/safety/safety-studies/Documents/SS1901.pdf

  - Undergrounding of Utility Lines
  - Relocated Utility Cabinets and Transformers
- Public Transit and Carpooling
  - Shuttle Bus and Parking Lot Improvements
  - Transit Bus Stop and Route Improvements

Caltrans-published benefit-cost analysis methodology and parameters assign monetary benefits to "journey quality" elements such as improved walking and cycling infrastructure. Caltrans "Cal-B/C Active Transportation" documentation stipulates that sidewalk characteristics such as curb level and pavement evenness are worth 7.8 cents and 2.6 cents per mile, respectively, for every pedestrian that travels along the sidewalk. For cyclists, Caltrans-published methodology states that the perceived cost of traveling by bicycle decreases by 51 percent for travel in separated bicycle lanes relative to travel along comparable roadways without bicycle lanes.[4] These "journey quality" benefits are realized by pedestrians and cyclists in addition to the safety benefits that are also generated by these improvements.

With respect to landscaping and roadway beautification, a Georgia study, for example, shows that forested land on a roadside buffer has a monetizable aesthetic value ranging from $371 per acre per year to $1,695 per acre per year, depending on location.[5] Similar benefits are expected to be generated by natural roadside tree, landscaping, and fencing improvements along Laguna Canyon Road.

4.3 Recreation and Health Benefits

Roadway improvements that facilitate or encourage recreation activities or exercise also generate societal benefits. Individuals inherently value recreation, and exercise yields health and wellbeing benefits that have broader effects on society.

Recreation and health benefits are expected to be generated by the implementation of the following potential improvements to Laguna Canyon Road:

- Roadway Design and Traffic Management
  - Sidewalks
  - Bicycle Lanes
- Public Transit and Carpooling
  - Shuttle Bus Stop and Parking Improvements

Caltrans Cal-B/C Active Transportation documentation specifies that increased physical activity in the form of walking or cycling generate societal benefits in the form of increased productivity (measured by reduced worker absenteeism), and increased health

[4] *Cal-B/C Active Transportation Version 7.1 User's Guide and Technical Documentation*. Available at https://dot.ca.gov/programs/transportation-planning/economics-data-management/transportation-economics

[5] *Economic Impact of Ecosystem Services Provided by Ecologically Sustainable Roadside Right of Way Vegetation Management Practices*, p. 14. Available at: http://rightofway.erc.uic.edu/wp-content/uploads/2018/05/2A4-FDOT-ecosystem-services-roadsides-report.pdf

(measured by reduced mortality risk). According to Cal-B/C methodology, each additional 365 miles of annual cycling or walking activity is expected for reduce the annual risk of mortality by 4.5 and 9 percent, respectively. Cal-B/C methodology also stipulates that the average number of personal sick days decreases by 6 percent when an individual is active for at least 30 minutes of exercise per day.[6]

4.4 Travel Time Savings

Travel time savings are generated by roadway improvements that reduce traffic congestion and facilitate higher average travel speeds. These benefits can be monetized by multiplying the total amount of time saved, in person-hours, by estimates of the value of time, in dollars per hour.

Travel time savings are expected to result from the following roadway improvements:

- Roadway Design and Traffic Management
  - Traffic Control Measures, Signals, and Speed Limits
  - HOV or Restricted Access Lanes
  - Reversible Lanes
- Public Transit and Carpooling
  - Shuttle Bus and Parking Lot Improvements
  - Transit Bus Stop and Route Improvements

Several studies have shown that managed access roadways such as HOV and reversible lanes can yield significant travel time savings. Reversible general access and HOV lanes have been found to be most effective for roadways that experience highly asymmetric directional roadway demand, as is the case at times for Laguna Canyon Road.

For example, an analysis conducted by the Colorado Department of Transportation found that adding a reversible eastbound lane to a 13-mile stretch of I-70 would reduce travel time by 11,866 person-hours per year, or a 13 percent improvement in travel time along the roadway.[7] Another study examined reversible HOV lanes on I-93 and Route 3 in Massachusetts, which connect Boston to outlying areas in the north and south.[8] The lanes are positioned to accommodate commutes into the city in the morning and reversed in the afternoon for the commute home. The study found that average travel times in the HOV lanes decreased by as much as 6 minutes and 33 seconds down from

[6] *Cal-B/C Active Transportation Version 7.1 User's Guide and Technical Documentation*. Available at https://dot.ca.gov/programs/transportation-planning/economics-data-management/transportation-economics

[7] *I-70 Reversible Lane, Georgetown to Floyd Hill, Phase II Feasibility Study*. Available at: https://www.codot.gov/library/studies/i70twintunnels-environmental-assessment/reference-materials/I70ReversibleLaneReport_Dec2010.pdf

[8] *Active Traffic Management Case Study*. Available at: http://www.dot.ga.gov/BuildSmart/Studies/ManagedLanesDocuments/MLIP/MLIP05%20Report%20Appendix%20C-Technical%20Reports.pdf

an average travel time of 12 minutes and 1 second in general-purpose lanes.[9] Another example studied the effect of reversible lanes on I-30 near Dallas, TX and found that commuters saved an average of 9 minutes in the mornings and 4.5 minutes in the evenings by using the lanes.[10]

In a more urban context, a study from Portugal considered the impact on travel times and traffic flow of a reversible center lane in a downtown urban area of the Lisbon metropolitan area. The center lane of a three-lane roadway was designed to change travel direction on a fixed cycle throughout the day to account for unbalanced directional road demand at different times. While only spanning 120 meters in length, this reversible lane was shown to reduce average traffic delay times from 122 seconds to 55 seconds, or by over 50 percent.[11]

Overall, results can vary based on the context of the roadway, but generally areas that add directional capacity during periods of unbalanced directional travel demand achieve operational time saving benefits. Research shows that these benefits can be found in both highway and urban settings, and benefits of this type would likely be generated by improvements to Laguna Canyon Road.

4.5 Improved Emergency Response

Emergency response benefits accrue as police, fire, and medical services are able to more quickly respond to emergency situations, potentially minimizing personal harm and property damage. The FHWA notes that emergency vehicle access to HOV lanes can enhance response times, allowing the vehicles to respond quickly with minimal negative affect on the flow of traffic.[12]

Improved emergency response benefits are expected to be generated by the following roadway improvements:

- Roadway Design and Traffic Management
  - Bicycle Lanes
  - HOV or Restricted Access Lanes
  - Reversible Lanes

4.6 Increased Property Values

All else being equal, any roadway or streetscape improvement project that increases the perceived desirability of a given location will increase the value of property in close

[9] *Mobility in the Boston Region: Existing Conditions and Next Steps*. Available at: https://www.bostonmpo.org/data/pdf/studies/highway/2004_cms/04cmp_ch6.pdf

[10] *Atlanta Regional Managed Lanes Implementation Plan: Appendix C*. Available at: http://www.dot.ga.gov/BuildSmart/Studies/ManagedLanesDocuments/MLIP/MLIP05%20Report%20Appendix%20C-Technical%20Reports.pdf

[11] *Implementation of Reversible Lanes in Traffic Management of Urban Road Infrastructures*. Available at: https://fenix.tecnico.ulisboa.pt/downloadFile/563345090417147/Extended%20Abstract_final.pdf

[12] *Potential Impact of Exempt Vehicles on HOV Lanes*. Available at: https://ops.fhwa.dot.gov/publications/exemptvehicleshov/chapter2.htm

proximity to that location. This results through market forces, as improvements to an area will increase the willingness to pay of prospective buyers bidding for limited real estate in a supply-constrained environment.

Many of the roadway and streetscape improvements under consideration for Laguna Canyon Road are expected to increase the desirability of the corridor and, correspondingly, the value of real estate in the area. These improvements include:

- Roadway Design and Traffic Management
    - Crosswalks
    - Sidewalks
    - Reconfiguration of Driveways and Roadway Access Points
    - Bicycle Lanes
- Roadway Aesthetics and Design
    - Street Trees
    - Landscaping Elements and Materials
    - Fencing

Unlike other benefit categories, however, increased property values are not a societal benefit in and of themselves as much as they are a representation and monetization of other societal benefits. For example, decreasing the amount of harmful pollutants emitted by an industrial facility would be expected to increase the value of houses around that industrial facility. In this situation, the reduction in emissions directly results in the property value increase. There is no reason for those property values to increase other than the reduced pollution. It would therefore be “double-counting” to fully monetize both the value of emissions reduction *and* the resulting increase in property values, as that would amount to measuring the same societal benefit of reduced emissions in two forms and adding them together.

While increased property values are not their own independent form of societal benefit, the consideration of property values can still be a useful metric to monetize benefits that are otherwise difficult to measure. For example, a roadway beautification project may increase the property values of land that overlooks the roadway. It may be difficult to monetize the value of the roadway beautification project in and of itself, but an analysis of the increase in property values that overlook the beautified roadway could provide a proxy for the societal value of roadway beauty.

4.7 Wildfire Mitigation

Wildfires can be devastating events. In recent Laguna Beach history, a 1993 fire that started north of El Toro Road burned 16,000 acres and destroyed 400 homes. Devastating wildfires are often caused by above ground electricity infrastructure, and wildfire prevention and mitigation benefits can be generated by the following roadway improvements:

- Roadway and Utility Integration
    - Undergrounding of Utility Lines

  - Relocated Utility Cabinets and Transformers

Undergrounding utility conduits has been reviewed and studied in California extensively due to the state's vulnerability to wildfires and recent experiences with utility conduit ignition. For example, above ground power lines sparked fires that devastated California in 2017 and 2018. The Pacific Gas and Electric Company (PG&E) estimates that the total liability related to the 2017 and 2018 fire could exceed $30 billion. The Los Angeles Department of Water and Power states that one of the safest ways to carry electricity is by burying power lines underground, and improvements of this kind could avert billions of dollars of fire damage.[13]

Data provided by Caltrans documents 7 recent incidents involving utility poles or above ground power lines that sparked small fires in the area of Laguna Canyon Road, and the undergrounding of power lines could have averted these fires. None of these incidents, however, resulted in loss of life or significant property damage.

4.8 Continuity of Utility Service

Above ground utility infrastructure, including electricity distribution and sub-transmission lines, are exposed to the natural elements and to human-caused damage (*e.g.*, crashes). Relocating utility infrastructure underground or better protecting it at ground level can generate societal benefits by decreasing the risk of utility service interruption. For example, a study conducted by the Virginia State Corporation Commission found that underground electricity lines "eliminate the need for most tree trimming maintenance, eliminate vehicular crashes with utility poles, reduce some electrical hazards, and nearly eliminate the need for extensive restoration efforts after major storms," improving the overall reliability of electrical service.[14]

Utility service continuity benefits are expected to be generated by the following potential infrastructure improvements:

- Roadway and Utility Integration
  - Undergrounding of Utility Lines
  - Relocated Utility Cabinets and Transformers

Data provided by Caltrans show 69 documented collisions between motor vehicles and utility poles and 7 utility pole-related fires between 2007 and mid-2019. The majority of these incidents, as well as additional documented utility pole disruptions, resulted in interruptions to utility service in the area of Laguna Canyon Road. The infrastructure improvements under consideration for this area could prevent these disruptions, generating societal benefits that would be realized in Laguna Beach and in surrounding communities.

[13] *It Only Takes a Spark: Enhancing LADWP's Wildfire Prevention Strategy*. Available at: https://lacontroller.org/audits-and-reports/dwps-wildfire-prevention/

[14] *Preliminary Analysis of Placing Investor-Owned Electric Utility Transmission and Distribution Facilities Underground in Florida.* Available at: http://www.psc.state.fl.us/Files/PDF/Publications/Reports/Electricgas/Underground_Wiring.pdf

4.9 Reduced Transportation Costs

Transportation cost savings are expected to be substantively generated by two potential improvements to the Laguna Canyon Road corridor:

- Public Transit and Carpooling
  - Shuttle Bus Parking Improvements
  - Transit Bus Stop and Route Improvements

These benefits will result from changes that facilitate public transportation and carpooling, making it easier for individuals to save transportation and parking costs by shifting to established transit services.

4.10 Stormwater Runoff Mitigation

Stormwater that flows away from roadways can be a source of flooding and erosion, and can spread contaminants from the roadway into nearby bodies of water. Stormwater runoff mitigation benefits are generated by hydrologic changes that retain stormwater or allow it to permeate into natural surfaces, reducing harmful runoff.

Stormwater runoff mitigation benefits are expected to be generated by the following infrastructure improvement:

- Roadway Aesthetics and Design
  - Landscaping Elements and Materials

A University of Florida report sponsored by the Florida Department of Transportation identified that limiting stormwater runoff reduces erosion, flooding and the pollution of lakes and rivers. The study also found that adding a considerable percentage of trees to the roadside right-of-way ecosystem had a quantifiable effect on reducing runoff. The study valued the benefit of this reduction of runoff at $465 million, but noted it could triple if sustainable management practices were implemented. This finding substantiated the results of other studies published in 1998, 1999, and 2008 that also showed trees and landscaping provide significant stormwater runoff benefits.[15]

4.11 Carbon Sequestration

Atmospheric carbon dioxide (CO_2) is naturally captured by plants and vegetation. This carbon is “sequestered” as it is converted from atmospheric CO_2 into a solid form through the process of photosynthesis. Sequestered carbon that is removed from the air no longer contributes to global climate change, generating environmental benefits.

Carbon that is sequestered in plant matter can reenter the atmosphere in a gaseous CO_2 form as the solid plant matter decays, whether through biodegradation or combustion. Accordingly, the length of time for which CO_2 is sequestered depends on the lifespan of

[15] *Economic Impact of Ecosystem Services Provided by Ecologically Sustainable Roadside Right of Way Vegetation Management Practices*. Available at: http://rightofway.erc.uic.edu/wp-content/uploads/2018/05/2A4-FDOT-ecosystem-services-roadsides-report.pdf

the plant. Similarly, plants that produce heavy "woody" solid matter sequester more carbon than lighter plants.

The roadway improvements under consideration for Laguna Canyon Road that could sequester carbon are only expected to yield a low magnitude of benefits. These roadway improvement projects are:

- Roadway Aesthetics and Design
  - Street Trees
  - Landscaping Elements and Materials

The University of Florida study discussed with respect to stormwater runoff mitigation also found that vegetation along roadside right-of-way ecosystems provides carbon sequestration benefits partially due to their proximity to the roadway. The report valued the benefit from carbon sequestration along Florida roadside rights-of-way at over $39 million, while a separate FHWA report valued this benefit between $157 and $363 million.[16]

4.12 Emissions Reduction

Emissions reduction benefits accrue primarily as infrastructure changes induce travelers to "shift modes" away from individual motor vehicles to more efficient and environmentally friendly forms of travel, such as public transit, carpooling, cycling, or walking. Emissions reductions can also result from more efficient traffic patterns and driving behavior that result in, for example, reduced vehicle idling and more consistent travel speeds with less braking and accelerating. Reductions in the combustion of petroleum-based fuels that result from any of these travel behavior changes will lead to less harmful pollutants being emitted by vehicles. The societal benefit of this reduced emission can be calculated by multiplying the mass of averted pollution by published recommended monetized values of various pollutants in dollars per ton.

The following infrastructure improvements are expected to generate emissions reduction benefits:

- Roadway Design and Traffic Management
  - Bicycle Lanes
  - HOV or Restricted Access Lanes
  - Reversible Lanes
- Public Transit and Carpooling
  - Shuttle Bus and Parking Lot Improvements

Given the relatively modest amount of mode shifting expected to be generated by these improvements, the magnitude of emissions reduction benefits is expected to be small.

[16] *Economic Impact of Ecosystem Services Provided by Ecologically Sustainable Roadside Right of Way Vegetation Management Practices*. Available at: http://rightofway.erc.uic.edu/wp-content/uploads/2018/05/2A4-FDOT-ecosystem-services-roadsides-report.pdf

5 Matrix of Improvements and Benefits

The matrix below summarizes the anticipated likelihood and magnitude of benefits potentially achieved by each of the potential improvements that may be undertaken if the City gains ownership of Laguna Canyon Road.

Figure 5-1. Matrix of Improvements and Benefits

Improvement Type			Benefit											
			Safety Benefits	Ease and Comfort of Travel	Recreation and Health Benefits	Travel Time Savings	Emergency Response Benefits	Increased Property Values	Wildfire Mitigation	Continuity of Utility Services	Reduced Transportation Costs	Stormwater Runoff Mitigation	Carbon Sequestration	Emissions Reduction
Improvement Type	Roadway Design and Traffic Management Improvements	Road Striping and Lane Design	○ ★	◉ ★										
		Traffic Control Measures	● ★	◉ ★		◉ ★								
		Crosswalks	● ★	● ★		◉ X		○ ★						
		Sidewalks	◉ ★	● ★	◉ ★			● ★						
		Shoulders	● ★	◉ ★										
		Driveways and Access Points	◉ ★	◉ ★				◉ ★						
		Bicycle Lanes	● ★	● ★	● ★		● ★	◉ ★						● ★
		HOV or Restricted Access Lanes				● ★	◉ ★							◉ ★
		Reversible Lanes				● ★	◉ ★							◉ ★
	Corridor Aesthetics and Design Opportunities	Street Trees	◉ X	● ★				◉ ★					● ★	
		Landscaping Elements		● ★				◉ ★				○ ★	○ ★	
		Fencing		● ★				◉ ★						
	Roadway and Utility Integration	Undergrounding of Utility Lines	● ★	◉ ★					○ ★	◉ ★				
		Relocated Utility Cabinets		○ ★					○ ★	○ ★				
	Public Transit and Carpooling	Shuttle Bus and Parking Lots	○ ★	◉ ★	● ★	● ★					◉ ★			◉ ★
		Transit Bus Stop and Routes	◉ ★	● ★		◉ ★					◉ ★			

Likelihood of Benefit		
●	◉	○
High	Medium	Low

Magnitude of Benefit		
★	★	★
High	Medium	Low

Potential Disbenefit
X

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