



DAVID EVANS  
AND ASSOCIATES INC.

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## MEMORANDUM

**DATE:** August 29, 2012  
**TO:** Rachael Hoy  
City of Portland  
Community Outreach & Information  
Bureau of Planning & Sustainability  
**FROM:** Doug Johnson, PE  
Senior Bridge Engineer  
David Evans and Associates  
**SUBJECT:** **West Hayden Island Bridge Cost Investigation**

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Dear Ms. Hoy,

As requested by the Bureau of Planning and Sustainability, David Evans and Associates (DEA) has performed a review of background information on the West Hayden Island bridge design and conducted a limited analysis of factors influencing the cost of the bridge as well as the feasibility of reducing the bridge width.

### **Background**

The City of Portland has been developing conceptual plans for a marine terminal on approximately 800 acres on the portion of Hayden Island west of the existing railway that bisects the Island. This proposed development would occupy no more than 300 acres of the 800 acre site, which is currently undeveloped. The only vehicular access to the island currently is provided from the I-5 interchange located east of the railway tracks on the eastern portion of the island. A new bridge spanning the North Portland Harbor (Oregon Slough) has been proposed to provide direct access to the terminal development from Marine Drive. Several previous reports have been produced dealing with the proposed bridge connection.

The following documents were reviewed for information pertaining to the bridge design and associated costs:

*1993: W&H Pacific, Conceptual Analysis of Hayden Island Bridge Connection to North Marine Drive*

This is a planning-level study of the crossing that evaluates three alignment alternatives and discusses issues such as traffic, geometrics, structure types, geotechnical and other issues. The report includes a cost estimate of \$16.0M - \$19.2M for the bridge and associated roadway and traffic signal work, as well as engineering and contingencies.

*1998: David Evans and Associates, Hayden Island North Portland Harbor Vehicular Bridge, Draft Type Size and Location Report*

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This is a comprehensive preliminary engineering design report for the crossing that evaluates alignment and geometric alternatives, bridge structure alternatives, traffic forecasts, utilities, right-of-way, effect on cultural and natural resources, permitting, hydraulics, drainage, foundation types and construction schedule. Design of the recommended alternative was completed to approximately the 30% level of completion. The cost estimate in the report for the recommended alternative is \$44M, including engineering and contingencies. This number includes \$30.2M for the North Portland Harbor Bridge alone; \$12.6M for associated roadways, retaining walls, signals, drainage and illumination; and \$1.0M for widening the North Marine Drive Railroad Bridge.

*1999: Parametrix, Draft West Hayden Island Planning Document, Vol. 4, Transportation Analysis*

This report is a detailed analysis of the highway transportation and access issues associated with the development of a marine terminal facility on West Hayden Island. The report examines forecast traffic demands on the island for several development alternatives, both with and without construction of the bridge described in the 1998 David Evans and Associates report. The discussion in the report related to the bridge is limited to traffic issues and no cost estimates are presented.

*2012: Worley Parsons, West Hayden Island Final Report*

The purpose of this report is to create a Base Concept Plan for the marine terminal, bringing together economic, environmental and recreational considerations. The report includes the bridge as an option in the plan, but notes that based on traffic analysis existing roads in East Hayden Island are sufficient to handle the anticipated traffic generated by the proposed development. The report lists the estimated cost of the bridge as \$50M - \$100M, which is attributed to the cost estimates in the 1993 W & H Pacific report escalated by the rate of Consumer Price Inflation (CPI) over the intervening years.

### **Discussion of Previous Cost Estimates**

The 1993 W&H Pacific cost estimate appears to be based on a very basic level of design, perhaps at a 5% level of engineering. The 1998 DEA cost estimate is based on a more developed 30% level of engineering and thus is expected to be inherently more accurate. Each of these two estimates is based on the prevailing prices in the construction industry at the time they were developed. Both of the estimates include factors for contingencies, engineering and administration for both the final design and construction phases of the project.

The cost estimate cited in the 2012 Worley Parsons report is based on the earlier 1993 W&H Pacific cost estimate, factored up by the rate of CPI. There are several problems with the approach used to generate this estimate. The 1993 W&H Pacific estimate was inherently less accurate than the 1998 DEA estimate because it was based on a more rudimentary level of engineering. In addition, the general rate of inflation in the CPI does not necessarily correspond to the rate of inflation in the construction industry, nor to the specific labor and material inputs that go into bridge and roadway construction. The effects of these discrepancies are likely to be compounded over time and could be significant given the 19-year interval from the 1993 estimate to the 2012 estimate.

### **Update of the 1998 DEA Cost Estimate**

The 1998 DEA cost estimate contains a detailed breakdown of construction items for the project, with pricing in 1998 dollars for each item. The 1998 design estimate includes:

- the 1,880-ft bridge crossing the North Portland Harbor channel
- widening of Marine Drive, including the Marine Drive bridge over the railroad, to provide turning lanes at the intersection with the new crossing
- traffic signals at Marine Drive
- approximately 300 feet of approach roadway south of the bridge
- approximately 1,250 feet of approach roadway north of the bridge
- roadway illumination system
- retaining walls to limit fill in sensitive areas on the island

This itemized breakdown has been updated based on current prevailing construction prices. This updated estimate provides a cost view of the 1998 design in 2012 dollars, using the same methodology as the 1998 report. The updated cost estimate in 2012 dollars is \$42M, which includes \$31M for the main bridge and \$11M for the other items. Contingencies at 25% add \$11M, plus final engineering and construction administration add an additional \$13M, for a grand total updated 2012 estimate of \$66M.

### **Opportunities for Cost Savings on the Bridge**

The 1998 DEA report examined six different bridge types and investigated the costs for each. The recommended alternative, a precast concrete girder viaduct, was the least expensive of the group, and it likely remains as the most economical choice.

The effect of a reduction in bridge width would be to reduce the concrete deck area, reduce the number of girders, which in turn would reduce the loads on the columns and foundations. With this type of bridge, it is reasonable to assume that the reduction in cost would be approximately proportional to the reduction in width. The bridge was designed with a total width of 74 feet, which includes four travel lanes @12', two shoulder/bike lanes @ 6', two sidewalks @6', and two outside bridge rails @1'. Assuming only two travel lanes @12' and everything else remaining the same, the total bridge width would decrease to 50 feet. The cost estimate for a reduced width bridge in 2012 dollars is \$32M, which includes \$21M for the main bridge and \$11M for the other items. This assumes no change to the "non-bridge" items included in the estimate. Contingencies at 25% add \$8M, plus final engineering and construction administration add an additional \$10M, for a grand total updated 2012 estimate of \$50M.

The bridge was designed for a navigational clearance of 75 feet, which was determined in coordination with the United States Coast Guard and river users. Although reducing this clearance would likely be very difficult to permit, a reduction in clearance to approximately 50 feet could lead to approximately 5% savings in bridge costs, for a total reduction of approximately \$2M.

### **Effect of Increasing Vertical Clearance**

If a substantial increase in vertical clearance became necessary there would be a substantial increase in bridge cost. Assuming the maximum 5% grades were maintained, an increase in the vertical navigational clearance to 95 feet would require at minimum an additional 400-foot length of bridge on each side of the channel to reach the same “touch-down” elevation at the bridge ends. The additional height would also create additional demands on the supporting bents and foundations. Because of space limitations on the south side, the bridge would need to cross over Marine Drive before touching down, which could result in additional structure costs. Overall, it is estimated that for a 95-foot vertical navigation clearance the structure costs alone would increase 60% -70% above those noted above. There may be a need to acquire additional right of way and additional roadway needs as well, but consideration of these factors are beyond the scope of this memorandum.

### **Potential Re-use of Spans from I-5 Columbia River Crossing**

The I-5 Columbia River Crossing (CRC) project will replace the existing I-5 bridge spans over the Columbia River, potentially making them available for re-use. The existing northbound structure was built in 1916, while the southbound structure was built in 1958. The southbound bridge is comprised of 4 reinforced concrete deck girder spans, 10 steel through truss spans, one steel vertical lift span and one steel deck girder span. The structure carries 3 traffic lanes, with a total clear width of 38.3’ plus one sidewalk with a width of 5.6 feet.

The steel truss bridge width is adequate for the reduced width option discussed above with two traffic lanes plus two 6-foot shoulders. The steel through truss spans from the southbound bridge are the most likely candidates for re-use on the West Hayden Island Bridge. The truss spans could not be used on the curved portions of the proposed bridge, but could be used for the straight portion, which is 1,369’ long. Four 266’ steel truss spans and one 279’ steel truss span could be used in this section, replacing 9 precast concrete girder spans. The number of bents in the water would be reduced by four; however the size of these bents would need to be substantially increased to carry the increased loads from the longer spans.

According to the most recent bridge inspection report (2011), the concrete deck is in satisfactory condition, with some spalling and cracking noted. The steel superstructure is in fair condition, with areas of minor section loss, nicked, gouged, bowed and twisted members, and substantial areas of pack rust, surface rust, and failing paint. The existing truss spans would require rehabilitation in order to be suitable for reuse. The rehabilitation would include complete removal of the existing lead-based paint, repair of minor defects and coating with a new paint system. All residues from the existing paint would need to be contained and disposed of as hazardous material.

Disassembly of the existing trusses into smaller individual pieces and subsequent reassembly would likely not be cost effective. A more likely scenario would be to jack up each truss as a unit from their existing supports. Jacking in this manner would require a careful analysis of the structure to avoid damage. Reinforcement of the lifting points may be required. It is not clear whether it would be feasible to allow the concrete deck to remain in place or whether it would need to be removed to reduce weight. Special lifting frames would need to be constructed and placed on a series of interconnected barges to allow for a synchronized lifting operation. The barges would then need to be towed to the new bridge location where the trusses would be lifted into place.

The cost of rehabilitating the five truss spans noted above is estimated at approximately \$11.5M, without engineering or contingencies. This does not include the cost of moving the trusses to the new bridge site nor the cost of a new concrete deck if necessary. These costs are difficult to estimate without more detailed study, but are likely to be in the range of an additional \$2M-\$5M. There would be an estimated savings to the CRC project of approximately \$1.5M in not paying for removal of these spans. The estimated cost of the precast concrete girder superstructure (precast girders and deck) that the truss spans would replace is approximately \$6.5M. The substructure cost is expected to be roughly the same for either the truss or precast girder options, since the increased size of the bents for the trusses will offset the reduced number of bents.

There would also be additional maintenance costs for the truss spans compared to the precast concrete girder superstructure. The truss spans will need to be re-painted every 20-30 years. There would also be a need for more frequent detailed inspections because of the fracture critical components of the trusses.

**Potential Reduction in Number of Piers in the Water**

The precast girder bridge as currently designed includes 6 piers within the boundaries of normal water elevation. Reducing the number of piers in the water would require a different structure type. Several alternative structure types with reduced numbers of piers in the water were evaluated in the 1998 DEA report. These alternatives are summarized in the table below:

Alternative	No. of Piers within normal water elevation	Estimated Cost – Bridge Only (\$1998)
Long Span Steel Arch	0	\$81M
Long Span Concrete Segmental	2	\$37M
Short Span Concrete Segmental	4	\$32M
Cable-Stayed	1	\$50M
Steel Plate Girder or Box	6	\$33M
Precast Concrete Girder	6	\$30M

Although the estimated costs for these alternatives are given in 1998 dollars, it is expected that if all of the estimates were updated to 2012 dollars the percentage differences would remain similar. Thus a reduction of two piers within normal water elevation would increase the bridge costs by approximately 7%, while further reductions would produce significantly greater cost increases.

### **Moyano Leadership Group Estimate Comparison**

In a memorandum dated July 13, 2012, Moyano Leadership Group (MLG) provided a cost estimate of \$81M for a two-lane bridge and \$84M for a four lane bridge. There are a number of different assumptions used in the analysis by MLG that account for the difference from the DEA estimates described above in this memorandum. The MLG analysis is based in part on an earlier MLG analysis described in a memorandum dated April 19, 2010 that was used to update costs for the project in terms of 2010 dollars. As in the DEA analysis, the MLG analysis used the cost estimate contained in the 1998 DEA Report for the 4-lane precast concrete girder bridge as a starting point.

The MLG applied a uniform factor for general construction pricing escalation to all of the items included in the original cost estimate. The 2010 MLG memorandum noted that general construction pricing increased to a peak level in 2008, at which point it was 88% above 1998 pricing. Subsequently, during the recessionary period that followed, construction pricing fell dramatically so that in 2010 it was only 47% above 1998 pricing. Because of concern that future pricing trends could reverse the dramatic declines of 2008-2010, MLG applied a compromise escalation factor of 67% to the 1998 pricing to produce their 2010 estimate. In the 2012 memorandum MLG added an additional 8% to account for pricing escalation from 2010 to 2012, for a total escalation factor of 75% applied to the 1998 pricing.

In the DEA analysis, pricing of each item was individually escalated to bring them in line with current 2012 pricing. In aggregate, this approach resulted in an overall escalation factor of 50% applied to the 1998 pricing. In comparison with the MLG estimate, the primary difference is the 20% premium MLG added in 2010 to account for the potential future reversal of the 2008-2010 price declines. Without this premium, the MLG 2012 escalation factor would be 55%, which is reasonably close to the 50% DEA factor.

Current construction pricing has not returned to the peak level of 2008. While it is difficult to predict future price trends it is prudent to account for some degree of price escalation when planning for projects some distance in the future. When comparing alternatives, it is important that all alternatives be priced on the same basis. This can be done by either pricing all alternatives in current dollars or by applying the same escalation factor for future price increases to all alternatives.

The MLG cost estimate also applied a 10% increase factor to substructure costs to account for seismic design code changes and an additional 15% increase factor to account for environmental regulatory changes since 1998. The DEA analysis did not include either of these factors. While seismic design codes have changed since 1998, it is our opinion that these changes are not likely to result in an increase in construction costs for this bridge. Similarly, while environmental requirements are constantly evolving, there are no specific restrictions affecting this project we are aware of that would lead to significant increase in construction costs. Environmental mitigation costs are not included in the cost estimates in this memorandum.

In the DEA analysis, it was assumed that the reduction in bridge width for a 2-lane bridge would result in a uniform level of cost reduction for both superstructure and substructure elements. This is an assumption that is

commonly used for planning level estimates. The MLG analysis assumes a similar level of cost reduction for superstructure elements but very little reduction in substructure costs. This assumption is based on the view that the specific characteristics of the site, the nature of the in-water work and the structural requirements of the drilled shafts will not allow significant cost savings to be achieved for the reduced bridge width. A comprehensive structural analysis of the drilled shafts for the 2-lane bridge has not been done, so it is difficult to resolve this difference in assumptions. Substructure costs are approximately half of the total bridge costs. If the DEA estimate was revised to eliminate any substructure cost savings for a reduced width bridge, the total cost estimate for a two lane bridge would increase from approximately \$50M to \$58M.

### **Limitations**

This memorandum is based on information contained in the references cited and no attempt has been made to independently verify this material. Some of the information in these references may be dated due to updated engineering codes, permitting requirements or other factors. All of the information presented is preliminary in nature and subject to change upon further design development. In providing opinions of probable cost, DEA provides no warranty that actual project costs will not vary from DEA's opinions due to many factors beyond DEA's control.

Attachments: Updated Cost Estimates