

Adventures in Building Another Washington Monument

Rebid Outcomes of Woodrow Wilson Bridge Project

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In December 2001, the Maryland State Highway Administration (SHA) opened a single bid for the substructure and superstructure contract to replace the Woodrow Wilson Memorial Bridge, the crossing of the Potomac River for I-95 and I-495 (Capital Beltway) traffic. This contract was part of the larger Woodrow Wilson Bridge project, a \$2.5 billion project to build the new Potomac River crossing and to reconstruct the four interchanges in its vicinity. The contract's estimate was a record for SHA at \$487 million. The single bid was for a budget-wrecking \$860 million and was rejected. The design team regrouped and focused its efforts on innovative means for bringing the project back on budget. Maryland SHA convened an independent review committee (IRC). Composed of industry experts, the IRC advised the design team on making the contract less expensive and more attractive to contractors to increase competition and reduce costs. Ultimately, the work was readvertised as three separate contracts. The outcome of redesigning and readvertising was to reduce the total bid amount for the work by \$362 million. Several lessons were learned in handling megaprojects: reach out to the construction industry early and often to rouse and maintain interest in the project; make terms of the contracts as contractor friendly as reasonable; and, when sizing the contract, ensure that it is manageable and that it balances competition and contract interface risk.

I-95 extends from the Canadian border of Maine to Miami, Florida, and connects most of the major cities on the East Coast of the United States, including Boston, New York, Philadelphia, Baltimore, and Washington, D.C. The existing Woodrow Wilson Memorial Bridge carries I-95 across the Potomac River, connecting Maryland and Virginia at the southern tip of the District of Columbia. The Woodrow Wilson Bridge is a vital link in I-95 and the Capital Beltway (I-495), the circumferential freeway surrounding the core of the Washington metropolitan area. The existing bridge has only a 50-ft vertical clearance, and thus a drawspan over the Potomac River's navigational channel is necessary to allow larger marine vessels to access Washington, the port of Alexandria, Virginia, and other points north of the bridge. This existing drawspan is opened an average of five times per week and usually only during nonpeak travel periods on I-95.

The bridge was designed in the 1950s and opened in 1961 as the southern crossing of the Potomac River for the Capital Beltway. When the Capital Beltway was completed in 1964, I-95 in the Washington region was still in the planning stage, and its proposed align-

ment extended north through the center of the District of Columbia. In 1976, it was decided that constructing an Interstate through the heart of Washington would be too disruptive to existing neighborhoods, and this portion of the highway was never built. As a result, I-95 was made coincident with the eastern side of the Capital Beltway bypassing the downtown D.C. area. Because of this decision, the Woodrow Wilson Bridge became the Potomac River crossing for all I-95 traffic (see Figure 1).

The bridge was anticipated to carry 75,000 vehicles per day over a four-lane divided highway. When the Capital Beltway was completed in 1964, the average daily traffic (ADT) of the bridge was 47,900. In the early 1970s, the anticipated 75,000 ADT of the bridge was surpassed. The bridge was eventually widened to six lanes with minimal shoulders. Today the Capital Beltway is eight lanes wide on either side of the Woodrow Wilson Bridge, but the bridge itself remains six lanes wide because of structural limitations, creating one of the worst bottlenecks on I-95. In 1997, the bridge's ADT was 203,000. The new bridge is expected to accommodate an ADT of 300,000.

As the structure continued to deteriorate under loads it was never expected to carry, a planning study commenced for the replacement of the structure. Several alternatives were considered: tunnels, high bridges, drawbridges. The Record of Decision approved side-by-side drawbridges with a 12-lane typical section, because this build alternative best met the purpose and need of the project while causing the least environmental disruption.

WOODROW WILSON BRIDGE PROJECT

The Woodrow Wilson Bridge Project corridor is 7.5 mi long. In addition to the Potomac River crossing, the bridge encompasses four interchanges: Telegraph Road and US-1 in Virginia and I-295 and MD-210 (Indian Head Highway) in Maryland. All four interchanges will have increased capacity and will be realigned to connect to the new Potomac River crossing (see Figure 2).

The alignment for the drawbridges is located approximately 30 ft (9.2 m) south of the existing bridge. Each new bridge is six lanes wide and separated into local and express lanes. To match the typical section on both sides of the Capital Beltway, four through lanes have been provided on each bridge, two in the local lanes and two in the express lanes. In addition, there will be an outside merge lane in the local lanes and space to accommodate either high-occupancy vehicles or future Metrorail trains in the express lanes, for a potential total of 12 lanes. The new bridge is located in Virginia, the District of Columbia, and Maryland, but Maryland is responsible for building the entire structure. The work in Virginia is almost entirely over land in Jones Point Park. The intersection of the Potomac River navigational

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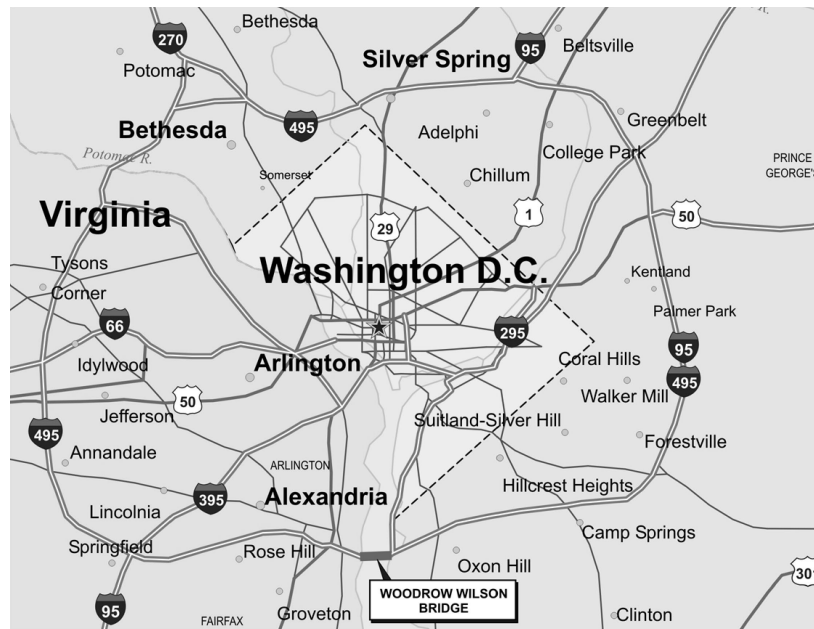


FIGURE 1 Washington, D.C., metropolitan area.

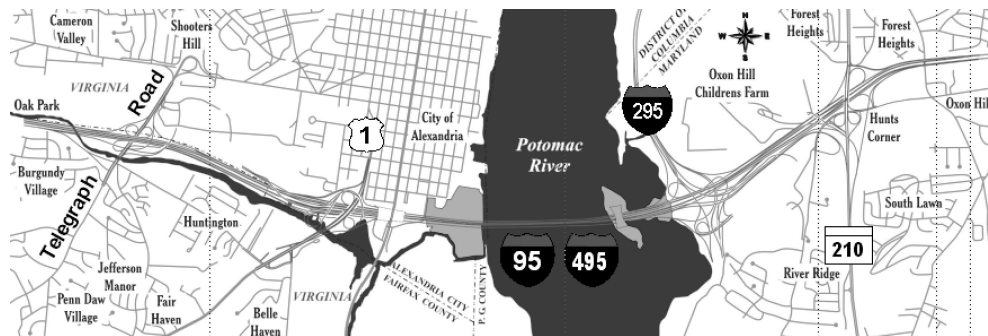


FIGURE 2 Project corridor.

channel and the new bridge, and thus the bascule (drawspan) is located at the southern tip of the District of Columbia. The rest of the structure is located over the Potomac River in Maryland.

The decision to build new drawbridges was made because many commercial, Navy, Coast Guard, and recreational vessels on the Potomac River require high clearances. A fixed bridge would have required a vertical clearance of 135 ft, which would have had significant visual impact on the city of Alexandria. Steep grades needed to achieve the required elevation gain would have significantly slowed traffic and caused difficulty for future rail transit. The new drawbridge is about 20 ft higher than the existing bridge, reducing the number of bridge openings each year from approximately 260 to 60.

The design of the bridge was chosen by competition. Four teams submitted seven entries. The winning design was submitted by Parsons Transportation Group and was chosen by a panel of public officials; distinguished technical, aesthetic, and urban planning experts; and federal and state bridge engineers. The concepts for the entries were based on arch concepts, like other notable bridges over the Potomac River in the Washington, D.C., area. The piers appear to be classical arches but are actually curved V-shaped piers. The poor soils in the Potomac River would have made true arches difficult and

expensive to build. Concrete pedestals and foundations atop piles support the posttensioned V-shaped piers. Each pier is closed at the top with a tie beam connecting each tip, which supports four longitudinal steel main girders and a conventional reinforced concrete deck (see Figure 3).

To facilitate construction on this \$2.5 billion contract, the work was broken into smaller contracts that are based on the overall sequence



FIGURE 3 Winning bridge design by Parsons Transportation Group.

of construction and the location of the work. Diverting I-95 traffic from the project area is not an option, so the existing bridge must stay in operation until the outer bridge is ready to accept traffic. The alignment for the new bridges is located south of the existing bridge, but there are some overlaps between the new and the existing bridges at their ends. The general sequence of construction is as follows:

1. Build as many bridge foundations as possible for the two bridges, omitting only those in conflict with the existing bridge.
2. Build the substructure and the superstructure for the outer-loop bridge (and the inner-loop bridge, where possible).
3. Shift all traffic from the existing bridge to the new outer-loop bridge.
4. Demolish the existing bridge.
5. Build the inner-loop bridge, including the remainder of the foundations.
6. Shift southbound traffic from the outer-loop bridge to the inner-loop bridge.

The Potomac River crossing work was broken into three contracts: a dredging contract, a foundations contract, and a substructure–superstructure contract. The work was broken down this way to allow the bridge foundations to start while the design of the substructure and superstructure was being finalized. The dredging contract was completed in the winter of 2000–2001. The foundations contract was awarded in the spring of 2001, and work was well under way when the bid opening for the third and final contract took place in December 2001.

CRITICAL DECISIONS

The general engineering consultant (GEC) overseeing the design and construction of the project is the joint venture of Parsons Brinckerhoff; URS; and Rummel, Klepper, and Kahl. Parsons Transportation Group is the designer of record for the Potomac River crossing. Representing the owners were FHWA, the Maryland State Highway Administration (SHA), and the Virginia Department of Transportation (DOT). Team members had extensive experience on large-scale projects from around the world. When the project was conceived, no one on the team thought that a lack of bidder interest would be an issue. The trend in the industry was to allow big projects to stay big to achieve advantages of economies of scale and to minimize contractor coordination and interface aggravations. Competition and good bids had resulted for the first two bridge contracts. Throughout the design phase, contractors had inquired about the contract's status. Several contractors bought plans, and many submitted questions during the early part of the advertisement phase—typically signs of strong interest. As the bid opening neared, it was rumored that only one bid would be submitted. This rumor appeared to be substantiated when only one joint venture submitted questions as the advertisement phase came to a close. It was hoped that if only one bid were submitted, it would be close to the contract's budget. However, the lone submitted bid, from a joint venture of Kiewit, Tidewater, and Clark, the team already building the foundations for the new bridge, was for \$859,954,042, 75% over the estimate, a difference of about \$365 million, and well above the available funding.

When the concept was approved, it was understood that the selected bridge alternative—with its aesthetic V-piers and movable spans—was not the least expensive option. A conventional design with routine piers and superstructure elements would have been less costly. A fixed-span bridge to replace the movable span would

have been even less expensive. However, the approved design was the result of years of consultation with diverse stakeholders and a huge investment in planning and design. Starting over would have resulted in years of delay and extra cost due to redesign and inflation. The reopening of a complicated planning and environmental-permitting process would have been necessary and would have had an unknown outcome. In the meantime, traffic bottlenecks would have worsened, and the bridge's condition would have continued to deteriorate. The Woodrow Wilson Bridge had to be replaced as soon as possible, and continuing with the approved concept was the best way to achieve this outcome.

At the time the single bid was opened, work was 36% complete on the \$125 million foundations contract. Halting this construction while deciding how to proceed would have been costly and would have caused additional delays.

Decisions had to be made quickly to minimize delay and cost, but it was understood that a successful outcome was essential. A second bidding failure would have reflected poorly on SHA and the project. With the stakes high, a search began for the best guidance available.

INDEPENDENT REVIEW COMMITTEE

SHA contacted the bidder to determine if there was any leeway on price or scope that would be acceptable to both parties. This was not possible, and the bid was rejected. However, discussions with the bidder provided valuable insight into preparation of the bid and identified aspects of the contract that could be made more attractive.

A number of bid openings on other megaprojects around the country also were experiencing disappointing bid results. There were many theories about why bids on megaprojects were turning out this way: uncertainty regarding the economy and the construction industry, especially after September 11, 2001 (9/11) too many megaprojects and not enough megacontractors, and too much risk in megaprojects. To analyze the reasons for the single high bid and to devise a strategy for proceeding, an independent review committee (IRC) was formed, composed of a cross section of industry experts. The committee was chaired by Tom Warne, former executive director of the Utah DOT. Committee members represented the points of view of the state–owner, consulting engineering community, contracting industry, surety industry, concrete and steel industries, federal government, and construction management community. The IRC was given the following tasks:

- Convene a value engineering team to identify and study means of making the contract less expensive;
- Review the contract documents for restrictions or requirements that might be viewed as overly burdensome;
- Interview contractors—those who bid on the contract, those who prepared bids but did not submit them, those who purchased plans, and others, and determine why they turned away from the contract;
- Evaluate readvertisement scenarios that would
 - Increase the number of contractors bidding,
 - Minimize impact to the project schedule,
 - Preserve the appearance of the proposed bridge,
 - Require that all bascule work be done by the same contractor,
 - Make the contract more contractor friendly,
 - Encourage competition among steel fabricators and precast concrete suppliers, and
 - Appropriately share risk between SHA and contractors.

The committee completed its work in just over 2 months. It prepared two reports, one addressing means of increasing competition

and one discussing possible value engineering changes to the design. The cost of the IRC was about \$150,000.

Potential bidders were identified by the IRC. They were asked about their perception of risk regarding constructability, schedule, availability of materials, environmental issues, disadvantaged business enterprises goals, insurance, bonding, operation of the bridge bascule, government oversight, and the proposed project labor agreement (PLA). Contractors were formally and informally interviewed about changes that would make the contract more appealing.

Constructability

The general consensus was that although the contract was difficult and challenging, constructability was not the deciding factor to forego bidding. The value engineering specification in the contract documents appeared discouraging, with its cumbersome approval process. Concern was expressed regarding the difficulty of casting and erecting the precast segments, and there was interest in alternative methods for construction.

Schedule

The IRC found the schedule to be somewhat aggressive but not unreasonable. The only issue raised regarding the contract schedule was that of liquidated damages. These were thought to be relatively high, and no offsetting incentive was offered.

Availability of Materials

Only one established precast concrete supplier was able to cast the required segments. Encouraging the use of an on-site or off-site temporary casting yard or use of a cast-in-place option would allow competitive alternatives.

Surety

Obtaining adequate bonding on a contract of this size was a major issue for smaller contractors deciding whether to bid. The events of 9/11 did not help with this issue. Some contractors interviewed suggested breaking the contract into smaller and shorter contracts to better control risk and to allow sufficient bonding to be more easily obtained. Others suggested that reduced bonding requirements were more common on megaprojects.

Multiple Layers of Oversight

One contractor cited the many layers of oversight as his major reason for not bidding on the contract. He believed that the multiple agencies and a GEC construction manager involved in such a politically sensitive environment would result in a high-risk project.

PLA

During the design of the project, SHA negotiated a PLA. Negotiations occurred with representatives of organized labor, and a tentative agreement was reached. This agreement, if included, would have required a process for the contractor to use labor supplied by the local

unions under certain conditions. Approval at the federal level was required, and it took considerable time to review the PLA and come to a decision. Well into the bidding period, FHWA rejected the PLA, and it was not incorporated. This led to a high level of uncertainty about the requirements for labor management, which resulted in the loss of competition, since certain open shop contractors refused to consider bidding on a contract requiring a PLA. Others were comfortable with PLAs. The uncertainty about whether the PLA would be included frustrated most contractors.

Contract Terms

Some general provisions requirements were perceived to be burdensome to the contractors. In particular, payment terms for mobilization (not enough early enough) were seen as being especially troublesome, as well as insurance, retainage, and partial payment requirements.

Contract Size

Contract size was not an issue to large contractors because this would allow them less interference from others and would allow for more and better staging areas. Smaller contractors were put off by the contract's size and recommended the work be broken down into more manageable pieces.

Competition from Other Megaprojects

At the time the contract was advertised, several contracts around the country were advertising concurrently or had recently been awarded. The contractor and supplier resources needed to bid and perform this type of work were stretched thin. For example, a large (\$1 billion) contract to construct part of the new San Francisco–Oakland Bay Bridge was advertised almost concurrently with the Woodrow Wilson Bridge contract. Some contractors that likely would have been interested in this project could not bid because of prior commitments. Other potential bidders had to choose which contracts to pursue, since the preparation of bids for major contracts is a huge and expensive undertaking.

Environmental Issues

Some contractors thought that the project, within the shadow of the nation's capital and its various regulatory agencies, would receive a higher level of environmental scrutiny than elsewhere. This was viewed as another element of increased risk.

STRATEGY FOR PROCEEDING

On the basis of the findings and recommendations of the IRC, several strategies were adopted.

Minimizing Delay in Implementing Project

To minimize delay incurred, certain elements of work that had been part of the original contract were moved to other contracts that were under way. For example, the Virginia abutment (approximate value, \$5 million) was moved to the US-1 Interchange Virginia Tie-In

Contract, and a portion of the piles to support the fender rings around the piers (approximate value, \$1 million) was moved into the foundations contract.

Because the bascule work had the longest construction duration and the greatest technical risk and because it was the easiest to separate into its own contract, this part of the work was re-advertised first.

Competition

The first key element of the IRC recommendations was an array of strategies for increasing competition. The following suggestions were implemented.

Three Smaller Contracts

The one large contract was broken into three smaller contracts to allow medium-sized contractors to bid on the work to increase the number of potential bidders. The nature of the bridge work (dual bridges, three distinct structure types, and different construction means) allowed for various scenarios for repackaging the work into smaller contracts. The three contracts were the bascule (BR-3A), the Virginia work over land (BR-3B), and the Maryland work over water (BR-3C).

Communication with Contracting Community

On typical highway projects, contractors come to government agencies for work. For huge contracts such as this one, government agencies must go to the contractors that can perform this type of work and communicate to them why they should bid on the contract. Given the recent rejection of the single bid, the industry needed reassurance that the contract, when re-advertised, would be awarded. A series of letters was sent to potential bidders to keep them informed of project developments. Advertisements were placed in major trade media. Personal calls were made to key managers at various large construction firms informing them of the recent changes to the contract, encouraging them to consider bidding, and requesting further suggestions for improving the project. Feedback from the contracting community indicated that these calls were well received.

Staggered Advertisement Dates

The bid opening dates of the three repackaged contracts were staggered sufficiently to allow contractors to bid on more than one contract. Beginning in July 2002, the contracts were re-advertised, one every 3 months. To allow the contractors time to better prepare bids, 4 months were scheduled between advertisement and bid opening.

Emphasis on Owner-Controlled Project

The emphasis was made that this is an owner-controlled project, that SHA personnel are on site and directly involved in the project, and that Maryland is committed to fast and fair decision making. It was also made clear that the owner would welcome working with contractors to implement value engineering changes and would support the contractor in developing the means and methods to build the bridge.

PLA

The three re-advertised contracts did not require nor prohibit use of a PLA. The decision was left to the contractors. This approach was consistent with FHWA requirements, and this point was emphasized in the marketing calls made to potential bidders.

Contractor-Friendly Specifications

The IRC reviewed the general provisions to determine what areas could be addressed to make the project more contractor friendly without subjecting the state to undue risk. Implemented suggestions included the following:

- Surety and bonding requirements were reduced. Typical SHA projects require a performance and payment bond in the amount of 100% of the contract price. This was reduced by 50%.
- Some insurance provisions were relaxed. Extensive insurance requirements, far beyond the typical for SHA projects, had been developed for the original contract. Some contractors thought they were too stringent. A review of the insurance requirements led to some relaxed provisions. For instance, limits for builder's risk insurance were reduced from full contract value to maximum probable loss.
- Retainage provisions were made less onerous. Typical SHA retainage for construction projects is 5%, with an opportunity for reduction based on good performance. Retainage was reduced to 2.5%, with an opportunity to reduce to as little as zero retainage, depending on performance.
- Incentives were added. The proposed incentive payouts were revised to encourage cooperation between adjacent contractors and to facilitate common completion dates for critical elements of work. Although the amounts available are not large relative to contract size, all potential bidders thought that reasonable incentives provided positive encouragement.
- Mobilization cap and payout provisions were increased. SHA usually provides no cap on the bid amount for mobilization. To control early cash flow, a cap was placed on the mobilization bid, and it was to be paid out over a longer period—for example, 12 months instead of the usual 6. A reasonable mobilization cap of 15% was ultimately implemented with a payout of 50% initially and a 6-month total payout period.
- Restrictions on working hours were made more favorable. This was a sensitive and painstakingly negotiated issue since the project is located adjacent to a community and an active park. Some additional concessions were provided regarding working hours, weekend work, and hauling access to the project through the community.
- Lump sum breakdowns were provided. To ensure that the contractors uniformly bid, the estimate of quantities for major items was provided in the contract documents. Discrepancies had to be resolved during the bidding period.
- Safety engineer requirements were clarified. Some bidders thought the requirements were onerous. These were clarified and adjusted.
- Partial payments were allowed for raw and stored materials. Typical SHA specifications were modified so that the contractor could receive partial payments for delivery of raw steel and for completion of fabricated steel before erection.
- Advanced notice-to-proceed items were identified. Contractors were encouraged to request an advanced notice to proceed on such early work items as shop drawings, schedule preparation, and permit

applications so that these time-sensitive projects could begin before formal contract award.

- Value engineering was encouraged in certain areas. The contract documents identified specific areas of the design where value engineering change proposals would be welcome and others where they would not be considered. Innovation was also encouraged in construction means and methods.

Value Engineering

The second key element of the IRC recommendations was the value engineering effort. All or portions of 24 value engineering proposals were pursued. The following are the more significant value engineering suggestions that were implemented:

- Steel box girders were replaced with steel plate girders.
- Potential bidders were allowed to consider the option of either precasting the piers or casting them in place.
- The design of the V-piers was refined to simplify the tie beams and the knuckle connection.
- Structural elements were redesigned to increase uniformity and repeatability, especially in precasting formwork.

RESULTS

Competition

The strategies to increase competition were quite successful. Eighteen construction firms bid on the three contracts, individually or as part of joint ventures, as shown in Table 1. Of the 18 firms, 10 bid on at least two contracts, and 5 bid on all three. At least four bids were received on each of the three contracts:

- The bascule contract attracted five bidding teams, with a low bid by the joint venture of American Bridge—Edward Kraemer & Sons for \$186 million. This was 10.7% over the estimate of \$168 million.
- The Virginia approach contract attracted seven bidding teams, with a low bid by the joint venture of Granite—Corman Construction for \$115.5 million. This was 27.7% under the estimate of \$160 million.
- The Maryland approach contract attracted four bidding teams, with a low bid by the joint venture of Edward Kraemer & Sons—American Bridge—Trumbull for \$191 million. This was 25% under the estimate of \$255 million.

The three repackaged contracts bid for a combined total of \$492 million, about 15.6% under the combined estimate of \$583 million. The original contract's estimate was \$487 million. About \$6 million worth of this work was moved to other contracts, so the combined bid total is only \$11 million (2%) higher than the original estimate and \$362 million lower than the original bid.

Value Engineering

From feedback from the contracting community, it appears that the value engineering changes were well received and contributed to the significantly lower bids. Several suppliers indicated in particular that the decision to change from box girders to plate girders increased the number of steel fabricators who could participate in the project. Addi-

tional value engineering proposals are expected from the contractors as the project moves forward.

Budget

The sum of three separate superstructure bids is \$362 million less than the amount of the single bid received in December 2001. This result is outstanding. Of Maryland's portion of work for the Woodrow Wilson Bridge project, 80% is now under contract, with the sum of all bids received for this work at 3% below the original budget.

Schedule

With the three bridge contracts underway, the project should meet the updated project schedule. Although about 1 year was lost from the original project schedule, the first of the two new bridges will be open to traffic by late 2005 or early 2006, and the second bridge should open by late 2007 or early 2008.

CONCLUSION

The obvious goal when advertising any megaproject is to receive bids within the accepted budget by contractors capable of doing the work in the scheduled time frame. To improve the odds of this outcome, some best practices should be followed.

First, competition must be addressed—less competition between megaprojects and more between contractors. Various steps, similar to those undertaken on the Woodrow Wilson Bridge project, could be implemented to achieve this goal:

- Avoid advertising contracts at the same time as other megaprojects. This is difficult to achieve, since milestone dates for large projects tend to change frequently. However, because contractors have only so many resources for bid preparation, awareness of the schedules for other large contracts around the country and avoiding concurrent bid periods is desirable.
- For megaprojects, the management viewpoint should be that the owner needs the contractors and competition more than the contractors need any one project. Owners too often follow the reverse philosophy in administering their routine programs.
- Reach out to the construction industry, both nationally and internationally, to encourage their early and continued interest. Subcontractors, specialty firms, and suppliers should be included in this outreach.
- Refine general provisions to reflect more contractor-friendly terms to further emphasize the tone of encouragement.
- Strive to remove any uncertainty that may be read into a contract before contractors have committed a substantial investment to prepare a bid, especially regarding funding and labor issues.
- Emphasize that the owner will take an active role in working with the contractor to resolve issues early to avoid perceptions of an absentee owner.
- Clarify the labor requirements for the project at an early stage. Although the merits of a PLA can be debated reasonably either way, it is important that the labor requirements be clearly and promptly conveyed to the contracting community at the outset of the bidding period. In some regions, including a PLA can limit competition if a significant number of potential bidders are firmly open shop.

TABLE 1 Bidding Results

	Contractor	Number of Bids	BR-3A Team Ad Date: 7/2/02 Bid Opening: 11/7/02 Low Bid:\$186 million	BR-3B Team Ad Date: 10/15/02 Bid Opening: 2/13/03 Low Bid: \$115.5 million	BR-3C Team Ad Date: 1/6/03 Bid Opening: 5/1/03 Low Bid: \$191 million
1	American Bridge	2	*American Bridge/ Kraemer & Sons		*Kraemer & Sons/ American Bridge/ Trumbull
2	Archer Western	1	Archer Western		
3	Cianbro	3	Cianbro/Weeks/McLean	Cianbro/Weeks/ McLean	Cianbro/Weeks/ Granite/McLean
4	Cleveland Bridge	1	Fru-con/Cleveland Bridge		
5	Corman Construction	1		*Granite/Corman Construction	
6	Facchina	1		Facchina	
7	Fru-con	3	Fru-con/Cleveland Bridge	Fru-con	Fru-con
8	Granite	2		*Granite/Corman Construction	Cianbro/Weeks/ Granite/McLean
9	Kraemer & Sons	2	*American Bridge/ Kraemer & Sons		*Kraemer & Sons/ American Bridge/ Trumbull
10	Lane	1		Tidewater Skanska/Lane	
11	McLean	3	Cianbro/Weeks/McLean	Cianbro/Weeks/ McLean	Cianbro/Weeks/ Granite/McLean
12	O&G	1	Perini/Tutor-Saliba/ O&G		
13	Perini	1	Perini/Tutor-Saliba/ O&G		
14	Tidewater Skanska	3	Tidewater Skanska/ Traylor Brothers	Tidewater Skanska/Lane	Tidewater Skanska/ Traylor Brothers
15	Traylor Brothers	2	Tidewater Skanska/ Traylor Brothers		Tidewater Skanska/ Traylor Brothers
16	Trumbull	2		Trumbull	*Kraemer & Sons/ American Bridge/ Trumbull
17	Tutor-Saliba	1	Perini/Tutor-Saliba/ O&G		
18	Weeks	3	Cianbro/Weeks/McLean	Cianbro/Weeks/ McLean	Cianbro/Weeks/ Granite/McLean
Total Number of Bids			5	7	4
Of those who bid on BR-3A, how many bid on BR-3B?			X	3 Teams, 5 Contractors	X
Of those who bid on BR-3A, how many bid on BR-3C?			X	X	4 Teams, 7 Contractors
Of those who bid on BR-3B, how many bid on BR-3C?			X	X	3 Teams, 6 Contractors
Of those who bid on BR-3A AND BR-3B, how many bid on BR-3C?			X	X	3 Teams, 5 Contractors

*The successful low bidder for each of the three contracts.

Second, there is the issue of contract interface risk. This refers to the inconvenience and aggravation associated with many contractors working in proximity to one another, getting in each other's way, causing delays. This risk can be reduced by breaking the megaproject into larger construction contracts. In theory, this strategy can result in reduced costs because of economies of scale, if there are enough contractors willing and able to bid—a difficult condition to guarantee.

One should be aware, however, that owners have demonstrated difficulty in attracting sufficient numbers of bidders to obtain competitive prices for very large contracts. Few contractors can take on large construction contracts. A balance must be struck between low-

ering contract interface risk and increasing competition. This may lead to one contract or multiple contracts depending on the nature of the construction, size of the project, complexity of the work, and level of apparent interest from contractors. On the basis of the bid results for the Woodrow Wilson Bridge project, future contracts probably should not exceed a range of \$200 million to \$250 million (in 2004 dollars) unless there are overwhelming technical reasons to preclude smaller segments or sufficient competition is virtually assured. Although common sense may dictate that economies of scale obtained through larger contracts may result in lower bids, the experience gleaned from the Woodrow Wilson Bridge project is that

competition is far more effective in achieving this result. Any factors tending to decrease competition should be carefully considered before being applied to a project.

Careful determination of contract limits to reduce contractors' dependency on each other, development of schedules and incentives to avoid conflicts, and requiring contractors to coordinate critical activities are ways to encourage contractor cooperation. On the Woodrow Wilson Bridge project, incentives have been included that require all contractors to work toward a common goal. In this case, separate goals are also established for specific overlapping items. If these goals are not met by all contractors, no one is paid the incentive, even the contractors who were successful in meeting this goal. By specification, all contractors are required to attend regular corridor coordination meetings and to cooperate with adjacent contractors. Conversely, for very large contracts, no corresponding means exist to mitigate a lack of competition.

When developing contracts for a megaproject, two questions should be asked: When is big too big? and Have we exposed ourselves to more risk than we are comfortable with? The first question is difficult to answer as it depends largely on the nature of the work in the individual contract and on the regional, national, and even international market forces that exist at the time of bidding—which can change abruptly. In December 2001, a complex signature \$500 million bridge contract in the Washington metro area was too big and pro-

duced a poor outcome. However, 1 year later, three contracts in the \$150 million to \$250 million range for the same bridge were properly sized with successful outcomes. It may be simplistic to conclude that \$500 million signature bridge contracts are too large but that contracts for similar work in the \$200 million dollar range are acceptable. It could be that in certain market conditions, even \$200 million contracts could be far too large. However, the lesson learned in Maryland is that \$500 million is too big. As additional experience is gained on projects of similar magnitude, a more definitive answer to, How big is too big? may become apparent.

The question, Have we exposed ourselves to more risk than we are comfortable with? must be answered by each owner. Billion-dollar-plus megaprojects in the transportation industry are becoming more common in the United States. Most owners have limited experience with such projects and therefore are entering into these large contracts with a great deal of discomfort and uncertainty. However, unless they are able and willing to break the project into more familiar contract sizes, they must accept a certain amount of risk in proceeding. Managing this risk is a fundamental issue for megaproject owners. Careful study of lessons learned on the Woodrow Wilson Bridge project and other megaprojects can help owners increase their comfort in managing their risk.

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