2008 Alternative Fuels Corridor Economic Feasibility Analysis

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Packet A

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Scoring Criteria 1: Qualifications Expertise of Team Members

Parsons Brinckerhoff Inc., (PB) working through its wholly-owned Strategic Consulting Group subsidiary, PB Consult Inc., has assembled a knowledgeable, highly experienced team for this project. Joining PB is the University of California – Davis Institute of Transportation Studies (ITS-Davis). At the forefront of emerging transportation technologies and issues, ITS-Davis is the leading research institution in the area of economic and environmental analysis of advanced vehicles and alternative fuel infrastructure. Their research has been carried out by a multi-disciplinary research team in the Hydrogen Pathways Program and the Sustainable Transportation Energy Pathways (STEPS) Program. They have worked on numerous energy and infrastructure analysis projects for the State of California's Air Resources Board (ARB) and Energy Commission (CEC) as well as the US Department of Energy (DOE) and Department of Transportation (DOT).

The project will be managed by Brent Baker, a Principal Consultant in PB's Strategic Consulting Group who is based in Seattle and has been working with WSDOT since 1991. Brent will be supported by a core team of experts, including PB's national Public-Private Partnership initiatives leader Pamela Bailey-Campbell, finance and economics team members Nick Amrhein, Greg Heinz, and Michael Benouaich, ethanol expert Greg Christian, and Kathleen Leotta, a transportation planner and sustainability expert in PB's Seattle office. Project staff from ITS-Davis include Dr. Marshall Miller, the Project Manager for the ITS group, and researcher on electricity analysis. Dr. Miller will be supported by Michael Nicholas, station placement analysis, Nathan Parker, biodiesel analysis, Dr. Chris Yang, hydrogen and electricity analysis, Dr. Andrew Burke, electricity analysis, and Dr. Joan Ogden, hydrogen analysis.

PB has worked on numerous projects in the state of Washington, nationally and abroad. Most recently, we led the consultant effort to prepare the 2007 Finance Plan for the SR 520 bridge replacement. PB prepared toll traffic and revenue projections, combined them with other sources of revenue that had been identified for project purposes and compared those sources with the project financial needs, clarifying the "gap" in funding that existed. Particular emphasis was placed on identification of the range of toll-backed financing that could be generated under a number of different tolling scenarios. Brent Baker served as project manager. The project began in 2006 and is expected to end in 2009.

Strategic Consulting Group of PB

As PB's separate Strategic Consulting advisory group doing business as PB Consult, Inc., the Strategic Consulting Group offers the insight of various infrastructure industry leaders, with extensive experience advising clients worldwide. Our consultants and affiliates include world-class specialists in government policy, public agency management, organization development and strategic planning, and program and project delivery, among other areas. We specialize in management, technical, financial and operational analysis, and consultation to help clients to optimize their assets, to deliver services and projects more cost-effectively, and to better compete in today's economy.

The Strategic Consulting Group of PB has four staff members in the Seattle office and an additional 10 staff members in the Portland Metropolitan Area, for a total of 14 in the Pacific Northwest. Nationwide, the Strategic Consulting Group has 90 staff members.

Parsons Brinckerhoff

Parsons Brinckerhoff (PB) is a global leader in developing and operating infrastructure around the world, with 10,000 employees dedicated to meeting the needs of clients and communities in the Americas, Europe, Africa, the Middle East, Asia and Australia-Pacific regions. PB offers skills and resources in strategic consulting, planning, engineering, program and construction management, and operations for all modes of infrastructure, including transportation, power, community development, water and the environment (www.pbworld.com).

Since its inception in 1885, PB has been recognized as one of the world's leading professional consulting, engineering, planning, construction management and design-build firms for all types of infrastructure organizations. In fact, Engineering News-Record (ENR) has consistently rated PB among the country's Top 10 engineering and planning firms. Throughout our 120-year history, our multidisciplinary and comprehensive professional services have helped both our public and private sector clients achieve a wide range of goals—of varying size, scope and complexity.

PB has 190 staff members located in Seattle, and an additional 92 in the Portland Metropolitan Area, for a total of 282 staff members in the Pacific Northwest. PB employs 5,200 professionals nationwide.

UC Davis ITS

The Institute of Transportation Studies at the University of California, Davis (ITS-Davis) was formally established in 1991 by the Board of Regents of the University of California. The Institute is now a multi-faceted, internationally recognized program with more than 60 affiliated faculty and researchers, 80 graduate students, and a $6 million annual budget. The Institute is the only research institute in the UC system that hosts a perfectly matching graduate education program, the Master's and Ph.D.-conferring Transportation Technology and Policy graduate education group.

Research

ITS-Davis is a leading center of transportation studies, specializing in sustainable transportation themes. It is unique in its multidisciplinary approach to transportation technology, fuels, basic science, human behavior and policy. The Institute's dedicated faculty, staff and students examine a range of transport topics in three core areas of research and analysis:

- Travel behavior and transport systems modeling
- Environmental vehicle technologies and fuels pathways
- Climate change, air quality, and other environmental impacts

The Institute thrives on a strong network of research partners, both on campus and off. Researchers engage in projects with other campus departments as well as with universities and research centers around the world. Strong relationships with government and nongovernmental organizations, and with energy, environmental, and automotive industry experts further enhance the research program.

Education

The Institute's education program is designed to meet the world's growing needs for qualified, thoughtful and dedicated engineers, policy makers, technicians and advocates. Its interdisciplinary approach transcends the boundaries of traditional engineering-based studies to include social and behavioral sciences, ecology, and management. Students interact with a broad range of researchers and leaders from

industry, government, public interest groups, and academia through seminars and workshops, internships, visiting lectures, fellowships and grants. ITS-Davis offers a variety of specialized courses, from social costs of transportation to fuel cell vehicle systems engineering. ITS-Davis hosts the UC Davis University Transportation Center, a multi-year, multi-million dollar program funded through matching federal and state transportation grants designated for graduate education activities.

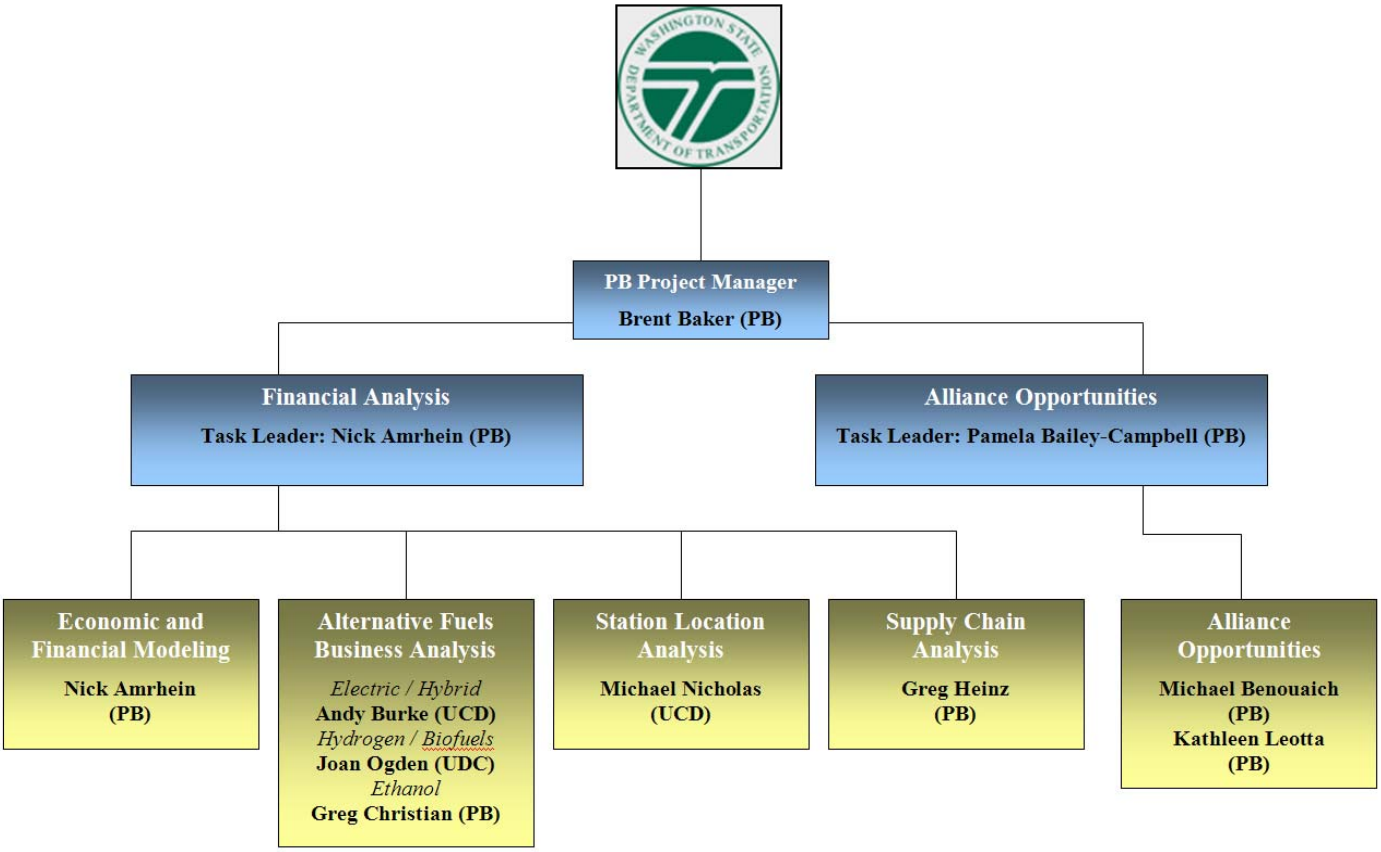
Expertise Table

The table below shows key staff's expertise areas, years of experience and whether or not they have worked with WSDOT before.

Key Staff	Years of Experience	Economic Analysis	Financial Modeling	Station Location Analysis	PPP & Alliance Strategies	WSDOT	State & Federal Regulations	Alternative Fuels					
								CNG/LNG	Hydrogen	Ethanol	Biofuels	Electric	Hybrid
Brent Baker	19	◆	◆		◆	◆	◆						
Nick Amrhein	7	◆	◆	◆	◆	◆	◆						
Greg Christian	28						◆			◆			
Pamela Bailey-Campbell	28				◆		◆						
Michael Benouaich	6	◆	◆		◆		◆					◆	
Greg Heinz	13	◆	◆			◆	◆						
Kathy Leotta	14				◆	◆	◆				◆		
Marshall Miller	14						◆	◆	◆			◆	◆
Michael Nicholas	8			◆			◆		◆				
Andrew Burke	30						◆		◆			◆	◆
Joan Ogden	20						◆		◆		◆		
Nathan Parker	5						◆		◆		◆		
Christopher Yang	6						◆		◆			◆	

Organizational Chart

The organizational chart shown below reflects the discipline-focused teams that will focus on technical aspects of the project. These teams will coordinate with each other and through the Task Leaders in conjunction with the Project Manager, Brent Baker. Sub-task leaders are listed in the gold boxes, though these individuals will be supported by others on the project Team.



Hours Available Per Month

All key staff identified in this proposal have enough time available in their project and other work schedules to accommodate their role on this project. Expected availability for the duration of the project is listed below, showing expected hours available per month.

Key Staff	June	July	August	September	October
Brent Baker	40	40	40	60	60
Nick Amrhein	40	40	40	40	40
Greg Christian	32	32	32	32	32
Pamela Bailey-Campbell	20	20	20	20	20
Michael Benouaich	60	80	80	80	80
Greg Heinz	80	80	60	40	40
Kathy Leotta	60	60	60	60	60
Marshall Miller	40	40	40	40	40
Michael Nicholas	40	40	40	40	40
Andrew Burke	25	25	25	25	25
Joan Ogden	32	32	32	32	32
Christopher Yang	25	25	25	25	25
Nathan Parker	25	25	25	25	25

Strategic Consulting Group of PB Project Experience

The Strategic Consulting Group of PB has extensive experience in performing economic and financial feasibility studies for both the public and private sector. The Strategic Consulting Group has also worked in recent years on innovative projects incorporating new technologies for the trucking and rail industries. In 2007, the Strategic Consulting Group worked with the City of Dallas to create a new energy management plan as Dallas worked towards its goal of becoming one of the greenest cities in the country.

Energy Management Plan for the City of Dallas, Texas

The City of Dallas (City) retained Strategic Consulting as their Energy Management Consultant to facilitate and assist the City in developing a comprehensive Energy Management Program. The City's objective was to develop a long-term energy management program that was both cost effective and sustainable. To accomplish this, the City's stated that the program would need to encompass both the supply and demand side of energy management.

The Strategic Consulting Group Team that prepared the Energy Management Program designed a systematic work plan to successfully accomplish the project. This work plan had three initial stages:

- Stage 1 – *Investigation* – included data collection, assembly and verification of utility account records, analysis of alternative energy suppliers and utility rates and rate structures, interdepartmental load aggregation, investigation of self/distributed generation opportunities, identification and preparation support of financing/grant opportunities.
- Stage 2 – *Evaluation and Analysis of Data Collected* – the Strategic Consulting Team worked with City staff to develop the "balance" between demand side and supply side initiatives. This was be

accomplished through modeling of the City's baseline consumption patterns followed by modifications to the model for "what-if" pro forma adjustments to energy consumption and alternative energy supply opportunities.

- Stage 3 – *Survey* – the Strategic Consulting Team developed auditing programs that were used by the City to verify utility payments and invoicing. This stage included establishing benchmarking and performance measures that City staff could use to monitor departmental energy efficiency as well as energy provider performance.

At the completion of these three stages, the Strategic Consulting Group Team began preparing the City's Energy Management Action Plan. This was followed by provision of procurement services by the Strategic Consulting Team energy procurement experts. The procurement services task included a pilot program using a limited number of City accounts. It was anticipated that this task would become both a test of the procurement process recommended in the Energy Management Action Plan, as well as a training tool for City staff and the proposed Energy Manager.

The work plan included five workshops and final presentation support to City small group, Council Committee meeting, and City Council. The five workshops were scheduled as a kick-off meeting, one after each stage in the work plan, plus one workshop to present the draft recommendations in the Energy Management Action Plan. These workshops were facilitated by the Strategic Consulting Team and were an open forum where the Strategic Consulting Team reported on project progress and obtained project input from appropriate City staff representatives.

The City successfully purchased 334 million kilowatt-hours of green power in 2008, reaching its goal of being one of the greenest cities in the United States. The City was ranked number 1 on the Environmental Protection Agency's (EPA) list of purchases of green power among local governments in the United States. The City was also ranked number 9 on the EPA's National Top 25 list of green power purchasers.

Strategic Consulting is currently providing additional energy management services to the City. The total consultant fee was $713,900.

IdleAire Investment Grade Feasibility Assessment

Studies indicate that there are 4.2 million large diesel trucks in America, and 1.3 million of them are long-haul trucks with sleepers. Current common practice is for drivers to idle their engines during loading and unloading, and while at rest stops for required layover periods. While idling allows the trucks to maintain refrigeration and receive air conditioning, radio/TV power, and various other "household" appliances, it also causes noxious emissions, wears out engines, uses approximately one gallon of fuel per hour of idling, and can cause sleep deprivation in drivers. The ATE system, invented by IdleAire Technologies, allows truck drivers to turn off their engines during rest periods, and receive power from a window-mounted service module installed at truck stop sites. The result is reduced emissions and improved air quality, as well as added comfort and convenience for truck drivers.

The Strategic Consulting Group, with Vollmer Associates, was engaged to support IdleAire, a start-up company, as the company sought financing for a national rollout of its new advance truck stop electrification (ATE) and diesel emissions control technology. The Strategic Consulting Team prepared an investment grade feasibility assessment for the expansion of the technology and advised IdleAire on several business and commercial issues crucial to the development and achievement of its business plan.

As a start-up technology company, IdleAire needed to demonstrate need for the product, potential returns to the investment, and credibility of the company. IdleAire turned to Strategic Consulting to carry out an investment grade feasibility assessment. The feasibility report, 'Assessment of Revenue and Cost Projections for the Nationwide Expansion of Advanced Travel Center Electrification,' was instrumental in providing investors with a thorough understanding of the new technology, its benefits to the trucking and travel center industries, an independent forecast of future financial operations through 2014, and an opinion on the reasonableness of the assumptions underlying that forecast.

The feasibility report reviewed, among other items, the logistics of a nationwide rollout, costs of capital equipment and maintenance of installations and technology upgrades, cost of staffing travel centers, and expected profit margins.

The in-cab service module connects to the truck's window, delivering heating, cooling and a variety of other services.

The Strategic Consulting Group Team also undertook a trucking industry survey of major fleet owners, the largest truck stop operators and drivers, in order to evaluate IdleAire's value proposition. The survey included interviews with 3,052 truck drivers in person at 22 travel center locations. The survey of driver behavior and truck stop operations led to the development of an original, statistically-based revenue forecasting model that accounted for such variables as diesel prices, weather patterns, fleet employees versus independents, and numbers of active IdleAire members, among others.

In debt markets the sole source of debt repayment is future revenue from profitable business operations. A third-party review of future financial performance is necessary in efforts to raise capital from investors. The feasibility report created by Strategic Consulting was a determination of reasonableness of future profitability in IdleAire, and was a crucial factor in raising capital for IdleAire.

The Strategic Consulting Teams' two-year effort culminated in an investment-grade feasibility report and led to the successful issuance of $320 million in discount notes and warrants. The total consultant fee was $3.5 million.

Financing and Contracting Options for the Caltrain Electrification Program

The Strategic Consulting Group is currently assisting the Peninsula Corridor Joint Powers Board (PCJPB) evaluate the financing and procurement options under Public-Private Partnership (PPP) to convert the existing Caltrain diesel engine mode of propulsion to electric along the 50 miles of rail tracks from San Francisco to San José. Completion of the Caltrain Electrification Program would represent the culmination of more than 15 years of investment by San Mateo, Santa Clara and San Francisco counties in the

preservation and improvement of commuter rail service on the Peninsula. The Program includes the procurement of electrification infrastructure and new electric rolling stock, along with improvements to communication systems.

The Strategic Consulting Group's work started with a review of potential public and private project delivery and financing options along with risk allocation strategies that would best answer Caltrain's goals to attract and accommodate future ridership demand and move toward financial sustainability. Through a series of workshops, the Strategic Consulting Group provided Caltrain staff with all the elements necessary to understand and evaluate PPP procurement strategies, concession structures, and market expectations based on case studies highlighting best practices as well as pitfalls. Our collaborative efforts resulted in the identification of appropriate procurement and financing scenarios balancing Caltrain's objectives with private sector requirements. These scenarios were then evaluated for financial viability.

Working from the initial capital improvement program, Strategic Consulting first developed a base case scenario to assess the funding shortfall that Caltrain would face if it were to implement the Program using public sources of funds for various rolling stock procurement and funding scenarios. This "public sector comparator" model identified the need to modify the initial procurement schedule so it could be financed tough public funds. The Strategic Consulting Group then worked with Caltrain and its rolling stock advisors to identify and model the operating economics of the system. We developed a project finance model to evaluate the Program from the point of view of a potential private partner delivering and financing the project (such models are often termed "shadow bid" because they reflect expected operating and financial structures that could be used by private bidders). The Strategic Consulting Group is currently testing the financial feasibility and financial risks from the private sector's perspective using this model. Our analysis further includes an implementation plan for the Program under the preferred delivery option including all aspects of procurement, partner selections, development of appropriate performance criteria and standards. Our final work product is due at the end of August.

Tasks include:

- Review current legislative framework and Caltrain organization and authority
- Identify, assess, and model capital requirements and operating economics of the Program
- Establish base case under public delivery method and funding mechanism (public sector comparator)
- Identify and assess potential PPP delivery methods and financial structures
- Develop project finance model to assess financial feasibility and risks of the preferred PPP scenarios
- Develop organizational model for the preferred delivery option

The total consultant fee: $284,545.

Traffic and Revenue Studies (2002-2008) – Orange County, California

The Orange County Transportation Authority (OCTA) and the California Private Transportation Corporation (CPTC) had been in negotiations for the acquisition of the SR91 Express Lanes project. The acquisition would allow for badly needed non-toll improvements in the SR91 Corridor. Acquisition would also permit use of tax-exempt debt and potentially reduce the costs of borrowings. OCTA required a review of future

revenue potentials of the Express Lanes to support a subsequent bond offering and to set future tolling strategies.

The Strategic Consulting Group, in association with Vollmer Associates, was selected by OCTA and the Transportation Corridor Agencies (TCA) to conduct traffic and revenue studies and prepare investment grade forecasts for their facilities.

For the Orange County Transportation Authority (OCTA), the Team's work supported the acquisition of the SR91 Express Lane franchise. For TCA, studies were performed for the Foothill/Eastern and San Joaquin toll roads in support of TCA's goal to re-capitalize and possibly consolidate of TCA's toll road assets. The TCA assignment has been expanded to include an internal strategic evaluation of potential revenues related to completion of the Foothill South project and to a tunnel connecting Riverside and Orange Counties.

For both agencies, the Strategic Consulting Group Team was commissioned to prepare small area land use and demographic forecasts, providing critical inputs for the Vollmer traffic and revenue model. The Team created an integrated land use data processing model that supported Base Case traffic and revenue forecast for each road and various sensitivity tests. The Team completed extensive interviews with major land owners, developers, major businesses, county and city officials, academics and political officials to secure first hand information on those factors affecting future economic activity and development patterns. The Team critically reviewed national, local and regional forecasting services to prepare an independent forecast for the region and for study areas served by each toll road.

For TCA, the Strategic Consulting Group Team prepared forecasts of revenues from the TCA's Development Impact Fee program for each toll road; a dedicated revenue stream derived from commercial and residential construction within prescribed impact zones. Fees are collected when building permits are pulled. This complex analysis was conducted under terms of California's enabling legislation and the individual agreements negotiated with major property owners. DIF fees, measuring hundreds of millions of dollars over the life of the TCA projects, are a critical component of TCA's credit worthiness and debt service capacity. The work required an in-depth analysis of Orange County real estate markets and determinations of their capacity to absorb new development in all major land use categories.

The initial work for TCA was completed in 2004, but the Strategic Consulting Team was re-engaged in the spring of 2007 to perform updates to the original work leading up to a transaction scheduled for the Fall of 2008. Total consultant fee: $1,500,000

SR520 Bridge Finance Plan

In 2007, the Washington State Legislature and Governor Christine Gregoire passed into law a requirement that the Washington State Department of Transportation (WSDOT) complete a proposed plan of finance for the SR 520 Bridge Replacement and HOV Project. The Strategic Consulting Group and PB was retained assist WSDOT in the preparation of this plan and supporting technical analysis. The finance plan examined the sources of revenue that have been identified for project purposes and compared those sources with the project financial needs, clarifying the magnitude and timing of the projected funding gap. Particular emphasis was placed on identifying the range of toll-backed financing that could be generated under a number of different tolling scenarios. Brent Baker served as project manager. Key findings of the Finance Plan included:

- Determination of the funding gap under the current project definition, in terms of both the magnitude of funding as well as in the timing of uses;

- Delays in delivering the project will exacerbate the magnitude of the funding gap; alternatively, accelerating the project may reduce overall project costs, but would alter the timing of when funding was needed;
- Findings regarding the viability of some identified funding sources and the risk that funding will not materialize;
- Tolling SR 520 may contribute between $0.85 and $1.5 billion in project funding when tolling begins after the new facility is opened to traffic; and
- Tolling the existing SR 520 facility prior to opening the new facility could generate an additional $0.5 billion.

The Strategic Consulting Group served as a key collaborator and contributor throughout preparation of the Finance Plan. In addition to other management duties the Strategic Consulting Group led or participated in key roles on five separate steering committees, made up of client, consultant, and stakeholder staff, that were established to guide the direction of the project effort. Additionally, the Strategic Consulting Group managed the toll traffic modeling effort and served as the client liaison for this work. The Strategic Consulting Group contributed directly to the Finance Plan technical analysis by coordinating the estimation of operations and maintenance costs associated with the physical roadway facility and the toll collection function; establishing the financial parameters that were assumed in determining toll revenue financial capacities; summarizing the non-toll capital funding sources; and modeling the project's cash flows, including estimated annual expenditures and funding sources.

The Strategic Consulting Group consolidated all of the data collected and analyzed into a summary report and technical appendix used by the Washington State Legislature and Governor Gregoire for long and short-term budgetary planning purposes. The total consultant fee was $953,000.

Washington State Ferries

PB has been preparing 16 year forecasts of revenue and ridership for Washington State Ferries over the past 20 years. Brent Baker has been PB's project manager and primary technical analyst for this work since 1991 under a series of on-call task order contracts. Under Brent's direction, the Strategic Consulting Group of PB's work included developing econometric demand models, analyzing time series ridership data, evaluating different fare scenarios and vessel capacity constraints, and forecasting revenue subject to available vessel capacity by route, month and fare category.

The Strategic Consulting Group has directed and participated in all of the technical efforts that have produced the current revenue forecasting methodology and model specifications. In addition, the Strategic Consulting Group has been responsible for several key innovations made in the ridership and revenue forecasting process, particularly in the areas of assessing fare elasticities of demand and incorporating the effects of vessel capacity constraints on vehicular demand. Revenue projections are prepared from demand estimates using an Excel spreadsheet model that factors in each route's nominal fare structure and proposed fare changes over time. A package is prepared summarizing the forecasts for presentation to the Transportation Revenue Forecast Council and a notebook documenting the forecast is delivered to the WSF.

Other work performed under various contracts has included estimation of fare increase impacts, revenue maximizing fare structures, preparation of the agency's biennial operations report, ridership survey analysis, and consultant participation on the WSF Tariff Policy Committee and in system planning efforts.

One unique assignment for WSF included developing and tracking the virtual performance of a fuel price hedging strategy designed to minimize Washington State Ferries (WSF) fuel expense budget risk to price volatility. As the largest ferry system in the U.S. with more than 20 vessels on a dozen routes, WSF was interested in reducing its risk exposure to increasingly variable prices for diesel fuel. The Strategic Consulting Group developed a price hedging strategy involving the use of exchange-traded diesel fuel oil options contracts designed to improve the predictability of fuel expenditures by managing the risk of adverse price fluctuations. The strategy tested the use of rolling put and call options with up to a six month duration to form a "costless" or zero-premium collar of floor and ceiling prices on fuel costs. The strategy was tested over nine months and proved to substantially minimize the fluctuation in predicted fuel costs versus the actual costs paid. The total contract value is expected to be $285,000.

Parsons Brinckerhoff Project Experience

As awareness has increased to the importance of greening our world, PB has been on the forefront of helping clients achieve the objective. From LEED designed facilities to alternative fuel, PB has delivered cutting edge technologies in real-world applications. As an example, PB is the only national engineering firm with a dedicated hydrogen division that focuses on providing cost effective engineering solutions to hydrogen infrastructure. In addition to providing innovative solutions over the past 122 years, for more than a decade we've designed and managed construction for various alternative fuel vehicle infrastructures, including the projects listed below.

Lambert-St. Louis International Airport Compressed Natural Gas Facility

Officials at Lambert-St. Louis International Airport (Lambert Airport) decided to use compressed natural gas (CNG) as an alternative to gasoline and diesel fuel in a fleet of vehicles for facilities operations and maintenance. To serve this fleet, a skid-mounted CNG production, storage, fueling, and defueling system was installed at the airfield maintenance yard. PB prepared the bid package, which consisted of drawings and specifications for installation of the CNG facility, and provided construction services. A 130 standard cubic feet per minute (scfm) (4m3/min) compressor and a 30,000 cubic foot (850m3) storage module provided refueling capacity for eight vehicles twice a day during peak demand.

The basic system included the following elements:

- A 100 horsepower motor to drive the 130 scfm CNG reciprocating compressor, which compressed natural gas at 5 psig (0.35 Kg/cm2) to 4,500 psig (316 Kg/ cm2)
- A storage module consisting of three 10,000 cubic foot (283 m3) storage tanks to contain CNG at three pressures up to 4,500 psig (316 Kg/ cm2).
- A two-hose, fast-fill fuel dispenser to dispense at either 3,000 psig (211 Kg/ cm2) or 3,600 psig (253 Kg/ cm2), depending on the vehicle tank requirement. The dispenser will supply 56 liters (15 gallons) of CNG in about four minutes so that eight vehicles can be refueled in one hour.
- A defueling system to remove CNG from the vehicle fuel tank before maintenance work is performed in the service garage. It will use residual vehicle tank pressure to discharge natural gas to a receiver in the incoming 5 psig low-pressure (0.35 Kg/ cm2) gas line.

The defueling system eliminated the need for modifications and methane detectors inside the maintenance building to detect and evacuate any accumulation of natural gas from fuel leaks. Without the defueling system, the expense of the building modifications would have made the implementation of the CNG program cost prohibitive.

A card reader system was installed on the dispensers and was integrated with the existing fuel management system. The system was capable of tracking use of multiple fluids by individual vehicles operated by various departments.

Selection of a compressor for the CNG system included consideration of a natural gas engine drive compressor. The engine drive was determined to be about twice as expensive as an electric motor and would not be as reliable in the low horsepower range. A diesel engine drive was also considered, but would have required more maintenance than the electric motor, cost about the same as a natural gas engine drive, and increased the pollutant discharge.

The compressor was specified to have a low operating speed to increase reliability, since speed affects the life of the cylinders, piston rings, valves, and bearings. A large compressor was selected to reduce running time, since compressor life is also related to hours of running time.

Lambert Airport considers this CNG project as the first step in its use of natural gas vehicles. Future expansion could include additional CNG capacity for maintenance vehicles, shuttle buses, and airline support vehicles. CNG capacity can be increase by adding another CNG skid and dispenser or by replacing the existing system with a larger unit. The CNG system was specified to be skid mounted so that it could be relocated for the planned expansion of the airport.

The total consultant fee was $2.4 million.

Ethanol Plant Building Design

ICM, Inc., headquartered in Colwich, Kansas, is one of the premier design/engineering firms for ethanol processing facilities in the world. ICM is known for its unique patented process that produces ethanol fuel from corn while leaving very little waste. ICM sells this process to companies that wish to build ethanol plants, and self-performs the construction of the facility. ICM has designed and served as construction manager for over 100 ethanol plants in the U.S. ranging from 40 million gallon per year to 110 million gallon per year facilities. Due to recent high demand, ICM needed assistance in producing construction documents for ethanol production facilities across the country and needed a design firm that can work under extremely aggressive schedules. Parsons Brinckerhoff (PB), as prime consultant, provided foundation and steel framing design, mechanical and plumbing design, architectural design and interface, and permitting assistance services, and is currently providing construction administration for the ethanol plant in Clymers, Indiana. Design work has recently completed for plants in Greenville, Ohio and Liberal, Kansas. ICM has expanded PB role to provide civil design services for a 40 million gallon per facility in Levelland, Texas.

After successfully completing the assignment, ICM has decided to continue to use our design services for other ethanol plants across the U.S. The total consultant fee was $900,000.

California Fuel Cell Partnership for Hydrogen Fuel Cell Vehicles

For this project, PB designed four facility types: underground, multi-level, public parking; above ground, multi-level public parking; 10-bay vehicle maintenance facility; and a two-car residential garage. PB's approach was to design conventional facilities and then, based on safety and hazard analysis, to prepare facilities modification design. Our hazard analysis focused on examining hydrogen fuel cell vehicle safety parameters and conducting computational fluid dynamics modeling. Based on the parameters provided

during the design, PB's analysis recommended that special modifications were unnecessary. The total consultant fee was $300,000.

Australian National Hydrogen Study

PB conducted a study to assess the opportunities and impediments associated with Australia's possible transition toward a hydrogen economy. We investigated the potential use of hydrogen for Australia's long-term energy supply, taking into account current and future energy supplies; energy market developments and projections; technical developments; industry development opportunities; infrastructure requirements; financial, investment and policy issues; economic impacts; environmental impacts; and regional development. The Commonwealth is currently examining implementing the study recommendations. The total consultant fee was $87,000.

Diesel Hybrid-Electric Bus Evaluation

Sound Transit retained PB to evaluate a 40-foot diesel hybrid-electric bus. The aim of this project is to provide Sound Transit with an objective evaluation of hybrid-electric technology in transit buses. Based on the evaluation, Sound Transit and other transit agencies would determine the feasibility of including such technology in future bus purchases. The evaluation included determining the bus' fuel economy, noise and tailpipe emissions, life-cycle cost, operator and customer comments, availability, and reliability. The total consultant fee was $60,000.

UC Davis Institute of Transportation Studies Project Experience

Hydrogen Pathways Program

http://hydrogen.its.ucdavis.edu/

The Hydrogen Pathways Program (2003 - 2006) at the UC Davis Institute of Transportation Studies (ITS-Davis) was a major collaboration between ITS-Davis, state, national and international government agencies, and international energy and automotive companies.

The primary goal of this four-year, multi-million dollar research consortium was to evaluate the technical, economic, environmental, business, and policy implications of a hydrogen transportation future. The interdisciplinary research team consisted of 15 faculty and 25 graduate students with expertise in engineering, science, planning, environmental analysis, policy and business. The program was directed by Prof. Joan Ogden. A consortium of 20 industry and government sponsors supported the program.

Major research areas are highlighted below.

Design and Analysis of Hydrogen Infrastructure

The goal is to be able to model hydrogen demand and infrastructure development spatially and over time, based on a range of credible demand scenarios, and to develop insights and rules of thumb for low cost

hydrogen transitions under different economic and market assumptions. We have developed a series of engineering/economic models of hydrogen infrastructure systems.

- Some of these projects are listed below. Hydrogen Refueling Equipment Costs Database – information on the costs of hydrogen refueling stations including capital costs for equipment (e.g. compressors, storage tanks), non-capital costs for construction (e.g. design, permitting), and total costs (e.g. $/station, $/kg).
- Hydrogen Energy Station Economics Model – including energy stations and the effects of scale economies on station costs using the Clean Energy Technology Economics and Emission Model (CETEEM)
- Hydrogen Fueling Station Deployment Model – identifies attractive station locations based on anticipated local hydrogen demand and calculated measures of consumer convenience
- Assessing the Reliability of a Hydrogen-Based Energy System – development of a methodology to assess the reliability of hydrogen energy systems in terms of the adequacy and security of various pathways
- SSCHISM Steady State Hydrogen Pathway Model – We have developed an engineering economic model of complete hydrogen supply chains from production through refueling.
- GIS-based Regional Hydrogen Infrastructure Models – Using real-world geographic data, we developed detailed models for how a future hydrogen infrastructure might be designed subject to realistic constraints.
- Transition Studies – We employed dynamic programming methods, coupled with spatial data and engineering/economic models, to examine the characteristics of a regional hydrogen transition as a function of technology advancement, policy and energy prices.

Hydrogen Pathway Policy Analysis

The overarching goal of this study is to understand the dynamics of policy change that relate to hydrogen as an energy carrier. To pursue this goal, the project will follow three interrelated research venues: study of policy dynamics, improving policy theory, and creates a policy resource for parties interested in hydrogen policy.

Fuel Cell Vehicle and Hydrogen Market Research and Analysis

Identifying consumer response to fuel cell vehicles (FCVs) and studying the relationship between vehicle markets and fuel infrastructure is central to determining the long-term potential for this new vehicle technology. H2 Pathways researchers studied a range of factors that will shape consumer decisions about FCVs, including the vehicles' ability to provide mobile electricity and vehicle-to-grid power, and their design and performance attributes. We also examined the role of social marketing, and unexpected attributes and questions that arise as more consumers are exposed to the technology.

Lifecycle Cost and Emissions Analysis

This project included a Motor Vehicle Cost and Performance Model. This model compares the performance and economic characteristics of fuel cell vehicles to other vehicle technologies such as: battery electric vehicles; hybrid gasoline electric vehicles; and various alternative fuel internal combustion engine vehicles.

The model also estimates fuel cycle emissions of air pollutants and greenhouse gases of various vehicle/fuel pathways. Recently, the model has been updated to include detailed analysis of the external and social costs associated with advanced vehicle technologies.

The total program cost was $4,000,000.

UC Davis STEPS (Sustainable Transportation Energy Pathways) Program

http://steps.its.ucdavis.edu/

In 2007, the UC Davis Institute of Transportation Studies (ITS-Davis) launched a new four-year multi-disciplinary research effort, Sustainable Transportation Energy Pathways (STEPS) program. STEPS builds upon the Hydrogen Pathways research program (see above). The overarching objectives of the STEPS program are: 1) to develop the theory, tools, and methods that allow for *self-consistent* and *transparent* comparisons of promising alternative energy and vehicle pathways; and 2) to apply these tools and methods in comparative assessments of four general transportation energy pathways – *hydrogen*, *biofuels, electricity and fossil fuels*.

- Hydrogen. We will continue research conducted under the Hydrogen Pathways Program exploring new areas such as hydrogen/electricity systems, conducting regional transition case studies, understanding the impact of alternative policies, and enhancing key hydrogen pathways models for infrastructure development strategies.
- Biofuels. This track builds upon UC Davis's current work within the California Biomass Collaborative and the considerable agricultural and biological expertise of the university. The biofuels track includes analysis of various biorefinery production systems, infrastructure strategies, environmental and land-use impacts, and vehicle analysis.
- Electricity. Electricity production methods, total grid capacity, and time-of-day charging impacts on the utility sector are being studied. Additionally, research is ongoing on consumer behavior and preferences for electric drive attributes, including all-electric range and charging time.
- Fossil Fuels. This track includes both the business as usual reference case, where petroleum-based fuels continue to dominate transportation energy, and the evolution of fuels produced from other fossil fuel resources, including tar sands, oil shale, and coal with carbon sequestration. Expanded use of diesel fuel will also be studied.

The STEPS program recently completed its first year. The research team is made up of 16 faculty and 26 graduate students in a variety of departments (Environmental Science & Policy, Civil Engineering, Biological & Agricultural Engineering, Mechanical and Aeronautical Engineering, Economics, Agriculture & Resource Economics, Plant Sciences). STEPS has 22 industry and government sponsors. STEPS researchers have produced over 30 research publications, and have received numerous awards. STEPS researchers advised CA state and national policymakers on alternative fuels and energy policy.STEPS is widely recognized as the largest University program of its type. The first year program cost was $1,600,000.

California Hydrogen Highway Blueprint Plan

http://www.hydrogenhighway.ca.gov/blueprint/blueprint.htm

On April 20, 2004, the Governor signed Executive Order S-7-04 calling for the development of the California Hydrogen Blueprint Plan (Blueprint Plan). Governor Arnold Schwarzenegger directed the

California Environmental Protection Agency (Cal/EPA) to develop a "Blueprint Plan" that will expedite availability of hydrogen fueling stations and products that use hydrogen. The Blueprint Plan was developed through a collaborative process with input from more than 200 stakeholders from energy, auto and technology companies, environmental organizations and local, State and federal government agencies.

The Blueprint Plan focused on 5 areas of interest:

- Societal Benefits Topic Team Report: Environment and health
- Rollout Strategy Topic Team Report: Blueprint and timeline
- Implementation Topic Team Report: Insurance, liability and codes & standards
- Economy Topic Team Report: Business and investment
- Public Education Topic Team Report: Marketing, communication and education

UC Davis researchers contributed significantly to the development of the California Hydrogen Blueprint Plan, and played leadership roles. Hydrogen Pathways Program director Dr. Joan Ogden was appointed by the Governor to be one of 15 members of the Blueprint Advisory Panel, who had oversight of the report.. Ten other UC Davis researchers worked with the topic teams, below including Michael Nicholas (Rollout Strategy), Marshall Miller (Implementation), and Chris Yang (Economics). Michael Nicholas developed the station siting algorithm used in developing the Blueprint's rollout plan. The Blueprint Plan was presented to the Governor in May 2005.

The researchers volunteered time on this project so the total cost was $0.

Western Governor's Association Biomass Plan

The goal of the Strategic Development of Bioenergy in the Western States project is to provide the Western Governor's Association (WGA) and their respective state energy policy organizations and legislatures a clear understanding of the contribution that bioenergy (fuels, electricity and thermal energy) can make to energy requirements of the western United States by 2015 and provide a recommended policy framework to create the environment in which bioenergy projects can appropriately develop.

UC Davis researchers contributed to this work by developing biofuel supply chain model that estimates the supply of biofuels based on the distribution of biomass supplies and the production technologies. Supply curves for biofuel production in 2015 were estimated for the region and each state. The final report from this work is under review with the WGA.

The total project cost was $77,000.

Advanced Energy Pathways Project (California Energy Commission): Evaluating the Effects of Advanced Energy System Pathways on Energy Flows and Emissions in California

The goal of this project is to conduct an integrated analysis that compares alternative transportation fuel pathways from the perspective of electricity and natural gas sectors, greenhouse gas emissions, tailpipe emissions, gasoline consumption, cost-effectiveness, technical challenges, infrastructure issues, safety issues, and policy implications, and to provide policy-makers with as comprehensive a view as possible of the various pathways and their costs and benefits.

The objectives of this project are to quantify the impacts of alternative fuel pathways on the environment and electricity, natural gas, and coal sectors. For each of the pathways considered, the metrics used for quantification included the amounts of increase or decrease in air pollutants, carbon dioxide emissions, peak electricity demand, overall electricity and natural gas consumption, and overall system cost.

UC Davis is collaborating with the California Energy Commission, Lawrence Livermore National Laboratory, GETF, and Lawrence Berkeley National Laboratory on this work. Dr. Chris Yang is principal investigator..

The total project cost was $417,746.00.

Scoring Criteria 2: Qualifications of Proposed Team Leader(s)

The Strategic Consulting Group is offering WSDOT the services of its most highly qualified project manager for this project, Brent Baker. Brent has nearly 20 years of experience in managing projects in transportation economics, planning and financial analysis. He is one of our Senior Certified Project Managers, with broad-ranging experience conducting travel demand and revenue forecasting, financial modeling, economic feasibility studies and funding plans for highways, ferries and transit. He holds a masters degree in Economics from the University of Washington. Most noteworthy, Brent has extensive experience with WSDOT policies and procedures, having managed several of PB's engagements on WSDOT projects in both prime and subcontractor roles over the past 15 years.

Project Management Experience

Brent will be responsible for all project tasks and phases, and will assist WSDOT in maintaining the agreed-upon scope, schedule and budget. He will also be responsible for assuring that the quality of PB's products meet or exceed WSDOT and PB standards. Examples of Brent's project management experience with PB are detailed in the table below. In addition, Brent's relevant project experience is provided in Section 3.

Project Name	Client / Organization	PM Responsibilities / Tasks	Project Dates
Econometric Modeling & Revenue Forecasting	WSDOT Ferries Division (Washington State Ferries)	Project Manager: Led demand modeling, revenue forecasting, and an analysis of fuel market hedging opportunities	2006-present; 2000-2006; & 1996-2000
SR 520 Bridge Replacement and HOV Project GEC (Finance Plan and Toll Traffic & Revenue Study task)	WSDOT via subcontract with HDR	Project Manager and project team task manager for the Finance Plan and Traffic & Revenue Study: Oversaw demand modeling, revenue projections, O&M estimates and financial analysis documentation	2006-present
Sound Transit Phase 2 Planning	Sound Transit via subcontract with PB Americas	Project Manager and finance/economics task leader: Developed financial tools and conducted financial modeling and analysis of phase 2 investments; led the benefit-cost methodology development and application	2006-present

Familiarity with Relevant State/Federal Regulations/Procedures

Having managed WSDOT projects for over 15 years, Brent has an excellent familiarity with the relevant regulations and procedures that can govern planning studies, economic evaluations and financial analysis. He is familiar with the many public sources of data that can efficiently be used to develop analysis assumptions and benchmark results. For alternative fuels, some of the most valuable sources are expected to be:

- The US Department of Energy,

- The US Energy Information Agency,
- The US DOT (FHWA),
- The Puget Sound Clean Cities Coalition, and
- The California Energy Commission.

Proven Project Management Expertise

In his tenure with PB, including Strategic Consulting Group, Brent has managed over two dozen projects, all of them to a successful completion within budget. Much of this is due to Brent's management style that reflects conscientious attention to scope, schedule and budget. Brent has earned the status of Senior Certified Project Manager within the firm, and he has also completed a certificate program in project management at the University of Washington. The successful management of each of our projects — large, medium, or small — is of great importance to Strategic Consulting and our clients. Because our business is in the hands of Brent and the other proposed key staff, we feel it is paramount that we build their project management skills. The table below provides examples of Brent's ability to successfully manage scope, schedule, and budget issues, as well as unforeseen changes that arise during projects.

Project Name	Challenge	Resolution
Alaskan Way Viaduct and SR 520 Bridge Finance Plans of 2006 (WSDOT; On-Call Engineering Specialty Services)	Managing Scope Change: Four weeks into a fast-paced, six week schedule to analyze revenue sources and prepare project funding plans, the client requested a major change in the scope and content of the work.	With two weeks remaining to do two months of work, Brent sat down with the client and revised the work plan, prioritizing tasks to ensure that the most critical elements would be completed. He then mobilized additional resources and together they worked long days to meet the deadline despite the change in scope.
2007 SR 520 Finance Plan	Change and Evolution in a Project: Six months of analysis were due to be published in the SR 520 Finance Plan in December 2007 when a broad transportation ballot measure to provide a key source of project funding failed just as the draft report was being produced.	Despite direction to base the analysis on the passing of the ballot measure, Brent took steps along the way to make sure that information explaining how the toll revenue results would differ if the ballot failed would be available. Even so, an additional toll scenario was requested following the ballot failure. Brent and his team were able to analyze this additional scenario and re-tailor the finance plan to the changed conditions and still meet the December 31 deadline.

SR 520 Toll Feasibility Study (WSDOT)	Controlling Budget: A local neighborhood group opposed to the project hired a consultant to critique the 2004 SR 520 Toll Feasibility Study in a public setting, claiming that the analysis was flawed and that it should have tested higher tolls in order to reduce demand so that WSDOT could build a bridge with a smaller footprint.	Brent worked with WSDOT to prepare a written response to the detailed comments and technical questions received from the neighborhood's consultant. The objective approach taken in the written response helped to deflect the criticism and educate the opponents, allowing WSDOT to avoid doing additional, unwarranted work.

Scoring Criteria 3: Key Team Members Qualifications

Brent Baker (Strategic Consulting Group of PB – Project Manager)

Brent Baker will be the Team Leader/Project Manager for WSDOT on this project. Brent's experience as a project manager for WSDOT and other clients can be found in Section 2. Brent is an experienced infrastructure economist and financial analyst, with expertise specializing in transportation-related project finance, toll revenue forecasting, travel demand estimation, benefit-cost evaluation, and funding analyses. He holds a Masters Degree in Economics from the University of Washington with specialization in econometrics, benefit-cost analysis and public finance. Brent serves as the Strategic Consulting Group's Pacific Northwest expert in modeling economic impacts and evaluating the economic viability and financial feasibility of infrastructure projects. His technical, advisory and management experience covers highway, ferry, rail, and transit projects, and includes value pricing/toll revenue forecasting, travel surveys, economic feasibility studies, tariff elasticity analyses, financial model development and application, statistical modeling, service planning and funding studies.

Brent, having worked with WSDOT on a number of engagements, is well-versed in WSDOT's regulations and procedures. Prior relevant projects for Brent are listed below.

- SR-520 and I-90 Toll Traffic and Revenue Projections, Seattle, Washington: project manager for this effort to model demand and forecast toll revenues and O&M costs for parallel bridge crossings of Lake Washington. Project duration: 2006 – current
- Alaskan Way Viaduct & Seawall Project, Seattle, Washington: task leader for several elements of this urban highway replacement project, including an economic analysis of construction and facility closure impacts, a toll feasibility study, a stated-preference survey to assess willingness to pay tolls, and financial planning including an analysis of federal, state and local funding sources. Project duration: 2006 – current
- Econometric Modeling/Traffic and Revenue Forecasting, Washington: project manager for this ongoing contract with Washington State Ferries (WSF) to prepare traffic and revenue forecasts by route and fare category for the largest ferry system in the U.S. Led the development of the econometric forecasting models designed to estimate price elasticities and analyzed the impacts of alternative tariff policies and service levels. Project duration: 2006 – current

Nick Amrhein (Strategic Consulting Group of PB - Task Leader)

Nick Amrhein is the financial analysis task leader. As a consultant with seven years of experience, specializing in market-based real estate development and economic analysis related to transportation projects, Nick is an expert at developing financial models to provide maximum flexibility for sensitivity analysis under shifting assumptions. Nick holds an M.B.A. in Finance and Management Information Systems from the Rochester Institute of Technology.

Nick has worked for many different state departments of transportation, including WSDOT as well as many other public sector clients, giving him varied and extensive experience in dealing with public agency regulations and procedures. A short selection of Nick's relevant project experience is detailed below.

- Washington State Department of Transportation, Seattle, WA (SR 520 Bridge Finance Plan): part of the team of traffic engineers and financial advisors that developed a toll revenue forecast and financial plan for the rebuilding of the SR 520 Bridge over Lake Washington. Similar analysis

was performed for the parallel route to the south, Interstate 90. The analysis involved assembling a variable rate toll structure based on traffic volumes, and matching the resulting revenue projections with capital and operating costs in a comprehensive cash flow model built collectively by the project team. Net cash flows from the model were used by the Department of Finance to develop estimates of bonding capacity to pay for the project. Project duration: 2006 – current

- Northwest Parkway Authority, Denver, CO (The Northwest Parkway): performed two real estate and economic market studies (2005 and 2006) and produced socioeconomic forecasts for use in forecasting toll revenue to support the potential refinancing of the Authority's debt. Reviewed adopted DRCOG forecasts and conducted over 40 interviews with economic developers, chambers of commerce, real estate developers, brokers, business leaders, and other stakeholders in the Denver metro area. Built and operated a comprehensive financial model and performed sensitivities to provide rating agencies and bond insurance companies with a clear understanding of the impact of changing land uses and demographics in the corridor on toll revenue projections. Project duration: 2001 – 2007
- Transportation Corridor Agencies (TCA) Traffic and Revenue Study, Orange County, CA: managed land use aspects of a team that conducted traffic and revenue studies and prepared investment grade forecasts for the Foothill/Eastern and San Joaquin toll roads in support of TCA's goal to re-capitalize and possibly consolidate its toll road assets. Forecast revenues from the TCA's Development Impact Fee (DIF) Program under varying development scenarios and macroeconomic conditions using land use and financial models. The TCA assignment included an intensive land use research component, an internal strategic evaluation of potential revenue sources. The original assignment was conducted in 2003 and an update to this work was completed in 2008. 2001 – 2008

Pamela Bailey-Campbell (Strategic Consulting Group of PB – Task Leader)

Pamela Bailey-Campbell is the national Public Private Initiatives market leader for PB. Pamela's role reflects PB's emphasis on serving clients in the fast-paced public-private partnership arena. In her role as market leader, Pamela leads all aspects of public-private partnerships for PB in the Americas across all infrastructure sectors. Pamela is a nationally recognized leader in the field, with more than 25 years of experience in the development, financing, and implementation of projects that involve public-private partnerships (PPPs). She has expertise with the entire development process for PPPs including strategic policy and guidelines, organizational aspects through all elements of procurement, evaluation and negotiations. Her advisory work has also included toll feasibility assessments, risk assessment, tolling and violation enforcement technology and operations of major toll road and public-private facilities. One of the advantages Pamela brings to clients is her hands-on PPPs expertise. A few highlights of her work include the Innovative Partnerships Program for the Oregon Department of Transportation, the concession procurement for the Northwest Parkway, the concession procurement for the LBJ Freeway in Texas, the HOT Lane Pilot Program in Washington State, the SR125 concession in California and the first non-recourse financing of a toll road in Canada.

As the former Executive Director, Chief Operating Officer and Chief Financial Officer fro the E-470 Public Highway Authority in Denver, Pamela was responsible for development, negotiation, and implementation of one of the first transportation project design/build processes in the United States. Through this role, as well as from being a project manager on various projects to numerous state departments of transportation and

other public agencies, Pamela has extensive experience in public agency regulations and procedures. For this project, Pamela will be the technical lead on evaluating PPP options. Pamela's project experience is below.

- Oregon Innovative Partnership Program (OIPP) Program Management Services: lead the team that assisted the Oregon Department of Transportation to develop public-private transportation projects for solicitation and to respond to proposals initiated by private firms and units of government by providing program management services to develop and implement this program. The services include the development of PPP policies and guidelines, implementation of an OIPP Program Management Plan; assisting in SEP-15 applications with FHWA, development and implementation of public-private partnership procurement processes, establishing project selection criteria; and assisting in proposal evaluation, contract negotiations and oversight of early development activities by the private sector partner. Project duration: 2006 – 2007
- SR 167 HOT Lane Pilot Project, Seattle, WA; Toll/HOT Lane Project Development Task Leader: provided management and oversight to the Washington Department of Transportation for the state's first HOV lane to HOT Lane conversion. The overall project included developing preliminary design of the converted facility; assisting with National Environmental Policy Act and State Environmental Policy Act documentation; managing an Origin and Destination and public opinion mail survey; and preparing a concept of operations program for the HOT Lanes tolling concept. The concept of operations program provided key elements of how the SR 167 tolling system should operate and perform, and how the system would be interoperable with other tolling systems in Washington State. Project duration: 2005 – 2007
- Ministry of Transportation of Québec, Québec, Canada, Concession Structuring & Transaction Support: Advisor to the MTQ for the original traffic and revenue assessments and procurement of Autoroute 25 ($400M) and Autoroute 30 ($1.4B), the first two highway PPPs in Québec. Scope included the assessment of traffic and revenue risks and development allocation and mitigation strategies including amendments to existing legislation, tolling regime, revenue guarantee, and revenue sharing mechanisms. Project duration: 2006 – current

Greg Christian (PB)

Greg Christian will be the ethanol technical advisor on this project. Greg is a senior architect with PB. He is experienced in the design and construction of renovation projects for various infrastructure facilities, including ethanol plants. Greg is a registered architect in the state of Missouri. For the ICM ethanol plant building design, Greg worked on an aggressive schedule, providing the complete project design and construction documents in under three months. Greg has been intimately involved with the ethanol industry for the last three years, and his works has included producing designs for several ethanol plants across the Midwest.

Greg has worked for various public agencies throughout the Midwest and, prior to joining PB, owned his own firm providing ongoing facility and architectural services for numerous clients. Greg has many years of experience in working with public agencies and has been involved with many different regulations and procedures.

Currently, he is active in studying the logistics of delivering ethanol to the marketplace. His project experience is below.

- ICM Ethanol Plant Building Design, Multiple Locations: project manager for the design and construction administration of six $145 million ethanol plants each involving two buildings that form the central processing of the ethanol fuel: the 37,000-square-foot (3,440-square-meter) Fermentation/ Processing Building and the 30,000-square-foot (2,790-square-meter) Energy Center. Sites are located in Clymers, Indiana; Greenville, Ohio; Liberal, Kansas; Council Bluffs, Iowa; Concordia, Kansas; and Ithaca, Michigan. Project duration: December 2005 – March 2006.
- General Motors Corporation, Warren Technical Center, Warren, Michigan: responsible for schematic design study and cost estimating for several projects to be located at the Warren Technical Center. Projects ranged from fuel fill tank farms and specialized testing facilities to presentation rooms for automobiles. Project duration: 2004 – 2005
- Fluid Fill Tank Farm, General Motors Corporation, Warren Technical Center, Warren, Michigan: served as project architect for the refurbishment and activation of the existing fuel tank farm serving the Warren Technical Center. This included the construction of enclosures and mechanical systems involved with fuel distribution into the vehicle assembly areas. Project duration: 2004 – 2005

Michael Benouaich (Strategic Consulting Group of PB)

Michael Benouaich specializes in the financial and strategic analysis of capital projects and companies in the global infrastructure sector with emphasis on project finance, public-private partnerships (PPP), and innovative public finance mechanisms. Michael is part of the national Public Private Initiatives leadership team for PB. Trained in civil engineering and finance, he has been working closely with government and industry clients to provide financial capacity and funding analysis, and to structure and implement innovative infrastructure delivery methods. Michael holds a Master of Science in Finance from the Massachusetts Institute of Technology and a Master in Civil Engineering from the Swiss Federal Institute of Technology

Through his work on advising public-sector clients in PPP transactions and financial feasibilities, Michael has gained a solid understanding of the respective roles of public and private stakeholders as well as public agency regulations and procedures. On this project Michael will leverage his expertise in PPPs to work with Pamela Bailey-Campbell on developing alliance strategies and will also lend expertise to the financial analysis. . Highlights of Michael's work experience are presented below:

- Caltrain, Peninsula Corridor Joint Powers Board, California, Electrification Program PPP Financial Feasibility & Structuring:: Lead advisor. Assisted Caltrain in evaluating contracting options, risk allocation strategies, and financial feasibility to convert the existing Caltrain diesel-powered commuter rail service to electrically-powered service using a PPP. Developed project finance model assessing the level of subsidy required to procure the electrification infrastructure and new electric rolling stock (estimated at $1.3 billion) under a concession model. Investigated opportunities for Caltrain to monetize emissions reduction through emerging carbon trading schemes. Project duration: 2007 – current
- Private Developer, Texas, Renewable Power Financial Feasibility: Developed project finance model to assess the preliminary feasibility of developing 3500 MW of generating capacity, including 2200 MW of wind power, along with 300 miles of transmission lines to link the wind resources of the South Plains of West Texas to the Electric Reliability Council of Texas (ERCOT) market. Assisted developer in presenting the project to the local City Council and municipal power utility to gather project support. Project duration: 2007 – current

- Ministry of Transportation of Québec, Québec, Canada, PPP Structuring & Transaction Support: Project manager and lead advisor assisting the MTQ with risk analysis and pricing strategy for the procurement of Autoroute 25 ($400M) and Autoroute 30 ($1.4B), the first two highway PPPs in Québec: Assessed traffic and revenue risks and developed allocation and mitigation strategies including amendments to existing legislation, tolling regime, contract language, revenue guarantee, revenue sharing mechanisms, as well as internal management procedures. Project duration: 2006 – current

Greg Heinz (Strategic Consulting Group of PB)

Greg Heinz has a wide base of experience in the development of public infrastructure, from the development of project implementation and financing plans to roles in planning, design, and construction. Greg has successfully worked on projects involving major roadways, highways, transit systems, and airport facilities. His specific roles on these projects have varied, including responsibilities as a strategic consultant, group facilitator, project manager, and design manager. His strengths include: financial analysis of infrastructure and related cost and revenue sources; project management and project leadership; and group facilitation focused on identifying organizational and project-specific challenges and development of targeted, tailored solutions.

Greg will work on economic analysis and financial modeling on this project. He holds an M.B.A. from Wake Forest University. Greg has worked with WSDOT on multiple projects and is very familiar with their regulations and procedures.

- Washington State Department of Transportation, Seattle, WA (SR 520 Bridge Finance Plan): financial consultant for the preparation of a detailed project finance plan as mandated by the Washington State Legislature. Development of the plan includes: completion of more thorough traffic and revenue forecasts of five scenarios of tolling the Lake Washington crossing; evaluation of operating and maintenance expenses; determination of net revenues generated by tolls; determination of the financial capacity of the various toll revenue streams; evaluation of non-toll revenue sources; modeling of project cash flows, matching sources of funds with project uses; and evaluating size and timing of project funding gaps for each of the scenarios under consideration. Project duration: 2006 – current
- Columbia River Crossing, Portland, OR / Vancouver, WA: financial consultant for the development of a project financing plan for this replacement of the existing I-5 crossing of the Columbia River between Portland, Oregon and Vancouver, WA. Project elements included the identification of project funding and financing options, tolling revenue projections, and the development of an overall project financing plan. The project has been undertaken by the I-5 Transportation and Trade Partnership to improve the traffic and relieve congestion on I-5 in the Portland Metropolitan area, with a focus on upgrading or replacing the existing bridge crossing the Columbia River. Alternative financing options were considered for the project, including: a regional tolling plan, which could include tolling the new I-5 bridge in addition to the nearby I-205 crossing; various public private partnership (PPP) arrangements, with particular emphasis in attracting additional capital funding; and assorted value-capture techniques. Project duration: 2006 – current
- Alaskan Way Viaduct, Seattle, WA: financial and economic consultant for the development of an economic impacts assessment of a catastrophic failure of the Alaskan Way Seawall as measured by changes in regional transportation costs. This analysis consisted of determining the changes in travel behavior associated with several different failure scenarios of varying severity, and applying

cost and time factors to these changes. The results of this analysis enabled the US Army Corp of Engineers to make a more compelling business case to secure funding for replacement of the seawall. Project duration: 2006 – current

Marshall Miller (UC Davis)

Dr. Marshall Miller is a Senior Development Engineer at the Institute of Transportation Studies at the University of California, Davis. He is the Director of the Hydrogen Bus Technology Validation Program which studies fuel cell and HCNG buses. He runs the Hybrid Vehicle Propulsion Systems Laboratory where he does research on fuel cells, advanced batteries, and ultracapacitor technology. His overall research has focused on advanced environmental vehicles and fueling infrastructure to reduce emissions, greenhouse gases, and oil usage.

He received his B.S. in Engineering Science and his M.S. in Nuclear Engineering from the University of Michigan. He received his Ph.D. in Physics from the University of Pennsylvania in 1988.

Michael Nicholas (UC Davis)

Michael Nicholas received his B.S. in Physics at the University of Puget Sound and earned his masters in Transportation Technology and Policy at UC Davis. He is currently working on his PhD at UC Davis. His research has focused on the geographic aspects of alternative fuel infrastructure, particularly station siting. As station siting has been a problem for any alternative fuel, he has been interested in studying this problem to see where failures have been made in the past, and how society might best solve them in the future.

Andrew Burke (UC Davis)

Dr. Burke holds B.S. and M.S. degrees in Applied Mathematics from Carnegie Institute of Technology, a M.A. degree in Aerospace Engineering and a Ph.D. in Aerospace and Mechanical Sciences from Princeton University. For this project, Andy Burke will be working on analysis of alternative fuels.

Since 1974, his career work has involved many aspects of electric and hybrid vehicle design, analysis, and testing. He was the head systems engineer on the U.S. Department of Energy–funded Hybrid Vehicle (HTV) project while working at the General Electric Research and Development Center in Schenectady, N.Y. While a Professor of Mechanical Engineering at Union College in Schenectady, he continued his work on electric vehicle technology through consulting with the Argonne and Idaho National Engineering (INEL) Laboratories on various DOE electric vehicle and battery programs. Dr. Burke was employed from 1988-1994 at INEL as a principal program specialist in the electric and hybrid vehicle programs. His responsibilities at INEL included modeling and testing of batteries and electric vehicles and the technical management of the DOE ultracapacitor program. Dr. Burke has authored over 100 reports and papers on electric and hybrid vehicles, batteries, and ultracapacitors.

Dr. Burke joined the Research Faculty of the Institute of Transportation Studies at UC Davis in July 1994. He has performed research on and taught graduate courses on advanced electric driveline technologies specializing on batteries, ultracapacitors, fuel cells, and hybrid vehicle design, control and simulation.

Joan Ogden (UC Davis)

Dr. Joan Ogden is Professor of Environmental Science and Policy at the University of California, Davis and Director of the Sustainable Transportation Energy Pathways Program at the campus's Institute of Transportation Studies. Her primary research interest is technical and economic assessment of new

energy technologies, especially in the areas of alternative fuels, fuel cells, renewable energy and energy conservation. She has published over 100 technical papers on energy topics. Her recent work centers on the use of hydrogen as an energy carrier, hydrogen infrastructure strategies, and applications of fuel cell technology in transportation and stationary power production. She has served on energy-related committees convened by US Department of Energy, the National Academies and the state of California. She holds BS in mathematics from the University of Illinois (1970), and a Ph.D. in theoretical physics from the University of Maryland (1977). Prior to joining the faculty at UC Davis, Ogden was a research scientist at Princeton University's Environmental Institute.

Christopher Yang (UC Davis)

Dr. Christopher Yang is a project scientist and co-leader of Infrastructure System Analysis within the Sustainable Transportation Energy Pathways (STEPS) research program at the Institute of Transportation Studies at the University of California, Davis. He completed his PhD (2003) from Princeton University in the Mechanical and Aerospace Engineering Department focusing on fuel cell membrane materials research. One of his current research areas is the modeling of hydrogen production and distribution infrastructure and understanding how a hydrogen economy could evolve over time. This work focuses on understanding issues related to the evolution of the hydrogen economy on a regional and geographic context and includes developing simplified H_2 pathway models for hydrogen production and distribution and optimizing economics and location of production facilities and distribution networks using GIS. Another research topic is the interplay between fuel and electricity production systems with the introduction of advanced electric-drive vehicles. This work focuses on identifying and understanding the integration and interactions between advanced transportation fuels and electricity production in California. Issues include co-production strategies, competition and coincidence in timing for primary energy feedstocks and environmental and economic implications. He has also worked in developing scenarios for future energy demands and identifying options for reducing greenhouse gas emissions in the transportation sector.

Nathan Parker (UC Davis)

Nathan Parker s a Ph.D. student in Transportation Technology & Policy at UC Davis. His research concerns finding optimal biofuel supply chains using real-world geographies. His current projects include a GIS biomass resource assessment for the western states and developing an optimization model to design biofuel supply chains in California. He has also studied the costs and design of hydrogen pipeline systems. Nathan holds a B.S. in physics from Wake Forest University (2001), and a MS in Transportation Technology & Policy from UC Davis (2007). His Master's thesis received a Wootan Award from the Center for University Transportation Centers, as the best Master's thesis in transportation planning and policy in the US in 2007.

Scoring Criteria 4: Project Approach

The Strategic Consulting Team has developed an approach that will answer the questions regarding the financial viability of delivering alternative fuels along the Interstate 5 (I-5) corridor. Our approach is straight-forward, utilizing Strategic Consulting staff who are expert financial and economic analysts supplemented by other PB and UCD technical experts representing the most advanced knowledge base available in the alternative fuels industry. In parallel to the financial analysis, our PPP experts will evaluate the potential partnering opportunities available to WSDOT for bringing critical mass to the project's implementation plan for a successful corridor-wide rollout.

The analysis will cover a wide range of alternative fuels in a business analysis context, but will conducted at a conceptual level of effort to allow the study to be completed within the available budget resources. Combining the financial and economic expertise of the Strategic Consulting Group with the technical alternative fuel expertise of UCD will enable the Team to quickly access cutting edge research and information to refine and structure key model assumptions and provide WSDOT with an accurate picture of the corridor's financial viability.

The cornerstone of our approach will be to build a comprehensive financial model capable of multiple-input sensitivity analysis to estimate the financial viability of both an individual station and the entire I-5 corridor to be self sustaining in the distribution of alternative fuels of various types. If the corridor is not financially feasible, we will calculate the necessary initial subsidy and/or ongoing subvention payments that would be required over time until demand achieved a level that made the corridor stand-alone financially viable on an annual basis.

The following specific steps in this analysis approach provide an overview, with additional detail for each step following.

1. Assemble the project team and work with WSDOT to refine our proposed approach into a work plan that prioritizes key objectives, clarifies deliverables and can be completed within the available time and resources.
2. Establish benchmark capital and operating costs and revenues by conducting a business analysis of a 'traditional' gasoline and diesel service station.
3. Build a generic financial analysis model based on the benchmark analysis and customize versions of the model for each alternative fuel type using inputs from the Team's technical experts. Each 'alternative' fueling station Business Analysis model will contain the following components:
    a. Capital and operating costs of stations
    b. Cost of goods sold based on analysis of supply chain / wholesale distribution
    c. Station spacing analysis determining the number of stations needed in the corridor for a given service level
    d. Conceptual future demand for each fuel type

    The model will be structured to analyze the potential gap between expected demand and the demand levels required to make the corridor financial feasible. This gap will serves as the basis to estimate an annual subsidy that would be required to support the corridor.

4. Analyze how WSDOT-owned right-of-way, financing, tax abatement or other contributions in addition to identified alliance opportunities could together feasibly subsidize the corridor on an annual basis until the market matures sufficiently to make the corridor self-sufficient.

Work Plan Refinement and Deliverables

Our approach to this engaging assignment as follows below addresses our understanding of the scope of work provided by WSDOT. However, we believe that an important first step will be to assemble the project team for a "kick-off" meeting with WSDOT to clarify the primary objectives for this project, to identify the role(s) where WSDOT staff may want to focus participation, and to finalize a scope of work and set of deliverables that can be achieved within the identified schedule and budget.

The following approach is proposed with the flexibility to emphasize or deemphasize various elements based on WSDOT's objectives and priorities. It recognizes WSDOT's expectation that the definition of the project deliverables may be a moving target as the work progresses and various findings are developed. The PB team acknowledges that WSDOT will need both a final report and a short summary "white paper" or folio to help communicate the alternative fuels economic analysis and findings. A limited number of financial model sensitivities will be proposed to WSDOT after substantial completion of the analysis and performed to provide ranges potential subsidy levels or other outputs as deemed material. The consultant team will be available to participate in presentations to WSDOT and/or the State Legislature following completion of the project technical work.

'Traditional' Fuel Station Business Analysis

The operation of an alternative retail fuel service station is expected to have certain costs and business characteristics that are similar to "traditional" fueling stations, defined herein as stations selling standard gasoline and diesel fuel products and sundries. Our approach will utilize an analysis of traditional stations from a financial and operational standpoint to establish benchmarks that can be compared to the conceptual pro forma financial plans developed for alternative fueling stations.

Most motorists see little or no difference between brands of gasoline, therefore service stations must compete on cleanliness, location, convenience, services and price. Assuming that multiple service stations in a given location have similar or perceived similar levels of convenience, service and cleanliness, the remaining determinant for consumers to choose a station is price. Most traditional service stations maintain thin margins on fuel sales in order to be as competitive as possible with direct competitors. As such, staying in business relies on large volumes of fuel sales and sales of sundry and convenience products and services.

An analysis of the traditional service station will illuminate these interrelationships and provide context for the financial analysis of the alternative fuel stations. The engagement team will develop a basic capital cost profile for a traditional service station along with annual operating costs that would be applicable in the I-5 corridor. Additionally, a cost of sales and profitability profile will be developed using the same framework that is utilized to develop the alternative fueling station financial analyses.

'Alternative' Fuel Station Business Analysis

The goal of this task is to better understand the prospective economics of alternative fuel production, delivery and refueling in Washington State. Our team members have specific backgrounds and experience with the dominant petroleum fuel alternatives, including hydrogen, biodiesel, electric/hybrid, and ethanol, that is directly applicable to this study. The following sections describe our approach for each fuel, which

generally consists of an analysis of supply and operations costs relative to expected demand, as noted above.

Hydrogen

The team will determine the capital cost of hydrogen infrastructure (i.e. investment cost) and delivered unit hydrogen costs (i.e. $/gallon of gasoline equivalent). The hydrogen infrastructure cost analysis will be conducted using the UC Davis SSCHISM model, a steady-state full pathway model developed by Dr. Chris Yang and Dr. Joan Ogden (Yang and Ogden 2007). This model allows us to design the infrastructure and estimate capital and operating costs for the entire hydrogen supply chain: production, storage, delivery, and refueling. SSCHISM uses hydrogen equipment costs and performance from the H2A model developed by the U.S. Department of Energy. Using an idealized spatial model, SSCHISM combines the H2A component level data into complete hydrogen supply pathways from hydrogen production through refueling.

Inputs include information about the level of demand (market fraction of hydrogen vehicles), area population and size, the number of stations, local feedstock and energy prices and constraints on viable types of supply. Additionally, the level of technology advancement can be specified (current technology or 2015 technology), and policies such as carbon taxes can be modeled. Outputs include the delivered hydrogen cost to the vehicle ($/kg), hydrogen infrastructure capital and operating costs and energy use and CO2 emissions for different supply pathways. The SSCHISM model is capable of estimating hydrogen infrastructure costs for 400 different cities (urbanized areas) in the US (all cities with population > 50,000 people), including 11 cities in Washington state. A variety of hydrogen supply options will be evaluated, including natural gas, coal, biomass and electricity. We will explore the sensitivity of the results to changes in energy prices, market fraction and other key inputs.

Electricity / Hybrid Electric

Advanced vehicles that use grid electricity include battery-powered electric (BEV) and plug-in hybrid (PHEV) vehicles. Both of these types of vehicles offer attractive means of reducing fuel consumption for passenger cars and light-duty trucks and using low-carbon and renewable resources in transportation. In the study, the status of the technology and cost of both BEVs and PHEVs would be assessed and the market demand (sales) of these vehicles projected for the next twenty years. Recent studies of the advanced vehicles at ITS-Davis will provide both the vehicle characteristics and use pattern input data for this effort.

The issues involving the production and distribution of electricity and charging station siting differ significantly from other alternative fuels infrastructure. The production and distribution of electricity is well developed, and charging stations will tend to be distributed at homes and work rather than at central or interstate corridor locations where large number of vehicles refuel. Some number of public charging stations may be useful at certain locations. Battery packs can be charged at different powers. Most home and work charging stations will provide relatively low power because this option is less expensive. Low power charging (slow charging) requires longer charge times. Public charging could provide higher power (fast charging) at higher costs, and more vehicles could be charged at those stations per day.

The effect of the advanced vehicles on the overall demand for grid electricity will be calculated both with respect to total quantity of demand and the timing of demand as both of these are important considerations on the impact of the new EV-related demands on the utility load factors). The existing profile of electricity demands in Washington will be examined and vehicle charging will be analyzed in the context of using off-peak power. The additional generators that are used to meet the EV-related demand can be determined and the emissions can be calculated (McCarthy and Yang 2008). In addition, estimates will be made of the

infrastructure needed to provide public charging for the BEVs and PHEVs. The estimates will include the number and cost of the public charging stations (slow and fast) as well as how these stations would be placed. The availability and cost of home and work charging facilities will also be studied and the fraction of households and places of work that could provide charging estimated. These factors relative to the market penetration of BEVs and PHEVs have been studied for California in the past at ITS-Davis.

While power production for BEV or PHEV charging can come from any feedstock, Washington State's grid has significant contributions from renewable sources. We will characterize the existing electric grid and our work will look at the renewable component of power production and determine to what extent the addition electricity demand from charging stations will affect current and potentially new renewable power production.

Biodiesel

The biodiesel section will summarize issues relating to biodiesel at three stages of the supply chain – the supply of feedstocks, the production technologies and the distribution of the fuel. Biodiesel can be produced from vegetable oils or animal fats. In general, exploiting waste or secondary product streams are most advantageous – both economically and environmentally. The limitations in the supply of waste oils (yellow grease) and animal fats for biodiesel feedstock in Washington will be described using data from a recently performed resource assessment for the western U.S. In addition, we will discuss the limitation of seed oil supply generally. A brief description the technologies that are available to produce biodiesel will be provided. This will include the cost of production, efficiencies and matching of feedstock to technologies. Finally, the issues with the distribution of biodiesel will be highlighted.

Ethanol

The development processes and delivery methods for corn-to-ethanol and cellulosic-to-ethanol fuels are very similar. Generally, a biological fermentation process of a feedstock is used to extract sugars to make 200 proof alcohol, then distilled and denatured to ethanol. Unlike in grain, the sugars in cellulose are locked in complex carbohydrates called polysaccharides, or long chains of simple sugars. Separating these complex structures into fermentable sugars is essential to the efficient and economical production of cellulosic ethanol.

Ethanol is generally shipped to a petroleum plant for blending into the petroleum fuel stock form sold today at retail locations. One potential problem with the current delivery method is that it places control of the alternative fuel in the hands of those who could see it as a threat to its primary business, i.e. the 'traditional' oil companies. Ethanol is already blended with traditional gasoline in small quantities in many markets to reduce vehicle emissions. While some petroleum companies are embracing alternative fuel development, other delivery methods should be evaluated and could involve ethanol being blended with petroleum product independently of the petroleum companies, and then shipped to fueling stations.

Another alternative delivery method involves ethanol being delivered from the ethanol plant to a storage facility and then delivered unblended to the end-user. Fueling stations outfitted with blending pumps would be needed to combine the fuel to the specifications of the end-user's automobile. This approach allows for direct delivery of ethanol to fueling stations and removes any mark-up by a blending "middleman." This is considered the future of ethanol distribution since different cars perform better on different blends of ethanol/petroleum fuel.

There is capacity to deliver ethanol now but if demand increases substantially, there would be a pinch in the transportation industry's ability to deliver product (via truck and rail), especially to the west and east coast markets. In our analysis of the ethanol business operating environment, we will analyze the costs of

wide spread ethanol use in the I-5 corridor, weighing the benefits of lower adverse environmental impacts, and a reduction in petroleum-based fuel use with looming transportation issues in the supply chain and the relatively sparse availability of the fuels in the current market.

Station Location Analysis

In most locations, gasoline stations are ubiquitous, providing a range of locations so as not to restrict the travel of consumers. However, replicating the same number of locations for an alternative fuel is not necessary or desirable in the near term. A key question for early alternative fuel infrastructure placement is to determine how many stations are necessary and where best to site those stations.

UC Davis has developed a model that can help determine the number and placement of alternative fuel stations. This model has been applied in projects such as the California Hydrogen Highway Blueprint Plan and for regions such as the South Coast Region near Los Angeles in California.

There are three basic inputs required for the model: customer locations, a road network, and potential sites for stations. Customer locations can be determined by population from the census. Additional information for customer locations can be determined by previous adoption of alternative fuel vehicles such as electric or CNG vehicles. Road volumes (vehicle throughputs) for freeways and major arterials, if available, are useful as well. Road networks data can be input from census tiger line data or a travel model network database. Existing gasoline station sites can be used as potential station locations.

With these inputs, we can measure the convenience of consumers in terms of average travel time to the nearest station for different metropolitan regions. In general the model can calculate average travel time as a function of the number and locations of stations. Previous studies have shown that not all areas are equal when comparing current infrastructure to future infrastructure needs. For example, ten percent of stations in one area may be equal in terms of convenience to six percent somewhere else. Interregional station siting will also be addressed. Providing mobility between metropolitan regions is critical to widespread acceptance of a fuel. Since interregional availability is tied to the physical range of the vehicle, more straightforward calculations based on distance can be made as to the appropriate placement of this infrastructure. The locations of stations identified through the above methods can apply to any alternative fuel, although it is most critical to site hydrogen carefully as it is not interchangeable with conventional fuel.

Analysis of Supply Chain / Wholesale Distribution

An in-depth understanding of the complete supply chain for any of the potential fuel alternatives is essential to performing an analysis that will inform the feasibility of supplying alternative fuel(s) in the I-5 corridor. The current state of technology related to production of the fuels and delivery to the end distribution stations will be reviewed. The project Team will also complete an accounting of potential advances that are anticipated to occur in the near term. This analysis will be undertaken by the Sub-task leader with the full support of each of the alternative fuel technical experts.

A full supply-chain analysis would begin with a background review of each of the fuel types, including how and where the fuel is produced and how the fuel would be delivered to the retail station. For example, ethanol and biodiesel are fuels that can be delivered via tanker truck and dispensed via traditional fueling apparatus, thus requiring relatively little in distribution investment. Compressed natural gas (CNG) can be delivered via the same network that delivers gas for residential and commercial purposes. The distribution of some of the other fuels is currently problematic. Hydrogen, for example, is most efficiently distributed by pipeline direct from the source, such as petroleum refineries. This pipeline network is relatively limited, and thus other, more expensive distribution methods are required. Alternatively hydrogen can be produced at the station from natural gas or electricity.

For each of the fuels considered, critical issues associated with the respective supply chains will be explored. The questions the Team will seek to answer include:

- What is the current local and global demand for the fuel? What is the expected future demand?
- What is the current production capacity, and can this capacity be increased in the short and long term, if forecasts indicate that demand will exceed output?
- What is the most economically efficient method for distributing the fuel to the fueling stations, considering the fuel's origin?
- Is the infrastructure that is required for distribution in place? If not, can it be constructed, and at what cost?
- What level of demand/market share for each fuel would be sufficiently high to encourage private-sector investment in distribution? If such a share appears unattainable, what level of economic subsidy would be required to engage private investment?
- What does the future picture of distribution resemble? Is there a promise of additional investment, technological advances, and public-sector support in favor of this particular fuel?

The supply chain analysis for each of the fuel types will be presented in a compare-and-contrast format report, relating the relative merits and drawbacks inherent to each of the fuel types. This supply chain analysis report will be used to inform other work elements associated with the study, including the station analysis and examination of alliance opportunities.

Alternative Fuels Demand Analysis

The uncertainty of demand for alternative fuels in Washington State, Oregon, and California is to some degree a reflection of the classic chicken and egg problem. Consumers are or will be reluctant to purchase new-technology vehicles if the supply, availability and cost of the fuels are in doubt. Nevertheless, some assessment of the demand for alternative fuels will be critical to the analysis. We recognize that this is a rapidly changing environment, and will thus attempt to make some gross assumptions about where the industry may lie in the near and far terms.

The assessment of future demand for alternative fuels relates to both the potential scale of total demand and the demand by fuel type. Our approach will be to assess the fuels and alternative fuel vehicles most commonly used at this time in the study corridor, and some broad ranges for a future year (e.g., 2030) along the corridor given currently available data or assumptions for alternative transportation fuels and technologies.

The U.S. Energy Information Administration, for example, has developed forecasts for the use of alternatively fueled vehicles up to 2030 for the U.S. as a whole, however these may not be appropriate for use on the west coast. Instead, national projections will augmented with reliance on state level estimates and forecasts. For example, the California Energy Commission's Alternative Fuels Plan indicates that:

> "A number of different analyses were done that looked at the penetration of various alternative fuels into the transportation fuel sector. These analyses were done using the best available full fuel cycle analysis method. Analysis of a moderate growth case shows that plausible goals, on a gasoline gallon equivalent basis, for the use of alternative fuels in the on-road and off-road sectors (excluding air, rail, and marine), including, but not limited to, electricity, natural gas, propane, hydrogen, ethanol, renewable diesel, and biodiesel are:

- 9 percent by 2012
- 11 percent by 2017
- 26 percent by 2022

With these goals, the Plan accelerates the growth of alternative fuels, displacing more than 4 billion gasoline gallon equivalents (20 percent) in 2020. This could grow to at least 30 percent by 2030. By 2050, alternative fuels could provide more than half the energy needed to power California's transportation system."

California, Oregon, and Washington may also individually and collectively emphasize different types of fuel and energy sources than the U.S. as a whole. For example, Washington State's Climate Advisory Team[1] indicated that one of the key climate change related recommendations is to "Ensure Washington has vehicles that are as efficient as possible and use non-carbon or lower carbon intensity fuels developed sustainably from regional resources," including "maximizing in-state production of sustainable biofuels and biofuel feedstocks."

Washington, Oregon, and California may also place more emphasis on surface transportation from electricity (plug-in hybrid vehicles or PHEVs) than other states might, in large part because they do not rely heavily on fossil fuels for the production of electricity. According to the U.S. Energy Information Administration's State Electricity Profiles 2005 most power generation in Washington, California, and Oregon is from carbon free or low carbon sources (hydroelectric, natural gas, nuclear, and other renewables) and all three states are emphasizing the increasing use of renewable energy in electric power generation in the future.

For this reason, the increasing use of plug-in hybrid electric vehicles and eventually all-electric vehicles may offer advantages in petroleum dependency as well as offer considerable reductions in greenhouse gas emissions along the I-5 corridor.

All three states are already considering the increasing use of PHEVs or electric vehicles in the future fleet mix. For example, Washington State's Climate Advisory Team[2] indicated that one of its priority policy options for the transportation sector is the acceleration and integration of PHEV use, and recommended removing barriers to more rapid adoption, creating initial incentives, and providing for the integration of PHEVs with other energy systems. This strategy aims for PHEVs to account for 10% of car, SUV and small truck VMT statewide by 2020. Similar goals can be found in California and Oregon.

In the longer-term, hydrogen fuel cells may play a role in alternative transportation energy, and planning and analysis should be mindful of not precluding future conversion of infrastructure to use for hydrogen fuel cells.

The Team's approach to assessing the demand for alternative fuels will include the following actions:

- Perform an assessment of the fuels and alternative vehicle technologies most commonly used at this time.
- Outline what alternative fuel and vehicle technologies will most likely be used in the future along the corridor based on public policy and industry trends.

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[1] (Leading the Way: A Comprehensive Approach to Reducing Greenhouse Gases in Washington State, Recommendations of the Washington Climate Advisory Team, February 1, 2008)
[2] *Leading the Way: A Comprehensive Approach to Reducing Greenhouse Gases in Washington State*, Recommendations of the Washington Climate Advisory Team, February 1, 2008

- Briefly describe the users (demographics, geographies, commercial use, and governmental fleets) of each alternative fuel.
- Establish assumptions for and quantify demand in aggregate along the I-5 corridor (or by segment or station area) for alternative fuels.

Alliance Opportunities

Innovation in alternative fuel technology, still in its early stages, is following the classical technology diffusion cycle. After the initial research and development and the early adoption by a few pioneers, the benefits of alternative fuel technologies have become more widely recognized and accepted. Major public and private investment in certain technologies is expected as stakeholders form opinion and adopt or reject the new technologies.

As WSDOT has recognized, one obstacle to the widespread acceptance and use of alternative vehicles is the inadequate availability of fueling stations. To date, a wide array of public and private stakeholders have invested significant resources – monetary as well as political and intellectual capital – in promoting alternative fuels, and have a vested interest in these fuels' market acceptance.

These stakeholders have organized into coalitions, partnerships, governmental programs, or industry-specific and special-interest groups. Identifying these stakeholders and understanding how to leverage and align their interests with those of WSDOT will be the first step in developing sustainable alliances strategies to further the availability of alternative fuels in the I-5 corridor.

Our proposed approach for the identification of alliance opportunities is to research existing initiatives by public, private, and not-for-profit stakeholders and, based on the findings of the Financial Analysis and discussions with WSDOT, outline the types of alliance opportunities that will work the best to achieve WSDOT's goals for the I-5 corridor.

The following list of public, private and not-for-profit entities are examples of the types of potential participants our Team will conduct interviews with to gauge interest in partnership opportunities along the I-5 corridor. Based on these interviews, the Team will outline the vehicles though which these partnership could be created.

Private Stakeholders

Alternative Fuel Producers and Dealers

Because production technologies can differ widely, most producers and dealers of alternative fuels focus on one fuel type such as hydrogen or ethanol. Having invested capital in research and development, manufacturing, and storage equipment, they have direct financial interest in the establishment of alternative fueling facilities to promote the widespread use of their own fuel products.

Oil and Gas Companies

Oil and gas companies are fully aware of the energy, economic and environmental security concerns of consumers and nations around the world. They are in a position to lead the way in development of alternative fuels, from their research and development capabilities to the ownership of refineries, storage capacity and distribution networks suitable for liquid fuels.

Recognizing the potential for a large-scale technological shift, most oil companies are actively engaged in developing alternative fuel technology. BP, for instance, is emblematic of the change in the marketplace, with their rebranding from "British Petroleum" to "Beyond Petroleum." They have developed R&D

partnerships with companies such as GE and Dupont to accelerate the development and deployment of hydrogen fuel and biofuel. As these companies compete for leadership in alternative fuels, they are looking for strategic investment that would give them a competitive advantage. The Corridor of the Future designation for I-5 could provide them with a high-profile opportunity to showcase their technologies as well as market their image of good "corporate-citizen."

Fuel Transporters

The I-5 corridor is unique as it connects most major cities along the West Coast from Mexico to British Columbia. The options for fuel transport cover all modes (maritime, road, rail, and pipeline) increasing significantly the potential number of stakeholders in the transport industry. In the case of fuel transport via barges for instance, potential stakeholders could include port authorities such as the Port of Seattle; and their participation in making land available for storage or distribution. Pipelines offer an attractive option for linear distribution along I-5. WSDOT could considerably improve the economics of such distribution networks, leveraging its ROW long the I-5 to stimulate private investment.

Clean Fuel Vehicle Manufacturers and Technology Providers

In addition to fuel producers and distributors, automobile manufacturers and technology providers are engaged in large-scale investment programs. They have established a number of partnerships to explore and promote the use of alternative fuels such as biomass and hydrogen. The Department of Energy's FreedomCAR and Fuel Partnership, for example, brings together companies such as DaimlerChrysler, Ford, and GM (as well as oil and gas companies such as Chevron) together to look at many issues necessary to market acceptance and deployment, including the needed infrastructure for refueling alternatively fueled cars and trucks.

Infrastructure and Station Builders and Operators

The builders and operators of alternative fuel infrastructure and stations would benefit directly from increased business linked to new construction. In Washington State, Saybr Contractors for instance, has developed specific expertise in the alternative fuels arena and is partnering with the Puget Sounds Clean Cities Coalition to develop natural gas fuel facilities.

Beyond the direct benefits to contractors and operators, such construction activity would also bring larger economic benefits to the State including employment and revenue from sales and incomes taxes. The State could facilitate the activity of such local firms by providing short-term tax benefits.

Large Vehicle Fleet Owners

Potential partners for WSDOT include companies in the logistics and transportation business who own large fleets. Large retailers, trash hauling companies, bus companies are all potential partners. A partnership with these stakeholders could involve the development of maintenance and fuelling stations on WSDOT-owned ROW. The developers of such fueling station would benefit from an established customer base, while fleet owners could reduce transportation costs, possibly obtain tax breaks or other incentives, and enhance their public image for "going-green."

Other Private Companies That Are Not Direct Industry Participants

With environmental concerns influencing consumer decisions, many companies are investing in enhancing their "green image." Recently in California, the "Green Power Group- California Affiliates" was formed, including companies such as Advanced Micro Devices, Apple, Cisco Systems, and eBay. Though this

partnership surrounds purchasing and developing new sources of renewable energy, a similar partnership could be imagined involving alternative fuel.

Individuals

One of the most important groups of private stakeholders in this initiative will be the individual citizens of Washington State. Where they may currently be reluctant to purchase an alternative fuel vehicle (AFV) without the proper infrastructure to support it, this initiative has the potential to mitigate those concerns. Citizens of the State are already among the most environmentally conscious in the country and stand to benefit from decreased travel costs, potential tax breaks from purchasing AFVs, and an increased sense of environmental awareness and contribution.

Public Stakeholders

Federal Government

The federal government provides wide-reaching incentives for AFV ownership and AFV infrastructure investments. Some of the major agencies are involved in promoting alternative fuels, including the U.S. Department of Energy, Department of Agriculture, the Department of Transportation, the Environmental Protection Agency, as well as the Internal Revenue Service. Washington State has already demonstrated its ability to partner with the federal government as I-5 has been designated as part of the USDOT Corridors of the Future Program.

WSDOT could take advantage of numerous existing programs such as the Department of Energy's FreedomCAR and Fuel Partnership, the EPA's National Clean Diesel Campaign or the SmartWay Transport Partnership, and the Department of Agriculture's various programs to encourage bio-based energy products, to name but a few.

State Governments

Supporting WSDOT's initiative, Washington State government agencies can offer land parcels or linear right of way, tax incentives, direct grants (with or without the federal assistance), and other actions fostering investment and partnerships. An example of state-level involvement is BioEnergy Washington, a multi-agency workgroup comprised of various Washington State Agencies including the Department of Agriculture, Ecology, WSDOT, to name a few. This group's agenda includes promoting a BioEnergy economy in the state through making policy recommendations and distributing funds to support industry growth.

The State of Washington also has a very large fleet of vehicles including cars, trucks and buses, which could be combined with other fleets to help support the early development of fueling stations as noted above.

Finally, Oregon and California share the same interests providing opportunities for continuation of the WSDOT initiative along the I-5 corridor. Washington State is already partnering with its neighbors as a member of the Western Climate Initiative (WCI) pursuing aggressive targets for greenhouse-gas emissions reduction. The WCI is pursuing an emissions cap and trade market scheme to meet its targets, which could serve as a catalyst for investment in alternative fuels technology in the region.

Local Governments, Agencies and Business Districts

Cooperation from local districts and governments along I-5 will help this program to be a success. Local governments and local public agencies can make contributions in similar ways that other State agencies can, as they own ROW and fleets of vehicles which could serve to establish a customer base for the AFV

infrastructure. Public utilities that provide power generation (Seattle City Light, Snohomish County PUD, Tacoma Power) could also play a major role in developing plug-in hybrid electric vehicle (PHEV) recharging stations.

Not-For-Profit Stakeholders

Clean Cities Coalition

The network of over 80 volunteer Clean Cities Coalitions across the country provide a deep pool of resources for technical expertise and coordination to foster public and private collaboration in the deployment of alternative fuel infrastructure and related services. Puget Sound Clean Cities Coalition in Washington is already promoting the expansion of infrastructure for refueling AFVs and has demonstrated many success stories. Other Clean Cities Coalitions such as Columbia-Willamette in northern Oregon could also contribute.

Cooperatives

Existing cooperatives represent part of the supply chain for fuel that is already in place. In Washington, there are a number of cooperatives of individuals that buy alternative fuels such as biodiesel collectively and distribute to the cooperative members.

Economic Development Agencies

Economic Development Agencies are interested in promoting initiatives that will bring jobs to their region. This project will provide local and state economic development agencies with additional means to attract companies specializing in alternative fuel delivery and R&D as well as companies looking to grow in an area where petroleum use can more easily be minimized, thereby enhancing their environmental stewardship efforts.

Other Not-for-Profit Stakeholders

Other not-for-profit stakeholders include climate change associations and advocacy groups, transportation and construction industry associations, and state and regional universities and research centers among others.

Scoring Criteria 5: Study Timeline

The timeline for this analysis is aggressive, especially given the range of business mechanics to be covered and the number of fuels that will be analyzed. To meet this aggressive schedule, the Team proposes a relatively flat organizational structure with strong task leader roles to provide deputy project management in the coordination of information flows and subtask activities as they are performed in tandem.

The Team includes enlisted alternative fuel experts and financial / economic experts who are capable of performing their respective analysis with minimal direction from the Project Manager. As such the Task Leaders will be empowered to perform their respective analyses and the Project Manager can rely on them for coordination and guidance of the various pieces of the project while focusing on the bigger picture delivery of the .

The following exhibit shows that given a June 1 start date, the Project can be completed by mid-September, approximately four weeks earlier than the October 15th date put forward by WSDOT. This should provide sufficient schedule flex for unforeseeable events that may arise over the course of the work, including communicating and coordinating with outside parties during the busy summer vacation period. The approximate number of hours spent on each task (per week) are exhibited in yellow.

Week Beginning	1-Jun	8-Jun	15-Jun	22-Jun	29-Jun	6-Jul	13-Jul	20-Jul	27-Jul	3-Aug	10-Aug	17-Aug	24-Aug	31-Aug	7-Sep	14-Sep	21-Sep	28-Sep	5-Oct	12-Oct	19-Oct	Total Hours
Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
Client Meetings / Updates	8				8				16			8				16						**56**
Financial Analysis																						
Traditional Station Modeling		16	16	16	16																	64
Station Spacing Analysis			10	10	10	10	10	10	10	10	10	10	10	10								120
Alternative Station Analysis			32	32	32	32	32	32	24	24	24	32	32									328
Supply Chain Analysis				16	16	16	16	16	16	16	16											128
Alternative Station Modeling							8	8	8	16	16	20	20	20								116
Financial Analysis										16	16	16	24	24								96
Documentation							24	24	24					24	24	32						152
																Financial Analysis						**1,004**
Alternatives Analysis																						
Devise Interview Framework											8	8										16
Review Financial Analysis												8	8									16
Conduct Interviews													8	8	8							24
Documentation												8			16							24
																Alternatives Analysis						**80**
																Total Project Hours						**1,140**