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Civil/Marine Consulting Engineers

SUBSTRUCTURE INVESTIGATION, TESTING & ASSESSMENT OF BASCULE PIERS

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Performed For:

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EXECUTIVE SUMMARY

This project was carried out to assess the current condition of the North and South Bascule Piers, which support the 16th Avenue South Bridge in Seattle, Washington. This structure crosses the Duwamish River near Boeing Field, in south Seattle. The following report provides details on the existing condition of the bascule piers such that up to date information is available and can be utilized to provide data allowing for knowledgeable decisions to be made as to the bridge's structural integrity and it's remaining service life. This report also contains a comparison of the present findings with the results of a previous inspection of the structure which was carried out in 1986.

The overall condition of the submerged section of the two Bascule Piers ranges from fair to poor. Evidence of significant deterioration in the form of cracking and spalling was found in both of the examined structures.

The North Bascule Pier, appears to be in the worst condition. This result is consistent with that found during the 1986 inspection, which reported the North Bascule to have sustained the most significant deterioration of all six substructure piers which support the bridge across the waterway. Significant cracking and efflorescence was noted above El. -3.0, K. Co. Datum, on all exterior faces of the Pier. It should be noted that severe vertical cracking was discovered in the vicinity of the bridge bearings. Generally, extensive spalling and areas of exposed and corroded reinforcing steel was discovered on all faces below El. -10.0.

The South Bascule although in better condition than the North, has also sustained significant damage in the form of cracking and spalling. This Pier exhibits significant vertical cracking of the structure in the vicinity of the bridge bearings, as well as cracking above El. -3 and heavy spalling below El. -10.

In addition to the visual inspection of the two Piers, representative core samples of the concrete, were extracted from each structure. These cores were subjected to both compression testing and to chemical analysis to determine the sulfate and chloride ion concentrations present in the material. The results of the compression testing suggests that there has been a significant decrease in the compressive strength of the concrete since the 1986 inspection. A direct comparison of two immediately adjacent cores, one taken during the 1986 inspection and one taken during this investigation, shows the ultimate compressive strength of the material to be 4,500 psi and 3,250 psi respectively. This represents a reduction of 1,250 psi, or a loss of 28% in the compressive strength of the concrete. Similar but less significant strength reduction values were obtained for the South Bascule Pier.

The chemical analysis showed no evidence to support deterioration of the concrete due to sulfate attack. However high levels of chloride ions were found in the samples, suggesting the possibility of chloride induced corrosion as a potentially significant contributor to the deteriorative process affecting these structures. Given the reduction in the compressive strength and the high level of chloride ion concentration, we recommend that an underwater half cell potential measurement survey of the bridge be carried out. This survey would help to confirm that the internal reinforcing steel is undergoing active corrosion, and would also be used to determine the extent and location of the ongoing reactions. This information is crucial to the overall structural assessment of the facility with regards to maintenance repair or replacement options, including the feasibility of utilizing an impressed current or galvanic cathodic protections system to prevent further corrosion of the interior reinforcing. Recommendations for structural analysis to determine the current safe operational loads of the two piers has also been made.

Also included in this project, was the acquisition of bottom soundings around the two Bascule Piers, as well as at locations 50 ft upstream and downstream of the bridge edges. This study showed no evidence of exposed footings or areas of significant scour or aggradation. Recommendations for continued monitoring have been made.

Additionally, although not within the scope of this project, cursory inspection of the timber crib system located on either side of the channel and protecting the two Piers, was conducted. Given the age of the structure and the fungal deterioration evident in the pile tops, recommendation for a comprehensive inspection of the piles and framing timbers has been made to locate and quantify any damage that may lead to extensive deterioration and possible failure of the system.

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1.0 INTRODUCTION

1.1 PROJECT AUTHORIZATION

This project was conducted by Echelon Engineering, Inc. for the King County Department of Public Works, under a sub-consultant agreement with Sverdrup Civil, Inc, dated June 13, 1994. The specific tasks completed on this project are as detailed in section 1.3 of this report.

1.2 PROJECT BACKGROUND & PURPOSE

The 16th Avenue South Bridge was originally constructed in or about 1930. Over the course of it's life, various maintenance repair programs have been carried out. This maintenance has included concrete repairs to portions of the substructure Piers and the Bascule Towers.

In the mid 1980's, a number of operational problems with the bridge lead to an inspection and evaluation of the structure by the Sverdrup Corporation. As part of that project, an underwater inspection of all of the substructure components, including four concrete piers and two Bascule Towers was conducted in 1986. Initially, visual investigation of all of the piers/towers was conducted to identify the pier which exhibited the most severe deterioration. The North Bascule Pier was found to have sustained the most damage, and was therefore subjected to a comprehensive and detailed investigation, which included visual/tactile inspection and compression testing of several extracted concrete core samples.

This project has been carried out to provide information on several factors, including a comparison of the current condition of the Bascule Piers, with that found during the 1986 inspection and to assess of any changes in the status of the substructure members so as to provide in-site on the rate of deterioration, as well as the remaining service life of the structure. This data also provides a comprehensive database detailing the specific damage and deterioration of the Bascule Piers, such that structural analysis may be conducted, as well as to provide information on which to base the development of any required maintenance design and/or repairs.

1.3 SCOPE OF SERVICES

The scope of this project covered the underwater and topside inspection, (below El. +12.12 King Co. Datum), of the North and South Bascule Piers which support the moveable portion of the 16th Avenue South Bridge, located in Seattle, Washington. The investigation was carried out both to confirm the findings of the previous underwater inspection conducted in 1986 and to document the current condition of the Bascule Piers.

Detailed inspection of the North Bascule Pier was conducted to note any further deterioration in the previously documented damage, as well as to locate any additional damage and/or further deterioration of the structure since the 1986 investigation. Inspection of the South Bascule Pier was conducted to develop a baseline document of the current damage and deterioration of the Pier. Minimal information on the condition of the South Pier was available due to the scope of the investigation conducted in 1986. Therefore, this project provided for the development of a detailed database of the existing condition of this structure, as well as detection of any significant structural damage and documentation of the location and condition of any cracking, spalling, efflorescence or other types of deterioration to the structure. This information provides the current status of the members allowing for future monitoring and for maintenance design and repair.

The project included the extraction of a total of 12 concrete core samples, taken at six locations, (3 from the North Bascule Pier and 3 from the South Bascule Pier respectively). The core samples were subjected to compression testing to provide information on their ultimate compressive strength, as well as chemical analysis to determine the soluble chloride and sulfate ion concentrations within each core sample.

Profile elevations of the Duwamish River channel were developed by sounding the mudline, at approximate 20 ft. intervals across the channel, at locations 50 feet upstream and downstream of the bridge edges. In addition, soundings of the mudline elevations around the piers was carried out to provide information on existing conditions with respect to current and potential scour conditions, including any signs of aggradation, degradation, local scour and/or contraction scour.

2.0 METHODOLOGY

2.1 THEORY OF INSPECTION PRACTICE

In service deterioration of bridge structures can be caused by a variety of factors, including mechanical impact and abrasion, as well as general deterioration of concrete and/or corrosion of interior reinforcing steel. A number of chemical and physical factors can affect the durability and condition of concrete structures. Acidic conditions, sulfate attack, chloride attack, weathering factors, velocity abrasion, and over loading conditions can cause the deterioration of these members. Deteriorative agents may act independently, or in many cases, they may act in concert with one another, to effect the rapid deterioration of structural components. If not detected, such that some form of remedial maintenance can be implemented, the deterioration may continue to advance, leading to the possible destruction of the member and to potential catastrophic failure of the structure.

A variety of inspection and testing techniques, including both nondestructive and destructive methods, are utilized by Echelon Engineering, Inc. to locate and assess the extent of such damage, both qualitatively and quantitatively. The resulting database can then be utilized as a comparative reference for future inspections, for repair designs, and on which to base the assessment of facility use modifications or changes. This data may also be used in the analysis of a structure's useful residual life including current and future maintenance requirements, and facility replacement analysis.

2.2 INSPECTION & ASSESSMENT TECHNIQUES

Echelon Engineering, Inc. utilizes a crew composed of professional engineers, biologists and technicians specifically trained and experienced in the nuances of detecting and assessing the various types of deterioration that affect bridge structures. Several of Echelon's key personnel have successfully completed training in the guidelines developed by FHWA for the underwater inspection of bridge structures.

The first line of inspection carried out by Echelon personnel, is data review. Under this phase, the plans, drawings and any prior inspection data is reviewed. All plans are confirmed and/or modified to accurately represent the existing position of all structural components to be inspected. In addition, a working "identification system" is defined to positively identify all members to be examined and a series of field inspection data tables is then laid out for each type of structural member to be inspected, (i.e. bridge pier, face of pier, etc.). In the case of the 16th Avenue South Bridge, drawings from a previous inspection as well as several original design drawings, were available and served as a base of reference for the inspection.

As the project progresses, a *Level I*, visual/tactile inspection of all members is conducted. If in the inspector's judgment, additional detailed inspection of the member is warranted to accurately assess the extent of subsurface deterioration, a *Level II*, detailed inspection, involving cleaning and close visual examination of the member is conducted. A *Level III* inspection, for final assessment and verification of the damage encountered, including detailed quantification of the damage, as well as various nondestructive and minimally destructive testing techniques, can then be employed to further assess the members condition.

Soundings around the piers, as well as channel profiles at specific intervals both upstream and downstream of the bridge, are conducted by the field crew as a part of the Level I inspection. This data is often useful in determining locations where scour and/or abrasion of the substructure may have occurred, thus allowing for detailed Level II and III inspection activities to be directed at suspect areas.

For the investigation of above water portions of structural components including, piers, footings, and fender systems, our firm utilizes visual assessment of members, (*Level I* inspection), augmented with an assortment of nondestructive and/or minimally destructive techniques, (*Level III* inspection, i.e. detailed measurement, coring, drilling, compression testing or ultrasonic testing), to assess the members condition and the internal deterioration present.

For underwater inspection, all members initially receive a thorough visual/tactile examination, (*Level I* inspection), from the mudline to the cap or to the designated upper limit of the inspection. Cleaning, to remove fouling organisms allows for further assessment, (*Level II* inspection), to determine the extent of any scaling, spalling, cracking, rust bleeding, efflorescence, or impact damage. Underwater coring, (Level III inspection) can also be carried out to extract representative concrete samples for strength testing and for chemical analysis.

All findings from the field investigation are recorded to provide details on the location, type and degree of damage found. In addition to the field inspection data, the inspectors generate field sketches and take representative photographs to illustrate and document typical conditions. In some instances video documentation, both underwater and topside, of the structural conditions encountered may be carried out.

Upon completion of the field investigation, all data is reviewed while still on-site such that any omissions in the investigation may be determined and corrective action taken without the requirement for an additional site visit. Various locations of both damaged and undamaged members are selected for QA/QC inspection and data verification, (i.e. quality assurance/quality control).

The data generated is then analyzed in light of the damage found, the loading requirements for the facility and the condition of the adjacent areas. Echelon's reporting format provides a descriptive narrative outlining the scope of the project, the equipment and methodologies utilized, a summary of the inspection results, a comprehensive analysis and concise description of the findings, along with conclusions and recommendations for the structure. The narrative is augmented by descriptive figures, sketches and illustrative photographs as required. The inspection data gathered is presented in tabular format and organized to present specific details on the location and extent of any damage found. The results are also presented graphically on plans and detail drawings as required.

2.3 PERSONNEL & EQUIPMENT

The field investigation was conducted by a crew composed of a combination of professional and technical personnel, capable, experienced, and certified, (FHWA), in the underwater inspection and assessment of bridges. The field inspection crew utilized on this project was composed of the following personnel:

S.D. Sommerfeld, P.E.	Project Manager/Engineer - Diver
E.B. Vegsund, B.Sc.	Inspection Technician/Biologist - Diver
M.J. Tuhy	Inspection Technician/Safety Officer - Diver

All investigations including visual inspection, cleaning, probing, measuring photographic documentation, soundings and channel profiles, of the Bascule Piers was carried out utilizing a variety of inspection and support instrumentation & equipment as follows:

12' Aluminum boat
SCUBA Diving systems and support equipment
ORCATRON SCUBA PHONE Underwater Communications System
Hydraulic Coring Equipment w/ 4" diameter bits
Cleaning tools, Sounding hammer, & 12" probing rod
James V Meter, MK-II Ultrasonic testing instrumentation
100 ft sounding tape & chain
Nikonos V underwater camera system with SB 103 flash
35 mm Topside camera system with flash & telephoto lens
Miscellaneous support & safety equipment

Extraction of the concrete core samples taken was carried out by Global Diving and Salvage Inc., a Seattle based commercial diving/underwater construction firm, under the supervision of Echelon personnel. Global's field crew was comprised of the following personnel:

B. Humberstone	Diver/Core Drill Operator
T. Thompson	Boat Operator/Tender
W. Tyer	Tender

3.0 OBSERVED CONDITIONS

3.1 FIELD INVESTIGATION

The field investigation was carried out during the interval of July 25 through August 5, 1994. Weather conditions were good, with warm summer temperatures and light winds. Tides were favorable, with low tides allowing for exposure of the substructure down to El. -12 King Co. Datum. Underwater visibility ranged from fair to poor during the inspection, (i.e. from 5 ft. to 1 ft.). Inspection activities were scheduled to maximize investigation of the above water portions of the structure during intervals of low tides. Underwater inspection activities were scheduled during intervals of relatively good visibility.

The examined structure, the 16th Avenue South Bridge, is located along 16th Avenue south, west of Boeing Field in South Seattle, (Refer to Appendix A, photos 1 - 3). The structure is a Bascule bridge which spans the Duwamish Waterway, and was constructed in or about 1930. The bridge runs in an approximate north - south direction and is supported by six concrete piers which are identified from south to north as Pier 2 - South; Pier 1 - South; South Bascule Pier; North Bascule Pier; Pier 1 - North; and Pier 2 - North, respectively. This investigation covered the inspection of the two Bascule Piers which provide substructure support for the moveable portion of the bridge.

Evidence of past maintenance was noted on both Bascule Piers, which exhibited localized concrete repairs/patching to several of the corners (i.e. repairs of corner spalling). The repair patches noted, extend primarily from the high water to the low water level, (i.e. El. 0.0 to El. -12.98 King County Datum). The date of this maintenance is unknown. However, it was conducted prior to the 1986 inspection as is evidenced by photos supplied as a part of that report. No evidence of maintenance to the substructure members appears to have been conducted since the 1986 inspection.

For the purposes of this investigation, the four faces of the Bascule Piers have been identified as: North; West; South; and East, corresponding to their compass locations. In all cases, the horizontal reference for location of damage and deterioration, has been identified as STA 0+00 along the left hand edge of the specific face being investigated. All vertical elevations are referenced to the King County Datum, (i.e. El. -12.98 K. Co.. Datum = El. 0.0 M.L.L.W.). Similarly, the four faces of the Interior Pit of each Bascule Pier have also been identified by their compass references, with stationing beginning along the left edge of the face and all elevations referenced to King Co. datum.

Soundings were taken at intervals around the circumference of each Bascule Pier. Additionally, soundings, to plot the river bottom, (channel profile), were also taken at approximate 20 ft intervals across the river at two locations, 50 ft upstream and 50 ft downstream of the bridge edges.

In addition to the visual/tactile investigation of the Piers, a total of six locations were selected for extraction of concrete core samples. Three sites were selected on each Pier, with one site located in an area of generally sound concrete and the remaining two taken from areas of damage/deterioration. Two concrete samples, measuring 4" in diameter by ~11" in length, were taken at each of the six sites, for a total of 12 samples. The extracted cores were tested to determine their ultimate compressive strength, as well as for chemical analysis to determine the amount of soluble chloride and sulfate ions present in the material. For direct comparative purposes, one of the cores taken in the North Bascule was cut adjacent to a core test site taken during the 1986 inspection. All core holes were filled with fast curing "Splash Zone", a quick setting epoxy grout.

The inspection data generated during this investigation has been summarized in the accompanying tables, (Reference Appendix C of this report), and shown graphically on the enclosed drawings, (Reference Appendix B). Table 1 details the condition of the North Bascule Pier. Within this table is a detailed listing of the damage and deterioration encountered along the four exterior faces of the Pier, as well as the four faces of the Interior Pit. This data is also presented graphically on Drawings 3 thru 5. Table 2 and Drawings 6 thru 8 present the condition of the South Bascule Pier.

Table 3 presents the results of the concrete testing, including ultimate compressive strength values, as well as chemical analysis of the twelve test samples. Table 4 presents the bottom profile soundings taken at locations 50 ft upstream and downstream of the bridge edge. This data has been plotted and is presented on Appendix B, Drawing 1. The soundings taken around the two Bascule Piers have been plotted directly on the elevation views of the specific Pier faces.

3.2 EXISTING CONDITIONS: NORTH BASCULE PIER

Investigation of the North Bascule Pier shows the overall condition of the concrete to be poor. The overall deterioration encountered during this investigation suggests that there has been an increase in the amount of deterioration to this Pier since the inspection conducted in 1986. The following points summarize and illustrate the conditions found.

North Bascule - Exterior Walls

1. The deterioration of this Pier was found to be more extensive than that of the South Bascule Pier.

2. The level of damage encountered during this inspection appears to be significantly more than that found in the 1986 investigation.

3. Numerous areas of heavy spalling and cracking were noted throughout the structure. (Refer to Appendix A, photos 4 and 5).

4. The majority of the corners of the Pier, have received concrete repairs/patching. The condition of these patches was found to range from good to poor. In several areas, the bond between the newer, concrete repair material and the older, original concrete, has deteriorated resulting in the delamination and spalling of these repairs. (Refer to Appendix A, photo 6).

5. Generally, the condition of the concrete above El. -10 King Co. Datum, (i.e. low water), is in better condition than that below this elevation. The majority of the

areas above El. -3.0 exhibit heavy hairline cracking and efflorescence. Additionally, numerous locations have sustained significant horizontal and/or vertical cracking. The North and South faces exhibit the most severe cracking. In some areas these cracks are in excess of 1/2 inch in width and over 4 inches in depth. Significant cracking was found in the vicinity of the bridge bearings. Many of the cracks in these locations penetrate from the exterior face through to the Interior Pit. (Refer to Appendix A, photos 7, 8 and 10).

6. Below El. -10 the condition of the concrete surface is generally poor. Extensive areas of heavy spalling were found. The majority of these areas exhibit "punky" concrete, which is soft and were easily crumbled by the diver/inspector during the cleaning and inspection procedure. (Refer to Appendix A, photos 9, 11 and 12)

7. Large areas of spalling and cracking were found on all exterior faces of the Pier. However, the most extensive damage was found on the South and East faces of the structure. This damage included heavy corner spalling and exposed rebar, with large areas of concrete which literally "fell off" in chunks when touched, (Refer to Appendix A, photos 25 and 26). The concrete beneath these locations is also soft and easily crumbled.

   Two areas were found to exhibit extensive spalling to the point where the internal reinforcing steel has been exposed and is now heavily corroded. These sites are located along the east face, as well as in the northeast and southwest corners of the Pier. (Refer to Appendix A, photo 11).

8. The general condition of the extracted concrete core samples showed the material to be of uniform composition with aggregate sizes ranging from 1/2" to 1 1/2" in diameter. Core sample No. 6 was taken adjacent to a location that was tested during the 1986 investigation, and served as the comparative sample. Sample No.'s 4 and 5 both exhibited signs of cracking and loose aggregate.

9. Although not within the scope of this project, a cursory inspection of the Timber Crib Wall showed evidence of fungal deterioration to the timber piles.

North Bascule - Interior Pit

1. The condition of the walls lining the Interior Pit is similar to that found on the exterior faces of the structure, with evidence of hairline cracking and efflorescence visible in the areas above El. -3.0. Several large cracks were noted to extend through the north wall out of the northeast and northwest corners, to the exterior wall. No areas of spalling were noted on any of the interior walls. (Refer to Drawing 5 and Appendix A, photos 21 - 23).

2. A thick layer of silty-clay, ("mud"), was found to have migrated into the Bascule Pit. Presently, this build up does not appear to limit the flow of water in and out of the pit, due to tidal fluctuations.

3.3 EXISTING CONDITIONS: SOUTH BASCULE PIER

Investigation of the South Bascule Pier shows the overall condition of the concrete to be fair. Although minimal information on the condition of this pier was documented during the 1986 inspection, the overall deterioration encountered during this investigation suggests that there has been an increase in the amount of deterioration to this Pier since the previous inspection. The following points summarize and illustrate the conditions found.

South Bascule - Exterior Walls

1. This Pier was found to be in better overall condition than the North Bascule Pier.

2. The level of damage encountered during this investigation appears to have increased since the previous inspection conducted in 1986.

3. The damage found is primarily restricted to spalling of the corners, as well as vertical and horizontal cracking. This damage was found on all faces of the structure. (Refer to Appendix A, photos 13 - 18).

4. Consistent with the damage encountered during investigation of the North Bascule Pier, the majority of the extensive concrete damage, (major spalling, deterioration of the concrete, etc.), was located below El. -10, (King Co. Datum). Above this elevation the condition of the concrete appears more sound, with areas of minor/moderate spalling and cracking. However, several severe cracks were noted.

5. The damage to the upper elevations of the Pier, (above El. -10), included several vertical and horizontal cracks, as well as hairline cracking and efflorescence, indicating contamination of the concrete. (Refer to Appendix A, photos 15 and 17).

6. Concrete surfaces below El. -10 were found to range from sound, or undamaged, to areas where the concrete was soft and easily crumbled by the diver/inspector. Several areas were found to exhibit heavy spalling with exposure and corrosion of the internal reinforcing steel. (Refer to Appendix A, photo 19).

7. Cracking was noted in the North and South faces of the Pier, located in the vicinity of the bridge bearings for both the fixed and moveable portions of the structure. These cracks were found to vary in length, and to range from 1/4" to 1/2" in width, and greater than 3 inches in depth when probed with a slender wire. (Refer to Appendix A, photo 13).

8. One area of particular concern was found on the East face, where a significant crack was found running vertically down the face of the structure. This crack was found to begin at approximately El. -14.0, (King Co. Datum) and continued down the diagonal face and into the mudline at El. -20.0. This crack ranged from 1/2 inch in width and 1/4 inch in depth, at its beginning, to 3/4" inches in width and a depth of greater than 6 inches at a location on the diagonal face just above the mudline. (Refer to Appendix A, photo 20).

9. The general condition of the extracted concrete core samples showed the material to be of uniform composition with aggregate sizes ranging from 1/2" to 2" in diameter. Core sample No. 1 was taken at a location of visually sound concrete

and served as the comparative reference. Sample No.'s 2 and 3 both exhibited signs of cracking.

10. A cursory inspection of the Timber Crib Wall showed evidence of fungal deterioration to the timber piles.

South Bascule - Interior Pit

1. The condition of the walls lining the Interior Pit is similar to that found on the outer faces of the Pier, with evidence of hairline cracking and efflorescence visible in the areas above El. -3.0. Several large cracks were noted to extend through the north wall out of the northeast and northwest corners, to the exterior wall. (Refer to Drawing 8 and Appendix A, photo 24).

2. A thick layer of silty-clay, ("mud"), was found to have migrated into the Bascule Pit. Comparatively, the amount of sedimentation within this structure is greater than that in the North Bascule Pit. Presently, this build up does not appear to limit the flow of water in and out of the pit, due to tidal fluctuations.

3.4 EXISTING CONDITIONS: SOUNDINGS

Investigation of the bottom elevations in the vicinity of the Bascule Piers, as well as across the channel at locations 50 ft upstream and downstream of the bridge, shows the mudline to be fairly uniform and regular, with no areas of exposed footings or signs of significant scour. The following points summarize and illustrate the conditions found.

1. Soundings taken at approximate 5 ft. intervals around the North Bascule Pier found no locations of exposed footing or scour. Evidence of aggradation of the mudline was found along the North face, (shoreward side), where mudline elevations were found to range from El. -20, at the northeast corner, to El. -14, along the northwest corner.

2. Frequent soundings around the South Bascule Pier also showed no areas of exposed footing or scour. Evidence of significant aggradation was discovered along the west face of the Pier, where a "sand bar", beginning at the bridge and extending approximately 100 ft downstream, is evident at low tides.

3. Channel soundings, conducted at 50 feet upstream and downstream of the bridge edges, were taken at approximate 20 ft intervals across the waterway. These findings are presented in Table 4 of Appendix C and are shown graphically on Drawing 1 of Appendix B. As stated, the bottom elevations are generally regular, with no areas of significant deviation, (i.e. holes or mounds of sediment or debris).

4. The channel depth was found to be generally consistent, sloping gradually down from the shore and averaging 30 to 35 ft. across the channel at 0.0 tide, (King Co. Datum). No evidence of scour or aggradation, other than the previously noted north face of the North Bascule and the sandbar located on the downstream side of the South Bascule Pier, was found.

4.0 STRUCTURAL CONDITION ASSESSMENT

4.1 EVALUATION: GENERAL

This investigation showed the North Bascule Pier to have sustained significantly more deterioration than the South Bascule structure. This corresponds with the general findings of the previous inspection conducted in 1986, which determined that the North Bascule had sustained the most extensive deterioration of all of the six concrete Piers which provide substructure support for the bridge across the waterway. Of particular significance, is the observation that the condition of the North and South Bascule structures have continued to deteriorated since the 1986 inspection.

A direct comparison of the results of the two investigations, that conducted in 1986 and the present inspection, is of questionable accuracy considering the negative impact that weather and visibility conditions apparently had on the 1986 inspection. During that investigation, extremely heavy rain was experienced during the fieldwork, which resulted in near flood conditions with zero underwater visibility. The data obtained and reported was based on general observations and photographs taken during low tide conditions. Investigation of the submerged surfaces of the Pier, (i.e. below El. -12.98, King Co. Datum), was accomplished by tactile means, and therefore provides less accurate information than that provided by the combination visual/tactile inspection, which was carried out in the current 1994 investigation. Nevertheless, there appears to have been a significant increase in the level of deterioration to both the North and South Bascule structures.

Several objective factors support the apparent increased level of deterioration of the structures. These include an increase in the extent of the cracking and efflorescence, located in the upper zone of both piers, (above El. -3), and an increase in the amount of spalling and general concrete deterioration, below El. -10. Direct comparison of the data and photos provided in the 1986 report, show that there has been a significant increase in the spalling and vertical cracking, as well as an increase in the hairline cracking and efflorescence visible on the exterior faces of the structures.

Additionally, analysis of the concrete cores suggests that there has been a decrease in the ultimate compressive strength of the material since 1986. Core sample no. 4, taken from the North Bascule Pier during this investigation, was extracted adjacent to core, (sample no. 1), taken during the 1986 inspection. Direct comparison and analysis of these two samples shows compressive strengths of 4,500 psi, (1986) and 3,250 psi, (1994), respectively, which signifies a reduction in strength equal to 1,250 psi, (i.e. a 28% loss of compressive strength).

4.2 EVALUATION: NORTH BASCULE

As discussed, the North Bascule Pier has sustained an increase in the amount of deterioration since its previous inspection. This deterioration is evident by additional, severe, vertical cracking in the areas of the bridge bearings, as well as an increase in the frequency and degree of spalling within the submerged zone, (i.e. below El. -10). Typical examples of the spalling damage encountered in these areas include: corner spalling to depths of 14" resulting in the exposure and extensive corrosion of the reinforcing steel; generalized bands of spalling which cover significant percentages of the surface area on the exterior walls; and delamination and spalling of the concrete corner repairs.

Significant cracking was observed to radiate out from the corners of the Interior Pit, through the Pier's side wall to the exterior face of the structure. These cracks are primarily located in the vicinity of the bridge bearings. (Refer to Appendix A, photos 21 & 22). One particularly large crack was observed at STA 0+46 on the South face. This vertical crack extends from El. +12 down to approximate El. -12. The crack is approximately 1/2" in width and was found to penetrate greater that 4" into the structure. (Refer to Appendix A, photos 7 & 8). This cracking may have resulted from the combination of an increase in the actual imposed live loads, in excess of the original design values, coupled with the deterioration of the concrete and reduction of the ultimate strength.

Test Results - Ultimate Compressive Strength

As previously referenced, the compressive strength of the concrete appears to have significantly deteriorated since the 1986 inspection. The compressive test values for the three cores taken in the 1986 project were: 4500 psi; 4970 psi; and 4710 psi, resulting in a mean value of 4,727 psi. During the current project, three sites were selected on the North Bascule Pier for core sample extraction. Two cores were taken at each of the 3 sites, one exterior, or surface sample and one interior sample, for a total of six samples.

One core, Sample No. 4, was taken adjacent to the Sample No. 1 location from the 1986 inspection. This site is located in an area of generally sound concrete. However, cracking of the face was noted in the vicinity. The remaining two sites were located in areas of severe deterioration such as to provide information on the strength of the concrete in the vicinity of damage/deterioration.

For comparative purposes the results of the exterior cores, (Samples No. 4, 5 & 6 - exterior), will be considered first. The results of the compressive testing of these three cores is: 3,250 psi; 3,050 psi; and 2,450 psi, respectively, with an average value of 2,917 psi. This mean value of the exterior cores shows the concrete of the North Bascule Pier to have experienced a loss of strength of approximately 1810 psi since 1986, which represents a reduction in the ultimate compressive strength of 38%.

Analysis of the compressive strength of the three interior core samples, (No. 4, 5 & 6 - interior), resulted in ultimate strengths of: 2,310 psi; 4,650 psi; and 2,880 psi, with an average value of 3,280 psi. Comparison of the interior cores, although not directly comparable with the 1986 data due to the depth at which the samples were taken, shows a loss of strength of approximately 1,447 psi since 1986, which represents a reduction in the ultimate compressive strength of 31%.

The results of chemical analysis of the compression test samples provides further in-site into the deteriorative processes that are affecting the concrete substructure supporting the bridge. Refer to Appendix C, Table 3 for the results of the concrete testing and analysis.

Test Results - Soluble Chloride Ion Concentration

The results of the chloride ion analysis provides information in support of the extensive spalling which was found on all faces of the structure. Concrete mixes contain varying levels of chloride ions. However, under normal, non-corrosive, conditions, the chloride present is not at a sufficient level to allow for corrosion to occur. When this level of chloride within the concrete increases, as with age, exposure or because of other conditions, (i.e. increased temperatures, high concentrations of salts in the surrounding environment, etc), the chloride level within the material may rise to a critical or threshold value. When this level is reached, the chloride level can affect the condition of the imbedded reinforcing steel and allow active corrosion of the metal, which then develops significant expansive forces in the structure, thus causing spalling of the exterior concrete cover.

This critical or threshold value is generally considered to be 1.2 lbs. of chloride per cubic yard of concrete, which translates to approximately 300 ppm, (parts per million). As can be seen from the results of the chemical analysis, (Refer to Appendix C, Table 3), the majority of the soluble chloride ion concentrations are in excess of the 300 ppm threshold. Therefore, conditions exist which are generally conducive to corrosion reactions involving the reinforcing steel. Results from the analysis of soluble chloride concentrations shows the exterior samples to generally exhibit higher concentrations of soluble ions, with a mean value of 907 ppm, while the interior samples exhibit an average value of 366 ppm.
>> THRESHOLD

This level of chloride ion concentration does provide an environment conducive to corrosion of the reinforcing steel and may explain the extensive deterioration as evidenced by the heavy damage due to spalling found on this Pier. Further evidence in support of this explanation can be seen in Appendix A, photos 25 and 26, which show "chunks" of concrete that have spalled off of corners of the structures. The black staining and rust coloration, evident in the concrete, is indicative of active corrosion reactions which can affect the interior rebar, causing expansive forces, which result in the spalling of the surface concrete.

Additionally, tidal fluctuations which affect the structure on a daily basis, allow for leeching of the cement out of the concrete thus providing for general degradation of the material. This may explain the extensive areas of soft and easily crumbled concrete that can be found throughout the intertidal zone of the structure.

Test Results - Soluble Sulfate Ion Concentration

In order for sulfate attack to be considered a significant deleterious factor, the surrounding environment, (i.e. the Duwamish River), would have to contain high levels of sulfates. The following breakdown provides the generally recognized levels of risk with respect to environmental exposure for sulfate deterioration:

Mild Exposure	0 - 150 ppm
Moderate Exposure	150 - 1,500 ppm
Severe Exposure	1,500 - 10,000 ppm

Given that even after 60+ years of exposure to the waters of the Duwamish River, the accumulated soluble sulfates present within the concrete are generally in the "Mild" to "Moderate" exposure range, sulfate deterioration does not appear to have been a significant factor in the overall deterioration of the structure. Values of the chemical analysis show the soluble sulfate concentration to range from 80.7 to 2,730 ppm. Generally, the interior core samples exhibit much higher concentrations of sulfate ions, with a mean value of 1,148 ppm, while the concentrations in the exterior samples averages 102 ppm.

4.3 EVALUATION: SOUTH BASCULE

Comparatively speaking the condition of the South Bascule Pier is better than that of the North. This is evidenced by the generally better condition of all areas of the exterior walls. Additionally, the current investigation has shown that there is a general increase in the extent of the damage since the 1986 inspection. However, data documented during that investigation is minimal.

The concrete in the submerged surfaces of the Pier, (below El. -10), are in fair condition. There is far less generalized spalling and/or corner spalling in the South Pier than that found in the North Bascule Pier. Additionally, the depth of deterioration of the concrete and spalling of the surfaces in the South Pier extends for a maximum of 9" into the Pier, which is less than that experienced on the North Bascule structure.

Although the overall cracking found throughout the structure was also less than that encountered in the North Bascule Pier. Areas of significant vertical cracking, as well as areas of hairline cracking and efflorescence, are evident in the above water portions of the structure. Several significant vertical cracks were noted on the north face, including one located at STA 0+45.8, (refer to Appendix A, photo 13). Additionally, two significant vertical cracks were noted on the south face of the Pier, each of which supports the growth of vegetation, which often produces tremendous expansive forces within the crack as the plant develops. As was the case with the North Bascule Pier, the majority of the significant vertical cracks were located in the vicinity of the bridge bearings.

Of specific note, was a substantial crack located on the east face in the submerged portion of the pier. This crack is located at STA 0+20, beginning at El. -14 and extending some 6 ft down, along the diagonal face of the wall and into the mudline. At it's worst location, this crack is approximately 3/4 of and inch wide and over 6" in depth. Minor spalling along the crack was also noted.

As was evident with the North Bascule, the South Pier also exhibits several cracks that radiate out of the corners of the Interior Pit, through the side walls to meet with cracks evident on the exterior faces of the Pier. These cracks ranged from hairline cracks to significant vertical cracks with widths of 1/4 to 1/2 inch. This cracking may have resulted from the combination of an increase in the actual imposed live loads, in excess of the original design values, coupled with the deterioration of the concrete and reduction of the ultimate strength.

Test Results - Ultimate Compressive Strength

The compressive strength of the concrete in the South Bascule Pier is significantly greater than that of the samples taken from the North Bascule Pier. For comparative purposes the results of the exterior cores, (Samples No. 1, 2 & 3 - exterior), will be considered first. The results of the compressive testing of these three cores is: 4,080 psi; 3,800 psi; and 5,020 psi, respectively, with an average value of 4,300 psi. This mean value of the exterior cores shows the concrete of the South Bascule Pier to have an average ultimate compressive strength of 1,383 psi greater than the mean value of the exterior core samples taken from the North Bascule Pier. This difference shows the strength of the concrete which comprises the South Pier to currently exceed that of the North Pier by 47%.

A direct comparison of the results of the interior cores counters this trend, with results of the three cores being: 2,970 psi; 2,050 psi; and 4,250 psi, respectively, with an average value of 3,090 psi. This mean value of the interior cores shows the concrete of the South Bascule Pier to currently have an average ultimate compressive strength of 190 psi less than the current mean value of the interior core samples taken from the North Bascule Pier, (average value of 3,280 psi). Utilizing these values, a comparison shows that there is presently a 6% differential between the ultimate compressive strength values of the interior core samples taken from the North and South Bascule Piers.

The results of chemical analysis of the compression test samples provides further in-site into the deteriorative processes that are affecting the concrete substructure supporting the bridge. Refer to Appendix C, Table 3 for the results of the concrete testing and analysis.

Test Results - Soluble Chloride Ion Concentration

Results from the analysis of soluble chloride concentrations, shows the exterior samples to generally exhibit higher concentrations of soluble ions, with a mean value of 1,665 ppm, while the interior samples exhibit an average value of 605 ppm. This level of chloride ion concentration, (greater than 300 ppm), does provide an environment conducive to corrosion of the reinforcing steel and may explain the deterioration as evidenced by the damage due to spalling found on this Pier.

Test Results - Soluble Sulfate Ion Concentration

As discussed in Section 4.2 above, the concentration of soluble sulfates in the surrounding environment allows for estimations as to the potential for deterioration due to sulfate attack. The accumulated soluble sulfates present within the concrete samples extracted from the South Bascule Pier, are generally in the "Mild" to "Moderate" exposure range, suggesting that sulfate deterioration has not been a significant factor in the overall deterioration of the structure. Values of the chemical analysis show the soluble sulfate concentration to range from 48.9 to 445 ppm. Generally, the interior core samples exhibit higher concentrations of sulfate ions, with a mean value of 279 ppm, while the concentrations in the exterior samples averages 73.8 ppm.

4.4 EVALUATION: SOUNDINGS

Depth soundings were taken at intervals around the circumference of both the North and South Bascule Piers. This data has been plotted directly on the drawings located in Appendix B of this report. No evidence of significant scour was found in the vicinity of either Pier. Additionally, no areas of exposed footing was noted on either of the structures.

Evidence of aggradation was found along the north face of the North Bascule Pier, as well as a build-up of sediment along the west side, (downstream), of the South Bascule Pier. Neither of these locations appears to impact vessel traffic as they are located on the shoreward sides of the Piers, away from the channel.

Channel profiles were conducted at locations 50 ft upstream and downstream of the bridge edges to determine the existing bottom elevations and for use in analysis of potential scour conditions. These profiles have been plotted on Drawing 1 of Appendix B, and show a relatively flat river bed, with no evidence of scour or aggradation within the main channel. No former data is available for comparative purposes. However, given the apparent stability of the river banks as evidenced by the long term neighboring structures/facilities, (i.e. the Boeing warehouse along the north bank, and the South Park Marina on the southern bank), it appears that the channel is not undergoing any significant scour or aggradation.

Although outside the scope of this project, cursory investigation of the condition of the timber crib system protecting the Bascule Piers was conducted. Evidence of significant biological deterioration in the form of fungal decay or dry rot was noted in the tops of several of the piles. Also, given the brackish nature of the water, and the general improvement in the water quality as a result of the EPA regulations, it may be that water conditions are improving to the degree such that the environment can support marine borer activity. This possibility may lead to further damage of the timber piles and framing members.

5.0 RECOMMENDATIONS

5.1 CONCLUSIONS:

The overall condition of the submerged section of the two Bascule Piers ranges from fair to poor. Evidence of significant deterioration in the form of cracking and spalling was found in both of the examined structures.

The North Bascule Pier, appears to be in the worst condition. This result is consistent with that found during the 1986 inspection, which reported the North Bascule to have sustained the most significant deterioration of all six substructure piers which support the bridge across the waterway. Significant reduction in the ultimate compressive strength of the concrete within the North Pier has resulted since the 1986 investigation, and reflects an estimated 38% loss in strength. Of additional concern is the severe vertical cracking in the vicinity of the bridge bearings. We recommend that structural analysis of this Pier be conducted to determine the safe operating loads that the structure can support.

The South Bascule although in better condition than the North, has also sustained significant damage in the form of cracking and spalling. No previous compressive strength values are available for comparative analysis, as cores from this Pier were not taken in the previous inspection. This Pier has also sustained significant vertical cracking of the structure in the vicinity of the bridge bearings. We would also recommend structural analysis of this Pier to determine the current safe operational loads which can be supported.

The apparent reduction in the compressive strength of the concrete in both piers, coupled with the relatively high values of soluble chloride ions found in the concrete and severe spalling of the exterior walls, suggests that the strength reduction is due to chloride induced corrosion of the internal reinforcing steel, as well as from leeching of salts and cement through the concrete which is accelerated by tidal fluctuations. Therefore, prior to the development of specific maintenance designs & repairs, we recommend that confirmation of the locations and extent of any active corrosion of the internal reinforcing steel be conducted. In order to more accurately assess the actual locations and extent of the active corrosion, potential measurements of the submerged bridge faces, (utilizing test procedures outlined in ASTM C-876; Half-cell Measurements), should be carried out. Analysis of this data would then verify whether active corrosion is currently occurring, and would also quantify the extent of the deteriorative process within the structures. Additionally, analysis of the data will provide valuable information which can be used to assess maintenance repair or replacement options including the feasibility of utilizing either an impressed current or galvanic cathodic protection system to prohibit further corrosion of the interior reinforcing.

Soundings conducted during this investigation suggests that conditions within the channel are not conducive to scour and/or significant aggradation problems at this time. Continued monitoring of the bottom elevations will provide additional information concerning any potential concerns with respect to general and/or constriction scour conditions. The detail provided by this inspection can serve as a base line for future inspections and scour analysis.

We would also recommend that the timber crib system, located on either side of the channel, be examined. Given the age of the structure and the fungal deterioration evident in the pile tops, a comprehensive inspection of the piles and framing timbers may be warranted to locate and quantify any damage that may lead to extensive deterioration and possible failure of the system.

APPENDIX A
Photos

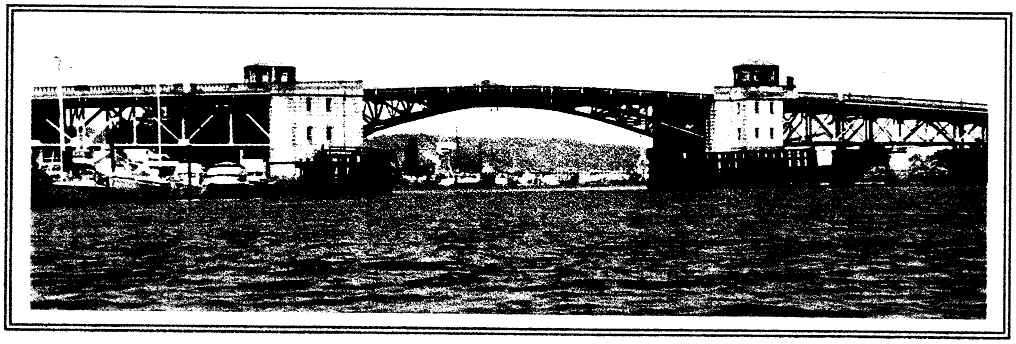

PHOTO 1: 16th Avenue Bridge - Viewed from the east.

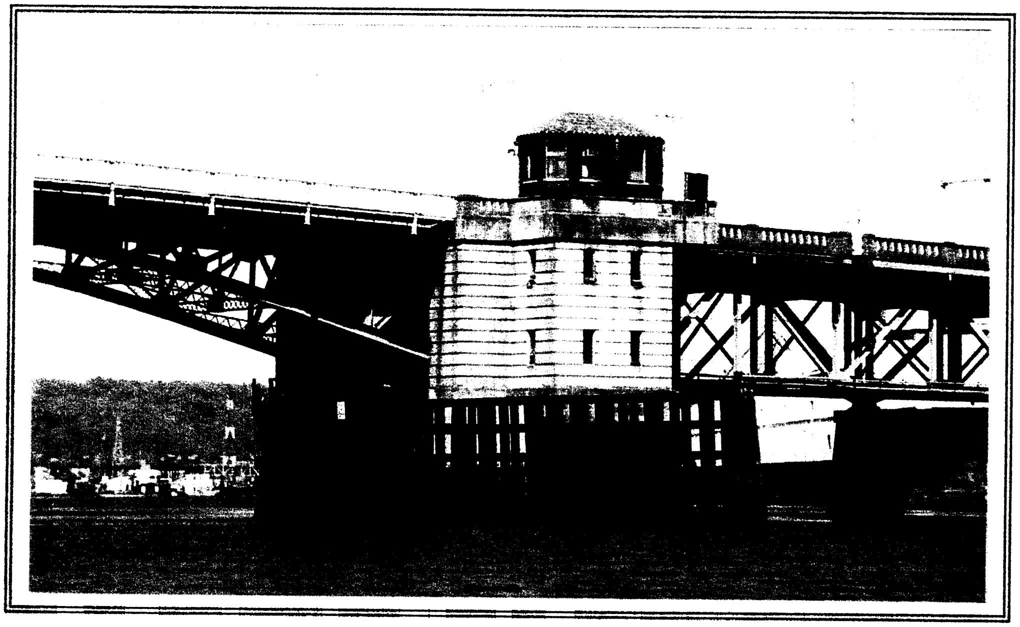

PHOTO 2: North Bascule - Viewed from the east.

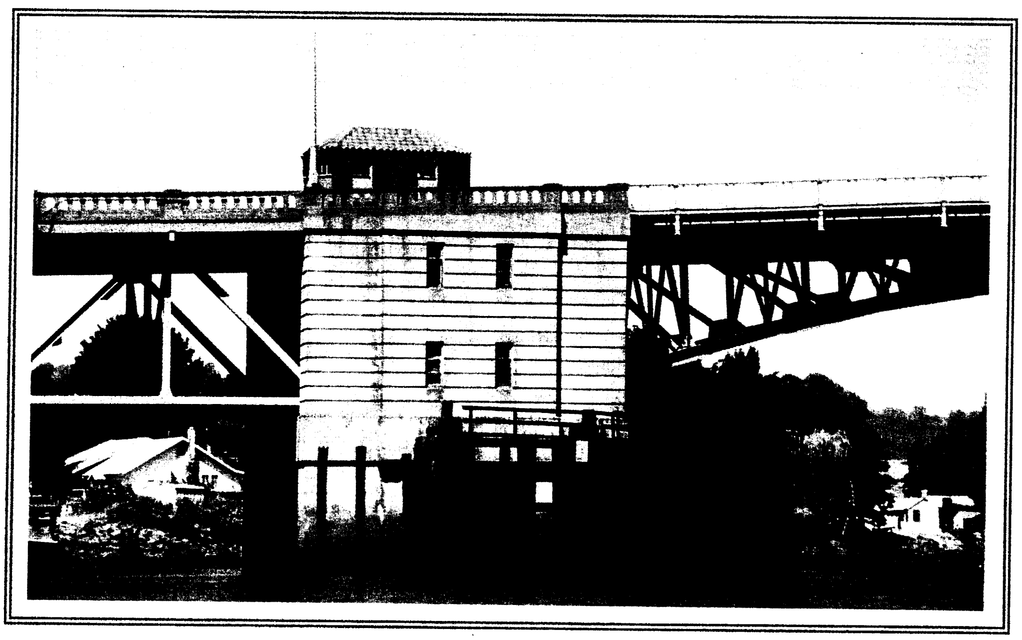

PHOTO 3: South Bascule - Viewed from the east.

PHOTO 4: North Bascule, North Face - Note the large vertical and diagonal cracks located between STA 0+05.1 and STA 0+14.8, respectively. Also note the horizontal crack at the waterline, as well as the hairline cracking and efflorescence.

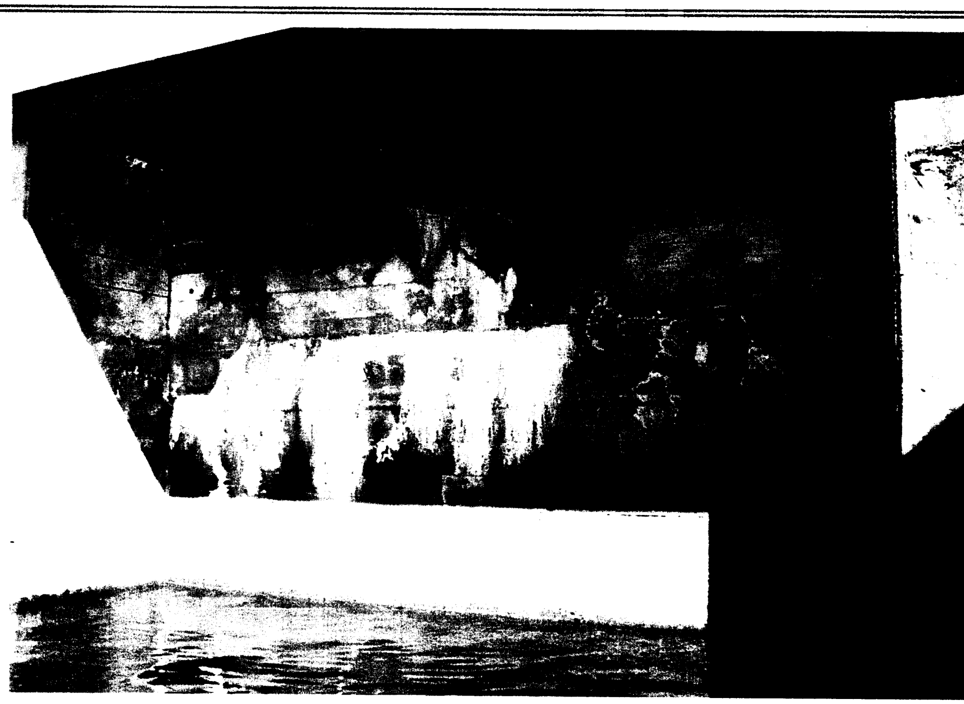

PHOTO 5: North Bascule, East Face - Extensive hairline cracking with efflorescence, located between STA 0+12.4 and 0+26.6.

PHOTO 6: North Bascule, South Face - Typical concrete repair/patch with degradation of the bond between the patch material & the base concrete, resulting in delamination of the edges.

PHOTO 7: North Bascule, South Face - Extensive vertical cracking between STA 0+40 & 0+50. Also note the hairline cracking with efflorescence.

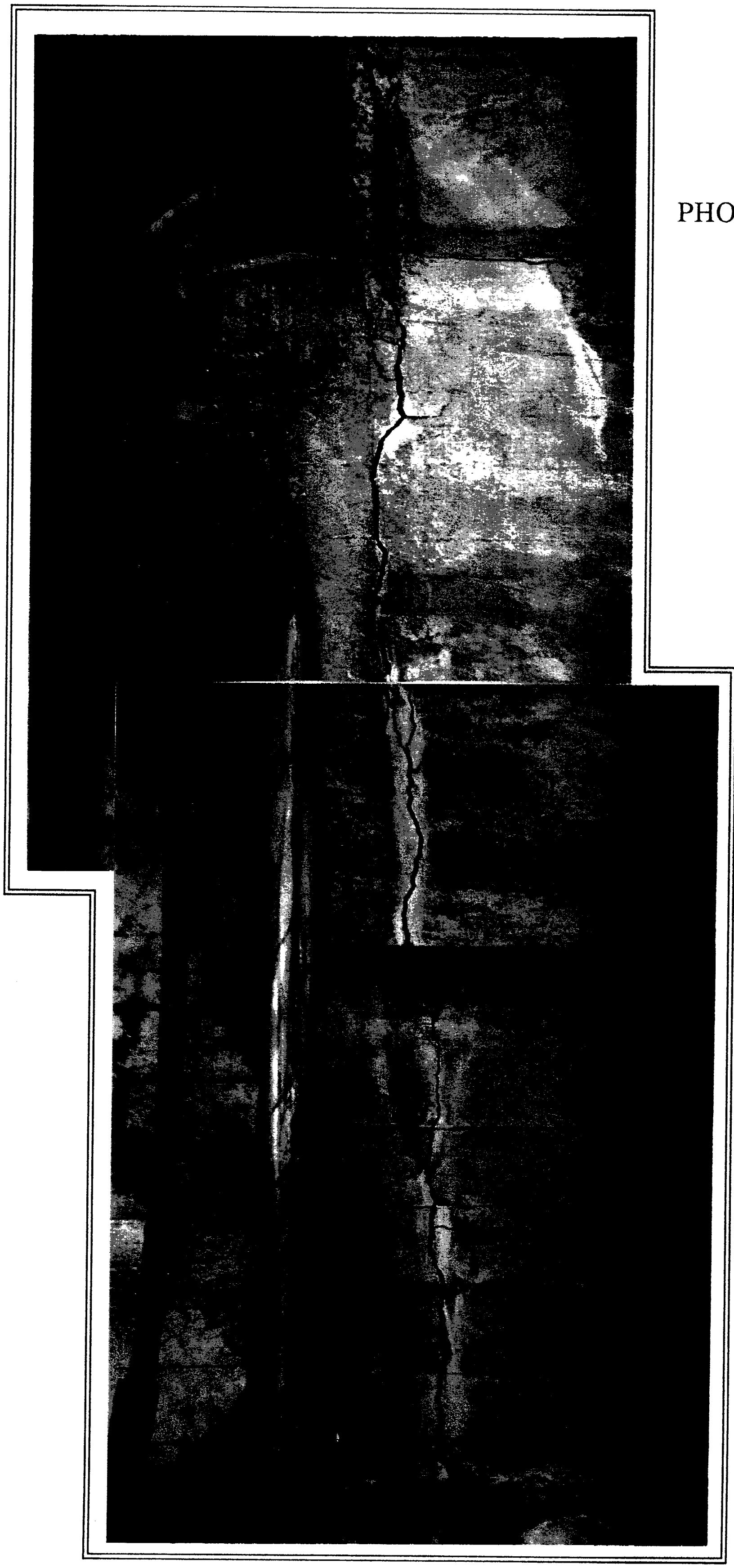

PHOTO 8: North Bascule, South Face – Severe vertical cracking at STA 0+46, this crack exceeds 4" inches in depth and continues through the pier and into the interior pit.

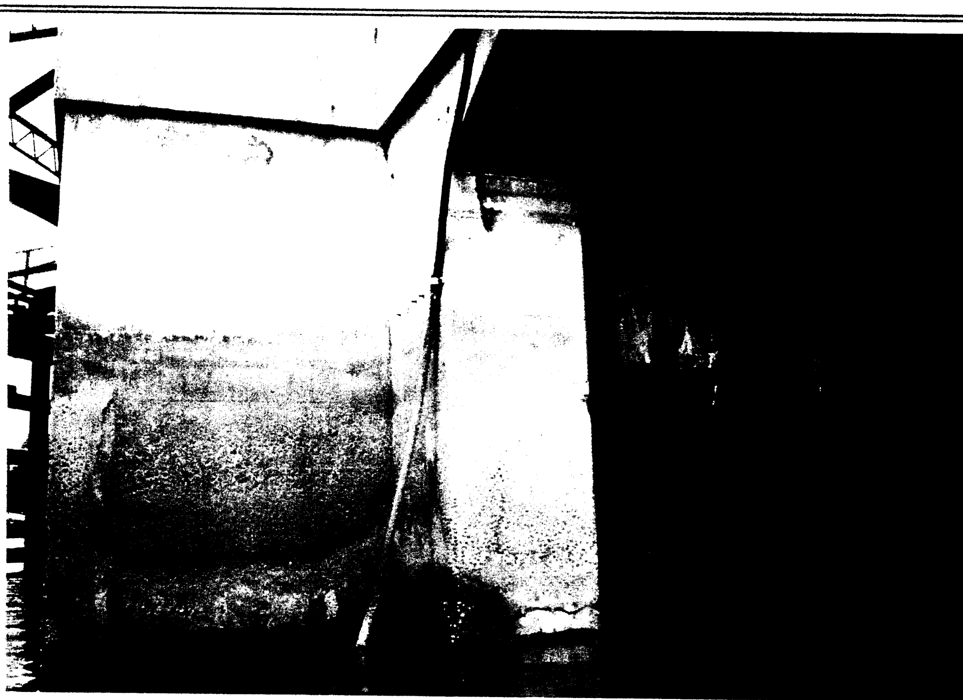

PHOTO 9: North Bascule, East Face - Note the corner spalling and delamination of corner repair/patches near the waterline. Also note the hairline cracking and efflorescence along the right side of the photo.

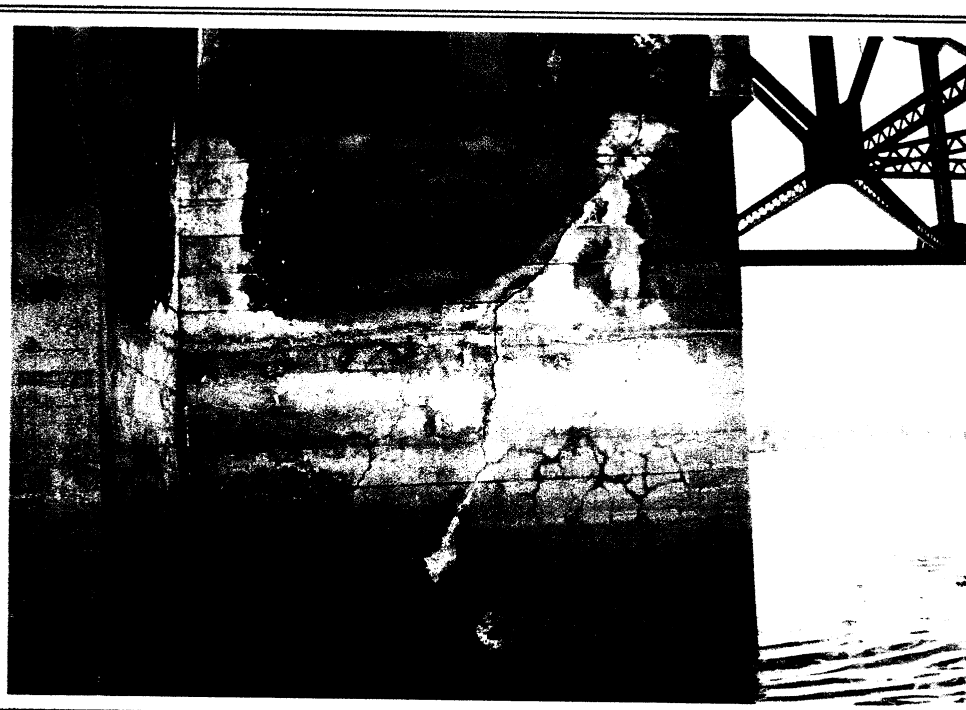

PHOTO 10: North Bascule, East Face - Diagonal and hairline cracking along the east-west wall at STA 0+35 to 0+39.

PHOTO 11: North Bascule, Northeast Corner - Corner spalling with exposed and corroded reinforcing steel. The concrete in this area is soft and easily crumbled. Large chunks can easily removed by hand.

PHOTO 12: North Bascule, East Face - Corner spall located beneath the waterline @ STA 0+08.8. This spall runs for 4' down the corner and has a depth of 9 inches. No rebar was found at this location.

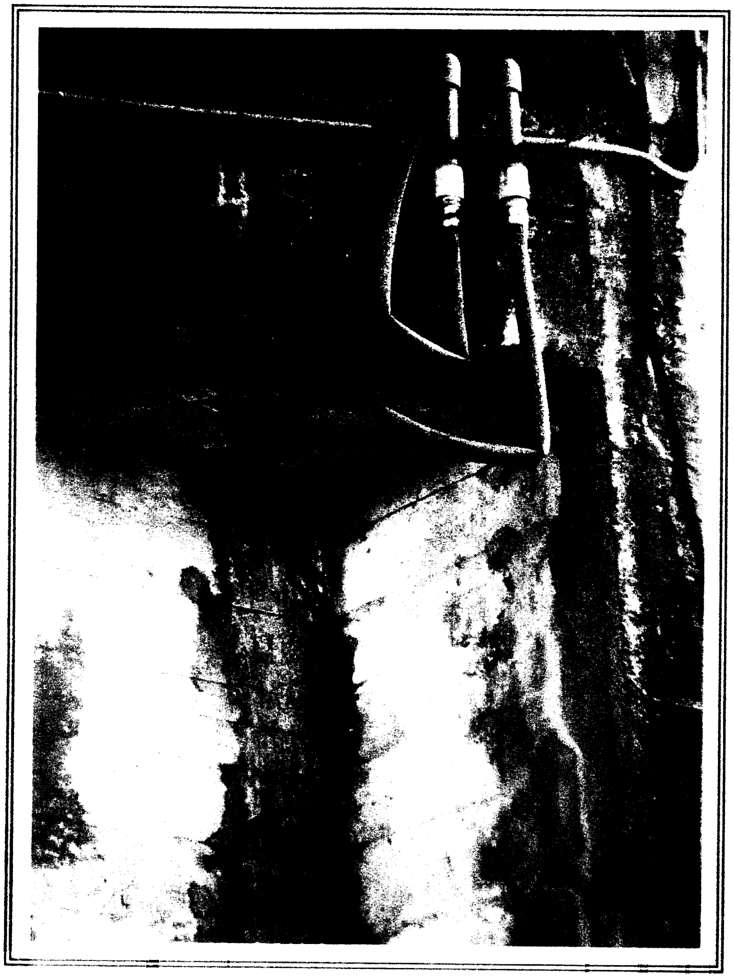

PHOTO 13: South Bascule, North Face - Severe vertical cracking at STA 0+45.8. This crack extends for 24' down the wall with a width of up to 3/4" and a depth in excess of 3 inches.

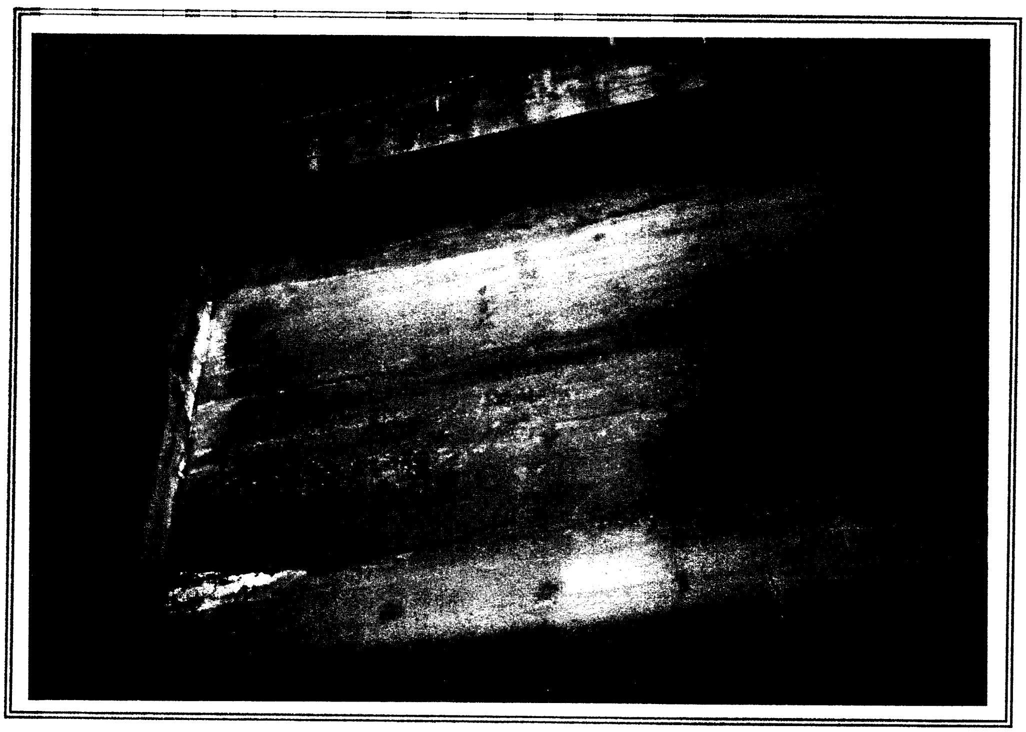

PHOTO 14: South Bascule, North Face - Vertical cracking down the length of the wall. Several vertical cracks are located along this face.

PHOTO 15: South Bascule, West Face - Typical cracking with efflorescence, (STA 0+30.3 to 0+39). Note the exposed and corroded reinforcing steel in the upper right corner.

PHOTO 16: South Bascule, South Face - Note the uniform horizontal and vertical cracking along the face. Also note the corner spalling and vertical crack along the left portion of the photo, which supports the growth of vegetation.

PHOTO 17: South Bascule, East Face - Extensive hairline cracking with efflorescence, (STA 0+26 to 0+39).

PHOTO 18: South Bascule, East Face - Note the large corner spall adjacent to the core location, sample #2.

PHOTO 19: South Bascule, West Face– STA 0+12.4, large corner spall. Note the cracking along the face. The concrete in this location is soft and easily crumbled.

PHOTO 20: South Bascule, East Face - Severe crack along the diagonal face at STA 0+20, elevation -14 to -20, (MDL). This crack ranges from 1/2" to 3/4" in width and greater than 6" in depth.

PHOTO 21: North Bascule, Northwest Corner - Vertical cracking along the west face of the interior pit. Note the corner cracking which extends through the wall to the exterior face.

PHOTO 22: North Bascule, Northwest Corner - Top view of the corner, note the crack that originates on the exterior south wall, (left), and continues deep into the pier.

PHOTO 23: North Bascule, East Face of Interior Pit - Horizontal and vertical cracking.

PHOTO 24: South Bascule, East Face of Interior Pit -
Note the extensive hairline cracking with efflorescence denoting contamination of the concrete.

PHOTO 25: Concrete Sample - Taken from the badly spalled, northeast corner of the North Bascule. Note the black and rust coloration of the material. The concrete is soft and brittle, and easily broken by hand.

PHOTO 26: Concrete Sample - Taken from a badly spalled corner. Note the black and rust coloration of the material. The concrete is soft and brittle, and easily broken by hand.

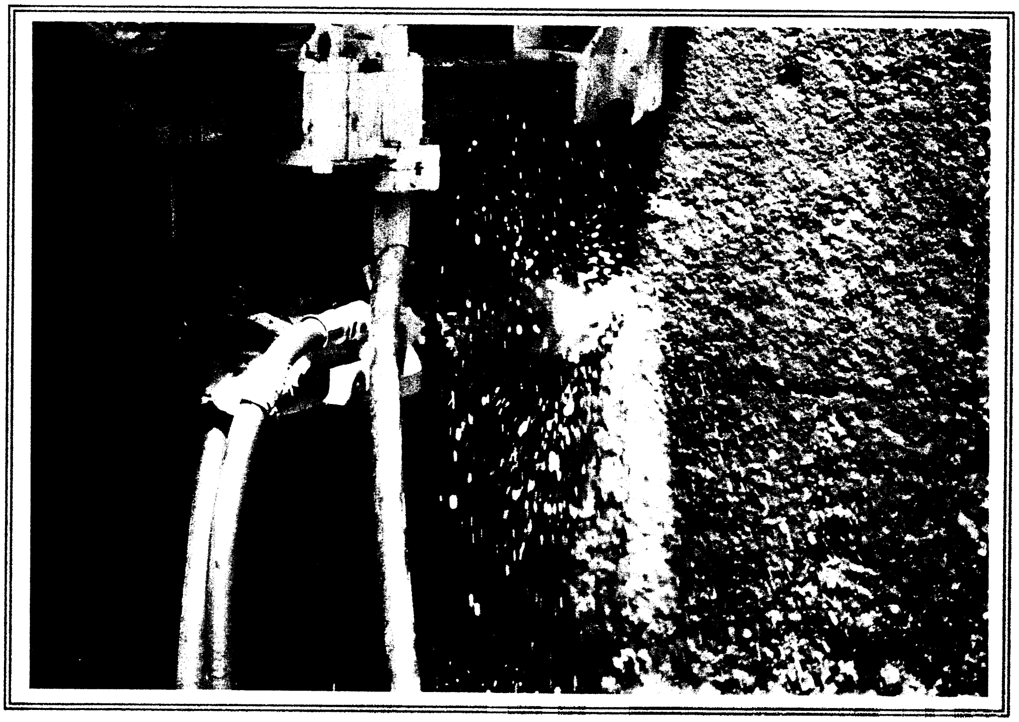

PHOTO 27: Concrete coring equipment secured to the Pier in the process of taking a core sample.

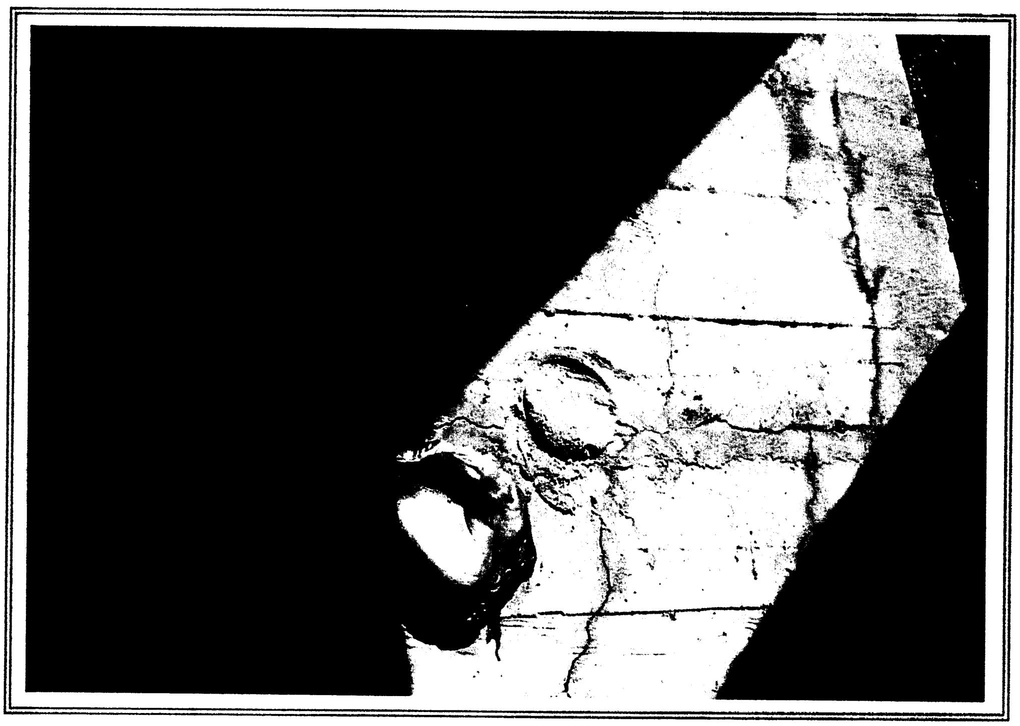

PHOTO 28: North Bascule, East Face - Core drill location, note the 1986 core location, (center right) and the adjacent core location of Sample #4, (center left).

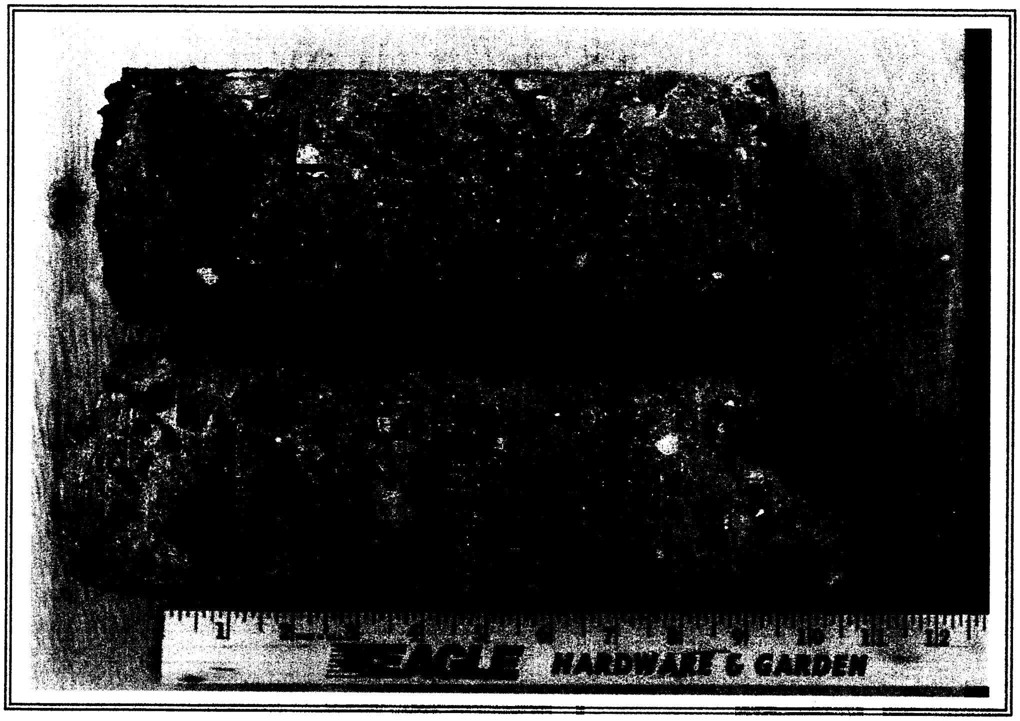

PHOTO 29: Concrete Core Sample #1 - Interior and exterior sections.

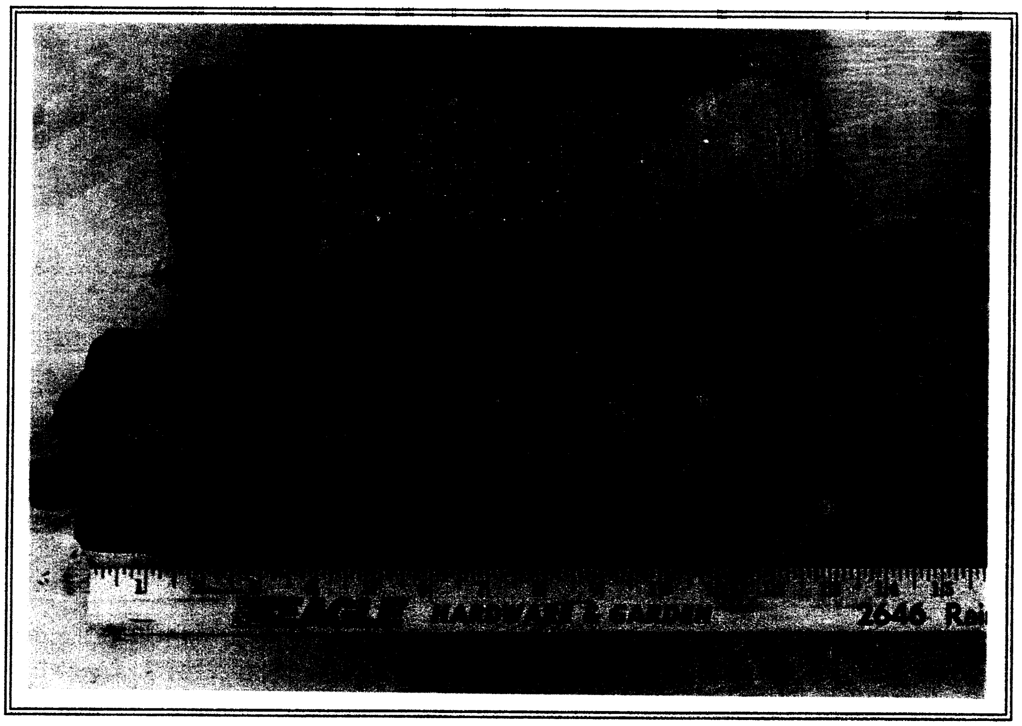

PHOTO 30: Concrete Core Sample #2 - Interior and exterior sections.

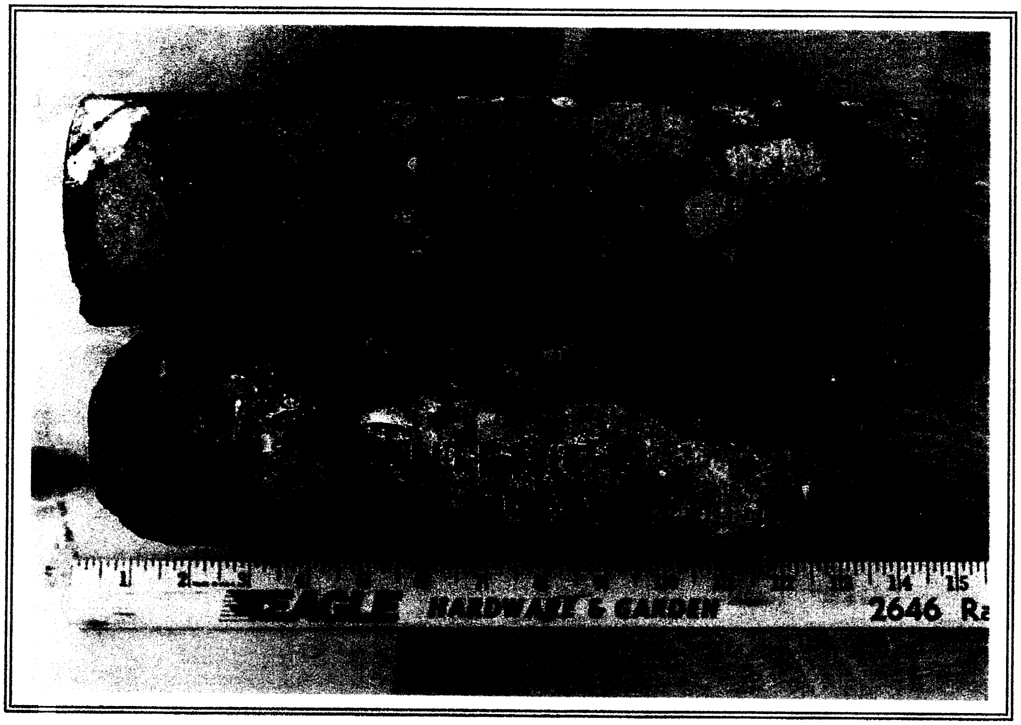

PHOTO 31: Concrete Core Sample #3 - Interior and exterior sections.

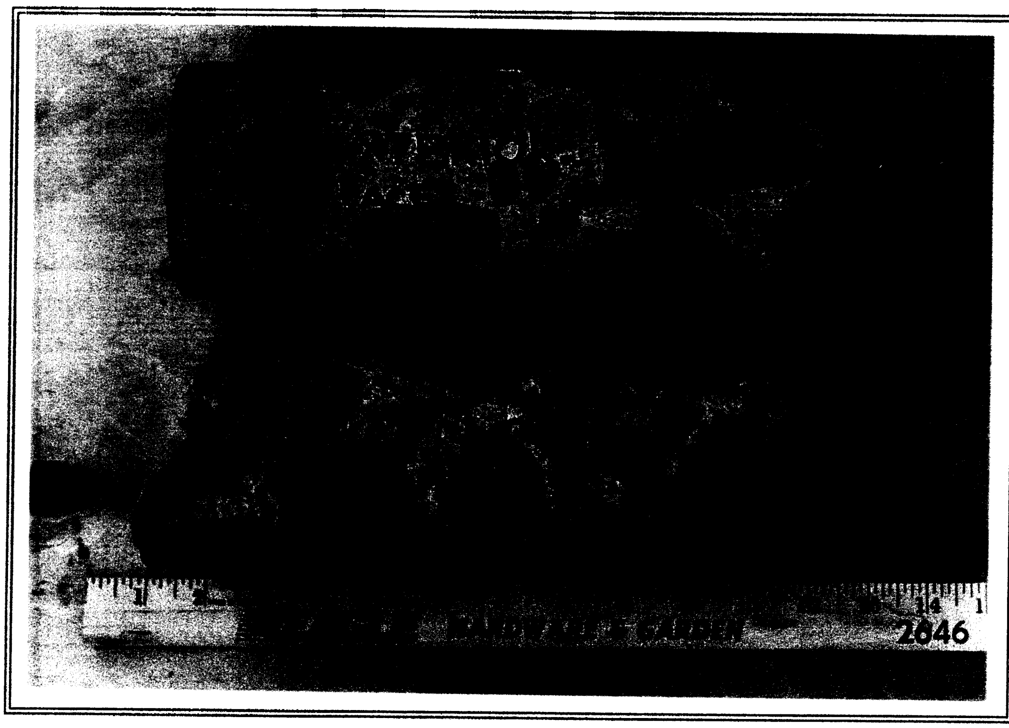

PHOTO 32: Concrete Core Sample #4 - Interior and exterior sections.

PHOTO 33: Concrete Core Sample #5 - Interior and exterior sections.

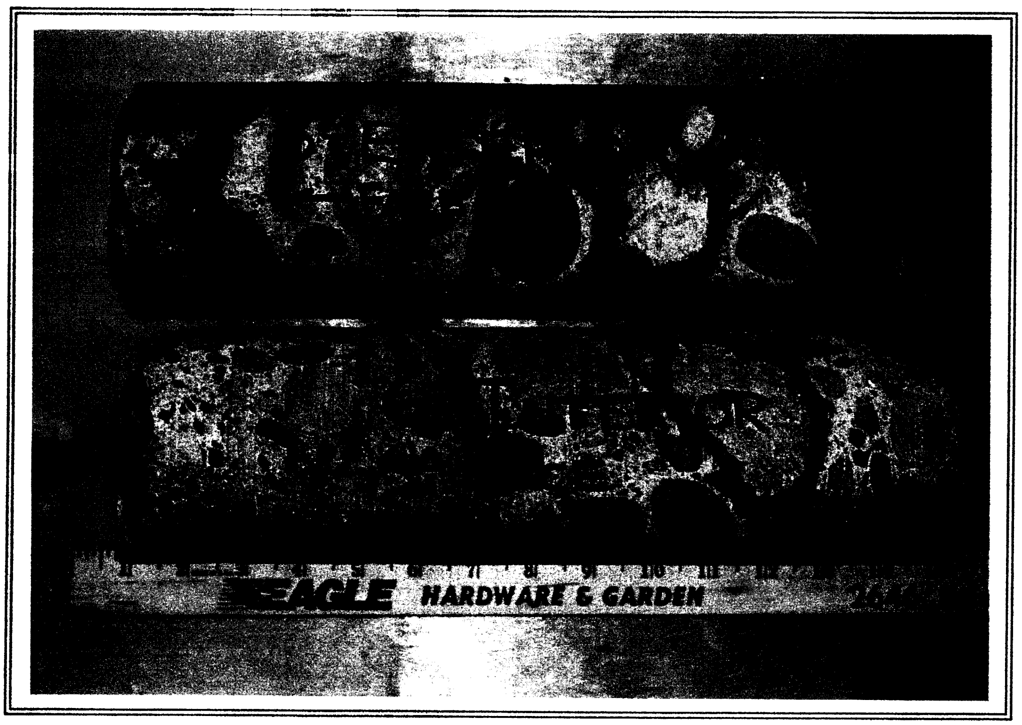

PHOTO 34: Concrete Core Sample #6 - Interior and exterior sections.

APPENDIX B
Figures

Abr	Abrasion
Att	Attack
B.	Bankia
Br	Batter Pile
C	Corbel
Ck	Check
CMP	Corrugated Metal Pipe
Corr	Corrosion
Cr	Crack
Creo	Creosote
D	Damaged
Dbl	Double
Dest	Destroyed
Dia	Diameter
Diag	Diagonal
Dn	Down
E	East
Fg	Fungal
Fr	Fender Pile
ft	Feet
Hvy	Heavy
ITZ	Intertidal Zone
L.	Limnoria
LA	Limited Access
Lg	Large
lt	Light
MBC	Marine Borer Cavity
MC	Main Cap
mD	Minor Damage
MD	Major Damage
MDL	Mudline
Mech	Mechanical
Miss	Missing
Mod	Moderate
Mtl	Metal
N	North
OBH	Open Bolt Hole
Ph	Pinholes
Ph/k	Pinholes in Knots
P.O.P.	Pushed off Drift Pin
RCP	Reinforced Conc. Pipe
S	South
SC	Sub-cap
Sk	Shake
Sm	Small
Sp	Split
SPL	Splash Zone
Stl	Steel
SUB	Submerged Zone
Tp	Top
Tunn	Tunnels
Typ	Typical
UD	Undamaged
W	West
WS	Water Staining

North Bascule Pier

ECHELON ENGINEERING, INC.
Seattle, Washington

TABLE 1

North Bascule Pier

Inspection Data

STA	Elevation (K. Co. Datum)	CONDITION/DAMAGE	Height (Vert.)	Width (Horiz.)	Depth
NORTH BASCULE PIER: North Face			STA 0+00 = Left Edge, (east)		
0+00	0 to −7	Concrete Repair/Patch; Delamination @ edges	7'−0	1'−0x1'−3	−
	−7 to −20,(MDL)	Corner Spall − Concrete is soft and easily crumbled Rebar exposed & corroded	13'−0	1'−0x1'−0	3"
0+00/0+49.6	3 to −2	Hairline Cracking w/ efflorescence	5'−0	−	−
0+05.1/0+14.8	−10 to −11	Band of Spalling − Concrete is soft & easily crumbled	1'−3	10'−0	6"
0+06	−7	Form Joint w/ Spall	1"	1'−0	1/2"
0+08	3 to −2	Vertical Crack	5'−0	1/4"	> 4"
0+12/0+14.8	3 to −1	Diagonal Crack	4'−0	1/4"	3"
0+14.8	2 to −10	Concrete Repair/ Patch − UD	12'−0	1'−0x1'−0	−
0+14.8/0+39.8	−7	Form Jt w/ cracks & spalling	1/4" to 1/2"	25'−0	1/4" to 1/2"
0+22	−13	Inlet/ Outlet − Heavy Spalling around opening. Concrete is soft & easily crumbled	−	−	6" to 8"
0+25/0+37	−4 to −5	Generalized Surface Pitting	1'−0	12'−0	1/2"
0+33	−13	Inlet/ Outlet − Heavy Spalling around opening. Concrete is soft & easily crumbled Rebar is exposed & corroded	−	−	6" to 8"
0+39.8	0 to −12 −12 to −14,(MDL)	Concrete Repair/Patch − UD Corner Spall − Concrete is soft & easily crumbled	12'−0 2'−0	1'−6x1'−6 3" x 6"	− 3"
0+41/0+43	−9	Form Joint w/ Spalling	1'−3	6"	6"
0+42	3 to −2	Vertical Crack w/ efflorescence	5'−0	1/4"	3"
0+44	0 to −2	Vertical Crack w/ efflorescence	2'−0	1/4"	4"
0+47	3 to −2	Vertical Crack w/ efflorescence	5'−0	1/4"	1"

TABLE 1
North Bascule Pier
Inspection Data

STA	Elevation (K. Co. Datum)	CONDITION/DAMAGE	Height (Vert.)	Width (Horiz.)	Depth
0+44/0+49.6	0	Horizontal Crack w/ efflorescence	1/4"	6'−0	1/2"
0+49.6	−1 to −10	Concrete Repair/Patch – Delaminating @ edges	11'−0	1'−6x1'−6	–
0+49.6/0+54.7	−10 to −14,(MDL)	Band of Spalling – Concrete Is soft & easily crumbled	4'−0	5'−0	1"
0+54.7	−4 to −12	Concrete Repair/Patch; Delaminating @ edges Concrete is soft & easily crumbled	8'−0	1'−6x1'−6	–

TABLE 1
North Bascule Pier
Inspection Data

STA	Elevation (K. Co. Datum)	CONDITION/DAMAGE	Height (Vert.)	Width (Horiz.)	Depth
NORTH BASCULE PIER: West Face			**STA 0+00 = Left Edge, (west)**		
0+00	−4 to −12	Concrete Repair/Patch; Delamination @ edges	8'−0	1'−6x1'−6	–
	−12 to −14, (MDL)	Corner Spall – Concrete is soft & easily crumbled	2'−0	9"	1"
0+00/0+39	−4 to MDL	Surface Pitting	–	39'−0	1/8" to 1/4"
	12 to 0	Hairline Cracking w/ efflorescence	12'−0	–	–
0+04	6 to 0	Vertical Crack	6'−0	1/4"	1/2"
0+09	6 to 0	Vertical Crack	6'−0	1/4"	1/2"
0+14	−4 to −12	Concrete Repair/Patch – UD	8'−0	1'−3x1'−6	–
	−8	Form Joint w/ spalling on E/W Face	2"	2'−0	1/2"
0+14/0+26	3	Horizontal Crack efflorescence	1/4"	12'−0	1/4"
0+16	6 to 0	Vertical Crack	6'−0	1/4"	1/2"
0+26	−13 to −18, (MDL)	Corner Spall – Concrete is soft & easily crumbled	5'−0	3'−0x1'−6	9"
0+26/0+39	−12 to −14	Band of spalling	2'−0	13'−0	7"
0+33	−6	Core Location – 1986	–	4" Dia	–
0+36	3	Core Location – 1986	–	4" Dia	–
	0	Mechanical Spall – Due to coring, 1986	–	6" Dia	1 1/2"
0+39	−7 to −22, (MDL)	Corner Spall; Rebar Exposed	15'−0	3'−0	1'−0

TABLE 1

North Bascule Pier

Inspection Data

STA	Elevation (K. Co. Datum)	CONDITION/DAMAGE	Height (Vert.)	Width (Horiz.)	Depth
NORTH BASCULE PIER: South Face			**STA 0+00 = Left Edge, (north)**		
0+00	−7 to −22,(MDL)	Corner spalling – Concrete is soft & easily crumbled Rebar exposed & corroded	15'−0	1'−6x1'−0	6" to 18"
0+00/0+08.8	−16 to −23	Band of heavy spalling	7'−0	9'−0	5" to 12"
0+00/0+14.8	10 to 2	Hairline Cracking w/ efflorescence	8'−0	–	–
0+05/0+08.8	−5	Form Jt w/ Horizontal Crack Concrete is soft & easily crumbled	2"	4'−0	1/4" to 3"
0+08.8	12 to −11	Vertical Crack in Corner	23'−0	1/4"	2" to 3"
	0 to −11	Concrete Repair/ Patch – Delaminating @ edges Concrete is soft & easily crumbled	10'−0	1'−0x1'−0	–
	−11 to −20,(MDL)	Corner Spall – Concrete is soft & easily crumbled, Rebar exposed & corroded	9'−0	1'−0x1'−6	13" to 14"
0+08.8/0+14.8	12 to −3	Hairline Cracking w/ efflorescence	15'−0	–	–
	−17 to −20,(MDL)	Band of Spalling – Concrete is soft & easily crumbled	3'−0	6'−0	6"
0+14.8	12 to 0	Vertical Crack down corner w/ efflorescence	12'−0	1/4"	1"
	0 to −8	Concrete Repair/Patch – Delaminating @ edges	8'−0	1'−3x1'−6	–
	−8	Corner Spall	9"	6" x 6"	2"
	−8 to −10	Vertical Crack on N/S Face	2'−0	1/4"	1"
0+14.8/0+22	0 to −3	Diagonal Cracking	3'−0	1/4"	1/4" to 1/2"
0+14.8/0+27	−6	Form Jt w/ Horizontal Crack & spalling	1/8"	12'−0	0 to 2"
	−16 to (MDL)	Band of spalling	1' to 3'	12'−0	1/2" to 9"
0+19/0+24	−10	Spalling	6" to 8"	4'−0	1" to 2"
0+26/0+39.8	3 to −1	Hairline Cracking	4'−0	–	–

TABLE 1
North Bascule Pier
Inspection Data

STA	Elevation (K. Co. Datum)	CONDITION/DAMAGE	Height (Vert.)	Width (Horiz.)	Depth
0+27/0+39.8	−16 to MDL	Band of Spalling	1'−0	13'−0	1"
0+30	12 to −2	Vertical Crack	14'−0	1/8" to 1/4"	2" to 3"
0+38	−9	Spall – Soft and Crumbly	9"	7" to 8"	2"
0+39.8	12 to 3	Vertical Crack w/ efflorescence	9'−0	1/4"	1"
0+39.8	0 to −11	Concrete Repair/Patch – UD	11'−0	1'−6x2'−0	–
	−11 to −16	Corner Spall – Concrete is soft & easily crumbled, Rebar is exposed & corroded	5'−0	1'−6x2'−0	13"
0+39.8/0+45.8	10 to −1	Hairline Cracking w/ efflorescence	11'−0	–	–
0+39.8/0+54.7	−11	Horizontal Crack w/ efflorescence – Concrete is soft & easily crumbled	1/8" to 1"	15'−0	1" to 2"
0+42/0+45	−7 to −8	Band of Spalling	1'−0	3'−0	1/2" to 1"
0+45.8	−3	Corner Spall	1'−0	9" x 9"	6"
	−3 to −11	Concrete Repair/Patch – Delaminating @ edges	8'−0	1'−0x1'−6	–
	−11 to −13	Corner Spall – Concrete is soft & easily crumbled	2'−0	1'−0x1'−0	6" to 8"
0+45.8/0+54.7	−13 to MDL	Band of spalling – Concrete is soft & easily crumbled	5'−0	10'−0	1/2" to 2"
0+46	12 to −11	Vertical Crack	23'−0	1/2"	> 4"
0+49	12 to 3	Vertical Crack	9'−0	1/4"	1/2"
0+54.7	0 to −10	Concrete Repair/ Patch – Delaminating @ edges	10'−0	1'−6x1'−6	–
	−10 to −11	Corner Spall	1'−0	3" x 6"	3"

TABLE 1
North Bascule Pier
Inspection Data

STA	Elevation (K. Co. Datum)	CONDITION/DAMAGE	Height (Vert.)	Width (Horiz.)	Depth
NORTH BASCULE PIER: East Face			STA 0+00 = Left Edge, (south)		
0+00	0 to −10	Concrete Repair/Patch; Delaminating @ edges	10'−0	1'−3x1'−3	–
0+00/0+08.8	12 to 0	Hairline Cracking	–	9'−0	–
0+01	−10 to −14	Spall – Rebar Exposed	4'−0	2'−0	3"
0+02	−7	Spalling	3"	1' – 6	1 1/2"
0+02/0+08.8	−12	Band of Spalling – Concrete is soft & easily crumbled	1'−0	7'−0	2"
0+06	12 to 0	Vertical Crack	12'−0	1/4"	1/2"
0+07	−7	Steel Pipe	–	4" Dia	–
0+08.8	12 to 0	Vertical Crack on Corner w/ Efflorescence	12'−0	1/4"	1/4"
	−7	Form Joint w/ spalling On E/W Face	2"	4'−0	3/4"
	−7	Multiple Attachment Bolts For Utilities – Corroded on E/W Face	–	–	–
	−7 to −11	Corner Spall – Concrete is soft & easily crumbled	4'−0	9"x9"	6"
0+08.8/0+12.4	−3 to −7	Concrete Repair/ Patch Delaminating at Bottom	4'−0	3'−0	–
	−11 to −16	Band of Spalling – Concrete is soft & easily crumbled Rebar Exposed	5'−0	3'−0	12" to 14"
0+10	−4 to −7	Vertical Crack	3'−0	1/4"	1/4"
0+12.4	6 to −4	Vertical Crack in corner w/ efflorescence	10'−0	1/4"	1/4"
	−7	Form Joint w/ spalling on E/W Face	4"	7'−0	1"
0+12.4/0+20	−7	Form Joint Spalling	3" to 10"	7'−0	2"
0+12.4/0+26.6	3	Horizontal Crack w/ efflorescence	1/4"	14'−0	1/2"

TABLE 1
North Bascule Pier
Inspection Data

STA	Elevation (K. Co. Datum)	CONDITION/DAMAGE	Height (Vert.)	Width (Horiz.)	Depth
0+12.4/0+26.6	−8 to −10	Spall – Concrete is soft & easily crumbled	2'−0	12'−0	4"
	−12 to −14	Band of Spalling – Concrete is soft & easily crumbled	2'−0	12'−0	2"
0+14	6 to −1	Vertical Crack w/ efflorescence	7'−0	1/4"	1/4"
0+18/0+26.6	6 to 3	Hairline Cracking w/ efflorescence	3'−0	–	–
0+24	6 to 3	Vertical Crack	3'−0	1/4"	1/2"
0+26.6	3 to −1	Vertical Crack w/ efflorescence	4'−0	1/4"	1/4"
	−12 to MDL	Generalized Spalling of wall on E/W Face	6'−0	4'−0	1−2"
0+26.6/0+28	−5	Spall	1'−0	1'−0	2"
0+26.6/0+30.3	−4 to −6	Concrete Repair/Patch; Delaminating @ edges	2'−0	3'−0	–
	−11 to −20,(MDL)	Spall – Concrete is soft & easily crumbled w/ rebar exposed & corroded	9'−0	4'−0	12" to 14"
0+30.3	−7	Corner Spall – Concrete is soft & easily crumbled	9"	1'−0x1'−6	6"
	−8	Corner Spall – Concrete is soft & easily crumbled	1'−0	1'−0x1'−0	3"
0+30.3/0+39	3 to 0	Hairline Cracking	3'−0	–	–
	−10 to −16	Band of Spalling – Concrete is soft & easily crumbled	6'−0	9'−0	5"
0+35	−6	Spall/Delamination – Conc. is soft & easily crumbled	1'−0	1'−0	2 1/2"
0+35 / 0+37	6 to −1	Diagonal Crack w/ efflorescence	7'−0	1/4"– 1/2"	3"
0+39	0 to −7	Concrete Repair/ Patch; Delamination @ edges	7'−0	1'−6x1'−6	–
	−7 to −20,(MDL)	Corner Spall – Rebar exposed & corroded	13'−0	1'−0x1'−6	13" to 14"

TABLE 1
North Bascule Pier
Inspection Data

STA	Elevation (K. Co. Datum)	CONDITION/DAMAGE	Height (Vert.)	Width (Horiz.)	Depth
NORTH BASCULE PIER: Interior Pit North Face		STA 0+00 = Left Edge, (west)			
0+00/0+02	3 to 2	Hairline Cracking	1'–0	–	–
0+05/0+07	3 to 2	Hairline Cracking	1'–0	–	–
0+18	0 to –5	Vertical Crack	5'–0	1/8"	1/4" to 1/2"
NORTH BASCULE PIER: Interior Pit West Face		STA 0+00 = Left Edge, (south)			
0+04	3 to 0	Vertical Crack	3'–0	1/8"	1/2" to 1"
0+05/0+10	3 to 1	Hairline Cracking	2'–0	–	–
0+08	3 to 0	Vertical Crack	3'–0	1/8"	1/2" to 1"
0+16/0+18	0 to –2	Diagonal Crack	2'–0	1/4"	1"
0+18/0+21	3 to –6	Vertical/Diagonal Crack	9'–0	1/2"	1"
0+19/0+23	2 to –1	Diagonal Crack	3'–0	1/8" to 1/4"	1/2" to 1"
0+20/0+23	0 to –2	Diagonal Crack	2'–0	1/8" to 1/4"	1/2" to 1"
NORTH BASCULE PIER: Interior Pit South Face		STA 0+00 = Left Edge, (east)			
0+00	12 to 11	Vertical Crack	1'–0	1/4"	1/2" to 1"
0+00/0+04	3 to 1	Diagonal Crack	2'–0	1/4"	1/2" to 1"
0+10/0+13	12 to –1	Vertical Crack	13'–0	1/4"	1"
0+25	11 to 6	Vertical Crack	5'–0	1/4"	1"
NORTH BASCULE PIER: Interior Pit East Face		STA 0+00 = Left Edge, (north)			
0+00/0+04	3 to –2	Diagonal Crack	4'–0	1/4"	3/4"
0+00/0+013	0 to –3	Horizontal Crack w/ radiating hairline cracking	3'–0	1/4"	1/2" to 1"
0+05/0+09	3 to –1	Hairline Cracking	4'–0	–	–
0+16	3 to –3	Vertical Crack	6'–0	1/4"	1/2" to 1"
0+17	6 to 3	Vertical Crack	3'–0	1/8"	1/2" to 1"

South Bascule Pier

TABLE 2
South Bascule Pier
Inspection Data

STA	Elevation (K. Co. Datum)	CONDITION/DAMAGE	Height (Vert.)	Width (Horiz.)	Depth
SOUTH BASCULE PIER: North Face		STA 0+00 = Left Edge, (east)			
0+00/0+08.8	6 to 3 −6	Hairline Cracking Form Joint w/ Spall	3'−0 2"	– 9'−0	– 3/4" to 1"
0+00/0+54.7	2	Form Jt w/ Horizontal Crack	0" to 1/4"	–	–
0+08.8	6 to −21, (MDL) −6 to −21, (MDL)	Verticle Crack down Corner Corner Spall Rebar Exposed	27'−0 15'−0	1/4 1'−0x1'−3	1/2" 8"
0+08.8/0+14.8	9 to 0	Hairline Cracking	9'−0	–	–
0+14.8	9 to 3	Vertical Crack down Corner w/ efflorescence	6'−0	1/4"	1/4"
0+14.8/0+32	−3 to −2	Horizontal Crack	1/4"	17'−0	1/4" to 1/2"
0+20/0+22	−7	Form Jt w/ Spall	2"	2'−0	1 1/2"
0+25	12 to −6	Verticle Crack	18'−0	1/4"	1/2"
0+32	12 to −4	Verticle Crack	16'−0	1/4"	1/4"
0+39.8	−6 to −12, (MDL)	Corner spall – Concrete is Soft & easily crumbled	12'−0	1'−0x1'−0	9"
0+39.8/0+54.7	12 to 0	Hairline Cracking w/ efflorescence	12'−0	–	–
0+45.8	12 to −12, (MDL) −6 to −12, (MDL)	Verticle Crack down Corner Corner Spalling	24'−0 6'−0	1/2" to 3/4" 6" x 6"	>3" 1" to 1 1/2"
0+45.8/0+54.7	−7	Form Joint w/ Spall	1" to 2"	10'−0	1"
0+54.7	−7 to −12	Corner Spall – Concrete is soft & easily crumbled Rebar exposed & corroded	5'−0	6"	5"

TABLE 2
South Bascule Pier
Inspection Data

STA	Elevation (K. Co. Datum)	CONDITION/DAMAGE	Height (Vert.)	Width (Horiz.)	Depth
SOUTH BASCULE PIER: West Face			STA 0+00 = Left Edge, (north)		
0+00	−7 to −12,(MDL)	Corner Spall – Rust Bleeding Concrete is soft & easily crumbled, Rebar exposed & corroded	5'−0	9" x 9"	6"
0+08.8	2 to −3	Hairline Cracking down corner w/ efflorescence	5'−0	–	–
	−7 to −10,(MDL)	Corner Spall w/ Cracking – Concrete is soft & easily crumbled	3'−0	9" x 9"	4"
0+08.8/0+12.4	3 to 1	Hairline Cracking	2'−0	–	–
0+12.4	−8 to −10,(MDL)	Corner Spall w/ Cracking Concrete is soft & easily crumbled	2'−0	6" x 6"	2"
0+12.4/0+26.6	−6	Form Jt w/ Spalling	2"	14'−0	1/2" to 1"
0+18/0+26.6	6 to −3	Hairline Cracking w/ efflorescence	9'−0	–	–
0+26.6	−7 to −12,(MDL)	Corner Spall – Concrete is soft & easliy crumbled	5'−0	9" x 9"	6"
0+29	−2 to −7	Vertical Crack	5'−0	1/4"	1/4"
0+30.3	−7 to −12,(MDL)	Corner Spall – Concrete is soft & easliy crumbled	5'−0	9" x 9"	6"
0+30.3/0+39	6 to −6	Hairline Cracking w/ w/ efflorescence	12'−0	–	–
0+39	−6 to −13,(MDL)	Corner Spall w/ Cracking – Concrete is soft & easily crumbled	9'−0	6" x 6"	6"

TABLE 2
South Bascule Pier
Inspection Data

STA	Elevation (K. Co. Datum)	CONDITION/DAMAGE	Height (Vert.)	Width (Horiz.)	Depth
SOUTH BASCULE PIER: South Face STA 0+00 = Left Edge, (west)					
0+00	−3 to −15	Corner Spall – Concrete is soft & easily crumbled	10'−0	6" x 6"	3"
0+00/0+03	−2 to −7	Hairline Cracking	5'−0	–	–
0+00/0+05.1	−8 to −9	Band of Spalling – Concrete is soft & easily crumbled	1'−0	5'−0	3"
0+00/0+54.7	−2	Form Jt w/ Horizontal Crack	1/4"	55'−0	1/4" to 1/2"
0+05.1	0 to −3 −6 −6 to −8	Vertical Crack on E/W Face Form Joint w/ Spalling Corner Spall – Concrete is soft & easily crumbled, Rebar exposed & corrosed	3'−0 3" 2'−0	1/4" 1" 1'−0x1'−0	1/4" 1/4" 5"
0+05.1/0+54.7	−10 to MDL	Generalized surface pitting	2" to 3"	2" to 3"	1/8" to 1/4"
0+08	3 to −6	Vertical Crack w/ Vegetation	9'−0	1/4" to 1/2"	1/2" to 1"
0+9.0/0+39.8	1 to −4	Hairline Cracking	5'−0	–	–
0+14.8	−6 to −8	Corner Spall – Concrete is soft & easily crumbled	2'−0	9" x 9"	6"
0+14.8/0+20	−8 to −9	Band of Spalling – Concrete is soft & easily crumbled	5'−0	1'−0	1/2"
0+22	−14	Inlet/ Outlet – Spalling w/ rebar exposed & corroded	–	–	3"
0+33	−14	Inlet/ Outlet – Spalling w/ rebar exposed & corroded	–	–	3" to 4"
0+39.8	−6 to −8	Corner Spall – Concrete is soft & easily crumbled	2'−0	6" x 6"	3"
0+45	3 to −3	Vertical Crack w/ Vegetation	6'−0	1/4"	1/2" to 1"
0+49.6	0 to −7 −7 to −23,(MDL)	Corner Concrete Patch – UD Corner Spall – Concrete is soft & easily crumbled	7'−0 15'−0	12" 13" to 9"	6" 3" to 6"
0+51	3 to 0	Vertical Crack	3'−0	1/4"	1/4" to 1/2"
0+54.7	6 to 3 −4 to −22,(MDL)	Vertical Crack Corner Spall – Concrete is soft & easily crumbled	3'−0 6"	1/4" 6"	1/2" 1"

TABLE 2
South Bascule Pier
Inspection Data

STA	Elevation (K. Co. Datum)	CONDITION/DAMAGE	Height (Vert.)	Width (Horiz.)	Depth
SOUTH BASCULE PIER: East Face			STA 0+00 = Left Edge, (south)		
0+00	−5	Corner Spall	6"	3"	3"
	−10 to −22,(MDL)	Corner Spall, Concrete is soft & easily crumbled	12'−0	6" x 9"	6" to 9"
0+00/0+39	6 to −4	Hairline Cracking w/ efflorescence	10'−0	−	−
	−7	Form Joint w/ Spall	6"	39'−0	1/2"
	−10 to (MDL)	Minor Pitting	−	−	1/4"
0+10/0+14	7	Spall w/ rebar exposed & corroded	3"	4'−0	3"
0+14	6 to −8	Hairline Crack down Corner w/ efflorescence	14'−0	−	−
	−8 to −17	Vertical Crack down Corner w/ spalling, Diagonal Crack along diagonal face & into vertical face	9'−0	1/2"	1 1/2" to 2"
0+18	3 to −3	Vertical Crack w/ efflorescence	6'−0	1/8"	1/4"
0+20	−14 to −20,(MDL)	Vertical Crack down diagonal face	6'−0	1/2" to 3/4"	>6"
0+26	6 to −7	Hairline Cracking down corner w/ efflorescence	13'−0	−	−
	−7 to −17,(MDL)	Corner Spall w/ Crack Concrete is soft & easily crumbled	10'−0	1'−0x1'−6	2" to 6"
0+39	−2	Corner Spall	3"	6"	2"
	−7 to −20,(MDL)	Corner Spall − Concrete is soft & easliy crumbled	13'−0	6" x 6"	7"

TABLE 2
South Bascule Pier
Inspection Data

STA	Elevation (K. Co. Datum)	CONDITION/DAMAGE	Height (Vert.)	Width (Horiz.)	Depth
SOUTH BASCULE PIER: North Face			**STA 0+00 = Left Edge, (west)**		
0+00/0+01	2	Horizontal Crack	1'–0	1/8"	1/8" to 1/4"
0+00/0+02	1	Horizontal Crack	2'–0	1/8"	1/4"
0+00/0+04	0 to –6	Diagonal Crack	6'–0	1/8"	1/8" to 1/4"
0+09	10 to –7,(MDL)	Vertical Crack	17'–0	1/4"	1/2" to 1"
0+15	10 to –7,(MDL)	Vertical Crack	17'–0	1/4"	1/2" to 1"
0+25	9 to 6	Vertical Crack	3'–0	1/4"	1/2" to 1"
SOUTH BASCULE PIER: West Face			**STA 0+00 = Left Edge, (north)**		
0+00/0+04	3 to –4	Diagonal Crack	7'–0	1/4"	1/2" to 1"
0+00/0+08	3 to 0	Horizontal Crack w/ Radiating hairline cracking	3'–0	1/4"	1/8 " to 1/4"
0+03/0+12	–1 to –2	Horizontal Crack	1'–0	1/8"	1/8" to 1/4"
0+08	1 to –4	Vertical Crack	5'–0	1/8"	1/8" to 1/4"
0+11	3 to –3	Vertical Crack	6'–0	1/8"	1/8" to 1/4"
0+15/0+23	3 to –6	Vertical Cracking w/ radiating hairline cracks	9'–0	1/8"	1/2" to 1"
SOUTH BASCULE PIER: South Face			**STA 0+00 = Left Edge, (east)**		
0+04	1 to –3	Vertical Crack	4'–0	1/8"	1/8" to 1/4"
0+07	–3 to –4	Vertical Crack	1'–0	1/8"	1/8" to 1/4"
0+12	1 to –4	Vertical Crack	5'–0	1/8"	1/8" to 1/4"
0+20	0 to –4	Vertical Crack	4'–0	1/8"	1/8" to 1/4"
SOUTH BASCULE PIER: East Face			**STA 0+00 = Left Edge, (north)**		
0+00	4 to –1	Vertical Crack	5'–0	1/4"	1/2" to 1"
0+07	3 to –5	Vertical Crack	8'–0	1/8"	1/2" to 1"
0+16/0+21	0 to –3	Hairline Cracking	3'–0	1/8"	1/8" to 1/4"

Concrete Data

TABLE 3
North & South Bascule Piers
Concrete Core Data

SAMPLE No.	LOCATION			TEST RESULTS		
	Face of Bascule	STA	Elevation (KC Datum)	Ultimate Comp. Strength, (psi)	Sol. Chlorides (ppm)	Sol. Sulfates (ppm)
SOUTH BASCULE PIER						
1 – Exterior	North	0+52	−4	4080	926	98.9
– Interior				2970	209	445
Average				3525	568	272
2 – Exterior	East	0+26	−7	3800	1410	73.7
– Interior		on E/W		2050	205	284
Average		Face		2925	808	179
3 – Exterior	South	0+10	−16	5020	2660	48.9
– Interior				4250	1400	107
Average				4635	2030	78
NORTH BASCULE PIER						
4 – Exterior	West	0+35	3	3250	463	138
– Interior				2310	388	500
Average				2780	426	319
5 – Exterior	West	0+35	−15	3050	1780	86.5
– Interior				4650	491	2730
Average				3850	1136	1408
6 – Exterior	East	0+15	−3	2450	477	80.7
– Interior				2880	218	213
Average				2665	348	147

River Profile Data

TABLE 4

River Profile Data

READING No.	DESCRIPTION	Mudline Elevation (King Co. Datum)
SOUNDINGS; 50 ft Upstream		
1	Center Line Pier 2 – South	−0.6
2	Panel Point	−2.7
3	Panel Point	−5.1
4	Panel Point	−8.2
5	Center Line Pier 1 – South	−12.1
6	Panel Point	−13.6
7	Panel Point	−16.3
8	Panel Point	−20.6
9	S. Edge/Face of South Bascule	−21.7
10	SE Corner South Bascule	−21.8
11	NE Corner South Bascule	−30.0
12	N. Edge/Face of South Bascule	−29.3
13	Panel Point	−30.3
14	Panel Point	−31.6
15	Panel Point	−31.6
16	Panel Point	−32.3
17	Stiffener Location	−32.8
18	Center of Span	−33.2
19	Stiffener Location	−34.2
20	Panel Point	−30.3
21	Panel Point	−27.6
22	Panel Point	−24.0
23	Panel Point	−19.8
24	S. Edge/Face of North Bascule	−17.8
25	SE Corner North Bascule	−17.4
26	NE Corner North Bascule	−19.0
27	N. Edge/Face of North Bascule	−19.6
28	Panel Point	−17.9
29	Panel Point	−15.5
30	Panel Point	−13.4
31	Center Line Pier 2 – North	−12.3
32	Panel Point	−11.1
33	Panel Point	−10.0
34	Panel Point	−8.2
35	Center Line Pier 1 – North	−3.0

TABLE 4

River Profile Data

READING No.	DESCRIPTION	Mudline Elevation (King Co. Datum)
SOUNDINGS; 50 ft Downstream		
1	Center Line Pier 2 – South	1.0
2	Panel Point	0.6
3	Panel Point	−3.5
4	Panel Point	−4.2
5	Center Line Pier 1–South	−5.1
6	Panel Point	−10.3
7	Panel Point	−13.2
8	Panel Point	−17.6
9	S. Edge/Face of South Bascule	−18.5
10	SE Corner South Bascule	−15.6
11	NE Corner South Bascule	−12.3
12	N. Edge/Face of South Bascule	−12.0
13	Panel Point	−12.2
14	Panel Point	−15.7
15	Panel Point	−21.6
16	Panel Point	−25.4
17	Stiffener Location	−28.1
18	Center of Span	−30.3
19	Stiffener Location	−31.5
20	Panel Point	−31.2
21	Panel Point	−31.8
22	Panel Point	−32.1
23	Panel Point	−33.4
24	S. Edge/Face of North Bascule	−32.3
25	SE Corner North Bascule	−31.0
26	NE Corner North Bascule	−27.8
27	N. Edge/Face of North Bascule	−23.0
28	Panel Point	−21.3
29	Panel Point	−18.1
30	Panel Point	−21.1
31	Center Line Pier 2 – North	−22.9
32	Panel Point	−17.6
33	Panel Point	−12.9
34	Panel Point	−12.5
35	Center Line Pier 1 – North	−10.4