APPENDIX 4

Alternatives Analysis Report

May 2015

Pacific Coast Highway Safety Study: Alternatives Analysis Report

City of Malibu

Prepared for:
City of Malibu
and
Southern California Association of Governments

May 15, 2015

Sign-off Sheet

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1.0 INTRODUCTION

Within the City of Malibu, State Route 1 (SR-1), also known as Pacific Coast Highway and as PCH, travels for approximately 21 miles and contains 19 signalized intersections. The study's limits stretch from just south of Mullholland Highway to just south of Tuna Canyon Road. As a State Highway, PCH is controlled, operated, and maintained by the California Department of Transportation (Caltrans).

The corridor serves as an important route between coastal Los Angeles and Ventura County. Equally, it is an important access route for Malibu residents and provides access to several important recreational areas, the beaches of the Southern California coast and the Santa Monica Mountains National Recreation Area. Because of the various land-uses, activity areas, and corridor traffic demands, PCH is congested, vehicle speeds are often excessive, and traffic collisions become all too frequent.

Due to high traffic volumes and other factors, the roadway experiences a high number of traffic collisions, approximately one per day. The incidents can result in injuries or death and also can cause the roadway to be closed or congested around collision sites frequently. In response to these concerns, the Southern California Association of Governments (SCAG) administered a contract for safety studies along the corridor to identify remedies to reduce the frequency and severity of collisions. Funding for the studies was allocated by Caltrans with a local match from the City of Malibu.

Starting in 2012, LSA Associates was contracted with SCAG to produce a series of reports quantifying and analyzing the PCH corridor for potential safety improvements. A variety of locations, conditions, and deficiencies were identified in the Existing Conditions Report and Safety Assessment Report. The safety of the roadway has been evaluated numerous times further in the past, and many of the results of previous studies were considered in this report.

At the conclusion of the previous study, the City of Malibu reviewed the report and determined that greater analysis was desirable to closely and precisely identify specific actions that could be undertaken at this time to improve safety and reduce the frequency of collisions. At the end of 2014, SCAG in association with the City of Malibu, contracted with Stantec Consulting Services Inc. to complete the desired focus study.

The issues recognized in the previous study have been combined with our own technical assessment of the corridor's existing conditions through extensive field reviews and an analysis of recent collision data. These previous reports have been incorporated in the Appendices. Our study included a comprehensive analysis of traffic collision reports taken in 2012-2014 and a review of prior information and analysis. We also conducted an updated public workshop in February, 2015 to solicit additional public input and advice of our preliminary assessment of conditions.

Introduction
May 15, 2015

This Alternatives Analysis Report has been prepared to present potential solutions and recommendations to improve safety along the PCH corridor. The report includes a detailed listing of collision locations and types, an inventory of comments received and prior improvement suggestions, and an evaluation of potential recommended improvements, based upon effectiveness and constraint criteria.

The text sections of this report provide information on the analysis and suggest how certain classes of improvements may be very effective in improving safety. The methodology for evaluation of recommended and suggested improvements is also discussed. A series of appendices follow the report text. These all provide valuable and comprehensive information on issues and recommendations.

Many of the appendices present information in geographic format based upon the official post mile for the route as designated by Caltrans. This post mile system increases traveling from one end of the study area to the other, thus providing a precise method of locating sites and incidents. It should be noted that there is not consistency in whether PCH is a north/south route or an east/west route. Generally many residents of Malibu refer to it as an east/west route, true to the compass, but Caltrans considers PCH to be a north/south route when viewed from a State perspective. This inconsistency played a significant role in this study, because collision reports refer to collision sites based upon their direction from a nearby intersection, and rely upon the compass directions. Some reports use the east/west convention while others use north/south. In order to be consistent with Caltrans official milepost system, all distance references in the appendices consider PCH to be a north/south route.

Appendix A is a complete tabulation of collision locations and frequency. Each reported collision is summarized and located on a line of the table. Collisions are presented in order from the north end of the City near Ventura County, to the other end past Tuna Canyon Road.

Appendix B summarizes public comments received from the public workshop held on February 19th, 2015 as well as comments gathered from previous PCH safety studies sorted by geographic location, starting at the northern City limits.

Appendix C provides a listing of recommended projects for final consideration and approval.

- Table 1 lists all recommended projects by geographic location, beginning at the northern City limits.
- Table 2 sorts the recommended projects by merit score.
- Table 3 sorts the recommended project list by overall score including the consideration of possible project constraints.

Appendix D presents a series of figures showing all study recommendations by location. Pages D1 through D16 details intersection-focused projects, while pages D1 7 through D49 shows all recommended projects for the entire corridor on aerial photography mapping.

Appendix E provides a listing of recommended maintenance projects that are implementable by Caltrans in the short-term.

Appendix F groups the recommended projects together for future implementation purposes. Their estimated design and construction costs are provided. For those categorized as feasibility studies, the cost estimate provided is for the study itself, not the cost to design and construct the project should it move forward.

Appendix G provides a prioritized list of the recommended groupings of projects.

Appendix H provides the final listing of individual prioritized projects. The prioritization is based on the grouping prioritization in Appendix F and on the individual project's merit ranking. Those projects with higher merit scores were assigned as higher priority.

Following approval of the study and recommendations by the City of Malibu, the City anticipates pursuing study recommendations for funding and implementation based largely upon the priority and logical grouping of individual recommendations.

2.0 PROJECT IDENTIFICATION AND DEVELOPMENT

2.1 SUMMARY OF COLLISIONS AND PATTERNS

The initial study task was to prepare a geographic listing of all reported traffic collisions for the study area over the last three years (January 1, 2012 – December 31, 2014) together with a summary of factors summarized for each collision. The listing is based upon the Statewide Integrated Traffic Records System (SWITRS) supplemented by scanned copies of individual collision or incident records (which by State law do not reveal involved parties names). The SWITRS system includes information on the date, location, type of collision, severity, and other factors. The individual records contain narratives, diagrams, and information unique to each collision.

The three year collision history included about 1,000 incidents. While these were more highly concentrated in the central Malibu area and on the more heavily traveled portion of the roadway to the south, collisions have been reported at or near all points along the roadway over the three year reporting period. This history was compared with the data presented in the previous study. The most recent pattern of collisions had not changed substantially from past analyses, although the precise number of incidents and specific locations are subject to annual variation. Between the John Tyler Drive and Big Rock intersections, the total number of collisions during the three years was 574 and the total collision rate is 2.73. The total number of injury collisions was 221 and fatal collisions were 4, with collision rates equaling 1.05 and .019, respectively.

Closer analysis of the collisions determined that the capabilities, design features, and method of operation of uncoordinated traffic signals was perhaps the most significant contributing factor, and rear end collisions approaching traffic signals was the most common type of incident. Collisions involving left turns at signalized intersections without left turn arrows were also frequent.

Collision patterns common at non-signalized locations included hitting parked cars, vehicles making U-turns at midblock locations related to parking, and collisions near the two marked uncontrolled crosswalks in the pier area.

Collision reports for the entire PCH corridor within the City of Malibu during the three-year period included 376 injury and 9 fatal collisions. The fatal locations tend to be widely scattered and not closely associated with the sites with frequent collisions. Also, most fatal collisions involved a pedestrian or a bicyclist. There were also frequent non-fatal collisions involving pedestrians and bicyclists. Pedestrian collisions tend to involve pedestrians crossing away from intersections or crosswalks. Bicycling collisions tend to involve through bicycles and turning motor vehicles, but less frequently have involved through vehicles striking bicyclists due to narrow roadway features or parked cars occupying the roadway shoulders.

The largest concentration of collisions occurred in the 1.4 mile segment of roadway between Sweetwater Canyon Drive and Carbon Canyon Road, an area that includes commercial uses, restaurants, hotels, and numerous residences with driveways along PCH. Along this segment of PCH, 89 collisions occurred during the three-year period and included a wide variety of collisions such as rear end, sideswipe, broadside, and hit object collisions; although, the majority (53 collisions, 60 percent) were rear end collisions.

The single intersection with the most collisions was Las Flores Canyon Road where 80 collisions occurred at or within 100 feet of the intersection. Over 50 percent (41 collisions) were rear end collisions at this intersection. This intersection is very close (approximately 250 feet) to the Rambla Pacifico Street intersection where an additional 15 collisions happened, and confusion caused by the two closely spaced intersections may contribute to the number of collisions occurring at this location.

2.2 ONGOING PACIFIC COAST HIGHWAY PROJECTS

Some improvements are underway that could improve safety. This section provides project descriptions along with their funding status. There may be additional measures, including those in our recommendations that could further improve safety if included as committed projects. An example would be the Trancas tunnel to Zuma beach in conjunction with the replacement of the Trancas Creek bridge.

Tables 2-1 and 2-2 show the City's currently programmed and requested Measure R projects.

Table 2-1. Measure R Programmed Projects

Funding Agreement No.	PROJECT NAME	Total Allocation
MR311.24	Civic Center Way Improvements	$3,350,000
MR311.30	PCH Roadway and Bike Improvements from Busch Drive to North City limits	$500,000
MR311.31	PCH Roadway and Bike Improvements from Busch Drive to South City limits	$750,000
MR311.26	PCH Raised Median and Channelization from Webb Wy to Puerco Cyn	$3,950,000
MR311.27	PCH Intersection Improvements	$3,300,000
MR311.32	PCH and Big Rock Dr. Intersection & La Costa Crosswalk Imp.	$950,000
MR311.28	PCH/Kanan Dume Road Intersection and Arrester Bed	$900,000
MR311.29	PCH Regional Traffic Message System	$300,000
	TOTAL	$14,000,000

Table 2-2. Measure R Programming for Requested Projects

Funding Agreement No.	PROJECT NAME	Total Allocation Requested
MR311.26	PCH Raised Median and Channelization - Webb Wy to Puerco Cyn Rd.	$3,000,000
MR311.29	PCH Regional Traffic Message System	$500,000
	PCH Shoulder Enhancements	$3,500,000
	TOTAL	$7,000,000

The ***PCH Bike Improvements Project*** for the northern portion of the City from Busch Drive to the northern City limits was recently completed. It includes a 6" shoulder striping and signage upgrades throughout the entire seven miles from Trancas Canyon Road to the northern City limits on both sides of PCH, as well as the following improvements:

- Zuma Beach Bike Lane - Install a Class II Bike Lane installed on the ocean side of the highway from Trancas Canyon Road to Busch Drive. The Bike Lane is 6 feet wide, running parallel to the highway and adjacent to the shoulder parking pedestrian access areas for approximately two miles.

- PCH and Morning View Dr. Intersection - Dedicated northbound right turn lane onto Morning View Dr. constructed with a 4-foot bike lane to the left of the right turn lane, relocate the existing bus stop, and storm drain, sidewalks, and ADA improvements.

- PCH and Trancas Canyon Rd. Intersection – Install a 300 foot long raised concrete median installed.

The ***PCH Raised Median and Channelization Project*** will improve and install raised medians along PCH/SR-1 from Webb Way to Puerco Canyon Road, a distance of approximately 2 miles. The project will channelize the highway, regulate turn movements and improve the regional operational flow of traffic. In response to preliminary design discussions with Caltrans, the City of Malibu is requesting additional funds necessary to complete the design and construction of the project. The City is currently working with Caltrans to combine the Caltrans' initiated median improvement project currently planned from Puerco Canyon Road to Corral Canyon Road. This project may include a landscaped median utilizing reclaimed water.

For the ***PCH and Big Rock Dr. Intersection*** and ***La Costa Crosswalk Improvements Project***, the Big Rock Drive intersection improvements have been completed, which included the installation of a protected-permissive left turn signal phase, curb and gutter, Americans with Disabilities Act (ADA) improvements, bike detection loops on Big Rock Drive, replacing signal poles, and

repainting the crosswalk. The City of Malibu is currently in the design phase of the La Costa Crosswalk improvements.

The ***PCH at Kanan Dume Road Intersection*** and ***Arrester Bed Improvements Project*** was completed and included channelizing the intersection, modifying the existing gravel filled arrester bed, and installing additional signage along Kanan Dume Road. The arrester bed is intended to slow runaway trucks and prevent them from entering the intersection at PCH. The City also restriped/signed Kanan Dume Road to enable motorists to turn north or south from the middle lane onto PCH.

The ***PCH Regional Traffic Message System Project*** will enable the City of Malibu and other agencies to notify travelers of critical regional traffic and safety information and better facilitate traffic flow throughout the region. As part of the project, permanent changeable message signs will be installed at strategic locations along the PCH/SR-1 corridor in Malibu. In response to preliminary design discussions with Caltrans, the City is requesting additional funds necessary to complete the design and construction of the project. The City is currently proposing to install Caltrans Model 520 signs in the vicinity of PCH and Kanan Dume Road and PCH and Malibu Canyon Road.

The ***PCH Shoulders Enhancements Project*** will improve the existing highway shoulder at strategic locations along PCH/SR-1 to provide sufficient room to accommodate multiple users simultaneously. This project will enhance the shoulder to reduce conflicts and potential for collisions and, thus, serve to reduce incident delay on the highway. The locations for enhancements have not been finalized yet.

The ***PCH Bus Stop Improvements Project*** is under construction and is anticipated to be completed by summer 2015. The project will improve eleven existing bus stops served by MTA Line 534. In general, the improvements may include the relocation of bus stops and the installation of concrete benches, sidewalks, pedestrian railings, and ADA improvements.

2.3 TRAFFIC SIGNAL SAFETY AND OPERATIONAL IMPROVEMENTS

In response to the high number of collisions associated with traffic signals, the project team placed special focus upon the traffic signals and operation along the corridor, in part due to the number of collisions resulting in rear end incidents or collisions with cross traffic. These collisions can often be associated with traffic signal design and operation features that can be adjusted through traffic signal timing or design improvements. Techniques that improve the visibility of signal indications, reduce the need to stop, provide separate control of conflicting traffic movements (via left turn arrows, etc.), and identify traffic gaps prior to turning yellow can improve safety for the most frequent types of collisions being experienced.

Investigations reveal that the traffic signals along the corridor are not in optimal condition to meet the demands of existing traffic. They are not interconnected using communication equipment that provides for coordinated or synchronized operation. They are not always able to detect gaps in traffic flow, and the detectors that sense traffic and search for gaps are often

located too close to the intersection. While different timing plans are used based upon time of day and seasonal flows, the timing plans must be input manually at the beginning and end of every season. Also timing plans used on popular beach weekends are similar to weekday peak period plans, even though the flow of vehicles is in the opposite direction.

Traffic signal control technology has improved considerably since the traffic signals were constructed. A primary recommendation of this study is to upgrade and modernize the traffic signals to be able to respond optimally to existing traffic conditions and to allow for more sophisticated traffic control. Specific improvements would include the following:

- Provide reliable communication for traffic signals between Las Flores and John Tyler intersections, plus a communication link to the Caltrans Traffic Management Control Center. Also provide similar communication for traffic signals between Paradise Cove and Trancas Canyon.

- Provide traffic signal phasing changes to provide left turn signals for traffic turning left from PCH at locations where they are not currently present, including Las Flores and John Tyler.

- Modify traffic signal phasing so that pedestrians are not crossing PCH while left turns from tee intersections simultaneously turn through the crosswalk, including Trancas Canyon, John Tyler, Webb Way, and Las Flores.

- Modify traffic signal detection locations in the pavement so that vehicles are detected at a sufficient distance that motorists at prevailing speeds have sufficient time to stop for yellow signals. The distance is currently based upon posted speeds which are typically up to 10 mph lower than many vehicles are traveling. This causes drivers to be placed in a dilemma zone where they are forced to either brake suddenly or run a right light. The Federal Highway Administration (FHWA) has specifically identified this treatment for effectiveness in reducing collisions at signalized intersections.

- Modify traffic signals at locations where signal poles are installed within the roadway shoulders and fully exposed to vehicle traffic. Varying levels of construction to provide curbing, standing area for pedestrians, and access maps will be required.

The proposed signal improvements will require an investment of about $300,000 per intersection. The results are expected to produce a large reduction in traffic collisions at or near traffic signals. The improvements will also provide for more effective timing of traffic signals to meet the needs of regular, seasonal, and special traffic demands. Improved signal synchronization will reduce the frequency of vehicle stops and will more readily allow for development and implementation of timing plans for use on summer weekends or during incidents that disrupt traffic. It may also facilitate the development of timing plans that reward motorists for driving at slower speeds by

design. The technique of setting signals for 35-40 mph flow is often effective in reducing overall vehicle speeds between signals.

An added benefit will stem from the ability to operate the traffic signals to serve vehicles more frequently. A number of collisions may be occurring away from intersections, especially in the pier area, because the signals currently change very slowly and infrequently and do not produce regular breaks in the traffic flow. Motorists exiting driveways may not have clear vision of through traffic and may be taking excessive risks by entering the traffic flow when through traffic is heavy. It is common to see motorists turning against red signals or making aggressive movements because the signals are not cycling fast enough. Waits of three minutes or more have been observed, experienced, or reflected in the timing records.

2.4 MEDIAN AND TURNING SAFETY IMPROVEMENTS

Many collisions involve vehicles making left turns onto or off of PCH at unsignalized intersections or away from intersections. A surprisingly large number of collisions involve motorists making U-turns away from intersections. The condition of the medians varies along the route. Left turns are generally permitted through the presence of a two-way left turn lane for much of the route. Raised medians are constructed in some areas, especially from Webb Way to Corral Canyon. Some of these medians are relatively old, so the median height has been reduced by repaving until it is almost negligible. Newly constructed landscaping is provided for the raised median segment, between Webb Way and Cross Creek Road.

Painted double-double yellow lines are used to simulate medians in some areas. Many of these areas provide less than 10 feet within the median area, which is too narrow to fit waiting vehicles. Some of these areas have been supplemented with orange paddle marker systems that discourage vehicles from trying to cross the median. These systems can optically appear to be more effective than raised medians but vehicles are often seen crossing these markers. Motorists also know they can knock them down and they spring back.

Construction or reconstruction of raised medians is generally recommended in all areas where left turns are already prohibited by striping or paddle marker systems. Following provision of medians, the paddle marker systems will no longer be required. Concrete curbs would be provided, and landscaping opportunities may become available where the median width is greater than six feet. The City of Malibu is planning to construct a new wastewater treatment plant in the vicinity of the Civic Center area and will have opportunities to possibly utilize reclaimed water for the installed landscaping. Also, when considering the use of raised concrete median curbs, it is important to also consider strategic locations for emergency vehicle crossings.

Prohibition of left turns can become controversial, especially in commercial areas and in front of residential driveways. Limited segments of raised median are recommended at sites in areas with collision history, where they benefit pedestrians, or help to better manage speeds. More extensive raised medians may further improve safety but they may interfere with access to

commercial and residential establishments or not allow U-turns for many miles. The study recommends medians at locations where most justified due to demonstrated safety problems and in areas where U-turns can be made nearby.

Landslide activity near Big Rock has partially or fully closed the inland shoulder in the vicinity. The study suggests that the median be reduced to allow for restoration of the shoulder in these areas. This will increase the separation between motorists and the concrete barriers that occupy or close the shoulder, reducing the potential for collision with fixed objects. In addition crash cushions or protective treatments are proposed where the end of these concrete barriers is exposed to oncoming traffic.

2.5 COLLISIONS WITH PARKED CARS

Collisions with parked cars have been reported frequently. This is primarily due to cars parked on the highway shoulders in the pier commercial and nearby residential areas, in front of some residences, and at or near popular beaches. Areas with heavy beach related parking include the three small beach areas north of Trancas Canyon, Zuma Beach, Paradise Cove, Winding Way, Escondido Canyon, Corral Canyon, the beach houses south and south of Las Flores, Moonshadows Restaurant, and small beaches near Topanga Canyon Road.

State Coastal Policy discourages reduction of parking supply in the Coastal Zone. In response, study recommendations seek to reduce collisions with parked vehicles by providing wider roadway shoulders through restriping to narrow the striped median or travel lanes slightly. Consideration of a wider edge line, such as a six-inch bicycle lane stripe is also proposed. The City of Malibu has recently implemented the wider edge line from Busch Drive to the northern city limits. The standard width for travel lanes is 12 feet, but Caltrans may allow a special exemption for reductions to 11 feet in appropriate areas where separation from regularly parked cars is achieved. A reduction from 12 feet to 11 feet would be a typical application, but no narrow reductions are proposed by this study.

The area from Malibu Pier to Carbon Canyon provides 12-foot travel lanes and 12-foot parking lanes that are heavily used. The parking lanes are also heavily used by bicyclists. Reducing each travel lane by one foot will allow the parking lanes to increase to 14 feet, meeting the preferred distance for a bicycle lane adjacent to heavily used parking. Increasing the shoulder width will also provide improved view of approaching vehicles for traffic exiting driveways in areas with heavy parking demand.

Several other popular beach areas experience heavy parking demand, including the three small State beaches north of Trancas Canyon, and the area near Corral Canyon. The median and travel lane dimensions exceed minimum standards in these areas. The shoulders can be widened by restriping to conform to minimum standards readily. This can allow additional space for pedestrians who walk from parked cars to beach access points.

Parking is heavily used at some locations where it will be difficult to narrow roadway features. Where justified, more ambitious projects are recommended to provide more area for parking or wider shoulders. The tight areas include the Paradise Cove area, the Escondido Canyon area, the Westward Beach Road area, and the Las Flores/Rambla Pacifico area. More ambitious and costly improvements are recommended for these areas, which will require widening and may require acquisition of private property. Recommendations do not anticipate the need to acquire developed properties, but refinement of feasibility studies may determine that private development is affected. At that time, the merits of the project may be appropriate for reevaluation.

2.6 OTHER IMPROVEMENT TYPES

Some traffic signs throughout the corridor are showing their age. This is indicated by lack of reflectivity at night when illuminated by vehicle headlights. These include warning signs that can be important in alerting drivers to conditions ahead, as well as street name and other signs that allow motorists to find destinations with minimum distraction. Maintaining signs along PCH is the responsibility of Caltrans. A thorough review of signs throughout the corridor is recommended to insure that signs not meeting current standards for reflectivity or usage are upgraded or replaced. This includes illumination of overhead SIGNAL AHEAD warning signs that have minimal reflectivity and can be very difficult to read after dark due to flashing yellow lights adjacent.

Street lighting can be a controversial topic in semi-rural areas. The need for continuous street lighting is not recommended or justified in rural or semi-rural areas because continuous street lighting is not strongly connected to collision frequency in these area types. The primary benefits of street lighting are to allow walkers to not require flashlights and to reduce crime in the illuminated areas. Street lights are recommended at isolated intersections in areas where local streets meet PCH because they help to illuminate vehicles waiting on side streets at intersections, correspond with more traffic and turn movements, or places where pedestrians may cross more frequently.

In lieu of street lighting, greater use of reflective treatments is encouraged. Caltrans now installs reflective plastic delineator posts along the outside of all curves along highways in dark areas. These can be seen for a long distance in advance and help motorists to anticipate the alignment changes in the roadway, improving safety after dark. This treatment is generally recommended along the outside of curves in undeveloped areas especially north of John Tyler Drive.

Additional improvements are suggested at sites based upon their potential to reduce collisions or in response to localized conditions that are appropriate for treatment, such as corners with limited sight distance, unusual striping configurations, or poor conditions for frequent pedestrians. Justification for these treatments should be undisputable.

Pedestrian crossings at uncontrolled locations near beaches are often observed. In some cases it may be possible to provide a properly designed pedestrian undercrossing from the inland side to the beach, especially near canyon waterways. Where recommended, these would consist of properly designed undercrossings providing adequate width, head clearance, and fully improved walking surface meeting ADA requirements. Some public commenters have suggested pedestrian bridges. These are not recommended because of the reluctance of pedestrians to climb above the roadway, cross, and drop back down to street level. Undercrossings are more appropriate for access to the lower elevations of the beach and are already provided at locations outside of the study area, such as Topanga Beach.

No additional traffic signals are recommended for the corridor at this time. Minimal justification and warrants should be conducted regularly to verify the traffic patterns along PCH have not changed significantly. The safety problems evident for the existing intersections demonstrate that traffic signals are not generally considered to be a universally accepted safety device.

A new traffic control treatment is recommended for the marked uncontrolled crosswalks in the pier area. Pedestrian hybrid beacons (PHB) are similar to traffic signals, but rest in dark until pedestrians request a crossing. They flash yellow, solid yellow, then red for traffic. Pedestrians receive a WALK signal after traffic has stopped. Soon after, the signal will flash red for motorists, allowing them to proceed after the pedestrian has cleared the intersection. The PHB is a good option over a full pedestrian signal because it provides a positive stop control in areas without the high pedestrian traffic volumes that typically warrant the installation of a signal. Additionally, it allows vehicles to proceed once pedestrians have cleared the roadway, allowing for improved vehicle flow.

2.7 SUMMARY OF IMPROVEMENTS AND CATEGORIES

A total of 130 projects were developed by the Study Team by utilizing historic collision data and input from the public. All projects are listed geographically in Appendix C, Table 1.

The projects were separated into four categories:

- Projects with safety benefits throughout the corridor
- Projects identified at specific locations due to particular conditions
- Projects that require further evaluation
- Projects that involve routine maintenance to restore intended use

Corridor-wide projects address safety issues repetitively or continuously along PCH. These projects are a result of the physical conditions, activities or behavioral patterns along the roadway. These include signal system improvements, traffic sign and marking upgrades, and consistent treatment of medians.

Location-specific projects are recommended at discrete locations. Recommendations are generally specific to the location and description of the improvement. A series of figures on aerial photography mapping showing study recommendations by location are provided in Appendix D. The study team has strived to identify non-controversial improvements or improvements where the extent of issues justifies a more ambitious project. Most improvements are of low-to-moderate costs, but improvements at some locations may cost millions of dollars, especially if new roads, bridges, or acquisition of property is required.

Some more ambitious projects are suggested that may merit further evaluation. While these are effective for safety, they may be controversial to segments of the community or conflict with State policies. These include consideration of a system of roundabouts to control intersections and reduce overall speeds north of Trancas Canyon. While their safety, effectiveness, and traffic viability is clearly proven, single lane roundabouts would require reducing through travel lanes and multi-lane roundabouts will require right of way. Single lane roundabouts have the added benefit of providing excess pavement potential for beach parking on the ocean side, but public reaction to roundabouts in areas where they are not common can be challenging.

Several maintenance projects have been identified as a result of the corridor's safety analysis and are listed in Appendix E. These projects can be completed and implemented in a relatively short time period. These types of projects maintain things as they were intended and in good working order. Some projects that fall under this category include worn out signs, broken or burned out lighting fixtures, bushes and shrubs along the PCH right of way that have become overgrown. Maintenance projects cannot be funded by the City, and therefore, Caltrans is responsible for completing these projects.

3.0 PROJECT EVALUATION PROCEDURE

The recommended were rated based on a set of performance measures. Maintenance projects were not rated and are provided in Appendix E. These measures would give priority to certain projects that score high at alleviating existing safety issues, community support, and congestion relief. This rating process resulted in an ordered list of recommended projects. This list is shown in Appendix C, Table 2.

The steps to move forward with any identified project may be presented with various constraints that will ultimately affect its outcome. Projects with potential issues may be more difficult to finalize and implement. Therefore, a second rating process was conducted that assigned points for project constraints. A recommended list of projects, arranged by overall score (which equals the merit score plus constraint score), is provided in Appendix C, Table 3.

The sections below detail how each merit and constraint was rated.

3.1 PROJECT MERITS

Collision Relief: Up to five points were awarded for collision relief. Projects not normally associated with safety improvements were assigned 1 point. If the project has potential to reduce collisions, 2 points were assigned. Those projects that are widely accepted and used safety measures were assigned 3 points. If the project has potential to reduce some collisions, 4 points were assigned. Finally, 5 points were assigned if the project has great potential to reduce many collisions, typically 20 or more of the type most susceptible to correction based upon the proposed measure.

Community Support: Up to five points were awarded based upon community support. Projects with numerous positive comments and little or no negative comments received the highest score. Projects expected to be controversial, divisive, or have low support were rated lowest.

Traffic Congestion Relief: Up to three points were awarded based upon ability to alleviate existing traffic congestion. Most projects are not expected to alleviate congestion and were awarded zero points. Projects that have a potential for significant traffic improvements throughout the corridor received 3 points. Projects that improve traffic operation at particular segments received 2 points. Finally, projects that improve traffic operations for an individual intersection received 1 point.

3.2 PROJECT CONSTRAINTS

Institutional Challenges: Negative points were assigned to projects with institutional challenges. Most recommended projects do not have serious institutional challenges and were assigned zero points. Projects that could possibly deviate from normal practices or special permissions

were assigned negative 1 point. Projects that will most certainly deviate from normal practices were assigned negative 2 points. Those projects that conflict with strong policies were assigned negative 3 points.

Complexity: Projects with complexity issues were also assigned negative points. Complex projects that will clearly involve major issues such as environmental impact, special permitting, acquisition of right of way, risks (such as landslides), and uncertainty of cost estimates are assigned negative three points. Projects that potentially have minor or major issues are assigned negative one or negative two points, respectively. Projects that are considered routine are assigned zero points.

4.0 RECOMMENDED PROJECTS BY PRIORITIZED GROUP

We anticipate that a significant number of projects will most likely be undertaken at once. Many of the projects are minimal in scale and should be combined to minimize effort of delivery. Therefore, individual projects have been combined into larger-scale projects that involve similar requirements or construction techniques. Each of the 130 recommended projects was categorized into one of the project categories listed in Table 4-1.

Table 4-1. Project Grouping Categories

Category	Cost Estimate
Signal System Improvements	$3,703,000
Street Light Improvements & Traffic Signal Synchronization	$2,505,000
Median Construction	$6,700,000
Other Signing and Striping Improvements	$1,059,000
Sidewalk-Related Improvements	$625,000
Special Projects	$303,000
Feasibility Studies	$5,735,000
Total Cost	**$20,630,000**

The project categories listed above represent groupings of projects that are suitable for budgeting or application for special project funding. The content of the projects identified in this appendix are listed in the previous appendix in greater detail and will assist in insuring the project groups are comprehensive and consider the wide variety of measures under consideration.

The projects were grouped with consideration to their location, the scale of the project, and their similarities. Once grouped, conceptual design and construction costs were estimated and are presented in Appendix F. If the estimated construction cost of the project groups was considered too large for likely immediate funding, it was divided largely based upon geography. For example, the estimated cost of all signal and electrical improvements was deemed large enough that it was divided into two projects.

Most of the projects are implementable with a minimum of expected difficulties once funding is secured. This is especially true for the Traffic Signal and Electrical projects, the median projects, and the Signing and Striping projects. Projects requiring special study or feasibility studies have greater uncertainty and will take longer to provide for implementation of improvements.

The grouped projects were given prioritization rankings based on their potential benefit as a group with consideration for the merit scores for the highest ranking projects in each grouping. Under this approach corridor wide signal system improvements were rated as high priorities, and individual intersection signal modification projects were included to form complete projects that address a multitude of conditions or goals. This prioritized grouping is listed in Appendix G.

5.0 FINAL PROJECT PRIORITIZATION

The final outcome of this Safety Study is a list of prioritized, recommended projects. This list was established by utilizing the prioritized grouping in the previous section and then by ranking the individual projects based on their potential safety benefit (or merit score). This list is provided in Appendix H.

Implementation of the proposed projects will be a major step toward reducing safety-related issues along the PCH corridor in the City of Malibu.