SMITH ENGINEERING & MANAGEMENT

November 5, 2012

Sent via electronic transmission: Jason meyer@dot.ca.gov

Mr. Jason Meyer
California Department of Transportation
P.O. Box 3700
Eureka, CA 95502-3700

Subject: Del Norte 197/199 Safe STAA Access Project

P12010

Dear Mr. Meyer:

As requested by Friends of Del Norte and the Environmental Protection Information Center, I have reviewed the Caltrans Draft Project Report (hereinafter "the PR") and supporting documentation for the Routes 197/199 Safe STAA Access Project in Del Norte County My qualifications to perform this review include registration as both a Civil and Traffic Engineer in California and 44 years professional consulting practice in these fields. I have extensive experience in matters of highway design and highway safety in California. My professional resume is attached. My comments follow.

Assessment In Brief

Contrary to the repeated statements in the PR, introduction of the longer STAA trucks and construction of the measures necessary to enable them to theoretically navigate the route combination is likely to increase rather than decrease crashes. The PR and related documents fail to evaluate this probability.

A simpler program of improvements not involving provision for STAA trucks could improve traffic safety at lower cost and with less invasive changes to the roadside environment.

Supporting evidence for these points is provided below.

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Why the Project May Render the Route Combination Less Safe

What the Project does is to define a minimum program of improvements that *theoretically enable* an STAA truck to be driven through the route combination without crossing the centerline, running off the road or striking a roadside obstacle. We use the words "theoretically enable" advisedly, because the facilities that would be provided by the Project require that the drivers of STAA trucks and other long vehicles to select and maintain a virtually perfect line of travel through some curves to avoid crossing the centerline, running off the road or otherwise striking a roadside obstruction. For example, the fact sheet for exceptions to mandatory design standards for The Narrows (DN 199 PM 22.7 – 23.0) included as PR Attachment F-4 indicates that the swept path width for an STAA truck on the proposed alignment at this location is 12 feet wide. This means, as the cited attachment indicates, that with only 12-foot travel lanes and 2-foot shoulders on either direction of the roadway under the Project, the driver of an STAA vehicle has only 1 foot of tolerance to either side of the perfect line through the curve; any more deviation either way and the passage involves a hazardous incident. Ordinarily, if there were 12-foot lanes and shoulders conforming to the applicable mandatory 8-foot width standard, an STAA driver would have 4 times as much leeway to either side of the perfect line through the curve to negotiate it safely than the Project provides.

The driver's difficulty in picking and maintaining a near perfect line through this particular location are compounded by three closely spaced reversing curves, each of shorter radius (sharper curvature) than the mandatory minimum radius for a 40 mph design speed (respectively only 59%, 68% and 73 percent of the mandatory design minimum). Hence, the driver's task is not just picking and maintaining a near-perfect line through a narrow area, but doing so on thrice-reversing curves of substandard sharpness.

Moreover, the driver's difficulty is further compounded by the fact that these curves restrict stopping sight distance to that adequate for 30 miles-per-hour, and to only 25 miles-per-hour for a 120-foot section rather than the 40 mph approach speed. In other words, the driver must slow down from normal speed, pick and maintain a near perfect line through a narrow area on a set of sharp, triple-reversing curves at a place where line-of-sight to that perfect line-of-travel is restricted.

These compounding conditions, to say nothing of other normal ones like high wind, wet pavement and dark of night, lead to an obvious conclusion that the proposed Project's features impose too challenging task on big-rig drivers and as the result, frequent hazardous incidents involving failure to stay with the narrow 1-foot envelope of tolerance to either side of the perfect line will occur. Consequently, even with the proposed roadway modifications, introduction of

STAA trucks to the route combination will increase hazard to the traveling public. It is insufficient to claim that the geometric features of the route, though continuing to be substandard with the Project improvements, are better than what exists and that an STAA truck, if perfectly driven under perfect conditions can safely negotiate the route combination. If Caltrans is determined to authorize STAA trucks on this route, it must define and implement an improvement plan that provides a normal envelope of safety for the variations from the perfect driving line that a normal, alert truck driver running the entire length of the route would typically experience including the variations that result from the vaguaries of wind, wet pavement and dark of night. If such an improvement plan is too costly or is too detrimental environmentally, then Caltrans must admit it is infeasible to approve STAA trucks on this route combination.

When the consequences of all the Project's exceptions to mandatory design standards are viewed in combination as in the above example, it becomes obvious that Caltrans attempt to justify designating this route combination for STAA trucks while avoiding the enormous cost and environmental consequences of improving the road to, or even close to, minimum mandatory standards, involves a significant compromise to public safety.

A second safety issue, aside from crashes involving big rigs, is how the Project's roadway features affect the safety of other roadway users. The PR's record shows that most of the crashes involve run-off-the-road or (to a much lesser extent) centerline crossover incidents where excessive speed, wet pavement and nighttime darkness were factors. The PR and its Exceptions To Mandatory Standards attachments assert that the added shoulder widths at most of the locations where work is contemplated will create an increased recovery area that will enable motorists to avert many crashes. This optimistic assertion ignores two salient contrarian factors.

- The added shoulder width at most locations is marginal in relation to mandatory minimum shoulder width and to true clear recovery zones.
- The increases in curve radius and other improvements to curve alignments and introduction of engineered superelevation on curves will tend to increase traffic speed, thereby increasing the propensity of run-off incidents and increasing the width of recovery area needed to avoid crashes.

Below we examine how the Project's features affect these considerations at each work location.

<u>Ruby 1</u>

Although the PR Table associated with Section 5 claims that Ruby 1 meets all mandatory design standards, the actual approved Fact Sheet Exceptions to

Mandatory Design Standards for this location reveals that there are two exceptions and appears to have omitted a third. The first exception is to the mandatory shoulder width of 4 feet applicable at this location. The Project design does provide the required 4 foot shoulders on the inside of curves because it is needed to accommodate STAA offtracking. But on the outside of the curves, where run-offs due to speed, darkness and wet pavement most frequently occur, a variable shoulder ranging from as little as 0.5 feet (as little as 12.5 percent of mandatory minimum) up to the mandatory 4 feet would be provided (this is changed from the existing shoulder of 0.5 feet to 3.4 feet). The changes to the outside shoulders are obviously very marginal. Meanwhile, the Project would also increase curve radii in the area from seriously non-conforming 300 and 430-foot lengths to 575 and 550-foot radii and improve superelevation, though not fully conforming to mandatory standards as noted in the Exceptions Fact Sheet. These changes will *increase* the comfortable speed through the curves from 36 to 42 miles-per-hour (a 16.7 percent increase). This change in comfortable speed would offset the benefits of marginally increased recovery areas the Project provides on the outside of curves, the place on curves where most run-offs occur due to excess speed, wet pavement and darkness.

Interestingly, this overall section of Route 197 has a purported design speed and posted speed limit of 55 miles-per-hour although advisory speeds of 35 and 30 miles-per-hour are posted on the subject curves. This poses several issues.

- The standard curve radius for a 55 mile-per-hour design speed is 1000 feet.[1] The PR and the Exception Fact Sheet make no mention that the curve radii proposed in the Project at this location, although improved, remain only approximately half the mandatory minimum for the design- and posted speed.
- The fact that the posted speed limit on the specific Ruby 1 area approach is 55 miles-per-hour makes it likely that many vehicles will enter the subject curves at speeds well above the advisory speed signs of 30 and 35 miles-per-hour or the comfortable speed of 42 miles-per-hour. Contrary to the claim of the PR and its exceptions attachment, this makes it unlikely that the Project's marginal improvement to recovery area would reduce the incidence of the types of collisions experienced at the subject location.
- The PR admits that traffic enforcement on the subject routes is sparse. This makes it likely that many vehicles will attempt to travel faster than the posted and advisory speed limits.
- *Highway Design Manual* Topic 309.1(2) indicates that on conventional highways a clear recovery zone of 20 feet minimum is desirable. Although this is a desirable, not mandatory standard, it illustrates the sheer

[1] Value interpolated from Caltrans *Highway Design Manual* Table 203.2.

inadequacy of the proposed 0.5 to 4-foot shoulders in this segment of the Project, especially with the changes to the curve radii and superelevation engendering increased speeds.[2]

In summary, there is no reasonable support for the PR's assertion that safety will be enhanced by the proposed marginal increases in shoulder width (recovery area) would reduce crash incidence and substantial evidence that changes in speed characteristics engendered by the Project would cause greater crash incidence.

Ruby 2

The concerns in this segment of the Project are similar to those described above for Ruby 1. The Project would widen shoulders at these curves from a variable 0- to 2 feet to a consistent 2 feet (minimum mandatory standard at this location is 4 feet). The Project would also change the radius of curves at this site from 200 feet to a still substandard 400 feet (minimum mandatory standard for 40 mile-per-hour speed limit is 550 feet. Sight distance, though improved, would remain 23% short of the mandatory minimum for 40 miles-per-hour. Rather than decreasing collision incidence, the increased speed engendered by the improved curve radius, compounded by the remaining sight distance deficiency, would likely offset any benefits of the increased recovery area provided by consistent 2-foot shoulders and result in increased crash incidence.

Patrick Creek Location 1.

The proposed horizontal curve and shoulder changes at this location appear as a reasonable response to the constraints of the site. However, the PR unreasonably minimizes its estimate of the potential consequences the considerable sight distance deficiencies at this location, dismissing them as likely to cause only minor rear-end collisions. In fact, at a 55 mile-per-hour speed, rear end collisions have the potential to be far worse than minor and in addition, losing sight of the road ahead can cause drivers to misjudge the alignment with more serious run-off-the-road and cross-centerline crashes as the result. In addition, the PR appears to have failed to assess the potential compounding effects of sight distance limitations on overlapping or closely spaced combinations of horizontal curves. More study of this issue is needed.

Patrick Creek Location 2

[2] Conventional highways with posted speed limits with posted speed limits at or below 40 miles-per-hour and curbs are exempt from clear recovery zone requirements. Since the posted speed limit is 55 and no curbs exist or are proposed, this exemption does not apply to the Ruby 1 segment.

The PR considered 3 alternatives at this location: replacing the existing bridge at an upstream location with corresponding roadway changes, replacing the existing bridge at a downstream location with corresponding roadway changes, or preserving the existing bridge with changes to the approach roadway alignments to increase curve radii, eliminating the need for large vehicles to cross the roadway centerline while entering and exiting the bridge. Subsequently, Caltrans has settled on the downstream bridge replacement as the preferred alternative. The alternative to preserve the existing bridge is dismissed, despite costing only two-thirds the cost of the replacement alternatives (roughly $6 million versus $9 million). The reason given is "functional obsolescence".[3] Since the primary element of functional obsolescence apparently is the need of large modern vehicles to cross the roadway centerline while getting on and off the bridge, a condition remedied by approach realignments in the 'preservation alternative', this dismissal is ridiculous. Although the present bridge lacks room for walkable and bikeable shoulders, this is not reasonable justification for dismissal through functional obsolescence, since much of the entire 197/199 route combination lacks walkable and bikeable shoulders.

Caltrans PR also failed to consider two other very low cost alternatives for preserving the existing bridge that are easily and quickly constructible and that would avoid the environmentally intrusive massive rock slope cuts needed to realign the approaches in the 'bridge preservation' alternative and that are also features of the upstream and downstream bridge replacement alternatives. The simplest would be to place signs on the immediate approaches to the bridge requiring traffic approaching the bridge to "Yield To Traffic On Bridge". In this way, there would be no conflict when large vehicles need to cross the centerline while entering or exiting the bridge. The other slightly more sophisticated way of maintaining the functionality of the existing bridge and approaches without massive approach reconstruction is to operate the bridge and its immediate approaches in reversible one-way operation controlled by traffic signals at each end. This latter alternative would also remedy the current lack of shoulders satisfactory for use by bikes and pedestrians, since, with the bridge essentially operating as a one-lane bridge, there would be adequate room for walkable/bikeable shoulders.

The Exceptions To Mandatory Design Standards Fact Sheet for the downstream bridge replacement alternative reveals that Caltrans currently preferred alternative would involve significant compromises to design standards. In an area where the posted speed limit is 55 miles-per-hour, the three approach curves, realigned at high costs with massive rock slope cuts, would only support speeds of 25, 32 and 32 miles-per-hour respectively and would have curve radii

[3] No evidence of structural deficiency is presented.

only 21.4%, 25% and 25% of the minimum mandatory curve radius for the 55 mile-per-hour speed limit. This large a disparity between the high speeds at which vehicles approach and the low design speeds supported by the substandard curve radii is a circumstance under which run off the road and centerline crossing hazardous incidents will continue to be prevalent.

Similarly, the compromises to mandatory minimum standards for curve radius, shoulder width and other separations from lateral obstructions result in 4 situations where the mandatory minimum 500 foot stopping sight distance to support the 55 mile-per-hour speed limit is not achieved, with available sight distance limited to respectively 131-, 177-,199- and 199-feet (26% to 40% of the mandatory minimum). These available sight distances support safe speeds of only 21, 26, 30 and 30 miles-per-hour respectively. The large disparity between the posted speed limit and the safe speeds that would be supported by available sight distance is a serious compromise to safety. This situation is compounded by portions of the road located within Patrick Creek Narrows Location 2 where stopping sight distance is also compromised below mandatory minimum by the proposed vertical alignment of the road. There are 4 such locations some of which are contiguous or overlapping to the locations where sight distance is also impaired by horizontal obstructions. Available sight distance at these locations are respectivel 300-, 442-, 330- and 370-feet, supporting safe speeds of 40, 50, 42 and 45 miles-per-hour (as contrast with the 500-feet minimum required for the 55 mile-per-hour speed limit).

Patrick Creek Location 3

Modifications proposed at Location 3 involve construction of a soldier pile retaining wall, eliminating an S-curve alignment and widening shoulders.
Although an S curve is eliminated, all of the 5 remaining curves in the segment continue to be substandard (less than the 1000-foot mandatory minimum for a 55 mile-per-hour design speed). The remaining curves have respective radii of 895-, 300-, 300- ,300- and 500-feet, supporting design speeds of 52, 30, 30, 30, and 38 miles per hour respectively. Hence, there remains a serious disparity between the safe speeds of the curves and the speed limit at 4 locations as identified in the Exceptions To Mandatory Design Standards Fact Sheet. However, the Fact Sheet fails to note that this creates substantial potential for motorists to over-drive the curve and that the proposed design is also in conflict with the principles of Alignment Consistency described in *Highway Design Manual* Topic 203.3. This topical section states:

> "*Sudden reductions in alignment standards should be avoided. Where physical restrictions on curve radius cannot be overcome and it becomes necessary to introduce curvature of lower standard than the design speed for the project, the design speed between successive curves should change not more than 10 miles per hour. Introduction of curves with lower design speeds*

should be avoided at the end of long tangents, steep downgrades , or at other locations where high approach speeds may be anticipated."

Clearly, the disparity between Curve 31 (52 mph) and Curve 32 (30 mph) is more than double the tolerable maximum and is a safety concern. A similar disparity exists in Patrick Creek Narrows Location 1 between Curve 12 (53 mph) and Curve 11 (31 mph).

The proposed Project leaves stopping sight distance below minimums at 4 locations, two due to lateral obstructions and two due to vertical alignment. The lateral obstructions limit available sight distance to that suitable to 28- and 30 miles per hour. The vertical alignment sight distance obstructions limit available sight distance to that safe for 40 and 47 miles-per-hour. The safe speeds at the horizontal obstruction areas particularly disparate from the 55 miles-per-hour posted speed limit for the area.

The Narrows

The deficiencies in the Project proposal for this segment have already been discussed extensively in this report and will not be reiterated here.

Washington Curve

This area of US 199 has a posted speed limit of 55 miles-per hour. Inexplicably, Caltrans has chosen to design the Project in this segment for a design speed of 40 miles per hour instead of the posted speed limit and the actual design fails to meet mandatory standards for even that reduced design speed. The existing Washington Curve is a broken back-curve comprised of a compound curve of 422- and 161-foot radii curves joined to a 1410 radius curve by a very short tangent. The proposed alignment changes the broken-back compound curve to 430- and 180-foot radii curves joined to a 1308-foot curve by an even shorter tangent. Minimum radius for 40 mile-per-hour design speed curves is 550 feet, substantially more than what is proposed.

Even at the 40 miles-per-hour design speed, the proposed curves are seriously deficient. The longer radius part of the compound curve hase as safe speed of 23 miles-per-hour, the shorter part has a safe speed of approximately 35 miles-per-hour. When compared to the posted speed limit of 55 miles-per hour (which would require a minimum 1000 foot radius curve), the proposed curve is clearly hazardous.

The PR's Exceptions To Mandatory Design Standards Fact Sheet reveals that the proposed design fails to meet the mandatory minimum stopping sight distance for the purported design speed of 40 miles-per-hour (300) feet but fails to disclose what the actual available sight distance would be. Clearly, the available sight distance would be far below the mandatory minimum sight distance for traffic approaching at the signed speed limit of 55 miles-per-hour at this location (500 feet).

The PR Exceptions To Mandatory Design Standards Fact Sheet admits that even at the 40 miles-per-hour design speed, the proposed Project will not meet the mandatory minimum standards for stopping sight distance (300 feet), although it fails to disclose by how much. Clearly, the available stopping sight distance is vastly less than the 500 foot mandatory minimum for the posted speed limit of 55 miles-per-hour that should be the real design speed at this location. Although the Fact Sheet attempts to minimize the adverse safety consequences of the substandard design, the reality in this situation, as with other proposed situations in the Project where stopping sight distance is substandard, the fundamental fact is that if drivers cannot see far enough ahead on the road to stop safely, they are likely to run off it or hit something in it.

The proposed design would only provide 50% of the mandatory minimum shoulder width applicable to this segment. Given the other substandard design elements noted above, this would compound safety problems.

Cost Effective and Environmentally Sensitive Measures To Enhance Safety Without STAA Accommodation Are Possible

Caltrans could enhance the safety of the 197/199 route combination for the general motoring public without the high cost and environmental intrusion necessary to accommodate STAA trucks. Measures, some of which are currently included at some locations as minor features of the proposed Project, include:

- Open graded pavement surface at all locations,
- More prominent edge line and centerline delineation including raised reflective markers and centerline and edge line rumble strips,
- More extensive curve warning, and advisory speed signing
- Night lighting at selective locations,
- Transverse rumble strips in advance of the sharpest curves, most complex curve combinations, or ones with safe speeds at large differential from the approach roadway,
- Radar displays of vehicle speed,
- The previously mentioned signal-controlled, alternating one-way operation of the bridge at Patrick Creek Narrows Location 2 or the aforementioned "Yield To Traffic On Bridge" regulatory sign solution for the same location,
- Trucker-directed advisory signing such as is employed along the mountainous section of I-80 between the Nevada State Line and Auburn.

The PR should be redone to design and evaluate an alternative that is based on these principles.

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Other Issues

Lack of Measured Speed Data

It is evident from Caltrans documentation that speed, particularly the differential between approach speed limits and the speeds that are safe at the "pinch points" addressed in the Project as well as the differential between speeds at which drivers attempt to drive through the "pinch points" and the safe speeds through those "pinch points" is a major causal factor in the crash experience documented in the PR. However, there is no evidence on record that Caltrans has ever considered the actual distribution of speeds driven at the pinch points and there approaches. This vital data should be collected and considered in determining whether the modifications proposed in the Project are adequate improvements for public safety, detrimental, or measures that solely provide a justification for shoe-horning STAA trucks onto the road.

Inconsistency of Traffic Volume, Truck Volume and Truck Percentage Data Between PR and Caltrans Posted Data

Data posted on the Caltrans Traffic Data Branch internet web site for US 199 northeast of the junction with SR 197, the location closest to the proposed Project work sites on US 199 indicate 2010 annual average daily traffic (AADT) of 4200, a truck percentage of 18.52 % of AADT and a truck volume of 778 AADT. Yet the PR analysis for the Project locations on US 199 uniformly assume the existing traffic volume is only 3000 AADT, the truck percentage is only 12% of AADT. In fact, the traffic and truck volumes that existed in 2010 on this area of US 199 already considerably exceed the PR's projected traffic and truck volumes for 2013, 2023 and 2033. Clearly, the PR has based its analysis of Project adequacy and critical design variables like Traffic Index (TI)[4] on seriously understated traffic and truck volumes on US 199.

Caltrans Traffic Data Branch posts traffic and truck volumes at two locations bracketing the Ruby 1 and Ruby 2 sites on SR 197. These show AADTs of 1800 vehicles and a truck percentage of 12.33% (222 trucks) to the northwest of the Ruby sites and 2300 vehicles and a truck percentage of 5.65% (130) trucks to the southeast. The average, since the Ruby sites lie between these count points is 2050 AADT and 176 trucks (truck percentage of 8.59). The PR baseline for the Ruby sites is only 1700 AADT and a truck percentage of only 8 percent (equivalent to only 136 trucks – 50 per day less than the above average. In fact, the PR's 2013 forecasts are below the 2010 values and its 2023 forecasts barely exceed them.

[4] This is a critical parameter used in determining the required structural strength and composition of the roadway surface based primarily on the expected numbers of heavy vehicle axel passages over the expected life of the pavement.

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Again, the PR analysis appears to have relied on understated estimates of overall traffic and truck traffic both current and in the future. This is particularly disturbing since the section of US 199 between its junction with SR 197 and its junction with US 101 is reported to have carried an AADT of 719 trucks (15.63%). If the segment of SR 197 between US 199 and US 101 is improved as proposed in the Project, some of the truck traffic on the sinuous section of US 199 between its junctions with SR 197 and US 101 would likely shift to the improved SR 197, especially if Caltrans signs direct truck traffic that way. Caltrans analyses of Project truck traffic have made no evident attempt to estimate diversions of truck traffic from the westerly segment of US 199 to SR 197 that the Project would cause. This is a serious flaw in the analysis.

Improper Use of Accident Statistics

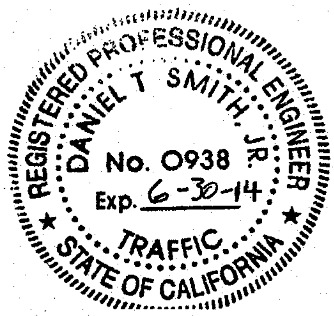
A well understood truism in highway safety analysis is the fact that curves are locations where some of the highest accident rates tend to occur. In the case of the PR, accident statistics are presented for short segments involving one or several curves. Accident rates at these locations are compared to the statewide average accident rate for 2-lane conventional highways in rural areas with similar terrain. This apples-to oranges comparison of accident rates for individual curve segments or short segments involving a multiple curve sequence to the overall statewide average for 2-lane conventional highways (which averages in many, many miles of tangent segments where few accidents normally occur) is a comparison that exaggerates the apparent deviation of crash rates on the subject route segments above that which is purportedly typical, thus exaggerating the need for some kind of improvement action based on safety. A fair comparison of crash rates on the subject segments to overall State Highway System 2-lane conventional highway crash rates in similar rural terrain on curves would present an unbiased depiction of the safety situation on the subject route segments and would doubtless show that the subject segments experience crash rates more typical of curve segments statewide.

Conclusion

Based on all of the points noted in detail above, we are convinced the Project Report's analysis and conclusions are inadequate and need to be revised. The Project's provisions are insufficient to authorize STAA trucks on the subject routes with reasonable safety to the public. Caltrans has failed to evaluate the safety impacts associated with the Project's exception to mandatory minimum design standards. An alternative that improves the operational safety characteristics of the route combination at modest cost and with minimal environmental intrusion is preferable to one that accommodates STAA trucks at significantly higher cost and environmental intrusion accompanied by detrimental effects on public safety.

Sincerely,

Smith Engineering & Management
A California Corporation



Daniel T. Smith Jr., P.E.

DANIEL T. SMITH, Jr.
President

EDUCATION

Bachelor of Science, Engineering and Applied Science, Yale University, 1967
Master of Science, Transportation Planning, University of California, Berkeley, 1968

PROFESSIONAL REGISTRATION

California No. 21913 (Civil) Nevada No. 7969 (Civil) Washington No. 29337 (Civil)
California No. 938 (Traffic) Arizona No. 22131 (Civil)

PROFESSIONAL EXPERIENCE

Smith Engineering & Management, 1993 to present. President.
DKS Associates, 1979 to 1993. Founder, Vice President, Principal Transportation Engineer.
De Leuw, Cather & Company, 1968 to 1979. Senior Transportation Planner.
Personal specialties and project experience include:

Litigation Consulting. Provides consultation, investigations and expert witness testimony in highway design, transit design and traffic engineering matters including condemnations involving transportation access issues; traffic accidents involving highway design or traffic engineering factors; land use and development matters involving access and transportation impacts; parking and other traffic and transportation matters.

Urban Corridor Studies/Alternatives Analysis. Principal-in-charge for State Route (SR) 102 Feasibility Study, a 35-mile freeway alignment study north of Sacramento. Consultant on I-280 Interstate Transfer Concept Program, San Francisco, an AA/EIS for completion of I-280, demolition of Embarcadero freeway, substitute light rail and commuter rail projects. Principal-in-charge, SR 238 corridor freeway/expressway design/environmental study, Hayward (Calif.) Project manager, Sacramento Northeast Area multi-modal transportation corridor study. Transportation planner for I-80N West Terminal Study, and Harbor Drive Traffic Study, Portland, Oregon. Project manager for design of surface segment of Woodward Corridor LRT, Detroit, Michigan. Directed staff on I-80 National Strategic Corridor Study (Sacramento-San Francisco), US 101-Sonoma freeway operations study, SR 92 freeway operations study, I-880 freeway operations study, SR 152 alignment studies, Sacramento RTD light rail systems study, Tasman Corridor LRT AA/EIS, Fremont-Warm Springs BART extension plan/EIR, SRs 70/99 freeway alternatives study, and Richmond Parkway (SR 93) design study.

Area Transportation Plans. Principal-in charge for transportation element of City of Los Angeles General Plan Framework, shaping nations largest city two decades into 21'st century. Project manager for the transportation element of 300-acre Mission Bay development in downtown San Francisco. Mission Bay involves 7 million gsf office/commercial space, 8,500 dwelling units, and community facilities. Transportation features include relocation of commuter rail station; extension of MUNI-Metro LRT; a multi-modal terminal for LRT, commuter rail and local bus; removal of a quarter mile elevated freeway; replacement by new ramps and a boulevard; an internal roadway network overcoming constraints imposed by an internal tidal basin; freeway structures and rail facilities; and concept plans for 20,000 structured parking spaces. Principal-in-charge for circulation plan to accommodate 9 million gsf of office/commercial growth in downtown Bellevue (Wash.). Principal-in-charge for 64 acre, 2 million gsf multi-use complex for FMC adjacent to San Jose International Airport. Project manager for transportation element of Sacramento Capitol Area Plan for the state governmental complex, and for Downtown Sacramento Redevelopment Plan. Project manager for Napa (Calif.) General Plan Circulation Element and Downtown Riverfront Redevelopment Plan, on parking program for downtown Walnut Creek, on downtown transportation plan for San Mateo and redevelopment plan for downtown Mountain View (Calif.), for traffic circulation and safety plans for California cities of Davis, Pleasant Hill and Hayward, and for Salem, Oregon.

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Transportation Centers. Project manager for Daly City Intermodal Study which developed a $7 million surface bus terminal, traffic access, parking and pedestrian circulation improvements at the Daly City BART station plus development of functional plans for a new BART station at Colma. Project manager for design of multi-modal terminal (commuter rail, light rail, bus) at Mission Bay, San Francisco. In Santa Clarita Long Range Transit Development Program, responsible for plan to relocate system's existing timed-transfer hub and development of three satellite transfer hubs. Performed airport ground transportation system evaluations for San Francisco International, Oakland International, Sea-Tac International, Oakland International, Los Angeles International, and San Diego Lindberg.

Campus Transportation. Campus transportation planning assignments for UC Davis, UC Berkeley, UC Santa Cruz and UC San Francisco Medical Center campuses; San Francisco State University; University of San Francisco; and the University of Alaska and others. Also developed master plans for institutional campuses including medical centers, headquarters complexes and research & development facilities.

Special Event Facilities. Evaluations and design studies for football/baseball stadiums, indoor sports arenas, horse and motor racing facilities, theme parks, fairgrounds and convention centers, ski complexes and destination resorts throughout western United States.

Parking. Parking programs and facilities for large area plans and individual sites including downtowns, special event facilities, university and institutional campuses and other large site developments; numerous parking feasibility and operations studies for parking structures and surface facilities; also, resident preferential parking .

Transportation System Management & Traffic Restraint. Project manager on FHWA program to develop techniques and guidelines for neighborhood street traffic limitation. Project manager for Berkeley, (Calif.), Neighborhood Traffic Study, pioneered application of traffic restraint techniques in the U.S. Developed residential traffic plans for Menlo Park, Santa Monica, Santa Cruz, Mill Valley, Oakland, Palo Alto, Piedmont, San Mateo County, Pasadena, Santa Ana and others. Participated in development of photo/radar speed enforcement device and experimented with speed humps. Co-author of Institute of Transportation Engineers reference publication on neighborhood traffic control.

Bicycle Facilities. Project manager to develop an FHWA manual for bicycle facility design and planning, on bikeway plans for Del Mar, (Calif.), the UC Davis and the City of Davis. Consultant to bikeway plans for Eugene, Oregon, Washington, D.C., Buffalo, New York, and Skokie, Illinois. Consultant to U.S. Bureau of Reclamation for development of hydraulically efficient, bicycle safe drainage inlets. Consultant on FHWA research on effective retrofits of undercrossing and overcrossing structures for bicyclists, pedestrians, and handicapped.

MEMBERSHIPS

Institute of Transportation Engineers Transportation Research Board

PUBLICATIONS AND AWARDS

Residential Street Design and Traffic Control, with W. Homburger *et al*. Prentice Hall, 1989.

Co-recipient, Progressive Architecture Citation, *Mission Bay Master Plan*, with I.M. Pei WRT Associated, 1984.

Residential Traffic Management, State of the Art Report, U.S. Department of Transportation, 1979.

Improving The Residential Street Environment, with Donald Appleyard et al., U.S. Department of Transportation, 1979.

Strategic Concepts in Residential Neighborhood Traffic Control, International Symposium on Traffic Control Systems, Berkeley, California, 1979.

Planning and Design of Bicycle Facilities: Pitfalls and New Directions, Transportation Research Board, Research Record 570, 1976.

Co-recipient, Progressive Architecture Award, *Livable Urban Streets, San Francisco Bay Area and London*, with Donald Appleyard, 1979.