ESSB 6392: Design Refinements and
Transit Connections Workgroup | **Appendix C: Public comments**

Washington State Department of Transportation

SR 520 Bridge Replacement and HOV Program

I-5 to Medina: Bridge Replacement and HOV Project

ESSB 6392 Workgroup recommendations Public comment summary

Below is a summary of the comments received by participating agencies and the general public on the Workgroup's recommendations during the comment period from Sept. 13 to 24, 2010.

Participating agency comments:

Seattle City Council

Sept. 13 key verbal comments

On Sept. 13, 2010, WSDOT and SDOT provided a Workgroup update to the Seattle City Council Special Committee on SR 520. At this meeting, several council members commented on the Workgroup recommendations for SR 520. A full summary can be found in Appendix C. Key comments include:

- Montlake second bascule bridge: Specify the triggers for the second bascule bridge, and determine far in advance if we need a second bascule bridge in the first place. Establish a strict decision-making process for the construction of this second bascule bridge.
- Tolling: Promote tolling on SR 520 as a way to fill the funding gap for the bridge and manage traffic.
- Traffic: Reduce traffic, don't just move it to different surface streets.

Comment letter

The Seattle City Council provided a comment letter on the Workgroup recommendations. Comments include:

- Montlake bascule bridge: Decide if and when the bridge is needed. The Council supports exploring alternatives and establishing triggers for future evaluation of the needs for the second crossing.
- Traffic management:
    - Use dynamic tolling with other traffic management tools to more efficiently and effectively manage traffic operations on SR 520.

- Create a mitigation funding source that will allow WSDOT and SDOT to address specific issues in neighborhoods affected by traffic as they arise.
- SDOT and WSDOT should continue working together on traffic management issues, especially in the vicinity of Roanoke Park.

- Portage Bay Bridge:
  - Make the bridge as narrow as possible.
  - Create a "boulevard" design on the bridge that will enhance the character of the bridge and assist with traffic speed control.
  - WSDOT should continue working with the Seattle Design Commission and SDOT to continue refining the designs for the Portage Bay Bridge.
- Foster Island and the West Approach:
  - Continue exploring options to narrow structures through the SR 520 corridor, including structures above Foster Island.
  - Examine the impacts of reducing speeds to 45 miles per hour and creating a roadway design that is consistent with lower speeds.
- Parks and public land:
  - The land in McCurdy Park that is removed from public use should be replaced with comparable lands in the vicinity.
  - Create safe and attractive bicycle and pedestrian connections between the Arboretum and the Montlake lid.
  - Minimize disruptions to other public lands in the vicinity.
- Commitment to high capacity transit and light rail in the SR 520 corridor: Ensure that every possible consideration is accounted for without substantially increasing the cost or environmental scope of the project.
- Other: The Seattle City Council also provided general comments on funding and process, including support for I-90 tolling. The Council's full comments are available in Appendix B.

Seattle Mayor

- Light rail: Make SR 520 light rail ready from the start and emphasize high capacity transit. Address technical questions regarding shoulder widths on the bridge deck to accommodate light rail, building additional pontoons to support light rail and the West Approach bridge gap.
- Environment: Address environmental concerns, including protecting natural areas and open spaces and reducing vehicle miles traveled and greenhouse gas emissions.
- Traffic: Develop plans for managing SR 520 traffic in Seattle neighborhoods.
- Project funding: Address the $2 billion funding gap for the Seattle portion of this project.

University of Washington

- Montlake second bascule bridge: The second Montlake bascule bridge is a critical element to enhance pedestrian, bicycle and transit access to the University of Washington (UW) campus. The existing sidewalks on this bridge are too narrow to accommodate the increase in cyclists who will be able to cross SR 520 on the new path. Transit could also be delayed as traffic has to merge from the SR 520 interchange area into the four existing (and narrow) lanes.
- Arboretum: Support for the preferred alternative's design that removed ramps from the sensitive area of the Arboretum, while maintaining most of the functionality for transit. The design retains capacity along Montlake Boulevard so that transit is not unduly delayed.
- Left turn on 24th Avenue E and E Lake Washington Boulevard: Permanent turn restrictions on 24th Avenue E would compromise transit flow on Montlake Boulevard.
- Montlake Triangle bicycle and pedestrian crossing: Significant benefits to the University and the broader community from the overcrossing of Montlake Boulevard which WSDOT can use public funds to support.

King County Department of Transportation:

- Montlake second bascule bridge: Recommendations related to phasing the second bascule bridge in the preferred alternative may significantly impact transit speed and reliability, particularly on 23rd Avenue E, Montlake Boulevard and Pacific Street. KCDOT requests further analysis by WSDOT to determine the impact of phasing the second bascule bridge as part of this project.
- Traffic modeling for bus stops in Montlake Triangle area: Additional traffic modeling to fully understand the general traffic congestion and travel time impacts of the different options, as well as associated estimated costs, will also be critical and KCDOT looks forward to reviewing that information.
- Loss of Montlake freeway transit station: To preserve the connection that is being removed with the Montlake freeway transit station, additional and ongoing operating resources will be needed. KCDOT looks forward to upcoming conversations with WSDOT about how to appropriately mitigate for the transit station removal in order to maintain current levels of connectivity.

General public comments

After the release of the Workgroup's draft recommendations, the public was invited to provide comments between Sept. 13 and 24 by e-mail, online survey, mail, or in person at the Seattle City Council Special Committee hearing on SR 520 on Sept. 13.

A total of 138 comments were received, including:

- 72 by online survey
- 50 by e-mail
- 14 at the City Council meeting.
- 2 by mail

The comments covered a wide spectrum of topics and opinions and were identified with one of the following key categories.

Removal of Montlake freeway transit station (47 comments)

All comments noted concerns with the removal of the Montlake freeway transit station. Most comments focused on how the removal of the transit station would create a difficult commuting situation for cyclists and those commuting to the Eastside. Many comments believe that new stops on the Montlake lid will not replace the functionality of the current flyer stop, and several Montlake residents stressed the importance of routes such as the Sound Transit 545 that use the transit station. One comment suggested adding a transfer stop at the University of Washington to make up for the loss of the transit station.

Montlake second bascule bridge (32 comments)

A majority of comments showed opposition to the second bascule bridge. Of the comments in opposition to the bascule bridge, many indicated that construction of the bridge would have negative effects on the Montlake neighborhood, the character of the existing bridge and the Montlake cut. Several comments noted that a second bascule bridge will not help traffic at all, as "traffic congestion arises from poor traffic management north and south of the bridge."

Several comments provided ideas on how to improve the design of the second bascule bridge, including only allowing transit, HOV and bicycle/pedestrian access on the bridge, constructing transit priority lights on the bridge, and converting the two inner lanes to reversible lanes allowing traffic flows to change during peak commute periods. One comment recommended bypassing the drawbridge so that traffic flows are improved and reliable.

Several comments did indicate support for this bridge and urged the Workgroup to not support plans to delay or phase the bridge, stressing that delaying or phasing the second bascule bridge will negatively impact traffic, homes and businesses in the Montlake area.

Transit locations, connectivity and general issues (32 comments)

Comments were usually focused on transit issues such as stop locations and bus transfers. Many comments requested designs that better accommodated bus and high capacity transit, and designs that optimized transfers. Several comments recommended a better connection between buses and the University of Washington light rail station.

Bicycle and pedestrian issues (23 comments)

Many comments recommended bicycle and pedestrian improvements. Several comments supported the bicycle lane on the floating bridge, with one comment requesting the placement of this lane on the south side of the bridge, instead of the planned location to the north. Several comments requested a bicycle tunnel in the Montlake Triangle area, and to the Burke-Gilman trail. One comment supports construction mitigation measures to protect cyclists and pedestrians in the Montlake area. Several comments also mentioned bicycle facilities on E Shelby Street, 23rd and 24th Avenue E. Specifically, one comment requested that bicycles not be allowed on 23rd and 24th Avenue E, as an easy alternative exists on the nearby Burke-Gilman trail. Finally, several comments showed support for design plans including bicycle parking, lockers, ports and covered racks.

Effects to the Arboretum (16 comments)

Many comments centered on strong opposition to traffic in the Arboretum. There were several comments about Foster Island, including a desire to protect Foster Island habitat, reduce the width of the roadway over the island, and improve noise mitigation from the west side of the island to the bridge deck. One comment strongly advocated for Arboretum improvements such as crosswalks and the replacement of waterfront affected by the project. A few comments also focused on the involvement of the ABGC both as part of the Arboretum planning effort as well as future design processes. One comment opposes the removal of ramps through the Arboretum in the SR 520 preferred alternative, believing that this will cause more traffic for the nearby neighborhoods.

Light rail (13 comments)

Many comments opposed a bridge that was not light rail ready from the beginning. Several comments support the Workgroup's recommendations for future light rail plans, and one comment opposes any light rail on the bridge in the future. One comment noted that there should be clear measures that will enable future light rail projects on SR 520, and one comment opposes any light rail alignments built above Marsh Island or the Montlake Cut for environmental protection reasons.

Left turn from 24th Avenue E to E Lake Washington Boulevard (12 comments)

Many comments centered on strong opposition to allowing left turns from 24th Avenue E to E Lake Washington Boulevard. Of those comments opposing the left turn, one comment wrote that "allowing this left turn will negatively affect this section of 24th Avenue's ability to function as a safe bicycle boulevard." Several comments strongly supported the left turn, stating that "it has been demonstrated to be an important feature that will ensure reasonable flow through the area south of the new SR 520 Montlake interchange." Another comment believes that the left turn "…must be maintained at all times. To eliminate or reduce it creates a larger carbon footprint by requiring vehicles to travel longer distances resulting in more emissions."

Funding (11 comments)

Many comments voiced concerns about the funding gap and recommended that the project not begin until all funding sources are clearly identified. One comment requested that the Legislature identify where project funding will come from, and many comments are concerned that a lack of funding will result in a "bridge to nowhere" and that Seattle improvements will inevitably be delayed.

Noise (9 comments)

Many residents asked the Workgroup to support noise abatement measures. Several comments recommended reduced speed limits and the reduction of traffic on surface streets. Some comments noted concern with the effectiveness of absorptive materials, noise walls and quieter concrete. The height of the noise walls was also discussed, with one comment supporting higher walls, and one comment urging for shorter walls to maintain SR 520 as a scenic highway. Finally, one comment recommended that noise walls and lids should be placed on hold until the economy improves.

Montlake Boulevard improvements (8 comments)

Responses generally focused on the width of the roadway and plans for transit priority on Montlake Boulevard. Comments outlined that dedicated north/south transit lanes should be established on Montlake Boulevard, buses should be allowed to make a free right turn on Montlake Boulevard, and transit access should be the highest priority for Montlake Boulevard. Many comments also suggested ways to widen Montlake Boulevard and the Montlake Boulevard overpass. One comment suggested that an 8-foot or 10-foot sidewalk in the Montlake area severely underestimates the current and future demand for bicycling and walking, and suggested including a sidewalk that meets the current and future demand, including possible on-street bicycle facilities.

Portage Bay Bridge Improvements (8 comments)

Several comments supported the removal of a planted median on the Portage Bay Bridge. Several comments recommended reducing the width of the bridge, for practical and environmental reasons. Finally, a comment suggested that a design competition should be held to determine the design of the bridge, and one comment recommended that the speed limit on the bridge should not be as low as 45 miles per hour, as this would cause traffic delays.

Corridor management planning (7 comments)

Some comments focused on the need for better corridor management planning. One comment emphasized the need for a corridor management plan rather than a corridor management agreement. Another comment developed a sample corridor management plan that could be used by WSDOT.

Floating bridge Improvements (7 comments)

Several comments provided recommendations on the design of the floating bridge. Comments included increasing the width of the bridge to eight lanes, while several comments opposed a wider bridge, and one comment recommended enough room be saved to add another SOV lane in the future. Finally, one comment wrote that the height of the new bridge should be no greater than that of I-90.

Environmental issues (5 comments)

Some comments focused on concerns about environmental impacts from this project and Workgroup recommendations. One comment focused on extra greenhouse gases produced if traffic backs up on E Lake Washington Boulevard as a result of a restricted left turn from 24th Avenue E. Other comments focused on wildlife habitat and parks impacts due to the SR 520 project.

I-5/SR 520 connections (4 comments)

In this area, comments were primarily focused on the ease of connecting to and from SR 520 and I-5. One comment recommended adding a southbound ramp to eastbound SR 520 from the express lanes of I-5, and widening the westbound ramp from SR 520 to southbound I-5. Another comment requested that the technical team re-evaluate the direction of the I-5/SR 520 reversible HOV lanes, as traffic may be better served if the HOV lanes operate in the opposite direction. Comments also noted concern with the width of SR 520 as it meets I-5, with one comment stating that “this will cause even more bottlenecks than today.”

ESSB 6392 Workgroup
600 Stewart St., Ste. 520
Seattle, WA 98101

RE: SR 520 Public Comments: Cascade Bicycle Club

ESSB 6392 Workgroup:

On behalf of Cascade Bicycle Club and our over 13,000 members, we appreciate the opportunity to provide public comment on the SR 520 I-5 to Medina Design Refinements and Transit Connections, as released by the ESSB 6392 Workgroup. With thousands of current and potential future bicyclists affected by SR 520 and the landings, Cascade Bicycle Club is invested in the outcome of this project.

We appreciate the state's efforts to coalesce key stakeholders to identify solutions to the design challenges confronting this project. While improvements have been made to the design of the preferred alternative, we still have concerns about specific elements of the project. We appreciate your consideration and attention to the following recommendations.

Key concerns and recommendations

General

Funding Gap and Project Phasing: Given a two billion dollar funding gap, we are concerned that the final SR 520 product will either exclude critical elements of the current plans or postpone critical elements of the project. With this in mind, we urge you to prioritize the investments that support overall mobility and environmental sustainability, such as traffic calming measures, a complete nonmotorized network through the project area, lids and efficient access to transit. These provisions are absolutely necessary to support the state's commitment to reducing VMT and GHG, and moreover, they will alleviate some of the negative impacts of this project in the surrounding communities.

The funding gap threatens to postpone elements of the SR 520 project. Delaying any facet of this project should not result in reduced mobility for the thousands of people who bike and walk in the area to access destinations such as the UW and the Burke Gilman Trail. Safe and efficient access for bicyclists and pedestrians should be a priority for the SR 520 Program and should not be compromised or delayed in the event that funding is not available. The project phasing should allow for bicycle and pedestrian facilities to be available concurrently, if not prior to, the opening of the floating bridge and landings to general-purpose traffic.

Bicycle and Pedestrian Connectivity through Construction: Construction mitigation is necessary throughout the duration of the SR 520 project. The Montlake area has some of the highest volumes of bicyclists and pedestrians in Seattle. With the intensity of construction activities planned for this area, we strongly encourage the implementation of a construction mitigation plan that supports efficient and safe access for bicyclists and pedestrians and doesn't render bicycling and walking impracticable for thousands of people during construction.

Design Specific

Montlake Boulevard at E Hamlin Street: According to the materials from the August 19 ESSB 6392 Workgroup meeting, the Montlake cross section will include a widening of the current sidewalk to 10 feet, from the current eight feet. Options were presented to alleviate concerns about losing two feet of landscaped buffer to a sidewalk, including maintaining the two feet as a permeable surface to function as a sidewalk while supporting the landscaped buffer. Decisions are being made about how to reallocate the existing, minimal green space and pedestrian/bicycle facilities that together support environmental remediation, urban design and mobility. Meanwhile the seven-lane vehicle cross section in this corridor, or 77 feet of asphalt, remains untouched. An eight-foot or 10-foot sidewalk in this area severely underestimates the current and future demand for bicycling and walking. **We encourage the state to reevaluate the cross section in this corridor to include a sidewalk that meets the current and future demand, and possibly includes on-street bicycle facilities.** If the state does not intend to reduce the number of GP lanes in this corridor, the lane widths, at a minimum, should be reduced to allow for a nonmotorized facility that meets guidelines and supports demand.

24th Avenue East: 24th Avenue East currently functions as a critical link in Seattle's bicycle network. The Seattle Bicycle Master Plan has proposed this route as a future bicycle boulevard. Under the SR 520 preferred alternative, 24th Avenue East will intersect five lanes of the SR 520 westbound off-ramp—a 65-foot cross section where three GP lanes and two direct access HOV lanes (one EB and one WB) will filter into the city street and bicycle network. At this intersection, vehicles will be able to turn left to access Lake Washington Boulevard and head southbound on Montlake. This would negatively affect this section of 24th Avenue's ability to function as a safe bicycle boulevard. While a variety of trails/paths are planned in this area, these should not be viewed as a replacement to Seattle's on-street bicycle network. The state should consider the implications of this design for the bicycle and pedestrian network.

Montlake Bascule Bridge Cross Section: The cross section of the current bascule bridge has five feet of right of way space that has not been programmed. We believe this space could function as a bicycle facility if materials are used to prevent bicyclists from riding directly on the bridge grates. We encourage the state to consider this possibility, and to consider reducing the east side GP lane to 11 feet, which would allow for a six-foot bicycle facility on the west side of the bridge.

While we support a bicycle facility along the bascule bridge, it would need to safely integrate with connecting bicycle infrastructure on both approaches to the bascule bridge on Montlake. Providing the supporting bicycle infrastructure across the Montlake Cut is necessary, particularly if a second bascule bridge, with a planned 18-foot bike/pedestrian sidewalk, is not built until a later date. By improving the bicycle and pedestrian infrastructure along the current bascule bridge, the need to construct the second bascule bridge may not be as immediate (given a bicycle/pedestrian level of service is identified as a trigger).

10th Avenue E and Roanoke: We encourage the State to consider tightening up the intersection configuration at 10th and Roanoke. This is a critical route for bicyclists. The planned configuration shows curb radii that will facilitate faster moving vehicles and ultimately threaten the safety of bicyclists and pedestrians through the corridor.

E. Shelby: While final design decisions have not been made with regards to E. Shelby, we support improvements to the bicycle infrastructure along this route. Of the two alternatives currently proposed—a one-way eight-foot separated bikeway or a two-way 12-foot separated bike lane—we would recommend the two-way 12-foot separated bike lane.

Bicycle Parking: In our conversations with WSDOT and in the June 17 technical team work plan, bicycle parking was stressed as a key focus of the ESSB 6392 Workgroup. We have not received information about plans for bicycle parking throughout the project area. Bicycle parking—lockers, ports, and covered racks—should be included in the SR 520 design plans. At a minimum, the current bicycle parking along Montlake should be replaced because current demand exceeds capacity.

We appreciate your consideration of the above comments and look forward to working with you to further refine the SR 520 design. Please contact us should you have further questions.

Sincerely,

Chuck Ayers
Executive Director
Cascade Bicycle Club

U.S. Department
of Transportation
Federal Transit Administration

REGION X
Alaska, Idaho, Oregon, Washington

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Submitted after the close of the comment period.

September 30, 2010

Ms. Julie Meredith
Washington Dept. of Transportation
SR 520 Bridge Replacement and HOV Program Project
600 Stewart St.
Suite 520
Seattle, WA 98101

Re: FTA Comments on ESSB 6392 Draft Recommendations Report

Dear Ms. Meredith:

Thank you for the opportunity to comment on the ESSB 6392 Working Group Draft Report on Design Refinements and Transit Connections for the SR 520 Bridge Project ("Draft Report"). The Federal Transit Administration ("FTA") is always pleased to see the Washington Department of Transportation working to improving improve transit facilities and connections, especially on complex projects such as the SR 520 Bridge Project. We appreciate WSDOT's work and that of the Working Group in this regard.

In general, the Federal Transit Administration ("FTA") endorses the significant improvements suggested for pedestrian and bicycle connections. The Draft Report properly reflects, in our view, the increasing numbers of pedestrians and cyclists who will use transportation facilities in the project area, and also reflects the investments that will help incorporate them smoothly into the system.

In other areas, FTA reiterates concerns that were raised in our comments on the Supplemental Draft Environmental Impact Statement (SDEIS) last April:

- How will the Project incorporate the SR 520 High Capacity Transit Plan ("the HCT Plan")? The key short-term elements of the HCT Plan are Bus Rapid Transit ("BRT"), and the Montlake Multimodal Center. The Draft Report does not include a consistent vision or description of how either of them will be integrated into the Project.

- In particular, the Draft Report does not seem to consider the multimodal center as a necessary element of effective transit service in the project area. The Draft Report's supporting White Paper on Bus Stop Locations observes, "The 2008 HCT Plan recommended the creation of a multimodal transit hub in the Montlake Triangle area, **and** suggested an expanded bus stop on NE Pacific Street between NE Pacific Place and the existing taxi/patient drop-off/pick-up location" (p. 2) (emphasis added). [1] However, the Draft Report speaks **only** to expanded bus stops. It does not appear to address the need for or the requirements of a transit hub that would add BRT to regular bus service, light rail service, and pedestrian-bicycle connections. If the functional requirements of this kind of a transit center can be met with only the expanded surface-street bus stops recommended in the Draft Report, that should be explained.

- In addition, the White Paper on Bus Stop Locations does not mention BRT service as a factor in the placement or requirements of bus stops in the vicinity of the Montlake Interchange, notwithstanding that the main criterion for locating the Montlake Interchange bus stops is the convenience of transferring between local bus service and regional bus service (White Paper, p. 3) – a significant portion of which will be BRT.

- Similarly, as noted in FTA's comments on the SDEIS, effective BRT would require direct access to UW Station. The Draft Report is not clear whether Options E and F (which do appear to provide direct access to UW Station) contemplate regular bus service or BRT; would that affect the analysis comparing the effectiveness of potential bus stop locations around the Montlake Triangle?

- The Draft Report apparently used light rail ridership forecasting which assumed that UW Station would be the Central Link terminus, and accordingly,

- the Draft Report observes that "further evaluation should include ridership estimates that include the light rail extension to Northgate" (White Paper, p. 24). FTA agrees that this is critical information. Among other things, it might alter the current assumption that only 20 percent of riders will transfer between bus and rail at UW Station.

- FTA understands the significant challenges in planning at the Montlake Triangle. The Montlake Triangle Charrette (MTC) that occurred as part of the ESSB 6392 process was clearly a useful step in that process. Still, we urge WSDOT, King County Metro, the University of Washington, and Sound Transit to reach a preferred alternative for the Triangle quickly. Sound Transit's UW Station and the Central Link light rail line represent a sizeable public investment, and FTA – a principle funder of the Link project – encourages the affected agencies to continue their focus on finalizing this critical element in order to minimize the need for Sound Transit or King County Metro to re-work any completed construction required to accommodate changing Montlake Triangle plans.

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[1] The Plan states, "Not only will the Montlake Multimodal Center improve access to the University District, it will also be a major transfer point between rail, the proposed SR 520 bus rapid transit lines and the existing local transit service" (p. 28).

Again, FTA sincerely appreciates the project team's efforts on this complex project. Please let me know if we can provide assistance in any way.

If you have questions, please contact John Witmer at John.Witmer@dot.gov or 206-220-7964.

Sincerely,

RF Krochalis
Regional Administrator

cc: Daniel M. Mathis, FHWA
James Irish, Sound Transit
Ron Posthuma, King County Metro
Peter Dewey, University of Washington Transportation Services

6392 Workgroup
WSDOT
SDOT

Thu 23 Sep '10

Re: Comments on ESSB 6392 Process from Friends of Seattle's Olmsted Parks

Dear Reviewers,
This SR 520 Preferred Alternative is a bad compromise!

The perceived benefit of direct access to eastbound HOV for regional transit, which is the fundamental basis of this Preferred Alternative, is a big loser for the WP Arboretum and Lk Washington Blvd. Metro transit representatives insisted on direct HOV access in Alternative A during the 520 Mediation and in Alternative A+ during the Legislative Workgroup deliberations (to avoid weaving across 2 lanes of toll controlled, potentially free-flowing, lanes on 520), but their buses will be weaving across 2 lanes of congested Montlake Blvd in this Preferred Alternative anyway!? The trade-off for this dubious "benefit" is more lanes of concrete over water, increased wetland impacts in the Arboretum (over by Marsh Island) and terrible choices for traffic on Lk Washington Blvd through the Arboretum.

The most obvious consequence of this Preferred Alternative is the continued and increasing traffic volumes on Lk Washington Blvd through the Arboretum. On the day this PA was announced, I asked WSDOT Asst. Sec. Dave Dye how the traffic would be handled at the south end of 24th, to lessen the impact on the Arboretum. He said that tolling would solve it. Most unfortunately that possibility has disappeared from your discussions. Not allowing a left turn there by General Purpose (GP) traffic gets SDOT riled up and saying that they would have to do something they really don't want to do, like enlarge the street right of way south of the Hop-in Grocery (no house takings), even though that was evaluated in the SDEIS for Alternative A and found to be effective. That would then cause further dismay at SDOT due to traffic volumes on Boyer and Interlaken (residential non-arterial streets) for residents trying to get back to Madison Park and Madrona. These are cascading consequences of the ill-considered decision on the use of 24th for traffic exiting to the south in this Preferred Alternative.

Complicate all of that by moving the southbound Montlake bus stop from the existing transit island to where it would block off access to the Hop-in Grocery parking (for questionable benefit to pedestrian street crossing access), and again the Arboretum and Lk Washington Blvd are the big losers, because this makes it even harder to get 520 traffic to the south.

The only ray of sanity in this process has come from the State Historic Preservation Officer (SPHO), who has recently determined that Lk Washington Blvd deserves to be evaluated as an individual resource for the FHWA Section 106 Historic Preservation

Review. This means that there will be a higher standard for detrimental impacts to Lk Washington Blvd.

At this point you should seriously consider eliminating the eastbound bus access ramp to 520 and it's left turn pocket on Montlake, and put it back on the quarter clover leaf where it is now, which also restores the HOV access ramp for traffic from the south. Bring back the proposed new traffic signal at the end of the westbound 520 off-ramp for traffic heading south, and eliminate 24th Av across the lid all together. Doing these would reduce environmental impacts and the project cost substantially, some of which should be re-directed to help commuters switch to transit. There would be 9 lanes on 520 at Marsh Island instead of 12 lanes and less parkland would need to be traded for. PM peak hour traffic on Lk Washington Blvd would be 1200 vph instead of 1500 vph, and there would be no need for tolling equipment or turning restrictions. The need for intrusive traffic calming bumps and the visual blight of additional signage on historic Lk Washington Blvd would be un-necessary. Stop this cascading descent into destruction of these precious park resources.

Larry Sinnott, AIA
Boardmember, Friends of Seattle's Olmsted Parks (FSOP)
FSOP Rep to SR 520 Mediation

Greater Seattle Chamber of Commerce

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September 22, 2010

Julie Meredith
SR 520 Program Director
ESSB 6392 Workgroup
600 Stewart St., Ste. 520
Seattle, WA 98101

RE: Chamber comments on SR 520 Draft Recommendations Report

Dear Julie,

Thank you for the opportunity to comment on the ESSB 6392 Design Refinements and Transit Connections Workgroup Draft Recommendations Report for the SR 520 Bridge Replacement and HOV Program.

The Greater Seattle Chamber of Commerce believes that our economic vitality relies on dependable infrastructure, and the replacement of the 520 Bridge is of paramount importance to the Puget Sound region and the entire state of Washington. We support the preferred alternative announced by the Governor earlier this year and we are pleased construction will begin on key portions of the bridge in the very near future.

The business community is keenly interested in refinements to the West side approach for the SR 520 replacement project as they relate to the Preferred Alternative recommended by the SR 520 Workgroup. We continue to value solutions that improve safety and reliability within the 520 corridor, enhance mobility for transit, freight and other modes of travel, while respecting the concerns of the communities adjacent to the corridor. These evaluation criteria are consistent with our comments and suggestions made through the many years of study and debate that have preceded this draft report.

We appreciate the effort made by the various committees involved in this draft report and, for the most part, we can support its recommendations. However, we are concerned with some elements that we believe could increase congestion in the Montlake area and potentially degrade transit service, general mobility, and the neighborhood itself.

First, we believe the current and projected traffic numbers and local transit service demand and reliability supports the construction of a second bascule bridge across the Montlake Cut. The idea of using triggers and future evaluation criteria is curious when one considers the requests and studies put forth by Metro Transit and the statements from current users within the Montlake corridor. WSDOT's experts state the bridge is needed for reasonable service and flow, and we believe a second bascule bridge is needed as well.

Second, the left turn lane at 24th Avenue has been demonstrated to be another important feature that will ensure reasonable flow through the area south of the new SR 520 Montlake Interchange. We note the report supports this movement, but we realize there is pressure to limit it. We can support the traffic calming efforts proposed within the Arboretum, but we cannot support those who would propose pushing more traffic into Montlake. We believe further limitations would degrade transit service, mobility and the neighborhood.

We believe the remaining recommendations found in the report are in the spirit of earlier efforts and should be forwarded to the Governor and Legislature.

We appreciate the opportunity to state our views on this critical matter, and we look forward to working with you to move this project to completion.

Sincerely,

Mark A. Weed
Transportation Committee Chair
Greater Seattle Chamber of Commerce

Laurelhurst Community Club
Madison Park Community Council
Serving Seattle's Laurelhurst and Madison park Communities since 1920

September 24, 2010

To: WSDOT ESSB 6392 Workgroup

Re: Comments from Laurelhurst Community Club and Madison Park Community Council

Representatives from our densely populated communities have been actively engaged in the plans and design process for the re-build of SR520 for over 15 years.
We also participated fully in the State Mediation process for over 18 months to develop viable solutions for new designs that will serve the transportation needs of the corridor and best respects the environment which will be impacted by its re-build.

This process will result in a new SDEIS which evaluates all options proposed.
In addition to Options A, K, and L, the seven stake holding communities adjacent to SR520 endorsed Plan M, which is a 700 foot underpass tunnel under the Montlake Cut as the best option to increase mobility and reduce environmental impacts. It was not officially included in WSDOT's top 3 SDEIS options. We still support that solution as the most optimal for the re-build of SR520 at a price tag of $49.5 million, excluding bloated earmarks from the University of Washington to its plan.

In reviewing the Workgroup's recommended Option A+, our communities do not support this as our preferred option, but will comment on the technical aspects of the Workgroup's recommendations and requests for better outcomes for our residents.

Our comments include the following:

1.The entire corridor must be functioning with all lanes as it crosses from the portal at the Eastside through to I-5 or it **should not** be built across Lake Washington until a complete financing package is approved . Building any partial bridge would result in a dysfunctional transportation corridor for Seattle residents and eastside HOV users .A partially built bridge will create traffic bottlenecks at the western high rise on top of lake Washington at the merge point. (see page 29-funding program and other separate comment pages submitted on this issue)

2. Neighborhood traffic management for Seattle city streets must be planned with SDOT **before** the bridge plan is final. Analysis of travel times must be re-done with a new model, based on any changes recommended by the Technical Workgroup e.g. added volumes to streets adjacent to the Arboretum and Lake Washington Blvd, cut through traffic on Montlake streets, and the diversion and back ups into streets in the University District and through Ravenna as drivers find alternative ways to reduce travel times. Operations at NE 45th St, Montlake Blvd through to Sandpoint Way NE will be effected with any new configurations of access to SR520.

3. Transit travel times must be predictable and efficient to encourage ridership. Removing the second bascule bridge to build instead at a late stage will increase transit travel time, which is contrary to a top priority of the new bridge design. The north/south mobility of Montlake Blvd must be maintained with adequate capacity to accommodate planned expansion for the University of Washington, the University Village and Seattle Children's Hospital which will add over 3800 daily vehicular trips over the next 5 years. Reducing capacity will be detrimental to the businesses and institutions so important to support robust regional growth.

4. Removing an exit ramp westbound for transit and vehicles down to one lane (page10) will result in longer travel times for transit and vehicles. In existing conditions, westbound now has 2 exits, one north and one south. The A+ design combines this function into 1 exit ramp, and adds 2 stoplights, the result will be creating gridlock with back ups onto SR520. The original plan allowed for greater capacity of this dual function with 2 lanes, albeit it creates a larger footprint. **Tradeoffs for this option must not result in a plan where it creates worse mobility than existing** for western access. Game days for football, special events and basketball will be untenable for access to the University and neighborhoods in northeast Seattle and those south of the Monlake Cut, trying to exit using only 1 ramp as well as everyday peak time operations.

5. The left hand turn from 24th Ave East to Lake Washington Blvd must be maintained at all times. To eliminate or reduce it creates a larger carbon footprint by requiring vehicles to travel longer distances resulting in more emissions. It will also reduce wait times for transit and all vehicles on the westbound off ramp. Arboretum traffic can be mitigated using methods recommended by the Technical Workgroup.

6. Noise reduction strategies- there is a need to define exactly where the 4 foot traffic barriers will be located. The statement on page 22 of the report is vague. Our two neighborhoods **specifically request these barriers continue through to the top of the western high rise to reduce noise.** Noise reduction has been the number one priority for mitigation for 15 years. The new quieter concrete study is not yet complete. Data should be provided to affected communities before imbedding in the bridge design.

7. Speed limit reduction to 45mph should be implemented from Foster Island through Portage Bay to mitigate sound emitted from higher speeds and to facilitate the gradually inclined ramp on Portage Bay through to I-5.

8. An underpass tunnel or sunken interchange at the Montlake/Pacific streets triangle would be a more optimal solution for connectivity of buses and Sound Transit than the proposed overpass recommended by the Technical Workgroup. The users' exposure to weather, the steep incline and long travel distances make this unfriendly and create a penalty for transit riders and non-motorized travelers. In addition, the University of Washington should provide space for shuttle drop offs for their own bus shuttles with connections to Seattle Children's Hospital, outlying campus housing residents and offer space for potential University Village shuttles to keep more SOV off the roads. This could be made in an adjacent parking lot, away from traffic.

The triangle layout also needs to be coordinated with the new construction of Husky Stadium. Efficient connectivity to light rail and buses should continue to be improved.

9. The height of the new bridge should be no greater than that of I-90. Our most affected neighborhoods object to the proposed 20 foot high "viaduct" structure which will leave a lasting scar of visual blight in neighborhoods on both sides of Lake Washington. WSDOT must work to get this profile back closer to the water without further excuses.

Thank you for considering the views of the Laurelhurst Community Club and the Madison Park Community Council. We look forward to continuing to work with you to improve the rebuild of SR520 for the future of the State of Washington.

Sincerely,

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SR 520 Integrated, Multimodal Corridor Management Agreement (CMA) Updated 9/24/10 V.Gunby
(Representing the Ravenna Bryant Community Association)

(*Article, 9/23/10 from the New Urban Network Publication*.) **David Kooris**, the President of the Regional Plan Association of Greater New York spoke 9/17/10 at Yale University on *Transportation and Climate Change*. *"The transportation planning institution has been focused on cars and highways for so long that the tools that are available to them are not able to answer the questions that face them.*
"The transportation establishment is being asked to help reduce the negative impact of cars and trucks on the World's climate, but in this era of sophisticate modeling, transportation agencies have fallen flat.

Conventional Transportation planning has focused on speed, distance, and throughput. But that no longer tells us what we need to know, if they ever did. Some of the chief things emphasized today according to Kooris are "access, proximity and VMT. The overall number of miles driven should be cut, to help the World avert hotter and erratic weather.

We need to know where the vehicle trips are taking place, how long they are, and how much the trips shrink in response to various kinds of development patterns, mass transit options and public policy interventions. The problem is data availability" It is difficult to get data that is reliable and that answers the questions we are now asking."

As transportation funding becomes increasingly dependent on performance, as is possible in the new federal transportation bill, greater attention may well be paid to outcomes such as congestion mitigation and emissions reduction. *That would encourage governments to make more connections between transportation decisions, and land-use planning and taking an integrated approach. Those who want to tackle global warming by reducing the need to drive and fostering compact communities are hindered by* ***the transportation establishment slow pace in devising the tools American needs***."
"************************************

Background: My description of a proposed SR 520 Corridor Management Agreement has been updated from my draft prepared in 2001, when I was a member of the Translake SR 520/I-90 Study, representing 1000 Friends of Washington. In the past 9 years urban transportation planning has been progressing toward a new concept of Smart Growth and supporting Smart Transportation policies to foster transit and community objectives, in contrast to past practices of states mainly building and maintaining highways.

The Translake I-90/SR 520 1997-2002 study included the recommendation to develop a SR 520 Corridor Management Agreement. WSDOT applied and received a FHWA Grant and hired a Consultant and study CMAs. WSDOT was awarded about $800,000.for study and to Report findings back to an Advisory Committee and. FHWA. During the Consultant's study WSDOT's TDM Staff and the PSRC TDM staff met with U of W staff, city staff and citizens to review, respond and provide direction, to the Findings and the conclusions/recommendations of the study.

Jean Mabry on the WSDOT TDM staff oversaw the study. After over a year the Consultant's studies and Advisory group meetings it was completed. Later Jean retired from WSDOT, and the study went to the PSRC to oversee, and King Cushman the PSRC staff, who was part of this study retired, so there is little institutional staff memory at WSDOT or PSRC for this study, or its recommendations. Robin Mayhew, PSRC Transportation Staff member now has the study in her files.

Since then I was part of the recent SR 520 Mediation group, making input on behalf of the Ravenna Bryant Community Association on the development of SR 520 SEIS. The Westside Mediation group had agreed on recommending a SR 520 Corridor Management Agreement.

In fact, during the SR 520 Mediation the Corridor Management Agreement was one of the few recommendations that was agreed on by all participants. It was included in the Final Mediation Report.

Now that the Westside SR 520 funding for completion is uncertain, and Phasing the WESTSIDE is more likely, a CMA is more critical than ever with a negotiated Agreement between affected jurisdictions, public and private interests, and the effected communities.

New USDOT Studies, Policies and the proposed FHWA Reauthorization Funding for Highway Programs are focusing on improving the sustainability and performance of urban Transportation Systems. (The delayed 6 year FHWA Reauthorization is rumored to be passed during the 2010 "lame-duck" Congressional Session.)

Under the new **2010 adopted 4-County PSRC 2040 Transportation Plan,** there is the program designating 12 "SMART CORRIDORS. The PSRC Transportation Staff is responsible for reporting/monitoring for the Transportation Performance of the chosen Regional Corridors, one of which is the SR 520/I90 Cross Lake Corridor. SMART is an acronym for SMART Corridors Congestion Management Process CMP.
-**Safe/Sustainable**-for Livable Communities and addressing Financially Realistic Investments,
Multimodal-offer competitive choices for the public,
Accessible-providing accessibility to all people and maximizing existing, facilities to support multiple modes of transportation
-Reliant and Resilient,-The reliable movement of people and goods of a prioritized transport system, and resiliency, is crucial to our economy, particularly when one key facility may be unavailable, and
Technology –Making the most of our Regional system. Managing it 24 hours a day as efficiently accessible with technologies and information to the traveling public and operators for informed smart transportation choices

One of the SR 520 Workgroup "White Papers"-'Corridor management and HOV performance plan" is a very limited description of the original Grant studying proposed SR 520Corridor Management greements.(CMA) The CMA we propose is at Westside SR 520 Management Plan/Agreement, that is broad enough to cover the initial objectives and Westside goals, relating to promises made to the Communities, the Arboretum, the University, SDOT and the Transit agencies, Bikers and Pedestrians on the Final agreed to Westside Design. Westside SR 520 has many final project details that have been reviewed and discussed over the during the Translake Plan, the 520's Mediation group, the Legislative Workgroup and now the 520 Staff Workgroup on Design Refinements, Transit Refinements, Arboretum Traffic Calming and Traffic Management. Draft" White papers." If we do not have an Agreement how can be assured that it will ultimately happen, given the lack of assured completion funding? .

Currently the Westside SR 520 Project lacks $2 Billion to start and complete due project funds, until the SR 520 West-side project plan with various levels of funding is available, and when full-funding is available for completion..

- WSDOT, with the staff Workgroup advising, needs to determine the West-side highest Priorities, when partial West-side project funding is available.
- Westside Construction and Operational Priorities and Timing, when funding is assured and the Westside is under construction,
- Long-term, Integrated Multi-modal goals and objectives, for the SR 520 Corridor's Performance, with Alternative Operational Strategies to keep the Cross-lake Washington system sustainable over time

WSDOT with other interested parties, including the PSRC, need to prepare, discuss and authorize the execution of a SR 520 West-side Corridor Management Inter-local Agreement to promote sustainable, long-term corridor inter-modal performance, urban livability and multimodal access to areas it serves.

The CMA should include Seattle, adjacent cities adjacent to the SR 520, the County, Communities and public and private large employers located adjacent or near to the reconstructed SR 520 multi-modal transportation corridor should be part of the Agreement.

Joint discussion and the setting long- term SR 520 Corridor Performance Goals/Objectives/Outcomes and prioritizing them, with phased Funding, if necessary ,and Monitoring the Corridor's Performance overtime. (PSRC SMART Corridor Program will do the technical Monitoring)

WSDOT and its partners should assure that over future years SR 520's design will respect and support a "Sustainable" and "Complete Streets and Corridor." With new adopted Corridor Policies and Strategies that are conducive to increasing the use of Transit and HOVs, the reduction of Green House Gas emissions and Single Occupant Vehicles trips and increasing Transit, High Occupancy Vehicles in the new 520 center lanes. Shifting from SOV trips is important goal to protect urban communities and reduce our dependence on foreign energy, that is detrimental to our nation's security and to our pocketbooks. It will improve the health for all of our citizens, particularly children, and is beneficial for our region's Economic Security. It will also promote consistent Transit supportive land uses and Community Development programs along with Individual behavior changes/actions.

(The following suggested SR 520 Corridor Management Agreement could be made under the authority of Washington State's Inter-local Cooperation Act, RCW 39.34.)

WHEREAS, the purpose of the agreement is to provide a framework for a public/private **SR 520 Corridor Management Agreement Partnership,** and to start to work cooperatively now and in the future with corridor adjacent jurisdictions, large public and private employee entities, and citizens to facilitate the orderly and sustainable development of communities through SR 520 efficient movement of people and goods.

WHEREAS, the 47-member Translake Washington Study Committee was appointed in May of 1998 to recommend reasonable and feasible solutions to improve mobility across the north end of Lake Washington, particularly from Seattle to Redmond, and

WHEREAS, over a 14 month study period the Translake study Committee agreed on the problem statement and evaluated alternatives and concepts across a full range of transportation solutions, and the Committee recommended that the project level **DEIS** process be conducted by WSDOT, for a high level bridge at Montlake, and that the statutory processes was followed by a SR 520 Mediation group and a Legislative Work group ,resulted in a SR 520 Preferred Alternative Design A+, after the circulation for Public Comment of a Supplemental SR 520 EIS, and

WHEREAS, one of the Translake's Committee's, and the later SR 520 Mediation Committee recommended SR 520 Transportation Demand Management and Systems Management measures that build and expand on the region's considerable commitment and successes in Commute Trip Reduction programs, and would include both land use actions and effective trip reduction measures, while enhancing private and commercial traffic mobility. (A list of potential TDM Measures was listed in the Translake's Committee's Technical Report, and some are listed at the end of this file.)

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WHEREAS, the Translake recommendation's supported the development of an Inter-local Corridor Management Agreement to implement new TDM and TSM measures. The Inter-local Agreement developed could include **Trip Reduction Goals** with a **Milestones and a Monitoring** program on existing conditions, before Construction, and through any possible Phasing stages of Westside construction, until Completion. It would report to the relevant Communities, and Public and Private interests on the status of various Westside SR 520 plans, any need for revisions from the original Westside Plans/proposals, and Monitoring Reports on the multi-modal operational implementation and the status of long-term integrated multi-modal operation of SR 520 Westside vehicle trip reduction plans, and,

WHEREAS, these recommendations anticipate cooperative leveraging of the USDOT and non-WSDOT funds with involvement of local and regional jurisdictions, this monitoring of SR 520 should encourage providing public incentives for implementing a TDM program that would be carried out by the public and private sectors, and

WHEREAS, it is assumed that the PSRC's SR 520/I-90Translake Corridor would be part of a larger coordinated program for Monitoring Cross-Lake Travel, a new SR 520 Pre-construction Pricing/Toll system in March 2011, and

WHEREAS, the Transportation of people will become more critical in the future as population increases, if land uses and transportation systems are not to be planned and funded in urban areas as a network of multimodal, integrated Corridors during their in their Pre-Planning , EIS processes, Construction and future Operations, and

WHEREAS, in 2000 through 2002 the alternatives from the Translake study were evaluated by three Committees, Executive, Technical and Advisory, and at Citizen Open Houses to select the SR 520 alternative designs that would be included in the initial Environmental Impact Statement (EIS), and,

WHEREAS, the recent 2010 SEIS and Translake's past record of a lack of SR 520 design decision, which is documented in state Legislation from the 1998 Translake study, through a Mediation Process for deciding the 2010 Westside SR 520 Preferred Alternative, and.

It is now hereby agreed to as follows: The proposed Parties to the Corridor Agreement are: (WSDOT, Seattle, Bellevue, King County, Kirkland, Points Communities, Redmond, ,Puget Sound Regional Council, METRO, Sound Transit, the Arboretum and 520 Corridor adjacent Private and Public Employers, and adjacent Seattle Neighborhoods and Communities , and

1. <u>Objectives of the Partnership</u>- An **Integrated, Multi-modal Transportation Corridor Agreement** is one of the important tools needed to assure that policies and actions promised during the Translake planning, the recent SR 520 SDEIS and Mediation process are implemented. Future corridor congestion can only be reduced or avoided through alternative strategies to encourage Transit, Tolling and Transportation Demand Management Policies to reduce auto-dependent sprawl and overall vehicle trips. The fundamental goal is to reconnect corridor decisions made during all of the SR 520 studies with our Region's ability to implement sustainable growth management, strong, well-planned, interconnected urban centers, a healthy environment, a strong economy, and a firm urban growth boundary.

The Partnership should be formed and revised to response to changing needs over time, so that the reconstructed Translake corridor can be collaboratively planned, and remain sustainable over time. This will adjust to changing need for the movement of people and goods to move efficiently across Lake Washington, and within our urban growth area. The overall long-term objectives for rebuilding the Corridor and adopted local Growth Management Policies will fail if there is no oversight of SR 520's Performance.

The new most current **2010 Draft State <u>Growth Management Transportation Element is another new direction in overseeing the performance improvements of state Corridors.</u>**
WAC 365-196-430, pg 76. states--
"(c.iii) - <u>*For state owned transportation facilities, level of service standards for highways, as prescribed in Chapters 47.06.430 and 47.80 RCW, to gauge the **performance** of the system. The purposes of reflecting level of service standards for state highways in the local comprehensive plan are to monitor the **performance** of the system, to evaluate improvements strategies, and to facilitate coordination between county's or city's six year street, road or transit program and the department of transportations ten year investment program*</u>."

(v.)<u>*Forecasts of traffic for at least ten years based on the adopted land use plan to provide information on the location, timing and capacity needs of future growth*</u>*.*

<u>TDM- RCW 36,70A070 (6) (a)</u> (v) Requires that the transportation element include transportation demand strategies. These strategies are designed to encourage the use of alternatives to single occupancy travel and to reduce congestion, especially during peak times

The priorities and programs implemented by this Partnership should complement existing programs and local plans, and accelerate the efforts to promote multimodal Transit/HOV use to reduce SOV auto trips and to support improved air quality and Smart Growth policies in our region.

To gauge the performance of the system of development goals and objectives to reinforce urban centers, support an increase the use of transit/HOV modes, encourage a jobs housing balance, reduce sprawl and the resulting traffic congestion. It should also improve air quality and decrease our reliance on nonrenewable resource energy consumption.

2. <u>Definitions</u>:
A. <u>Trip Reduction Measure</u>- means an incentive or disincentive intended to reduce the number of single occupancy auto trips, or the rate of single occupancy vehicle miles traveled.

B. <u>Transportation Demand Management (TDM)</u>- is a variety of measures like Tolling, ITE and other newer strategies to maximize the people moving capability of transportation systems, and to influence the need for or changing the mode or the time of travel. Proposed financial incentives and improved, reliable Transit Routes and Services, are needed to shift the cost in money and time to the user. Travel times on routes taken should promote improved transit services to urban transit centers or area promoting transit oriented development

<u>To be successful-</u> An important part will be CMA task to involve the local major public and private employers will be through the Regional Metropolitan Planning Agency (PSRC) and the above jurisdictions current regulatory powers. Also needed is defining a successful <u>Process for a public and private sector involvement and Advisory role.</u>

<u>Policies</u>: Suggestions are needed for monitoring the Performance for each future stage of the Westside or entire rebuilt SR 520 project, from I-5 to SR 202.

A. SR 520 Completion Stages:
1. Interim EIS/FEIS/ROD with and Project Planning/Refinement, Stage Pre-Construction
2. Construction Staging-Setting Priorities/ Avoiding Conflicts/Criteria for meeting Construction Deadlines
3. Public Accountability and Transparency with Post-Construction CMA Programs and long- term Westside SR 520 Operations

B. Sources of Funding for Project Allocation, Revolving Funds, Regional Funds, Pricing Increased Federal Urban Partnership Funds and/or new State or FHWA SR 520 Funds, Other ?
C. Annual Prioritizing the Allocations of Program Funding
D. Defined Process for the Resolution of Issues
E. Monitoring, Benchmarks, Reporting Processes
F. Process for the Revision, Amendments of the Corridor Agreement
G. Effectiveness, Duration, Termination
H. Land use/ Growth Management Elements- Suggested programs (See Attachment 2)
I. Intelligent Transportation Elements and Transportation Demand and System's Management
J. <u>Long-term Performance Accomplishments/Problems</u>, Adapting to Changing Conditions- Energy usage, GHG Reduced, Financial Savings, Community and Private and Public Responses

ATTACHMENT 1 Work Trip Reduction "Pro-Transit /Reduce VMT Reduction's Target"Programs

1. Improved and predictable Transit Services and Routes

2. Private Buses, Carpooling or Vanpooling programs, including payment for fuel, insurance or parking. Benefits.
3. Transportation Management Associations (TMA)-A commuter matching service to facilitate ride-sharing for commute trips.
4. Providing for carpool and vanpooling.
5. Use of company vehicles for carpooling or vanpooling.
6. Provision for preferential parking for carpool or vanpool users which may include close-in parking or covered parking facilities,
7. Cooperation with other transportation providers to contract for additional regular or express buses to the work site or school site,
8. Subsidized Transit fares, cash out parking.
9. Construction of special loading/unloading facilities for transit carpool or vanpool users.
10. Provisions for constructing pedestrian walkways or bicycles routes to the work or school site and
11. Provision for bicycle racks, lockers and showers for employees who walk or bicycle to work or school.
12. Establishment of new telecommuting program, compressed work weeks or flexible work times for employees,
13. Work hours program should not interfere with ridesharing or transit.
14. Establishment of a program of parking incentives such as a rebate to encourage employees or students not use the parking lot.
15. Incentives for employees or students to live closer to work or students to live closer to work or school .
16. Provision for day care and/or emergency "Guaranteed Ride Home".
17. Establishment of trip reduction committees or TMA's to define new strategies and implementation measures.
17. Trip reduction Grant program to encourage businesses to invest in Trip Reduction techniques and sell the parking lot land..
18. HOV Lanes- High Occupancy Toll lanes would have time-variable pricing. .
19. **Other Non-Commuter Specific Programs**- TDM Strategies-To encourage more energy efficient vehicles and timely travel behavior with preferential lane treatment for multi-occupant vehicles, particularly at choke points, with transit alternatives**. Example: Montlake Bridge**

Other Related Programs-

Public/Government sponsored employee transit passes and reduced parking incentive programs)
College/School Programs-U-Pass, Campus TM Programs, High School Demonstration Programs,
Sporting, Tourist, Event Programs-Travel Education, Information and Management ITE-wristwatches, palm pilots, internet connections for bus arrival/schedule times
Complete Streets
Preferential lanes and Transit Only Zones, with Local Shuttles and circulation systems.
Parking Benefit Districts-Use parking funds for local neighborhood enhancements.
Bike and Pedestrian Routes- Sidewalks, Protected Bus stops and walkways, Schedule info.
Neighborhood Bike/Transit Integration. Storage, Bike Rentals/Maintenance
New Information Systems relating to Transit Schedules, TDM,
Improving Transit Security Issues.

REGIONAL

*Reducing Costs of Auto Ownership-(Pro-rate insurance, Registration costs are based on miles driven, Distance based Auto Costs, Vehicle Rentals, Coops, use "Flexcar" systems.
*Re-establish Regional PSRC's TDM Committee- A resource for the coordination of all regional TDM activities particularly Parking Information or Pricing Programs.

Corridor Management Agreement and Tools- elsewhere US DOT Studies, Federal Management and Operations Hanbook, FHWA Report # FHWA –OP-003), Technical Memorandum, U.S. Department of Transportation, FHWA , June 2007 (FHWA –JPO-06-037 and Rule 940.

See Other States-Vermont Corridor Agreement Handbook ,
_______________Smart Development Code Handbook-Oregon,

TDM Strategies-Development, Rewards,Incentives,Sticks- Example: Location efficient Mortgages

*Time-of-day pricing (use Toll revenue to fund Transit operations on the SR 520 lids and to support TDM Programs
*Incentives to Retrofit Strip Malls.
*Establish and assembly a“ Revolving Fund” for financing of Transit Oriented Development/Housing.

*Property Tax deferrals for multi-family housing near Transit Routes.

7.6

* REVISE public Infrastructure priorities, to build sidewalks, bikeways, open space and Policies for aiding “Complete Streets” Policies, Plans and Funding.

*Develop a Model TDM Handbooks-coordinate national, state and local information

* Transfer of Development Rights (TDR) King County Program

* Housing development at or over new Metro Park and Ride Lots

* Parking Management Policies- Fees for Park and Ride Lot Use

* Local Trip Reduction Ordinances (TROs)

*Auto-free zones, Traffic Calming installations- Road Pricing

* Propose supportive Land use measures to encourage transit oriented development and free shuttle services, Location-Efficient Mortgages, Maintain adopted Urban Growth Boundaries.

* Pedestrian-oriented local infrastructure, connecting Suburban cul-de-sacs to local streets, connecting to new suburban “grid” with local arterials, and the development of Bus Rapid Transit and local Bus systems.

*Increase fuel taxes, sales tax on gasoline. Parking taxes or restrictive neighborhood parking permits,
* Change Vehicle Registration fees based upon mileage or Insurance fees based upon mileage.
.
Conclusion: No single SR 520 Corridor Management strategy will work by itself. SR 520 sponsors need to adopt Accessibility Management Objectives, and to transform the existing State analysis from monitoring state Corridor Congestion, like SR 520, with a new Planning Paradigm. That includes Corridor Management. It should seek to adopt “broader urban system’s analysis,” with new Performance criteria focused on **Moving People and Goods**.

Corridor management Agreements have proven to be effective in clarifying responsibilities, and integrating new multimodal operations on an urban state Corridor like SR 520. SR 520 will be the first in our state to build and initiate this type of coordinated and planned successful multimodal operations. The Project Impact Plan, Dated December 2008. p.ES-7 identified one of the Long Term Improvements, to “Explore opportunities to develop a SR 520 Corridor Management Agreement with local jurisdictions along the SR 520 Corridor.

Accessibility and Performance Monitoring of the SR 520 Performance Objectives and adopted Policies will help to create an adaptive, flexible and community supported transportation system that meets the future growth in population and protect the economic, environmental and community values our Community has been discussing and asking for.

Given the history of this project’s SR 520’s Performance studies, direction the USDOT is currently heading, the state revised Growth Management Act WAC sited in this paper, the PSRC’s, SR 520 Partnership Agreement and new SMART 12 Corridor’s Performance Monitoring, it is timely to include the CMA as part of the continuing WSDOT oversight/responsibility for the completion and long-term success of the project.

WSDOT and Workgroup Staff need to understand the importance of using a SR 520 CMA process.
The Final SR 520 recommendations would be incomplete if it is not included as an essential short and long term element of the project.

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9/24/10

TO: SR 520 Workgroup /Members, 9/13/10 Report
RE: SR 520 Design Refinements and Transit Connections- Draft Recommendation's Report
From: Virginia Gunby, Representing the Ravenna Bryant Community Association

As we move ahead to the important last weeks for the various Staffs will be involved in the 520 Workgroup assignment, to refine the **SR 520 draft Final Working Plan Report** for the West-side section, the following are the Public Comments and the major concerns of the Ravenna Bryant Community Association, whom I represent.

Overall Conclusions on the Report and Workgroup Process: the 520 Workgroup's Process did not result in quality draft Issue papers, anticipated in the ESSB 6392 Legislation or by the public attending their Meetings. The Public Process did include tine for Public Comments at the end of the meetings. But many who attended did not feel that they were hearing anything new, based upon the deliberative in-depth study we had expected, on SR 520 related significant issues. The major controversial Issues were avoided, particularly if there were rumors of changing "political positions, not based on facts.

After attending all of the Workgroup-Public meetings, a number of us concluded that the public agency staff members of the Workgroups at the meeting, were either very shy and unaccustomed to discussing issues in public, or had met at an earlier Meeting, discussed and agreed on their Recommendations. All issues had been resolved prior to the Public Meeting. The outcome was that at the "Public Meetings" there was little Workgroup member discussion of any the facts or reasons to support their recommendations, quantifying information or documentation, or the Pros and Cons of the specific Recommendations presented to the Public attending the meetings.

Comments

1. Our RBCA organization reviewed the draft Workgroup White paper Reports required by state legislation ESSB 6392 and strongly suggest the overall the reports lacked depth of information needed to reach recommended conclusions, There was little or no quantification/factual data, no triggers suggested and only a few logical explanations for their Staff's" Recommendations." We urge that in the future the Public Process be more informative and in the Final draft Report Issue any White Papers issued, include quantification/documentation to back-up the Final Recommendations

2. **Arboretum Issues** there is an apparent disconnect between the Workgroup process and WSDOT/Arboretum's meetings that must be rectified. I have been attending all of the separate SR 520Staff/ Arboretum/ABGC Meeting/Discussion, and I am concerned that there were Draft Report recommendations that could significantly impact the Arboretum, that are **not supported or agreed to by the ABGC.**

The Arboretum and its relationship to SR 520 was separated from the Workgroup process in the 2010 Legislation. Unfortunately by not being included as part of the Workgroup's Assignment their current positions are incomplete, or not noted in the 9/13/10 Reports. The WSDOT Staff and ABGC needs to coordinate more with the Workgroup, as it continues to meet until later in the year.

Unfortunately some of the Draft Report's overlaps the Arboretum impacts, (Turning/Queuing and Channelization) White paper) such as allowing the left turns at E. 24th for all vehicles onto Lake Washington Blvd. rather than only HOVs, as was in the 520 Preferred Alternative. ESSB 6392 required when it included that the Westside SR 520 Design should "minimize any increases in traffic volumes through the Washington Park Arboretum and other adjacent neighborhoods.

This draft recommendation/decision does the opposite. The Draft suggests that time of day restrictions on the 24th East left turn onto Lake Washington Blvd. "be considered in the future."(Page 5.) The ABGC has recommended Tolling on LWB., as one way to reduce traffic caused by SR 520 users, but a 2007 and 2010 State Legislation directed that Tolling will only be on the SR 520 Bridge, and that all of the 520 Toll funds will be dedicated for paying off the 30 Year Bonds, so unless state law is revised these options are not feasible. All of the draft Report included Arboretum recommendations that had not been discussed, or if discussed had not been approved by the ABGC Committee, which is scheduled to have two meetings a month that include discussions on SR 520, through the end of 2010.

In order to achieve future excellent preferential Transit/HOV service to really reduce the number of vehicles on Montlake Blvd., WSDOT and SDOT must work on alternative routes that is not the Arboretum, traffic calming is not enough! Vehicles/users from the south need to be guided to alternative routes or Transit/HOV Services before the rebuilt SR 520 project is opened. WSDOT needs to work more now on an integrated, multi-modal Plan with WSDOT/SDOT/METRO Transit and Sound Transit, to reduce trips during construction and after the Bridge and Westside is completed.

Since the existing Arboretum Ramps will be removed early in the reconstruction process, driving behavior using the Arboretum can be changed, with proposed new Transit services, A Public information Campaign to direct traffic out of the Arboretum to alternative Routes, diversion of traffic to I-90 to avoid paying SR 520 Tolls in the future,
Other strategies are needed to reduce SR 520 SOV traffic using Lake Washington Blvd., the Historic Registered Olmsted-designed Parkway.

NO left turn from 24th to Lake Washington Boulevard-through the Arboretum**.** The Workgroup must find new and better ways in support of the position to reduce auto traffic through the Arboretum. It must deny a left turn from the Montlake SR 520 HOV off-ramp at the 24th St. intersection and Lake Washington Blvd. Allowing it only for HOV use would encourage the formation of HOV users, and help to decrease the use of the Arboretum's Lake Washington Blvd. from and to the south, through adjacent neighborhoods and/ or to East Madison Street. The Olmsted Boulevard should not continue as a SR 520 State Entrance or Exit road.

3 **Project Funding Gap** -Not part of the Workgroup's Work Plan is the Westside's Large Funding $2 Billion Gap. Because of the funding gap of on the Westside SR 520 project, WSDOT staff needs to plan for an overall feasible **Staged Building the Westside 520 in Transition Stages. Phasing and selecting the priority sections to be the first built. Programs and a Construction stages should move People and Goods, and include a post 520 Construction Strategy. An SOV Reduction Plan needs to be completed now, while the uncertain funding gap continues.**

Inter-agency collaboration is critical to Plan for the 4 year Transition Stage, after the permanent removal of the existing Arboretum Ramps, to no Ramps. Early 2011 pre-construction Tolling of the existing Bridge will help, but the effort to reduce SR 520 related Arboretum trips must be started now. "An Arboretum Traffic Reduction Plan" strategy should be studied now, quantified, and the results monitored and continued after construction.

4. The **new SR 520 Multi-modal SR 520 "Transition Plan**" must be developed that includes creative and effective overall strategy to increase Transit/HOV with a SOV reduction strategy, that will significantly reduce Peak (AM/PM) SR 520 traffic, through the Arboretum and on Montlake Blvd. We have an opportunity during the 4-year Transition to campaign, and during traffic limitations construction to change current driving habits and achieve a long-term successful performance for Transit use on with preferential lanes on Montlake Blvd. to reduce auto use through the Arboretum, and the adjacent community, while the SR 520 is rebuilt, and after it is completed.

New Transition Multi-modal Strategies to increase Transit Ridership and HOV use must be a major part of the Transition and Final Plan. The results must be monitored, during the Pre and active west-side Construction stages, and after the west-side SR 520 is completed. To measure and achieve desired outcomes.

5. **Phasing the Parallel Montlake Bridge**-We heard at last Thursday's (9/9) 520 Workgroup meeting that "Triggers" would be suggested for Criteria to evaluate IF the bridge is needed or When it should be built. Some of the City Council Members believe that the proposed parallel Montlake Bridge, included in the preferred SR 520 Design, built to a 3 lane complementary design, should not be built. Obviously they haven't been there during the Peak hours. Or should be "phased"? If built it would be **delayed until 2016-18**, after the opening of the Stadium LRT Station--! This is a political recommendation, not based on any facts, and lots of misinformation fantasies. All of the studies we have seen have confirmed that there are currently over 550 daily Transit Trip's on Montlake Blvd and over the current gridlocked 4-lane Montlake Bridge that cannot keep their schedules today, due to congestion. WSDOT, not the city of Seattle will pay for and build the parallel Montlake Bridge of a similar complementary design, and both bridges. Both bridges will likely have 3 lanes, with the one lane north and south potentially dedicated to Transit and HOV use. and increased space for Pedestrians and Bicycle users.

Reasons to Built the parallel Montlake Bridge as Soon as Possible-
a.. Existing auto, pedestrian, and bike traffic patterns at this narrow "pinch-point" with the current 4-lanes first Montlake Historic Bridge(build in 1925) needs to have the added parallel Bridge on the (east-side) as part of the SR 520 project. Even the city's Nelson/Nygaard Consultant recommended this "improvement" to the Council and Mayor.
b. The new parallel bridge will provide space for a **third transit preferential lanes**, to speed transit to the new stops by the Stadium LRT Station, the U of W Hospital/the Campus and the University District. Transit is heavily used and it can be improved and attract more riders if the parallel bridge is built as soon as possible. Triggers if really objectively applied, would validate that the Montlake Bridge corridor needs the new Bridge NOW! The report does not suggest criteria for building the second Montlake Bridge such Transit Travel and Route Schedule Impacts, Bike user counts and limitation or safety issues for using Bikes or for Pedestrians. The Coast Guard permits for the new Bridge will take time to obtain and should be considered, 2 home owners whose house will be taken, are left suspended with uncertainty, as to their future, and the condemnation proceedings also take time, and need to be considered in the schedule.

c. With the new Stadium Transit LRT station under construction, future increases in Transit use and improvements in Transit performance (speed, passenger use and routes) is needed to reduce SOV trips through this busy arterials.

d. North/South Pedestrian and Bicycle space and use will continue to be significantly restricted, if the second bridge is not part of the improvements, as soon as possible.

e. On March 27, 2007, Mayor Gregg Nickels signed a Seattle Council passed "**Complete Streets"Ordinance 122386**. The a new city **"Complete Street's Policy** for Transportation Projects, states guiding principles and practices so that transportation improvements in the city are planned, designed and constructed to encourage Transit- use, Biking and Walking, to improve city arterial travel conditions, while promoting safe operations for all users. The Ordinance was proposed by Council members Licata and Drago and passed the Council with a 9/0 unanimous vote.

f. Sound Transit's U of W Stadium area LRT Station, under construction and to be completed around 2015, will provide speedy 7 minute Transit trips into the Seattle CBD, and bus transfer connections, to existing southern or future east and planned northern LRT routes for transit users, and the Complete Street's Policy should guide the City's decisions and planning actions, with the WSDOT and Transit staffs.

g. Supporting the city policy of the "Complete Streets" Ordinance, during the reconstruction of SR 520 transportation facilities adjacent to city arterials, including capital improvements, is one of the major reasons, that RBCA urges the that the new parallel Montlake Bridge is in the Final SR 520 Plan Recommendations.

.

5... Recognizing that a rebuilt SR 520 with two new widened HOV lanes will be focused on achieving a new, integrated, multi-modal state urban transportation system, a SR 520 **Corridor Management Agreement** is critical. Monitoring of the new integrated, multi-modal 520's performance and revising its operations when needed can help to successfully achieve the desired results for Seattle, the Arboretum, and WSDOT's urban system, and meet adopted long range regional performance objectives, over the short and long-term use of rebuilt corridor. It should be through an Inter Local Agreement, written and adopted in collaboration with Seattle, WSDOT, Transit agencies and adjacent 520 eastside cities, and major employers, with citizen and user engagement. The city of Seattle is supporting a Corridor Management Agreement with them.
It is a great way to begin!

WSDOT/PSRC studied proposed a SR 520 Corridor Management Agreement concept through a SR 520 FHWA Grant by WSDOT/PSRC during 520's Translake Phase, in the late 1990's & early 2000's. We urge the Council to help make the "Agreement" a reality. (The WSDOT study is now stored at the PSRC,-with Robin Mayhew as the PSRC Staff contact.)

SR 520 will become our first planned, integrated, multi-modal state rebuilt urban Corridor. It could initiate a new focus on short and long- term monitoring to achieve a 520 public/private multi-modal, inter-agency performance objectives, through the 520 multi-modal systems. Reporting results at least annually is needed, through public engagement and new user information. The Agreement would also be integrated with city and county Comprehensive plans, consistent with the new state Growth Management Act objectives, to reduce auto-dependent land uses, and the state's adopted Goals to reduce vehicle-related causes for Green-house gases and Climate Change.

6...**Other Arboretum Issue RBCA supports Tolling SR 520** The Legislature has written into law that the SR 520 Tolls will only be imposed on the SR 520 Bridge, and the Toll funds will be only used to pay off the costs of SR 520 Construction. The cost to the Arboretum to sponsor and fund a Tolling system within the Arboretum would be prohibitive. We oppose any transportation funds being used to pay for installation of the equipment and/or to administer this program. King County's Marymoor Park has an Entrance fee for cars parking in the park. Any entrance fees to this unique, Olmsted planned urban, historic public Arboretum Park, and the connecting Lake Washington Boulevard need Public review and Discussion, before a decision is made.

Other actions to redirect Arboretum traffic could be the city's action with Arterial signage, to direct 520 traffic to new alternatives for auto and Bus Routes. New Transportation Demand Management Policies and Transit services are needed on 23rd and Montlake Blvd. for SOV's. (SDOT's *University Area Transportation Plan* includes a HOV lane from 25th NE intersection with Montlake Blvd. to Pacific Place, to speed transit services to the LRT station from the North.) The predicted reduction of SOV's through Tolling costs of $3.50 one way, and new public efforts will increase the use of Transit/HOVs is needed on both cross lake Bridges, and local Arterials. And adjacent city Arterials should be studied, to learn the benefits to achieving the city's Complete Streets Policy, particularly for Transit. state Treasurer has found that if both Bridges were Tolled, the long-term interest rates over the 30 year SR 520 Bridge Bonds, would be much less. New State funding for local transit systems should also be supported by the Council at the 2011 State Legislature, possibly from changing the state Tolling laws . The FHWA needs to approve Tolling of I-90, before it can be used.

7 New increased Transit Services need Funds for Operations- Related to the reduction of traffic through the Arboretum is the fact that if the FHWA or Mercer Island does not approve Tolling of I-90, and it is not Tolled, more of the 520 users from south of SR 520, and Capitol Hill, will divert from 520 and use I-90. That is a short-term solution to reduce the traffic thru the Arboretum., buy the Legislative Workgroup recommended Tolling I-90 as another way to fill the SR 520 Funding Gap. An option is for WSDOT to lobby and encourage **the state's 2011 Legislature to Toll I-90, and urge the WSDOT Commission to agree to Toll both cross-lake bridges, at similar rates, when they deliberate the SR 520 Toll rates in the near future. Taking Transit saves time and money. Transit can carry up to 60 people in the space of two cars. It could saves the average car owner an average of over $600 per month that it cast to own a car. Many low income families with autos/ pay at least 20% of their monthly income on auto related expenses.**

8.**Portage Bay Bridge** To reduce costs, increase the community's involvement and satisfaction, and provide and improved overall design, the proposed replacement of the **Portage Bay Bridge** should be decided though a Bridge-Design Competition, involving the adjacent community and homeowners.

a. During the Mediation process some of the members met with WSDOT Bridge Staff and asked if Design Competition would cost less and were told that it could develop a better design and reduce the costs, up to $100 million. Therefore for the above reasons, we support the Portage Bay Bridge Design Competition
b. The proposed center landscaped area should be removed to reduce the width of the Portage Bay Bridge. Any plants would probably not grow well due to the bridge location at the bottom of a steep grade, where the vehicle fumes would collect and affect the plants.
c. Reducing the speed to 45mph and quieting the surface noise of the Bridge should be high priorities, and on the list of design requirements...

Thank you for the opportunity for the RBCA to submit Comments on the Draft Recommended Report and Workgroup White Papers. If we did not make specific comment on one of the papers it was because we found it did not need changes. These were the Noise Reduction Strategies, the Montlake Triangle Charrette, and the Light Rail Transit Accommodation . We urge the Staff to use our recommendations in you next steps in completing the Recommendations for the refinement of the SR 520 WestSide Design.

September 27, 2010

WSDOT SR520 Technical Coordination Team
SR 520 Project Office, Plaza 600 Building
600 Stewart Street, Suite 520

RE: SR520 Bridge Replacement and HOV Program/ESSB 6392 Workgroup Process

Dear SR 520 Team:

The Seattle Bicycle Advisory Board (SBAB) appreciates the opportunity to have participated in the SR 520 Bridge Replacement/ I-5 to Medina project relating to the ESSB 6392 Workgroup Process. Your consideration of our input for enhanced and better connected regional and local bicycle facilities is appreciated.

Based on the results and recommendations stated in the "Bicycle and Pedestrian Connections and Amenities White Paper", SBAB feels that issues relating to *enhancing regional and local connections, increasing mobility and safety, and improving bicycle facilities* were adequately addressed.

SBAB also recommends:

1. SBAB continue to be a part of all future workshops, reviews and discussions relating to bicycle facility improvements associated with this project including further Montlake Triangle Charettes, Arboretum Master Plans/Loop Trail extensions, and Seattle and WSDOT work with Section 106 consulting parties, etc. in this area.

2. SBAB strongly encourages WSDOT to contribute appropriate funding to the pedestrian and bike improvements for those facilities recommended as the preferred alternative and those additional components that will be added to the network.

Again, thank you for the opportunity to provide advice and guidance regarding best practices for bicycle facilities. We look forward to continued coordination with your team.

Sincerely,

Ann Boyd, Max Hepp-Buchanan, Gabe Grijalva
Participating Members from the Seattle Bicycle Advisory Board

Cc: Mayor Michael McGinn, City of Seattle; Peter Hahn, SDOT; Jennifer Wieland, SDOT

The Seattle Bicycle Advisory Board shall advise the City Council, the Mayor, and all departments and offices of the city on matters related to bicycling, and the impact which actions by the city may have upon bicycling; and shall have the opportunity to contribute to all aspects of the city's planing processes insofar as they relate to bicycling.

- City Council Resolution 25534

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24 September 2010

ESSB 6392 Workgroup
600 Stewart St., Ste. 520
Seattle, WA 98101

Comments on SR 520 Design Refinements and Transit Connections Draft Recommendations Report

Dear SR 520 Project Staff:

We appreciate this opportunity to comment on the SR 520 Design Refinements and Transit Connections Draft Recommendations Report. The ESSB 6392 Workgroup has done good work to improve the project westside design since WSDOT announced a preferred alternative for the SR 520 project in April 2010, but further improvement is needed.

Sierra Club urges the development of transportation options that support state, county and city greenhouse gas (GHG) emission reduction goals. We favor GHG assessments that evaluate, rank, and select project elements and design configurations, rather than simply identify mitigation measures for a business-as-usual approach. We especially support an optimized role for transit in the SR 520 corridor design since high capacity transit (HCT) promotes compact, walkable residential and commercial areas around transit stations thereby reducing associated GHG emissions. The design modifications recommended by the ESSB 6392 Workgroup should also achieve these objectives:

* emphasize the movement of people and goods rather than vehicles;
* restore and protect the Arboretum and its wetlands, and Lake Washington;
* improve air quality and reduce traffic noise, for human and environmental health;
* promote thriving communities while reducing sprawl.

Most focus of the SR 520 project is on its role in regional mobility, but the project must place an emphasis on walking, biking, and transit use in the surrounding corridor. This theme is present in our comments below, which are organized around topics addressed by the workgroup followed by additional discussion regarding costs, project phasing, and broader considerations relating to this project.

Minimize traffic and project footprint impacts on Arboretum

Lake Washington Boulevard was never intended to carry the traffic volumes associated with access ramps to and from SR 520. The design modifications do not do nearly enough to remedy the problem of excess traffic through the Arboretum. In particular, Sierra Club takes issue with the left turn movement from 24th Avenue E to eastbound Lake Washington Boulevard. A design change is needed here to allow only right turns from 24th Avenue E to westbound Lake Washington Blvd for vehicles to reach Montlake Blvd and travel southbound.

Serious consideration of tolling on Lake Washington Blvd through the Arboretum must be part of the local and SR 520 corridor traffic impact assessment and management plan. A variable toll, e.g., weekday vs. weekend, or peak commute vs. mid-day, should be considered to reduce traffic volume through the Arboretum, while assessing peak period HOV lanes on the Montlake/24^{th}/23^{rd} arterial corridor.

We implore project designers to continue seeking ways to achieve the following objectives when refining this project:

(1) Reduce in-water impacts of structures through the Arboretum, Foster Island, and other wetlands;

(2) Design a consolidated, lowest impact overall project footprint.

Corridor Management Agreement needed to enshrine transit priority

The use of intelligent transportation systems and other design and operational features to form a corridor management plan is laudable. However, the SR 520 project should be accompanied by a Corridor Management Agreement (CMA) among WSDOT, Sound Transit, King County Metro, and jurisdictions along the corridor that sets objectives for travel efficiency, adjacent land use patterns, GHG emission reductions, and establishes priority use of the corridor for transit. The added two lanes of a new bridge must be designated for transit use only, with the understanding that light rail will utilize these lanes so the corridor is never more than six through lanes.

A solution that builds better urban form and reduces the incidence of sprawl will better move people efficiently and conveniently through the corridor without adding to vehicle miles traveled, GHG emissions, and expanding infrastructure for vehicles. We know from past experience and elsewhere that additional capacity produces latent demand for highway space and the new lane miles fill up producing more congestion. A CMA should recognize that congestion is primarily a pricing problem best solved with tolling. The revenue raised from tolling of SR 520 must in part go to support transit, both regional and local, to provide more mobility options and address social equity concerns.

A CMA is not only about transit and tolling but also emphasizes the quality of the urban spaces. Rather than accommodate more vehicles entering Seattle, this corridor should be designed and managed around guidelines that are alternatives to misguided notions of congestion relief:

(1) Implement mobility solutions that improve air quality and reduce traffic noise, for human and environmental health

(2) Integrate transit-oriented development (TOD) into this major transit project

Narrower footprint options for Portage Bay Viaduct

Replacement of a previously proposed westbound auxiliary lane with a managed shoulder on the Portage Bay viaduct is a welcome improvement, but further creative design alternatives could be used to narrow the footprint of the roadway in this segment. When the additional two lanes of the bridge are designated transit-only, four through lanes can serve the segment between Montlake Blvd and I-5. The managed shoulder could be rendered unnecessary with modifications such as these:

(1) Revise the ramps to and from the west at Montlake Blvd, which connect to the Portage Bay roadway, to make them more favorable for through transit movements;

(2) Place the westbound on-ramp to SR 520 on the left side where it becomes a third Portage Bay lane uphill;

(3) This left lane that serves merging vehicles entering from Montlake Blvd and transit bound to downtown Seattle feeds into the transit/HOV ramp connecting to the I-5 southbound express lanes in morning hours. All traffic would merge right during afternoon hours since the transit/HOV connection is from northbound I-5 to eastbound SR 520 at that time.

A five-lane Portage Bay viaduct with narrower shoulders that are not intended to carry traffic at peak times results in a narrower overall footprint in this segment. In this urban context, the highway should employ narrowed lane and shoulder widths to lower vehicular speed (with corresponding lower speed limits), reduce noise and air pollution, increase fuel efficiency, and save lives.

Transit Connections: Retain flyer stop functionality at Montlake Blvd.

The location of transit stops on the Montlake lid is favorable for ensuring good connections between regional service using the SR 520 corridor and local service operating in the Seattle street grid. Even better transit connectivity and enhanced operational flexibility are achieved with ramp configurations to and from the west that are more favorable for transit through movements. Adding downtown Seattle oriented bus routes to the regional stops in the east and west bound directions should be the objective of further design refinements to the SR 520 – Montlake Blvd interchange.

We are concerned about the source and longevity of the proposed added subsidy for separate bus service for Downtown Seattle and University District markets across the replacement SR 520 bridge. The plan proposed by Metro Transit and Sound Transit to increase cross-Lake bus service to separately serve the U District and downtown markets can be effective during peak periods. However, this duplication of bus routing across the bridge may not be the best allocation of resources in off-peak times, and may prove to be fiscally unsustainable. Transit service through this busy intersection should emphasize connectivity and flexibility, both of which are maximized by routing downtown Seattle oriented buses to the regional stops (east and west bound) on the lid adjacent to Montlake Blvd.

Design changes that would retain the "flyer" stop functionality as part of this interchange without necessitating further width can include these elements:

(1) The two inside lanes of SR 520 are transit only east of the Montlake Blvd. interchange, so they connect directly to the Montlake lid without additional width of on- and off-ramps;
(2) Four through lanes of general-purpose traffic pass underneath Montlake Blvd; no transit lanes are needed since all SR 520 buses serve the regional stops;
(3) Combine transit and general-purpose traffic exit and on-ramp lanes together on one ramp structure connecting with SR 520 to and from the west;
(4) Reconfigure off- and on-ramps west of Montlake Blvd to the center of SR 520 to provide for easier transit connections with the I-5 express lanes.

Design and construct the bridge to accommodate light rail transit (LRT)

Sierra Club supports a replacement SR 520 bridge and corridor that prioritizes transit use. This means designing and building structures that are light rail-ready when they open for use. We urge the Legislature, Governor, and WSDOT to redesignate the added two lanes in this corridor to be transit only from the beginning, at least between I-5 and 108th Ave NE or I-405. As noted above, two additional lanes are not necessary from Montlake Blvd west to I-5 since LRT is assumed to cross the Cut and reach the UW station. Phasing these lanes for bus rapid transit and later LRT is essential to assist the region respond to challenges of climate impact mitigation, rising energy costs, and population growth.

While the refinements to the preferred alternative improve the prospects for adding LRT to the SR 520 corridor, several concerns remain insufficiently addressed for moving this project to final design. Sierra Club echoes the concerns raised in the Seattle Department of Transportation Technical Memorandum on Light Rail Transit Accommodation in the SR 520 Preferred Alternative. In particular, we urge the design be further refined to answer lingering questions about these elements:

(1) the width of the bridge deck;
(2) confirmation of the number of additional flanker pontoons required to support LRT (no more than 6 lanes for the bridge); and
(3) design of the west approach and second Montlake Cut bascule bridge.

The emphasis on highway mega-projects continues to enable increased traffic and more numerous and longer trips, while constraining fiscal capacity for building out our mass transit system. The transportation system in the Puget Sound region needs to be refocused to meet increasing demand for transit, while preparing us for the inevitable price spikes in petroleum resulting from the realization of peak oil. The current system is neither sustainable nor scalable; we should redirect resources away from added vehicle capacity towards transit investments that help stop sprawl and reduce GHG emissions.

Funding gap requires more ambitious use of tolling

The approximately $2 billion budget shortfall for this project raises a valid concern that WSDOT will be unable to follow through on those elements of the design that are most favorable to pedestrians, bicyclists, transit connections, and neighborhood continuity. To help counteract the funding gap, Sierra Club supports implementation of tolls on the SR 520 bridge and nearby I-90 bridge as soon as is practical, as we also stated in a December 2009 letter to the 520 Legislative Workgroup and in an April 2010 comment letter on the project SDEIS. This toll revenue must support transit operations in the cross-Lake corridor to provide meaningful options, promote public trust, and ensure equity among users of different means.

The effects of traffic demand management through tolling of the existing bridge are not adequately considered when projecting capacity needs for the preferred alternative. Yet the existing bridge will have tolls implemented by Spring 2011 through the Lake Washington Congestion Management Project. Variable toll rates set according to peak demand will invariably lead to improved traffic flow. WSDOT must be willing to adjust its preferred alternative as we learn from demand management how price, capacity, and transit reliability are related.

Potential phasing of project is opportunity to promote transit priority

Since a replacement floating bridge is funded but the western approach from Foster Island to I-5 lacks funding, the operation of the corridor during a potential phased implementation has become a concern. Continued use of the western approach connected to a replacement six-lane floating bridge during an interim period might appear to move the traffic jam into Seattle. We see a phased project in which a 6-lane bridge funnels to four lanes from Foster Island west as an opportunity to create the exclusive transit-only lanes for which we advocate above. In fact, the use of two additional lanes by anything except transit in such a scenario would invite an unmitigated failure at such a bottleneck with negative consequences for environmental and mobility objectives.

Summary: broader concerns

Sierra Club is committed to a future of smarter energy and transportation choices. Our choices today will determine whether we have a sustainable system tomorrow. When investing in transportation infrastructure for half or three-quarters of a century, the state must ensure we reduce GHG emissions, meet increasing demand for transit, and prepare for the inevitable price spikes in petroleum resulting from the realization of peak oil. Our resources are best spent to advance environmentally effective, minimal damage actions. Therefore, Sierra Club urges WSDOT to revise its SR 520 preferred alternative by:

* eliminating turning movements that direct traffic onto Lake Washington Blvd. E. through the Arboretum;
* using minimal impact design standards, seeking waivers from business-as-usual practices where necessary;
* retaining SR 520 transit access to and from the west at Montlake Blvd. so downtown oriented bus routes also serve the regional stops on the Montlake lid;

* incorporating the response to tolling into more realistic capacity estimates and resulting designs;
* designating any additional two lanes as transit only; and
* designing the SR 520 corridor to accommodate light rail transit within never more than a 6-lane footprint.

We appreciate the opportunity to comment on these project design refinements for such an important transportation investment.

Sincerely,

Morgan Ahouse
Chair, Sierra Club Cascade Chapter

From: SR520users@aol.com
To: SR520Pontoons_DEIS@wsdot.wa.gov
Sent: 7/12/2010 8:25:42 P.M. Pacific Daylight Time
Subj: Comments on inadequacies of DEIS for State Route 520 pontoons

Sir or Madam:

The above-identified DEIS is legally and otherwise inadequate due to complete failures to identify ways and to analyze means by which all current alternatives have omitted essential considerations, entirely, as to the Washington State Department of Transportation's major-and-continuing misuses of 18th Amendment funds to finance engineering costs and other substantial expenses, up to and including this date, in order thereby to advance WSDOT's intentional violations of the Washington State Constitution's Article II, Section 40, in its said unconstitutional furtherances of significant monetary benefits for planned **nonhighway** facilities of and for planned **nonhighway** uses by the Central Puget Sound Regional Transit Authority (*i.e.* as WSDOT's former co-lead agency for its State Route 520 replacement programs) so as thus to facilitate that junior taxing district in its plans for future exploitation of the SR 520 corridor through WSDOT's unconstitutional misappropriations of millions of dollars in constitutionally restricted state funds (*i.e.* for light-rail services).

Additionally, these manipulations by WSDOT, as lead agency herein, and by Sound Transit, as its previous co-lead agency herein, implicate an ongoing conspiracy between said state agency and said junior taxing district in order to violate the Washington State Constitution both intentionally and also willfully by siphoning off millions of dollars of constitutionally restricted state funds, *i.e.* for unlawful purposes, through misfeasance in public office at common law by and among their respective public officers previously and presently.

Respectfully submitted.

Will Knedlik, Chairman
SR 520 Users Alliance

University District Community Council
4534 University Way N.E.
Seattle, WA 98105

September 21, 2010

ESSB 6292 Workgroup
Washington State Department of Transportation
600 Stewart Street # 520
Seatttle, WA 98101

Received
SEP 23 2010
SR520 Document Control

RE: Draft Report, SR 520 Design Refinements

Dear Workgroup members:

This letter concentrates on three prime concerns with the ESSB Draft Report, dated September 13, 2010:
(1) Delay of the second bascule bridge across the Montlake Cut
(2) Routing SR 520 traffic ontoLLake Washington Boulevard through the Arboretum; and
(3) Replacement of park land taken from Montlake/McCurdy Parks.
It quotes passages from government documents and then assigns the recommendations a rating

<u>(1) Delay of rthe Second Bascule Bridge Across the Montlake Cut</u>:

The Nelson/Nygaard Report to the Seattle City Council, dated March 2010, entitled "SR 520 Project Enhancement," at pages 13 and 14, described why the Second Bridge is important and the result if a Second Bridge is not built, as follows:

""The Montlake Interchange and subequently the Montlake Cut are keys to both local and regional transportation patterns. The Montlake Interchange accommodates about 55% of all traffic on SR-520 with a total daily traffic volume of 53,000. Also important is its role as a transit corridor. Each day 594 bus trips cross the Montlake Interchange and Montlake Bridge. 365 of those are local bus trips and 229 are regional bus trips. Local ridership comprises about 60% of all transit person trips made over the Montlake Cut. The roadway sysrtem here acts [as] the receptor and distributor of trips to and from SR 520 as well as accommodating a significant amount of local Seattle traffic. At the bridge, three lanes in each direction are squeezed to two lanes in each direction. At peak times this merging causes congestion, slowing transit, as well as general purpose traffic.

"The Montlake bridge also serves as a major pedestrian and bicycle corridor between neighborhoods to the south and the U-district. In the future the new pedestrian and bicycle facility added to SR 520 will increase bicycle and pedestrian volumes as the Montlake Bridge becomes the link between two major regional non-motorized facilities the Burke-Gilman Trail and the SR 520 Regional trail."

....

[If no second bascule bridge is built] "Traffic operations on Montlake Boulevard remain as they are today and degrade in the future if traffic volumes increase as forecast. There is a risk to SR-520 operations from cars backing up onto the mainline from off ramps in both the Eastbound and Westbound directions during peak traffic periods.

"Transit would remain impeded by congestion on Montlake Blvd. from south of SR 520 to well north of Pacific Street.

"Under forecasted higher traffic volumes pedestrian and bicycle usage becomes less attractive to more casual riders and walkers as they experience more traffic close to

their path of travel."
This analysis is supported by statistics, modeling, and opinions of the Washington State Department of Transportation ("WSDOT") and independent consultants. Delay of the second bascule bridge deprives the public of its benefits and subjects the public to all the detriments in the interim.

The draft recommendation deserves a "D" for Doubt or Disbelief of the panel in the information collected or judgment of WSDOT staff and consultant.

(2) Routing SR 520 Traffic through the Arboretum:

The Draft Report recommends routing westbound SR 520 trafffic destined for Madison Park, Madison Valley, Madrona, and the east slope of Capitol Hill tto Lke Washington Boulevard and through the Arboretum, by-passing Montlake Boulevard and 23rd Avenue East, which are the designated arterials and truck routes under Seattle's Complete Streets Ordinance. It achieves this, objective by allowing SR 520 traffic from the Montlake off-ramp to turn left onto 24th Avenue East and then east to Lake Washington Boulevard at all tiimes of the day. Estimated volumes would reach about 500 vehicles per hour peak hour.

The Arboretum and Botanical Gardens Committee, the manager of the Arboretum, on November 19, 2009, established six Guiding Principles, in part, as follows:.

"The proposed SR 520 project in and around the Washington Park Arboretum should:

1.. Enhance the Washington Park Arboretum through the design, construction and operation of SR 520 ...;
2. Avoid harm to the Washington Park Arboretum and its collections;
3. Respect the historical, aesthetic and design integrity of the Park; ...
5. Reduce traffic on Lake Washington Boulevard below levels that exist today on the boulevard between Montlake Boulevard and East Madison Street; and
6. Preserve and restore the Arboretum as an accessible place of quiet and respite.

Allowing the left turn from 24th Avenue East to Lake Washington Boulevard violates all these Guiding Principles. The Arboretum and Botanical Gardens Committee might accede to permitting a left turn there during rush hours only. If so, such a concession might be made --- but no more than that.

The draft recommendation rates a "D" for for Detracting from the Arboretum.

(3) Advance Acquisition of Replacement Park Land

The Draft Report ignores this important issue. Both the Project Impact Plan developed during mediation and the Draft Supplemental Environmental Impact Statement had contemplated replacement of park land taken for the SR 520 project in kind by suitable property in the vicinity and each identified potential replacement sites. This was a fundamental assumption of both documents. However, some City of Seattle officials are now asking for cash for land taken from Montlake and McCurdy Parks in order to pay one-half of the proceeds to the Museum of History and Industry for use elsewhere.. The design refinements should stipulate replacement in kind for park land taken and identify preferred sites.

Cash out payment is unacceptable for these reasons:

(a) WSDOT has a duty to avoid and mitigate harm. Payments for land reduce pro tanto the amount available for those purposes;

b) WSDOT is required to replace the Waterfront Trail; portions of the park land taken supply parking and access to the trail, and are so close to the trail as to impact it:

(c) The City of Seattle has a long-standing policy and ordinance for replacement of park land taken for a project.

Resolution 19689, passed November 9, 1963 states:

" "BE IT RESOLVED ....

That the City Council affirms the policy that all lands and facilities now and hereafter held for CIty park and recreational purposes should be preserved for such purposes, and if necessarily diveerted to any other purpose by any public agency, such lands be compensated for, and immediately replaced by equal or better facilities in the vicinity..."

Initiative Measure No. 42 states, in part, as follows:

"Whereas, all of our parks need such protection in order to be preserved for public purposes and for our legacy of parks to be passed on to future generations; and

"Whereas, this ordinance would continue and strengthen a City policy against divsrsion of park lands and facilities contained in Resolution 18689, passed in 1963; ."

. BE IT ORDAINED BY THE CITY OF SEATT.LE AS FOLLOWS:

""SECTION 1. All lands and facilities held now or in the future by The City of Seattle for park and recereation purposes, whether designated as park, park boulevard, or open space, shall be prserved for such use; and no such land or facility shall be sold, transferred, or changed from park use to another usage, unless the City shall first hold a public hearing regarding the necessity of such a transaction and then enact an ordinance finding that the transaction is necesary because there is no reasonable and practical alternative and the City shall at the same time or before receive in exchange land or a facility of equivalent or better size, value, location and usefulness in the vicinity, serving the same community and the same park purposes."

East Montlake Park was dedicated by the plat of Montlake in 1909. It is held by the City in trust for the public, and as dedicated park land, RCW 35.22.280 (11) requires its replacement in kind and in an exchane. transaction.

Chapter 370, Laws of 2006, Section 304 (affirmed by Chapter 518, Laws of 2007, Section 305) forbids starting construction until a "record of decision has been reached providing reasonable assurance that projects impacts will be avoided, minimized, or mitigated *as much as practicable* to protect against further adverse impacts on neighborhood environmental quality as a result of ... SR 520 ... and that any such impacts will be addressed through engineering design choices, mitigation measures, or a combination of both." (emphasis supplied) No such assurance can be made nor be creditted if moneys for park land taken are diverted elsewhere. ESSB 6292, itself, calls for enhancement of the Arboretum.

The proposed diversion of park proceeds would be unlawful and must be stopped. In overlooking this looming unlawful action, the Draft Report rates a "D' for Dinconnectuon or Discordance..

Thank you for the opportunity to comment.

Yours truly

Matt Fox
President

cc Arboretum and Botanical Gardens Committee
Mayor Mike McGinn
Seattle City Council
Board of Park Commissioners

Jean Amick [redacted]

This plan to expand the bridge with NO expanded access or egress to it or from the north or south on Seattle arterials seems like the traffic will just back up onto the bridge as it can't get off. Certainly we need a second draw bridge for any roads on the Seattle side to function.

We live near the present bridge and the noise can be awful. How about a lower speed limit to alleviate some of the increased noise that a 6 lane bridge will create?

It seems that transit connectivity is still complicated. For the 1,000's of folks crossing at the U Hospital and stadium area a free ped/bike lid or tunnel to deal with Montlake Blvd traffic is needed. Plus sky bridges are ugly.

Added two four way traffic lights at 24th Ave E and Montlake Blvd where exiting to Seattle will really clog up the exiting. Now we have a free right turn or free left off to Lake Washington Blvd. In the "better" future we have to deal with two additional lights??

Also, the reversible HOV lanes were designed 20 years ago before Bellevue had any highrise offices and condos and Microsoft was smaller. Reversible lanes take up lots of space and are a real drag for traffic. Note the clog up at the northbound one at Seneca Street. We should have HOV all the way all day!

Please make the new 520 bridge connect better to Seattle side. I know our geography is more complicated that the eastside but for $4 Billion, there should be some improvement for Seattle.

Jean Amick
[redacted]

Jorgen Bader
[redacted]

September 20, 2010

ESSB 6392 Workgroup
600 Stewart St. # 520
Seattle, WA 98101

RE: Comment on SR 520 Draft Report
Recommendations

Dear Workgroup Members:

The Draft Report of the SR 520 Workgroup, established by Chapter 248, Laws of 2010 ("Workgroup"), falls short of its statutory assignment. The Draft Report prioritizes bike trails; easy motorist travel from SR 520 to Madison Park and the Madison Valley; delaying the second bascule bridge; and to some extent, bus stops. These elements get precise stipulations. Parks, the environment, and long range transit planning get postponement, more process, and an array of partial remedies for consideration in the by-and-by.

The Draft Recommendations should have been coordinated with the Arboretum Impact Plan and long range regional transit planning for the area. Chapter 248, Laws of 2010 in Section 2 directed convening three separate workgroups and preparation of a plan to address mitigation of impacts of the project upon the Washington Park Arboretum. The fourth sentence of sub-part 4(b)(v) states:

> Wetland mitigation ... as a result of ... the program's impacts on the arboretum *must, to the greatest extent practicable, include on-site wetland mitigation of the Washington park arboretum, and must enhance the park arboretum.*" (emphasis supplied)

Section 1 (vetoed by the Governor) stated the purpose of the legislation, including "... the effective connection for transit to the university link light rail line, consistent with the requirements of RCW 47.01.408, and light rail services through the state route number 520 corridor, consistent with the requirements of RCW 47.01.410."

Chapter 517, Laws of 2007, in Section 3 (2) called for the SR 520 plan to ".. minimize any increases in additional traffic volumes through the Washington park arboretum and other adjacent neighborhoods." Section 6 directs preparation of a "multimodal transportation plan" for effective and efficient public transportation.

I. TRANSIT

A. Corridor Management Agreement ---

The Draft Report, pp. 8 and 14, recommends a "corridor management ***plan*** for transit/HOV lanes" to be implemented by the Washington State Department of Transportation ("WSDOT"). It should recommend a Corridor Management ***Agreement*** *among the jurisdictions in the region covering an array of topics, both immediate and long term, -- all to assist transit, carpooling, and other measures that would reduce the volume of single occupancy vehicles and makes travel more efficient.*

An attachment "A", entitled "Corridor Management Plan" outlines its contents. The proposed plan describes operational activities that the Washington State Department of Transportation ("WSDOT") would take to control and assist traffic flow on SR 520 and the immeidately adjacent access ways. The *Agreement* needed would involve WSDOT and corridor municipalities and have a much broader scope.

A Corridor Management Agreement would avoid or mitigate long term adverse land use impacts; preserve air quality; and reduce greenhouse gas emissions. The Final Report should discuss and recommend it in a paragraph like this:

> The State of Washington will as part of the SR 520 Bridge Replacement and HOV Project execute an intergovernmental SR 520 corridor management agreement with Sound Transit, King County Metro, the affected municipalities, the Puget Sound Regional Council, and the University of Washington as recommended by the policies and manuals of the United States, Federal Highway Administration, for increasing transportation efficiency and multi-modal coordination and monitoring and reporting performance. Such an agreement would include the subjects in WSDOT's usual project agreements with municipalities, (such as construction of the facility, maintenance, coordination of operations, incident management, surveillance and enforcement, emergency evacuation, and municipal uses of right-of-way) and also encompass off-site elements, such as programs for promoting transit, shuttle services, and carpools, and ride-sharing; coordination of multiple transportation modes; information sharing technology; traveler information; educational programs; traffic demand management; and land use policies oriented toward transit.

The SR 520 Program description, p. 4, prepared for the Seattle City Council, dated November 24, 2009, entitled "SR 520 Bridge Replacement and HOV Program Overview" contains a project entitled "Lake Washington Congestion Management Project." The corridor management agreement would fit in with it. The United States, Federal Highway Administration ("FHWA") website, publishes documents encouraging corridor agreements, e.g. "Federal Management and Operations Handbook" (FHWA Report No. FHWA-OP-09-003), Technical Memorandum, U.S. Department of Transportation, Federal Highway Administration, June 2007 (FHWA-JPO-06-037) and Rule 940.

Corridor management agreements have proven to be effective in clarifying relationships and responsibilities; in integrating the functioning of transportation facilities and systems of different jurisdiction; and in coordinating activities so that the aggregate result is more productive than the sum of the individual efforts of the participants. Such an agreement at the outset also reduces the opportunity for local governments to avoid contributing while their residents would get the benefits of the activities of those agencies that do. This sometimes happens when environmental and conservation programs involve restraint in the use of resources among the participants for the common good; those who make no sacrifice --- sometimes called "free riders" --- reap the benefits and opportunists may move in to take more. Long term monitoring of performance and revisions, if needed, help to keep the performance at a high sustainable level over time and preserve the value of the investment.

The Project Impact Plan, dated December 2008, p. ES-7, identified among the "Long Term Improvement Suggested by Mediation Participants" for all options: "Explore opportunities to develop a SR 520 Corridor Management Agreement with local jurisdictions along the corridor to encourage transit friendly land use and other development decisions." The Project Impact Plan, Appendix 10.3, identifies potential Transportation Demand Management Strategies, prepared by WSDOT for the SR 520 Corridor Program. This was one of the few elements on which all the communities, north and south of the Lake Washington Ship Canal, agreed.

The Final Report would be incomplete if it were to fail to recommend this essential element.

B. Parallel Bascule Bridge ---

The Draft Report, pp. 7 and 14, recommends developing a phasing plan for construction of the second bascule bridge and identifying specific measures during an evaluation period. The second bascule bridge was an integral element in (a) Alternative "A" endorsed by a plurality of the participants in mediation; (b) in the preferred alternative by the legislative workgroup in 2009, and (c) in the preferred alternative recommended by the Governor on April 2010. Nothing in Chapter 248, Laws of 2010 authorizes deleting or delaying it; and deferring it can scarcely be considered a "design refinement."

The "trigger" approach is disingenuous, costly, and unfair to the residents:

1) The parallel bascule bridge across the Montlake Cut is

needed for efficient bus connections to the UW Husky Stadium Sound Transit Station. The Nelson/Nygaard Report to the City Council, dated March 20, 2010, called the Montlake Interchange and crossing the Montlake Cut "keys" to to local and regional transportation patterns. 594 Metro bus trips cross daily -- 365 local and 229 regional. Congestion slows transit, and without the bridge, transit would be impeded from Madison St and 23rd Avenue East to University Village on the north. METRO has cut north-south service on 25th Avenue N.E. from N.E. 45th St. to Montlake down to two routes; it would add more if the Montlake crossing had HOV/bus lanes. The HOV and bus only lanes on N.E. Pacific St. can get buses to the Montlake Bridge, but not across. Seven lanes on the north of the Montlake Cut and six lanes on the south converge to four lanes on the Historic Montlake Bridge. That bottleneck causes back-ups that may effectively preclude in-lane bus stops envisioned by the Draft Report, pages 16 and 17.

2) The Nelson/Nygaard Report warns that, if the second bascule bridge is not built, cars may back-up on the mainline of SR 520 both eastbound and westbound from the off-ramps during peak hours. That forecast is very probable. It happens now, and eastbound during Husky events, the back-ups affect I-5 flows.

3) Computer modeling during mediation showed the need for the second bridge in travel time savings for motorists, bus passengers, and freight. None of the proponents of delay have produced any statistics or computer modeling to show that the second bridge is not needed to meet the higher anticipated SR 520 volumes or to accommodate local north-south traffic.

4) Building the second bascule bridge early on will accustom commuters to using the bus and provide better bus service at the outset. Moreover, it will reduce the traffic diversion that now occurs as motorists drive out of their way to the N.E. 65th on-ramp to I-5 in order to get access to SR 520 rather than endure the delays of Montlake congestion. To a lesser extent, westbound motorists on SR 520, who go to N.E. Seattle, now choose to use the N.E. 45th, N.E. 50th, an N.E. 65th St. off-ramps when the off-ramp at Montlake Boulevard backs-up on SR 520. The second bridge will reduce that increment to I-5 congestion.

6) Getting the needed bridge permits from the United States takes time. The sooner the process begins, the sooner it is likely to be completed, and construction can begin. Construction costs escalate over time and with any up-swing in the business cycle. Constructing a project in two phases, rather than one continuous project, adds unnecessary interim restoration work.

7) By announcing plans, but delaying a final decision, WSDOT blights the two houses involved. The homeowner have little incentive to maintain their premises and, if so inclined, would encounter difficulty in trying to sell their property during the uncertainty. California cases have held condemnors liable for damages for impairment of use from the time of the announcement until the actual taking of possession or abandonment of condemnation proceedings. It is very unfair to the owners: say, that there is a roof leak. Does the owner put a bucket on the floor? nail a tarp over the roof? or order that section of the roof repaired? The first makes sense if the dislocation happens

within a few months; the second, if dislocated after a season; and the third if the process takes years. It's unfair to the adjacent property owners: abutting owners lay out and maintain their yards with an eye to the property next door. They don't know what to expect, and if an abutter decides to sell, prospective buyers won't know. When facing an unknown, buyers may assume the worst and reduce their offers accordingly

Delay amounts to denial during the interim, and all the adverse impacts of no bridge (bottlenecks, back-ups, long delays, diversions etc.) occur until construction is complete. The Draft Report, p. 14, mentions the "triggers" but fails to identify or describe them. Attachment "A," entitled "Second bascule bridge phasing" names three factors: transit travel time, pedestrian and bicycle passage, and impeding SR 520. The list omits traffic congestion on Montlake Boulevard N.E. and/or congestion in the Montlake area; impacts on the Arboretum or cut through traffic.. Both Chapter 517, Laws of 2007, Section 3 and Chapter 248, Laws of 2010 mention minimizing traffic in the Arboretum and the neighborhood. Naming alone gives no weighing of factors, e.g. must all three be at failure? what is the baseline? The vaguery sets up another lever to delay the project on the Seattle side.

The "trigger approach" with the Montlake bascule bridge contrasts with the draft report's recommenation for a southbound left turn from 24th Avenue East to Lake Washington Boulevard. With the bascule bridge, it disregards notorious congestion, foregoes immediate testing of its traffic channelization techniques, and discounts computer programming. With the left turn, the draft report assumes unresolvable congestion would occur to Montlake Boulevard should the left turn be restricted.

II WASHINGTON PARK ARBORETUM

<u>A) The "Left Turn"to Lake Washington Boulevard</u> --

The Draft Report recommends that westbound traffic from SR 520 that turns southbound on 24th Avenue N.E. be allowed to make another left turn from 24th Avenue East to Lake Washington Boulevard (the "Left Turn" herein). The Draft Report, itself, makes no restrictions, although an exhibits hints at possible restrictions, e.g. on bicycle Sundays or marathon races through the Arboretum. Earlier planning had restricted the Left Turn to HOV vehicles. The volumes exceed 500 vehicles per hour during peak hour. The Draft Report has no performance standards or "triggers," and no acknowledgment of any impacts of allowing 500+ vehicles per hour to the park drive. In constrast to its outright allowance, the Draft Report at pp. 7, 8, 9 and 14 offers vague promises of traffic calming strategies to alleviate the harm that its decision will surely cause.

The Draft Report is disingenuous on the Left Turn. It omits material facts that legislators are entitled to know:

- It fails to mention or considerthat Lake Washington Boulevard is a **park drive and the spine of a City park of statewide significance.** RCW 1.20.120. As such, it is protected by Section 4 (f) of the United States Department of Transportation Act of 1966, 41 USC 303 (c).

- It fails to mention the volumes of vehicles thrust upon Lake Washington Boulevard in the Arboretum or their impacts; and it pretends that traffic management can mitigate their impact. There is "no fail safe" to abort the decision should there be adverse impacts; and

- It fails to disclose the absence of concurrence by the Arboretum and Botanical Gardens Committee ("ABGC"), established to manage the Arboretum. In fact, the Statement of Principles -- adopted by the ABGC runs contrary to the recommendation.

Allowing the Left Turn would be against the tenor of the discussion at the ABGC members at its September 8, 2010 meeting. At that meeting, some members of the ABGC said rather reluctantly that the Left Turn may be allowable during peak hours only, but they were firm that it should otherwise be prohibited. No member of the ABGC spoke in favor of the Left Turn. During the ABGC discussion, one member cited the Guiding Principles adopted November 18, 2009 and posted on its website. Principles 5 and 6 state: "Reduce traffic on Lake Washington Boulevard below levels that exist today on the boulevard between Montlake Boulevard and East Madison Street; and Preserve and restore the Arboretum as an accessible place of quiet and respite." The WSDOT program manager responded that no decision had been made and left the impression that further consultation would ensue. Had she said that the Workgroup would be asked to approve an unlimited Left Turn, the ABGC would have taken a more explicit stand.

The Workgroup approved the Left Turn at its meeting the next day without being told of the ABGC's guiding principles or its discussion of concern at its September 8, 2010 meeting; the impact on the Arboretum; or the peak hour only option. During the public comment period afterwards, citizens told the Workgroup about the ABGC's actions and discussion. Yet, in presenting its Draft Report to the Seattle City Council on September 13th --- four days later ---, the Workgroup again omitted any reference to the impact on the Arboretum or the ABGC's concerns, stance, or discussion. Neither the Draft Report nor the Appendix entitled, "Arboretum traffic management," discuss the impact on the Arboretum of the Left Turn or the peak hour only option. Each focuses only on the effect of vehicles that would make the Left Turn if routed to Montlake Boulevard East during the evening rush hour. It estimates that incremental volume at 20% of the load. Off-peak Montlake Boulevard has ample capacity for the volumes including the would-be Left Turners. That justification would apply at most 10 to 15 hours per week. Instead, the Draft Report authorizes the Left Turn 24x7 or 168 hours per week --- at least 10 times the peak hour period cited.

The Left Turn encourages commuters, who have a choice, to use

Lake Washington Boulevard and Madison St. rather than 23rd Avenue East, the designated arterial. The prospect of avoiding Montlake congestion and its bus stops and pull-outs will make the Arboretum by-pass the favored route for large sections of the Central Area and neighborhoods further south. The added volumes of vehicular traffic conflict with the design of Lake Washington Boulevard as a park drive and harms the ambience of the Arboretum. It is contrary to the aim of Chapter 248, Laws of 2010, which seeks to enhance the Arboretum. It makes managing traffic in the Arboretum very much more difficult and far less likely to be effective. The added vehicules make bicycle commuting more risky on Lake Washington Boulevard. Many motorists will continue to turn right at Boyer Avenue East, a narrow neighborhood roadway with traffic circles.

If allowed, peak hour Left Turns usage should then be an exception to the normal practice. There is precedent for peak hour allowances only e.g.

> The shoulder on the westbound Portage Bay bridge. The SR 520 plan calls for through traffic use of the shoulder as an auxiliary lane during peak hours. At other times, it is a safety shoulder closed to traffic.
>
> Parking along arterials. Forbidding parking makes the curb lane available for through traffic and expands the capacity of the street for the duration. With an absolute "no parking anytime" signage, people know not to park in a location. With no parking except 7-9 A.M. or 4-6 P.M., people expect to be able to park most of the time. Some parking and ride lots are available only on weekdays.

If the Left Turns is limited to rush hour use only, then SR 520 traffic will use 23rd Avenue N.E. during the evening, mid-day, and weekends. The restricted time needs to be a condition and a stipulation in any allowince of the Left Turn, itself , and not some possibility hidden in an appendix and trotted out to apply on bicyle Sundays ans during marathon races.

The draft recommendation for the Left Turn differs from the manner the Draft Report approaches other issues, e.g.

- Time restraints are stated in the allowance of dsriving on the Portage Bay shoulder --- it's not left to a vague traffic management plan to be developed later;
- The University's concurrence was obtained before making recommendations as to the Montlake Triangle at N.E. Pacific Street --- it was not by-passed as the ABGC was;
- Computer studies were presented before some traffic operational decisions were made --- not as with the Left Turn where rationalizations are coming afterward;
- Elsewhere, ecouraging high occupancy vehicles comes into play --- with the Left Turn, anything goes, anytime;
- The contrast is especially strong as to the second Montlake bascule bridge. With the second bridge, the Draft Report calls for experimental remedies first and, if proved inadequate --- as likely ---, then construction. With the Left

Turn, the Draft Report recommends re-opening the floodgates and then seeking to control the flow. During construction, the Left Turn will be closed off so that the public will have become accustomed to its closure. Prudent traffic engineering would bar the Left Turn unless and until conditions on the ground show that it is needed.

B) Applicaton of funds paid for park lands ---

To meet the statutory goals of protecting and mitigating adverse impacts on parks and wetlands and protect against "further adverse impacts on neighborhood environmental quality" (Chapter 370, Laws 2006, Section 304 (3)), design refinements need to address replacement of the waterfront taken from the Arboretum and East Montlake/McCurdy parks and recommend advance acquisition of identified sites. Recent disclosures cast replacement in doubt and require the Workgroup to take it up.

East Montlake/McCurdy Parks are the western entryway to the waterfront trail and supply the parking for visitors. The Draft Supplemental Environmental Impact Statement contains a 4(f) Statement as an Attachment 1. Its Exhibit 4 states the the SR 520 Project will take 3.7 acres from Montlake and McCurdy Parks. Of this acreage, 2.11 of East Montlake Park and .09 acres of McCurdy Park are subject to Section 6 (f) of the Land and Water Conservation Act of 1965. Section 6 (f) requires replacement in kind. Section 4 f) requires that the project avoid or minimize harm.

Replacement in kind seemed to be a given from the Draft Supplemental Environmental Impact Statement, Section 4 (f) Attachment The documents identified waterfront sites of great value. The diagrams and discussion portray a consolidated park without apportioning the segments owned by the University of Washington, the Arboretum Founation, and The City of Seattle. This treatment anticipated that the coordination would continue.

In 1909, the plat dedicated East Montlake Park; in the 1940's, the Port of Seattle deeded shorelands of McCurdy Park to the City of Seattle for park purposes. Draft Supplemental Environmental Impact Statement, Attachment 7, pages 29 and 30. Ordinance 78355 authorized a lease of portions of the site to the Seattle Historical Society for the constructiom of the Museum of History and Industry ("MOHAI"); in the lease, the City retained ownership of the land. The City acquired the construction site from the University of Washington, Board of Regents, pursuant to RCW 28B.20.354 (Chapter 45, Laws of 1947) and Ordinance 78354. The lease agreement for MOHAI was executed January 18, 1950.

The *Seattle Times*, Friday, September 10, 2010, Pages B-1 and B-9, and September 17, 2010, page B-2 reported that WSDOT and MOHAI had reached agreement on the amount to be paid for taking of the MOHAI building and for relocation of its exhibits and other personalty. The article went on to write that City officials and MOHAI were planning to apportion payments to Seattle for the park land. MOHAI would let up to one-half of the payment for the land for use elsewhere. (Note: Council Bill 116955 appropriates $ 40,000,000 to be paid for the building to MOHAI, and excludes the land.) A split of the proceeds for the land would be unlawful and contrary to WSDOT environmental documents.

Resolution 19680 and Initiative 42 of The City of Seattle require that the land taken would be replaced by equivalent land in the vicinity. Any diversion of moneys paid for park land would violate Initiative 42; the City Charter, Article VI; and the common law. It would be contrary to the spirit and policy of Section 517, Laws of 2007 and Chapter 248, Laws of 2010 to minimize impacts on the Arboretum. It also brings into play RCW 43.09.210, cf. *State v. Greys Harbor County, 98 Wn.2d 606 (1983), and Heerman v. City of Woodland, Unpublished Opinion, Court of Appeals # 30823-1-II (2005)*; and it casts doubt on representations about mitigation in WSDOT's environmental documents and in the Section 4(f) and in Section 6 (f) processes.

The Final Report should should stipulate that all park land taken be replaced in kind, and, to assure its proper application, that instead of paying cash to Seattle for park land, WSDOT should acquire replacement sites and exchange land for land. With I-90, WSDOT conveyed replacement land for the parts of Sturgus Park and Judkins Playfield that were taken. An in kind conveyance maximizes the use of the available funds for mitigation and would reduce the lasting adverse impacts of the project on parks, Allowing the City to make a partition and a diversion of proceeds would have the opposite effects. The Final Report should disclose to the legislature the looming threat.

<u>C)</u> <u>Crosswalk by Japanese Gardens</u> ---

The Draft Report needs to commit WSDOT to participating in constructing safety improvements in the Arboretum, such as the crosswalk by the Japanese Tea Garden. People cross Lake Washington Boulevard there to get to or from the main Arboretum areas and to parking spaces. Vehicles race by there at velocities well above the speed limits; the serpentine roadway reduces sight distances; and the volumes are so heavy that there are few breaks in the traffic flow. This crosswalk is so important that it should also have been made part of the "Bicycle and Pedestrians Connections" package of recommendations. The Appendix A white paper, so entitled, unfortunately omits any mention of it.

The Draft Report calls for traffic management and calming on Lake Washington Boulevard. It says nothing about WSDOT sharing the cost. A WSDOT handout at the September 8 meeting of the

ABGC assigned the crosswalk as a project to the Seattle Department of Transportation ("SDOT") to implement. WSDOT's stance falls short of its statutory assignment. Chapter 248 builds on a base of Chapter 517, Laws of 2007, and Washington environmental laws, including the State Environmental Policy Act (RCW 43.21C). Court decisions often require a new project to clean up and correct damage currently being done, e.g. The new SR 520 bridge will reduce water pollution and noise pollution caused by the current bridge.

The crossing to the Japanese Tea Garden is a safety issue --- more so than one of traffic calming. The peril arises from the volume and speeds of traffic on a park drive originally designed for carraiges and upgraded to pleasure driving. 50% of the traffic --- particularly those who hurry along --- go to or from the SR 520 bridge. (The statistic comes from Appendix A, "Arboretum Traffic Management). The SR 520 volumes alone exceed the numbers that Lake Washington Boulevard was designed for or carried before SR 520 was built. If the current SR 520 Bridge were to float away --- as some of WSDOT's internet videos have warned might happen in a severe windstorm --- traffic volumes would decline below those of the "no action" estimate and no crosswalk would be needed. WSDOT therefore has a responsibility for the crosswalk. It may share that responsibility with SDOT on a proportionate basis, but it can not absolve itself from any duty to participate in affording a remedy.

D) <u>Representation of the ABGC in further proceedings with respect to Urban Design and Streetscape</u>

The Draft Report should make sure that the ABGC (a) is empowered to set criteria and goals, (b) has a representative on the design team, and (c) is consulted throughout the whole process, including the Montlake lid and the drainage ponds.

The WSDOT design team has given exemplars of its work: the pillars of the undercrossing to Foster Island, the Montlake lid, and the drainage pond at East Montlake Park. In its sketches, the undercrossing looked like the concrete posts under the West Seattle Bridge or by the stadia in SODO. The Montlake lid design is a plain, green lawn with footpaths to bus stops. The drainage pond is a sterile trapezeum like the sumps for contaminants seen hidden outside factories. What criteria were they using? What were their goals? Where was their imagination? The columns and the sidewall of the highway should have artistic treatment to match the greenery and values of the Arboretum or its cultural heritage. The Montlake lid is the western gateway to the Arboretum and should build anticipation, e.g. community floral gardens, artwork, or exhibits that interest people waiting for the bus. One resident suggested that the waiting area by the bus should have play structures like those in University Village or Madison Park themed to Arboretum wildlife. As for the drainage pond, the High Point Housing community has a model that is a focal point for the community.

E) Consultation ---

The Draft Report lacks sensitivity to the environment and ecology in its design refinements. In fact, it overlooks these impacts.

In the Next Steps on page 19, the Draft Report needs to direct WSDOT to consult with informed citizen organizatons in their area of interest and expertise. WSDOT's outreach so far has failed to invite specialized citizen organizations into its processes, except to a limited extent during mediation.

East Montlake Park is a prime viewing area in Seattle for astronomers to see the cosmos. Highway lighting may impair viewing. Dark Skies Northwest is more than willing to consult about adjusting the highway lighting so as to preserve East Montlake Park as a viewing area for looking at astronomical phenomena. Check www.darkskiesnorthwest.org on the internet for contact information.

The Arboretum has a rich host of avian life and Foster Island is a hub roosting area for crows. *The Street Smart Naturalist: Field Notes from Seattle*, p. 197. Crows assist insect pest control. WSDOT should be asked to consult with the Seattle Audubon Society, 8050 -- 35th Ave. N.E.,Seattle, 98115 ((206)523-4483) and take it into its confidence about activities in the Union Bay wetlands.

In the environmental documents so far, WSDOT has written up impacts on endangered species and species of concern; it has lumped other species under the generic "wildlife." The Arboretum hosts bats, which aid in insect control. Bats Northwest, P.O. Box 3026, Lynnwood, WA 98046 ((206) 256-0406)(www.batsnorthwest.org) studies and befriends them. During a discussion about Seattle's proposed tree ordinance, a member suggested that spar poles with bat houses should be placed strategically wherever trees are cut in a natural area lest the bats disappear and the ecology be disrupted.

III TASKS AHEAD

A Design Competition for Portage Bay Bridge ---

Although five months have elapsed since the Governor announced her preferred alternative, neither WSDOT nor the Workgroup has made a decision on a simple, basic question: Will the project stipulate a design for the Portage Bay bridge that involves false arches or open the design to competition? During mediation, a minority faction proposed the false arch concept; others strongly opposed it calling for design competition. Most of the mediation panel took no position on the issue.

Design competition offers an opportunity to save money, to produce a more pleasing design, and to give the public a voice in the selection of the Portage Bay crossing. Otherwise, the design will be completed by WSDOT's design team or WSDOT may adopt a plan involving false arches. The work products of the Design Team for the crossing of Foster Island are insensitive to the park environment. The false arch design adds at least Twenty Million Dollars ($ 20,000,000) to the cost, and the extra weight requires larger, heavier posts for support which take up more surface area of the bay than necessary.

What does it say to the legislature that a Workgroup, established to make design refinements and which has two members of the Seattle Design Commission as Coordination Team Members, would not make a decision to go for design competition? or to reject an expensive design that has unnecessary adverse environmental impacts? Not even Appendix A in its white paper, "Urban Design and Stretscape," mentions this looming issue. If the Workgroup needs advice, there's still time to put the proposition before the Seattle Design Commission and report its recommendation. With the large deficit in financing the SR 520 project, the 2009 legislative workgroup asked for recommendations on ways of reducing expenditures. Here's one.

<u>B) Process</u> ---

Last year, the legislative workgroup set a model that should have been followed. It met in public, heard from experts and agency personnel, considered extensive detailed consultant reports, and then made definite decisions. It did its homework first. This Workgroup is proceeding in the opposite direction: it has made some decisions, put over most with platitudes and mostly makes vague promises to work things out. It was preparing its exhibits *after* its draft report was published and when published, those exhibits lack supporting detail on key issues. The legislative workgroup decision was precise, adopting a complete plan. This Workgroup's Draft Report is precise as to most of the the five matters described in the first paragraph of this letter; the rest is descriptive or, else so to speak, embroidery in the air.

Conclusion

The Workgroup needs to go back over its draft report and redo it in accordance with recommendations of the Arboretum and Botanical Gardens Committee and the concerns raised in this letter.

Yours truly

Jorgen Bader

From: Linda Baker [redacted]
Sent: Friday, September 24, 2010 9:13 AM
To: SR520 Technical Workgroup
Subject: oppose second montlake bridge

Hello,

I am a former Seattle resident writing to express my opposition to the 520 plan, especially the addition of a second Montlake bridge,
which will only worsen traffic and destroy a historic neighborhood.
The shortsightedness of the freeway project is astounding. China, India, Europe invest in mass transit--the U.S. is stuck in the 20th century road building mindset, despite volumes of evidence showing that building more roads only encourages more traffic.

Linda Baker
[redacted]

From: marcia baker [redacted]
Sent: Thursday, September 23, 2010 10:43 AM
To: SR520 Technical Workgroup
Subject: Second Bascule Bridge

Sirs:

The plan to eventually destroy the beauty of the historic Montlake Bridge (along with several houses and land near it) in the name of so- called improvements to traffic, is a grave mistake with consequences for everyone who visits this area.

The permanent aesthetic damage to one of the most beautiful and unusual urban scenes in America cannot be paid for by a few more bicycle lanes across the Cut. As is well known, moreover, the traffic congestion in the Montlake Bridge area is NOT due to the bridge itself; studies quoted in the Coalition response to the SDEIS documented the fact that the congestion arises from poor traffic management north and south of the bridge.

The idea of building a second bridge across the Cut, almost identical to that now suggested by WSDOT, was first suggested in 1954; WSDOT would do well to study this history. The idea was considered very poor then and it is worse now.

Do not build this bridge; our descendants will thank you.

Yours

M. B. Baker

From: Paula Bennett [redacted]
Sent: Thursday, September 23, 2010 7:03 PM
To: SR520 Technical Workgroup
Subject: a second Montlake bridge

Regarding the sr520 plans - I just learned recently about the proposal for a second Montlake bridge. Not a wise idea in my opinion. I do not believe it would be worth the expense and it would also ruin a nice neighborhood.

Paula Bennett

Bosch, Jerome [redacted]
Fri 9/24/2010 10:43 AM

I travel the Montlake interchange daily and there is no way a second bridge will do anything to help the backups. So why ruin the look and feel of the current bridge as well as take out multiple homes and require a much wider swath through a beautiful neighborhood.

Just say NO!! Please!

Jerry Bosch

[redacted]

[redacted]

[redacted]

From: Richard Bourgin [redacted]
Sent: Thursday, September 23, 2010 8:52 PM
To: SR520 Technical Workgroup
Subject: Released from eSafe1 SPAM quarantine: ESSB 6392 project

Dear Sir/Madam,

I lived in the university area for many years before moving to the east coast. I still visit family there several times a year, so I continue to know the area well. The idea of a second Montlake bridge over the cut and the elimination of some houses near Montlake blvd. is hard to swallow. When coupled with the effect it will have on the original, wonderful Montlake bridge - to esthetically kill it, nothing less - I find it unfathomable that this is in the works at all.

I gather it is late in the project design, but not too late to completely eliminate the second Montlake bridge and the home destructions near where it would be from your designs. This part of the project is seriously ill-conceived; perhaps there is short-term gain (I'm not aware of any), but there is no question that in the long-term it's construction will cause a great loss for the community without helping traffic.

Thank you.

Dr. Richard D. Bourgin

[redacted]

September 24, 2010

Project Director
SR 520 Bridge Replacement and HOV Program
Plaza 600 Building, Suite 520
600 Stewart Street
Seattle, WA 98101

Re: Work Group Draft Recommendations
Design Refinements
Public Comment (Due - September 13-24, 2010)

Dear Sir/Madam:

In accordance with the public "handout" at the Seattle City Council meeting of the Special Committee on SR 520, Briefing and Progress report on ESSB 6392 Workgroup, I wish to take this opportunity to provide my comments for your consideration, review, and subsequent publication. They are as follows.

First, in your public handout, under the heading "Next Steps: SR 520 Program Funding" you have described a "Funding gap: $1.98 billion (as of March 2010)".

When considering this enormous gap in available funds I do not see any mention of, nor allowance made, for the very reasonable concept of either delaying or canceling such ancillary items as noise walls and freeway lids. As you know, their role has nothing to do with vehicular capacity or highway safety. Indeed, they may have the opposite result.

In this regard, I take exception to the comment made at the September 13th city council hearing (by SR 520 Program Project Director, Ms. Julie Meredith) who told the council and attending public that, "Noise walls are required when noise thresholds are exceeded." I presume she includes freeway lids in this category. However, she did specify this is in accordance with 23 CFR 772. Unfortunately a reading of this federal regulation does ***not*** support such an assertion, merely that it requires consideration.

For example, 23 CFR 772.9 (a) clearly states, "… giving weight to the benefits and cost of abatement, and to the overall social, economic and environmental effects." With an expected 115,000 motorists per day facing an annual new tax in excess of $1.6 Billion (in tolls if you prefer to call this tax a toll) just how were these new economic hardships justified? In the case of the Roanoke Interchange and the lids on I-5 and over SR 520, from 10th to Delmar, surely you are not suggesting these are to provide additional parks and green space to an already cash strapped Seattle Parks Department, are you? Are you suggesting these are necessary to provide some sort of neighborhood connection? If so, on what urban planning basis is this assumed?

I have traveled through nearly every state in the union and have yet to see such a plethora of "freeway lids" as proposed for this SR 520 project. (Indeed, outside of Washington State I have seen none apart from the over-the-freeway Federal Post Office in Chicago.) How could these proposed lids on SR 520 have possibly been dreamed-up given the mandates of 23 CFR 772.9 (a), or did you just ignore this part of the federal regulations? Moreover, if you feel they are so necessary, why not cover their full costs with a local improvement district (LID) so that those who benefit from them pay for them?

Next. looking at the lids in the Roanoke interchange, and referring to Table 5.7-1 we see the following data regarding impacted residences.

Existing – 24 houses. *No Build* - 24 houses. *Option A* without Walls - 26 houses

The difference between the *existing*, *no-build* and the *Option A* is only two (2) houses, as you will see from Table 5.7-1. Is WSDOT suggesting there is some sort of "overall social, economic" benefit in the order of hundreds of millions of dollars in lids and walls for just two houses? Where is the economic justification?

Moreover, to any reader, it is clear the expansion of SR 520 is not in a "new location or the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment or increases the through traffic" to make this a Type I project within the meaning of 23 CFR 772.5, Definitions, part 'h'. As a Type II project, 23 CFR 772.7, Applicability, part 'b', says these "… are not mandatory requirements …." As a consequence, please explain why WSDOT has ignored the obvious constraints within this CFR. Stated differently, just why are 115,000 motorists per day facing an annual new tax in excess of $1.6 Billion? Where is the economic justification to so burden these motorists within this CFR when "reasonableness" is the byword?

Continuing, I see from Exhibit 21, *Sound Wall Locations and Heights for the 6-Lane Alternative, Seattle*, so-called noise walls on the south side of SR 520 ranging in height from 14 feet, near the Roanoke I/C lid, to 10 feet in height easterly into Lake Washington out past Foster Island and nearly to the west transition span. As an obvious scenic highway is it the intention of WSDOT to cut-off all views to the south for all motorists traveling this route (while paying very high tolls in the bargain)? How does this comport with 23 CFR 772.9 (a) and its focus on "environmental effects", not the least as they must surely apply to motorists who are, as you know, paying the substantial costs?

Of course, the north side of SR 520 is not so bad in terms of view blockage. After all, unlike the south noise wall, there is a gap in the north wall near the Seattle Yacht Club and, too, it does not start until about midway into Foster Island.

Nonetheless, to virtually every driver and passenger crossing the bridge these proposed noise walls, with their height well above most vehicle rooflines, would obviously cripple any concept of SR 520 retaining any sort of a "scenic highway" designation. Surely, this is not your intention.

To conclude this section on the so-called noise abatement portion of the SR 520 project, I find its implementation to be far outside of any mandated CFR requirement and, as such, especially given its enormous cost, an obvious candidate for elimination, at best, or to be put-off until the economy of the state improves, at the least.

Please delete the lids and noise walls until a thorough assessment of their applicability has been documented, with such documentation, including the effects on motorists who, in the end, are paying the tolls. At a minimum, please provide better justification for their retention apart from the simplistic recitation of a few decibel readings on a map.

Second, while the presentation also included the "Bascule Bridge Phasing" (to use your title) regarding a second bridge over the Montlake cut, I did not see any geometric or other street improvements to the Pacific Avenue Street/Montlake Boulevard intersection – the so called "Montlake Triangle". Where are its capacity enhancements? Indeed, where are the DHV forecasts and their associated LOS computations? These would be a good starting point, even if the good folks at SDOT and the city council cannot understand them.

You have described certain "Bus Stop Locations: Montlake Triangle Vicinity" (to again use your title) but, perhaps inadvertently, there is absolutely no mention of the required capacity improvements attendant to the above noted second bascule bridge. To put this in some sort of perspective, exactly why should any funds be spent for a second bascule bridge in the total absence of even a modest change to the attendant additional capacity needs at the Montlake Triangle to make the second bascule bridge economically justifiable? Why would a prudent engineer consider expanding one leg of a 3-legged intersection, from four (4) to six (6) lanes, in the total absence of corollary improvements on even just one of the other two legs of the intersection if not the other two? I do not understand this design. It needs further explanation. Can you provide one?

Finally, I have seen no LOS analyses or even long-range DHV forecasts for the section from Montlake to the Seattle CBD. Where are they? How is it possible to economically justify the curious new 2-lane addition onto the reverse roadway of I-5? These lanes are not used for 24-hours a day for seven days a week. At best they are operable for perhaps only 10-hours a day, each. So, with that time limitation where is the appropriate road user benefit analysis (RUBA) in accordance with published federal standards relating to its economic feasibility?

To conclude my concerns, I am not convinced there is a need for any lid or noise wall given the nearly 50-year history of this highway and the fact that it is not undergoing any change in its horizontal or vertical geometry that would shift it to a Type I category within the meaning and intent of the CFRs. Further, since the CFRs are replete with required economic considerations, these kinds of ancillary components can well be delayed until the economy improves. If the budget for the project is shy by some "$1.98 billion (as of march 2010)", as you put it, why not delay these clearly unnecessary but expensive accessories whose values are so small the county assessor has not made one single property value adjustment at those homes bordered by existing noise walls? And finally, is there any justification for the two, new reverse roadway ramps whose utility within the Seattle CBD is open to question? I, for one, would like to see it.

Thank you for your attention to the above, I look forward to your reply as I am sure well over 100,000 motorists, who are now about to face a new tax of $1.98 billion, in the name of a toll, doubtless do as well.

Sincerely,

Christopher V. Brown, P.E.

cc Office of the Mayor
Seattle City Council
LTC

From: [redacted]
Sent: Tuesday, September 21, 2010 11:35 AM
To: SR 520 Bridge Replacement & HOV Project
Subject: SR 520 Bridge Replacement and HOV Program Feedback

Sent from: Cameron Charles
Address: [redacted]
City: Seattle
State: WA
County: King County
Zip: [redacted]
Email: [redacted]
Phone: [redacted]

Comments:
To whom it may concern, I have been following the developing plans for the replacement of the 520 floating bridge, and I would like to voice my concern over the lack of accommodation for future light rail expansion to the east side. I have made several trips to Europe this past summer on business, and the biggest difference I notice between Seattle and the cities I visited is the excellent and wide spread metro network present in all of these cities. This makes getting around without a car a very viable option, and greatly improves the metropolitan area by reducing congestion and the need for the wide, multi-lane roads that we favor in North America. As the price of oil continues to rise I think it will be increasingly important to improve public transit infrastructure, and I believe that we should start now by planning for this eventuality instead of postponing it and burdening future generations with fixing problems that result from our short term thinking. Sincerely, Cameron Charles

From: Jules Cohen [redacted]
Sent: Friday, September 24, 2010 8:41 AM
To: SR520 Technical Workgroup
Subject: Feedback on ESSB 6392 Workgroup has released the Design Refinements and Transit Connections Draft Recommendations Report

To whom it may concern,

I live in eastern Capitol Hill and use transit to get home from my work in Redmond every day. The Soundtransit bus that I take the most often is the 545 because its stop is convenient and because of the frequency of the buses is excellent. At peak hour I know that I can head to the bus stop and never have to wait more than 5 or 10 minutes for a bus bound for Montlake. However, depending on where I am in the afternoon I will sometimes catch a different bus like the 242 or one of the buses heading across 520 from the Bellevue transit center to get to Montlake. Since all these busses cross the 520 bridge and stop at Montlake I have a great deal of flexibility and transit today works really well for me. From Montlake I simply hop on a southbound 43 or 48 and I am quickly home.

The fact that the preferred proposal does not include a flyover or similar facility allowing all busses crossing the 520 bridge to stop at Montlake severely alters this, dramatically reducing my transit options and the frequency of busses available to me. This will make using transit to get to and from work more challenging and less appealing.

Our region should be providing more options and incentives to get people to choose transit over single occupancy vehicles. Tolling on the bridge will cause more people to look for ways to get out of their cars. Transit should embrace folks seeking alternative transit options by providing frequency and flexibility that make taking the bus the obvious choice. Providing fewer transit options and limiting connections is a step backwards for our region and will create a major inconvenience for commuters like me.

I strongly urge you to select a design for Montlake that allows all buses crossing SR-520, particularly the 545, to stop at Montlake and facilitates easy north and southbound transfers. A solution like the one at the 51st exit on 520 where the bus simply exits and re-enters the freeway, dropping riders on the offramp, would be sufficient. This is what we have today and doing less represents a step in the wrong direction for commuters and the region.

Jules Cohen

From: Craig Dalby [redacted]
Sent: Wednesday, September 22, 2010 10:16 PM
To: SR520 Technical Workgroup
Subject: Comments on ESSB 6392 Workgroup Draft Recommendations

While many aspects of the current SR 520 plan are acceptable, one detail is notable for its low return on investment. The addition of a second drawbridge across the Montlake Cut would damage the aestheics of the existing Montlake Bridge -- a structure listed on the National Register of Historic Places -- remove houses from the Montlake neighborhood, and provide marginal improvements in bus travel times.

Most of the transit advantages from constructing a second bascule bridge could be realized at much lower cost by building the proposed HOV lanes and transit priority lights on Montlake Boulevard, then having the HOV lanes merge with other traffic to cross the Montlake Cut on the existing Montlake Bridge, as is the case now for transit eastbound on Pacific Street. The current bridge would provide adequate capacity for bicycles and pedestrians.

On a side issue, it should also be mentioned that no future light rail alignments should be built above Marsh Island or over the Montlake Cut. An underground route would be preferred.

Craig Dalby

Richard Dunn [redacted]
September 24, 2010

The construction of a second bascule bridge would be a idea. It will only jam up traffic at Pacific and create long traffic backups along 24th in both directions. It will also create a Montlake Blvd in the E Hamlin/E Shelby area of Montlake which will be too wide to even consider crossing on foot or bicycle. The bridge will ruin the aesthetic qualities of the original bridge. The two bridges going up at the same time will increase the waiting time for boat traffic which will increase the backups.

Richard Dunn
[redacted]

From: GatorGregg[redacted]
Sent: Wednesday, September 22, 2010 4:53 PM
To: SR520 Technical Workgroup
Subject: 520 comment

It is critically important that noise abatement measures be used on the south side of the Portage Bay viaduct both for environmental protection but most importantly for the health of the residents of the Portage Bay and Roanoke neighborhoods. The current noise levels are unhealthy and any new construction design must correct this problem that violates health codes and neighborhood noise ordinances. The noise barrier on the south side must be high enough and designed properly to address that issue.

Thanks for all that you are doing to make this new bridge a valuable asset to the Puget Sounds area.

Gregg DuPont

Submitted after the close of the comment period.

From: John Flinn [redacted]
Sent: Wednesday, September 29, 2010 2:41 PM
To: SR520 Technical Workgroup
Subject: montlake flyer bus stop

I realize public comment period has closed, but if you are still keeping a tally of responses, I wanted to add a note of concern regarding possible elimination of the express bus stop at Montlake as part of the 520 reconfiguration. That station is the primary access point for Capitol Hill residents who work at Microsoft and other eastside locations, and without it I would likely have to eliminate the bus from my commute options. (The time it takes to utilize a local bus to get to downtown express bus stops is not feasible.)

I look forward to hearing more about the decision-making process and recommendations, and hope that a solution will include express service stops relevant for commuters in the Capitol Hill / Montlake / University area.

Thanks
John Flinn
[redacted]

From: Joshua Daniel Franklin [redacted]
Sent: Friday, September 17, 2010 7:47 AM
To: SR520 Technical Workgroup
Subject: Montlake Flyer Freeway station

Please revise the design to incorporate Montlake Flyer Freeway stations. If they are done well, they can provide access to both sides of Montlake Blvd, reducing the number of streets to be crossed.

The Montlake Flyer station provides the following benefits:
- allows higher frequency and longer span of service for Redmond and Kirkland buses to both downtown and U-District - allows easy transfers to Central District and Capitol Hill buses, not just U-District - Makes it easy for people coming from downtown to access the arboretum and Montlake business district, and gives Montlake-area residents express service to downtown Seattle - Provides transit service capacity during Husky Stadium events (esp. football games) when Montlake Blvd is a parking lot

Also please make transit access on Montlake Blvd the highest priority. The current situation of single-occupant vehicles crowding out bus service is unacceptable.

Thanks,
Joshua Franklin
[redacted]

Naud Frijlink [redacted]

The current proposal effects routes that currently stop at the Montlake Flyer Station such as ST545 and MT 242, which service the Microsoft Corporate Campus: “These would no longer make a stop in Montlake.”

This would significantly impact my ability to commute to my work on the Eastside from Montlake.

I hope that a solution can be found where somehow these bus stops can remain.

Naud Frijlink
[redacted]

Matt Garson [redacted]

Please reconsider the current 520 bridge plan. The current plan is too short-sighted, failing to emphasize the need for prioritized mass transit, in the form of both bus and light-rail. Cities across the world, e.g., Moscow, are starting to learn the painful lesson that no matter how you scale roads, cars will always expand to consume all available capacity. The only solution is regional mass transit system.

Clearly, the current mass transit system is insufficient. There's both a capacity problem and prioritization problem - with busses, even if capacity were increased, they'll still be fighting with cars. If, however, buses are priortized such that they have their own lanes, they will become a clear beneficial alternative to car traffic - their commute times will be consistent and consistently faster than cars during traffic. Similarly, light-rail offers an advantage in that it doesn't share the road with cars. It will be on-time and, especially during traffic, faster than both cars and buses. Light-rail should be a benefit for the entire King County region. Restricting it to just Seattle, rather than pushing light-rail across 520 to serve Bellevue will mean that as 520's car capacity increases, Seattle and I-5 will see an increase in car traffic that they cannot cope with. In other words, the current plan doesn't think end-to-end; by increasing the throughput of only a portion of the transportation system, i.e., 520, all that accomplishes is increasing the number of cars that move from one end to the other. Mass transit, especially prioritized mass transit that includes light-rail, is the only solution that can scale.

Please stop the current plan in favor of one that will serve the region in the long-term by prioritizing mass transit. A year or two further delay doesn't matter, if the correct long-term solution isn't built. Otherwise, we will saddle future residents of this area with same traffic problems that we have today - but, they'll just experience them on a bigger 520 bridge.

From: Evelyn Goldenberg [redacted]
Sent: Thursday, September 23, 2010 7:52 PM
To: SR520 Technical Workgroup
Subject: Montlake Neighborhood -- second bascule bridge and resulting negative impact

I am not from the area but I know it well, and think that destruction of the historic Montlake Bridge and houses around it (by adding a second bridge next to it) will not solve the traffic problem but will be a permanent loss to the region and its visitors. I would hope that a solution could be found that would have significantly less negative impact on the Montlake neighborhood.

Evelyn Goldenberg

From: paigeha@[redacted]
Sent: Friday, September 17, 2010 4:41 PM
To: SR 520 Bridge Replacement & HOV Project
Subject: SR 520 Bridge Replacement and HOV Program Feedback

Sent from: Paige Hamack
Address:
City:
State: WA
County:
Zip: [redacted]
Email: [redacted]
Phone:

Comments:
Please make the 520 bridge light rail ready. To not do so is short-sighted and will be more expensive in the long run. I live in a neighborhood bordering the bridge (Bryant) and work in Redmond, commuting across SR 520 daily.

Hill, Scott (RBC Wealth Mgmt) [redacted]

Fri 9/24/2010 10:11 AM

I am emailing this morning regarding the 520 Bridge and the design refinements. As a resident of Montlake, I am discouraged that this project has come this far without providing solutions to resolve the transportation issues that plague our neighborhood. My primary concerns are the following:

1. The proposed bridge will destroy the habitat and environment through the Foster Island corridor (133' wide vs. existing 60')

2. The additional lanes will deposit more vehicles into an already heavy traffic congestion beyond Pacific St and S on 23rd exacerbating the issue with traffic as the city streets are ill equipped to handle higher volumes of motor vehicles.

3. The cost of the bridge ($4.65 billion) is underfunded ($2 billion) and the likely cuts to the West side will be the lids. This will DESTROY the arboretum and the Montlake neighborhood as it will increase noise, pollution, and alter the environment.

4. The second Montlake Bridge will ruin Montlake and destroy the character of the cut and the existing bridge that is recognized by the National Historic Society.

There are so many conflicting arguments about this project and so many additional problems with the design. As a resident living in close proximity to the staging area, I could go on and on. I urge you to think critically about this proposal and not allow a bridge to be built "just to do something". The Preferred Alternative does not solve or problems with thoughtful solutions and damages our neighborhood, the city and the region.

Sincerely,

Scott D. Hill, CIMA, AWM [redacted]

Opposition to second Montlake bridge
Nancy Hooyman [redacted]
Fri 9/24/2010 12:16 PM

As a UW employee who needs to get to campus each day and a long-time Montlake resident, I am totally opposed to a second Montlake bridge. Rather than expanding 520 to move more cars and disrupt neighborhoods by building a second bridge, it is better to focus on options for mass transit and getting people out of their cars. Simply funneling more cars onto a second Montlake bridge create even more traffic congestion along 23rd and Pacific Avenue. There is simply not room for more cars. Plan for an energy efficient future rather than building concrete structures for more cars.

Nancy R. Hooyman, PhD

From: James Howey [redacted]
Sent: Thursday, September 23, 2010 11:27 AM
To: SR520 Technical Workgroup
Subject: proposed elimination of montlake 520 stop

I was disturbed to learn that the montlake stop on 520 might be eliminated as part of the 520 replacement plan.

The montlake bridge is a major north south artery, particularly for bus and bike commuters, and this plan would eliminate their transfer to many eastbound bus routes. I take 545 or 242 to Redmond. There are other lines to Bellevue that would also be affected.

This would hit bike commuters especially hard. The montlake stop offers connections between the east side and the Burke-Gilman trail. I can't think of a more important bus-bike transfer point in the city. This move would eliminate North End access to Redmond via bike.

I hope to learn that you are reconsidering this proposal.

Thanks,

James howey.

second montlake bridge
John Hutchinson [redacted]
Fri 9/24/2010 10:54 AM

As a neighbor and interested party who looks at and uses the Montlake bridge daily, I think building two adjacent drawbridges across the Montlake cut is short sighted. I agree the bridge needs to be three lanes each way (with both right lanes designated for traffic getting on and off of 520), but why not just build a new better wider bridge? The structure is clearly tired and aging and if someone took the time to study it, probably needs to be replaced. Two bridges require two openings, two sets of machinery and their coordination so they go up and down together each time a boat needs to pass. Most importantly two bridges will look ridiculous! If Olmstead had wanted two bridges he would have built two. I understand the historic preservation of saving the current bridge, but traffic and the times have made the current bridge too small. And a new 6 lane bridge could be built saving one or both of the towers and made to look nearly identical to the current structure as well as being state of the art from an engineering standpoint. Preserve the spirit of the Olmstead Legacy by building a similar looking wider replacement bridge, rather than the eyesore of two adjacent structures! Please let Mr Olmstead rest in peace…
John Hutchinson [redacted]

From: Patrick Jones [redacted]
Sent: Thursday, September 23, 2010 10:11 AM
To: SR520 Technical Workgroup
Cc: [redacted]
Subject: 520

WSDOT

My wife and I wanted to write in and express our sincere desire that the 84th interchange near Hunts Point be a LOOP design and NOT the 1/2 diamond design. The vast majority of residents of Hunts Point have voted for the Loop design as its impacts to our neighborhood are far less than those created by the 1/2 diamond. Less private property takings, no switching of the SOV/HOV lanes, etc. Please proceed with a LOOP design onramp at the 84th interchange with bicycle traffic going under 84th. Thank you!

Pat & Marianne Jones
[redacted]

From: Tara Kraft [redacted]
Sent: Friday, September 17, 2010 4:29 PM
To: SR520 Technical Workgroup
Subject: 520 recommendation

I approve of your recommendation and would like this project to move forward. Thanks for the good work, I hope the mayor finally listens to the people of his city that, like me, support your work and urge that we move forward.

Thanks,
Tara Kraft
[redacted]

Emily Lieberman [redacted]
September 24, 2010

My family relies on the frequency and flexibility of the westbound 545 and other westbound buses crossing 520 W to get to Montlake to connect to the southbound 43 or 48. Please ensure that these buses continue to stop at Montlake under your new plan.

Fewer Eastside-to-Montlake connections will make using public transit less convenient and appealling for our family.

Emily Lieberman
[redacted]

From: gretchen luxenberg [redacted]
Sent: Thursday, September 23, 2010 6:26 PM
To: SR520 Technical Workgroup
Subject: Montlake Bridge

To whom it may concern:
Please consider these comments as part of the official record on this project. As a citizen of Seattle for many decades, I have witnessed the loss of many historic buildlings, structures and landscapes over the years. The Montlake Bridge is a historic treasure that should not be compromised in this 520 development. First, it is listed in the National Register of Historic Places, the nation's official list of properties worth preserving and protecting--the NATION'S, not the city's, official list. The homes nearby are also designated historic properties. The impacts to the Montlake neighborhood's historic resources are huge and these cultural resources are irreplaceable.
The advantages suggested by the building of a second bridge are so minimal compared to the cultural resource losses. Build the proposed HOV lanes and transit priority lights on Montlake Boulevard and allow the HOV lanes to merge with other traffic over the existing Montlake Bridge. The existing bridge has lots of room for bicycles and foot traffic.

Please do not remove historic homes and directly and indirectly cause impacts to the historic Montlake Bridge by constructing a second bridge. The second bridge will have adverse impacts to the Montlake Bridge and require mitigation. It is not necessary, overly expensive (the project is already over budget) for the minimal gains you perceive will result.

thank you for the opportunity to comment on this important project.

Gretchen Luxenberg
[redacted]

Second Montlake Bridge Comment

Mickels, Erik A [redacted]

Fri 9/24/2010 10:41 AM

As a Montlake resident who is very familiar with the patterns of the Montlake drawbridge, I am surprised that the concept of a second Montlake drawbridge has gotten this much steam. At first, I thought it was a joke…since during boating season cars idle for hours a week as the bridge sits in the up position.

What is next… a third drawbridge in the year 2030? You can add 10 drawbridges and the problem will still not be solved.

The only intelligent plan would be to somehow bypass the drawbridge such that traffic flows are smooth and predictable and are no longer at the mercy of boat traffic.

Regards,

Erik Mickels

Neighbor to the Montlake Bridge

From: Andrew Nestingen [redacted]
Sent: Thursday, September 23, 2010 9:14 PM
To: SR520 Technical Workgroup
Subject: SR-520 rennovation--Montlake Bridge

Hello,

It is a bad idea to replace the Montlake Bridge a 2-story bridge, because that will not solve any problems. The traffic tie-ups are NOT due to the Montlake Bridge, but rather to the poor traffic management north and south of it. I do not live in the Montlake neighborhood, but go back and forth to the university from the Central District for work.

Thanks for considering my opinion!

All best wishes,
Andy

[redacted]

[redacted]

From: Walter Oelwein [redacted]
Sent: Thursday, September 23, 2010 8:43 AM
To: SR520 Technical Workgroup
Subject: Response to the "Preferred Alternative"

Hello,

My comments on the SR520 design are the following:

--The preferred alternative did not take into account the comments from the SDEIS process. The comment period for the SDEIS ended on April 15, and the Preferred Alternative came out on April 30 (with lots of conceptual pictures). I ask that before you announce your “preferred alternative” you review, respond to and improved the design based on the comments from the SDEIS process. I have attached my extensive comments from that comment period to this email, and I belive that most of them still hold true. This is where the citizens put a lot of energy to comment on the different alternatives, and to get the "preferred" alternative which does not reflect these comments was disturbing. To understand what the citizens feel about the "Preferred Alternative", go to the SDEIS comments and look at any mention of Option A -- you'll see the general objection to Option A's terrible design that does not take into account any of the neighborhood input that compares the Options we thought were on the table until you suddenly deleted them can came up with a renamed Option A.

--The Neighborhood coalition negotiated in good faith to develop AND ENDORSE Option K. The "Preferred Alternative" reflects little of the Option K design. If you want endorsement of the "Preferred Alternative", bring back option K. Simple as that.

--Any design that has a "Second Bascule Bridge" is nothing short of ridiculous. This "design" of having on/off freeway traffic wait for one or two bridges to go up and down replicates and increases one of the core problems of the current design. Shame on any transportation official who thinks that a second bascule bridge is a good idea. You must have a tunnel to get on and off the freeway (as in Option K), and Montlake Blvd. will cease to have gridlock during the day.

--WashDOT recently admitted in the public forum (and numours other times) that they have NEVER studied the traffic impact of the second bascule bridge during non-peak times. This is absurd, as the bridges go up and down only during non-peak times, and this is what causes congestion during the day and on weekends. One only has to compare the backups on the University Bridge (minimal) to the Montlake Bridge (one mile plus) to understand that the bascule bridge is what causes the problems.

--One of the major claims in the SDEIS is incorrect and needs to be revised -- that traffic will be backed up eastbound to 405, because cars will be waiting to get onto 405 for up to 90 minutes during peak times (and, according to your claims, the increased lanes on 520 will alleviate this). This claim that traffic backs up to 405 eastbound is flat out wrong. This is the only place where traffic does not back up at an interchange in this corridor. To make claims of improvement in traffic flow based on this analysis is fraudulent.

--Six lanes on the Portage Bay bridge is overkill and way too wide. Much of the traffic gets on and off at Montlake, so it doesn't make sense to have a wide freeway where you don't have as much traffic, especially over a public water space, as is found in Portage Bay.

--Finally, I believe that WashDOT should approach this project in a wholly different manner. It was in vogue in the 50's and 60's to invoke "progress" by building massive freeways, not concerning itself with the environmental impact or contexts of such structures. Now that we are in the new century, the thinking has changed to understand that the environment, the context, and the design has an impact on the quality of life, the quality of the economy and the long-term health of the local environment. We have long since learned that large blights like massive freeways help transportation, but not quality of life or the environment. We have also learned that bigger is not necessarily better when it comes to freeways. This project is being designed with the 50’s frame of mind (how can we add more lanes). If WashDOT really wanted to get this project done in an expedient manner, and show concern for the safety of the drivers and help drive the economy forward and reduce congestion and maximize the positive environmental impact given the context of the project, WashDOT should have taken the following approach:

1) Apologize for the atrocious freeway design of the 50s and 60s that somehow found it OK to build massive freeway structures over and through parkland and residential areas, where every day people who live and breathe in the area deal with the noise, darkness and pollution that once denoted “progress.”

2) Pledge to create a design that reclaims parkland, eliminates noise, and otherwise restores the local area to its potential, especially given that it is a close-in neighborhood with a high-tax base that also has massive amounts of parkland and is a major factor in driving the Seattle area economy forward.

3) Do everything possible to re-design the freeway underwater/underground and with mass transportation built-in, as is done in other modern cities, where it has been discovered that freeways and railways can indeed be placed underground. Perhaps it’s time Washington State learn this?

4) Give back the parkland and eliminate the noise, pollution and shading in the parks and in the neighborhood.

If WashDOT had taken this approach, how much difficulty would there have been in coming up with a “Preferred Alternative?” To underscore this point, Sound Transit is building a tunnel under the Montlake Neighborhood and the Montlake Cut, and there has been no resistance to project. Instead we are excited by this new transportation link and we anticipate it will be good for the neighborhood and the city/metropolitan area.

Please consider the “Preferred Alternative” as WashDOT has outlined it to be a massive design failure. If WashDOT wants to get this project done, go back to Option K, or better yet, take a contemporary approach to design that can achieve the goals of all constituent parties. This will help the economy and the environment.

Sincerely,

Walter Oelwein
[redacted]

SR 520 Replacement and HOV Program
I-5 to Medina
Suggested Changes
9/22/2010

The SR 520 Replacement and HOV Program should solve regional issues. The project needs to be adaptable to include changes in the future that we may or may not contemplate today. The new design should improve traffic circulation to be cost effective. The State of Washington, Sound Transit, King County, the City of Seattle, Bellevue, Kirkland and Redmond all benefit from the proposed changes.

The design process used by the State, the Mayor and the Seattle City Council failed to comply with the spirit of SB 6392 by excluding neighborhood groups in the technical design of the project.

> **ENGROSSED SUBSTITUTE SENATE BILL 6392**
> 61st Legislature
> 2010 Regular Session
>
> "(iii) A work group convened by the mayor and city council of the city of Seattle to include sound transit, King county metro, the Seattle department of transportation, the department, the University of Washington, and other persons or organizations as designated by the mayor or city council to study and make recommendations of alternative connections for transit, including bus routes and high capacity transit, to the university link light rail line."

There is no value in spending $2 billion for the project if the Pacific Street and Montlake Blvd. intersection remains at Level "F" under the Preferred Design. There is not value in the project if the SOV lanes remain at the 520 Eastbound lanes remain at Level F. You cannot justify the project if traffic cannot be improved North of Pacific Street. You cannot provide reliable transit services to the Northeast communities of Seattle with the current Preferred Design.

Option A fails to accommodate effective bridge connections for high capacity transit to 520 as called for in RCW 47.01.408.

> **RCW 47.01.408**
> (2) The state route number 520 bridge replacement and HOV project shall be designed to accommodate effective connections for transit, including high capacity transit, to the light rail station at the University of Washington."

In fact, RCW 47.01.408 fails to acknowledge that it is neither practical nor effective to include high capacity transit with HOV in the same lane. The design excludes the inevitable conflict between SOV and transit on the bridge.

By definition, the Preferred Design does not meet the requirements of a "Multimodal" design. The current design does not have a reasonable connection and intersection of light rail, transit, HOV, SOV, bicycle and pedestrian traffic. The Preferred Option does not meet the requirements of RCW 47.01.410.

> **RCW 47.01.410**
> State Route No. 520 improvements — Multimodal transportation plan.
> As part of the state route number 520 bridge replacement and HOV project, the governor's office shall work with the department, sound transit, King county metro, and the University of Washington, to plan for high capacity transportation in the state route number 520 corridor. The parties shall jointly develop a multimodal transportation plan that ensures the effective and efficient coordination of bus services and light rail services throughout the state route number 520 corridor. The plan shall include alternatives for a multimodal transit station that serves the state route number 520 - Montlake interchange vicinity, and mitigation of impacts on affected parties. The high capacity transportation planning work must be closely coordinated with the state route number 520 bridge replacement and HOV project's environmental planning process, and must be completed within the current funding for the project. A draft plan must be submitted to the governor and the joint transportation committee by October 1, 2007. A final plan must be submitted to the governor and the joint transportation committee by December 2008.

The Preferred Design does not take into account the successes of the Park and Ride lots at South Everett, Lynnwood and Montlake Terrace (under construction) along I-5. The current design does not take into account the success of the Bellevue College Park and Ride lot along I-90 and the Mercer Island Park and Ride lot HOV at I-90 to 80th S.E..

Option "L" was over designed. However, the design capitalized on congestion at the intersection of Pacific Street and Montlake Blvd. If between 41 to 48% of the traffic on Pacific Street go to and comes from 520, then a direction between 520 and Pacific must be included in the design.

The following is a list of suggested changes to the current "Preferred" design that improve on the general elements of Option "L":

1) Add Southbound ramp to Eastbound 520 from the Express Lanes of I-5. It would come from the West lane of the Express Lanes just South of E. Roanoke. There may be a grade adjustment to the Westbound 520 ramp to Southbound I-5 at the Main Line. This can be either Northbound or Southbound depending on the direction of the Express Lanes.
2) Widen Westbound ramp from 520 to Southbound I-5 at the Mainline.
3) To save money, leave the 10th Ave and Roanoke intersection with the current alignment. Eliminate the lid at 10th and East Roanoke/Delmar unless sports facilities are include. The noise level at the lid will not reduce the noise to an acceptable level to use the space as a park. The noise in this area is generated from I-5 and the overpass of Delmar and 520. If you walk on the West side of Roanoke Park along Broadway, the line of sight identifies one of the key sources on noise is from I-5.
4) Eliminate Boulevard landscaping at the Portage Bay Viaduct to save money.

5) If the speed limit along the Portage Bay Viaduct is reduced to 45 MPH, traffic will continue to back up along I-5 both Southbound and Northbound. Use traffic flow speed limits.
6) Widen Montlake Blvd. Northbound from East Roanoke to East Shelby to add HOV lane on the East side of Montlake Blvd.
7) Widen Southbound Montlake Blvd. from East Shelby to East Roanoke to add HOV lane to the Eastbound ramp to Eastbound 520 and on South to East Roanoke.
8) Widen Montlake Blvd. from East Shelby to the Westbound 520 on ramp.
9) Add a bike tunnel to the Burke-Gillman trail at 15th, University Ave. and Brooklyn Ave. This will improve transit access to 15th.
10) Add free right hand turn from Westbound N.E. Pacific ST. to Northbound 15th Ave NE. This will improve transit access to 15th.
11) Bury a one car and bike lane from Northbound Montlake Blvd. to Westbound N.E. Pacific on the Eastside of Montlake Blvd. just North of the Existing Montlake Bridge. Widen Pacific as soon as possible once the new buried ramp is passed Montlake Blvd. Bike lane should tie into the Burke-Gillman trail.
12) Build Second Bascule Bridge similar to Option “L”. Should additional funding be found in the future, the Second Bascule Bridge will allow light rail to have direct access to the University Station and 520 while avoiding the Montlake and 520 intersection. I am disappointed in the drawings by the State for Option “L”. The drawings are not to scale and give the impression that this design is overwhelming.
13) Bury Eastbound N.E. Pacific to the new Second Bascule Bridge for general purpose, HOV and bike traffic.
14) Bury Westbound N.E. Pacific from the new Second Bascule Bridge just under Montlake.
15) Widen Southbound Montlake Blvd. from Wahkiakum Lane to the existing Montlake Bridge by one lane. Bury this new lane from Southbound Montlake to the Second Bascule Bridge. It would be HOV only from 7 to 9 AM. The UW bridges across Montlake are not historic by design. The Southern most bridge is not tall enough to meets the needs of today. The new bridges could be design to avoid pedestrian traffic as it crosses the Burke Gillman Trail. The UW can deed property to maintain the importance of the Burke Gillman Trail.
16) Provide new general-purpose turn lane from the Second Bascule Bridge to Northbound Montlake Blvd.
17) Provide expanded Transit Center at the University Station which would accommodate the of bus traffic from North and Southbound Montlake and East and Westbound N.E. Pacific to provide a more seamless transition from bus/carpool to light rail.
18) Provide Park and Ride facilities at the South parking lot of Husky Stadium adjacent to the UW Station.
19) Add HOV lane from the Second Bascule Bridge to East and Westbound lanes of 520. Tie would be of the same design as the Mercer Island HOV ramp at I-90 to 80th S.E.
20) Add bike lane from 520 to the Second Bascule Bridge.
21) Tie Northbound East Lake Washington Blvd. to the Second Bascule Bridge with general-purpose lane and the HOV lanes to East and Westbound 520. Allow a general-purpose lane across the Second Bascule Bridge to Westbound N.E. Pacific and Northbound Montlake Blvd. Use a roundabout at this new intersection on the South side of 520. This will allow individuals from the Madison Park, Madrona and the like as well as those traveling along Madison to avoid the Montlake and 520 intersections. It will eliminate the need to use Boyer and Interlaken between the Arboretum and 24th.

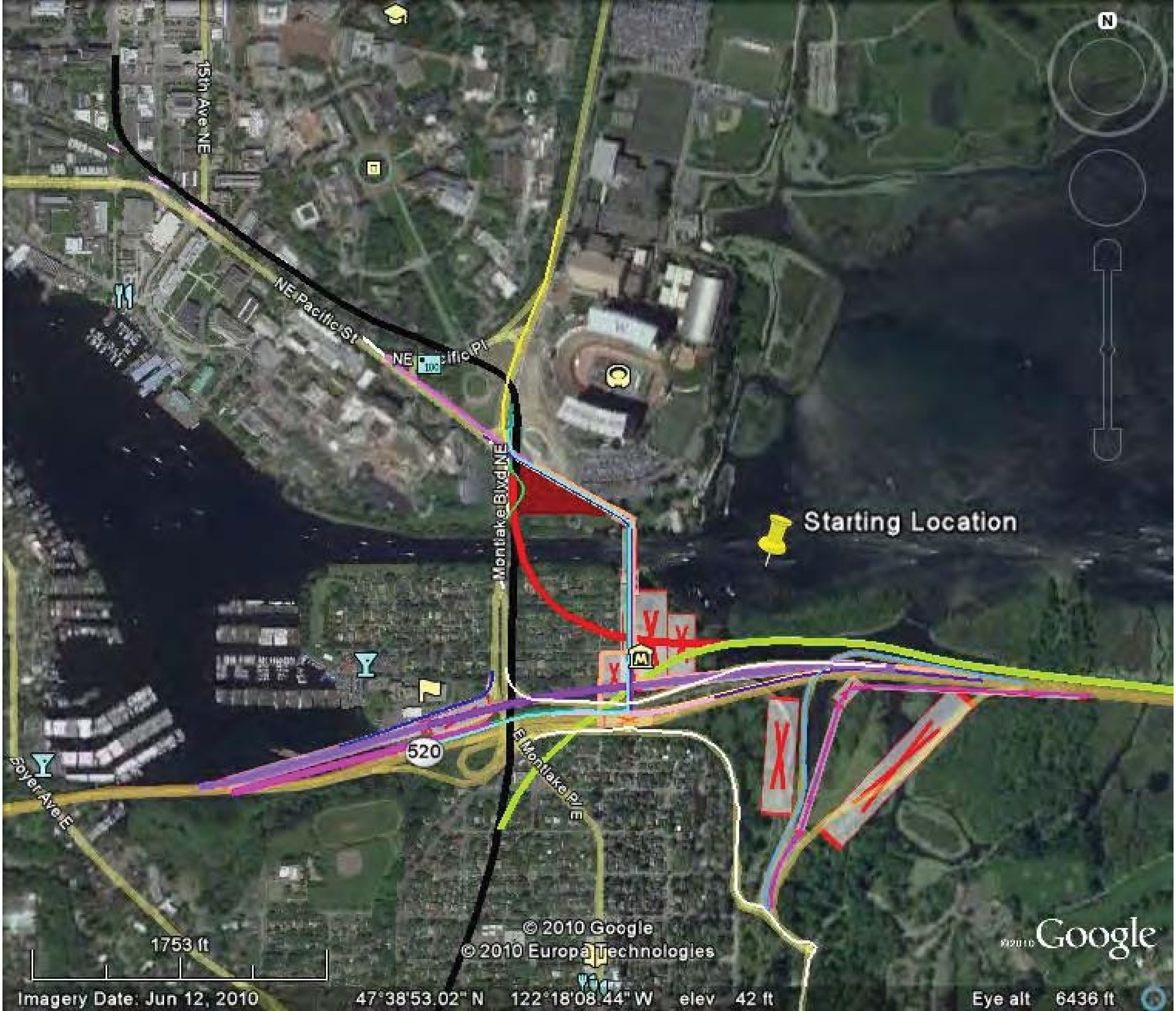
22) Maintain the Southbound ramp from Westbound 520 to Lake Washington Blvd. East and the Arboretum. This will prevent traffic from cutting through the East Montlake neighborhood to avoid the Montlake intersection.
23) Realign the sweep of the entrance ramp from Lake Washington Blvd. East to Eastbound 520. Widen ramp to include a HOV lane and two lanes of general purpose. This will help eliminate the traffic from backing up through the Arboretum. It will also reduce the amount of traffic that would go to the Montlake and 520 intersections.
24) Widen East Lake Washington Blvd. to three lanes from 24th N.E. to Montlake Blvd. One lane to Southbound, one lane Westbound to the Eastbound 520 ramp and one Northbound on Montlake Blvd.
25) Maintain a general-purpose lane exit from Westbound 520 to Northbound Montlake Blvd. as a free right turn.
26) Do not install the traffic light just North of 520 on Montlake and do not add the ramp to Montlake Blvd. for both general purpose and HOV access to 520. Eliminate the Transit Stop at this location. This would reduce the width of 520 in this area by two lanes.
27) 24th Ave East does not need to be realigned across 520. The lid at this location needs to be reduced to save addition costs.

This proposed design will allow the existing footprint of 520 at Montlake to remain.

To test the viability of Option A+, close both East and Westbound ramps to Lake Washington Blvd. East for two months while the University of Washington is in session. Add a temporary traffic light on the North side on 520 at Montlake Blvd. for two months at the same time. The intersections at Boyer, East Roanoke, Montlake Blvd. and Pacific will be overwhelmed by the amount of traffic caused by the details of Option A.

I have attached copy of my proposed plan. I do not have the skills, resources or the software to make a better drawing of my design.

John O’Neil
[redacted]


15th Ave NE
NE Pacific St
NE Pacific Pl
Montlake Blvd NE
Starting Location
520
E Montlake Pl E
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1753 ft
© 2010 Google
© 2010 Europa Technologies
Google
Imagery Date: Jun 12, 2010
47°38'53.02" N
122°18'08.44" W
elev 42 ft
Eye alt 6436 ft

Sally Pasette [redacted]
Fri 9/24/2010 10:01 AM

I don't live in Montlake but am concerned about the proposal to build a 2nd bridge to the east of the Montlake Bridge. This is bound to ruin the aesthetics of the current bridge, which is on the National Historic Registry. (We have other concerns about the 520 project but understand today is the deadline for comments on the bridge). We also understand the 2nd bridge will not be built until traffic studies prove the need.

Montlake Blvd is already a bottleneck and dumping more traffic off 520 at the current exit just before the Montlake bridge will cause even more congestion.

An off ramp should be developed to bypass the Montlake bridge for northbound traffic. The current off ramp should be maintained for the traffic accessing Hamlin and Shelby St and possibly the hospital and south campus of the UW. The new off ramp should drop off traffic north of the Montlake bridge, hopefully north of NE Pacific. A second bridge over the ship canal would be avoided and, assuming the widening of Montlake Blvd, traffic would be alleviated.

Thank you for your consideration.

Sally Pasette
[redacted]

From: John Peterson [redacted]
Sent: Monday, September 27, 2010 10:43 AM
To: SR520 Technical Workgroup
Subject: Elimination of the Montlake Flyer stop

Eliminating the Montlake flyer stop will adversely impact my commute options since I use any number of busses to get from north Seattle to Montlake to continue my commute to Microsoft's Redmond campus. Unfortunately, neither the Microsoft sponsored Connector bus service nor accessing a route like the 242 directly are viable options for me since the nearest stop from my home for either is more than 1.5 miles away.

For context, I've been a transit commuter for all of the 9+ years I've worked at Microsoft – I'm a committed bus rider.

Is there a planned mitigation or suggested alternative?

Regards,
John Peterson

[redacted]

From: Steven Purcer [redacted]
Sent: Friday, September 24, 2010 9:46 AM
To: SR520 Technical Workgroup
Subject: Second Bascule Bridge at Montlake

Regarding the ancillary improvements under consideration at Montlake I wanted to submit my objections to any planned addition of a second bascule bridge over the Montlake Cut. I believe any discussion of a second bridge prospect is premature until current planned improvements related to the SR 520 project are in place and their impacts on traffic volumes and flows through and near the Montlake area have been fully analyzed, Further, I believe serious consideration should be given to modifying traffic flow over the existing bridge in the form of converting the two inner lanes to "convertible lanes", enabling switching traffic in the mornings to 3 lanes north, then at midday reversing them to 3 lanes south, all via signals. The model of the Lions Gate Bridge in Vancouver, BC is an excellent one as it is also designated a national historic site. Trolley buses could still navigate the two outer lanes, and during non-peak and weekend times the traffic lanes could revert to 2 lanes in each direction. I believe advantages to this type of approach allows retaining the charm and beauty of the bridge structure and avoids house removal and other character changes to the Montlake neighborhood.

Thanks for accepting my input.
Steve

From: Sean Riley [redacted]
Sent: Wednesday, September 22, 2010 5:37 PM
To: SR520 Technical Workgroup
Subject: SR520 Feedback on Design Refinements and Transit Connections Draft Recommendations Report

Submitting This via Email (also submitted through the online tool)

To Whom It May Concern,

My wife and I are residents of East Lake Washington Boulevard (2465 E. Lake Washington Blvd (on the bend across from the water)). As measured, the noise decibels are above legal limits in front of and around our home (even in off-peak hours). Please consider the residents of this extremely busy, dangerous and noisy street as you discuss noise reduction mitigation and traffic calming measures.

The proposed traffic calming measures will do nothing to reduce the number of cars on LWB, which, in addition to noise and speed, is the largest concern for LWB residents. My wife and I, for example, can no longer use our driveway due to the number of cars, which come to a complete halt in front of our home on weekends and peak weekday traffic hours. In fact, my actually wife got in a car accident pulling out of our driveway due to speed and traffic issues in front of our home. In addition, the windows in our home literally rattle when trucks go by.

As a method of making LWB safer for residents and bringing the noise level closer to legally allowable limits, **please do not allow cars to maintain left turn movement from 24th Avenue to eastbound Lake Washington Boulevard.** Please also consider additional mitigation measures if the new plans to not bring noise levels to legally allowable limits (like subsidizing installation of double paned windows for residents). Please also consider tolling on LWB for cut through traffic. Lastly, please consider all measures to reduce the noise and traffic volume in front of our home beyond outlawing the left hand turn from 24th Avenue to LWB (speed humps, police ticketing, a median that stretched the entire length of East Lake Washington Blvd., etc.).

Thank you so much for your time. We really appreciate you hearing our voice.

Sean and Morgan Riley
[redacted]

From: Chad Sheffield [redacted]
Sent: Thursday, September 23, 2010 11:43 AM
To: SR520 Technical Workgroup
Subject: FW: Review and Comment on the SR-520 Bridge Replacement Design

This is the latest info (below) that I received from my employer's commute team. The comment about the Montlake Flyer Station doesn't sound correct to me because there will still be stops at Montlake (the triangle or lid?) that a route like the 545 could use. Or are they correct?

==

SR 520 Bridge Replacement and HOV Program

Draft design refinements and transit connections for the new SR 520 are now available online for public review and comment. The recommendations were developed by a workgroup including the city of Seattle, University of Washington, and transit agencies as they discussed refinements to the SR 520 preferred alternative that was announced in April.

Public comments are being accepted through September 24th on the workgroup's website. A final report will be submitted to the governor and state Legislature on October 1st.

The preferred alternative eliminates the Montlake Flyer Station stop due to major reconfigurations of the freeway, the Sound Transit UW light rail station, and revisions to transit service in the area. As a result, routes that currently stop at the Montlake Flyer Station such as ST545 and MT 242, which service the Microsoft Corporate Campus, and ST566, which services the Microsoft worksites in downtown Bellevue, would no longer make a stop in Montlake. If you access a bus at the Montlake Flyer Station, we encourage you to take a few minutes to understand the proposed changes and make your views known here or by e-mailing sr520techworkgroup@wsdot.wa.gov.

From: Liam M Stacey [redacted]
Sent: Monday, September 13, 2010 4:16 PM
To: SR520 Technical Workgroup
Subject: How we could avoid second bascule bridge

Dear Committee members:

Arguments for why we do not need a second bascule bridge.

Fear of losing funding is not a reason to add more concrete

1.

Pacific Avenue direct Access to Husky stadium is unnecessary and sabotages the traffic flow across the bridge.

With the pedestrian bike overpass, there is no need for north bound traffic to stop. Thus the next bottle neck up stream is likely to be the overpass interchanges, not the bascule bridge.

Drivers from the East, could park on East campus parking lots.

2.

South bound Montlake to Eastbound 520

Create an additional lane on the bridge to absorb cars that currently back up the South bound traffic on Montlake bascule bridge.

3.

As a cyclist who crosses the Montlake bridge every day, I find that the slow crossing of the Montlake cut is not a serious problem.

We could bolt on an extra bike lane: and this would certainly be preferable to crowding out the historical view and use of the bridge with a second bridge.

4.The planned N-S underground transit could reduce the need for this bridge.

P.S.

There is still no viable explanation for why cyclists have to ride on the north, or “down wind on rainy days” side of the floating bridge. Please do not leave us in the mist!!! (just commute across I-90 for one winter and you will understand.)

1. Pontoons can have wave attenuating profiles that eliminate wave problem.

2. New height of bridge will also help eliminate wave problem.

3. Cyclists strongly dislike getting soaked while crossing I-90, (rain storms are accompanied by South winds in our region).

Thank you,

Liam M Stacey
[redacted]

From: Liam M Stacey [redacted]
Sent: Friday, September 17, 2010 10:09 PM
To: SR520 Technical Workgroup
Subject: wave attenuation

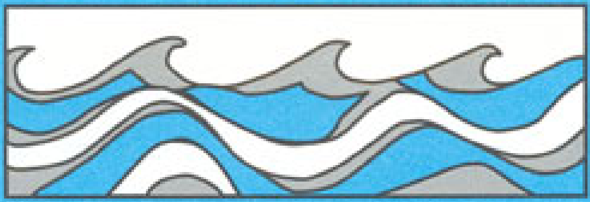
Dear sr520 working group members,

I am just writing to note that my suggestions for using wave attenuation prove to be quite redundant. I just found a paper produced in the 1970s by UW engineers on solutions to the wave problem. I suggest that the paper be passed on to the design department.

University of Washington
Department of Civil and Environmental Engineering

ATTENUATION OF RANDOM DEEP WATER WAVES BY A POROUS WALLED BREAKWATER

E. P. Richey
D. B. Morden
B. J. Hartz



Water Resources Series
Technical Report No. 36
August 1973

Seattle, Washington
98195

Department of Civil Engineering
University of Washington
Seattle, Washington 98195

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15. Supplementary Notes

in cooperation with the United States Department of Transportation
Federal Highway Administration

16. Abstract

The porous walled resonating chamber, a type of breakwater, is investigated as a means of reducing reflected waves from structures subjected to random wind generated waves in deep water. Extending laboratory monochromatic studies to a full-scale apparatus appended to a floating bridge allows assessment of scale factors and the effects of random waves on the predicted performance of the device as a linear damped oscillator. The full-scale device is shown to be frequency selective at a frequency precisely corresponding to the predicted resonance of the system. The forces, measured on the porous wall, are lower than predicted and the device completely eliminates the problem of wave runup onto the bridge roadway.

The method of evaluating the energy attenuation by the breakwater incorporates spectral analysis of digitized data recorded at fixed locations equidistant in front of the chamber and at a remote station away from the influence of the breakwater. Analysis demonstrates that the time average energy density at a fixed location where incident and reflected waves co-exist is influenced not only by the wave amplitudes, as expected, but also by the product of the amplitudes and a function of the phase angle. The chamber effects a change in the random phase angle during reflection, producing a different effective distance of wave travel to the fixed location and thus negating quantitative analysis of the energy dissipation.

17. Key Words	18. Distribution Statement
Wave attenuation, breakwater	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
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The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Washington State Department of Highways or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

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LIST OF SYMBOLS

A_j, A_{jet}	total contracted pore jet area
A_p	total geometric area of pores
Attn	Attenuation
A_w, A_{wall}	total porous wall area (including A_p)
a	surface wave amplitude
a_i	incident wave amplitude
a_r	reflected wave amplitude
BW	station in front of the breakwater
b	breakwater chamber width
C	wave celerity
C_D	Discharge coefficient
D	distance from wall to gage
d	depth of water at S.W.L.
E_L	non-conservative energy converted during reflection process
$\overline{E}$	average total energy density per unit area of sea surface
$\overline{E}_K$	average kinetic energy density
$\overline{E}_p$	average potential energy density
e	natural logarithm base
f	frequency
g	acceleration due to gravity
H	wave height
H_i	incident wave height
H_r	reflected wave height
h	breakwater chamber depth
i	incident

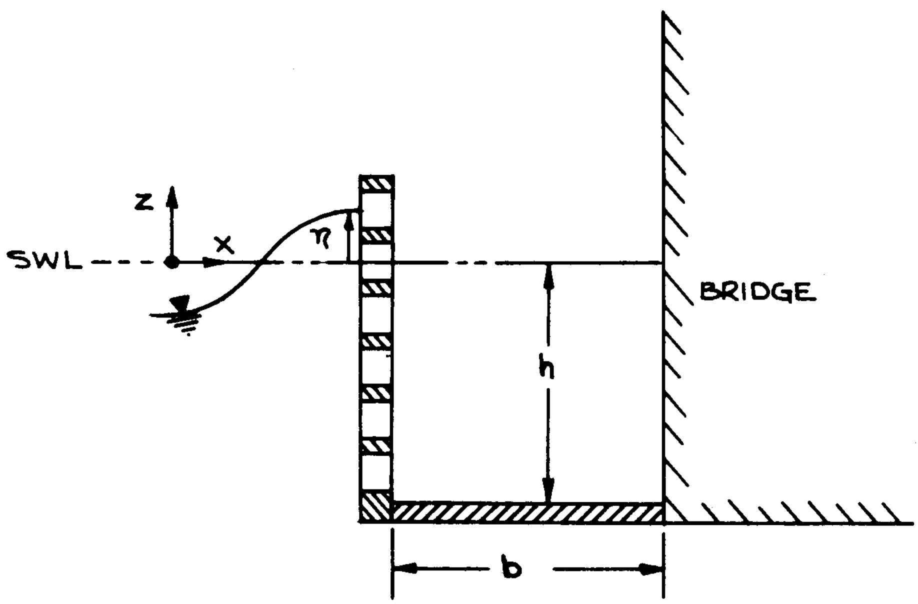
j	index
k	wave number = $2\Pi/L$
L	wave length
m	effective breakwater porosity
m'	geometric porosity
$\overline{PE}$	average potential energy density
$\overline{KE}$	average kinetic energy density
R	reflection coefficient, H_r/H_i
S	reflection coefficient for a solid vertical wall
S.W.L.	still water level
T	wave period
t	time measurement
x	horizontal coordinate
z	vertical coordinate, + upward
γ	specific weight of water
δ	effective length of pore
η	wave surface elevation
η_i	incident wave surface elevation
η_r	reflected wave surface elevation
η_{max}	monochromatic wave envelope relative maximum surface elevation
η_{min}	monochromatic wave envelope relative minimum surface elevation
η_t	surface elevation resulting from the sum of η_i and η_r
θ_i	phase angle of incident wave
θ_r	phase angle of the reflected wave
Π	dimensionless constant, 3.1416

ρ	mass density of water
Σ	summation
σ	wave angular frequency = $2\Pi f$. Also, variance.
τ	time lag
ω	chamber natural frequency
∞	a fixed measuring location in front of a solid vertical barrier; not influenced by the breakwater, but subject to the same average incident conditions.

CHAPTER I

INTRODUCTION

The present study investigates the response of a porous walled breakwater to random, wind generated, deep water waves, with the particular focus on the characteristics of waves reflecting from it. As shown in the sketch below, the porous wall breakwater is an L-shaped device which, when appended to a solid wall, forms a chamber with a porous front wall, a solid back wall and a solid but removable bottom. When attached to a barrier, such as a floating bridge, the chamber operates as an energy loss system reducing reflected wave energy while also reducing the structural loads on the barrier.



Incident waves impacting the device produce a pressure differential across the porous wall. A portion of the incident energy is reflected and the remainder enters the pores where the potential energy associated with wave height is converted to kinetic energy in the form of jets passing through sharp edged orifices. Inside the chamber, the kinetic energy of the jets is dissipated through turbulent mixing and diffusion. When the level inside the chamber is sufficient to overcome the incoming momentum, the process reverses and again energy is lost through the non-conservative mixing and diffusion process. A laboratory and analytical model study had demonstrated that the system, when exposed to monochromatic waves, acted as a linear damped oscillator or resonator with a maximum efficiency at one discrete frequency, with the efficiency decreasing continuously on both sides of the dominant frequency. The laws for scaling breakwater performance under the monochromatic wave input to the prototype subjected to a random incident wave system are not well defined, so a field study was undertaken to obtain data for a critical assessment of the full-scale breakwater.

To monitor the efficiency of the full-scale breakwater, two stations are established to measure the sum of the incident and reflected wave heights. One station is in front of the breakwater and the second, or remote station, in front of the solid reflector (vertical pontoon wall) away from the influence of the breakwater. Small amplitude wave theory demonstrates that wave energy is related to the square of the wave height and that the sub-surface pressure fluctuations are functions of the surface disturbances. Over a period of time, the total incident energy of both stations will be the same. For the ratio of wave length to pontoon width under investigation, no waves are transmitted under the floating bridge. Thus, any difference in energy between the two stations can be attributed to a difference in reflected wave energy. Spectral analysis allows the superposition of waves of different frequencies to describe wave height in a random sea. The energy is proportional to the squares of these superimposed components. Using spectral analysis, the random wave (sub-surface pressure) records are analyzed and the time average total energy density at the remote station is compared with the total energy in front of the breakwater. The breakwater is also instrumented with force gauges to ascertain the maximum resultant force exerted by waves on the porous walls.

Porous walled resonating chambers can be tuned to create maximum energy dissipation at dominant incident wave conditions, resulting in a reduction of reflected waves and at the same time, reducing the loads on the floating structure.

Though the initial objectives and theory presume to acquire a quantitative evaluation of the amount of energy dissipated by the chamber, the analysis demonstrates a dependence of the time averaged energy density, for coexisting incident and reflected wave system, upon the product of the wave amplitudes, the physical distance to the barrier, and the phase angle. The chamber alters the phase angle during reflection. This results in the distance to the two measuring stations being effectively different in front of the break-water and at the solid wall and thereby negating the desired comparison. Fortunately, the other objectives are independent of this problem.

Background and Literature Review

General:

Breakwaters have long been used to protect coastlines and vessels within harbors and marinas from storm damage. Traditionally they are constructed of rubble piled to a sufficient height and width to minimize the transmission of energy over or through the structure. Due to its relatively low cost and high efficiency, most shallow water installations still incorporate variations on the rubble mound concept including various interlocking concrete components.

The complex wave-rubble breakwater interaction in shallow water remains the topic of many recent publications.

The amphibious assaults and vessel damage repair requirements during the Second World War introduced the need for temporary and portable breakwaters. Hudson(1)[1] conducted model tests on portable concrete caissons for use during the beach landings on D-Day. At the same time, the use of temporary floating breakwaters to reduce transmitted wave energy was investigated by Minikin(2).

In each of the preceding cases the breakwaters were used to reduce transmitted energy and the amount of reflected or dissipated energy was of little consequence. Most investigations dealt exclusively with devices placed in relatively shallow water where the characteristics of the incident waves were affected by the sloping bottom.

As water depth increases, rubble breakwaters become impractical. An early device used in deep water was the pneumatic breakwater which incorporated a submerged pipe emitting compressed air producing currents that reduce the transmission of wave energy through turbulent mixing and partial or complete breaking. Patented by Philip Brahser(3) in 1907, and in use in Dover, England for protection of boats since 1904, this device was the subject of several investigations during the 1950's.

Another device using the principle of an opposing current is the hydraulic breakwater, introduced in the mid 1950's. Nece, Richey, and Rao(4) investigated the use of the hydraulic breakwater to reduce the height of waves in deep water. Analytical work by Garrison(5) has demonstrated that a rigid

[1]NOTE: Superscripted numbers refer to number in reference section.

plate with zero draft reflects ninety percent of the wave energy incident upon it for wave length to bridge width ratios of 2.4:1. Ordinarily a breakwater is used to reduce transmitted energy. However, there are certain structural installations, such as piers, floating bridges, bulkheads, etc., where waves reflecting from the structure can be a concern if they should impinge on a site or shoreline sensitive to a new, or changed wave climate. A mechanism that would increase the losses in the reflection process would not only reduce the site interaction problem but at the same time could reduce the loadings on the structure and anchor system and thereby effect savings in construction and maintenance costs. The hydraulic breakwater lends itself well to this application. The submerged pipe can be run along the structure with the water jet aimed away from it. Unfortunately, the efficiency of these devices is quite low[(4)] and the power requirements are high. Other types of deep water energy reduction devices have been studied which require no power to drive them. Various types of floating breakwaters have been tested, including surface and subsurface rafts of various size, complexity and porosity. Investigations concentrate on reflection transmission, and energy dissipation through wave interference, forced instability of waves, and turbulent action and energy dissipation by porous and deformable surface membranes, as well as the breakwater motions and forces on the anchor cables.

Two energy attenuation concepts which can be attached directly to a floating platform and require no power to drive them are horizontal hollow cylinders and porous walled chambers. In 1964, Lawson[(6)] and Kirkham reported on various model studies including stacks of horizontal hollow cylinders to absorb waves within a rectangular ship mooring basin. The cylinders were placed longitudinally in stacks at the end of the basin, and were qualitatively reported to show promise for reducing reflected waves. In 1968, Bourodimos and Ippen[7] reported on horizontal open tubes aligned with the direction of the wave travel. Tests of floating and fixed arrays of tubes of various lengths were shown to attenuate periodic wave energy by de-tuning the energy through currents induced within the tubes and by generating turbulence at both ends of the tubes. Unfortunately this interesting concept is primarily studied with relation to reducing transmitted energy. Peak energy dissipation was shown to occur for pipe lengths of approximately half of the design wave length. Application in a random wave system was not discussed. Possible applications of this device to floating bridges would require that the array of tubes be held some distance away from the solid structure. Research would have to be conducted on the interaction between the reflection wall of the bridge and the array. An alternative use would be to attach the tubes directly to the bridge forming an array of closed pipes of different lengths. This concept may also function as a de-tuning device but its efficiency would undoubtedly be much less than the open tube concept. Even if the open tube concept could be cantilevered from a reflecting surface of the bridge and still function well, pressures exerted on the horizontal surfaces of the tubes would result in large forces which would be exaggerated by the cantilever distance resulting in very large moments being transmitted to the bridge. Thus this design would reduce the reflected wave problem at the expense of additional structural loading on the bridge.

The porous walled breakwater, on the other hand, readily lends itself to incorporation in a floating bridge structure comprised of a porous wall set parallel to the solid wall of a floating bridge to form a chamber. The porous walled breakwater dissipates wave energy through turbulence and diffusion mixing of the jets passing through the porous wall. This dissipation process reduces the reflected wave energy without transmitting the energy to the structure, which, combined with its ease of incorporation, justifies careful consideration of this device for application to floating bridge structures. The subject of this investigation is the extension of the knowledge about porous walled breakwaters, as based upon linear and monochromatic theory and model studies, to the full-scale wind/wave case, with emphasis on the reflected wave components.

Evolution of Porous Walled Breakwaters:

Studies relating to the effects of porosity on rubble breakwaters have been conducted for years primarily to define the effects of porosity on wave transmission and breakwater structural stability. In 1961, Jarlan(8) introduced a porous walled breakwater similar to that being considered in this investigation. A chamber was created by a porous front and solid back wall and a solid bottom. Jarlan presented experimental data for a fixed breakwater in shallow water but did not relate the importance of the various breakwater parameters. In 1965, Jarlan(9) applied acoustic theory to analyze the effects of holes in a vertical concrete breakwater which absorbed wave energy by dissipation in voids behind the porous wall. His major concern was with the construction of dikes and protection against shoreline erosion. From his shallow water studies and analytical work, Jarlan concluded that the wave chamber and wall porosity affect the efficiency of the breakwater but the width of the chamber was unimportant and the device was not frequency selective.

In 1966, Marks(10) investigated a mobile porous walled breakwater for fixed or floating application in shallow water. In comparing this device to a solid caisson-type structure he recorded approximately 50% less total force on the porous walled breakwater. Sloping the porous face 30° produced a six fold increase in vertical forces. Interested primarily in bottom scouring and forces, Marks drew no conclusions about the wave reflections.

In 1968, a joint study by Marks and Jarlan(11) reviewed the effects of irregular wave trains on model porous walled breakwaters fixed to pilings and set on a shallow bottom. Their major concern was with force reduction and breakwater effects on scouring the bottom. The back wall was perforated as well as the front and a perforated interior wall was added to further reduce the forces on the structure. The interior wall was shown to be less effective than the perforated back wall. No information was given on wave reflection. Incidentally, an artificial island in the North Sea is presently being built (12,13) with a protective outer ring wall of the perforated "Jarlan" type.

The concept of resonating chambers is discussed by James(14) as rectangular cavities built into rubble breakwaters. Applying to shallow water and harbor entrances the optimum resonator geometry was shown to depend on harbor entrance width. Though the paper does not apply directly to the present investigation it does illustrate the importance of viewing chambers as frequency selective devices. Another demonstration of frequency selection occurs with double curtain wall chambers, which are composed of two solid vertical walls where the front wall is set slightly below still water level. Tonaka(15) demonstrated that the transmission coefficient for this device peaks at one frequency (the resonant frequency) and falls off with increasing or decreasing frequency. Tonaka did not record the characteristics of the reflected waves. Ricey and Sollitt(16) observed that the reflection coefficient of the double curtain wall devices obtains a minimum at the same resonant frequency that the maximum for the transmission coefficient occurs. The frequency sensitivity of the reflected wave energy has also beeen demonstrated for rubble type permeable breakwaters(17) where the reflection coefficient decays as a damped oscillation with increasing wave frequency.

The porous walled breakwater was shown by Richey and Sollitt[16] to have similar optimum performance at a natural frequency. The natural frequency was shown to depend on the chamber characteristics of porosity, width, depth, and pore geometry as well as wave length and steepness. Results of model studies in single frequency waves suggest that the optimum porous walled device has the following characteristics:

Vertical porous wall.

Porosity: A uniform porosity, m', between .2 and .3.

Chamber depth: Efficiency increases as depth increases to a depth of one half wave length.

Pore geometry: Circular holes provide an effective length of fluid mass accelerated through the pores to be equal to four-thirds the pore diameters[18].

Chamber width: Design variable.

Chamber width is selected as the method of tuning the breakwater to the dominant wave conditions at the location where the structure is to be used. Theory and model studies show that the chamber width controls the resonant frequency of the breakwater. The relationship between chamber width and incident wave length is dependent on all other breakwater parameters. Burrows[19] demonstrated that the forces on a porous wall (porosity = .196) in front of a solid wall were as little as 65% of the force calculated for a solid plate submerged to the same depth.

Objectives

The present investigation extends the model work of Richey and Sollitt[16] by testing a full-scale porous walled breakwater subjected to wind generated random waves. The chamber width is varied with and without the solid chamber bottom to test the efficiency of the breakwater in an attenuating reflected wave energy over a wide range of wind speeds for each configuration. The force upon the porous wall is measured for each configuration.

The program initially focused on two aspects of the design extension, namely, the forecast for the breakwater performance and the omission of the bottom from the chamber. The forecast involved conventional modeling laws, and also the assumption that the reflection coefficient was a linear function of wave frequency, even though the analysis had shown it to be nonlinear and to depend upon other wave parameters as well. A key question is whether the breakwater responds in random wind-wave exposure in a manner similar to its performance as a linear damped resonator in model studies exposed to monochromatic waves. The extent to which scale factors relate the model and full-scale hardware will be analyzed.

Laboratory experimental data showed that if the chamber bottom were left off, the main effect was to shift the optimum performance toward the shorter wave lengths with only a nominal reduction in reflection coefficient. A second objective is therefore to check these laboratory results in random wave systems; the omission of the chamber bottom would simplify some field installations considerably.

A basic test section designed to accomplish the two objectives above would also contribute additional data of importance to the project as a whole and to the general subject of wave-structure interaction such as:

1. Data on the actual wave spectrum in Lake Washington as a function of wind speed and duration.

2. Extend the value of existing experimental and theoretical work by providing experimental links between the systems.
3. Force measurements to be compared with other prototype data and model results.
4. The reduction in wave overtopping onto the bridge roadway, a phenomenon not amenable to model analyses.
5. A measure of the scale effects between model and prototype.

Test Apparatus

A breakwater (Figure 1) section 38 feet long and having the cross section illustrated in Figure 2 is used for the basic full-scale test unit. A 3.3 foot, central portion of the vertical porous wall is mounted so that force data can be obtained from strain gages on cantilever beam which support the test panel. The width of the unit can be set at 3,5, or 7 feet, but is set at 5 feet initially; the bottom is removable.

Specific Application:

The effects of random, wind-generated, deep water wave systems on a porous walled breakwater are investigated by appending the full-scale prototype to the south side of Evergreen Point Floating Bridge traversing Lake Washington to join Seattle and Bellevue, Washington (Figure 3). The breakwater, attached near the midspan, has been exposed for a period of two years to the various wave conditions developed over a 2.8 mile effective fetch by dominant wind from the southern sector.

The sixty foot bridge pontoon width is sufficiently large compared with wave lengths present that transmitted wave energy is eliminated for all wind conditions. Thus, any incident energy produced over the fetch and not dissipated by wave breaking--or losses at the bridge becomes a reflected wave system proceeding from the bridge. The floating pontoon span, 7580 feet long, traverses the typically 200 foot deep lake, 12° off from an east-west crossing. Thus, a southerly wind produces a progressive wave system which reflects from the vertical pontoon walls and proceeds toward the western shore at an approximate angle of 24°. For some wind conditions reflected waves impinge on the western shore 4,000 feet south of the bridge[20].

Wind roses show winds from the southerly sector to be dominant in frequency and magnitude followed by those from the north. Winds from the east or west seldom occur and are of short duration. Previous investigations[20] have shown that steady eight to twelve mph. winds are required to form a significant reflected wave system. Wave breaking exists when wind conditions exceed 25-30 mph. Wave systems produced by winds in excess of 30 mph contain sufficient energy upon impact with the solid pontoon wall that runup overtops the guard rail eleven feet above still water level.

The overtopping water is windblown onto the windshields of traffic on the four lane, 50 mph roadway. Wind driven wave peaks resulting from wind conditions above 40 mph contain sufficient momentum to cross all four lanes of traffic. Though wind conditions in excess of 40-45 mph are rare, winds are high as 60 mph, gusting to 75 mph, have been recorded during the test period (March 26, 1971).

Design Constraints

To create a reasonable scope for the investigation and minimize the expenditure, the prototype breakwater was made of a length sufficient only to eliminate end-effects on a central force-instrument panel and at a pressure monitoring station in front of the breakwater. The presence of a high traffic density roadway immediately adjoining the test sight required that the units be constructed in a modular form and transported for attachment to the bridge without modifications to the pontoon assembly. This was accomplished using a straightforward steel and wood modular construction, assembled at the University of Washington and transported to the bridge by barge where they were appended to the bridge using hooks over the guard rail and held rigidly in place by cables running under the bridge to the guard rail on the opposite side. It was necessary that the breakwater be capable of withstanding exposure to wind and wave conditions produced by 60 mile an hour winds, and remain operational for an unspecified period of months. Thus, the structure was carefully designed to provide an appropriate tradeoff between strength and economy.

CHAPTER II

THEORY, APPLICATION, AND PREDICTION

Overview

Wind blowing over a body of water imparts energy to the surface producing a random wave system. If the resulting progressive wave system impacts a barrier, conservation of energy requires that the energy either be transmitted, dissipated, or reflected. If the wind speed is sufficiently high instability will occur and some energy will be dissipated through the turbulence losses associated with wave breaking. Once reflected, the wave train traveling against the wind contains significant amounts of energy which are slowly consumed by viscous shear. Previous investigations[20] have shown impingement of reflected waves on the shoreline 4000 feet from the bridge (25% of the fetch length).

The bridge pontoons form a semi-immersed, rectangular floating breakwater with a width nearly equal to the longest incident wave length. This eliminates any significant transmission of energy to the lee side of the bridge. The use of solid vertical walls on the pontoons results in a nearly perfect reflection barrier. Thus, almost all of the energy imparted by the wind to the incident wave train is reflected and proceeds upwind. A reduction of reflected wave energy can most efficiently be accomplished by converting energy to non-conservative forms using a breakwater device at or near the barrier. The condition of deep water which necessitates the construction of a floating bridge also restricts the type of breakwater which can logically be incorporated for increasing losses.

The porous walled resonating chamber being investigated lends itself readily to incorporation with a floating structure. The device converts the potential energy of the incident wave into kinetic energy as jets of water passing through sharp edged orifices where non-conservative turbulent mixing and diffusion dissipate a portion of the energy. An advantage of this loss mechanism, besides requiring no power to drive it, is that the energy does not affect the structure. The result is a device that reduces the reflected waves while reducing the loading on the structure. The load reduction can result in structural design and operating cost reductions.

The measurement of the efficiency of the porous walled chamber is a problem. Small amplitude wave theory demonstrates that the average total energy per unit surface is proportional to the square of the wave height. Though the wave heights in a wind generated sea surface are quite complex, they can be treated as a linear summation of sinusoidal waves of various amplitudes, frequencies, and phase angles. A wave height sensor is mounted in front of the chamber to measure the combined field of incident and reflected waves. The net force experienced by the porous wall is monitored at the center of the structure. A second (remote) station in front of the solid vertical bridge wall and away from the influence of the breakwater is used to establish the wave height without the chamber.

Surface piercing gages, available at the outset of the investigation, were found to lack the resolution necessary to function in fresh water. Small amplitude wave theory also establishes the sub-surface pressure fluctuations as a unique function of the surface waves. Therefore, sub-surface pressure transducers are used to monitor the vertical pressure at a constant depth in front of the chamber and at the remote station. The pressure is proportional to the wave height which, in turn, is proportional to the square root of the total energy.

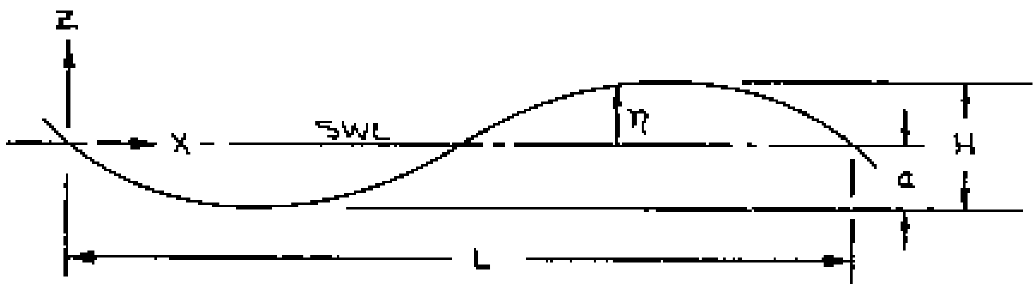
In principle, the efficiency of a given chamber configuration is established by analyzing the pressure fluctuations due to the sum of the incident and reflected waves in front of the breakwater and at the remote station away from the influence of the breakwater. For all conditions of interest, at the particular test site studied, transmitted energy is zero[20]. Over a period of minutes the total incident wave energy at the two stations, separated by 150 feet, is the same. Thus any difference in the total energy monitored at the two stations can be attributed to a change in the reflected wave energy.

Over the period of minutes during which a record is taken, the wind generated waves are approximately stationary Gaussian random processes with zero averages. As such, the relevant statistical properties are contained in the autocovariance function and the power spectrum. The exact computation of the spectrum would require a record of infinite length. The acquisition of analog records twenty to sixty minutes in length allows calculation of spectral estimates for digitized sections of the data using the window closing technique of Jenkins and Watts[21].

Small Amplitude Wave Theory

A classical and basic simplified description of wave motion is described by small amplitude wave theory. Small amplitude or linear wave theory is developed in detail in numerous texts, i.e., Lamb[22] and Ippen[23]. The theory, based on mathematical potential flow analysis of an ideal fluid, provides a useful treatment of wave motion and forces for real waves of finite height. The theory is not applicable in conditions where there is wave breaking. Sinusoidal wave profiles predicted from the theory provide an equal distance from the still water level to the crest of the trough. In actuality, the crest is somewhat higher than the trough. The fundamental relationship between the wave period, T, wave length, L, and the wave speed, C, for the sinusoidal wave is

$$T = \frac{L}{C} \quad 1$$



In general, the theory relates the wave speed to wave length and depth, d, by

$$C^2 = \frac{gL}{2\pi} \tanh \frac{2\pi d}{L} \quad 2$$

but $\frac{L^2}{T^2} = C^2$

Therefore, combining the above equations yields

$$L = \frac{gT^2}{2\pi} \tanh \frac{2\pi d}{L} \quad 3$$

Thus, for a known water depth each wave period corresponds to a unique wave length. For depths greater than one-half of the wave length, the hyperbolic tangent function approaches unity, making the wave speed independent of depth. For deep water conditions, the basic relationship between wave velocity and wave length is

$$C^2 = \frac{gL}{2\pi} \qquad 4$$

Substituting the square root of Equation 4 into the fundamental relationship, speed equals length divided by period gives

$$C = \frac{gT}{2\pi} = \frac{gT}{2\pi} = 5.12T \qquad 5$$

This can also be rewritten as

$$L = 5.12T^2 \qquad 6$$

A table demonstrating the relationship between the various deep water parameters relevant to the present investigation is shown in Figures 4 and 5.

Conservation of energy requires that energy transmitted by wind and the progressive wave system incident to the vertical wall on the floating bridge must either be transmitted, reflected or dissipated through losses. Though the losses due to breaking of the waves cannot be accounted for by small amplitude wave theory, the linear theory will provide a relationship between wave height and energy. The average potential energy density, $\overline{PE}$, of a single frequency progressive wave per unit area of sea surface (energy density) is due to the displacement of the water surface and is shown by linear theory to be equal to

$$\overline{PE} = \frac{\gamma}{4L} \int_0^t \eta^2 \, dt = \frac{\gamma a^2}{4} \qquad 7$$

where a is the wave amplitude and γ is the specific weight of water. The kinetic energy, KE, of the water particles per unit area of sea surface averaged over a wave length is equal to

$$\overline{KE} = \frac{\gamma a^2}{4} e^{4\pi nL} \approx \frac{\gamma a^2}{4} \qquad 8$$

Thus, the average energy per unit area of sea surface for a progressive wave contains equal contributions from the kinetic and potential energy. The resulting average energy density is

$$\overline{E} = \frac{\gamma a^2}{2} = \frac{\gamma H^2}{8} \qquad 9$$

For the case of a complex surface the superposition of linear components provides the result that

$$\overline{E} = \frac{\gamma}{8} \sum_{j=1}^{n} H_j^2 \qquad 10$$

Loss Mechanism of a Porous Walled Breakwater

As progressive incident waves strike the porous wall, the difference in head between the incident wave and the water inside the chamber creates a pressure differential across the porous wall. Some of the wave energy is reflected from the wall and the remainder enters the pores, or square-edged orifices. Potential energy of the incident wave height is converted to the kinetic energy of jets passing through the orifices (Figures 6 and 7). As the jets mix with the fluid inside the chamber, the kinetic energy is lost due to non-conservative turbulent mixing and diffusion. When the level inside the chamber is sufficient to overcome incoming momentum, the process reverses and the jets exiting the chamber again have kinetic energy converted to losses through further turbulent mixing and diffusion. The outgoing energy results in the generation of another reflected wave.

Measurement of Wave Height

Initial attempts to measure the wave height with a fixed surface piercing gage showed insufficient resolution in fresh water with the equipment available at the beginning of the test. An alternate method was chosen using sub-surface pressure transducers. The sub-surface pressure fluctuations can be shown to be a direct function of the surface waves. Small amplitude wave theory shows that the pressure beneath the surface is equal to

$$P = \gamma\left[\eta \frac{\cosh(\frac{2\pi}{L}(d + Z)}{\cosh(\frac{2\pi}{L} d)} - Z\right] \qquad 11$$

For our investigation, d = 200 ft., Z = - 5 ft. (Z up defined as positive). Therefore the variables are L and η. Contributions of the hyperbolic cosine terms for wave lengths of 20 and 40 ft. are shown as follows:

$$L = 20: \quad \frac{\cosh \frac{2\pi(195)}{20}}{\cosh \frac{2\pi(200)}{20}} = .992 \qquad 12$$

$$L = 40: \quad \cosh \frac{2\pi(195)}{40} = .993$$

Thus, the primary variable is

$$\eta = \frac{H}{2} \sin\left(\frac{2\pi x}{L} - \sigma t\right) \qquad 13$$

Therefore, time dependent pressure fluctuations are directly related to wave height and, through equation 10, can be used to obtain the wave energy.
The above is shown for a single harmonic, while the actual sea state contains many components which are treated by linear superposition during analysis.
The pressure is shown to be a unique function of the wave height and in turn the energy differences at the two measuring stations, one in front of the

breakwater, the other away from the influence of the breakwater are derived from the spectral analysis of the squared pressure fluctuations. The pressure sensors were at the same depth (five feet) beneath the water surface and the concern was with the difference in energy between stations, so the conversion from pressure at depth to equivalent wave height need not be performed. The $-\gamma z$ contribution to the pressure (equation 11) due to hydrostatic pressure on the transducer is 2.16 p.s.i. The output signal of the data acquisition amplifier establishes the 2.16 psi a zero output to allow the entire recorded data signal to be wave induced pressure fluctuations.

Wave Reflection; Reflection Coefficient and Energy Dissipation

In the laboratory experiment on the porous walled breakwater (16) waves of a single frequency (monochromatic) were used, so the reflection coefficient R, defined as the ratio of reflected wave height (H_r) to the incident wave height (H_i) can be obtained from

$$R = H_r/H_i = \frac{\eta_{max} - \eta_{min}}{\eta_{max} + \eta_{min}} \qquad 14$$

wherein η_{max} and η_{min} are the maximum and minimum amplitudes of a wave envelope developed by traversing a height gage through the standing wave which developed in front of the model breakwater. The technique inherent in the statement of Eq. 14 can be applied when only two components are present, so it cannot be used to reduce a random wave field to its components.

The premise assumed in planning the full-scale experiment was that the energies in a composite wave system could be expressed as proportional to sum of the squares of the wave heights (Eq. 10) of the individual waves composing the system, and that pressure (height) measurements at two stations, one (designated ∞) at a depth of 5 feet and a horizontal distance of 7 feet in front of the vertical wall of the bridge and another (designated B.W.) the same depth and distance in front of the porous breakwater could be analyzed to determine the difference in energy between the two locations. Practically no energy is transmitted by the Evergreen Point Bridge at any of the wave frequencies encountered on Lake Washington; the vertical plane wall of the bridge is nearly a perfect reflector until wave breaking and overtopping occur, so the difference between the energies at the two stations is attributable to the energy dissipation introduced by the breakwater. By locating the two gages identically with respect to depth and distance from the walls of concern, the need for correcting the pressure data to surface heights and accounting for secondary effects to the two locations can be eliminated by focussing on the differences in energy between the two locations, i.e.:

$$E_\infty = E_i + E_{r\infty} \qquad 15$$

$$E_{BW} = E_i + E_{rBW} \qquad 16$$

The energy at B W should be equal to or less than that at the remote station (∞). The reflection process from the vertical wall is an efficient one, so, until breaking and overtopping develop, $E_i \cong E_{r\infty}$ and

and

$$E_\infty = 2\,E_i \qquad 17$$

$$E_{r_{BW}} = E_{BW} - [E_\infty]/_2 \qquad 18$$

$E_{r_{BW}}$ is the energy in the wave system reflected from the porous wall.

The average energy densities, $\bar{E}_\infty$ and $\bar{E}_{BW}$, can be determined from spectral analyses of the pressure data from the two gages, the energy in reflected system computed from Eq. 18, and the effectiveness of the breakwater as a ratio of $E_{r_{BW}}/E_{\infty}$.

In the lab study[16], the reflection coefficient $R = H_r/H_i$, as determined from model data, was used to predict energy spectrum for the reflected wave, and then the energy loss due to the breakwater was found as the difference between the predicted incident and reflected spectra.

The energy dissipation due to porous breakwater is a very basic notion, and can be used alone to compare the relative effectiveness of different breakwater geometries and incident wave conditions. Although, the reflection coefficient is a convenient concept, and was used in the lab study to predict the energy loss dissipation by the breakwater, it cannot be found directly from the pressure data at the two sites. It can be predicted, by computing an incident height-frequency curve from the pressure data at station ∞, and predicting a reflected height-frequency curve by using the computed energy E_{BW} by the method used to predict the reflected wave spectrum in (16, p. 58). It should be pointed out again, that the concern is to evaluate the energy reduction accomplished by the breakwater--the reflection coefficient is a convenience term.

The reflection coefficient has been shown by dimensional reasoning (ref. 16, p. 35) to depend upon the set of variables

$$R = f(m, H_i/L, b/h, h/L, \delta b/mLh) \qquad 19$$

wherein m is the porosity, L is the wave length, b the breakwater width, h its depth, and δ the effective pore length. A key question is whether the breakwater responds in the random wind wave exposure in a manner similar to its performance as a linear, damped oscillator in the model basin where the input waves were monochromatic. The measures of its response will be the sensitivity of the reflection coefficient (or energy loss) to the terms in Eq. 19, particularly to the last term. An alternative form for this term is σ^2/ω^2, where σ is the wave angular frequency and $\omega^2 = mgh/\delta b$, the breakwater width is changed and measurements are taken over a range of input wave conditions so the wave parameters containing wave height and length (or frequency) will vary. The bottom of the breakwater is removed for another set of conditions. Though no theoretical analysis of performance was made in (16) with the bottom out, the empirical data from the lab experiment provides a basis for a similarity comparison between the model and the prototype.

The reflection coefficient can be related to the amount of energy dissipated during the reflection process. Conservation of energy requires that

$$E_i = E_r + E_t + \text{dissipation losses} \qquad 20$$

For the present investigation the transmitted energy is zero. Thus the amount of potential and kinetic energy dissipated (converted) to non-conservative energy such as turbulence or heat is

$$E_D = \text{Dissipation losses} = E_i - E_r \qquad 21$$

From small amplitude theory $E = \frac{\gamma H^2}{8}$

$$E_D = \frac{\gamma}{8}\,[H_i^2 - H_r^2] \qquad 22$$

As a ratio of the energy not recovered during reflection to the available incident energy the

$$\text{Energy dissipation ratio} = \frac{E_D}{E_i} = \frac{\frac{\gamma}{8}[H_i^2 - H_r^2]}{\frac{\gamma}{8} H_t^2} \qquad 23$$

$$\%\ \text{energy dissipated} = (1 - R^2)\ 100 \qquad 24$$

The percentage of energy dissipation represents the efficiency of a device in converting incident energy into non-conservative forms and thereby reducing the reflected wave energy. For example, perfect reflection ($R = 1$) results in zero dissipation during reflection, while the total elimination of reflected waves ($R = 0$) corresponds to a 100% energy dissipation (see Figure 8).

Method of Evaluating Energy Dissipation

To evaluate the effectiveness of the full-scale porous walled breakwater in reducing reflected wave energy from a solid vertical barrier, two stations are established to measure the sum of the incident and reflected wave height. The presence of a continuous floating structure at the test site eliminates transmitted wave energy, and also negates the possibility of obtaining incident or reflected wave signals individually. Thus, the method proposed at the outset of the investigation for determining the reflected energy reduction by the breakwater exposed to random incident waves requires the following steps.

1) Time histories of the summations of the random waves are simultaneously acquired over periods of at least twenty minutes at each station, one in front of the breakwater and the second an equal distance in front of the solid reflector (bridge pontoon wall) away from the influence of the breakwater (See Figure 1).
2) Small amplitude wave theory demonstrates that the energy in a progressive wave is proportional to the square of the wave height and that the wave

heights of waves progressing in opposite direction add linearly. Under the linear assumption a random wave can be described by the superposition of a Fourier series of sinusoidal waves of different frequencies and associated amplitudes. Using spectral analysis the time average total energy density, calculated from the variance, is obtained at each station.

3) Over a period of minutes the incident energy at the two stations is the same. Thus, any difference in the average total energy density at the two locations must be due to a difference in reflected wave energy.

Following this line of reasoning the wave height at the fixed station in front of the solid vertical wall (∞, denoting the conditions without a breakwater) is the superposition of the incident (i) and reflected (r) components

$$\eta(t)_\infty = \eta(t)i_\infty + \eta(t)r_\infty =$$

$$\left[\sum_j \frac{H_j}{2} \cos\ (-2\pi f_j t + \phi_j)\right]_{i\infty} + \left[\sum_k \frac{H_k}{2} \cos\ (+ 2\pi f_k t + \phi_k)\right]_{r\infty} \qquad 25$$

where ϕ_i and ϕ_k are the phase angles associated with the various random components likewise the wave height in front of the breakwater (B W) are

$$\eta(t)_{BW} = \eta(t)_{iBW} + \eta(t)_{rBW}$$

$$= \left[\sum_j \frac{H_j}{2} \cos\ (- 2\pi f_j t + \phi_j)\right]_{i_{BW}} + \left[\sum_k \frac{H_k}{2} \cos(+ 2\pi f_k t + \phi_k)\right]_{rBW} \qquad 26$$

The average energy content in a random wave is found from spectral analysis to be proportional to the variance, σ^2. The variance for a series of cosine waves of different frequencies, f, and amplitudes, a_j, equals $\sigma^2 = \sum_j \frac{1}{2} a_j^{\,2}$. Thus, recalling equation 10, the average energy density of the incident and reflected waves in front of the solid wall and in front of the breakwater can be expressed by the specific weight, γ, times the respective variances. The average total energy density in front of the breakwater,

$$\bar{\bar{E}}_{BW} = \gamma\sigma^2_{BW} = \gamma(\sigma^2_{i_{BW}} + \sigma^2_{r_{BW}}) \tag{27}$$

and the corresponding average total energy density in front of the solid wall is

$$\bar{\bar{E}}_{\infty} = \gamma\sigma^2_{\infty} = \gamma\ (\sigma^2_{i_\infty} + \sigma^2_{r_\infty}) \tag{28}$$

The variance is obtained over a sufficient period of time (5.6 minutes) that the average incident energy to the two locations is the same, i.e.,

$$\gamma\sigma_{i_\infty}{}^2 = \gamma\sigma_{i_{BW}}{}^2 = \gamma\sigma_i{}^2. \quad \text{Therefore,}$$

$$\bar{\bar{E}}_{BW} = \gamma\sigma^2_{BW} = \gamma(\sigma_i{}^2 + \sigma^2_{r_{BW}}) \text{ and} \tag{29}$$

$$\bar{\bar{E}}_{\infty} = \gamma\sigma^2_{\infty} = \gamma(\sigma^2_i + \sigma_{r_\infty}{}^2). \tag{30}$$

Subtracting equation 29 from 30 results in the average energy density difference at the two stations due to the presence of the breakwater

$$\bar{\bar{E}}_{\infty} - \bar{\bar{E}}_{BW} = \gamma(\sigma^2_{r_\infty} - \sigma^2_{BW_\infty}) \tag{31}$$

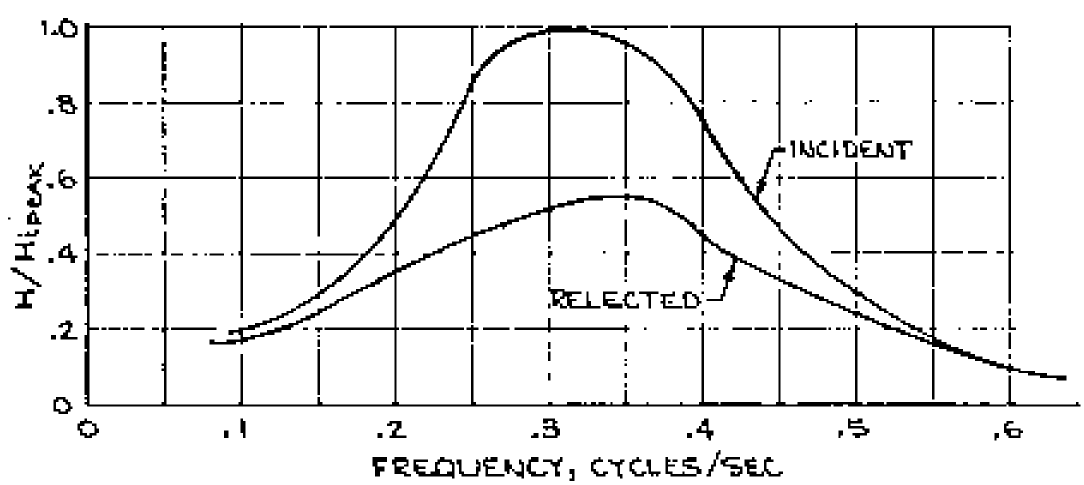
This amount of energy decrease cannot be expressed as a percentage of the incident energy because $\gamma\sigma^2_i$ cannot be obtained independently. Though the wave spectra for the incident wave alone cannot be measured, the method described by (16, pg. 58) provides a means of predicting a reflected height-frequency curve. Alternatively, the energy can be ratioed to the average total energy density in front of the solid wall, σ^2_{∞}. This ratio is defined as attenuation

$$\text{ATTENUATION} = \frac{\text{Average Reflected Wave Energy Decrease Due to the Breakwater}}{\text{Average Total Energy without the Breakwater}}$$

$$= \frac{\bar{E}_\infty - \bar{E}_{BW}}{\bar{E}_\infty} = \frac{\gamma(\sigma_\infty^2 - \sigma_{BW}^2)}{\gamma\sigma_\infty^2} =$$

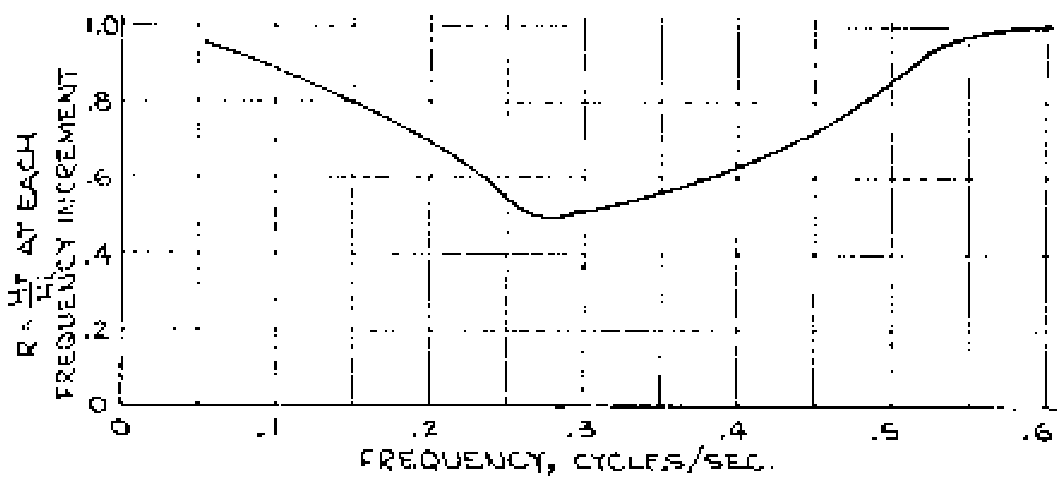
$$\therefore \text{ ATTENUATION} = 1 - \frac{\sigma^2_{BW}}{\sigma^2_\infty} \qquad 32$$

Example of Reduction in Energy by a Linear Damped Oscillator. The oscillator, or resonator, can only affect the amplitude and phase of the incident wave not the frequency. The complex wind generated incident wave can be decomposed into a number of sinusoidal waves each having a different frequency, random phase, and an associated wave height. For this illustration the incident wave has a peak frequency of .3, that is .3 is the frequency of the component wave assigned the greatest wave height. Suppose, for example, the square of the non-dimensional incident and reflected wave height vs. frequency distribution in front of the breakwater is that shown in the figure below.

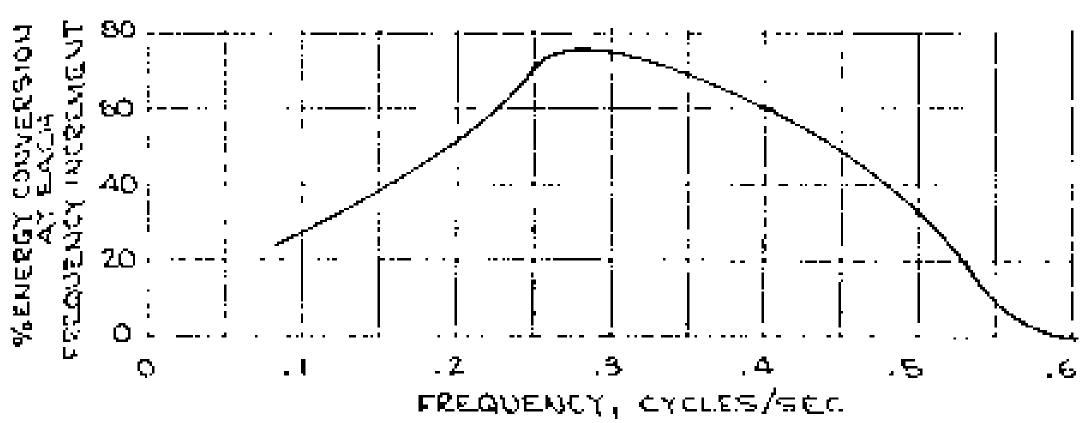


The breakwater, operating as a resonator reduced the amplitude of the incident wave at every frequency below .6. The maximum reduction occurred at f = .27. The peak reflected energy occurred at .35. The knowledge that the system models as a linear resonator provides the information that the difference in reflected wave height at the frequencies .27 and .35 is solely due to a selective reduction in the incident wave height by the breakwater for the two distinct frequencies. None of the reduction in wave height at f = .27 was accomplished by the reassignment of incident wave height at that frequency to reflected wave height at a different frequency.

The reflection coefficient for this example would be the ratio of H_r/H_i for each increment of frequency.



The associated non-conservative energy conversion is



Expected Conditions at Test Site

The model studies of the porous wall breakwater subjected to monochromatic waves by Richey and Sollitt [16] produced the following results. The chamber is frequency dependent upon the wave frequency and steepness as well as the chamber characteristics of porosity, depth, pore geometry and chamber width. The chamber was shown to act as a linear damped oscillator or resonator, having a natural frequency

$$\omega = \sqrt{\frac{mgh}{\delta b}} \qquad 33$$

where m is the effective porosity, h - the chamber depth, δ - the effective core length,taken as 1.3 times the diameter of the orifice, and b is the chamber width.

The ratio of the model chamber depth to the full-scale requirement of 6.4 feet provides a scale ratio of 1:12. Figure 9 shows the model experimental reflection coefficient for a breakwater that would scale to a four foot chamber width, have a geometric porosity of .196 using one foot diameter holes uniformly spaced on two foot centers, and include a solid bottom. Figure 10 presents the corresponding experimental reflection coefficient for a chamber with the only variable change being an increase in geometric porosity to .333. Comparison of the two figures indicates that the minimum reflection coefficient is shifted to higher wave numbers as the porosity increases and the range of wave numbers over which the chamber is effective increases. The theory [16] predicts a decreasing reflection coefficient with increasing porosity up to an optimum porosity, and the experimental results indicate that the optimum occurs between .2 and .3 (16, Figure 3). Based on the model results for the full-scale investigation m' is chosen as .293, produced by one foot diameter holes uniformly spaced on eighteen inch centers.

Figure 11 displays the shift in minimum reflection coefficient with variations in chamber widths for the model chamber with .196 geometric porosity. From the discussion above, the minimum reflection coefficient corresponding to each chamber width should be shifted to higher wave numbers (smaller wave lengths) for the prototype due to the increased porosity.

Removal of the bottom from the breakwater shifts the occurrence of the minimum reflection coefficient to higher wave numbers and produces a higher minimum reflection coefficient as shown in Figure 12.

Having established an appropriate prototype porosity the variable remaining to tune the breakwater is the chamber width. For maximum energy dissipation the chamber width must be chosen to produce a minimum reflection coefficient near the frequency for which the wave energy at the test site is a maximum. The natural frequency can be determined from equation 33.

$$b = \frac{mgh}{\delta\omega^2} \tag{34}$$

Experimental results indicate the maximum energy dissipation occurs near $\sigma^2/\omega^2 = 1.2$. Thus

$$b = \frac{mgh(1.2)}{\delta\sigma^2} = \frac{1.2mgh}{\delta(2\pi f)^2} = \frac{1.2mhL}{2\pi\delta} \tag{35}$$

where m is the geometric porosity times an appropriate jet discharge coefficient[(16)(25)] of approximately .77. The prototype chamber width can thus be expressed as a function of incident wave length

$$b = \frac{1.2(.77)(.293)(6.4)(L)}{2\pi\ (4/3)} = .207L \tag{36}$$

or as a function of wave frequency

$$b = \frac{1.2(.77)(.293)(32.174)(6.4)}{16/3\pi^2\ f^2} = 1.06/f^2 \tag{37}$$

where the wave length or frequency should correspond to the maximum energy condition at the test site.

The calculated effective fetch for the test sight on the Evergreen Point Floating Bridge is 2.8 miles (calculation Figure 13). An annual wind rose for the area, Figure 14, indicates that winds from the southerly section are dominant in frequency and magnitude. Maximum wind speeds and duration expected are approximated by Figure 15. Previous investigations[20] have shown that steady eight to twelve mph winds are necessary to create a significant reflected wave system. Thirteen to thirty mph winds often occur. Forty mph storms lasting up to five hours occur at the test site during the winter. The short duration maximum recorded during the two years test period was 60 mph gusting to 75 mph. The significant wave height and frequency as a function of the windspeed at the test site is shown in Figure 15 (predicted by the method presented in (24).

Though the breakwater must be capable of withstanding the extreme wave conditions, the chamber width is selected to produce maximum energy dissipation for wave conditions which produce the maximum total reflected energy. Windspeeds of 8-12 mph are required to produce a noticeable reflected wave system[20]; thus, even though Figure 14 shows that the majority of the time incident winds speeds are below 12 mph, it is of no value to tune the chamber to these conditions. As shown in Figure 16, the increase in wave height at the test site is approximately linear with increasing windspeed. Since energy is proportional to the square of the wave height, a dramatic increase in reflected energy occurs with increasing windspeed. Though the reflected energy during a given period of time is much greater at higher windspeeds, the total length of time each condition exists during the year rapidly decreases for windspeeds above twenty mph. Wave breaking begins to help dissipate energy at the test site for wind speeds in excess of 25-30 mph.

a three second period for a chamber configuration similar to the present investigation except for the porosity. Assuming a linear relationship between the force and the area of the porous wall, the ratio between Burrows porosity and that of the present investigation would suggest an expected force of 205 pounds on the solid wall of the full-scale breakwater at a windspeed of about 40 mph.

The porous walled caissons investigated by Jarlan (13) use a porosity, m´, of approximately .3. For the system, including porous front wall and solid back wall, Jarlan demonstrates a seventy percent reduction in force relative to that acting on a solid wall alone. Marks (10) also measured the forces exerted on both walls of a porous walled chamber. Being concerned with much longer wave lengths and shallow water conditions, the scale of the chamber is ten times that of the present test. Making the scale conversion the chamber would correspond to a 3.4´ wide chamber at the present test site designed for a forty-four foot wave with a three second period and a 1.5 foot wave height. With a porosity, m´, of about .25, Marks recorded a 69% reduction in the sum of the horizontal forces on the porous and solid wall relative to the force on the same size solid wall alone.

The present investigation makes no attempt to develop an analytic prediction for the wave forces against a porous wall. Rather, the maximum forces on the porous wall and the frequency distribution of the force for the matrix of wind generated wave conditions and chamber configurations are obtained experimentally. Establishment of the force reduction obtained by incorporating the breakwater could allow substantial reduction in the design load requirements and maintenance costs of a floating structure.

Experimental Force Evaluation

The chamber created by the porous walled breakwater includes a porous front wall and solid back wall. Because the device was appended to an existing floating bridge the back chamber wall was formed by the bridge pontoon. The force against the back wall is not measured but can be calculated, because the major component of water movement inside the chamber is the level change due to the influx and emptying of the chamber. Runup and the shock pressure due to breaking waves are non-existent at the back of the chamber. Thus the maximum force on the solid chamber wall can be calculated simply as the hydrostatic force due to the maximum level within the chamber.

The wave system in front of the breakwater and the level within the chamber result in forces against the porous wall. As detailed in the next chapter, central 3.3 feet of the porous wall form an instrumented test section allowing the acquisiton of the representative maximum force free from end effects and provides a porosity representative of the entire porous wall. The use of a short test section also assures the force is not averaged by the limited crest length of the waves.

The vertical force on the thin porous wall is assumed to be insignificant. For use primarily as a design input for fatigure loading the frequency distribution of the force is acquired using the same spectral analysis program used to analyze the wave data. Though the resulting spectral amplitudes are not an expression of pounds of force, the plots indicated the frequency at which the peak force occurs and provide information regarding secondary peaks, if any.

The portions of the prototype breakwater subjected to the most force are the chamber end plates. These solid walls, required to provide two dimensionality within a reasonable length for the experiment, are subjected to a

This range of uncertainty, both in the frequency corresponding to the optimum performance of a given chamber width and the windspeed which produces the most total energy at the test site during the year, suggests that a range of chamber widths be tested. Figure 16 is used to establish the relationship between windspeed and the significant frequency (at the test site) and Figure 4 to relate this frequency to the corresponding dominant wave length. This wave length can then be related to the desired chamber width through equation 34 for the resonant frequency and equation Eq. 36 for laboratory predicted optimum performance. Choosing chamber widths that correspond with a wind range of 12 to 25 mph results in a reasonable choice of chamber widths being five and seven feet. The test apparatus is built to also allow a three foot width in case the full-scale device reacts to a frequency lower than predicted. A table demonstrating the predicted characteristics is shown below.

Chamber Width (feet)	Predicted Natural Frequency of, ω (eq. 34) (HZ)	Approximate Windspeed at Test Site Associated with with ω (mph)	Frequency Predicted from eq. 36	Approximate Corresponding Windspeed (mph)
3	.545	12	.63	<10
5	.435	15-20	.48	15
7	.365	20-25	.38	22

Summary of Prototype Breakwater Specifications

Porous walled resonating chamber.

- Porous vertical front wall: porosity (m′) = .293
- Solid vertical back wall (bridge pontoon wall)
- Solid, removable chamber bottom
- Solid end plates (to establish two dimensionality with the minimum chamber length)
- Chamber depth: 6.4 feet
- Pore geometry: one foot diameter round sharp edge orifices uniformly spaced on 18" centers.
- Chamber width: design variable: 3, 5 and 7 feet.

Forces

The forces exerted on a solid vertical wall by the various wave forms have been the subject of numerous investigations and as a result are reasonably predictable.

Existing methods can be used to calculate the approximate maximum force exerted on the solid wall of the floating bridge pontoon. On the other hand, literature examining the maximum forces on a porous wall in front of a solid wall exposed to random deep water waves is very limited. A laboratory investigation by Burrows [19] indicated that the force on a vertical porous wall used to form a chamber in front of a solid vertical reflecting wall was less than the force exerted on a solid wall immersed to the same depth. For a porosity, m′, of .196 and a depth of immersion scaled to the present investigation a reduction in force of 65% was obtained relative to the theoretical value for a solid plate extending to the same depth. Burrows further predicts a full scale force of 236#/lineal foot of wall due to a three foot wave height with maximum pressure differential near the pontoon when a wave outside the chamber is overtopping the guardrail at the same time the chamber level is low. This effect is amplified when the waves crests are not parallel to the bridge as evidenced by wave runup onto the roadway near one side of the chamber for wind conditions too low to produce overtopping anywhere else along the bridge. The forces exerted on these panels were not measured because permanent breakwater would likely span the entire length of the structure and have porous end plates to reduce the loading.

CHAPTER III

APPARATUS AND INSTRUMENTATION

General Description of Equipment

The experiment required construction of a full-scale porous walled breakwater and the associated instrumentation to monitor the forces upon the breakwater and wave characteristics in front of and inside the attenuator as well as those beyond its region of influence. The apparatus, assembled at the University of Washington, C. W. Harris Hydraulic Laboratory, is attached to the south side of the second Lake Washington Floating Bridge near the center of the lake (400 feet west of the drawspan).

The breakwater, shown in Figures 17-20, is a chamber created by the solid wall of the bridge, a removable solid bottom, and a movable, porous vertical wall. The water can pass into and out of the chamber through uniformly spaced, round holes (orifices). The chamber extends three feet above and 6.4' below still water level, the dimensions of the chamber are maintained by securing the bottom and porous wall panels to steel superstructure attached to the side of the bridge. The characteristics of the breakwater are determined by evaluating the difference between the sea state (pressures) immediately in front of the breakwater and at a remote location along the bridge where the breakwater does not influence the sea state. The breakwater is of sufficient length, thirty-eight feet, only to eliminate end effects on the limited region where force and pressure measurements are obtained. The chamber is enclosed on each end by solid end panels attached to the steel superstructure. The apparatus is constructed to allow chamber widths, b, of three, five, and seven feet and can be tested with or without the bottom panels.

The central 3.3 feet of the porous wall is held in position at the top and bottom by pairs of cantilever beams. The output of strain gages attached to the beams are monitored to establish the resultant horizontal force "felt" by the porous wall. Two tripods house pressure transducers which are used to measure the pressure five feet below S.W.L. One tripod extends seven feet nine inches out from the side of the bridge 150 feet east of the breakwater to monitor the pressure due to waves away from the influence of the breakwater. The second tripod is attached to a porous wall and measures the pressures due to waves seven feet nine inches in front of the breakwater. The outputs of each of the calibrated pressure and force sensors are amplified and recorded onto analog tape for periods of at least twenty minutes per run. The various components of the apparatus are treated in detail in the following sections.

<u>The Breakwater</u>

Steel Superstructure (Figure 21):

Two modules of steel trusses and cross bracing attach to the bridge using hooks over the bridge railing eleven feet above S.W.L. to sustain loading down and away from the bridge. Seven feet below S.W.L. horizontal extensions of the trusses extend underneath the bridge to prevent upward motion. From the center truss extension of each module 75' cables run under the bridge to the north side where they are attached to hooks over the north bridge railing. Turnbuckles are used to hold the modules rigidly against the bridge. Steel bracing welded between the modules maintain the required spacing for the test section. The modules contain all the installation hardware required to create three, five, or seven foot wide enclosed chambers. Overall dimensions of the superstructure are: height = 19 feet, width = 8 feet, and length = 38 feet.

Porous Walls (Figure 22):

Four porous walls, each eight feet long, ten feet high and seven inches thick are set into slots at the base of steel trusses and bolted to truss crossmembers at the top. Each wall contains thirty, one-foot-diameter holes spaced on eighteen inch centers. Each hole is lined with sheet metal to provide a seven-inch-long sharp-edged orifice. The ratio of the geometric area summation of all holes to the total wall frontal area (porosity) is .293. The walls are of wooden construction incorporating 3/4 inch plywood sandwiched over two-by-sixes to transmit loads vertically to pairs of $2\frac{1}{4}$ inch angle iron edges at the top and bottom. The angle iron transmits the forces horizontally to the trusses and in turn to the bridge. Seven feet of porous wall extend below and three feet above still water level. One row or orifices is above S.W.L., one row has centers coincident with the S.W.L., and the remaining four rows are uniformly spaced beneath the S.W.L.

Test Section:

A 3.3 foot wide by ten foot high wall with the same thickness and porosity as the porous walls is suspended between the two steel modules. Constructed in a manner identical to the porous walls, the resultant forces on the wall are transmitted vertically by the sandwiched wood construction to horizontal angle iron edges at the top and bottom. The angle iron is rigidly mounted to 3"X3"X16" inch sections of mild steel each with machined sections of steel extending 12 inches from each end to form cantilever beams (Figure 23). A two inch diameter steel cylinder is welded to the free end of each beam. The cylinder is placed into receptacles on the steel superstructure which allow free rotation while minimizing horizontal motion. The machined surfaces on each beam are fitted with strain gages. Thus, the resultant force on the test section is transmitted through upper and lower instrumented cantilevered beams of precise dimension. The test section is always placed at the same chamber width as the rigid porous walls. The dimension of the chamber is sufficient to insure that the forces registered on the test section are representative of the maximum value which would occur for a chamber extending the length of the bridge; i.e., end effects are not felt by the test section. The calculated force corresponds to an infinite crest length, and thus is greater than the average value that would occur on a long wall.

Chamber Bottom (Fig. 24)

A solid removable bottom is provided for the chamber. The bottom is divided into sections of corresponding dimension to the three chamber widths and may also be removed completely. The panels are of sandwiched wooden construction incorporating $\frac{1}{2}$ inch plywood over 2 x 8's on twelve inch centers. The bottoms are held in place on top of the lower steel truss I-beams by welded studs. A diver can remove a section of bottom by removing nuts and an angle iron retainer allowing the section to float to the surface. Due to bottom thickness, the depth from S.W.L. to the bottom of the chamber is 6.4 feet while the corresponding distance to the bottom of the porous wall is seven feet. The porosity of the chamber is calculated based on the 6.4 foot chamber depth. The uniformity of hole locations also takes into account the physical chamber depth of 6.4 feet.

End Panels:

To provide reasonable economies the length of the prototype breakwater is only sufficient to reasonably assure two-dimensional flow characteristics at the test section and pressure gages and thus the chamber must be solidly closed at both ends. The end panels are of wooden 3/4" plywood sandwich construction with the loads being carried by vertical 2 x 8's on two foot centers to the top and bottom where the panels are bolted securely to plates welded to the steel truss I-beams on the superstructures. Each end panel extends from seven feet below S.W.L. to three feet above S.W.L. and is divided into three sections to allow end panels which are flush with the front of the breakwater for each chamber width. Due to the extreme forces created by wave runup the end panels nearest the bridge must be much stronger than the others. The additional problem of wave runup propagating along the bridge, was not accounted for in the original analysis and failure of these panels on two occasions resulted. The final configuration required doubled 2 x 8's on twelve inch centers sandwiched by sheets of 3/4 inch plywood.

Miscellaneous:

Due to the eleven foot distance from the bridge railing to S.W.L. a ladder and work platform were installed. The platform is three feet above still water level and directly behind the test section. From the platform, adjustments and inspection of the test section locator receptacles are possible.

A 14 foot A-Frame (Fig. 25) built from $2\frac{1}{2}$ inch pipe is used in conjunction with winches to provide a self-sufficient means of changing chamber widths. The base of the frame fits into specified locations on adjoining pairs of trusses. The vertex of the frame is thus centered over a porous panel. Using one winch from the porous wall to the vertex and a second from the vertex to the module cross-members on the bridge railing, any needed combination of height and distance from the bridge is possible.

Sensor and Instrumentation Enclosures

Pressure Sensor Tripod in Front of Breakwater:

The sea state is monitored using pressure transducers. To allow measurement of the summation of incident and reflected waves over a wide range of wave height the pressure transducers were placed five feet below the still water level. The transducers were mounted seven feet nine inches away from the nearest surface to avoid affecting the pressure records by the jet velocity from the breakwater pores or wave runup. To avoid pressure readings due to instrument motion it was necessary to build rigid mounting devices.

A tripod constructed of 2.5 inch galvanized pipe is bolted to and extends from the porous panel beside the test section (recall Figure 18). The transducer is housed within a machined, water-tight plug which, in turn, screws into the vertex of the tripod. A 1/4 inch inside diameter pipe extends horizontally from the transducer diaphragm, through the plug and horizontally away from the assembly for twelve inches, where it terminates in a 1/4 inch ID., 90° elbow with the opening facing upward. The end result is a rigid, water-tight pressure sensing device exposed to the vertical pressures existing at a location seven feet nine inches in front of the porous wall and five feet below S.W.L. Because it is attached directly to one of the porous walls, the distance between the chamber and pressure measuring station is constant regardless of breakwater chamber width. One leg of the tripod is water-tight to allow passage of wiring from the transducers to the surface without sealing problems or danger of debris fouling in the wires.

Remote Pressure Sensor Tripod: (Figure 18)

In order to monitor the sea state at a control station beyond the influence of the breakwater another transducer measures the pressure seven feet nine inches out from the bridge, 150 feet east of the breakwater and five feet beneath S.W.L. The transducer mounting including the 1/4 inch pipe and 90° elbow extension are identical to those used in front of the breakwater. 2.5 inch pipe is used to form a hook over the guard rail, extends eighteen feet from the rail to the bottom of the bridge, where it connects to a cable from a hook over the opposite guard rail. A turnbuckle attached to the cable is used to place sufficient tension in the cable to hold the pipe rigidly against the bridge. A horizontal 2.5 inch pipe, containing the transducer, extends from a tee in the vertical member to form a water-tight passage to allow wiring to be run from the transducer to the roadway without exposure to debris or sealing problems. The horizontal pipe is rigidly positioned by angle iron bracing.

Pressure Sensor Receptacle Inside Breakwater:

To monitor vertical pressure components within the chamber, a receptacle was constructed of 2.5 inch galvanized pipe welded to a large flat base allowing it to be placed on the floor of the chamber at the chamber centroid. The transducer was fitted into a machined plug sealing the top of the pipe. From the transducer diaphragm a 1/4 inch inside diameter plug extends to a point five feet below the S.W.L.

Instrumentation Enclosure: (Figure 19)

The presence of a 50 mph freeway within three feet of a test set-up presents a rather unique problem with regard to placement of power supplies, amplifiers, and recording instrumentation near the weather. This problem is circumvented by centering the breakwater over one of the bridge pontoon access panels. Wiring from the various pressure and force sensors are routed over the guard-rail and through the access panel into the bridge pontoon.

Due to the common presence of a few inches of water within the pontoon, scaffolding was erected to form a safe working platform. Extreme humidity and condensation within the pontoon further required that a sealed box be built on top of scaffolding to provide a controlled environment for the various instruments. The box, constructed of plywood, contains the required electrical outlets and is of sufficient size to enclose and protect all of the instrumentation. The front cover of the box opens up to form a protective cover from road debris during data acquisiton, and is weather stripped to provide a water-tight seal when closed. A 40 watt light remains on to provide heat and eliminate moisture inside the box.

Instrumentation for Data Acquisition (Figure 26)

Force Sensors:

The resultant horizontal force on the porous walls of the breakwater due to the differences between the pressures exerted on the inner and outer surfaces are monitored by sets of strain gages affixed to cantilever beams at the top and bottom of the test section. As shown in Fig. 27 a net force toward the bridge causes the strain gages on the front of the beam to be in compression while the gages on the back of the cantilevers are placed in tension. The four gages form a bridge such that the change in resistance due to the tension and compression on the strain gages result in a positive voltage output for the net force toward the bridge. Similarly, a net force away from the bridge results in a negative signal. The output, linear over the entire range of interest, is the same for both beams and periodic calibrations during the test have substantiated repeatability. The beams are constructed of one by three inch 44,000 psi. hot rolled steel machined to close tolerances in the region of the strain gages. The use of two-inch round cylinders at the end of each beam provides an accurate method of maintaining precisely twelve inch long cantilever beams.

Pressure Sensors:

The resultant pressure fluctuations due to the incident and reflected surface waves are measured five feet below the still water level by pressure transducers. Three similar transducers are used, one each inside and in front of the porous walled chamber and the other as a control station in front of the solid bridge wall away from the influence of the breakwater. Inside the breakwater the transducer was mounted vertically at the chamber centroid. The others monitored pressure fluctuations at a 1/4" diameter, upward facing circular opening 93 inches (seven feet nine inches) in front of the porous wall of the breakwater and at the same distance in front of the solid bridge wall.

Initially Viatran Model 218 transducers were incorporated to monitor pressure fluctuations over zero to five psig. range. An integral amplifier produced a five volt maximum output signal which eliminated the need for a separate carrier amplifier. A 2/1 and 4/1 reduction in signal before submittal to the 1.4 volt maximum P.I. tape recorder allowed two ranges of voltage yielding better resolution on low wind condition records. Unfortunately, the individually shielded six strand wiring, including a 28 volt supply and self-contained calibration circuit, between the transducer and the instrumentation enclosure had sufficient capacitance that the two hundred feet of wiring required for the remote gage resulted in occasional erratic output signals.

To increase the output signal reliability the Viatran unit with self-contained amplifiers were replaced by Viatran PTB 101 transducers having a millivolt output signal with a 0-15 psi range. The transducer linearity is within ± 0.75% F.S., hysterisis less than 0.25%, and repeatability within 0.1%.

Power Supply:

Electricity is supplied to the floating portion of the bridge from the eastern shore to operate various functions including lights and the drawspan mechanisms. The nearest outlets available for test instrumentation are two hundred feet from the instrumentation enclosure and the same circuit supplies a series of lights within the pontoon. The losses within the wiring and the variation in circuit load creates a variation in voltage beyond the acceptable range of the test instrumentation. Therefore, a transformer and voltage regulator are placed into the supply line to provide a constant 117 volts to the data acquisition instrumentation. The voltage regulator is a Superior Electric Co. Stabiline 1 KVA. maximum unit which produces 110-120 volts, 60 cycle, from an allowable input range of 95-135 volts, 60 cycle.

The associated transformer is a General Radio Variac Adjustable Transformer, Type 100, set to maintain 117 volts. Because of an initial 50 volt ground variation, the incoming ground line is now common to all instruments and metal structures.

Amplifier:

A six channel Honeywell carrier amplifier is used to amplify the millivolt strain gage and pressure transducer outputs from millivolts to a maximum of 1.4 volts for input to the Precision Instrument (P.I.) tape recorder. Each channel incorporates variable capacitance and resistance potentiometers which allows zeroing of output signal for steady state input signals. Thus, the millivolt output of the pressure transducers due to a still water depth of five feet (2.6 psi) can be zeroed out allowing the entire amplified signal to be pressure fluctuations due to wave action.

Each channel includes a step variable attenuation switch. Calibrations made over the applicable range for each setting allow full-scale output from smaller input values and thus increase the resolution for lower windspeed conditions. Voltage and milliampere gages are visually monitored to confirm that transient, temperature-induced, zero shifts, within the amplifier during warmup, have been removed prior to data recording.

Tape Recorder

Analog data are recorded onto one inch tape using a fourteen channel Precision Instrument reel to reel recorder. All data are recorded at 3.75 inches/second using the associated factory installed carrier frequency and observing the 1.4 volt maximum peak input requirement to assure a linear input/output relationship.

Oscilloscope:

On-line pressure and force fluctuation, are monitored with a Hewlett-Packard 1224 twin sweep oscilloscope. Real time monitoring is used to assure that sensors are operational and that sensor output appears reasonable and peak values are observed to establish the appropriate amplifier attenuation setting.

Anemometer:

The nominal windspeed and direction are acquired from existing instrumentation on top of the bridge tower (Z approximately forty feet) a few hundred feet from the breakwater. A hand-held Dwyer anemometer is used to supplement the wind speed data from the tower gage. The Dwyer model consistently provides readings five mph lower than the tower gage.

Junction Box and Calibration Voltage:

A junction box, in-line between the amplifier and the tape recorder, contains a monitoring switch allowing selection of channels for oscilloscope viewing. The junction box also provides an easy means of disconnecting the amplifier output and signal to allow a constant 1.35 volt calibration signal to be put onto the tape prior to each data record. The calibration voltage is supplied by mercury cells which provide a constant 1.35 volts until the onset of rapid and noticeable deterioration, when a new cell is installed.

Data Reduction Instrumentation (Figure 28)

Ampex Tape Recorder

For convenience the P.I. recorder remains on the bridge and a fourteen channel Ampex recorder is used for analog playback. Originally, the two machines operated at different carrier frequencies (for the same tape speed). The Ampex was modified to make the units compatible. The resulting configuration allows the analog tape to be recorded and played back at 3.75 inches/second (Using the Ampex carrier frequency corresponding to the factory installed frequency for 1-7/8 inches/second). The ordering of channels was opposite on the two machines (P.I. channel 1 = Ampex channel 14; 2 = 13; etc.). For convenience, the arbitrary factory numbering of channels on the Ampex is reversed to allow data, originally recorded on channel one, for example, to be referred to as channel 1 data throughout the reduction and analysis.

Low Pass Filters:

High frequency noise is eliminated from the signals of interest by low pass filters. Analog force data passes through a one Hz filter which begins to effect the data at .8 Hz. Analog pressure data, containing pertinent information at frequencies to 1.5 Hz, is passed through a 2.5 Hz filter.

Systron Donner:

The analog data both filtered and unfiltered is digitized on a Systron Donner recorder/digitizer. The analog data is scanned at equal time intervals to produce a discrete value for each channel at each time increment. The sampling rate being used throughout the data reduction is .328 second (sample frequency resolution .0030 cycles/second). The Systron Donner unit digitizes data into records of 512 points each. The records are taken in pairs of 512 point records immediately adjoining one another on the analog tape. Digital values are automatically coded onto magnetic computer tape compatible with the CDC 6400.

CDC 6400:

Digitized data is processed on the CDC 6400 digital computer at the University of Washington.

Cal-Comp Plotter

Final spectral plots, such as the figures shown in the appendices are machine plotted using a Cal-Comp plotter.

Installation Technique

Modular components of the porous wall breakwater were assembled on the Oceanography Dock at the University of Washington (Figure 29).

Following assembly the 2730 pound units were crane-lifted onto a barge in the Lake Washington Ship Canal. The barge was towed to the south side of the Evergreen Point Bridge where a crane, operated from the roadway, hung the units onto a bridge guard railing. Cables, attached to the bottom of each module, were connected through turn-buckles to hooks over the bridge railing on the north side of the pontoons. Sufficient tension was put into the cables to assure a rigid attachment. A similar installation technique was employed to mount the remote pressure transducer station.

Calibration Techniques

Strain Gages:

Prior to installation of the pairs of cantilever beams on the test section, the linearity of the strain gage bridge output with applied force was determined on a calibrated press at ore Hall, University of Washington. The outer ends of the beams were grounded and the load applied on the rigid 3x3x16 inch center section, as shown in Figures 30 and 31. The beams, deflected in both directions, demonstrated repeatability within 0.6% for range 0-3000 pounds with a maximum non-linearity of less than 1% (maximum 0.9% at 1200 pounds). The output for both pairs of beams was virtually identical with scatter for both being within the same 0.6% bandwidth.

The stiffness of the 3x3x16 inch sections from which the cantilevers extend was assessed by comparing the result of point loading at the center and distributing the load over the 3x16 inch surface. The maximum calibrated output difference corresponded to 12 pounds in 3000 (0.4%). The increase in stiffness due to the method of attachment to the test section assures that the beams are truly cantilevers.

Force Sensors:

Following attachment of the cantilever beams to the test section, the entire assembly was installed into the receptacles provided between the two rigid breakwater modules. Periodically, on calm days, a hydraulic ram including a calibrated pressure gauge, is placed between the bridge and the test panel. With known pressures applied the amplifier output voltage can be calibrated for various amplifier attenuation settings. Typical calibration curves are shown in Figures 32 and 33.

Pressure Transducer Calibration:

Pressure transducers were originally calibrated by recording the amplifier outputs for various elevations of a water column within a clear plastic hose (0 - 12 feet). Following installation into the fixed receptacles, five feet below still water level, the amplifier was set to produce zero output at the five foot depth. Plastic tubing connected to the transducer inlet allows static water columns above SWL to be used to calibrate the transducer outputs for various amplifier attenuation settings. Periodically this technique is used to check transducer and amplifier output. The linearity, originally demonstrated out of the water, is assumed to exist for the distances between the gauge and still water level. The approximate linearity is finally verified by removing the transducers from the fixed receptacles and calibrating the amplifier output as a function transducer distance below still water level in one foot increments from zero to eleven feet below S.W.L. Calibration curves are shown as Figures 34-36, for each of the transducers.

Tape input/output calibration:

Prior to each data record the amplifier input to the tape recorder is momentarily replaced by a constant 1.35 volt calibration signal from a mercury cell. Inserted for each channel, the plus and minus signal provides the known input needed to calibrate the voltage output of the tape playback.

CHAPTER IV

TEST PROCEDURES, DATA ACQUISITION AND PROCESSING

Test Requirements

To adequately establish the performance of the porous walled breakwater subjected to random wind conditions a range of data is required for reasonably steady wind conditions between eight and at least thirty-five m.p.h. At each wind condition the assessment of performance requires an analog record of force and pressure fluctuations for at least twenty minutes. During the twenty minute record the wind produced wave system should neither be building, declining nor changing direction. For a given breakwater configuration, a data set is complete when records meeting the above criteria are acquired for windspeed increments of approximately five m.p.h. Complete data sets are acquired for four breakwater configurations; five and seven foot chamber widths each with and without a solid chamber bottom.

Data Acquisition

Prior to each record all equipment is warmed up for a period sufficient to remove temperature induced signal transients. During this period the windspeed and direction must remain substantially constant.

The $\pm$ 1.35 volt calibration signal is recorded onto the analog tape and the oscilloscope monitored to check that the pressure and force output signals are reasonable and that the choice of amplifer attenuations produces a peak output less than 1.4 volts. The attenuation and wind conditions are logged and a minimum twenty minute record is recorded. The record is aborted if the average wind increases, decreases or changes direction noticeably or if an extraneous signal is monitored on the oscilloscope;

i.e., saturated transducer output, amplifier mean voltage shift, or the superposition of boat-created waves.

Data Processing

The analog data tapes containing continuous wave (pressure) and force records are processed at the University of Washington. The procedure is shown schematically in Figures 37 and 38.

Segments of the twenty to sixty minute analog pressure and force records are converted to digital records containing 1024 discrete values taken at equal (0.328 second) time increments resulting in a Nyquist frequency of 1.52 Hz. Each digital record represents 5.6 minutes of analog data satisfying the criteria that the total incident energy at the chamber equals that at the solid wall (remote station) 150 feet away. Analog tapes are played back on an Ampex recorder. The channel assignments of raw data are always:

Channel #	Sensor
1	top force gages
2	bottom force gages
3	pressure transducer away from the influence of the breakwater (or remote transducer)
4	pressure transducer in front of porous wall (near transducer)
5	Pressure transducer inside of chamber

The ± 1.35 volt calibration signals recorded on the P.I. before each data record is played back on the Ampex and on an ouput/input calibration factor is acquired for each channel; individually.

The output of the Ampex is branched for each channel. One branch is directly input to the digitizer, the other branch goes through a low pass filter and then into the digitizer. Thus, the digitizer receives ten channels of input; 1-5 being raw analog data and 6-10 the corresponding filtered analog data.

The filters are incorporated to eliminate noise which occurs at frequencies above the Nyquist frequency (1.52 cycles/sec) and thus prevent possible aliasing problems in the final spectral analysis. Care is taken to avoid filtering data which are part of the phenomena being investigated. Originally both one Hz. and 2.5 Hz. low pass filters were applied to the early data. The resulting force data were identical indicating that all pertinent data occurs at frequencies less than one Hz and hence the use of a one Hz filter assured the elimination of extraneous signals without a loss of real information. The response function of the filter starts to drop off at 0.8 Hz. Comparison of filtered and low noise unfiltered data also indicates no significant error in force data using the one Hz. filter. Pressure transducer data, on the other hand, indicate a significant amount of energy existing at frequencies up to 1.5 Hz. For each of the pressure channels the high frequency equipment noise is removed without loss of desired data by incorporating a 2.5 Hz. filter.

The five unfiltered and five filtered channels of data are input to the Systron Donner digitizer. The analog data is scanned to produce a discrete value for each channel at equal time increments. The sampling rate used throughout the data reduction is .328 sec. The Systron Donner digitizes data into records of 512 points each. For most of the data reduction, adjoining pairs of these records are used to create digital records of 1024 (2^{10}) data points. The digital values are automatically recorded onto magnetic computer tape compatible with the CDC 6400.

Thus, segments of analog data records twenty to sixty minutes in length are converted into digital records each corresponding to approximately 5.6 minutes (1024 points x .328 seconds/point) of the original record. Comparison of the different digitized data lengths for the same data record demonstrates that 1024 points provide sufficient duration to validate the assumption that the total incident energy at the two pressure stations (150 feet apart) is the same. The relative lengths of the digitized and analog records allow the reduction of at least three digitized records from each analog case. Eventual comparison of the analyzed data at the beginning and end of an analog record provides a check on the stationarity of the process.

The sampling rate and the use of low pass filters are sufficient to assure that the energy belonging to sinusoids calculated to pass through these equally spaced points will not belong to a high frequency wave being assigned to a lower frequency (its alias).

The second step in data processing involves the conversion of the digital tape to punched computer cards containing 10 digital values per card. A Fortran program (HOOD5, undocumented) is used on the CDC 6400 computer to make the conversion and calculate maximum, minimum and mean raw values for each channel. The program printout lists the complete raw digital data and the maximum, minum and mean values. Perusal of the printout allows recognition of incomplete or erroneous data (the Systron Donner is subject to occasional saturation which appears on the raw data printout as groups of a constant value).

The Systron Donner digitizes groups of 512 data points, with a lag of .640 seconds between records, a continuous 1024 point record is synthesized by averaging the last value in one 512 point record with the first value on the 512 point record immediately following it. The average value is punched on the card as a 513th point and the two records are placed together and input as one continuous record containing 1025 points for the remainder of the data analysis.

Spectral Analysis

Digitized records which appear to be complete and correct are resubmitted to the CDC 6400 in puched card form. Though bulky, the intermediate step of card production allows analysis of any record or individual channel merely by selective stacking of groups of cards. The data is reduced using the lag product method of spectral analysis. The computer program used is the Numerical Spectral Analysis Program (NSAP). The procedure is basically that given by Jenkins and Watts [21].

The original digital data is first shifted to a zero mean value. The P.I./Ampex correction factor to account for any amplitude differences between the originally recorded data and the playback values, and the scale calibration factors for the sensors based on the slope of the linear feet of water vs. millivolt or pounds of force vs. millivolt curves are combined to give a final scale factor for use on the data. The calibration is applied to the zero mean raw data and a listing of discrete calibrated data points is printed out along with the associated calculated maximum, minimum and mean values, as well as the variance.

A numerical DC filter subroutine is applied to the data to eliminate erroneous energy contributions introduced during the initial data recording by slight, temperature induced, amplifier and transducer transients. These transients occurred over a period of minutes and would be interpreted during spectral analysis as an apparent DC shift in the data.

The autovariance function for the first 57 lags of 1024 data points is calculated, listed, and plotted. The variance of zero lag product value is listed. A factor of two is introduced into the program so that the variance, proportional to the total energy per unit horizontal area at the sensor for the period of the record, automatically becomes the mean-square of differences of all possible pairs of values.

The Tukey window is applied to the autocovariance function and the A.C.V.F. is transformed. Smoothed spectral estimates are then calculated and plotted for 20, 40, 50, 60 and 80 lags. For each case the variance (area) and peak spectral ordinate value and frequency are tabulated. Histograms for ten divisions of data points are also calculated and presented for each record.

Careful perusal of the spectral estimate plots allows the selection of the number of lags required to minimize both the bias and the instability. The smoothed spectral estimate plot for the minimum bias and instability, typically 50 lags, was then placed on magnetic tape for use to create final Cal-comp plots. For convenience and uniformity in presentation the ordinates on Cal-Comp plots are non-dimensionalized (normalized) by the variance creating a plot with unit area under the curve. The plot scales are held constant for all plots and thus allow easy overlay of curves. The ordinate has a range of normalized smoothed spectral estimate values from 0 to 9.6 while the abscissa includes frequencies from zero to 1.5 cycles/sec., approximately the Nyquist frequency.

CHAPTER V

ANALYSIS

The premise upon which the full scale test was based assumes the following:

1) Virtually no energy is transmitted to the lee side of the bridge. Therefore, the incident wave energy must be either reflected by the bridge or dissipated (converted to a non-conservative form of energy).

2) Linear wave theory can be used to relate energy to wave height and sub-surface pressures.

3) Time histories of the summations of incident and reflected random wave heights, taken simultaneously in front of the breakwater and at a station away from the influence of the breakwater, can be analyzed using spectral analysis to yield the average total energy at the two locations.

4) Over a period of minutes the average incident energy is the same at the two locations.

5) Therefore, differences between the calculated average total energy at the two stations are due to differences in the average reflected wave energy. This difference must be caused by energy dissipation at the breakwater.

To conveniently relate the amount of dissipation occuring for different wave conditions and breakwater configurations, the term attenuation was introduced. Attenuation proports to ratio the energy dissipated by the chamber to the sum of the incident and reflected energy in front of the solid bridge pontoon (remote station). Incorporating spectral analysis (equations 26-32) the attenuation is given by the difference in variance at the two locations divided by the variance at the remote station, Attn $\equiv 1 - \sigma^2_{BW}/\sigma^2_{\infty}$.

The vertical wall of the bridge pontoon (remote station) is nearly a perfect reflector below windspeeds causing wave breaking and overtopping. Thus, the denominator in the attenuation should represent almost twice the incident wave energy. Under these conditions, the expected range of values for attenuation is between 0 (no energy dissipation) and .5 (total dissipation of incident energy, no reflection). Early in the course of data reduction attenuation values beyond the expected range appeared. Immediately suspecting a calibration error, the instrumentation was recalibrated and program calibration inputs checked. Finding no discrepancies, but still suspecting a measurement error, the transducers and amplifiers were changed completely. New data continued to produce unexpected attenuation values. The use of sub-surface pressure transducers to monitor surface fluctuations was examined as a source of error. Higher order pressure terms, not accounted for by the small amplitude analysis, were shown to be too small to contribute the amount of discrepancy being observed. The influence of the jets (exiting the breakwater pores) on the pressure readings was demonstrated to produce less than a one percent error in calculated energy. Consultation with other researchers in the field failed to provide a plausible solution.

Having reasonably established the validity of the data records it is necessary to assume that either the attenuation values being observed are real, or there is an error in the assumptions, or an error in the method used to reduce the data to acquire the attenuation. Negative attenuation values are calculated from some data records suggesting that there is more energy in front of the breakwater than at the remote location. Negative attenuations are calculated at windspeeds below that required for wave breaking or overtopping, suggesting the creation of energy by the chamber. This creation being physically impossible allows one to safely assume that attenuation, as calculated, does not represent the desired ratio of energies as defined in equation 32.

The inconsistency is introduced by the assumption that the average energy calculated from spectral analysis of the time history of the sum of the incident and reflected wave heights is the same as the sum of the average energies calculated for the incident and reflected waves individually. At this time, the author cannot quantitatively evaluate the extent of this difference and therefore cannot calculate the amount of energy dissipated by the breakwater as originally intended.

The following sections enumerate the subtle error in the original assumptions and demonstrate, as presently understood, the complex nature of the difference between attenuation and the actual energy dissipation. Methods which may serve to relate the two quantities are suggested but not presently pursued. The attenuation is recorded for the various wind/wave conditions and chamber configurations in the appendices in hope that the author or another investigator will relate the quantity to actual energy dissipation at a future date. Fortunately, other objectives of the investigation are independent of this problem.

Evaluation of the Attenuation of a Monochromatic Wave Using Wave Envelope Traverses

An initial appreciation for the problem of evaluating the energy can be obtained by examining a monochromatic incident wave and the associated monochromatics reflected wave. The incident wave surface can be represented by

$$\eta_i = a_i \sin(kx - \sigma t + \theta_i) \quad . \qquad 39$$

and the reflected wave surface can be represented by

$$\eta_r = a_r \sin(kx + \sigma t + \theta_r) \qquad 40$$

Richey and Sollitt (16, p. 41-45) demonstrate that the incident and reflected wave height, H_i and H_r, can be obtained directly for superimposed monochromatic waves by traversing the envelope of the resulting standing wave. Linear wave theory relates the energy to the square of the wave height and therefore, for this case the reduction in energy during reflection is

$$E_i - E_r = \frac{\gamma}{8}(H_i^2 - H_r^2) \qquad 41$$

To calculate the attenuation for the above case, the wave characteristics in front of the breakwater and in front of a vertical solid reflecting barrier must be known. Throughout the present investigation the transmitted wave energy is virtually zero. Also, the breakwater responds as a linear resonator only acting upon the phase and amplitude of a wave and not affecting the frequency during reflection. Thus, incident and reflected wave heights for a monochromatic wave system can be obtained by traversing the standing wave in front of the breakwater to give $H_{i_{BW}}$ and $H_{r_{BW}}$. Similarly, the wave heights in front of the solid barrier can be obtained and designated H_{i_∞} and H_{r_∞}. The calculation of attenuation requires that the average incident conditions at both locations be the same; thus, $H_{i_{BW}} = H_{i_\infty} = H_i$.

$$\text{Attenuation} = \frac{\overline{E}_\infty - \overline{E}_{BW}}{\overline{E}_\infty} \qquad 42$$

From equation 9, $\overline{E}_\infty = \frac{\gamma}{8}(H_i^2 + H_{r_\infty}^2)$ and $\overline{E}_{BW} = \frac{\gamma}{8}(H_i^2 + H_{r_{BW}}^2)$. Therefore

$$\text{Attenuation} = \frac{H_{r_\infty}^2 - H_{r_{BW}}^2}{H_{i_\infty}^2 + H_{r_\infty}^2} \qquad 43$$

Recalling the reflection coefficient, $R = \frac{H_{r_{BW}}}{H_i}$, in front of the breakwater and defining the reflection coefficient at the solid wall as S, where

$$S = \frac{H_{r_\infty}}{H_i} \qquad 44$$

and substituting R and S into the attenuation, yields

$$\text{Attenuation} = \frac{S^2 - R^2}{1 + S^2} \qquad 45$$

The solid wall is nearly a perfect reflector until wave breaking occurs. Assuming a perfect reflector, $H_{r_\infty} = H_i$ or $S = 1$. Therefore, for the approximation of perfect reflection at the solid wall for monochromatic waves

$$\text{Attenuation} = \frac{1 - R^2}{2} \qquad 46$$

The range of values expected for attenuation under these conditions is between zero, when no dissipation occurs at the breakwater, and .5 when all the incident energy is dissipated by the chamber.

Evaluation of the Attenuation of a Monochromatic Wave Monitored at a Fixed Location

For comparison, the same monochromatic wave system analyzed in the last section will be re-evaluated with the constraint that data must be acquired at a fixed location. As in equation 39, the incident wave surface is represented by

$$\eta_i = a_i \sin(kx - \sigma t + \theta_i)$$

For convenience, the fixed measuring station is established so that the initial phase angle, $\theta_i = 0$. Therefore,

$$\eta_i = a_i \sin(kx - \sigma t) \qquad 47$$

The reflected wave surface is

$$\eta_r = a_r \sin(kx + \sigma t + \theta_r) \qquad 48$$

where θ_r is, for this case, the phase angle between the incident and reflected wave and is equivalent to $\sigma\tau$ where τ is the time lag. Thus, by superposition, the resulting surface is

$$\eta_T = \eta_i + \eta_r = a_i \sin(kx - \sigma t) + a_r \sin(kx + \sigma t + \theta_r) \qquad 49$$

but $\sin - \sigma t = -\sin \sigma t$; therefore

$$\eta_T = \underbrace{[(a_i + a_r \cos \theta_r) \sin kx + a_r \sin \theta_r \cos kx]}_{A(x)} \cos \sigma t \qquad 50$$

$$+ \underbrace{[(-a_i + a_r \cos \theta_r) \cos kx - a_r \sin \theta_r \sin kx]}_{B(x)} \sin \sigma t$$

Ippen (23, p. 58) points out that this is not a progressive wave and that the average potential energy per unit surface area is a function of x.

$$\overline{PE}(x) = \frac{\gamma}{4}[A^2(x) + B^2(x)]$$

$$= \frac{\gamma}{4}\{[(a_i + a_r \cos \theta_r) \sin kx + a_r \sin \theta_r \cos kx]^2 \qquad 51$$

$$+ [(-a_i + a_r \cos \theta_r) \cos kx - a_r \sin \theta_r \sin kx]^2\}$$

expanding

$$\overline{PE}(x) = \frac{\gamma}{4}[a_i^2 \sin^2 kx + 2a_i a_r \cos \theta_r \sin^2 kx + a_r^2 \cos^2 \theta_r \sin^2 kx$$

$$+ 2a_i a_r \sin kx \sin \theta_r \cos kx + 2a_r^2 \cos \theta_r \sin kx \sin \theta_r \cos kx$$

$$+ a_r^2 \sin^2 \theta_r \cos^2 kx + a_i^2 \cos^2 kx + a_r^2 \cos^2 \theta_r \cos^2 kx \qquad 52$$

$$- 2a_i a_r \cos \theta_r \cos^2 kx + 2a_i a_r \cos kx \sin \theta_r \sin kx$$

$$- 2a_r^2 \cos \theta_r \sin \theta_r \sin kx \cos kx + a_r^2 \sin^2 \theta_r \sin^2 kx]$$

combining terms and making use of trigonometric identities the time average potential energy per unit surface area at x becomes

$$\overline{PE}(x) = \frac{\gamma}{4}(a_i^2 + a_r^2 - 2a_i a_r \cos(\theta_r + 2kx))$$
$$\overline{PE}(x) = \frac{\gamma}{16}(H_i^2 + H_r^2 - 2H_i H_r \cos(\theta_r + 2kx)) \qquad 53$$

The average total energy density at x, being twice the sum of the constituent potential energies, is

$$\overline{E}(x) = \frac{\gamma}{8}(H_i^2 + H_r^2 - 2H_i H_r \cos(\theta_r + 2kx)) \qquad 54$$

It is noted that if the time average potential energy density at x, equation 53, is integrated over x for one wave period and averaged,

$$\overline{PE} = \frac{\gamma}{16L} \int_o^L (H_i^2 + H_r^2 - 2H_i H_r \cos(\theta_r + 2kx))dx \qquad 55$$

the resulting average potential energy is

$$\overline{PE} = \frac{\gamma}{16}(H_i^2 + H_r^2) \qquad 56$$

and the associated average total, being twice the sum of the components by linear wave theory, equals

$$\overline{E} = \frac{\gamma}{8}(H_i^2 + H_r^2) \qquad 57$$

It is this result that was assumed throughout the development of the theory. Thus, if the wave system is traversed, as done in the laboratory studies, the assessment of the average energy is directly proportional to the sum of the squares of the wave heights which are easily obtained from traverse data by equation 14.

The effect of a fixed measuring location on the calculated average energy of a monochromatic wave system in front of the solid bridge wall can be calculated from examination of equation 54. By setting $x = 0$ at the measuring station the energy varies as the cosine of the phase angle between the incident and reflected wave, which, in turn, is a function of the ratio between the wave length and twice the distance, D, to the barrier. Ippen (23, p. 49) points out that though an imperfect reflection can be represented by the superposition of a standing wave and a progressive wave, the resulting surface is itself a "standing wave" because the resulting wave envelope is stationary. Thus, the average total energy per unit surface area monitored at a fixed point is a function of not only the incident and reflected wave heights, but also the location of the measuring station and the phase angle between the incident and reflected wave. Small amplitude wave theory can be incorporated to define the time required for an incident wave to travel from the fixed measuring location, be reflected at the solid wall, and return to the measuring station as a reflected wave. By setting $x = 0$ at the measuring station, the phase angle becomes that which is required by the wave of frequency $\sigma = \frac{2\Pi}{T} = \sqrt{\frac{2\Pi g}{L}}$, to travel a distance 2D. Thus, at a given measuring station, each wave frequency produces a constant phase relationship between the incident wave and that reflected from a solid barrier.

The phase relationship between the incident wave and that reflected from a porous walled breakwater is complicated by the fact that a portion of the wave is reflected at the porous wall and the remainder is operated on by the chamber, resulting in a different phase angle.

Attenuation can be calculated from the surface fluctuations at the same distance in front of a solid wall and a porous walled breakwater. From equation 32 attenuation equals the difference in the average total energies at the two locations divided by the average total energy at the solid wall.

Substituting the energy from equation 54 using subscripts ∞ at the station in front of the solid wall, and BW in front of the breakwater, and requiring that the incident wave be the same at the two locations, the attenuation (ATTN) becomes

$$\text{ATTN} = \frac{\overline{E}_\infty - \overline{E}_{BW}}{E_\infty} = \{\tfrac{\gamma}{8}[H_i^2 + H_{r_\infty}^2 - 2H_iH_{r_\infty}\cos(\theta_{r_\infty} + 2kx)] - \tfrac{\gamma}{8}[H_i^2 + H_{r_{BW}}^2 - 2H_iH_{r_{BW}}\cos(\theta_{r_{BW}} + 2kx)]\} / \{\tfrac{\gamma}{8}[H_i^2 + H_{r_\infty}^2 - 2H_iH_{r_\infty}\cos(\theta_{r_\infty} + 2kx)]\} \qquad 58$$

$$\text{ATTN} = \frac{H_{r_\infty}^2 - H_{r_{BW}}^2 - 2H_i[H_{r_\infty}\cos(\theta_r + 2kx) - H_{r_{BW}}\cos(\theta_{r_{BW}} + 2kx)]}{H_i^2 + H_{r_\infty}^2 - 2H_iH_{r_\infty}\cos(\theta_{r_\infty} + 2kx)}$$

again employing the reflection coefficient, $R = \frac{H_{r_{BW}}}{H_{i_{BW}}} = \frac{H_{r_{BW}}}{H_i}$, in front of the breakwater and $S = \frac{H_{r_\infty}}{H_i}$, for the reflection coefficient at the solid wall the attenuation becomes

$$\text{ATTN} = \frac{S^2 - R^2 + 2R\cos(\theta_{r_{BW}} + 2kx) - 2S\cos(\theta_{r_\infty} + 2kx)}{1 + S^2 + 2S\cos(\theta_{r_\infty} + 2kx)} \qquad 60$$

Comparison of equation 60 with 45 demonstrates that the value of the attenuation can be different if the surface fluctuations are monitored at a fixed point rather than obtained by the wave height traverses of the wave envelope.

Random Waves

Random waves can be represented by the summation of a series of sinusoidal waves each with their own amplitude, frequency, and initial phase angle. In front of a solid wall an incident and reflected wave exists for each frequency. Thus, by superposition, the resulting surface is,

$$\eta_T = \eta_i + \eta_r = \sum_j (a_{i_j} \sin(k_j x - \sigma_j t + \theta_{i_j})) \qquad 61$$

$$+ \sum_j (a_{r_j} \sin(k_j x + \sigma_j t + \theta_{r_j}))$$

At each frequency the contribution to the average energy at a fixed unit surface area could be described by equation 54 except for the further constraint that in a random system the incident phase angle cannot be set to zero. Thus, the attenuation calculated from the random fluctuation of the surface at a fixed point involves not only the Fourier components of the incident and reflected wave heights but also terms due to the product of the incident and reflected waves and the associated random phase angles.

The recorded signal is only $\eta_T(t)$. Fourier analysis of this signal provides component wave heights and phase angles as though η_T were a single series of sinusoidal waves. Spectral analysis computes a variance for the series of sinusoidal waves so that the variance is the average sum of the squares of each component amplitude $(\sigma^2 = \sum_j \frac{1}{2} a_j^2)$ and the average energy is $\gamma\sigma^2$. The fact that η_T includes both incident and reflected components each including the summation of a series of sinusoids with random phase angles may well mean that analysis of the η_T signal results in a different calculated average energy than the sum of the energies calculated for η_i and η_r individually, if they could be obtained.

The introduction of extraneous terms or the elimination of existing ones is even more likely during spectral analysis of the η_T in front of the breakwater due to the additional phase relationship introduced between the random incident and reflected wave components by the fluctuation of the chamber.

At this place in time the author can only express caution that the variance calculated from the surface fluctuations of superimposed random incident and reflected waves does not directly relate the average total energy of the wave system.

Alternatives

The present study does not resolve the apparent discrepancy between the average total energy and that calculated from the variance obtained from spectral analysis of the surface fluctuations at a fixed location. Though they are not pursued at this time, two alternative methods of data analysis show promise as a means to separate the incident and reflected wave energy.

A recent paper by Thornton and Calhoun [26] presents a method of separating the incident and reflected wave energy spectra using in-line pressure transducers. To obtain the required records, in the present experiment, two additional transducers were mounted five feet further away from the porous wall and the solid wall. Thus, for the final few data records, pressure fluctuations at a constant depth were obtained at two distances in front of the breakwater and at a matching set of distances in front of the solid pontoon wall. At this time, only a sample data reduction has been accomplished. The results show promise. Due to the limited length of the prototype breakwater, diffraction from beyond the chamber could be affecting the surface fluctuation at the gage furthest in front of the breakwater.

It should be noted that if this process works it will only separate incident and reflected spectra for that portion of the investigation using the extra transducers. It is possible, however, that the understanding acquired for those records could provide a basis for better evaluating the remainder of the data.

A second method of evaluating the data could be adapted from an extension of spectral analysis originated by Tukey called Power Cepstrum [27]. Though intended for an entirely different subject, it assumes a model where the monitored signal is the sum of an incident random process and an attenuated reflected process with a time delay.

The analysis demonstrates that the resulting energy spectra are influenced not only by the incident and reflected amplitudes but also a function of the cosine of the frequency and time delay. The analysis provides a method of separating the incident and reflected spectra. The similarity between this result and that found for equation 54 suggests that the transformations required for Cepstrum Analysis may provide a clearer interpretation of the present experimental data.

Case Example and Attenuation Interpretation

On February 27, 1972 (Run Number 3, 53, g, shown as the last run in Appendix I) a data record was acquired for 35-40 mph winds gusting to 50 mph out of the SSW. The chamber with a solid bottom had a width of seven feet. During the 20 minute record, an observer stood on the working platform, three feet above the still water level. During the same period the water level within the chamber was never greater than three feet above S.W.L. The record log during this observation stated, "the chamber is obviously functioning very well for this wind condition. Waves are passing well overhead on both sides of the chamber along the bridge and yet none of the incident waves are going over the three foot high breakwater porous wall. Another effect which is definitely clear is that the breakwater would completely eliminate the wave runup onto the roadway for this wave condition. There is still a significant amount of wind-blown spray but no wave overtopping." Following digitizing and spectral analysis of this wave record, the attenuation was shown as minus 10.7%. The initial impression from such a result would be that the chamber created rather than attenuated energy. Even aside from the observed situation, a linear damped oscillator is incapable of altering the frequency of waves impending upon it. Therefore, another explanation is necessary. Careful analysis shows that the term involving the product of the reflected and incident wave heights is an expression which, if the two terms are well correlated, results in a very strong positive or negative influence upon the attenuation. Therefore, the attenuation cannot be used as calculated to judge the performance of the breakwater. It is important to note that the peak frequency occurring in front of the breakwater and at the remote ∞ station were the same for the record under investigation. We can thus conclude that the chamber was operating at its natural frequency and that the actual conversion by the chamber to non-conservative energy was nearly a maximum as indicated by model tests and as observed during the record. The corresponding model results demonstrated an 80% reduction in incident energy for the condition scaling to the record in question. Thus, the difference between the 10% increase in wave energy during reflection shown by the attenuation and the 80% reduction in wave energy in the laboratory are due, at least partially, to this product term. It is therefore necessary to use the random wave data to establish and substantiate the model frequencies for the various conditions. At the same time the frequencies of interest at the test site can be established. Therefore, the efficiency of any given full-scale breakwater condition cannot presently be quantified except by linking it back to the equivalent model data.

Selection of Nyquist Frequency

Figure 39 is a representative spectral plot chosen from Appendix II.

The plot presents a distribution for a five foot chamber with a solid bottom exposed to a 20-25 mph wind/wave condition. The remote spectra shows a peak frequency at approximately .4Hz and a distinct secondary peak at .75Hz. If the Nyquist frequency was chosen incorrectly for the data, i.e., too low, the secondary peak could represent data folded to .75Hz from a frequency above the Hyquist frequency. Figure 39 was obtained from a digital record of 1024 points at equal .328 second intervals; resulting in a 1.52Hz Nyquist frequency. Thus, the secondary peak could represent data that should be assigned to 2.29Hz (1.52 + (1.52 - .75)).

Figure 40 is the spectra for the same breakwater geometry exposed to a 35 mph wind/wave condition. Notice that both the primary and secondary peaks are shifted to a lower frequency. If aliasing had occured the second peak would have shifted toward the Nyquist frequency. Therefore, it is concluded that the aliasing is not a problem and the Nyquist frequency was properly chosen for the data processing.

CHAPTER VI

RESULTS

Scope

The data, taken simultaneously at a fixed location in front of a porous walled breakwater and at a remote station away from the influence of the breakwater, for a matrix of wind conditions and chamber configurations is reduced, using spectral analysis and the resulting spectral plots and calculations are presented. The cautions detailed in the analysis are incorporated and care is taken to interpret the spectra and attenuation results in a manner which separates definite results from less distinct interpretations. The original objective of energy evaluation is not met as quantitatively as would have been possible with a complete separation of the incident and reflected wave components and an assessment of the effects of the chamber on the "effective" distance to the fixed measuring stations. The analyzed data do provide a positive link between the monochromatic wave model studies and the full-scale random wave investigation. In particular, the porous walled breakwater is frequency selective when exposed to wind generated waves; and the natural frequency corresponds to that of a linear damped oscillator as linearly scaled from dimensional analysis of the model studies. The maximum resultant forces exerted on the porous wall are also presented.

Reduction of Wave Runup

The guard rail on the Evergreen Point Bridge is eleven feet above the still water level. Wind conditions in excess of 35 mph produce waves with sufficient energy to runup and overtop the guard rail, creating a potential hazard to traffic on the bridge (figures 41 and 42). When the same waves impact the porous wall of the breakwater much of the energy goes into turbulent jets passing through the wall into the chamber. For extreme conditions, i.e., winds greater than 40-45 mph, waves overtop the three foot high porous wall and break into the chamber. For the highest observed windspeed of 45 mph, gusting to 55, the maximum wave runup on the back wall of the chamber was four feet and the chamber pumped completely full only once during the forty-five minute observation period. The wind-carried spray from breaking waves a distance from the bridge, is also diminished slightly due to the decrease in reflected wave height.

It can be safely concluded that the application of a resonating chamber with a porous wall five to seven feet in front of the pontoon and extending three feet above S.W.L. would completely eliminate wave runup onto the roadway of the Evergreen Point Floating Bridge. With proper scaling comparable runup reductions could be incorporated into other deep water structures.

Frequency Selective Device

Laboratory studies [16] demonstrated that the porous walled breakwater behaves as a linear damped oscillator when exposed to monochromatic waves. As resonators the models dissipated a maximum energy near the natural frequency of the chamber. Theory demonstrates that the natural frequency can be adjusted by varying the chamber width. In particular, the ratio of the resonant frequencies for breakwater configurations of varying widths equals the square root of the chamber width. One of the major objectives of full-scale investigation was to determine the breakwater response to random wind generated waves. The full-scale breakwater is shown in operation in figure 43.

Figure 44 demonstrates that the full-scale breakwater is frequency selective when subjected to random waves. If the chamber were not frequency selective the peak frequencies at the two stations over the record periods of approximately six minutes should approximate a one to one correspondence at all wind speeds. As indicated in the figure, the peak frequency in front of the chamber tends toward a central frequency. The location where a line passing through the data crosses the one to one correspondence is the "crossover" frequency. The shift in the "crossover" frequency for the two chamber widths is seen to correspond with the square root of the chamber width; a response predicted by theory for the natural frequency of a linear resonator. The value of the crossover frequency for each chamber width corresponds to the theoretical natural frequency for a linear resonator. The crossover frequency of the five and seven foot, solid bottom, chambers correspond to the peak frequency of incident waves produced by 15-20 and 25-35 mph wind conditions, respectively. The expected crossover frequency for a chamber width of three feet would occur for windspeeds of 10-15 mph. The association of maximum energy dissipation with the natural frequency from laboratory tests and the correspondence of the natural and crossover frequencies were sufficient information to eliminate testing of the three foot chamber width. That is, no matter how effective a three foot chamber is at reducing waves in the 10-15 mph range, if the dominant incident energy at the test site occurs for 25-30 mph winds, a seven foot chamber width would provide a better tuned chamber. The peak frequency inside the chamber is shown in figures 45 and 46.

Effect of Removing the Chamber Bottom

The removal of the bottom from the breakwater chamber results in a shift of the crossover frequency to a lower value (figure 47). Removing the bottom from a five foot wide chamber produced a crossover frequency shift from .43 cycle/second to approximately .39 cycles/second, which corresponds to a change from matching the peak incident wave frequency produced by a 20 mph wind to that produced by a 25 mph wind. Theory dictates that the resonant frequency is inversely proportional to the chamber depth. Therefore, removing the bottom results in an apparent decrease in chamber depth.

Forces; Magnitude and Frequency

The virtual elimination of wave runup by the porous walled chamber greatly reduces the forces exerted on the solid vertical wall (existing bridge pontoon). With the chamber installed, the maximum force on the solid wall is due principally to the hydrostatic pressure of the water when the chamber is full. For maximum observed wind conditions of 40-45 mph with higher gusts, the chamber never completely pumped to its full height, three feet above still water level. Secondary disturbances superimposed upon the level of the chamber produce an occasional additional height at the wall of at most 1.5 feet. Along the remainder of the bridge for the same windspeed, pontoon walls were subjected to forces due to wave runup containing sufficient energy to overtop the guard rail eleven feet above S.W.L.

By allowing water to pass through the porous front wall of the chamber, it is also subjected to less force than would be exerted on a comparable solid wall. The measured maximum resultant force on the porous wall was 118 pounds per linear foot of wall, measured during a 35-40 mph (gusting to 50) wind condition, and thus was an even greater reduction in force than predicted. Actual finite wave crest lengths would further reduce the average force per unit length acting on a long wall.

The peak frequency of the force is shown in figure 48 to be more nearly related to the chamber crossover frequency than the incident wave frequency. As shown throughout the appendices, the distribution of force with frequency contains only one significant peak which occurs between .35 and .6 cycles/second.

Attenuation

The variance of a record of progressive random wave heights, obtained from spectral analysis, is directly proportional to the average energy per unit surface area (average energy density). Throughout the present study, the signals recorded at two stations, one in front of the breakwater and a second or remote station near by, but away from the influence of the breakwater, were the sum of incident and reflected waves.

The method of data reduction involved computing the variance of the sum of the incident and reflected waves at the two stations. The resulting variances, taken as the sum of average incident and reflected energy densities, were computed over a sufficiently long time period to assure that the incident energy at both stations was the same. Also, knowing that no energy was transmitted beyond the test site, the differences between the variances were attributed to the average energy dissipation of the reflected waves by the chamber. This difference between the variance at the two stations ratioed to the variance at the remote station was defined as Attenuation (equation 32) and taken to be the average energy density dissipated by the breakwater as a ratio of the average total energy density in front of the solid reflecting barrier.

Attenuation, calculated in this manner, is displayed throughout the appendices for a matrix of chamber configurations and wind speeds. However, the range of calculated Attenuation values did not correspond with visual observation nor reasonable physical expectations. The analysis in Chapter Five demonstrates a discrepancy between the variance and the average energy density. When incident and reflected waves coexist, a "standing" wave envelope results. The time average energy per unit surface area of an incident-reflected wave system measured at a fixed location may differ from the time average energy per unit surface area of the incident-reflected wave system.

This apparent contradiction in terms is due to the fact that actual average energy of a wave is the sum of the time averaged energy of the wave at each point averaged over a wave length. For a progressive wave this average can be obtained at a fixed location. The presence of both incident and imperfectly reflected waves results in a standing wave envelope. As such the time average energy density is not averaged over a wave length. The resulting difference in calculated energy, for each component wave frequency, is shown in equation 54 to be related to the product of the amplitudes of a phase angle between the incident and reflected wave. For waves reflected from the solid wall, the phase angle is simply related to the distance between the fixed measuring station and the barrier. In front of the breakwater, the expression is complicated by the effect of the breakwater. The porous walled breakwater, a linear resonator, does not affect the frequency of a wave during reflection, but does affect the amplitude and, unlike a solid wall, the phase angle. Due to the alteration in phase angle, the calculated average energy density at the two locations, both the same physical dimension from a wall, can be based on different portions of the standing wave envelope. Thus, even though the physical distance between the two measuring stations and the respective barriers is a constant, they are effectively at different locations. Therefore, energy calculations based on data acquired during the present field test cannot be used directly to analyse the amount of energy dissipated by the breakwater.

Possible alternative methods of analysis are suggested in the analysis section. Attenuation, as calculated, is included in the hope that future work will allow a method of relating the calculated spectra and variances to the actual average energy density. The attenuation calculated for various wind conditions is summarized in figures 49 and 50. The occurence of a negative attenuation corresponding to frequencies near the predicted natural frequency demonstrate the strong influence of the chamber on shifting the phase angle of the wave during reflection at frequencies near resonance. The calculation of an apparent energy increase in front of the chamber near the resonant frequency can be noted throughout the appendices. It must be remembered that this value is due to the effects enumerated in the analysis and is not representative of the average energy density at that frequency.

CHAPTER VII

CONCLUSION AND RECOMMENDATIONS

Conclusion

The porous walled breakwater behaves as a linear damped oscillator, or resonator, when exposed to random wind generated waves. The cross-over frequency of the system occurs at the frequency predicted by theory to be the natural frequency of a linear resonator and the frequency response of the full-scale device exposed to random waves scales properly from the results of models exposed to monochromatic waves. The model resonators produce a maximum reduction in reflected wave energy near the natural frequency. If the full-scale chambers correspondingly dissipate the maximum energy near the natural frequency, the five and seven foot chamber widths investigated produce a maximum energy dissipation for random waves resulting from 15-20 and 25-35 mph storm conditions, respectively.

The runup and overtopping onto the roadway are completely eliminated by the porous walled chamber with an associated reduction in force exerted on the pontoon wall. The magnitude of the force on the porous wall is less than predicted and its frequency distribution appears to correspond well with the peak frequency recorded in front of the break-water.

It is concluded that the porous wall resonating chamber, a device which can easily be appended to an existing structure or incorporated into a new structure, does reduce the reflected wave energy and the force exerted on the structure without requiring any power to drive it.

Though observation verifies that the breakwater works well, the amount of energy dissipated by the chamber cannot be quantified at this time. As enumerated in the analysis, the time average energy density of co-existing incident and reflected waves at a given point is not only a function of the wave heights, as is the case for progressive waves, but is also a function of the distance to the barrier, the product of the incident and reflected amplitudes, and the random phase angle. For a constant physical distance to a barrier, the change in phase angle during reflection caused by the breakwater produces an effectively different distance to the porous wall than to a solid wall. Thus, the energy density calculated during this investigation at two fixed stations, one in front of the breakwater and another in front of a solid wall cannot be directly compared. However, the performance of the chamber exposed to random wind generated waves is like that of the models in monochromatic wave systems in several respects. The effect of changing the chamber width; the match with predicted resonant frequencies; the result of removing the chamber bottom; and the observed attenuation at the resonant frequency, are consistant between model and full-scale results. Therefore, it is concluded that the two systems are indeed hydraulically similar.

Recommendations

The porous walled resonating chamber provides many benefits for application to floating structures. The units are light wieght, require no power, and can be pre-fabricated and appended to existing structures or can be an integral and structural part of new structures. For applications to existing floating bridges the porous walled chamber could be easily incorporated into cantilevered lanes on existing pontoons, while at the same time reducing the structural loads upon the pontoons by the wave action. Dimensions can be selected from the parameters developed in the study. A seven foot chamber width with a solid chamber bottom is recommended for an exposure like the one at the Evergreen Point Bridge. In a permanent installation large spill ports should be provided above the top of the porous wall to allow spillage of exceptionally large waves into the chamber. Occasional perforations between compartments would equalize loads on supports.

The amplification of the force on solid end panels noted during this investigation can be eliminated in a permanent full length installation by using porous end plates. The mass transport into the chamber results in an accumulation of surface debris. A permanent installation should allow for easy removal of this debris.

Academically, the possible alternative data analysis methods suggested should be pursued to provide a means of quantifying the energy dissipated by the breakwater.

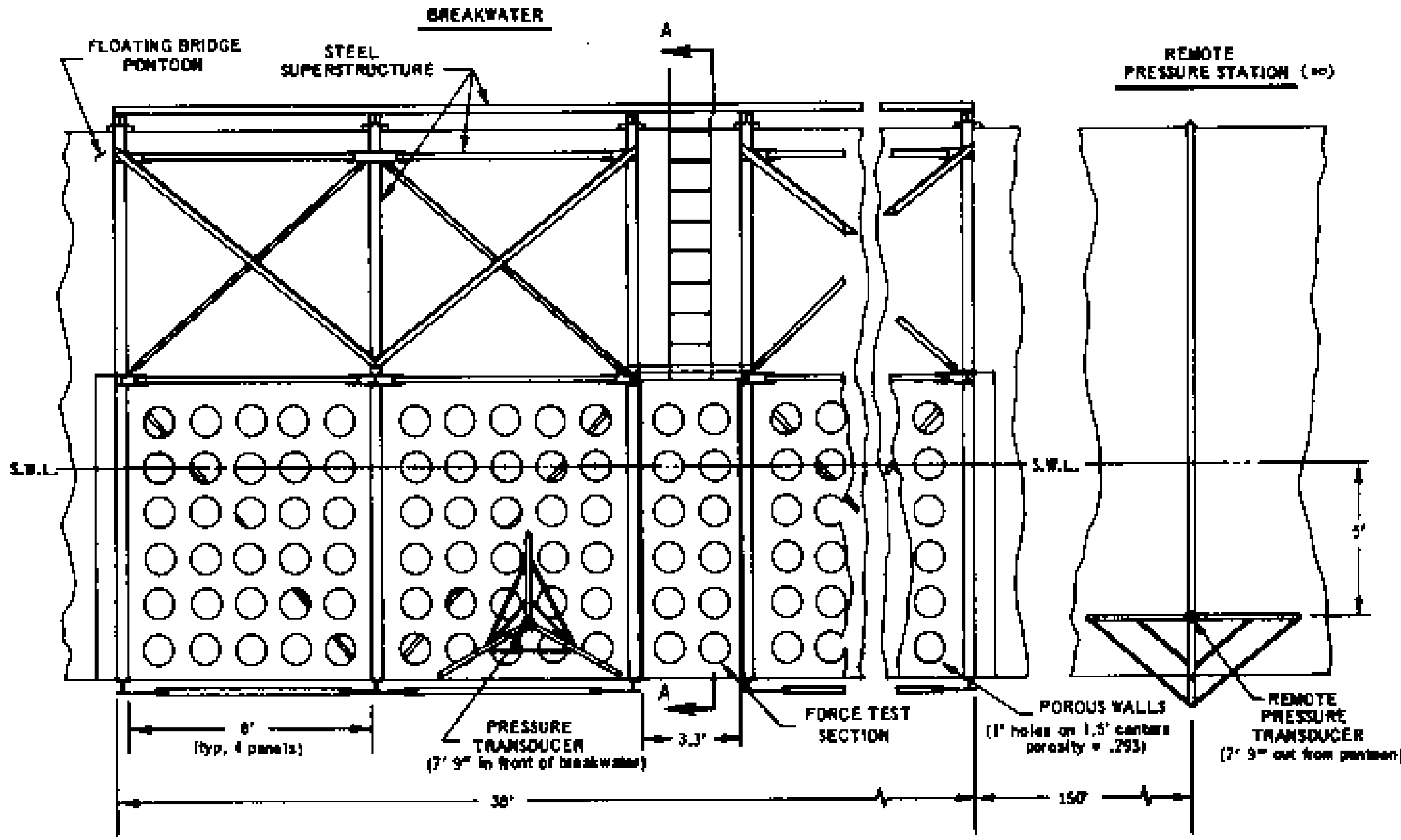


FIGURE 1. Porous Walled Breakwater; Front View.

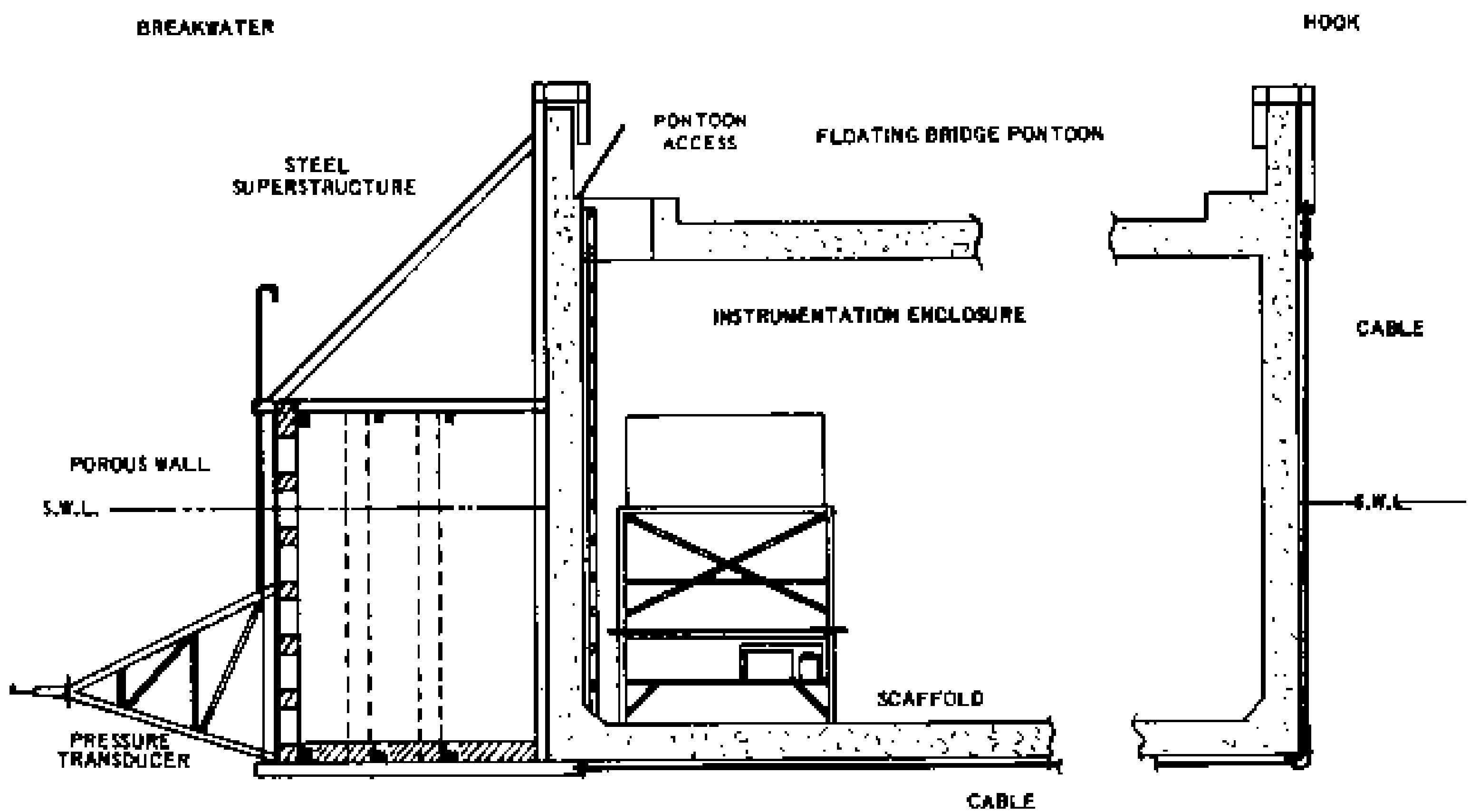


FIGURE 2. Cross-Section A-A Of Breakwater Attached To Floating Bridge Pontoon.

FIGURE 3. TEST SITE

DEEP WATER WAVE SPEED AND LENGTH AS A FUNCTION OF WAVE PERIOD OR FREQUENCY (SMALL AMPLITUDE THEORY)

T (sec)	f (cycle sec)	Co (ft/sec)	Co (knots)	Lo (feet)
0.6	1.66	3.07	1.82	1.84
0.7	1.43	3.58	2.12	2.51
0.8	1.25	4.09	2.42	3.28
0.9	1.11	4.61	2.73	4.15
1.0	1.00	5.12	3.03	5.12
1.1	.91	5.63	3.33	6.19
1.2	.83	6.14	3.64	7.37
1.3	.77	6.65	3.94	8.65
1.4	.71	7.17	4.24	10.0
1.5	.67	7.68	4.55	11.5
1.6	.63	8.19	4.85	13.1
1.7	.58	8.70	5.15	14.8
1.8	.56	9.21	5.45	16.6
1.9	.53	9.72	5.76	18.5
2.0	.50	10.2	6.06	20.5
2.1	.48	10.7	6.36	22.6
2.2	.45	11.2	6.67	24.8
2.3	.43	11.8	6.97	27.1
2.4	.42	12.3	7.27	29.5
2.5	.40	12.8	7.58	32.0
2.6	.38	13.3	7.88	34.6
2.7	.37	13.8	8.18	37.3
2.8	.36	14.3	8.48	40.1
2.9	.34	14.8	8.79	43.0
3.0	.33	15.4	9.1	46.1
3.1	.32	15.9	9.4	49.2
3.2	.31	16.4	9.7	52.4
3.3	.30	16.9	10.0	55.8
3.4	.29	17.4	10.3	59.2
3.5	.29	17.9	10.6	62.7
3.6	.28	18.4	10.9	66.4
3.7	.27	18.9	11.2	70.1
3.8	.26	19.4	11.5	73.9
3.9	.26	20.0	11.8	77.9
4.0	.25	20.5	12.1	81.9
4.5	.22	23.0	13.6	104
5.0	.20	25.6	15.2	128

FIGURE 4. Range Of Deep Water Wave Parameters Applicable To Test Site .

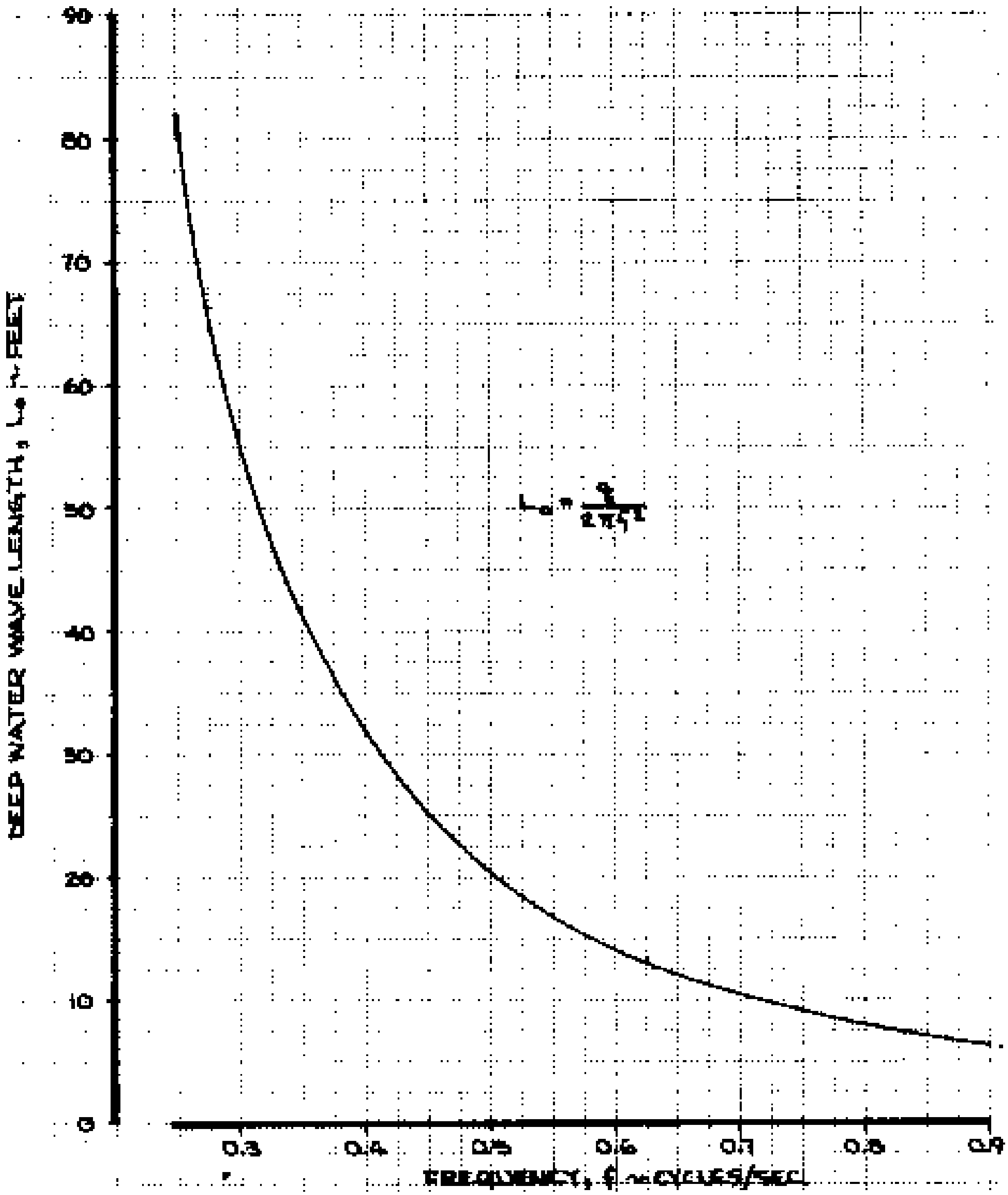


FIGURE 5. Deep Water Wave Length Versus Frequency.

Figures 6 & 7 Breakwater Operation.
(Incident wave energy converted to kinetic energy [jets] and dissipated through turbulent mixing and diffusion.)

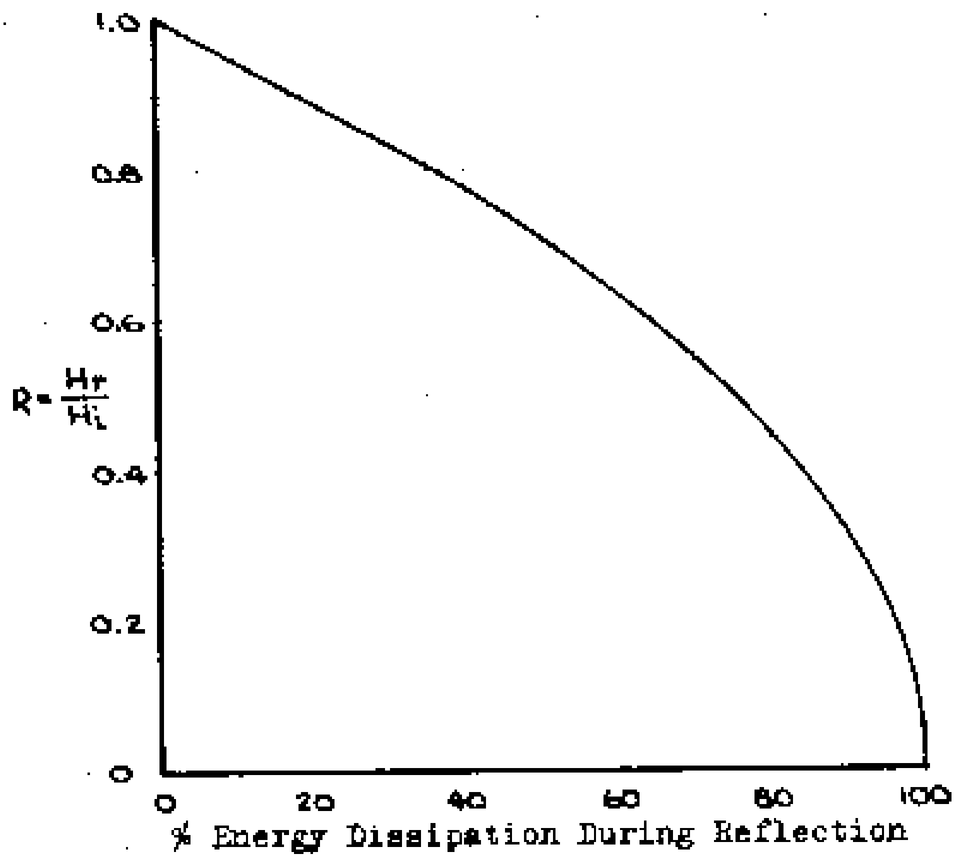


FIGURE 8. Relationship Between Energy Dissipation and Reflection Coefficient.

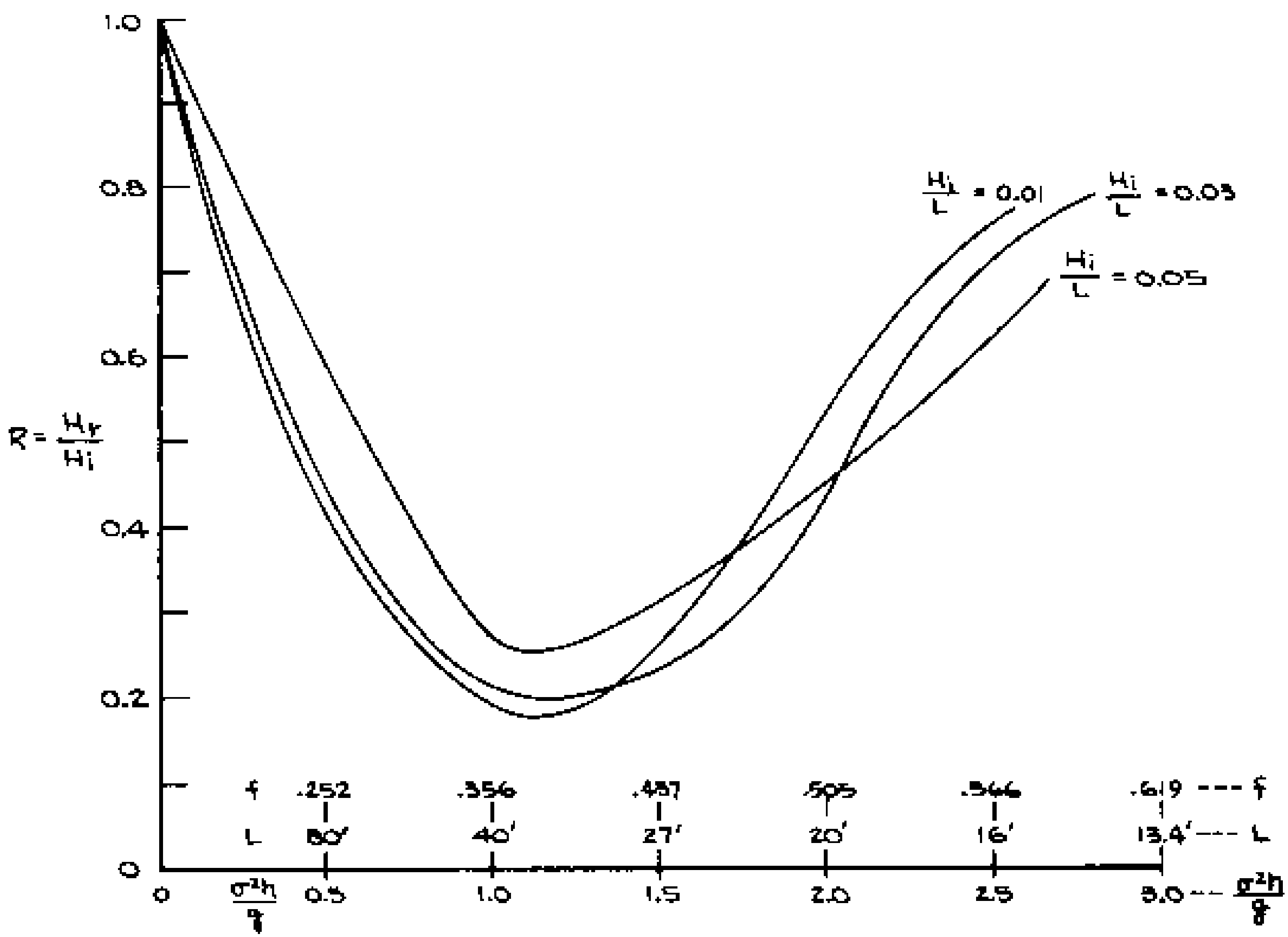


FIGURE 9. EXPERIMENTAL REFLECTION COEFFICIENT; MODEL BREAKWATER CORRESPONDING TO 4' CHAMBER WIDTH, POROSITY = .196, SOLID BOTTOM

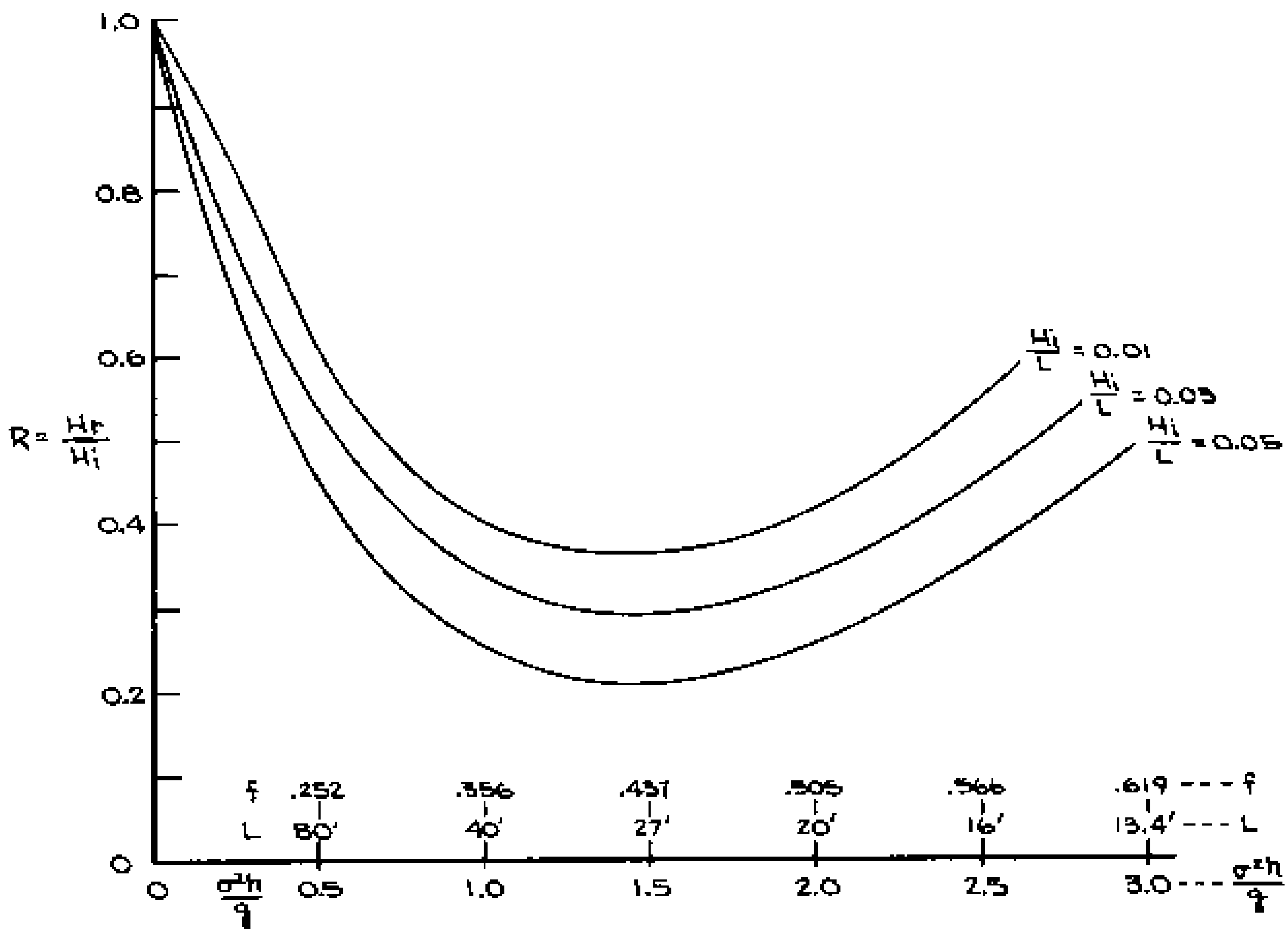


FIGURE 10. EXPERIMENTAL REFLECTION COEFFICIENT ; MODEL BREAKWATER CORRESPONDING TO 4' CHAMBER WIDTH, POROSITY = .333, SOLID BOTTOM

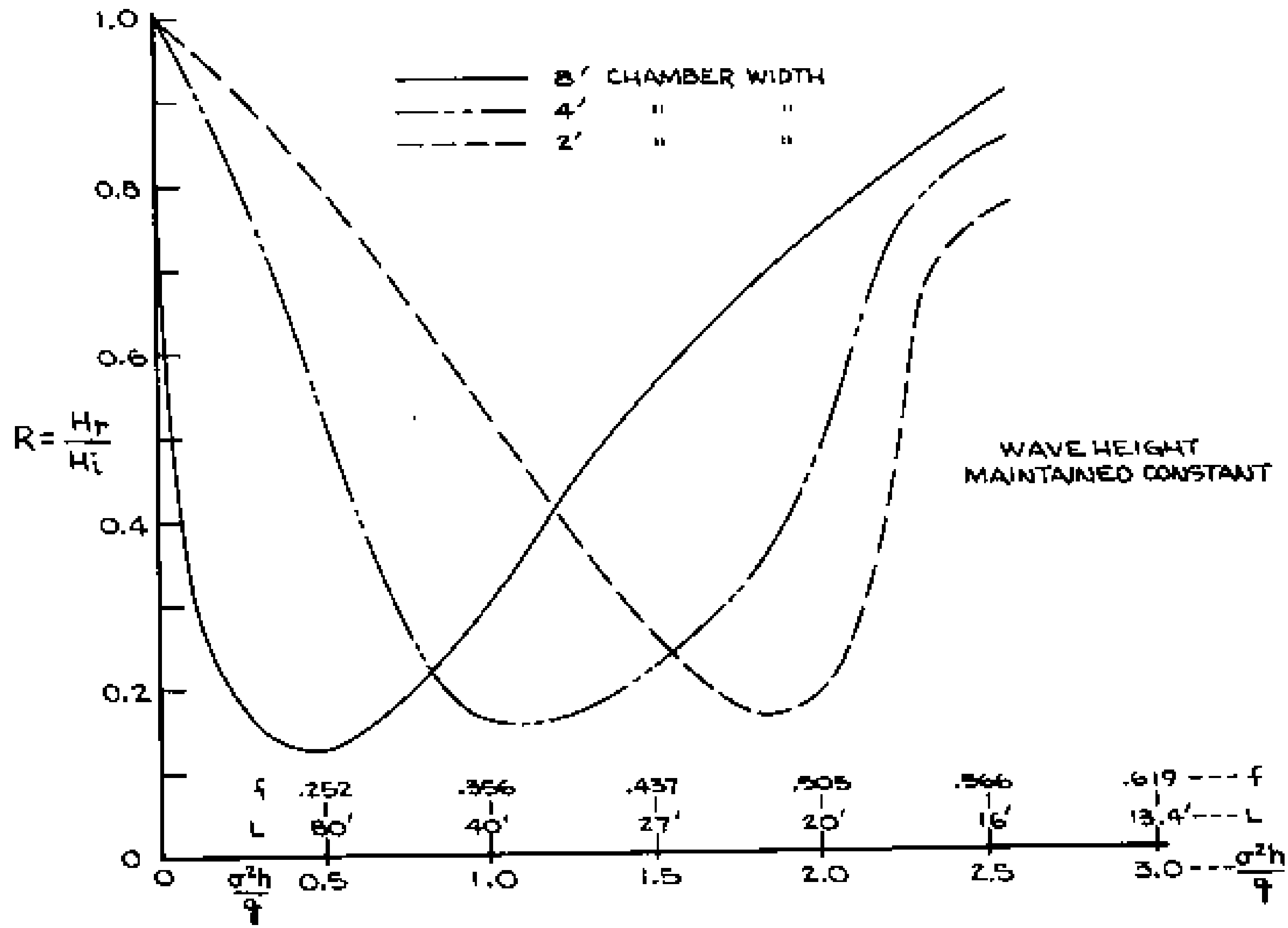


FIGURE 11. EXPERIMENTAL REFLECTION COEFFICIENT DEPENDENCE ON BREAKWATER WIDTH; MODEL SCALE, POROSITY = .196, SOLID BOTTOM

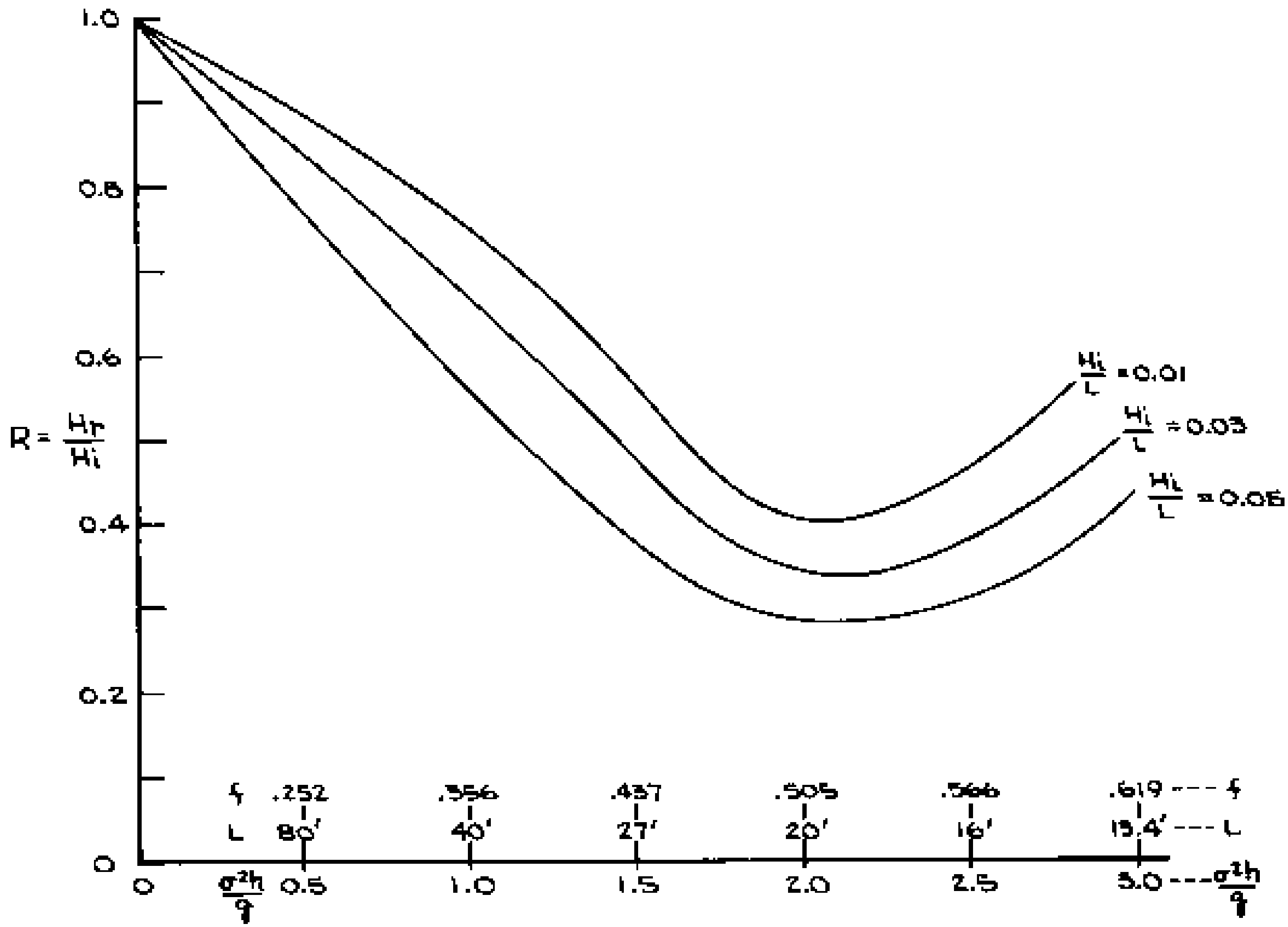


FIGURE 12. EXPERIMENTAL REFLECTION COEFFICIENT ξ MODEL BREAKWATER CORRESPONDING TO 4' CHAMBER WIDTH, POROSITY = .333, BOTTOM REMOVED

	cos α	X_i"	X_i cos α
42	.743	1.09*	.81
36	.809	1.15	.93
30	.866	1.28	1.11
24	.914	1.72	1.57
18	.951	2.65	2.52
12	.978	2.57	2.51
6	.995	2.54	2.53
0	1.000	2.52	2.52
6	.995	2.40	2.39
12	.978	2.30	2.25
18	.951	2.53	2.41
24	.914	2.54	2.32
30	.866	2.60	2.25
36	.809	1.00	.81
42	.743	.88	.65
Total	13.512		27.58

$$F_{EFF} = \frac{\Sigma X_i \cos\alpha}{\Sigma \cos\alpha}$$

$$= \frac{27.58}{13.512}$$

$= 2.04$ UNITS

2.18 MILES = 5 UNITS

$\therefore F_{EFF} = 2.8$ MILES

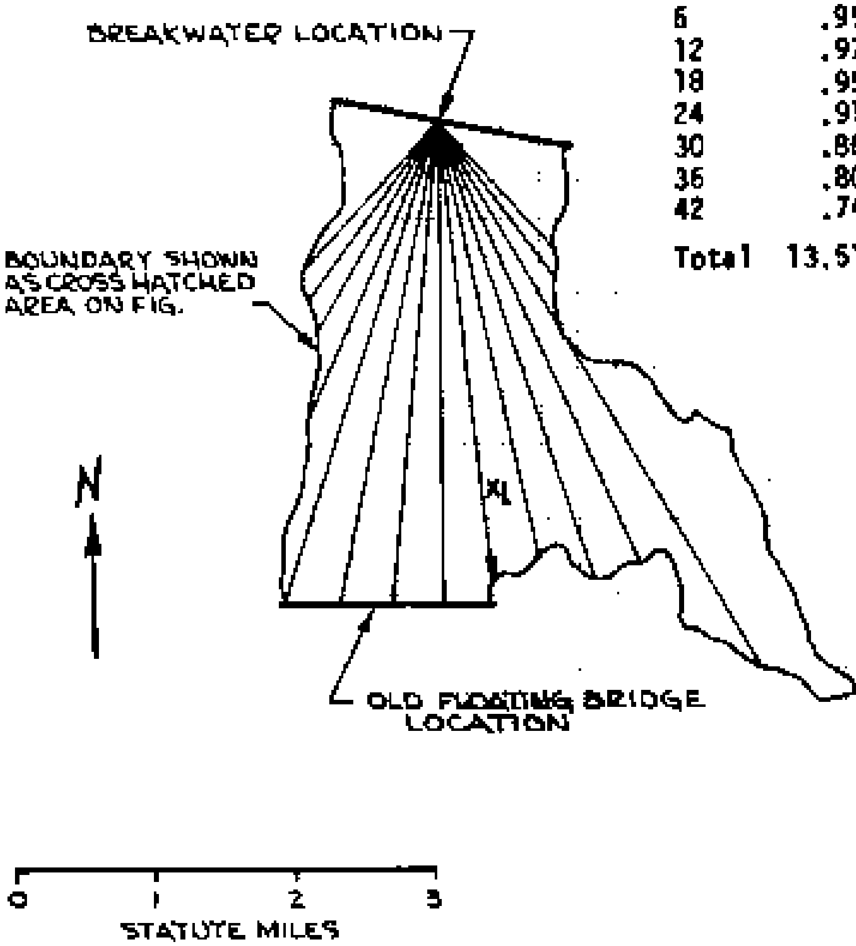


FIGURE 13. COMPUTATION OF EFFECTIVE FETCH FOR SOUTHERLY WIND

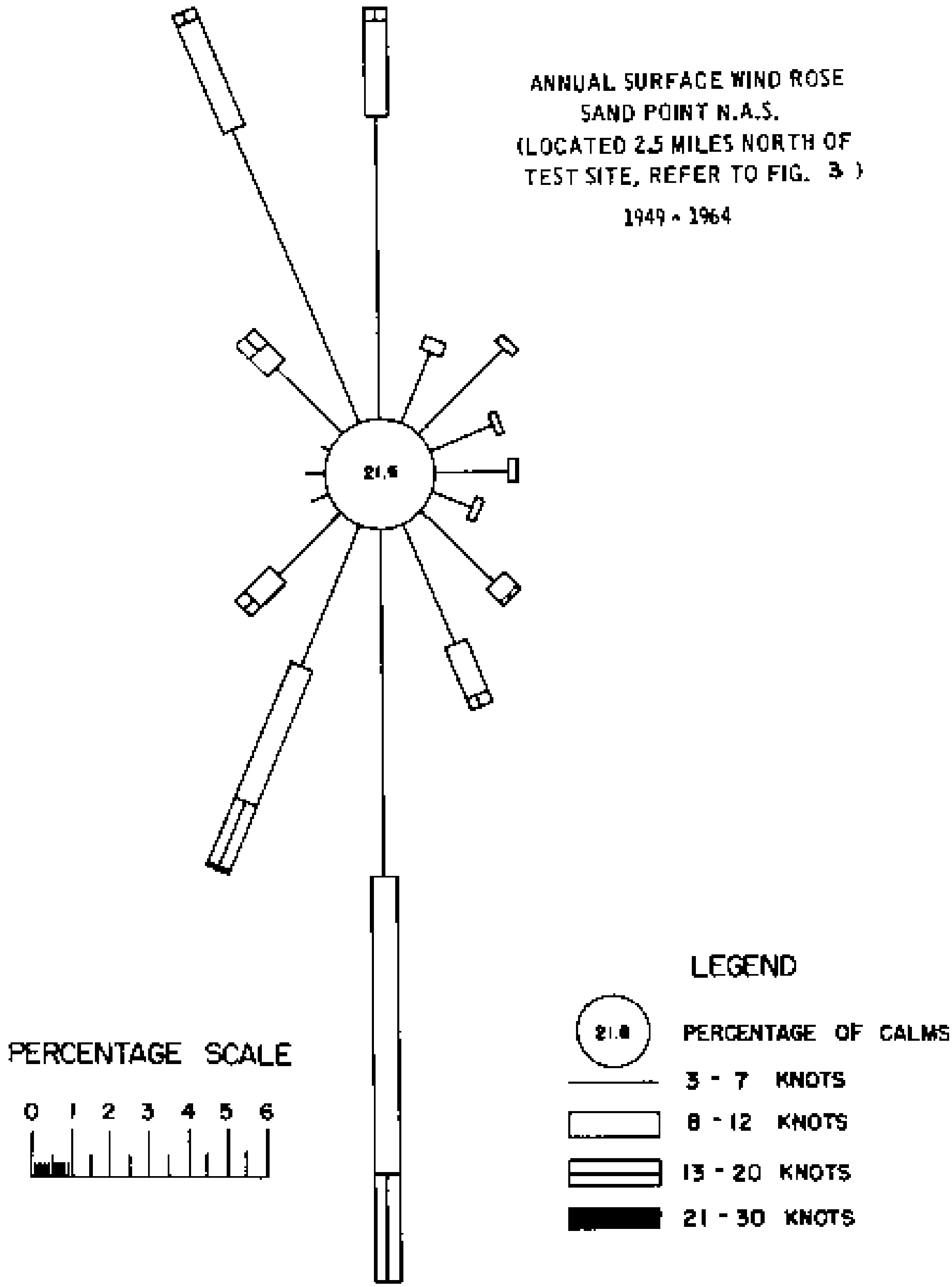
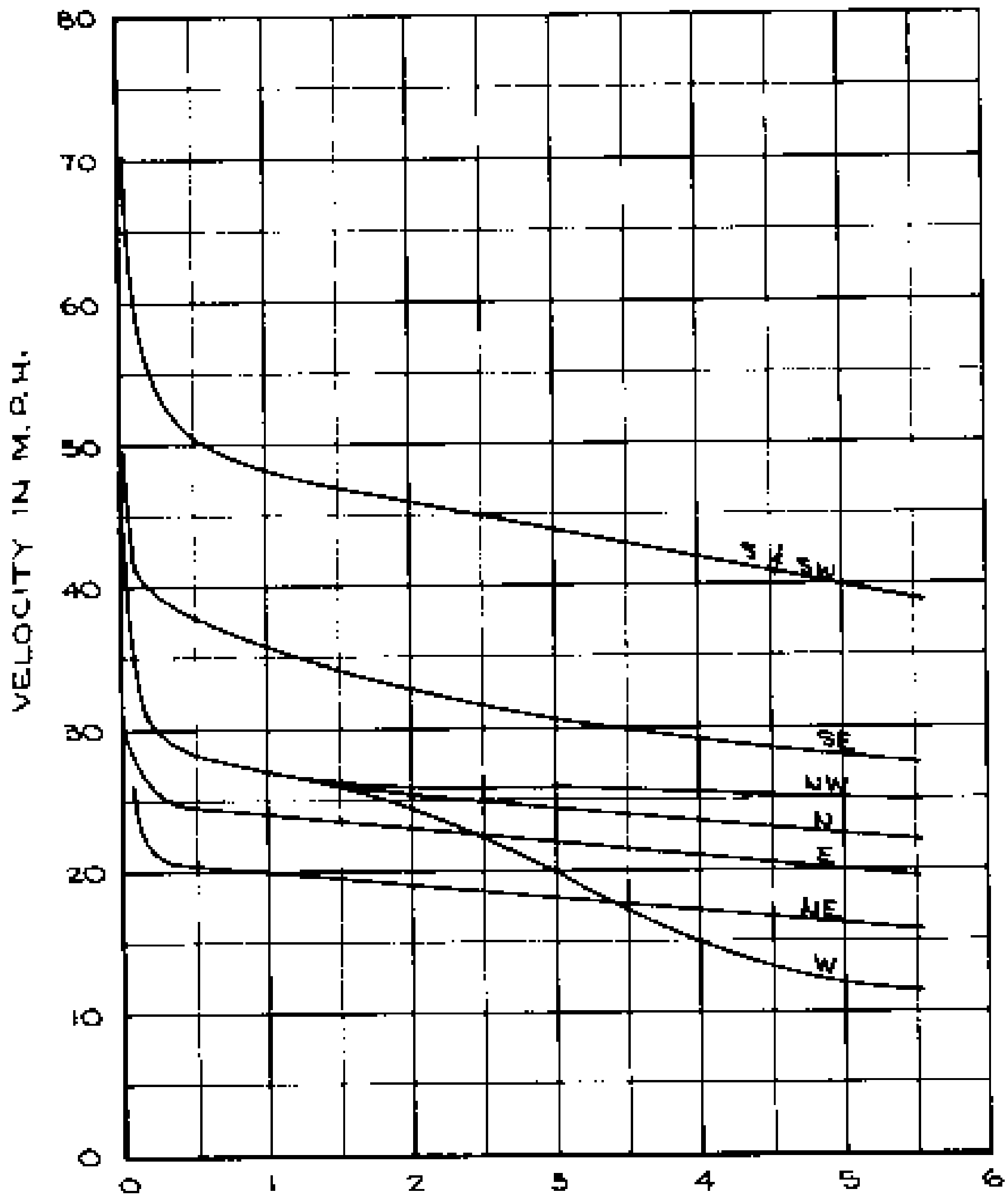


FIGURE 14. APPROXIMATE ANNUAL WIND ROSE FOR TEST SITE



NOTE: BASED ON MAXIMUM RECORDED WIND MOVEMENT FOR DURATIONS TO 5 HRS. FOR SEATTLE CITY OFFICE, U.S. WEATHER BUREAU. PERIOD OF RECORD 1900-1955

FIGURE 15. WIND VELOCITY DURATION CURVE AT TEST SITE

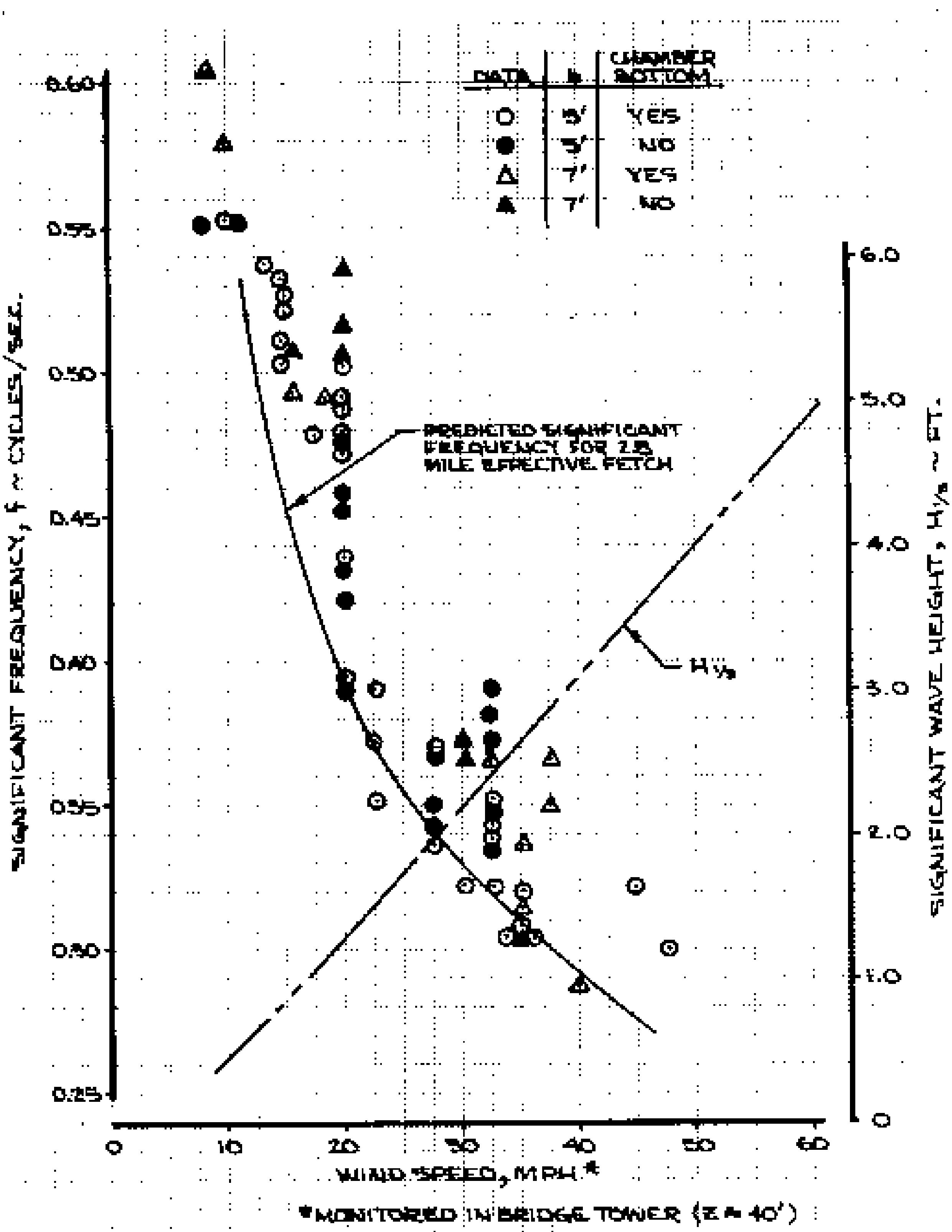


FIGURE 16. SIGNIFICANT FREQUENCY AS A FUNCTION OF WINDSPEED; PREDICTION AND DATA

* TEST SECTION CANTILEVER BEAM ASSEMBLY RECEPTACLES

Figure 17 Breakwater Module Installed on the Evergreen Point Floating Bridge.

Seven foot chamber width shown.

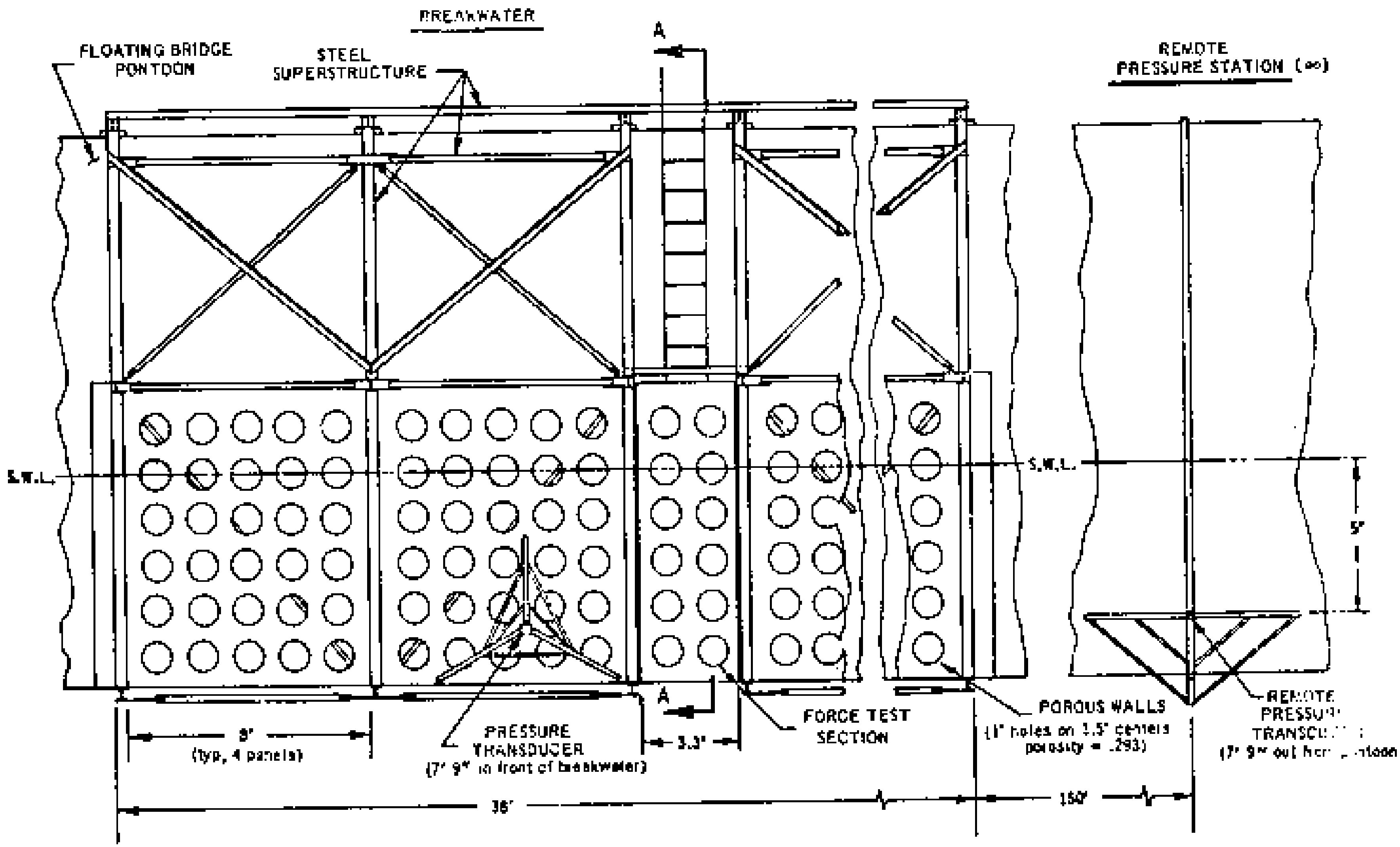


FIGURE 13. Porous Walled Breakwater and Remote Station; Front View.

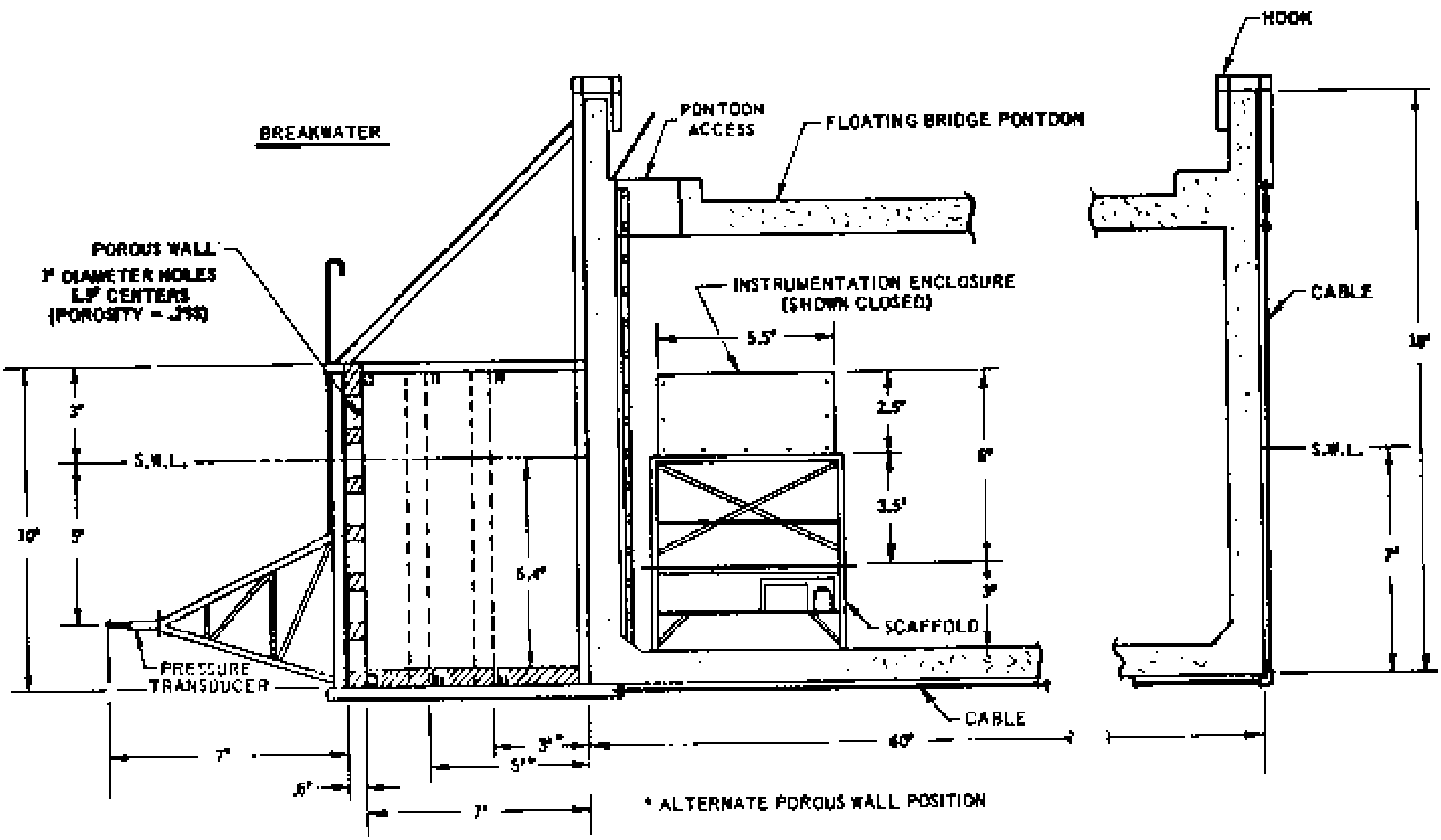


FIGURE 19. BREAKWATER SCHEMATIC (SECTION VIEW) INCLUDING KEY DIMENSIONS.

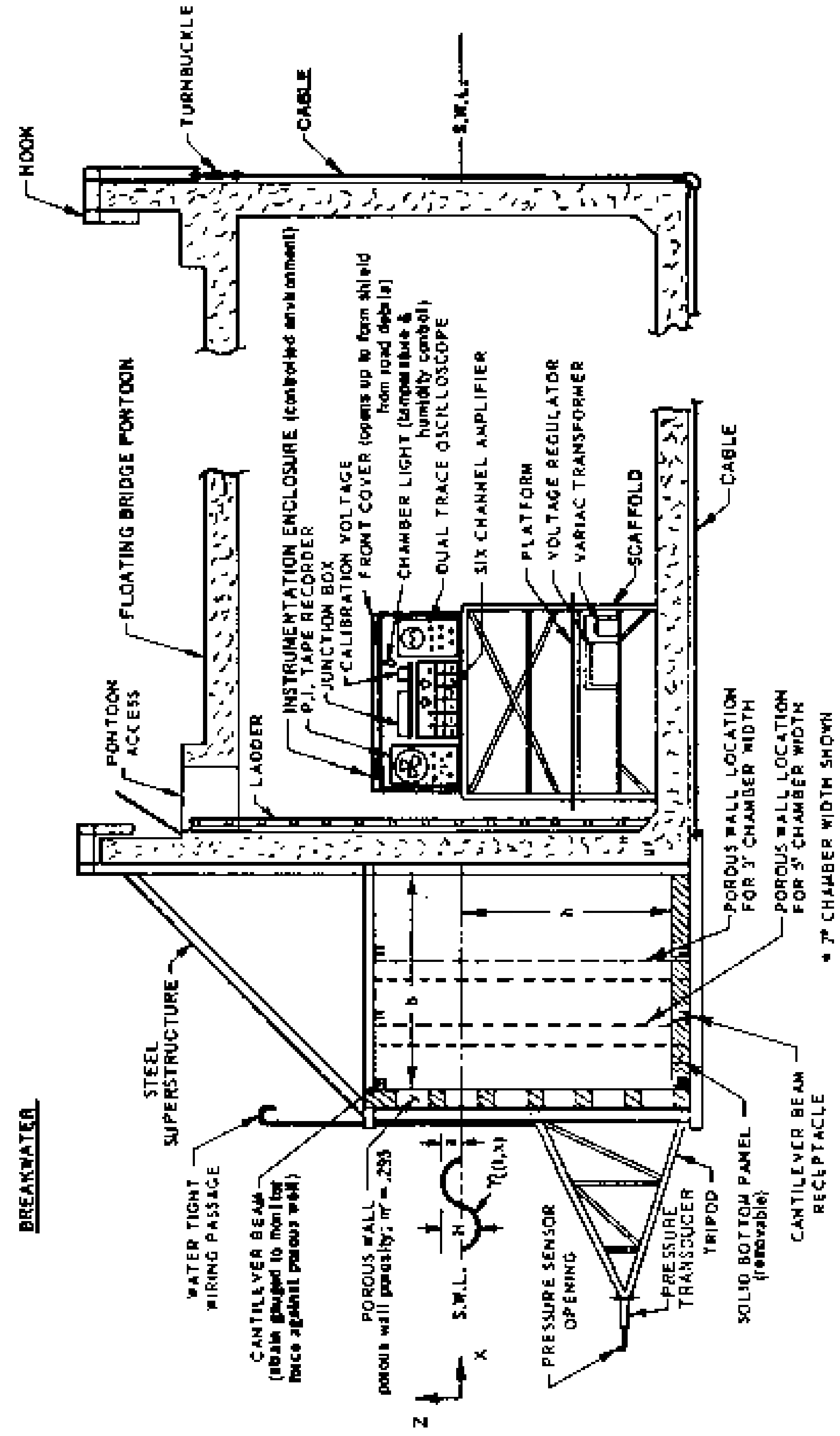


FIGURE 20. NOMENCLATURE (SECTION VIEW A - A)

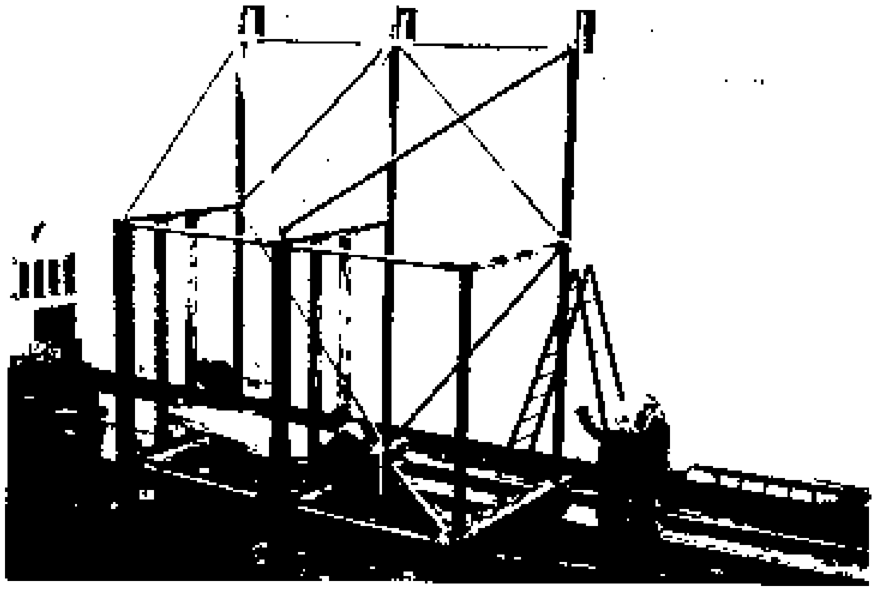


Figure 21 Steel Superstructure. One Module Shown. Removable bottom panel being installed.

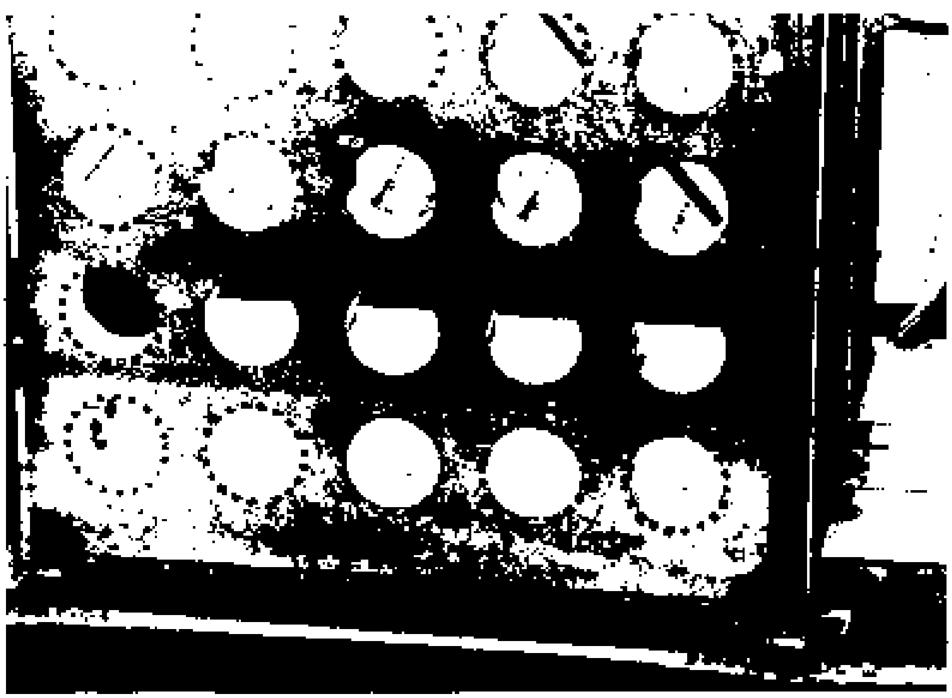


Figure 22 Porous Wall

Figure 23 Test Section and Cantilever Beam Assemblies

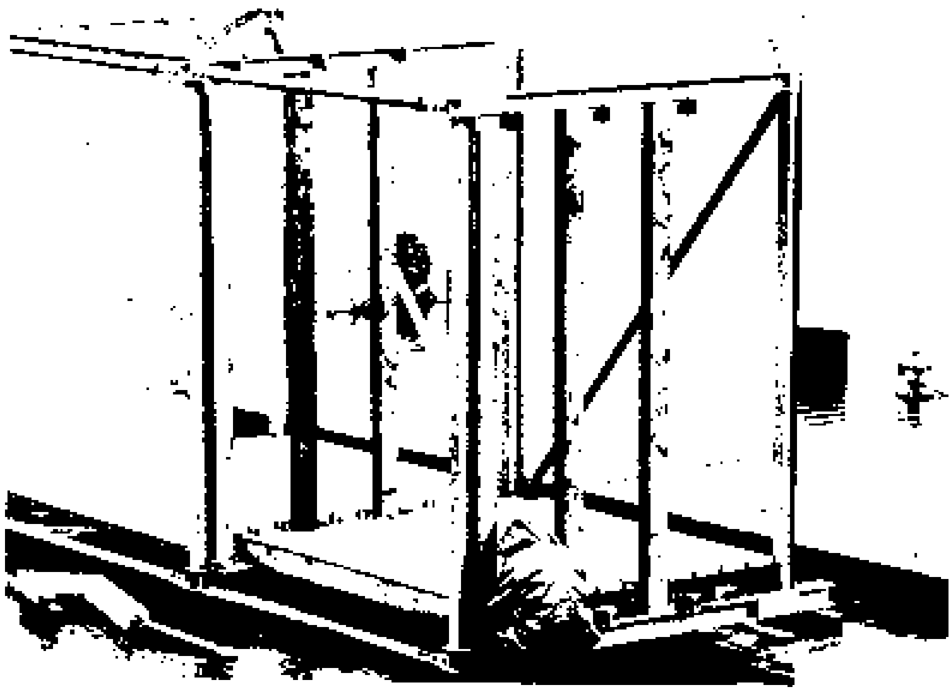


Figure 24 Removable Chamber Bottom Installed on one Module. (One porous wall panel removed; hook and turnbuckle in foreground).

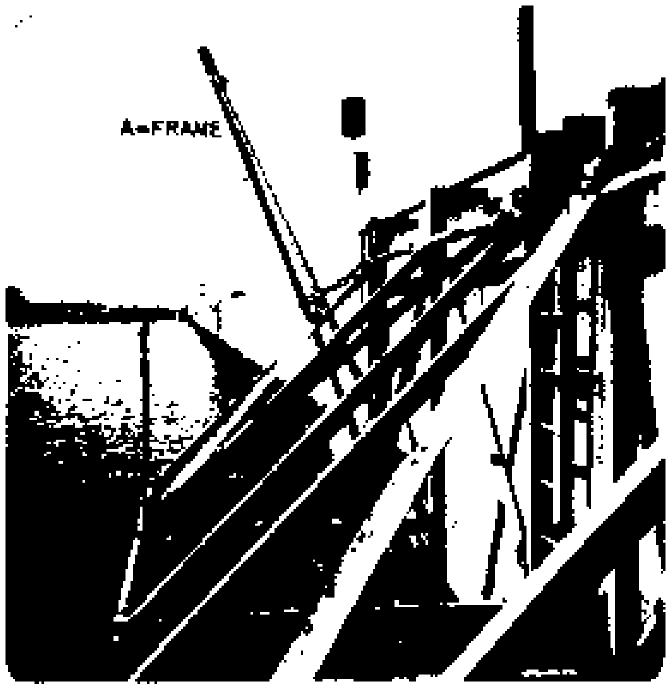


Figure 25 A-Frame; Allowing Self-contained Chamber Width Variations.

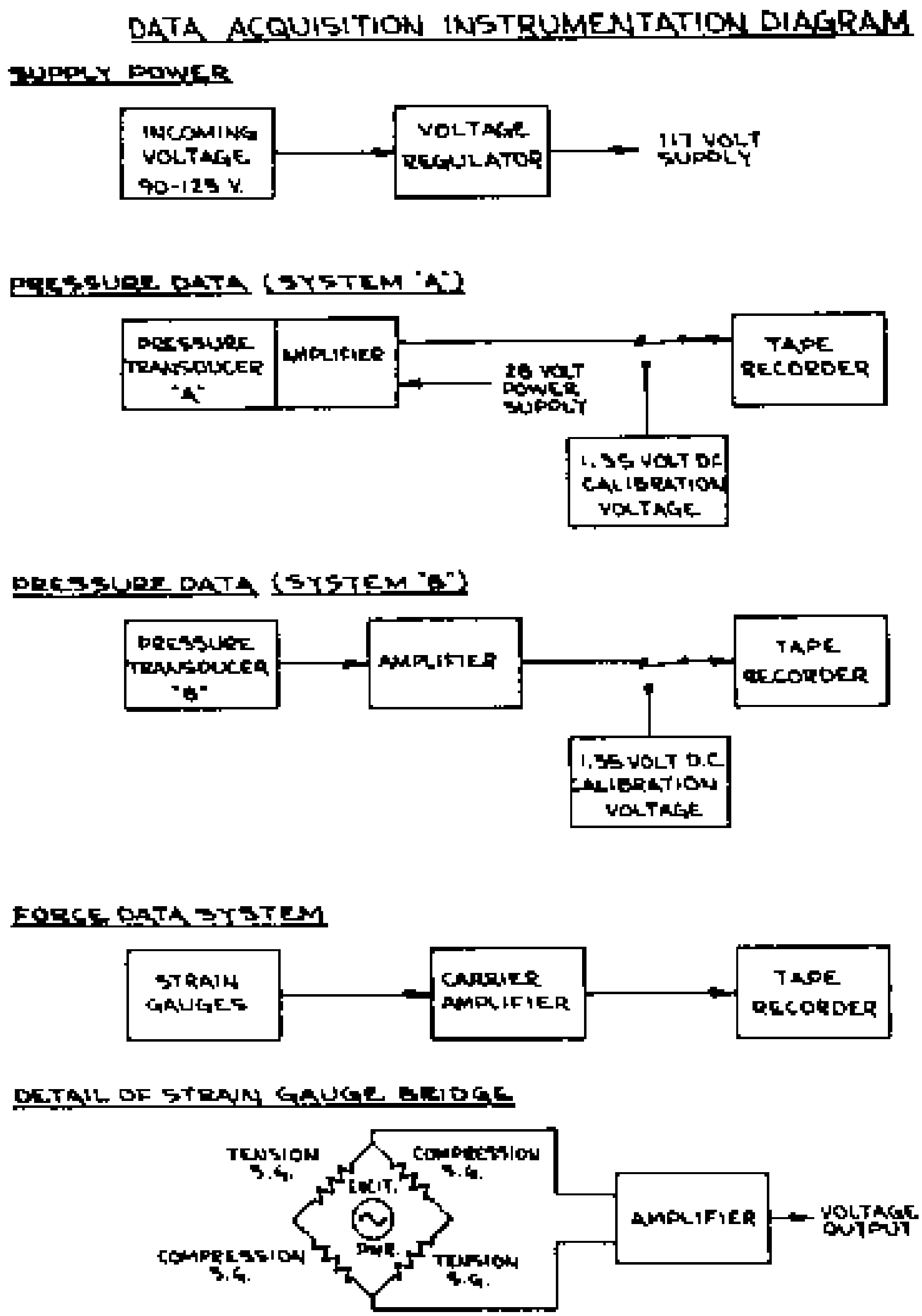


FIGURE 26. DATA ACQUISITION INSTRUMENTATION DIAGRAM

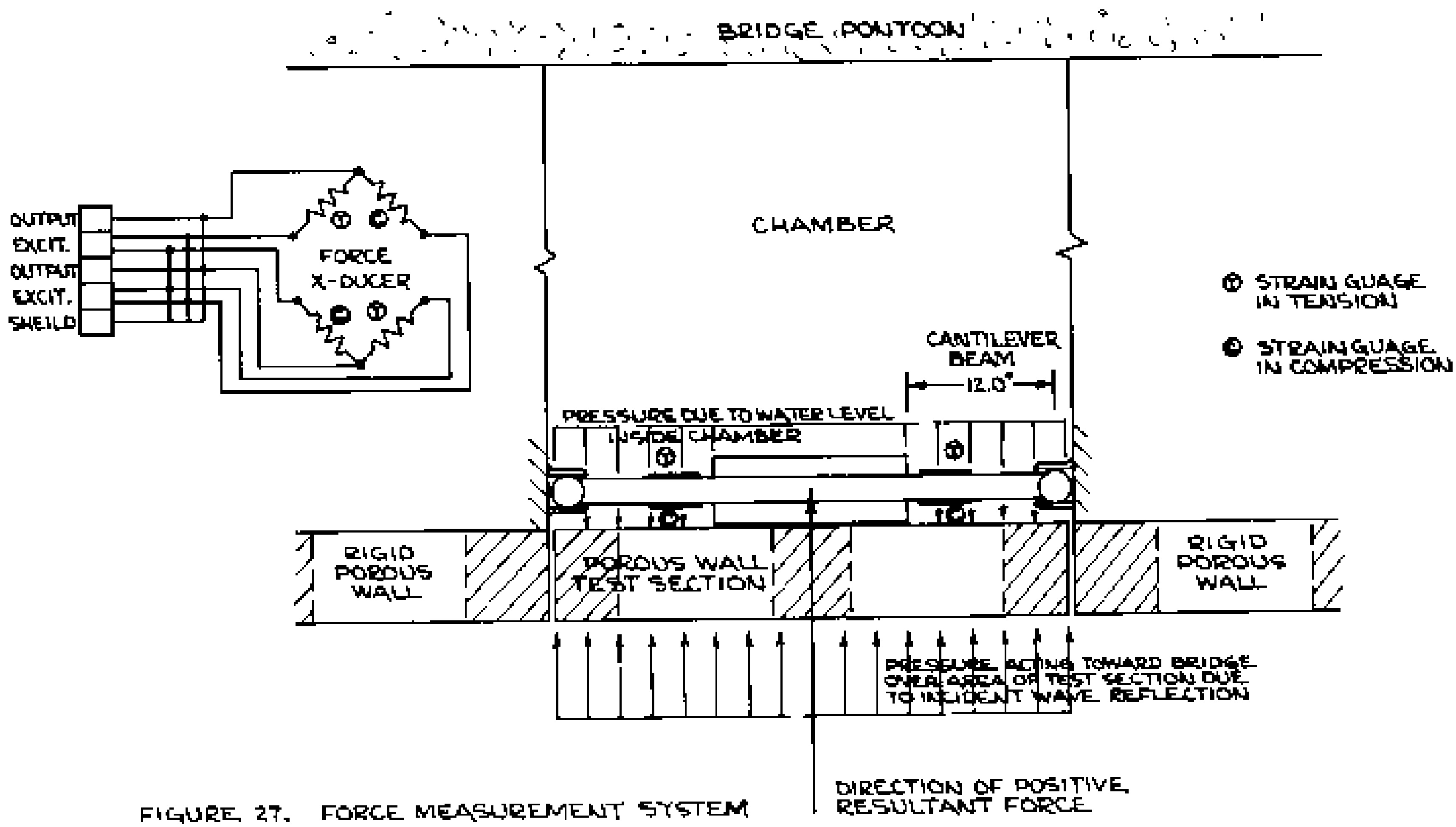


FIGURE 27. FORCE MEASUREMENT SYSTEM

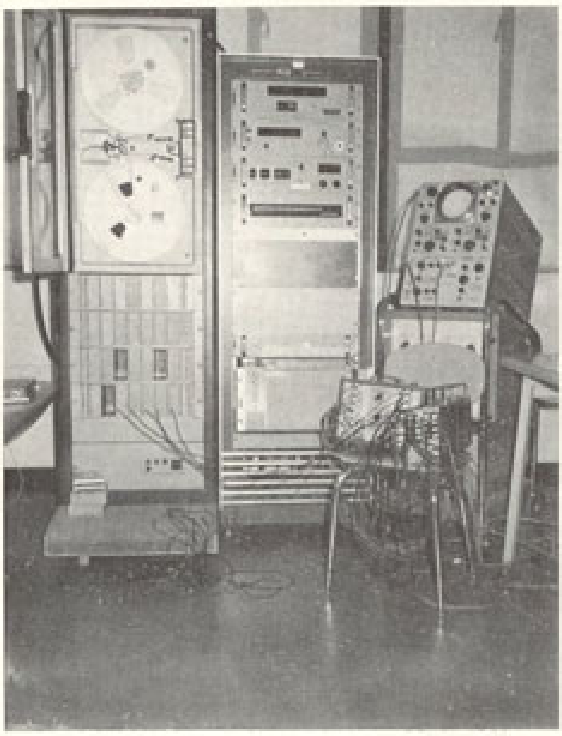


Figure 28 Data Reduction Instrumentation

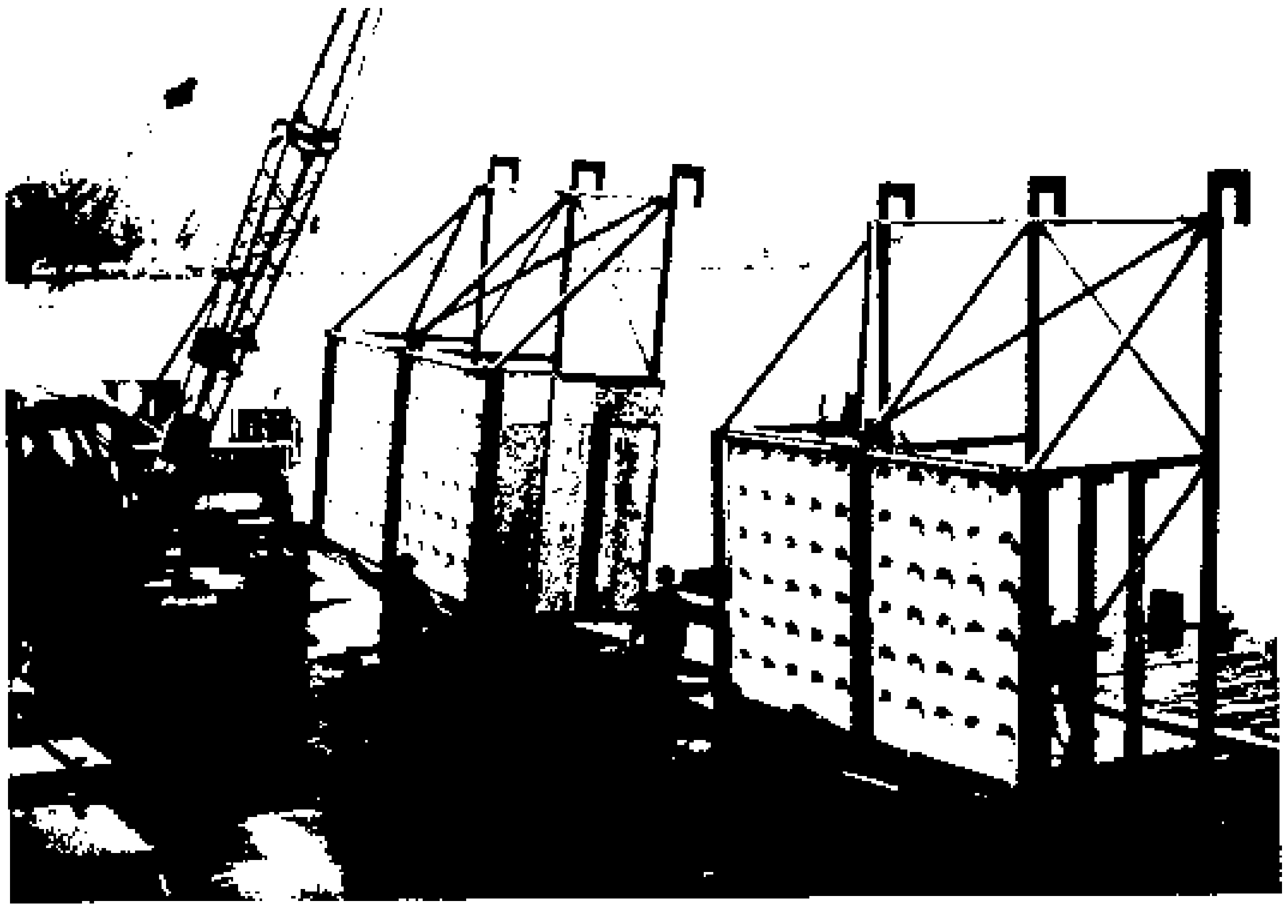


Figure 29 Assembled Breakwater Modules Before Installation

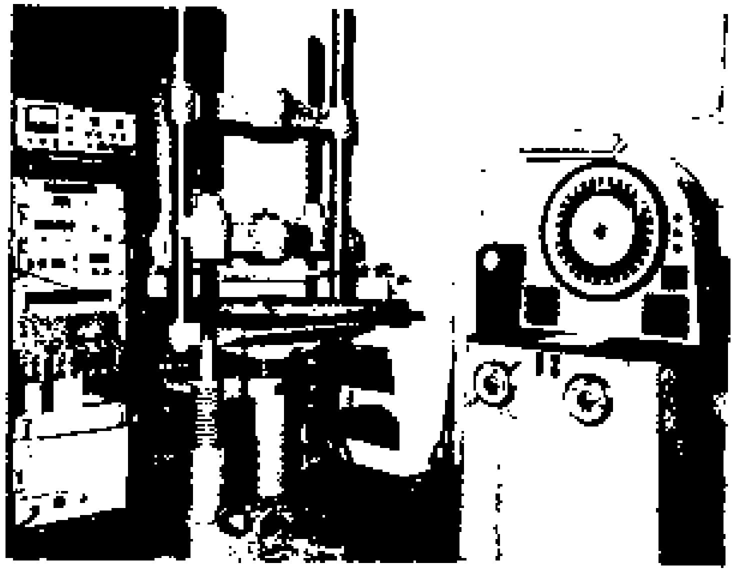


Figure 30 Cantilever Beam Calibration:
Known Force Input vs. Strain Gauge Output.

Figure 31 Close-up of Cantilever Beam Assembly.

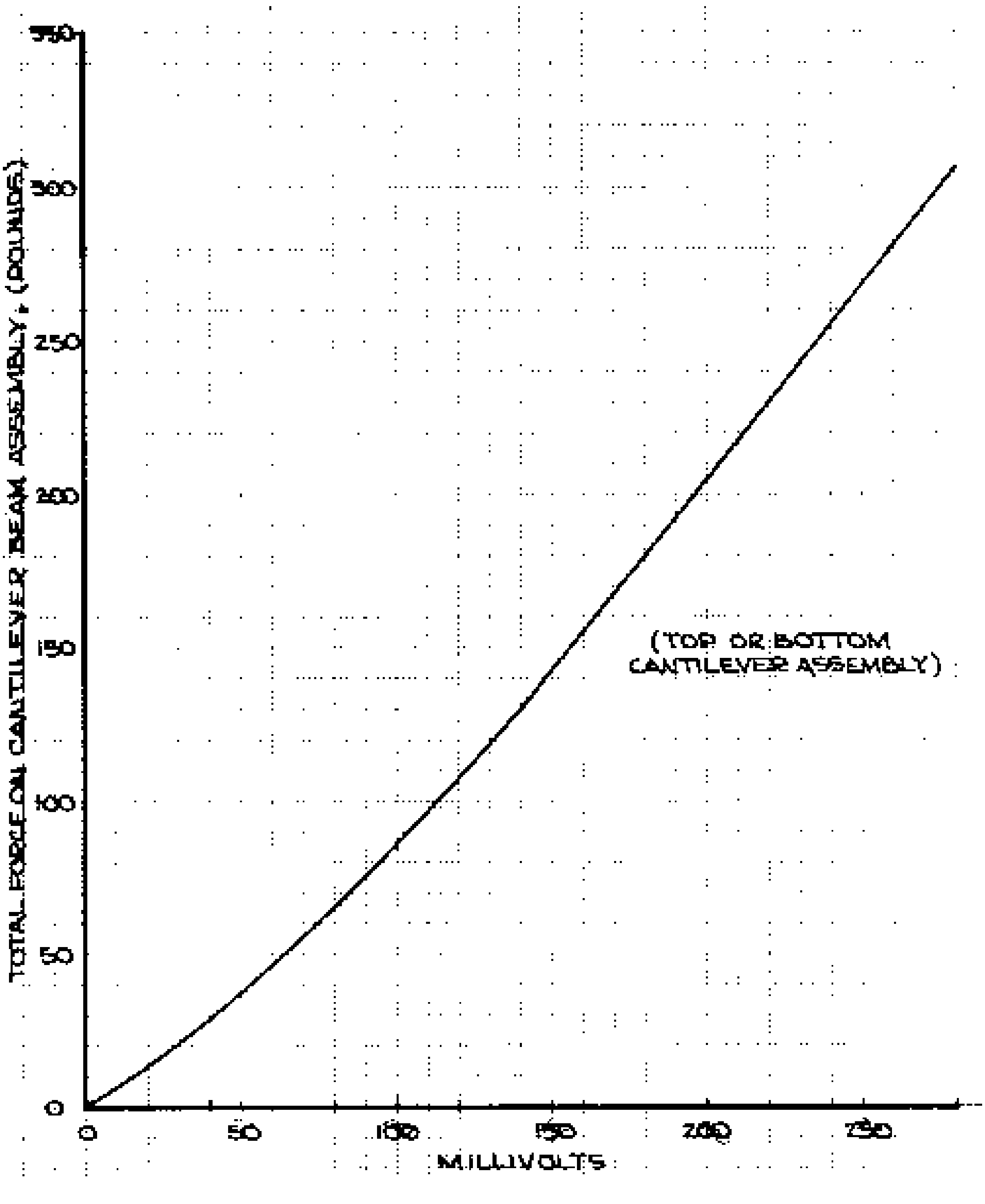


FIGURE 52. FORCE CALIBRATION CURVE (1 of 2)

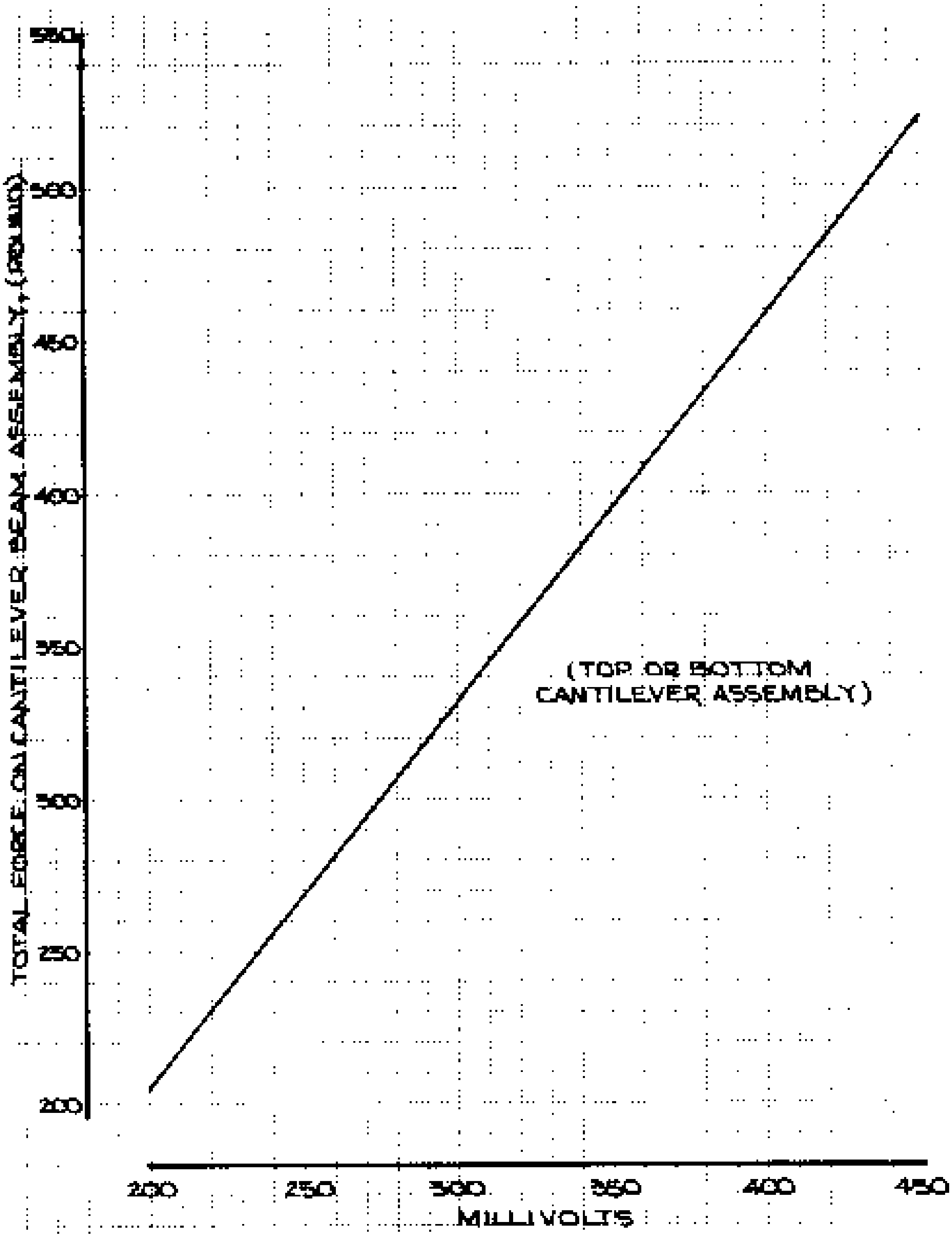


FIGURE 35. FORCE CALIBRATION CURVE (2 of 2)

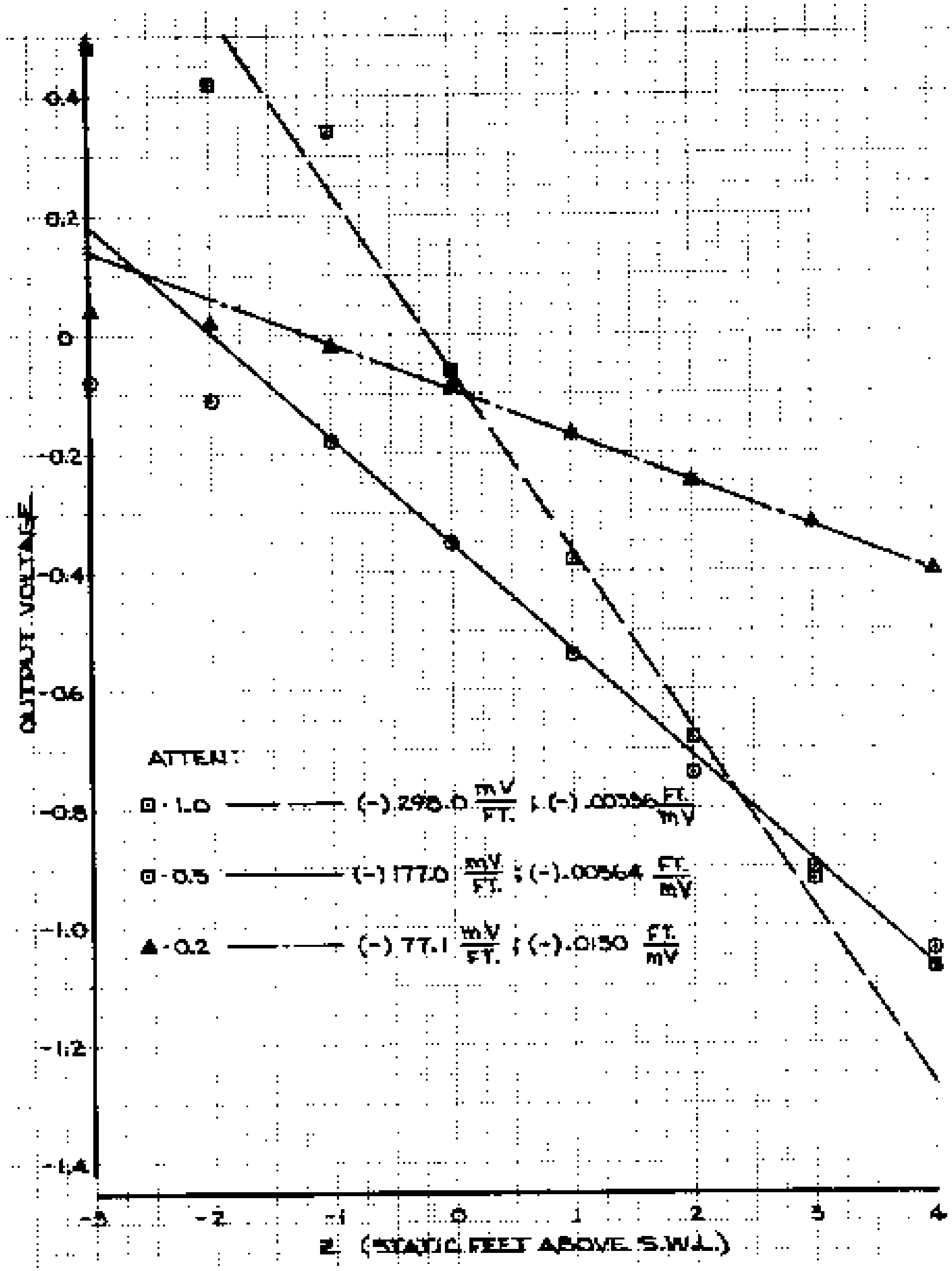


FIGURE 54. REMOTE (-) TRANSDUCER CALIBRATION CURVE (CHANNEL # 3)

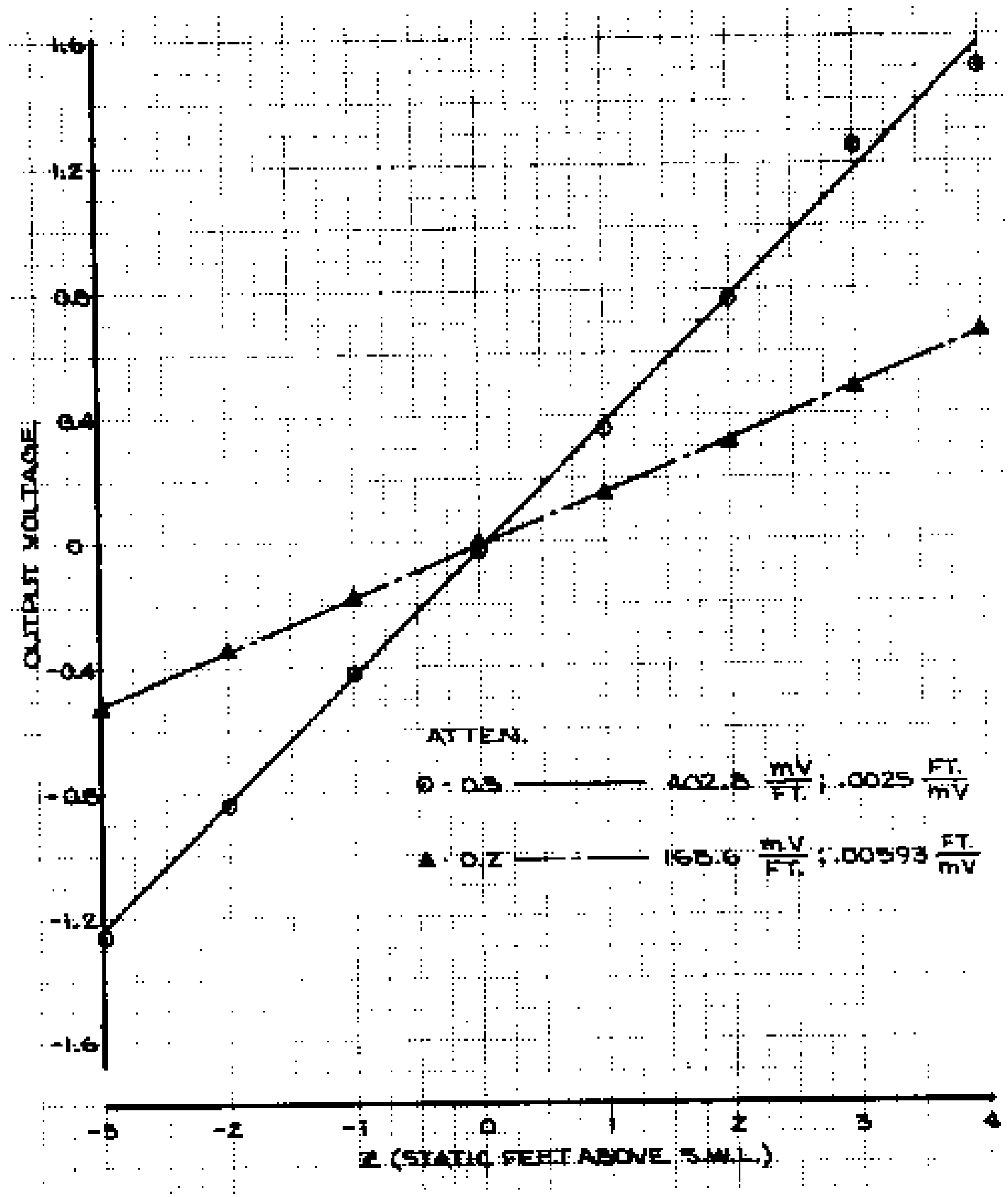


FIGURE 38. CALIBRATION CURVE FOR TRANSDUCER IN FRONT OF BREAKWATER (CHANNEL #4)

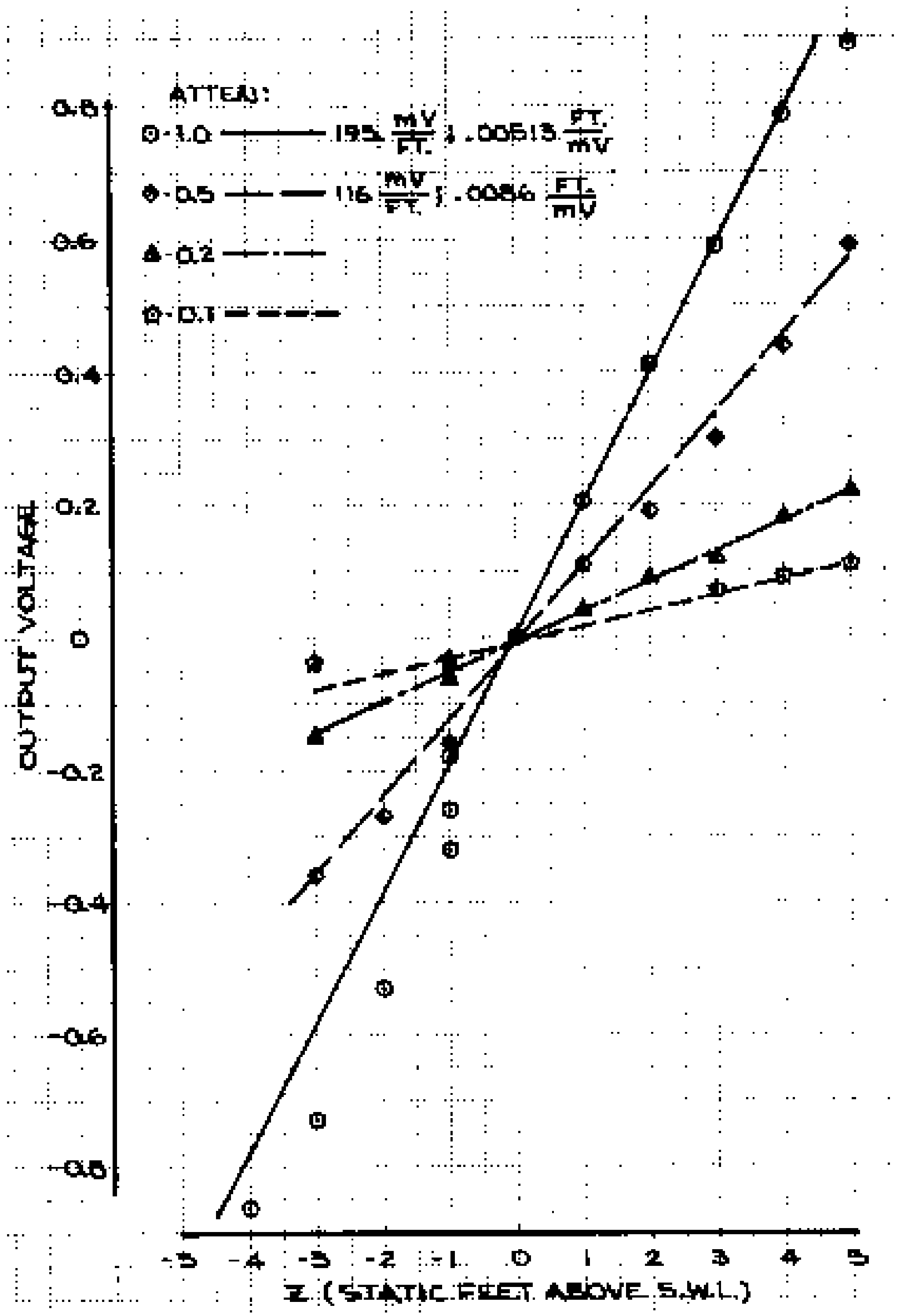


FIGURE 36. CALIBRATION CURVE FOR TRANSDUCER INSIDE CHAMBER (CHANNEL #5)

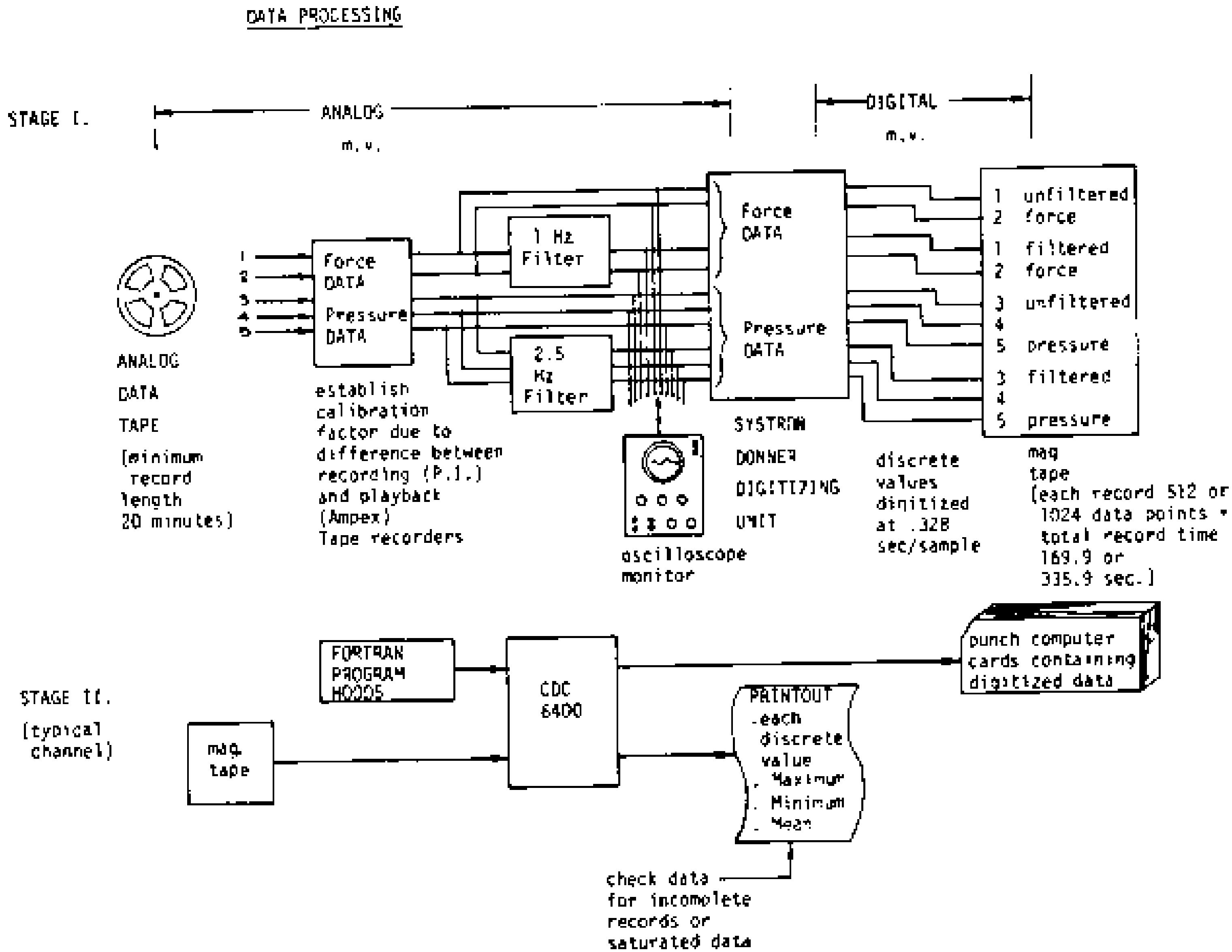


FIGURE 37 . Initial Data Processing

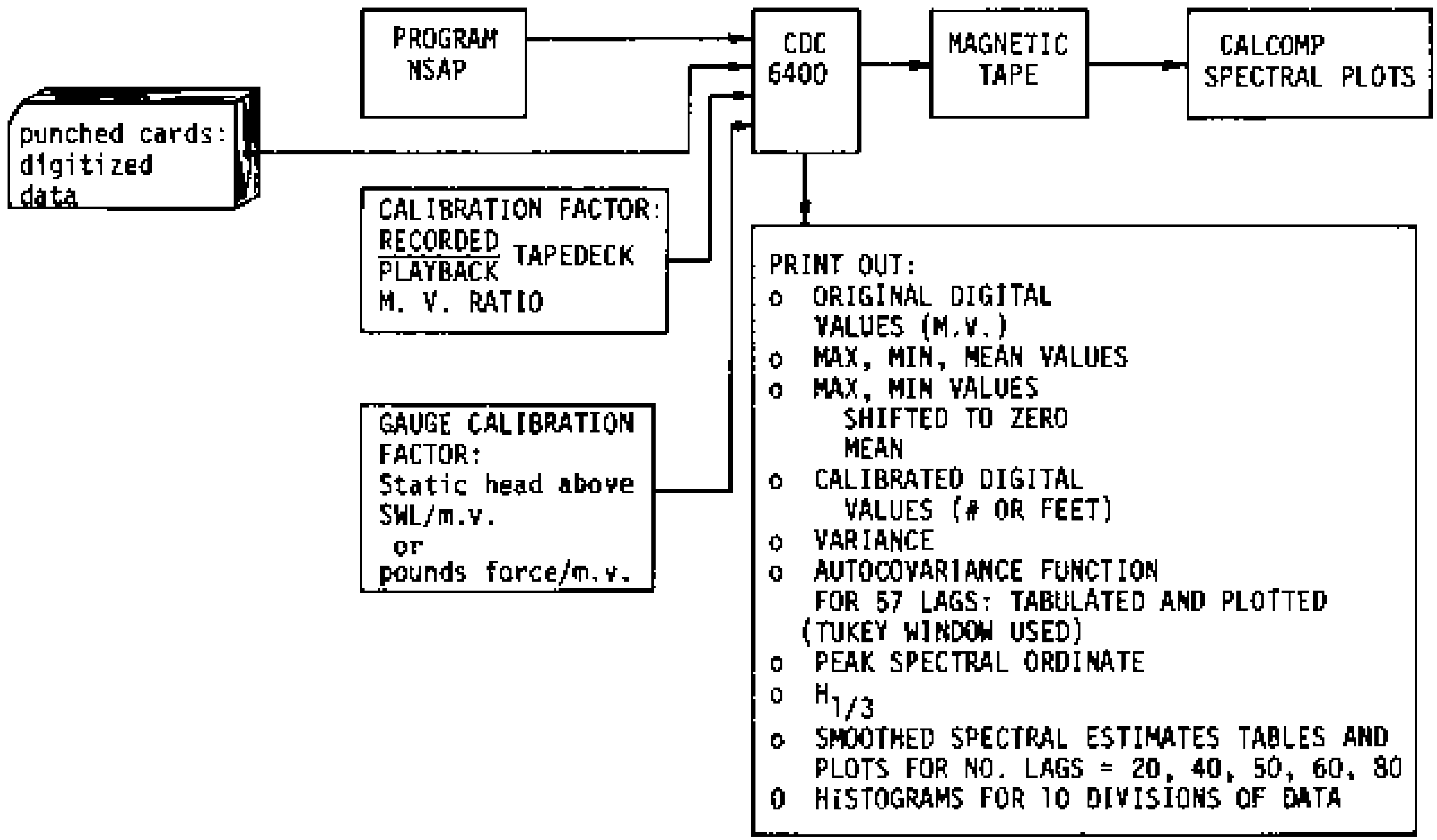


FIGURE 38. FINAL DATA PROCESSING

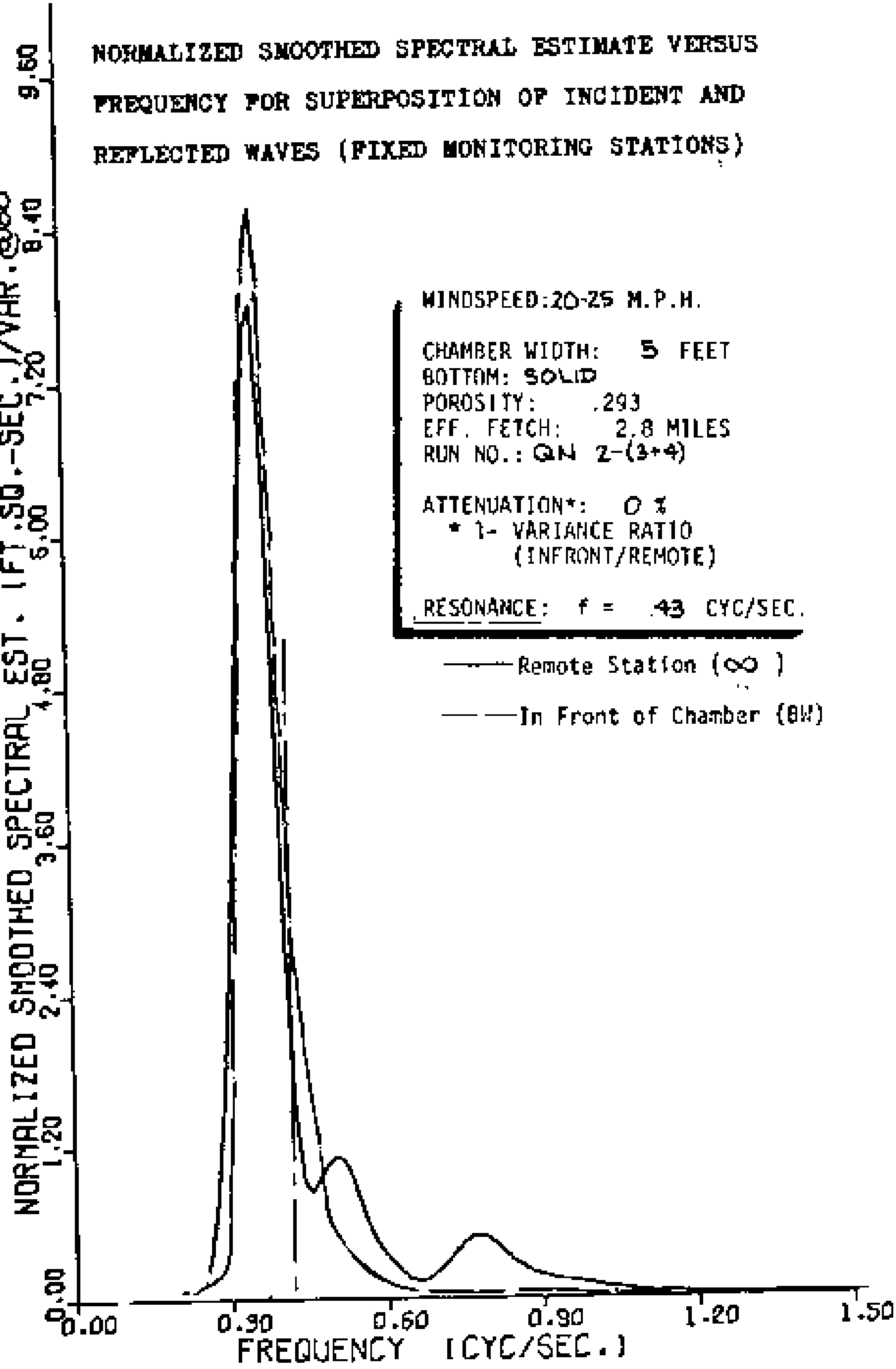


FIGURE 39. SPECTRAL PLOT FOR NYQUIST FREQUENCY EXAMPLE

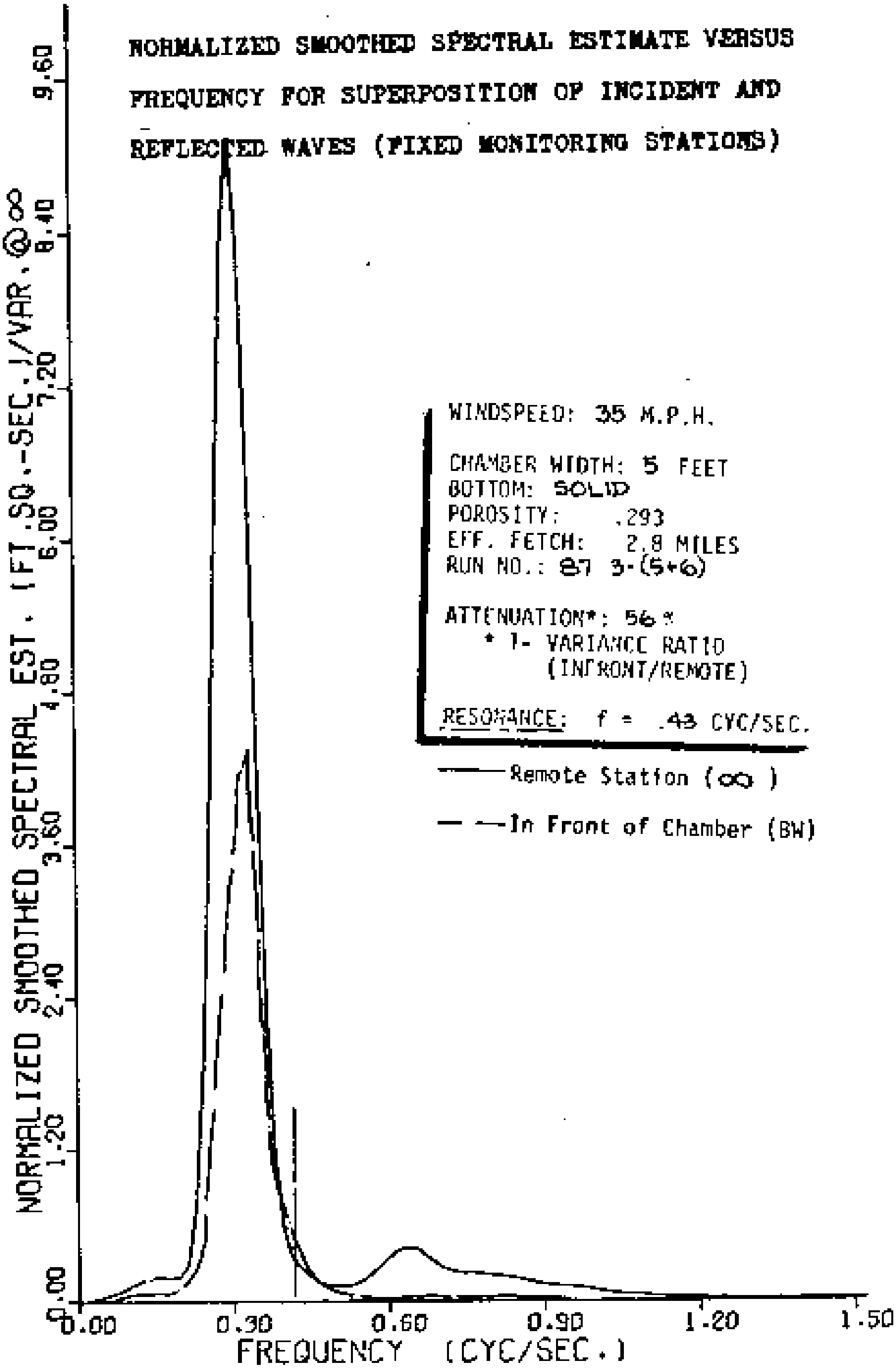


FIGURE 40. SPECTRAL PLOT FOR NYQUIST FREQUENCY EXAMPLE

FIGURE 43 Breakwater Operation. Energy Conversion To Non-Conservative Forms.

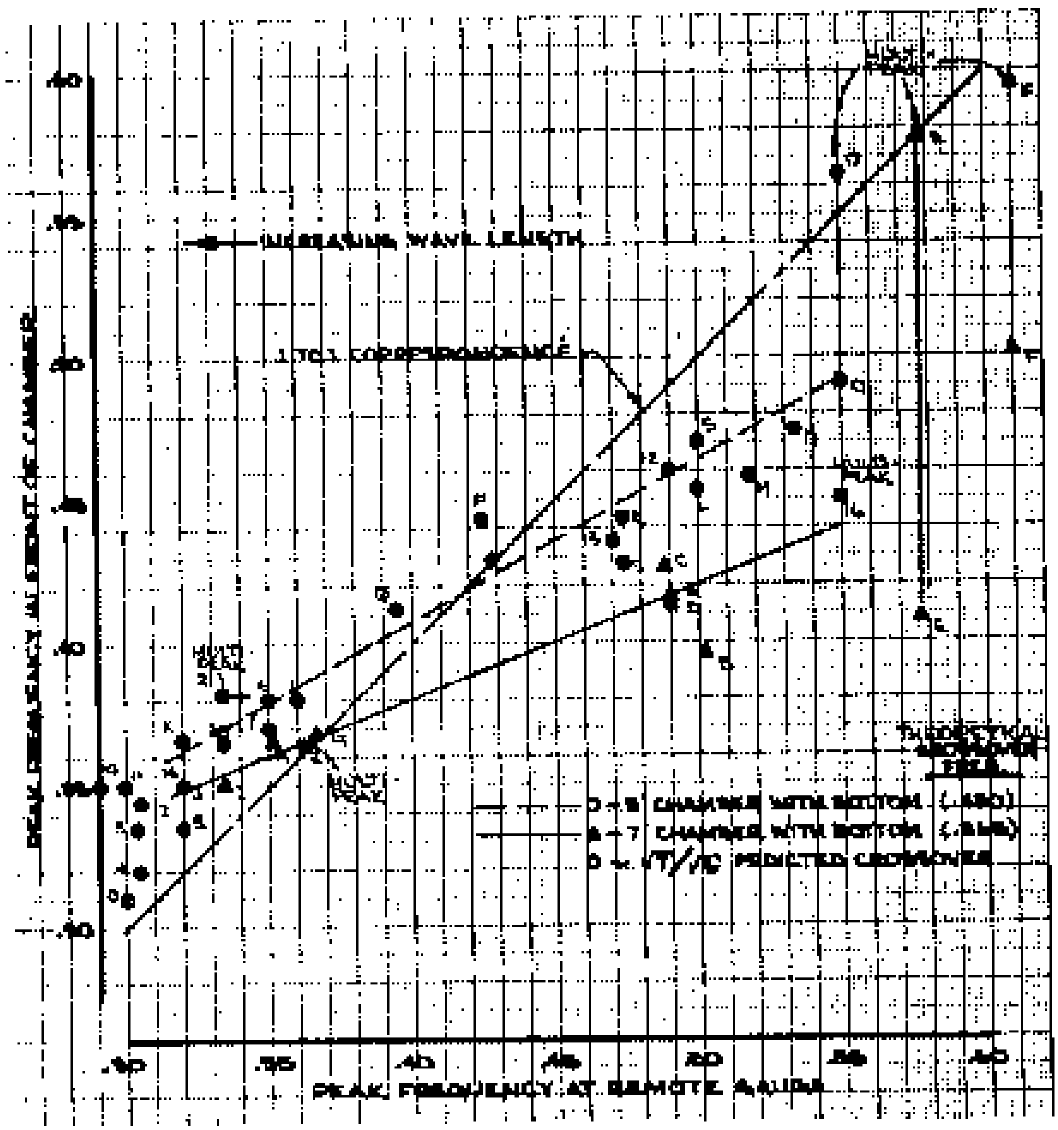


FIGURE 44. Effect of Chamber Width on Peak Frequency; Data and Predicted Crossover Frequencies.

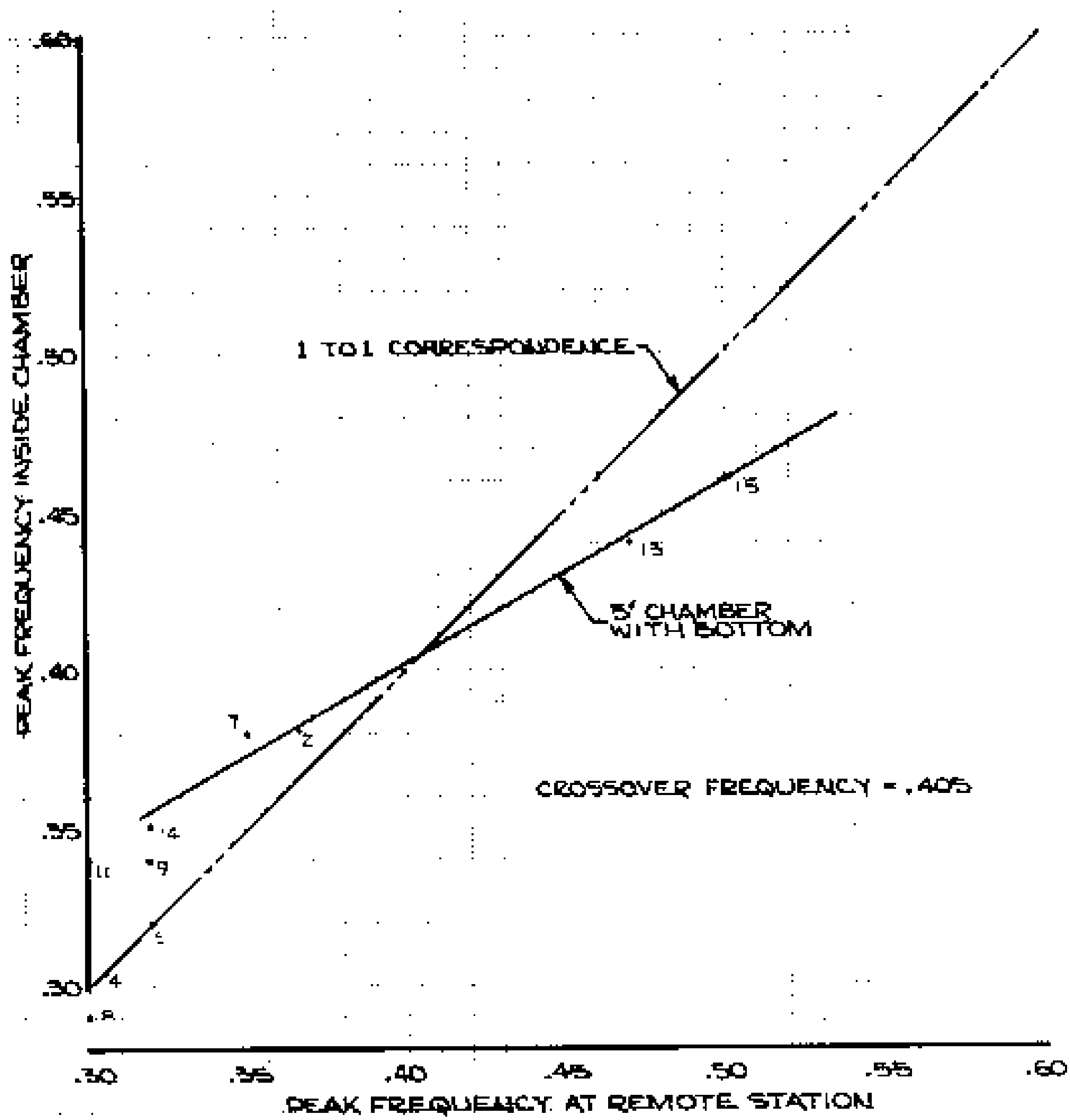


FIGURE 45. PEAK FREQUENCY DISTRIBUTION INSIDE OF FIVE FOOT WIDE CHAMBER WITH SOLID BOTTOM

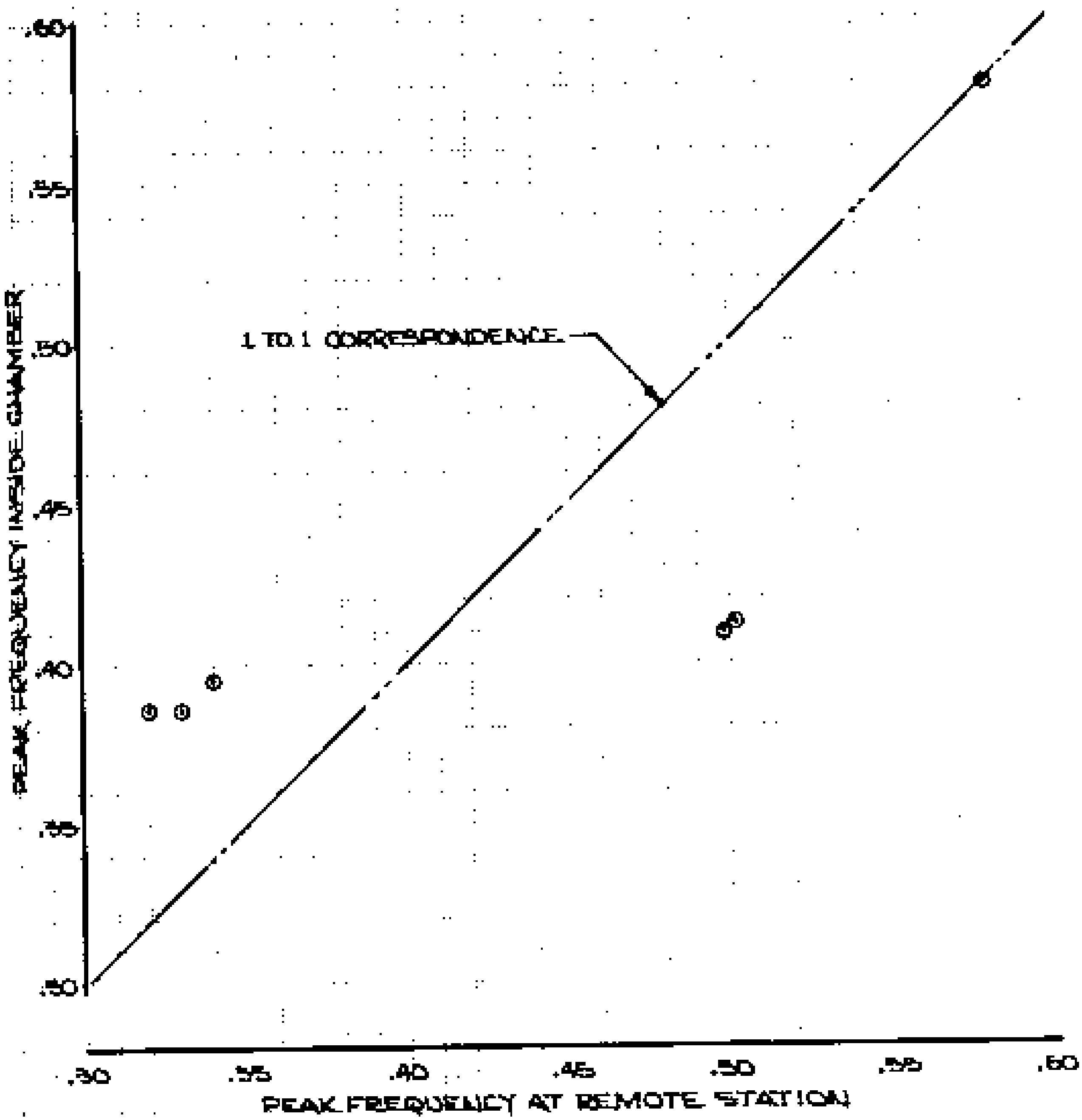


FIGURE 46. PEAK FREQUENCY DISTRIBUTION INSIDE SEVEN FOOT WIDE CHAMBER WITH SOLID BOTTOM

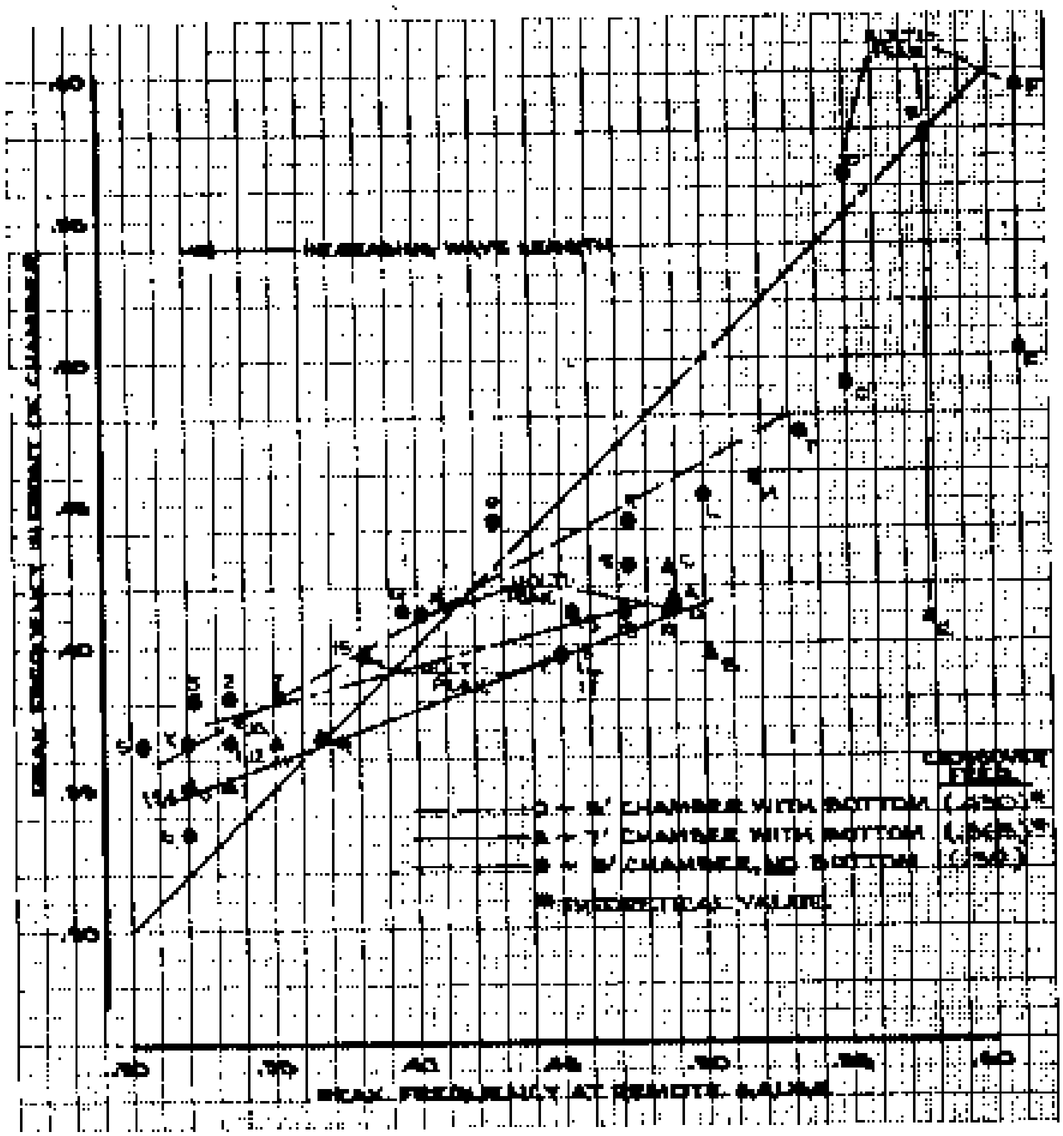


FIGURE 47. Effect of Bottom Removal on Peak Frequency.

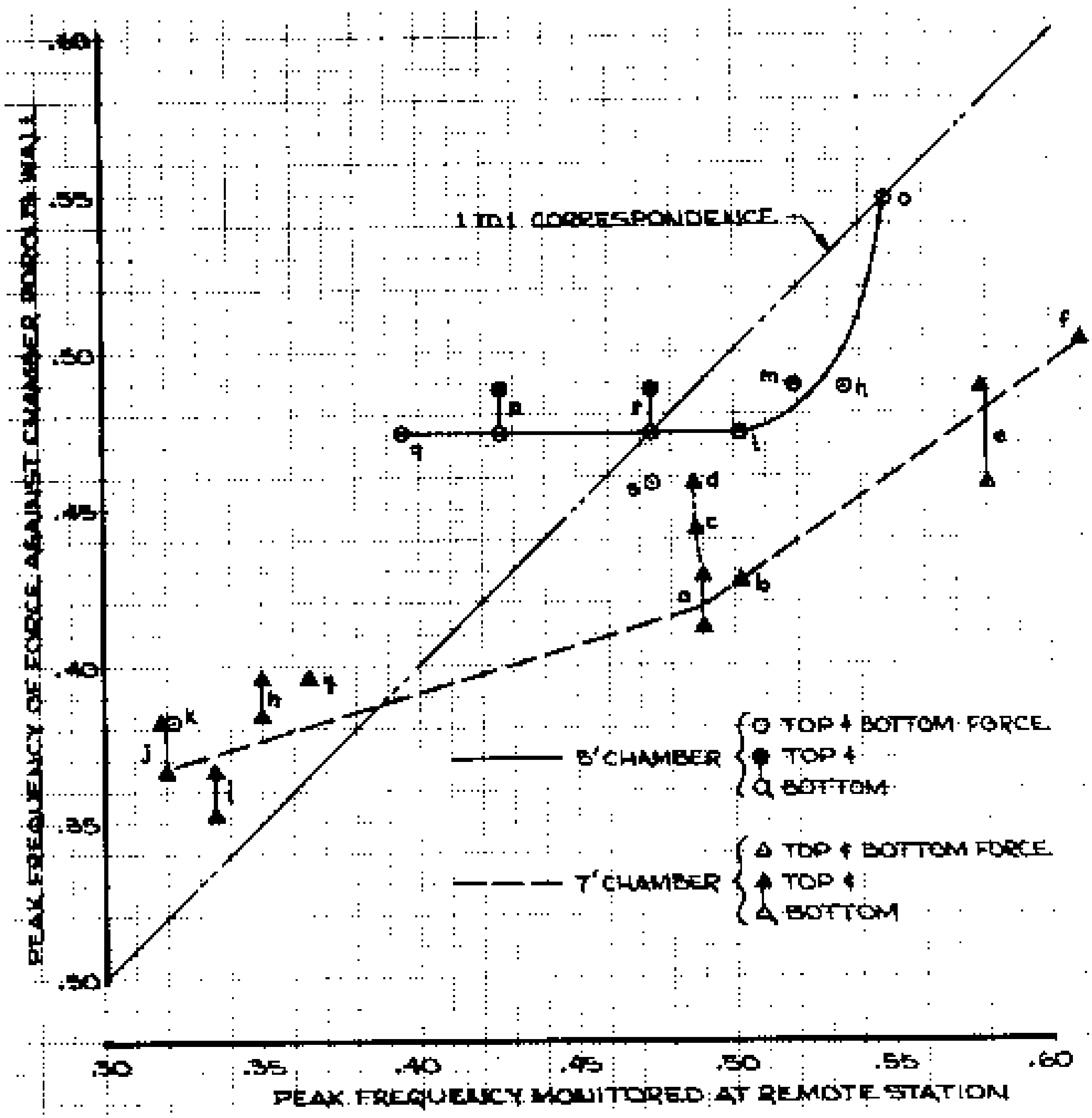


FIGURE 48. PEAK FREQUENCY DISTRIBUTION OF FORCE

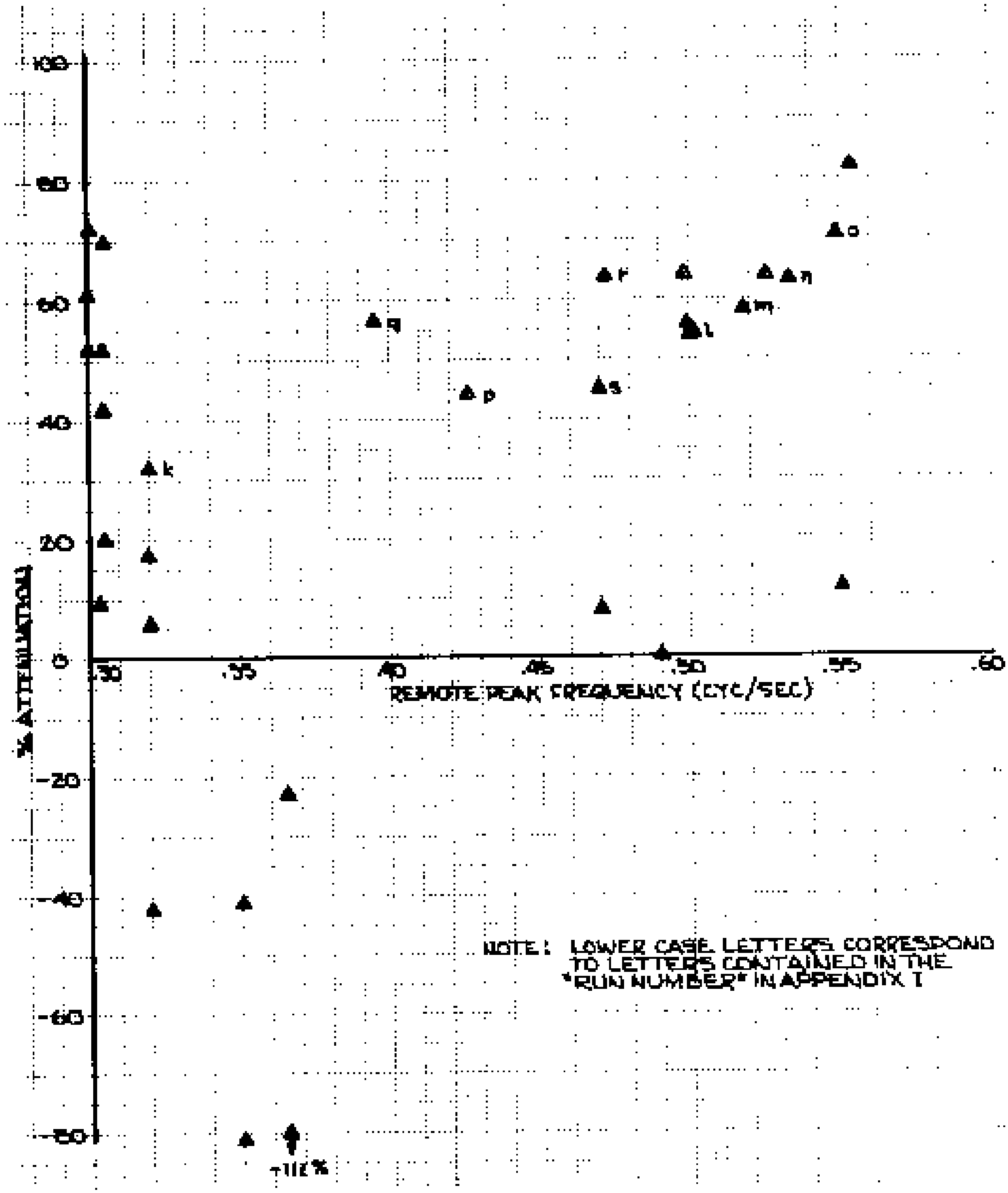


FIGURE 49. % ATTENUATION VS. PEAK FREQUENCY MONITORED AT THE REMOTE STATION FOR CHAMBER WIDTH EQUAL TO FIVE FEET

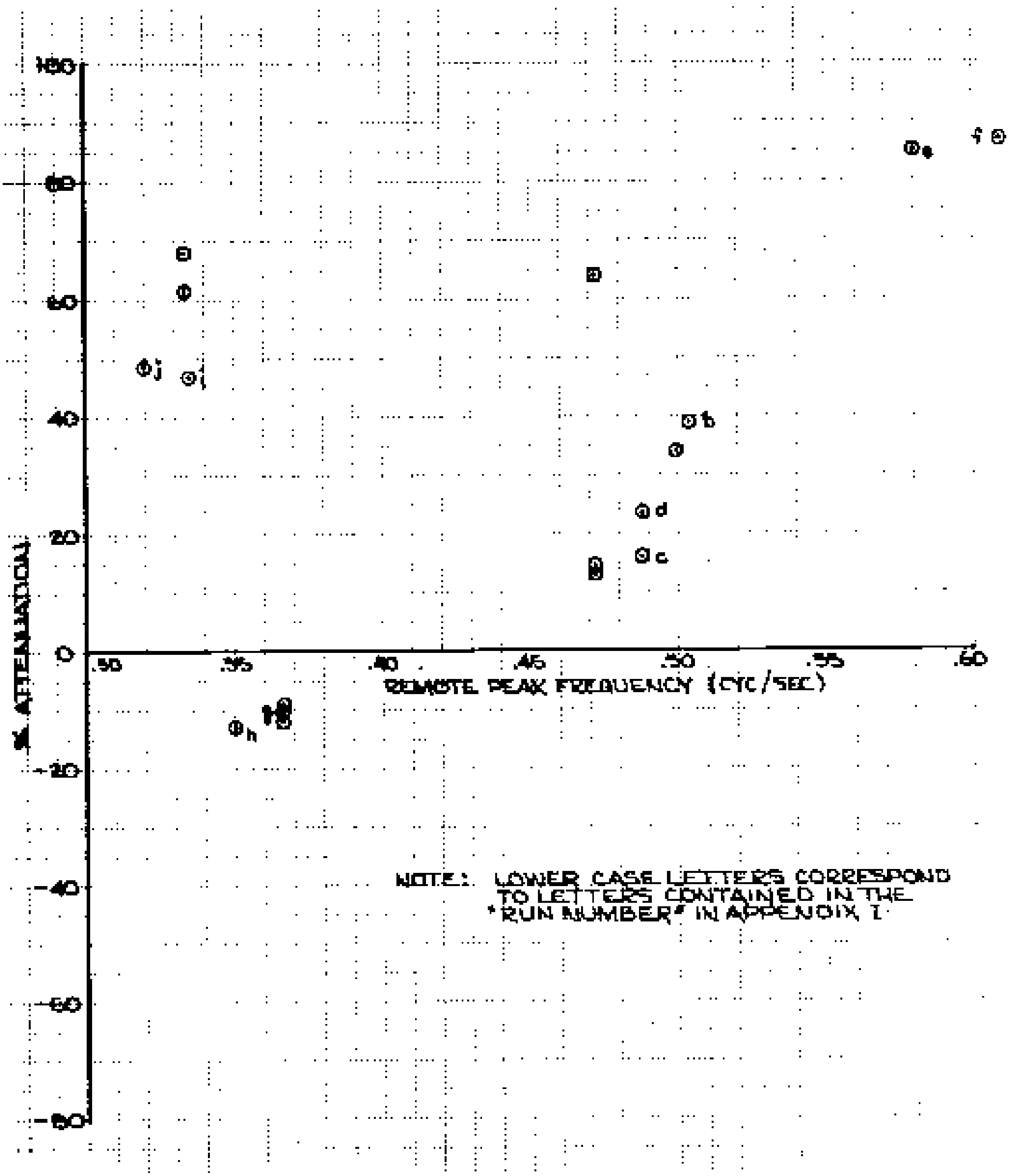


FIGURE 50. % ATTENUATION VS. PEAK FREQUENCY MONITORED AT THE REMOTE STATION FOR CHAMBER WIDTH EQUAL TO SEVEN FEET.

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Note: Appendices I through IV of this report, pages 132-236, containing tabulations and CalComp plots of representative records of various chamber widths and wind conditions, have not been included in the main report. Copies have been filed with the State of Washington, Washington State Highway Commission, Department of Highways, Olympia, Washington.

From: Liam M Stacey [redacted]
Sent: Thursday, September 23, 2010 10:25 PM
To: SR520 Technical Workgroup
Subject: Important note on Traffic calming through Arboretum --

Dear working group members.

I am writing to note a rarely discusses problem about the traffic through the Arboretum drive: Spill over traffic onto the bike route on 28th-26th streets between Madison and Boyer Ave E.

The problem is every morning and evening. Impatient drivers swerve by cyclists on the narrow road. I have witnessed many altercations. Calming the traffic through the Arboretum will not discourage spill over traffic. Only reducing car trips through the arboretum will.

Thank You,

Liam M Stacey
[redacted]

From: Liam M Stacey [redacted]
Sent: Thursday, September 23, 2010 11:05 PM
To: SR520 Technical Workgroup
Subject: Before we assess triggers for second bascule bridge..

Dear Working-group members,

North bound traffic is slowed by the Pacific-Montlake Blvd intersection. Since traffic flow models must assume the behavior of future drivers in future technology automobiles, it is unlikely that we will be able to accurately model the flow until this intersection has attained its future configuration.

The biggest single slowdown for this intersection is the Northbound stoplight, followed by the wait for the North bound Left turn. Here is the simple solution: eliminate intersection access to this husky stadium parking lot:

1. All UW students and Hospital employees who were commuting from the West can and should park in West-campus parking lots, thus eliminating the need for an entrance at this intersection
2. Those commuting from the South can still enter where they do now, and exit by the Husky ticket lines. Those commuting from the north can and should park in North side lots.
3. With the addition of the pedestrian bridge, north bound traffic can run with out stopping until the intersection by the Husky ticket lines
4. Since the intersection would be clear of E-W traffic, the North to West left turn lanes could be extended 1.5 car lengths, and cars could be channelized before the bridge thus reducing the chances of their delaying North bound traffic.

The South Bound Slowdown is largely due to the wait at the intersections on the SR520 overpass, Not due to the lane restriction of the Bascule bridge. Channelizing the bus lane before the bascule bridge, and adding an extra lane on the overpass would speed up South bound transit: Currently cars get bogged by the line to get on to SR520. This could be channelized early, and with the help of an extra lane on the overpass, these drivers could be removed from the Southbound flow.

It may be possible to allow non-sr520 cars to drive in the transit lane of the bascule bridge, by putting a penalizing electronic toll on that lane that would only go into effect if the same car drove on the 520 bridge a short while later.

Liam M Stacey
[redacted]

Greetings -

I regret that I was not in town during the few public meetings in which these issues were discussed. I do have comments to share, so I will do my best to present them here:

Montlake Triangle Charrette:
- Montlake Blvd Overpass: This appears to need an access point on the northwest corner. The structure as currently described - '30 feet wide with a sloping ramp facing south on the westside', does not look inviting to cross, especially when approached from the north or the east. One would have to hike double the length of the ramp just to access the bridge. A simple tweak to address this, is to include a set of wide stairs dropping off the northeast corner, so that one has a choice of direction to approach it from. These stairs should have a 'bike-groove' on the side, like in the original sound transit design.
While it is good to have a totally bikeable ramp with a long gentle slope, there should be stair or terrace options in the opposite direction which the ramp does not serve.
- I would like to see more of a wider 'land-bridge' style crossover for Montlake Boulevard, like the drawing published in the original 520 preferred alternative. The sketch in this document looks very constricting. Ideally, a terraced bank should fan up to the highest point on both sides of the street, so the user can approach and leave from any direction. This will have the added benefit of feeling more safe - less of a feeling of being boxed-in. Wider approach terraces will also better manage the crowds during stadium events.

Bus Stop Locations:
- Option H: This appears to have an error in the design. This option has the very good idea of keeping all the stops on the inside of the Triangle, and thus closer to the light rail stop. However, WHY would a NORTHBOUND bus loop around TWICE? That just does not make sense to me, and that delay would pretty much eliminate this option from the table as it is currently presented. I believe that this is a grave error in this draft, and should be corrected. Please remove this this extra loop, then RE-EVALUATE the timing details in this option. You do not understand how close this couuld be to the ideal bus stop arrangement.
In summary, keep the Northbound routes much the same they are now.
Then let the South-bound routes make an extra turn around the triangle. This should be a free right-turn onto montlake boulevard.
The lane next to the triangle on Montlake Blvd is already an HOV, which could tweaked to allow priority travel to the center lane on the montlake bridge. Now both stops are considerably closer to light rail, and no one has to dash across an at-grade crossing to make a transfer.
This should be the final and ideal arrangement in my opinion. Its travel times would be comparable to the current times, and connections would be vastly improved.
- Options A,B,and C: At the very least, I would push for a mid-block crosswalk. The existing southbound stop by the Medical Center is just too far from the rail station. It also requires an at-grade crossing to make connections from either main campus, or the rail station. I think we should also explore using the existing tunnel near the taxi-pullout - that is, branch an access point off of it that lines up better with the sidewalk and bus stop, in addition to the med-center.

- Option E or F: Please do not use these for general transit routes, as these would slow them down too much with all the turning and looping. A neighborhood shuttle, i.e. serving U-Village and Childrens Hospital, might be allowed to pull into the stadium area and make a short turn-around. This only makes sense if the stadium/triangle is the end-point on the route.

Montlake Lid Turn Lanes and signals for Transit Options:
- Due to the lack of a montlake transit stop, there should be a provision for transit to leave and re-enter the highway, making a stop on the montlake lid stops (stop locations as proposed). This would help certain routes that pass through, but do not go to the u-district or downtown (route 242 for example). This would also help late-night routes fill in service for Montlake/U-district when the dedicated u-district routes are done for the evening. Consider route 255 being able to fill in for the service of route 540 after say 8pm at night, by allowing a stop at the montlake lid. The design of turn lanes and signals should allow for the following two cases:
1) A Bus leaves 520 westbound, then stops at the montake lid stop.
Rather than turning right for the U-district, it just goes straight (crossing all north/south lanes), and gets on the the westbound on-ramp. This would mainly require a signal to support the bus crossing both directions of traffic. This signal would only need be triggered by those routes that use it and only during non-peak times.
2) A Bus leaving 520 eastbound takes the montlake exit, then turns left toward the montlake bridge. It then immediately turns right into the HOV eastbound entrance, making a stop on the montlake lid. This would only require ensuring that the curb is rounded enough for the bus to make a right-turn onto the lid (north-to-east).

Light Rail Accomondation:
- Please clarify that Light Rail and bus transit can definitely share the same lane on the bridge in the future. This is done in the metro bus tunnel downtown, as well as other instances of light rail (consider Portland where light rail is even mixed with regular traffic). There should be no need for bumping buses into general traffic if light rail is added to the bridge.

Thanks for your time. I would appreciate it if you can let me know that you have received and understand my comments. Please let me know if further clarification or discussion might be helpful.

Sincerely,

Kevin Steffa
[redacted]

I strongly object to the proposed design because it is a poor design for transit operations and is completely inadequate for efficient transit operations around the Montlake area.

In particular, the proposed design does not adequately replace the function of the Montlake Flyer freeway station, nor does it allow for reliable or efficient transit north-south transit operation on Montlake Blvd.

I have been a cross-lake transit commuter for many years, including 6 years as a resident in Montlake, attended classes at UW, worked in Redmond and Kirkland, and currently Eastside resident frequently traveling to Seattle. I have frequently used the Montlake Flyer freeway station for over 30 years.

For over 40 years our region's transit riders have had access to the Montlake Flyer freeway station, and this station serves thousands of riders every day – both riders who can walk to their destinations, and those who transfer to buses on Montlake Blvd.

It is not fair or just for transit riders to lose this facility when the freeway right of way is being INCREASED.

It makes no sense to lose this facility when the 520 corridor is being promoted as a bus transit corridor.

It is a bad long-run investment decision for our region not to design the Montlake Flyer freeway station when 2010 is accepted to be the year of peak oil, and Chinese and Indian demand will make oil much more expense and we have to be able to transport people using less fuel.

The Montlake Flyer station permits bus routes from Redmond and Kirkland to downtown Seattle, which run 7 days/week for 18-19 hours/day to provide transfers for riders headed to the Central District, Capital Hill, and the U-District, and walking access to Montlake, Husky Stadium, UW Medical Center and south campus. During times when there isn't enough ridership to justify direct U-District service, transit remains available via the Montlake Flyer station. In addition it permits operation of a high frequency/low wait time service with a transfer, as an alternative to an infrequent service which has to split bus operating hours. Metro estimated that removing the Montlake Flyer station would increase annual operating costs by $5-6 million due to the need for duplicate service. Metro's initial support was contingent on receiving operating funds to compensate, but I don't believe those have been provided.

Routes 43/44 & 48 provide 8 buses/hour in each direction through Montlake, so transfers are readily available.

Furthermore, the design does not provide a good conflict-free route for these transit buses. Northbound the buses are on the outside lane, even until a stop at Shelby St, and then must merge to left turn at Pacific St. Southbound, the buses are intended to remain in the outside lane, but they must conflict with all SOV traffic headed for 520, as both the westbound and eastbound on-ramps are right turns.

I believe that it would be possible to create dedicated north-south transit lanes on Montlake that would function better. With a second bridge, these lanes might be on the far east side for both directions, which would also allow a stop near Link – or they might be center transit lanes with island stops, which might be the only workable approach if there is no second Montlake bridge.

The promise to the Montlake area was not to increase car traffic, but to increase transit use. The present design does not make it easy to provide efficient transit service – it drives up cost, due to elimination of transfers requiring duplication of service, and the service along Montlake has not been optimized.

I strongly urge you to initiate a redesign at Montlake that permits retention of the Montlake Flyer freeway station for through east-west buses, and to design a better north-south route for transit service on Montlake Blvd. If these marching orders are given to engineers they should be able to come up with designs that do that.

Carl Stork
[redacted]

From: thefoodgir[redacted]
Sent: Saturday, September 18, 2010 7:17 PM
To: SR 520 Bridge Replacement & HOV Project
Subject: SR 520 Bridge Replacement and HOV Program Feedback

Sent from:
Address:
City:
State: WA
County:
Zip:
Email: [redacted]
Phone:

Comments:
Please, please, please build for a bridge that will allow for some form of light-rail ready bridge from the start!

Public Comments on the ESSB 6392 Workgroup draft recommendations
Submitted at the Seattle City Council Special Committee on SR 520 meeting
September 13, 2010

Comments below are a summary of verbal comments and are not recorded verbatim.

Comment 1: Paul W. Locke

I'm concerned about costs after the SR 520 bridge is built because of any employees you have to hire. I think if you decide on a rail system across the bridge, you should have a system without any operators. Additionally, any contractor who could do the job right should be able to bid on this project, regardless of their labor agreements and work rules. You must bring down the costs of this project.

Comment 2: Larry Sinnott with Friends of Seattle's Olmsted Parks

The Arboretum has fallen thru the cracks. The ESSB 6392 process has soft spots like the lack of a separate negotiating track for the ABGC, and a lack of representation on the Workgroup board from the Arboretum. When the preferred alternative was announced, the Governor, Council Member Rasmussen and the King County Executive said that this preferred alternative would help protect the Arboretum. However, this left turn will allow traffic to reinvade the Arboretum after construction is complete. This council must tell SDOT to protect the arboretum.

Comment 3: Jorgen Bader with the University District Community Council

The state is taking many acres of land from the MOHAI property, and other parks in the area. It is illegal to divert any funds earned from these properties to anything else than the Seattle Parks and Recreation system.

Comment 4: Genesee Adkins with King County Metro

King County Metro (Metro) Believes that this Workgroup process has given the region a critical opportunity to provide input and for transit agencies to provide design refinement suggestions. Metro's interests in this project are to improve transit reliability, travel times, and to serve key markets. Keeping buses moving is top priority for Metro, and a continuous HOV lane will help support this priority. We hope that you will give strong consideration to design choices that will enhance transit through the SR 520 corridor.

Comment 5: Colleen McAleer with the Laurelhurst Community Council

The importance of the Montlake interchange is vital. 115,000 vehicles pass through this interchange every day, and this impacts all of the neighborhoods in northeast Seattle. The Laurelhurst Community Council does not support this “partial bridge” and we feel that this construction will run out of funds before it reaches the Westside. You should wait to construct this until you can fund the entire bridge.

Comment 6: Jean Amick with the Laurelhurst Community Council

I agree with all comments so far today. We need to be concerned with the Montlake interchange. I think we should make the speed limits slower across the entire SR 520 bridge. I’m also concerned about the plans for triggers for the second bascule bridge, so please continue to pay special attention to that.

Comment 7: Brent White

The bus stops on the Montlake lid do not replace the functionality of the current freeway bus stops. Bus service should run from the eastside to the light rail station. Passengers can then take light rail to their final destinations. If we don’t do this, we will end up spending money unnecessarily, and defeat the point of having a U-Link station in the first place. I also feel that HOV lanes should be on the outside of Montlake Boulevard.

Comment 8: Virginia Gunby with the Ravenna/Bryant Community Council

I’m glad you talked about the funding gap today. I feel that it’s up to the council to seek some answers to the sources of revenue that state will be using. The State Treasurer has said that if SR 520 and I-90 were both tolled, we could receive lower interest rates on the bonds. This is something we must look at. Furthermore, a share of the toll revenue should be used to increase transit on SR 520 and local streets.

Delaying or phasing the Montlake bridge is not consistent with the Council’s Complete Street ordinance that was adopted in 2007. The City of Seattle is national leader in complete street programs and considered a complete street advocate.

We need an HOV lane from 25th Avenue NE to Montlake the area. This will help traffic dramatically.

Reducing traffic through the Arboretum is a very important aspect in this entire plan, and should be respected.

Comment 9: Jonathan Dubman with the Montlake Community Council

I feel that your projections for 2030 are wrong. Our country is moving towards reduced carbon emissions, and the country is looking to Seattle to lead this effort. These projections are stuck in the 20th century, and we need to plan for the future. As for the second bascule bridge, there is no good time to construct this. Doing so will remove views, homes, and would destroy this landmark. We need a new HOV lane that should run from University Village all the way down Pacific. We need reliable, frequent bus service up this corridor from the UW, University Village and Children's Hospital. The state can afford a bridge, but doesn't have enough bonds to get the bridge to I-5. Please use your authority to advocate for state policy that is consistent with what is in the best interest for the public. How much money would we save on not constructing the second draw bridge, and instead, have queue jumps in all directions on Montlake Boulevard?

Comment 10: Chris Brown

The designs for the bascule bridge are fine, but what are your plans for Pacific Street? This is where the bottleneck usually lies. When a bottleneck occurs, the bridge operator doesn't let boats through during backups, resulting in long wait times for watercraft. What exactly is the city council proposing for improvements along Montlake Boulevard when the second bascule bridge is in place? I encourage you to really look at the types of traffic programs that you will put in place to synchronize traffic signals in this area.

Comment 11: Paige Miller with the Arboretum Foundation

The Arboretum is very pleased that the preferred alternative has removed the ramps from the Arboretum. But, it won't do any good to remove these ramps if we don't remove the traffic through the Arboretum. The function of those ramps has been moved to 24th Avenue E and Montlake Boulevard. Because of this, in 2030, there will be more traffic through the Arboretum than there is now. The goal of ABGC and the Arboretum Foundation is to reduce traffic counts below current levels, and not to see it rise. E Lake Washington Boulevard was designed for four thousand vehicles a day. It now has 18 thousand vehicles a day, and it is anticipated that the preferred alternative will result in around 20 thousand vehicles per day. The Arboretum can't handle this, and we need traffic management in place. There are tradeoffs associated with this, but we can't be afraid to examine them. We also feel that tolling should be seriously studied and implemented. The other objective of the Arboretum is to reduce impacts to Foster Island. The increase in width to the bridge across Foster Island will have a huge impact, and we'd like to see this bridge as narrow as possible.

Comment 12: Liam Stacey

We should be producing less concrete and discouraging traffic, as this will be better for the environment. We don't need the second bascule bridge because:

- Drivers might be encouraged to take alternative routes, or use alternative modes of transportation.
- The slow crossing across the Montlake Cut is not a serious problem. It makes the trip safer for pedestrians and cyclists.
- A lightweight pedestrian and bicycle lane can be bolted to the existing bridge.

Additionally, please place the bicycle lane across SR 520 on the south side of the bridge to avoid the elements during storms.

Comment 13: Mark Weed with the Greater Seattle Chamber of Commerce

The data that was presented today relating to E Lake Washington Boulevard was confusing. In the future, I'd like to get the best information possible. The phasing of the Montlake second bascule bridge troubles me. I've heard several different and conflicting sets of statistics about this today, too. The businesses in the area, the University and Children's Hospital will be negatively impacted by this, so it's critical that we receive the most accurate information.

Comment 14: Tim Gould with the Sierra Club

I take issue with subject of transit flyer stop functionality. I think we should look at ways of designing transit stops on lid to and from the westbound direction. Doing this would keep the flyer stop functionality in place. I think we should make two lanes on the bridge transit/HOV only. These lanes would exit to the Montlake Lid, resulting in only four lanes going under Montlake Boulevard. This would reduce the width of the structure, and keep the neighborhood happy.

ESSB 6392: Design Refinements and Transit Connections Workgroup Recommendations Report
Online survey comments received September 13 - 24, 2010

Do you have any comments on the ESSB 6392 draft recommendations report?	
Name	**Open-Ended Response**
Samuel Nelsen	September 24, 2010 Submitted by the Seattle University Crew Alumni Association and the student-directed Seattle University Rowing Team. Contact information is provided at the end of the document. These comments pertain to the proposed alterations to the Montlake Interchange, specifically the area of the Stormwater treatment facility just north of the Montlake lid where currently are found the MOHAI building, parking lot, and surrounding land and shoreline. We would like to submit for your records our interest to work with the City and with the WSDOT in discussing a possible future site for a rowing boathouse/shellhouse for Seattle University. For years this area has been considered an ideal location for such a facility, but for various reasons the site has not been petitioned for since late 1960. The alumni of the program are examining program goals, and are reinitiating the examination of the possibility of this site as a future home for Seattle University's rowing program. After examining the conceptual representations of the proposed transportation developments, it appears that the space along the shore to the east of the treatment facility, and the triangular space just north of the facility to the right of the proposed parking lot, would be excellent areas to build a boathouse. The ideal launching point is on the shore about 150 feet south of the footbridge that crosses to Marsh Island, and is an easy walk from the surrounding land. KEY INITIAL POINTS: -- Rowing is Seattle's Olympic sport, and another high-quality college rowing facility strengthens Seattle's image of being a mecca for the sport; -- Rowing inspires awe in the average passerby. Crews launching from a facility surrounded by green space and public paths increase attraction to the area and diversify local sightseeing opportunities; -- Site has been recognized as an ideal location for a boathouse since late 1960; -- Majority of boating equipment in the rowing facility would be human-powered crafts; -- Site provides sheltered launching area for crews; -- Adjacent body of water to the east, just south of Marsh Island, provides safe enclosed practice area for new rowers; -- Footbridge arch to Marsh Island requires no structural changes to allow crews to pass underneath: the span is wide enough and tall enough to allow the passing of any crew; -- Proposed footpaths along the shore and adjacent to the proposed parking lot can be utilized by athletes carrying boats to and from the boathouse and the water. No additional paths need be created; -- and the site has easy access to the highway system for transportation of rowing shells to away-regattas (races). There are additional reasons and insights that will be shared via alternate formal routes, as necessary, as the discussion continues. These comments are to begin the discussion. They do not represent the viewpoints of the institution of Seattle University, but rather come from the alumni of Seattle University's rowing program and the members of the student-managed rowing program itself. While we have no intention of asking the City or the WSDOT to alter or adjust their proposals for the transportation routes, we do believe that certain adjacent areas are, and can still be, mutually beneficial sites for a potential boathouse. Thank you for your time, and we look forward to furthering the discussion. This document is being submitted by Samuel Nelsen, who can be reached via phone at (415) 342-2284, and via email at samnelsen@gmail.com.
Scot Merrick, M.D.	I was recently able to attend the Sept. 9, 2010 meeting (only because I was on a long Labor Day vacation, as the meeting is during normal work hours). I am shocked to find that the "Preferred Alternative" for the west side has changed significantly from the A+ option that the Montlake Community was made aware of at the Nov. 24, 2009 meeting. The new design has been vetted without any local neighborhood input or advanced knowledge. It calls for a major On-Off ramp at the junction of East Lake Washington Blvd. and 24th Ave. E. The homes immediately adjacent to this ramp will have unacceptable exposure to noise, carbon monoxide and dangerous traffic. The concept of left turns at this off-ramp on to the boulevard will lead to serious congestion, dangerous pedestrian/bicycle crossings and potentially interfere with emergency vehicle access to the local residents in peak traffic, Husky football games, etc. This has not been adequately studied or presented to the local community. Why should residences at this junction pay the most of ANY along 520, when we have already suffered from the destruction of our environment by the current 520? More respect and consideration should be given to the residents along East Lake Washington Blvd--the true ground zero of this project. It would be far better to have any on-off access to the Preferred Alternative to occur in the current arboretum area, farther away from the residences and an area when left or right turns can be engineered with far less impact on pedestrians, bicyclists and the like, not to mention moving the noise AWAY from the residences. As a homeowner along the boulevard, the meeting struck me as a discussion amongst special interest groups, who are able to send representatives (most likely with financial remuneration) to argue their point. For those of us who work, the majority of the 520 meetings are not possible to attend as they have been scheduled during regular working hours. My family built (1920) and have owned a home at the proposed boulevard ramp. It is outrageously unfair to us to do anything but restore the area to what is was before 520, as much as possible. We have lived with noise and pollution in excess of Federal standards since 1963, not to mention the property devaluation of an historic residence. The proposed option will do little to remedy that and has not been fairly presented to the neighbors--the ramp design in its current location is not acceptable and MUST be moved east the arboretum area.
Jill Heijer	520 Design Group, I am very concerned about the privacy on the bike trail and on the local trail for the houses around the trails. I would like to see total privacy by large hedges that will blends into the natural surrounding but planted close enough and have the ability to grow high enough to act like a wall to give privacy to the residence along the paths. I am happy to see that the bike path is now under the street across the 520 West onramp area. I do not understand fully the area at the end of Fairweather Basin. I am highly concerned with the landscaping of the two lots purchased by DOT at the end of the Basin. I would like to see how DOT is going to replicate the private park like setting that was the heart of that basin. I understand that many large trees over 30 feet high are going to be removed for that surrounding area and they need to be replace with new large trees. The freeway was not visible from the basin area and I understand that a large sound wall with a retention wall below will be added to this area. This wall needs to be terraced to be able to landscape in front of it at different levels to continue to keep the park like natural setting of the area and to keep the area a "Tree City" , which it has been for over 50 years. The wall along this area needs to be visual appealing as it is a large part of the basin quality of life. I think that the staggered formation and soft gray color of the wall around the new Seattle Sculpture Park would be a good template for the wall along the Fairweather Basin area. I am willing to be on any committee to help with the design in the Fairweather area. Please let me know how I can be involved and help with the design. Thanks so much, Jill Heijer
John Albert	DON'T BUILD THIS BRIDGE!!!!!!!!!!! Two lanes on 520 should be dedicated to mass transit/ light rail. The footprint should remain as is but 1 lane of all purpose traffic each way and 1 lane for mass transit each way. We need to think about a city/county/statewide transportation plan built around mass transit... like every other major urban area has already done. The second bascule bridge should not be included. There is no evidence that it significantly helps traffic. Your defacing a land mark for little to no benefit. Traffic calming for the Arboretum would be wonderful but how can you say the moving of the Lake Washington BLvd ramps has no impact on local traffic. Approximately 70% of the Arboretum traffic enters 520 via the LWB ramps, once ramps are moved northwest that traffic will now be in front of houses on Lake Washington Bvd. It is terrible that all of this work is being done behind the scenes with the University and the Arboretum. There needs to be a seat at the table for the effected neighborhoods.
Luke	For the regional path to the burke-gilman trail/UW, please avoid the solution that widens sidewalks. Any high-volume cycling/pedestrian shared path, like this will be, invariably causes conflicts between the two groups when the spaced shared is small. In New York, for instance, even when shared paths are wide, in high traffic areas cyclist speed and pedestrian unpredictability do not mix well.
David Seater	I'm concerned about the transit design for people living in north/east Capitol Hill and commuting to the Eastside. Currently, this is a fairly easy transfer from the 43 or 48 to the eastbound 520 flyer stop, giving access to core routes like the 545, 255, and many other commuter routes. Returning, the transfer is not quite as easy and requires walking up the hill from the westbound 520 flyer stop, crossing 520 on Montlake, then either waiting through three crosswalks or going down the stairs to cross under Montlake and come back up. In the new design these transfers are not possible. The 545, 255, and commuter routes originating in downtown Seattle will not be able to provide service at Montlake, cutting off those who transfer from the 43, 48, or other routes. While there are new stops provided on the Montlake lid HOV lanes, bus service through those stops will either require duplicating existing Seattle <-> Eastside routes with UW <-> Eastside routes, a dramatic reduction in service frequency, or a combination of the two. To avoid unnecessarily duplicating service, accommodations should be made to allow transfers to and from buses running along 520. Bi-directional HOV on- and off-ramps could accomplish this. Additionally, the new design does not provide fast, reliable transit service to the new Link light Rail station. Buses coming from 520 or Montlake will have to wait in traffic to cross the Montlake bridge, and after crossing will not have a stop providing

Do you have any comments on the ESSB 6392 draft recommendations report?	
Name	**Open-Ended Response**
Daniel Liebling	RE: Closure of Montlake Flyer bus stops affecting transit routes ST545 and MT242 I work at Microsoft in Redmond and live in Greenwood, Seattle. I currently bike about 6 miles to Montlake every day and catch either the ST545 or MT242 to Redmond. By my own count I have taken over 3,000 transit trips over 8 years of commuting, so I believe I speak with some experience. Every day as I wait at the Eastbound stop on SR-520, there are around a dozen people waiting for the 545, despite this route running approximately every 10 minutes at peak times. Furthermore, there is typically a line of several cyclists waiting to Redmond or at least across SR-520. This line can be 10 deep during the summer when cycling is more popular. Microsoft Commute notified us that these routes would "no longer make a stop in Montlake." I cannot find an explicit reference to this on the ESSB 6392 site. The transit maps do note stations on the lid, but I can't see how an east- or west-bound bus on SR-520 would stop there. If this is correct, I think it is a mistake given the large volume of transit commuters that use the Montlake Flyer stops. At the very least, those routes should be altered to serve the Montlake neighborhood. Under the proposal, MT242 could be rerouted (which might be faster given the typical delays on I-5 S/B in AM) to Montlake from 65th St P&R, via NE Ravenna Blvd, 15th Ave NE, NE Pacfic and NE Montlake Blvd to allow
	Eliminating the Montlake Station eliminates the express routes from Redmond and Bellevue to the University of Washington. If this stop is not added somewhere else on the route, this is a major takeback from our community, especially those of us who commute regularly to the University (including my own children), and ultimately puts more cars on the road. I can't believe that's even being considered as an option.
Jack Whisner	WSDOT re ESSB 6392: The program is under funded in three major ways: the capital program is short $2B; the loss of the Montlake freeway stops is inadequately mitigated due to a lack of service subsidy; and, the Montlake Triangle solution suggested by the UW is short many millions. Where will the necessary funding be found? That must be answered by the Legislature; they have the big highway dreams. A partial solution would be for the Legislature to quickly and more comprehensively implement dynamic tolling of all the limited access highways in King, Pierce, and Snohomish County. It primary objective could be demand management; highway flow could be maintained at 45 mph. all modes would benefit with better speed and reliability. The current course of the Legislature is to focus tollling on revenue generation and to do so in a timid manner. Systemwide dynamic tolling would include all lanes on both translake bridges. The Legislative direction to study HOT lanes on I-90 is backwards; there is little demand for priced roadways in the peak direction, given the I-90 express lanes; the congestion in in the reverse peak direction. The congested lanes should be tolled. This is true on I-5, another corridor in need of $2 billion for rehab. The application of dynamic tolling to SR-520 may provide the opportunity to reduce the scale of the project. The six-lane profile is mandated by the Legislature. All the westside options require the loss of the Montlake freeways stops. This is a terrible policy. If frequent all-day transit routes are to be provided on SR-520 to and from downtown Seattle, then there should be a transfer point. The WSDOT sponsored SR-520 HCT study calls for several routes to be elevated to BRT service levels; there is no available stream of service subsidy. The preferred Montlake interchange is clever, but not affordable and a failure due to the loss of the Montlake freeway stops. riders between Seattle south of the Cut and eastside buses are harmed the most. One solution would be to make the center two lanes transit only between the general purpose on and off ramps east of Montlake Boulevard and the westbound general purpose on ramp. the center transit lanes would rise to a signalized intersection with Montlake Boulevard. the freeway stops would be on the ramps east of Montlake Boulevard cantilevered over the regular lanes. the routes oriented to and from downtown and the routes orient to and from the U District would all serve the stops in both directions. Yes, the HOV traffic would have to weave out of the transit lanes in the Montlake area (or sit through the in-lane stops and signals), but that would be OK, as the four tolled lanes will be free flow and so much traffic is oriented to and from the U District that four lanes will be sufficient capacity. This solution would be less costly and more effective. The transit agencies do not, and probably will not, have sufficient service subsidy to mitigate the loss of the Montlake freeway stops; this is especially true at off peak times when current service headways are the longest. The program also includes a reversible connection between SR-520 and the I-5 reversible lanes. This is also clever, but flawed. The 1997 WSDOT OUM Predesign studies asserted that there were 3.5 lanes of traffic in that section of the reversibles. There is a choke point on the I-5 reversibles at SR-522, but the SR-520 connection would add a second chokepoint. There are more transit trips with higher loads going from and to the north on I-5 than on SR-520. Perhaps the reversible connection portion of the project should await the implementation of north Link to Northgate when the number of I-5 bus trips can be reduced. The Montlake Triangle solution must be found quickly. The U Link opening is expected in 2016. A solution with less civil construction would be less costly and less disruptive. Also, the Legislative study asked for an examination of the connection between U Link and the SR-520 buses; a more important transfer connection is between Steven Way bus routes and U Link. the walk is longer and the number of riders greater. Thank you for considering this note.
Chris Bryant	It is unacceptable that the recommendations provide no continuation of bus transit stops on the SR 520 roadway at the Montlake interchange. I am among hundreds of commuters every day who utilize the eastbound and westbound SR-520 flyer stops for transit from the Montlake area to the Eastside and to Downtown Seattle. Many of these commuters are transferring from one route to another, a situation that will be adversely impacted if there is no transfer station present, and/or if there is additional required walking between stops. Because the recommendation is unclear about how transit times from the Montlake interchange will be impacted by the reduction/elimination of bus stops on the SR-520 roadway - it is a major oversight and should not be approved.
Vadim Meleshuk	ST545 bus pull out stop is absolutely critical for me. We recently bought a house in Montlake just so that we can conveniently take ST545. If the bus stop is removed and the route is replaced with a new UW<->Redmond bus, my top priority is scheduling frequency matching that of 545 - every 10 minutes during the rush hour.
	I ride the Sound Transit 545 virtually every day from Redmond to Montlake, and I was very disappointed to see that the preferred route eliminates the Montlake freeway stops. I personally transfer from the 545 to the 43/48, and I see a large number of people daily who make the same transfer, or transfer to one of the routes going North from Montlake. It is very important to me for those transfers to be as convenient as they are now. It would be unfortunate to force a route like the ST545 to get off the highway at Montlake in order to let passengers off. It would be even worse for it to skip the Montlake stop entirely. I hope there is a way to solve this problem. Thank you!
Mauricio Gonzalez de la Fuente	Top-line: No real need for an expanded bridge. Keep the footprint as is. Just moved from the Sammamish to Seattle and since my move, I have become a Sound Transit aficionado. I went from driving every day to work to taking the 545 bus every day. I am saving $7-8 a day in gas alone and I shaved 10 - 15 minutes to my commute. I never thought that moving to the city will have such an advantage. After having been an advocate of a replacement and expansion of the 520 bridge, I no longer see the point having discovered the benefits of the bus service. Why not just build a bridge that is identical to the one we have today? Why not encourage people to take the bus? Why not expand the bus service and save ourselves a large part of the 4B cost of the proposed bridge? And if you build the bridge, why not optimize for mass transit? The specs that I see listed do not accommodate for greater bus service and do too much to encourage single ocupancy vehicles. I am certain that you all have done a tremendous job planning for what is a very challenging project. I am your typical customer. My daughter goes to school on the East Side (now using the school bus) and I work on the East Side but I no longer see the point of an expended bridge when there are more affordable and convenient options. Thank you for all the work you do. I hope that a smaller, less expensive bridge with greater focus on mass transit becomes a viable option to the massive bridge I see in the current plan. If you are interested in discussing my scenario further I would be more than happy to meet with you. I am a strong believer in the freedom that a car can give us all but I feel a greater sense of freedom when I arrive at home and see the car, covered in tree sap and realize that I have an extra $7 that used to go to pay for gas sitting in my pocket! Thank you very much for this very informative site. Thank you, Mauricio Gonzalez de la Fuente (family of 3, dad works at Microsoft and commutes by bus, daughter at Overlake School in Redmond and takes school bus, wife works from home)
Angela Liao	As a Seattle resident commuting to Redmond via the 545, I disagree with the direction of the reversible transit/HOV ramp to the I-5 express lanes; headed from the Eastside to downtown Seattle in the morning and from downtown Seattle to the Eastside in the evening, as we often see many buses piled up in in the junction heading to Redmond in the morning, and heading back to Seattle in the pm. Would like to ask for consideration of the ratio of bus commuters vs. car commuters in making this decision, and ask that we encourage more bus usage.

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Name	**Open-Ended Response**
Gerrit Saylor	The ESSB 6392 "Transit connections: bus stop locations" white paper defines a criteria for the Montlake Interchange stop : "Does the location of the Montlake interchange stops provide a convenient transfer point between local bus service on Montlake Boulevard and regional bus service on SR 520?" With the elimnation of the Montlake Flyer stop, the recommended options A, B, & C do not actually provide a convenient transfer point to regional bus traffic. Unfortunately there is no HOV/transit exit at the Montlake interchange for any eastbound bus originating from either north or south I-5 locations. While the actual stop may be a reasonably convenient location it serverely restricts the transit options for passengers boarding at Montlake for Eastside destinations due to shortsightedness in the eastbound HOV exit options. As an example, this removes the ability of any riders from North Capitol Hill, Montlake, and Madison Park from being able to catch ST545 to the Overlake P&R and the major employment center around the Microsoft Campus.
	This report was doomed to failure from the outset, as the working groups are stacked with people who do not represent the population of the Eastside, or Puget Sound in general. This working group is predominantly Seattle based, and mass-transit centric, when the largest segment of the population using I-520 is not - they are Puget Sound based, and CAR centric. Thus, the largest user base has been left out of these considerations. And it clearly shows in the results. The primary purpose of this highway and bridge is to expedite the transport of cars, trucks, and buses, in that priority order, between I-5 and I-405. Absolutely nothing should be done which in any way will constrain or restrict this primary mission. Unfortunately, the planning group seems to have missed this clear mission statement from the outset. For example, there should be a full six lanes (4 general purpose and 2 HOV) completely connecting I-5 to I-405. This means no reduction of lanes at any point, including on/off ramps, or for future light rail considerations (which should be net additions, and not conversions or replacements). There also should be no reduction in speed limits, as faster speeds accommodate greater volumes of traffic. The six-lane configuration is already a compromise between Seattle and the Greater Eastside, which by and large demanded 8 lanes, and therefore absolutely no further compromise on the capacity or throughput is acceptable!!! Six full lanes IS your reduction. Since cost is a very serious issue, every attempt to control costs that are consistent with the primary mission of moving cars, trucks, and buses, in that priority order, should be made. This means that expensive lids, extra bridges which are not I-520 traffic bridges (e.g. Bascule), bicycle lanes, and fancy interchanges that are not directly part of I-520 (such as MTC), should be eliminated. Stop spending taxpayer money like it grows on trees! These are expensive design extensions that do nothing to facilitate greater capacity and faster movement of traffic on I-520. All such frivolous expenses need to be eliminated immediately! Remember folks - this 6 lane bridge is already a very serious compromise between the minority interests (i.e. City of Seattle, King County Metro, University of Washington, Sound Transit) and the majority interests (i.e. residents of Puget Sound, including Bellevue and the entire Greater Eastside). There are more than 3 million people in the Puget Sound Region, only 0.5 million of which live in Seattle. And virtually every one of those 3 million people has a car and/or a drivers license. If you hope to have acceptance by the majority of the people impacted by, and paying for, this bridge replacement, you need to stop this tail-wagging-the-dog exercise in financial excess, and get back to the primary mission for this bridge: moving cars, trucks, and buses, in that priority order, between I-5 and I-405. Attempts to fund this bridge replacement will run into serious opposition, possibly even failure, because you have completely ignored the desires of the many, and catered to the excess wishes of the few.
Maxim Oustiougov	1) It appears that there is no way to get onto buses traveling from downtown Seattle - such as 545. This will make bus travel very inconvenient, and potentially unfeasible to a big group of people - there are hundreds of us boarding 545 at Montlake every day. I'm one of them. 2) It appears that the Lk Washington Blvd entry onto 520-East has been eliminated. It is not clear how the new redesigned entry at Montlake Blvd would accomodate increased traffic - there are two lanes coming into the tunnel, but then they merge with existing 3 lanes of traffic into... 3 lanes. I don't see how this would make things any better for any motorist traveling on 520 - and it will make it worse for those of us living closer to Lk Washington Blvd.
Kevin Strharsky	please please please please do not eliminate the Montlake Flyer Station stop. it is a major passage way from the east side to seattle if you ride a bicycle .
	Elimination of a 520 freeway bus stop at Montlake is extremely short-sighted, regardless of the new configuration of the freeway. This stop is heavily used by commuters from the Eastside who, contrary to transit planners in Puget Sound, don't want to always go downtown as a destination or to connect to other transit.
Bruce Long	Eliminating the Montlake Flyer Station eliminates one of my emergency routes home. I normally ride the Microsoft Connector between Seattle and Redmond but if I have to work late or if there were a mid-day emergency, my best option to get home from Redmond to either NW Seattle or my daughter's school on Capitol Hill is to take Sound Transit 545 or Metro 242 to the Montlake Flyer Station and transfer to Metro 48. The time I have chosen this commute option I have noticed several other passengers making the same transfer. Eliminating this station would certainly impact people who work on the east side and take night classes at the UW as well.
Jack Nichols	I'm glad to see that we're finally moving forward with replacing the bridge. It's currently a disaster, particularly for transit that gets backed up trying to cross the bridge. I'm disappointed however that nothing is being done to address the issue of getting on EB 520 from SB I5. The current traffic situation is bad and getting worse, and this plan does nothing to make it better. The problem is that to get on EB 520, you have to be in the far left lane. Within the mile or two north of 520, there are numerous onramps that approach from the far right lane (as well as a few from the left lane). Everyone getting on 520 that has the misfortune of accessing I5 from the right side onramps - particularly those on the 45th and 50th St onramps - has to get across all 4 lanes of traffic to get to 520. The net effect is a giant bottleneck that usually backs up to Northgate at all hours of the day because people are trying to criss-cross the lanes of I5 to access 520 while some people are trying to criss-cross the other way to get to downtown. It's a mess. I've heard various government officials maintain in the paper and such that "most people go to downtown." I assure you that's not the case. One of our largest regional employers - Microsoft - is not in downtown, and all those cars must cross 520 to get there. A large number of MSFT employees live in North Seattle, and even for those of us that take transit (as I do), we are still screwed over by the I5 to 520 onramp configuration. MSFT is not the only employer impacted by this - Bellevue and Redmond in particular have firms that have a large number of employees that live in North Seattle. It would be great to see this issue addressed in the plan. Some possible ideas include: allow EB 520 traffic to enter from the right lane of SB I5 as well as the left lane (via a flyover); allow EB 520 traffic, specifically busses, to enter from the SB I5 express lanes and get the freeway at 45th or 50th; add a second bus-only lane to access 520 from the current configuration. I'm sure there are other ideas, but the bottom line is that 520 and North Seattle need to be treated with the same level of attention that South Seattle and I90 have in the past few years. Most of the recent transit improvements (Link, Sounder, etc.) do nothing for those of us that live in North Seattle. Thanks.
	By removing the montlake stop for Bus ST566 you are eliminating my way to use public transportation to work and back. Microsoft does not have a connector that goes to the Bellevue location. Please do not remove the Montlake stop.
Manuel Fahndrich	Eliminating the transit bus stops at 520 & Montlake is a really bad idea. Myself and many people commuting between Redmond/Bellevue and Seattle rely on those stops in their daily commute.
Jeremy Braun	The Montlake bus stop (the Flyer station) provides valuable commuter access to East/West buses for several core residential neighborhoods of Seattle. Please do not remove it.
Shiv	there should be a way to catch the 545 on/near montlake

Do you have any comments on the ESSB 6392 draft recommendations report?	
Name	**Open-Ended Response**
Jason Torla	I am a frequent transit rider at the montlake 520 stop. Every work day I bicycle from my neighborhood in Fremont to catch a bus across 520 that stops at Montlake (taking advantage of the bicycle lockers at montlake). I am hearing a buzz that the new 520 design will not support a stop at montlake for some of the express busses that go across 520. This is not an acceptable design in my mind. Every time I board the bus (or disembark from the bus at montlake), I am boarding with at least a dozen other riders. The alternative for me to catch the next best stop would add at least 50% to my overall commute. This transit method is popular. I know and see dozens of other riders/cyclists who do the same commute every day. A plan that doesn't accomodate this in the future plans would mess up our commutes.
Kimber Keagle	To whom it may concern, I understand that the preferred alternative eliminates the Montlake Flyer Station on SR 520. This is a huge detriment to bus commuters in the Montlake neighborhood, and other transfer commuters who heavily rely on this popular bus stop. My husband and I catch the bus from the Montlake Flyer Station EVERY WEEKDAY. We purchased a house in the neighborhood 8 years ago specifically because of this bus stop, since neither of us drive to work. We have a 10 minute walk to the Montlake Flyer Station which gives us access to express buses downtown Seattle and to the east side. Almost every day I encounter a neighbor at the Montlake Flyer Station, but more importantly I witness the large number of people waiting at the bus stop, particularly for buses to the east side. This stop is so popular that often times only some of the awaiting people can fit onto a bus, while the remainder must wait for the next bus. Eliminating this bus stop would force a large number of people to DRIVE to the east side, as there are no equal public transportation alternatives provided for in the neighborhood. Eliminating the Montlake Flyer Station reveals a lack of understanding of how popular and important this major stop is to public transportation users.
Philip Ries	We need to be sure to make light rail a realistic possibility. To do that, agencies must explore the light rail design more deeply. Would adding light rail in the future mean removing 2 lanes (the HOV lanes)? In what other ways would light rail affect the roadways?
	Eliminating the Montlake freeway bus stops is terrible. Tons of eastside commuters use those stops. Please do not eliminate them. I can say with certainty that I will drive my car much more often if they are eliminated.
Travis Hobrla	Since the Montlake Flyer station is disappearing, bus access to 520 via easily accessible entrance/exit lanes is extremely important. This station serves a large part of North Seattle that wants to go across 520, and has a very high ridership.
Paul Viola	Thanks for taking the time to read this feedback. I am Montlake resident and a heavy user of buses to Microsoft. The current proposed plan eliminates the bus stop in Montlake on 520. I am deeply concerned that I would no longer be able to use transit to travel across the 520 bridge. Of course that would also apply to others that use the 43 and 48 to transfer to these buses. We need to build 520 so that it encourages use of rapid transit. The current proposal discourages rapid transit use. I believe this runs directly counter to our region's needs.
	How will I catch the bus at Montlake? This doesn't appear to be addressed in the current plan.
Shayon Ghosh	The current preferred alternative for the SR 520 bridge replacement project eliminates the Montlake Flyer stop that I currently use daily as part of my commute from Montlake to Redmond. I ride the Sound Transit 545 bus that perfectly suits my needs because of its high frequency and off-peak availability; the passenger load on most rides, even relatively late at night, is high as well. If the Montlake Flyer stop is removed, I am concerned that the result will be a net loss in transit accessibility for me and the many others who use it. The current plan indicates that the service provided by buses like the ST 545 will be replaced with other service that originates in the University District, but that would mean that Sound Transit and King County would need to run twice as many buses to provide the same quality of service. This is clearly impractical. I urge the workgroup to reconsider the elimination of the Montlake Flyer stop.
	Two lanes + HOV will likely be insufficient for this bridge. I would recommend using three standard lanes, or you'll cause congestion.
Andrew Enfield	The proposed removal of the Montlake Flyer stop, without iron-clad guarantees of funding for 100% replacement of service (which haven't been made, to my understanding), is a very unfortunate step. I often transfer at that particular location, and without such an option I'm afraid that commuting by car - even with tolls - would be enough of an improvement that I'd find myself driving too often. Furthermore, the apparent disregard for transit-oriented design between 520 at Montlake and the University of Washington and the new Husky Stadium light rail station is extremely disheartening. (See, for example: http://seattletransitblog.com/2010/09/09/montlake-blvd-and-pacific-st-bus-volumes). In this day and age, and in a city with traffic like Seattle and natural barriers like Lake Washington, transit should be considered from the get-go and often given priority over single-car transportation. It's truly unfortunate that the current plan doesn't go nearly far enough in this regard.
Carl Parker	My understanding is that the Montelake Freeway stations will be eliminated under the new design. If that is the case, how will people make connections between busses that cross the bridge, such as the 545 and 242, and intra-city buses that pass through the Montelake area such as the 43, 44, and 48. Also, where will bicyclists be able to load their bikes to travel across the bridge (assuming that they don't want to brave wind, weather, and traffic riding across the bridge on their bikes).
Richard Korry	Perhaps I got it wrong it but it appears that there is no longer a "Montlake Flyer" bus stop available and that routes such as the Metro 242 and the ST 545 will no longer make a Montlake stop. I see bus stops for the Montlake Interchange but those appear to be on the lid for bus traffic entering or exiting SR 520 and not for bus traffic continuing on SR 520. Again, if I am wrong, the presentation is not clear on this point. If this is true then I am appalled. I use this stop daily for either the 242 or the 545. The number of passengers that use the Montlake for a variety of transfers from east side bus traffic is huge. Please tell me that this is not true. If it is true my ability to use transit to the east side will be dramatically impacted.
L Baldwin	Is there any way to include a stop for the 545 at Montlake? Riding into downtown to ride back to the university district adds 40+ minutes onto an already 1.5 hour bus commute. Not having the Montlake stop will cause me to give up riding the metro and go back to being a single person car commuter.
Alex Wetmore	Eliminating the Montlake flyer stop is a major problem. I currently do a mixed modal bike/bus commute from Roosevelt to Redmond. The Montlake Flyer stop gives me options every few minutes during rush hour to get from the UDistrict to Redmond on the 545, 242, and 256. I'm not the only one who does this, there is often a queue of 5 or 6 cyclists waiting for the next bus going to Redmond at Montlake. The elimination of this stop means that many busses going from downtown to Redmond will no longer stop anywhere near the UDistrict. There will be much less capacity for bikes to make that route, and the busses won't come as frequently making this type of commute harder to plan around. When I don't do the mixed-modal commute I do a simple transfer at Montlake (using a combo of the 48 and 545). The new design proposal eliminates those options too. I understand that the Montlake Flyer stop is one of the busiest stops in the system because it does tie together busses going to residential neighborhoods around Seattle and busses going to the Eastside. The new design is likely to cause me to drive to work 2-4 days per week, where I currently drive to work once a month or less.
Alex Brogger	Overall I like the plan, but I have one very major concern that would keep me from endorsing it. That is what is happening at montlake. It appears that Routes such as ST545 and MT242 will no longer be able to stop at Montlake and instead will just continue past. I personally take the 545 every day and the Montlake stop is one of the busiest. This stop usually fills teh few remaining seats and fills the standing room. It is the easiest access point to the eastside for people living in NE and SE Seattle. Losing this stop seems like a major flaw in the plan and would greatly increase commute times for many residents who now have to go downtown and/or wait longer for routes that operate less frequently.

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Online survey comments received September 13 - 24, 2010

Do you have any comments on the ESSB 6392 draft recommendations report?	
Name	**Open-Ended Response**
Michael Blome	I am concerned that the preferred design eliminates the Montlake flyer station. This is a heavily-used bus stop during peak hours for people who live on Capitol Hill and in NE Seattle and work on the Eastside. Specifically, the 545 is a very popular bus and many riders board it at Montlake. Do you have a plan in place to provide a replacement transit option that is at least as convenient and frequent as the 545?
Rachel Popkin	I currently commute to Redmond from Capitol Hill by taking the 43 to the 545 at Montlake. If the preferred alternative is chosen, I'm not sure how I will get to work. I'm also disappointed that steps haven't been taken to improve that transfer point, especially in the 520-WB to SB on Montlake direction. Currently that is one of the worst commuter transfers in the city, requiring commuters to wait for 3 separate crosswalks, or to go down stairs and back up stairs on the other side of Montlake.
Adam Szofran	Montlake is a major bus transfer point and I can't believe that the preferred bridge alternative eliminates the Montlake stop on eastbound 520. I use that stop daily to get to work riding either the 545, 242, or 256 routes. There are lots of other pedestrians and bicylists waiting at the stop with me so I am not alone. How are we supposed to get to our jobs on the east side now?
Laura Williams	I am concerned that the preferred alternative eliminates the Montlake Flyer Station, as this eliminates one of the primary ways I am able to use public transporation to commute to and from my job. Many of my neighbors and colleagues rely on this option as well Presently, it is difficult, awkward, and needlessly time-consuming to make a bus commute from many North Seattle neighborhoods (Wedgwood, View Ridge, Ravenna, Roosevelt, etc.) to Redmond/Microsoft. It's MORE time-consuming to take buses than it is to go by car, and this is one of the reasons so many people continue to sit...alone....in their single occupant vehicles on the damned bridge. You typically have to take a bus, ride a bike, walk, or otherwise make it to Montlake, and then take the 545 or 242 across. If these bus stops are eliminated, routes to Microsoft will become even more complex and time-consuming, and I don't see how this is in the public interest, as it will continue to discourage the use of public transit. It's not clear if alternative routes would be planned. If the Montlake Flyer Station is eliminated, it would be nice to see additional bus routes and stops created to serve the neighborhoods both North and South of Montlake, so that people who currently rely on the option of picking up a bus at Montlake have other convenient ways of grabbing a bus to Redmond.....without having to route themselves through downtown or backtrack West or North to Greenlake P&R or Northgate. People won't use public transit if it feels illogical, stupid, or inconvenient to do so. Given the employment dynamics of this region, I *should* be able to walk out of my house and pick up a bus at a stop that's no farther than 3-4 blocks from my house, that will take me directly to the eastside....I can presently do with the 71, 73, etc. to get downtown, but I can't do it to get to where I actually work. All of the bus routes in N. Seattle seem optimized for getting downtown, but a good portion of my zip code seems to work on the eastside (judging by hangtags on cars). This seems broken. And building a new bridge is not the only fix required here.
Simon Bernstein	The Montlake flyer station is my primary means of commuting to the Eastside. Without this station, I would have no easy way to catch the bus to work, which would probably result in my having to drive to work. Montlake is a major interchange, and not having a place for buses to stop on 520 at Montlake will limit the usefulness of bus transit for all commuters who live along the eastern half of Seattle, from Sandpoint down to Leschi/Mt Baker, including Montlake and Capitol Hill East of 15th Ave. I urge you to reconsider removal of the Flyover Station.
Christa Anderson	I would prefer not to lose the Montlake stop, as that cuts off the best route to Capitol Hill via the 545. If we do lose this stop we will need other access to this route.
Reid Warner	Yes, Montlake Flyer is a critical link for those of us bike commuting from Ballard and other parts of Seattle. Do not eliminate the highway stops at Montlake. Our Bike Lockers are there as well and I was on a waiting list for 5 years to obtain one.
Jerel Frauenheim	It's really disappointing that the preferred option removes the Montlake Flyer bus stop. It is a critical piece of the commute to have buses stop at Montlake for travel to and from both the eastside and seattle.
Greg Enell	Hello, I live at [redacted] E Lake Washington Blvd and I'm writing today to express concern traffic volumes and subsequent noise on E Lake Washington Blvd. As it is now, the noise levels on our street are already above legal limits and I fear that a specific component of the new plan will worsen the problem. The specific component I speak of is the plan to allow left hand turns off of 24th, funneling traffic eastbound on E Lake Washington Blvd. As far as I can tell, that will increase noise and traffic on a street that is already problematic, thus worsening the current situation and further diminishing the value and appeal of my home. All that said, my family and my neighbors would be greatly appreciative of anything you can to do minimize traffic and noise on E Lake Washington Blvd. Eliminating the left turn off 24th would be a good start. If more can be done, that would be great. Thank you for allowing me to provide feedback. All the best, Greg Enell
Sara Wastvedt	I support the SR 520 Preferred Alternative. It addresses two major issues that the other alternatives did not. First, it provides for minimizing the traffic impact to the Arboretum. I hope that as the plan goes forward, traffic calming in the Arboretum will remain a top priority. If anything, traffic levels should be reduced from their current levels. Second, it accommodates future light-rail. I have a suggestion to help mitigate the flow of traffic on 23rd/24th Avenue. Do not allow bicycles. The Burke-Gilman Trail runs parallel just 2 blocks away. There's no reason to have a lane of traffic slowed following a cyclist, when an easy alternative exists.
	1 - Minimize traffic in the Arboretum as aggressively as possible 2 - Improve noise mitigation from Foster Island's west side out to the bridge deck
Brian Ward	Regarding the bike/pedestrian path on the floating span portion of the project, I request design considerations be made to reduce or isolate wind, noise and debris impacts generated by the automobile traffic to users of the ped/bike path. I bike commute from Seattle to Bellevue using the I-90 crossing where I frequently encounter sand and storm water spray generated by high speed west bound autos. The prevailing southerly wind exacerbates this problem too. The noise is also deafening. I think these impacts discourage use. I suggest the ped/bike path for SR520 have a barrier between it and the auto lanes sufficiently high to reduce noise and elimenate spray, both sand and stormwater to users on the path.
Jeff lykken	Be sure to leave enough room so you can add another SOV lane. The current design does not have enough capacity. When HWY 16 bridge was first planned it only was going to be a 6 lane bridge, then they made it an 8 lane bridge which makes sense.. Why can't they make 520 an 8 lane bridge, it almost seems that the designers are idiots to spend 4 billion and only get a joke 2 lanes each way with a worthless carpool lane. (it will be like I-405 in Renton everyday) another joke. Jeff Lykken
Sean Riley	To Whom It May Concern, My wife and I are residents of East Lake Washington Boulevard (2465 E. Lake Washington Boulevard (on the bend in front of the water)). As measured, the noise decibels are significantly above legal limits in front of and around our ouse (even in off-peak hours). Please consider the residents of this extremely busy, dangerous and noisy street as you discuss noise reduction mitigation and traffic calming measures. The proposed traffic calming measures will do nothing to reduce the number of cars on LWB, which, in addition to noise and speed, is the largest concern for LWB residents. My wife, for example, can no longer use our driveway due to the number of cars, which come to a complete halt in front of our home on weekends and peak weekday traffic hours. In fact, she got in an accident one morning coming out of our driveway due to the speed and traffic in front of our home. In addition, the windows in our home literally rattle when trucks go by (trucks that are over the limit for Lake Washington Boulevard, BTW). As a method of making LWB safer for residents and bringing the noise level closer to legally allowable limits, please do not allow cars to maintain left turn movement from 24th Avenue to eastbound Lake Washington Boulevard. Please also consider additional mitigation measures if the new plans to not bring noise levels to legally allowable limits (like subsidizing installation of double paned windows). Please also consider tolling on LWB for cut through traffic. Lastly, please consider all measures to slow down traffic in front our home for safety reasons (speed humps, a median that runs the entire length of ELWB, police ticketing, etc.). Thank you for your time. -Sean and Morgan Riley

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Name	**Open-Ended Response**
Morgan Riley	I am a resident of East Lake Washington Boulevard, where the noise decibles are above legal limits even in off-peak hours. Please, please consider the residents of this extremely busy, dangerous and noisy street as you discuss noise reduction mitigation and traffic calming measures. The proposed traffic calming measures will do nothing to reduce the number of cars on LWB, which, in addition to noise and speed, is the largest concern for LWB residents. I, for example, can no longer use our driveway due to the number of cars, which come to a complete halt in front of our home on weekends and peak weekday traffic hours. In addition, the windows in our home literally rattle when trucks go by. As a method of making LWB safer for residents and bringing the noise level closer to legally allowable limits, please do not allow cars to maintain left turn movement from 24th Avenue to eastbound Lake Washington Boulevard. Please also consonsider additional mitigation measures if the new plans to not bring noise levels to legally allowable limits (like subsidising installation of double paned windows). Please also consider tolling on LWB for cut through traffic.
Dustin Shane Collings	All of the plans I have been able to see look beautiful, but I don't know if I've seen ESSB 6392... Dustin Collings
	Light rail should be built with this project. Bus system is out of date for an area of our size. The new bridge design requires the HOV lanes to be taken away if the light rail gets put in and I think that's a horrible idea. If the light rail is not added to this project, it should at least have it's own dedicated space and not require the removal of lanes that commuters will use and not want to give up. You are essentially killing the possibility of the light rail to the eastside on SR 520. No way once the HOV lanes are open that people will agree to closing them for a train.
Richard Meyer & Susan Harmon	The bridge appears to be ok with the light rail as a given. However, 520 is too wide from the bridge to I-5 as this will cause even more bottlenecks than now. The highway is much too wide over Fishers Island wildlife area. We can't lose any more of this wonderful spot. Finally, that second bridge over Monlake Cut is awful. It will spoil the entire look of that location. Please continue four lanes from I-5 to the bridge. Thanks.
Diana	I think a planted median strip on the Portage Bay bridge is a poor use of our tax dollars as well as wasted space where it is at a premium. Bus stops should have pull outs at a minimum to relieve congestion and minimize road rage during peak traffic hours. I do not want a light rail system at all, but if there will be one, it should definitely not take up a dedicated HOV lane. The transportation system on the east side is laughable at best (45 minutes to get from Bellevue to Seattle, when it's a 20 minute drive) and few people will find it useful to have the light rail system. If a light rail is put into place, they should plan for an 8 lane bridge and replace one of the general use lanes on both EB/WB with the light rail. If that is not acceptable, the light rail should have it's own dedicated bridge near the existing SR520.
Ben Martin	Looks good, let's do it!
Jared Randell	I see that the bridge design has the requirement (via state law) to lay the foundation or enable scalability for future Light Rail Development. This is great. I am concerned however about the oversight of meeting this requirement during the project. When the Seattle bus tunnel was built, there was a similar requirement (not sure if it was law or not) that light rail foundation was to be laid for futuree light rail development. However, when light rail was later developed, that original foundation had to be redone so essentially the requirement for futre scalability for light rail was not met. My concern is that in the 520 bridge the same thing would happen. I would hate to hear after the bridge was built with scalability for future light rail enhancements that the foundational elements would have to be redone at additional costs etc. In short I want to make sure that the requirement to enable future light rail projects on 520 bridge has a clear success measure that will be revisited when actual light rail development is begun on 520.
	We need better connections between buses arriving at the UW from the Eastside via 520 and the Link station. There should be dedicated HOV ramps for buses to exit without being stuck in traffic. If there is a second drawbridge, it should be a busway (with pedestrian/bike lanes, perhaps) to keep the buses moving unhindered by SOV traffic. The bus stops should be convenient to get to from the Link Station and visa-versa.
Jordan Swanson	We live on one of the houseboats to the north of the new Hwy 520 project in Portage Bay, and are concerned that the Noise Reduction workgroup has moved away from effective noise abatement efforts (walls of sufficient height) to ineffective or untested measures. Noise is a problem now, partly because speeding is common and very difficult to moderate or enforce. Increased traffic with additional lanes will only exacerbate this problem. Measures such as new absorptive materials in the roadway or short sidewalls are not sufficiently proven to risk destroying such a peaceful bay and habitat. We strongly support effective measures such as sidewalls of closer to 8 or 10 feet in height, and do not believe that speed-reduction techniques or new types of surfaces will result in a viable solution in the short or long term.
Scot Soares	As a cyclist, I strongly encourage you to make sure there is a safe path across the new 520 corridor for cyclists and pedestrians! Thanks.
Brent White	Thank you for the opportunity to comment on the SR 520 project. I am a bus rider who is disappointed that so many billions of dollars could be spent on this project, only to make transit across Lake Washington worse than it is now. As you know, the functionality of the Montlake flyer stop (allowing transfers between downtown buses and UW buses) will soon be gone forever, except to the extent such functionality can be replaced by an easy transfer at UW Station, and increased frequency of service to and from UW. Indeed, the time it takes to wait for a bus and travel downtown will be a dead heat between the option to split bus service and the option to consolidate service *if* the 520 buses pick up and drop off by the UW Station elevators, because increased frequency would make up for increased travel time. Given that this is not the plan, both groups of riders will face longer waits for buses, and miss out on the opportunity for an easy connection to the Link transit spine. Additionally, riders travelling between downtown Seattle and campus will face longer waits for buses to get them across campus because most of the buses will be skipping the station. This is a large group of riders who are getting short-changed. Riders between UW and the eastside will have much less frequency of service because of the current plan to not have most buses stop at UW Station. Riders between downtown and campus will have less frequency of service due to buses skipping the station. Riders between downtown and the eastside will have less frequency of service as well. Every group of riders comes out losers. The fix is simple: Move the northbound HOV lane to the outside of Montlake Blvd, where buses can easily pull into UW Station, make their stop, loop around, and turn right onto Pacific Ave. Then continue the HOV lanes north along Montlake for buses headed to northeast Seattle neighborhoods. A small amount of travel time would be added to those already on buses, and wanting to get into campus. For 520 riders, this is offset by the extra frequency from route consolidation. It would be another minute on the bus, and several minutes less standing in the rain. Thank you, again, for the opportunity to comment. I hope this project to dramatically increase vehicle capacity across Lake Washington will be at least a small net positive for transit.
Jeremy Mazner	As a Capitol Hill resident who commutes daily by bus to Overlake, I ask that the workgroup consider the following: 1) optimizing for transfer from NB local service (metro 43 and 48) to EB ST545, and from WB ST545 to SB 43/48 2) providing staircase-free access for riders bringing bicycles or strollers, or riders who are unable to use stairs 3) how to provide space and access to private/commercial transit service operators, such as the Microsoft Connector and Microsoft Bike Shuttle. Microsoft employees will be poorly served by any reconfiguration of bus stops that favors UW commuters. Providing a way for Microsoft Connector shuttles coming from I-5 to pick up Microsoft employees along 520 (for the morning commute, and vice-versa for PM commute) would limit the negative impact of bus stop reconfiguration.
Andrew Kwatinetz	The proposal does not go far enough to improve the experience for commuters who leave their car at home: bus, bike, and/or walk. The corridor cannot handle more cars, so we should be working harder to get people out of their cars. Longer distances, dangerous cross-walks, and inconvenient stops/hours are all steps in the wrong direction.

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M. E. Grabicki	I live in Pike/Pine, & I commute daily to Redmond via 520. I read this report but still don't really understand what's being torn down & what's being built. I can't figure out when or where my commute will be affected. At some point will there be a website that better illustrates the realities of your plans, presented via interactive maps or descriptions that make sense to the general public? I'll admit I had to look up "bascule" & "charrette," & even after a second reading don't have a clue when this work will begin affecting commuters or for how long. I could use the extra time to explore alternate work schedules, transportation, routes, or even consider changing jobs or neighborhoods. Between this project & the Link Light Rail station a few blocks away from my home, I'm trying to understand what the next several years of construction & traffic impact look like.
Dennis Neuzil	Please adopt and implement the preferred plan's bike and pedestrrian facilities.
Dirk Heniges	I would love a bike crossing option! I have found myself stuck on one side or the other of Lake Washington numerous times and had to bike up around the North end of the lake or down to I-90, a significant distance on a bicycle.
Jay Varnier	I really don't understand why this plan is even being considered. Any thing less than a 8 lane super bridge is a waste of my taxpayer money. If the city of Seattle is to be a truly great place to live and work than some sacrifices will have to be made by the Mount lake area residents.They can not hold our city hostage with there NIMBY attitudes. A 6 lane bridge will do little to ease traffic congestion that is choking our city.I know it will be a budget buster but you must find a way to build a 8 lane bridge anything less will be short sighted. I know as a taxpayer I would feel a lot better paying my toll and commuting on a bridge that has a chance of crossing in 10 min or less and that will never happen with a 6 lane bridge.
Dustin Shane Collings	Dear W.S.D.O.T., Your alternative plan for a lid looks great. It is nice of you to offer to remove the unused ramp we have. Yours truly, Mr. Dustin Collings Seattle, Wash.