State Route 520
Floating Bridge and Landings Project
Seattle, Washington

AMERICAN PUBLIC WORKS ASSOCIATION - Washington Chapter

2017 PUBLIC WORKS PROJECT OF THE YEAR NOMINATION
Category: Transportation / Division: More than $75 million

Washington State Department of Transportation
Program Overview

State Route 520 is one of two east-west freeways linking Seattle and the large, growing population and employment centers concentrated along the east side of Lake Washington. The highway extends approximately 13 miles, from I-5 in Seattle to SR 202 in Redmond, Wash., home to Microsoft and the approximately 40,000 employees who work at its sprawling Redmond campus. In 2011, as reconstruction of SR 520 ensued, an average of 115,000 vehicles traveled daily between Seattle and the Eastside on this key highway.

Located within a densely populated urban area, SR 520 was constructed in the early 1960s with two general-purpose lanes in each direction, but no shoulders for disabled vehicles. The highway’s long, fixed bridges across Seattle’s Portage Bay and Union Bay were built with hollow, concrete support columns – a design that made them vulnerable to the region’s seismic activity. SR 520’s floating bridge across Lake Washington, opened in 1963, rested upon 31 concrete pontoons anchored to the lake’s deep bottom. Severe windstorms and strong waves caused the bridge to sway and heave as waves swept over cars on its roadway. Winter storms periodically caused the bridge’s closure to traffic.

Strong wave action also produced pontoon cracks and leaks that required significant maintenance and retrofits. A failure of the aged bridge would have had catastrophic consequences for the region’s economy.

In the late 1990s, state and local office holders, business leaders, community organizations and others began discussing the highway’s future, with an emphasis on safety and reliability. Not only were the highway’s aging bridges structurally vulnerable, but its traffic lanes grew increasingly congested as the region’s population and employment steadily increased. The group evaluated all reasonable and feasible options to improve traffic across Lake Washington. A few of the options considered included a tunnel beneath Lake Washington, an eight-lane expansion of the corridor, and a no-build alternative with seismic retrofits of the old, fixed bridges. After more than a decade of discussion, studies and debate, the region agreed on a reconstructed corridor with six-lane replacement bridges and adjoining, on-land roadway.
A phased construction program

The $4.6 billion SR 520 Bridge Replacement and HOV Program approved by the state Legislature actually involves several large construction projects, each under a separate contract with the Washington State Department of Transportation. The corridorwide program involves:

- The construction of a casting basin in Aberdeen, Wash., and 33 of the new floating bridge’s 77 pontoons. The Aberdeen pontoon project was completed in March 2015.

- The reconstruction of SR 520’s Eastside segment between I-405 and Lake Washington’s eastern shore, completed in fall 2015.

- The replacement of the old floating bridge and its east landing. The new floating bridge – the world’s longest floating highway – opened to traffic in April 2016.

- The construction of a new, solid-column West Approach Bridge North to carry three lanes of westbound traffic from the new floating bridge to Seattle. This bridge opens to traffic in summer 2017.

- The three-stage construction of all remaining corridor improvements in Seattle – the “Rest of the West.” These improvements will include a new Portage Bay Bridge, the south (eastbound) half of the new west approach bridge, and two landscaped, community-connecting lids over SR 520. Construction on the first stage of this work is scheduled to begin in 2018.

The Floating Bridge and Landings Project

The new SR 520 floating bridge, opened to traffic in April 2016, is enhancing traffic safety, improving travel reliability, relieving congestion and expanding the public’s transportation in a variety of ways:

- Replacement of the old, structurally vulnerable four-lane floating bridge with a stronger, six-lane bridge supported by the biggest, heaviest, strongest bridge pontoons ever built.
• Addition of dedicated transit/high-occupancy vehicle (HOV) lanes in each direction.

A bus travels on one of SR 520’s new bus/carpool lanes.

• Addition of a separate bicycle and pedestrian path on the bridge and its adjoining highway, giving the public a new option for commuting between major employment centers on either side of Lake Washington.

A bicyclist pedals on the new floating bridge’s bicycle-pedestrian path.

• A bridge design that can accommodate future light rail.

• An elevated bridge superstructure / roadway so that wind-whipped waves no longer crash over live traffic, and bridge-maintenance crews can access the pontoons below the roadway deck without disrupting traffic.

• Addition of shoulders on the roadway so disabled vehicles no longer disrupt traffic.

• A higher, 70-foot clearance for boat navigation under the new bridge, which eliminated the need for a drawspan that, on the old bridge, caused half-hour traffic delays when opened for passing boats.

The new floating bridge’s east high-rise has a 70-foot-high navigation channel for boats.

The floating bridge’s design-build contract included construction of 44 supplemental stability pontoons at an existing casting basin Tacoma, and the precasting of the bridge’s superstructure – primarily roadway deck panels and high-rise columns – at a lakeside industrial site in Kenmore, Wash.
Scope of work

- The new bridge consists of a floating bridge structure – at 7,708.5 feet, the longest in the world – with a fixed east approach and transition structures on the east and west ends between the fixed structures and floating bridge.

- The Washington State Department of Transportation (WSDOT) furnished 33 of the floating structure’s pontoons; the design-builder furnished 44, along with bridge anchors and anchor cables.

- Constructed pontoons were built and moored until needed for assembly.

- All 77 pontoons were towed to Lake Washington either from Grays Harbor (a 278-nautical-mile Pacific Ocean route) or from Tacoma (Puget Sound route, approximately 30 nautical miles).

Tugboats move a 360-foot-long pontoon through a Seattle drawbridge en route to Lake Washington.

- Bridge assembly involved joining 21 longitudinal pontoons, 2 cross (end) pontoons, and 54 supplemental stability pontoons to form the floating bridge substructure.

- The superstructure that carries the roadway deck was installed on top of the pontoons.

- A new bridge maintenance facility, dock and crew access was constructed beneath the east approach structure.

- Stormwater-treatment systems were constructed on the new, 1.5-mile-long floating bridge. An innovative stormwater treatment method was developed that includes bridge-deck sweeping, trapping heavy pollutants in modified catch basins, and providing spill containment in the supplemental stability pontoons. This eliminated the need to pump stormwater off the bridge to land-based treatment facilities.

- The old floating bridge and approach structures are being removed from the lake (through January 2017).
Criterion 1: Contract Completion Date / Time Extensions

WSDOT’s request for proposals for the Floating Bridge and Landings Project cited a September 2016 date for physical completion of the project. The design-build contract WSDOT signed with Kiewit/General/Manson, A Joint Venture, accelerated the scheduled physical completion to July 2015, with incentives included for completion as early as December 2014.

As part of the Floating Bridge and Landings Project, WSDOT provided the design-builder the 21 needed longitudinal pontoons and two cross (end) pontoons, as well as 10 of the bridge’s 54 supplemental stability pontoons. The 33 WSDOT-furnished pontoons were built in Aberdeen under a separate contract. The pontoon-delivery schedule was advertised in the RFP documents for the Floating Bridge and Landings Project, and the design-builder was required to develop a schedule based on the delivery dates of the WSDOT-provided pontoons. During the course of the floating bridge project and after the first four large pontoons were towed to Lake Washington, the team discovered that the pontoons WSDOT provided had design inadequacies that potentially could have shortened their required 75-year design life.

Due to the magnitude of the potential cost and delay associated with this issue, the project was in jeopardy of breaking down into a protracted, corrosive dispute and potential litigation. However, the design-builder and WSDOT project teams resolved the issue without litigation or the use of the project’s Disputes Review Board. Instead, they worked quickly and collaboratively to develop repair plans for the four pontoons on the lake, negotiate a settlement to the cost and schedule impacts, and re-sequence the construction to keep the project moving forward and minimize the delay to opening the bridge. The pontoon-repairs scope and associated delays added approximately $134 million to the project budget and 16 months to the schedule.

In the end, the new floating bridge opened to traffic in April 2016, ahead of the RFP’s September 2016 target. In addition, the all-in, $1.5 billion cost of the bridge was below the WSDOT engineer’s estimate of $1.7 billion.

Other factors also affected the project schedule. Due to the unique issues involved with building a floating bridge on water and the special environmental conditions involved, winter work restrictions were imposed that prohibited any pontoon-joining work between October and March due to winter storm season and associated waves and winds. The project team quickly recognized the impact this restriction posed to completing the bridge in a timely manner, including the risk of losing knowledgeable workforce and critical equipment to other projects during the extended six-month down time. The design-builder and WSDOT worked together to establish weather criteria and restrictions allowing pontoon joining to continue during the winter months while still addressing and mitigating the risk of damaging the pontoons during winter joining.
In addition to the winter joining, the superstructure and roadway had to be built once the pontoons were joined. In order to expedite the superstructure construction, the team elected to use a precast, segmental deck-panel system for the low-rise portion of the bridge. This allowed the off-site construction of 776 deck panels, including bridge barrier, for transport to the bridge in a just-in-time manner. The precast deck makes up more than 73 percent of the floating bridge’s total length.

The on-land, lakeside site in Kenmore, Wash., where the floating bridge’s precast roadway deck panels and barriers were constructed.

The deck panels were set in place and post-tensioned together to form the superstructure and road deck in one placement. This process not only accelerated the bridge’s assembly but reduced the amount of in-water construction and its associated environmental risk.

**Criterion 2: Construction Schedule, Management, Control Techniques, Commitment to Sustainability**

WSDOT’s plan for successfully improving the corridor was to create a team of committed individuals and firms capable of addressing all the challenges inherent in such a large and complex project. WSDOT believed a design-build contracting and delivery method would best ensure that goal. A design-build approach assigns risk to the entity that can best address or mitigate risk. Design-build also provides the contractor flexibility and incentive to innovate, accelerate the delivery schedule, reduce costs to WSDOT and, overall, better manage the project and associated risks. Some of the desired characteristics WSDOT sought for the floating bridge team included commitment to the needs of the program, technical expertise in disciplines such as bridge design, environmental analysis and mitigation planning, and high-level skill in communications and public outreach, program management, cost schedule analysis, and finance.

To facilitate management of the project’s design and construction, the team developed an extensive cost and risk management process early on. This work included the design-builder’s development of a risk register to identify, track, and manage project risks and identify changes that could impact the project budget. The team maintained this register through frequent and thorough communication, and through the daily involvement of key construction and design managers in all task force meetings. This presence offered early identification of risks and potential cost-impacting changes, which allowed opportunity for owner/contractor coordination to either manage or totally avoid issues that would otherwise impact schedule and budget.

Throughout design development, whenever potential changes, even those meant to reduce costs, were identified, the team first developed detailed estimates that identified potential savings and factored in redesign costs. In this way, management could fully appraise the value of the changes and ensure budget performance.
Aligning design and construction schedules

During the proposal stage, the design-builder and its designers developed detailed schedules that both addressed desired contractor construction timing and sequencing while recognizing designer processes, durations and necessary QA/QC processes. In addition, a detailed schedule for the many owner reviews was developed to realistically portray the durations and process required to solicit thoughtful commentary from WSDOT.

This process recognized the project’s complexity and the significant burden that the design and design-review process would have on all parties. This comprehensive advance planning allowed WSDOT, the designers and the construction contractors to work from day one with a realistic and shared vision.

Throughout construction, the team utilized a central project database called CentricProject that enabled all parties to easily access an integrated document control system. This database included all design submittals, RFIs, RFCs, Quality Incident Reports, and other important documents that were immediately available to all project staff. Providing this direct link allowed the project teams to share real-time information, resulting in reduced schedule delays that could have been caused by responses to information requests. The central database also created continuity, consistency and eliminated the risk of incompatible as-built elements or documentation.

Design-build best practices

Design-build best practices commenced in design and continued on through construction and bridge commissioning. Design, construction and commissioning all made extensive use of task forces composed of WSDOT, design-builder and third-party staff. This collaborative approach helped promote understanding of the work, identify and resolve issues, and avoid undue schedule and cost risk.

An active executive oversight committee met continually to maintain dialogue and alignment between WSDOT and design-builder executives. To promote over-the-shoulder review and real-time feedback, WSDOT and design-builder offices were fully integrated in collocated facilities near the project site as well as in on-site construction trailers. A project charter and escalation process was adopted to help build and reinforce a common mission and provide a timely process for administrative dispute resolution. This escalation process involved resolving issues to avoid claims or litigation.

Other best practices included monitoring changes throughout design development and construction. Prior to changes being implemented, the project team would first develop detailed estimates that identified potential savings and factored in redesign costs. In this way, the project team could fully appraise the value of the changes and ensure budget performance. The earliest implementation of this concept was in WSDOT’s Alternative Technical Concept (ATC) model. During the RFP stage, the design-builders were allowed to propose alternative methods for evaluation and approval. This allowed the project team the freedom to innovate while also assigning and mitigating risks with changes to the technical requirements of the project.

A specific ATC included altering the spacing of the low-rise columns to accommodate the precast concrete deck-panel construction. This helped mitigate environmental and schedule risks by transferring work off the lake to an industrial site, while ensuring just-in-time delivery of required bridge elements.
Our commitment to sustainability

The SR 520 Floating Bridge and Landings Project was WSDOT’s first design-build project ever to have a contractual commitment to sustainability.

The project RFP required the winning contractor to develop a Sustainable Practices Plan describing and quantifying the specific sustainability strategies and actions to be undertaken during the design and construction of the new floating bridge, with intention to lay a foundation for continuous improvement in sustainability. The Sustainable Practices Plan the design-builder created, in partnership with WSDOT, outlined a comprehensive structure and approach for sustainability planning, monitoring and reporting.

The structure allowed the design-builder to develop benchmarks or baselines and quarterly/yearly tracking methods for metrics such as materials reuse and recycling, reduced fossil-fuel use in transportation, reduced energy use, and reduced water use – all with a goal of continuous improvement. During project construction, the team adjusted its means and methods based on lessons learned from quarterly and yearly reporting. The team met and exceeded the plan’s identified continuous-improvement goal while realizing the cost benefits from implementing sustainable practices. The plan’s goals included:

- An innovative stormwater-treatment system – with high-efficiency sweepers, modified catch basins, over-sized sumps and specially designed lagoons inside pontoons – to capture bridge runoff and keep pollutants out of Lake Washington.

- A bridge-column design that reduced overall material use and significantly reduced on-water concrete work.

- A footing design that reduced concrete requirements by approximately 12,500 cubic yards – along with a 3,100-ton reduction in greenhouse gas emissions.

- The use of high-strength rebar that reduced the total amount of rebar needed by approximately 260 tons.

A first-year summary of recycling performance on the floating bridge project.
Reusing the existing pontoons

The project actions underscored the team's commitment to sustainability. One example is in the decommissioning of the old floating bridge. The design-builder purposefully sold all of the old pontoons to a third party for reuse elsewhere as piers, docks or other marine facilities. And much of the old bridge’s other components – primarily girders, cross-beams and columns from the approaches and high-rise sections – are being recycled for use in projects elsewhere.

Preserving natural resources

For the bridge’s approach structures, the project team was able to shift the location of piers for the approach bridges to the floating structure. This pier shift enabled a wider channel for marine navigation under the bridges, minimized in-water work, and reduced impacts to the lake. Additional advantages included the use of spread footings in lieu of drilled shafts. As a result of these approaches, the team preserved 800 square feet of shallow water habitat, reduced the volume of concrete used by 12,500 cubic yards, avoided penetrating a vital aquifer with deep shafts, and minimized the amount of permanent lakebed disturbance by 95 percent.

In addition, the project team is in the process of applying for LEED Silver certification for the new, 19,600-square-foot bridge maintenance facility built beneath the bridge’s east landing on the Medina shoreline.

Criterion 3: Safety Performance

The floating bridge team’s safety program evolved from the design-builder’s standard program over the life of the project. Many challenges were overcome, such as continually shifting job-site access for crews and materials, confined work space, fall protection, and marine work. However, the program always focused around craft engagement. Craft Voice In Safety (CVIS) focused on helping people make the right choices, even when no one was looking. A safety team of experienced craft employees, including subcontractors, met weekly with upper managers to discuss safety protocols. Concerns were brought to the CVIS team anonymously by other craft employees, or observed on weekly safety walks. Giving an anonymous voice to the people doing the work made the job site safer for everyone.
Crews held daily safety meetings prior to starting their operations. Crews also had weekly Toolbox Training topics to review a new tool or refresh safe work habits. Weekly safety reports were used to communicate changes in job-wide hazards, such as traffic switches, parking, and new rules on personal protection equipment.

Despite posting project safety statistics that better the industry standard in most key categories, the fatality of a crew foreman during the project showed that continued attention to safety training and protocols is imperative.

### Criterion 4: Environmental Stewardship

WSDOT is committed to building and maintaining a sustainable, integrated multimodal transportation system for the people of Washington – a system that supports healthy communities and economic vitality while protecting the environment. From the start of the floating bridge project, we planned and designed project elements with the goal of minimizing their environmental effects or avoiding impacts altogether. During construction, we required best practices to preserve the region’s natural resources and promote public health and safety. And where project impacts were unavoidable, we’ve partnered in initiatives to mitigate the impacts.

To minimize environmental effects while working in Lake Washington, the team utilized specialized bubble curtains to reduce underwater noise during pile driving. Crews also employed truck-wash stations to reduce dust, erected silt and turbidity curtains to halt erosion and prevent runoff, and used vegetable-based hydraulic fluids to minimize damages from potential spills. At WSDOT’s four-acre pontoon casting basin in Aberdeen, the team created an innovative way to safely gather fish that entered the harbor-side casting basin, inspect them, and return them safely to the Chehalis River.

**Floating bridge safety statistics**

*(through April 30, 2016)*

- Total hours worked on project: 2,716,710
- Duration of construction (in months): 56
- Fatalities: 1
- Cases with days away from work: 2
- Cases with job transfer or restriction: 3
- Other recordable cases: 13

**While driving piles in Lake Washington, crews used “bubble curtains” to protect fish from the work’s underwater noise.**

Unforeseen to bridge designers, the cormorant, a native sea bird, occasionally dove into the stormwater treatment lagoons in the supplemental stability pontoons looking for food. Once inside the wells, the birds could not fly out due to limited space. The team designed and permanently installed special ramps to allow sea birds to walk out of the wells.
Specially designed "bird ramps" allow seabirds to safely exit the stormwater lagoons inside many of the floating bridge’s supplemental stability pontoons.

An environmentally smarter highway

While the old bridge discharged untreated stormwater directly into the lake, current environmental rules required the new bridge to treat all stormwater. Treating runoff on the new floating bridge demanded innovative design options, in part, because best management practices (BMPs) approved by the Washington State Department of Ecology (Ecology) for treating highway runoff are all designed for roadways on land. But on the world’s longest floating bridge – at 1.5 miles end to end, not including its east and west approaches – pumping runoff to land for treatment was not feasible.

WSDOT addressed this challenge with a unique strategy for complying with current Ecology water-quality regulations. Based on evaluations of installation, operations and maintenance cost, the innovative system uses the new floating structure itself as part of the solution for treating stormwater. WSDOT staff proposed using “All Known, Available, and Reasonable methods of prevention, control and Treatment” (AKART) to treat the stormwater runoff. The innovative AKART approach, as approved by Ecology and constructed, includes a three-component treatment train using:

- monthly high-efficiency sweeping;
- modified catch basins with over-sized sumps; and
- specially designed stormwater lagoons incorporated into the floating bridge.

A custom-built highway sweeper, dubbed “Broom Hilda” in a community naming contest, sweeps highway debris into the floating bridge’s stormwater system on a monthly basis.

Capturing and removing roadway pollutants

- Pollutants from Cars
- Remaining heavy pollutants in stormwater
- Spills

PROBLEMS

- Bridge sweeping
- Settling/vacuuming and clean stormwater
- Spill containment

SOLUTIONS
With the new system, heavy metals and other road debris that used to run into Lake Washington now are captured in the modified catch basins and properly disposed. In addition, motor oils, antifreeze and other floating pollutants that flow through the bridge’s drainage system are captured and contained in the pontoon lagoons, where the liquids are periodically skimmed and disposed.

Ecology requires a four-year monitoring of the system, and the data collected will be used to determine if stormwater-discharge concentrations compare with the predicted concentrations in the study dilution model. After 50 years of discharging untreated stormwater to Lake Washington, the new SR 520 floating bridge will result in cleaner stormwater runoff and improved aquatic habitat for critical species, including salmon protected under the Endangered Species Act.

**Improving local parks and natural areas**

Where environmental impacts could not be prevented, the team looked toward mitigation. While the new bridge required absorbing five acres of land within Seattle’s Washington Park Arboretum, the project also enhanced the much-loved park. Key improvements included a new multiuse trail; restoration work to Arboretum Creek and the Waterfront Trail; a new north entry into the Arboretum with various trail and park enhancements there; and an enhanced SR 520 pedestrian undercrossing on Foster Island.

The SR 520 project also is enhancing other parks and sensitive natural areas within the region as mitigation, including the University of Washington’s Union Bay Natural Area, wetlands along Evans Creek and Bear Creek in the Redmond area, and south Lake Washington shoreline restoration for juvenile-salmon propagation.
Promoting greener transportation

The addition of transit/HOV lanes on the new floating bridge and adjoining highway is expected to allow the highway to carry 17 percent more people during peak traffic in a little as 5 percent more vehicles. Compared to traffic conditions with a “no-build,” four-lane highway, the expanded corridor’s promotion of transit and carpooling is expected to produce a 10 percent reduction in greenhouse-gas emissions from the highway. In addition, the project’s creation of a regional, cross-lake bicycle and pedestrian path between Seattle and Redmond provides a healthier, carbon-free travel alternative.

Criterion 5: Community Relations and Public Safety

One of the project’s many open houses for sharing information and receiving public comment.

To understand and address the concerns of the public and key stakeholders, WSDOT began an assertive public outreach program early in the planning process. Together with consultants and contractors, WSDOT has continued the effort throughout the project’s design and construction phases. From the start of conceptual planning in the late 1990s on up through the 2016 completion of the new floating bridge and demolition of the old bridge, the team has met literally hundreds of times with stakeholders, including local jurisdictions, regulatory agencies, residents and businesses within the corridor, neighborhood organizations, environmental groups, Native American tribes and others. The project team has continually collaborated to keep external stakeholders informed of upcoming activities, hear their questions and address their concerns. The outreach has included open houses, briefings to elected officials and community organizations, weekly email newsletters to more than 12,000 subscribers, targeted fliers, work-site tours, media engagement (both traditional and social media), and prompt response to thousands of public emails and hot line calls (more than 1,600 responses in 2016 alone). The outreach not only helps to maintain two-way communications with the public, but in many instances serves to avoid, minimize or mitigate impacts to local communities and historic properties.

The team’s construction approach addressed many key stakeholder concerns by using accelerated bridge construction to shift the majority of construction activities to off-site, industrially zoned locations such as the pontoon-casting facilities in Tacoma and Aberdeen, and the shore-side construction yard in Kenmore where bridge anchors and low-rise deck panels were constructed. Construction closures of the floating bridge, when necessary, were confined almost exclusively to weekends so as to avoid disruption of weekday commutes.

The Grand Opening celebration of the new SR 520 floating bridge was held on April 2-3, 2016. The event featured family-friendly, interactive exhibits and displays showcasing the science, technology, engineering and math (STEM) involved in building a floating highway. 50,000 people participated in the event, which also included a community fun run and the Emerald City Bike Ride with routes across the
bridge. During the bridge’s ribbon-cutting ceremo-
ny, a representative of Guinness World Records
presented Gov. Jay Inslee a certificate designating
the bridge – at 7,708.5 feet, end to end – as the
world’s longest floating bridge. The ceremony
opened with a tribal blessing by Muckleshoot Tribal
Councilman Louie Ungaro, and closed with a tribal
song by members of the Muckleshoot Language
Group.

**Criterion 6: Overcoming adverse conditions**

Replacing the world’s longest floating bridge was
understood to be a technically challenging assign-
ment, but equally challenging was gaining public
consensus on what, if anything, should be done to
address SR 520’s safety and mobility problems.
Some residents had lived in the corridor area since
SR 520 and its first floating bridge were built more
than a half century ago. Many complained bitterly
about the way the corridor was originally sited and
constructed, and how the highway for decades had
disrupted their neighborhoods and lives. Critics did
not hesitate to contact their city councils, mayors,
state legislators, governor, and even congressional
representatives in trying to stop or dramatically
downsized the needed bridge and corridor improve-
ments.

Public discussion, debate and preplanning lasted
14 years, with many alternative alignments and
lake-crossing options considered. Eventually – con-
cluding with a Final Environmental Impact State-
ment in 2011 – the region agreed on an expanded
six-lane corridor that not only would replace aging,
structurally vulnerable bridges, but would add bus/
carpool lanes to ease the highways worsening con-
gestion, and a regional, cross-lake bicycle-pedestri-
an path to provide a nonmotorized travel option.

**Technical and physical challenges**

One uncontrollable issue the team faced was the
effect of strong winds and waves on a long float-
ing structure. Severe winds and waves, usually
in winter, caused the old SR 520 floating bridge
to twist, heave and bend, and wind-swept waves
regularly washed over vehicles crossing the bridge.
The old bridge – built to withstand sustained winds
of 57 mph (later retrofitted for 77 mph winds) –
frequently had to be closed during storms. Major
storms caused pontoon cracks and other structural
damage requiring periodic repairs and retrofits, and
increased maintenance.

A storm batters the old SR 520 floating bridge. At the
photo’s center is the old bridge’s drawspan and operator
tower.

Based on extensive wind/wave analysis, the proj-
ect team designed a bridge with the largest and
heaviest pontoons and bridge anchors ever built –
capable of withstanding 98 mph winds (a 100-year
storm).

Other technical challenges the team had to address
included designing a bridge and approaches to
withstand the region’s seismic activity; crossing a
200-foot-deep lake underlain with a 200-foot-deep
layer of soft, unstable soils for anchor placement; finding a suitable pontoon-construction site; meeting the navigational requirements of the region’s large boating population both during and after construction; and maintaining traffic flow while building the new bridge.

In every instance, the team successfully met the challenge.

**The challenge of limited access**

The only land access for floating bridge construction and over-water assembly was a narrow, steep hillside on Lake Washington’s eastern shore. Homes are to the immediate left, and the old floating bridge’s east approach is at right.

One of the most significant challenges to actually constructing the new floating bridge involved access – specifically, how to move crews and materials to the work site as efficiently as possible. The project site afforded limited land access, reachable from a single location on the eastern shore and bordered by residential housing. The restricted site meant all land access to over-water construction activities had to occur within a 150-foot-wide stretch of shoreline. To provide lake access, the team built a temporary access roadway down the steep eastern embankment, along with a temporary trestle, to reach the East Approach’s pier 1 and, ultimately, the floating pontoons as they were installed.

A key strategy for addressing the access issue was to turn the large over-water project into a land-based project wherever possible. Land-based construction provides a safer work environment, mitigates possible environmental effects to the lake, simplifies access for material and personnel, improves construction consistency and quality, allows for standardization of equipment, shortens the project schedule, and greatly reduces costs.

Most significantly, the project team continually sought to maximize the use of precast elements; many of them (including 776 precast panels of roadway deck) were constructed away from the bridge on one of the lake’s few remaining useable industrial sites near the north end of Lake Washington. A secondary benefit of this shore-side site was an adjacent concrete batch plant, and waterfront access with a modest dock facility. Using concrete from the batch plant kept thousands of trucks off the roads, with commensurate air-quality benefits. It also meant concrete pours could be scheduled without concern for traffic-related truck delays and work disruptions from severe weather on the lake.
Throughout the contract-proposal phase and into design, the project team worked to develop a design and choose construction methods that fulfilled WSDOT’s goals. Specifically, the work focused on:

- Infrastructure improvements that ease the bridge’s long-term maintenance demands, simplify maintenance access and increase safety for WSDOT maintenance crews.

- Reducing on-water construction and minimizing impacts to the Lake Washington ecosystem.

- Delivering an iconic structure on time and within budget.

Several significant improvements typified this effort, including:

- **Reduction of in-water work** through the relocation of the east approach bridge footing to the shoreline. Originally planned to be placed within Lake Washington, the revised design moved this footing to land on the shoreline, which eliminated in-water construction in a critical salmon-spawning lakeshore gravel bed.

- **Elimination of exposed steel elements** in the bridge superstructure. The revised design provides an all-concrete superstructure that eliminated exposed steel envisioned in RFP conceptual documents. This provides a much more durable structure with greater performance in the difficult conditions of Lake Washington.

- **Increased maintenance access** on the pontoon deck. The revised design provided 10-foot clearance, well above the 7-foot-6-inch minimum identified in RFP documents. The added clearance allows greater maintenance access and mobility on the pontoon deck, which is critical to support bridge-preservation activities.

Criterion 7: Additional considerations

Floating bridges must function in a demanding, complex environment. With more than 70 years’ experience in the design and ownership of floating bridges, WSDOT engineers have unique insight into the issues associated with these structures. (WSDOT’s current inventory includes four of the world’s five longest floating bridges.) It was with this knowledge that WSDOT developed a demanding set of design and construction criteria for potential design-build teams on the SR 520 project. Subsequently, WSDOT and its selected consultants and contractors collaboratively designed, engineered and built a new SR 520 floating bridge with the future in mind.

With such a large structure and large outlay of public resources, WSDOT had to ensure the new bridge’s long-term structural integrity and its capacity to handle the increased traffic volumes projected for the region decades from now.
• The SR 520 floating bridge is designed to have a service life of 75 years. The average age of Washington’s state-owned vehicular bridges is 45 years. Achieving the 75-year service life can be accomplished – and perhaps exceeded – with normal maintenance.

• The new floating bridge is engineered to accommodate light rail by adding supplemental pontoons to support the weight of light rail. The bridge could handle light rail in the future either by converting the transit/HOV lanes to light rail, or by adding more bridge width without a loss in vehicular lanes.

• When SR 520 is fully reconstructed with HOV lanes extending from Seattle to Redmond, a rush-hour commute from Seattle to Bellevue – in both the HOV lane and the general-purpose lanes – is expected to be about a half hour shorter than it would be on a four-lane SR 520.

• The new floating bridge, as noted earlier, is built to withstand wind speeds of 98 mph (100-year storm).

Benefitting from experience

Lessons WSDOT and its design-build team learned from building, operating and maintaining floating bridges led to noteworthy design enhancements and innovations on the new SR 520 floating bridge, including:

• Access to pontoons and elevated superstructure – Since the majority of WSDOT’s maintenance effort is spent on the floating portion of the bridge, the project team developed a design that improves crew and equipment access to the pontoon deck, provides ease of movement once there, and significantly reduces the number of constricted spaces.

• Cable-replacement convenience – From past experience working on floating bridges and accomplishing cable replacement, the design-build team recognized the importance of simplifying this work to minimize costs of this frequent bridge-preservation activity. For the new floating bridge, the team designed the overhead superstructure to provide 16 feet of vertical clearance from the waterline at the anchor-cable ports. This clearance provides ample room to position work derricks and facilitate cable replacement.

• Durable road deck – The Precast Segmental Bridge Deck Protective System provides WSDOT with a more durable road deck that reduces by half the frequency of repaving. The roadway deck uses a more durable concrete and reduces the number of expansion joints that will require replacement in the future. Further, the design included substantial use of precast concrete for significant sections of the floating structure, including the roadway deck and lane barriers.

• Reduced-impact maintenance facility – The project improved efficiency for WSDOT crews by providing direct access to the maintenance facility’s dock and yard from the freight elevator; increasing the size of the maintenance yard and shop by 33 percent; and containing the yard, which minimizes impacts to adjacent residential properties.

• Improved access to pontoons – Full-height stairwells within the bridge’s sentinels provide WSDOT maintenance crews and contractors an easier and safer alternative to boat access. The conceptual design envisioned WSDOT personnel accessing the pontoon deck either by boat or by climbing over the pedestrian rail, down a series of ladders, and through a hatch. The design-builder’s revised design improved WSDOT crew access by extending the stairwell within the sentinels all the way to the road deck.
APWA - Washington Chapter

2017 PUBLIC WORKS PROJECT OF THE YEAR

Category: Transportation / Division: More than $75 million

SR 520 Floating Bridge and Landings Project - Seattle, Washington