PORTLAND-MILWAUKIE
LIGHT RAIL PROJECT

Portland-Milwaukie Light Rail Bridge
Conduct of Construction

June 2011

Portland-Milwaukie Light Rail Project is a partnership among:

CLACKAMAS COUNTY · METRO · MILWAUKIE, OREGON · FOUNDED 1847 · MULTNOMAH COUNTY · OREGON CITY · The Oregon Department of Transportation · PDC PORTLAND DEVELOPMENT COMMISSION · TRIMET

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TY LIN INTERNATIONAL

HNTB

The Portland-Milwaukie Light Rail Bridge is a central segment and a distinct component of TriMet's larger Portland-Milwaukie Light Rail (PMLR) Project. The project will extend light rail 7.3 miles from Portland State University in downtown Portland to South Waterfront, across the Willamette River to OMSI and the Central Industrial Eastside, through inner Southeast Portland and the City of Milwaukie, and into North Clackamas County. PMLR will connect residential neighborhoods with employment, education and recreational centers, and provide several opportunities for transit-oriented development.

This Conduct of Construction (COC) describes the measures Kiewit Infrastructure West Co. and TriMet are taking to ensure minimally disruptive construction of the Portland-Milwaukie Light Rail Bridge over the Willamette River. Including mobilization work, construction will take place from spring 2011 to summer 2014. The COC addresses work hours, safety precautions, noise variances, and noise and vibration mitigation. It also describes river navigation restrictions around the construction zone.

Additionally, the COC details construction phases and processes by which the bridge will be built (see project phase sections). It covers mobilization and site preparation, in-water work and pier construction, tower and span creation, placement of the cables, additional superstructure finishes, and the removal of temporary work bridges.

The Willamette River

The Willamette River is the defining natural feature of Portland. It divides the westside from the eastside, provides habitat to a variety of plant and animal species, and has historically served as a recreational and industrial site. Past industrial uses have resulted in sediment and water quality degradation, which several ongoing efforts strive to mitigate.

In addition to carrying working river traffic, such as barges and tugs, the river also hosts a variety of recreational activities including fishing, kayaking, sightseeing and dragon boat racing. The river's banks provide opportunities for walking, running and cycling. Many residents, institutions and businesses are located within walking distance of the Willamette. At the bridge construction site on the river's east bank, existing institutions include the Oregon Museum of Science and Industry (OMSI), Portland Opera's rehearsal space and administrative offices, and one of two Portland Spirit sightseeing moorages on the Willamette River. Launch sites for kayaking and rowing opportunities are also located immediately to the north, as well as further south. On the west bank, former industrial lands will be the site of a future light rail station and the Oregon Health and Science University's South Waterfront Campus.

The Portland-Milwaukie Light Rail Bridge

Organized into three separate segments for planning, design and construction purposes, PMLR includes the construction of several structures. The Portland-Milwaukie Light Rail Bridge will span the Willamette River between the Marquam (Interstate 5) and Ross Island (Hwy 26) bridges in the South Waterfront district of Portland. The bridge will link the developing South Waterfront with Portland's Central Industrial District (CEID) and will carry light rail, streetcars, buses, pedestrians and cyclists. It will be a signature long-span, transit-only bridge.

Led by former Portland Mayor Vera Katz, the Willamette River Crossing Partnership recommended the bridge alignment in May 2008. In February 2009, the Willamette River Bridge Advisory Committee, also chaired by Mayor Katz, recommended the cable-stayed bridge type ultimately selected for the bridge. Along the way, federal, state and local agencies have overseen the design of the bridge and construction planning.

The cable-stayed bridge structure will have a total length of 1,720 feet (abutment to abutment) and a width between 75 and 110 feet, being wider at its two towers. It will consist of five spans with two abutments, two landside piers above the ordinary high water level of the Willamette River, and two towers located in the river. Upon completion TriMet's bridge will be the first long span cable-stay bridge in Portland and the first bridge to be built across the Willamette in more than 40 years.

Project impacts and mitigation

Project impacts to river users (water and land), the local community, and the environment will be minimized through:

- Working closely with TriMet to communicate construction progress and potential hazards
- A careful selection of construction means and methods
- Design innovation

Communication

Community Affairs

Throughout the course of the project, Kiewit will work with TriMet Community Affairs to keep stateholders engaged and informed. By using TriMet's project web site, Facebook, Twitter, as well as river users' websites, Kiewit will keep the community informed of the project's progress. These notices will contain information about the upcoming work and possible work zone hazards, as well as the temporary no wake and exclusion zones [Figure 1.1].

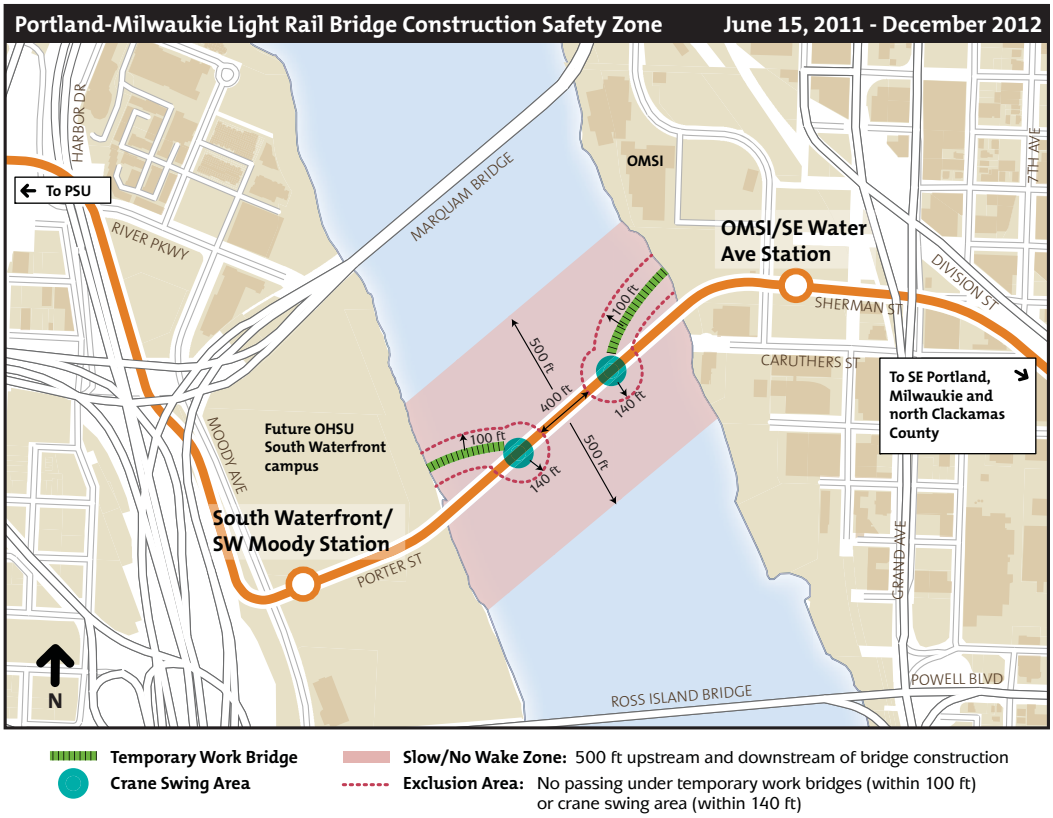

Figure 1.1 - Slow/no wake zone.

TriMet's Community Affairs program assists residents, businesses and citizens affected by construction with timely information and issue resolution. This is accomplished by:

- Periodically holding informational meetings regarding construction progress
- Maintaining access to businesses and recreational sites
- Providing construction updates online
- Maintaining a 24-hour, 7-day-a-week construction hotline for assistance with construction issues

DeeAnn Sandberg is the TriMet Community Affairs Representative for the Portland-Milwaukie Light Rail Bridge. The hotline for bridge construction is 503-962-2222. DeeAnn can be reached directly at 503-701-5260. Construction updates for the bridge and the entire project can be found at *trimet.org/pm*.

River users

Kiewit will communicate with the general commercial traffic through TriMet by using regular updates to the Coast Guards' "Notice to Mariners." Changes to the navigation route and work zone will be announced to all commercial traffic. Working in concert with the Oregon State Marine Board, Kiewit has developed a plan to communicate river restrictions with recreational river users. The approved plan includes signage, lighting on construction structures and equipments, and notification buoys. Signage noting the construction zone will be placed at nearby boat ramps and parks. The project team and TriMet Community Affairs staff have met with the Portland Spirit (operated by American Waterways), Willamette Jetboat Excursions, and other marine stakeholders to develop this plan. Marine communication meetings with key stakeholders will provide all parties with the opportunity to stay updated on the upcoming construction work.

To warn those on the river at night, Kiewit will maintain the lighting of its vessels, work bridges, pier caps, and other obstructions throughout the duration of construction.

Landside patrons

Kiewit will make efforts to minimize impacts to people who walk, run or cycle along the river's edge. Trail closure notifications and detour routes will be posted at trail locations near OMSI and the Portland Opera as warranted. TriMet's project website will have information regarding trail closure and detour schedules.

Kiewit will also install signs to identify areas of construction. These signs will be placed in prominent

traffic zones where construction is occurring. They will identify the PMLR bridge crossing, Kiewit, project partners and other bridge contractors. They will be maintained throughout the duration of construction. Signage will be reviewed prior to installation.

Local community

Project staff will keep the community informed by these methods:

- Notification of upcoming construction by TriMet Community Affairs via email and social media channels
- Participation in TriMet special events, such as the June 30, 2011, project groundbreaking at the bridge site
- Completion of impact mitigation plans
- Timely incident notification

In addition to the above listed items, Kiewit project management will work with TriMet to assist with all construction tours relating to the bridge. A Kiewit engineer and/or safety manager will lead construction tours organized by TriMet. Visitors attending these tours will view construction from a viewpoint and be expected to follow the project safety rules.

Construction tours may include educational tours for members of local schools and businesses or other local community groups. These tours scheduled through TriMet will provide details of the project's construction efforts and serve as a forum to discuss how the construction industry improves job creation and the local economy.

Means and methods

River users

Kiewit will further minimize our impact to the river by keeping the center river channel clear of construction equipment. Kiewit will erect two tower cranes, one on each pier cap, upon completion of tower foundations. The tower cranes will provide support for the construction activities in order to minimize the use of floating cranes in the river channel. Construction materials will be hoisted by the tower cranes from trucks on the work bridge, further reducing in-water construction equipment. Like the materials, all concrete will be delivered to the work bridge and then bucketed or pumped to the point of placement. This approach reduces our reliance on supply barges in the work zone, thus minimizing the project's impact on river users.

Landside community

Kiewit has also constructed a bridge connection for the Greenway Trail at the landing of the eastern work bridge.

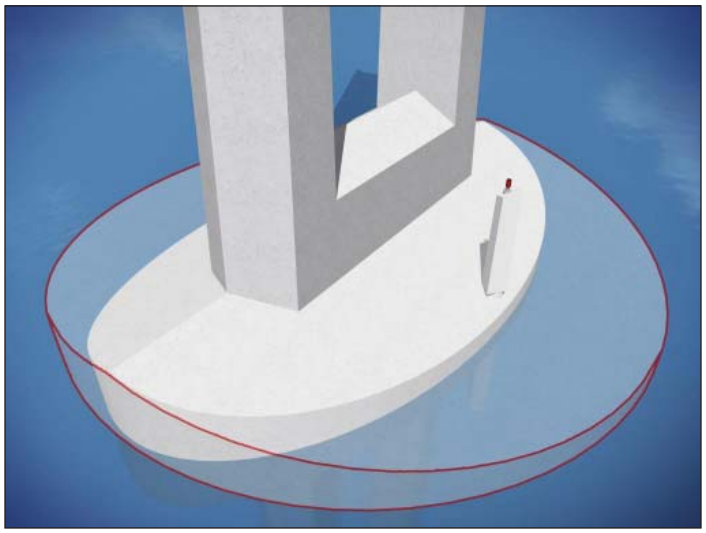

Figure 1.2 - Optimized Pier Cap 30% design outlined in red.

This temporary bridge passes over the construction access road. Construction equipment and personnel traveling to the work bridge will pass under the Eastside Greenway Trail, thereby providing pedestrians and cyclists safe and unhindered passage through the construction area.

In addition to the pedestrian crossing, Kiewit will delineate the construction limits with fencing. The fencing will serve to protect the traveling public from entering hazardous areas and prevent construction activities and equipment from entering the public travel ways.

In order to reduce impacts to the public, construction deliveries will be minimized during typical peak hours. Landside deliveries at the west site will come by way of SW River Parkway and for the east site deliveries will come via SE Water Avenue. Barge deliveries will be used primarily for larger items such as pipe pile, cofferdam sheets and aggregate. Working hours will typically take place between 7 a.m. and 6 p.m., but for some activities —such as construction of cofferdams, temporary work bridges, and installing rebar—double shifts will be used. For example, concrete pours for select drilled shafts, pier caps, towers and deck spans will require 24 hour shifts to make a continuous pour. Additionally, extended hours of operation may be used to maintain schedule and/or to reduce congestion on the project. Nighttime activities will be limited to activities that will produce lower noise levels such as delivery of materials, drilling shafts, pouring concrete, constructing forms and scaffolding, and placing rebar and trestle beams. High noise level activities like pile driving will be limited to daytime hours.

Environment

Impacts to the environment will be minimized by

- Optimizing design elements such as using a smaller, less invasive tower foundation [Figure 1.2]
- Using bubble curtains during pile driving (described in Phase 1)
- Enforcing training, subcontractor compliance, inspections and monitoring
- Planning work and respecting in-water windows
- Using proven best management practices

Design innovation

Innovative structure design will also be a component of minimizing the bridge's impact on river users and the environment.

Figure 1.3 - A derrick barge is a crane mounted on a barge (DB-LA) will be used for the PMLR Bridge construction.

The use of a smaller tower foundation is a major design innovation in this regard. A smaller foundation substantially reduces navigational obstructions and lessens the associated scour protection required at both towers. The reduced foundation design provides the Portland Spirit with an additional 40 ft. of overall navigational clearance when docking at their facility located on the east bank of the river. In addition, Kiewit has reduced foundation size by 43 percent and decreased the number of tower foundation drilled shafts by 25 percent from the bid document baseline 30 percent complete package (decreased from 16 to 12 shafts). This design optimization decreases required scour protection, minimizes the permanent in-river impacts of potential river rise, and reduces river flow changes along with associated impacts to the river, environment and species covered by the Endangered Species Act (ESA).

Additionally, relying on cast in-place superstructure construction instead of precast minimizes reliance on large barges to erect precast segments, which further protects the navigational channel.

Construction policies

Noise and working hours

On June 22, 2011, the City of Portland issued Kiewit a noise variance for bridge construction. The variance is in effect from June 30, 2011 through June 29, 2012, and any additional periods will be considered independent of that variance. Kiewit or their contractor will have portable sound level meters on the job at all times for noise level spot checks on specific operations. Higher noise level activities like pile driving will be limited to the hours of 7 a.m. to 6 p.m. In general, nighttime construction activities will be limited to less intrusive sounds compared to the normal daytime activities of the project, but the variance allows for 30 nights of louder construction noise levels than the general noise variance levels. The contractor will be required to use "smart alarm" back-up beepers, instead of a standard reversal alarm, between the hours of 6 p.m. and 10 p.m. and a guide person or "spotter" for backing equipment between 10 p.m. and 7 a.m. the next day.

Construction information is available to noise receivers at the 24-hour hotline: 503-962-2222.

Nighttime construction activities include delivery of materials, drilling shafts, pouring concrete, constructing forms and scaffolding, placing rebar and trestle beams, and use of track and barge cranes, haul trucks, compressors, loaders, light plants and pumps.

Kiewit has worked to mitigate noise through detailed planning and careful equipment selection. Some major noise-generating activities include pile driving, drilling of shafts and concrete pumping. It is difficult to project

when and where each activity will take place, but it is anticipated that some portions of the bridge structure will require nighttime construction (for a more detailed list of hours and activities, please see the "Means and Methods - Landside Community" section above).

In general, Kiewit will reduce noise by using appropriate means of construction. Among these include:

- Drilling shafts instead of driving piles for the two abutment foundations.
- Installing sheets and piles with vibratory methods if possible and impacting them only as necessary.
- Using existing on-site power sources in lieu of generator power.

Safety and security

The eastside Greenway Trail will be a direct route for pedestrians and cyclists to move through the eastern limits of the project site. Since the Greenway Trail must remain open during construction, Kiewit will take measures to ensure public and worker safety by:

- Constructing a temporary bridge over the access road to the east work bridge.
- Maintaining adequate lighting along the trail near the work area.
- Fully fencing the work bridge entrance and both lay down yards.
- Installing fencing along the work bridge.

Temporary signage and viewing station

On the edge of the project limits along the eastside Greenway Trail, Kiewit will assemble a construction viewing station to allow the public to view the project from a safe distance. The viewing station will include information such as a link to TriMet's project website, TriMet Community Affairs telephone numbers, project facts and schedule updates, as well as provide an opportunity for the public to appreciate the project's evolution through posted photographs of various construction activities. Large, highly visible informational and directional signage will also be placed at both yard and office entrances directing visitors, pedestrians and deliveries to the appropriate areas of the project. Signage will include TriMet Community Affairs phone numbers, designated parking areas, and directional arrows. Additional safety and quality signs will also be located throughout the project to aid in setting project expectations and requirements.

Figure 1.4 - Cofferdam is a structure used to isolate a work area from a water body.

Construction sequencing and schedule

Phase I construction activities

Winter through spring 2011

- Mobilize to staging areas
- Set up office trailers
- Build access roads and grade yard
- Create an access road for the eastside work bridge

Coordination with adjacent contractors

ZRZ Realty Company and Oregon Health & Science University (OHSU) are performing construction in the area of the PMLR bridge crossing. Coordination began in early 2011 when Kiewit first met with ZRZ to discuss in-water work schedules. Working closely with ZRZ as they schedule and complete remedial work on the west side of the river will aid in the timely completion of the first in-water work activities for the bridge project (see Phase 1 Construction Activities). OHSU will be developing its Schnitzer Campus adjacent to the bridge site, and coordinating site preparation as well as construction traffic will aid in the completion of both projects. Communicating construction efforts with other contractors working on connecting the west and east project segments with the bridge, as well as the SW Moody Avenue Project, will also be necessary to complete the project efficiently.

Mobilization and site preparation

Prior to the start of the in-water work period (July 1, 2011), yard improvements, access road development, and access to the work locations will take place. Setup of the project offices and the main yard in the west access area will occur in spring 2011. In June 2011, Kiewit detoured the Eastbank Esplanade just south of OMSI in conjunction with the construction of a below-grade access road down to the eastside work bridge. Kiewit excavated the area of the trail in-line with the access road to allow placement of a pedestrian/cyclist bridge spanning the access road. With this bridge in place and tied into the trail, Kiewit removed the trail detour and finished excavating and grading the access road underneath. Early placement of the bridge and reopening the trail before the access road is complete minimized the duration of the trail detour and returned the trail to its original route. This approach eliminates potential conflicts between construction access and the trail users.

Figure 1.5 - An oscillator is necessary for the drilled shafts operation.

Summer through fall 2011

July 1 to October 31, 2011, first in-water work window.

- Place layer of sand (sand blanket) prior to pile installation in the Willamette River
- Simultaneously, install two cofferdams and work bridges on the east and westside of the river with two cranes
- Place east and westside permanent scour blanket
- Begin pier shaft installation at west tower

In-water work window

To protect endangered species located in the project vicinity, regulatory agencies have established a project in-water work window. In-water work is authorized between July 1 and October 31 of each calendar year. To complete the project on time, Kiewit will install scour protection, work bridge pile and cofferdams at both tower locations simultaneously within the first in-water work period starting July 1, 2011.

Scour protection and cofferdams

Scour protection is necessary to prevent the removal of sediment by the current from the river, such as sand and rocks, from around bridge piers. We will begin the first phase of scour protection at the start of the in-water work period in July 2011. This will include placing the initial sand layer surrounding the tower piles and work bridge pile to allow the sheet pile and pile driving work to begin. To protect fish from the impacts, Kiewit will perform the pile driving work using a bubble curtain. The bubble curtain is comprised of a barrier of bubbles to muffle the noise and vibration created by the construction equipment.

Two derrick barges [Figure 1.3] and associated support barges, anchored by using anchors or spuds driven into the river bottom, will place the scour protection and support the other marine work. During this initial phase, Kiewit will verify and mark the location of the underwater utilities near the east tower. After the utilities are marked, Kiewit will restrict construction activities in this area. Following the sand layer installation at each tower pile, Kiewit will place the cofferdam [Figure 1.4]. This semi-watertight enclosure can be pumped out to allow construction work below the waterline. Once the cofferdam is installed, Kiewit will perform fish salvage and install scour protection inside the cofferdam by filling it with sand, gravel and cobbles to the bottom of the pile cap elevation. Using a derrick barge and clam bucket, Kiewit will complete the scour protection layers outside each cofferdam as the respective cofferdam is completed. The cofferdam at each pile cap will be removed by vibratory hammer in a subsequent in-water work period after the tower construction is complete (phases 2 and 4).

Work bridges

Starting in July 2011, the pile driving for the work bridges on each side of the river will begin. Kiewit will start from the shore, progressing out to the pile cap location with the west work bridge piles, superstructure steel

and timber decking. A land crane working from the west shore will assist a derrick barge for the first long span over an existing sediment cap. After completing the west work bridge, the east work bridge will be built with a derrick barge. Once the main run of each work bridge is constructed, a work platform will be built over the cofferdam providing access for the drilled shaft operations. Working from the platform, instead of solely from barges, will provide better access and lay down area for the shaft equipment. It also reduces the need for marine equipment.

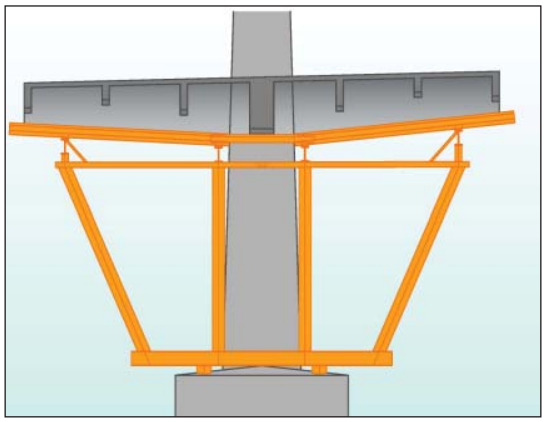

Figure 1.6 - Falsework (orange) is a temporary structure used to support the bottom deck forms.

Tower foundation-tower shafts

With the cofferdam complete and the work bridges providing access, 10-foot diameter drilled shafts will be constructed for the foundation of the towers. Serving as the base for towers, each pier cap will be founded on six shafts. A permanent casing at each shaft will be oscillated to the top of the Troutdale formation (a soil layer beneath the Willamette River). The oscillator equipment [Figure 1.5], which produces an oscillating screwing action in a downward direction, is the equipment and technology used in shaft construction.

After excavating the casing to the bottom of the shaft, Kiewit will install the rebar cage. The rebar cage will be pre-fabricated into sections—the first section will be the bottom third of the shaft and the second will be the top two-thirds of the shaft. Next, the shaft concrete will be placed, while the permanent casing is extracted to its final elevation and cut to grade at the top. After all six tower shafts are filled with concrete, we will remove the work platform and begin the pier cap construction.

Phase 2 construction activities

Winter 2011 and 2012

- Complete pier shafts at west tower
- Construct pier shafts at east tower
- Construct westside shafts – west abutment and west landside pier
- Construct west tower pier cap
- Begin west approach span (span 1) west abutment to west landside pier

Spring through summer 2012

- Construct west and east tower pylons and west pier table
- Remove eastside cofferdam (second in-water work window July 1 - October 31, 2012)
- Complete westside approach span (span 1)

Tower pier cap

Once the shafts are complete, Kiewit will begin construction of the 95-foot wide by 55-foot long pier cap [Figure 1.2] on top of the cofferdam fill. To begin, water will be removed from the cofferdam to below the pier cap elevation. Then the cofferdam fill will be fine-graded.

After the cofferdam fill is fine-graded, Kiewit will place, align and secure the pile cap forms. Kiewit will then install the reinforcement for the foundation and lower pylons. Placement of the tower crane [Figure 1.7] anchorages within the pile cap between the two tower legs will follow accordingly. Finally, Kiewit will install the pile cap made up of 2,300 cubic yards of concrete. A tower crane at each tower pile cap will service the subsequent tower and superstructure construction. Using tower cranes versus cranes on barges will improve operational safety, providing the crane operator a better vantage point to see the work. Tower cranes reduce impacts to river users and help the environment because they use electric power instead of diesel power.

West and east towers

Upon pile cap completion, Kiewit will use custom fabricated forms to construct the towers in two levels, lower level (below bridge deck) and upper level (above bridge deck). For the lower level, Kiewit will cycle a single set of forms to construct the two legs below the deck. For the upper level, Kiewit will use two sets of forms to accommodate simultaneous construction of both legs. When the west tower lower level is complete, Kiewit will cycle the forms to construct the east tower lower level. Once each tower's lower level is complete, construction of the upper level begins. Following this approach allows both the west and east towers to be constructed in near parallel activities.

Each tower leg will be built in 10 concrete pours, consisting of two pours to the deck level, then eight approximately equal height pours to the final slanted top cap section. The slanted top cap section will be

placed after the segmental superstructure is complete.

West pier table

The two pier tables (west in Phase 2 and east in Phase 3) consist of a 146-ft., 3-in. long, widened belvedere (overlook) bridge section centered atop each tower. Kiewit will build the middle 113-ft., 9-in. long section of the pier table using falsework [Figure 1.6]. The falsework will be fully supported on the pier cap and tower legs. After the falsework is completed and decked, the formwork for the pier table will be placed, and then the section will be poured in two lifts. A block out through the pier table will be made for the tower crane to extend up through the deck. This block out will be filled once the superstructure is complete and the tower crane is removed. Kiewit will erect the segmental traveler and forms at each end of the completed pier table section. Each end section of the pier table will be constructed as two 16-ft., 3-in. sections.

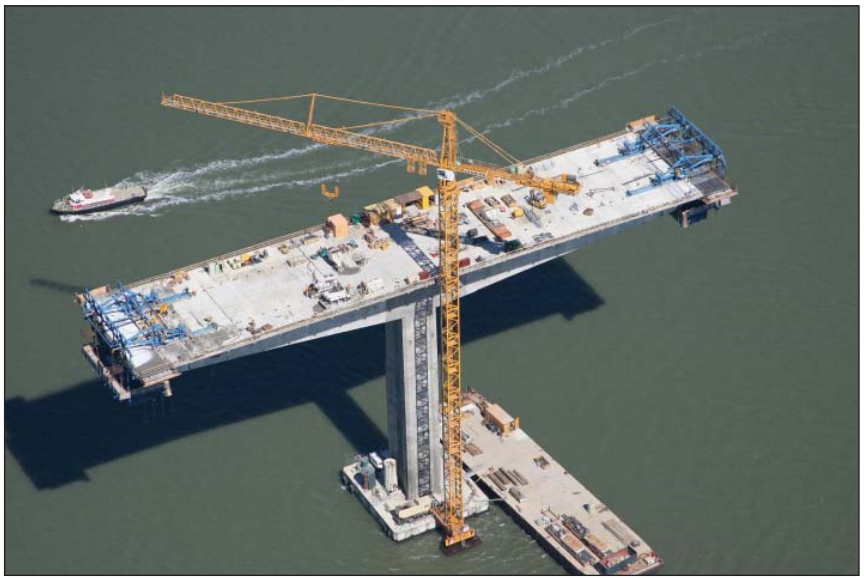

Figure 1.7 - Tower Cranes (yellow) will be placed on the pier cap to service the bridge construction. Traveler system (blue) is specialized form support systems used when doing repetitive work in a linear fashion (PMLR Bridge Deck).

Westside abutment and end spans

Kiewit will construct perched abutment pier caps and Mechanically Stabilized Earth (MSE) retaining walls. Once two 8-ft. shafts are complete, a 6-ft. diameter column will be built above each shaft. This work will be followed by the abutment cap, which creates the "perched abutment pier caps" and back wall. The MSE wall will then be built behind the abutment and along the sides of the embankment to retain the fill material. The back wall of the cap will support an expansion joint for the end of the bridge and the approach slab. Finally, the architectural wall façade will be constructed using an architectural finish.

Landside pier

Kiewit will build the columns using one full height form to eliminate construction joints. Each column will be supported on an 8-ft. diameter drilled shaft.

End spans

The superstructure of the two end spans will be constructed on typical 12-in. by 12-in. timber post falsework. Once the falsework is erected, a bottom deck platform will be constructed on top of the falsework to provide access and support for the formwork as well as overhead protection for workers below. After the concrete is placed, the post-tensioning (cables within the structure) will be stressed and the forms and falsework removed. Before placing the falsework on the eastside, the area along the river bank will be cut down to rough grade for the future Eastside Willamette River Greenway Trail alignment. By cutting a traffic opening in the falsework and providing overhead protection, the superstructure construction will pose minimal impact to the simultaneous trail work occurring below.

Removal of east cofferdam

During the in-water work window in July 2012, the east cofferdam will be removed using a derrick barge and a vibratory hammer.

Phase 3 construction activities

Fall 2012 through winter 2012 and 2013

- Begin west tower bridge deck construction using a traveler system (spans 2 and 3)
- Construct east tower pier table

Segmental deck construction

Kiewit will use cast-in-place, balanced cantilever, and segmental construction. The cast-in-place segment length used will be 16 ft., 3 in. Kiewit will use two travelers [Figure 1.7], one on each side of the Tower, in order to simultaneously build the bridge in both directions. Once complete, the travelers will be moved to the East Tower. The segmental formwork will be custom fabricated to fit the travelers and adjusted to the variable cross-sections throughout the bridge to accommodate the

Overhead Catenary System (OCS), support foundations and widened belvedere sections. After the traveler is launched, Kiewit will adjust the forms to fit the bridge cross-section as necessary for that segment. The first segment past each cable stay will be built as a typical cantilevered segmental bridge segment. Following the concrete pour, Kiewit will release the forms, then launch the traveler to the next segment. In the second segment, the bridge will require additional support from temporary cable stays.

After the traveler and formwork are launched out to the second segment, Kiewit will attach and tension a temporary cable stay to each edge girder (thicker ridged section of bridge deck profile) of the previous segment. The stays will run from the deck to the corresponding tower leg located at the top of the tower access platform above the permanent stays. After the temporary stay is attached and stressed, the cycle continues as typical. When the second segment is poured and the permanent cables are installed, the temporary stays in the previous segment are released and then will be used on the next segment. The travelers concurrently continue to build off of both sides of the cantilever deck until they reach the end, where a closure segment will be cast to connect the bridge together.

Cable stays

The cable stay installation begins after the corresponding segments on both ends of the cantilever are poured and the post-tensioning stressed. Both ends must be complete before beginning this work, because the permanent cable-stay strands run through a tower saddle and are not anchored in the tower. Kiewit will use the single strand installation method, a proven method used on several other cable-stayed bridge projects.

The tower crane hoists each of the four fabricated HDPE pipes (pipes that house the actual cable system) so they can be secured in position at the tower. Once the pipes are aligned with the two saddles in the tower and the deck anchorages, strand installation can begin. A hanging scaffold system will provide access at the saddles. From there Kiewit will assist the strand through the saddle from the pipe and ensure the strands are properly aligned. After the protective coating is removed from the end, the strand is pulled off a dispenser coil and pushed up one of the pipes from the deck, guided through the saddle, and then pushed down the other pipe to anchor in the opposite segment. A typical strand pusher, or a winch, is used for the operation. Once the strand reaches the segment on the other end, the strand is cut to length, the protective coating is removed from the cut end, both ends are placed in to the cable-stay deck anchorage, and then tensioned.

Crew individually install and stress each strand before another strand is installed in the stay. After the strand is anchored at both ends, the strand is stressed from both ends simultaneously to keep the point of zero movement in the tower saddle and avoid damage within the saddle. The next strand is then installed, and the process continues until each stay is complete.

Phase 4 construction activities

Spring, summer and fall 2013

- Complete west tower bridge deck
- Construct east tower bridge deck using traveler system (span 4 and 5)
- Remove the west work bridge and cofferdam (third in-water work window July 1–October 31, 2012)
- East Path closure to complete all east bank work for East landside Pier and Abutment
- Complete the eastside approach work

Segmental deck construction

Please refer to Phase 3 Construction Activities for the specifics of segmental deck construction.

Removal of east work bridge and cofferdam

During the in-water work window in July 2013, the west work bridge and cofferdam will be removed in a method similar to removal of the east cofferdam using a derrick barge and/or a vibratory hammer. The east work bridge deck and pile will be removed in 2014 during Phase 6 work.

Eastside abutment, end spans and landside pier

The eastside construction will be performed similar to the westside work in Phase 2. The Eastbank Esplanade will be detoured from May 1, 2013 thru December 31, 2013 in order for the abutment and landside pier to be constructed. In addition final trail improvements will be undertaken by another contractor during this detour period.

The segmental construction of the bridge will continue one segment past the last cable stay towards the West and East landside Piers. Once this last segment and the corresponding end span deck are complete, the end closure will be constructed to join the two bridge sections. Kiewit will utilize falsework to avoid loading the bridge during the pour. This, along with pouring at ideal temperatures, will minimize any differential movement of the cable-stayed bridge to the end span until stressing

the post-tensioning running through the closure to lock the bridge together can be completed.

Phase 5 construction activities

Winter 2013 and 2014 through spring 2014

- Complete Tower 4 deck construction (span 4 and 5)
- Complete eastside approach span (span 6)
- Complete all bridge connections (closures)
- Complete bridge finishes (drainage, fire protection, handrail, light rail track, electrical lighting and barrier railing)

Completion of deck segmental

As the superstructure nears mid-span from both sides, the edge girder widens and then splits into a pair of edge girders. This allows the last two sets of cable stays to anchor between the edge girder pairs and maintain the required navigational clearances. Kiewit will adjust the segmental formwork and traveler for the added combined edge girder width and continue through this area building bridge segments as before.

Mid-span closure

At mid-span, segmental construction will stop near the last cable stay. This results in a closure length of approximately 49 ft. Once both back span closures are complete, the mid-span cantilever (deck) ends will be tied together and the closure completed. Kiewit will place four edge girders across the closure, leaving a 4-ft. closure on each end to the cantilever tip. Then the rebar across the closures will be coupled together and the edge girder closures will be cast. Once the concrete has achieved initial strength, Kiewit will partially stress the post-tensioning running through the mid-span closure to lock the bridge together. Kiewit will then hoist up a platform and formwork to build the remaining portion of the mid-span closure.

Track, barrier and top slab

Upon the completion of the west closure pour, which is the first of the three stages, construction of the barrier and track work will begin. This work will proceed from the West Abutment to the center of the West Tower. Following the completion of the east closure pour, barrier and track work will be completed from the center of the East Tower to the East Abutment. Construction of the last stage, which is the center or mid-span closure, will allow the barrier and track work to be completed from the center of the East Tower to the center of the West Tower.

Finishing

Kiewit will complete finishing work, such as lighting, electrical, cable dampeners, pedestrian railing and drainage, as well as punch list items, including concrete dry finish, as construction of the bridge progresses.

Phase 6 Construction Activities

Summer 2014

- Remove east work bridge and clean up

Work Bridge Removal

During the final in-water work window that begins July 1, 2014, the east work bridge will be removed using a derrick barge and/or a vibratory hammer. Removal of the work deck and pile will conclude the in-water work for the project.

Summary of construction sequencing and schedule

Phase I construction activities

Winter through spring 2011
- Mobilize to staging areas
- Set up office trailers
- Build access roads and grade yard
- Create an access road for the eastside work bridge

Spring through fall 2011
July 1 to October 31, 2011, first in-water work window.
- Place layer of sand (sand blanket) prior to pile installation in the Willamette River
- Simultaneously, install two cofferdams and work bridges on the east and westside of the river with two cranes
- Place east and westside permanent scour blanket
- Begin pier shaft installation at west tower

Phase 2 construction activities

Winter 2011 and 2012
- Complete pier shafts at west tower
- Construct pier shafts at east tower
- Construct westside shafts – west abutment and west landside pier
- Construct west tower pier cap
- Begin west approach span (span 1) west abutment to west landside pier

Spring through summer 2012
- Construct west and east tower pylons and west pier table
- Remove eastside cofferdam (second in-water work window July 1 - October 31, 2012)
- Complete westside approach span (span 1)

Phase 3 construction activities

Fall 2012 through winter 2012 and 2013
- Begin west tower bridge deck construction using a traveler system (spans 2 and 3)
- Construct east tower pier table

Phase 4 construction activities

Spring, summer and fall 2013
- Complete West Tower bridge deck
- Construct East Tower bridge deck using traveler system (span 4 and 5)
- Remove the west work bridge and cofferdam (third in-water work window July 1–October 31, 2012)
- East Path closure to complete all east bank work for East landside Pier and Abutment
- Complete the eastside approach work

Phase 5 construction activities

Winter 2013 and 2014 through spring 2014
- Complete Tower 4 deck construction (span 4 and 5)
- Complete eastside approach span (span 6)
- Complete all bridge connections (closures)
- Complete bridge finishes (drainage, fire protection, handrail, light rail track, electrical lighting and barrier railing)

Phase 6 Construction Activities

Summer 2014
- Remove east work bridge and clean up

Work Bridge Removal
During the final in-water work window that begins July 1, 2014, the east work bridge will be removed using a derrick barge and/or a vibratory hammer. Removal of the work deck and pile will conclude the in-water work for the project.