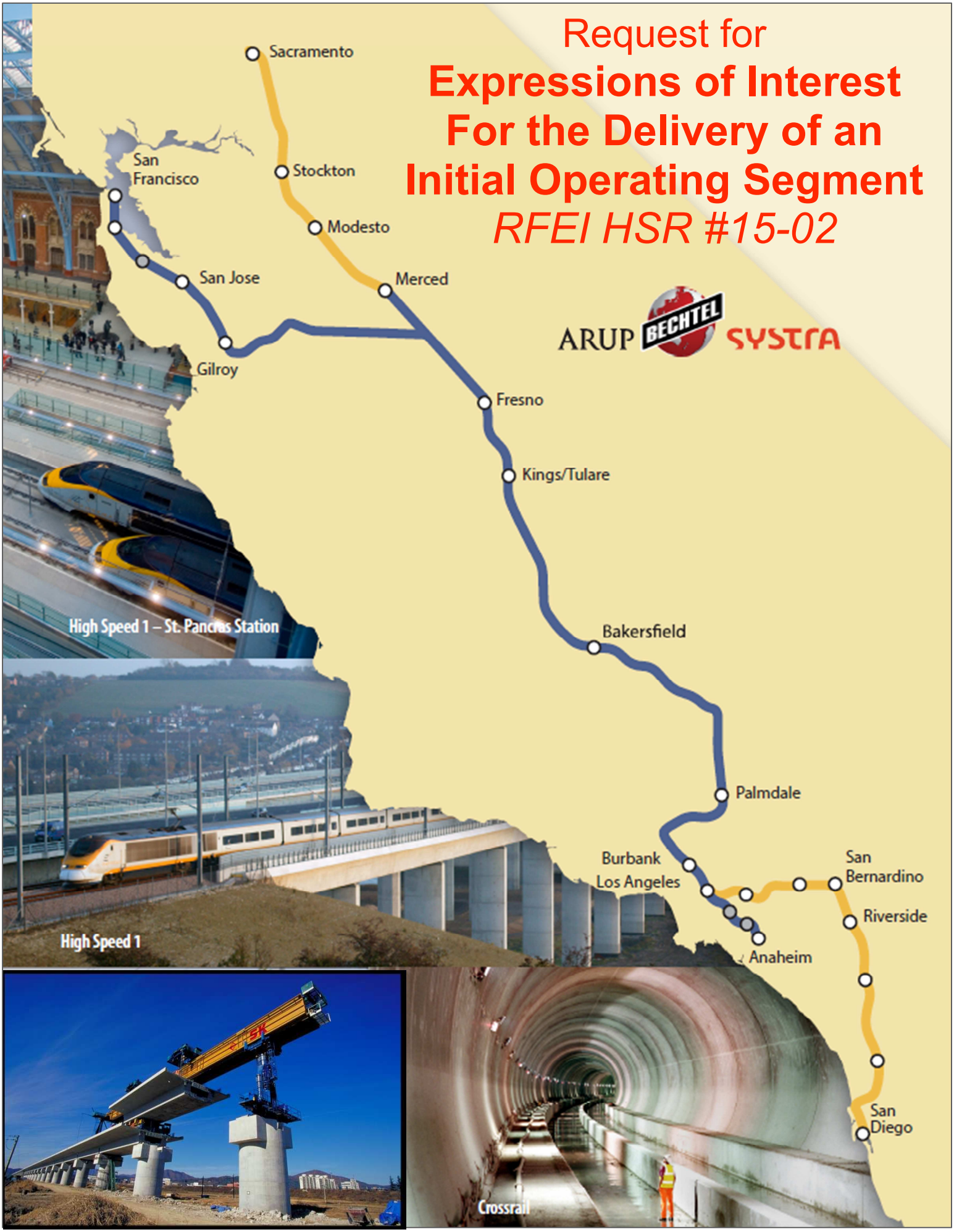
Request for

Expressions of Interest For the Delivery of an Initial Operating Segment

RFEI HSR #15-02

ARUP BECHTEL SYSTRA



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1 Transmittal Letter

September 28, 2015

Ms. Rebecca Harnagel
California High-Speed Rail Authority
770 L Street Suite 620, MS #2
Sacramento, CA 95814

Re: Request for Expressions of Interest for the Delivery of an Initial Operating Segment
RFEI HSR#15-02

Dear Ms. Harnagel,

We are pleased to present this Expression of Interest (EOI) for the Delivery of an Initial Operating Segment in response to the Authority's Request for Expressions of Interest (RFEI) HSR# 15-02. Bechtel Infrastructure submits this EOI on behalf of itself and its Team, which includes:

- Arup North America Ltd., with its international expertise in civil engineering; and
- SYSTRA Consulting Inc., offering worldwide experience in rail systems, signaling and operations;

Bechtel, Arup and SYSTRA all have a strong background in complex rail projects. When combined, the three organizations bring decades of deep experience working together to successfully development and deliver high speed railways around the world. We have applied our extensive practical project delivery experience to the questions you have posed in the RFEI and in the development of our recommendation approach to delivering an Initial Operating Segment.

We hope that you find the enclosed EOI informative. We are available to discuss our experience and recommendations and provided any additional information the Authority would find beneficial. The point of contact for our team is:

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Sincerely,

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2 Firm Experience & Team Structure

The Bechtel/Arup/SYSTRA team is energized and ready to bring to CHSR our broad experience of high speed rail projects around the US and the world, to integrate the many parts of a system while mitigating risks, and to meet the challenges brought on by diverse geographical segments, difficult terrain, and financial constraints. Our companies have collaborated on this response as a team as we believe our combined strengths and resources offer the necessary combination of expertise and insight to develop a bespoke delivery model for this program:

- Bechtel is one of the largest project managers in the world, renowned for delivering complex infrastructure safely, on time, and within budget to both the public and private sector. As a contractor, Bechtel is known for its ability to take on mega-projects on a lump-sum basis, such as our current work designing and building three liquid natural gas facilities on Curtis Island ($26 billion in TIC) or two lines of the Riyadh Metro ($10B TIC).
- Arup is one of the leading global design firms, with extensive experience in solving complex high speed transportation challenges, from planning through execution. From Arup's instrumental role in the development of HS1 in the 1980's to our current commission setting the standard for Texas Central Railroad we remain at the forefront of High Speed Rail development.
- SYSTRA is a world-leading rail systems consultant, with experience from preliminary design through operations and maintenance. SYSTRA has been involved with the planning, design, delivery, integration, and operations and maintenance services for the French HSR, playing a major role in every line of the 1,250 mile-network, one of the most comprehensive, safest, efficient, and reliable passenger services in the world. SYSTRA has been also involved in the development or implementation of HSR projects throughout the world, including Taiwan, Korea, Moscow, St Petersburg, Oslanken 3 in Sweden, Puhne Amhedabad in India, and Kuala Lumpur Singapore.

Unparalleled Global HSR Experience

Our team members - Bechtel, Arup and SYSTRA – have been involved in the development, delivery or operations of more than half the HSR systems in the world.

Beyond our individual technical strengths, we have three decades of experience working together on major programs, and established relationships among our companies and people, enabling us to engage the finest of our skills in a structure to help our customers. We are confident that the skills of each team member will be vital to the delivery of the IOS, but have deferred defining our team structure until the Authority has determined its delivery approach for the IOS so that we can structure according the needs of that approach.

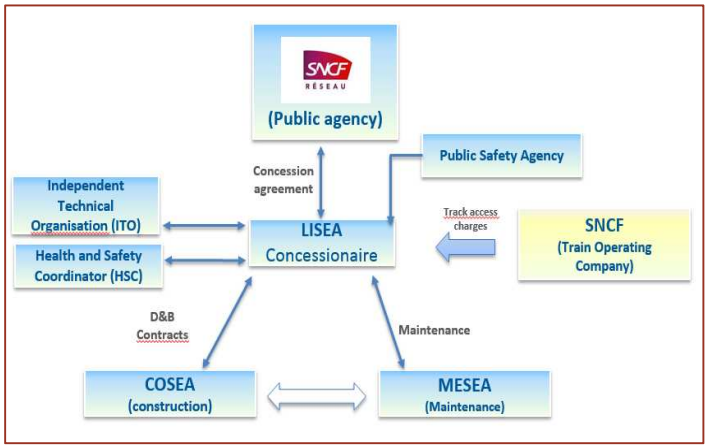
Our companies' relevant experience informing our analysis and recommendations for the IOS delivery approach is outlined below, grouped by the key challenges facing the CHSR program: technical delivery and operating challenges, securing private investment and the difficulties of mountainous terrain.

HSR Technical Delivery and Operating Challenges

- ***Southern Europe Atlantic High Speed Line – SEA PPP in France***: Designed to connect the French Atlantic coast to the rest of Europe and the Iberian Peninsula, the SEA High Speed Line is a vital transportation program, which will reduce traffic on major roads and benefit the region by reducing CO2 emissions. The SEA program is vital for the economic health of the region as half of the trade with Spain comes from the Atlantic coast. The $9B, 210-mile new line primarily involves the creation of new railway infrastructure (civil engineering and engineering structures) and superstructure (track and catenary systems, work bases, maintenance bases and electric power supplies). This line is currently under construction and will be commissioned in 2017. Project highlights:
  - A 50-year concession~~s~~ contract - the program brings together private partners, reduces investment from public funds and is managed by SNCF Réseau to ensure that the work complied with all the commitments made to the public.
  - The concession contract is held between SNCF Réseau and LISEA (Southern Europe Atlantic Line), the company responsible for the project.
    - COSEA (Southern Europe Atlantic Construction) will be responsible to LISEA for design and construction. Five partnerships have been put together by COSEA to build this line:

- Design partnership (SGC) led by SYSTRA and composed of SYSTRA , EGIS Rail, ARCADIS and Vinci
- Energy partnership (SGE) composed of SYSTRA, CEGELEC, Vinci Energie and INEO
- Superstructure partnership (SGS) composed of SYSTRA, TSO, EUROVIA TF, CEGELEC, INEO, TSO Caténaires and EUROPENNE TF,
- Signaling and telecommunications partnership (SGST) composed of SYSTRA (50 %) and INEO (50%)
- Infrastructure partnership (SGI) composed of Vinci Construction, EUROVIA, NSE, BEC and Dodin Campenon Bernard.

Figure 1: SEA PPP Concession Organization



- MESEA (Southern Europe Atlantic Maintenance) will be responsible to LISEA or operations and maintenance. MESEA is composed of Vinci (70%) and SYSTRA (30%).

- ***High Speed 1 – London to the Channel Tunnel in United Kingdom***: High Speed 1 is the UK's first high speed railway and the first of a new generation of lines capable of carrying passengers at speeds of up to 186 mph. At 67 miles and $11B, construction included 3,000 new structures, including 16 miles of tunnels (mostly twin-bore), 150 bridges and three major viaducts. Bechtel, Arup and SYSTRA participated in the developer consortium, London Continental Railway (LCR) and in the delivery of the system as the majority of Rail Link Engineering, the JV formed to execute the design, procurement and construction management of the program for LCR. The primary contract structure for RLE was an EPCM contract, where RLE was responsible for the engineering, procurement and construction management of the system, employing an innovative contract structure that shared cost risk on the construction with the developer (LCR) and the government. The project was completed on schedule with a significant cost underrun and the key contractual milestones were achieved early, ranging from four weeks to five and half months of schedule savings. Technical highlights include:

  - Delivery:
    - Developed new standards and specifications for installation, maintenance and operation based upon high speed rail standards from the Europe, including French TGV program.
    - Strategically created a multiple-segment approach to deliver high speed services, reducing overall program duration and providing earlier delivery of benefits.
    - Conducted the dynamic studies and studies on the interaction between the rail and structure to develop optimal lightness of the structure before going out to bid for the construction contracts.
    - Supported purchase of new Japanese rolling stock for domestic high-speed services with capability for use on conventional network.
    - Modeled the financial options for procurement to find the lowest net present value options accounting for capital, operational and maintenance costs.
    - Delivered major new depot for half the Eurostar fleet well under budget and over three months ahead of schedule. This allowed earlier-than-planned operations trials and greatly de-risked the migration of services from Waterloo (low-speed) to St. Pancras Line (high-speed).
    - Worked with manufacturers Hitachi and Alstom and operators to develop and integrate multiple traction power, train control and communication systems for interoperability with new and existing infrastructure.
  - Operations & Maintenance
    - Maintenance facilities were developed in conjunction with operators and were designed and built to optimize the new high-speed rolling stock and infrastructure reliability.
    - Prepared conceptual operating plans in the early stages of development, defining functional requirements along with asset and system performance reliability targets.
    - Developed Reliability, Availability and Maintainability (RAM) targets and plans for asset management during design and construction.

  - » Coordinated the introduction of the high-speed international Eurostar trains, domestic Javelin trains and new freight locomotives on High Speed 1.

- ***Beijing-Tianjin High Speed Line in China:*** Economically strong, both cities-provinces, capital Beijing (15 million inhabitants) and Tianjin (11 million inhabitants) were designated to receive the first high speed Chinese rail line. Tianjin is a major industrial and commercial city, 75 miles from Beijing; and is an important harbor for the maritime transport, coastal transport and for foreign trade. The project was officially launched in 2005, and the line was brought into service before August 2008, for the opening of the first Olympic Games in China. This line, on which trains are able to reach a speed of 186 mph, was considered a pilot for the future network of passenger high speed lines in China.
  - Located in a moderately seismic zone, this line consists of 60 miles of viaducts with reinforced or prestressed concrete. Considering the nature of argillaceous grounds, these works are founded on piles. The track system is built on prefabricated slabs that were laid on concrete. SYSTRA's mission was to verify the civil work, which involved the static and dynamic analysis of the deck, the correlation between tracks and structures and transition zones between bridges and ballasts, structure of the piles and foundations, including seismic analyses, the verification on decks, design of ballasts, and the track design made on slab.

- ***East European High Speed Rail - 2nd phase in France***: To meet the challenges of this project, the operation was divided into several geographical sections and technical batches. SYSTRA led the design of 65 miles of new high speed railway line between Baudrecourt and Vendenheim. The new line will enhance economic, tourism and cultural development of the areas served by this new segment.

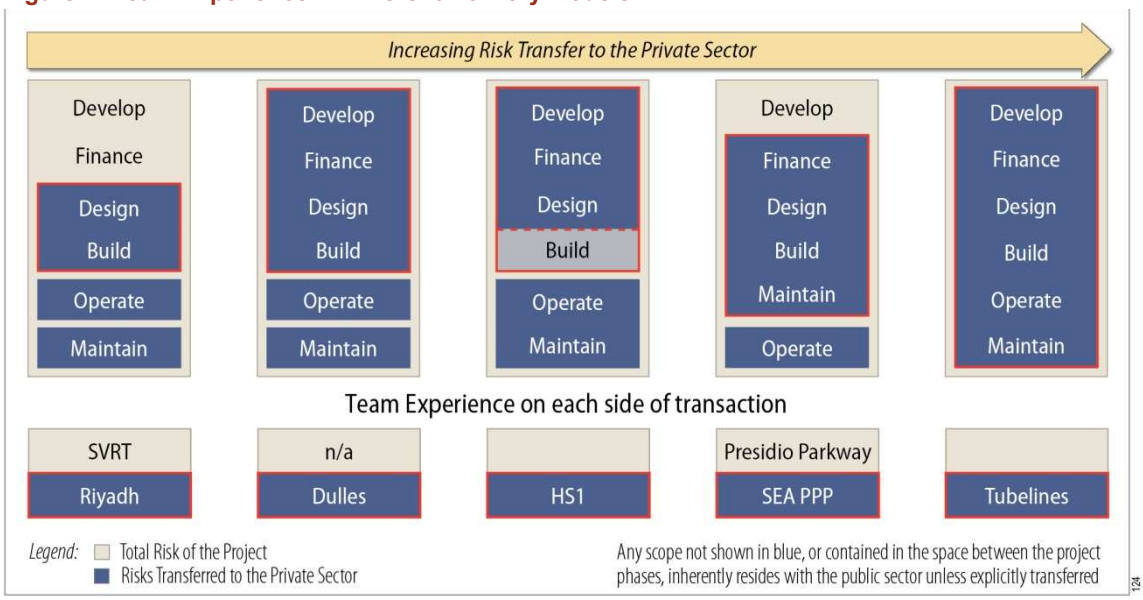
- ***Tangiers to Kenitra High Speed Rail in Morocco:*** Africa's first high speed railway, the project presented dangers not common in other parts of the world.
  - A major challenge was the ground the railway crosses, which contains compressible soils, a mixture of silts, clays, and sands. The risk was that the weight of the line could cause liquefaction, instability, and settlement. On the Northern section of the route, the team built viaducts to avoid the poor ground. On the Southern section, the team installed drainage and applied surcharge loads. An innovative design solution was the use of asphalt for the upper layer of the track bed.
  - The local population was unfamiliar with the concept of high speed rail, and was accustomed to crossing railway lines, anywhere, on foot and with animals. SYSTRA worked to bridge the differences between local and international standards and practice.

- ***Taipei-Kaohsiung High Speed Rail in Taiwan:*** The largest public transport project undertaken on the island, the project was implemented using a Public/Private Partnership (PPP) scheme within the framework of a BOT (Build-Operate-Transfer) concession contract. The contract comprised two parts: construction and railway operation of the new line and stations for 35 years and development and commercial operation of shopping areas around five new stations for 50 years. The civil and structural work consisted of 38 miles of tunnels and 156 miles of viaducts and bridges. The construction was divided into 12 sections, and each was assigned to a consortium of companies.

Securing Private Investment

As a world leader in project development and financing, Bechtel has launched, together with its joint development companies, more than 85 projects, representing $43B in project value in the last 40 years. We have developed a unique insight into both customer and contractor needs across the entire project life cycle. This enhances our ability to devise innovative contracting and financing solutions for complex projects. The figure below captures a selection of different delivery models across the spectrum of public-private risk transfer, and projects where our team members have participated on either or both sides of the arrangement.

Figure 2: Team Experience in Different Delivery Models



Select Team Experience in Different Delivery Models. *As more phases of the project are bundled together, more risk is transferred.*

Highlights of our experience developing securing private investment for rail projects include:

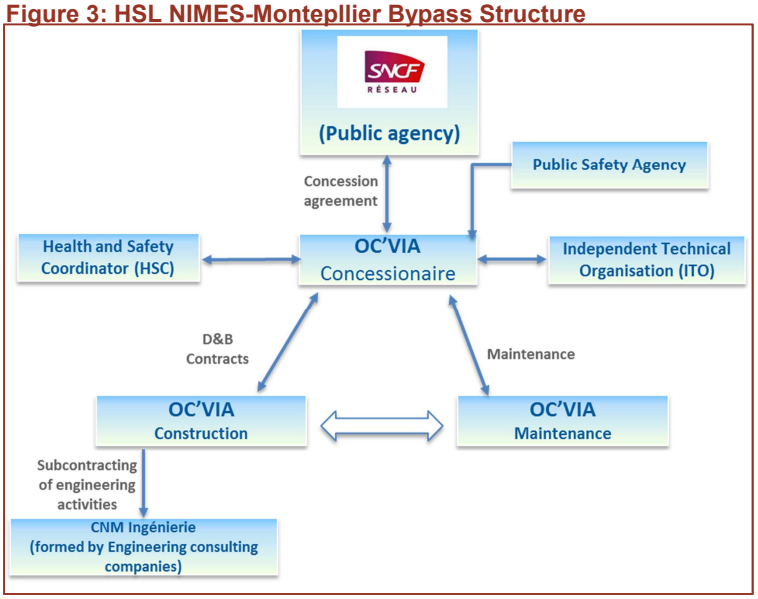
- ***High Speed 1 – Financing***: High Speed 1 was developed as a P3 with full private financing, and later restructured with public support when the ridership forecast was revised downward and no longer supported the financing arrangements. Financing highlights include:
  - Project Restructuring: The project was originally structured to incorporate engineering, construction, operation and maintenance of the high speed rail along with operation of the Eurostar passenger services, as well as the development rights of related real estate assets. Early on, Bechtel deduced that Eurotunnel, the young company operating the Channel Tunnel (that connects to HS1), was not achieving the forecast passenger traffic and corresponding fare revenues. We developed an alternative model that divested the operations, transferred project oversight back to the public sector and broke the construction into two phases to enable financing. We also developed a structure where the design/build joint venture would deliver under a target-price contract that included economic incentives. We developed a creative solution where the project company issued bonds guaranteed by the government so that the UK Government avoided issuing new debt related to the project. This staged construction and new commercial structure better allocated the risks and capabilities, empowering us to deliver a successful project.
  - London Tunnel Alliance: The London tunnels were bid as four separate packages due to their size and complexity. During execution, Bechtel identified an opportunity to optimize the tunnels' delivery, creating the "London Tunnel Alliance," in which the customer and the four contractors shared the risks and worked together to optimize the construction sequence to take advantage of sharing resources, structuring economies of scale in ring manufacture and reducing contractor management costs. This structure helped deliver the highest-risk element of the project on time and under the original budget.
  - Cost Risk Sharing: The project's second phase carried higher geological and economic risk associated with tunneling under central London. We developed and implemented a first-of-its-kind risk-sharing mechanism that

allocated responsibility for potential cost overruns in a tiered system among Bechtel, the design/build partners, and third-party insurers we helped to identify. This was a very innovative scheme that enabled the private sector to take on an unprecedented amount of risk while also mitigating lenders' concerns and achieving financial close.

- ***HSL NIMES – MONTPELLIER BYPASS*** Led by OCVIA (a private company formed by Bouygues Construction, Colas Rail, Alstom Transport and Spie Batignolles) this $3.1B PPP is responsible for design, construction and maintenance for 25 years up to 2037, excluding stations.

  - Revenue: availability payment
  - The concessionaire OCVIA is holder of the PPP contract and has set up a $2B financing plan comprised of:
    - » Equities: $130M
    - » Public subsidies: $665M
    - » Bank loan: $1.180M (this is a long-term bank loan granted by 11 Banks and partially refinanced at the opening of the line through the « Dailly » law in favor of the EIB and the French Caisse des Depôts.
  - Upon completion of the line, OCVIA will receive a rent in return for its investment, if the targets of performance and availability of the line are met.
  - At the end of the partnership agreement, the line will be handed over to SNCF Réseau. OCVIA's PPP is included within a broader program that also includes stations and other works performed by RFF

Figure 3: HSL NIMES-Montepllier Bypass Structure

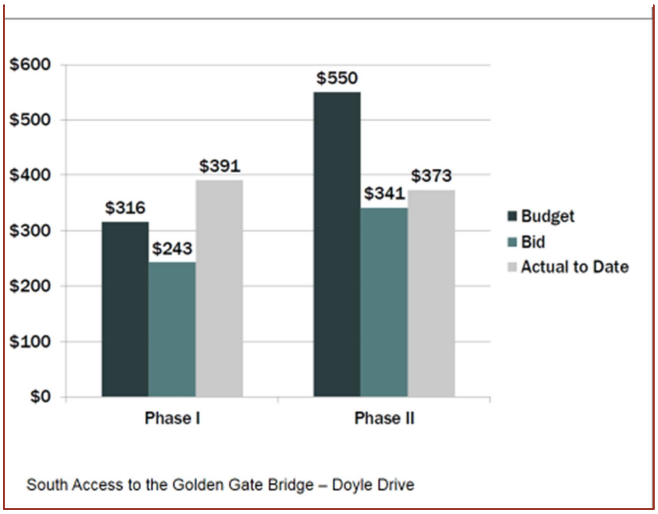


- ***Tube Lines:*** Development and financing of a 30-year concession to manage a $4B capital investment program to upgrade and maintain the track, stations, civil works and rolling stock on three principal lines of the London Underground system. Financing highlights include:

  - The initial financing of this massive project presented unusual challenges related to non-recourse financing: the scope of work was not clearly defined, and the precise condition of the assets of a transit system built in the second half of the 19th century was largely unknown. Furthermore, the payment mechanism to the concessionaire was fixed for only the first 7.5 years and was then subject to revised terms, further complicating the project financing.
  - Bechtel and its partners arranged an alternative structure where the concessionaire and the CapEx and OpEx seconding parties had an incentive program that aligned with stakeholders and provided enough flexibility to react to unforeseen circumstances. Holding true to our accountability and our innovation, we designed this alternative commercial structure and additionally committed contingent debt and equity to the project, thus providing the necessary confidence to the lenders that we would deliver.
  - Following initial financial close, we developed a more efficient financing structure and a mechanism that could unlock significant amounts of value to the project financing with the same cash-flow levels. The refinancing structure entailed issuing multi-tier bonds in the capital markets, where a top tranche carried 100% underpinning from the government entity and benefited from a very attractive credit rating and small margin. As a result, the weighted-average cost of all bonds yield a financial benefit of over $100 million that was shared between the project company and the client.

- ***Presidio Parkway***: Arup's transaction advice team advised the California Transportation Commission on the use of P3 procurement for the Presidio Parkway. This constitutes California's first P3 for this type of infrastructure. The project provides a good comparison between Phase 1, which was procured through design-bid-build, and Phase 2, which was the P3 element: The P3 project proved to be less expensive per lane mile and is set to meet the budget and schedule while Phase 1 was 60% over the bid price and some 20 months over schedule.

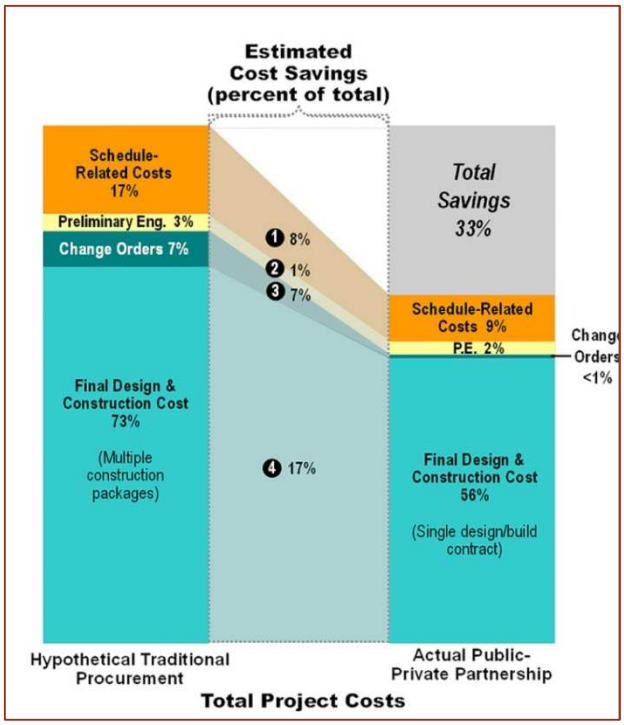
Figure 4: Presidio Parkway Comparison: DBB vs DBFM



- ***Dulles Metro Phase 1:*** Development, design and construction of this 11.6-mile extension of the Washington, DC metro system in Virginia, which provides high capacity rail services through the highly congested business hub of Tysons Corner and the Dulles (Airport) Corridor. Financing highlights include:
  - Bechtel developed and presented the project as an unsolicited bid to the State of Virginia. As a result, it was procured by the State under their Public Private Transportation Act (PPTA) because of its innovative contracting approach and involvement of the design/build contractor with development and financing.
  - We worked with the customer to develop an initial financing plan, developed and maintained a project financial model and supported the customer in the submittal of funding applications for FTA New Starts funding and TIFIA. The proposed financial plan included the establishment of a special taxing district and revenues from the adjacent toll road to fund the project to reduce the amount of government subsidies needed to fund the project.
  - To reduce cost and avoid the public sector paying a risk premium to lock-in the pricing of some components at the time of the execution of the design-build contract, an allowance item structure was developed to transfer the execution risk to the contract and deferred transfer of the cost risk until the design had more fully developed and better competition could be generated for these high-ticket items.

- ***Portland LRT:*** A 5.6-mile extension of Portland's light-rail system from the city's Gateway Transit Center to Portland International Airport. The project included four at-grade stations and three major light rail transit (LRT) bridges.
  - The Portland LRT project was the first US light-rail transit PPP project, which Bechtel initiated with an unsolicited proposal to the City of Portland. We contributed approximately 25% of the project's funding in return for development rights to a 120-acre area surrounding one of the new stations. This approach leveraged private sector investment to avoid the need for public funding. The originality of our proposal entailed the creation of an open and transparent communication channel among the diverse entities involved, including the City of Portland, the Portland International Airport and TriMet (Portland Transit Authority), which in turn evolved into an accelerated decision-making group that could quickly reach resolution on key issues.
  - The fast-track PPP model translated into a shorter schedule and project savings estimated at 33% compared to a traditional procurement with lengthy design/build packages. Construction cost savings were largely achieved due to our increased control of interfaces as well as our ability to fix the project scope early through the expedited development

Figure 5: Estimated Savings from P3 for Portland LRT



process and more efficient coordination of stakeholders.
- The following figure (Figure 3-17) illustrates the estimated savings by category resulting from our innovative fast-track PPP procurement model in Portland LRT.

Development of HSR through Mountainous Regions

- ***Seoul-Busan High Speed Line in the Republic of Korea:*** The 255-mile Korea High Speed Rail line connects the capital of South Korea, Seoul, with the southern port city of Busan. The line opened between Seoul and Daegu in 2004, with the final 80-mile section through mountainous terrain to Busan completed in 2010. The journey times of five hours along Korea's most densely populated corridor have been reduced to little more than two hours by the 186-mph "KTX" high speed trains. Like the planned Californian network, the Korean high speed line made full use of the existing rail network to penetrate urban areas and to serve rebuilt existing stations in Seoul, Daejon and Busan. Existing right-of-way was utilized to deliver benefits earlier and to extend the reach of the network. For the first six years of operation, KTX trains used a pre-existing low speed track segment to reach Busan. The southwestern cities of Gwangju and Mokpo are still served by existing lines, pending new line construction.
  - Notable for its structures because of the difficult and mountainous topography, there are 75 tunnels, totaling 118 miles in length, more than 70 bridges and viaducts totaling 75 miles.
  - Bechtel and SYSTRA were able to bring new international standards of quality and efficiency to the largest single project in a rapidly developing economy, one in which the phenomenal speed of growth had sometimes outstripped capacity to meet the high standards of design, construction and operations fundamental to the successful high speed railway that Korea now has. Bechtel provided project management that helped drive schedule and cost certainty and delivered new standards in safety, quality and efficiency. SYSTRA provided technical engineering expertise to design and commission into service the rolling stock and signaling system.
  - To assist in the selection of the right technology, we led an evaluation of capital and operational aspects using high speed transportation technologies from Germany, France and Japan.
- ***Modernization of the "Haut-Bugey" Line in France***: Contracted directly by the owner, Réseau Ferré de France, (now SNCF Réseau) the project's 200+ designers and contractors were managed by SYSTRA. This challenging project, an extension of the HSR service on conventional line (enabling blended rail operations), features remarkable civil engineering structures driven by the mountainous terrain: the route twists, turns, and negotiates steep inclines. Two bends had to be substantially modified to improve safety and speed. This pioneering project's innovations included:
  - Direct management by the owner, contracts covering all materials supplied by contractors, including railway equipment, railway safety guaranteed by a contractor, rigid catenary*, catenary sections that can be switched between 1,500 V and 25,000 V and traveled at high speeds.
  - An inventive catenary solution was adopted for the tunnels: rigid catenary is installed along 3.5 miles of line. The catenary is rigidified and becomes a contact bar at a constant height, which allows the suppression of the recesses required to fit normal catenary supports (considered too aggressive for the elderly arched tunnel structure). The spaces required for the Aerial Contact Profile are smaller and limit damage to the arch.

3 Project Approach

HSR programs are complex by nature and present significant delivery challenges anywhere in the world. To evaluate and recommend a delivery approach, it is critical to lay out the context of known challenges and objectives so that each model can be assessed based on its ability to meet challenges or optimize against objectives.

Project Context: Challenges & Objectives

The California HSR program has all the technical challenges of delivering and operating HSR, compounded by the sheer scale of the program, that it will be the first HSR in the US and the current funding shortfall. The objectives of the Authority are similar to most other large public infrastructure programs and stem from the need to demonstrate value for money for the tax-payers and attract additional investment.

- Challenges:
  - **HSR Technical Challenges** result from integration risk amplified by the speed and resulting performance requirements needed for safe and reliable performance at high speeds. For HSR, the value of combining civil and systems infrastructure is higher due to the narrow tolerances required for the track and associated structures. Furthermore, the opportunities to optimize over the lifecycle are high, as the infrastructure must be maintained to a higher standard than conventional track. These lifecycle integration challenges have led many other HSR owners and developers to either issue large concession contracts to develop, design, build and maintain, like SEA PPP, or to maintain a large central team to closely manage the design and take responsibility for the system as a whole, while a series of contractors are engaged to deliver the components, like Haut-Bugey line described above.
  - The **sheer scale of the CHSR** program creates additional complexity driven by the diversity of the geography along the alignment and the magnitude of the investment required to deliver a $68B program. The physical, and financial scale of the CHSR program preclude it from being delivered via a single entity responsible for development through operations, unlike the Texas HSR program from Houston to Dallas or XpressWest from Las Vegas to Victorville.
  - As the **first HSR in the US**, CHSR is leading the way with the FRA for the development of standards and requirements for dedicated HSR systems, creating more uncertainty that is difficult for the private sector to quantify and bear the risk.
  - **Funding constraints** also pose a significant challenge, as the amount of capital required is extensive and there is significant competition among important infrastructure programs for scarce public dollars. Private funding is available, but requires a clear path to predictable returns, which generally requires a smaller system, like Houston-Dallas, an IOS that can operate at a loss or an existing system where there is demonstrated traffic, like SEA PPP (the 10th HSR line to be built in France).
- Objectives:
  - **Accelerate project schedule** to deliver benefits faster to the public and assure continued public support of the program.
  - **Minimize cost**, which is vital to both the need to reduce capital investment required upfront to fit within available funding and the desire to deliver value-for-money to the tax-payers and create an asset for the State of California that generates more revenue than liabilities. Optimization over the lifecycle is important to ensure that the HSR services can operate without a subsidy, compliant with Proposition 1A and voter expectations.
  - **Transfer delivery and maintenance risk** to the public sector by reducing the number of contracts and residual integration risk that resides with the Authority.
  - **Secure private investmen**t and **maximize leverage of Cap & Trade funding stream.**

Discussion of Potential Options for Delivery Approach

In light of the challenges described, particularly the scale of the project, the requirements for the IOS to operate without a subsidy and the need to attract significant private investment to complete Phase 1, the Bechtel/Arup/SYSTRA team's recommended approach is to accelerate the development of IOS-North as a public investment, and deliver the balance of Phase 1, the Bakersfield-Anaheim section, herein called the Basin Connection (BC), with significant private investment. Our rationale is three-fold:

1) Packaging the entire Phase 1 as a single $30B PPP would exceed market capacity and risk appetite.
2) IOS-North has less technical risk due to its geography and greater certainty of achieving its Record of Decision (ROD) in 2017 because there are few practical alignment options within the Caltrain ROW. While we recognize that the Authority is committed to achieving all the RODs in 2017, initiating the procurement for the IOS delivery contract before receiving RODs still poses risks related to time and money spent on a bid that may be delayed. Reducing this risk will result in more interest for the procurement.
3) The BC has greater opportunity for private sector investment and development.
    a) IOS-North has fewer opportunities for development as the northern stations (SF-SJ) are in already-developed areas and shared with Caltrain. The BC can be leveraged by incentives for greater commuter and tourist passengers.
    b) Development rights in areas not currently served by effective rail connections (Palmdale and Burbank).
    c) Opportunity to incentivize through track access charges for multiple operators; include traffic risk exposure in a DBFM, as the developer will have the opportunity to negotiate with multiple operators to use their infrastructure, including the CHSR Operator, XpressWest, Amtrak and Metrolink. Through track access charges, there is also the potential to engage freight stakeholders that can be incentivized to shift Metrolink traffic off of freight corridor and onto HSR tracks as a blended system, similar to the blended system planned for San Francisco to San Jose.
    d) Demonstrated traffic and reduction of operating/start-up risk through contracting IOS-North lowers the risk profile of the development of BC making such a deal more marketable and bankable, than the reverse of building IOS-South first.

Separate from the decision of which IOS to build, there are many ways to package the scope to achieve the Authority's objectives. We agree that with the approach outlined by the Authority in the Request for Expressions of Interest (RFEI) to package the scope into three primary contracts: vehicle supply and maintenance, operations and infrastructure delivery (design, construction and maintenance). This structure will enable maximum transfer of revenue risk to the private sector. Therefore, for the purpose of this EOI, we will focus on the contracting options for the infrastructure delivery for IOS-North and how they achieve the Authority's objectives.

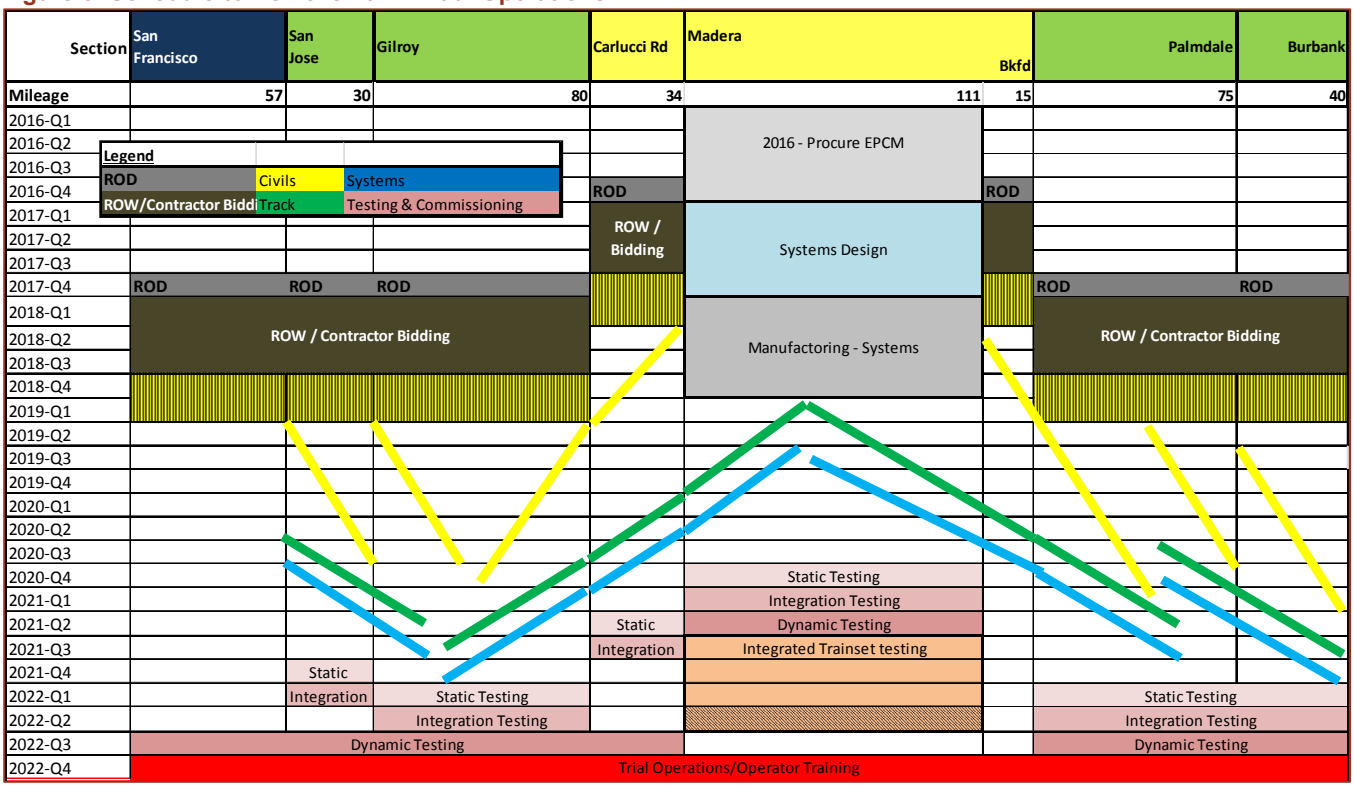
Optimize Schedule Objective

If the primary objective is to start operations as soon as possible, we recommend an EPCM approach, in which one entity takes full responsibility for the engineering, procurement and construction management, including all integration risk though testing and commissioning. This procurement approach enables the public sector to transfer significant responsibility at a much earlier stage before construction prices can be efficiently locked in, particularly before a ROD has been secured. This is beneficial as it allows the EPCM to immediately start on the systems design and advance the completion of the test track, which we believe is the critical path to operations, without adding the extraordinary amount of contingency that would be needed for the private sector to take a lump sum risk on such preliminary design information. A cost-sharing mechanism, such as a target cost contract or strong incentive program between the Authority and EPCM contractor, would enable the sharing of construction risk up to the time of award, at which point it is transferred to the contractor. This very successful delivery model was used to deliver the UK's High Speed 1 program, as that project also exceeded the capacity of the private sector to fully finance and develop at risk.

For CHSR, this would be one entity, engaged in 2016 to immediately start on systems design in 2017, and then drive design development to optimize lifecycle costs and a packaging strategy to maximize price competition within the construction scope. Maintenance commitments could be included for this EPCM entity after a period of design development, as could financing, as the EPCM would have significant control over the design and construction, enabling it to price and manage the long-term maintenance risk. Based on our preliminary schedule analysis, shown in the March chart below (Figure 2), this is the only way to achieve operations in 2022.

The disadvantage to this approach is incomplete transfer of cost risk to the private sector.

Figure 6: Schedule to Achieve 2022 Initial Operations



Optimize Cost

If the primary objective is to minimize cost, our team recommends splitting the IOS-North into multiple DB and DBFM contracts, scoped and sized to maximize competition and alignment of risks. Price competition would be maximized by:

- Keeping total value of each contract below $3B to drive competition and have three or more bidders per package. Above this threshold the contracting risks become "enterprise-threatening" and firms join together to share risk, which reduces efficiency of delivery strategy for driving innovation and reducing costs.
- Splitting civil and systems to allow cost optimization for each component. The need for exclusive partnerships in bidding DB or DBFM drives teams together, which creates sub-optimal choices because the Authority would be precluded from choosing optimal civil and systems solutions.

For CHSR, this would result in four to five DB or DBFM civil contracts (like CP1, CP2-3, etc.) of $1-3B and one systems contract for approximately $4B.

The disadvantage to this approach is that the Authority will remain responsible for the integration risk between these five or six major contractors, in addition to the interfaces between them in construction and maintenance.

Optimize Risk Transfer

If the primary objective is to transfer risk to a single private sector entity, the Bechtel/Arup/SYSTRA team recommends a single firm, fixed price DBFM contract for the entire IOS. Our analysis indicates a market capacity for up to a $10B DBFM, which would require strategically carving out select elements that can be managed more effectively by the Authority and its RDP. The non-integral work that can be done in advance of the DBFM should still be managed separately. For example:

- Environmental service, including obtaining the ROD in advance of financial close.
- ROW services and land acquisition.
- Major utility work, including relocations and new power feeds to traction power substations.
- Relocation of existing freight tracks displaced by the new HSR alignment.
- Selected roadway crossings, where roads can be shifted away from the HSR in advance, and better executed by Caltrans with local contractors.

There are several disadvantages to this approach:

- Given the preliminary nature of the design completed for the environmental documents, a DBFM bid on that basis in 2017 would be burdened with a large cost premium to transfer all the risk under a lump-sum contract at this time.
- The same challenges of reduced competition, described above, will be faced with a $10 DBFM, as only two or three teams would be able to form.
- A P3 consortium of this size will likely become dominated by the suppliers exclusive to it, and will be internally structured as lump-sum turn-key (LSTK) contracts with cross-indemnities for each other's risks that the individual members cannot price or mitigate. The vested interest in supply contracts and individual risk exposure will lead to inefficient pricing and increases the risk that the consortium collapses during execution, which would seriously jeopardize the program. We have witnessed this in our PPP concessions, particularly in comparing the performance of our Tube Lines concession against that of its peer concession, Metronet.

Recommended Approach

As we understand that schedule, cost and risk transfer are equally important objectives for the Authority, our recommendation is a blended approach to capture the best of each approach described above: ***a single DBFM contract that is procured as a progressive lump-sum contract with contingent financing, which is established at the time of award. It will include a defined mechanism for shared pain/gain on cost savings against the initial estimate that is developed on the basis of the environmental documents to the final fixed price.***

While many public agencies are now utilizing a progressive design-build approach for complex infrastructure, the combination of adding financing and maintenance to a progressive design-build would be first of its kind. To achieve this contract, a pre-qualification round would be necessary to ensure the selected team has the ability to achieve financial close and deliver the IOS. Qualifications requirements should focus on primarily:

- Proven HSR experience, particularly the asset performance of the HSR systems operating currently.
- A record for executing operations and maintenance of rail systems.
- Proven ability to arrange financing for projects of this magnitude and complexity, particularly with uncertainty in the total program cost at the time of financial close.

Presuming that financial close should be achieved by the end of 2017, the shortlist of bidders and the RFP should be issued by the end of 2016, with bids due six to nine months later in the third quarter of 2017. This will enable the selection of the preferred bidder and negotiations to finalize commercial arrangements before year-end and as soon as the ROD has been achieved. Bids would be evaluated on the basis of:

- Proposed project management structure and fee.
- Proposed approach for progression lump-sum contract.
- Evaluated NPV for financing solution for the progressive lump-sum contract, on the basis of the preliminary engineers' estimate (developed by the RDP on the basis of the environmental documents).

We believe this approach will enable the Authority and the public to share the cost savings created by the DBFM, advancing the design and increasing the competition for the major civil and systems components, while immediately transferring all execution, integration and maintenance risk to the DBFM effectively. Schedule savings will be able to be achieved by avoiding the delay one year or more) that teams would need to further develop the engineering necessary to optimize lifecycle cost and price construction execution aggressively, which would push financial close to late 2018.

The table below summarizes the delivery approaches and their ability to deliver against the Authority's objectives.

	Accelerate Schedule	Minimize Whole Life Costs	Transfer Risk
EPCM Contract	✓+ Earliest start on Test Track	✓ Achieved via Incentives, Maintenance Pricing & Avoid significant pricing premiums (contingency on Construction)	~ Authority Retains Cost Risk
5-6 DB and DBFM contracts <~$3B	~ Schedule Incentives for DB	✓+ Best pricing achieved	~ Authority Retains Integration Risk
Single DBFM	✓ More time to execute DBFM but P3 has greater schedule incentives & control	~ Limited competition, high contingency needed to cover design development.	✓+ Maximum and quickest risk transfer achieved
Progressive Lump-Sum DBFM	✓+ Less bid time required to price; same P3 schedule incentives	✓+ Best pricing achieved through later packaging to drive competition	✓ Staged risk transfer as progressive lump-sum is developed.

4 Responses to RFEI Questions

4.1 Question 1: Driving Innovation, Whole-Life Costs & Schedule

Is the delivery strategy (i.e., combining civil works, track, traction power, and infrastructure) likely to yield innovation that will minimize whole-life costs and accelerate schedule? If so, please describe how. If not, please recommend changes to the delivery strategy and describe how those changes will better maximize innovation and minimize whole-life costs and schedule.

In general, the proposed delivery strategy will yield innovation that help minimize whole-life costs and positively affect the schedule. Key areas where this is likely to occur is through the consolidation of the systems wide elements: track, traction power, signals, systems and communications. This is best illustrated by the South Europe Atlantic High Speed Rail Line- SEA PPP project of approximately $8-10B (7.8B Euros) currently under construction and set for commissioning and opening in 2017.

Experience with similar delivery strategies

- South Europe Atlantic High Speed Rail Line- SEA PPP in France
  - 50 year concession contract bringing together private partners to fund and carry out the project.
  - Reduced investment required from public funds.
  - Revenue: track access charges
- HSL NIMES – MONTPELLIER BYPASS (3.1B USD)
  - PPP in charge of design construction and maintenance during 25 years up to 2037, excluding stations
  - Led by OCVIA (a private company formed by Bouygues Construction, Colas Rail, Alstom Transport and Spie Batignolles)
  - Revenue: availability payment
- Seoul-Busan HSL- Korean Train eXpress (Republic of Korea)
  - While not a PPP, this program pooled international contractors with comprehensive high speed rail construction/operations experience with local Korean partners. Key aspects of this contract were the work sharing and technology transfer, and the team worked with Alstom on transferring into O/M.

While our experience leads us to concur that the proposed delivery strategy will drive innovation and yield whole-life cost and schedule savings, additional areas to consider to achieve greater results include:

- P3 will place the integration risk on the developer. By allowing a global approach for a PPP, innovation can be maximized from similar experiences.
- Within a P3 structure, however, there should be subcontracts that are competitively bid to drive competition among contractors though cost savings will accrue to the P3 developer unless a cost-sharing mechanism is established.

4.2 Question 2: Transfer of Risk to Private Sector

Does the delivery strategy adequately transfer the integration and interface risks associated with delivering and operating a high-speed rail system? What are the key risks that will be borne by the State if such risk transfer is not affected? What are the key risks that are most appropriate to transfer to the private sector?

The key to defining an appropriate contract structure is to identify the interfaces and ensure that an entity is clearly responsible for that interface. Significant pre-work is required to fully define these interfaces:

- Identify all points of interface for each system (these must be defined with as much technical and commercial precision as possible).

- Develop the undefinable or less definable aspects so that they are all contained within the same package or sub-package (i.e. eliminate undefinable interfaces between different contractors).
- Determine which sub-packages can be bundled within the same larger delivery package then establish which interfaces can be passed down to that delivery partner and which interfaces should be managed by the Authority.

The major interfaces during the delivery phase are:

- Civils/Systems interface.
- Civils/Track interface.
- Systems/Rolling Stock interface.
- Track/Rolling Stock interface.

The interfaces among the civil, systems and track disciplines are well defined and fall clearly within the scope of the DBFM; however, the rolling stock interfaces are with both the DBFM and the rolling stock contracts. As such the Authority will need to manage this interface by establishing rigorous criteria to ensure that the rolling stock is compatible with the track and systems. This is a common interface on high speed rail projects and is reasonable to manage. Alternatively, including the rolling stock in the DBFM contract will further increase the contract size and reduce the benefits to the Authority of selecting the DBFM and rolling stock contracts individually rather as opposed to a predetermined team.

We understand that the heavy maintenance facilities are proposed currently as part of the rolling stock contract. While this allows the rolling stock provider to plan the maintenance facility for the trainsets there are advantages in including some of the civil work for the facilities in the DBFM contract.

Including maintenance in the DBFM contract and rolling stock contracts strongly incentivizes the optimization of whole life costs; however, when operating several entities will be responsible for maintenance:

- Operator: Stations
- DBFM: Mainline, systems, station platforms
- Rolling stock: Maintenance facilities and trainsets

This approach reduces the maintenance scope of the operations contract, allowing the operator to focus on maximizing fare-box revenue. However, these maintenance activities will need to be managed through maintenance agreements to ensure clear lines of responsibility. When a segment is operational, maintenance engineering can be a substantial amount of work for a new service, especially if it includes maintenance engineering for the rolling stock and the associated onboard interfaces. Depending on the structure of the contract, if rolling stock is included, it can be considerable additional revenue or a significant risk that includes liquidated damages for below target availability of the assets. Bombardier/Alstom had the latter experience with Amtrak's Acela that resulted in a negotiated early exit from the contract.

Risk Transfer

The key to any successful procurement is transferring risk to the entity most able to address it. The Authority can consider the risks by the following categories:

Risks to be retained by the State

- Definition of performance standards and technical requirements that delivery partner(s) will need to meet, including changes to them after contracts execution.
- Environmental clearance.
- Procurement of ROW.
- Procurement of sufficient renewable energy sources to meet commitments. Adding this to the DBFM concessionaire's already large and complex scope likely would be infeasible. The renewable energy supply could be handled as a separate procurement via a series of DBFOM's or simpler PPA's with third-party providers.
- Ridership and fare-box revenue.
- Force of nature, including earthquakes, terrorism, civil unrest, etc.
- Availability of funding sources such as Cap and Trade funding, Prop 1A funds, etc.
- Changes in law.

- Obtainment of Buy America waivers from the Federal government, if certain systems or components subject to Buy America cannot be sourced in the US
- Archaeological discoveries in the ROW, not specifically identified in the EIR/EIS.
- Protection of endangered or protected species not specifically identified in the relevant EIR/EIS/
- Delivery of off-site environmental mitigations, i.e., not located within the project's ROW.
- Property taxes, if/where applicable, such as possessory interest taxes.

Shared risks

- Project Interfaces.
- Interfaces with other rail operators in locations where "blended service" is to be provided.
- Interfaces with third parties such as state and federal regulatory agencies and relationships with local entities (city and county governments), including obtaining permits from these third parties (for example, by making the developer responsible up to certain schedule and/or cost thresholds).
- Insurance aspects that are either best "self-insured" by the Authority or rolled into a statewide insurance program managed by the state (e.g. earthquake risks).
- Regional subsidence.
- Ground risk that is subject to a Geotechnical Baseline, at least for the tunnels and other structures in more challenging sites.

Risks transferred to private sector

- Maintenance risk.
- Availability of system.
- Technical (performance).
- Cost and schedule overruns –subject to Authority-retained risks and risk-sharing provisions above.
- Quality.

4.3 Question 3: Inclusion of Other HSR Components in DBFM

Are there any other components of a high-speed rail system that should be included in the scope of work for each project (e.g., rolling stock, train operations, stations)? If so, how will this help meet the Authority's objectives as stated in this RFEI?

The broad approach to packaging components into the DBFM supports the Authority's objectives for the procurement. Key points on the scope of this contract:

- Incorporating additional major elements to an already very large DBFM contract would increase its size, making it less attractive to the market.
- Packaging elements like rolling stock into the DBFM while reducing Authority-managed interfaces would inhibit the Authority's ability to select separately the best value rolling stock supplier and DBFM consortia.
- Including civil construction for maintenance facilities in the DBFM would avoid the rolling stock supplier needing to provide those skills, alongside the DBFM consortia, and allow them to focus on the facilities needed to maintain and stable the trainsets.
- Making some activities small, individual contracts that are outside of the DBFM contract can mitigate risks and engage smaller contractors and local agencies. These may include:
  - Major utility diversions and supply.
  - Remediation of contaminated ground.
  - Construction of selected road over crossings.
  - Relocation of existing railroad tracks displaced by HST.
- Separating the maintenance scope from the operations contract maximizes the ability of the operator to take revenue risk, particularly in the initial operating phase (as maintenance risk is borne by the DBFM).
- Separating the stations contracts allows the Authority to work with local cities and agencies and local developers to develop attractive stations which maximize private investment.

4.4 Question 4: Appropriate Contract Term for DBFM

What is the appropriate contract term for the potential DBFM contract? Will extending or reducing the contract term allow for more appropriate sharing of risk with the private sector? If the Respondent recommends a different delivery model, what would be the appropriate term for that/those contract(s)?

The most common duration for DBFM contracts is a 30-year operating period, though contracts range from 20-50 years, depending on other factors affecting the delivery strategy and operational characteristics for each system. From a risk and financing perspective, the PPP market is comfortable with this duration and we do not think it will negatively affect competition or financing. Within this range, the primary factor to consider is the timing for major renewals and potential for future investments in additional capacity.

Major renewals for an HSR system will occur at approximately 20-30 years and 50-60 years after the start of operations. If there will be future investments in capacity upgrades, it is most efficient to time these with the capital asset renewal program. Therefore, to best align incentives, longer maintenance periods should be matched with an incentive to make cost-beneficial upgrades to achieve maximum usage of the system. While some systems have been delivered with a 50+ year term, the systems that capture real value for money beyond 20-30 years are systems with less uncertainty in the traffic projections because there is greater upside for the increased upfront investment and less likelihood of future capacity expansions.

Given the opportunity described in our approach section to transfer investment risk (and leverage private capital) for the future capacity expansions and additional/alternate operators, we believe there will be a desire to upgrade the infrastructure at 20-30 year renewals. Therefore, the DBFM contract for IOS-North should be limited to a 20-30 year period, and could be combined potentially with southern BC into a concession that is carrying the investment and traffic risk for capacity upgrades.

4.5 Questions 5: Appropriate Contract Size

What is the appropriate contract size for this type of contract? What are the advantages and disadvantages of procuring a contract of this size and magnitude? Do you think that both project scopes should be combined into a single DBFM contract?

The primary drivers on package sizing are the financial market capacity and the capacity of the contractors to bear the magnitude of the construction risk. As package sizes grow, larger teams will form to reduce individual company exposure to a tolerable level, reducing competition and increasing the interface and integration risks within the team, reducing the cost efficiencies gained by bundling scope.

Within the context of a P3, the practical size limit is constrained by how much work can be contracted at one time (particularly initially to control exposure at financial close) and how much risk the contractors and equity participants are willing to put on their balance sheets as Letters of Credit and bonds of 40-50% become unworkable. Both of these factors are exacerbated by long construction durations to start-up and the release/elimination of construction risk.

From a financial perspective, we think the upper limit for a deal size is $7-8B. From a construction perspective, the market's appetite for P3s is generally $1-3B, with plenty of competition for these contracts. Above $4B, there are significantly fewer teams competing due to consolidation of teams. For the most efficient execution, the optimal contract size would be to stay within this limit and split the scope into a $3-4B Systems DBFM and $3-4B civil design-build or DBFM contracts for IOS- North or South. More work could be packaged together to transfer more risk to the private sector and achieve greater cost certainty, but it is less likely to achieve significant cost savings because the private entity will need more contingency to cover the risks, and will capture any cost savings resulting from their innovation. Conversely, multiple P3 packages will create challenges from a financing perspective as each P3 would need a clear and separate source of funding.

Based on this assessment, we suggest the best way forward would be to focus on IOS-North and pursue selecting risks that can be equally or better managed by the Authority. This will pull the value of the IOS-North procurement to under $10B, in combination with the recommendations outlined in Section 3: Project Approach, to improve the financial strength of the program.

4.6 Question 6: Teaming & Competition

Does the scope of work for each project expand or limit the teaming capabilities? Does it increase or reduce competition?

Where there are greater synergies among scopes of work, there will be greater efficiencies in teaming, primarily within the civil infrastructure and systems. While including rolling stock would increase risk transfer to the private sector, it would limit teaming options because each vehicle supplier would likely have to be in an exclusive teaming arrangement. This can dilute the ability for the infrastructure DBFM teams to compete on providing the most efficient delivery, which is an opportunity greater than the savings likely to be achieved at the vehicle/system interface (compared with the Authority's ability to control that interface through its contracts and consultants).

As discussed above, the size of the package also affects teaming options, but a package up to $10B is likely to attract two, possibly three, teams. Below $4B, there would be significantly more competition.

4.7 Question 7: Raising Financing

Given the delivery approach and available funding sources, do you foresee any issues with raising the necessary financing to fund the IOS-South project scope? IOS-North project scope? Both? What are the limiting factors to the amount of financing that could be raised?

Our assessment indicates that the available Prop 1A funding, along with the funds that could be leveraged by the expected Cap and Trade funding, would provide sufficient funds for the IOS-North. However, raising financing of the order of magnitude proposed for a DBFM procurement in one year will be a worldwide record and, relative to state issuance in any one year, would also be a very significant amount. To ensure that the project is attractive for private investment, the following elements should be included:

- The contracting approach and risk allocation model should be designed in line with the response to Question 2 above, such that it can be absorbed by the market.
- Government-backed guarantees (by the State and/or Federal governments) can be developed for the sources of revenue to pay back the initial investment and ongoing maintenance expenses. With a system of revenue guarantees backed with good quality credit sources, significant financing could be raised.
- The ability to raise the needed financing would be impacted by:
  - Significant disruptions to market conditions or deterioration of the state's fiscal position.
  - Exposure of the debt portion of the financing, which would compose the majority of the financing, to construction or revenue risks. This would significantly limit the ability to raise the amounts needed, in addition to raising the financing costs.

Based on the information provided the sources of funding anticipated can be summarized as follows, based on financial close in 2018, construction starting in 2019, and extending through 2025 (first full year of operation in 2026):

Source	Order of Magnitude Financing Available	Comments
Prop 1A	$4B	Net of amounts currently committed for the FCS contracts
C&T pay-go during construction	$5B	Assumes use C&T funding during construction as cash = 10 years @ $500M p.a., starting in 2016 through construction completion in 2025
Private finance	$8-12B	Repayment starting on the first year of operation from two main revenue sources: (a) Availability Payments funded by the Authority with C&T funding, plus (b) Guaranteed Minimum Revenue from fare-box collection (using net cash flow from operations based on revenue and O&M cost projections from the Authority's business plan).
Total	$17-21B	

Notes:

- Stations assumed to be funded by development at stations, parking, commercial activity and local taxes.
- Additional funding could be made available from activities such as:
  - Third party use of ROW (fiber network, cell towers).
  - Advertising.
  - Commercial operations on the trains (parcel delivery etc.).
  - Leasing track access to other operators (Metrolink and Amtrak) particularly for IOS-South/Basin Connection.

4.8 Question 8: Recommended Changes to Existing Funding Sources

What changes, if any, would you recommend be made to the existing funding sources? What impact would these changes have on raising financing?

As explained above, any delivery model will need to have government-backed guarantees (by the state and/or federal governments) for the sources of revenue to pay back the initial investment and ongoing maintenance expenses:

- Prop 1A bonds issued by the state. By definition these are state-backed obligations.
- C&T annual contributions would need to be guaranteed at the stated funding level, i.e., any shortfall due to C&T market fluctuations would not affect the HSR funding source. For example, the state would commit to provide to HSR the first $500M in funding that it collects annually from the C&T program, rather than a percentage. Further, the state would have to commit to making up any shortfalls below the $500M from the C&T program in any given year.
- Fare-box revenues (and any other ridership-dependent revenues such as advertising in trains and stations, etc.) will be subject to a minimum revenue guarantee to raise any financing from ridership-dependent revenues. In other words, if fare-box revenue in any year falls below a certain level, the shortfall would be made up from a state or federal backed funding source. For example, the guaranteed minimum revenue line could be defined as a schedule of values equal to some percentage of the revenue forecast provided in the Authority's business plan – the higher that percentage, the more finance will be possible to raise.
- Other revenues (not ridership dependent) would likely not require government backstops.

We view these as essential elements of a successful financing strategy for the HSR project.

4.9 Question 9: Appropriate Payment Mechanism

Given the delivery approach and available funding sources, is an availability payment mechanism appropriate? Could financing be raised based on future revenue and ridership (i.e., a revenue concession)? Would a revenue concession delivery strategy better achieve the Authority's objectives?

An Availability Payment model can work very well if the source of payments is sufficient enough to raise the necessary initial financing and is predictable with an acceptable credit rating. Given the information provided for the RFEI, it appears that the C&T source can meet the second criterion, if it has a priority claim on the C&T proceeds or other state backing, but it does not have a sufficient level to raise enough financing by itself to complete the required level of funding for construction.

A hybrid model that combines the sources of funding listed under Q7 above could potentially fund a construction project of $17-21B size plus the O&M for that project. This would not be a traditional "revenue concession" model, as the ridership revenue component would need to have a guaranteed minimum revenue.

4.10 Question 10: Cost & Schedule Savings from Preferred Delivery Model

Based on the Authority's capital, operating, and lifecycle costs from its 2014 Business Plan, describe how the preferred delivery model could reduce costs, schedule, or both. Please provide examples, where possible, of analogous projects and their cost and/or schedule savings from such delivery models.

The team has extensive experience covering a large number of delivery models. With a PPP, the private party has a very strong incentive to meet the schedule: avoid significant financial penalties from lenders and begin receiving revenue. The private party has many tools to manage the project to make the schedule shorter, such as less rigid procurement rules, ability to manage concurrent engineering, initiation of early procurement of long lead material at risk and faster mobilization of staff. With the size of the project, scale effect may be beneficial, i.e. in terms of standardization.

We believe that lifecycle costs can be minimized since capital cost and maintenance costs are embedded in the interest of the P3. However, it must be borne in mind that private sector financing is generally more expensive than the equivalent public sector financing due to higher expectations for returns for the risks borne. Furthermore, with the schedule described for this DBFM contract, it is likely that the P3 will price conservatively to account for all the unknowns and then keep the savings resulting from their innovations. Savings achieved through innovation after financial close are captured by the P3 concessionaire unless a cost-sharing mechanism is included to share these savings.

4.11 Question 11: Comparison to Contracting for Each Component

How does this compare to separately procuring each high-speed rail component (i.e., separate contracts for civil works, rail, systems, power separately)? Please discuss design/construction costs, operating/maintenance/lifecycle costs, and schedule implications.

When procured separately, each individual component is likely to be less expensive because of the ability for each specialist to bid on its individual expertise and leave the integration and interface risk, and associated contingency required, with the Authority. Furthermore, each component will be individually optimized, again creating the appearance of a lower cost achieved with separate procurements, but likely missing opportunities for design and construction investments that yield net life-cycle cost advantages. With this delivery approach, the opportunity for innovation and life-cycle cost-optimization rests with the Authority, or perhaps Rail Delivery Partner, to find these opportunities or adjust each contract to create secondary incentives to counteract the drive for each component contractor to optimize only within their scope boundary, which is especially challenging with Design-build contracts where design responsibility has been subcontracted to multiple entities. In short, we do not believe this approach would be advantageous for the CHSR program.

4.12 Question 12: Technical Challenges

For each project, are there any technical changes to the respective scope of work that would yield cost savings and/or schedule acceleration while still achieving the Authority's objectives? If so, please describe.

There are a number of areas where technical change could be made to achieve cost and schedule benefits:

- Design the system alignment based on achievable operating speeds. In areas of steep gradient, such as the Tehachapi Mountains and San Gabriel Mountains, it is unlikely that the trains will operate at 220 mph. These areas could be designed with tighter curves to reduce the extent of expensive tunnels and high viaducts.
- Increase the extent of ground investigation carried out in the early stages of design to better quantify the ground risk and allow more efficient structural design.
- Use single span bridges and culverts through high embankments for road crossings.
- Reduce onerous requirements for limiting structure movements that lead to a requirement for very stiff foundations. Current seismic design rules appear to be derived from road bridges without adjustment for the heavier structures and lower tolerance of failure experienced by rail bridges. The consequence of this is that it is difficult to satisfy the ductility requirements as the structure behaves elastically under earthquake conditions.
  (N.B. In the UK the Eurocode committee has commenced a review of the current code requirements - on which the CHSR TM is based).
- Use rail joints. If these are permitted on structures there would be more opportunity to use continuous spans (with larger standard spans) over distances greater than 660 ft. This would open the way for considering precast segmental viaducts and push launches in difficult to access locations and may also reduce the number of locations where a steel truss was the only viable solution.

To incentivize early delivery of an operating system the provision of a minimum level of infrastructure at the outset, with a staged delivery philosophy, could be considered. For instance, the provision of a single track tunnel though the Tehachapi's for instance, rather than two twin bored tunnels, would allow operations to commence early. This would not reduce the overall cost of the systems, it would increase it in fact, but would allow early operations, maximizing the use of available funds to achieve the longest IOS possible and transferring the future investment decision to a concessionaire to determine when it would be best to build out the remaining parts of the system and how to fund it. Note – there would need to be a thorough review of the impacts on the safety case to confirm the feasibility of the staged implementation.