

Portland - Milwaukie Light Rail

Willamette River Bridge

WRBAC Committee Meeting

November 13, 2008



Deliver a bridge that embodies the Portland aesthetic is functional and affordable

- **Aesthetic – the right bridge for the context**
- **Function – the right bridge for the use, site and environment**
- **Cost – the right bridge for the budget**
- ***Viable solutions must balance all three***

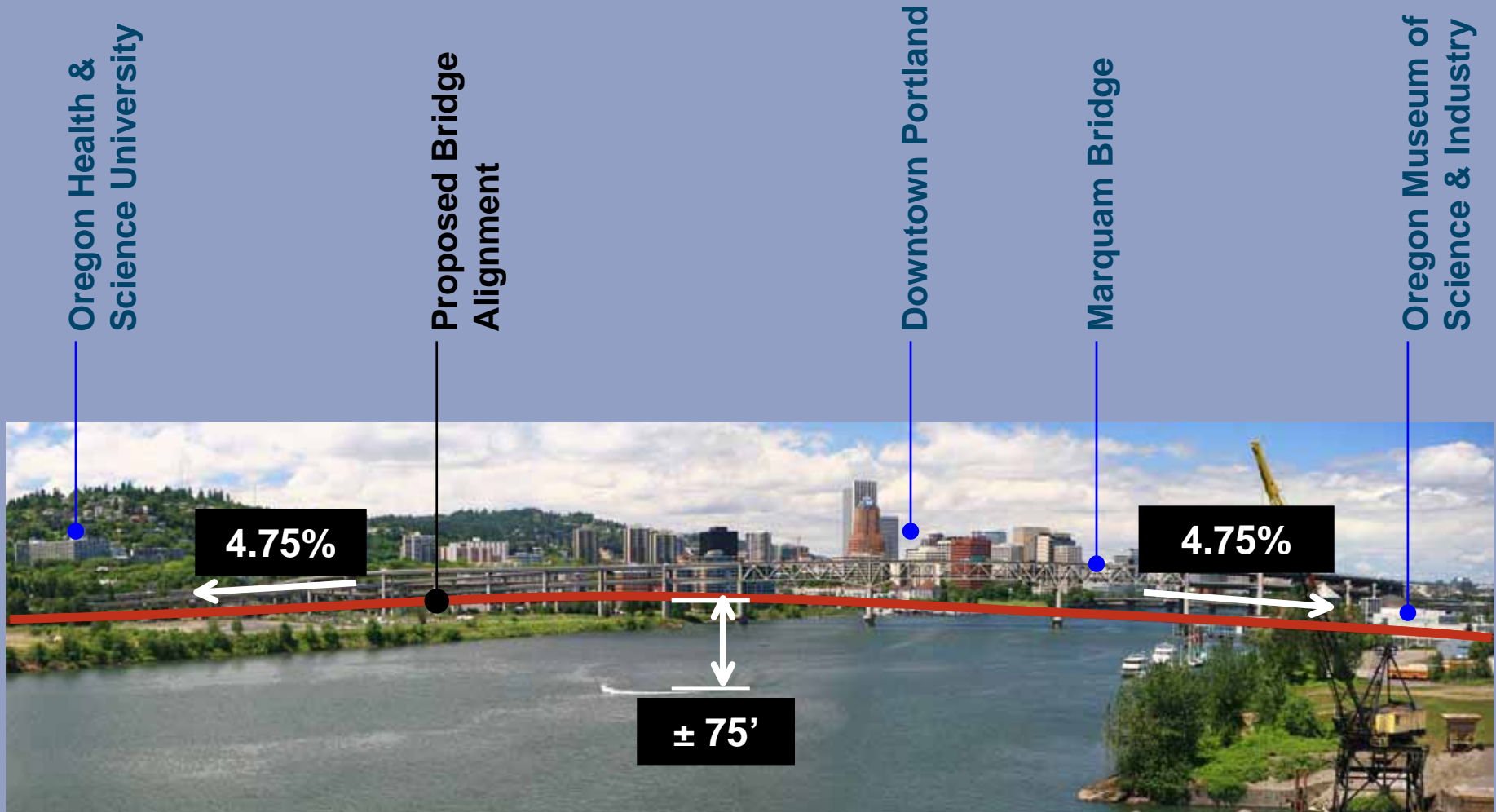


Proposed Bridge Alignment from LPA



Design Parameters and Constraints

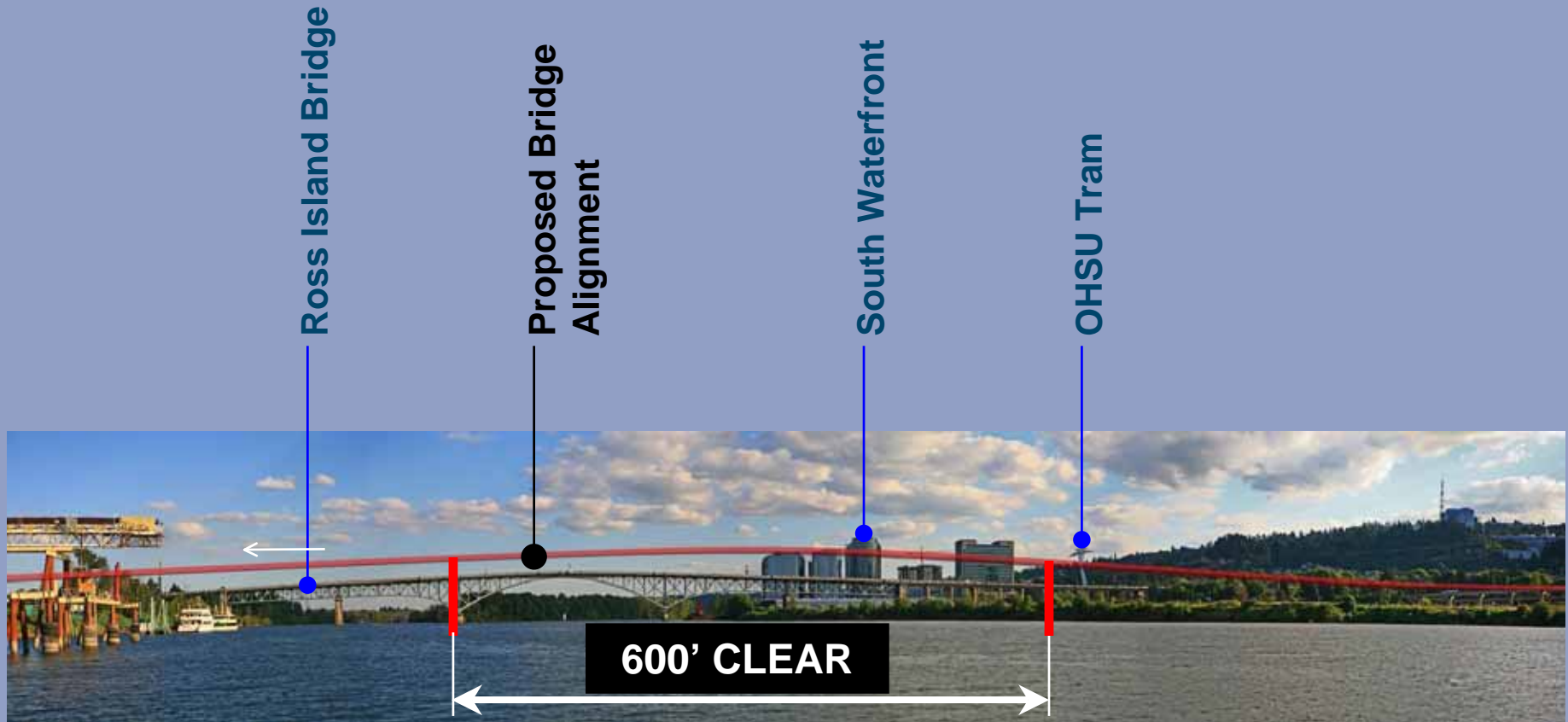
Willamette River Transit Bridge



Additional analysis on vertical clearance to occur during Preliminary Engineering

Design Parameters and Constraints

Willamette River Transit Bridge



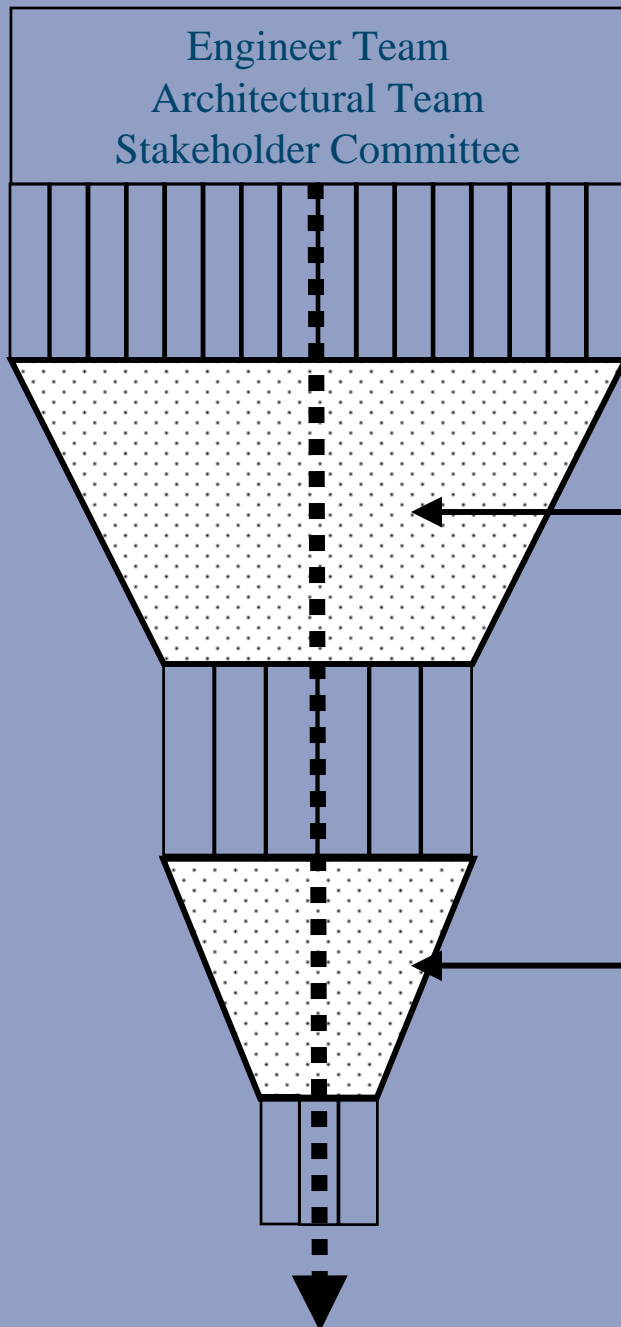
**LPA included a range of spans
300' to 780' clear**

The Narrowing Process

Willamette River Transit Bridge



Process Diagram



Information Gathering
Establish Bridge Design Framework

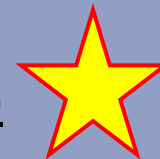
Develop Range of Potential Bridge Types (**Many**)

Screen

Engineer, Architecture and Urban Design Development of
Initial Viable Alternatives (**Some**)

Screen

Verify Viable of Alternatives (**Few**)

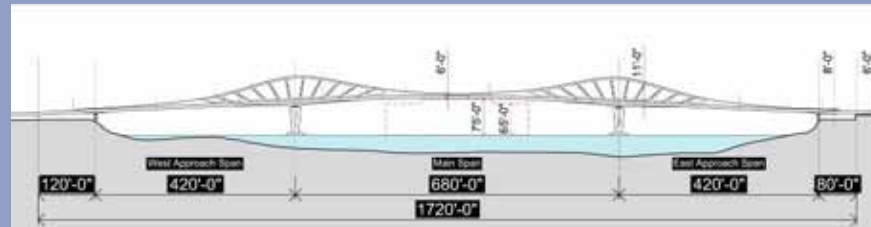


Begin Full Public Conversation

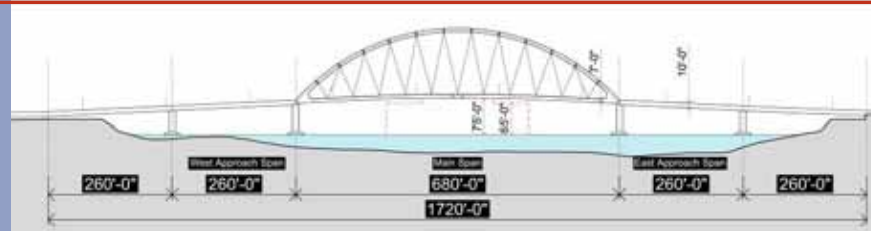
“Some” Bridge Types

Willamette River Transit Bridge

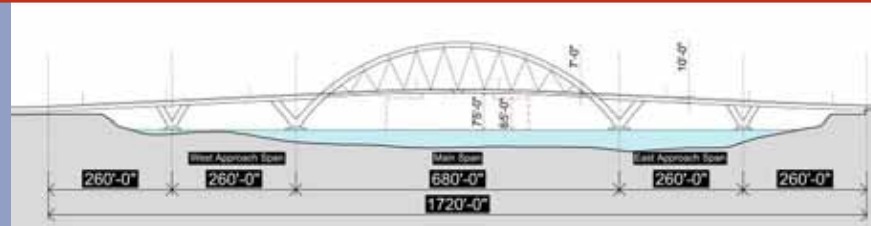
Wave Frame



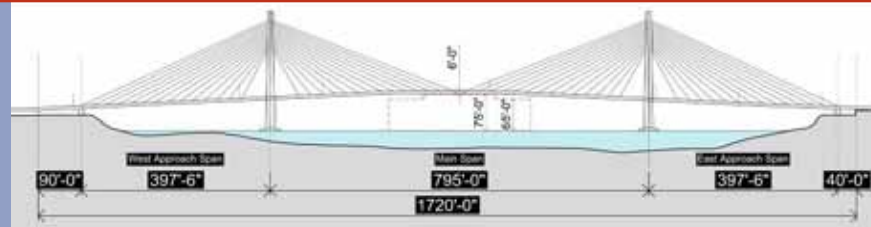
Tied Arch



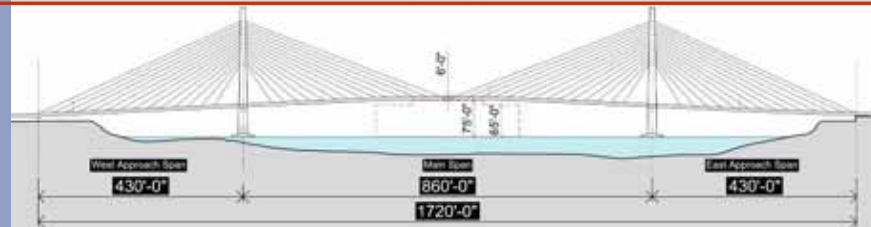
Through Arch



Cable Stayed - 4



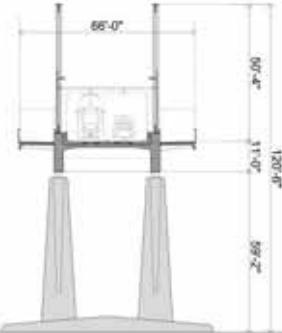
Cable Stayed - 2



“Some” Bridge Types

Willamette River Transit Bridge

Wave Frame
120'-0"



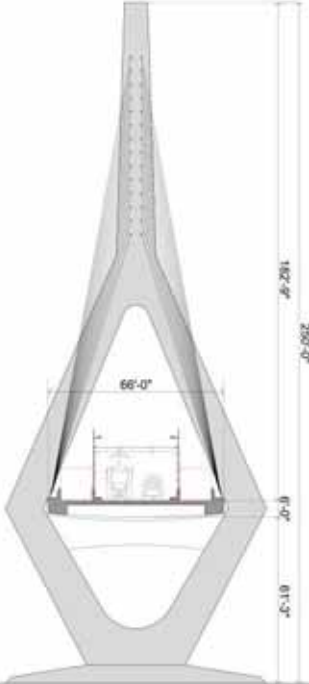
Tied Arch
223'-0"



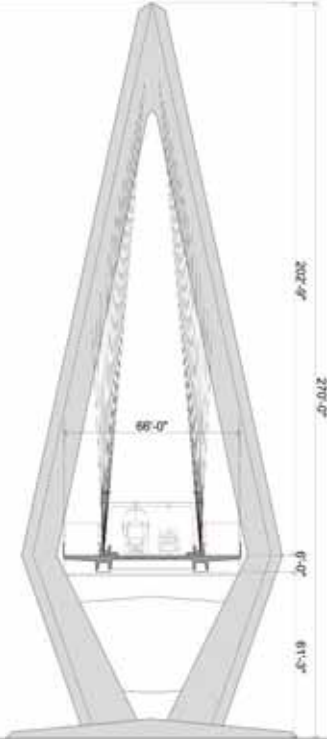
Through Arch
180'-0"



Cable Stayed - 4
250'-0"



Cable Stayed- 2
270'-0"



Tied Arch

Examples

Willamette River Transit Bridge



Through Arch

Willamette River Transit Bridge



Steel shown as white – Concrete shown as gray

Wave Frame

Willamette River Transit Bridge



Steel shown as white – Concrete shown as gray

Cable Stayed – 2 Pier

Willamette River Transit Bridge



Steel shown as white – Concrete shown as gray

Cable Stayed – 4 Pier

Willamette River Transit Bridge



Steel shown as white – Concrete shown as gray

Engineering

Cost

- Initial cost
- Life cycle cost - maintenance



Risk

- **Cost escalation risk (superstructure)**
- **Foundations and geotechnical**
- **Design risk**
- **Bid risk**
- **Schedule risk**
- **In-water construction risk**
- **Permitting risk (navigational – environmental)**



Fundamental Performance

- Number, location and size of piers
- Seismic performance
- Modal optimization of section
- User comfort – deflection and vibration



Architectural

- Looking at the bridge (proportion and scale)
- Being near the bridge (experience on greenway, walkways and river)
- Being on the bridge (experience crossing the river)



Urban Context

- Portland core values, traditions and symbolism
- Compatibility with existing context, fabric and adjacent bridges
- Reflection of current technology and innovation



Supplemental Criteria

Greenway

- Depth of span over greenway (vertical clearance)
- Width of span over greenway
- Length of span at greenway (column to abutment)
- Greenway trail user experience



Environmental – Sustainability

- Environmental impacts during construction
- Resource use – availability of local materials
- In-water piers in or near known contaminated media cap



Bridge Operations

- Line of sight between modes
- OCS integration - complexity
- Emergency response on bridge
- Extent of inspections
- Access for inspections



Miscellaneous

- **Utility duct bank integration**
- **Pier proximity to existing subsurface utilities**
- **Accommodates asymmetrical loading**
- **Accommodation of curved greenway spans**



Opportunities

- Ability to treat stormwater on bridge
- Addition of wildlife habitat on/under bridge
- Additional fish habitat near bridge
- Habitat enhancement at staging site
- Incorporate alternative energy



Draft Ranking from 10/28/08 Working Group

	Wave frame	Tied Arch	Thru Arch	Cable Stayed	Cable Stayed
Center-to-center Span Width	680	680	680	795	860
Cost	To Be Determined				
Risk					
Fundamental Performance					
Architectural					
Urban Context					
Greenway					
Environmental - Sustainability					
Bridge Operations					
Miscellaneous					
Opportunity					

Legend	
High Score	
Moderate Score	
Low Score	

Each alternative has opportunities and challenges

Tied and Through Arches

Willamette River Transit Bridge

Challenges

- In-water pier proximity to existing subsurface utilities



12" Gas main
Fiber optic line



Tied and Through Arches

Willamette River Transit Bridge

Challenges

- In-water pier proximity to proposed contaminated media cap



Tied and Through Arches

Willamette River Transit Bridge

Challenges

- **Environmental Permitting Risk**
 - Piers in shallow water



Tied and Through Arches

Willamette River Transit Bridge

Challenges

- **Navigational Permitting Risk**
 - Horizontal and vertical clearances



Thicker Deck



Tied and Through Arches

Willamette River Transit Bridge

Challenges

- Navigational Permitting Risk
 - Maneuvering



**Piers near
Portland Spirit**

Tied and Through Arches

Willamette River Transit Bridge

Challenges

- Greater depth of structural section over the Greenway trail



Challenges

- One of a kind – prototype
- Higher risk profile



2 and 4 Pier Cable Stayed

Willamette River Transit Bridge

Challenges

- Architectural and Urban Context



Discussion

Willamette River Transit Bridge



- Evaluate structural performance of options
- Define construction sequence
- Create computer models
- Analyze for service loads
- Analyze for seismic loads



- **Determine member sizes and quantities**
- **National Constructors Group**
 - Cost bases
 - Cost certainty
 - Constructability review
 - Contractor's risk assessment
- **J. Paul Silvestri, National Constructors Group**



J. Paul Silvestri

Willamette River Transit Bridge

- Graduate of Stanford
- 39 years building major heavy civil



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Engineering News Record, American Segmental Bridge Institute



- **Representative projects:**
 - **Woodrow Wilson Bridge, WA DC**
 - **Maumee Bridge, Toledo, OH**
 - **Dames Point Bridge, Jacksonville, FL**
 - **San Francisco to Oakland Bay Bridge, east span replacement, CA**
 - **I70, New Mississippi Bridge, St. Louis, MI**
 - **Alameda Corridor, Los Angeles, CA**
 - **I405, Seattle, WA**
 - **Gerald Desmond Bridge, Long Beach, CA**



Risks

Willamette River Transit Bridge

- **Foundations**
- **Material – Substructure**
- **Material - Superstructure**
- **Fabrication - Erection**
- **Schedule**
- **Design**

Tied Arch



Through Arch



Wave Frame



2 Pier Cable Stayed



4 Pier Cable Stayed



- **Foundations**

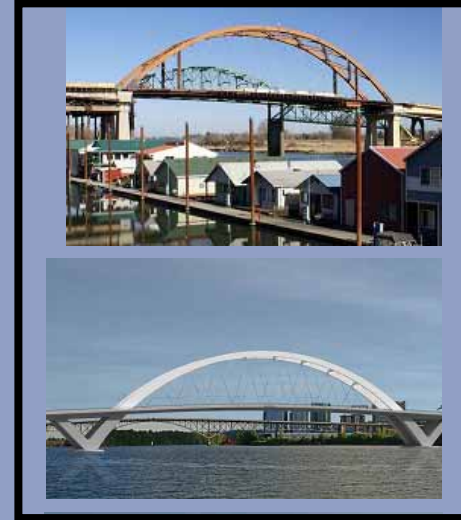
- **Conceptual method developed minimizes risk**
 - **Unforeseen conditions**
 - **Environmental (noise and vibration)**
 - **In-water construction window**
- **Conceptual method the same for all types**



- **Material - Substructure**
 - **Concrete**
 - **Readily available**
 - **Lower cost and schedule risk**
 - **Same for all substructures**



- **Material - Superstructure**
 - **Standard steel**
 - **Available from multiple sources**
 - **Moderate cost and schedule risk**
 - **Two have standard steel superstructures**



- **Material - Superstructure**

- High performance steel
- Available from only one source
- Volatile pricing
- Special run - availability limited
- Material sizes at upper limit of availability
- Higher cost and schedule risk
- One has HP steel superstructure



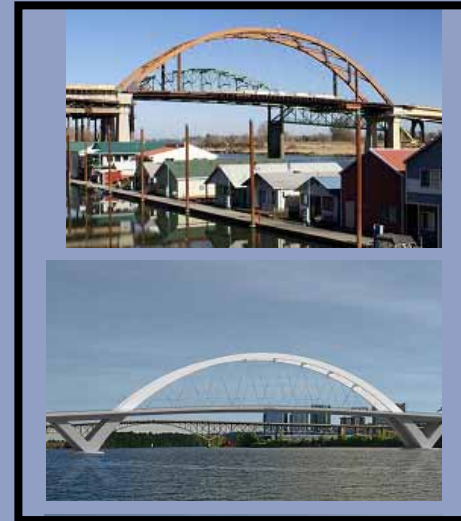
- **Material – Superstructure**

- Concrete
- Readily available
- Lower cost and schedule risk
- Two have concrete for the superstructure



- **Fabrication - Erection**

- **Standard steel at superstructure**
- **Option A: On-site at staging yard**
- **Option B: Near bank on temp work platform**
- **Option C: In place on temp work platform**
- **Moderate schedule and cost risk**
- **Two have standard steel superstructures**



- **Fabrication - Erection**

- High performance steel at superstructure
- **Option A: In place on temporary work platform**
 - Restrict navigation to 150' 3 - 4 month
 - Helps manage construction risks
 - Lowers labor cost
 - Reduces schedule



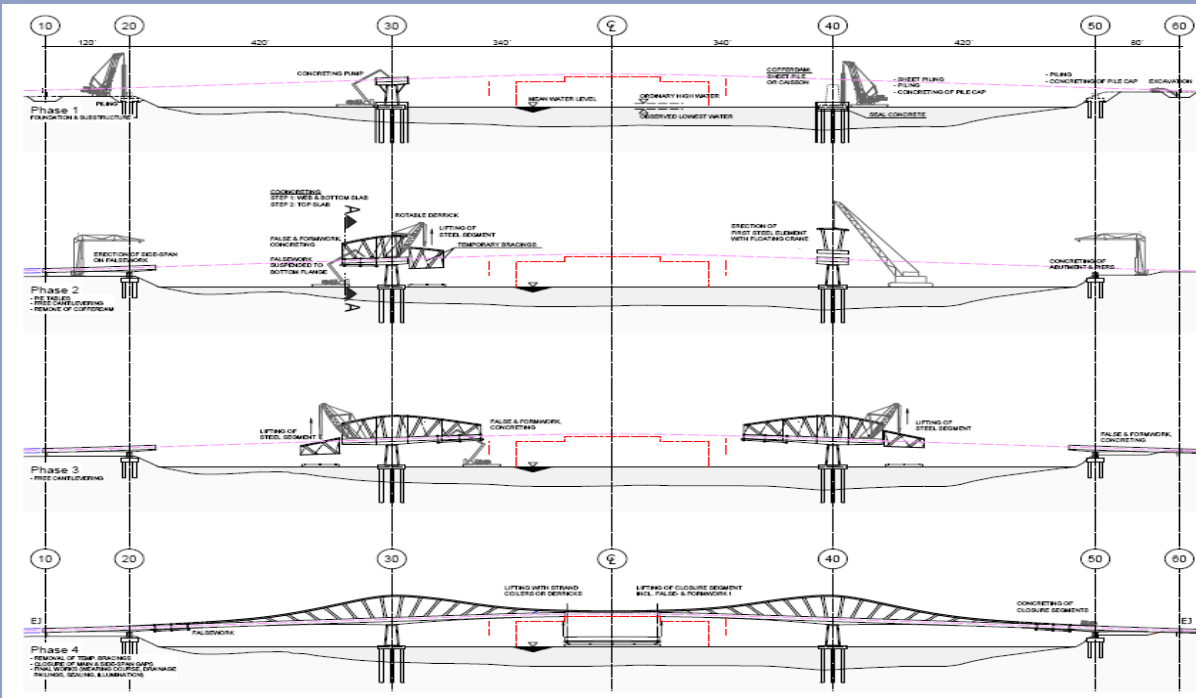
- **Fabrication - Erection**

- High performance steel at superstructure

- **Option B: Balanced cantilever method**

- Higher construction risk

- Jones Act – Increase labor cost 10%



- **Fabrication - Erection**
 - High performance steel at superstructure
 - Complex – highly technical welding
 - Higher cost and schedule risk
 - One has HP steel superstructure

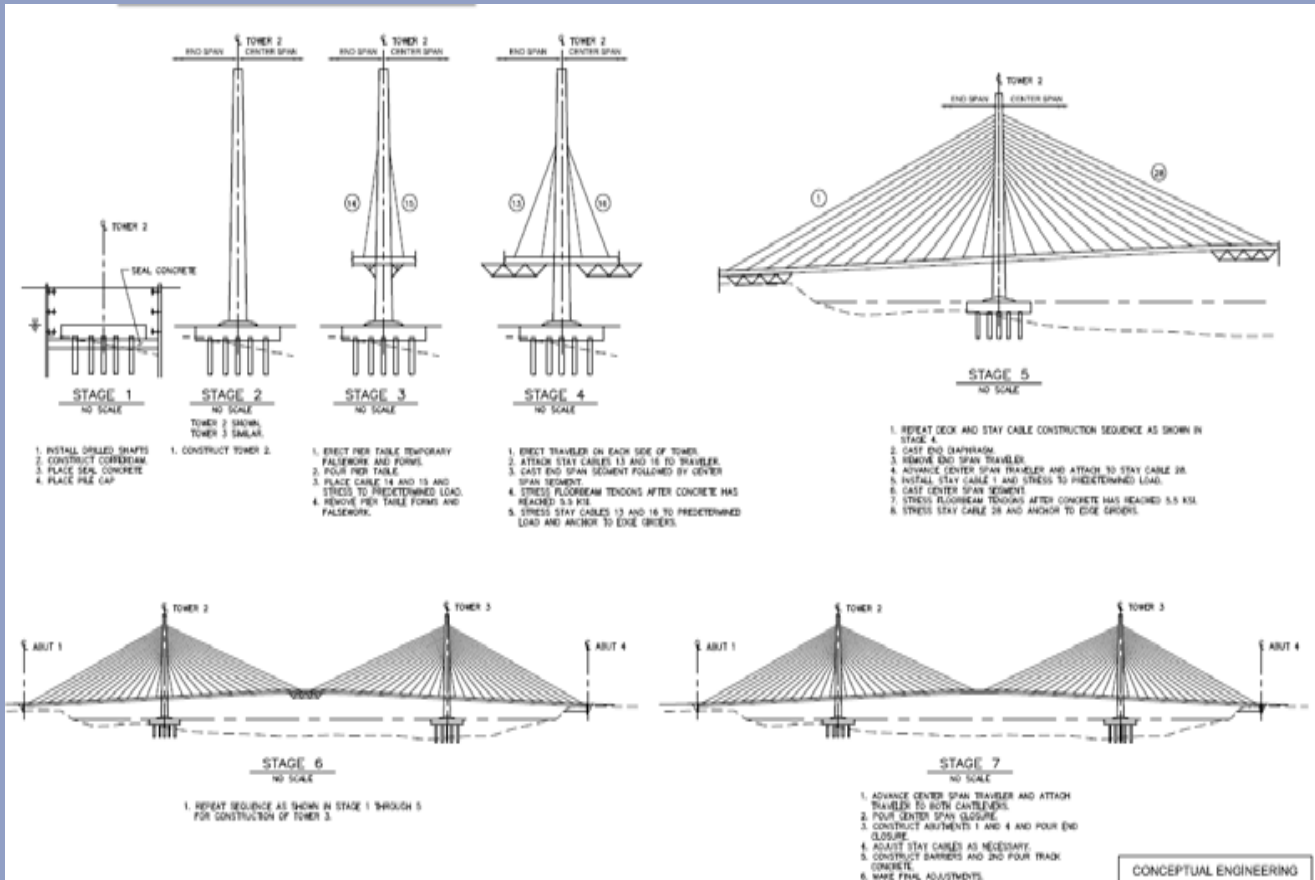


Risks

Willamette River Transit Bridge

- **Fabrication - Erection**

- Concrete at superstructure
- Balanced cantilevered method



- **Fabrication - Erection**
 - **Concrete at superstructure**
 - **Balanced cantilevered method**
 - **Limit in-water work**
 - **Lower schedule and costs risk**
 - **Two have concrete superstructures**



Risks

Willamette River Transit Bridge

- **Schedule**
 - Moderate construction durations
 - Tied and Through Arch



Risks

Willamette River Transit Bridge

- **Schedule**
 - Longest construction duration
 - Wave Frame



Risks

Willamette River Transit Bridge

- **Schedule**
 - Shortest construction durations
 - **Two and Four Pier Cable Stayed**



- **Design – Tied and Through Arch**
 - Conventional design
 - Complex steel to concrete connections
 - Moderate cost and schedule risk



- **Design – Wave Frame**
 - Prototype design
 - Complex steel to concrete connections
 - Non redundant structure
 - Higher cost and schedule risk



- **Design – Four Pier Cable Stayed**
 - Conventional design
 - Complex construction of cantilevered walkway
 - **Moderate cost and schedule risk**



Risks

Willamette River Transit Bridge

- **Design – Two Pier Cable Stayed**
 - Conventional design
 - **Lowest cost and schedule risk**



Risks

Willamette River Transit Bridge

	Wave frame	Tied Arch	Thru Arch	4 Pier Cable Stayed	2 Pier Cable Stayed
Center-to-center Span Width	680	680	680	795	860
Major Risk Categories					
Foundations					
Material - Substructure					
Material - Superstructure					
Fabrication - Erection					
Schedule					
Design					

Legend	
Higher Risk	
Moderate Risk	
Lower Risk	



- **Foundations**
- **Material – Substructure**
- **Material – Superstructure**
- **Fabrication - Erection**
- **Schedule**
- **Design**

Tied Arch



Through Arch



Wave Frame



2 Pier Cable Stayed



4 Pier Cable Stayed



Questions?

Working Group Recommendations

Willamette River Transit Bridge

- **Continue evaluation of cost and risks**
- **Present information at December 11th meeting**



- **WRBAC formal adoption of recommendation of viable types (December 11, 2008)**
- **WRBAC recommendation to PMLR Steering Committee (January meeting, TBD)**
- **Additional design and process to select final bridge type (January to March 2009)**



Thank you

